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PI/PD Name: David J McLaughlin

Gender: ☒ Male ☐ Female

Ethnicity: (Choose one response) ☐ Hispanic or Latino ☒ Not Hispanic or Latino

Race: (Select one or more)
- ☐ American Indian or Alaska Native
- ☐ Asian
- ☐ Black or African American
- ☐ Native Hawaiian or Other Pacific Islander
- ☒ White

Disability Status: (Select one or more)
- ☐ Hearing Impairment
- ☐ Visual Impairment
- ☐ Mobility/Orthopedic Impairment
- ☐ Other
- ☐ None

Citizenship: (Choose one) ☒ U.S. Citizen ☐ Permanent Resident ☐ Other non-U.S. Citizen

Check here if you do not wish to provide any or all of the above information (excluding PI/PD name): ☒

REQUIRED: Check here if you are currently serving (or have previously served) as a PI, co-PI or PD on any federally funded project ☒

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PI/PD Name: V. Chandrasekar

Gender: ☒ Male ☐ Female

Ethnicity: (Choose one response) ☐ Hispanic or Latino ☒ Not Hispanic or Latino

Race: (Select one or more)
- ☐ American Indian or Alaska Native
- ☒ Asian
- ☐ Black or African American
- ☐ Native Hawaiian or Other Pacific Islander
- ☐ White

Disability Status: (Select one or more)
- ☐ Hearing Impairment
- ☐ Visual Impairment
- ☐ Mobility/Orthopedic Impairment
- ☐ Other
- ☒ None

Citizenship: (Choose one) ☒ U.S. Citizen ☐ Permanent Resident ☐ Other non-U.S. Citizen

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PI/PD Name: Sandra Cruz-Pol

Gender: ☐ Male ☒ Female

Ethnicity: (Choose one response) ☒ Hispanic or Latino ☐ Not Hispanic or Latino

Race: (Select one or more)
- ☐ American Indian or Alaska Native
- ☐ Asian
- ☐ Black or African American
- ☐ Native Hawaiian or Other Pacific Islander
- ☐ White

Disability Status: (Select one or more)
- ☐ Hearing Impairment
- ☐ Visual Impairment
- ☐ Mobility/Orthopedic Impairment
- ☐ Other
- ☐ None

Citizenship: (Choose one) ☒ U.S. Citizen ☐ Permanent Resident ☐ Other non-U.S. Citizen

Check here if you do not wish to provide any or all of the above information (excluding PI/PD name): ☒

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PI/PD Name: Kelvin K Droegemeier

Gender: ☒ Male ☐ Female

Ethnicity: (Choose one response) ☐ Hispanic or Latino ☒ Not Hispanic or Latino

Race: (Select one or more)
- ☐ American Indian or Alaska Native
- ☐ Asian
- ☐ Black or African American
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- ☒ White

Disability Status: (Select one or more)
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PI/PD Name: James F Kurose

Gender: ☒ Male ☐ Female

Ethnicity: (Choose one response) ☐ Hispanic or Latino ☒ Not Hispanic or Latino

Race: (Select one or more)
- ☐ American Indian or Alaska Native
- ☒ Asian
- ☐ Black or African American
- ☐ Native Hawaiian or Other Pacific Islander
- ☐ White

Disability Status: (Select one or more)
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- ☐ Mobility/Orthopedic Impairment
- ☐ Other
- ☐ None

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List of Suggested Reviewers or Reviewers Not To Include (optional)

SUGGESTED REVIEWERS:
Not Listed

REVIEWERS NOT TO INCLUDE:
Not Listed

COVER SHEET FOR PROPOSAL TO THE NATIONAL SCIENCE FOUNDATION

PROGRAM ANNOUNCEMENT/SOLICITATION NO./CLOSING DATE/if not in response to a program announcement/solicitation enter NSF 03-2

NSF 02-024 **12/03/02**

FOR CONSIDERATION BY NSF ORGANIZATION UNIT(S) (Indicate the most specific unit known, i.e. program, division, etc.)

EEC - ENGINEERING RESEARCH CENTERS

FOR NSF USE ONLY

NSF PROPOSAL NUMBER

0313747

DATE RECEIVED	NUMBER OF COPIES	DIVISION ASSIGNED	FUND CODE	DUNS# (Data Universal Numbering System)	FILE LOCATION
				153926712	

EMPLOYER IDENTIFICATION NUMBER (EIN) OR TAXPAYER IDENTIFICATION NUMBER (TIN)

043167352

SHOW PREVIOUS AWARD NO. IF THIS IS
☐ A RENEWAL
☐ AN ACCOMPLISHMENT-BASED RENEWAL

IS THIS PROPOSAL BEING SUBMITTED TO ANOTHER FEDERAL AGENCY? YES ☐ NO ☒ IF YES, LIST ACRONYM(S)

NAME OF ORGANIZATION TO WHICH AWARD SHOULD BE MADE

University of Massachusetts Amherst

AWARDEE ORGANIZATION CODE (IF KNOWN)

0022210000

ADDRESS OF AWARDEE ORGANIZATION, INCLUDING 9 DIGIT ZIP CODE

University of Massachusetts Amherst
408 Goodell Building
Amherst, MA. 010033285

NAME OF PERFORMING ORGANIZATION, IF DIFFERENT FROM ABOVE

PERFORMING ORGANIZATION CODE (IF KNOWN)

ADDRESS OF PERFORMING ORGANIZATION, IF DIFFERENT, INCLUDING 9 DIGIT ZIP CODE

IS AWARDEE ORGANIZATION (Check All That Apply) (See GPG II.C For Definitions)
☐ SMALL BUSINESS ☐ MINORITY BUSINESS
☐ FOR-PROFIT ORGANIZATION ☐ WOMAN-OWNED BUSINESS

☐ IF THIS IS A PRELIMINARY PROPOSAL THEN CHECK HERE

TITLE OF PROPOSED PROJECT **Center for Collaborative Adaptive Sensing of the Atmosphere \(CASA\)**

REQUESTED AMOUNT	PROPOSED DURATION (1-60 MONTHS)	REQUESTED STARTING DATE	SHOW RELATED PRELIMINARY PROPOSAL NO. IF APPLICABLE
$ **17,000,000**	**60** months	**09/01/03**	**6149109**

CHECK APPROPRIATE BOX(ES) IF THIS PROPOSAL INCLUDES ANY OF THE ITEMS LISTED BELOW

☐ BEGINNING INVESTIGATOR (GPG I.A)
☐ DISCLOSURE OF LOBBYING ACTIVITIES (GPG II.C)
☐ PROPRIETARY & PRIVILEGED INFORMATION (GPG I.B, II.C.6)
☐ HISTORIC PLACES (GPG II.C.9)
☐ SMALL GRANT FOR EXPLOR. RESEARCH (SGER) (GPG II.C.11)
☐ VERTEBRATE ANIMALS (GPG II.C.11) IACUC App. Date _____
☐ HUMAN SUBJECTS (GPG II.C.11)
Exemption Subsection _____ or IRB App. Date _____
☐ INTERNATIONAL COOPERATIVE ACTIVITIES: COUNTRY/COUNTRIES INVOLVED (GPG II.C.9)
_____
☐ HIGH RESOLUTION GRAPHICS/OTHER GRAPHICS WHERE EXACT COLOR REPRESENTATION IS REQUIRED FOR PROPER INTERPRETATION (GPG I.E.1)

PI/PD DEPARTMENT
Electrical & Computer Engineering Dept.

PI/PD POSTAL ADDRESS
Knowles Engineering Building

Amherst, MA 010033285
United States

PI/PD FAX NUMBER
413-545-4652

NAMES (TYPED)	High Degree	Yr of Degree	Telephone Number	Electronic Mail Address
PI/PD NAME **David J McLaughlin**	**PH.D**	**1989**	**413-545-2725**	**dmclaugh@mirsl.ecs.umass.edu**
CO-PI/PD **V. Chandrasekar**	**Ph.D.**	**1986**	**970-491-6600**	**chandra@engr.colostate.edu**
CO-PI/PD **Sandra Cruz-Pol**	**PhD**	**1998**	**787-832-4040**	**SandraCruzPol@ieee.org**
CO-PI/PD **Kelvin K Droegemeier**	**Ph.D.**	**1985**	**405-325-0453**	**kkd@ou.edu**
CO-PI/PD **James F Kurose**	**PhD**	**1984**	**413-545-1585**	**kurose@cs.umass.edu**

Electronic Signature

CERTIFICATION PAGE

Certification for Authorized Organizational Representative or Individual Applicant:

By signing and submitting this proposal, the individual applicant or the authorized official of the applicant institution is: (1) certifying that statements made herein are true and complete to the best of his/her knowledge; and (2) agreeing to accept the obligation to comply with NSF award terms and conditions if an award is made as a result of this application. Further, the applicant is hereby providing certifications regarding debarment and suspension, drug-free workplace, and lobbying activities (see below), as set forth in Grant Proposal Guide (GPG), NSF 03-2. Willful provision of false information in this application and its supporting documents or in reports required under an ensuing award is a criminal offense (U. S. Code, Title 18, Section 1001).

In addition, if the applicant institution employs more than fifty persons, the authorized official of the applicant institution is certifying that the institution has implemented a written and enforced conflict of interest policy that is consistent with the provisions of Grant Policy Manual Section 510; that to the best of his/her knowledge, all financial disclosures required by that conflict of interest policy have been made; and that all identified conflicts of interest will have been satisfactorily managed, reduced or eliminated prior to the institution's expenditure of any funds under the award, in accordance with the institution's conflict of interest policy. Conflicts which cannot be satisfactorily managed, reduced or eliminated must be disclosed to NSF.

Drug Free Work Place Certification

By electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative or Individual Applicant is providing the Drug Free Work Place Certification contained in Appendix A of the Grant Proposal Guide.

Debarment and Suspension Certification

(If answer "yes", please provide explanation.)

Is the organization or its principals presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from covered transactions by any Federal department or agency? Yes ☐ No ☒

By electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative or Individual Applicant is providing the Debarment and Suspension Certification contained in Appendix B of the Grant Proposal Guide.

Certification Regarding Lobbying

This certification is required for an award of a Federal contract, grant, or cooperative agreement exceeding $100,000 and for an award of a Federal loan or a commitment providing for the United States to insure or guarantee a loan exceeding $150,000.

Certification for Contracts, Grants, Loans and Cooperative Agreements

The undersigned certifies, to the best of his or her knowledge and belief, that:

(1) No federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.

(2) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form-LLL, ''Disclosure of Lobbying Activities,'' in accordance with its instructions.

(3) The undersigned shall require that the language of this certification be included in the award documents for all subawards at all tiers including subcontracts, subgrants, and contracts under grants, loans, and cooperative agreements and that all subrecipients shall certify and disclose accordingly.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by section 1352, Title 31, U.S. Code. Any person who fails to file the required certification shall be subject to a civil penalty of not less than $10,000 and not more than $100,000 for each such failure.

AUTHORIZED ORGANIZATIONAL REPRESENTATIVE	SIGNATURE	DATE
NAME **Carol Sprague**	**Electronic Signature**	**Dec 17 2002 5:01PM**

TELEPHONE NUMBER	ELECTRONIC MAIL ADDRESS	FAX NUMBER
413-545-0698	**sprague@resgs.umass.edu**	**413-545-1202**

*SUBMISSION OF SOCIAL SECURITY NUMBERS IS VOLUNTARY AND WILL NOT AFFECT THE ORGANIZATION'S ELIGIBILITY FOR AN AWARD. HOWEVER, THEY ARE AN INTEGRAL PART OF THE INFORMATION SYSTEM AND ASSIST IN PROCESSING THE PROPOSAL. SSN SOLICITED UNDER NSF ACT OF 1950, AS AMENDED.

PROJECT SUMMARY

Our ability to monitor, anticipate, and respond to changing circumstances and events is increasingly important, particularly with regard to our physical surroundings. Nowhere is this capability more vital to society, or the challenges associated with its practical implementation greater, than in the context of the atmosphere, where hazardous local weather, such as thunderstorms, tornadoes, microbursts, snow storms, and floods – as well as lofted radiological, chemical and biological agents – can, in a matter of minutes or hours, destroy or contaminate life and property over vast areas. Yet, the portion of the atmosphere that contains the bulk of both natural and man-made hazards – the lower troposphere and particularly the atmospheric boundary layer – is grossly undersampled by today's sensing technologies.

Our ERC proposes a revolutionary new paradigm in which transforming systems of distributed, collaborative, and adaptive sensing (DCAS) networks are deployed to overcome fundamental limitations of current approaches. Here, *distributed* refers to the use of large numbers of appropriately spaced sensors capable of high spatial and temporal resolution throughout the entire troposphere. These systems will operate *collaboratively* within a dynamic information technology infrastructure, *adapting* to changing conditions in a manner that meets competing end-user needs. These systems will achieve breakthrough improvements in sensitivity and resolution leading to significant reductions in tornado false-alarms, vastly improved precipitation estimates for flood prediction, fine-scale wind field imaging and thermodynamic state estimation for use in airborne hazard dispersion prediction and other applications.

Successful implementation of DCAS systems will require fundamental breakthroughs consistent with the *NSF Technical Merit Review Criteria*. Among these breakthroughs will be integration and sharing of knowledge across disciplines; design and fabrication of low-cost, multi-beam, solid-state radars; creation of a systems-based architecture to organize sensing, computing, and communications resources; development of two-way end-user interfaces that dynamically target system resources; deployment of integrative test beds to validate assumptions and understand emergent system behavior; implementation of cross-linked hierarchical data storage and processing; and improved understanding of small-scale atmospheric processes.

To achieve these breakthroughs, we have assembled leading engineering and computer science experts from the University of Massachusetts, Amherst. They will work in partnership with scientists and engineers from the University of Oklahoma, Colorado State University and the University of Puerto Rico, Mayaguez, and corporate partners including Raytheon, IBM, Vaisala, and federal and state government agencies to create the Center for Collaborative Adaptive Sensing of the Atmosphere (CASA). We will create scalable prototype test beds to demonstrate the potential for DCAS to revolutionize our understanding, detection, and prediction of hazardous atmospheric phenomena–with end users involved from the outset.

CASA meets the NSF Broader Impacts Review Criteria through: comprehensive education and outreach programs that introduce systems-based engineering to K-12 students via the mandated engineering/technology curriculum in Massachusetts, and serves as the mechanism for expanding participation by under-represented groups in engineering and scientific endeavors at all levels. Further, it will engage first-responders and other end users through the provision of both technology and training. CASA will address the observation, prediction and response of weather, an issue that affects between 10 percent and 30 percent of the U.S. gross national product.

Our management structure has the flexibility to take advantage of our broad partnership. For example, CASA will collaborate with industry partners, who, in turn, will create new product lines and services based on our new paradigm for sensing, analyzing, predicting and responding to atmospheric hazards in the troposphere.

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*Proposers may select any numbering mechanism for the proposal. The entire proposal however, must be paginated. Complete both columns only if the proposal is numbered consecutively.

The Center for Collaborative Adaptive Sensing of the Atmosphere (CASA)

Core Academic Partners	*Strategic & Outreach Affiliates (Carrying out Research and Education Functions)*
University of Massachusetts, Amherst (UMass) Lead	National Severe Storms Laboratory (Strategic Affiliate)
University of Oklahoma (OU)	Oak Ridge National Laboratory (Strategic Affiliate)
Colorado State University (CSU)	Tufts University (Outreach Affiliate)
University of Puerto Rico, Mayaguez (UPRM)	RIce University (Outreach Affiliate)
	Mount Holyoke College (Outreach Affiliate)
	University of Colorado (Outreach Affiliate)
	University of Delaware (Outreach Affiliate)
Central Management	
David McLaughlin, Director (UMass, Armstrong Professor, ECE), (Principal Investigator)	Kelvin Droegemeier, Deputy Director (OU, Regents Professor, Meteorology), (Co-Principal Investigator)
V. Chandrasekar, Associate Director (CSU, Professor, ECE), (Co-Principal Investigator)	Jim Kurose, Associate Director (UMass, Professor, CS), (Co-Principal Investigator)
Sandra Cruz-Pol, Associate Director (UPRM, Associate Professor, ECE), (Co-Principal Investigator)	Fred Carr, Associate Director, (OU, Professor, Meteorology)
Brenda Philips, Executive Director (UMass, College of Engineering)	

Research Thrust 1: Sensing	*Stephen Frasier, UMass and V. Chandrasekar, CSU, Thrust Co- Leaders*	
Stephen Frasier, Co-Leader (UMass, Assoc. Professor, ECE)	Ramakrishna Janaswamy (UMass, Professor, ECE)	Steve Reising (UMass, Asst. Professor, ECE)
V. Chandrasekar, Co-Leader (CSU, Professor, ECE)	David McLaughlin (UMass, Armstrong Professor, ECE)	Rafael Rodriguez Solis (UPRM, Associate Professor, ECE)
Jose Colom (UPRM, Assoc. Professor, ECE)	Lionel Orama (UPRM, Assoc. Professor, ECE)	Steve Sekelsky (UMass, Research Assoc. Professor, ECE)
Sandra Cruz-Pol (UPRM, Assoc. Professor, ECE)	Andrew Pazmany (UMass, Research Assoc. Professor, ECE)	Russ Tessier (UMass, Asst. Professor, ECE)
Robert Jackson (UMass, Professor, ECE)	David Pozar (UMass, Professor, ECE)	
Research Thrust 2: Distributing UMass, Thrust Co- Leaders	*Jim Kurose, UMass and Israel Koren,*	
Israel Koren, Co-Leader (UMass, Professor, ECE)	Dennis Goekel (UMass, Assoc. Professor, ECE)	Victor Lesser (UMass, Professor, CS)
Jim Kurose, Co-Leader (UMass, Professor, CS)	Weibo Gong (UMass, Professor, ECE)	Prashant Shenoy (UMass, Assistant Professor, CS)
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Research Thrust 3: Analysis and Prediction *Kelvin Droegemeier, OU and Steven Rutledge, CSU, Thrust Co-Leaders*		
Kelvin Droegemeier, Co-Leader (OU, Regents Professor, Meteorology)	Mike Biggerstaff (OU, Associate Professor, Meteorology)	Frank Colby (UMass – Lowell, Professor, Meteorology)
Steven Rutledge, Co-Leader (CSU, Professor, Meteorology)	Howie Bluestein (OU, Professor, Meteorology)	Paula Rees (UMass, Assistant Professor, Civil and Environmental Engineering)
Phil Bedient (Rice University, Professor, Environmental Engineering)	Fred Carr (OU, Professor, Meteorology)	Baxter Vieux (OU, Professor, Civil Engineering and Environmental Science)

End User Integration Team *Havidan Rodriguez, UPRM and Kevin Kloesel, OU, Co-Leaders*	*Technical Integration Team* *Jim Kurose, UMass, Leader*
Havidan Rodriguez, Co-Leader (UPRM, Professor, Center for Applied Research)	**Jim Kurose, Leader (UMass, Professor, CS)**
Kevin Kloesel, Co-Leader (OU, Research Associate, Oklahoma Climatological Survey)	V. Chandrasekar (CSU, Professor, ECE)
B. Aguirre (UDelaware, Professor, Sociology, Outreach Affiliate)	Frank Gallagher (OU, Research Professor, Meteorology)
Walter Diaz (UPRM, Associate Professor, Center for Applied Social Research)	Steve Sekelsky (UMass, Research Associate Professor, ECE)
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Mike Biggerstaff (OU, Associate Professor, Meteorology)	Donal O'Shea (Mt. Holyoke College, Dean of Faculty)
V.N. Bringi (CSU, Professor, ECE)	Kathleen Rubin (UMass, Assistant Dean, K-12 Outreach Center)

Other Functions Including Members of Advisory Boards (If known)	
John Armstrong (IBM, Ret.), Chair of Industrial Advisory Board	Dennis Mileti (University of Colorado), Science Advisory Board
Paul Smith (SD School of Mines), Chair of Science and Engineering Advisory Board	Pietro Vantresca (Raytheon), Industrial Advisory Board
Walter Dabberdt (Vaisala), Industrial Advisory Board	

* other definitions

Department Abbreviation - Department Name –

List of Industrial/Practitioner Members/Supporters

	Organization	Name/Title	C/I*	Type**
INDUSTRY	**Manufacturers**			
	M/A COM	James Fallon, Director of Programs and Strategic Accounts	C	LB
	Raytheon	Greg Shelton, Vice President, Engineering and Technology	C	LB
	Vaisala	Walter Dabberdt, Director, Strategic Research	C	LB
	Telephonics	Lawrence J. Rytter, President, Command Systems Division	C	LB
	ProSensing	Jim Mead, President	C	SB
	Information Technology			
	IBM	Don Bonelli, Vice President, IBM Software Group	C	LB
	One Net	Bill Johnson, Director, Network Operations	C	G
	Private Weather Companies /End Users			
	The Weather Channel	Ray Ban, Executive Vice President	C	LB
	Baron Services	Greg Wilson, Director, Strategic Planning	C	SB
	Weather Services International	Michael Kliest, Vice President Engineering	C	SB
	Texas Medical Center	Richard Wainerdi, President and CEO		LB
	Vieux Associates	Jean Vieux, President	C	SB
	Infrastucture			
	Flash Technology	Ron Brown, Director	C	SB
GOVERNMENT AGENCIES	National Weather Service	John Hayes, Director, Office of Science and Technology	C	G
	National Severe Storms Lab	James Kimpel, Director	C	G
	NCAR	Dave Carlson, Director, ATD Division	C	G
	Oak Ridge National Laboratory	Brian Worley, Director CS&E Division	C	G
		* LB = Large Business, SB = Small Business, G = Government		

II. VISION AND RATIONALE

II.A. Societal Vulnerability to Atmospheric Hazards. Current approaches for observing the atmosphere are based upon a long-established paradigm of widely separated, geographically fixed sensors that, for the most part, operate independent of a) the phenomena being observed; b) the disparate needs of end users; and c) counterpart sensors that sample the same or nearby regions. This is particularly true of the WSR-88D Next Generation Doppler Radar (NEXRAD) system, 141 radars, serving as the cornerstone of the nation's storm-sensing system. Despite the tremendous capabilities of NEXRAD, it remains *fundamentally constrained* in sensitivity and resolution (Figure 1). It is unable to view much of the lower atmosphere because of Earth's curvature and is unable to measure thermodynamic quantities. Moreover, because NEXRAD radars have single beams and non-overlapping coverage volumes, they are not a coordinated network and cannot be configured in response to multiple end-user needs.

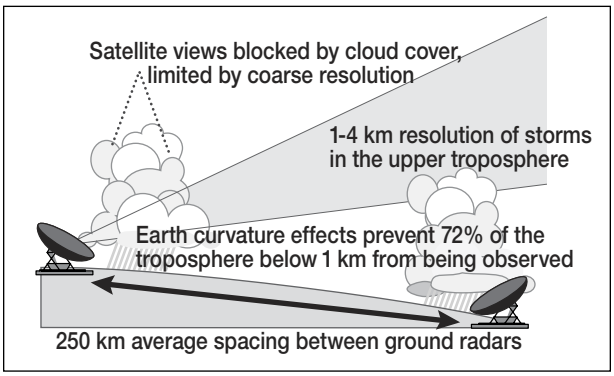

Figure 1. Limitations of current observing approaches

Other sensing technologies complement NEXRAD but suffer similar limitations. Spatial resolution from microwave satellite sensors degrades significantly near the ground, while optical and infrared satellite sensing are obscured by cloud cover. *In-situ* measuring probes carried on balloons and commercial aircraft provide information on thermodynamic state, but these probes sample only at single points in space and thus leave vast volumes unsampled. Global Positioning System (GPS)-based water vapor retrievals, hold great promise for the future, but they also suffer from diminished vertical resolution near the ground. Dense surface meso-networks are of tremendous value, though they only sample the atmosphere at or below 10 meters above ground level.

Sensing of the lower atmosphere and the detection, analysis and prediction of hazards is only part of the challenge of observing, understanding, and responding to atmospheric hazards. The "last mile problem" of effectively delivering data, products and training to multiple end users – especially emergency managers and first-responders – is vitally important, yet often overlooked or unachievable based on the limitations of current approaches. Future technologies must be designed with the "last mile" as the "first mile," with end users involved in system design from the very beginning.

II.B. The ERC Vision: A Transforming Paradigm. Our ERC proposes a revolutionary new paradigm founded upon transforming systems of distributed, collaborative, and adaptive sensing networks designed to overcome the fundamental limitations of current approaches. Here, *distributed* refers to the use of large numbers of volumetric-sampling sensors, spaced appropriately, to overcome blockage due to the Earth's curvature, resolution degradation caused by beam spreading, and large temporal sampling intervals resulting from the use of mechanically steered devices. In addition to providing high-resolution sampling throughout the entire troposphere, this distributed concept lends itself to the efficient utiliza-

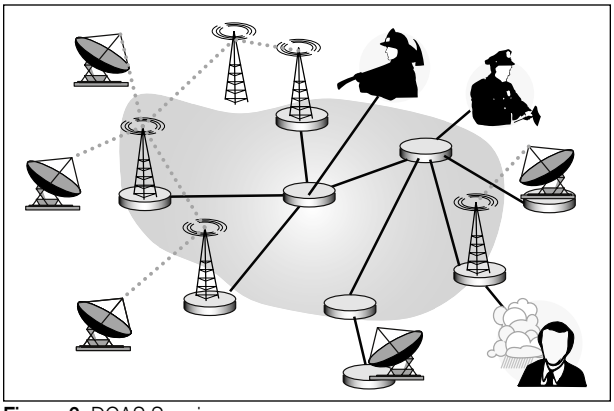
Figure 2. DCAS Sensing

tion of low-power solid-state radars. Those radars, after being developed, are highly reliable, inexpensive, adaptive, and can operate *collaboratively*, via coordinated targeting of multiple radars and their beams, based upon a rapid identification and classification of targets using atmospheric analysis tools. In this manner, the system is able to determine needs and allocate resources such as radiated power, polarization diversity, frequency, bandwidth, and computing cycles – toward regions of the atmosphere where particular threats exist. *Adaptive* refers to the ability of these sensing networks, including the computing and communications infrastructure, to rapidly reconfigure in response to changing conditions in a manner that optimizes response to competing demands. For example such a system could track tornados for public warning while also collecting information on the parent storm for scientific analysis and providing quantitative precipitation estimates for input to hydrologic prediction models. We refer to this overall concept as *distributed collaborative adaptive sensing* (DCAS). Deployment of DCAS systems will achieve breakthrough improvements in sensitivity and resolution for sensing storms, clear-air winds and turbulence, thermodynamic state, and other crucial variables throughout the entire troposphere, especially the atmospheric boundary layer, which today remains largely unobserved.

II.C. A Deployment Scenario. An example of the DCAS concept and its potential to reach multiple user communities is a hypothetical array of 100 small Doppler radars deployed on cellular phone towers in southeastern Texas. The radars – spaced on towers an average of 35 kilometers apart– would resemble cellular base stations, but radiate far less power and occupy what had been unused space mid-way down the towers. At 10 watts average power, the radars would be fabricated using very low-cost microwave and digital chips, and would cost approximately $20,000 each to purchase and install. The radar array would be jointly owned and operated, at a cost of $3 million per year, by the State of Texas, three municipalities, two local airports, The Texas Medical Center, and one major theme park–all end users, each with somewhat different needs:

It is midday in early July under clear skies and the DCAS network is configured for routine coordinated surveillance of the 3-D wind field from the ground to 3 km altitude. These "clear air" winds provide the basis for determining the location, concentration, and physical state of pollutants and other potential airborne hazards, and are used to monitor the transitory movement of birds for military and civilian aircraft safety, and to monitor the flight of insects in support of regional biodiversity research. Graphical products generated in real time and conveyed via the Internet to public safety officials identify regions of potential fire danger. Raw sensor data also flows into continuously-running homeland security dispersion models at Oak Ridge National Laboratory in Tennessee.

In response to daytime solar heating of the ground, wind convergence zones form within the boundary-layer over wheat fields in Montgomery County, 100 km north of the city of Houston. Pattern detection algorithms identify the convergence zones in the 3-D wind fields and alert forecasters to possible thunderstorm development. Simultaneously, these data are archived on the Web for use in studying the theory of thunderstorm initiation. The radars are automatically tasked by a control program to sample the moisture fields in a 30 x 30 km region surrounding the convergence zone, and the resulting observations are fed into an atmospheric data assimilation system to produce a fine-scale 3 D state analysis that initializes a high-resolution numerical prediction model. The model generates a multitude of predictions, including conditional probabilities in 1,000 different categories that are provided to private companies for use in proprietary risk-assessment models, and to local emergency managers for proactive allocation of potential flood prevention resources. The Transtar Transportation Group and The Texas Medical Center, two Houston entities whose daily operations depend upon accurate rainfall and flood forecasts, pay close attention to the predictions. Based on the data, the Medical Center dispatches a maintenance team to check on the supply of sand bags and test the flood-doors.

As clouds and precipitation begin to develop within the convergence zone, the radars automatically adjust their mode of operation under localized collaborative control to provide extremely fine-scale, calibrated precipitation rate estimates over Montgomery County. Meanwhile, in Houston to the south, skies remain clear and the DCAS network is mapping the 3-D moisture and temperature field to quantify the atmosphere's precipitable water and stability, assessing its potential to fuel thunderstorms that might be spawned near Houston. The detection by one of the radar beams of a small circulation to the north, in Montgomery County, causes the beams of nearby radars to enter tornado-tracking mode, where they hand-off tracking responsibility to neighboring radars as the tornado progresses eastward. Public confidence in the associated warnings is high and false alarms are low because the radars are able to sample the entire structure of the tornado. The location, intensity, movement, and projected path of any tornado activity are automatically reported to the National Weather Service, local media outlets, private companies (e.g., The Weather Channel), and emergency managers. When the tornado destroys two radars within the network and disrupts local communication links, other nearby radars assume tracking responsibility and the network reroutes network traffic to ensure that the most important data reach their destinations.

As the storms move south toward Houston, they intensify, in agreement with prediction models and short-term statistical algorithms. When rain begins falling in Houston, radars in the metropolitan area automatically reconfigure under localized collaborative control to map precipitation at 200 meter resolution with a precision of several millimeters per hour. These measurements feed distributed hydrologic models that track surface and sub-surface water as well as the depths and flow-rates of streams that may flood major transportation arteries, homes, businesses, industries, and hospitals. When the predicted rainfall rate exceeds that which can be handled by the water management system, the Harris County 911 Center, Emergency Response Center, and Medical Center spring into action – a full 30 minutes prior to the arrival of flood waters. As a result, flood gates are deployed, traffic is rerouted around rising water levels, and urgent medical care continues uninterrupted.

In the above scenario, all components of the sensing and prediction system work collaboratively and adapt not only to the changing weather, but also to the many competing needs of multiple end users, which themselves can change abruptly in space and time. The overall control of the DCAS system is able to simultaneously meet the needs of multiple end users, based upon established prioritized policies and the dynamically changing characteristics and capabilities of the observing system. This scenario is in stark contrast to today's technologies, which can neither observe the atmospheric boundary-layer nor adapt to multiple user needs. The DCAS paradigm extends the reach, efficiency and cost-effectiveness of an observing system, and creates the opportunity for the operation of sophisticated, customized sensing and predicting tools by federal, state and local entities; privately operated venues, such as golf courses, stadiums and theme parks; and weather-sensitive industries, such as energy generation and transport, aviation, agriculture, manufacturing, off-shore exploration and fishing.

II.D. The Partnership of this ERC. An academic, industrial and government partnership, the Center for Collaborative Adaptive Sensing of the Atmosphere (CASA) will develop the fundamental knowledge and technologies needed to research and engineer DCAS systems. We will develop scalable prototype systems to demonstrate the potential to improve the nation's severe – weather and hydrologic warning, prediction and emergency response infrastructure. Our multidisciplinary efforts to research, develop, field-test, and operate prototype test bed systems, working in partnership with the manufacturers of the sensors and the end users of the data, will provide a fertile environment for educating the next generation of engineers and K-12 students and preparing them to think broadly about complex engineered systems.

The lead academic institution in this ERC, the University of Massachusetts, is a national leader in microwave remote sensing, low-cost microwave technology, networking, distributed computing and edu-

cational outreach. The core academic partners include the University of Oklahoma, a recognized center of excellence in meteorology and decision support for emergency management; Colorado State University, a leader in radar facilities and cloud studies, and the University of Puerto Rico, specializing in antenna design, remote sensing, sociology of weather and educational outreach. Our academic outreach partners have expertise in education, technology policy, and hazards response. We are joined by private sector and government partners who create and use today's weather observing/response technologies and radar systems and who are likely to help create the next-generation systems. These partners include Raytheon Co., The Weather Channel, Vaisala, the National Severe Storms Laboratory and the National Weather Service (both part of the National Oceanic and Atmospheric Administration), Oak Ridge National Laboratories, M/A-Com, IBM, the National Center for Atmospheric Research, and other companies, agencies, and labs that are recognized as world leaders in sensing, information technologies, and weather data applications.

II.E. Broader Impacts of CASA

II.E.1. The Transforming Impact on Society and the Economy. Through a challenging and innovative program of interdisciplinary research, systems implementation and education, CASA's programs and activities fulfill the National Science Board's broader impacts and technical merit criteria. CASA will advance fundamental knowledge – of the troposphere, of application driven, cross-layer, resource allocation, and of electromagnetic wave-atmosphere interaction, and apply this knowledge to create DCAS systems. These new engineered systems will benefit society by saving lives and property through improved understanding, detection and warning of atmospheric events, as illustrated in the deployment scenario in section II C.

CASA's disruptive technology – collaborative, adaptive networks of low-cost, high-resolution sensors – has the potential to spawn new markets and products, both in the United States and abroad. Currently the cost of deploying a weather radar is prohibitive for all but the wealthiest governments. A high-power radar that gathers data for broadcast media costs $750,000, and the more accurate and longer-range NEXRAD radars cost $5.5 M each. In contrast, the cost of radars in a DCAS system is projected to be less than $20,000 per node. This low cost creates the possibility of deploying small networks of these sensors for airports, municipalities, and even for countries abroad where observation systems are non-existent and the acquisition capital is beyond reach. The enabling infrastructure to support the networks, cell phone towers and their associated "backhaul" data network, is today being deployed in many of these countries, making this a very real possibility.

II.E.2. Impacts on Education, Infrastructure, and Diversity. CASA will advance discovery and understanding by promoting teacher training and learning. CASA's on-going research and multidisciplinary approach to systems design and implementation will inspire new courses and curricula for teacher training institutes for K-12 teachers, undergraduate courses, graduate research and outreach to the public. In addition, CASA will sponsor a national conference on incorporating engineering frameworks into K – 12 curricula for state education departments nationwide.

Weather and the Internet are intrinsic elements of the problems proposed here that are accessible and appealing to many students. The social impacts and complexity of DCAS will also appeal to women[1] and traditionally underrepresented groups in engineering and science. In its undergraduate summer research programs, teacher training institutes, and other programs, CASA will look to recruit women and underrepresented groups to participate in its programs. In addition, CASA will help to build a new PhD program at partner school University of Puerto Rico Mayaguez, by operating a graduate student exchange program among all of CASA's academic partners. At Mount Holyoke, a women's college, the center will capitalize on a new dual-degree program with UMass to bring female liberal arts students into the engineering pipeline.

The Center will enhance infrastructure for research by developing a number of test beds that can collect and store atmospheric observations for analysis, algorithm development, education, and other uses. The educational infrastructure will be supported by the Center through the development of K-12 curricula with the integration of new courses into the Massachusetts state curriculum frameworks, the creation of a summer "content institute" and new on-line learning and multi-media tools centered around weather topics. In order to broaden dissemination and enhance scientific and technological understanding, CASA will hold a weeklong institute each summer for policy makers, journalists, business leaders, and other decision makers to address critical topics relating to cost/benefits of observing and warning systems.

II.F. Overview of This Proposal. The following section of this proposal describes the DCAS engineered systems view. Section IV reviews the state of the art in atmospheric sensing, distributed computing and predicting. Our Strategic Plan and Milestone Timeline are presented in Section V. The research program follows in Section VI. Section VII describes our vision and plans for education and outreach. Industrial engagement and partners are described in Section VIII. Finally, our management plan is presented in Section IX.

III. THE ENGINEERED SYSTEM

Our engineered systems goal is to develop distributed collaborative adaptive sensing (DCAS) systems that manage and rationally allocate a large, but finite, quantity of physical and computational resources in order to sample the atmosphere when and where the observing needs are greatest. Our concept for resource management in response to a changing environment and changing user needs is shown in Figure 3. The radars represent the sensing devices and their associated processors, communication links, and other physical attributes. The distributed, adaptive computation component represents network protocols, distributed computing algorithms and storage, quality control. This component also represents data access technologies that connect the data-generating physical sensors with data-consuming and sensor-directing atmospheric analysis, prediction, and decision-making tools. Information flow between components in DCAS systems is reciprocal. Raw sensor data are quality-checked, compressed, and processed as they flow from sensors to distributed analysis and prediction algorithms. These algorithms ingest observations to identify and classify hazardous phenomena – such as rainfall rates, tornadoes and clear-air microbursts – and predict the evolution of the atmosphere using both statistical and dynamical models. Distributed control routines provide real-time steering of the sensing process by adjusting sensing mode and resolution and configuring the compression, synthesis and processing of data, while optimally matching end user needs to the available resources. The end users represent the broad community of users who make decisions and take action based on observations and predictions. This community includes, for example, county and municipal emergency managers, first responders, the public, scientists and students, and decision-makers in hospitals. A primary function of a DCAS system is to translate end user needs into prioritized tasks so that the system can create, modify, and then adjust optimized resource configurations to satisfying multiple end-user needs.

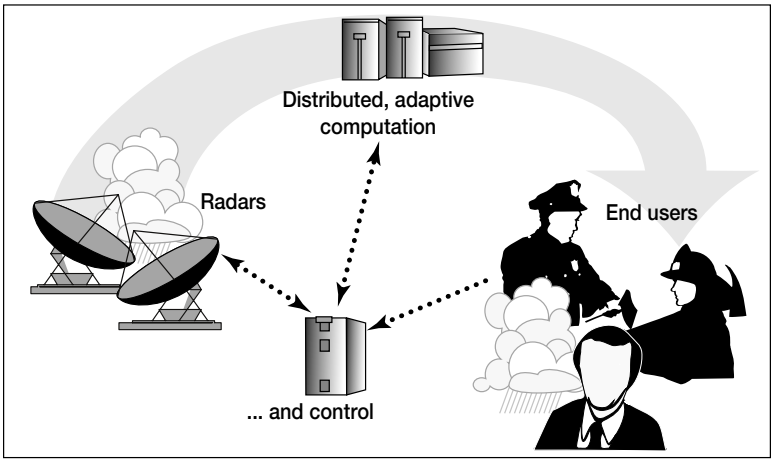

Figure 3. DCAS Engineered Systems View

IV. STATE OF THE ART

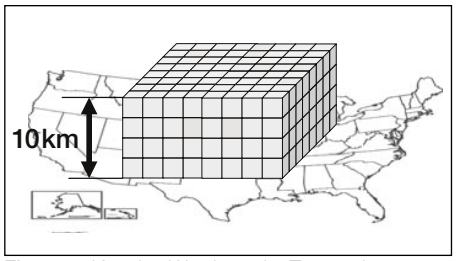

Figure 4. Keeping Watch on the Troposphere

IV.A. The DCAS Paradigm Shift. When quantized to a spatial resolution of 100 m – the resolution needed to detect tornadoes, map rainfall on the scale of individual drainage basins, and initialize next-generation forecast models – the troposphere above the United States contains more than 240 billion pixels. This enormous number, combined with the need for continuous monitoring, easily overwhelms our ability to keep track using current paradigms. Installing dense networks of short-range radars on cellular telephone towers and rooftops offers the potential to solve the problems of the Earth's curvature, sensitivity, and coarse resolution that fundamentally limit current observing approaches. By sensing at close ranges, such as 10s of kilometers to match the height of the troposphere, rather than at 100s of kilometers, terrain blockage due to Earth's curvature is eliminated. In addition to sensing the lower troposphere, short-range operation achieves substantially higher spatial resolution than is possible today via the reduction of beam-spreading.

To demonstrate the potential of the DCAS concept, Figure 5 compares a NEXRAD image of a tornado-producing thunderstorm (top panel) with an image collected by a tornado-chase team from the Universities of Massachusetts and Oklahoma while operating a millimeter wavelength radar aimed at the same storm[2]. The NEXRAD image reveals the classic "hook echo" pattern associated with a mesocyclone (a region of persistent vertical rotation produced by a violent thunderstorm that can be a precursor to a tornado). The lower image, with a spatial resolution of 7.5 m, captures considerable detail within the tornado itself, in sharp contrast to higher-altitude proxy of the tornado detected by NEXRAD. This example illustrates how dense radar networks can directly view tornadoes with high spatial resolution near the ground, rather than relying on higher-level tornado precursors. DCAS systems have tremendous potential to significantly reduce tornado false-alarm rates, which today exceed 80% with NEXRAD[3]. In addition, DCAS approaches achieve high resolution quantitative precipitation measurements, and have the potential to sense the optically-clear atmosphere as described in section VI.A.3. Finally, DCAS meshes extremely well with collaborations under way to predict the wind-induced transport of chemical, biological, and radiological hazards (Section VIII).

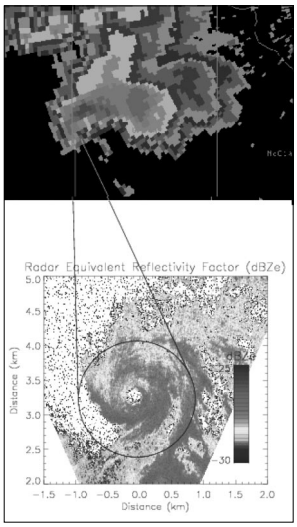

Figure 5. NEXRAD (top) and DCAS (bottom) tornado views

IV.B. Hazard Detection and Prediction. The current operational weather radar [4] – the NEXRAD system [5 6]– provides 1 to 4 km spatial resolution and five minute temporal updates. NEXRAD-based real-time decision support systems[7 8 9 10 11 12] have increased the lead time for tornado warnings and provided numerous other benefits[13]. Tools also have been developed for short-term forecasting (nowcasting)[14]. NEXRAD is extremely valuable because of its ability to observe at long ranges. However, NEXRAD suffers several weaknesses such as the high false-alarm rates for tornado detection noted above. Because of the Earth's curvature, NEXRAD samples only 28% of the troposphere below 1 km altitude, and its azimuthal resolution is coarser than 1 km for 80% of its sampling volume over the United States. This resolution is too coarse to capture the spatial density of precipitation, thus limiting the accuracy of hydrologic analysis and urban flood prediction models[15 16 17 18 19 20 21 22 23].

NEXRAD operates in only two modes – storm and clear air – and its update times are inadequate for initializing numerical models and tracking rapid changes in weather[24]. It is not operated as a true coordinated network,

but rather as many autonomous systems. Finally, NEXRAD does not observe either the temperature or water vapor fields – both of which are crucial for four-dimensional assimilation and numerical weather prediction (4DA/NWP). Neither of these fields is provided at km-scale resolution by any existing observing system today.

Today's highest resolution operational models (10-20 km grid spacing) solve the hydrostatic equations of motion, which assume that vertical accelerations are small. They are inadequate for explicitly capturing phenomena, such as individual thunderstorms, which are highly non-hydrostatic, and require high spatial resolution (< 1 km). Research conducted during the past several years [25 26 27 28 29 30 31 32 33] clearly demonstrates that model grid spacing of 1 km or less are required to adequately capture the evolution of convective storms and other local phenomena and that *the next major advancement in 4DA/NWP is expected to come with the application of non-hydrostatic, storm-resolving models that are initialized with observations at a resolution 2 to 4 times finer than the grid spacing[34]. This requires observations at 200 m to 400 m resolution.*

IV.C. Enabling Technologies for DCAS. The large operating range of NEXRAD radars and their predecessors requires the use of physically large and expensive antennas and high power transmitters. Straightforward geometric and radar sensitivity calculations show that the volumetric coverage problems of these systems can be overcome by deploying distributed networks of small, low-power (<10 W) radars at 10 to 30 km spacing[35]. Short range operation limits the impact of attenuation and enables the radars to operate at higher frequencies than NEXRAD where scattering from hydrometeors, such as raindrops and hail, are substantially enhanced due to Rayleigh sensitivity (in which scattered level increases with the fourth power of frequency). Short wavelengths also enable small antennas to be used, thereby satisfying a practical requirement for deploying large numbers of sensors in a DCAS network. These arguments and a set of supporting calculations were presented by the PIs of this proposal to a recent NRC panel (Weather Radar Technology Beyond NEXRAD), the published report of which concluded,[36] *"The potential for a network of short-range radar systems to provide enhanced near-surface coverage and supplement (or perhaps replace) a NEXRAD-like network of primary installations should be evaluated thoroughly."* The low power levels of these sensors (< 10 watts average) points to the future development of very low-cost solid-state multibeam radars fabricated from high-volume inexpensive microwave and digital integrated circuits and manufacturing techniques. The Microwave Remote Sensing Laboratory at UMass has developed a single-beam (non-networked) prototype of such a radar, built using $45k worth of hardware, that today flies on NOAA Hurricane Research Aircraft[37 38].

A recent National Research Council study concluded, "The potential for a network of short-range radar systems to provide enhanced near-surface coverage and supplement (or perhaps replace) a NEXRAD-like network of primary installations should be evaluated thoroughly."

IV.D. Clear-Air and Thermodynamic Sensing Technologies. Clear-air wind, temperature, and humidity fields are difficult to sense because these fields produce sensor signatures that are much weaker than those of precipitation. During warm seasons, insects serve as tracers of boundary layer airflow[39]. Lacking these tracers, the spatial and temporal resolution of clear-air wind retrievals are coarse – in most cases limited to vertical profiles only a few km in depth. Clear-air echo from refractive index fluctuations is the basis for wind profiling radars that are vertically pointing systems constrained by their scattering mechanism to operate at low microwave frequencies where they compete with other systems for use of the radio spectrum. Collaborative operation of the distributed radars encompassed in DCAS would benefit from substantial increases in scattering cross section by viewing clear-air in bistatic geometries[40 41]. Techniques for calibrating bistatic radar systems[42]

and processing bistatic signals for dual-Doppler storm observing[43] and polarimetric scene characterization[44] have established the viability of fully polarimetric, coherent bistatic sensing in recent years.

IV.E. Distributed Computing and Networking. In order to realize the dynamic wide-area sensing, computation and communication system envisioned in this proposal, significant advances will be required in distributed computation (particularly, application- resource allocation), collaborative signal-processing algorithms, and networking – all of which will be driven by dynamic application-specific requirements and policy decisions. The resulting systems will represent a paradigm shift – away from static, centralized computations in which data flows from sensors to a single centralized computation site – to a distributed, collaborative, adaptive sensing and computing environment. In this latter approach, the data to be sensed are determined dynamically and adaptively; are routed adaptively in the face of network outages/overloads, changing points of computation, and changing application-dictated priorities; and are filtered, estimated, and "fused" before reaching points of computation. Moreover, new elements, such as new deployed sensors, must be rapidly assimilated into the network. Most importantly, the volumetrically-targetable, group-oriented sensing, communication and computation infrastructure must serve as a responsive underlying substrate for the application. These needs speak to a new application-responsive architecture in which computation occurs not only at the network edge, but also at "active" points throughout the network.

While proposed quality of service network architectures[45] provide for a limited form of traffic priority and time-sensitivity, they do so at insufficiently coarse time scales. Similarly, while today's routing protocols can respond to link failures, they are constrained to reconfigure based on pre-assigned link weights. While many sensor net projects are beginning to unfold[46 47 48], many have fundamental power constraints or lack application-level "steerage." Recent signal processing approaches to multi-sensor estimation of atmospheric variables have been based on relatively simple models[49] and have not exploited powerful new tools such as factor graphs[50 51]. While the resource allocation and optimization techniques we will consider – such as the Markov decision processes, distributed Lagrangian relaxation, and negotiation – have been applied with some success in other environments, research will be required to determine the extent, and form, in which they can be applied in our application-driven adaptive system.

IV.F. Deployment Considerations and Cost Feasibility. Operational deployment of DCAS systems could involve networks in urban zones, specific watershed or catchment basins, regions specifically vulnerable by their geography to recurring hazards (such as hurricane or flood-prone coastlines and states frequented by the dry-line and tornado-producing thunderstorms), and mountainous regions where terrain blockage of today's observing systems is most severe. The number of sensors deployed could range from tens (e.g., an urban flooding district, such as Houston, Texas) to hundreds (e.g., across a single state in "tornado alley"). As a specific example, 150 sensors would be needed to cover Oklahoma at an average spacing of 35 km. Assuming that the radars cost $10K to manufacture* and therefore $20k each to buy and install atop existing infrastructure elements (cellular towers and rooftops), the deployment cost would be approximately $3 M, not including recurring costs. This is comparable to the cost and deployment density of the Oklahoma Mesonet[52]. A useful data point in this regard is the $2M annual cost for data telemetry, maintenance, and end-user training associated with the Oklahoma Mesonet. The Oklahoma state Legislature recognizes the economic value of the Mesonet and annually supports this cost, including round-the-clock operations, through the Oklahoma Climatological Survey (OCS), a participant in this proposal. While

* Low-power multi-beam phased arrays can be realized by distributing power across the face of a microstrip antenna combined with digital beam-forming. Current GaAs monolithic microwave integrated circuits are able to generate 1 W of microwave power at X-band using microwave chips that cost less than $100 each. When combined with low-cost packaging technologies, these point to solid-state radars costing less than $10k in component parts today.

it is recognized that the data transport and maintenance costs of a network of remote sensors may differ from those of an in-situ network, this analysis does suggest cost feasibility for DCAS systems. Moreover, when the added benefits of DCAS are considered, particularly its potential for flood predicting and deployment in concert with homeland security systems, the potential cost/benefit effectiveness of DCAS systems appears exceptionally high.

IV.G. Capsule Summary of Key Advances in Sensing, Distributing, and Analysis/Prediction Relevant to CASA

Technology	Contributor/History
Doppler weather radar	With a variety of collaborators (OU, CSU, others), NSSL developed and proved the practical value of Doppler weather radar in the 1960s and 1970s, culminating in 1976-1978 with the Joint Doppler Operational Project that led to the WSR-88D (NEXRAD).
Mobile Doppler radar	With Los Alamos National Lab and UMass, OU pioneered use of mobile Doppler radars, first via millimeter radars and then larger, longer-wavelength systems to study tornadoes at close range.
Clear-air wind measurements	Building on theoretical basis by V.I. Tatarskii[53], work in clear- air scattering was pioneered in late 60's and 70's by researchers at NOAA-Wave Propagation Labs and elsewhere. Monostatic radar wind-profilers developed to a commodity product (Vaisala).
Bistatic measurements and techniques	Wurman at OU pioneered use of bistatic radars for severe storm observation.[43] McLaughlin, while at Northeastern, developed calibration and instrumentation technologies for polarmetric scattering from terrain using bistatic radar.[42 44]
Electronically scanned array radars for environmental sensing	Developed by MIRSL at UMass for air-sea interaction and atmospheric boundary layer studies during the 90's[37 38 54 55].
Low-cost solid-state devices for microwaves	Use of high-speed Si devices is driven by computer industry. Since 1995, the quality of Si CMOS has been adequate for microwave applications (Stanford U. was one of the first proponents). Si-Ge transistors introduced by IBM are the device of choice for low-cost mm-wave ICs
Low-cost microwave packaging	Use of plastics for low-cost packaging is driven by the military through DARPA's HDI and MAFET programs. Most notable was GE's development of laminated HDI packaging. Other schemes include Ball Grid Arrays championed by M/A-COM and demonstrated for effective commercial-military integration[56].
Radar-based weather hazard detection & short-term forecasts	NSSL, Lincoln Laboratory, and NCAR have been the principal developers of algorithms designed to detect weather hazards from single Doppler weather radar data.
Small-scale numerical weather prediction	The Center for Analysis and Prediction of Storms pioneered the numerical prediction of storm-scale weather, with Doppler weather radar data as a primary input.
Network and distributed systems architecture	Internet architectural principles developed by Cerf and Kahn in mid-1970s, and refined (including application programming interface) by ARPA researchers over the next decade. Active networking (AN), including functionality within the network, led by DARPA in late 1990s.
Network Quality of Service	Standards bodies (IETF and ITU) led development of new service specifications for performance-sensitive traffic for Internet and ATM networks, respectively from mid 1990s onwards.
Group communication	IETF defines Internet multicast service model in early 1990's. Research in multicast error control and congestion control in late 1990's by several research groups, including UMass.

V. STRATEGIC RESEARCH PLAN

Twelve significant barriers to realizing DCAS systems are shown in Figure 6. Barriers one through four are at the systems-level and address the need to cross multiple research disciplines *(Bar1)*, define an architecture and evolve a set of requirements for future DCAS systems *(Bar2)*, define and create two-way end user interfaces *(Bar3)*, and create test beds to test hypotheses and discover the emergent behavior of these systems *(Bar4)*. Figure 6 is our strategic concept, in which three "planes" of research and experimentation (contributions to the fundamental knowledge base; enabling technology base; and system architecture and technology integration) are enabled, encouraged and integrated to overcome these identified barriers.

At the system architecture and technology integration level, we have defined three test beds, *NetRad, CLEAR, and FLEETS* (described in Figure 8) that define and embody DCAS requirements. Designing, deploying, and experimenting with the technical components and end-users of these test beds will be the mechanism that drives and integrates our research and keeps CASA focused on engineered systems *(Bar4)*. These systems provide the context for the sensing, distributed computing, and analysis/prediction research thrusts of this ERC to jointly research *(Bar1)* systems architectures *(Bar2)* and engage end-users in defining and creating the two-way user interface of DCAS systems *(Bar3)*.

Fundamental research to establish the theoretical basis for DCAS systems will address the physical mechanisms by which the NetRad, CLEAR, and FLEETS systems sense *(Bar12)* and predict *(Bar10)* hazardous atmospheric phenomena at small spatial scales and develop the rational basis for allocating the sensing, computing, and communicating resources of these systems *(Bar11)*.

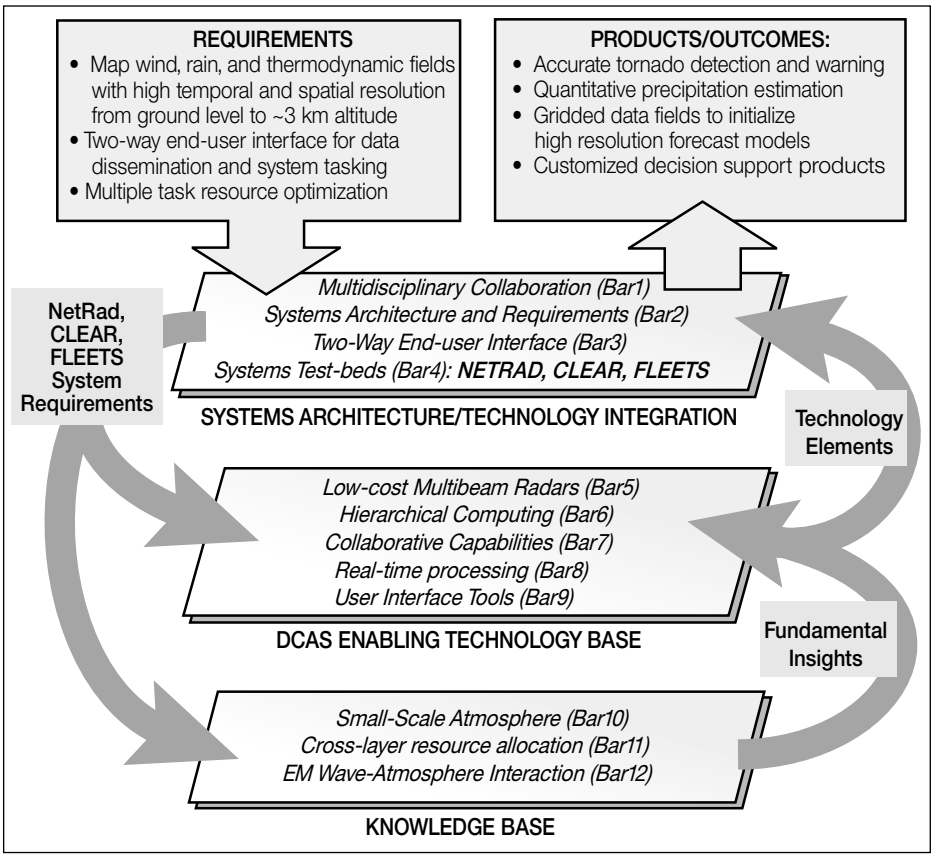

Figure 6. CASA Strategic Concept

NetRad, CLEAR, and FLEETS (Figure 8) define the enabling technology and fundamental knowledge research needs. An example of a need requiring cross-thrust collaboration *(Bar1)* is the "de-ghosting" of ambiguous radar echoes in NetRad. This problem requires that the range-Doppler ambiguity function[57] be reformulated for the case of a two dimensional network of radars *(Bar11)*. While the resource coordination needed to perform de-ghosting will be informed by resource allocation algorithms *(Bar6)* developed in the Distributing thrust, the software that implements this function requires a sensing component to perform the measurements and interpret sensed values, an analysis/prediction component to determine the utility of different levels of fidelity for these values, and the distributing component to gather values and perform computations *(Bar6, Bar7)*.

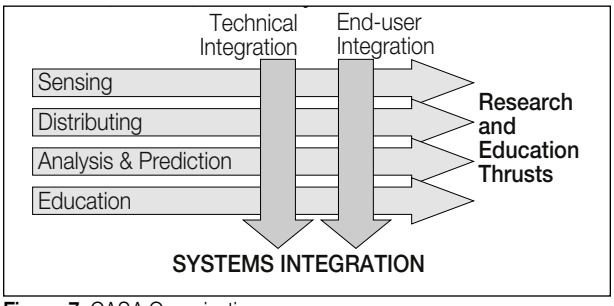

Figure 7. CASA Organization

V.1. ERC Organization. CASA will be organized into three core research thrusts (Sensing, Distributing, and Analysis/Predicting) that span the primary disciplines of electrical engineering; computer sci-

ence and engineering; and meteorology, hydrology, and atmospheric science, respectively (Figure 7). In addition to research, education will be a core thrust for CASA. Cross-cutting these thrusts will be Technical Integration Teams that maintain the requirements and specifications of the system test beds. The structure of these teams will evolve based on research needs of the center over time. An "End-User Integration" team also will cross-cut the research thrusts. This team will have the responsibility for working with potential end-users and studying applied social, policy, and behavioral issues that relate to deploying the DCAS systems and to the use of these systems in hazardous decision-making.

V.A. The Integrative Role of Test Beds. With multiple research thrusts and a network of geographically distributed research teams, the integration of research activities and teams will be an important factor in CASA's success. Our NetRad, CLEAR and FLEETS test beds play a central role in achieving this integration. Indeed, it has been noted in the context of other large scale distributed research efforts, that test beds can provide important "glue" between the teams. A recent report[58], reflecting on DARTnet – a DARPA sponsored network research test bed that arguably has been the most successful distributed network research test bed to date – notes that "DARTnet users formed a research community with a culture of collaboration. [This collaboration] was undoubtedly fostered and sharpened by the distributed DARTnet test bed. Installing a DARTnet router made each site a part of the research community." As described below, we have structured our test bed activities precisely to form a research community among CASA researchers.

V.A.1 The University of Oklahoma (OU) NetRad Test Bed will be deployed in Oklahoma, in the center of "tornado alley" and leveraging the existing OneNet telecommunication infrastructure (described in the facilities and equipment section of this proposal with significant in-kind support committed by OneNet). Our plan is to deploy 9-16 small radars across a 210 km x 210 km spatial region (the approximate size of a mesoscale storm), beginning in year two and building-out this network over time. Smaller scale test beds – consisting of two or three radars and associated computing/networking – will be deployed at each of the remaining academic partner sites, to allow local development and small-scale experimentation. Simulated additional sensor nodes will be used to explore larger-scale scenarios at these sites. Common hardware and a common software codebase will demand close interaction and provide easier integration of efforts in the large-scale Oklahoma NetRad test bed site. Over time, as our research (fundamental knowledge plane) and developed technology base (DCAS technology plane) advance, the distributed smaller scale systems will be integrated into the Oklahoma NetRad facility (sys-

NetRad, to be deployed as a system-level testbed during the first five years of this ERC, embodies dense networks of small, geographically fixed low power multiple-beam radars *(Bar5)* that resolve precipitation and other atmospheric structures from the ground to the middle troposphere with 100's of meter spatial resolution. The radars will be sited on existing rooftops and towers for which power and networking connectivity already exist and interconnected with a backbone communications network. Points of computation and storage will be located along various points in the network *(Bar2)* to buffer information, perform signal processing and quality control *(Bar6),* and apply assimilation and feature detection algorithms to collected data *(Bar8).* Combining this information with prioritized user needs *(Bar3),* resource allocation control software *(Bar9)* will send configuration commands (e.g., beam positions or scan rates, polarization, frequency) to individual radars, in real time in a manner that best meets the needs (in terms of utility and policy) of different users and applications *(Bar3).*

CLEAR, to be deployed during years 6 through 8, builds upon and extends NetRad to enable atmospheric mapping in the non-precipitating or optically clear atmosphere. This system relies on collaboration between sensors *(Bar7)* (e.g., multistatic radar operation and multiple-path propagation link measurements) and array processing algorithms *(Bar8)* to achieve the extreme sensitivity needed to resolve clear-air winds and to spatially resolve the four dimensional temperature and moisture fields.

FLEETS, to be deployed after year 8, continues to build upon the DCAS paradigm but takes advantage of anticipated size reductions in sensors, created within this center and elsewhere, as well as new mobile platforms (e.g., unpiloted airborne vehicles), to transport self-contained DCAS networks to remote locations. This includes oceans and other locations where land-based infrastructures are unavailable. In addition to the many sensing challenges associated with Fleets comes notable networking challenges since land-based communication infrastructures may be unavailable or only intermittently reliable.

Figure 8. Three Generations of DCAS Systems

tems architecture and technology integration plane) in order to cost-effectively develop a larger-scale system. Oklahoma also will be the center of development of analysis/prediction algorithms and software. Although each partner site will have small-scale replicated test beds, the research foci of the sites will be distinct as described below:

V.A.2 The University of Massachusetts (UMass) Test Bed will be used to evaluate, calibrate, and test novel designs, manufacturing techniques (in conjunction with industrial partners) and approaches to achieving low-cost sensors and sensor networks. The UMass site also will be the test bed where initial development and evaluation of distributed resource allocation techniques and networking protocols will be performed. This test bed will be operated leveraging the existing facilities of the Microwave Remote Sensing Laboratory and making use of the extensive test equipment, outdoor testing facilities, and vehicles maintained by that lab for microwave remote sensing. A simulator that will be integrated into the small-scale test beds to simulate larger-scale scenarios also will be developed and maintained at UMass, but installed at all partner sites.

V.A.3 The University of Puerto Rico, Mayaguez (UPRM) Test Bed will have a network of radars installed atop laboratory roof-tops and a mobile test vehicle configured to test new antenna arrays and wireless link components of NetRad. A truck/van will be purchased and outfitted with wireless telemetry equipment (such as 802.11). Student and faculty teams from UPRM and UMass have worked for the past 18 months to open this laboratory; the UPRM administration has allocated its space, and Raytheon Co. has provided the radars to UMass/UPRM to initiate this test bed.

V.A.4 The Colorado State University (CSU) Test Bed will test radars developed by the UMass and UPRM teams against observations from the CSU NSF CHILL National Radar Facility and Pawnee research radars. The goal will be to calibrate and test quantitative precipitation estimation algorithms using NetRad data and compare their results against results derived from numerous in-situ instruments such as wind profilers, high-quality disdrometers and rain gauge networks deployed in the area.

V.B. ERC Timeline. Our strategic timeline is shown in Figure 9. Hardware and software implementation of NetRad, CLEAR, and FLEETS test bed systems occurs in sequence over the 10 years of the ERC and beyond. However, early investigations of these systems at the fundamental and technology level will begin in Year 1 for all three systems. This strategy of "thinking ahead" will bring new ideas and concepts that can be tested during the deployment of the NetRad system. During Year 1 and continuing throughout the project, focus groups

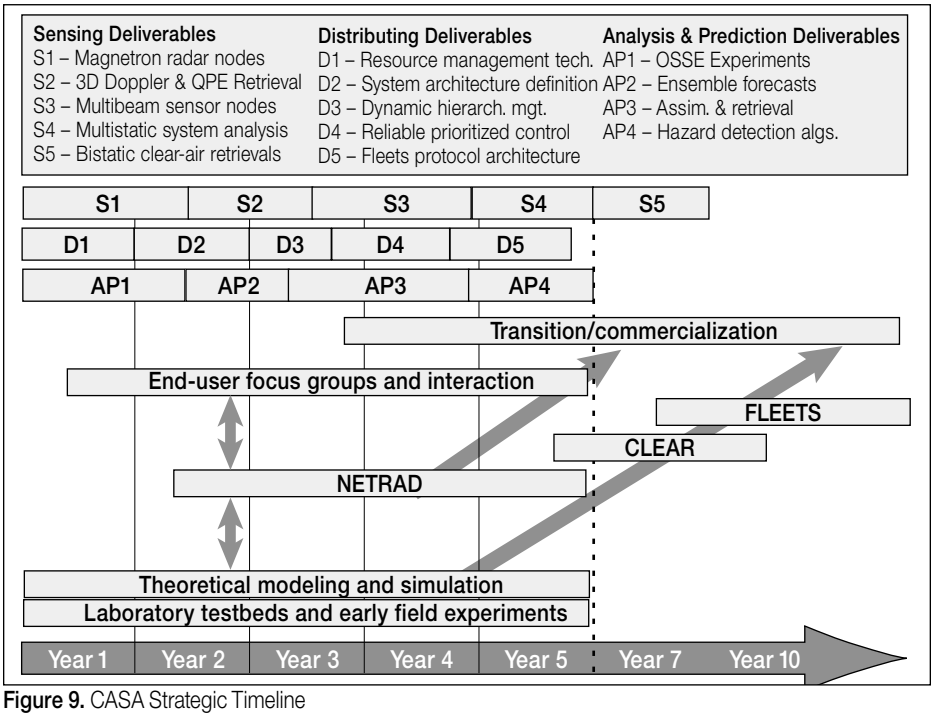

Figure 9. CASA Strategic Timeline

will be developed to engage potential end users. Participants will come from public safety, emergency management, agriculture, transportation, the military, the National Weather Service, media outlets, education, and private weather firms. These sources will be used to assess how DCAS systems and their data can be used in critical planning, decision-making, and forecasting.

Our strategy is to deploy multiple systems-level test beds in order to test and understand DCAS systems in multiple environments (such as climatologically different regions with different population densities and different end-user communities.) An important component of our strategy will be to deploy additional test beds in locations that leverage cost-sharing opportunities. Two specific examples illustrate this strategy. First, owing to the importance of flooding in the context of weather-related hazardous decision-making, we have strategically targeted Houston, Texas as a candidate site for a future deployment of NetRad. The meteorological and "end-user" aspects of a deployment in Houston are sufficiently different from those of Oklahoma (severe thunderstorms and tornadoes over large areas vs. heavy localized flooding in an urban region; rural population vs. dense population), that the lessons learned from an emergent DCAS system in Houston will be valuable to understanding how these systems behave generally. The Texas Medical Center (whose supporting letter is attached) has agreed to provide logistical and maintenance support should we locate a test bed there, and their personnel will be valuable members of an end-user focus group. Our outreach partner, Rice University in Houston will help us study this possibility in Year 1. Another example is the SensorNet project being developed by our strategic government partner, Oak Ridge National Laboratory, and our industrial affiliate, Flash Technology. SensorNet is a deployment of in-situ probes (as opposed to volumetric sensing proposed herein) to detect weapons of mass destruction in the Homeland Security context. SensorNet deploys atop cellular towers and has significant potential to cost-share infrastructure elements with NetRad and may create opportunities to locate sensors in many different regions. Decisions about locating these test beds will be made in the context of our strategic planning process in conjunction with our Industrial Advisory Board (described in Section IX).

VI. RESEARCH PROGRAM

VI.A. Sensing Research Thrust. The sensing thrust will define, develop and field-test novel sensors, sensor configurations, and algorithms for extracting quantitative information from DCAS networks. Such networks will exploit electromagnetic wave-atmosphere interaction via scattering, delay, attenuation, and depolarization mechanisms with sensors arranged in monostatic, multistatic, and multiple forward-path geometries. Fundamental research in electromagnetic wave-atmosphere interaction (*Bar12*) will investigate the physical mechanisms by which DCAS networks measure precipitation, wind, temperature, and moisture fields and will address critical design parameters such as range/Doppler ambiguity structure, waveform design, polarization basis, and other key parameters needed to realize DCAS systems. Enabling technology research will address the design of low-cost, rapid-scan, and multibeam radars (*Bar5*) and novel collaborating configurations for sensing the optically-clear air (*Bar7*).

VI.A.1. Low-cost Multibeam Radar Networks (*Bar5*). An initial set of specifications for the individual radars of NetRad is given in

NetRad System Parameters and Specifications		
Operating frequency	10.0	GHz
Antenna diameter	1	meter
Antenna beam width	1.7	deg
Noise figure	5	dB
System loss	4	dB
Maximum height	3,000	meters
Update time	60	seconds
Range resolution	100	meters
CHIRP Gain	20	
Pulse integration gain	20.8	
Azimuth resolution (at 14 km range)	424	meters
Sensitivity (min dBz at 0 dB SNR)	0.0	dB

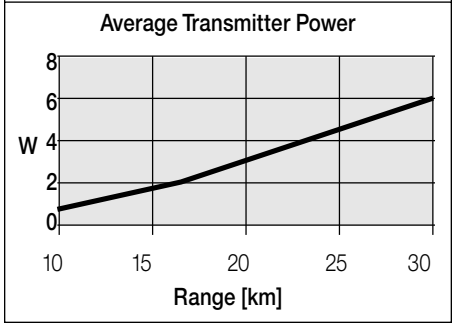

Table 1. NetRad System Parameters and Specifications

Table 1, showing the system parameters and average transmitter power required for these sensors vs. operating range. These values are based on simulations and design tradeoffs conducted during the preparation of this proposal and presented to recent National Research Council panels[35 59]. These values will evolve over the course of the ERC as the DCAS architecture is better understood, and maintaining these specification values will be the responsibility of the sensing research thrust. Early testing of NetRad will be accomplished using dual-polarization, magnetron-based Doppler radars and embedded data acquisition/processors based on field-programmable gate arrays *(S1 – referring to sensing deliverable 1 in the strategic timeline)*. Another project will leverage RF technologies developed for the wireless and automotive industries to achieve rapid, electronically-scanned antenna arrays having multiple beams and reconfigurable embedded processors for pulse compression and sensor-level covariance estimation. Initial designs will achieve rapid phase-scanning in one dimension (elevation or azimuth) and frequency-scanning in the orthogonal plane*(S3)*. Low-cost phase-phase scanned multi-beam radars at 10 GHz and higher frequencies will be enabled by research on solid-state modules developed on silicon and silicon/germanium substrates using and low-cost packaging technologies. This research component will leverage the substantial expertise and infrastructure capabilities of CASA's industrial partners through packaging technologies such as M/A-Com (implementing Ball Grid Arrays) and Raytheon (implementing High-Density Interconnect) to create conformal arrays.

VI.A.2. Network-Based Quantitative Precipitation Estimation, Classification, and Doppler Field Retrieval *(Bar4, Bar10, Bar12)*. Fundamental studies of the polarimetric backscatter covariance and forward propagation matrices of precipitation will be conducted leading to algorithms for reflectivity and 3D/Doppler retrieval, hydrometeor classification, and quantitative precipitation estimation for NetRad *(S2)*. In contrast to conventional reflectivity estimation in which a simple observation is available in a range cell, the DCAS approach provides a three dimensional weighting of the reflectivity at a location in space viewed by a set of sensors, each suffering from attenuation along a different path. The resultant reflectivity field can be obtained through an optimal estimate from multiple echo signals. Techniques such as polarimetry[60] and tomographic/stereo processing[61 62] will be used to remove attenuation effects.

S. Frasier (Co-Leader)	UMASS	ECE
V. Chandrasekar (Co-Leader)	CSU	ECE
V. Bringi	CSU	ECE
J. Colom	UPRM	ECE
S. Cruz-Pol	UPRM	ECE
R. Jackson	UMASS	ECE
R. Janaswamy	UMASS	ECE
D. McLaughlin	UMASS	ECE
L. Orama	UPRM	ECE
A. Pazmany	UMASS	ECE
D. Pozar	UMASS	ECE
S. Reising	UMASS	ECE
R. Rodriguez	UMASS	ECE
S. Sekelsky	UMASS	ECE
R. Tessier	UMASS	ECE

Table 2. Sensing Thrust Researchers

VI.A.3. Clear-Air Wind Imaging Using Multistatic Radar Networks *(Bar7, Bar12)*. While clear-air echo from refractive index fluctuations, known as Bragg echo, is limited to low microwave frequencies (S-band and below) in monostatic configurations, it can be exploited at higher microwave frequencies in bistatic configurations that involve forward-scatter geometry. The scattering mechanism to be exploited here is bistatic Bragg-scattering (the mechanism responsible for troposcatter, or over-the-horizon propagation). Clear-air radar scattering is proportional to the spatial spectral density of refractive index fluctuation due to turbulence, evaluated at the Bragg-resonant wavelength. The radar wavelength is half the turbulence wavelength for monostatic geometries but smaller for a bistatic geometry due to bistatic range-dilution[57]. As a consequence of the shape of the refractive index spectral density within the inertial sub-range for turbulence, the bistatic volume reflectivity is substantially enhanced over backscatter by a factor of $\sin(\theta/2)^{-11/3}$ where bistatic θ is the scatter angle[40 41 63]. This enhancement can in some geometries be 30-50 dB. Furthermore, bistatic range dilution enables short wavelength radars to "see" clear-air echo that would otherwise be invisible, thus establishing the theoretical feasibility of imaging boundary layer winds in the optically-clear air using networks of physically small, low power radars operating, for example, at X-band *(Bar7)*. Our feasibility studies

conducted to date indicate that a network of 10 W radars deployed at 10 km grid spacing and operating in a multistatic configuration, such as that envisioned by CLEAR, would be capable of mapping clear-air winds from 300 m to 3 km height. Research topics to be addressed include evaluation of frequency dependence, bandwidth and spatial coverage. Understanding *(S4)* of these will then enable 1) validation of retrieved winds against other measurements, such as wind profilers, 2) studies of boundary-layer structures observable via the bistatic geometry and 3) assessment of the relative importance of different scattering sources, such as insects and precipitation *(S5).*

VI.A.4. Temperature and Humidity Estimation Through Tomographic Reconstruction of Clear-Air Refractivity Fields *(Bar7, Bar12).* Radio propagation is affected by the path-integrated effects of the vertical profiles of temperature and humidity, which together define the refractivity profile. While research in deducing these profiles from remote sensing observations is in its infancy[64 65], fast and efficient parabolic equation (PE) numerical codes have been developed to simulate accurately the effects of atmospheric boundary layer parameters such as temperature, humidity gradients, and boundary layer depth) on signal amplitude and phase[66 67]. While much of this research has been conducted in the maritime environment – where tactical radar performance is strongly affected by low-level ducting conditions – its application to terrestrial boundary layers may provide additional detail on refractivity structure. Detailed simulation studies will be conducted to investigate phase, amplitude sensitivities and frequency dependences and to motivate methods for constrained inversion of observations to refractivity fields. Surface layer refractivity also can be derived from the absolute phase of radar echoes from fixed ground targets[68]. Because phase is measured modulo-2π, it is itself ambiguous, requiring a critical density of suitable ground targets for unique solutions. A DCAS network offers the potential for mapping horizontal structures of surface refractivity over wide areas. Although higher frequencies likely to be employed in these networks will exacerbate the phase ambiguity problem, the DCAS network permits multiple observations of common regions which must yield equal refractivity estimates. Network-based refractivity retrievals will be tested and evaluated in the context of demonstration test beds. Finally, constrained inversion techniques to combine surface layer refractivity, path-integrated profiles, and other available observations such as integrated water vapor from radiometers or GPS, RASS virtual temperature profiles will be investigated. In the literature on acoustics, such inversion is termed travel-time tomography[69], which we propose to adapt to electromagnetic propagation.

VI.B. Distributing Research Thrust. The distributed computing and communication infrastructure provides the underlying resources for moving data from sensors to points of computation, performing intermediate processing on sensor data (e.g., data grooming, de-aliasing), and running the various data-driven weather-related algorithms (e.g., 3 D wind, precipitation, temperature and moisture field retrieval, hazardous weather identification, short-term prediction), see Figure 10.

At the "edge" of the hierarchy are the physical sensors and their local (embedded) processing engines. These sensors are connected into the network in a heterogeneous manner – some with relatively high bandwidth links (e.g., 802.11 NetRad wireless links), while others may have relatively low bandwidth links (e.g., fractional T1 NetRad links). Commodity computing devices that perform tasks

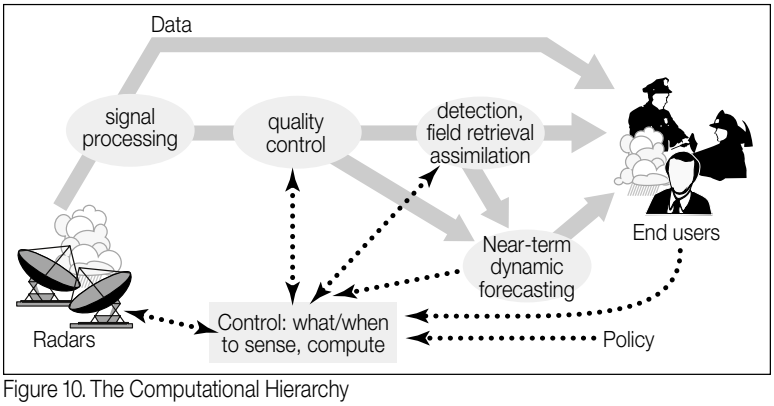

Figure 10. The Computational Hierarchy

such as quality control on sensor data, retrieval of atmospheric fields, and hazardous event detection will be located both at routing points within the network and at back-end facilities. More specialized supercomputers will perform near-term dynamic forecasting using numerical and ensemble models. Fundamental research *(Bar11)* will investigate collaborative approaches for adaptive resource allocation, communication, and computation in a dynamic environment in which phenomena under observation, relative priorities of system tasks and goals, and available system resources can change over multiple time scales. Enabling technology research will design novel application-driven, on-line, and policy-based resource allocation approaches *(Bar6, Bar7, Bar8)*; network protocols that support group-oriented, reliable, real-time communication *(Bar7, Bar8)*; and new hierarchical, collaborative signal processing techniques *(Bar6, Bar7)* specifically tailored to the DCAS environment. An overall architecture (Bar2) will be developed for this complex system of interacting components, ensuring that the resulting system is manageable, performs well, and is able to evolve to support unanticipated uses and needs[70]. Various system modules, and their services and interfaces, will also be defined. We do not underestimate the importance of these latter tasks *(D2)* – this software is the "glue" between the data-generating physical sensing platforms and the tools of atmospheric analysis and prediction, and thus is crucial to the overall success of a DCAS system. Additional infrastructure issues (in particular, security) are no less important, but can be addressed using existing and emerging technologies.

Researcher	Institution
J. Kurose (Co-Leader)	UMass, CS
I. Koren (Co-Leader)	UMass, ECE
D. Goeckel	UMass, ECE
W. Gong	UMass, ECE
P. Kelly	UMass, ECE
C.M. Krishna	UMass, ECE
V. Lesser	UMass, CS
P. Shenoy	UMass, CS
D. Towsley	UMass, CS
L. White	OU, Math
A. Jayasumana	CSU, ECE

Table 3. Distributing Thrust Researchers

VI.B.1. System Architecture, Fault-Tolerance and Resource Management. A core challenge for DCAS systems is that of resource allocation *(Bar11)*. Here, resource allocation refers to controlling radar functions (e.g., determining beam targeting and measurements), computation scheduling, and network bandwidth use. NetRad provides the illustrative context for defining the initial parameters of this resource allocation problem. In a network of possibly hundreds of radars, resource coupling will primarily be among "nearby" (on the order of 10) radars. Each radar has approximately 10 beams, with each beam being individually targetable and capable of scanning though any of 1800 different beam positions. Each radar must be tasked (e.g., to observe several thunderstorms and regions of circulation, high wind, and hail within, and clear-air region between storms) with retasking occurring on the 10s of seconds to minute timescale. With a single NetRad data rate of several hundred Kbps to several Mbps (depending on compression[71] and weather activity), these rates would not stress network backbone links or (under normal circumstances) wireless links. Fractional T1 link bandwidth must be carefully allocated. Weather-related computations have well-known computational requirements for a given problem size, but being data-driven, their executions must be coordinated amongst themselves and with data collection and resolution.

Our overall approach towards system architecture, fault tolerance and resource management reflects the specific challenges posed by DCAS systems:

- Application-driven. The "utility" of accomplishing a given task (e.g., sensing a given thermodynamic property of a given voxel) can only be defined by the driving weather application(s). A given task can also often be accomplished with different degrees of "fidelity," with additional resources yielding increased fidelity. The decision as to which resources can best accomplish a task requires synergistic interaction among sensing, distribution, and weather-prediction researchers *(Bar1)*.
- Dynamic. The sensing and predicting goals of the system will change over time, as the weather itself evolves. Additionally, available system resources may change as failures and outages occur.

- Hierarchy. The large scale, complex nature of the resource allocation problem suggests hierarchical decomposition *(Bar6)*, both in space (performing localized computations) and in time (e.g., small time-scale beam control vs. slower time-scale radar group configuration). Hierarchical control policies can also be used to first recover locally, and later more globally, from failures of sensors, links, and computers *(D3)*.
- Policy and humans in the loop. Policy decisions will also play a crucial role. Conflicts occur, for example, when competing requests for resources come from different sources, e.g., the NWP algorithm running within the DCAS system and an industry entity that requests sensed or synthesized data. While a utility-based approach provides mechanisms for making resource allocation decisions, the utility values themselves must be coordinated via policy. Human decision making, often including humans-in-the-real-time-loop, will often be required.

Our initial research in resource allocation will be targeted at understanding the applicability, advantages and disadvantages of three broad approaches towards DCAS resource allocation *(D1)*. In the *online/offline Markov Decision Process based approach*, a local reward (utility) function is defined for each voxel that depends on radar parameters such as range resolution, cross-beam resolution, target rescan time, radial velocity, and reflectivity. These local functions in aggregate define a global reward function that can be maximized using Markov Decision Theory (MDT). Here, a suitable state-space would reflect radar and computing subsystem conditions, as well as the operating mode of the sensors, together with the prevailing weather conditions. MDT calculation of an optimal resource allocation is computationally intensive, suggesting a decomposition into separate offline and (lightweight) online tasks, an approach we have successfully used in the past[72]. The *Distributed Lagrangian Relaxation approach* is based on on-line, decentralized Lagrangian relaxation techniques. Here virtual "prices" are assigned to resources to reflect the degree of resource contention. Computations requiring the use of the resources then iteratively adjust their resource demands given the level of resource contention (as reflected in pricing signals such as observed delay) and the utility of their computation. Distributed Lagrangian relaxation techniques have recently been successful used for bandwidth allocation in large scale wired and wireless networks[73] [74]. Finally, the *Distributed Negotiation approach* is built upon a distributed, mediation-based negotiation protocol among cooperating nodes[65]. Here, each node gains a localized, partial view of the global resource allocation problem of those tasks that are in direct conflict over the desired resources. This allows the node to act as a mediator – to identify over-constrained sub-problems and make proposals to eliminate such conditions. Our experience with this approach in a distributed sensor-network multi-target tracking task[76] indicates that nodes can rapidly converge on solutions that are in most cases "good enough" and "fast enough." Overall, this approach has many common characteristics with the parallelized distributed hill-climbing approach of distributed breakout[77].

VI.B.2. Hierarchical and Collaborative Signal Processing. A network of densely spaced sensors with rapid local communication creates the possibility of applying innovative and sophisticated signal processing techniques. Within the NetRad system, we will study methods by which observations from multiple radars looking at common meteorological phenomenon can be fused at a higher-level *(D3)*. Range ambiguous (multiple trip) "ghost" echoes may be expected to be a common artifact in a dense network where individual low-power radars operate at high pulse rates. While such ghosts can be mitigated to a limited extent through phase coding techniques[78], fusing multiple views of common volumes from multiple locations may eliminate them entirely. The challenge here is to exploit properly "soft information" on data quality to enable a data fuser to correctly combine imagery. Algorithms that produce the best such soft information at a rate acceptable for the low data rate links connecting sensors into the network, and the method for combining such information at a higher level of the computational hierarchy will be considered.

The CLEAR system is focused on measuring precipitation-free winds, temperature, and humidity. We will explore a promising collaborative technique that performs tomographic inversion to obtain these values from a set of "slices" through the region of interest (e.g., multiple propagation links or radar echoes from many "hard" clutter targets). The fundamental challenge here is that the number of available observations will typically be significantly smaller than the number of voxels for which estimates are desired. Deterministic approaches will assume a parameterized model, with fewer parameters than independent equations available, and attempt the (in general, non-linear) inversion. Simplification is obtained through linearization when justified. Stochastic approaches will focus on the characterization of the unknown quantities as elements of a hierarchical random process (e.g., a Markov random field[79]) with spatially and temporally varying mean and variance. The probability distribution of the observations based on the process of interest will also be characterized. These together fuel algorithms that solve the critical "many-to-one" problem by finding the set of voxel values that are most likely given the model and the observations.

VI.B.3. Network Protocols. Application-specific data transport protocols will be developed for DCAS systems, to provide real-time, semi-reliable delivery of sensed data to computation nodes, as well as real-time reliable delivery of control messages among system components *(D5)*. These protocols will differ from TCP and the traditional "best effort" service model in that: (1) control data (e.g., sensor reconfiguration) will typically require priority over sensor data[48] and will require both real-time and reliable delivery, (2) lost packets may be as likely to result from errors on the wireless channel as from network congestion (3) in-order data delivery is not required for many computations, with more recently arriving data being more important than older data. The use of proactive forward error correction for real-time reliable data delivery[80], and service differentiation[81 82] will provide the foundation for developing protocols that meet these requirements. The correct fusion of data by collaborative signal processing algorithms requires that data fused from independent sensors be temporally coherent with each another. Our recent work on application-level transport protocols that guarantee temporal coherency across streams of dynamic data will be particularly useful here[83 84]. Finally, policy-based routing approaches developed for Internet protocols will prove useful in developing policy-based resource allocation in NetRad.

The multi-sensor tomographic sensing measurements in CLEAR will require the research and development of multicast communication protocols[85 86] among collaborating sensors, both for control and sensor data transfer services *(D5)*. New, dynamic forms of group addressing and naming will be developed to communicate among groups of sensors on the basis of function and location[87]. CLEAR introduces additional interdependencies in the resource allocation problem in that sets of sensors must be allocated as a group to perform tomographic sensing, making group communication a crucial part of the infrastructure.

FLEETS provides even longer-term network research challenges. Since communication connectivity may be intermittent, mobile sensors must be able to "store and carry" accumulated data. We will investigate extending techniques from today's emerging peer-to-peer networks to allow mobile sensors to store/carry data from other mobile sensors to the points of attachment to the fixed infrastructure *(D5)*. With collaborative mobile sensing, sensing/computation clusters will naturally form and later dissolve, perhaps while being detached from the fixed infrastructure. Thus, the protocols we develop must also determine which elements take on the job of communicating sensor cluster computation to the fixed infrastructure, even after a cluster has dissolved. While massive swarms do present problems of scale (which can be managed through hierarchy), their considerable redundancy makes other problems much simpler than in smaller or medium-scale systems. Similarly the analysis of large scale systems is also considerably simpler due to the application of large-scale asymptotics. We believe that medium-scale systems are much more likely candidates for initial deployment, and thus will undertake research aimed at addressing the problems arising in such systems,

without relying on the simplicity that often accompanies massive-scale, highly-redundant systems.

VI.C. Analysis And Prediction Research Thrust.

The DCAS observing technologies to be developed and deployed by CASA will both require and enable a broad range of fundamental research in the atmospheric and hydrologic sciences. Further, they are expected to create a paradigm shift in research methodology because, for the most part, weather and hydrologic prediction models and detection systems have until now been passive recipients of observational data for initialization (input) and validation (output). In the new paradigm enabled by CASA, such systems will be coupled in real-time with observational networks such that the observation-gathering process is controlled by the requirements of technologies that make use of the data. The associated meteorology and hydrology research needed to effectuate this change, described below, will be funded by CASA, whereas a much larger body of basic research, conducted by the broader community using CASA data, will be supported by external sources.

K. Droegemeier (Co-Leader)	OU	Meteorology
S. Rutledge (Co-Leader)	CSU	Atmos. Sciences
F. Carr	OU	Meteorology
H. Bluestein	OU	Meteorology
B. Vieux	OU	Civil & Env. Engineering
P. Rees	UMass	Civil & Env. Engineering
P. Bedient	Rice University (Outreach)	Civil & Env. Engineering
M. Biggerstaff	OU	Meteorology
A. Shapiro	OU	Meteorology
M. Xue	OU	Meteorology

Table 4. Analysis and Predicting Thrust Researchers

VI.C.1. Data Analysis, Assimilation, Parameter Retrieval, and Numerical Prediction. The ultimate value of data gathered by NetRad, CLEAR and FLEETS will depend upon the availability of systems for assimilating them with other observations, retrieving from them quantities that cannot be observed directly, and projecting them forward in time, with other data, using statistical and dynamic forecast systems. However, significant fundamental research will be required to accommodate the unique features of DCAS systems. For example, the ubiquity of overlapping sampling regions in NetRad will create transition zones among single-, dual- and multiple-Doppler coverage, and thus an increased likelihood of solution non-uniqueness and mathematical ill-posedness. Additionally, because sensor operating characteristics may change frequently with time, and because the same volumes or features in the atmosphere may be sampled by similar devices operating in different modes, dynamic assimilation constraints and methods for specifying error covariances will need to be completely rethought.

Among the many benefits expected from CASA is insight into the practicability of numerically predicting intense local weather, such as individual thunderstorms and their larger aggregates, and in that context identification of the requisite observations, model grid spacings and model physics. Recent experiments at CAPS, in which NEXRAD radar data were assimilated with other observations, suggest that the general morphology of certain large, persistent thunderstorms can be captured reasonably well using grid spacings of ~3 km[26]. Other studies have shown similar results and have examined the impact of grid spacing on storm morphology[30 32]. However, it is becoming clear that grid spacings far smaller than 1 km – perhaps as low as 100 m – may be needed to represent explicitly the turbulent characteristics and fine-scale rotational features of some thunderstorms[88 89 90 91 92 93]. CASA will provide the observations needed to address this key issue.

Another particularly challenging research topic in atmospheric prediction involves the mechanisms of storm initiation. Because NEXRAD samples only a small portion of the atmospheric boundary-layer and operates with relatively coarse temporal resolution, it is difficult to capture the low-level, fine-scale 3 D structures that are known to play a role in convective initiation[94 95 96 97]. The physical/dynamical coupling of such structures with surface characteristics, e.g., ground cover and heat and moisture fluxes, is vitally important but at present cannot be assessed without data such as those to be provided by CASA. Prior to

the availability of NetRad data, we will explore many of these issues via observing system simulation experiments (OSSEs), in which very high resolution atmospheric simulations are sampled –- in a manner consistent with NetRad collection strategies – to yield a set of calibrated pseudo-observations for use in assimilation and prediction experiments. Indeed, such studies will guide the design of NetRad itself, particularly with regard to estimating spatial resolution, temporal frequency of data collection, error tolerances, and the capabilities required in CLEAR. Data denial experiments will be used to quantify the relative value of each data source and identify redundancies in information content. *(AP1)*

Finally, given the inherent predictability challenges associated with events such as individual thunderstorms, which are manifest in numerical models as uncertainties in specifying initial conditions, physical processes, and parameters, we will apply ensemble techniques *(AP2)* to generate probabilistic forecasts (an ensemble consists of several forecasts, all valid for the same time, that are started from slightly different initial conditions, produced by different models, or utilize different options within the same model). *(AP2)* In this context, CASA provides an unprecedented opportunity for using adjoint- or ensemble-based sensitivity analysis – which identifies regions of the atmosphere that are most sensitive to errors and, consequently, that require the most dense or frequent observations – to optimally gather precisely those observations needed to maximize forecast quality.

VI.C.2. Hazardous Weather Detection Algorithms. Most existing hazardous weather detection algorithms were developed for a specific sensor and cannot readily be applied to others, even among different types of the same sensor. They possess little real-time flexibility because the sensors driving them operate independent of the phenomenon being sampled, and data quality typically degrades with range, particularly in the case of radars, owing to basic geometry. Current algorithms also are limited because most sensors sample only a few quantities (beam-parallel wind and precipitation intensity in the case of Doppler radars). Yet, most severe weather phenomena are sensitive to volumetric changes in temperature and moisture. In DCAS, range dependency will virtually be eliminated because each sensor samples only a small region. Retrieval techniques will generate dynamically consistent thermodynamic variables on the scales of the radar observations themselves, thus providing more complete information for detection algorithms. Applying its long history in developing algorithms for detecting thunderstorms[8], tornadoes[11], mesocyclones[10], hail[9] and rainfall[12], the NSSL will participate in formulating new algorithms for DCAS sensors. Corporate partners, who develop such algorithms for commercial purposes (e.g., Baron Services for weather hazard identification in TV radars and Vieux and Associates for quantitative precipitation estimates that feed hydrologic and flood decision models), also will participate. Particular attention will be given to studying reductions in false alarm rate by comparing detections of the same phenomena observed simultaneously by NetRad and NEXRAD. CAPS will take a complementary approach and apply detection algorithms to assimilated data sets – with the advantage that the algorithms operate on uniformly gridded fields of *all meteorological variables* (not just those of individual sensors) and thus are independent of the observing technologies or strategies used. *(AP4)*

VI.C.3. Quantitative Precipitation Estimation and Flood Forecasting. Capturing the quantity and spatial distribution of precipitating events is an essential component of accurate hydrologic analysis and flood prediction. Physics-based distributed (PBD) hydrologic models created from the outset to utilize the spatial heterogeneity of the inputs and terrestrial parameters have shown dramatic improvements in prediction and predictability. Vflo is an example of a PBD model that is used in real time with radar input[98 99]. This model will be used to test the forecast skill offered by quantitative prediction estimation (QPE) produced by NetRad. Initial tests will be conducted for basins in Houston and used in conjunction with the flood forecast system operated by outreach partner Rice University and Industrial Partner Vieux and Associates.

VI.C.4. Phenomenological and Process Studies. ERC funding will be directed toward a limited number of topics designed to improve our fundamental understanding of the small-scale atmosphere in the context of DCAS sensor deployment. As noted by Davies-Jones et al.[100], in the context of present limitations in our ability to understand tornadoes, "…datasets currently available … suffer from the lack of wind information in the lowest few hundred meters [of the atmosphere]." With such data to be provided by NetRad, we will study the dynamics of tornadogenesis, the interaction of the tornado-scale circulation with its parent storm, and the dynamics by which successive mesocyclones and tornadoes form within the same storm. The ability to distinguish between tornadic and non-tornadic storms having otherwise similar characteristics is a key goal of this research. We also will study the structure and evolution of horizontal convective rolls (HCRs) in the boundary-layer, as they are known to create extremely small-scale variations in static stability and thus influence storm initiation[94]. Vieux and Associates, Inc. will study the quantitative estimation of precipitation using surface gauges for both calibration and verification, with particular emphasis on the use of polarization diversity to determine hydrometeor species. Comparisons will be made with NEXRAD data collected for the same events, and the precipitation estimates will be input to hydrologic and flood forecasting models verified using stream gauge and other data. This work will be of vital importance to the U.S. Weather Research Program[101].

VI.C.5. DCAS Model and Algorithm Formulation. Two important tasks must be accomplished in the context of meteorological software in order for the DCAS paradigm to succeed. The first involves the development of DCAS-enabled hazard detection algorithms, data analysis and assimilation systems*(AP3)*, and numerical forecast models that operate in a dynamically adaptive, fault-tolerant manner, while the second involves generating syntactically relevant meta data from these applications for feeding the NetRad master optimization program that drives DCAS sensors. The current state of the art in the former consists of serials tasks that proceed in discrete steps, where data are collected, models and analysis systems are run, and results are analyzed. If any of these elements fails, the entire process typically fails. In stark contrast, the DCAS scenario involves highly nonlinear dependencies among sensors, tools, and end users that have complex feedback loops and are dynamic in structure. Indeed, the exact sequencing and scale of the tasks will change in response to the weather, to current system attributes, and to rapidly changing user needs.*(AP3)* Consequently, we will develop the meteorological software components to achieve these goals, borrowing heavily from research now under way in the context of Grid- and Web-enabled applications[102]. With regard to optimization, we will create a library of semantically flexible attributes (e.g., latitude, longitude, height, depth, intensity, aspect ratio, direction of movement, rate of change) that associate with a wide variety of atmospheric phenomena (e.g., tornadoes, gust fronts, thunderstorms, rain shafts, microbursts, mesocyclones, hail cores). Both will be assigned numerical values, with the latter prioritized based upon particular user needs, for input to the master optimization program. The overall system will have the flexibility to re-assign priorities based upon changing user needs, sensor configuration (e.g., in case of outages), and number and type of phenomena detected at any given time.

VI.D. The End-User Integration Team. This team will be responsible for developing focus groups to engage potential DCAS end-users and for conducting applied social and policy research to understand how these systems should best integrate into existing organizations and decision-support tools.

K. Klossel (Co-Leader)	OU	OK Climate. Survey
H. Rodriguez (Co-Leader)	UPRM	Sociology
W. Diaz	UPRM	Sociology
B. Aguirre	UDelaware	Disaster Res. Ctr. (outreach)
R. Piekle Jr.	UColorado	(outreach)
D. Mileti (Sci. Advisor)	UColorado	Hazards Res. Ctr.

Table 5. End-User Integration Team

VI.D.1. End-User Focus Groups. Beginning in the first year of this project, focus groups of potential DCAS end-users from multiple agencies will be

formed to 1) visualize how future DCAS systems would be assimilated into critical planning, decision-making, and forecasting activities; 2) develop a set of "beta site" end users for our test bed deployments; and 3) provide a source of advice for strategic planning and a platform for fund raising to support additional test bed deployments. Three focus groups will be formed during the first year of this ERC: 1) Dr. Kevin Kloessel of the Oklahoma Climate Survey will organize a statewide group of potential end-users from diverse sectors across Oklahoma in conjunction with the NetRad test bed. He will draw from the extensive network of end users currently served in Oklahoma through the decision-support/training programs run by the state-funded OK-First program; 2) Drs. Rodriguez and Diaz, both with UPRM, will organize groups in Puerto Rico in conjunction with the test bed in Puerto Rico. The UPRM group maintains an existing network of public-sector emergency managers through the CISA center in Puerto Rico and has created a network of media and private-sector concerns eager to work with them; 3) Dr. Dennis Mileti, a CASA scientific advisor who directs the Hazards Research Center at UColorado, will organize a group having nationwide representation. Mileti's extensive contacts within the Hazards community nationwide will help to regionally "scale" the focus studies provided by the other groups. These groups also will be an important source of information for our strategic planning process, helping us to steer our research projects and test beds in response to user feedback. In the set of letters supporting this proposal, Dr. Richard Wainardi, the CEO of The Texas Medical Center in Houston, discusses his motivation and intentions to serve in a focus group and to support a future test bed in Houston where frequent flooding events are a problem for medical, transportation, and other interests. In addition, groups such as these will form the basis for decision routines for determining priorities for adaptive sampling, for understanding the value of alternative products for various classes of end users, and for the development of institutional mechanisms for the transfer of information to those end users. Over the longer term, these focus groups are expected to lead to sustainability of the activities of this center, beyond the funding period of the NSF grant.

VI.D.2 Technology Policy (Pielke Jr.). The research proposed in this proposal is sufficiently novel that realizing its promise for societal benefit may require an evolution of existing decision making processes and institutions to accommodate new scientific and technological capabilities. Experience has shown that the transfer of meteorological research into operational settings can be challenging even in the best of cases (e.g., see the 2001 NRC Report "Crossing the Valley of Death"). Several groups are examining the current institutional and policy framework for connecting meteorological research with operational services in government and also looking at partnerships among government, academia and the private sector for enhancing the connections of research and societal needs. Experience with such issues in biotechnology and information technology suggest that the design of institutional and policy framework is itself a topic worthy of focused research, commonly understood as the study of "technology policy." We propose to include in the first year of our project the development of a research agenda focused on technology policy in the atmospheric sciences. The goal would be to develop, evaluate, and recommend a range of alternative institutional and policy frameworks capable of effectively managing the transfer of knowledge and technology into useful products and services in the public and private sectors. Technology policy research on such alternatives will necessarily be highly integrative of the engineering, scientific (meteorological and social science), and end user aspects of the project, and will have to be fully integrated with the implementation and evaluation of the project test beds. While the results of this research will have direct applicability to the broader scope of work proposed herein, they also may have broader relevance to discussion of the evolution of the nation's weather and climate services.

VI.D.3. Applied Social Research. Such research will be conducted to understand where different end-users get their weather information, how much confidence they have in it – their perception of forecast

reliability, how weather analyses and forecasts affect the decision-making processes of policy makers and the general public, and how various users deal with the uncertainty inherent in weather-based decision-making. In this context, the end-user group is considered to contain emergency responders as well as large-scale economic interests such as agriculture, the insurance industry, utilities, the airline industry, and government at all levels. Longitudinal research will be conducted to understand changes in end users' decision-making processes as NetRad products become available and disseminated. Research tools will include interviews, focus groups, and survey-based studies in the test bed sites of this ERC. Extreme weather events (such as major landfalling hurricanes) can result in mass evacuations and significant casualties that severely disrupt society's day-to-day function[103]. This component will examine how organizations use, manage, and disseminate information such as weather forecasts, and how this relates to the levels of preparedness and their capacity to respond to high-impact events (e.g., hurricane, flashfloods, landslides, etc.). Furthermore, we will examine how policy makers incorporate weather information into their routine decision-making processes and how this impinges on the decisions they make under high-impact or extreme weather conditions.

VII. EDUCATION AND OUTREACH: VISION.

The next generation of engineers will be required to develop a more sophisticated understanding of complex engineered systems and their potential in the service of humanity. We have developed the education and outreach vision of CASA with this central tenet in mind. Our plan is to educate undergraduate and graduate engineering students, as well as younger people, in understanding the complexity and interdisciplinary nature of engineered systems and their impacts on society.

CASA creates a powerful opportunity to affect the future direction of engineering education and outreach. The center also is well-positioned to address many significant problems related to the paucity of females and minorities in the engineering pipeline. Complexity, compelling social implications, cross-campus teaming, and the obvious appeal of weather and the Internet–are all elements intrinsic to this ERC.

To implement the education and outreach vision, we have developed an agenda that will have local, state and national impact through partnerships that will span K-12 through lifelong learning. CASA's goals are to: deliver meaningful professional development for K-12 teachers (VII.A.1.); create a national dialogue with other states on policy, standards and assessment for K-12 engineering curricula (VII.A.2); develop, pilot and disseminate innovative interdisciplinary curricula for undergraduate and graduate students by leveraging instructional technology (VII.B.1; VII.E.); provide opportunities for inter-level research teams, emphasizing collaborative work across disciplines and universities (VII.B.2-3); develop partnerships and curricula that increase diversity within the engineering pipeline (VII.C.); and educate the public and key decision-making personnel on the results of this ERC (VII.D.).

VII.A. Pre-Collegiate Educational Opportunities

VII.A.1. Professional Development For Teachers. The first state in the nation to do so, Massachusetts recently adopted statewide curriculum frameworks for engineering and technology at all grade levels. The curriculum frameworks are a crucially important foundation supporting the development of a technically literate future workforce. However, teachers need professional development courses to acquire the knowledge of engineering concepts that they now are expected to teach. (This is supported by the recommendations of the Glenn Commission Report, Before It's Too Late.) The compelling

Raytheon has committed $50,000 for K-12 outreach because they believe in CASA's educational vision that teachers are the key to exciting all children about engineering.

CASA research activities and our K-12 outreach linkages with the Massachusetts Department of Education (DOE), the City of Springfield, Mass., Tufts University and the NSF-sponsored STEM Institute at UMass, will enable us to develop exciting professional-development programs for teachers that will have real impact.

We plan to deliver high-quality, professional development through Summer Content Institutes. We will create these institutes in partnership with the DOE and raise awareness of the social importance and complexity of our research problem. Examples of ERC-inspired courses for K-12 teachers that will be explicitly linked to the Massachusetts curriculum frameworks include "Understanding Radars," "Weather Prediction," and "Remote Sensing of the Atmosphere." Unique to these courses will be the use of real-time data in areas of relevance to the participants as well as hands-on interaction. These courses all have the potential to excite and deepen the engineering and science content knowledge of teachers. In addition to developing new curricula, our existing educational programs and curricula offered by University of Oklahoma, University of Puerto Rico, Mayaguez and Tufts University will be reviewed, enhanced and disseminated through the national conference proposed in VII.B.2. In order to further develop our partnership with the Springfield public schools, we will give preference for registration at the Summer Content Institutes to teachers from this school district who reach many underrepresented student populations. In addition, we will actively recruit teachers who are women and underrepresented minorities to participate in the program. To further the outreach potential of the Summer Content Institutes, we will work with the Center of Engineering Educational Outreach at Tufts to investigate large-scale dissemination of professional development for teachers. On-line learning and multimedia tools will extend our reach to teachers beyond our local boundaries.

VII.A.2 National Dialogue on K-12 Engineering Education. We will establish and present an annual national conference, co-sponsored with the Massachusetts Department of Education that brings other states' DOEs together to debate, understand and disseminate the importance of engineering content in science and math education. Government, education, industry and national groups will be invited to participate. A national forum, one that brings educators and engineers together for this discussion, does not currently exist but could greatly speed up progress by having states share information on challenges, "lessons learned," outstanding curricula, and assessment techniques. This conference, led by CASA and the Massachusetts DOE, will influence and focus the direction of U.S. states' guidelines with respect to K-12 learning, teaching and assessment in engineering and technology.

VII.B. COLLEGIATE EDUCATIONAL OPPORTUNITIES

VII.B.1. Undergraduate Engineering Curriculum Innovations. In keeping with the vision of CASA, we plan curricula that will emphasize the broad, multi-disciplinary nature of complex systems, integrating science and technology, economics, public policy, the social sciences and humanities with engineering fundamentals. Particular attention will be paid to creating curricula that inspire the participation of female students. Six new courses will be developed and then shared among all partners. Each course will have a corresponding Content Institute for K-12 teachers. The content institute will be supported by a rich Web site, disk-based lectures, and virtual labs.

Curriculum development teams (including K-12 teachers) will work with ERC researchers to directly transfer research results into the new courses and K-12 Content Institutes (See Table 6). Although research transfer often is accomplished in upper-level courses, it is a specific goal of this ERC to extend that transfer to lower-level undergraduate courses and K-12 in order to help with recruitment and retention, in particular from under-represented groups. According to our ten-year plan, the initial six new courses will be piloted and assessed within the ERC partnership but then will be distributed more broadly through tar-

CASA Curriculum K-12 Through Graduate Level: New Courses To Be Developed				
Lead	**Course Name:**	**Academic Level:**	**Faculty:**	**K-12 Content Institute**
UMass	Complex Engineered Systems	Freshman/ Mount Holyoke course	Burleson, Djaferis, McLaughlin, Mount Holyoke, K12 Teacher	Engineering To Solve Societal Problems
UPRM	Social Impacts of CASA	Sophomore General Education Elective, Interdisciplinary	Diaz, Rodriguez	The Social Impact of Technology
UPRM	Sensing Lab	Sophomore Lab EE, CSE	Cruz-Pol, Colom	Remote Sensing of the Atmosphere
UMass	Distributed Sensor Networks	Junior Lab Course CSE, EE, CS	Kurose, Tessier	Networks
CSU	Radar Meteorology	Senior/Grad Interdisciplinary	Chandrasekar, Bringi Rutledge	Understanding Radars
OU	Meteorology	Senior/Grad Interdisciplinary (on-line course)	Droegemeier	Weather and Prediction

Table 6. New CASA courses

geted workshops at national meetings, such as through the annual conference (proposed in V.B.2), the NSTA, ASEE, and others, and through a comprehensive Web site.

VII.B.2. Undergraduate Research Experiences. In addition to the coursework, which provides a means for broad dissemination of our research, the distributed sensor test beds for this ERC, and the tangible weather quantities they measure, will provide numerous opportunities for students at all skill levels to participate in CASA. Mechanisms will include freshman seminars, REU-funded summer research, senior design projects, and opportunities for teachers who desire hands-on participation in ERC projects. Undergraduate engineering and science students at all partner campuses will benefit from mentoring and from an intensive research experience supported by undergraduate assistantships funded by the ERC. We plan to offer 20 of these assistantships per year in the early years across the four core campuses of the center and to increase this number to 50 with financial support from our industrial partners. These students will work in teams along with graduate students, faculty, and industry mentors to design, fabricate, deploy, field-test, and operate the very test beds that form the basis for our research. We have piloted this program through UMass and UPRM over the past several years, with undergraduate and graduate students traveling back and forth between campuses. They have team-designed the first sensor node for NetRad using hardware provided by Raytheon. CSU has hosted more than 80 undergraduates from around the country, providing them with research experiences focused on the Front Range remote sensing infrastructure.

CASA has a serious commitment to diversity and a goal of recruiting 50% women and 30% minority students to fill REU.

VII.B.3. Graduate Research Experiences. For 20 years, UMass has teamed with Raytheon, GE and BAE Systems in an industrial M.S. Program in Microwave Engineering. Raytheon, Vaisala, and the other industry partners have committed to expand this program with industrial funding for students working toward Ph.D. degrees and professional engineers researching sensing elements of CASA. This will suffuse the professional element throughout the collaboration and ensure that technology is transferred back to industry. Graduate research experiences will be enhanced by cross-campus teaming and faculty and student exchanges across the campuses of the academic and industrial partners of this team. Graduate students participating in CASA from UPRM (which today does not have Ph.D. programs in EE or Meteorology/ Atmospheric Sciences) will be able to work toward Ph.D. degrees in Engineering, Meteorology, or Atmospheric Sciences at UMass and CSU, while spending significant time in residence in Puerto Rico working with faculty and students on the UPRM test bed. A new certificate program in Atmospheric Sensing will be

developed at UPRM, combining courses from three different departments as well as the new courses developed by CASA.

VII.C. Engineering Pipeline/Diversity. CASA offers a unique environment for creating new opportunities for the recruitment and retention of female and minority engineering students. In particular, the UMass College of Engineering has a long pro-active history as a leader in diversity initiatives and a substantial infrastructure in support of students from underrepresented groups on which to build. Combined with CASA's compelling research and collaborative culture, this will be an ERC where women and minority students will flourish. Core partner UPRM, and outreach partners Mount Holyoke College, the DOE and the Springfield, Mass., school district, provide opportunities to increase the participation of underrepresented students. Industrial partners Microsoft and Raytheon have a significant interest in working with us on diversity programs and have programs in place at the UMass and UPRM campuses on which to build.

VII.C.1. Inspiring Female Students To Study Engineering. In 2001, UMass and Mount Holyoke College (MHC), an all-women college, developed an innovative, dual-degree program designed to bring MHC students into the engineering pipeline. Students attending Mount Holyoke are able, in five years time, to graduate with both a B.A. from MHC and a B.S. degree from the UMass College of Engineering (COE). We plan to develop a new ERC-focused, freshman-engineering course (Complex Systems), in collaboration with Mount Holyoke faculty as a mechanism to recruit female students into this dual-degree program. A specific challenge will be to develop curricula that are relevant and engaging to women. We will evaluate the success of the new curricula in attracting women to study engineering and we will disseminate this model and curricula to other liberal-arts colleges and to organizations that support women engineers. The success of this initiative will provide a model for other liberal-arts colleges.

Mount Holyoke College students in the dual-degree program will be recruited for REU positions, as will students from Smith College (which has a new engineering program.)

VII.C.2. A Pipeline for Minority Students. One of the long-standing goals of the UMass COE is to recruit new minority students, at both the undergraduate and graduate levels. Examples of this commitment include our participation in the NSF CSEM Scholarship Program, the National Consortium for Graduate Degrees for Minorities in Engineering and Science (GEM) and as lead institution in the NSF Northeast Alliance for Graduate Education and the Professoriate (NEAGEP). UPRM is also a partner institution in NEAGEP. CASA will continue to build upon these programs by working closely with the Springfield, Mass. public schools. Springfield is the second-largest city in Massachusetts and is located within 30 miles of UMass-Amherst. Springfield has a large minority population (31.18% ethnic minorities) and an excellent community college — Springfield Technical Community College (STCC)— from which to recruit. STCC has provided many diverse students to our undergraduate programs through an articulated transfer agreement.

VII.D. Outreach To The Public And Policy Makers – Lifelong Learning. This ERC has the potential to significantly improve technological literacy due to its broad impact on society and tangible applications of engineering and science. We plan to hold a national one- to two-day open forum – following the annual ERC advisory board meeting or other national forum such as AAAS. We will invite policy makers, journalists, business leaders and other decision makers to address critical topics relating to cost/benefits of observation and warning systems and the component technologies of DCAS. These topics will be informed by our technical work and by our applied social and policy research investigations, our experiences in the field, and our interactions with industrial and government partners. In addition to our K-12 outreach programs, we will work with the Weather Channel and the National Weather Service to develop innovative public education programs and Web-based materials to transfer ERC research.

VII.E. Innovations In Pedagogy, Instructional Technology and Assessment. Instructional technology is a key aspect of providing effective education in the area of complex engineered systems. Although numerous tools are available for learning about weather, visualization tools need to be developed to teach about complex networks of sensors for observing the weather. Multimedia tools for visualizing, analyzing and ultimately designing complex systems will be developed, leveraging previous NSF-funded projects by the PIs. Distance education will be used at all levels to allow inter-partner collaboration and curriculum sharing as well as broad dissemination to K-12 teachers. This also leverages previous projects of the PIs in distance education and retargets curricular materials in the areas of Multimedia Systems and Information Technology. The UMass Center for Educational Assessment will lead the effort in developing and deploying novel assessment tools for engineering curriculum.

VII.F. Education And Educational Outreach Team

The members of the CASA education and outreach team *(Table 7)* have extensive experience for leading this thrust successfully. This effort will be led by a full-time CASA education director. UMass ECE Professor Wayne Burleson, UPRM Professor Sandra Cruz-Pol, and UMass Assistant Dean of Engineering Kathleen Rubin initially will co-chair this team. There is a high priority on including under-represented groups on the education and outreach team and in the search for the CASA education director.

VIII. INDUSTRIAL COLLABORATION/TECHNOLOGY TRANSFER

VIII.A. Overview. Our Industrial Membership Program (IMP) fosters academic-industrial exchanges of practice-oriented knowledge/technology on one hand, and fundamental and enabling technology research on the other. IMP goals are (1) to ensure that the strategic direction and operational plans of CASA address current and future market opportunities; (2) to transfer knowledge and technology into industrial practice and/or R&D by engaging industry in center research projects and test beds; (3) to involve industry in supporting our education programs; (4) to generate resources for CASA including cash, equipment, in-kind expertise, access to labs and foundries, and logistical support for test beds.

Univ. of Mass.	Professor Wayne Burleson (Engineering Education) Asst. Dean Kathleen Rubin (K-12 Education Outreach) Christopher Emery, Physics and Electronics Teacher (ret.), Lecturer – Clinical Faculty, School of Education Morton M. Sternheim, Director, STEM Education Institute
Tufts University	Professor Martha Cyr, Dir., Engin. Education Outreach Ctr
Colorado State University	Professor V.N. Bringi, Electrical and Computer Engineering Prof. Omnia El-Hakim, Civil Engineering
Univ. of Oklahoma	Dr. Kevin Kloesel, Dir. of Outreach, Climatological Survey
Mount Holyoke College	Professor Donald O'Shea, Dean of Faculty
Univ. Puerto Rico Mayaguez	Professor Jose Colom, ECE Department Professor Walter Diaz, Political Sciences Department Professor William Frey, Ethics Ctr., Humanities Department
Mass. Dept. of Education	Dr. David Driscoll, Commissioner Barbara Libby, Math, Science and Pre-Engineering
Springfield, Mass. Public Schools	Dr. Joseph Burke, Superintendent of Schools Erline Provost, Director of Science
Teacher	Don Bjorn, Technology Education, Sutton, Mass., Vice-President, MassTEC
Raytheon Corporation	Greg Shelton, VP, Pietro Ventresca, VP Engineering
Microsoft Research	Scott Williams, Program Manager, University Relations
Polycom	Michael Baker, VP, Vertical Integration & Educ. Markets

Table 7. Education and Outreach Team

VIII.B. Industry Partners and Affiliates. During the development of the CASA pre-proposal, 60 representatives from industry, government agencies, and academia assembled at UMass on April 16, 2002, for a day-long workshop. We have continued to build relationships with a core group of industry partners through "industry days" that were instrumental in shaping our vision and research plan. To date, these partners have committed nearly $2M in support for the first year of CASA. Our strategic mix of industrial members includes sensor and information technology com-

panies that manufacture hardware, software, subsystems, and components (Raytheon, IBM, M/A-Com, Telephonics, Flash Technology, ProSensing); providers of weather sensors, services and forecasts (Vaisala, Baron Services, The Weather Channel, Weather Services International, and Vieux Associates) and private-sector end users of weather products (Texas Medical Center). In addition to private-sector partners, we also are collaborating with federal agencies and laboratories (see section VIII.D). Most of the technology and sensor companies listed here will join CASA as ***Industrial Partners,*** providing cash and in-kind support according to the schedule outlined in Appendix III. The weather-sector and end-user partners also include ***Industrial Affiliates,*** who contribute to CASA principally through in-kind support for test beds and end-user access. As Industrial Affiliates, these suppliers will be important conduits to end users of our systems. Our strategy is to grow our industrial support base by focusing primarily, though not exclusively, on technology partners during the first three years of CASA and then include additional weather service suppliers as our systems-level test beds come on line and generate useful data. Below are examples of activities in which we will engage our Industrial Partners and Affiliates:

- CASA Doctoral Programs, Undergraduate Co-ops, and Engineers-in-Residence. Raytheon currently sends employees to UMass to earn M.S. degrees in microwave engineering and plans to extend that program with a doctoral component focusing on CASA research problems. Raytheon and other companies plan to hire Co-op students who spend academic-year time working with CASA faculty, and several companies have made plans to staff our academic labs with professional engineers to work on components of DCAS systems.
- Collaboration on Research Projects. Low-cost radar is an example of an enabling technology that interests many of our partners, several of whom plan to use their in-house foundries and production capabilities lines to collaborate in developing these sensors. The mix of companies involved in the partnership will enable sensors to be developed in several different ways, ranging from short-term approaches (using off-the-shelf chips), to longer-term strategies that involve new chip designs based on emerging microwave semiconductor fabrication processes (such as Si and SiGe). This flexibility will result in short-term deliverables that can be transferred into industrial practice early in the ERC as well as much longer-term projects.
- Support of DCAS Test Beds. DCAS systems-level test beds are capital and infrastructure-intensive investments, and our strategy for funding them involves leveraging support from our partners. Suitably modified marine radars, for example, will be provided by Raytheon at cost, or through donation or loan, and will be deployed in our field sites. (Five such radars were donated during the development of this proposal and are being used to establish our first campus test beds in Massachusetts and Puerto Rico). The NetRad systems-level test bed will use towers owned and operated by OneNet and the lease costs of tower space will be heavily discounted as a result of Oklahoma's involvement in this research (see support letter). The Texas Medical Center has offered to support the placement of NetRad radars on its rooftops and to support the communication and maintenance of these nodes as well. Likewise, our partnership with Flash Technology and Oak Ridge National Laboratory will enable us to leverage the infrastructure of their "SensorNet" project to deploy sensors atop cellular telephone towers in different regions of the country for future deployments for homeland security. These are a few examples of our strategy to leverage external funding to enable deployment of systems test beds and achieve sustainability for CASA.
- Connection to End Users. Our weather-service partners provide access to many types of end users who are motivated to help us research and deploy DCAS systems. WSI, for example, provides customized weather products to broadcast, aviation, and other sectors; Vieux and Associates provides specialized

flood alerts to Texas Medical Center; The Weather Channel, through its broadcasts, accesses millions of public users; and IBM supports specialized weather predictions to functions such as the Olympics and space launches.

VIII.C. Industrial Membership Program and Advisory Board. Industrial membership and intellectual property policies associated with CASA are outlined in Appendix III. Industrial membership consists of tiered cash fees and in-kind contributions based upon company size. ***Industrial Partners*** enjoy early access to center research of interest, "Technology Alerts," describing breakthrough results, and access to intellectual property (IP) generated by core ERC research. All Partners have royalty-free, non-exclusive access to that IP from core research as well as ability to enter into proprietary sponsored research contracts with center faculty with negotiated exclusivity over IP rights. Partners may receive discounted overhead (indirect costs) on proprietary research at the discretion of the campus involved; may participate in graduate fellow programs for directed research at $25,000 per student; and may access undergraduate students through co-ops. ***Industrial Affiliates*** receive regular reports on CASA projects and may attend semi-annual meetings.

All Industry Partners and Affiliates participate in the Industry Advisory Board (IAB), the formal mechanism for capturing industry input on strategy and operations. Dr. John Armstrong will chair the IAB. He brings outstanding industry expertise from his former position as Vice President for Science and Technology at IBM and through his membership on IBM's corporate management board. He also chairs the National Research Council Committee on Public/Private Partnerships in Weather and Climate Services, and very recently finished serving on the National Science Board. The role of the IAB is described in the Management Section (Section IX).

VIII.D. Government Partners. These partners include federal agencies, such as the National Weather Service and its research affiliate, the National Severe Storms Laboratory (NSSL, where NEXRAD was developed); Oak Ridge National Laboratories; federally funded research and development centers such as the National Center for Atmospheric Research; and state agencies such as the Oklahoma Climatological Survey and OneNet, the statewide Internet service provider across Oklahoma. These agencies will participate on the IAB and interact through project selection and center steering in the same manner as Industrial Affiliates. Examples of planned collaboration are detailed in the letters of support from these groups.

IX. MANAGEMENT

IX.A Institutional Composition, Leadership and Team Diversity.

IX.A.1 The CASA Team. The academic partnership of this ERC contains expertise spanning all critical competency areas of our research initiatives.

UMass-Remote Sensing, Microwave Engineering, Networking, Distributed and Embedded Computing. The largest academic laboratory of its kind in the nation, the Microwave Remote Sensing Laboratory (MIRSL) at UMass designs, fabricates, and field-tests novel microwave systems for studying the atmosphere, ocean, and Earth's surface. The research culture of this lab places high value on group design and collaboration among engineering teams and application scientists. The computer science department at UMass has significant experience in designing large-scale software systems and architectures for complex systems and resource allocation problems. It is ranked among the top 20 computer science departments in the nation. Having led several large-scale collaborative research projects, the networking and distributed systems faculty have received numerous recognitions for outstanding research contributions, as evidenced in the attached biographies.

OU – Meteorology, Weather Data Dissemination, Flooding Hydrology; Infrastructure. University of Oklahoma (OU), at the center of the largest meteorological research, operations and academic community in the nation, brings meteorological research and application elements to this partnership. The Oklahoma Weather Center, which comprises a dozen institutions employing more than 650 people, has many ties to federal, state, and private users of weather data all around the world. OU is home to the Center for the Analysis and Prediction of Storms (CAPS), which is one of the original NSF Science and Technology Centers that has successfully transitioned advanced weather prediction capabilities to the airline, energy, and other sectors. OU's Oklahoma Climate Survey received the Harvard-Kennedy School's Innovations-in-Government award for its OK-First program, which connects radar and in-situ weather network data to emergency managers and schools across Oklahoma.

CSU – Weather Radar Processing, Polarimetric-Based Quantitative Information Extraction. Colorado State University has a distinguished history in Doppler and polarimetric radar data processing to bridge the sensing expertise at UMass with meteorological expertise at OU. The CSU-CHILL Radar, an NSF facility located at CSU, is testament to the expertise at the university on radar engineering and radar meteorology. The CSU-CHILL is jointly managed by the departments of Electrical Engineering and Atmospheric Science. CSU scientists have been pioneers in the development of polarimetric radar techniques, signal processing, radar networking and quantitative information extraction from weather radars. CSU is also home to the Cooperative Institute for Research in Atmosphere, with extensive outreach activities to federal, state and local government as well as industry.

UPRM – Diverse Student Population; Sociology of Weather Hazards; Emerging Antenna Design/Testing and Remote Sensing Group. U. of Puerto Rico-Mayaguez includes expertise in antenna design, remote sensing, and in the sociological response to weather hazards, an important societal impact of CASA research. UPRM's ECE department has maintained a long-term research collaboration with UMass (two of its faculty are graduates of the UMass microwave remote sensing program) recently culminating in a joint Ph.D. program whereby UPRM students can complete doctorates at UMass through research performed at UPRM. (The memorandum of understanding establishing this program is in place). CASA will figure strongly in the development of a strong graduate program at UPRM in electrical and computer engineering.

Outreach Partners. To complement the strengths of the core academic partners, we have arranged for educational outreach and scientific advice in hazards research and in public policy. These partners include U. Colorado (see Section VI.D), Tufts, Rice, U. Delaware and Mount Holyoke (see Sections VII.A.1 and VII.C.1).

IX.A.2 Center Diversity. CASA strongly values diversity on all levels. Currently, under-represented groups account for nearly one-third of the ERC Leadership Team as illustrated in the chart below. This group includes two women, one of whom is African American, the other, Hispanic.

Strengthening Diversity. We will appoint a director of diversity to our advisory board to oversee the outreach efforts of CASA and to link to industry diversity programs. Our approach to expanding participation of underrepresented groups has the following elements:

	Directorship – 7 people	Thrusts – 44 people
Women	Total: 2 UMass, UPRM	Total: 5 UMass, UPRM, Tufts,
Men	Total: 5 UMASS, OU, UPRM, and CSU	Total: 39 UMASS, OU, UPRM, and CSU
Under-represented Racial and Ethnic Groups	Total: 2 UMass, UPRM	Total: 6 UMass, UPRM
Other Racial and Ethnic Groups	Total: 4 OU, UMass, CSU	Total: 38

Table 8. CASA Diversity Statistics

Leadership. CASA will provide doctoral-level graduate training to Hispanic students through joint Ph.D. programs between UPRM and UMass (engineering) and UPRM and CSU (atmospheric sciences). OU has a 3-2 program with Clark-Atlanta, an HBCU. Faculty, undergraduate and graduate student exchanges among all partner campuses of CASA particularly will enhance these programs. Student teams will engineer test beds on Puerto Rico that will engage engineering, meteorology, and emergency management officials as part of their training. The outcome of these programs will be increased numbers of highly educated women and Hispanics in Puerto Rico who can assume leadership positions in science, technology and academic fields immediately after graduation. Moreover, through our strong industrial collaborations, we should be able to address retention of these groups in the workforce.

Faculty CASA will actively support and recruit women and minority faculty for leadership roles. Although several women faculty members will participate in the research initiatives and activities of CASA, we recognize the need to increase this level of participation and leadership. The efforts described above will address pipeline issues; however, we will look to the UMass College of Engineering, which has twice the national average of women faculty, and our partner institutions to replicate their successful approaches to recruiting women faculty.

Students Through the involvement of UPRM (where 40% of the engineering students are women), and Mount Holyoke (where all students are women), we will engage substantial numbers of female and minority students in the research and education programs of CASA.

Mentoring An advisory group of women engineers will be established to mentor faculty and students and suggest ways to recruit and retain women in our programs. We already have begun to assemble an enthusiastic group that includes some of our own graduates, members of our IAB, and government partners.

IX.B. Organizational Structure and Management System

IX.B.1. Organizational Structure. The central management team is shown in Figure 11. The members of this team are responsible for different aspects of CASA's vision. Director McLaughlin will have overall responsibility for integrating and maintaining CASA's vision for DCAS systems, with responsibility for final approval of the annual budget, strategic direction, and research priorities. Deputy Director Droegemeier of OU will assist the director with strategic planning and center oversight and will focus on meteorological applications of DCAS in conjunction with Associate Director Fred Carr. Jim Kurose of UMass will focus on software and system architecture, while V. Chandrasekar of CSU will focus on quantitative information extraction of sensor data, and Sandra Cruz-Pol of UPR will focus on education aspects of the vision. The executive director, Brenda Philips, will work closely with the director, participating in strategic planning and also managing day-to-day operations of the entire collaboration. Her duties will include ensuring effective communications between and among internal and external stakeholders; assembling information for project reports; and handling financial management. These ERC directors, collectively known as the central management team, orchestrate CASA's overall scientific direction; recruit new industry and government agencies to take part; enforce the highest standards in ethics and research quality; develop diversity; monitor progress relative to established milestones; and promote broad dissemination of results. The central management team meets weekly via teleconference.

Research Thrust Areas, Technical Integration Team, and End-User Integration Team. Each research thrust is led by two faculty members from different departments or partner schools. The leaders manage and ensure timely progress of research and identify problems and new opportunities. A technical liaison drawn from among each institution's participants will coordinate test bed activity on each campus, and the technical liaisons will be known collectively as the Technical Integration Team. The End-User Integration Team

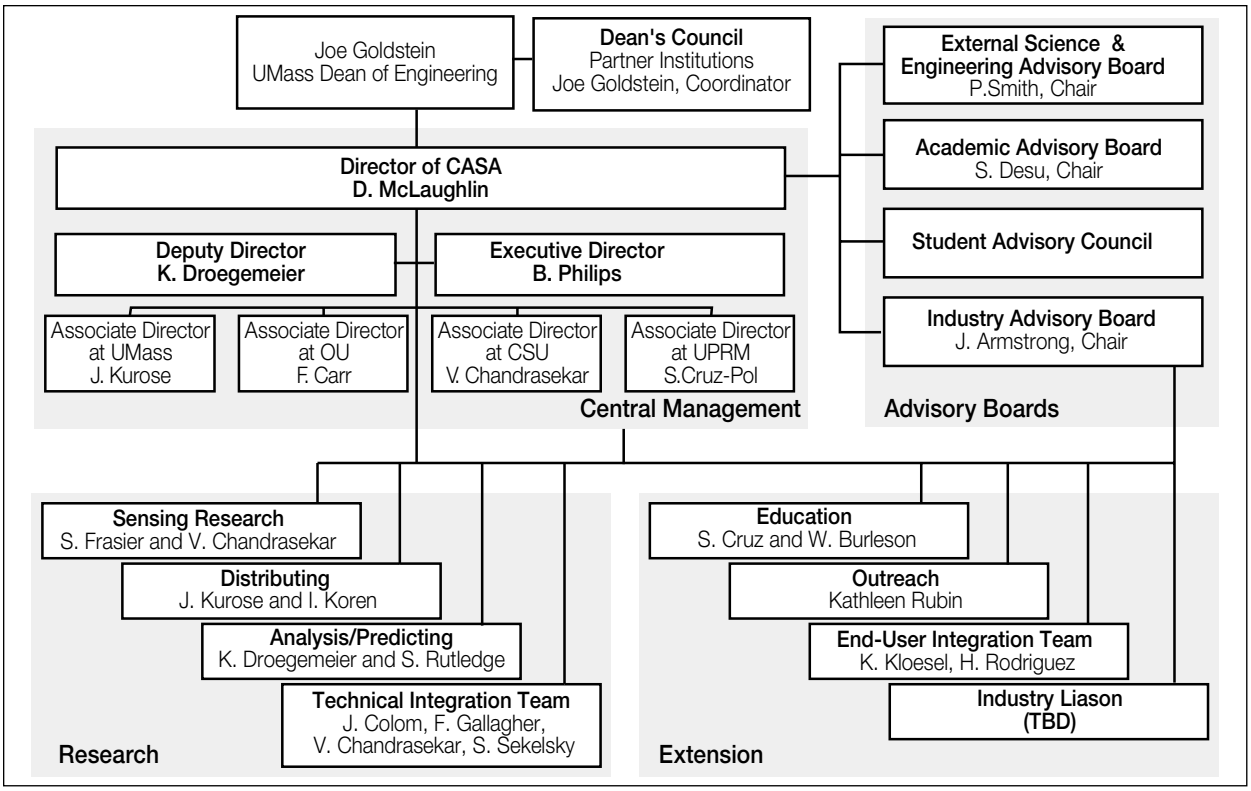

Figure 11. CASA Management Structure

will report to the central management team to maintain the combined technical, application, and entrepreneurial foci needed to create the two-way end-user interface of DCAS.

Industrial Liaison and Administration. An Industrial Liaison maintains relationships with our industrial partners, ensures they have knowledge of IP and other technology transfer opportunities, connects them to CASA researchers and projects; and participates in recruiting new members. Additional administrative functions including financial reporting and event planning supports the ERC. This group reports to the executive director.

Education and Outreach. Each partner school has an education representative whose activities are coordinated by a full-time education director located at UMass and by the director of outreach for K-12 activities.

Advisory Boards. External advice on research and project selection will come from semi-annual meetings of our Industrial Advisory Board (IAB, see Section VIII.C). In addition, a Scientific and Engineering Advisory Board, led by Dr. Paul Smith, who chaired the NRC panel, "Weather Technology Beyond NEXRAD," will be appointed to advise the central management team on all aspects of the project and will meet yearly. A Student Advisory Board will provide input and organize activities to promote educational opportunities in the ERC.

IX.B.2. Management System

Key foci of the management process include project selection and strategic planning, integration and communication, increasing diversity, and decentralized management of initiatives and projects.

Vertical Integration and Communication. Integration of CASA's activities occurs structurally through the design and implementation of systems-level test beds and the evolution of smaller-scale test beds on each core campus. Regular meetings, via the Access Grid and desktop video conferencing, will facilitate communi-

cation. Through these, individual project researchers will collaborate regularly, and sufficient travel support has been requested to accommodate several face-to-face collaborations per year as well as attendance at conferences. Once each year, an "all-hands" meeting will be held at one of the core campus sites.

Project Selection and Strategy. CASA's strategic research plan will be influenced by input from the IAB, the SAB, and the results of research projects themselves. One IAB meeting during each year will review strategy and incorporate end-user input to ensure research and test bed activities are proceeding toward the end-to-end systems goals of DCAS. The second meeting each year will be used to update and recommend specific projects for funding in the following year based on research proposals submitted by faculty investigators. These proposals will establish objectives and goals and serve as a vehicle for assessment and evaluation of research progress. A committee staffed by representatives of the IAB and center researchers will perform assessment and evaluation and make recommendations to the central management team on project funding for the following year. The central management team will allocate funds, with the director maintaining final responsibility for approving projects and maintaining the budget. In this way, CASA will move toward its systems-level goals, but adjust the budget and priorities to take advantage of unforeseen opportunities, discontinue unsuccessful projects, and ensure that the projects are aligned with the needs and interests of the Industrial Partners. In the event that projects are discontinued, a phase-down approach will be used to protect the graduate students involved.

IX.C. Headquarters and Equipment Infrastructure. The Headquarters for CASA will be located on the ground floor of Marcus Hall on the UMass campus, where 7,000 square feet of laboratory and office space are committed for renovation upon notification of funding for CASA. This new space will include administrative offices, conference and telecommunications facilities, laboratories supporting CASA research hardware and test beds; and office space for graduate students and engineers-in-residence. Marcus Hall houses the administrative offices for the Department of Electrical and Computer Engineering and is adjacent to the College of Engineering administrative offices in Marston Hall, and to the Knowles Engineering Building, which houses the Microwave Remote Sensing Laboratory. It is also in close proximity to the Computer Science Building.

IX.D. Receptivity of Academic Institution to ERC Culture. The CASA director reports to the UMass Dean of Engineering, Joseph Goldstein, who helped develop one of the first ERCs, at Lehigh University (ATLSS). Dean Goldstein will chair an Advisory Council composed of appropriate deans from the partner institutions. An Academic Advisory Board will be led by Dr. Seshu Desu, department head of ECE, who will advise the central management team on matters relating to academic issues. On this advisory board will be the vice chancellor for research, pertinent department heads, and one or two faculty members. Liaison will be made with partner institutions. This reporting structure aligns the strategic needs of the center with critical decisions on faculty hiring, tenure and promotion, and space allocations that are ultimately approved by the administration. This structure also allows for expansion of the Microwave Remote Sensing Laboratory, which is a strategic focus area within the College of Engineering at UMass. As an outgrowth of that laboratory, with collaborations within the microwave and computer engineering groups, this ERC is well-aligned with the growth strategies of the College of Engineering and the Department of Electrical and Computer Engineering (ECE). Two additional faculty members will be hired within the ECE Department in CASA research thrust areas. Likewise, the distributing aspects of the ERC are aligned with the strategic plan for growth in the UMass Computer Science Department, and an additional faculty member will be hired there as well. The director of CASA will work with the departments involved to establish and staff search committees for these new positions and will be consulted on tenure and promotion decisions for faculty involved with CASA research.

IX.E. Financial Planning and Support. The financial model for CASA is based on the evolution of the systems technology and the increasing potential for industry and government funding as systems mature and can offer more value. In the early years of CASA, as fundamental research and small-scale test bed projects dominate the agenda, NSF will fund most activities, along with contributions from sensor manufacturers. When the first large test bed is implemented in Oklahoma, and data begin to flow, we expect to attract many new industrial members who use weather data to create customized forecasts for end users. By the time the CLEAR systems are implemented, we anticipate significant industrial participation in CASA. From the outset, we will solidify partnerships with major collaborators such as Oak Ridge National Laboratory and other entities. We are confident that NSF funds and existing scientific and industrial partnerships are sufficient to realize the first systems-level test beds within CASA.

Source	Cash	In-Kind	Total
Industry	225k	1,590k	1,815k
Total University cost sharing	1,208k	454k	1,662k
State Gov	-	53k	53k
Local Gov.	-	-	-
Other Federal Agency	-	40k	40k
Other	-	-	-
Total	1,433k	2,137k	3,570k
Requested from NSF	2,500k	-	2,500k
Total	3,933k	2,137k	6,070k

Table 9. Committed Support for Year 1 and Request from NSF

Source/ Support /	Industry	University	State/ Local Gov	Other Fed. Agencies	Other	NSF	Total
Sensing		575k				360k	935k
Distributing		276k				200k	477k
Predicting		111k				179k	290k
Total Research		**963k**				**739k**	**1702k**
Shared Equipment & Facilities	1,684k	97k	39k	40k		491k	2,352k
Education & outreach	50k	142k	14k			184k	377k
End user Integration		73k				168k	241k
Industrial Collab.	81k						81k
Mgt.		388k				188k	576k
Travel						69k	69k
Indirect Cost						661k	661k
Total	**1,815k**	**1,662k**	**53k**	**40k**		**2,500k**	**6,070k**

Table 10. Functional Budget for Year 1 for Committed & Requested NSF Funds

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Biographical Sketch
David J. McLaughlin

David McLaughlin received his BS and PhD degrees in Electrical Engineering from UMass in 1984 and 1989, respectively. He spent 10 years on the ECE faculty at Northeastern University where he created the Radar Systems Laboratory and led research in the area of bistatic radar. While at Northeastern, he also led the development of that university's BS degree program in Computer Systems Engineering. Since 1999 he has been with the ECE faculty at UMass, where he is the Armstrong Professor of Engineering and Director of the Microwave Remote Sensing Laboratory. He has conceived and developed numerous radar and remote sensing systems including the "C-Scat" radar that routinely flies on NOAA research aircraft to gather data on hurricanes.

A. Professional Preparation

Doctor of Philosophy, Electrical and Computer Engineering, University of Massachusetts, September 1989
Bachelor of Science, Electrical and Computer Engineering, University of Massachusetts, May 1984

B. Appointments

Armstrong Professor, University of Massachusetts, 1/2002 to present. Department of ECE.
MIRSL Director, University of Massachusetts, 9/98 to present. Department of ECE.
Associate Professor, University of Massachusetts, 1/2000 to 12/2001. Department of ECE.
Associate Professor, Northeastern University, 9/95 to 12/99. Department of ECE.
Visiting Scientist, Rome Air Development Center, USAF, Hanscom AFB, 9/94 to 5/95. Electromagnetic Scattering Group.
Summer Faculty Research Fellow, Rome Air Development Center, USAF, Hanscom AFB, 6/96 to 9/96. Electromagnetic Scattering Group.
Assistant Professor, Northeastern University, 9/89 to 8/95. Department of ECE.
Summer Faculty Research Fellow, Naval Research Laboratory, US Navy, Washington DC, 6/89 to 9/89. Remote Sensing Division.
Summer Faculty Research Fellow, Naval Research Laboratory, US Navy, Washington DC, 6/89 to 9/89. Radar Division.

5 Publications Relevant to this Proposal

D.J. McLaughlin, Y. Wu, W.G. Stevens, and M.J. Sowa, "Fully Polarimetric Bistatic Scattering Measurements of Forested Hills," **IEEE Transactions Antennas and Propagation,** Vol. 50, pp. 101-110. January 2002.

Pazmany, A., J.B. Mead, S.M. Sekelsky, D.J. McLaughlin, and H. Bluestein, "Multi-Frequency Radar Estimation of Liquid Cloud and Precipitation Properties using an Artificial Neural Network," **preprints of the American Meteorological Society Radar Conference,** July 1, 2001, Munich, Germany.

M.A. Sletten, G.O. Marmorino, T.F. Donato, D.J. McLaughlin, and E.M. Twarog, "An Airborne, Real Aperture Radar Study of the Chesapeake Bay Outflow Plume," **Journal of Geophysical Research -- Oceans,** Vol. 104, No, C1, January 1999, pp. 1211-1222.

N. Allan, D.B. Trizna, and D.J. McLaughlin, "Numerical Comparison of Technigques for Estimating Doppler Velocity Time-Series from Coherent Sea Surface Scattering Measurements," **IEE Proceedings – Radar, Sonar, and Navigation,** Vol. 145, No. 6, December 1998, pp. 367-373.

D.J. McLaughlin, Z. Ren and Y. Wu, "A Bistatic Polarimeter Calibration Technique," **IEEE Transactions on Geoscience and Remote Sensing,** Vol. 33, No. 3, May 1995, pp. 796-799.

Synergistic Activities

- Director of the Microwave Remote Sensing Laboratory
- Frequent participant in remote sensing field campaigns aimed at understanding hurricanes, tornadoes, and other terrestrial, atmospheric, and oceanic phenomena.

Recent Non-UMASS Collaborators

Pete Black (NOAA/AOML/HRD), Frank Marks (NOAA/AOML/HRD), Howie Bluestein (OU), Paul Chang (NOAA/NESDIS), Mark Sletten (NRL), Nick Allan (NRL), Dennis Trizna (NRL), William Stevens (USAF), Mike Sowa (USAF), Yuliang Wu (Raytheon), Jim Mead (ProSensing)

Graduate Advisor

Prof. Robert McIntosh, Department of Electrical and Computer Engineering, College of Engineering, University of Massachusetts – Amherst.

Graduate Students and Post-Docs Supervised

Nicholas Allan (Ph.D), Yuliang Wu (Ph.D.), Elizabeth M. Twarog (M.S., Ph.D.), Alex Zhang (M.S., Ph.D., post doc), Nicholas Hamawi (M.S.), Timothy Kearney (M.S.), Ahren Hartman (M.S.), Eugene Boltniew (E.E.), Jeffrey Barclay (M.S.), William Stevens (M.S.), Zhikui Ren (M.S.), Vidhya Tharanjaran (M.S.)

Kelvin K. Droegemeier
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Kelvin K. Droegemeier has been working in the areas of numerical atmospheric simulation and prediction since beginning his doctoral work in 1980 at the University of Illinois at Urbana-Champaign. He has authored more than 250 refereed and conference publications on thunderstorm dynamics and predictability, data assimilation, mesoscale dynamics, computational fluid dynamics, massively parallel computing, and aviation weather. He has received numerous awards, including the NSF Presidential Young Investigator Award, NSF Pioneer Award, *Discover Magazine* Award for Technology Innovation, *Computerworld* Smithsonian Award, NOAATech 2002 Award, and the FAA Excellence in Aviation Award. Dr. Droegemeier also is one of the youngest Fellows of the American Meteorological Society.

Dr. Droegemeier co-founded the NSF Science and Technology Center for Analysis and Prediction of Storms, and continues to serve as its director. He has been a major force behind the development and application of high performance computing, serving most recently on the NSF Blue Ribbon Panel for Cyberinfrastructure. He initiated and currently directs the Collaborative Radar Acquisition Field Test (CRAFT), which is a national project directed toward developing strategies for the real time delivery of NEXRAD radar data via the Internet. In his more than 18 years at the University of Oklahoma, Dr. Droegemeier has generated over $28 million in external research funding and graduated more than two dozen students. He currently is a member of the UCAR Board of Trustees and serves on several National Academy committees.

Professional Preparation

University of Oklahoma	Meteorology	B.S., 1980
University of Illinois at Urbana-Champaign	Atmospheric Sciences	M.S., 1982
University of Illinois at Urbana-Champaign	Atmospheric Sciences	Ph.D., 1985

Academic and Professional Appointments

Regents' Professor, School of Meteorology, University of Oklahoma, October 2001

Professor, School of Meteorology, University of Oklahoma, July 1998-Present

OU Associates Foundation Presidential Professor, University of Oklahoma, 1998-2002

Founder and Director, Environmental Computing Applications System,1996-2002

Director, Center for Analysis and Prediction of Storms (NSF Science and Technology Center), University of Oklahoma, July 1994-Present

Associate Professor, School of Meteorology, University of Oklahoma, 1991-1998

Director of Model Development Program, Center for Analysis and Prediction of Storms, University of Oklahoma, 1989-1994

Visiting Senior Fellow, Army High Performance Computing Research Center, University of Minnesota (Sabbatical) 1 January - 30 June 1992

Deputy Director, Center for Analysis and Prediction of Storms, July 1991-February 1992

Assistant Professor, School of Meteorology, University of Oklahoma, 1985-1991

Co-Founder and Deputy Director for Research, Center for Analysis and Prediction of Storms, 1989-1991

Graduate Research Assistant, University of Illinois, 1980-1985

5 Publications Relevant to this Proposal

Droegemeier, K.K., 1997: The numerical prediction of thunderstorms: Challenges, potential benefits, and results from realtime operational tests. *WMO Bulletin*, **46**, 324-336.

Xue, M., D.-H. Wang, J.-D. Gao, K. Brewster, and K. K. Droegemeier, 2002: The Advanced Regional Prediction System (ARPS), storm-scale numerical weather prediction and data assimilation. In press for *Meteor. and Atmos. Physics*.

Droegemeier, K.K. and Co-Authors, 2002: Project CRAFT: A test bed for demonstrating the real time acquisition and archival of WSR-88D Level II data. Preprints, *18th Int. Conf. on Interactive Information Processing Systems (IIPS) for Meteorology, Oceanography, and Hydrology*, 13-17 January, Amer. Meteor. Soc., Orlando, Florida, 136-139

Ware, R.H., D.W. Fulker, S.A. Stein, D.N. Anderson, S.K. Avery, R.D. Clark, K.K. Droegemeier, J.P. Kuettner, J.B. Minster, and S. Sorooshian, 2001: Real time national GPS networks for atmospheric sensing. *J. Atmos. and Solar-Terr. Phys*., **63**, 1315-1330.

Weygandt, S.S., A. Shapiro and K.K. Droegemeier, 2002: Retrieval of initial forecast fields from single-Doppler observations of a supercell thunderstorm. Part I: Single-Doppler velocity retrieval and Part II: Thermodynamic retrieval and numerical prediction. *Mon. Wea. Rev*, **130**, 433-453 and 454-476.

5 Other Significant Publications

Johnson, K.W., J. Bauer, G.A. Riccardi, K.K. Droegemeier, and M. Xue, 1994: Distributed processing of a regional prediction model. *Mon. Wea. Rev*., **122**, 2558-2572.

Sathye, A., G. Bassett, K. Droegemeier, M. Xue, and K. Brewster, 1996: Experiences using high performance computing for operational storm scale weather prediction. *Concurrency: Practice and Experience*, **8**, 731-740.

Xue, M., K. K. Droegemeier, and V. Wong, 2000: The Advanced Regional Prediction System (ARPS) - A multiscale nonhydrostatic atmospheric simulation and prediction model. Part I: Model dynamics and verification. *Meteor. and Atmos. Physics*., **75**, 161-193.

Xue, M., K. K. Droegemeier, V. Wong, A. Shapiro, K. Brewster, F. Carr, D. Weber, Y. Liu, and D.-H. Wang, 2001: The Advanced Regional Prediction System (ARPS) - A multiscale nonhydrostatic atmospheric simulation and prediction tool. Part II: Model physics and applications. *Meteor. and Atmos. Physics*, **76**, 134-165.

Hou, D., E. Kalnay, and K.K. Droegemeier, 2001: Objective verification of the SAMEX '98 ensemble forecasts. *Mon. Wea. Rev*., **129**, 73-91.

Synergistic Activities

- Co-founder and Director, NSF Science and Technology Center for Analysis and Prediction of Storms (graduated in 2000)
- Founder and director of the Collaborative Radar Acquisition Field Test (Project CRAFT)
- Member of the NSF Blue Ribbon Panel on Cyber Infrastructure and NSF Geosciences Directorate Advisory Committee
- Founder and director of the Environmental Computing Applications System

Recent Non-OU Collaborators

Eugenia Kalnay, Efi Foufoula-Georgiou, David Fulker, Tim Crum, David Montroy, Denise Russell, Linda Miller, Michael Eilts, Greg Wilson, Ming Xue, Frederick Carr, Alan Shapiro, David Jahn, Daniel Weber, Jidong Gao, Qin Xu, Rick Anthes, Stephen Weygandt, Yvette Richardson, Ray Ban, Michael Kleist, Steve Leyton, T. Adam Kelly, Michael R. Smith, Ben Domenico, Beth Plale, Dennis Gannon, Robert Wilhelmson, Sara Graves, Mohan Ramamurthy, Richard Clark, Sepideh Yalda, Everette Joseph, Steven R. Smith, Keith Brewster, Jerry Brotzge, Jason Levit, Richard Carpenter, Gene Bassett, Kevin Kelleher, Dingchen Hou, Roger Pielke, Jr., Edwin Adlerman, Randolph Ware, Daniel Harris, Rick Anthes, Vince Wong, Seon-Ki Park, Anil Rao, Henry Fuelberg, Robert Davies-Jones, Douglas Lilly, Luther White, Zhi Wang.

Graduate Advisor

Dr. Robert Wilhelmson, Professor of Atmospheric Sciences, University of Illinois at Urbana-Champaign

Graduate Students and Post-Docs Supervised

Graduate Students (21 degrees completed, 7 students in progress): Students Completed: Richard Carpenter (M.S., Ph.D.), Kimberly Carver (M.S.), Steven Lazarus (M.S., Ph.D), Kriste Lyon Paine (M.S.), William McPherson (M.S.), Renee McPherson (M.S.), James T. Johnson (M.S.), Michael Babcock (M.S.), Yong Li (Ph.D.), Hao Jin (M.S.), David Jahn (M.S.), Seon-Ki Park (Ph.D.), Stephen Weygandt (Ph.D), Edwin Adlerman (M.S), Jason Levit (M.S.),Yvette Richardson (Ph.D.), DeWayne Mitchell (M.S.), Xuechao Yu (M.S.), Matthew Miller (M.S.) Current Students: Edwin Adlerman (Ph.D), Hee-Dong Yoo (Ph.D.), Ernani Nascimento (Ph.D.), Gary Foulks (M.S.), Nicki Hickmon (M.S.), Janelle Janish (M.S.), Xuechao Yu (Ph.D.). Post-Docs (9 total to date): Gary Dietachmayer, Shian-Jiann Lin, Miodrag Rancic, Alan Shapiro, Ming Xue, Vince Wong, Gene Bassett, David Zhi Wang, Donghai Wang.

Biographical Sketch
James F. Kurose

Jim Kurose has been working in the areas of computer networking, operating systems, performance modeling, and multimedia systems since 1980, beginning with his PhD research at Columbia University. Professor Kurose is the author of more than 150 journal and conference papers. He has received several best paper awards for his research contributions. He was elected a Fellow of the IEEE in 1997 "For contributions to the design of real-time communication protocols" and a Fellow of the ACM in 2002 "For contributions to the design and analysis of network protocols, and for technical leadership in the field."

Professor Kurose has led a number of multi-PI research efforts at the University of Massachusetts, and he and his research group have been involved in a number of large-scale experimental network research testbed efforts including DARTnet, ABone, and Emulab. He recently chaired the October 2002 NSF Workshop on Research Network Testbeds. He has experience with large scale software system development through these efforts, and through his work at IBM on a software product for modeling resource contention systems including distributed and networked systems. He has been Chairman of the Department of Computer Science, and has held a number of leadership positions within the IEEE Communications Society and ACM Sigcomm.

A. Professional Preparation

Doctor of Philosophy, Computer Science, Columbia University, May 1984
Masters of Science, Computer Science, Columbia University, May 1980
Bachelor of Arts, Physics, Wesleyan University, May 1978

B. Appointments

Professor, University of Massachusetts, 9/96 to present. Department of Computer Science.
Department Chair, University of Massachusetts, 9/98 to 6/01. Department of Computer Science.
Visiting Professor, INRIA, Sophia Antipolis, France, 9/97 to 2/98. RODEO Project.
Visiting Scientist, Institut Eurecom, Sophia Antipolis, France, 2/98 to 6/98. Multimedia Networking.
Associate Professor, University of Massachusetts, 9/90 to 8/96. Department of Computer Science.
Visiting Scientist, IBM Thomas J. Watson Research Center, 9/90 to 8/91. Communications group.
Assistant Professor, University of Massachusetts, 9/84 to 8/90. Dept. Computer Science.
*Consultant, Programmer*IBM TJ. Watson Research Center, 9/80 to 5/88. Performance Modeling and Methodology

C1. Recent Publications: related to this proposal.

J. Kurose (ed.), "NSF Workshop on Network Research Testbeds," Report to National Science Foundation, Nov. 2002.

D. Rubenstein, J.Kurose, and D. Towsley, "Detecting Shared Congestion of Flows Via End-to-end Measurement," *IEEE/ACM Transactions on Networking*, Volume 10, Number 3, June 2002.

D. Rubenstein, J. Kurose, D. Towsley, "A Study of Proactive Hybrid FEC/ARQ and Scalable Feedback Techniques for Reliable Real-Time Multicast," *Computer Communications Journal,* March 2001.

R. Ramjee, T. LaPorta, J. Kurose, D. Towsley, "Migration policies for user agents in wireless networks," *IEEE Journal on Selected Areas in Communications*, Volume: 18 Issue: 11 (Nov. 2000), pp. 2465 - 2477

S. K. Kasera, S. Bhattacharyya, M. Keaton, D. Kiwior, J. Kurose, D. Towsley, S. Zabele, "Scalable fair reliable multicast using active services," *IEEE Network Magazine,* January 2000

M. Adler, Z. Ge, J. Kurose, D. Towsley, S. Zabele, "The Channelization Problem in Large Scale Data Dissemination," *IEEE 2001 Int. Conf. on Network Protocols,* pp. 00 -109

C2. Recent Publications: other significant work.

C. Zhang, B. DeCleene, J. Kurose, D. Towsley, "Comparison of Inter-Area Rekeying Algorithms for Secure Wireless Group Communications," *2002 IFIP Performance Conference* (Rome, Sept. 2002).

B. DeCleene, L. Dondeti, S. Griffin, T. Hardjono, D. Kiwior, J. Kurose, D. Towsley, S. Vasudevan, C. Zhang, "Secure Group Communications for Wireless Networks," *IEEE MILCOM 2001*, Nov. 2001, pp. 113 -117.

M. Bradshaw, B. Wang, S. Sen, L. Gao, J. Kurose, P. Shenoy, D. Towsley, "Periodic broadcast and patching services: implementation, measurement, and analysis in an Internet streaming video testbed, " *Proc. ACM Multimedia 2000*, (Ottawa, Canada), pp. 280 - 290.

B. Levine, J. Crowcroft, C. Diot, J.J. Garcia-Luna Aceves, J. Kurose, "Consideration of Receiver Interest in Content for IP delivery," *Proc. IEEE Infocom 2000* (Tel-Aviv, Israel, March, 2000)

D. Synergistic activities

Dr. Kurose is the past Editor-in-Chief of the *IEEE Transactions on Communications* and was the founding Editor-in-Chief of the *IEEE/ACM Transactions on Networking*. He has been active in the program committees for IEEE *Infocom,* ACM *SIGCOMM*, and ACM *SIGMETRICS* conferences for a number of years, and has served as Technical Program Co-Chair for these conferences. He has been a member of program committees for a number of other conferences, including *IWQoS, NOSSDAV*, and *ICDCS;* and has served on various panels for the National Science Foundation, the National Academy of Sciences, and DARPA.

He is the eight-time recipient of the Outstanding Teacher Award from the National Technological University (NTU), the recipient of the Outstanding Teacher Award from the College of Natural Science and Mathematics at the University of Massachusetts, the recipient of the 1996 Outstanding Teaching Award of the Northeast Association of Graduate Schools, and the 2002 recipient of the IEEE Computer Society Taylor Booth Medal. He was named Massachusetts 2002 Workforce Development Leader of the Year by the Massachusetts Telecommunication Council and received the UMass President's award for his efforts leading the statewide CITI (Commonwealth Information Technology Initiative) – a Massachusetts Board of Higher Education collaborative effort among the 28 campus of public higher education in the state. With Keith Ross, his is the co-author of Computer Networking – a Top-Down Approach Featuring the Internet (Addison-Wesley 2000). He is a Fellow of the IEEE and the ACM.

E. List of Collaborators in last 48 months (not including current UMass collaborators):

S. Bhattacharyya (Sprint), C. Casetti (Politecnico Torino), D. Clark (MIT), J. Crowcroft (UCL), B. DeCleene (Alphatech), C. Diot (Sprint), L. Dondeti (Nortel), J.J. Garcia-Luna Aceves (UCSC), S. Griffin (Nortel), G. Hjalmtysson, R.H. Hwang (National Cheng Chung Univ. Taiwan), V. Firoiu (Nortel), A. Karlin (Washington), S.K. Kasera (Lucent), M. Keaton (Alphatech), D. Kiwior (TASC), R. Koodli (Nokia), T. LaPorta (Bell Labs), F. LoPresti (AT\&T), D. MacAuley (Microsoft), S. Moon (Sprint), R. Nagarajan (Bell Labs), E. Nahum (IBM), J. Padhye (ACIRI), D. Patterson (Berkeley), R. Ramjee (Bell Labs), D. Rubenstein (Columbia), K. Ross (EURECOM), S. Sahu (IBM), S. Sen (AT&T) ,J. Salehi, S. Savage (UCSD), M. Yamamoto (Osaka U.), M. Yajnik (Telcordia), S. Zabele (ALphtech), E. Zegura (GaTech) ,Z.L. Zhang (Minnesota).

List of Completed PhD advisees in last five years:

S. Bhattacharyya, T. Bu, T. Friedman, V. Firoiu, S. Kasera, S. Moon, E. Nahum, J. Padhye, R. Ramjee, D. Rubenstein, S. Sahu, J. Salehi, S. Sen, D. Yates, M. Yajnik, Z. Zhang.

Names of graduate advisors:

M. Schwartz (Columbia), Y. Yemini (Columbia)

Biographical Sketch
V.Chandraekar

Dr. Chandrasekar (Chandra) has made pioneering contributions in the area of "Polarimetric Radar Observations of the Atmosphere". Dr Chandra has extensive experience in Radar System Design, Radar Network Development, DSP Design as well as RF Communication Systems. He has contributed significantly to the areas weather radar and applications to Atmospheric Sciences. He also conducts research on related topics including Image Processing, Neural Network Applications and Large Scale System Simulation. He has organized and participated in six large multi-agency, national level experiments involving many radars, aircraft and ground instrumentation. He was a Co-PI on the Advanced Communication Technology Satellite (ACTS) program at CSU and the CO-PI on the CSU-CHILL radar facility. He has served on design review panels of major development projects such as the NCAR ELDORA Airborne Doppler Radar Systems. He is a Science Team Member of the NASA TRMM mission. He is a member of the National Academy of Sciences panel on " Future Radar Systems beyond NEXRAD " . He has won numerous awards including, *the NASA Technical innovation Award , 2002, Cermack Outstanding Advisor Award, 2001, Abell Outstanding Researcher Award, 2001, Distinguished Minority Service Award , 1999, Deans Council Award for Excellence in Teaching and Research, 1996, Halliburton Foundation Young Faculty Research Excellence Award, 1993.*

EDUCATION: Ph.D. Colorado State University, 1986

APPOINTMENTS:

1998 – Current	Professor, Colorado State University
1993-1998:	Associate Professor, Colorado State University
1990-1993:	Assistant Professor, Colorado State University
1989-1990:	Assistant Professor, University of Alabama in Huntsville
1986-1989:	Research Assistant Professor, Colorado State University

PUBLICATIONS:

Text Books

i) Co-author "***Polarimetric Doppler Weather Radar***", Cambridge University Press, ISBN 0 -521-62384-7, 2000.

i) Co-author of undergraduate textbook, "***Proability and Random Processes***" *McGraw-Hill,* ISBN 0-07-001563-5, 1997.

Articles Author/co-author of over 80 Journal articles and 130 Conference papers.

FIVE PUBLICATIONS RELATED TO THE PROPOSAL

1. H. Liu and V. Chandrasekar, 2000: "Classification of Hydrometeors based on Polarimetric Radar Measurements: Development of A Fuzzy Logic System and In-situ Verification". *J. Atmos, Ocean. Tech.,* Vol. 17, pp. 140-164.
2. A. Mudukatore, V. Chandrasekar and R.J. Keeler, 1998: "Pulse Compression for Weather Radars", *IEEE Trans GRSS*, Vol. 36, No. 1, pp. 125-142.
3. I.J. Caylor and V. Chandrasekar, "Time Varying Ice Crystal Orientation Observed with Multiparameter Radar", *IEEE Trans GRSS*, Vol. 34, No. 4, pp. 847-858, 1996.
4. E. Gorgucci, G. Scarchilli and V. Chandrasekar, 1992: "Calibration of Radars Using Polarimetric Techniques", *IEEE Transaction of Geoscience and Remote Sensing,* Vol. 30, No. 5, pp. 853-858.
5. V. Chandrasekar, J. Hubbert, V.N. Bringi and P. Meischner, 1994: "Transformation of Dual-Polarized Radar Measurements to Arbitrary Polarization Bases", *J. Tech.,* Vol. 11, No. 4, pp. 937-949.

FIVE OTHER PUBLICATIONS

1. V. Chandrasekar and V.N. Bringi, 1987: "Simulation of Radar Reflectivity and Surface Measurements of Rainfall", *J. Atmos. Ocean. Tech.,* Vol. 4, No. 3, pp. 464-478.
2. V. Chandrasekar and R.J. Keeler, 1993: "Antenna Pattern Analysis and Measurements for a Multiparameter Radar", *J. Tech.,* Vol. 10, No. 5, pp. 673-683.
3. V. Chandrasekar. G.R. Gray, V.N. Bringi, and R.J. Keeler, 1988: "Efficient Differential Reflectivity Processing from Logarithmic Receivers", *J. Atmos, Ocean. Tech.,* Vol. 6, No. 4, pp. 663-670.
4. V. Chandrasekar, W.A. Cooper and V.N. Bringi, "Axis Ratios and Oscillations of Raindrops", *JAS*, Vol. 45, No. 8, pp. 1323-1333.
5. V. Chandrasekar, G.R. Gray and J. Caylor, 1993: "Auxiliary Signal Processing System for a Multiparameter Radar" *J. Atmos. Ocean. Tech.,* Vol. 1, No. 2, pp. 586-592.

SYNERGISTIC ACTIVITIES

Dr Chandra has served as the REU Director for over 10 years, promoting undergraduate research participation. He has actively participated in educational outreach efforts by offering distance education courses as well as building online educational programs associated with the CSU-CHILL radar. He was a founding member of the " Undergraduate research initiative" at CSU. Dr Chandra has served as the associate editor of J. Atmospheric and Oceanic technology as well as *JAM.* He is a member of the IEEE ADCOM , AMS Commission on radar meteorology and has served on AGU committee on precipitation and NSF panels. Dr chandra serves as the departmental advisor for the honors program.. He has advised 15 Masters students and 14 Ph.D. students. He is a long standing member of the Technical program committees of AMS conference on radar meteorology as well as IEEE conference on Geoscience and Remote Sensing.

LIST OF SCIENTISTS WITH PAST COLLABORATION:

1)Dr. W. Krajewski, University of Iowa, 2) Dr. J. Smith, Princeton University ,3)Dr V.N.Bringi, Colorado State University, 4) Dr. Steven Rutledge, Colorado State University, 5) Dr K.Knupp, University of Alabama in Huntsville, 6) Dr R.Doviak, National Severe Storms Laboratory, 7) Dr R.J Keeler (NCAR)

Sandra L. Cruz-Pol, PhD.

Electrical and Computer Engineering Department
University of Puerto Rico, Mayagüez, PR 00681-9042
http://ece.uprm.edu/~pol
SandraCruzPol@ieee.org
Tel. (787)832-4040 x2444 Fax (787) 831-7564

Sandra Cruz Pol received her BS from UPRM, MS from UMass and PHD from Penn State University, all in Electrical Engineering and with the Magna Cum Laude distinction. Her graduate research included the calibration of the Microwave Atmospheric Absorption Model near 22 GHz and the Ocean Emissivity Model for Microwave Brightness Temperatures seen from space over calm ocean utilizing data from the TOPEX/Poseidon Satellite Mission and ancillary oceanographic and atmospheric data.

She is currently an Associate Professor and the director of the Laboratory CLiMMATE (CLoud Microwave Measurements of ATmospheric Events). She is currently working in various projects sponsored by NSF and NASA, within the microwave remote sensing area including an Engineering Research Center. In addition, she recently received the NASA Faculty Award for Research for she is working in the retrieval of multidimensional cloud liquid water content images using a dual-frequency millimeter-wave Cloud Profiling Radar System (CPRS) and in the precipitation estimation using S-band and W-band radars, in a joint project with the University of Massachusetts (UMass) Microwave Remote Sensing Laboratory (MIRSL).

She developed a graduate course on Microwave Remote Sensing and teaches courses in the area of Applied Electromagnetics including Antenna Theory, and Electromagnetic Theory. Her research interests include Microwave Remote Sensing of natural phenomena, modeling of the Microwave Atmospheric Absorption and stratus, cirrus and precipitation clouds studies using S, W and Ka-Bands.

Professional Preparation:

- **UPR at Mayagüez(UPRM) Electrical Engineering BS 1987 (Magna Cum Laude)**
  Specialization in Electronics
- **UMass Electrical Engineering MS 1991 (Magna Cum Laude)**
  MS Thesis: "Phase Error Analysis for Polarimetric Radars"
- **Penn State University Electrical Engineering Ph.D. 1998 (Magna Cum Laude)**
  PhD Thesis: "An improved Model For the microwave Brightness temperature seen from space over Calm Ocean"

RESEARCH

Microwave Remote Sensing of Atmospheric Constituents, Water vapor absorption model near 22GHz, Ocean Wind-Excess Emissivity modeling using satellite data, Stratus Clouds Active remote sensing, Liquid water cloud retrieval from W-and Ka band radar, Cirrus Clouds Ice crystals modeling, Active range gauge using S-band and W-band radars to study rain rate.

RESEARCH PROPOSALS

NASA Faculty Award for Research- Microwave Remote Sensing of Clouds $300,000 for 3 years (PI)

NASA Image Processing and Extraction Group (IPEG) from the Tropical Center for Earth and Space Science Studies- $5M over 5 years (Co-PI)

NSF- An engineering Research Center (ERC) for Subsurface Sensing and Imaging Systems.(CENSSIS) - $12.4M over 5 years for 4 institutions.(Co-PI)

PROFESSIONAL EXPERIENCE

Associate Professor 1991 - 2002	University of Puerto Rico at Mayagüez	Mayagüez, PR
Research Assistant 1987 - 1991	Microwave Remote Sensing Laboratory	Amherst, MA

Publications Most closely related

Cruz Pol, S. L., C. S. Ruf and S. J. Keihm, "*Improved 20-32 GHz Atmospheric Absorption Model*," Radio Science, Vol. 33, No. 5, pp. 1319-1333, September-October 1998.

León-Colón, L., S. Cruz-Pol , and S. Sekelsky "*Active Rain-Gauge Concept for Liquid Clouds using Verticaly oriented W-band and S-band Doppler radars"*, SPIE 9th International Symposium on Remote Sensing, Crete, Greece, 2002.

Cruz Pol, S. L., N. Colón and S. Sekelsky, "*Multidimensional Cloud Images Retrieval From Dual- Frequency Millimeter-Wave Radar* ", IGARSS 2001 Sydney, Australia, July 2001.

Cruz Pol, S. L., and C. S. Ruf, "*A Modified Model for the Sea Surface Emissivity at Microwave Frequencies,"* IEEE Trans. on Geosciense and Remote Sensing, Vol.38, no. 2, March 2000.

Cruz Pol, S. L., "*Modified Model for the Microwave Brightness Temperature of the Ocean and its Relevance To The TOPEX/Poseidon Satellite*" Proceedings of SPIE; Propagation and Imaging through the Atmosphere III, July 1999, Denver, CO, Vol. 3763, pp. 250-258, 1999.

Other Significant Publications

Colón-Díaz, Nivia, S.M. Sekelsky, and S. Cruz-Pol, "Cloud Images retrieval and Characterization using a Ground-based dual-wavelength millimeter radar", *SPIE 9th International Symposium on Remote Sensing*, Crete, Greece, 2002.

Villa, J. M., S.L. Cruz-Pol, and S.M. Sekelsky, "Modeling, simulation and comparison study of Cirrus Clouds Ice Crystals", *SPIE 9th International on Remote Sensing*, Crete, Greece, 2002.

Cruz Pol, S. and Colom Ustáriz, J., "A Case Study: High Percentage of Women in Engineering College at UPRM", *WEPAN Conference 2002*, San Juan, PR, June 2002.

Cruz Pol, S. L., C. S. Ruf and S. J. Keihm, "Modified Model for the Microwave Sea Surface Emissivity", *IGARSS '99 Symposium Proceedings*, Germany, 1999. •

Cruz Pol, S., "Graduate School Challenges specific to Hispanic Students", *Henaac Conference*, South Padre Island, TX, October, 2002.

Synergistic Activities

- Calibrated Microwave Atmospheric Attenuation model recommended by JPL for future NASA microwave radiometric missions to measure water vapor in troposphere.
- Received the Outstanding Achievements in Mentoring from the National Consortium for Minorities Education in Engineering and Sciences (GEM), San Diego, 2001.
- Co-developed a new Microwave & RF Laboratory to be used for several undergraduate courses.
- Developed a Microwave Remote Sensing module to be included in an Electromagnetics course to increase understanding and interest of students in a very difficult course.
- Developed modules for Outreach program for Elementary High School students on Electricity, Electronics, El Niño and Remote Sensing.
- Wrote a 100-page manual for the Course of Antennas.

Collaborators & Other Affiliations

Stephen Sekelsky and David McLaughlin, (Univ. of Massachusetts)
Stephen Keihm, Jet Propulsion Laboratory (JPL)
Christopher Ruf, (Michigan Univ. in Ann Harbor)

List of Completed Ms Advisees in last four years: Nivia Colón , Jorge Villa

Graduate Advisors

(Late) Robert McIntosh, (UMass)
Christopher Ruf, (Michigan Univ. in Ann Harbor)

BRENDA J. PHILIPS
Executive Director
Commonwealth Information Technology Initiative
University of Massachusetts
bphilips@ecs.umass.edu

Brenda Philips has both her undergraduate and graduate degrees from Yale University, including an MBA. She has over 10 years experience creating and managing programs that involve education, technology, and entrepreneurship.

Professional Preparation:

Yale University, French, BA 1981

Yale School of Management, MBA, 1986

Appointments:

12/00 - present	Executive Director, Commonwealth Information Technology Initiative, University of Massachusetts
9/98 – 12/00 (part time)	Co-Founder and Executive Director, EntreNetwork – The Western Massachusetts Entrepreneurship Consortium
9/93 – 7/00	Co-Founder and Director, Lemelson National Program at Hampshire College and National Collegiate Inventors and Innovators Alliance, Amherst, MA.
1986 - 1993	Vice President, Marketing and Advertising, Shawmut Bank, Hartford CT
1985	Intern, Lincoln Center for the Performing Arts, New York, NY
1981 - 1984	Assistant Manager, Chemical Bank, New York, NY

Synergistic Activities:

Commonwealth Information Technology Initiative - Implemented and directed Massachusetts-wide initiative which seeks to expand computer science and information technology curricula at all 29 public higher education institutions – community colleges, state colleges, and the UMass system. Planned as a three year, $7 million program, CITI focuses on creating Information Technology (IT) minors and concentrations, improving computer science curriculum, and enhancing faculty skills and knowledge to address IT workforce needs in the state.

Lemelson National Program and National Collegiate Inventors and Innovators Alliance - Created and directed $5.5 million educational program fostering invention, innovation and entrepreneurship among undergraduate college students. This program promotes an educational model that incorporates experiential learning and student-faculty collaborative teams. Lemelson projects focus on digital, environmental, and assistive (for the disabled) technologies.

EntreNetwork, **The Western Mass Entrepreneurship Consortium** - Created consortium that develops high-impact, collaborative programs promoting entrepreneurship including conferences, web resources and benchmark studies. Consortium members include UMass, Mass Ventures, Babson College,

Hampshire College, Springfield Technical Community College, and the Massachusetts Small Business Development Center.

Collaborators & Other Affiliations:

Future Forward Technology Conference, Boston, MA – Member of Board of Advisors

Gregory S. Prince, Jr, President, Hampshire College

Stephen Spinelli, Director and Professor of Entrepreneurship , Arthur M. Blank Center for Entreprenership, Babson College

Technology Enterprise Council, Hadley, MA – Member of Board of Directors

SUMMARY PROPOSAL BUDGET YEAR 1

FOR NSF USE ONLY		
PROPOSAL NO.	DURATION (months) Proposed	Granted
AWARD NO.		

ORGANIZATION
University of Massachusetts Amherst

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR
David J McLaughlin

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-mos. CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. **David J McLaughlin - Director**	**0.00**	**2.10**	**2.00**	$ **39,064**	$
2. **Wayne Burleson - Education Thrust Co-Leader**	**0.00**	**0.00**	**1.00**	**9,276**	
3. **V. Chandrasekar - Associate Director**	**0.00**	**0.00**	**0.00**	**0**	
4. **Sandra Cruz-Pol - Associate Director**	**0.00**	**0.00**	**0.00**	**0**	
5. **Theodore E Djaferis - Education Researcher**	**0.00**	**0.00**	**1.00**	**9,633**	
6. (**6**) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	**5.15**	**1.08**	**12.00**	**159,902**	
7. (**11**) TOTAL SENIOR PERSONNEL (1 - 6)	**5.15**	**3.18**	**16.00**	**217,875**	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (**0**) POST DOCTORAL ASSOCIATES	**0.00**	**0.00**	**0.00**	**0**	
2. (**3**) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	**36.00**	**0.00**	**0.00**	**181,000**	
3. (**5**) GRADUATE STUDENTS				**96,685**	
4. (**0**) UNDERGRADUATE STUDENTS				**0**	
5. (**0**) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				**0**	
6. (**0**) OTHER				**0**	
TOTAL SALARIES AND WAGES (A + B)				**495,560**	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				**77,963**	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				**573,523**	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.) **per attached** $ **131,800**					
TOTAL EQUIPMENT				**131,800**	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				**32,500**	
2. FOREIGN				**0**	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ **0**					
2. TRAVEL **0**					
3. SUBSISTENCE **0**					
4. OTHER **0**					
TOTAL NUMBER OF PARTICIPANTS (**0**) TOTAL PARTICIPANT COSTS				**0**	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				**39,819**	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				**23,200**	
3. CONSULTANT SERVICES				**30,247**	
4. COMPUTER SERVICES				**0**	
5. SUBAWARDS				**1,257,628**	
6. OTHER				**22,823**	
TOTAL OTHER DIRECT COSTS				**1,373,717**	
H. TOTAL DIRECT COSTS (A THROUGH G)				**2,111,540**	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) **Overhead (Rate: 55.0000, Base: 706290)**					
TOTAL INDIRECT COSTS (F&A)				**388,460**	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				**2,500,000**	
K. RESIDUAL FUNDS (IF FOR FURTHER SUPPORT OF CURRENT PROJECTS SEE GPG II.C.6.j.)				**0**	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ **2,500,000**	$

M. COST SHARING PROPOSED LEVEL $ **2,660,930** AGREED LEVEL IF DIFFERENT $

PI/PD NAME
David J McLaughlin

ORG. REP. NAME*
Carol sprague

FOR NSF USE ONLY		
INDIRECT COST RATE VERIFICATION		
Date Checked	Date Of Rate Sheet	Initials - ORG

 ***ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET**

SUMMARY PROPOSAL BUDGET COMMENTS - Year 1

Other Senior Personnel

Name - Title	Cal	Acad	Sumr	Funds Requested
Droegemeier, Kelvin K - Deputy Director	0.00	0.00	0.00	0
Faculty, Other - Researcher	0.00	0.00	9.00	84645
Frasier, Stephen J - Sensing Thrust Co-Leader	0.00	1.08	2.00	28588
Kurose, James F - Associate Director	0.00	0.00	1.00	14669
Philips, Brenda - Executive Director	2.15	0.00	0.00	17000
Rubin, Kathy - Director, Outreach	3.00	0.00	0.00	15000

SUMMARY PROPOSAL BUDGET — YEAR 2

FOR NSF USE ONLY		
PROPOSAL NO.	DURATION (months) Proposed	Granted
AWARD NO.		

ORGANIZATION: **University of Massachusetts Amherst**

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR: **David J McLaughlin**

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-mos. CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. **David J McLaughlin - Director**	**0.00**	**2.00**	**2.00**	$ **40,017**	$
2. **Wayne Burleson - Education Thrust Co-Leader**	**0.00**	**0.00**	**1.00**	**9,740**	
3. **V. Chandrasekar - Associate Director**	**0.00**	**0.00**	**0.00**	**0**	
4. **Sandra Cruz-Pol - Associate Director**	**0.00**	**0.00**	**0.00**	**0**	
5. **Education Director**	**2.48**	**0.00**	**0.00**	**13,000**	
6. (**7**) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	**5.15**	**1.02**	**13.00**	**177,511**	
7. (**12**) TOTAL SENIOR PERSONNEL (1 - 6)	**7.63**	**3.02**	**16.00**	**240,268**	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (**0**) POST DOCTORAL ASSOCIATES	**0.00**	**0.00**	**0.00**	**0**	
2. (**3**) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	**36.00**	**0.00**	**0.00**	**190,050**	
3. (**5**) GRADUATE STUDENTS				**105,021**	
4. (**0**) UNDERGRADUATE STUDENTS				**0**	
5. (**0**) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				**0**	
6. (**0**) OTHER				**0**	
TOTAL SALARIES AND WAGES (A + B)				**535,339**	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				**84,432**	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				**619,771**	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.) **per attached** $ **247,487**					
TOTAL EQUIPMENT				**247,487**	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				**52,778**	
2. FOREIGN				**0**	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ **0**					
2. TRAVEL **0**					
3. SUBSISTENCE **0**					
4. OTHER **0**					
TOTAL NUMBER OF PARTICIPANTS (**0**) TOTAL PARTICIPANT COSTS				**0**	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				**30,000**	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				**23,200**	
3. CONSULTANT SERVICES				**18,750**	
4. COMPUTER SERVICES				**0**	
5. SUBAWARDS				**1,658,549**	
6. OTHER				**23,265**	
TOTAL OTHER DIRECT COSTS				**1,753,764**	
H. TOTAL DIRECT COSTS (A THROUGH G)				**2,673,800**	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) **Overhead (Rate: 55.0000, Base: 593090)**					
TOTAL INDIRECT COSTS (F&A)				**326,200**	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				**3,000,000**	
K. RESIDUAL FUNDS (IF FOR FURTHER SUPPORT OF CURRENT PROJECTS SEE GPG II.C.6.j.)				**0**	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ **3,000,000**	$

M. COST SHARING PROPOSED LEVEL $ **2,767,181** AGREED LEVEL IF DIFFERENT $

PI/PD NAME: **David J McLaughlin**

ORG. REP. NAME*: **Carol sprague**

FOR NSF USE ONLY — INDIRECT COST RATE VERIFICATION		
Date Checked	Date Of Rate Sheet	Initials - ORG

 ***ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET**

SUMMARY PROPOSAL BUDGET COMMENTS - Year 2

Other Senior Personnel

Name - Title	Cal	Acad	Sumr	Funds Requested
Djaferis, Theodore E - Education Researcher	0.00	0.00	1.00	10115
Droegemeier, Kelvin K - Deputy Director	0.00	0.00	0.00	0
Faculty, Other - Researchers	0.00	0.00	9.00	88877
Frasier, Stephen J - Sensing Co-Leader	0.00	1.02	2.00	29517
Kurose, James F - Associate Director	0.00	0.00	1.00	15402
Philips, Brenda - Executive Director	2.15	0.00	0.00	17850
Rubin, Kathy - Director, Outreach	3.00	0.00	0.00	15750

SUMMARY PROPOSAL BUDGET YEAR 3

FOR NSF USE ONLY		
PROPOSAL NO.	DURATION (months) Proposed	Granted
AWARD NO.		

ORGANIZATION
University of Massachusetts Amherst

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR
David J McLaughlin

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-mos. CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. **David J McLaughlin - Director**	**0.00**	**1.90**	**2.00**	$ **41,019**	$
2. **Wayne Burleson - Education Thrust Co-Leader**	**0.00**	**0.00**	**1.00**	**10,227**	
3. **V. Chandrasekar - Associate Director**	**0.00**	**0.00**	**0.00**	**0**	
4. **Sandra Cruz-Pol - Associate Director**	**0.00**	**0.00**	**0.00**	**0**	
5. **Theodore E Djaferis - Education Researcher**	**0.00**	**0.00**	**1.00**	**10,621**	
6. (**6**) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	**5.15**	**0.98**	**12.00**	**175,265**	
7. (**11**) TOTAL SENIOR PERSONNEL (1 - 6)	**5.15**	**2.88**	**16.00**	**237,132**	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (**0**) POST DOCTORAL ASSOCIATES	**0.00**	**0.00**	**0.00**	**0**	
2. (**3**) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	**36.00**	**0.00**	**0.00**	**199,553**	
3. (**4**) GRADUATE STUDENTS				**88,200**	
4. (**0**) UNDERGRADUATE STUDENTS				**0**	
5. (**0**) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				**0**	
6. (**0**) OTHER				**0**	
TOTAL SALARIES AND WAGES (A + B)				**524,885**	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				**81,307**	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				**606,192**	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.) **per attached** $ **187,235**					
TOTAL EQUIPMENT				**187,235**	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				**45,298**	
2. FOREIGN				**0**	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ **0**					
2. TRAVEL **0**					
3. SUBSISTENCE **0**					
4. OTHER **0**					
TOTAL NUMBER OF PARTICIPANTS (**0**) TOTAL PARTICIPANT COSTS				**0**	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				**30,000**	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				**23,200**	
3. CONSULTANT SERVICES				**18,750**	
4. COMPUTER SERVICES				**0**	
5. SUBAWARDS				**2,272,188**	
6. OTHER				**20,612**	
TOTAL OTHER DIRECT COSTS				**2,364,750**	
H. TOTAL DIRECT COSTS (A THROUGH G)				**3,203,475**	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) **Overhead (Rate: 55.0000, Base: 539137)**					
TOTAL INDIRECT COSTS (F&A)				**296,525**	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				**3,500,000**	
K. RESIDUAL FUNDS (IF FOR FURTHER SUPPORT OF CURRENT PROJECTS SEE GPG II.C.6.j.)				**0**	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ **3,500,000**	$

M. COST SHARING PROPOSED LEVEL $ **2,767,181** AGREED LEVEL IF DIFFERENT $

PI/PD NAME
David J McLaughlin

ORG. REP. NAME*
Carol sprague

FOR NSF USE ONLY		
INDIRECT COST RATE VERIFICATION		
Date Checked	Date Of Rate Sheet	Initials - ORG

 ***ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET**

SUMMARY PROPOSAL BUDGET COMMENTS - Year 3

Other Senior Personnel

Name - Title	Cal	Acad	Sumr	Funds Requested
Droegemeier, Kelvin K - Deputy Director	0.00	0.00	0.00	0
Faculty, Other - Researcher	0.00	0.00	9.00	93319
Frasier, Stephen J - Sensing Co-Leader	0.00	0.98	2.00	30493
Kurose, James F - Associate Director	0.00	0.00	1.00	16172
Philips, Brenda - Executive Director	2.15	0.00	0.00	18743
Rubin, Kathy - Director, Outreach	3.00	0.00	0.00	16538

SUMMARY PROPOSAL BUDGET

YEAR 4

FOR NSF USE ONLY		
PROPOSAL NO.	DURATION (months) Proposed	Granted
AWARD NO.		

ORGANIZATION
University of Massachusetts Amherst

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR
David J McLaughlin

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-mos. CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. **David J McLaughlin - Director**	**0.00**	**1.81**	**2.00**	$ **42,069**	$
2. **Wayne Burleson - Education Thrust Co-Leader**	**0.00**	**0.00**	**1.00**	**10,738**	
3. **V. Chandrasekar - Associate Director**	**0.00**	**0.00**	**0.00**	**0**	
4. **Sandra Cruz-Pol - Associate Director**	**0.00**	**0.00**	**0.00**	**0**	
5. **Theodore E Djaferis - Education Researcher**	**0.00**	**0.00**	**1.00**	**11,152**	
6. (**6**) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	**5.15**	**0.93**	**18.00**	**248,857**	
7. (**11**) TOTAL SENIOR PERSONNEL (1 - 6)	**5.15**	**2.74**	**22.00**	**312,816**	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (**0**) POST DOCTORAL ASSOCIATES	**0.00**	**0.00**	**0.00**	**0**	
2. (**3**) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	**36.00**	**0.00**	**0.00**	**209,537**	
3. (**5**) GRADUATE STUDENTS				**115,794**	
4. (**0**) UNDERGRADUATE STUDENTS				**0**	
5. (**0**) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				**0**	
6. (**0**) OTHER				**0**	
TOTAL SALARIES AND WAGES (A + B)				**638,147**	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				**88,831**	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				**726,978**	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.) **per attached** $ **193,392**					
TOTAL EQUIPMENT				**193,392**	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				**44,838**	
2. FOREIGN				**0**	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ **0**					
2. TRAVEL **0**					
3. SUBSISTENCE **0**					
4. OTHER **0**					
TOTAL NUMBER OF PARTICIPANTS (**0**) TOTAL PARTICIPANT COSTS				**0**	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				**15,789**	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				**23,200**	
3. CONSULTANT SERVICES				**18,750**	
4. COMPUTER SERVICES				**0**	
5. SUBAWARDS				**2,595,642**	
6. OTHER				**23,265**	
TOTAL OTHER DIRECT COSTS				**2,676,646**	
H. TOTAL DIRECT COSTS (A THROUGH G)				**3,641,854**	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) **Overhead (Rate: 55.0000, Base: 651174)**					
TOTAL INDIRECT COSTS (F&A)				**358,146**	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				**4,000,000**	
K. RESIDUAL FUNDS (IF FOR FURTHER SUPPORT OF CURRENT PROJECTS SEE GPG II.C.6.j.)				**0**	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ **4,000,000**	$

M. COST SHARING PROPOSED LEVEL $ **2,600,973** AGREED LEVEL IF DIFFERENT $

PI/PD NAME
David J McLaughlin

ORG. REP. NAME*
Carol sprague

FOR NSF USE ONLY		
INDIRECT COST RATE VERIFICATION		
Date Checked	Date Of Rate Sheet	Initials - ORG

 ***ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET**

SUMMARY PROPOSAL BUDGET COMMENTS - Year 4

Other Senior Personnel

Name - Title	Cal	Acad	Sumr	Funds Requested
Droegemeier, Kelvin K - Deputy Director	0.00	0.00	0.00	0
Faculty, Other - Researcher	0.00	0.00	15.00	163312
Frasier, Stephen J - Sensing Co-Leader	0.00	0.93	2.00	31519
Kurose, James F - Associate Director	0.00	0.00	1.00	16980
Philips, Brenda - Executive Director	2.15	0.00	0.00	19680
Rubin, Kathy - Director, Outreach	3.00	0.00	0.00	17366

SUMMARY PROPOSAL BUDGET

YEAR 5

FOR NSF USE ONLY		
PROPOSAL NO.	DURATION (months) Proposed	Granted
AWARD NO.		

ORGANIZATION
University of Massachusetts Amherst

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR
David J McLaughlin

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-mos. CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. **David J McLaughlin - Director**	**0.00**	**1.73**	**2.00**	$ **43,171**	$
2. **Wayne Burleson - Education Thrust Co-Leader**	**0.00**	**0.00**	**1.00**	**11,275**	
3. **V. Chandrasekar - Associate Director**	**0.00**	**0.00**	**0.00**	**0**	
4. **Sandra Cruz-Pol - Associate Director**	**0.00**	**0.00**	**0.00**	**0**	
5. **Theodore E Djaferis - Education Researcher**	**0.00**	**0.00**	**1.00**	**11,710**	
6. (**6**) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	**5.15**	**0.89**	**18.00**	**260,793**	
7. (**11**) TOTAL SENIOR PERSONNEL (1 - 6)	**5.15**	**2.62**	**22.00**	**326,949**	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (**0**) POST DOCTORAL ASSOCIATES	**0.00**	**0.00**	**0.00**	**0**	
2. (**3**) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	**36.00**	**0.00**	**0.00**	**178,690**	
3. (**5**) GRADUATE STUDENTS				**121,590**	
4. (**0**) UNDERGRADUATE STUDENTS				**0**	
5. (**0**) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				**0**	
6. (**0**) OTHER				**0**	
TOTAL SALARIES AND WAGES (A + B)				**627,229**	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				**81,836**	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				**709,065**	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.) **per attached** $ **44,417**					
TOTAL EQUIPMENT				**44,417**	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				**38,892**	
2. FOREIGN				**0**	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ **0**					
2. TRAVEL **0**					
3. SUBSISTENCE **0**					
4. OTHER **0**					
TOTAL NUMBER OF PARTICIPANTS (**0**) TOTAL PARTICIPANT COSTS				**0**	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				**12,000**	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				**23,200**	
3. CONSULTANT SERVICES				**18,750**	
4. COMPUTER SERVICES				**0**	
5. SUBAWARDS				**2,757,430**	
6. OTHER				**23,265**	
TOTAL OTHER DIRECT COSTS				**2,834,645**	
H. TOTAL DIRECT COSTS (A THROUGH G)				**3,627,019**	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) **Overhead (Rate: 55.0000, Base: 678148)**					
TOTAL INDIRECT COSTS (F&A)				**372,981**	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				**4,000,000**	
K. RESIDUAL FUNDS (IF FOR FURTHER SUPPORT OF CURRENT PROJECTS SEE GPG II.C.6.j.)				**0**	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ **4,000,000**	$

M. COST SHARING PROPOSED LEVEL $ **2,632,664** AGREED LEVEL IF DIFFERENT $

PI/PD NAME
David J McLaughlin

ORG. REP. NAME*
Carol sprague

FOR NSF USE ONLY		
INDIRECT COST RATE VERIFICATION		
Date Checked	Date Of Rate Sheet	Initials - ORG

 ***ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET**

SUMMARY PROPOSAL BUDGET COMMENTS - Year 5

Other Senior Personnel

Name - Title	Cal	Acad	Sumr	Funds Requested
Droegemeier, Kelvin K - Deputy Director	0.00	0.00	0.00	0
Faculty, Other - Researcher	0.00	0.00	15.00	171470
Frasier, Stephen J - Sensing Co-Leader	0.00	0.89	2.00	32594
Kurose, James F - Associate Director	0.00	0.00	1.00	17830
Philips, Brenda - Executive Director	2.15	0.00	0.00	20664
Rubin, Kathy - Director, Outreach	3.00	0.00	0.00	18235

SUMMARY PROPOSAL BUDGET

Cumulative

FOR NSF USE ONLY		
PROPOSAL NO.	DURATION (months) Proposed	Granted
AWARD NO.		

ORGANIZATION: **University of Massachusetts Amherst**

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR: **David J McLaughlin**

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-mos. CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. **David J McLaughlin - Director**	**0.00**	**9.54**	**10.00**	$ **205,340**	$
2. **Wayne Burleson - Education Thrust Co-Leader**	**0.00**	**0.00**	**5.00**	**51,256**	
3. **V. Chandrasekar - Associate Director**	**0.00**	**0.00**	**0.00**	**0**	
4. **Sandra Cruz-Pol - Associate Director**	**0.00**	**0.00**	**0.00**	**0**	
5. **Education Director**	**2.48**	**0.00**	**0.00**	**13,000**	
6. (**7**) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	**25.75**	**4.90**	**77.00**	**1,065,444**	
7. (**12**) TOTAL SENIOR PERSONNEL (1 - 6)	**28.23**	**14.44**	**92.00**	**1,335,040**	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (**0**) POST DOCTORAL ASSOCIATES	**0.00**	**0.00**	**0.00**	**0**	
2. (**15**) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	**180.00**	**0.00**	**0.00**	**958,830**	
3. (**24**) GRADUATE STUDENTS				**527,290**	
4. (**0**) UNDERGRADUATE STUDENTS				**0**	
5. (**0**) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				**0**	
6. (**0**) OTHER				**0**	
TOTAL SALARIES AND WAGES (A + B)				**2,821,160**	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				**414,369**	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				**3,235,529**	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.) $ **804,331**					
TOTAL EQUIPMENT				**804,331**	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				**214,306**	
2. FOREIGN				**0**	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ **0**					
2. TRAVEL **0**					
3. SUBSISTENCE **0**					
4. OTHER **0**					
TOTAL NUMBER OF PARTICIPANTS (**0**) TOTAL PARTICIPANT COSTS				**0**	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				**127,608**	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				**116,000**	
3. CONSULTANT SERVICES				**105,247**	
4. COMPUTER SERVICES				**0**	
5. SUBAWARDS				**10,541,437**	
6. OTHER				**113,230**	
TOTAL OTHER DIRECT COSTS				**11,003,522**	
H. TOTAL DIRECT COSTS (A THROUGH G)				**15,257,688**	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE)					
TOTAL INDIRECT COSTS (F&A)				**1,742,312**	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				**17,000,000**	
K. RESIDUAL FUNDS (IF FOR FURTHER SUPPORT OF CURRENT PROJECTS SEE GPG II.C.6.j.)				**0**	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ **17,000,000**	$

M. COST SHARING PROPOSED LEVEL $ **13,428,929** AGREED LEVEL IF DIFFERENT $

PI/PD NAME: **David J McLaughlin**

ORG. REP. NAME*: **Carol sprague**

FOR NSF USE ONLY		
INDIRECT COST RATE VERIFICATION		
Date Checked	Date Of Rate Sheet	Initials - ORG

C ***ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET**

BUDGET JUSTIFICATION

Overview

The University of Massachusetts requests funding of $2.5, $3.0, $3.5, $4.0, $4.0 for each of the first five years of operation of the ERC. NSF funding will principally fund faculty research, the creation of test beds, and educational programs. Industry monies and in-kind contributions fund equipment and infrastructure for test-beds and for educational programs. UMass in-kind and cash contribution augments faculty and graduate student participation in the ERC and pays for part of administration.
.
As illustrated in the chart below, UMass and its core academic partners have committed a total of 48% cash cost sharing in the first year of the ERC. This cash cost sharing decreases in subsequent years to 30 – 38% of NSF funding as the center becomes established and is able to attract larger amounts of industrial funding. Total cash cost sharing over the 5 year grant period is 36% or $6.2 million. .

	Year 1	Year 2	Year 3	Year 4	Year 5	Total
UMass (2 staff positions, Faculty Start-up, New Faculty Salary, Equipment)	684k	731k	769k	591k	611k	3,140k
OU (Administrative Position, Faculty Start –Up)	289k	289k	289k	289k	289k	1,445k
CSU (University Match)	74k	78k	81k	96k	109k	440k
UPRM (Release Time, University Match)	160k	177k	193k	213k	234k	$977k
TOTAL	1208k	1275k	1332k	1189k	1243k	6247k
Percentage of NSF Funding	48%	43%	38%	30%	31%	36%

Narrative

A1. David McLaughlin salary. Director David McLaughlin will spend full time on the ERC. He will spend half his time on directing, 4 months of his time on CASA research, and he will teach one ERC related course per year. NSF funding provides summer salary and course release, the remainder of his time is provided through in-kind university contributions.

A2 and A5. Wayne Burleson and Theodore Djarferis will both work on CASA's Education program. NSF funds one summer month salary.

A.6. This section lists other faculty investigators and administrators, including Stephen Frasier co-leader of the sensing thrust, Jim Kurose, co-leader of the distributing thrust, Brenda Philips the full time program executive director, and Kathy Rubin, Director of Outreach. Each year we budget 56 months of faculty time devoted to research, which includes appointment of three new faculty members and associated start of $250,000. Funding for 9 of the 56 months is requested from the NSF; the remainder comes from University cash and in-kind contributions. Based on program goals and deliverables, faculty will be selected to participate in CASA research

B2. This pays for a financial manager/bookkeeper for the ERC.

B3. Each year up to 12 UMass graduate students will be supported with graduate research assistantships. UMass will also waive tuition for these students. The NSF will fund 5 of these graduate students each year.

B4. Undergraduates are supported through a cash contribution from the Dean of Engineering office.

C. Fringe Benefits are calculated in the following manner:

- 22% fringe on part of A1 and A6: [Steve Frasier (academic year time), Brenda Philips, Kathy Rubin] and B2
- 1.45% FICA on items A1, A2, A5, A6
- 93% Workman's Comp on items A6 and B
- 11/week Health & Welfare on items B3
  $2,194 GEO on item B3

D. Equipment funds will be used for sensor fabrication and deployment, including costs for a hardware and software technicians. These costs are exempt from overhead as per OMB circular 21. A breakdown of each year is illustrated below:

	Year 1	Year 2	Year 3	Year 4	Year 5
Hardware Engineer	$68,000	$71,400	$74,970	$78,719	$41,327
Hardware Technician	$53,000	$55,650	$58,433	$61,354	$64,422
Fringe	$30,303	$31,171	$33,313	$34,932	$26,367
Equipment	$131,800	$247,487	$187,235	$193,392	$44,417
Supplies	$26,697	$27,588	$27,588	$13,377	$1,642
TOTAL	**$309,800**	**$433,896**	**$381,538**	**$318,733**	**$178,175**

G1, G3, G6. Materials and Supplies, consultant services, and Other. ERC's are multi-institutional, complex organization with many different stakeholders; therefore the NSF permits administrative costs for an ERC. These funds cover the administrative expenses associated with running an ERC, such as office supplies, web design, marketing and meetings. Part of the consultant cost pays for a K-12 teacher to spend a summer participating in ERC Research, and a k-12 curriculum development stipend as part of the education program.

G5. Academic partners will have sensor test-beds on their campuses and active faculty involvement in research. OU has the largest sub-award which reflects their core role atmospheric analysis and the size and scope of the Oklahoma test bed. Contracts by year and by institution are indicated below:

Year 1	Year 2	Year 3	Year 4	Year 5
OU $439k	OU $735k	OU $1,291k	OU $1,477k	OU $1,517k
CSU $370k	CSU $388k	CSU $407k	CSU $502k	CSU $578k
UPRM $349k	UPRM $385k	UPRM $423k	UPRM$466k	UPRM $512k
Outreach $100k	Outreach $150	Outreach $150	Outreach $150	Outreach $150k
TOTAL $1,258	TOTAL $1,658	TOTAL $2,272	TOTAL $2,596	TOTAL $2,757

M. Cost Sharing Level

Cost Sharing of $13.3 million is anticipated for the first five years of the ERC. Over half of the cost share (70%) comes from projected in-kind donations of equipment, infrastructure, and engineers' time to support test-bed deployment and growth. $1.1 million comes from committed cash membership fees from CASA's industrial membership program, and $3.4 million comes from University Cash, and $1.2 million come from committed University in-kind contributions, and $7.7 million from committed in-kind contribution from industrial members.

SUMMARY PROPOSAL BUDGET YEAR 1

FOR NSF USE ONLY		
PROPOSAL NO.	DURATION (months) Proposed	Granted
AWARD NO.		

ORGANIZATION: **Colorado State University**

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR: **V. Chandrasekar**

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-mos. CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. **V. Chandrasekar - PI**	**0.00**	**0.00**	**1.00**	$ **11,356**	$
2. **V N Bringi - co-PI**	**0.00**	**0.00**	**0.90**	**10,498**	
3. **Anura Jayasumana - Sr. Pers.**	**0.00**	**0.00**	**0.90**	**9,869**	
4. **Steven A Rutledge - co-PI**	**0.00**	**0.00**	**0.95**	**12,467**	
5.					
6. (**0**) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	**0.00**	**0.00**	**0.00**	**0**	
7. (**4**) TOTAL SENIOR PERSONNEL (1 - 6)	**0.00**	**0.00**	**3.75**	**44,190**	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (**1**) POST DOCTORAL ASSOCIATES	**12.00**	**0.00**	**0.00**	**40,131**	
2. (**0**) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	**0.00**	**0.00**	**0.00**	**0**	
3. (**5**) GRADUATE STUDENTS				**103,540**	
4. (**3**) UNDERGRADUATE STUDENTS				**10,546**	
5. (**0**) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				**0**	
6. (**0**) OTHER				**0**	
TOTAL SALARIES AND WAGES (A + B)				**198,407**	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				**20,066**	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				**218,473**	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
TOTAL EQUIPMENT				**0**	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				**0**	
2. FOREIGN				**0**	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ **0**					
2. TRAVEL **0**					
3. SUBSISTENCE **0**					
4. OTHER **0**					
TOTAL NUMBER OF PARTICIPANTS (**0**) TOTAL PARTICIPANT COSTS				**0**	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				**0**	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				**0**	
3. CONSULTANT SERVICES				**0**	
4. COMPUTER SERVICES				**0**	
5. SUBAWARDS				**0**	
6. OTHER				**52,810**	
TOTAL OTHER DIRECT COSTS				**52,810**	
H. TOTAL DIRECT COSTS (A THROUGH G)				**271,283**	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) **F&A (Rate: 45.0000, Base: 218473)**					
TOTAL INDIRECT COSTS (F&A)				**98,313**	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				**369,596**	
K. RESIDUAL FUNDS (IF FOR FURTHER SUPPORT OF CURRENT PROJECTS SEE GPG II.C.6.j.)				**0**	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ **369,596**	$

M. COST SHARING PROPOSED LEVEL $ **74,484** AGREED LEVEL IF DIFFERENT $

PI/PD NAME: **V. Chandrasekar**

ORG. REP. NAME*: **Carol sprague**

FOR NSF USE ONLY		
INDIRECT COST RATE VERIFICATION		
Date Checked	Date Of Rate Sheet	Initials - ORG

 ***ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET**

SUMMARY PROPOSAL BUDGET — YEAR 2

FOR NSF USE ONLY		
PROPOSAL NO.	DURATION (months) Proposed	Granted
AWARD NO.		

ORGANIZATION: **Colorado State University**

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR: **V. Chandrasekar**

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-mos. CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. **V. Chandrasekar - PI**	**0.00**	**0.00**	**1.00**	$ **11,810**	$
2. **V N Bringi - co-PI**	**0.00**	**0.00**	**0.90**	**10,893**	
3. **Anura Jayasumana - Sr. Pers.**	**0.00**	**0.00**	**0.90**	**10,240**	
4. **Steven A Rutledge - co-PI**	**0.00**	**0.00**	**0.95**	**12,844**	
5.					
6. (**0**) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	**0.00**	**0.00**	**0.00**	**0**	
7. (**4**) TOTAL SENIOR PERSONNEL (1 - 6)	**0.00**	**0.00**	**3.75**	**45,787**	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (**1**) POST DOCTORAL ASSOCIATES	**12.00**	**0.00**	**0.00**	**42,225**	
2. (**0**) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	**0.00**	**0.00**	**0.00**	**0**	
3. (**5**) GRADUATE STUDENTS				**108,682**	
4. (**3**) UNDERGRADUATE STUDENTS				**11,061**	
5. (**0**) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				**0**	
6. (**0**) OTHER				**0**	
TOTAL SALARIES AND WAGES (A + B)				**207,755**	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				**22,006**	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				**229,761**	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
TOTAL EQUIPMENT				**0**	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				**0**	
2. FOREIGN				**0**	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ **0**					
2. TRAVEL **0**					
3. SUBSISTENCE **0**					
4. OTHER **0**					
TOTAL NUMBER OF PARTICIPANTS (**0**) TOTAL PARTICIPANT COSTS				**0**	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				**0**	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				**0**	
3. CONSULTANT SERVICES				**0**	
4. COMPUTER SERVICES				**0**	
5. SUBAWARDS				**0**	
6. OTHER				**54,923**	
TOTAL OTHER DIRECT COSTS				**54,923**	
H. TOTAL DIRECT COSTS (A THROUGH G)				**284,684**	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) **F&A (Rate: 45.0000, Base: 229761)**					
TOTAL INDIRECT COSTS (F&A)				**103,392**	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				**388,076**	
K. RESIDUAL FUNDS (IF FOR FURTHER SUPPORT OF CURRENT PROJECTS SEE GPG II.C.6.j.)				**0**	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ **388,076**	$

M. COST SHARING PROPOSED LEVEL $ **78,090** AGREED LEVEL IF DIFFERENT $

PI/PD NAME: **V. Chandrasekar**

ORG. REP. NAME*: **Carol sprague**

FOR NSF USE ONLY		
INDIRECT COST RATE VERIFICATION		
Date Checked	Date Of Rate Sheet	Initials - ORG

 ***ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET**

SUMMARY PROPOSAL BUDGET YEAR 3

FOR NSF USE ONLY		
PROPOSAL NO.	DURATION (months) Proposed	Granted
AWARD NO.		

ORGANIZATION: **Colorado State University**

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR: **V. Chandrasekar**

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-mos. CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. **V. Chandrasekar - PI**	**0.00**	**0.00**	**1.00**	$ **12,283**	$
2. **V N Bringi - co-PI**	**0.00**	**0.00**	**0.90**	**11,410**	
3. **Anura Jayasumana - Sr. Pers.**	**0.00**	**0.00**	**0.90**	**10,727**	
4. **Steven A Rutledge - co-PI**	**0.00**	**0.00**	**0.95**	**13,432**	
5.					
6. (**0**) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	**0.00**	**0.00**	**0.00**	**0**	
7. (**4**) TOTAL SENIOR PERSONNEL (1 - 6)	**0.00**	**0.00**	**3.75**	**47,852**	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (**1**) POST DOCTORAL ASSOCIATES	**12.00**	**0.00**	**0.00**	**44,129**	
2. (**0**) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	**0.00**	**0.00**	**0.00**	**0**	
3. (**5**) GRADUATE STUDENTS				**113,933**	
4. (**3**) UNDERGRADUATE STUDENTS				**11,614**	
5. (**0**) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				**0**	
6. (**0**) OTHER				**0**	
TOTAL SALARIES AND WAGES (A + B)				**217,528**	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				**24,100**	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				**241,628**	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
TOTAL EQUIPMENT				**0**	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				**0**	
2. FOREIGN				**0**	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ **0**					
2. TRAVEL **0**					
3. SUBSISTENCE **0**					
4. OTHER **0**					
TOTAL NUMBER OF PARTICIPANTS (**0**) TOTAL PARTICIPANT COSTS				**0**	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				**0**	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				**0**	
3. CONSULTANT SERVICES				**0**	
4. COMPUTER SERVICES				**0**	
5. SUBAWARDS				**0**	
6. OTHER				**57,119**	
TOTAL OTHER DIRECT COSTS				**57,119**	
H. TOTAL DIRECT COSTS (A THROUGH G)				**298,747**	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) **F&A (Rate: 45.0000, Base: 241628)**					
TOTAL INDIRECT COSTS (F&A)				**108,733**	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				**407,480**	
K. RESIDUAL FUNDS (IF FOR FURTHER SUPPORT OF CURRENT PROJECTS SEE GPG II.C.6.j.)				**0**	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ **407,480**	$

M. COST SHARING PROPOSED LEVEL $ **81,871** AGREED LEVEL IF DIFFERENT $

PI/PD NAME: **V. Chandrasekar**

ORG. REP. NAME*: **Carol sprague**

FOR NSF USE ONLY		
INDIRECT COST RATE VERIFICATION		
Date Checked	Date Of Rate Sheet	Initials - ORG

 ***ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET**

SUMMARY PROPOSAL BUDGET — YEAR 4

FOR NSF USE ONLY		
PROPOSAL NO.	DURATION (months) Proposed	Granted
AWARD NO.		

ORGANIZATION: **Colorado State University**

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR: **V. Chandrasekar**

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-mos. CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. **V. Chandrasekar - PI**	**0.00**	**0.00**	**1.00**	$ **12,774**	$
2. **V N Bringi - co-PI**	**0.00**	**0.00**	**0.90**	**11,941**	
3. **Anura Jayasumana - Sr. Pers.**	**0.00**	**0.00**	**0.90**	**11,225**	
4. **Steven A Rutledge - co-PI**	**0.00**	**0.00**	**0.95**	**14,092**	
5.					
6. (**0**) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	**0.00**	**0.00**	**0.00**	**0**	
7. (**4**) TOTAL SENIOR PERSONNEL (1 - 6)	**0.00**	**0.00**	**3.75**	**50,032**	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (**1**) POST DOCTORAL ASSOCIATES	**12.00**	**0.00**	**0.00**	**44,529**	
2. (**1**) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	**6.00**	**0.00**	**0.00**	**33,769**	
3. (**6**) GRADUATE STUDENTS				**131,548**	
4. (**3**) UNDERGRADUATE STUDENTS				**12,270**	
5. (**0**) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				**0**	
6. (**0**) OTHER				**0**	
TOTAL SALARIES AND WAGES (A + B)				**272,148**	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				**33,681**	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				**305,829**	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
TOTAL EQUIPMENT				**0**	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				**0**	
2. FOREIGN				**0**	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ **0**					
2. TRAVEL **0**					
3. SUBSISTENCE **0**					
4. OTHER **0**					
TOTAL NUMBER OF PARTICIPANTS (**0**) TOTAL PARTICIPANT COSTS				**0**	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				**0**	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				**0**	
3. CONSULTANT SERVICES				**0**	
4. COMPUTER SERVICES				**0**	
5. SUBAWARDS				**0**	
6. OTHER				**59,402**	
TOTAL OTHER DIRECT COSTS				**59,402**	
H. TOTAL DIRECT COSTS (A THROUGH G)				**365,231**	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) **F&A (Rate: 45.0000, Base: 305829)**					
TOTAL INDIRECT COSTS (F&A)				**137,623**	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				**502,854**	
K. RESIDUAL FUNDS (IF FOR FURTHER SUPPORT OF CURRENT PROJECTS SEE GPG II.C.6.j.)				**0**	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ **502,854**	$

M. COST SHARING PROPOSED LEVEL $ **96,709** AGREED LEVEL IF DIFFERENT $

PI/PD NAME: **V. Chandrasekar**

ORG. REP. NAME*: **Carol sprague**

FOR NSF USE ONLY — INDIRECT COST RATE VERIFICATION		
Date Checked	Date Of Rate Sheet	Initials - ORG

 ***ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET**

SUMMARY PROPOSAL BUDGET — YEAR 5

FOR NSF USE ONLY		
PROPOSAL NO.	DURATION (months) Proposed	Granted
AWARD NO.		

ORGANIZATION: **Colorado State University**

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR: **V. Chandrasekar**

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-mos. CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. **V. Chandrasekar - PI**	**0.00**	**0.00**	**1.00**	$ **13,285**	$
2. **V N Bringi - co-PI**	**0.00**	**0.00**	**0.90**	**12,492**	
3. **Anura Jayasumana - Sr. Pers.**	**0.00**	**0.00**	**0.90**	**11,743**	
4. **Steven A Rutledge - co-PI**	**0.00**	**0.00**	**0.95**	**14,811**	
5.					
6. (**0**) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	**0.00**	**0.00**	**0.00**	**0**	
7. (**4**) TOTAL SENIOR PERSONNEL (1 - 6)	**0.00**	**0.00**	**3.75**	**52,331**	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (**1**) POST DOCTORAL ASSOCIATES	**12.00**	**0.00**	**0.00**	**46,584**	
2. (**1**) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	**12.00**	**0.00**	**0.00**	**56,897**	
3. (**6**) GRADUATE STUDENTS				**145,463**	
4. (**3**) UNDERGRADUATE STUDENTS				**13,027**	
5. (**0**) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				**0**	
6. (**0**) OTHER				**0**	
TOTAL SALARIES AND WAGES (A + B)				**314,302**	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				**41,709**	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				**356,011**	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
TOTAL EQUIPMENT				**0**	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				**0**	
2. FOREIGN				**0**	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ **0**					
2. TRAVEL **0**					
3. SUBSISTENCE **0**					
4. OTHER **0**					
TOTAL NUMBER OF PARTICIPANTS (**0**) TOTAL PARTICIPANT COSTS				**0**	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				**0**	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				**0**	
3. CONSULTANT SERVICES				**0**	
4. COMPUTER SERVICES				**0**	
5. SUBAWARDS				**0**	
6. OTHER				**61,781**	
TOTAL OTHER DIRECT COSTS				**61,781**	
H. TOTAL DIRECT COSTS (A THROUGH G)				**417,792**	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) **F&A (Rate: 45.0000, Base: 356011)**					
TOTAL INDIRECT COSTS (F&A)				**160,205**	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				**577,997**	
K. RESIDUAL FUNDS (IF FOR FURTHER SUPPORT OF CURRENT PROJECTS SEE GPG II.C.6.j.)				**0**	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ **577,997**	$

M. COST SHARING PROPOSED LEVEL $ **108,660** AGREED LEVEL IF DIFFERENT $

PI/PD NAME: **V. Chandrasekar**

ORG. REP. NAME*: **Carol sprague**

FOR NSF USE ONLY — INDIRECT COST RATE VERIFICATION		
Date Checked	Date Of Rate Sheet	Initials - ORG

 ***ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET**

SUMMARY PROPOSAL BUDGET

Cumulative

FOR NSF USE ONLY		
PROPOSAL NO.	DURATION (months) Proposed	Granted
AWARD NO.		

ORGANIZATION: **Colorado State University**

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR: **V. Chandrasekar**

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-mos. CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. **V. Chandrasekar - PI**	**0.00**	**0.00**	**5.00**	$ **61,508**	$
2. **V N Bringi - co-PI**	**0.00**	**0.00**	**4.50**	**57,234**	
3. **Anura Jayasumana - Sr. Pers.**	**0.00**	**0.00**	**4.50**	**53,804**	
4. **Steven A Rutledge - co-PI**	**0.00**	**0.00**	**4.75**	**67,646**	
5.					
6. ( ) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	**0.00**	**0.00**	**0.00**	**0**	
7. (**4**) TOTAL SENIOR PERSONNEL (1 - 6)	**0.00**	**0.00**	**18.75**	**240,192**	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (**5**) POST DOCTORAL ASSOCIATES	**60.00**	**0.00**	**0.00**	**217,598**	
2. (**2**) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	**18.00**	**0.00**	**0.00**	**90,666**	
3. (**27**) GRADUATE STUDENTS				**603,166**	
4. (**15**) UNDERGRADUATE STUDENTS				**58,518**	
5. (**0**) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				**0**	
6. (**0**) OTHER				**0**	
TOTAL SALARIES AND WAGES (A + B)				**1,210,140**	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				**141,562**	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				**1,351,702**	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
TOTAL EQUIPMENT				**0**	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				**0**	
2. FOREIGN				**0**	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ **0**					
2. TRAVEL **0**					
3. SUBSISTENCE **0**					
4. OTHER **0**					
TOTAL NUMBER OF PARTICIPANTS (**0**) TOTAL PARTICIPANT COSTS				**0**	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				**0**	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				**0**	
3. CONSULTANT SERVICES				**0**	
4. COMPUTER SERVICES				**0**	
5. SUBAWARDS				**0**	
6. OTHER				**286,035**	
TOTAL OTHER DIRECT COSTS				**286,035**	
H. TOTAL DIRECT COSTS (A THROUGH G)				**1,637,737**	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE)					
TOTAL INDIRECT COSTS (F&A)				**608,266**	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				**2,246,003**	
K. RESIDUAL FUNDS (IF FOR FURTHER SUPPORT OF CURRENT PROJECTS SEE GPG II.C.6.j.)				**0**	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ **2,246,003**	$

M. COST SHARING PROPOSED LEVEL $ **439,814** AGREED LEVEL IF DIFFERENT $

PI/PD NAME: **V. Chandrasekar**

ORG. REP. NAME*: **Carol sprague**

FOR NSF USE ONLY		
INDIRECT COST RATE VERIFICATION		
Date Checked	Date Of Rate Sheet	Initials - ORG

C ***ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET**

Colorado State University Budget Justification and Statement of Work

Dr. V. Chandrasekar (Chandra) will serve as the lead PI for Colorado State University. In addition he will also be the Associate Director for the ERC. Dr. Chandra will assist the director and the management team while at the same time maintaining the responsibility for the activities associated with CSU. Dr. Chandra will receive administrative support from the Department and the College for routine administrative duties. On the research thrusts, Dr. Chandra will Co-Lead the sensing thrust with Dr. Frasier of UMASS. One month of support is requested to cover both duties.

The sensing thrust research at CSU will be conducted by Professors Bringi and Chandra. Professor Bringi will be responsible for the electromagnetic scattering research as well as analysis of in-situ observations. Prof. Chandra will lead the research in developing algorithms, validation of radar parameter retrievals and quantitative precipitation estimation. Dr. Chandra will also collaborate with Drs. Frasier and Janaswamy of UMASS in conducting early theoretical studies on the "CLEAR" research activities. In addition Dr. Chandra will collaborate with Dr. Vieux of OU to work on the flooding problem. Prof. Jayasumana will lead the distributing effort at CSU. Drs. Jayasumana and Chandra will work towards defining the radar data protocols as well as developing parameters that describe the space time observation requirement for CASA. Prof. Jayasumana will also study the adaptively changing congestion control mechanisms. Partial support for Drs. Bringi and Jayasumana is requested to support their research activities in the proposal. Dr. Steve Rutledge of Atmospheric Science will lead the "predicting" thrust activity at CSU. His work will focus on the multiple Doppler analysis and retrievals in the NETRAD environment. All four core faculty will be supported in their research activities by other faculty through extensive collaboration as well as Graduate Research Assistants in the appropriate specialization. Support for tuition and stipends for the graduate research assistants are requested in the proposal.

Validation of radar parameter retrievals and precipitation estimates are important activities of the Colorado Front-range test bed. This activity will be led by a post doctoral research associate (to be named) under the supervision of Prof. Chandra. Towards the later years the algorithms developed need to be implemented at other system level test beds and partial engineering support for carrying out field level implementation is envisioned for the years four and five. Undergraduate student trainees will be hired as part of the testbed activities and stipends for the undergraduate students are requested .

The education and outreach initiatives will be conducted by both Professors Bringi and Chandra, and will be lead by Prof. Bringi. CSU will provide one month salary support for the education initiative.

All the administrative costs for the proposal are provided by CSU, including, travel, publication and page charges, specialized references, specialized software and licenses, and presentation materials and supplies. The college computing infrastructure (considered as one of the finest in higher education and rated as one of the "best connected university" by the Forbes Magazine) will be available to the project.

SUMMARY PROPOSAL BUDGET YEAR 1

FOR NSF USE ONLY		
PROPOSAL NO.	DURATION (months) Proposed	Granted
AWARD NO.		

ORGANIZATION: **University of Oklahoma Norman Campus**

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR: **Kelvin K Droegemeier**

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-mos. CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. **Kelvin K Droegemeier - PI**	**1.00**	**0.00**	**0.00**	$ **10,820**	$
2. **Michael Biggerstaff - Co-PI**	**1.00**	**0.00**	**0.00**	**7,500**	
3. **Howard Bluestein - Co-PI**	**0.00**	**0.00**	**0.00**	**0**	
4. **Keith Brewster - Co-PI**	**2.00**	**0.00**	**0.00**	**14,000**	
5. **Frederick Carr - Co-PI**	**1.00**	**0.00**	**0.00**	**9,970**	
6. (**10**) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	**10.98**	**0.00**	**0.00**	**76,154**	
7. (**15**) TOTAL SENIOR PERSONNEL (1 - 6)	**15.98**	**0.00**	**0.00**	**118,444**	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (**0**) POST DOCTORAL ASSOCIATES	**0.00**	**0.00**	**0.00**	**0**	
2. (**8**) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	**10.00**	**0.00**	**0.00**	**52,250**	
3. (**0**) GRADUATE STUDENTS				**0**	
4. (**0**) UNDERGRADUATE STUDENTS				**0**	
5. (**0**) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				**0**	
6. (**1**) OTHER				**9,153**	
TOTAL SALARIES AND WAGES (A + B)				**179,847**	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				**63,150**	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				**242,997**	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
TOTAL EQUIPMENT				**0**	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				**12,000**	
2. FOREIGN				**0**	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ **0**					
2. TRAVEL **5,000**					
3. SUBSISTENCE **0**					
4. OTHER **0**					
TOTAL NUMBER OF PARTICIPANTS (**0**) TOTAL PARTICIPANT COSTS				**5,000**	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				**13,000**	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				**0**	
3. CONSULTANT SERVICES				**0**	
4. COMPUTER SERVICES				**0**	
5. SUBAWARDS				**25,000**	
6. OTHER				**5,300**	
TOTAL OTHER DIRECT COSTS				**43,300**	
H. TOTAL DIRECT COSTS (A THROUGH G)				**303,297**	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) **MTDC (Rate: 45.5000, Base: 298297)**					
TOTAL INDIRECT COSTS (F&A)				**135,725**	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				**439,022**	
K. RESIDUAL FUNDS (IF FOR FURTHER SUPPORT OF CURRENT PROJECTS SEE GPG II.C.6.j.)				**0**	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ **439,022**	$

M. COST SHARING PROPOSED LEVEL $ **336,083** AGREED LEVEL IF DIFFERENT $

PI/PD NAME: **Kelvin K Droegemeier**

ORG. REP. NAME*: **Carol sprague**

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INDIRECT COST RATE VERIFICATION		
Date Checked	Date Of Rate Sheet	Initials - ORG

 ***ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET**

SUMMARY PROPOSAL BUDGET COMMENTS - Year 1

Other Senior Personnel

Name - Title	Cal	Acad	Sumr	Funds Requested
Gao, Jidong - Co-PI	0.98	0.00	0.00	5726
George, Brandon - Co-PI	2.00	0.00	0.00	13333
Kemp, Eric - Co-PI	0.00	0.00	0.00	0
Kloesel, Kevin - Co-PI	2.00	0.00	0.00	13333
Shapiro, Alan - Co-PI	1.00	0.00	0.00	6138
Thomas, Kevin - Co-PI	0.00	0.00	0.00	0
Vieux, Baxter - Co-PI	1.00	0.00	0.00	7949
Weber, Daniel - Co-PI	2.00	0.00	0.00	13667
White, Luther - Co-PI	1.00	0.00	0.00	10000
Xue, Ming - Co-PI	1.00	0.00	0.00	6008

SUMMARY PROPOSAL BUDGET — YEAR 2

FOR NSF USE ONLY		
PROPOSAL NO.	DURATION (months) Proposed	Granted
AWARD NO.		

ORGANIZATION: **University of Oklahoma Norman Campus**

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR: **Kelvin K Droegemeier**

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-mos. CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. **Kelvin K Droegemeier - PI**	**1.00**	**0.00**	**0.00**	$ **11,036**	$
2. **Michael Biggerstaff - Co-PI**	**1.00**	**0.00**	**0.00**	**7,650**	
3. **Howard Bluestein - Co-PI**	**1.00**	**0.00**	**0.00**	**12,504**	
4. **Keith Brewster - Co-PI**	**2.00**	**0.00**	**0.00**	**14,280**	
5. **Frederick Carr - Co-PI**	**1.00**	**0.00**	**0.00**	**10,169**	
6. (**10**) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	**15.00**	**0.00**	**0.00**	**99,801**	
7. (**15**) TOTAL SENIOR PERSONNEL (1 - 6)	**21.00**	**0.00**	**0.00**	**155,440**	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (**0**) POST DOCTORAL ASSOCIATES	**0.00**	**0.00**	**0.00**	**0**	
2. (**5**) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	**17.00**	**0.00**	**0.00**	**88,995**	
3. (**2**) GRADUATE STUDENTS				**40,800**	
4. (**0**) UNDERGRADUATE STUDENTS				**0**	
5. (**0**) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				**0**	
6. (**1**) OTHER				**9,153**	
TOTAL SALARIES AND WAGES (A + B)				**294,388**	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				**92,877**	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				**387,265**	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.) **Vehicle** $ **20,000**					
TOTAL EQUIPMENT				**20,000**	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				**27,000**	
2. FOREIGN				**0**	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ **0**					
2. TRAVEL **5,000**					
3. SUBSISTENCE **0**					
4. OTHER **0**					
TOTAL NUMBER OF PARTICIPANTS (**0**) TOTAL PARTICIPANT COSTS				**5,000**	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				**8,000**	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				**5,000**	
3. CONSULTANT SERVICES				**0**	
4. COMPUTER SERVICES				**0**	
5. SUBAWARDS				**90,000**	
6. OTHER				**12,383**	
TOTAL OTHER DIRECT COSTS				**115,383**	
H. TOTAL DIRECT COSTS (A THROUGH G)				**554,648**	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) **MTDC (Rate: 45.5000, Base: 437569)**					
TOTAL INDIRECT COSTS (F&A)				**199,094**	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				**753,742**	
K. RESIDUAL FUNDS (IF FOR FURTHER SUPPORT OF CURRENT PROJECTS SEE GPG II.C.6.j.)				**0**	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ **753,742**	$

M. COST SHARING PROPOSED LEVEL $ **248,868** AGREED LEVEL IF DIFFERENT $

PI/PD NAME: **Kelvin K Droegemeier**

ORG. REP. NAME*: **Carol sprague**

FOR NSF USE ONLY — INDIRECT COST RATE VERIFICATION		
Date Checked	Date Of Rate Sheet	Initials - ORG

 ***ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET**

SUMMARY PROPOSAL BUDGET COMMENTS - Year 2

Other Senior Personnel

Name - Title	Cal	Acad	Sumr	Funds Requested
Gao, Jidong - Co-PI	2.00	0.00	0.00	11900
George, Brandon - Co-PI	2.00	0.00	0.00	13600
Kemp, Eric - Co-PI	2.00	0.00	0.00	9265
Kloesel, Kevin - Co-PI	3.00	0.00	0.00	20400
Shapiro, Alan - Co-PI	1.00	0.00	0.00	6260
Thomas, Kevin - Co-PI	0.00	0.00	0.00	0
Vieux, Baxter - Co-PI	1.00	0.00	0.00	8108
Weber, Daniel - Co-PI	2.00	0.00	0.00	13940
White, Luther - Co-PI	1.00	0.00	0.00	10200
Xue, Ming - Co-PI	1.00	0.00	0.00	6128

SUMMARY PROPOSAL BUDGET YEAR 3

FOR NSF USE ONLY		
PROPOSAL NO.	DURATION (months) Proposed	Granted
AWARD NO.		

ORGANIZATION: **University of Oklahoma Norman Campus**

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR: **Kelvin K Droegemeier**

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-mos. CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. **Kelvin K Droegemeier - PI**	**1.00**	**0.00**	**0.00**	$ **11,257**	$
2. **Michael Biggerstaff - Co-PI**	**1.00**	**0.00**	**0.00**	**7,803**	
3. **Howard Bluestein - Co-PI**	**1.00**	**0.00**	**0.00**	**12,754**	
4. **Keith Brewster - Co-PI**	**3.00**	**0.00**	**0.00**	**21,848**	
5. **Frederick Carr - Co-PI**	**1.00**	**0.00**	**0.00**	**10,373**	
6. (**10**) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	**17.00**	**0.00**	**0.00**	**112,592**	
7. (**15**) TOTAL SENIOR PERSONNEL (1 - 6)	**24.00**	**0.00**	**0.00**	**176,627**	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (**1**) POST DOCTORAL ASSOCIATES	**6.00**	**0.00**	**0.00**	**20,808**	
2. (**7**) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	**41.00**	**0.00**	**0.00**	**181,810**	
3. (**6**) GRADUATE STUDENTS				**119,646**	
4. (**1**) UNDERGRADUATE STUDENTS				**5,202**	
5. (**0**) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				**0**	
6. (**1**) OTHER				**9,153**	
TOTAL SALARIES AND WAGES (A + B)				**513,246**	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				**143,046**	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				**656,292**	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
TOTAL EQUIPMENT				**0**	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				**27,000**	
2. FOREIGN				**0**	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ **0**					
2. TRAVEL **5,000**					
3. SUBSISTENCE **0**					
4. OTHER **0**					
TOTAL NUMBER OF PARTICIPANTS (**0**) TOTAL PARTICIPANT COSTS				**5,000**	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				**13,000**	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				**17,000**	
3. CONSULTANT SERVICES				**0**	
4. COMPUTER SERVICES				**0**	
5. SUBAWARDS				**220,000**	
6. OTHER				**21,412**	
TOTAL OTHER DIRECT COSTS				**271,412**	
H. TOTAL DIRECT COSTS (A THROUGH G)				**959,704**	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) **MTDC (Rate: 45.5000, Base: 728597)**					
TOTAL INDIRECT COSTS (F&A)				**331,512**	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				**1,291,216**	
K. RESIDUAL FUNDS (IF FOR FURTHER SUPPORT OF CURRENT PROJECTS SEE GPG II.C.6.j.)				**0**	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ **1,291,216**	$

M. COST SHARING PROPOSED LEVEL $ **253,844** AGREED LEVEL IF DIFFERENT $

PI/PD NAME: **Kelvin K Droegemeier**

ORG. REP. NAME*: **Carol sprague**

FOR NSF USE ONLY		
INDIRECT COST RATE VERIFICATION		
Date Checked	Date Of Rate Sheet	Initials - ORG

 ***ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET**

SUMMARY PROPOSAL BUDGET COMMENTS - Year 3

Other Senior Personnel

Name - Title	Cal	Acad	Sumr	Funds Requested
Gao, Jidong - Co-PI	3.00	0.00	0.00	18207
George, Brandon - Co-PI	2.00	0.00	0.00	13872
Kemp, Eric - Co-PI	3.00	0.00	0.00	14175
Kloesel, Kevin - Co-PI	3.00	0.00	0.00	20808
Shapiro, Alan - Co-PI	1.00	0.00	0.00	6386
Thomas, Kevin - Co-PI	0.00	0.00	0.00	0
Vieux, Baxter - Co-PI	1.00	0.00	0.00	8270
Weber, Daniel - Co-PI	2.00	0.00	0.00	14219
White, Luther - Co-PI	1.00	0.00	0.00	10404
Xue, Ming - Co-PI	1.00	0.00	0.00	6251

SUMMARY PROPOSAL BUDGET — YEAR 4

FOR NSF USE ONLY		
PROPOSAL NO.	DURATION (months) Proposed	Granted
AWARD NO.		

ORGANIZATION: **University of Oklahoma Norman Campus**

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR: **Kelvin K Droegemeier**

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-mos. CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. **Kelvin K Droegemeier - PI**	**1.00**	**0.00**	**0.00**	$ **11,482**	$
2. **Michael Biggerstaff - Co-PI**	**1.00**	**0.00**	**0.00**	**7,959**	
3. **Howard Bluestein - Co-PI**	**1.00**	**0.00**	**0.00**	**13,009**	
4. **Keith Brewster - Co-PI**	**3.00**	**0.00**	**0.00**	**22,285**	
5. **Frederick Carr - Co-PI**	**1.00**	**0.00**	**0.00**	**10,580**	
6. (**10**) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	**21.00**	**0.00**	**0.00**	**139,340**	
7. (**15**) TOTAL SENIOR PERSONNEL (1 - 6)	**28.00**	**0.00**	**0.00**	**204,655**	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (**1**) POST DOCTORAL ASSOCIATES	**6.00**	**0.00**	**0.00**	**21,224**	
2. (**9**) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	**65.00**	**0.00**	**0.00**	**280,953**	
3. (**6**) GRADUATE STUDENTS				**122,038**	
4. (**1**) UNDERGRADUATE STUDENTS				**5,306**	
5. (**0**) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				**0**	
6. (**1**) OTHER				**9,153**	
TOTAL SALARIES AND WAGES (A + B)				**643,329**	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				**189,690**	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				**833,019**	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
TOTAL EQUIPMENT				**0**	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				**27,000**	
2. FOREIGN				**0**	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ **0**					
2. TRAVEL **5,000**					
3. SUBSISTENCE **0**					
4. OTHER **0**					
TOTAL NUMBER OF PARTICIPANTS (**0**) TOTAL PARTICIPANT COSTS				**5,000**	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				**8,000**	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				**21,000**	
3. CONSULTANT SERVICES				**0**	
4. COMPUTER SERVICES				**0**	
5. SUBAWARDS				**150,000**	
6. OTHER				**21,536**	
TOTAL OTHER DIRECT COSTS				**200,536**	
H. TOTAL DIRECT COSTS (A THROUGH G)				**1,065,555**	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) **MTDC (Rate: 45.5000, Base: 904322)**					
TOTAL INDIRECT COSTS (F&A)				**411,467**	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				**1,477,022**	
K. RESIDUAL FUNDS (IF FOR FURTHER SUPPORT OF CURRENT PROJECTS SEE GPG II.C.6.j.)				**0**	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ **1,477,022**	$

M. COST SHARING PROPOSED LEVEL $ **258,922** AGREED LEVEL IF DIFFERENT $

PI/PD NAME: **Kelvin K Droegemeier**

ORG. REP. NAME*: **Carol sprague**

FOR NSF USE ONLY		
INDIRECT COST RATE VERIFICATION		
Date Checked	Date Of Rate Sheet	Initials - ORG

 ***ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET**

SUMMARY PROPOSAL BUDGET COMMENTS - Year 4

Other Senior Personnel

Name - Title	Cal	Acad	Sumr	Funds Requested
Gao, Jidong - Co-PI	3.00	0.00	0.00	18571
George, Brandon - Co-PI	2.00	0.00	0.00	14149
Kemp, Eric - Co-PI	3.00	0.00	0.00	14459
Kloesel, Kevin - Co-PI	3.00	0.00	0.00	21224
Shapiro, Alan - Co-PI	1.00	0.00	0.00	6513
Thomas, Kevin - Co-PI	3.00	0.00	0.00	17245
Vieux, Baxter - Co-PI	1.00	0.00	0.00	8436
Weber, Daniel - Co-PI	3.00	0.00	0.00	21755
White, Luther - Co-PI	1.00	0.00	0.00	10612
Xue, Ming - Co-PI	1.00	0.00	0.00	6376

SUMMARY PROPOSAL BUDGET YEAR 5

FOR NSF USE ONLY		
PROPOSAL NO.	DURATION (months) Proposed	Granted
AWARD NO.		

ORGANIZATION: **University of Oklahoma Norman Campus**

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR: **Kelvin K Droegemeier**

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-mos. CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. **Kelvin K Droegemeier - PI**	**1.00**	**0.00**	**0.00**	$ **11,712**	$
2. **Michael Biggerstaff - Co-PI**	**1.00**	**0.00**	**0.00**	**8,118**	
3. **Howard Bluestein - Co-PI**	**1.00**	**0.00**	**0.00**	**13,269**	
4. **Keith Brewster - Co-PI**	**3.00**	**0.00**	**0.00**	**22,731**	
5. **Frederick Carr - Co-PI**	**1.00**	**0.00**	**0.00**	**10,792**	
6. (**10**) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	**21.00**	**0.00**	**0.00**	**142,127**	
7. (**15**) TOTAL SENIOR PERSONNEL (1 - 6)	**28.00**	**0.00**	**0.00**	**208,749**	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (**1**) POST DOCTORAL ASSOCIATES	**6.00**	**0.00**	**0.00**	**21,649**	
2. (**9**) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	**65.00**	**0.00**	**0.00**	**286,573**	
3. (**6**) GRADUATE STUDENTS				**124,479**	
4. (**1**) UNDERGRADUATE STUDENTS				**5,412**	
5. (**0**) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				**0**	
6. (**2**) OTHER				**18,307**	
TOTAL SALARIES AND WAGES (A + B)				**665,169**	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				**194,315**	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				**859,484**	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
TOTAL EQUIPMENT				**0**	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				**27,000**	
2. FOREIGN				**0**	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ **0**					
2. TRAVEL **5,000**					
3. SUBSISTENCE **0**					
4. OTHER **0**					
TOTAL NUMBER OF PARTICIPANTS (**0**) TOTAL PARTICIPANT COSTS				**5,000**	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				**8,000**	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				**22,000**	
3. CONSULTANT SERVICES				**0**	
4. COMPUTER SERVICES				**0**	
5. SUBAWARDS				**150,000**	
6. OTHER				**21,659**	
TOTAL OTHER DIRECT COSTS				**201,659**	
H. TOTAL DIRECT COSTS (A THROUGH G)				**1,093,143**	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) **MTDC (Rate: 45.5000, Base: 931787)**					
TOTAL INDIRECT COSTS (F&A)				**423,963**	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				**1,517,106**	
K. RESIDUAL FUNDS (IF FOR FURTHER SUPPORT OF CURRENT PROJECTS SEE GPG II.C.6.j.)				**0**	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ **1,517,106**	$

M. COST SHARING PROPOSED LEVEL $ **264,099** AGREED LEVEL IF DIFFERENT $

PI/PD NAME: **Kelvin K Droegemeier**

ORG. REP. NAME*: **Carol sprague**

FOR NSF USE ONLY		
INDIRECT COST RATE VERIFICATION		
Date Checked	Date Of Rate Sheet	Initials - ORG

 ***ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET**

SUMMARY PROPOSAL BUDGET COMMENTS - Year 5

Other Senior Personnel

Name - Title	Cal	Acad	Sumr	Funds Requested
Gao, Jidong - Co-PI	3.00	0.00	0.00	18943
George, Brandon - Co-PI	2.00	0.00	0.00	14432
Kemp, Eric - Co-PI	3.00	0.00	0.00	14748
Kloesel, Kevin - Co-PI	3.00	0.00	0.00	21649
Shapiro, Alan - Co-PI	1.00	0.00	0.00	6644
Thomas, Kevin - Co-PI	3.00	0.00	0.00	17590
Vieux, Baxter - Co-PI	1.00	0.00	0.00	8604
Weber, Daniel - Co-PI	3.00	0.00	0.00	22190
White, Luther - Co-PI	1.00	0.00	0.00	10824
Xue, Ming - Co-PI	1.00	0.00	0.00	6503

SUMMARY PROPOSAL BUDGET

Cumulative

FOR NSF USE ONLY		
PROPOSAL NO.	DURATION (months) Proposed	Granted
AWARD NO.		

ORGANIZATION: **University of Oklahoma Norman Campus**

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR: **Kelvin K Droegemeier**

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-mos. CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. **Kelvin K Droegemeier - PI**	**5.00**	**0.00**	**0.00**	$ **56,307**	$
2. **Michael Biggerstaff - Co-PI**	**5.00**	**0.00**	**0.00**	**39,030**	
3. **Howard Bluestein - Co-PI**	**4.00**	**0.00**	**0.00**	**51,536**	
4. **Keith Brewster - Co-PI**	**13.00**	**0.00**	**0.00**	**95,144**	
5. **Frederick Carr - Co-PI**	**5.00**	**0.00**	**0.00**	**51,884**	
6. (**10**) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	**84.98**	**0.00**	**0.00**	**570,014**	
7. (**15**) TOTAL SENIOR PERSONNEL (1 - 6)	**116.98**	**0.00**	**0.00**	**863,915**	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (**3**) POST DOCTORAL ASSOCIATES	**18.00**	**0.00**	**0.00**	**63,681**	
2. (**38**) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	**198.00**	**0.00**	**0.00**	**890,581**	
3. (**20**) GRADUATE STUDENTS				**406,963**	
4. (**3**) UNDERGRADUATE STUDENTS				**15,920**	
5. (**0**) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				**0**	
6. (**6**) OTHER				**54,919**	
TOTAL SALARIES AND WAGES (A + B)				**2,295,979**	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				**683,078**	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				**2,979,057**	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.) $ **20,000**					
TOTAL EQUIPMENT				**20,000**	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				**120,000**	
2. FOREIGN				**0**	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ **0**					
2. TRAVEL **25,000**					
3. SUBSISTENCE **0**					
4. OTHER **0**					
TOTAL NUMBER OF PARTICIPANTS (**0**) TOTAL PARTICIPANT COSTS				**25,000**	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				**50,000**	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				**65,000**	
3. CONSULTANT SERVICES				**0**	
4. COMPUTER SERVICES				**0**	
5. SUBAWARDS				**635,000**	
6. OTHER				**82,290**	
TOTAL OTHER DIRECT COSTS				**832,290**	
H. TOTAL DIRECT COSTS (A THROUGH G)				**3,976,347**	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE)					
TOTAL INDIRECT COSTS (F&A)				**1,501,761**	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				**5,478,108**	
K. RESIDUAL FUNDS (IF FOR FURTHER SUPPORT OF CURRENT PROJECTS SEE GPG II.C.6.j.)				**0**	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ **5,478,108**	$

M. COST SHARING PROPOSED LEVEL $ **1,361,816** AGREED LEVEL IF DIFFERENT $

PI/PD NAME: **Kelvin K Droegemeier**

ORG. REP. NAME*: **Carol sprague**

FOR NSF USE ONLY		
INDIRECT COST RATE VERIFICATION		
Date Checked	Date Of Rate Sheet	Initials - ORG

C ***ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET**

University of Oklahoma (OU) Statement of Work/Budget Justification

SENIOR PERSONNEL

Dr. Kelvin Droegemeier, Regents' Professor of Meteorology and Director of the Center for Analysis and Prediction of Storms, will serve as Center Deputy. In this capacity he will assist the Director in all facets of Center leadership, planning, management, and linkages with external sectors, and will be responsible for all activities at the University of Oklahoma (OU). One month of salary is requested from the NSF for these tasks, with one month contributed by OU. He will be assisted in this capacity by Mr. David Jahn, CAPS Managing Director, for which OU is contributing 6 months of salary per year (none requested from the NSF). Dr. Fred Carr, Director of the School of Meteorology and McCasland Professor, will serve as the Associate Director at OU, being responsible for scientific coordination among all OU participants. One month of salary is being requested for these duties, with one month contributed by OU.

Associate Professors of Meteorology Alan Shapiro and Ming Xue will conduct research on radar data retrieval and assimilation as well as numerical prediction, for which one month of support is requested per year from the NSF with one month of match provided by OU. Associate Professor of Meteorology Mike Biggerstaff, and Presidential Professor of Meteorology Howard Bluestein, will contribute to radar system design and conduct research on tornadoes, storms, and other weather hazards. One month of salary is requested per year from the NSF, with one month of match provided by OU (Dr. Bluestein's support begins in year-2). Note that funding is requested only for meteorological research that is directly linked to the goals of CASA; other studies using data generated by CASA are expected to be funded by other sources.

Dr. Luther White, Presidential Professor of Mathematics, will help design the optimal control system for adaptive remote sensing. One month of salary per year is requested from the NSF for Dr. White, with 2 weeks per year contributed by OU. Dr. Baxter Vieux, Professor of Civil Engineering, will coordinate the hydrology research component of CASA and oversee the design, implementation, and operation of the Houston test bed. He also will coordinate the activities of Professor Phil Bedient at Rice University and linkages with the Texas Medical Center. Funding for a post-doctoral scientist, beginning mid-way through year-3, is requested for Dr. Vieux. Note that hydrology applications and product development will be performed by Vieux and Associates, a CASA corporate partner.

Dr. Frank Gallagher, presently a Research Meteorologist at OU who will be named a Research Professor if CASA is funded, will direct the NETRAD System Operations Control Center at OU. In this capacity he will serve as the technical and managerial coordinator of all NETRAD activities and as the principal liaison among OU, UMass, OneNet, and the end user coordinator at OU. He also will be a focal point for technical interactions with Oak Ridge National Laboratory. Dr. Gallagher will be housed administratively within CAPS and will report to Dr. Droegemeier, the Center Deputy Director. OU has agreed to fund Dr. Gallagher full-time from 1 January 2003 until NSF funding for CASA begins, after which he will be funded half by the NSF and half by OU.

Finally, Dr. Kevin Kloesel, Director of Outreach at the Oklahoma Climatological Survey (OCS), will coordinate all linkages between CASA and its end users, including emergency managers, the National Weather Service, and commercial interests. Dr. Kloesel will coordinate end-user focus

group meetings to ensure adequate input from the inception of CASA, and as data from NETRAD become available, OCS will seek other non-CASA funding to integrate them into OK-FIRST and to enhance associated training activities. For this work, we request three months of salary per year for Dr. Kloesel, though only 2 during year-1. One month of salary per year will be provided by OU.

OTHER PERSONNEL

Senior Research Scientist Dr. Daniel Weber, who manages the development and real time prediction activities of the ARPS, and Senior Research Scientist Dr. Keith Brewster, who is the architect of the ARPS Data Analysis/Assimilation System and an expert in objective analysis, will work with Senior Scientist Dr. Jidong Gao, an expert in variational data assimilation techniques, on using NETRAD data for high-resolution analyses and forecasts. Mr. Eric Kemp will develop and apply hazardous weather detection algorithms, working closely with scientists at the National Severe Storms Laboratory (see NSSL letter of commitment). Two to three months of funding per year is requested for these individuals, ramping up with time depending upon the anticipated availability of data for their research. In addition, funding is requested for Mr. Brandon George and Mr. Kevin Thomas, who manage local data ingest and supercomputing systems at OU that will be used by CASA for the research noted above. Finally, support for an MS-level research associate is requested beginning in year-3 to assist with development of algorithms for hazardous weather detection and their incorporation into the adaptive sensing and decision making infrastructure. A considerable fraction of this development will be undertaken by private sector partners (e.g., Baron Services) and by the National Severe Storms Laboratory – with whom this research associate will collaborate.

The deployment and operation of NETRAD represents a substantial activity during the first five years of the Center, and during year-1, Dr. Gallagher, Director of NETRAD System Operations Control Center, will spend most of his time deploying the first 2-3 test systems within OneNet and planning for the next phase. As this effort ramps up, he will require assistance, and thus we request full-time funding for a NETRAD technician mid-way through year-2. This individual will assist with technical planning and be responsible for installing systems and troubleshooting problems in the field, in close collaboration with UMass and Raytheon, who together will provide remote radar technical support and be responsible for major repairs and replacement. Three months of support for Mr. Scott Hill, the CAPS (and also SOCC) data ingest system manager, is requested beginning in year-2. Mr. Hill will manage the data ingest, archival, and dissemination of CASA data to all Center users.

NETRAD also will leverage considerable expertise and lessons learned from the operational Oklahoma Mesonet, particularly with regard to data formats, quality control, system monitoring, and preventative maintenance. Consequently, we request one month of salary per year for the Mesonet System Manager. To engage end users early in CASA requires providing glimpses of the types of products that are anticipated to be available once a production system is in place. To develop these prototype products, we request one month of funding per year for software development at the Oklahoma Climatological Survey. This work will be conducted in close collaboration with CASA corporate partners who will be developing more formal products for end users (e.g., Baron Services, The Weather Channel).

Leveraging its extensive award-winning education programs, the Oklahoma Climatological Survey will serve as the focal point for K-12 and higher education activities in the context of programs coordinated by and funded at UMass. Funding is requested for summer K-12 activities at

Oklahoma, possibly in concert with the Oklahoma Weather Center's long-standing Research Experience for Undergraduates (REU) program. Funding is requested for a total of 6 graduate and one undergraduate students, phased in with time as appropriate for their research topics. Four of these students will work on meteorology- and radar-related projects, with the other two focusing on optimal control theory and hydrology. The undergraduate student will work on the latter topic as well. In addition, students from Puerto Rico will visit OU to conduct research on CASA and be mentored by OU faculty and research scientists.

PERMANENT EQUIPMENT/TRAVEL/OTHER COSTS

CAPS recently purchased two 8-processor IBM clusters, one for acquiring standard meteorological observations and the other for NEXRAD radar data. The latter also serves as a prototype national distribution system for both academia and the private sector, and will serve the same function for CASA. Thus, the only permanent equipment being requested is a vehicle in year-2 for the SOCC Director and Technician – both of whom are expected to travel extensively across Oklahoma to establish and then operate/maintain the NETRAD test bed, as well as workstations for SOCC personnel hired in years 1 and 3. A total of $12,000 in year-1 is requested for domestic travel, principally to support collaboration among OU and other CASA participants, and to support expendable costs for travel within Oklahoma by SOCC personnel. Thereafter, the travel request expands to $27,000 per year, with all of the increase associated with deployment and maintenance of the NETRAD test bed sites. Nominal support is requested for materials and supplies, publications, and graduate student tuition, with $5,000 in participant support costs per year requested for end user focus group meetings. Because most emergency managers are funded by municipalities that have very limited budgets, the provision of travel support is the only way to ensure active participation by these important users.

SUB-CONTRACT

The Oklahoma NETRAD test bed will be deployed within OneNet, Oklahoma's official state-wide telecommunications network. As shown in its letter of commitment, OneNet will provide considerable administrative and network engineering expertise as in-kind match, each year, that includes but is not limited to site selection, preparation for use of OneNet towers, telecommunications and electrical power infrastructures, instrument installation, network management, and data services. Against that match, funding is being sought from the NSF, increasing each year, for equipment (routers, computers for local storage of NETRAD data), line charges, and tower rental. Specifically, $25,000 in permanent equipment (routers, computers) is being requested in year-1 for the installation as quickly as possible of 2-3 radars, the operation of which will be used to assist in planning for the larger NETRAD test bed. Against this $25,000, OneNet is providing free access to the towers and all necessary communication and technical support costs. In years 2 and 3, we request $45,000 and $120,000 in permanent equipment costs, respectively, for the installation of additional radars, particularly the large NETRAD test bed in western Oklahoma. Network maintenance costs of $45,000 and $100,000 are being requested from the NSF as well, against which OneNet will provide in-kind match of approximately $200,000 per year (communication costs, tower rental, technical support staff). In years 4 and 5, $150,000 per year is requested from the NSF to maintain the NETRAD test bed, against which OneNet is providing approximately $200,000 of match per year for communication costs, tower rental, and technical support staff.

SUMMARY PROPOSAL BUDGET — YEAR 1

FOR NSF USE ONLY		
PROPOSAL NO.	DURATION (months) Proposed	Granted
AWARD NO.		

ORGANIZATION: **University of Puerto Rico Mayaguez**

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR: **Sandra Cruz-Pol**

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-mos. CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. **Sandra Cruz-Pol - Assoc. Prof**	**0.00**	**0.00**	**0.00**	$ **0**	$
2. **Jose G Colom - Assoc. Prof.**	**0.00**	**0.00**	**2.00**	**5,981**	
3. **Walter Diaz - Assoc. Prof.**	**0.00**	**0.00**	**2.00**	**5,444**	
4. **Lionel Orama - Assoc. Prof**	**0.00**	**0.00**	**0.00**	**0**	
5. **Havidan Rodriguez - Professor**	**0.00**	**0.00**	**0.00**	**0**	
6. (**1**) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	**0.00**	**0.00**	**0.00**	**0**	
7. (**6**) TOTAL SENIOR PERSONNEL (1 - 6)	**0.00**	**0.00**	**4.00**	**11,425**	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (**0**) POST DOCTORAL ASSOCIATES	**0.00**	**0.00**	**0.00**	**0**	
2. (**0**) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	**0.00**	**0.00**	**0.00**	**0**	
3. (**8**) GRADUATE STUDENTS				**125,410**	
4. (**12**) UNDERGRADUATE STUDENTS				**43,440**	
5. (**0**) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				**0**	
6. (**0**) OTHER				**0**	
TOTAL SALARIES AND WAGES (A + B)				**180,275**	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				**1,051**	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				**181,326**	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
computers $ **7,500**					
misc. microwave equipment **22,000**					
van **30,000**					
wireless LAN equipment **4,000**					
TOTAL EQUIPMENT				**63,500**	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				**31,103**	
2. FOREIGN				**0**	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ **0**					
2. TRAVEL **0**					
3. SUBSISTENCE **0**					
4. OTHER **6,000**					
TOTAL NUMBER OF PARTICIPANTS (**25**) TOTAL PARTICIPANT COSTS				**6,000**	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				**21,713**	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				**1,341**	
3. CONSULTANT SERVICES				**0**	
4. COMPUTER SERVICES				**0**	
5. SUBAWARDS				**0**	
6. OTHER				**5,765**	
TOTAL OTHER DIRECT COSTS				**28,819**	
H. TOTAL DIRECT COSTS (A THROUGH G)				**310,748**	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) **total-(B+D) (Rate: 48.8000, Base: 78397)**					
TOTAL INDIRECT COSTS (F&A)				**38,258**	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				**349,006**	
K. RESIDUAL FUNDS (IF FOR FURTHER SUPPORT OF CURRENT PROJECTS SEE GPG II.C.6.j.)				**0**	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ **349,006**	$

M. COST SHARING PROPOSED LEVEL $ **279,956** AGREED LEVEL IF DIFFERENT $

PI/PD NAME: **Sandra Cruz-Pol**

ORG. REP. NAME*: **Carol sprague**

FOR NSF USE ONLY — INDIRECT COST RATE VERIFICATION		
Date Checked	Date Of Rate Sheet	Initials - ORG

 ***ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET**

SUMMARY PROPOSAL BUDGET COMMENTS - Year 1

Other Senior Personnel

Name - Title	Cal	Acad	Sumr	Funds Requested
Rodriguez, Rafael A - Assoc. Prof.	**0.00**	**0.00**	**0.00**	**0**

SUMMARY PROPOSAL BUDGET — YEAR 2

FOR NSF USE ONLY		
PROPOSAL NO.	DURATION (months) Proposed	Granted
AWARD NO.		

ORGANIZATION: **University of Puerto Rico Mayaguez**

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR: **Sandra Cruz-Pol**

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-mos. CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. **Sandra Cruz-Pol - Assoc. Prof**	**0.00**	**0.00**	**0.00**	$ **0**	$
2. **Jose G Colom - Assoc. Prof.**	**0.00**	**0.00**	**2.00**	**6,280**	
3. **Walter Diaz - Assoc. Prof.**	**0.00**	**0.00**	**2.00**	**5,717**	
4. **Lionel Orama - Assoc. Prof**	**0.00**	**0.00**	**0.00**	**0**	
5. **Havidan Rodriguez - Professor**	**0.00**	**0.00**	**0.00**	**0**	
6. (**1**) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	**0.00**	**0.00**	**0.00**	**0**	
7. (**6**) TOTAL SENIOR PERSONNEL (1 - 6)	**0.00**	**0.00**	**4.00**	**11,997**	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (**0**) POST DOCTORAL ASSOCIATES	**0.00**	**0.00**	**0.00**	**0**	
2. (**0**) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	**0.00**	**0.00**	**0.00**	**0**	
3. (**9**) GRADUATE STUDENTS				**143,923**	
4. (**12**) UNDERGRADUATE STUDENTS				**43,440**	
5. (**0**) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				**0**	
6. (**0**) OTHER				**0**	
TOTAL SALARIES AND WAGES (A + B)				**199,360**	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				**1,104**	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				**200,464**	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
computers $ **12,500**					
data aquisition boards **10,000**					
marine radar **8,000**					
Others (See Budget Comments Page...) **65,750**					
TOTAL EQUIPMENT				**96,250**	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				**31,500**	
2. FOREIGN				**0**	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ **0**					
2. TRAVEL **0**					
3. SUBSISTENCE **0**					
4. OTHER **6,000**					
TOTAL NUMBER OF PARTICIPANTS (**25**) TOTAL PARTICIPANT COSTS				**6,000**	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				**7,813**	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				**3,895**	
3. CONSULTANT SERVICES				**0**	
4. COMPUTER SERVICES				**0**	
5. SUBAWARDS				**0**	
6. OTHER				**5,828**	
TOTAL OTHER DIRECT COSTS				**17,536**	
H. TOTAL DIRECT COSTS (A THROUGH G)				**351,750**	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) **total-(B+D) (Rate: 48.8000, Base: 68137)**					
TOTAL INDIRECT COSTS (F&A)				**33,251**	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				**385,001**	
K. RESIDUAL FUNDS (IF FOR FURTHER SUPPORT OF CURRENT PROJECTS SEE GPG II.C.6.j.)				**0**	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ **385,001**	$

M. COST SHARING PROPOSED LEVEL $ **296,929** AGREED LEVEL IF DIFFERENT $

PI/PD NAME: **Sandra Cruz-Pol**

ORG. REP. NAME*: **Carol sprague**

FOR NSF USE ONLY — INDIRECT COST RATE VERIFICATION		
Date Checked	Date Of Rate Sheet	Initials - ORG

 ***ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET**

SUMMARY PROPOSAL BUDGET COMMENTS - Year 2

Other Senior Personnel

Name - Title	Cal	Acad	Sumr	Funds Requested
Rodriguez, Rafael A - Assoc. Prof.	**0.00**	**0.00**	**0.00**	**0**

**** D- Equipment**
measurement equipment (Amount: $ 12000)
milling machine (Amount: $ 30000)
misc. microwave equipment (Amount: $ 23750)

SUMMARY PROPOSAL BUDGET — YEAR 3

FOR NSF USE ONLY		
PROPOSAL NO.	DURATION (months) Proposed	Granted
AWARD NO.		

ORGANIZATION: **University of Puerto Rico Mayaguez**

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR: **Sandra Cruz-Pol**

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-mos. CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. **Sandra Cruz-Pol - Assoc. Prof**	**0.00**	**0.00**	**0.00**	$ **0**	$
2. **Jose G Colom - Assoc. Prof.**	**0.00**	**0.00**	**2.00**	**6,594**	
3. **Walter Diaz - Assoc. Prof.**	**0.00**	**0.00**	**2.00**	**6,003**	
4. **Lionel Orama - Assoc. Prof**	**0.00**	**0.00**	**0.00**	**0**	
5. **Havidan Rodriguez - Professor**	**0.00**	**0.00**	**0.00**	**0**	
6. (**1**) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	**0.00**	**0.00**	**0.00**	**0**	
7. (**6**) TOTAL SENIOR PERSONNEL (1 - 6)	**0.00**	**0.00**	**4.00**	**12,597**	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (**1**) POST DOCTORAL ASSOCIATES	**12.00**	**0.00**	**0.00**	**45,000**	
2. (**0**) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	**0.00**	**0.00**	**0.00**	**0**	
3. (**10**) GRADUATE STUDENTS				**162,435**	
4. (**12**) UNDERGRADUATE STUDENTS				**43,440**	
5. (**0**) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				**0**	
6. (**0**) OTHER				**0**	
TOTAL SALARIES AND WAGES (A + B)				**263,472**	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				**5,299**	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				**268,771**	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
data aquisition boards $ **5,000**					
measurement equipment **10,000**					
misc. microwave equipment **8,725**					
Others (See Budget Comments Page...) **4,000**					
TOTAL EQUIPMENT				**27,725**	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				**37,200**	
2. FOREIGN				**0**	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ **0**					
2. TRAVEL **0**					
3. SUBSISTENCE **0**					
4. OTHER **7,588**					
TOTAL NUMBER OF PARTICIPANTS (**40**) TOTAL PARTICIPANT COSTS				**7,588**	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				**18,475**	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				**62**	
3. CONSULTANT SERVICES				**0**	
4. COMPUTER SERVICES				**0**	
5. SUBAWARDS				**0**	
6. OTHER				**1,395**	
TOTAL OTHER DIRECT COSTS				**19,932**	
H. TOTAL DIRECT COSTS (A THROUGH G)				**361,216**	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) **tot-(B+D)+B1 (Rate: 48.8000, Base: 127615)**					
TOTAL INDIRECT COSTS (F&A)				**62,276**	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				**423,492**	
K. RESIDUAL FUNDS (IF FOR FURTHER SUPPORT OF CURRENT PROJECTS SEE GPG II.C.6.j.)				**0**	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ **423,492**	$

M. COST SHARING PROPOSED LEVEL $ **313,374** AGREED LEVEL IF DIFFERENT $

PI/PD NAME: **Sandra Cruz-Pol**

ORG. REP. NAME*: **Carol sprague**

FOR NSF USE ONLY — INDIRECT COST RATE VERIFICATION		
Date Checked	Date Of Rate Sheet	Initials - ORG

 ***ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET**

SUMMARY PROPOSAL BUDGET COMMENTS - Year 3

Other Senior Personnel

Name - Title	Cal	Acad	Sumr	Funds Requested
Rodriguez, Rafael A - Assoc. Prof.	**0.00**	**0.00**	**0.00**	**0**

**** D- Equipment**
portable radar tower (Amount: $ 2000)
wireless LAN equipment (Amount: $ 2000)

SUMMARY PROPOSAL BUDGET — YEAR 4

FOR NSF USE ONLY		
PROPOSAL NO.	DURATION (months) Proposed	Granted
AWARD NO.		

ORGANIZATION: **University of Puerto Rico Mayaguez**

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR: **Sandra Cruz-Pol**

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-mos. CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. **Sandra Cruz-Pol - Assoc. Prof**	**0.00**	**0.00**	**0.00**	$ **0**	$
2. **Jose G Colom - Assoc. Prof.**	**0.00**	**0.00**	**2.00**	**6,924**	
3. **Walter Diaz - Assoc. Prof.**	**0.00**	**0.00**	**2.00**	**6,303**	
4. **Lionel Orama - Assoc. Prof**	**0.00**	**0.00**	**0.00**	**0**	
5. **Havidan Rodriguez - Professor**	**0.00**	**0.00**	**0.00**	**0**	
6. (**1**) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	**0.00**	**0.00**	**0.00**	**0**	
7. (**6**) TOTAL SENIOR PERSONNEL (1 - 6)	**0.00**	**0.00**	**4.00**	**13,227**	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (**1**) POST DOCTORAL ASSOCIATES	**12.00**	**0.00**	**0.00**	**45,000**	
2. (**0**) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	**0.00**	**0.00**	**0.00**	**0**	
3. (**10**) GRADUATE STUDENTS				**162,435**	
4. (**16**) UNDERGRADUATE STUDENTS				**55,940**	
5. (**0**) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				**0**	
6. (**0**) OTHER				**0**	
TOTAL SALARIES AND WAGES (A + B)				**276,602**	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				**5,357**	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				**281,959**	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
data aquisition boards $ **10,000**					
misc. microwave equipment **10,000**					
wireless LAN equipment **4,000**					
TOTAL EQUIPMENT				**24,000**	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				**37,700**	
2. FOREIGN				**0**	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ **0**					
2. TRAVEL **0**					
3. SUBSISTENCE **0**					
4. OTHER **7,750**					
TOTAL NUMBER OF PARTICIPANTS (**25**) TOTAL PARTICIPANT COSTS				**7,750**	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				**17,538**	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				**3,343**	
3. CONSULTANT SERVICES				**0**	
4. COMPUTER SERVICES				**0**	
5. SUBAWARDS				**0**	
6. OTHER				**20,214**	
TOTAL OTHER DIRECT COSTS				**41,095**	
H. TOTAL DIRECT COSTS (A THROUGH G)				**392,504**	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) **tot-(B+D)+B1 (Rate: 48.8000, Base: 150127)**					
TOTAL INDIRECT COSTS (F&A)				**73,262**	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				**465,766**	
K. RESIDUAL FUNDS (IF FOR FURTHER SUPPORT OF CURRENT PROJECTS SEE GPG II.C.6.j.)				**0**	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ **465,766**	$

M. COST SHARING PROPOSED LEVEL $ **332,235** AGREED LEVEL IF DIFFERENT $

PI/PD NAME: **Sandra Cruz-Pol**

ORG. REP. NAME*: **Carol sprague**

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Date Checked	Date Of Rate Sheet	Initials - ORG

 ***ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET**

SUMMARY PROPOSAL BUDGET COMMENTS - Year 4

Other Senior Personnel

Name - Title	Cal	Acad	Sumr	Funds Requested
Rodriguez, Rafael A - Assoc. Prof.	**0.00**	**0.00**	**0.00**	**0**

SUMMARY PROPOSAL BUDGET — YEAR 5

FOR NSF USE ONLY		
PROPOSAL NO.	DURATION (months) Proposed	Granted
AWARD NO.		

ORGANIZATION: **University of Puerto Rico Mayaguez**

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR: **Sandra Cruz-Pol**

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-mos. CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. **Sandra Cruz-Pol - Assoc. Prof**	**0.00**	**0.00**	**0.00**	$ **0**	$
2. **Jose G Colom - Assoc. Prof.**	**0.00**	**0.00**	**2.00**	**7,270**	
3. **Walter Diaz - Assoc. Prof.**	**0.00**	**0.00**	**2.00**	**6,618**	
4. **Lionel Orama - Assoc. Prof**	**0.00**	**0.00**	**0.00**	**0**	
5. **Havidan Rodriguez - Professor**	**0.00**	**0.00**	**0.00**	**0**	
6. (**1**) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	**0.00**	**0.00**	**0.00**	**0**	
7. (**6**) TOTAL SENIOR PERSONNEL (1 - 6)	**0.00**	**0.00**	**4.00**	**13,888**	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (**1**) POST DOCTORAL ASSOCIATES	**12.00**	**0.00**	**0.00**	**45,000**	
2. (**0**) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	**0.00**	**0.00**	**0.00**	**0**	
3. (**11**) GRADUATE STUDENTS				**178,505**	
4. (**16**) UNDERGRADUATE STUDENTS				**55,940**	
5. (**0**) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				**0**	
6. (**0**) OTHER				**0**	
TOTAL SALARIES AND WAGES (A + B)				**293,333**	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				**5,418**	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				**298,751**	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
measurement equipment $ **21,000**					
misc. microwave equipment **15,300**					
tower **2,000**					
TOTAL EQUIPMENT				**38,300**	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				**39,600**	
2. FOREIGN				**0**	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ **0**					
2. TRAVEL **0**					
3. SUBSISTENCE **0**					
4. OTHER **7,750**					
TOTAL NUMBER OF PARTICIPANTS (**25**) TOTAL PARTICIPANT COSTS				**7,750**	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				**28,788**	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				**345**	
3. CONSULTANT SERVICES				**0**	
4. COMPUTER SERVICES				**0**	
5. SUBAWARDS				**0**	
6. OTHER				**20,288**	
TOTAL OTHER DIRECT COSTS				**49,421**	
H. TOTAL DIRECT COSTS (A THROUGH G)				**433,822**	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) **tot-(B+D)+B1 (Rate: 48.8000, Base: 161076)**					
TOTAL INDIRECT COSTS (F&A)				**78,605**	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				**512,427**	
K. RESIDUAL FUNDS (IF FOR FURTHER SUPPORT OF CURRENT PROJECTS SEE GPG II.C.6.j.)				**0**	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ **512,427**	$

M. COST SHARING PROPOSED LEVEL $ **353,734** AGREED LEVEL IF DIFFERENT $

PI/PD NAME: **Sandra Cruz-Pol**

ORG. REP. NAME*: **Carol sprague**

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INDIRECT COST RATE VERIFICATION		
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 ***ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET**

SUMMARY PROPOSAL BUDGET COMMENTS - Year 5

Other Senior Personnel

Name - Title	Cal	Acad	Sumr	Funds Requested
Rodriguez, Rafael A - Assoc. Prof.	**0.00**	**0.00**	**0.00**	**0**

SUMMARY PROPOSAL BUDGET

Cumulative

FOR NSF USE ONLY		
PROPOSAL NO.	DURATION (months) Proposed	Granted
AWARD NO.		

ORGANIZATION
University of Puerto Rico Mayaguez

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR
Sandra Cruz-Pol

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-mos. CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. **Sandra Cruz-Pol - Assoc. Prof**	**0.00**	**0.00**	**0.00**	$ **0**	$
2. **Jose G Colom - Assoc. Prof.**	**0.00**	**0.00**	**10.00**	**33,049**	
3. **Walter Diaz - Assoc. Prof.**	**0.00**	**0.00**	**10.00**	**30,085**	
4. **Lionel Orama - Assoc. Prof**	**0.00**	**0.00**	**0.00**	**0**	
5. **Havidan Rodriguez - Professor**	**0.00**	**0.00**	**0.00**	**0**	
6. (**1**) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	**0.00**	**0.00**	**0.00**	**0**	
7. (**6**) TOTAL SENIOR PERSONNEL (1 - 6)	**0.00**	**0.00**	**20.00**	**63,134**	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (**3**) POST DOCTORAL ASSOCIATES	**36.00**	**0.00**	**0.00**	**135,000**	
2. (**0**) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	**0.00**	**0.00**	**0.00**	**0**	
3. (**48**) GRADUATE STUDENTS				**772,708**	
4. (**68**) UNDERGRADUATE STUDENTS				**242,200**	
5. (**0**) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				**0**	
6. (**0**) OTHER				**0**	
TOTAL SALARIES AND WAGES (A + B)				**1,213,042**	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				**18,229**	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				**1,231,271**	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.) $ **249,775**					
TOTAL EQUIPMENT				**249,775**	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				**177,103**	
2. FOREIGN				**0**	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ **0**					
2. TRAVEL **0**					
3. SUBSISTENCE **0**					
4. OTHER **35,088**					
TOTAL NUMBER OF PARTICIPANTS (**140**) TOTAL PARTICIPANT COSTS				**35,088**	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				**94,327**	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				**8,986**	
3. CONSULTANT SERVICES				**0**	
4. COMPUTER SERVICES				**0**	
5. SUBAWARDS				**0**	
6. OTHER				**53,490**	
TOTAL OTHER DIRECT COSTS				**156,803**	
H. TOTAL DIRECT COSTS (A THROUGH G)				**1,850,040**	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE)					
TOTAL INDIRECT COSTS (F&A)				**285,652**	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				**2,135,692**	
K. RESIDUAL FUNDS (IF FOR FURTHER SUPPORT OF CURRENT PROJECTS SEE GPG II.C.6.j.)				**0**	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ **2,135,692**	$

M. COST SHARING PROPOSED LEVEL $ **1,576,228** AGREED LEVEL IF DIFFERENT $

PI/PD NAME
Sandra Cruz-Pol

ORG. REP. NAME*
Carol sprague

FOR NSF USE ONLY		
INDIRECT COST RATE VERIFICATION		
Date Checked	Date Of Rate Sheet	Initials - ORG

C ***ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET**

Budget Justification

1. Salaries, Wages, and Fringe Benefits: (NSF=$1,231,271; UPR: $929,152)

Senior personnel: The salary requested from NSF is to cover the summer salary of the senior personnel for the five year duration of the project and a postdoctoral associate in years 3-5. UPR will also provide senior personnel salary in addition to an in-kind contribution equivalent to ¼ time release for all faculty but the UPR CASA administrator and the End-User Integration Leader, which will receive ½ time release. (NSF: $198,135, UPR: $330,202)

Graduate Students: Eight graduate students in year 1, 2 PhD and 6 M.S. Year 2: 3 Ph.D. students and 6 M.S. students. Year 3: 4 Ph.D. students and 6 M.S. students. Year 4: 4 Ph.D. students and 6 M.S. students. Year 5: 4 Ph.D. students and 7 M.S. students. M.S. students are paid at a stipend rate of $917.00/mo and $1,200/mo. during summer. The Ph.D. students are paid at a rate of $1,200.00/mo. and $1,500.00/mo. during summer. Tuition and fees are being paid at a rate of $4,500/yr. Total of $772,708 requested to NSF.

Undergraduate Students – 12 undergraduate students will be paid at a rate of 6/hour for 10/hours/week for 32 weeks/year (160 weeks total) and 20 hours/week for 8 summer-weeks (40 weeks total). Total of $242,200 requested to NSF.

Administrative Support: A secretary and a system administrator are requested from UPR. Total of $155,000 requested to UPR.

Fringe Benefits: Fringe benefits are computed at a 9.2% rate for Senior Personnel and 10.6% plus 330/mo for administrative personnel. (NSF: $18,228; UPR:$76,509)

2. Permanent equipment (NSF=$250,175)

Funds are requested for miscellaneous microwave equipment, data acquisition boads, wireless LAN equipment, portable towers, computers, measurement equipment for educational lab, a van for propagation studies and a milling machine. Total of $250,175 requested from NSF

3. Materials (NSF=$94,325, UPR=$95,475)

Funds will be used for software from Ansoft and Agilent Technologies, IDL and CATI/CAI software. Office supplies for different support labs for five year period is also requested. Materials for the educational component are also requested to NSF. Microwave components (Surface Mount) will be purchased for the construction of radars as well as microwave laminates, cables, accessories and drill bits and accessories for the milling machine.

4. Travel (NSF=$177,500; UPR=$177,500)

Travel funds have been set aside for the senior personnel and students to travel to research conferences and to the other partner institutions. Travel money is also requested for a quick response team to visit locations after a weather related natural disaster occurs.

5. Publications (NSF=$8,985, UPR=$24,015)

Funds are requested to cover expenses for dissemination, reproduction, and per-page publication charges

6. Indirect Costs (NSF=$285,846)

Indirect costs are computed at a rate of 48.8% which is the current negotiated rate with federal government. The basis for this computation was $585,750, which includes all direct costs except permanent equipment and students salaries.

7. Participant Support (NSF=$35,088, UPR=$35,088)

Funds are requested to sponsor a school in the FSEA program, to pay stipends, room and meals for the participants of the teacher training program and for per-diem for the participants of the focus groups.

Current and Pending Support

(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: David J. McLaughlin	Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:
UMass Participation in the Air-Sea Flux Estimation in High Wind Boundary Layer

Source of Support: Office of Naval Research

Total Award Amount: $461,521 Total Award Period Covered: 5/24/01-9/40/05

Location of Project: University of Massachusetts

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr: 1.0

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:
WEB Based Data Archive for the High Wind C-Blast Project

Source of Support: Office of Naval Research

Total Award Amount: $155,737 Total Award Period Covered: 5/1/01-9/30/05

Location of Project: University of Massachusetts

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:
Realizing Network Sensor Webs through the Development of the Remote Instrument Definition Language

Source of Support: NASA

Total Award Amount: $66,000 Total Award Period Covered: 9/1/01-8/31/04

Location of Project: University of Massachusetts

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:
Improving Scatterometer Wind Vector Retrievals in the Presence of Precipitation

Source of Support: NOAA/NESDIS

Total Award Amount: $257,374 Total Award Period Covered: 8/1/01-7/31/04

Location of Project: University of Massachusetts

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr: 1.0

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:
Dual Frequency Doppler Radar of Tornados (Co-PI)

Source of Support: National Science Foundation

Total Award Amount: $378,947 Total Award Period Covered: 6/1/00-5/31/03

Location of Project: University of Massachusetts

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr: .50

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

Current and Pending Support

(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: David J. McLaughlin

Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Remote Sensing of Waves and Currents in the Nearshore Zone During (NECX) (Co-PI)

Source of Support: Office of Naval Research

Total Award Amount: $450,000 Total Award Period Covered: 1/1/02-9/30/4

Location of Project: University of Massachusetts

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr: .50

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

Current and Pending Support

(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: **Kelvin Droegemeier**

Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **Research Experiences for Undergraduates at the Okla. Weather Center**

Source of Support: **NSF**
Total Award Amount: $ **282,350** Total Award Period Covered: **04/15/01 - 03/31/04**
Location of Project: **University of Oklahoma**
Person-Months Per Year Committed to the Project. Cal:**0.00** Acad: **0.00** Sumr: **0.00**

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **Collaborative Radar Acquisition Field Test (CRAFT): A Prototype for Accessing and Distributing WSR-88D Base Data in Real Time**

Source of Support: **NOAA**
Total Award Amount: $ **165,833** Total Award Period Covered: **01/01/00 - 12/31/02**
Location of Project: **University of Oklahoma**
Person-Months Per Year Committed to the Project. Cal:**0.00** Acad: **0.00** Sumr: **0.00**

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **Collaboration with WSI Corporation in a Technical Evaluation of an Internet-Based System for the Real Time Delivery of WSR-88D Base Data**

Source of Support: **Weather Services International**
Total Award Amount: $ **25,329** Total Award Period Covered: **06/01/02 - 05/31/03**
Location of Project: **University of Oklahoma**
Person-Months Per Year Committed to the Project. Cal:**0.00** Acad: **0.00** Sumr: **0.00**

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **Collaboration with Vieux and Associates in a Technical Evaluation of an Internet-Based System for the Real TIme Delviery of WSR-88D Base Data**

Source of Support: **Vieux and Associates, Inc.**
Total Award Amount: $ **5,238** Total Award Period Covered: **07/15/03 - 07/14/03**
Location of Project: **University of Oklahoma**
Person-Months Per Year Committed to the Project. Cal:**0.00** Acad: **0.00** Sumr: **0.00**

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **Collaboration with AccuWeather in a Technical Evaluation of an Internet-Based System for the Real Time Delivery of WSR-88D Base Data**

Source of Support: **AccuWeather, Inc.**
Total Award Amount: $ **5,238** Total Award Period Covered: **10/01/02 - 09/30/03**
Location of Project: **University of Oklahoma**
Person-Months Per Year Committed to the Project. Cal:**0.00** Acad: **0.00** Summ: **0.00**

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

Current and Pending Support

(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: **Kelvin Droegemeier**

Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **Collaboration with Geo-Marine in a Technical Evaluation of an Internet-Based System for the Real Time Delivery of WSR-88D Base Data**

Source of Support: **Geo-Marine, Inc.**

Total Award Amount: $ **5,000** Total Award Period Covered: **07/15/02 - 07/14/03**

Location of Project: **University of Oklahoma**

Person-Months Per Year Committed to the Project. Cal:**0.00** Acad: **0.00** Sumr: **0.00**

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **A Real-Time National GPS Network for Atmospheric Research**

Source of Support: **NSF**

Total Award Amount: $ **1,999,683** Total Award Period Covered: **01/01/99 - 12/31/03**

Location of Project: **NCAR**

Person-Months Per Year Committed to the Project. Cal:**0.00** Acad: **0.00** Sumr: **0.00**

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **A Real-Time NGI-Based Direct Digital Ingest & Archive of WSR-88D Base Data as a Prototype for a National Distribution System**

Source of Support: **NOAA ESDIM Program**

Total Award Amount: $ **24,000** Total Award Period Covered: **10/01/02 - 09/30/03**

Location of Project: **University of Oklahoma**

Person-Months Per Year Committed to the Project. Cal:**0.00** Acad: **0.00** Sumr: **0.00**

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **Continued Development of the Web-EH Interface and Integration with Emerging Cluster and Data Mining**

Source of Support: **NSF (via NCSA)**

Total Award Amount: $ **100,000** Total Award Period Covered: **10/01/02 - 09/30/03**

Location of Project: **University of Oklahoma**

Person-Months Per Year Committed to the Project. Cal:**0.00** Acad: **0.00** Sumr: **0.00**

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **Dynamics of Rotation and Scale Selection in Deep Convective Storms**

Source of Support: **NSF**

Total Award Amount: $ **472,935** Total Award Period Covered: **08/01/00 - 07/31/03**

Location of Project: **University of Oklahoma**

Person-Months Per Year Committed to the Project. Cal:**0.00** Acad: **1.00** Summ: **0.00**

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

Current and Pending Support

(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: **Kelvin Droegemeier**

Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **The Sensitivity of Numerically-Simulated Deep Convective Storms to Imposed Large Amplitude Perturbations**

Source of Support: **USAF Eglin AFB**

Total Award Amount: $ **25,068** Total Award Period Covered: **06/01/01 - 12/31/02**

Location of Project: **University of Oklahoma**

Person-Months Per Year Committed to the Project. Cal:**0.00** Acad: **0.00** Sumr: **0.00**

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **Proof-of-Concept Test of an Internet-Based system for the Real-Time Acquisition of WSR-88D Base Data**

Source of Support: **Baron Services, Inc.**

Total Award Amount: $ **92,268** Total Award Period Covered: **12/01/01 - 11/30/02**

Location of Project: **University of Oklahoma**

Person-Months Per Year Committed to the Project. Cal:**0.00** Acad: **0.00** Sumr: **0.48**

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **Collaborative Research in Scale-Recursive Estimation of Precipitation for Applications to QPF Verification, Multi-Sensor Estimation, and Data Assimilation**

Source of Support: **NSF**

Total Award Amount: $ **186,670** Total Award Period Covered: **06/01/02 - 05/31/05**

Location of Project: **University of Oklahoma**

Person-Months Per Year Committed to the Project. Cal:**0.00** Acad: **0.00** Sumr: **0.50**

Support: ☐ Current ☐ Pending ☒ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **Engineering Research Center for Collaborative Adaptive Sensing of the Atmosphere**

Source of Support: **NSF**

Total Award Amount: $ **17,000,000** Total Award Period Covered: **10/01/03 - 09/30/08**

Location of Project: **Univ. of Oklahoma/Univ. of Massachusetts at Amherst**

Person-Months Per Year Committed to the Project. Cal:**0.00** Acad: **0.00** Sumr: **0.00**

Support: ☐ Current ☐ Pending ☒ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **Collaborative Research: ITR Linked Environments for Atmospheric Discovery (LEAD)**

Source of Support: **NSF**

Total Award Amount: $ **2,700,000** Total Award Period Covered: **10/01/03 - 09/30/08**

Location of Project: **University of Oklahoma**

Person-Months Per Year Committed to the Project. Cal:**0.00** Acad: **1.00** Summ: **1.00**

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*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

Current and Pending Support

(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: Kurose, James F.

Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: X Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Specialized Active Network Technologies
CoI: D. Towsley

Note: This grant expires before the start date of this proposal

Source of Support: Northrup Grumman Info. Tech (DARPA subcontract)

Total Award Amount: 454000 Total Award Period Covered: 8/30/99-12/31/02

Location of Project: University of Massachusetts Amherst

Person-Months Per Year Committed to the Project. Cal: Acad: 1.33 Sumr:

Support: X Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Secure Group Communications in Mobile Networking Environments

CoI: D. Towsley

Source of Support: Northrup Grumman Info. Tech (DARPA subcontract)

Total Award Amount: $343675 Total Award Period Covered: 5/25/00-5/24/03

Location of Project: University of Massachusetts Amherst

Person-Months Per Year Committed to the Project. Cal: Acad: 1.0 Sumr:

Support: X Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Fluid Methods for Modeling Large, Heterogeneous Networks

D. Towsley, PI; J. Kurose and WB Gong, ECE, Co-Is

Source of Support: DARPA

Total Award Amount: $970629 Total Award Period Covered: 4/20/00-4/20/03

Location of Project: University of Massachusetts Amherst

Person-Months Per Year Committed to the Project. Cal: Acad: 1.0 Sumr:

Support: ☒ Current Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

CISE Educational Innovation: Creating a Flexible Undergraduate Program in Computer Science

Source of Support: NSF

Total Award Amount: $475894 Total Award Period Covered: 9/15/99-8/31/03

Location of Project: University of Massachusetts Amherst

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr: .5

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

ITR:SII - Scalable QoS Control for the Next Generation internet..

Source of Support: NSF

Total Award Amount: $ $1248439 Total Award Period Covered: 9/1/00-8/31/05

Location of Project: University of Massachusetts Amherst

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr: 2.0

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*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

Current and Pending Support

(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: Kurose, James F.

Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: X Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

NSF-CNPq - Application level Adaptation and Control for retrieval and Delivery of Continuous Media Over the Internet

Source of Support: NSF

Total Award Amount: $59215 Total Award Period Covered: 10/1/00-9/30/03

Location of Project: University of Massachusetts Amherst

Person-Months Per Year Committed to the Project. Cal: 0 Acad: 0 Sumr: 0

Support: X Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Curriculum Development and Infrastructure for an Advanced systems Laboratory

Source of Support: NSF

Total Award Amount: $530229 Total Award Period Covered: 9/1/00-9/30/03

Location of Project: University of Massachusetts Amherst

Person-Months Per Year Committed to the Project. Cal: 0 Acad: 0 Sumr: 0

X Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Computer Networking: Curriculum Designs and Educational Challenges Workshop, August 20, 2002; Pittsburgh, PA

Source of Support: NSF

Total Award Amount: $20000 Total Award Period Covered: 8/1/02-7/31/03

Location of Project: University of Massachusetts Amherst

Person-Months Per Year Committed to the Project. Cal: 0 Acad: 0 Sumr: 0

Support: ☒ Current Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Workshop on Next Generation Research Testbeds

Source of Support:

Total Award Amount: NSF Total Award Period Covered: 9/15/02-2/28/03

Location of Project: University of Massachusetts Amherst

Person-Months Per Year Committed to the Project. Cal: 0 Acad: 0 Sumr: 0

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Measurement from the Middle

CoI: D. Towsley

Source of Support: NSF

Total Award Amount: $475211 Total Award Period Covered: 3 yrs

Location of Project: University of Massachusetts Amherst

Person-Months Per Year Committed to the Project. Cal: 0 Acad: 0 Sumr: 1.0

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*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

Current and Pending Support

(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: Kurose, James F.

Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Dynamic End-to-end Quality of Service (QoS) Management in Wireless Ad Hoc networks
CoI: D. Towsley and D. Goeckel, ECE

*.95 summer mo yr 2; .90 summer mo yr 3; and 1.2 summer months final 6 months.

Source of Support: ONR (subcontract with Alphatec, Inc.)

Total Award Amount: $765000 Total Award Period Covered: 3.5 yrs.

Location of Project: University of Massachusetts Amherst

Person-Months Per Year Committed to the Project. Cal: 0 Acad: 0 Sumr: 1*

Support: Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: EXCITE: Enabling X-Campus Information Technology Education

(W. R. Adrion, PI)

Source of Support: NSF

Total Award Amount: 599768 Total Award Period Covered: 5/4/03-5/3/06

Location of Project: University of Massachusetts Amherst

Person-Months Per Year Committed to the Project. Cal: 0 Acad: 0 Sumr: 0

Support: Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: Biocomplexity in the Environment: IDEA: Development and Testing of Field Sensors for Monitoring Carbon, Nitrogen and Phosphorus in the Aquatic Environment (D. Reckhow, PI)

*.1summer mo yr 2; ,25 summer mos yrs 3, 4 and 5.

Source of Support: NSF

Total Award Amount: $1999225 Total Award Period Covered: 5 yrs.

Location of Project: University of Massachusetts Amherst

Person-Months Per Year Committed to the Project. Cal: Acad: 0 Sumr: 0*

Support: ☐ Current X Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: (this proposal) Engineering Research Center for Collaborative Adaptive Sensing of the Atmosphere

Source of Support: NSF

Total Award Amount: $17000000 Total Award Period Covered: 5 yrs.

Location of Project: University of Massachusetts Amherst

Person-Months Per Year Committed to the Project. Cal: 0 Acad: 0 Sumr: 0

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

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*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

Current and Pending Support

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: **V. Chandrasekar**

Other agencies to which this proposal has been/will be submitted.

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **Development of a high performance offset Gregorian antenna for the CSU-CHILL National Radar Facility**

Source of Support: **National Science Foundation**
Total Award Amount: $ **1,406,010** Total Award Period Covered: **07/01/02-06/30/04**
Location of Project: **Colorado State University**
Person-Months Per Year Committed to the Project. Cal: **0.00** Acad: **0.00** Sumr: **0.00**

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **REU -- Electrical Engineering Focused Around the CSU-CHILL National Radar Facility**

Source of Support: **National Science Foundation**
Total Award Amount: $ **40,000** Total Award Period Covered: **06/01/02-05/31/03**
Location of Project: **Colorado State University**
Person-Months Per Year Committed to the Project. Cal: **0.00** Acad: **0.50** Sumr: **0.00**

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **TRMM/Radar and Microphysics Precipitation**

Source of Support: **National Aeronautics & Space Administration**
Total Award Amount: $ **314,329** Total Award Period Covered: **06/01/00-05/31/03**
Location of Project: **Colorado State University**
Person-Months Per Year Committed to the Project. Cal: **0.00** Acad: **1.00** Sumr: **0.00**

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **Virtual CSU-CHILL Radar**

Source of Support: **DARPA**
Total Award Amount: $ **650,000** Total Award Period Covered: **06/01/99-05/31/02**
Location of Project: **Colorado State University**
Person-Months Per Year Committed to the Project. Cal: **0.00** Acad: **0.25** Sumr: **0.00**

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **The CSU-CHILL Radar Facility**

Source of Support: **National Science Foundation**
Total Award Amount: $ **3,508,448** Total Award Period Covered: **09/01/01-08/31/06**
Location of Project: **Colorado State University**
Person-Months Per Year Committed to the Project. Cal: **0.00** Acad: **0.00** Summ: **1.00**

Current and Pending Support

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: **V. Chandrasekar**

Other agencies to which this proposal has been/will be submitted.

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title: **ITR/AP Sensor Fusion & Networking of Radars for Multiple Doppler & In-situ Observations**

Source of Support: **National Science Foundation**
Total Award Amount: $ **1,800,000** Total Award Period Covered: **10/01/01-09/30/06**
Location of Project: **Colorado State University**
Person-Months Per Year Committed to the Project. Cal: Acad: **1.00** Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:

Source of Support:
Total Award Amount: $ Total Award Period Covered:
Location of Project:
Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:

Source of Support:
Total Award Amount: $ Total Award Period Covered:
Location of Project:
Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:

Source of Support:
Total Award Amount: $ Total Award Period Covered:
Location of Project:
Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:

Source of Support:
Total Award Amount: $ Total Award Period Covered:
Location of Project:
Person-Months Per Year Committed to the Project. Cal: Acad: Summ:

Current and Pending Support

(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: Sandra L. Cruz-Pol

Other agencies (including NSF) to which this proposal has been/will be

Support: ☒Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **Tropical Center for Earth and Space Science Studies-** Information Processing and Extraction Group **(TCESS/ IPEG)**

Source of Support: NASA

Total Award Amount: $4,999,513.00 Total Award Period Covered: July 1, 2000 to July 30, 2005

Location of Project: University of Puerto Rico Mayagüez

Person-Months Per Year Committed to the Project. 1 Cal: Acad: Sumr: 1

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: , **An engineering Research Center (ERC) for Subsurface Sensing and Imaging Systems.(CENSSIS)**

Source of Support: NSF

Total Award Amount: $12.5 M(. Jointly w/NU, RPI, BU) Total Award Period Covered: July 1, 2000 to June 30, 2005

Location of Project: University of Puerto Rico Mayagüez

Person-Months Per Year Committed to the Project. 2.5 Cal: 2.5 Acad: Sumr:

☒ Current ☐Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: Center for **CLoud Microwave Measurement of ATmospheric Events (CLiMMATE)**

Source of Support: NASA

Total Award Amount: $300,000 Total Award Period Covered: April 1, 2002 to May 30, 2005

Location of Project: University of Puerto Rico Mayagüez

Person-Months Per Year Committed to the Project. 2.5 Cal: Acad: 2.5 Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Period Covered:

Location of Project: : University of Puerto Rico Mayagüez

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

Current and Pending Support
(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: Brenda Philips

Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:
Commonwealth Information Technology Initiative

Source of Support: Fidelity Investments
Total Award Amount: $1,200,000 Total Award Period Covered: 3/03-9/04
Location of Project: University of Massachusetts
Person-Months Per Year Committed to the Project. Cal: 7 Acad: Sumr:

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:
On-Line IT Course Development

Source of Support: Information Technologies Division (Mass State Gov't)
Total Award Amount: $200,000 Total Award Period Covered: 2/03-7/03
Location of Project: University of Massachusetts
Person-Months Per Year Committed to the Project. Cal: 5 Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:

Source of Support:
Total Award Amount: $ Total Award Period Covered:
Location of Project:
Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:

Source of Support:
Total Award Amount: $ Total Award Period Covered:
Location of Project:
Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:

Source of Support:
Total Award Amount: $ Total Award Period Covered:
Location of Project:
Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

 USE ADDITIONAL SHEETS AS NECESSARY

CASA Equipment and Facilities

LABORATORY:

UMass:
(1) Microwave Remote Sensing Laboratory consisting (9,000 sq. ft.), which consists of: Millimeter Wave Atmospheric Laboratory, Ocean Waves Laboratory, Ocean Winds Laboratory, Clear Air Atmospheric Laboratory, and Soil Moisture Laboratory.
(2) Wireless Systems Laboratory
(3) Architecture and Real-Time Laboratory
(4) Networking Research Laboratory
(5) Laboratory for Millimeter wave Devices and Applications (LAMMDA)
(6) Antenna Laboratory

OU:
(1) Center for Analysis and Prediction of Storms
(2) Environmental Modeling and GIS Laboratory (EMGIS)
(3) International Center for Natural Hazards and Disaster Research (ICNHDR)

CSU:
(1) CSU-CHILL Radar Facility and Pawnee Radar Facility
(2) Radar lab at Electrical and Computer Engineering Department
(3) Radar Meteorology lab at the Department of Atmospheric Science
(4) Cooperative Institute for Research in the Atmosphere (CIRA)
(5) Flash Flood Laboratory at CIRA
(6) Computer Networking Research laboratory

UPRM:
(1) Center for Applied Social Research
(2) The Center for CLoud Microwave Measurements of ATmospheric Events (CLiMMATE)
(3) Radiation Laboratory

CLINICAL: N/A
ANIMAL: N/A

COMPUTER:

UMass:
(1) MIRSL maintains a dedicated 810 sq. ft. Data Analysis Laboratory that hosts a network of Silicon Graphics and Linux workstations, and servers with approximately 1 TB storage capacity. Workstations are equipped with data analysis software (IDL) to support data reduction and interpretation of results from field experiments. These are shared among projects and students as needed. Windows workstations with CAD, logic design (ALTERA) and PC circuit layout and other software are located throughout the laboratory.
(2) The Wireless Systems Laboratory has a 700 square foot area in Marcus Hall hosting high-end PCs, and a small library of books, journals and conference proceedings.
(3) The Architecture and Real-Time Laboratory also has approximately 700 square foot of office and laboratory space in Marcus Hall.

(4) The Networks Research Laboratory houses approximately two dozen workstations and several large servers in a flexible network test bed of routers and hubs/switches connected via 10/100 Ethernet.
(5) LAMMDA has several workstations and PC that are used for IC design and package simulation. Agilent, Sonnet, CADENCE design tools are also available.
(6) The Antenna Laboratory houses PCs that make use of antenna design software, both commercial and specialized in-house packages.

OU:
(1) The Center for Analysis and Prediction of Storms (CAPS has recently installed two 8-processor IBM clusters, one dedicated for the ingest and archival of routinely-available weather data (e.g., from NOAAPort and other wide-area satellite and land-line feeds), and the other dedicated to the ingest and national redistribution of WSR-88D Level II Doppler radar data. These latter systems, both of which are configured in software and hardware for fault tolerance and also are linked to a robotic tape archival system, will serve as the principal data ingest and processing engines for NETRAD data. CAPS also operates 4-processor SGI Origin 200 and Origin 2000 systems, along with numerous Linux and Windows workstations.
(2) The Environmental Modeling and GIS Laboratory (EMGIS) is equipped with specialized computer hardware and software for processing and analysis of spatial data in GIS format for hydrologic modeling. The core computing is a 10-workstation Sun workstation cluster operating with MPI. Our parallelized version of r.water.fea is compiled and available for hydrologic modeling of basins in Oklahoma (Blue and Illinois Rivers) among others. GIS datasets are available through this laboratory useful in the generalized hydrologic evaluation of QPE.
(3) At the University of Oklahoma (OU), the ERC will also have access to a 256-processor Pentium IV cluster (1.0 teraflops peak performance) and a 32-processor IBM Regatta Power-4 SMP supercomputer (approximately 165 gigaflops peak performance), both of which were installed in April, 2002 as the foundation of the new Oklahoma Supercomputing Center for Education and Research (OSCER). The University of Oklahoma is linked to the Abilene backbone at OC-12 capacity.

CSU:
Colorado State University has been rated as a "Top 20 Cyber University" by Forbes magazine indicative of the extensive computing and networking infrastructure in place. The full computing and networking infrastructure is available to this ERC. Recently Hewlett Packard donated large networking and storage infrastructure (on the order of terabytes) to the college. Students working with CASA have access to this and similar, computing infrastructure. Between CSU-CHILL radar facility, the Radar Laboratory at the ECE department and the Radar Meteorology Laboratory at the Atmospheric Science Departments, there are numerous high performance work stations, radar display stations, and high performance computing clusters with access to the ERC. CSU also has unique scattering and precipitation simulation models developed and maintained by the faculty. The famous Regional Atmospheric Modeling System (RAMS) was developed and is maintained by CSU.

UPRM:
(1) CISA currently has eight Pentium desktop computers, one portable computer, and four laser and two inkjet printers. Software for the computers includes Atlas G.I.S., and LIMDEP, and other word processing and presentation software.
(2) The CLiMMATE Center is equipped with a number of Windows and Linux Workstations, and accessories.
(3) The UPRM Radiation Laboratory has one HP J Class Workstation and a IBM RISC 6000 for simulations and data processing.

OFFICE:

UMass:
(1) The Microwave Remote Sensing Laboratory is located on the first and second floor of the Knowles Engineering Building erected in 1991. Three rooms in Knowles are dedicated student office space and one to technicians and engineers working in MIRSL.
(2) The Wireless Systems Laboratory has a 700 square foot area in Marcus Hall hosting high-end PCs, and a small library of books, journals and conference proceedings.
(3) The Architecture and Real-Time Laboratory also has approximately 700 square foot of office and laboratory space in Marcus Hall.
(4) The UMass Department of Electrical and Computer Engineering will provide approximately 7,000 sq. feet of new office and laboratory space for the ERC effort in Marcus Hall.

CSU:
The radar engineering and radar meteorology laboratories offer extensive office space to host approximately 25 graduate students and 15 senior research personnel. The laboratories have three conference rooms, which are Internet ready. CSU is also home to the Cooperative Institute for Research in the Atmosphere (CIRA), a center for international cooperation in research and training, covering virtually all physical, economic and societal aspects of weather and climate. CIRA's activities and interests include: applications of meteorological satellite imagery, air quality, visibility, mesoscale studies, forecasting, agricultural meteorology, cloud physics, and atmospheric model evaluation. CIRA hosts the flash flood laboratory as well as the data center of the CloudSat program. All activities of the ERC at CSU will have the benefit of collaboration with CIRA.

OU:
(1) The School of Meteorology (SoM) occupies the top three floors of the 15-story Sarkeys Energy Center (SEC), located at the northeast corner of OU's main campus. Also housed in the Energy Center is the Center for Analysis and Prediction of Storms (CAPS, 11^{th} floor), the Cooperative Institute for Mesoscale Meteorological Studies (CIMMS, 11^{th} floor), the Oklahoma Climate Survey (OCS, 12^{th} floor) and the Geosciences Computing Network (GCN, 10^{th} floor). Students have access to a conference room, student lounge, and a rooftop observation deck.
(2) The International Center for Natural Hazards and Disaster Research (ICNHDR) center will be located in the National Weather Center along with OCS, CAPS and other NOAA/NWS agencies after 2005. With up to 2000 sq.ft., space will be made available for this project in this center for post-doctoral fellows, graduate and undergraduate students.

OTHER:

UMass/MIRSL maintains an atmospheric remote sensor testbed facility on the UMass campus at Tilson Farm. This site hosts a diverse suite of sensors including 915 MHZ a beam forming Turbulent Eddy Profiler (TEP), a high resolution 2.8 GHz FMCW profiler, and an X-band scanning precipitation radar. The site also has office space, power and Internet connections to support visiting hardware and new hardware development.

MAJOR EQUIPMENT:

UMass:
(1) The Microwave Remote Sensing Laboratory is one of the largest educational laboratories in the world for the design and fabrication of microwave remote sensing systems. As such, the laboratory is well equipped with vector network analyzers, spectrum analyzers and test equipment for characterization of microwave components up to 140 GHz. MIRSL also shares circuit board and fabrication facilities with other laboratories in the University's Microwave Electronics Laboratories (MEL).

MIRSL also maintains nearly two dozen unique portable remote sensors, including wind, precipitation and cloud radars that will be available to the proposed efforts. MIRSL sensors such as the Advanced Multi-frequency Radar system (funded by a current NSF MRI proposal) will be integral ERC remote sensing algorithm development activities.
(2) The Wireless Systems Lab is equipped with various test instrumentation including a TAS 4500 Flex 5 RF Channel Emulator, an Agilent 89640A Vector Signal Analyzer and an HP ESG 4433B Signal Generator

(3) The Architecture and Real-Time Laboratory has two state-of-the-art test beds: the RAPIDS distributed system or evaluating the probability of real-time distributed workloads missing their deadlines, and the Trident simulator for evaluating the ability of a real-time system to withstand workload surges.
(4) The Networks Research Laboratory houses approximately two dozen workstations and several large servers in a flexible network test bed of routers and hubs/switches connected via 10/100 Ethernet. These facilities are dedicated to experimental networking research.
(5) LAMMDA has network analyzer capability to 50 GHz, microwave probe station, spectrum analyzers to 50 GHz, sources well into the millimeterwave range, package prototype facilities, and wire-bond capability.
(6) The Antenna Laboratory has an antenna range suitable for measurements to 40 GHz. It has network analyzer capability to 40 GHz, and associated sources, oscilloscopes and measurement equipment.

OU:
(1) The Center for Analysis and Prediction of Storms at OU has an 8-processor IBM cluster for the exclusive ingest and national redistribution of WSR-88D (NEXRAD) Level II Doppler radar data.
(2) The Oklahoma Mesonet, operated by the Oklahoma Climatological Survey, is the world's premier surface environmental monitoring network and will be available for the project. The Mesonet comprises 115 tower-based observing systems that measure atmospheric, surface and sub-surface properties, with an average spacing of 26 km.

CSU:
(1) CSU-CHILL Radar, and the Pawnee Radar Research Complex*:* These two radars operating as a Dual-Doppler system provide unique validation opportunities for the systems developed in the ERC. CSU-CHILL is an advanced fully polarimetric S band radar, operated under a cooperative agreement with NSF. The CSU–CHILL radar facility is funded by the National Science Foundation and the State of Colorado with a mission of supporting the academic and research community by providing data, and evaluating experimental techniques in remote sensing of the atmosphere. The PAWNE radar is located approximately 50 km north of CSU-CHILL. Thus any Netrad deployment done in the vicinity of the CSU–CHILL and PAWNEE radars will have the

advantage of simultaneous coverage by these radars. In addition these radars can be requested for dedicated use for the ERC through NSF facility allocation panel.

(2) CSU will soon acquire (Spring 2003) an advanced low profile 2D-Video disdrometer that can be used for in-situ validation experiments.

UPRM:
A recent NSF MRI grant provided advanced research instrumentation for up to 50 GHz. This includes a network analyzer/microwave receiver, a spectrum analyzer, frequency synthesizers, a dedicated source, a near field scanner antenna measurement system plus anechoic chamber, and a PC board router.

OTHER RESOURCES:

OneNet, Oklahoma's official statewide communications and information network for education and government has over 800 customers supported with dedicated fractional T-1, T-1, DS-3 and Gigabit connections, as well as 45 radio towers located throughout the state. The resources of OneNet are available to the ERC Investigators for installation of sensors and antennas on its towers, as expressed in the attached letter of commitment.

Industry Support Letters

Raytheon

Gregory S. Shelton
Vice President
Engineering & Technology

Raytheon Company
Executive Offices
141 Spring Street
Lexington, Massachusetts
02421-7899 USA

December 5, 2002

Dr. Lynn Preston
Leader of the ERC Program
Division of Engineering Education and Centers
Suite 585
National Science Foundation
4201 Wilson Boulevard
Arlington, VA 22230

Dear Dr. Preston:

Raytheon is very pleased to participate in the Industry Partners Program for the proposed NSF Engineering Research Center for Collaborative Adaptive Sensing of the Atmosphere. (CASA). If the proposal is approved, Raytheon will become an active member of the ERC and serve on its industrial advisory board. Our commitment is outlined below:

- $200,000 cash membership fee for the initial five-year grant period to be paid in annual installments of $40,000.
- $1.5 million of in-kind contributions to be paid over the initial five-year grant period for radar equipment, lab space, and engineering time by Raytheon employees, some of whom will reside on the CASA team campus sites as part of earning their doctorate.
- $50,000 sponsorship for K-12 content institutes for teachers to learn new engineering and technology curriculum concepts.

Raytheon has had a long and successful relationship with the UMass College of Engineering and its Microwave Engineering program for over 20 years. This mutually beneficial program has helped us meet our needs for microwave engineers while helping UMass maintain the quality of its graduate and undergraduate programs.

We have already provided $110,000 in funding to this ERC proposal team - $50,000 in cash and $60,000 worth of equipment – for project definition and prototyping research by the UMass researchers and their partners at UPR-Mayaguez. In addition, we have participated in several Industry Day events, hosted the proposal teams at our site on several occasions, and participated in Red Team reviews of their proposal drafts. Quite simply, we appreciate the value the ERC program adds to industry-academia relationships, and we want this proposal to succeed. The engineered systems focus of CASA's programs adds the "systems dimension" to the design and thinking about radars and information technology that is essential for success in engineering careers. CASA's technical ideas about distributed systems are clearly innovative and visionary and could very well lead to new ways of designing radar systems and technologies in the future.

Raytheon has a strong commitment to promoting science and technology in K-12. We look forward to teaming with the ERC to create and disseminate engineering and science curricula as part of the new curriculum frameworks established by the Massachusetts Department of Education.

We believe the UMass ERC team and its core partners at the University of Oklahoma, University of Puerto Rico, and Colorado State University have put together an excellent proposal that is visionary and yet achievable. We are enthusiastic about being part of this endeavor.

Sincerely,

December 10, 2002

Raymond J. Ban
Executive Vice President
Meteorology Science
and Strategy

The Weather Channel, Inc.
300 Interstate North Pkwy.
Atlanta, GA 30339

[PHONE] 770.226.2161
[FAX] 770.226.2951
[EMAIL] rban@weather.com

Dr. Lynn Preston
Leader of the ERC Program
Division of Engineering Education and Centers
Suite 585
National Science Foundation
4201 Wilson Boulevard
Arlington, VA 22230

Dear Dr. Preston:

On behalf of The Weather Channel and its sister company Weather Services International (WSI); I am pleased to offer our support to the CASA Engineering Research Center. Our companies have worked with Drs. McLaughlin and Droegemeier since the inception of their Netrad concept, and we believe this project has significant potential for shaping the future of weather forecasting for severe and extreme weather events. As interested members of the weather industry, we would be honored to serve as advisors to this center and industry affiliates if the project goes forward.

Landmark Communications Inc. owns the Weather Channel, Inc. and WSI, Inc. The Weather Channel, Inc. started in 1982 as a cable company, and is now a multimedia company supplying weather information to consumers via television, telephone, newspaper, the Internet, and wireless devices. WSI, Inc. provides weather data and products to broadcast media, aviation, government and energy markets - industries that require customized weather information to make important economic and safety decisions. WSI, Inc. collects remotely sensed data from numerous sources and is a leader in applying radar technology to weather forecast products. In fact, WSI, Inc. was the first private company to develop a nationwide radar mosaic with descendant products depicting winter storm and severe flood events, all of which are now considered the 'industry-standard'.

As potential end users of the new systems envisioned by CASA we are interested in the "end-user interface" described in their proposal. We will work with the team to identify how consumers, broadcast media, aviation, and government users can benefit from these systems and their data to help shape both the design of Netrad and the strategy for creating fielded test beds.

Few programs have offered to change the way we approach observing the atmosphere as dramatically as CASA. To make a difference requires ambitious goals and the group led by Drs. McLaughlin and Droegemeier has the potential to make such a difference. We are looking forward to working with them on this very exciting effort and wish the team success in securing this project.

Sincerely,

Raymond J. Ban

cc: Michael Kleist

Walter F. Dabberdt, Ph.D.
Director, Strategic Research
Vaisala
8401 Baseline Road
Boulder, CO 80303
+303-499-1701 (central)
+303-262-4024 (direct)
+303-499-1767 (FAX)
mailto: walter.dabberdt@vaisala.com

December 10, 2002

Dr. Lynn Preston
Leader of the ERC Program
Division of Engineering Education and Centers
Suite 585
National Science Foundation
4201 Wilson Boulevard
Arlington, VA 22230

Dear Dr. Preston:

On behalf of Vaisala, I am pleased to submit this letter of support for the proposed Engineering Research Center at the University of Massachusetts. Vaisala is committed to becoming an industrial partner of the Center, and to serving on its Industrial Advisory Board. Our membership consists of the following commitments:

- $125,000 cash membership fee for the initial five-year grant period to be paid in annual installments of $25,000.
- $750,000 of in-kind contributions to be paid over the initial five-year grant period for equipment, lab space, and engineering and scientific time by Vaisala employees, some of whom will reside for extended visits on the CASA team campus sites.

Our company has been involved in the planning of the ERC through participation in Partners' Day at the University, visits to the UMass campus, and most recently, an external review of the proposal. In addition, we already are collaborating with the University of Oklahoma, a core partner in the ERC, on a number of weather instrumentation research projects and initiatives.As you may know, Vaisala was founded in 1936 by Professor Vilho Väisälä and today is the leading weather instrumentation company in the world. Vaisala is a publicly traded company with more than 1200 employees in 22 offices in 11 countries. U.S. headquarters are in Woburn, Massachusetts, and U.S. research and production are focused in our Boulder, Colorado facilities. Vaisala is the global leader in upper-air measurements, radar wind profiling, lightning detection systems, and ambient pressure and gas measurements (you may refer to our web site: http://www.vaisala.com).

As Vaisala Director for Strategic Research, I would also like to touch on Vaisala's vision for the future of mesoscale atmospheric forecasting and nowcasting, and how complementary are the vision and goals of the UMass ERC team. Vaisala sees major new developments in atmospheric forecasting that are possible through the implementation of synergistic research advances in numerical modeling, physical understanding and observations and measurements. But these advances will not be realized nor put into operation without the kind of cutting-edge research and developments in radar and networking technologies – and the ingest of these data into improved mesoscale models -- that are being proposed by the UMass ERC team.

Vaisala is especially interested in collaborating on the development of small, low-power, low-cost weather radars that can be deployed economically in high-density mesoscale networks. We see this as a backbone in future paradigms for improved mesoscale forecasting of severe weather and hydrology. Our interests in this aspect are to contribute to the design and development of the technology, and to make it available to the operational communities. Vaisala's existing expertise, resources and complementary products make this a very logical and effective technology transfer mechanism. Vaisala envisions an active two-way collaboration with UMass, the University of Oklahoma, and Colorado State University, involving exchange visits between Vaisala and university engineers in support of system design, development and testing.

Simply stated, we see tremendous value in the ERC. It brings to bear the very best minds and resources in remote sensing technology, network design, and mesoscale weather prediction. The UMass ERC team provides a very high likelihood for success, and Vaisala looks forward to its role as an industrial partner in the R&D phase, but also to helping to realize the ultimate societal benefits that will result from significantly improved forecasts of severe weather, flooding, and other high-impact atmospheric events.

I strongly encourage NSF's support of this well conceived program.

Sincerely,

Walter F. Dabberdt, Ph.D.

tyco Electronics
M/A-COM

M/A-COM, Inc.
1011 Pawtucket Boulevard
Lowell, MA 01853-3295

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www.macom.com

November 15, 2002

Dr. Lynn Preston
Leader of the ERC Program
Division of Engineering Education and Centers
Suite 585
National Science Foundation
4201 Wilson Boulevard
Arlington, VA 22230

Dear Dr. Preston:

M/A-COM is very pleased to become an industrial partner for CASA, The Center for Collaborative Adaptive Sensing of the Atmosphere, a proposed NSF Engineering Research Center. Principal Investigator Dave McLaughlin has assembled an excellent team, with partners from University of Oklahoma, Colorado State University, and University of Puerto Rico, Mayaguez, to create and implement a new paradigm for atmospheric observations systems. Our commitment is outlined below:

- $200,000 membership fee for the initial five-year grant period to be paid in average annual installments of $40,000.
- $1.5 million in-kind contributions of equipment, lab space, and engineering time to be paid over the initial five-year grant period.

Long recognized as a pioneer in microwave and radio frequency (RF) technology, M/A-COM has established itself as an industry leading developer and high-volume manufacturer of RF, microwave and millimeter wave semiconductors, components and technologies. Holding hundreds of patents in the field, M/A-COM has become known as expert technology innovators and integrators. Some of the major markets M/A-COM currently serves are wireless telecommunications, aerospace & defense and automotive.

M/A-COM shares CASA's vision of very low cost, low-power phased array radar networks and looks forward to working with the team to realize this transforming technology. As you may know, we have successfully integrated our commercial and military MMIC product lines and achieved the extreme cost-reductions in microwave ICs and packaging that are central to the radar networks that your team envisions. In addition, significant development work at M/A-COM and elsewhere has been focused on applying low cost technologies such as Silicon Germanium and Ball Grid Array packaging to wireless communications and wireless networks. These technologies are attractive because they can be used both for RF and computational functions, making possible higher levels of integration that, in turn; result in smaller and fewer components,

reconfigurability, and lower cost. We feel that these technologies, developed for our commercial communications products, can also be applied to the sensing applications you propose.

Successfully manufacturing advanced radar designs at a low cost is a challenging problem that has many potential commercial applications. M/A-COM has had many successes in this area for commercial and military customers. Examples of this are the 77 GHz Collision Avoidance Radar units for the Mercedes Benz product line. This highly complex unit is a fully functioning autonomous radar, which also provides adaptive cruise control and is being sold for less than $1,000. For surface combatant ships, M/A-COM has developed and produced low cost T/R modules for hundreds of dollars versus the traditional approach of thousands of dollars. Our ability to take advanced technology and translate it into low cost products is one of M/A-COM's core competencies.

M/A-COM is excited to participate and contribute to the research and development of these innovative technologies with the UMASS Engineering Research Center team. Our commitment is made, at this time, based on our current and projected views of our financial status and operating performance over the period of time envisioned for the ERC. Economic conditions may vary. Upon award, we will work together with UMass to define and construct this commitment to the NSF ERC within the outline and terms provided in this letter.

If you have any questions, please contact me at your convenience.

Sincerely,

M/A-COM
tyco / Electronics / M/A-COM

James J. Fallon
Director, Programs and Strategic Accounts

JJF/keg
File: JF:02:09L

FLASH TECHNOLOGY

ABOVE AND BEYOND

December 12, 2002

Dr. Lynn Preston
Leader of the ERC Program
Division of Engineering Education and Centers
Suite 585
National Science Foundation
4201 Wilson Boulevard
Arlington, VA 22230

Dear Dr. Preston:

Flash Technology is pleased to provide this letter of support for the proposed ERC partnership to develop the Center for Collaborative Adaptive Sensing of the Atmosphere. The boundary-layer wind-sensing technologies to be developed within this center will fulfill a vital gap in today's atmospheric monitoring capability and make very effective use of existing infrastructures such as cellular towers. If the CASA proposal is approved, we will become an affiliate member of the CASA Industrial Partners Program.

Working in conjunction with our strategic partner, Oak Ridge National Laboratory, we will provide in-kind support to enable CASA to leverage our ongoing efforts to deploy SensorNet-a new deployment of in-situ sensors mounted upon cellular towers. SensorNet is a management system for the real-time detection, identification, and assessment of chemical, biological, radiological, nuclear threats. SensorNet will bring together and coordinate all necessary knowledge and response assets quickly and effectively, thereby, providing the capability to dispatch informed first responders with minutes following a CBRN event. This is an issue of highest national concern for the Department of Homeland Security. The boundary-layer wind sampling and modeling capability envisioned by CASA will effectively enable the extension of SensorNet out to the scale and transport of the dispersion particles.

Flash Technology, headquartered in Franklin, Tennessee, is the world's leading full service provider of aviation obstruction lighting that is required by the FAA to be mounted on structures exceeding 200 feet in height. This includes cellular towers. Flash is a manufacturer of technology based products, has nation-wide field service force, and a National Operations Center that continuously monitors on a real-time the basis the operating status of field deployed units.

The potential for synergy between the SensorNet and the CSAA proposal is tremendous, and we are ready to help in many ways. Our in-kind support will include, but not be limited to, assistance

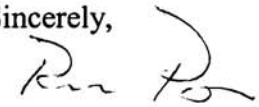
Flash Technology
P.O. Box 681509 ▪ Franklin, Tennessee 37068
Phone: 615-261-2000 ▪ Fax: 615-261-2600
www.flashtechnology.com

in performing site surveys and installing equipment on cellular and PCS communications towers and interfacing new CASA radars into our existing backhaul communications infrastructure. Many of the important issues related to CASA's system integration (e.g., the use of towers, communications and power infrastructures, data protocols) are very complementary with the SensorNet system, and we are pleased to assist the CASA project. We envision a mutually beneficial partnership in which we place SensorNet components on the CASA testbeds in Oklahoma and other areas, and likewise the CASA team would place sensors into the SensorNet infrastructure as we expand. We estimate the value of our in-kind service to be $100,000 per year.

We look forward to working with the CASA team to realize these ideas once this proposal is accepted. If I can provide any further assistance, please feel free to contact me at:

Phone: 615 261 2000
ron.brown@flashtechnology.com

Sincerely,



Ron Brown
Director

Sin

Baron
Services

December 10, 2002

Dr. Lynn Preston
Leader of the ERC Program
Division of Engineering Education and Centers
Suite 585
National Science Foundation
4201 Wilson Boulevard
Arlington, VA 22230

Dear Dr. Preston:

Baron Services is pleased to become an industrial member of CASA – the proposed NSF Engineering Research Center for Collaborative Adaptive Sensing of the Atmosphere. Upon successful award, we commit to membership fees of $50,000 for the first five years ($10,000 per year), plus $200,000 of in-kind contributions, the latter to include radar equipment, analysis software and products, and the time of our technical professionals as required jointly to support the Center.

Baron Services is a pioneer in the development of real-time, site-specific weather technologies for broadcasters, emergency management communities, and commercial enterprises. Baron has an installed base of nearly 100 radars at commercial broadcast television stations across the United States, and we have an additional 300 Emergency Manager and business customers who use our products. Our product lines have expanded to include real-time Doppler radar, advanced storm tracking and detection, instant alert systems, weather sensors, mobile weather vans and Internet displays.

We believe that CASA's vision of deploying low-cost, high-resolution radar networks has tremendous opportunities for technology transfer and commercialization both in the short term and over the long term. Broadcast radars today cost in the $400k to $800k range, and the low-cost radar networks being advanced by CASA could potentially reduce the cost of these systems by a significant factor while substantially improving the resolution and visibility in regions blind to current technology. As the cost of radars decreases and their capability increases – based on the solid-state embedded designs and networked approaches envisioned by the CASA team - whole new markets for radar networks will be created, not only in this country, but also outside of the United States in countries that today have very sparse or non-existent weather observing capabilities and simply can not afford the up-front cost of massive radar systems.

Baron Services is an entrepreneurial firm with extensive experience in deploying and maintaining groups of radars using today's technology. We've had a long and productive relationship with Dr. Kelvin Droegemeier of OU's school of meteorology related to today's NEXRAD systems. We intend to work closely with the CASA team in the research, design and deployment of the test beds so that we may, in parallel, develop a strategy of quickly deploying commercial products based on these experiments. As part

of our membership in the Industrial Partner's program, we would expect to enter into sponsored research agreements where Baron Services' employees and UMass faculty work together to create commercializable radars. Being able to share ownership of intellectual property that derives from proprietary research projects is a great benefit to industrial partners and we expect to utilize this capability as a member of CASA. Therefore, our participation as proposed herein is subject to successful completion of appropriate shared ownership agreements as required.

In summary, CASA presents visionary ideas that have commercial potential. We strongly recommend approval of this proposal, and look forward to working with the CASA team.

Sincerely,

Robert O. Baron
CEO, Baron Services, Inc.

TELEPHONICS
A Griffon Company

December 2, 2002

Dr. Lynn Preston
Leader of the ERC Program
Division of Engineering Education and Centers, Suite 585
National Science Foundation
4201 Wilson Boulevard
Arlington, VA 22230

Dear Dr. Preston:

Telephonics Corporation is pleased to become an industrial partner of CASA, The Center for Collaborative Adaptive Sensing of the Atmosphere. If the proposal is approved, we will become an active member of the ERC and serve on its industrial advisory board. Through this membership, Telephonics intends to provide:

- $50,000 cash membership fee for the initial five-year grant period to be paid in annual installments of $10,000.
- $250,000 of in-kind contributions to be paid over the initial five-year grant period for Telephonics engineering time, lab space and test equipment.

Telephonics Corporation is a worldwide leader in Integrated Information and Communication Systems with over $190M in annual revenue and over 1000 employees. Solidly based on electronic systems for essential defense programs, Telephonics develops innovative solutions to satisfy new requirements in defense, commercial, and international markets.

We see great value in this ERC. The engineered systems vision of dense networks of collaborating radars has clear potential to revolutionize ground-based sensing of weather and atmospheric hazards. The "Fleets" concept has applications in airborne sensing of dangerous clear-air turbulence – a potentially deadly aviation hazard for which no cost effective surveillance is presently available. Many of the technologies that will flow from this center – embedded processing for multibeam radar applications, ultra low cost phased array radars, and the associated signal processing and information technologies to create these new systems, could potentially serve as enablers of a variety of new products.

The mix of systems, concepts and innovative technologies in this proposal are clearly very visionary, and the microwave engineering and antenna groups at UMass are among the best in the nation. Telephonics envisions a strong synergy with these groups based upon our leadership in airborne weather radar and other air and ground surveillance radar sectors, as well as our expertise and internal IRAD effort relating to low-cost electronically steered phased array antennas. Our radar manufacturing and support facility is well suited to build the radar equipment need for this program. Accordingly we intend to make this facility accessible to the program on a timely basis. We look forward to working with these groups and the whole CASA team to realize these ideas once this proposal is accepted. If I can provide any further assistance, please feel free to contact me at 631-755-7150.

Sincerely,

Lawrence J. Rytter
President, Command Systems Division

815 Broad Hollow Road
Farmingdale, NY 11735

(631) 755-7000
FAX (631) 755-7010

December 12, 2002

Dr. Lynn Preston
Leader of the ERC Program
Division of Engineering Education and Centers
Suite 585
National Science Foundation
4201 Wilson Boulevard
Arlington, VA 22230

Dear Dr. Preston:

This letter confirms our commitment to become an Industrial Partner of CASA, The Center for Collaborative Adaptive Sensing of the Atmosphere, a proposed NSF Engineering Research Center. The team assembled by University of Massachusetts, Amherst -- which includes the University of Oklahoma, Colorado State University, and the University of Puerto Rico Mayaguez – is top notch and the Center's vision to create new atmospheric observing systems is of great importance to society and to the economy.

We will contribute $1.5 million in in-kind contributions of equipment and/or the time of IBM researchers and developers during the first five years of CASA's operation. In addition, a cash membership contribution is being considered as part of membership contribution process.

CASA seeks to integrate advanced sensing and monitoring devices with state of the art forecasting methodology. This scope of integration can now be addressed because of recent advances in computational power and networking. CASA's goals are consistent with our Deep Computing Initiative that explores the application of large amounts of computation to massive data sets in order to enable better decision-making. We believe the proposed center would both fit with our current activities and also begin to deal with the challenging data simulation problems that are encountered when networks of remote sensors are added.

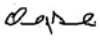
Our initial activities will focus on two areas:

- Grid Computing: We are planning to work with the College of Engineering to establish a grid computing test bed. This will be used by CASA faculty and IBM collaborators to develop and test distributed computing and control algorithms required by climate and weather applications and the new sensor networks.

- Weather Visualization and Modeling. IBM will offer complementary expertise in this area through IBM research colleagues who work on regional weather forecasting and their potential business applications. They focus on visualization methods and user interfaces for interacting, analyzing and disseminating both modeled and observed data. The Weather Visualization and Modeling group also will provide access to many end users of weather data so they may influence the design of the new observing system.

It is also IBM's policy to review these types of memberships on an annual basis. Nevertheless, we are very excited about our collaboration and look forward to working with the CASA team if the proposal is approved by the National Science Foundation.

Sincerely,



Daniel Bonelli
Vice President, Industry Marketing
IBM Software Group

Vieux and associates

SINCE 1992

December 12, 2002

Dr. Lynn Preston
Leader of the ERC Program
Division of Engineering Education and Centers
Suite 585
National Science Foundation
4201 Wilson Boulevard
Arlington, VA 22230

Dear Dr. Preston:

Vieux & Associates, Inc. enthusiastically endorses and offers to participate in the proposed ERC. We can provide useful input on hydrologic applications of technologies that affect detection and prediction of rainfall. Established in 1992 as an Oklahoma Subtitle S Corporation in Norman, Oklahoma, we are a technology development company providing GIS, hydrology, and radar rainfall services to governmental and commercial sectors in the US and internationally. Expertise in these three areas supports development of custom rainfall monitoring systems and flood alert systems. Since 1995 we have used remotely sensed data to provide quantitative precipitation estimates to our clients. Improved accuracy in rainfall estimates and rainfall forecasts hold much promise for better historic analysis of events and innovative development of flood alert and emergency management response.

In support of this proposal to-date, Vieux & Associates has contributed $4,445 in-kind. Upon project approval, we will provide:

- **$200,000 of in-kind contributions to be paid over the initial five-year grant period for development of hydrologic applications and quality assessment of NETRAD data.**
- **$50,000 cash membership fee for the initial five-year grant period to be paid in annual installments of $10,000.**

Additionally, we have introduced our client, the Texas Medical Center, to this project. Vieux & Associates will share representation with the Texas Medical Center as an Affiliate of the ERC.

We are excited about the prospects of offering services to our clients based on the technology developed by the ERC. Both in the US and internationally, we expect that considerable interest will come from organizations involved in management of water quantity and quality, and from those impacted by flooding. We wish to join with the ERC to design the NETRAD system to maximize its utility for rainfall detection and prediction for our market and end-users. We pledge our support and willingness to commit resources toward successful system development.

Sincerely,

Jean E Vieux

Jean E. Vieux
President

www.vieuxinc.com - 1215 Crossroads Blvd., Suite 118 - Nc ahoma - 73072.3359 - Ph: 405.292.6259 - Fx: 405.292.6258

PROSENSING
SYSTEMS ENGINEERING FOR ENVIRONMENTAL REMOTE SENSING

PROSENSING INC.
107 SUNDERLAND RD.
AMHERST, MA 01002
USA

TELEPHONE:
(413) 549-4402
FACSIMILE:
(413) 549-5203

Dr. Lynn Preston
Leader of the ERC Program
Division of Engineering Education and Centers
Suite 585
National Science Foundation
4201 Wilson Boulevard
Arlington, VA 22230

Dear Dr. Preston:

ProSensing Inc. is pleased to provide this letter in support of the proposed ERC partnership to develop the Center for Collaborative Adaptive Sensing of the Atmosphere. If the CASA proposal is approved, we plan to become an affiliate member of the CASA Industrial Partners Program.

ProSensing builds multi-channel digital receiver/signal processing weather radar processor boards and software tools used for pulsed and FMCW radar systems. These processors are ideally suited to processing the output of conventional, scanning single or dual polarization radars. ProSensing is also actively developing real-time processors for digital beamforming arrays, that may be suitable for the advanced weather radar systems described in the CASA proposal

As an affiliate member, ProSensing plans to support the ERC in the following ways:

- Provide weather radar signal processing hardware and software tools at a 20% discount off our standard commercial price.
- Provide in-kind engineering support, through contribution of up to 1 month annually of the direct labor of a software or electrical engineer to train UMass graduate students in the operation and programming of signal processing hardware and software provided by ProSensing.

The estimated annual value of these in-kind discounts and services is $50,000.

ProSensing has maintained strong ties to the University of Massachusetts from the founding of our company—formerly known as Quadrant Engineering—in 1982 by the Co-director's of the UMass Microwave Remote Sensing Laboratory. Since 2001, we have strengthened our ties to the University through active participation in the Millimeter Wave Business Group, (MWBG), a consortium of local companies and two laboratories at UMass, including the Microwave Remote Sensing Lab and Five College Radio Astronomy Observatory. The MWBG recently submitted a multi-million dollar homeland defense proposal which included participation of UMass, Millitech, ProSensing and Millivision.

For the past three years, we have been enthusiastic supporters of the University's effort to revolutionize atmospheric boundary layer remote sensing through the use of distributed, networked sensors. We look forward to being members of the CASA team, and would be glad to discuss our role in the ERC if you have any further questions. Please feel free to contact me at 413.549.4402 x-13, or via email at mead@prosensing.com.

Sincerely,

James B. Mead
President

Industrial Practitioner Support Letters

The Commonwealth of Massachusetts
Department of Education

350 Main Street, Malden, Massachusetts 02148-5023

Telephone: (781) 338-3000
TTY: N.E.T. Relay 1-800-439-2370

David P. Driscoll
Commissioner of Education

November 19, 2002

Dr. David McLaughlin
Professor of Electrical and
Computer Systems Engineering
University of Massachusetts
Knowles Engineering Building
Amherst, MA 01003

Dear David:

I am writing to express my enthusiastic support for your proposal to the National Science Foundation to establish an Engineering Research Center for *Collaborative Adaptive Sensing of the Atmosphere (CASA)*. Weather and the Internet do touch everybody and the idea of using these hooks to illustrate the engineering design process is very innovative – and very natural. A research partnership between CASA and Massachusetts teachers can help bring engineering and technology to life in classrooms and help us demonstrate how engineering endeavors are being used to achieve solutions to societal problems. These are just the kind of programs we need to light the spark of interest in our children and engage them in thinking and learning about engineering and technology.

Based on my previous experience with your College's K-12 educational initiatives, I am confident that CASA will benefit many Massachusetts teachers and children. I recently had a first-hand opportunity to visit UMass on November 1st and observe the fine work you are doing during your sponsorship of the annual Massachusetts Technology Education/Engineering Collaborative (MassTEC) conference. Your support for these technology education teachers is critical if we are to continue the progress we are making as a state with the new statewide Curriculum Frameworks that include engineering and technology.

I am particularly pleased that CASA will provide new materials and Summer Content Institutes for K-12 teachers. Professional development is critically important so that teachers receive the support they require to successfully engage their students in learning about engineering and technology. As I remarked at the MassTEC conference, as a state we are leading the way nationally with respect to inclusion of engineering teaching and learning for both teachers and children.

Your proposal also creates a remarkable opportunity for other state leaders to engage with industry and engineering through the creation of an annual conference. This conference will provide Massachusetts and other states a national forum to share and discuss strategies for implementing high quality technology/engineering programs K-12, effective models and practices, promising partnerships, and state policies that support technology engineering programs. Let me assure you that we will be pleased to co-sponsor such a conference with CASA and will lend our strong support and encouragement to other states to participate.

The Department of Education, and its Center for Teaching and Learning, look forward to partnering with your center over the next several years as we implement the Science and Technology/Engineering Curriculum Frameworks in Massachusetts and as other states engage in this nationally important dialogue.

I wish you all the best in your proposal.

Sincerely,

David P. Driscoll
Commissioner of Education

Central Office
P.O. Box 1410
195 State Street
Springfield, MA
01102-1410

THE PUBLIC SCHOOLS of SPRINGFIELD, MASSACHUSETTS

Dr. Joseph P. Burke
Superintendent of Schools

Voice: (413) 787-7087
Fax: (413) 787-7171
E-mail: burkej@sps.springfield.ma.us

December 3, 2002

Kathleen G. Rubin
Assistant Dean for College Outreach
University of Massachusetts
125 Marston Hall
130 Natural Resources Road
Amherst, MA 01003-9293

Dear Ms. Rubin:

I am very pleased to be asked to participate, as a member of the K-12 Outreach Board, with UMass, Amherst, College of Engineering, National Science Foundation proposal: Center for Collaborative Adaptive Sensing of the Atmosphere, CASA. I have worked with the NSF on many projects and support their work and initiatives as a way to improve science education in our country at all academic levels.

As we labor in the Springfield Public Schools to improved science and mathematics achievement for all students, collaboration with the College of Engineering at the University of Massachusetts will address our need for high quality professional development in support of the MA Science and Technology/Engineering Framework and the MA Mathematics Curriculum Framework. The potential for national summer conferences in conjunction with the MA, DOE will help to strengthen the importance of science, mathematics and engineering education.

In addition the opportunity for K-12 teachers to be part of CASA summer research projects is an exciting prospect. More importantly, the goal of the College of Engineering to recruit, retain and graduate minority students supports our desire that all Springfield students have the opportunity to be successful in the career areas of mathematics, science and engineering.

I look forward to being part of the K-12 Outreach Advisory Board as a way to increase the opportunities for both teachers and students in the Springfield Public Schools.

Sincerely,

Dr. Joseph P. Burke

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration

OFFICE OF OCEANIC AND ATMOSPHERIC RESEARCH

National Severe Storms Laboratory
1313 Halley Circle
Norman, OK 70069

Dr. Lynn Preston
Leader of the ERC Program
Division of Engineering Education and Centers, Suite 585
National Science Foundation
4201 Wilson Blvd.
Arlington, VA 22230

Dear Dr. Preston:

The National Severe Storms Laboratory (NSSL) is pleased to offer this letter of intent to become a Government Partner in support of the Center for Collaborative Adaptive Sensing of the Atmosphere (CASA) under NSF's Engineering Research Center Program. NSSL has participated in the planning activities leading to the preparation of this proposal and is desirous of collaborating with the CASA ERC. The use of radar to detect, predict, and warn of impending hazardous weather saves lives, protects property, and assists decision makers in reducing disruptions to our nation's economy.

NSSL is a federal laboratory housed in the Department of Commerce, National Oceanic and Atmospheric Administration, Oceanic and Atmospheric Research, (DOC/NOAA/OAR). NSSL's mission is to perform research and development to improve this nation's ability and to detect, forecast, and warn of severe and hazardous weather including tornadoes, high winds, large hail, flash floods, heavy snow, and ice storms. NSSL's approach is centered on the development of new radar and model-based detection and forecasting techniques. NSSL is the home of the National Weather Radar Testbed (NWRT) which includes a state-of-the-art phased array radar, two 10 cm dual polarized research radars and two 5 cm truck mounted, mobile radar platforms. NSSL conducts major field campaigns to test new facilities and techniques. A major drawback in the current national weather radar network is that much of the crucial lower atmospheric boundary layer is not scanned by radar because of the Earth curvature effect. The concept of a network of inexpensive, low power weather radars may prove vital in improving our ability to detect and forecast severe and hazardous weather. Thus, NSSL is very interested in partnering with the proposed CASA ERC to further develop and test this intriguing hypothesis.

For example, we envision collaborating with the CASA ERC in major field experiments to do radar system intercomparisions under the auspices of the NWRT. This would allow for the objective determination of the strengths and weakness of candidate operational systems and their relative value to the severe weather detection and forecast problem.

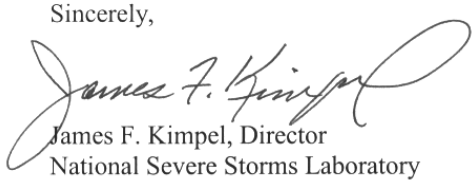
The outcome could very well point to the optimal mix of candidate systems to deliver the most cost effective solution for the nation.

Mutual benefits from a CASA - NSSL partnership are numerous and only can be highlighted here. NSSL has considerable expertise in radar hardware and signal processing design which is currently being applied to NEXRAD upgrades and a phased array radar platform. The phased array will employ adaptive scanning strategies, a concept shared with CASA. Thus the prospects are strong for symbiotic collaboration in these important areas.

NSSL has developed radar based hazardous weather detection algorithms for NEXRAD and certain FAA weather radars. Sharing these algorithms with CASA would save much time and effort. Furthermore, field tests employing NEXRAD, phased array radar, and CASA networks would lead to combined databases yielding a complete mapping of the troposphere. The resulting datasets would then be mined for algorithm improvement research and development. The same combined databases would form unprecedented high resolution information, in both space and time, for assimilation into experimental, cloud-resolving forecast models.

In addition, NSSL is willing to commit various in-kind resources to a successful CASA ERC. The research engineering and scientific personnel at NSSL will be available as consultants to assist in the design and execution of field campaigns. NSSL will provide some temporary space and IT support for collaborative efforts. Dr. Richard Doviak, the co-author of the Doppler weather radar textbook, will be assigned as the NSSL liaison to the CASA ERC. The NSSL staging facility and workshop areas will be partially subsidized by NSSL, depending on each groups' funding situation. The expectation is that this collaboration will lead to joint publications and joint research projects in the future. Subject to the availability of funds, NSSL estimates the total in-kind contribution for year one to be $40K, however this amount could increase for subsequent years during full field deployment and testing phase.

Sincerely,



James F. Kimpel, Director
National Severe Storms Laboratory

Dr. Lynn Preston
ERC Program Leader
Division of Engineering Education and Centers
Suite 585
National Science Foundation
4201 Wilson Blvd.
Arlington, Virginia 22230

Dear Dr. Preston:

The National Weather Service (NWS) Office of Science and Technology is pleased to offer this letter of support to the Center for Collaborative Adaptive Sensing of the Atmosphere (CASA) under the National Science Foundation's Engineering Research Center program. CASA's mission of developing cost effective radar sensors and observation techniques directly supports the NWS mission of protecting life and property.

We are an office of the National Weather Service, National Oceanic and Atmospheric Administration, Department of Commerce. Our mission is to drive innovative science and technology into NWS operations. In pursuit of the NWS mission to protect lives and property, we team with the National Severe Storms Laboratory to develop advanced radar technologies. These technologies contribute to an integrated observing system strategy which would benefit from CASA's sensors and observation techniques. Current NWS radar systems are highly effective in observing tornado signatures, rotating storms, and high precipitation but resolution is lost at the boundary layer. CASA's sensors would capture crucial boundary layer information, better define weather activity, and contribute to a more accurate forecast. These forecasts would significantly extend tornado warning lead times giving the public a greater window of safety.

We welcome the opportunity to work with the CASA team to develop effective radar systems and techniques toward applications to help safeguard the nation's people and economy. I strongly endorse the CASA initiative and look forward to collaborating with this effort.

Sincerely,

John L. Hayes, Director,
Office of Science and Technology

THE ASSISTANT ADMINISTRATOR
FOR WEATHER SERVICES

National Center for Atmospheric Research
Atmospheric Technology Division
P.O. Box 3000, Boulder, CO 80307

NCAR

Dr. Lynn Preston, ERC Program Leader
Division of Engineering Education and Center
National Science Foundation
Suite 585
4201 Wilson Blvd
Arlington, VA 22230

Dear Dr. Preston:

The Atmospheric Technology Division of the National Center for Atmospheric Research (NCAR/ATD) is pleased to offer this letter of intent to participate in the Center for Collaborative Adaptive Sensing of the Atmosphere under NSF's Engineering Research Center (ERC) Program. As a national center we are always anxious to assist the university community with their good ideas, as is the case here.

NCAR was a participant in the National Research Council's Committee on Weather Radar Technology Beyond NEXRAD. A recommendation of the committee was that "The potential for a network of short-range radar systems to provide enhanced near-surface coverage and supplement (or perhaps replace) a NEXRAD-like network of primary radar installations should be evaluated thoroughly." We are in agreement with this recommendation and would be pleased to participate in a CASA/ ERC effort to follow up on this recommendation. Under this proposal, a senior staff member from NCAR/ATD will serve on an advisory committee. If additional resources are found, our participation could be expanded to include contribution to a variety of technical areas, (e.g., phased array antenna scanning, low cost transmitter design, data networking, algorithm development and scientific evaluation of collected data).

NCAR is familiar with the excellent work of many (e.g. University of Massachusetts, Colorado Sate University, University of Oklahoma and NSSL) of the proposed CASA ERC partners and would be pleased to collaborate with them on this topic.

Sincerely

Jack Gaynor Acting ATD Director

Dave Carlson, Director
NCAR Atmospheric Technology Division

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NEXRAD WEATHER FORECAST OFFICE
4000 Carretera 190
Carolina, Puerto Rico 00979

December 2, 2002

National Science Foundation
Engineering Research Center
Program Director

Dear Lynn Preston:

In May 9, 2002, I sent you a letter of support for the proposed collaborative project with the UPR-Mayaguez. I just want to let you know that the Weather Forecast Office at San Juan, Puerto Rico supports the proposal titled " Collaborative Adaptive Sensing of the Atmosphere" (CASA) to be submitted to the NSF Engineering Research Center (NSF ERC) Program by the University of Puerto Rico-Mayagüez (UPRM) in collaboration with the University of Massachusetts (UMass), Colorado State University, and University of Oklahoma.

The high-resolution data obtained with the proposed technology is of great interest to the National Weather Service in Puerto Rico and the U.S. Virgin Islands. This realtime data should result in improvement of the existing capabilities of the current technology to accurately and efficiently examine atmospheric boundary conditions of the Island. The NWS is willing to collaborate with UPR-Mayaguez in the meteorological component of this proposal.

NOAA has a signed MOA in place with UPR-Mayaguez which strongly supports this type of data gathering and research activity. One of the goals of the MOA is to forge studies in the atmospheric sciences and eventually establish a formal Atmospheric Science Program. This CASA proposal will positively impact our partnership with UPR-Mayaguez

Sincerely,

Israel Matos

Mr. Israel Matos
Meteorologist-In-Charge
Weather Forecast Office
San Juan, Puerto Rico

OAK RIDGE NATIONAL LABORATORY
MANAGED BY UT-BATTELLE FOR THE DEPARTMENT OF ENERGY

Brian A. Worley
P.O. Box 2008
Oak Ridge, TN 37831-6359
Phone: (865) 574-6106
Fax: (865) 574-6275
worleyba@ornl.gov

December 16, 2002

Dr. Lynn Preston
Leader of the ERC Program
Division of Engineering Education and Centers
Suite 585
National Science Foundation
4201 Wilson Boulevard
Arlington, VA 22230

Dear Dr. Preston:

The Oak Ridge National Laboratory (ORNL) is pleased to offer this letter of intent to become a strategic Government Partner in support of the Center of Collaborative Adaptive Sensing of the Atmosphere (CASA) under National Science Foundation's (NSF) Engineering Research Center Program. ORNL is the Department of Energy's largest multipurpose science laboratory, and its science and technology agenda focuses on neutron sciences, scientific computing, complex biological systems, the provision of secure and reliable energy sources, materials research, and national security. ORNL has developed a strong alliance with a large number of the nation's premier universities through the Oak Ridge Associated University (ORAU) program, of which Oklahoma University (OU) is a member. ORAU provides valuable mechanisms for interacting with CASA, including research collaborations, faculty exchanges, graduate and undergraduate fellowships, and other programs.

ORNL's specific interest in CASA stems from the tremendous synergy between the NETRAD/CLEAR concepts of the ERC proposal and the ORNL SensorNet program, which uses sensors placed on cell phone towers to make single-point, in-situ measurements of chemical, biological, and radiological agents. Our SensorNet will strategically locate such sensors throughout the United States and send critical information to a national command center within minutes of detection, including location of the event, type agent released, predictions of movement and concentration, and the number of people that could be affected. The command center can then immediately dispatch informed first responders to the event area. *CASA would bring an entirely new dimension to SensorNet by providing high-resolution observations of the wind, temperature, and moisture fields in three-dimensional volumes, thus extending the reach of SensorNet from single points to the entire atmosphere and providing a mechanism for substantial improvements to the*

predictive capability of dispersion models. Furthermore, the collaborative/adaptive sensing strategy to be developed by CASA offers tremendous promise for optimally detecting a variety of specific hazards instead of performing marginally across a broad range.

Tens of millions of dollars will be invested in developing the framework for SensorNet and implementing early local systems, and a nationwide deployment could exceed a billion dollars. The CASA team is poised to leverage and participate in this tremendous investment, and we envision that ORNL-CASA interactions will occur in the following ways:

Joint development of strategies for using the nation's existing cellular tower infrastructure to deploy the communications backbone for coordinated atmospheric sensing in areas that are vulnerable to weapons of mass destruction (WMD);

Rapid early deployment of CASA sensors within existing SensorNet test beds and assimilation of the observations into ORNL dispersion models. By actually working together as soon as possible, CASA and ORNL will be able to leverage each other's knowledge and resources to more effectively plan for the future;

Placement of SensorNet sensors within the planned CASA test beds in Oklahoma and Houston, which in the former would leverage the extensive atmospheric observing infrastructure already in place, and in the latter would represent a keen opportunity for ORNL to study an important urban area that is highly vulnerable to WMD. We note that Oklahoma City is the site of a major urban WMD dispersion experiment in summer, 2003, and similar efforts elsewhere could leverage the synergy between ORNL and CASA;

Scientists at ORNL already have looked carefully at practical infrastructure issues important to CASA, e.g., use of towers, communications and power infrastructures, data protocols, data storage, security, and system survivability, and have developed a strategic alliance with the cell tower industry, including a partnership with Flash Technology in Franklin, Tennessee (a CASA Industrial Affiliate). These established relationships will reduce considerably the spin-up time for ERC test bed deployments, save money on deployment costs, and bring to ORNL expertise in volumetric remote sensing;

ORNL has core competencies in supercomputing and massive data storage, both of which are critical to CASA. Similarly, the atmospheric modeling and data assimilation components of CASA mesh well with ORNL's work on atmospheric dispersion modeling, especially because OU pioneered the assimilation of radar data into fine-scale prediction models.

ORNL brings additional assets of high value to CASA. One of the key objectives of CASA is real-time atmospheric detection and prediction, and ORNL strengths that will help ensure successful and expeditious attainment of many CASA implementation objectives include: (1) use of the SensorNet Common Data Highway for networking sensor data and development of a common information source with customizable presentation; (2) access to the new ORNL high performance computing infrastructure (planned expansion to a 100+ Teraflop machine within five years) and experienced personnel in high performance computing; (3) access to ORNL high performance storage systems and technology, including skilled personnel for rapid data transfer and storage; and (4) long-term personnel collaborations and exchanges to further build strategic partnerships among ORNL and universities to advance the national science base.

Because of the potential breadth and depth of interactions between CASA and ORNL, it is difficult at this point to estimate the financial leverage that ORNL brings to the ERC proposal. The early deployment of CASA radars within one SensorNet test bed alone would produce a cost match of several hundred thousands of dollars, and our plans for interaction are considerably more visionary. Consequently, we attempt no dollar estimate at this time, and simply note that if CASA is funded by the NSF, ORNL will become a major partner for scientific collaboration; for providing a possible physical infrastructure for deploying CASA radars; and for providing a potential operational infrastructure for use of CASA sensors in securing our homeland.

I look forward to this opportunity for collaboration between our organizations and the benefits provided to our country in addressing important national problems.

Sincerely,

Brian A. Worley

Brian A. Worley
Director
Computational Sciences and Engineering Division

BAW:air

Texas Medical Center

Richard E. Wainerdi, P.E., Ph.D.
President, Chief Executive Officer
and Chief Operating Officer

1133 John Freeman Blvd., Suite 406
Jesse H. Jones Library Building
Houston, Texas 77030-2894

(713) 791-8800
(713) 791-8872 Fax

December 5, 2002

Lynn Preston
Deputy Division Director
Division of Engineering Education and Centers
National Science Foundation
Arlington, Virginia

RE: NETRAD

Dear Ms. Preston:

Please accept my enthusiastic endorsement to develop advanced flood warning capabilities through your proposed Engineering Research Center for Collaborative Adaptive Sensing of the Atmosphere (CASA). I have been active in trying to find a solution to our flood problem for the Texas Medical Center (TMC) for almost two decades. Our member institutions have capital investments of over $7.8 billion. With over 100 buildings on more than 700 acres, we have considerable vested interest in preserving and sustaining our quality of healthcare services. Let me share with you the reasons why flooding is important to the delivery of medical services at the TMC.

We are the largest medical center in the world with 42 member institutions that include 13 hospitals. The hospitals provide over 6,000 licensed beds and over 400 bassinets. Over 62,000 people are employed in our facilities. Each day over 150,000 people cross our campus boundaries. We are equivalent to a small city, but dedicated to the best healthcare in the world. Some of our most famous institutes are world leaders in heart transplants, pediatrics and cancer treatment. Our ability to serve the medical needs of Houston, the United States, and international patrons is severely impacted by flooding from an adjacent drainage area called Brays Bayou. When we first located and started building the TMC, we were above the 100-year floodplain. But now, because of upstream urbanization and subsidence (Houston sunk due to groundwater withdrawal) we are subject to repeated flooding. Every year there are multiple alerts sounded due to heavy rainfall, and some years we suffer catastrophic losses due to flooding from tropical storms or unnamed storm events common to our near tropical climate.

Because of this threat, we have taken steps since 1997 to offer our member institutions advanced warning of impending flooding. Our member institutions need critical information about flooding on Brays Bayou and locally on our campus where local flooding causes transportation problems for emergency vehicles, patients, and employees. The hospitals have their own logistical operations that they implement to protect facilities from flooding. Staffing levels and potential evacuation of patients are coordinated based on this information. When flooding is imminent, elective medical procedures are cancelled; clinics and outpatient facilities are closed. This in turn causes business interruptions that affect our member institutions estimated at $26 million per day in lost revenue. This does not include the cost of implementing flood protection measures or any resulting damages. In June of 2001, we suffered nearly $2 billion in damages and untold losses in medical research from Tropical Storm Allison. Flood information and advanced warning saves millions of dollars in our medical center, improves the delivery of patient care, and reduces the potential for the loss of life. While flood warning systems do not prevent flooding they do allow us to operate more efficiently and to reduce the number of unnecessary cancellation of

surgeries, clinic closures, etc. In September 1998, Tropical Storm Frances nearly shut our institutions down. At the time, NEXRAD radar showed that no more rainfall was projected to move over the Brays watershed. This was a success story because we narrowly averted a shutdown using this information and avoided costly business interruption. Thankfully there were no major damages, unlike the experience with Allison last year.

I wholeheartedly support the development of the NETRAD technology by offering a location for installation of NETRAD radar on our facilities. In addition, we will work vigorously to encourage project participants to expand the system in Houston. We are very pleased to encourage research and development efforts to make this a world-class radar flood alert system. Our Senior Vice President, Mr. Henry Rietz has already offered support and is the contact person for this project. I look forward to the day when we can tell our member hospitals and institutions on a more timely and accurate basis when it will flood, and just as importantly, when it will not.

Sincerely,

Richard E. Wainerdi

REW/HLR/mck

cc: David McLaughlin, Ph.D.
Armstrong Professor and MIRSL Director
University of Massachusetts
Microwave Remote Sensing Laboratory
113F Knowles Engineering Bldg.
Amherst, MA 01003-4410

Letters of Support from University Officials

UNIVERSITY of
MASSACHUSETTS
JOSEPH I. GOLDSTEIN
Dean
125 Marston Hall
130 Natural Resources Rd.
Amherst, MA 01003-9293

College of Engineering
voice: 413.545.0300
fax: 413.545.0724
e-mail: JIGO@ecs.umass.edu

December 17, 2002

Dr. Lynn Preston
Leader of the ERC Program
Division of Engineering Education and Centers
Suite 585
National Science Foundation
4201 Wilson Boulevard
Arlington, VA 22230

Dear Dr. Preston:

I strongly support the attached proposal to establish an Engineering Research Center for Collaborative Adaptive Sensing of the Atmosphere (CASA). This proposal is the culmination of three years of effort between top engineering and computer science faculty at UMass, academic partners at OU, CSU, and UPRM, and a committed group of industrial and government partners from around the country. This team proposes a bold plan to revolutionize how we observe, understand, and react to the atmosphere around us. Similarly, the research proposed will revolutionize the way we design sensing and computing infrastructures and the way people interact with complex information systems.

Our industrial partners are fully engaged and are ready to transfer technology through the sharing of experiences and ideas, intellectual property, and by hiring our students. Together, we will introduce engineering and technology to teachers and school children to portray how our profession serves the needs of society. CASA is well aligned with the growth strategy of the College of Engineering and the Computer Science Department, and three additional faculty members will be hired within these areas to support the goals of the center. The College and the University are committed to providing the necessary space and facilities needed to make this center a success. Specifically, the College of Engineering commits to:

- In-kind contribution of faculty and staff time amounting to $1.2 million over the five year grant period.
- Start-up cost of 250,000 for three years for new faculty to be shared with the Provost
- $50,000 annually for undergraduate scholarships
- $50,000 annually from our endowment to support graduate students or post docs.

The bold agenda and rich collaboration proposed here represent engineering research and education at their best. I look forward to hosting a team for a site visit, and I thank you for letting us compete in the ERC program.

Sincerely yours,

Joseph I. Goldstein

Dean

UNIVERSITY OF
MASSACHUSETTS AMHERST
362Whitmore Administration Building
181 Presidents Drive
Amherst, MA 01003-9313

Office of the Provost
voice: 413.545.2554
fax: 413.577.3980
www.umass.edu/provost

December 13, 2002

Dr. Lynn Preston
Leader of the ERC Program
Division of Engineering Education and Centers
Suite 585
National Science Foundation
4201 Wilson Boulevard
Arlington, VA 22230

Dear Dr. Preston:

I am very pleased to submit our invited full-proposal to establish an Engineering Research Center for Collaborative Adaptive Sensing of the Atmosphere (CASA). As the lead institution, the University of Massachusetts at Amherst is submitting this proposal in partnership with our core academic partners at the University of Oklahoma, Colorado State University, and the University of Puerto Rico at Mayaguez. CASA complements our University-wide strategy of building our research activities to even higher levels and using this research to strengthen our teaching.

The faculty of the Microwave Remote Sensing Laboratory in the College of Engineering have had a strong research collaboration with the University of Oklahoma and Colorado State University for many years and have more recently begun a collaboration with the University of Puerto Rico at Mayaguez. Our faculty have developed novel radar systems and with their partners has been successful in sensing and understanding extreme weather events, such as tornadoes and hurricanes. This ERC grows out of that collaboration and is strengthened by information technology research that has the potential to revolutionize the way we communicate, acquire, store, and process information and interact with one another. The UMass computer science and engineering programs are world leaders in developing these technologies and the foundation of knowledge that supports them. This ERC brings these areas together and creates a truly multi-disciplinary research culture that merges engineering and computer science with meteorology, policy, education, and the humanities, all researching a compelling societal problem and together educating a new generation of students prepared to think broadly about complex engineered systems.

The University of Massachusetts has invested heavily in the areas of microwave remote sensing, computer science, and electrical and computer engineering over the last

decade. The University has built new buildings for two of these three areas and has added significant resources and new faculty to these programs. We have subsequently been joined by world-class faculty from our three academic partner institutions. In addition, nearly 20 companies and government agencies have committed or indicated a strong desire to join the Engineering Research Center as partners. These partners will work with us in many ways, from researching novel sensors to creating the data storage, communication, and computing infrastructure to connect these sensors to end-users most affected by extreme and high impact weather. Our partners will connect the Center's research to a first-rate engineering and technology education program that impacts students of all ages. Corporate partners and faculty will develop combined research/employment experiences through which students can apply their knowledge and become agents of technology transfer.

Because this Engineering Research Center is of such importance to the UMass academic program, I have made the following commitments:

- Contingent on the NSF award of an ERC at the requested amount, the University of Massachusetts Amherst will contribute $1,000,000 annually to the ERC continuing through the 5 to 10 year period of NSF support. This support will include three new faculty positions as well as administrative support and equipment for CASA testbeds. This contribution will exceed the required 10% cash match.

- The University of Massachusetts Amherst will provide the necessary space, resources, and infrastructure to run an ERC.

I am proud of the faculty, institutions, and corporate partners that have come together to define this center and initiate its development. The Center will be a centerpiece of the University of Massachusetts Amherst as it enters the new century. I invite the National Science Foundation to study our plans for a new center as detailed in the attached proposal and I look forward to host a site visit to our campus. I want to thank you and your colleagues, in advance, for your consideration of our proposal.

Sincerely yours,

Charlena Seymour
Senior Vice Chancellor for Academic Affairs
and Provost

Enclosure

The University of Oklahoma

OFFICE OF THE SENIOR VICE PRESIDENT AND PROVOST

5 December 2002

Dr. Lynn Preston
Division of Engineering and Education Centers, Room 585
National Science Foundation
4201 Wilson Boulevard
Arlington, VA 22230

Dear Dr. Preston,

The University of Oklahoma is pleased to be a major participant in the proposed Center for Adaptive Sensing of the Atmosphere (CASA). As you perhaps know, OU is home to one of the first 11 NSF Science and Technology Centers established in 1989, and thus we understand the importance of meaningful matching commitments for activities of scope and duration of an Engineering Research Center. To ensure that CASA is able to achieve its bold goals, we are pleased to commit the following matching support from the Office of the Provost and the Office of the Vice President for Research:

1. Pre-award cash match of $134,000 (salary, fringe benefits, and un-recovered indirect costs) to support a full-time scientist who will serve as the technical director of the Oklahoma test bed (formally the Director of the NETRAD System Operations Control Center). This individual will be the principal technical coordinator contact among UMass, the University of Oklahoma, OneNet, Oak Ridge National Laboratory, and appropriate private sector partners in designing, implementing, and operating the Oklahoma NETRAD test bed.

2. Recurring funds to support one faculty line in radar meteorology (salary, fringe benefits). This individual would be hired to further enhance the faculty expertise in radar technology.

3. Post-award cash match of $218,000 per year for 5 years (salary, fringe benefits, and un-recovered indirect costs) to continue supporting 0.5 FTE of the NETRAD System Operations Control Director, 0.5 FTE of an information technology specialist, and 0.5 FTE of a project manager for the entire Oklahoma component of the proposal.

The total 5-year cash match from the Office of the Provost and the Office of the Vice President for Research at the University of Oklahoma is thus $1.224M against an anticipated NSF commitment to OU of approximately $6.14M during the same period. Note, however, that the University of Oklahoma is committing other matching support, as outlined in separate letters.

Our offices stand ready to assist in all administrative aspects of this effort, including the site visit and all post-award activities. Please contact us if you require additional information.

Sincerely,

Nancy L. Mergler
Senior Vice-President and Provost
University of Oklahoma – Norman Campus

T.H. Lee Williams
Vice President for Research
Dean of the Graduate College
Regents' Professor of Geography

660 Parrington Oval, Room 104, Norman, Okla 5 0390 PHONE: (405) 325-3221 FAX: (405) 325-7470

The University of Oklahoma
SCHOOL OF METEOROLOGY

9 December 2002

Dr. Lynn Preston
Division of Engineering and Education Centers, Room 585
National Science Foundation
4201 Wilson Boulevard
Arlington, VA 22230

Dear Dr. Preston,

The School of Meteorology at the University of Oklahoma is pleased to be a major participant in the proposed Center for Adaptive Sensing of the Atmosphere. Toward achieving its goals, the School contributes ***one month of in-kind salary matching support, <u>each year</u>, for the faculty listed below***. The figures shown are for the first year only, and one might reasonably assume a 2% increase in base salary per year per faculty member.

	Salary (1 mo/yr)	Fringe Benefits (36.5%)	Indirect Costs (45.5%)	Total Per Yr
• Dr. Frederick H. Carr Mark and Kandi McCasland Professor of Meteorology	$9,970	$3,639	$6,192	**$19,801**
• Dr. Kelvin Droegemeier Regents' Professor of Meteorology and Director of CAPS	$10,820	$3,949	$6,720	**$21,489**
• Dr. Howard B. Bluestein Presidential Professor of Meteorology	$12,259	$4,475	$7,614	**$24,348**
• Dr. Mike Biggerstaff Associate Professor of Meteorology	$7,500	$2,738	$4,658	**$14,896**
• Dr. Alan Shapiro Associate Professor of Meteorology	$6,138	$2,240	$3,812	**$12,190**
• Dr. Ming Xue Assistant Professor of Meteorology	$6,009	$2,193	$3,732	**$11,934**
Total Commitment For Year-1				**$104,658**

Sincerely,

Frederick H. Carr

Frederick H. Carr
Director and Mark and Kandi
McCasland Professor of Meteorology

Energy Center, 100 East Boyd, Room 1310, Norman, 73019-0470 PHONE: (405) 325-6561 FAX: (405) 325-7689

Oklahoma Climatological Survey
The University of Oklahoma ~ College of Geosciences
100 East Boyd Street ~ Suite 1210 ~ Norman, OK 73019-1012

Telephone 405.325.2541 Facsimile 405.325.2550 Web Address www.ocs.ou.edu Electronic Mail ocs@ou.edu

December 10, 2002

Dr. Lynn Preston
Division of Engineering and Education Centers, Room 585
National Science Foundation
4201 Wilson Boulevard
Arlington, VA 22230

Dear Dr. Preston:

The Oklahoma Climatological Survey (OCS), a state agency located at the University of Oklahoma, is pleased to be a major participant in the proposed Center for Adaptive Sensing of the Atmosphere (CASA). To help CASA achieve its goals, the Survey will contribute one month of in-kind salary matching support (including fringe benefits and indirect costs), each year, for our Director of Outreach, Dr. Kevin Kloesel. The figures shown below are for the first year only. One might reasonably assume a 2% increase in base salary per year for future project years.

Salary (1 mo/yr)	Fringe Benefits (36.5%)	Indirect Costs (45.5%)	Total Contribution
$7,320	$2,672	$4,546	**$14,538**
Total Commitment For Year-1			**$14,538**

Dr. Kloesel will provide valuable expertise to CASA through his work with eventual users of CASA Netrad data. OCS has a decade of expertise in award winning outreach to K-12, higher education, emergency management and homeland security, and other users of radar data. My office stands ready to assist the CASA proposal effort, including the site visit and all post-award activities. Please do not hesitate to contact me if you require additional information.

Sincerely,

Kenneth C. Crawford, Director
Oklahoma Climatological Survey
Regents' Professor of Meteorology

The University of Oklahoma
DEPARTMENT OF MATHEMATICS

Decemeber 3, 2002

Dr. Lynn Preston
Division of Engineering and Education Centers, Room 585
National Science Foundation
4201 Wilson Boulevard
Arlington, VA 22230

Dear Dr. Preston:

I pledge 2 week of in-kind match. My salary fringe benefits are as follows.

$89,917/ academic year.....2 weeks salary	$4990
Fringe benefits = salary × 36.5%	$1821
Subtotal	$6811
IDC = Subtotal × 45.5%	$3099
Total	$9910

The effort will be split between research and teaching. For the teaching I will offer a course on Optimization by Vector Space Methods (taught under the name Calculus of Variations) in which constrained and unconstrained optimization are treated. Lagrange multiplier and adjoint methods will be developed in depth. We will also develop global and stochastic optimization methods. In past years many students from engineering, meteorology, and mathematics have taken this course.

Sincerely yours,

Luther W. White

Luther White
Presidential Professor

601 Elm Avenue, Room 423, Norma

73019-3103 PHONE: (405) 325-6711

The University of Oklahoma

SCHOOL OF CIVIL ENGINEERING AND ENVIRONMENTAL SCIENCE

December 9, 2002

Dr. Lynn Preson:
Division of Engineering and Educational Centers, Room 585
National Science Foundation
4201 Wilson Boulevard
Arlington, VA 22230

Dear Dr. Preston:

This letter commits in-kind match in support of the Engineering Research Center for Collaborative Adaptive Sensing of the Atmosphere (CASA). My effort will be to develop course materials that incorporate radar rainfall estimation concepts in two courses: CE 5843 Hydrology and CE3212 Water Resources Engineering. I pledge two weeks for this effort.

CE5843 Hydrology--This graduate course is taken by both meteorologists and other geoscience students together with graduate and undergraduate (as a professional elective) civil and environmental engineers. Typically the mixture of students is 40%/60% meteorologists to engineers. Radar rainfall estimation is a part of this course as well as distributed hydrologic modeling taught through project-based educational experiences in teams of scientists and engineers. The text used is by Bedient (Co-PI)and Huber, *Hydrology and Floodplain Analysis*. I am the author of Chapter 11, Radar Applications in Hydrology. From the outset in the course, basic concepts will be added to the course to enlarge the student's skills in understanding remote sensing of the atmosphere through collaborative and adaptable radar networks. As more discoveries and applications are developed through the CASA ERC, they will be incorporated into the course.

CE 3212 Water Resources Engineering—This is a first course taken by civil engineering undergraduates that deals with water. Rainfall-runoff is an important component of engineering practice in which radar is a viable and important source of input to hydrologic models. This course is currently being revised in our CEES curriculum making this an ideal time to incorporate new material.

202 West Boyd Street, Room 334, Norman, Okla 1024 PHONE: (405) 325-5911 FAX: (405) 325-4217

Salary and fringe benefits are as follows:

Academic salary for 2 weeks @ $71,542/year	$3,975
Fringe benefits @ 36.5%	$1,451
Sub-total	$5,426
Indirect costs ($45.5% of sub-total)	$2,469
Total In-Kind Matching Support	**$7,895**

Sincerely,

Baxter E. Vieux, Ph.D., P.E.
Professor

December 6, 2002

Dr. Lynn Preston
Division of Engineering and Education Centers, Room 585
National Science Foundation
4201 Wilson Boulevard
Arlington, VA 22230

Dear Dr. Preston:

Re: CASA Letter of Support

OneNet, an operational division of the Oklahoma State Regents for Higher Education, is extremely pleased to be an active partner in the proposed Center for Adaptive Sensing of the Atmosphere (CASA). As the State's official telecommunications network, OneNet owns and manages essential resources that will assist CASA in meeting its established goals and objectives as they relate to data collection and transmission. For example, OneNet operates an extensive fiber optic telecommunications network throughout Oklahoma that manages 109 public library circuits, 548 K-12 circuits, and 138 circuits directly linking all institutions of higher education. In addition to the land-based fiber optic resources, the infrastructure includes 45 towers that provide high-bandwidth microwave communications systems in the southwest portion of the state. The Oklahoma test bed of CASA radars will be operated within the OneNet infrastructure, for which OneNet, as a CASA partner, will provide data services, tower space, and other related capabilities, as specified in the proposal statement of work and budget.

In an effort to assure the success of CASA, OneNet is pleased to commit the following resources as in-kind contributions throughout the project's duration:

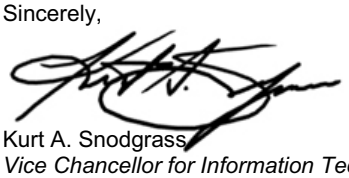
	Salary (1 mo/yr)	Fringe Benefits (27.2%)	Total Per Year
Bill Johnson Director, Network Operations	$7,004.00	$1,905.09	$8,909.00
	Salary (.5 mo/yr)	**Fringe Benefits (27.2%)**	**Total Per Year**
Kurt Snodgrass Vice-Chancellor of IT and Telecommunications	3,541.67	$963.33	$4,505.00
	Salary (2 mo/yr)	**Fringe Benefits (27.2%)**	**Total Per Year**
Roger Brown Network Support Engineer	$7,704.33	$2,095.58	$9,799.91

In addition to staff resources, OneNet will commit the first year of tower lease (3 radars) to the project, which is an in-kind match of $16,200 ($450/month x 12 months for 3 sites). As the 36-site NETRAD system is established, OneNet's in-kind contribution will increase substantially. Specifically, OneNet will provide matching support for tower space, personnel, communications links, and necessary hardware for 36 radars, which equates to approximately $200,000 of in-kind match, on average per year, beyond year one.

Total Commitment for Year-One	**$39,414.00**
Anticipated <u>Yearly</u> Commitment for Years 2-5	**$200,000.00**

In closing, I again want to express our enthusiasm for participating in this pioneering endeavor. CASA has the potential of dramatically transforming weather prediction in Oklahoma by providing a system that is unlike any other in the nation – ultimately positioning Oklahoma as a principal test-bed for weather radar systems.

Sincerely,



Kurt A. Snodgrass
Vice Chancellor for Information Technology and Telecommunications

655 Research Parkway
Suite 200
Oklahoma City, OK
73104
Phone: 405.225.9444
Fax: 405.225.9181
www.onenet.net

November 12, 2002

National Science Foundation
Engineering Research Center
Program Director

Dear Lynn Preston:

It is with great pleasure that I announce our full support to the NSF Engineering Research Center proposal titled "Collaborative Adaptive Sensing of the Atmosphere – CASA (NSF #0228415)". This Engineering Research Canter will be developed as a collaborative effort between the University of Puerto Rico-Mayagüez (UPRM), the University of Massachusetts (UMass), Colorado State University and the University of Oklahoma. The "Collaborative Adaptive Sensing of the Atmosphere – CASA" is a multi-disciplinary multi-campus effort that will benefit UPRM at different levels. Among these are: collaborative PhD programs between the participating institutions that will increase the research opportunities to underrepresented students in the Island; potential collaboration of ERC Industry Partners and UPRM; development of new educational and research areas through the academic partners. The UPRM is committed to support this high priority initiative and will provide 25% of the in-cash contribution requested for the proposal. The total in-cash matching funds for the five-year period provided by UPRM is $ 244,319. In addition, an in-kind contribution of $598,950.00 is provided as release time for faculty from the School of Engineering and the College of Arts and Sciences. UPRM has already committed the addition of a new faculty member with an atmospheric science/meteorology/radar system background, to be recruited by the Electrical and Computer Engineering Department, once the ERC grant has been awarded.

This proposal is focused on the development of new sensing technology aimed to significantly improve weather now-cast and forecast predictions in the U.S. and Puerto Rico, and ultimately around the globe. It is important to highlight that the geographical location of Puerto Rico and the presence of faculty members with the required expertise make UPRM a key member in the proposed Engineering Research Center. We also consider that, given the continuous risk of severe weather events in the Island, such as hurricanes and flash floods, this Center will make a significant impact on the Puerto Rican society.

UPRM is fully committed to support the initiative of the project investigators, Drs. José Colom-Ustáriz, Walter Díaz, Sandra L. Cruz-Pol, Rafael Rodríguez-Solís, Lionel Orama and Havidán Rodríguez in this high priority endeavor. Our institution will provide all the necessary support to make this a successful project.

Respectfully,

Dr. Jorge Vélez Arocho
Chancellor
University of Puerto Rico at Mayagüez

PO Box 9000 Mayaguez, Puerto Rico 00681-9000
Tel. (787)832-4040 exts. 3131, 3135, 3139 ó (787)265-3878 Fax (787)834-3031
Equal Opportunity Employer - M/F/V/I

December 2, 2002

University of
Puerto Rico
Vice President for
Research and
Academic Affairs

Lynn Preston, Leader of the ERC Program
Division of Engineering Education and Centers
Suite 585
National Science Foundation
4201 Wilson Boulevard
Arlington, VA 22230

Dear Ms. Preston:

The University of Puerto Rico enthusiastically supports the establishment of the *Collaborative Adaptive Sensing of the Atmosphere Center (CASA).* The Center will be hosted by the Electrical and Computer Engineering Department from our Mayagüez campus. This Department has a proven record in the establishment of similar centers in our faculty. The proposed CASA is a multidisciplinary and multicampus effort that will focus on the development of new sensing technology aimed at significantly improving weather now-cast and forecast predictions in the U.S. and Puerto Rico, and ultimately around the globe. This includes microwave sensors, data modeling and analysis, and socioeconomic impacts.

CASA, in addition to the strong research component, includes an educational component that covers K-12, undergraduate and graduate level activities. Also, the direct participation of industries, such as Hewlett Packard and Verizon, together with several government agencies (NWS, EMS, PBS), is an important element, which will contribute to the success of this effort. This initiative is in collaboration with the University of Massachusetts-Amherst, University of Oklahoma, and Colorado State University. The University of Puerto Rico team has already been collaborating with the researchers and educators from our partner institutions and is well positioned to quickly move forward with the proposed research and educational programs.

The requested funding for CASA is **$3.7** million (NSF - $2.1 million). The University of Puerto Rico will commit a cost sharing at a level of **$977,000** total in cash for the first five years of the Center to support the activities of our faculty. There is also a **$600,000** in-kind contribution for a total of **$1.57** million dollars in matching resources.

[redacted]
PO Box 364984
San Juan, Puerto Rico
00936-4984
(787) 764-8369
Fax (787) 756-7717

Finally, let me reiterate our institution's commitment in the establishment of this and other important initiatives in collaboration with your agency.

Cordially,

Manuel Gómez
Vice President

gmr/g:/crci-dir/vicep/2002/02g-075 ERC Colom NSF.doc

Universidad de Puerto Rico
Facultad de Artes y Ciencias
Recinto Universitario de Mayagüez

Oficina del Decano

University of Puerto Rico
College of Arts & Sciences
Mayagüez Campus

Office of the Dean

November 20, 2002

Dr. Lynn Preston
National Science Foundation
Engineering Research Center
Program Director

Dear Dr. Preston:

It is with great pleasure that I commit our support for the proposal entitled: "Collaborative Adaptive Sensing of the Atmosphere – CASA (NSF #0228415)" that our institution, the University of Puerto Rico-Mayagüez (UPRM) in collaboration with the University of Massachusetts (UMass), Colorado State University and University of Oklahoma will submit to the NSF Engineering Research Center (NSF ERC) program. This project seeks to develop a new class of systems that would provide better atmospheric boundary layer observations to significantly improve weather forecasting, now-casting and climate modeling studies. Furthermore, the project has a strong social impacts thrust in which two professors from the Department of Social Sciences of our College, Drs. Havidán Rodríguez and Walter Díaz will participate. Drs. Rodríguez and Díaz have strong backgrounds in disaster related research and in providing research mentoring to undergraduate students.

If this proposal is awarded, we are committed to granting Dr. Díaz release time of six credits per semester for the duration of the research project as Social Impact Thrust Director, and three credits per semester to Dr. Rodríguez. The Department of Social Sciences will provide space and infrastructure support to the social/political component of the project through its Center for Applied Social Research.

If you need any other information, do not hesitate to contact me.

Respectfully,

Deborah A. Moore

Dr. Deborah A. Moore
Acting Associate Dean of Academic Affairs and Research

PO BOX 9010 - MAYAGUEZ PR 00681-9010 - Tel. (787) 265-3828, 3830, 3831, 3832 - Fax (787) 265-1225

Universidad de Puerto Rico
Recinto Universitario de Mayagüez

Colegio de Ingeniería - Oficina del Decano

University of Puerto Rico
Mayagüez Campus

College of Engineering - Office of the Dean

November 12, 2002

National Science Foundation
Engineering Research Center
Program Director

Dear Lynn Preston:

It is with great pleasure that I commit our support for the proposal titled : "Collaborative Adaptive Sensing of the Atmosphere – CASA (NSF #0228415)" that our institution, the University of Puerto Rico-Mayagüez (UPRM) in collaboration with the University of Massachusetts (UMass), Colorado State University and University of Oklahoma will submit to the NSF Engineering Research Center (NSF ERC) program. This project seeks to develop a new class of systems that would provide better atmospheric boundary layer observations to significantly improve weather forecasting, now-casting and climate modeling studies. This will provide our students with the opportunity to participate in the study, analysis and generation of algorithms and sensors to characterize radiative and microphysical properties of these atmospheric events as well as their socio-political impacts. Such a demanding research project requires the participation of graduate students including master and PhD level. For this reason, a Memorandum of Understanding between UPRM, UMass and CSU will be in place for students to pursue their PhD degree while completing research work at Puerto Rico. In addition, UPRM has already committed the addition of a new faculty member with an atmospheric science/meteorology/radar system background, to be recruited by the Electrical and Computer Engineering Department, once the ERC grant has been awarded.

We recognize that the geographical location of the island of Puerto Rico and the presence of faculty members with the required expertise make UPRM a valuable key member in the proposed Research Center. We also consider that due to the continuous risk of severe weather events in the island, such as hurricanes and flash floods, this center will make a significant contribution to Puerto Rico's society.

The funding will have a great impact among underrepresented groups since UPRM is a leader in producing Hispanic and Female engineers. With approximately 4,700 students, UPRM is the eighth largest engineering college in the U.S. The University body consists of 99.9% Hispanic students. The ECE undergraduate student body also counts with the highest percentage of Female students in any ECE department in the nation (~40%).

UPRM is fully committed to support the initiative of the project investigators, Drs. José Colom-Ustáriz, Walter Díaz, Sandra L. Cruz-Pol, Rafael Rodríguez-Solís, Lionel Orama and Havidán Rodríguez in this high priority endeavor.

Our institution will provide all the necessary support to make this a successful project.

Respectfully,

Prof. Ramón Vásquez
Professor and Dean of Engineering

P.O. BOX 9040 • Mayagüez, Puerto Rico 00681-9040
Tel. (787) 832-4040 • Exts.: 3822, 3504, 3508 • Fax (787) 833-1190

Universidad de Puerto Rico
Recinto Universitario de Mayagüez

Departamento de Ingeniería Eléctrica y Computadoras
http://www.ece.uprm.edu/

University of Puerto Rico
Mayagüez Campus

Electrical and Computer Engineering Department
http://www.ece.uprm.edu/

National Science Foundation
Engineering Research Center
Program Director

November 13, 2002

Dear Lynn Preston:

It is with great pleasure that I commit our support for the proposed NSF Engineering Research Center described in the proposal titled: "Collaborative Adaptive Sensing of the Atmosphere – CASA (NSF #0228415)" where our institution, the University of Puerto Rico-Mayagüez (UPRM) will be participating as a full partner. This initiative is a collaborative effort with the University of Massachusetts (UMass), Colorado State University and University of Oklahoma.
As ECE Chaiman at UPRM, I am very pleased to join to the support expressed by UPR-Central Administration and UPR-Mayaguez Campus to this initiative.
Three of the researchers involved in the proposal are Associate Professors at the Electrical and Computer Engineering Department at UPRM, they are Dr. Sandra Cruz Pol, Dr. Rafael Rodríguez Solís and Dr. Jose G. Colom Ustáriz. The ECE Department fully supports multi-campus multi-disciplinary research initiatives such as this one and it is committed to provide with release time, for the duration of the award, to the professors involved in this project. The release time is distributed as follows:

Dr. Jose G. Colom - PI/ERC Coordinator at UPRM - 1/2 time (6 credits/hr)
Dr. Sandra Cruz Pol - Researcher - 1/4 time (3 credits/hr)
Dr. Rafael Rodríguez Solis - 1/4 time (3 credits/hr)
New Faculty Member for the ERC – 1/4 time (3 credits/hr)

The total in-kind contribution is approximately $67,500/yr. The release time will be provided to the professors for the duration of the award.

Sincerely,

Prof. Hector Monroy - Department Head
Electrical and Computer Engineering Department
University of Puerto Rico - Mayaguez
Mayaguez PR, 00681

Appvd: Dr. Ramón Vasquez
Dean of Engineering

Colorado State University

Knowledge to Go Places

Office of the
Provost/Academic Vice President
108 Administration
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Fort Collins, Colorado 80523-1001
(970) 491-6614
FAX: (970) 491-0215
www.colostate.edu

December 12, 2002

Ms. Lynn Preston
Deputy Division Director
Division of Engineering Education and Centers
Suite 585
National Science Foundation
4201 Wilson Boulevard
Arlington, VA 22230

Dear Ms. Preston:

I am very pleased to add my endorsement to the proposal from the College of Engineering for an Engineering Research Center in Collaborative Adaptive Sensing of the Atmosphere with Colorado State University as one of the participating schools. In addition to the Center's obvious importance to research training and advancement of knowledge, this ERC will bring numerous other benefits that are of significant strategic importance to our university.

Colorado State is designated as a Carnegie Research Extensive university, but in addition is also recognized as the school of choice for Colorado residents because of the importance we attach to undergraduate education. This Engineering Research Center will help us further enhance this area by providing added opportunities for students to participate in research. Our undergraduates will also benefit from increased knowledge that the faculty will bring to the classroom. With the significant recognition the Center will bring to CSU, we will be better able to hire and retain the highest quality faculty and recruit the best students at both the undergraduate and graduate levels.

We are committed to making this Engineering Research Center a centerpiece on our campus and to doing all that is necessary to ensure its success. We believe our matching, at a level in excess of 13%, demonstrates this. Our vision for Colorado State is one that places a premium on such endeavors as this Engineering Research Center, and we want to assure you of our ongoing commitment to its success.

Sincerely,

Peter J. Nicholls
Provost/Academic Vice President

Colorado State University

December 13, 2002

Office of Vice President for Research
& Information Technology
Fort Collins, Colorado 80523-2001
(970) 491-7194
FAX: (970) 491-5541
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Ms. Lynn Preston
Leader of the ERC Program
And Deputy Division Director
Division of Engineering Education and Centers
National Science Foundation
4201 Wilson Boulevard, Suite 585
Arlington, VA 22230

Reference: NSF 02-24

Dear Ms. Preston:

Colorado State University would like to express its strong support for the NSF Engineering Research Center (ERC) jointly proposed by the University of Massachusetts (prime), Colorado State University, the University of Oklahoma, and the University of Puerto Rica. The proposed ERC for the Center for Collaborative Adaptive Sensing of the Atmosphere (CASA) will fundamentally change the paradigm through which the next generation of remote sensing systems will be developed. Colorado State University has a long tradition of excellence in remote sensing with the expertise distributed between the Departments of Electrical and Computer Engineering and Atmospheric Science. The joint operation of the CSU-CHILL National Radar Facility at Colorado State University is evidence of the research excellence and collaboration between these two programs. We are very enthusiastic about Colorado State University's role in the proposed Center.

Colorado State University is committed to providing exemplary leadership and performance in research, education, diversity, outreach and industrial collaboration consistent with our status as a Carnegie Doctoral/Research University – Extensive and necessary to the conduct of an Engineering Research Center. The investigators involved in this program are among our most outstanding and productive faculty with proven records of achievement and innovation. For example, the team has made pioneering contributions in the areas of polarimetric radar development, radar networking and atmospheric analysis using systems. We are confident that with adequate funding this team will achieve major scientific and technological advances, and will fulfill its additional goal of educating a new generation of scientists, engineers, and technicians in this critically important area. The ERC proposal compliments Colorado State University's commitment to diversity, outreach to the public and policy makers, and integrating new knowledge into the curriculum and K-12 system.

The Colorado State University Departments of Electrical and Computer Engineering and Atmospheric Science have an impressive portfolio of research and scholarly activity that mirrors what would typify an Engineering Research Center. Collaborations exist with K-12, industry, Federal and nonprofit sponsors and involve activities ranging from the raw pursuit of new knowledge to those directly impacting the quality of living and well-being of the population at large.

Thank you for your consideration of this proposal.

Sincerely,

Anthony A. Frank
Vice President of Research and Information Technology

Colorado State University

December 12, 2002

College of Engineering
Office of the Dean
Fort Collins, Colorado 80523-1301
(970) 491-3366
FAX: (970) 491-5569
www.engr.colostate.edu

Ms. Lynn Preston
Deputy Division Director
Division of Engineering Education and Centers
Suite 585
National Science Foundation
4201 Wilson Boulevard
Arlington, VA 22230

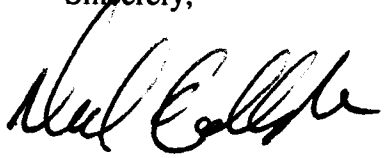
Dear Ms. Preston,

On behalf of the College of Engineering at Colorado State University, I would like to state my strong support for the Engineering Research Center in Collaborative Adaptive Sensing of the Atmosphere being proposed by Professors Chandra, Bringi, and Rutledge and their colleagues. This Center brings together a number of world leading research programs at a number of schools noted for their pioneering work in this discipline.

In particular, Colorado State's College of Engineering has a long tradition of excellence in remote sensing, with the expertise distributed between the Departments of Electrical and Computer Engineering and Atmospheric Science. The joint operation of the CSU-CHILL national radar facility by Professors Bringi, Chandra and Rutledge over a period of more than a decade is a testimonial to the research excellence and established collaboration between these two programs. This CSU team has made pioneering contributions in the areas of polarimetric radar development, radar networking and atmospheric analysis using radar systems. The research which will result from our partnership with the collaborating schools will build on this and is expected to fundamentally change the paradigm for future approaches to remote sensing. In particular, this ERC will develop the next generation of systems to serve the needs of society and the nation, in close collaboration with industry leaders including Raytheon, IBM and Vaisala, as well as the national laboratories of NOAA, DOE and DOD. This complex project involves novel scientific problems, as well as risky technological and integrating system-level challenges. As a result it will provide outstanding opportunities for educating undergraduate and graduate students to think broadly about complex engineered systems. The Center will enhance infrastructure by creating test beds for data, algorithm development and extending integration of education activities at the K-12, undergraduate and graduate levels.

As a result of the significance of this Center to the College's strategic plan to enhance our research programs and to raise national rankings we enthusiastically support this proposal and are committed to ensuring its success.

Sincerely,



Neal Gallagher

CASA INDUSTRIAL MEMBERSHIP PROGRAM AND INTELLECTUAL PROPERTY

CASA PARTNERS	CASA AFFILIATES
Annual Contribution: Large Company: 40k cash + 300k in-kind Medium Company: 25k cash + 200k in-kind Small Company: 10k cash + 50k in-kind In kind contributions include equipment, time spent on ERC activities by employees, access to labs, and access to infrastructure for test beds.	**Annual Contribution:** Large Company: 5k cash Medium Company: 3k cash Small Company: 1.5k cash
Annual contributions are pooled with $35 million in NSF and university funds to support ERC core research and industrial partnership program activities. Industry partners create a vision and strategy with a market orientation; participate in research and systems implementation; commercialize new technologies/knowledge or incorporate them into proprietary R&D; and participate in the ERC's education activities.	Annual contributions are pooled with $35 million in NSF and university funds to support ERC core research, industrial partnership program activities, and education activities.
Benefits: • Membership in Industrial Advisory Board that guides ERC research agenda. • Participation in ERC research of interest to company. • "Technology Alerts": earliest access to research results and IP generated by core ERC research. • First right of refusal for CASA IP. All partners have royalty-free access to IP from core research. Access is non-exclusive among ERC partners. • Ability to enter into proprietary sponsored research contracts with ERC and its faculty where exclusive IP rights can be negotiated. • Discounted overhead (indirect costs) on proprietary research (amount TBD) • Participation in Graduate fellows program for directed research at $25,000 per student. • Access to undergraduate student CO-Ops. • Attendance at annual ERC meetings to view core research results; receive publications.	**Benefits:** • Receive CASA research and other publications • Attend ERC annual conference open sessions.

CASA INDUSTRIAL MEMBERSHIP PROGRAM AND INTELLECTUAL PROPERTY

INDUSTRIAL PARTNERS AND AFFILIATES are entitled to the following benefits:

Industrial Advisory Board - PARTNERS may serve on the Industrial Advisory Board (IAB) of CASA with voting privileges. The IAB will participate in strategic planning by establishing priorities of educational and research programs and testbeds and evaluation of progress towards the ERC's goals and objectives. The IAB will also participate in tactical planning by helping set research priorities for research thrusts and help ensure synergy between research thrusts and testbeds. Further, the IAB will recommend to the ERC Director any needed mid-course corrections in research and/or personnel, as necessary. AFFILIATES may attend open sessions of IAB meetings.

Intellectual Property from CORE research - PARTNERS will receive a non-exclusive, royalty free rights to all intellectual property developed by the core research projects of the ERC for a reasonable period after an invention is disclosed. Core research represents all educational, research and other programs and administrative activity of the ERC conducted with the pooled resources of unrestricted cash contributions from PARTNERS, AFFILIATES, and other sources, including NSF, in general support of CASA's research, education, and test bed objectives. All patents, copyrights, trade secrets, and trademarks that result from CASA CORE projects shall belong to the academic institution of the inventor/creator. If faculty members from different institutions are the inventors, then the intellectual property will be shared among the institutions involved.

PARTNERS will have access to the test bed facilities and other instrumentation in the ERC at nominal fees to cover the operating costs. The purpose of establishing the testbeds is to provide testing, data collection, and demonstrations of DCAS systems to the Center faculty and the industrial PARTNERS.

Short Courses and Seminars. PARTNERS may request on-location short courses to be provided by ERC at fees to be negotiated between ERC and PARTNER to cover costs.

Publications - PARTNERS have access to the CASA newsletters, publications, and web sites maintained by the Center for timely exchange of information and facilitates access to the ERC created knowledge base to our industrial members. PARTNERS and AFFILIATES will receive a copy of all ERC reports & publications.

Proprietary (non-CORE) research contracts - PARTNERS will have rights, at the discretion of the campuses involved, to receive a discounted overhead rate on research contracts carried out by CASA and funded by cash investments through contract between the University of Massachusetts and/or one or more Academic Partners. PARTNERS may also negotiate exclusive royalty bearing licenses with the individual academic institutions. If the PARTNER is a co-inventor then the partner may share ownership of the intellectual property with the academic institution, consistent with the policies of the individual institution.

CASA INDUSTRIAL MEMBERSHIP PROGRAM AND INTELLECTUAL PROPERTY

Use of Patented Inventions or Copyrighted Materials – ERC Academic partners shall have the right to protected materials for educational and university research purposes.

Publication Delay - Industrial PARTNERS recognize that the results of projects must be publishable and agree that researchers engaged in projects shall be permitted to present at symposia and international, national, or regional professional meetings, and to publish in journals, theses, or dissertations, or otherwise of their own choosing, the methods and results of projects. However, CASA will provide copies of publications or experimental data to PARTNERS for review prior to publication or dissemination. PARTNERS may request a delay in publication so that the partner may secure intellectual property rights.

Patent Costs – Patent costs will be borne by the University and the industry partners interested in licensing the intellectual property.

Resumes of Research Faculty

Philip B. Bedient
Herman Brown Professor of Engineering
Professor of Civil and Environmental Engineering
Rice University
6100 Main St./MS – 317, Houston, Texas 77005
email – bedient@rice.edu

Professional Preparation

University of Florida	Physics	B.S., 1969
University of Florida	Environmental Engineering	M.S., 1972
University of Florida	Environmental Engineering	Ph.D., 1975

Academic and Professional Appointments

Herman Brown Professor of Engineering, Civil and Environmental Engineering, Rice University, 2001 to present.

Professor, Environmental Science and Engineering, Rice University, July 1986 to 2001.

Professor and Chair, Department of Environmental Science and Engineering, Rice University, July 1992 to 1999.

Associate Professor of Environmental Engineering, Rice University, July 1980 June 1986.

Assistant Professor of Environmental Engineering, Rice University, July 1975-June 1980.

5 Publications Relevant to the Proposal

Bedient, P. B. and W. C. Huber, 2002, *Hydrology and Floodplain Analysis*, 3rd Ed. Prentice-Hall Publishing Co., Upper Saddle River, NJ, 2002, 763 pages.

Rifai, Hanadi S., S.M. Brock, K.B. Ensor, and P.B. Bedient, "Determination of Low-Flow Characteristics for Texas Streams," *ASCE Journal of Water Resrouces Planning and Management*, (126)5, pp.310-319, September-October 2000.

Bedient, P.B., B.C. Hoblit, D.C. Gladwell and B.E. Vieux, "NEXRAD Radar for Flood Prediction in Houston," *ASCE Journal of Hydrologic Engineering*, 5(3), pp. 269-277, July, 2000.

Hoblit, Brian C., Baxter E. Vieux, Anthony W. Holder and Philip B. Bedient, "Predicting With Precision," *ASCE Civil Engineering Magazine*, 69(11), pp. 40-43, November, 1999.

Vieux, B.E. and P.B. Bedient, "Estimation of Rainfall for Flood Prediction from WSR-88D Reflectivity: A Case Study, 17-18 October 1994", *Weather and Forecasting*, 1998 American Meterological Society, 13:2, 407-415, June 1998.

5 Other Significant Publications

Bedient, P.B., Anthony Holder, and Baxter Vieux, "A Radar-Based Flood Alert System (FAS) Designed for Houston, TX," *International Conference on Urban Storm Drainage*, Portland, OR, September 2002.

Holder, Anthony, Eric Stewart, and P.B. Bedient, "Modeling an Urban Drainage System with Large Tailwater Effects Under Extreme Rainfall Conditions," *International Conference on Urban Storm Drainage*, Portland, OR, September 2002.

Bedient, P.B., Anthony Holder, Jude Benavides, and B. Vieux, "Radar Based Flood Warning System - T.S. Allison", submitted to ASCE *Journal of Hydrologic Engineering*, September, 2002.

Bedient, P. B., H. S. Rifai, and C. J. Newell, *Ground Water Contamination: Transport and Remediation*, 2nd Ed. PTR publ., Upper Saddle River, NJ, 1999, 605 pages.

Rifai, H. S., C. J. Newell, P. B. Bedient, F. S. Shipley and R. W. McFarlane, *The State of the Bay*, The Galveston Bay National Estuary Program, Webster, TX, 232 pp. (1994).

Synergistic Activities

Dr. Philip B. Bedient is the Herman Brown Professor of Engineering in Civil and Environmental Engineering at Rice University. He teaches and performs research in surface and ground water hydrology and flood prediction systems. He has interactions with a range of other universities, institutions, and consulting firms in the hydrology field. He set up and organized a major conference at Rice University during spring 2002 on Mitigating Severe Storm Impacts in Urban Areas with more than 40 invited speakers.

He has researched surface water problems including radar based flood alert systems, hydrologic modeling for flood prediction, water quality studies, and advanced GIS linkages in hydrology. He has most recently developed a real-time flood alert system for the Texas Medical Center based on NEXRAD radar data linked to advanced hydrologic models of an urban stream. He interacts with Drs. Baxter Vieux and Kelvin Droegemeier at University of Oklahoma in terms of radar rainfall systems, and with Dr. Richard Wainerdi, CEO of the Texas Medical Center in terms of implementing a radar-based flood alert system in Houston. He was involved in one of the first GIS studies of Galveston Bay watersheds for evaluating nonpoint source loading to the bay, funded by the EPA National Estuary Program. This involved interactions with Dr. Robert Macfarlane, noted ecologist, and Dr. George Ward at University of Texas. He was funded by the Advanced Technology Program Texas to evaluate water resources and water quality data and models in south Texas along the border with Mexico, which involved interactions with Dr. Hanadi Rifai at University of Houston and Dr. Ron Griffin at Texas A&M University.

Recent Collaborators and Co-Editors

Jude Benavides, Rice University.
Greg Characklis, University of North Carolina
Kathy Ensor, Rice University
Dawn Gladwell, Taggart Engineering & Assoc.
Stephanie Glenn, Rice University
Ronald C. Griffin, Texas A&M University
Anthony Holder, Rice University
Brian Hoblit, NEXRAIN
Charles Newell, Ground Water Services, Inc.
Hanadi Rifai, University of Houston
David Sabatini, Oklahoma University
Eric Stewart, Rice University
Baxter E. Vieux, University of Oklahoma
Charles Wainerdi, Texas Medical Center

Graduate Advisor

Wayne Huber, Professor, Department of Civil Engineering, Oregon State University

Ph.D. Dissertations - (10 Total)

Stephanie Glenn - 2002
Greg Characklis – 1999
Manar Z. El-Beshry – 1998
Loren P. Hopkins - 1998

Current Ph.D.

Jude Benavides
Natalie Capiro
Ria Safiolea

Post-doctoral Scholars Sponsored - (9 Total)

Stephanie Glenn, 2002
Maged Hamed - 1997

Master of Science Thesis - (46 Total)

Jude Benavides – 2001
Cristina Moreno – 1999
Suzanne Brock – 1998
AnnMarie Spexet – 1998
Paul Nelson – 1997
Cathy Yewdall – 1997

Current MS

Eric Stewart
Annemarie Whitko

Total Graduate Students Advised - 56

MICHAEL I. BIGGERSTAFF
Associate Professor, Meteorology Department
University of Oklahoma

EDUCATION

Ph.D., University of Washington, Atmospheric Sciences, 1991.
B.S., University of Texas at Austin, with highest honors in Engineering Sciences with an Atmospheric Science option, 1984.

PROFESSIONAL EXPERIENCE

2002-date	Associate Professor of Meteorology, University of Oklahoma.
1996-2002	Associate Professor of Meteorology, Texas A&M University.
1990-1996	Assistant Professor of Meteorology, Texas A&M University.
1984-1990	Research Assistant, University of Washington.
1990-1995	Severe Weather Officer for the Brazos County Civil Defense Office.

FIELD PROGRAM EXPERIENCE

2001	Lead Project Scientist for the Keys Area Microphysics Project conducted in Key West, FL.
1999	Aircraft Mission Coordinator for the Kwajalein Experiment (KWAJEX) based in the Republic of Marshall Islands.
1998	Airborne Doppler radar scientist during the Mesoscale Electrification and Polarimetric Radar Studies (MEaPRS) experiment based in Norman, OK.
1998	Ground-based System's Coordinator for the Texas-Florida Underflight (TEFLUN-A) experiment based in College Station, TX.
1997	Lead Project Scientist for Texas A&M's Convection and Lightning (TEXACAL) experiment based in College Station, TX.
1993	Airborne Cloud Physics and Radar Scientist during the TOGA-COARE field experiment based in Honiara, Guadacanal, Solomon Islands.
1987	Airborne radar scientist during Equatorial Monsoon Experiment (EMEX) field experiment based in Darwin, Australia.
1985	Ground based Doppler-radar scientist during PRE-STORM experiment based in Wichita, KS.

AWARDS

2000	Certificate of Appreciation from the University Honors Program for Outstanding Advising, Texas A&M University.
1996	Excellence in Teaching Award, College of Geosciences and Maritime Studies, Texas A&M University.
1995	Excellence in Advising Award, College of Geosciences and Maritime Studies, Texas A&M University.

RESEARCH INTERESTS

Mesoscale and radar meteorology with emphasis on the evolution of mesoscale storm structures, environmental characteristics supporting mesoscale storms, and the effects of mesoscale cloud systems on the broader scale environment. Also interested in severe local storms and the application of Doppler radar data to forecasting problems.

SELECTED FORMAL PUBLICATIONS

Biggerstaff, M. I., J. Guynes, and K. Moncla, 2002: Radar meterology at Texas A&M University: Past studies and current educational activities. *Bull. Amer. Meteor. Soc.*, submitted.

Biggerstaff, M. I., and S. A. Listemaa, 2000: A modified convective/stratiform partitioning algorithm using radar reflectivity. *J. Appl. Meteor.*, **39**, 2129-2150.

Nielsen-Gammon, J. W., M. I. Biggerstaff, M. E. Alcorn, D. Austin, K. P. Bowman, D. Djuric, J. Guynes, R. L. Panetta, R. White, and L. J. Wicker, 1996: Texas A&M University's Laboratory for the Exploration of Atmospheric Processes— TAMU's LEAP. *Bull. Amer. Meteor. Soc.,* 77, 2907-2918.

Sun, J., S. Braun, R. G. Fovell, M. I. Biggerstaff, and R. A. Houze, Jr., 1993: Warm Upper-level downdrafts associated with a squall line. *Mon. Wea. Rev., **121***, 2919-2927.

Biggerstaff, M. I. and R. A. Houze, Jr., 1991: Midlevel vorticity structure of the 10-11 June 1985 squall line. *Mon. Wea. Rev.,* **119**, 3066-3079.

FIVE OTHER PUBLICATIONS

Biggerstaff, M. I. and J. Guynes, 2000: A new tool for atmospheric research. *Preprints, 20th Conf. on Severe Local Storms,* Orlando, FL. Amer. Meteor. Soc., 277-280.

Karl, B. A., M. I. Biggerstaff, T. M. Smith, and R. W. Przybylinski, 1999: Performance and evaluation of the damaging downburst prediction and detection algorithm for bow echo storm systems. Preprints, 29th Conf. on Radar Meteor., 12-16 July 1999, Montreal, Quebec, Amer. Meteor. Soc., 113-116.

Biggerstaff, M. I. and R. C. Barritt, 1996: Role of gust front circulations in long-track severe straight line winds. 18th Conf. on Severe Local Storms, 19-23 Feb. 1996, San Francisco, CA. Amer. Meteor. Soc., 504-508.

Valdes-Manzanilla, A. and M. I. Biggerstaff, 1995: Doppler radar observations of convective band development near the center of a mesoscale convective vortex. 27th Conf. on Radar Meteor., 9-13 Oct. 1995, Vail, CO. Amer. Meteor. Soc., 564-566.

Biggerstaff, M. I. and R. A. Houze, Jr., 1993: Kinematics and microphysics of the transition zone of the 10-11 June 1985 squall-line system. *J. Atmos. Sci., **50***, 3091-3110.

COLLABORATORS

J. Straka (OU), L. Wicker (NSSL), E. Rasmussen (CIMMS), T. Doggett (TTU), B. Ferrier (NOAA), F. Zhang (TAMU), Y-K. Kim (FSU).

Ph. D. ADVISOR

R. A. Houze, Jr., University of Washington.

GRADUATE STUDENT AND POST DOCTORAL ASSOCIATES

E.-K. Seo (Postdoc, Ph.D.), S. Hristova-Veleva (Ph. D., MS), V. Chadwick (current MS), K. Moncla (MS), J. Santarpia (MS), D. Jamieson (MS), E. Amrhein (MS), K. Bellue (MS), D, Hobson (MS), K. Mattison (MS), M. Hashem (MS), K. Shelton-Mur (MS), A. Valdes-Manzanilla (MS), D. Wood (MS), S. Listemma (MS), M. Robinson (MS), J. Shaw (MS), B. Karl (MS), D. Billingsley (MS), S. Saul (MS), and R. Barritt (MS).

Howie Bluestein
Professor, Electrical Engineering Department
University of Oklahoma
Telephone: Email:

Professional Preparation

M. I. T.	Electrical Engineering	B. S., 1971
M. I. T.	Electrical Engineering	M. S., 1972
M. I. T.	Meteorology	M. S., 1972
M. I. T.	Meteorology	Ph. D., 1976

Appointments

Visiting Scientist, UCAR/COMET, 1991

Professor, University of Oklahoma, 1990 – present.

Visiting Scientist, NOAA/AOML/Hurricane Research Division (HRD), 1984.

Associate Professor, University of Oklahoma, 1983.

Visiting Scientist at NCAR, MMM Division, 1982-1985, 1989-2003.

Assistant Professor, University of Oklahoma, 1979.

Visiting Assistant Professor, University of Oklahoma, 1976.

Publications

i. related to project

Bluestein, H. B., and S. G. Gaddy, 2001: Airborne pseudo-dual Doppler analysis of a rear-inflow jet and deep convergence zone in a supercell. *Mon. Wea. Rev.*, **129**, 2270-2289.

Bluestein, H. B., and M. L. Weisman, 2000: The interaction of numerically simulated supercells initiated along lines. *Mon. Wea. Rev.*, **128**, 3128-3149.

Bluestein, H. B., and A. L. Pazmany, 2000: Observations of tornadoes and other convective phenomena with a mobile, 3-mm wavelength, Doppler radar: The spring 1999 field experiment. *Bull. Amer. Meteor. Soc.*, **81**, 2939-2951.

Bluestein, H. B., S. G. Gaddy, D. C. Dowell, A. L. Pazmany, J. C. Galloway, R. E. McIntosh, and H. Stein, 1997: Mobile, 3-mm wavelength, pulsed Doppler radar observations of sub-storm scale vortices in a supercell. *Mon. Wea. Rev*., **125**, 1046-1059.

Bluestein, H.B., W. P. Unruh, D. C. Dowell, T. A. Hutchinson, T. M. Crawford, A. C. Wood, and H. Stein, 1997: Doppler-radar analysis of the Northfield, Texas tornado of 25 May 1994. *Mon. Wea. Rev.*, **125**, 212-230.

ii. other significant publications

Bluestein, H. B., and P. C. Banacos, 2002: The vertical profile of wind and temperature in cyclones and anticyclones over the eastern two-thirds of the United States: A climatology. *Mon. Wea. Rev.*, 477-506.

Hutchinson, T. A. and H. B. Bluestein, 1998: Prefrontal wind-shift lines in the Plains of the United States. *Mon. Wea. Rev*., **126**, 141–166.

Bluestein, H. B. and D. R. MacGorman, 1998: Evolution of cloud-to-ground lightning characteristics in the Spearman, Texas tornadic supercells of 31 May 1990. *Mon. Wea. Rev*., **126**, 1451-1467.

Bluestein, H. B. and T. M. Crawford, 1997: Mesoscale dynamics of the near-dryline environment: Analysis of data from COPS-91. *Mon. Wea. Rev.*, **125**, 2161-2175.

Bluestein, H. B. and D. A. Speheger, 1995: The dynamics of an upper-level trough in the baroclinic westerlies: Analysis based upon data from a wind-profiler network. *Mon. Wea. Rev.* , **123**, 2369 - 2383.

Synergistic Activities

Authored trade book on severe thunderstorms and tornadoes

Authored two-volume textbook on Synoptic-Dynamic Meteorology

Tested and used mobile observing platforms, especially for W-band and X-band Doppler radars; organized community-wide NSF workshop on mobile instruments

Presented invited testimony for Subcommittees on Basic Research and Energy & the Environment, U. S. House of Representatives, Wash., D. C. (1999), "Tornadoes: Understanding, Modeling, and Forecasting Supercell Storms"

Appeared in IMAX film (STORMCHASERS) and in numerous television programs on tornadoes; am being filmed for new NOVA program on PBS television

Collaborators & Other Affiliations

i. Collaborators (last 48 months)

Mike Baldwin, NSSL
Wayne Feltz, CIMMS, Univ. of Wisconsin, Madison
Greg Forbes, The Weather Channel
Steve Gaddy, NWS, Grand Forks, ND
Carl Hane, NSSL
Paul Neiman, NOAA/ETL
Andrew Pazmany, Univ. of Massachusetts
Robert Rabin, NSSL
F. Marty Ralph, NOAA/ETL
Nilton Renno, Univ. of Arizona
Roger Wakimoto, UCLA
Morris Weisman, NCAR

ii. Graduate Advisor

Frederick Sanders, MIT (ret.)

iii. Thesis Advisor Sponsor (nine advised last five years)

Andrew Wood, OCS
Todd Crawford, WSI
Steve Gaddy, NWS, Grand Forks, ND
Peter Banacos, SPC
David Dowell, NCAR/ASP
Gregor Lehmiller, Koch Energy Co., Houston
Christopher Weiss, OU
Peter Leptuch, OU
Matthew Kramar, OU

V. N. Bringi

EDUCATION

1971 B.S. Electrical Engineering, Indian Institute of Technology
1976 Ph.D. Electrical Engineering, The Ohio State University

EXPERIENCE

1987-Present	Professor of Electrical Engineering, Colorado State University
1981-1987	Associate Professor, Colorado State University
1979-1981	Senior Research Associate, The Ohio State University
1977-1979	Post Doctoral Fellow, The Ohio State University
1976	NCAR Graduate Research Associate
1974-1976	UCAR Fellow
1973-1974	Graduate Research Associate, The Ohio State University

Dr. Bringi's research interests are in multiparameter radar theory and applications to remote sensing of precipitation. He was a member of the AMS Committee on Radar Meteorology, and has served on the NEXRAD Technical Advisory Committee. He is an Associate Editor for J. Atmos. Ocean. Tech. and is a member of the NSSL/NOAA's Radar Advisory Board.

Five Selected Publications Relevant to Proposed Research

1. Bringi, V.N., and V. Chandrasekar: Polarimetric Doppler Weather Radar: Principles and Applications, Cambridge University Press (in press), 2001.
2. Brunkow,D., V.N. Bringi , P. Kennedy, V.Chandrasekar and S.Rutledge,2000: A description of the CSU-CHILL national radar facility, J.Atmos.Ocean.tech, Vol.17, 1596-1608.
3. Doviak, R.J., V.N. Bringi, D.S.Zrnic and A.Ryzhkov,2000: Considerations for polarimetric upgrades to the WSR-88D operational radar network, J.Atmos.Ocean.Tech, Vol. 17, 257-278.
4. Hubbert, J. , V. N. Bringi, L. D. Carey and S. Bolen, 1998: CSU-CHILL Polarimetric Radar Measurements from a Severe Hailstorm in Eastern Colorado, J. Appl. Meteor, Vol. 37, 749-775.
5. Bringi, V. N., V. Chandrasekar and R. Xiao, 1998: Raindrop Axis Ratios and Size Distributions in Florida Rainshafts: An Assessment of Radar Algorithms, Trans. IEEE Geoscience and Remote Sensing, Vol. 36, 703-715.

Five Other Selected Publications

1. Beaver J. and V.N. Bringi,1997: The application of S-band polarimetric radar measurements to Ka-band attenuation prediction, Proc. IEEE, Vol. 85, No. 6, 893-909.
2. Hubbert, J. and V.N. Bringi, 2000: The effects of three-body scattering on differential reflectivity signatures, J.Atmos.Ocean.tech, Vol. 17, 51-61.
3. Bolen, S., V.N. Bringi and V. Chandrasekar, 1998: An optimal area approach to intercomparing polarimetric radar rain rate algorithms, J.Atmos.Ocean.Tech., Vol. 15, 605-623.
4. Abou-El Magd, V. Chandrasekar, V.N. Bringi and W. Strapp, 2000: Multiparameter radar and in-situ aircraft observations of graupel and hail, Trans IEEE Geoscience & Remote Sensing, Vol. 38, 570-578.
5. Gorgucci, E., G. Scarchilli, V. Chandrasekar and V.N> Bringi,2000: Measurement of mean raindrop shape from polarimetric radar observations, J. Atmos. Sci., Vol. 57, 3406-3413.

Advisors:

Ph.D. Thesis Advisor: Prof. T.A. Seliga
Post-Doctoral Advisor: Prof. T.A. Seliga

Broader Impact of Research:

1. Supervised research experience for undergraduates during the recent STEPS project. Students were provided experience on research weather radars, instrumenting a hail chase van, and were exposed to other research instrumentation, e.g., mobile electricity vans, lightning mappers, storm-penetrating aircraft. Students were also trained in severe storm core penetrations with the chase van and the problems encountered in taking data in a severe storm environment. Students also explained the chase van instruments to members of the media during the NCAR-sponsored STEPS Media Day last summer.
2. Member of NSSL/NOAA Radar Advisory Board related to the evolution of the WSR-88D radar.
3. Associate Editor, *Journal of Atmospheric and Oceanic Technology*

List of Collaborators (past 48 months):

1. Prof. K. Aydin, The Pennsylvania State University
2. Mr. David Brunkow, CSU-CHILL staff
3. Dr. L. Carey, Colorado State University
4. Prof. V. Chandrasekar, Colorado State University
5. Prof. A. Detwiler, South Dakota School of Mines & Technology
6. Dr. Richard Doviak, NSSL/NOAA
7. Dr. E. Gorgucci, CNR, Italy
8. Dr. T. Keenan, BMRC, Melbourne, Australia
9. Mr. P. Kennedy, CSU-CHILL staff
10. Dr. L. J. Miller, NCAR
11. Dr. W. Petersen, Colorado State University
12. Prof. S. Rutledge, Colorado State University
13. Dr. A. Ryzhkov, NSSL/NOAA
14. Dr. G. Scarchilli, CNR, Italy
15. Dr. D. Zrnic, NSSL/NOAA

List of PhD students/Post Docs advised:

1. John Hubbert, Colorado State University
2. J. Vivekanandan, NCAR
3. J. Turk, Naval Research Laboratory
4. V. Chandrasekar, Colorado State University
5. Y. Golestani, CIRA/CSU
6. R. Raghavan
7. L. Liu
8. I.J. Caylor
9. J. Beaver

Total Ph.D. students completed: 9
Total M.S. students completed: 10

Wayne P. Burleson

Professional Preparation.

MIT	EE	BS, 1983
MIT	EE	MS, 1983
University of Colorado	ECE	PhD, 1989

Appointments.

Associate Professor, Electrical and Computer Engineering, University of Massachusetts Amherst, 1996-

Assistant Professor, Electrical and Computer Engineering, University of Massachusetts Amherst, 1990-1995

Publications.

1. R. Tessier and W. Burleson, "Reconfigurable Computing for Digital Signal Processing" in *Programmable Digital Signal Processors*, Marcel-Dekker (editor, Yu Hen Hu), 2002. Shorter version appeared in Journal of VLSI Signal Processing Winter 2001.
2. A. Maheshwari and W. Burleson, "Current-sensing for Global Interconnects, Secondary Design Issues: Analysis and Solutions". *IEEE International Workshop on Power and Timing modeling, optimization and simulation. PATMOS*, Sept, 2001 (extended version submitted to IEEE Journal of Solid State Circuits).
3. A. Nalamalpu, S. Srinivasan, W. Burleson, "Boosters for Global Interconnect in CMOS VLSI", *IEEE Transactions on Computer Aided Design*. January 2002, Extended version of paper from ISPD'01.
4. W. Burleson, R. Tessier, D. Goeckel, P. Jain, J. Euh, S. Swaminathan, V. Thyagaran, "Dynamically Parameterized Algorithms and Architectures for Low-Power Signal Processing", *IEEE International Conf. on Acoustics, Speech and Signal Processing,* 2001 (extended version to appear in Journal of VLSI Signal Processing Systems)
5. W. Burleson, A. Ganz, I. Harris, "Educational Innovations in Multimedia Systems", *Journal of Engineering Education*, Winter 2001, extended version of paper from IEEE/ASEE Frontiers in Education Conference, November 1999. (Winner of Ben Dasher **Award for Best Paper**)

Synergistic Activities.

1. Co-leader of the CD-MANIC courseware development project (w/ Prof. J. Kurose and Prof. R. Adrion of UMASS Computer Science), a video-based Web CD/DVD approach to enable improved distance learning and on-campus learning. 12 full semester courses and numerous short courses have been presented to over 1000 students using this technology. NSF has funded research in novel pedagogy and assessment techniques based on these tools. Burleson also serves as Chair of Computer Engineering for National Technological University, the oldest and one of the largest institutions for graduate engineering distance education.
2. Development of a new course in Multimedia Systems for non-technical majors. This course teaches the basic principles of audio, image and video coding and multimedia systems using an intuitive approach based on multimedia instructional technology and group projects. The course was offered to 30 students at UMASS and has been converted to a CD format for distribution across the higher education system in Massachusetts, specifically targeting under-represented groups through urban community and state colleges. This course forms one of the core courses of the newly developed Information Technology minor at UMASS. This work has been supported by NSF, Microsoft and the Commonwealth of Massachusetts.
3. Collaborations with Microprocessor Design and CAD teams at Intel, Compaq, IBM and Motorola to develop and transfer advanced CMOS circuit techniques for on-chip interconnects. Burleson has a long history of interactions with the semiconductor and CAD industries, first as a designer in the mid 80's and more recently as a consultant. Synergistic activities include fostering multidisciplinary work

between circuit designers and architects, power and reliability experts, and algorithm/architecture co-design.

4. Multidisciplinary work in the area of VLSI and Signal Processing Systems. Co-chaired the annual Signal Processing Systems Workshop in 1996 and 1998. Serve on the IEEE Committee on the Design and Implementation of Signal Processing Systems. Serve as Associate Editor for Journal of VLSI Signal Processing Systems and IEEE Transactions on VLSI. Have given numerous invited talks and panels in the areas of reconfigurable computing, low-power VLSI and DSP systems.
5. Development of new courses, curriculum, assessment mechanisms and accreditation self-study for the ECE department. New courses in Advanced VLSI Circuit Design, VLSI Signal Processing, Computer Systems Manufacturing, Special Topics in Wireless Communications, VLSI Logic Synthesis and numerous significant enhancements to existing courses, typically involving instructional technology, group projects and content updates to reflect recent technological trends.

Collaborators & Other Affiliations

(i) Collaborators. M. Stan, M. Ciesielski, W. Liu, F. Klass, Y. Jeong, B. Jung, Z. Zhou, H. Choi, T. Kim, J. Ko, J. Narkiewicz, W. Lien, W. Marvin, J. Stankovic, C. Weems, K. Ramamritham, D. Niehaus, G. Wallace, J. Kurose, R. Adrion, I. Koren, C. Krishna, A. Ganz, R. Tessier, I. Harris, F. Hill, D. Goeckel, Z. Haddad, R. Woods, N. Shanbhag, K. Konstantinides, A. Chandrakasan, E. Manolakos, T. Meng, . R. A. Grupen, C. I. Connolly, K. X. Souccar, S. R. Park, M. Petronino, J. Carswell, R. Bambha, R. Tessier, D. Goeckel.

(ii) Graduate and Postdoctoral Advisors.
Louis Scharf, Colorado State University, Michael Lightner, University of Colorado, Richard Lyon, Foveon Systems, Campbell Searle, MIT.

(iii) Thesis Advisor and Postgraduate-Scholar Sponsor.
Mircea Stan, University of Virginia, Bongjin Jung, Intel, Jeongseon Euh, University of Massachusetts Amherst, Andrew Laffely, University of Massachusetts Amherst , Ning Weng, University of Massachusetts Amherst, Atul Maheshwari, University of Massachusetts Amherst, Subramanian Venkatraman, Intel, Prashant Jain, Tensorcomm, Ankireddy Nalamalpu, Intel (total: 9)

Jose G. Colom-Ustariz - Associate Professor
Electrical and Computer Engineering Department.
University of Puerto Rico, R.U.M.
Mayagüez, PR 00681-9042

Jose Colom has been involved in the design of microwave circuits and systems for the last few years. He coordinated for two years the Industrial Affiliates Program at UPRM focusing in research experiences for undergraduate students. He is co-PI of an NSF MRI for the development of the Radiation Laboratory at UPRM. He teaches courses in the area of applied electromagnetics and has developed graduate courses in Microwave Amplifiers and Radar Systems. He also created an Introduction to Electrical Engineeering course for freshman students under the NSF CenSSIS ERC, and is developing several experiments for the Tools and Toys Lab. He also has collaborated with Raytheon in the simulation of MMIC structures.

Education

University of Puerto Rico Mayaguez, Electrical Engineering, BSEE 1988

University of Massachusetts, Electrical Engineering, MSEE 1991

Pennsylvania State University, Electrical Engineering, PhD 1998

Appointments

1998 to present

University of Puerto Rico, Mayagüez, P. R.
Associate Professor. Teaches courses in the areas of Applied Electromagnetics, Antennas, Microwaves, and Electric Circuit Analysis. Research interest are microwave remote sensing, microwave circuits, numerical analysis techniques applied to microwave structures, multilayer circuits. Developed graduate courses in Microwave Active Circuits and Microwave Systems. Awarded (Co-PI) NSF MRI ($680k) for Development of Radiation Laboratory, Raytheon University Grant Award ($50k), IBM University Program Award ($40k). Coordinator of Industrial Affiliates Program at UPRM, Coordinator of COOP Students in ECE Dept., member of Academic Senate.

1994-1998

Penn State University, State College, PA.
TA: In charge of Microwave Laboratory. Advised over 40 students in the simulation, design, and implementation of microwave amplifiers and filters. Responsible for the fabrication of microwave circuits prototypes using T-Tech router. Circuits: amplifiers, balanced amplifiers, filters, patch antennas. Taught and modified laboratory experiments: Noise Figure measurements, operation and calibration of the hp8510C network analyzer, measurement of 1 dB compression point, measurements of RF components.

1991 to 1994

University of Puerto Rico, Mayagüez, P. R.
Instructor. Taught courses in the areas of Electromagnetics, Antennas, Microwaves and Electric Circuit Analysis. Co-developed a new Microwave Laboratory to be used for undergraduate courses. Developed new courses in the area of applied electromagnetics using EEsof microwave simulators.

Summer 1993

Motorola of PR, Vega Baja, P. R.
Research Engineer : Measured, simulated, and characterized response from loop antenna used for UHF and VHF pager units. Measured S-parameters for transistor used in UHF pager unit with network analyzer.

1987 to 1991

Microwave Remote Sensing Laboratory
University of Massachusetts, Amherst, MA 01002
R.A. : Modified of FM/CW 35 GHz radar for the observation of the ocean surface. S-parameter measurements up to 110 GHz. Characterization of simulated sea ice and different snow types at 35 and 95 GHz.

Fall 1986

NIST
Gaithersburg, MD
Coop Experience: Designed and fabricated a logical safety circuit for the operation of a high power laboratory. Ran calibration for high power transformers.

Publications

Colom, J. G. and R. Rodriguez-Solis, "Design and Simulation of a Tunable Multilayer Lange Coupler," Integrated Ferroelectrics ,Volume 42, 2002.

Colom J.G and R. Rodriguez-Solis " Frequency Agile Microwave Components using Ferroelectric Materials", SPIE 9th International Symposium on Remote Sensing, Crete, Greece, 2002.

Colom J. G. "COOP Experience at UPR Mayaguez," accepted ASEE CIEC Conference 2003

Colom J. G. and M. Toledo "Industrial Affiliates Program at UPR-Mayaguez: A Success Story", accepted ASEE CIEC Conference 2003

J. G. Colom and R. Barton, "A Novel Graphical Technique for Selection of Robust Design Point," ASEE 2001 Conference, New Mexico, June 2001.

J. G. Colom and R. Rodriguez-Solis, "Undergraduate Research using the Finite Difference Time Domain Technique for Electromagnetics," ASEE 2001 Conference, New Mexico, June 2001.

J. G. Colom and R. Rodriguez-Solis, "Design and Simulation of a Tunable Ferroelectric Lange Coupler," Ferroelectric Workshop, San Juan PR, June 2001.

J. G. Colom and S.L. Cruz Pol, "Remote Sensing Modules to Increase Interest In Traditionally Difficult Courses," IGARSS 2001 Conference, Sydney Australia, July 2001.

Synergistic Activities

Created with Dr. Rafael Rodiguez Solis the Radiation Laboratory - NSF MRI

Developed graduate courses in area of Microwave Systems and Microwave Active Circuits

Coordinator of Microwave Engineering course. Integrated CAD tools in course.

Last two years ranked top three in students evaluation (out of 50 faculty members).

Developing Electrical Engineering Freshmen course to introduce EE applications since first year.

Collaborators and Other Affiliations

Lynn Carpenter - PSU, Thesis Advisor
Raymond Luebbers - PSU, Collaborator
Felix Miranda, NASA, Collaborator
Zoya Popovic - UColorado, Collaborator
Steve Sekelsky, UMass, Collaborator
Calvin Swift, UMass, MS Advisor

Walter R. Díaz
University of Puerto Rico
Department of Social Sciences
Center for Applied Social Research (CISA)
P.O. Box 9266
Mayagüez, PR
w_diaz@rumad.uprm.edu

Since completing his Ph.D. in Political Science at the University of Michigan, Ann Arbor in 1998, Walter Díaz has done research on political campaign financing in Puerto Rico, but most of his work has been in applied social research. Among these research issues are the development of survey sampling frames for Puerto Rico (NSF and UPR Research and Development), public response to hurricane warning (U.S. Army Corps of Engineers), census response and racial issues (Westat and U.S. Bureau of the Census) and research mentoring of undergraduate students.

Professor Díaz has been the Director of the Center for Applied Social Research at the University of Puerto Rico at Mayagüez (UPRM) and is currently acting chairperson of the Department of Social Sciences at the UPRM.

Education

Ph. D., Political Science, The University of Michigan-Ann Arbor, 1998.
M. A., Political Science, The University of Michigan-Ann Arbor, 1991.
B. A., Political Science, University of Puerto Rico-Mayagüez, 1987

Appointments

2001- Acting Director, Department of Social Sciences, University of Puerto Rico-Mayagüez
1999-2001 Director, Center for Applied Social Research, Department of Social Sciences, UPRM
2001- Associate Professor and Researcher, Center for Applied Social Research, Department of Social Sciences, University of Puerto Rico-Mayagüez
1998-2001 Assistant Professor and Researcher, Center for Applied Social Research, Department of Social Sciences, University of Puerto Rico-Mayagüez
1991-1998 – Instructor and Researcher, Center for Applied Social Research, Department of Social Sciences, University of Puerto Rico-Mayagüez

Publications

1. Díaz, Walter. (2002). "*La investigación social aplicada desde una perspectiva política*" ("Applied Social Research from a Political Perspective"). In Ruíz, Sonia, ed. *Temas en Ciencias Sociales*. Puerto Rico: Oficina de Publicaciones RUM.
2. Albarrán Rafael and Díaz, W. (1999). "*La política del dinero: financiamiento de Campañas en Puerto Rico 1984-1992*" ("The Politics of Money: Campaign Finances in Puerto Rico 1984-1992"). In Anderson, John W., ed. *Política Electoral en Puerto Rico*. Spain: Editorial Plaza Mayor. Pp. 197-232.

Selected Grants

1. Co-Principal Investigator, "Certification Program in Applied Social Research. 2000-2002. Funded by *the Iniciativa para la Renovación Académica* program of the Office of the Vice-

President for Academic Affairs and Research of the University of Puerto Rico ($25,000.00). With Havidán Rodríguez (PI) and Janet Bonilla.

2. Principal Investigator, "Puerto Rico Census 2000 Assesment: Race/Ethnicity Component." 2000-2001. With María Mulero and Havidán Rodríguez. Series of focus groups exploring Puerto Ricans reactions to the Census 2000 race/ethnicity questions. Funded by Westat and the U.S. Bureau of the Census ($79,334.00).
3. Workshop, "Taking Research Beyond the Curriculum: Institutionalizing Structures to Support Student Research." Presented with Alfonso Latoni at the 1999 American Sociological Association Annual Conference. Chicago, August 10-16
4. Co-Principal Investigator, "Public Response to Hurricanes in the North Coast of Puerto Rico: A Behavioral Analysis." 1999-2000. With Havidán Rodríguez and Jaime Gutiérrez. Developed and implemented a sample survey to collect data on evacuation behavior during Hurricane Georges. Funded by the United States Army Corps of Engineers Planning Division, Jacksonville District ($59,405.00).
5. Principal Investigator, "National Identity and Status Choice, Phase I: Instrumentation and Infrastructure." (1998-2000). With Luis Cámara, Angel Israel Benítez, Havidán Rodríguez and María Mulero. Project's main goal is to build a national sampling frame for Puerto Rico. Funded by the National Science Foundation and the University of Puerto Rico ($52,113).

Synergistic Activities

1. Member, Islands Task Force of the Federal Emergency Management Agency and the U.S. Army Corps of Engineers. A final report was submitted to the Interagency Coordinating Committee on Hurricanes in Washington, DC: titled "Islands Task Force Report: A Briefing on Hurricane Evacuation Study Needs in the United States Island Communities" (2002).

Collaborators and Other Affiliations

1. Collaborators:
    a. University of Puerto Rico, Mayagüez: Janet Bonilla, Bienvenido Vélez.
2. Graduate Advisors: Gregory Markus (University of Michigan-Ann Arbor)

Theodore E. Djaferis

Department of Electrical and Computer Engineering
University of Massachusetts, Amherst, MA 01003
Tel: (413) 545-3561, FAX: (413) 545-1993
e-mail: djaferis@ecs.umass.edu

EDUCATION HISTORY:

University of Massachusetts Amherst ,B.S., Electrical and Computer Engineering, 1974.

Massachusetts Institute of Technology, Electrical Engineering and Computer Science, M.S. 1977.

Massachusetts Institute of Technology, Electrical Engineering and Computer Science, E.E.,1978.

Massachusetts Institute of Technology, Electrical Engineering and Computer Science, Ph.D., 1979.

ACADEMIC APPOINTMENT HISTORY:
Massachusetts Institute of Technology: Research Assistant/Teaching Assistant, Electrical Engineering and Computer Science, (1974-1979).

University of Massachusetts Amherst, Assistant Professor, Electrical and Computer Engineering, (1979-1985). Brown University, Visiting Associate Professor, Division of Engineering, (sabbatical, Fall 1985).

University of Massachusetts Amherst, Associate Professor, Electrical and Computer Engineering (1985-2000).

University of Massachusetts Amherst, Professor, Electrical and Computer Engineering (2000-now).

RESEARCH/PROFESSIONAL ACTIVITIES: My research interests include robust control of dynamical systems, control of complex systems, discrete event systems and control over networks. For a number of years I served as the Co-Director of the Laboratory of Perceptual Robotics at the University of Massachusetts Amherst. I am the author of more than ninety technical articles, a research monograph titled: *Robust Control Design: A Polynomial Approach* published by Kluwer Academic Publishers and a textbook entitled: *Automatic Control: The Power of Feedback* published by PWS. A revised printing of this book was published by Brooks/Cole. I am the co-editor of a research volume titled: *System Theory: Modeling, Analysis and Control*, published by Kluwer Academic Publishers. I served as Guest Editor of Kybernetika, on the Program Committees of several conferences and as a member of the Conference Editorial Board of the Control Systems Society. I served as the Finance Chair of the 1985 American Control Conference and as the Publications Chairman for the 1995 IEEE Conference on Decision and Control. I served as the Program Chairman of the 1997 Conference on Decision and Control and the General/Program Chair of the 5th IEEE Mediterranean Conference on Control and Systems. I was the General Chair of the Advances in Systems Theory Symposium held in 1999. I was as the General Chair of the 2001 Conference on Decision and Control. I served on the Board of Governors of the Control Systems Society 1996-1999 and have been elected to serve for the three-year term 2001-2003. I currently serve as Vice-President Member Activities for the IEEE Control Systems Society. I have received many grants/contracts from federal agencies and industrial organizations (NSF, AFOSR, EPRI/DOD, GE, Martin Marietta Aerospace, OTIS Elevator, Kollmorgen) and consulted for Telaxis/Millitech and Quantum. I am a three-time recipient of the Eta Kappa Nu Outstanding Professor Teaching Award in my Department, the recipient of a College of Engineering Outstanding Advisor Service Award in 1991. I was the recipient of the College Outstanding Teacher Award in 2001, have been nominated twice for this award in the past as well as three times for a University Outstanding Teaching Award. I am a member of Eta Kappa Nu and Tau Beta Pi and Fellow of IEEE (2003).

SYNERGISTIC ACTIVITIES:
1. Development of real-time management schemes of complex resource allocation systems (e.g., working with OTIS Elevator, on elevator dispatching).
2. Development of rapid prototyping tools for embedded control systems (e.g., working with Kollmorgen, on motion control applications).

3. Development of educational material for first-year engineering students (e.g., Automatic Control Module and accompanying textbook).
4. Participation in Workshops for high school teachers and high school students, (e.g., Ideas and Technology of Control Systems National Science Foundation Workshop for High School Teachers of Mathematics and Science, Chicago, IL, June 2000, 2002 Control Awareness Days, A Workshop For Las Vegas High School Students, Las Vegas, NV, December 2002, co-sponsored by NSF).

BOOKS/SELECTED PUBLICATIONS

1. T. E. Djaferis, "*Robust Control Design: A Polynomial Approach*," Kluwer Academic Publishers, Boston, 1995.
2. R. D. Kaminsky, T. E. Djaferis, "The Finite Inclusions Theorem," *IEEE Transactions on AC* ,Vol. 40, No. 3, 1995, pp. 549-551.
3. R. D. Kaminsky, T. E. Djaferis, "Application of the Finite Inclusions Theorem to Robust Analysis and Synthesis," *Inter. J. Control,* Vol. 64, No. 3, pp. 511-527, 1996.
4. T. E. Djaferis, "*Automatic Control: The Power of Feedback*," PWS Publishing Company, Boston, 1998. Revised Printing, Brooks/Cole Publishing, Pacific Grove, 2000.
5. T. E. Djaferis, and Irvin Schick, "*System Theory: Modeling, Analysis and Control,*" Editors, Kluwer Academic Publishers, Boston, 2000, 507 pages.
6. T. E. Djaferis, "An Automatic Control Module for First-Year Students," Proceedings, *1997 American Control Conference,* Albuquerque, NM, pp. 3176-3180.
7. T. E. Djaferis, "Automatic Control: A Theme for First-Year Engineering Study," Proceedings 1999, *IEEE Conference on Decision and Control*, Phoenix, AZ, pp. 1266-1271.
8. T. E. Djaferis, "Stability Preserving Maps and Robust Design," *Inter. J. Control,* Vol. 75, No. 9, 2002, pp. 680-690.
9. T. E. Djaferis, D. Pepyne, D. Cushing, "A New Parameterization of Stable Polynomials," *IEEE Transactions on AC* Vol. 47, No. 9, 2002, pp. 146-150.
10. S. Hart, N. Vozdolsky, T. E. Djaferis, "A Class of Networked Control Systems: Architecture, Design and Implementation," to appear, Proceedings 41st *IEEE Conference on Decision and Control,* Las Vegas , Nevada, December 2002.

GRADUATE ADVISOR: Sanjoy Mitter

GRADUATE ADVISEES: **PhD** A. Narayana, J. A. Franklin, S. T. Venkataraman, R. D. Kaminsky.
MS D. Ambos, M., Amin, L. K. Liu, B. Murah, R. Wagner, P. Spada, J. Ciolfi, W. Krawiec, D. Boudreau, S. Davenport., D. Brilis, D. Cushing

UNLISTED COLLABORATORS: Christos Cassandras (Boston University), Yu-Chi Ho (Harvard University), Manjumath Hegde (Washington University), Paul Min (Washington University), John Zaborsky (Washington University), Marija Ilic (MIT), Dave Pepyne (Harvard University, Yossi Chait (UMass Amherst), Christopher Hollot (Umass Amherst)

Stephen J. Frasier

Dept of Electrical and Computer Engineering
University of Massachusetts
Amherst, MA 01003

Education

U. Delaware	Electrical Engineering	BEE 1987
U. Massachusetts	Electrical & Computer Engineering	PhD 1994

Appointments

Assistant Professor, U. Massachusetts, 4/97-present

Senior Research Fellow, Microwave Remote Sensing Laboratory, U. Massachusetts, 9/96-3/97

Research Engineer, Microwave Remote Sensing Laboratory, U. Massachusetts, 9/94-9/96

Assistant Scientist, TRW Space & Defense (SciTec subsidiary), 7/87-6/90

Publications

Sun, J., D.H. Lenschow, S.P. Burns, R. Banta, R. Coulter, S. Frasier, T. Ince, C. Nappo, B. Balsley, M. Jensen, D. Miller, B. Skelly, J. Cuxart, W. Blumen, X. Lee, X-Z Hu (2002). Intermittent Turbulence in Stable Boundary Layers and its Relationship to Density Current, to appear in *Boundary Layer Meteorology,* 2002.

Frasier, S.J., F. Kong, J.R. Carswell, E.J. Knapp, C.T. Swift (2001). Pier-based Observations of Polarized Sea Surface Emission, *Radio Sci.*, **36**(4), 609-620.

Pollard, B.D., S. Khanna, S.J. Frasier, J.C. Wyngaard, D.W. Thomson, R.E. McIntosh (2000). Local Structure of the Convective Boundary Layer from a Volume-Imaging Radar, *J. Atmos. Sci.*, **57**(7), 2,281-2,296.

Mead, J.B., G. Hopcraft, S.J. Frasier, B.D. Pollard, C.D. Cherry, D.H. Schaubert, R.E. McIntosh (1998). A Volume Imaging Radar Wind Profiler for Atmospheric Boundary Layer Turbulence Studies, *J. Atmos. & Oceanic Tech.*, **15**, 849-859.

Frasier, S.J., Y. Liu, R.E. McIntosh (1998). Space-Time Properties of Radar Sea-Spikes and their Relation to Wind and Wave Conditions, *J. Geophys. Res.*, **103**(C9), 18,745-18,757.

Synergistic Activities

Associate Editor, IEEE Geoscience & Remote Sensing Society Newsletter: University Profiles, 2000-present

Member, Science Team, 1999 Cooperate Atmosphere Surface Exchange Study

Collaborators

Phlip Chilson	CIRES, U. Colorado, Boulder, CO.
Steven Elgar	Woods Hole Oceanographic Institution, Woods Hole, MA.
Todd Holland	Naval Research Laboratory, Stennis Space Ctr, MS.
Andreas Muschinski	NOAA Environmental Technology Laboratory, Boulder, CO.
Robert Palmer	Electrical Engineering Dept., U. Nebraska-Lincoln, NE.
Britt Raubenheimer	Woods Hole Oceanographic Instituition, Woods Hole, MA.
Tammy Weckwerth	Atmospheric Technology Division, NCAR, Boulder, CO.
John Wyngaard	Meteorology Dept, Penn State University, State College, PA.

Graduate and Postdoctoral Advisors

R.E. McIntosh (deceased)

Thesis Advisor

James Eshbaugh	MIT Lincoln Laboratories
Turker Ince	Aware, Inc.
Jie Li	Eaton Vorad

Dennis Goeckel split time between Purdue University and Sundstrand Corporation from 1987-1992, receiving his BSEE from Purdue in 1992. From 1992-1996, he was a National Science Foundation Graduate Fellow and then Rackham Pre-Doctoral Fellow at the University of Michigan, where he received his MSEE in 1993 and his Ph.D. in 1996, both in Electrical Engineering with a specialty in Communications Systems. In September 1996, he assumed his current position in the Electrical and Computer Engineering department at the University of Massachusetts, where he received early promotion to Associate Professor with tenure in 2001. His current research interests are in the areas of signal processing and communication theory.

Dr. Goeckel is the recipient of a 1999 CAREER Award from the National Science Foundation for "Coded Modulation for High-Speed Wireless Communications". He was a Lilly Teaching Fellow for the 2000-2001 academic year, and was named 2001 Outstanding Junior Faculty Member in the College of Engineering at UMass-Amherst. Currently, he is an Editor for the IEEE Transactions on Wireless Communications.

a. Professional Preparation

Ph.D., Electrical Engineering: Systems, University of Michigan, December 1996.

M.S., Electrical Engineering: Systems, University of Michigan, December 1993.

B.S., Electrical and Computer Engineering, Purdue University, May 1992.

b. Appointments

Associate Professor, Department of Electrical and Computer Engineering, University of Massachusetts - Amherst, 2001-present.

Assistant Professor, Department of Electrical and Computer Engineering, University of Massachusetts - Amherst, 1996-2001.

Consultant: Quadrant Engineering, Inc. (1998-2000), M/A-COM, Inc. (2000-2002), Mabuhay Networks (2001-2002).

c. Publications

Most Closely Related Publications:

[1] S. Wei, D. L. Goeckel, and R. Janaswamy, "On the Capacity of MIMO Systems with Antenna Arrays of Fixed Volume," conference version appeared at CISS 2002, full version to be submitted to the *IEEE Transactions on Communications*, November 2002, available from "http://www-unix.ecs.umass.edu/∼goeckel/mimo.html".

[2] G. Ananthaswamy and D. L. Goeckel, "A Fast-Acquiring Blind Predictive DFE," *IEEE Transactions on Communications,* Vol. 50: pp. 1557-1560, October 2002.

[3] D. L. Goeckel and G. Ananthaswamy, "On the Design of Multi-Dimensional Signal Sets for OFDM," *IEEE Transactions on Communications,* Vol. 50: pp. 442-452, March 2002.

[4] P. Örmeci, X. Liu, D. L. Goeckel, and R. D. Wesel, "Adaptive Bit-Interleaved Coded Modulation," *IEEE Transactions on Communications,* Vol. 49: pp. 1572-1581, September 2001.

[5] D. L. Goeckel, "Adaptive Coding for Time-Varying Channels Using Outdated Fading Estimates," *IEEE Transactions on Communications,* Vol. 47, pp. 844-855, June 1999.

Other Significant Publications:

[1] S. Wei, D. L. Goeckel, and P. A. Kelly, "The Complex Envelope of a Bandlimited OFDM Signal Converges Weakly to a Gaussian Random Process: Proof and Application", submitted to the *IEEE Transactions on Information Theory,* September 2002, available from "http://www-unix.ecs.umass.edu/∼goeckel/ofdm.html".

[2] S. Wei and D. L. Goeckel, "Error Statistics for Average Power Measurements in Wireless Communication Systems," *IEEE Transactions on Communications,* Vol. 50: pp. 1535-1546, September 2002.

[3] K. Kamath and D. L. Goeckel, "Adaptive Modulation Schemes for Minimum Outage Probability in Wireless Systems," submitted to the *IEEE Transactions on Communications,* September 2001, available from "http://www-unix.ecs.umass.edu/∼goeckel/adaptive.html".

[4] C. Köse and D. L. Goeckel, "On Power Adaptation in Adaptive Signaling Systems," *IEEE Transaction on Communications,* Vol. 48: pp. 1769-1773, November 2000.

[5] D. L. Goeckel and W. E. Stark, "Optimal Diversity Allocation in Multi-User Communication Systems: Part I: System Model, Part II: Optimization," *IEEE Transactions on Communications,* Vol. 47, pp. 1828-1836, December 1999, and Vol. 48, pp. 45-52, January 2000.

d. Synergistic Activities

[1] Lilly Teaching Fellow (2000-2001): Dr. Goeckel was selected as a Lilly Teaching Fellow for the 2000-2001 year; his focus was on methods of introducing active learning into lecture-style courses.

[2] Wireless Systems Laboratory: Dr. Goeckel is director of the Wireless Systems Laboratory, which builds testbeds to support theoretical communication and networking theory. Current major projects: (1) a demonstration of the first adaptive signaling system that adapts to the fast multipath fading, (2) remotely programmable system that provides packet error traces for the wireless channel.

[3] Undergraduate Research: Dr. Goeckel has supervised (and often supported) twenty-one undergraduate researchers in communications at UMass-Amherst. Members of the group have gone on to graduate school at Stanford, Michigan, Illinois, and Washington.

e. Collaborators: M. Adler (UMass-Amherst), B. Broderson (UC-Berkeley), W. Burleson (UMass-Amherst), Y. Chait (UMass-Amherst), M. Chu (Dealspring, Inc.), K. Chugg (USC), B. DeCleene (Alphatech), S. Frasier (UMass-Amherst), L. Gao (UMass-Amherst) A. Ganz (UMass-Amherst), W. Gong (UMass-Amherst), M. Grabb (General Electric), A. Hero (University of Michigan), C. Hollot (UMass-Amherst), B. Hughes (NSCU), B. Jackson (UMass-Amherst), R. Janaswamy (UMass-Amherst), P. Kelly (UMass-Amherst), C. Krishna (UMass-Amherst), J. Kurose (UMass-Amherst), B. Levine (UMass-Amherst), J. Machta (UMass-Amherst), L. Nagurney (Univ. of Hartford), W. Namgoong (USC), D. Pozar (UMass-Amherst), K. Ramamritham (UMass-Amherst), B. Ryan (University of Arizona), D. Schaubert (UMass-Amherst), B. Scholtz (USC), P. Shenoy (UMass-Amherst), R. Tessier (UMass-Amherst), D. Tse (UC-Berkeley), K. Townshend (NCSU), D. Towsley (UMass-Amherst), R. Wesel (UCLA), S. Zabele (Alphatech), Z. Zvonar (Analog Devices).

Graduate Research Advisor: W. Stark (University of Michigan).

Graduate Advisees: G. Ananthaswamy (Analog Devices), Yonggang Hao (UMass-Amherst), K. Kamath (Aware), C. Köse (UCLA), K. Liu (UMass-Amherst), P. Örmeci (Narad Networks), R. Rzeszutek (UMass-Amherst), S. Wei (UMass-Amherst), H. Zhang (UMass-Amherst), X. Zhang (UMass-Amherst).

Weibo Gong
Department of Electrical and Computer Engineering
University of Massachusetts
Amherst, Mass. 01003

Education

M.S., Engineering, Harvard University, 1985
Ph.D., Applied Mathematics, Harvard University, 1987

Work Experience

Professor, Department of Electrical and Computer Engineering, University of Massachusetts, 1997 - .

Adjunct Professor, Department of Electrical and Computer Engineering, University of Massachusetts, 1999 - .

Associate Professor, Department of Electrical and Computer Engineering, University of Massachusetts, 1993-1997.

Assistant Professor, Department of Electrical and Computer Engineering, University of Massachusetts, 1987-1993.

Honors and Awards

IEEE Control Systems Society George Axelby Outstanding Paper Award, 1997.

IEEE Fellow, elected 1998.

College Outstanding Senior Faculty Award, 2002.

Five Most relevant publications to this proposal:

V. Misra, W.Gong, and D. Towsley, "Fluid-based Analysis of a Network of AQM Routers Supporting TCP Flows with an Application to RED", *Proceedings of ACM/SIGCOMM*, 2000.

C. Hollot, V. Misra, D.Towsley and W. Gong, "A Control Theoretic Analysis of RED." IEEE Transactions on Aotumatic Control, Vol. 47, No. 6., June, 2002.

C. Hollot, V. Misra, D. Towsley, and W. Gong,"On Designing Improved Controllers for AQM Routers Supporting TCPFlows." in Proceedings of INFOCOM, Anchorage, April, 2001.

Y. Liu and W. Gong, "On Fluid Queueing System with Strict Priority", Submitted, IEEE Trans. on Automatic Control, 2002.

Y.Liu and W. Gong, "Challenges to Congestion Control Posed by Concurrent Downloadings" , IEEE Conference on Decision and Control, Orlando, Florida, Dec. 2001.

Five other significant publications:

Gong,W., D. Towsley, Y. Wu and D. Ye, "A Stochastic Differential Equation Model for Queues with Traffic Smoothing", Proceedings of the Allerton Conference, Oct. 2002.

Gong,W.,Y.Liu,V.Misra and D. Towsley,"On the web file size distributions", Proceedings of the Allerton Conference, Oct 2001.

Y. Chait, C.V. Hollot, M. Vishal, S. Oldak, D. Towsley, W.B. Gong,"(Fluid) Model-Based Controllers for AQM Routers Supporting TCPFlows," Proceedings of the American Control Conference,Arlington, VA, June 2001.

Jintao Xion, Weibo Gong and Chunming Qiao, "An Effective Method for Blocking Performance Analysis of WDM All-Optical Networks", Accepted, Journal of Lightwave Technology, 2002

A. Yan and W.B. Gong, " Time-Driven Fluid Simulation for High Speed Networks" *IEEE Transactions on Information Theory*, Vol. 45, No. 5,1999.

Professional Activities

Associate Editor, Journal of Optimization Theory and Applications;

Associate Editor, IEEE Transactions on Automatic Control (1993-1997);

Associate Editor, IEEE Transactions on Robutics and Automation (1995-1997);

Co-organizer, 1996 NSF-ARO workshop on Systems and Control Issues in Communication Networks, August 9-10, Airlie, Virginia.

Chair, IEEE Control Systems Society Network and Communication Technical Commmittee.

Guest Editor, IEEE Transactions on Automatic Control Speical Issue on Systems and Control Methods in Communication networks, June 2002.

Co-editor, Modeling, Control and Optimization of Complex Systems,

List of Collaborators in last 48 months on books, articles,papers, proposals

D. Towsley (U. Massachusetts) Y.C. Ho (Harvard University), J. Kurose (U. Massachusetts) B. Levin (U. Massachusetts) C. Hollot (U. Massachusetts) V. Misra (Columbia U.) D. Pepyne (Harvard University) W. Lee (Georgia Tech) C. Qiao (SUNY Buffalo)

List of Research Advisees in last five years (not including current students)

S. Nananukul, A. Yan, V. Misra, C. Liu,Y. Guo, Y. Liu

Name of graduate advisors

Y.C. Ho (Harvard University)

Robert W. Jackson
Professor of Electrical and Computer Engineering
University of Massachusetts, Amherst

Education:

B.S.E.E. Northeastern University, Summa Cum Laude (1975)
M.S.E.E. Northeastern University, (1980)
Ph.D. Northeastern University (1981), Advisor: Kenneth Golden
Dissertation Title: Electromagnetic Turbulence in Space Plasmas

Appointments:

Professor, University of Massachusetts/Amherst, September 2001.

Associate Professor, University of Massachusetts/Amherst, January 1989.

Assistant Professor, University of Massachusetts/Amherst, September 1982.

Assistant Professor, Northeastern University, December 1981 to August 1982.

Instructor, Northeastern University, September 1976 to September 1978.

Consultant, Hewlett Packard Co., 1990 (Lightwave/ Microwave Electronics)

Air Force Summer Faculty Research Fellow, 1984 (Electromagnetic Modeling)

Research Assistant, Northeastern University, 1978 - 1981(Space Plasmas)

Graduate Co-op Student Genrad Co., 1975 - 1976 (Test Equipment design).

Relevant Publications:

1. R. Carrillo, R. and R. W. Jackson, "A Technique for Interconnecting Millimeter Wave Integrated Circuits Using BCB and Bump Bonds," accepted (10/02) for publication in **IEEE Microwave and Wireless Components Letters**
2. Ito, R., R. W. Jackson, T. Hongsmatip, "Modeling of Electrical Coupling Between Interconnections used in a Multilayered BGA Package," **IEEE Trans. Microwave Theory and Techniques**, pp 1819-1825, September 1999.
3. Jackson, R.W., "Criteria for the Onset of Oscillation in Microwave Circuits," **IEEE Trans. on Microwave Theory and Techniques**, Vol. 40, pp. 556-568, March 1992.
4. Ho, Bin and R. W. Jackson, "Preserving Isolation in Grounded Coplanar Waveguide Circuits Without Via Holes," **2000 Conference on the Electrical Performance of Electronic Packaging** Proceedings Phoenix, October 2000 pp 265-268.
5. Jackson, R. W. and Z. Wang, "Radiation and Coupling Algorithms," *invited paper* for the, **"Workshop on Microwave and Mm-Wave Design Tool Applications for Virtual Prototyping**," at the IEEE Microwave Theory and Techniques Symposium, June 1999.

Other Publications:

1. Jackson, R. W., "A Planar Orthomode Transducer," **IEEE Microwave and Wireless Components Letters,** Vol. 11**.,**pp.483-485, December 2001
2. Wang, Z. and R. W. Jackson, "Coupling Algorithm for Dielectric Covered MMICs in Multi-Chip Enclosures," **IEEE Trans. Microwave Theory and Techniques**, pp 133-141, January, 2001.
3. Jackson, R. W. and H. Hsu, "Multilayer Elliptic Filter," **Electronics Letters**, Vol. 37, No. 13, pp. 838-839, June 2001.

4. Jackson, R. W., "Simple Analytical Formulas for the Non-Local Field Generated by Circuit Elements in Multi-Layer Structures," **IEEE Trans. Microwave Theory and Techniques**, pp 1967-1971, November, 2000.
5. Ito, R., R. Carrillo, and R. W. Jackson," RF Modeling of Vertical Interconnection Between Power-Ground Plane Combined with 2D TLM, **2001 Conference on the Electrical Performance of Electronic Packaging** Proceedings Boston, October 2001 pp 339-343.

Synergistic Activities:

1. Co-Editor of Special Issue on Electrical Performance of Electronic Packaging, Transactions on Microwave Theory and Techniques, March 2001.
2. Co-Editor of Special Issue on Coplanar Technology, International Journal of RF and Microwave Computer-Aided Engineering, October 2000.
3. Technical Committee - MTT-12 IEEE Society on Microwave Theory and Techniques, 1999-.
4. Technical Program Committee, IEEE Symposium on Microwave Theory and Techniques, 1999-.
5. Since 1987 taught Active Microwave Circuits on video through the UMass Video Instructional Program and the National Technical University. The course has consistently been in demand by students from Motorola, Hewlett Packard, Ansoft, Schlumberger, TriQuint, Rockwell, AT&T, Advanced MicroDevices, Conexant, Raytheon, and other companies.

Collaborators & Other Affiliations

(i) Collaborators. Unless otherwise noted all collaborators are from the University of Massachusetts:, K. Carver, E. El-Sharawy(U. Arizona), S. Frasier , D. Goeckel, R. Janaswamy, D. McLaughlin, D. M. Pozar, S. Reising.
(ii) Graduate Advisors. Kenneth I Golden University of Vermont
(iii) Thesis Advisor and Postgraduate-Scholar Sponsor. Four M.S thesis students: R. Moulany, (Photonics Inc.), H. Hsu (Acco) , B. Ho(IBM), B. Park(Conexant). One Ph.D. Student: C. Wang,

Ramakrishna Janaswamy Biographical Sketch

Ramakrishna Janaswamy is a Professor in the Department of Electrical and Computer Engineering, University of Massachusetts, Amherst. He spent the summer of 1994 at NASA Ames Research Center, Moffet Field, CA, the summer of 1995 at SPAWARSYSCEN (formerly NRaD), San Diego, CA conducting research in computational electromagnetics and tropospheric radiowave propagation respectively. He spent the academic year September 1997 to June 1998 at the Center for PersonKommunikation, Aalborg University, Denmark conducting research on propagation prediction for wireless communications. His research interests are in the areas of radiowave propagation prediction methods, analysis and design of antennas and applied electromagnetics.

Dr. Janaswamy was the recipient of the 1995 R. W. P. King Prize Paper Award for Best Paper by an author under age 36 of the IEEE Transactions on Antennas and Propagation. For his outstanding services and contributions, he was nominated and received the IEEE 3rd Millennium Medal from the Santa Clara Valley Section in June 2000. He received the Naval Postgraduate School Certificate of Research Recognition for his research efforts in 1992 and a Certificate of Recognition from ONR/ASEE for his research contributions. He is currently an Associate Editor of the American Geophysical Union journal *Radio Science*. He is a Fellow of IEEE and an elected member of USNC/URSI, Commissions B and F.

a. Professional Preparation

Ph.D., Electrical Engineering: Systems, University of Massachusetts, Amherst, September 1986.

M.Tech., Electronics & Communications Engineering, Indian Institute of Technology, Kharagpur, July 1993.

B.Tech., Electronics & Communications Engineering, Regional Engineering College, Warangal, May 1981.

b. Appointments

Professor, Department of Electrical and Computer Engineering, University of Massachusetts - Amherst, 2001-present.

Professor: 2000-2001, *Associate Professor*: 1993-2000, *Assistant Professor*: 1987-1993, Department of Electrical and Computer Engineering, Naval Postgraduate School, Monterey, CA, .

Assistant Professor, School of Engineering & Applied Physics, Wilkes University, Wilkes-Barre, PA, 1986-1987.

c. Publications

Related to this Proposal

[1] R. Janaswamy, "Angle of arrival and time of arrival statistics for Gaussian scatter density model," *IEEE Trans. Wireless Commun.,* vol. 1 (3), pp. 488-497, July 2002.

[2] R. Janaswamy, "Angle of arrival statistics for a 3D spheroid model," *IEEE Trans. Vehicular Tech.,*, vol. 51(5), pp. 1242-1247, September 2002.

[3] S.Wei, D. Goeckel, and R. Janaswamy, "On the capacity of fixed length linear antenna arrays under bandlimited correlated fading," submitted to *IEEE J. Select. Areas Commun.,* April 2002. (Available at http://www.ecs.umass.edu/ece/janaswamy/janaswamy_add_info/index.html)

[4] R. Janaswamy, "Effect of element mutual coupling on the capacity of fixed length linear arrays," to appear in *IEEE Antennas & Wireless Propagat. Lett.*, September 2002. (Available at http://www.ecs.umass.edu/ece/janaswamy/janaswamy_add_info/index.html)

[5] R. Janaswamy, *Radiowave Propagation & Smart Antennas for wireless Communications*, Boston: Kluwer Academic Publishers, 2000.

Other Significant Publications

[6] J. R. Kuttler and R. Janaswamy, "Improved Fourier transform methods for solving the parabolic equation," Radio Science, vol. 37 (2), pp. 5.1-5.11, March-April 2002.

[7] R. Janaswamy, "Path loss predictions in the presence of buildings on flat terrain: A 3D parabolic equation approach," to appear in *IEEE Trans. Antennas Propagat.*, August 2003.
(Available at http://www.ecs.umass.edu/ece/janaswamy/janaswamy_add_info/index.html)

[8] R. Janaswamy, "Radio wave propagation over a non-constant immittance plane," *Radio Science*, 36(3), pp. 387-405, May-June 2001.

[9] R. Janaswamy and J. B. Andersen, "Path loss predictions in urban areas with irregular terrain topography," *Wireless Personal Communications*, 12(3), pp. 255-268, March 2000. (Also see the addendum in *Wireless Personal Communications*, 14(3), pp. 303-304, September 2000.)

[10] R. Janaswamy, "A curvilinear coordinate based, split-step parabolic equation method for propagation predictions over terrain," *IEEE Trans. Antennas Propagat.*, vol. 46 (7), pp. 1089-1097, July 1998.

d. Synergistic Activities

While at the Naval Postgraduate School, the PI designed three new courses in emerging areas of electrical engineering. One of them on "Wireless Propagation and Smart Antennas" resulted in a book [**?**]. His several short courses offerings at professional IEEE meetings were all well attended and received high marks. He has supervised about 25 Master's theses and two postdoctoral appointments. He served the IEEE Monterey Bay Subsection for over six years, first as a Secretary and later as a Chairman.

e. Collaborators: M. A. Morgan (NPS, Monterey), R. C. Robertson (NPS, Monterey), R. W. Adler (NPS, Monterey), D. Goeckel (Mass-Amherst), D. M. Pozar (UMass-Amherst), D. H. Schaubert (UMass-Amherst), R. W. Jackson (UMass-Amherst), J. B. Andersen, (CPK, Aalborg University, Denmark), Y. Liu (NASA Ames research Center, Moffet Field, CA), J. R. Kuttler (Applied Physics Lab, Johns Hopkins Univ.), H. Hitney (SPAWARSYSCEN, San Diego), A. Barrios (SPAWARSYSCEN, San Diego), K. Anderson (SPAWARSYSCEN, San Diego, CA).

Graduate Research Advisor: D. H. Schaubert (UMass-Amherst).

Postdoctoral Advisees: Dr. Darwish Mohammed, Egyptian Air Defence, R. M. Jha, National Aeronatical Laboratories, Bangalore, India.

Dr. Kevin A. Kloesel
Director of Outreach
Oklahoma Climatological Survey
University of Oklahoma
100 E Boyd St Suite 1210, Norman, OK , 73019-1012
voice: (405)-325-5270 e-mail: longhorn@ou.edu

EDUCATION

Ph.D. Meteorology, Penn State, 1990.
Master of Science, Meteorology, Penn State, 1987
Bachelor of Engineering Science, The University of Texas at Austin, 1984

CURRENT

Research Associate, Oklahoma Climatological Survey. Duties include directing all outreach efforts for OCS, including outreach to public safety agencies, K-12 teachers, University faculty, rural electric cooperatives, and the transportation industry. The outreach activities supervised are comprised of collaborative data dissemination (in conjunction with NWS and SPC), training regimen and maintenance components. Additional duties include supervising continuing education opportunities for field meteorologists as well as non-meteorologists, and teaching classes within the School of Meteorology at the University of Oklahoma.

PREVIOUS

1998 - 2001 **Member**, State of Florida Commission on Hurricane Loss Projection Methodology. Duties include evaluation of numerical models designed to assess the costs of multiple scales of hurricane damage along the entire Florida coast, and educational outreach of these results to local communities and emergency management officals.

1995 - 2001 **Chairman**, American Meteorological Society's Board on School and Popular Meteorological and Oceanographic Education. Duties include supervising all Educational Initiatives for the Society.

1995 - 1998 **Associate Professor**, Department of Meteorology, Florida State University. Principally involved in research, teaching and forecasting of synoptic and meso-scale weather systems. Research topics include diagnostic studies of heavy precipitation events, the climatology of Gulf coastal cyclogenesis, as well as the thermodynamic structure of synoptic-scale systems over the Southeast US.

1995 - 1998 **Director,** Florida State Climate Center. As State Climatologist, I oversee the distribution and analysis of climatic data from observation sites throughout the State of Florida in support of government, industry, research, and education for the benefit of all citizens of Florida.

1995 - 1998 **Research Fellow**, Cooperative Institute for Tropical Research (CITM). Principally engaged in the application of synoptic and mesoscale analysis techniques to tropical weather systems, and the implementation of these techniques into the operational community.

1991 - 1998 **Founder** and **Director**, FLORIDA EXPLORES!. Supervise a program consisting of over 200 weather satellite data receiving stations in elementary, middle and high schools across Florida. Additional responsibilities include workshop presentations, curriculum design and the implementation and maintenance of the Florida EXPLORES! world-wide web home page.

1990 - 1995 **Assistant Professor**, Department of Meteorology, Florida State University. See "Associate" heading for duties and responsibilities.

1992 summer **Lead Forecaster**, Atlantic Stratocumulus Transition Experiment (ASTEX), Santa Maria, Azores. Engaged in forecasting for aircraft operations during ASTEX. Responsibilities included coordinating mission scientists and flight crews from five countries to meet the overall goals of the observational phase of the project.

1985 - 1990 **Research Assistant and Instructor**, Department of Meteorology, Penn State University. Principally engaged in research on the synoptic-scale forcing of marine boundary layer structure, as well as teaching lower division undergraduate Meteorology courses and labs.

1987 summer **Observer**, First ISCCP (International Satellite Cloud Climatology Project) Regional Experiment (FIRE). San Diego, California. Principally engaged in monitoring the output of instrumentation on the NCAR Electra aircraft and providing written summaries of those flights. Analysis and forecasting in support of mission operations was also performed.

1984 **Meteorological technical support**, Espey, Huston, & Associates, Austin, Texas. Principally engaged in working with the Texas Air Control Board on urban and rural visibility impairment in Texas, as well as providing expert testimony in forensic meteorological cases.

PUBLICATIONS (refereed):

1. Kloesel, K. A. and B. A. Albrecht, 1989: Low-level inversions over the tropical Pacific-Thermodynamic structure of the boundary layer and the above- inversion moisture structure. *Mon. Wea. Rev.* , 117, 87-101.
2. Wylie, D. P., B. B. Hinton, and K. A. Kloesel, 1989: The relationship of marine stratus clouds to wind and temperature advection. *Mon. Wea. Rev*., 117, 2620-2625.
3. Kloesel, K. A., 1992: Marine stratocumulus cloud clearing episodes observed during FIRE. *Mon.Wea. Rev*., 120, 565-578.
4. Kloesel, K. A., 1992: A 70-year history of marine stratocumulus cloud field experiments off the coast of California. *Bull. Amer. Met. Soc.* , 73, 1581-1585.
5. Kloesel, K. A., 1993: Above inversion profiles of moisture and ozone observed during FIRE. *Mon.Wea. Rev*., 121, 683-694
6. Ruscher, P.H., K.A. Kloesel, S.B. Hutchins, and S. Graham, 1993: Implementation of NOAA direct readout satellite data capabilities in Florida's public schools. *Bull. Amer. Met. Soc*., 74, 849-852.
7. Smith D.R., L.M. Bastiaans, J.W. Zeitler, R.A. McPherson, N.N. Rydell, G.V. Rao, H.P. Warthan, K.A. Kloesel, B.E.Heckman and M.K.Ramamurthy, 1997: Meeting Report on the Fifth AMS Symposium on Education. *Bull. Amer. Met. Soc*., 78, 71-79.
8. Bastiaans, L.M., D.R.Smith, R.A. McPherson, P.A.Phoebus, J.M. Moran, P.J.Croft, M.J. Ceritelli, G.V. Rao, J.T. Schaefer, F.J. Gadomski, K.A.Kloesel, R.G.Quayle, J.W.Zeitler, 1998: Meeting Report on the Sixth AMS Symposium on Education. *Bull. Amer. Met. Soc*., 79, 457-468.
9. Morris, D.A., K.C. Crawford, K.A. Kloesel, and J.M. Wolfinbarger, 2001: OK-FIRST: A Meteorological Information System for Public Safety. *Bull. Amer. Met. Soc*., 82.
10. Morris, D.A., K.C. Crawford, K.A. Kloesel, and G. Kitch, 2001: OK-FIRST: An example of successful collaboration between meteorology and public safety on 3 May 1999. *Wea and Fcst*. , (in press).

Israel Koren
Dept. of Electrical & Computer Engineering
University of Massachusetts, Amherst, MA 01003
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Professional Preparation
1967 -- B.Sc.(Cum Laude)
1970 -- M.Sc.All in Electrical Engineering, from the
1975 -- D.Sc.Technion - Israel Institute of Technology

Appointments
1986 -- Professor of Computer System Engineering, University of Massachusetts at Amherst.
1985 -- 1986 Head, VLSI Systems Research Center, Technion, Haifa, Israel.
1982 -- 1983 On Sabbatical leave at the CS Division, UC Berkeley.
1979 -- 1986 Senior Lecturer, Dept. of Electrical Engineering, Technion, Haifa, Israel.
1978 -- 1979 Assistant Professor, Univ. of Southern California, Los Angeles.
1976 -- 1978 Assistant Professor, University of California, Santa Barbara.

Honors
1991 Fellow, IEEE, ``For contributions to the field of fault-tolerant VLSI systems."
1991 Fellow, Japan Society for Promotion of Science.
1995 Best Paper Award, IEEE Transactions on Semiconductor Manufacturing.

Industrial Positions
Consultant to IBM, Analog Devices, AMD, Intel, Digital Equipment Corporation, National Semiconductor, Tolerant Systems and ELTA, Electronics Industries.

Professional Activities
(recent highlights)

Editor of IEEE Trans. on VLSI Systems since 2001.

Co-Guest Editor, Special Issue on Computer Arithmetic, IEEE Trans. on Computers, July 2000.

Member -- NSF Computer Arch. Research Proposals Review Panel, Feb. 1999.

Editor of IEEE Trans. on Computers 1992 - 1997.

Program Committee co-chair - The 14th IEEE Symposiums on Computer Arithmetic, Australia, April 1999.

General Chair - 1996 International Conference on Parallel Architectures and Compilation Techniques (PACT96), Boston, Oct. 1996.

General Chair - 1996 IEEE Symposium on Defect and Fault Tolerance in VLSI Systems (DFT96), Boston, MA, November 1996.

Program Committee Chair - 1995 IEEE Workshop on Defect and Fault Tolerance in VLSI Systems, Lafayette, LA, November 1995.

Program Committee member - The 1993, 1995, 1997 and 2001, 11th through 15th IEEE Symposiums on Computer Arithmetic.

Program Committee member - ASAP 92, 93, 94, 95, 96 and 97 - the International Conferences on Application-Specific Array Processors.

Current Research Topics:
Fault--tolerant architectures, real-time systems, yield and reliability, and computer arithmetic.

Collaborated with the following scientists:
C.M. Krishna, Z. Kohavi (Graduate advisor), Dhiraj K. Pradhan,
Gabriel M. Silberman, Adit D. Singh, Charles H. Stapper,
M. Yoeli (Graduate advisor).

Research Students Supervised
Supervised over 30 M.Sc and Ph.D students in the areas of Computer Architecture, Performance and Reliability Evaluation, Fault-tolerant Computing and Computer Arithmetic.

Students advised in the past five years:
David Albonesi, Ph.D; V. Chiluvuri, Ph.D; Zhan Chen, Ph.D; Joshua Haines, M.Sc; P. Lalwaney, Ph.D; Vijay Lakamaraju, Ph.D; Steve Morin, M.Sc: Dhananjay Phatak, Ph.D; Arun Venkataraman, M.Sc; Kai Yu, Ph.D;

List of Selected Publications
The following is a list of five recent publications including the most relevant to the proposed research.

M. Allalouf, G. Durairaj, J. Haines, V.R. Lakamraju, O.S. Unsal, K. Yu, I. Koren and C.M. Krishna, ``The RAPIDS

Simulator: A Testbed for Evaluating Scheduling. Allocation, and Fault-Recovery in Distributed Real-Time Systems," Dependable Network Computing, D. Avresky (Editor), pp. 413-431, Kluwer, MA, 2000.

J. Haines, V.R. Lakamraju, I. Koren and C.M. Krishna, ``Application-Level Fault Tolerance as a Complement to System-Level Fault Tolerance," The Journal of Supercomputing, Special Issue on ``Embedded Fault-Tolerant Computing Systems," Vol. 16, pp. 53-68, Kluwer, MA, 2000.

D. H. Albonesi and I. Koren, ``STATS: A Framework for Microprocessor and System-Level Design Space Exploration," Journal of System Architecture, Vol. 45, pp. 1097-1110, 1999.

O.S. Unsal, I. Koren, C.M. Krishna and C. A. Moritz, ``The Minimax Cache: An Energy-Efficient Framework for Media Processors," Proc. of the 2002 Intern. Symp. on High Performance Comp. Arch. (HPCA 2002), Feb. 2002.

V. Lakamraju, I. Koren and C.M. Krishna, ``Synthesis of Interconnection Networks: A Novel Approach," Proc. of the 2000 International Conference on Dependable Systems and Networks, pp. 501-509, June 2000.

C. M. Krishna
Electrical and Computer Engineering
University of Massachusetts at Amherst

Areas of Specialization: Real-time systems, distributed computing, fault tolerance, system modeling and analysis.

Education:

Ph. D. (Electrical Engineering): University of Michigan, 1984.
M.S. (Electrical Engineering): Rensselaer Polytechnic Institute, 1980.
B. Tech (Electrical Engineering): Indian Institute of Technology, Delhi, 1979.

Employment:

University of Massachusetts at Amherst
Professor: 1997 to present
Associate Professor: 1990 to 1997
Assistant Professor: 1984 to 1990

IBM T. J. Watson Research Center
Visiting Faculty, 1986.

Five Relevant Publications:

[1] V. Lakamraju, I. Koren, and C. M. Krishna, "Filtering random networks with multiple objectives," *IEEE Trans. Parallel and Distributed Systems,* Vol. 13, November 2002, pp. 1129—1149.

[2] G. Durairaj, I. Koren, and C. M. Krishna, "Importance sampling to evaluate real-time system reliability, *Simulation*, Vol. 76, March 2001, pp. 172—183.

[3] C. M. Krishna and K. G. Shin, *Real-Time Systems*, McGraw-Hill, 1997.

[4] A. Ganz, D. Tang, Z. Haas, and C. M. Krishna, "On the optimal design of multi-tier wireless cellular systems, *IEEE Communications,* Vol. 35, 1997, pp. 88—93.

[5] K. G. Shin, Y.-H. Lee and C. M. Krishna, "Optimal dynamic control of resources in a distributed system," *IEEE Trans. Software Engineering,* Vol. 15, October 1989, pp. 1188—1198.

Five Additional Publications:

[1] O. S. Unsal, *et al.,* "Cool-Cache: A compiler-enabled energy-efficient data caching framework for embedded/multimedia processors," *ACM Trans. Embedded Computing Systems,* to appear.

[2] O. Unsal, I. Koren, C. M. Krishna, and C. A. Moritz, "The minimax cache: an energy-efficient framework for media processors," *Int'l Symposium on High Performance Computer Architecture*, 2002.

[3] B. Li, A. Ganz, and C. M. Krishna, "A novel MAC protocol for WDM lightwave networks," *IEEE Journal on Selected Areas in Communications,* Vol. 18, October 2002, pp. 1876—1884.

[4] C. M. Krishna, editor, *Performance Modeling for Computer Architects,* IEEE Computer Society Press, 1995.

[5] Y.-H. Lee and C. M. Krishna, editors, *Readings in Real-Time Systems,* IEEE Computer Society Press, 1993.

Sampling of Current Professional Activities:

Guest Editor (with Y.-H. Lee): Special Issue of *Proceedings of the IEEE* on real-time systems (scheduled for 2003).

Program Committee member of the following conferences:
Sixth International Symposium on Autonomous Decentralized Systems, 2003
DSN-2003 Performance and Dependability Symposium.
IEEE Workshop on Parallel and Distributed Real-Time Systems, 2003.

Recent Collaborators:

Y.-H. Lee, Kang G. Shin, A. Ganz, I. Koren, O. Unsal, V. Lakamraju, J. Haines, K. Toutireddy, G. Durairaj, A. Singh, K. Yu, D. Tang, Z. Haas, A. Yan, X. Wang, W. B. Gong.

J. MacGREGOR SMITH
Department of Mechanical and Industrial Engineering
University of Massachusetts
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EDUCATION

1978	Ph.D., Mechanical and Industrial Engineering, University of Illinois, Urbana-Champaign Thesis topic: ***Algorithms for Generalized Steiner Network Problems***. Research Interests: Graphs, Networks, Combinatorial Optimization and Queueing Networks especially as applied to Computer-Aided Design, Analysis & Synthesis.
1969	Masters of Architecture, University of California, Berkeley
1968	Bachelors of Architecture, University of California, Berkeley

APPOINTMENTS

1985-present	Professor, Mechanical and Industrial Engineering, University of Massachusetts, Amherst.
1978-1985	Assistant Professor, Mechanical and Industrial Engineering, University of Massachusetts, Amherst.

PUBLICATIONS

Multi-Objective Routing w/in Large Scale Facilities using Open Finite Queueing Networks, **EJOR 121**. 105-123, 2000(with L. Kerbache.)

Topological Network Design of M/G/C/C Pedestrian Networks, **Transportation Research Series B**, **35**, 107-135, 2001. (with David Mitchell).

Large Production Line Optimization using Simulated Annealing, **International Journal of Production Research, 38**(3),509-541, 2000. (with D. Spinellis and C. Papadopolous).

Modeling Vehicular Traffic Flow using M/G/C/C State Dependent Queueing Models, **Transportation Science 31** (4), 324-336, 1997. (with R. Jain)

An Algorithm for Sub-optimal Routing in Series-Parallel Queueing Networks, **International Journal of Production Research 35** 5, 1413-1430, 1997. (with H. Gosavi)

Resource Allocation in State-Dependent Emergency Evacuation Networks, **The European Journal of Operational Research 89**,543-555, 1996. (with D. Bakuli.)

Buffer Allocation for a Class of Nonlinear Stochastic Knapsack Problems,**Annals of Operations Research 58** 323-360, 1995. (with N. Chikhale).

Application of State Dependent Queues to Pedestrian/Vehicular Network Design **Operations Research 42** 3, 414-427, 1994.

Generalized $M/G/C/C$ State Dependent Queues and Pedestrian Traffic Flows, **Queueing Systems (QUESTA) 15**, 365-386, 1994. (with J. Cheah)

SYNERGISTICS

National Council for Engineering Examiners and Surveyors, FE Board 1994- present
Community Advocacy Depot, Champaign-Urbana, IL, 1971 - 1978
National Clearinghouse for Criminal Justice Planning and Architecture Champaign, IL, 1972-1977
Center for Environmental Structure, Berkeley, CA, 1969-1971

COLLABORATORS
No other collaborators other than those listed above.

Ph.D. STUDENTS
Laoucine Kerbache, Ph.D. Industrial Engineering and Operations Research at the University of Massachusetts,Amherst Campus, February 1984, *Finite Queueing Networks and Optimal Design of Queues.*

Spilios Makris, Ph.D. Industrial Engineering and Operations Research at the University of Massachusetts, Amherst Campus, February 1984, *Multi-objective Optimization of Acoustic Sandwich Panels.* Co-Chairman with C.L. Dym.

Rob Weitz, Ph.D. Industrial Engineering and Operations Research at the University of Massachusetts, Amherst Campus, February 1985*, NOSTRADAMUS: An Interactive Forecasting Consultant.*

Kayhan Talebi, Ph.D. Industrial Engineering and Operations Research at the University of Massachusetts, Amherst Campus, August, 1985. *Stochastic Network Evacuation Models.*

Norbis, Mario, Ph.D. Industrial Engineering and Operations Research at the University of Massachusetts, Amherst Campus, September 1986*, Heuristics for the Resource Constrained Scheduling Problem.*

Daskalaki, Sophia, Ph.D. Industrial Engineering and Operations Research at the University of Massachusetts, Amherst Campus, October, *1987 Static and Dynamic Routing in Queueing Networks.*

Smith, Julie-DelVecchio Ph.D. Industrial Engineering and Operations Research at the University of Massachusetts, Amherst Campus, November 1989 *A Parallel Processing Algorithm for Set Packing Problems.*

Han, Youngnam Ph.D. in Industrial Engineering and Operations Research at the University of Massachusetts, Amherst Campus, September 1992. *Optimal Control and Analysis of Bulk Service Queueing Systems.*

Li, Wu-ji Ph.D. Industrial Engineering and Operations Research at the University of Massachusetts, Amherst Campus, March 1993. *Stochastic Facility Layout Planning and Traffic Flow Network Design.*

Bakuli, David Ph.D. Industrial Engineering and Operations Research at the University of Massachusetts, Amherst Campus, March 1993. *Stochastic Network Evacuation Models.*

Wang, Xiaoyu. Ph.D. Industrial Engineering and Operations Research at the University of Massachusetts, Amherst Campus, May 1994. *A Generalized Design Methodology for Large-scale Systems with Open Finite Queueing Networks.*

Gosavi, Hemant Ph.D. Industrial Engineering and Operations Research at the University of Massachusetts, Amherst Campus, February 1995 *The Optimal Routing Problem in Open, Finite Queueing Networks.*

Gonzales, Edgar, Ph.D. Industrial Engineering and Operations Research at the University of Massachusetts, Amherst Campus, September 1997 *Optimal Resource Allocation in Closed Finite Queueing Networks with Blocking after Service.*

Toppur, Badri, Ph.D.in Industrial Engineering and Operations Research at the University of Massachusetts, Amherst Campus, February 2002. *Steiner Minimal Trees in Three Dimensional Euclidean Space.*

Lionel R. Orama

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E-mail: lorama@ece.uprm.edu
URL: http://www.ece.uprm.edu/~lorama/

Education: Ph.D. degree in Electric Power Engineering, RPI, October 1997.

Current Position: Associate Professor, General Engineering Department, University of Puerto Rico, Mayagüez.

Director: UPRM Title 5 Project

Coordinator: Numerical Methods And Computer Languages

Courses taught:
- Surge Phenomena
- Fundamentals of Transformers and Electric Machinery
- Statics/Dynamics for Electrical Engineers
- Dynamics
- Computer Programming Using C

Research projects:
- Parameter estimation of vacuum arc plasma
- Voltage grading in suspension insulators
- Lightning discharge characterization
- Harmonic currents storage

Research Interests: Electrical Discharges in Vacuum and Gases, High Voltage Circuit Breakers, Engineering Education, Power System Transients, Power Systems Protection, Computer Applications in Power Systems.

5 Most Relevant Publications:

1. B. Rodríguez, L. R. Orama, "SF6 Arc Model: Nonlinear Equations and Parameter Fitting", Electro technology International Symposium 2002, San Juan, November 2002.
2. L. R. Orama, “Breakdown Phenomena of a Vacuum Interrupter after Current Zero”, International Conference on Power System Transients (IPST 2001), Rio de Janeiro, June 2001.
3. L. R. Orama, “Numerical Modeling of Circuit Breaker Arcs and Their Interaction with the Power System, Doctoral Thesis, Rensselaer Polytechnic Institute, Troy, NY, October 1997.
4. L. R. Orama, B. Rodríguez, "Numerical Arc Model Parameter Extraction for SF6 Circuit Breakers Simulation", provisionally accepted to the International Conference on Power System Transients IPST 03, Hong Kong, June 2003.
5. L. R. Orama, “High Voltage Hybrid Circuit Breaker”, accepted pending revisions, IEEE Trans. on Power Delivery.

Related Presentations:

1. “Atmospheric Electrical Discharges”, Residencia Universitaria Almenares, Mayagüez, November 2002.
2. “High Efficiency Motors for Energy Conservation", Puerto Rico Industrials Association, Carolina, Puerto Rico September 2001.

3. “Introduction to Energy Management for Energy Inspectors”, Energy Affairs Administration, Department of Natural Resources, San Juan, September 2001.
4. “Breakdown Phenomena of a Vacuum Interrupter after Current Zero”, International Conference on Power System Transients, Brazil, July 2001.
5. L. R. Orama, “Vacuum Interrupters in Series”, Poster session, FoPER ’98, University of Puerto Rico Mayagüez Campus, Mayagüez, Puerto Rico, February 1998.
6. L. R. Orama, “A Model for the Interruption Process in Vacuum Switches”, Faculty Seminar, Department of General Engineering, University of Puerto Rico Mayagüez Campus, Mayagüez, Puerto Rico, October 1997.

Honors and Awards:

Sigma Xi, The Scientific Research Society, Apr. 2002.

Who's Who, Historical Society, 2001-2002.

GEM Fellowship Programs, Doctoral Fellow in Engineering, Aug. 1994 - 1997.

Rensselaer Honors Convocation, Rensselaer Polytechnic Institute, Troy, NY, Nov. 1994.

National Deans' List, Polytechnic University of Puerto Rico, 1991- 1993.

Reserve Officers Association Award, AFROTC national decoration, May 1987.

PhD Supervisor: Prof. Mietek T. Glinkowski, Associate Professor, RPI.

Donal O'Shea

PROFESSIONAL PREPARATION:

Harvard University, A.B. (Mathematics)	6/74
Queen's University, M.Sc. (Mathematics)	1/77
Queen's University, Ph.D. (Mathematics)	1/81

APPOINTMENTS:

1998-present Dean of Faculty and Vice President for Academic Affairs, Mount Holyoke College. Asst Prof (1980-83), Class of 1926 Asst Prof (1983-86), Asso Prof (1986-1991), Prof (1991-96), Elizabeth T. Kennan Prof (1996-present) of Mathematics all at Mount Holyoke College.
1997-98 and 1991-92: Visiting Professor, University of Hawaii -- Manoa.
1988-89 Visiting Professor, Universität Kaiserslautern, Germany.
1984-85 Visiting Assistant Professor, University of Mass. at Amherst.
1983-84 Member, Institut des Hautes Etudes Scientifiques, Bures-sur-Yvette, France.

PUBLICATIONS (Research):

H.D. Tagare, D. Groissser, D. O'Shea. Non-rigid Shape Comparison of Plane Curves in Images, *Journal of Mathematical Imaging and Vision*, **16**: Feb (2002) 57-68.

David Cox, John Little, Donal O'Shea, *Using Algebraic Geometry*, New York: Springer, 1998. Japanese Translation, Springer-Verlag Tokyo, 2000.

D. O'Shea, Computing Invariants of Hypersurface Singularities, in S. Sertöz (ed.), pp. 296-347 in *Algebraic Geometry*, Marcel-Dekker, 1997.

D. O'Shea, C. Teleman, Limits of tangent spaces and a criterion for μ-constancy, pp. 78-85 in D. Trotman, L. Wilson (eds.) *Stratifications and Topology of Singular Spaces*, Paris: Hermann, 1997.

D. O'Shea, L. Wilson, Normal and conormal cones of real surfaces*, Chinese Quarterly Jounal of Mathematics*, vol**. 10**, No. 4, (1995) 62-71.

PUBLICATIONS (Related):

J.W. Bruce, D. O'Shea, and MHC Math Department, *Laboratories in Mathematical Experimentation: A Bridge to Higher Mathematics*, New York: Springer Verlag, 1997; *Instructors' Guide*, 1997. Chinese Translation, Chinese Higher Education Press Beijing and Springer-Verlag Berlin Heidelberg, 1998.

D. O'Shea, H. Pollatsek, Are Prerequisites Necessary? *Notices of Amer. Math. Soc*., May 1997, 210-221.

D. Cox, J. Little, D. O'Shea, *Ideals, Varieties, and Algorithms: An Introduction to Computational Algebraic Geometry and Commutative Algebra*, New York: Springer, 1992. *Second Edition*, 1996. Russian Translation, Mir Moscow, 1998. Japanese Translation, Springer-Verlag Tokyo, 2000.

J. Callahan, D. Cox, K. Hoffman, D. O'Shea, H. Pollatsek, and L. Senechal, *Calculus in Context* New York: W.H. Freeman, 1995; *Instructors' Manual for Calculus in Context*, 1996.

H.Tagare, A. Rangarajan, D. O'Shea. A geometric criterion for shape-based non-rigid correspondence, *Proceedings International Conference on Computer Vision*, Boston, June, 95, 434-439.

SELECTED SYNERGISTIC ACTIVITIES:

1. Creation of a new second year mathematics course that would serve as a bridge between elementary and junior-senior level mathematics. This was supported by two grants on which I was PD: a NECUSE (Pew Charitable Trusts) grant in 1994 for $18,500 entitled *Mathematics Laboratories for Sophomores* and a two-year NSF grant DUE-9554646 entitled *Mount Holyoke's Laboratory in Computer Experimentation* for $99,990.

2. Integration new computer algorithms into undergraduate curriculum. This work, with David Cox and John Little was supported by a NECUSE (Pew Charitable Trusts) grant in 1988 for $35,000 entitled *Computational Algebraic Geometry* and supplements of $15,000 and $10,000 received in 1989-90 and 1990-91. It resulted in a very successful and influential text (the third related publication above). In 1996-98, I was the PD on NSF grant DUE-9555132 entitled *Computational Algebra and Geometry* for $45,004 aimed at producing materials for teachers. This gave rise to the book *Using Algebraic Geometry* listed above.

3. Founder and director of a three year (1990-94) Regional Geometry Institute aimed at bringing together researchers, college and high school teachers, undergraduate and graduate students. The project was supported by a three year NSF RGI grant DMS-9013220 for $1,469,607 entitled *Geometry in the Machine Age.*

4. Creation and dissemination of a new calculus curriculum. This was supported by a five year *Calculus in Context* grant DMS-8814004 for $714,000 and a three year NSF grant DUE-9245065 for $205,000 entitled *Disseminating Calculus in Context*. I served as a co-PI on both. These efforts gave rise to the text *Calculus in Context.*

5. Co-PI with H. Pollatsek, L.M. Hsu and Stan Rachootin on a four year NSF grant DUE 9850028 entitled *Institution-Wide Reform of Science Laboratories at Mount Holyoke* aimed at reviewing all laboratory courses throughout the sciences at Mount Holyoke with a view to using them as an opportunity to teach quantitative skills.

COLLABORATORS:

David Cox (Amherst)
John Little (Holy Cross)
Harriet Pollatsek (Mount Holyoke)
Hemant Tagare (Yale)
Les Wilson (U. Hawaii, Manoa)

Dr. Andrew L. Pazmany
Associate Professor, Electrical and Computer Engineering
University of Massachusetts, Amherst, MA 01003
Phone: 413-545-3495 Email: pazmany@mirsl.ecs.umass.edu

Professional Preparation:

University of Massachusetts, Amherst	Electrical and Computer Engineering, B. S., 1986
University of Massachusetts, Amherst	Electrical and Computer Engineering, M. S., 1988
University of Massachusetts, Amherst	Electrical and Computer Engineering, Ph. D., 1993

Appointments:

Research Associate Professor, University of Massachusetts – Amherst, August 1998 – present.

Research Fellow, University of Massachusetts - Amherst, April 1996 – August 1998.

Research Engineer, University of Massachusetts - Amherst, May 1993 – April 1996.

Publications:

(i) Related:

Bluestein, H. B., A. L. Pazmany, 2000: Observations of tornadoes and other convective phenomena with a mobile, 3-mm wavelength, Doppler radar: The spring 1999 experiment. Bull. Amer. Meteor. Soc. **81,** 12, 2939-2951.

Pazmany, A. L. J. C. Galloway, I. Popstefanija, J. B. Mead, R. E. McIntosh and H. B. Bluestein, 1999: Polarization diversity pulse pair technique for millimeter-wave Doppler radar measurements of severe storm features. *J. Atmos. Ocean. Tech.,* **16,** 1900-1911.

Bluestein, H. B., S. G. Gaddy, D. C. Dowell, A. L. Pazmany, J. C. Galloway, R. E. McIntosh, and H. Stein, 1997: Mobile, 3-mm wavelength, pulsed Doppler radar observations of sub-storm scale vortices in a supercell. *Mon. Wea. Rev*., **125**, 1046-1059.

Bluestein, H. B., A. L. Pazmany, J. C. Galloway, and R. E. McIntosh, 1995: Studies of the substructure of severe convective storms using a mobile 3-mm wavelength Doppler radar. *Bull. Amer. Meteor. Soc.*, **76**, 2155 - 2169.

Pazmany, A. L., R. E. McIntosh, 1994: The use of estimation techniques to reduce noncoherent polarimertic radar measurement errors. *IEEE Trans. On Antennas and Propagation,* **42**(39):1325-1328

(ii) Other Significant:

Pazmany, A. L. 2001: Millimeter-Wave Radar Field Measurements and Inversion of Cloud Parameters for the 1999 Mt. Washington Icing Sensors project. NASA Tech. Briefs, CR-2001-211103.

Galloway, J. C., A. L. Pazmany, J. B. Mead, R. E. McIntosh, D. Leon, J. French, S. Haimov, R. D. Kelly and G. Vali, 1999: Coincident in-situ and W-band radar measurements of drop size distribution in marine stratus cloud and drizzle. *J. Atmos. Ocean. Tech.,* **16,** 504-517.

Galloway, J. C., A. L. Pazmany, R. E. McIntosh, D. Leon, J. French, R. D. Kelly and G. Vali, 1997: Detection of ice hydrometeor alignment using an airborne W-band polarimetric radar. *J. Atmos. Ocean. Tech.,* **14,** 3-12

Pazmany, A. L., R. E. McIntosh, R. D. Kelly and G. Vali, 1994: An airborne 95 GHz dual polarization Radar for cloud studies. *IEEE Trans. Geosci. And Remote Sensing,* **32**, 731-739.

Pazmany, A. L., J. B. Mead, R. E. McIntosh, M. Hervig, R. D. Kelly and G. Vali, 1994: 95 GHz polarimetric radar measurements of orographic cap clouds from the Elk Mountain Wyoming. *J. Atmos. Ocean. Tech.,* **11**, 140-153

Synergistic Activity:

- Responsible for the conceptual design, testing and the application of microwave and millimeter wave remote sensing systems scientific experiments.
- Technical supervisor to atmospheric radar programs (sponsored by NSF, NASA/JPL and ARO) such as the "Mobile Doppler radar observations of severe storms and tornadoes" (joint field experiments with the University of Oklahoma School of Meteorology in spring '93, '94, '95, '98, '99, '00, '01 and '02), "Cloud and precipitation studies using an airborne millimeter wavelength cloud radar" (airborne experiments at WISP '94, SCMS '95, WICE '97 and TRAC '98), "S-band FMCW radar to study the atmospheric boundary layer" (field experiment at CASES '99), and the 95 GHz JPL Airborne Cloud Radar (airborne experiment during summer '96).
- Radar operator scientists during TREx II White Sands Missile Range Multi sensor experiment.
- Radar operator/scientist during the Coastal Stratus (with the Univ. of Wyoming) experiment in 1995.
- Theoretical work has included the application of Kalman filtering to estimate the attenuation field from airborne dual-beam W-band radar measurements, to reduce polarimetric measurement errors and the joint development of a technique to improve the estimate of covariance measurements degraded by scatterer motion and the application of Neural Networks to estimate quantitative cloud and precipitation properties from multi-frequency radar reflectivity data and an adaptive cross-beam wind velocity algorithm.

Collaborators & Other Affiliations:

Bluestein, Howard B., University of Oklahoma School of Meteorology
Desrochers, Paul, Airforce Research Laboratory
Haimov, Samual, University of Wyoming Atmospheric Science Department
Kelly, Robert, University of Wyoming Atmospheric Science Department
Manheimer, Wallace, Naval Research Laboratory
Reehorst, Andrew, NASA Glenn Research Center
Testud, Jacques, CEPT France
Vali, Gabor, University of Wyoming Atmospheric Science Department

Graduate and Postdoctoral Advisors

Robert E. McIntosh, University of Massachusetts Electrical and Computer Engineering (deceased)

Thesis Advisor and Postgraduate-Scholar Sponsor

Olga Rodriguez Lopez, MS Thesis Committee Chair, AT@T Bell Laboratories
Vidhya Thyagarajan, MS Thesis Committee Chair, GDATech
Joan Pons, MS Thesis Committee Member, CASA Spain
Turke Ince, PhD Thesis Committee Member

David M. Pozar
Professor of Electrical and Computer Engineering
University of Massachusetts, Amherst, MA 01003
Phone: 413-545-2127 Email: pozar@ecs.umass.edu

Professional Preparation

University of Akron	Electrical Engineering	B.S., 1975
University of Akron	Electrical Engineering	M.S., 1976
Ohio State University	Electrical Engineering	Ph.D., 1980

Appointments

Professor, University of Massachusetts - Amherst, 1980-present.

Visiting Professor, Ecole Polytechnique Federale de Lausanne, Lausanne, Switzerland, 1988

Research Assistant, ElectroScience Lab, Ohio State University, 1976-1980

Teaching Assistant, University of Akron, 1976

Engineering Assistant (Co-op), National Security Agency, 1974

Five Publications Related to Proposed Project:

1. D. M. Pozar, "Microstrip Antennas," IEEE Proceedings, Vol. 80, pp. 79-91, January 1992.
2. D. M. Pozar, "Analysis of an Infinite Array of Aperture Coupled Microstrip Patches," IEEE Trans. Antennas and Propagation, Vol. AP-37, pp. 418-425, April 1989.
3. D. M. Pozar, "Finite Phased Arrays of Rectangular Microstrip Antennas," IEEE Trans. Antennas and Propagation, Vol. AP-34, pp. 658-665, May 1986.
4. D. M. Pozar, "General Relations for a Phased Array of Printed Antennas Derived from Infinite Current Sheets," IEEE Trans. Antennas and Propagation, Vol. AP-33, pp. 498-504, May 1985.
5. D. M. Pozar, "A Microstrip Antenna Aperture Coupled to a Microstrip Line," Electronics Letters, Vol. 21, pp. 49-50, January 17, 1985.

Five Other Publications:

1. **Microwave and RF Design of Wireless Systems**, John Wiley & Sons, November 2000 (also translated into Korean).
2. **Microwave Engineering**, second edition, John Wiley & Sons, 1997 (also translated into Orthodox Chinese, Greek, and Korean).
3. "Microstrip Antennas", Chapter 36 in the **Electrical Engineering Handbook, 2nd edition**, R. C. Dorf, editor, CRC Press, 1997.
4. "Microstrip Arrays: Analysis, Design, and Applications", Chapter 3 in **Advances in Microstrip and Printed Antennas**, K.-F. Lee, editor, Wiley, 1997.
5. **Microstrip Antennas**, Edited by D. M. Pozar and D. H. Schaubert, IEEE Press, 1995.

Synergistic Activities:

- Antenna and RF circuit design for wireless systems
- Microstrip antennas and phased arrays
- Ultrawideband radiation and propagation

Collaborators and Other Affiliations:

Research Collaborations with D. Goeckel, D. H. Schaubert, R. W. Jackson

Doctoral Students:

1.	1984	Yoon-won Kang	PhD	
2.	1989	James Aberle		PhD
3.	1989	Jeffrey Herd		PhD
4.	1989	Frances Harackiewicz		PhD
5.	1989	Nirod Das		PhD
6.	1992	Naftali Herscovici		PhD
7.	1995	Pamela Haddad		PhD
8.	1995	Wen Tsay		PhD
9.	1993	Steven Targonski	PhD	
10.	1997	Yi-Wei Liu		PhD
11.	1999	Sean Duffy		PhD
12.	2001	Apostolos Georgiadis		PhD

Steven C. Reising
Assistant Professor of Electrical and Computer Engineering

Education

Washington University, St. Louis, Missouri	Electrical Engineering	B.S., 1989
Washington University, St. Louis, Missouri	Electrical Engineering	M.S., 1991
Stanford University, Stanford, California	Electrical Engineering	Ph.D., 1998

Experience

University of Massachusetts, Amherst, MA — September 1998 to present
Assistant Professor of Electrical and Computer Engineering
Faculty Member, Microwave Remote Sensing Laboratory

Naval Research Laboratory, Washington, DC — Summers of 1999 and 2000
Navy-ASEE Summer Faculty Fellow

NASA Goddard Space Flight Center, Greenbelt, MD — Summer 1994
NASA Graduate Student Summer Fellow

Conner Peripherals, San Jose, CA — Spring 1993 - Spring 1994
Electronic Design Consultant

Stanford University, Stanford, CA — Fall 1991 to Summer 1998
Research Assistant
Space, Telecommunications and Radioscience (STAR) Laboratory

5 Publications Relevant to this Proposal

[1] L. A. Rose, W. E. Asher, S. C. Reising, P. W. Gaiser, K. M. St. Germain, D. J. Dowgiallo, K. A. Horgan, G. Farquharson, and E. J. Knapp, "Radiometric measurements of the microwave emissivity of foam," in press, *IEEE Transactions on Geoscience and Remote Sensing*, April 2002.

[2] L. Li, S. M. Sekelsky, S. C. Reising, C. T. Swift, S. L. Durden, G. A. Sadowy, S. J. Dinardo, F. K. Li, A. Huffman, G. Stephens, D. M. Babb, and H. W. Rosenberger, "Retrieval of atmospheric attenuation using combined ground-based and airborne 95 GHz cloud radar measurements," *Journal of Atmospheric and Oceanic Technology*, vol. 18, pp. 1345-1356, August 2001.

[3] A. Camps and S. C. Reising, "Wind direction azimuthal signature in the Stokes emission vector from the ocean surface at microwave frequencies," *Microwave and Optical Technology Letters*, vol. 29, pp. 426-432, June 2001.

[4] P. A. Bernhardt, C. A. Selcher, S. Basu, G. Bust, and S. C. Reising, "Atmospheric studies with the Tri-Band Beacon instrument on the COSMIC constellation," *Terrestrial, Atmospheric and Oceanic Sciences*, vol. 11, pp. 291-312, March 2000.

[5] S. C. Reising, U. S. Inan, and T. F. Bell, "ELF Sferic Energy as a Proxy Indicator for Sprite Occurrence," *Geophysical Research Letters*, vol. 26, pp. 987-990, April 1999.

Synergistic Activities

Lilly Teaching Fellowship, one of eight fellows at UMass Amherst, 2001-02.

Commonwealth Information Technology (IT) Initiative Award from the Massachusetts Board of Higher Education for the development of a joint course on research and writing for the Internet with a Professor of English, 2000.

Collaborators

William E. Asher, *Applied Physics Laboratory, University of Washington, Seattle, WA*
David M. Babb, *Dept. of Meteorology, Pennsylvania State University, PA*
Adriano Camps, *Polytechnic University of Catalonia, Barcelona, Spain*
Chi-Te Chen, *University of Washington, Seattle*
Steven J. Dinardo, *Jet Propulsion Laboratory, CalTech, Pasadena, CA*
David J. Dowgiallo, *Interferometrics, Inc., Naval Research Laboratory, Washington, DC*
Stephen L. Durden, *Jet Propulsion Laboratory, CalTech, Pasadena, CA*
Peter W. Gaiser, *Naval Research Laboratory, Washington, DC*
Arlie Huffman, *Colorado State University, Ft. Collins, CO*
Fuk K. Li, *Jet Propulsion Laboratory, CalTech, Pasadena, CA*
L Allen Rose, *Naval Research Laboratory, Washington, DC*
Hans W. Rosenberger, *Dept. of Meteorology, Pennsylvania State University, PA*
Gregory A. Sadowy, *Jet Propulsion Laboratory, CalTech, Pasadena, CA*
Karen M. St. Germain, *Naval Research Laboratory, Washington, DC*
Leung Tsang, *University of Washington, Seattle, and City University of Hong Kong*
Graeme Stephens, *Colorado State University, Ft. Collins, CO*

Graduate Advisors

Umran S. Inan, Professor, *Stanford University, Stanford, CA*
Timothy F. Bell, Senior Research Associate, *Stanford University, Stanford, CA*

Graduate Students Advised

Lihua Li, Ph.D, 2000 (co-advised with Research Professor S. Sekelsky).
Goddard Earth Sci. & Tech. Center, NASA Goddard Space Flight Center, Greenbelt, MD
Joan Pons, M.S., Sept. '02.
EADS CASA, Madrid, Spain
Kevin Horgan, M.S. expected Dec. '02
Mohammed Aziz, M.S. expected May '03
Sharmila Padmanabhan, M.S. expected Sept. '03
Flavio Iturbide-Sanchez, Ph.D. expected Sept. '04

Total graduate students advised at the University of Massachusetts at Amherst: 6

HAVIDAN RODRIGUEZ
Center for Applied Social Research (CISA)
Department of Social Sciences
University of Puerto Rico-Mayagüez, Mayagüez, P.R. 00681-9266
Tel: (787) 265-3839, ext. 2071, 2108, 2109
E-Mail: ha_rodriguez@rumac.uprm.edu

Professional Preparation

University of Maryland	Psychology	B.S., Cum Laude, 1981-1983.
University of Wisconsin-Milwaukee	Sociology	M.A., 1984-1986.
University of Wisconsin-Madison	Sociology	Ph.D., 1986-1991.

Appointments

Professor and Researcher, Center for Applied Social Research, Department of Social Sciences, Current

Frey Foundation Distinguished Visiting Professor, University of North Carolina-Chapel Hill, Spring 2002.

Visiting Scholar,University of Michigan-Ann Arbor. Population Fellows Program, MSI/HSI and PEAK Initiatives, School of Public Health, Summers of 2001, 2002, and 2003-forthcoming.

Interim Dean for Academic Affairs, University of Puerto Rico-Mayagüez, 1999.

Associate Dean for Academic Affairs and Research, Faculty of Arts and Sciences, University of Puerto Rico-Mayagüez, 1998-1999.

Director, Center for Applied Social Research (CISA), University of Puerto Rico-Mayagüez, 1997-1999.

Director, Minority Affairs Program, American Sociological Association, Washington, D.C., 1995-1998.

SELECTED PUBLICATIONS

Levine, F.J., Rodríguez, H., Howery, C.B., and Latoni, A. ***Promoting Diversity and Excellence in Higher Education Through Department Change***. (2002). Washington, DC: American Sociological Association.

Rodríguez, H. (2002). "¿Por qué los Desastres No Son "Naturales"?: Riesgo, Vulnerabilidad y Desastres en el Contexto Puertorriqueño" (Why are disasters not "natural:" Risk, Vulnerability, and Disasters in the Puerto Rican Context". In Sonia Ruíz (ed.). ***Themes in the Social Sciences***, Publications Office, College of Arts and Sciences, University of Puerto Rico-Mayagüez.

Gutierrez, J. and Rodríguez, H. (2002). "La Investigación Social Aplicada y los Desastres Naturales" ("Applied Social Research and Disasters"). In Sonia Ruíz (ed.). ***Themes in the Social Sciences***, Publications Office, College of Arts and Sciences, University of Puerto Rico-Mayagüez.

"A Socioeconomic Analysis of Hurricanes in Puerto Rico: An Overview on Disaster Mitigation and Preparedness." (1997). In Diaz, H. F. and Pulwarty, R.S., (eds.). ***Hurricanes: Climate and Socioeconomic Impacts***. Berlin, Heidelberg, New York: Springer, 121-143.

"Disaster Vulnerability and Emergency Management in Puerto Rico." (1996). In Amin, S.G. and Fullerton, S. (eds.). ***International Business Practices: Contemporary Readings***, 1996 Edition. Maryland, USA: A Publication of the Academy of Business Administration, 530-536.

SYNERGISTIC ACTIVITIES

Member, University of Puerto Rico Sea Grant Program Reconnaissance Research Team in Honduras. The objective of this research team was to assess the education and technical support needs of coastal communities in Honduras impacted by Hurricane Mitch in 1998. Funded by the United States Department of Commerce National Oceanic and Atmospheric Administration.

Disaster preparedness, mitigation, and educational training workshops for emergency management personnel in the regional districts of Arecibo, Mayagüez, Ponce, Carolina, Humacao, Guayama, and San Juan (2001-2002).

Member, Islands Task Force of the Federal Emergency Management Agency and the U.S. Army Corps of Engineers. A final report was submitted to the Interagency Coordinating Committee on Hurricanes in Washington, DC: titled "Islands Task Force Report: A Briefing on Hurricane Evacuation Study Needs in the United States Island Communities" (2002).

Rafael A. Rodríguez Solís

Department of Electrical and Computer Engineering
University of Puerto Rico
Mayagüez, PR 00681-9042
Office: (787) 832-4040, ext. 2106, Fax: (787) 831-7564
e-mail: rafaelr@ece.uprm.edu

Education

B.S., Electrical Engineering *06/90*
University of Puerto Rico, Mayagüez.
Magna Cum Laude. Specialization in Communications and Electronics.

B.S., Computer Engineering *06/90*
University of Puerto Rico, Mayagüez.
Magna Cum Laude. Specialization in Hardware Systems.

M.S., Electrical Engineering *12/93*
University of Florida, Gainesville.
Thesis: "Improved Modeling of R.F. and Microwave BJTs and Circuit Simulation." Evaluated and improved new physics-based model for microwave bipolar transistor. Compared results with existing empirical model and measured data to demonstrate agreement. Simulated several circuits using model developed.

Ph.D., Electrical Engineering *12/97*
The Pennsylvania State University, University Park.
Dissertation: "Analysis and Design of a Microwave 3-D Frequency Independent Phased Array Using Folded Slots." Designed, analyzed, built and tested antenna array prototypes from 2 to 12 GHz.

Experience

Associate Professor *01/98 to present*
University of Puerto Rico, Mayagüez.
Research interests: Broadband microwave antennas and circuits, microwave/millimeter-wave antennas, numerical method in electromagnetics.

- Director of UPRM Radiation Laboratory
- UPRM CenSSIS Education Thrust Leader

Visiting Scientist *06/99 to 08/99*
BBN Technologies, Cambridge, MA.
Consulted on antennas and R.F systems for wireless networks.

Independent Consultant *08/97 to 12/97*
REMCOM, Inc., University Park, PA.
Modeled, designed and fabricated microwave circuit and antennas. Validated and tested electromagnetic simulators.

Instructor *06/97 to 08/97*
The Pennsylvania State University, University Park.
Taught Engineering Electromagnetics course to Electrical Engineering juniors.

Engineering Technical Associate *08/96 to 08/97*
BBN Systems and Technologies, Cambridge, MA.
Evaluated and recommended wireless LAN adapters and developed Linux device drivers.

Summer Intern *05/96 to 08/96*
BBN Corporation, Cambridge, MA.
Integrated wireless IP-secure LAN using custom off the shelf components. Demonstrated integrated system to customers and upper management. Developed service offerings using the integrated system.

Summer Staff *06/95 to 08/95*
MIT Lincoln Laboratory, Lexington, MA.
Developed computer model of complex phased array antenna system to investigate effects of random failures and excitation errors in the radiation pattern.

Engineer I *05/90 to 08/91*
Telefónica Larga Distancia, San Juan, Puerto Rico.
Specified required test equipment for sites, developed synchronization plan for network and prepared bid specifications to purchase test equipment and network synchronization system.

Rafael A. Rodríguez Solís

Publications

- J. G. Colom, R. A. Rodríguez-Solís, J. Almodóvar, M. Castañeda, "Design and Simulation of a Tunable Multilayer Lange Coupler," Integrated Ferroelectrics, vol. 42, pp 313-321.
- J.K. Breakall and R.A. Rodríguez Solís, "A new design method for low sidelobe level log-periodic dipole antennas," Applied Computational Electromagnetics Society Journal, Nov. 1996, pp. 9-15.
- J. Colom-Ustariz, R. Rodríguez-Solís, S. Vélez, S. Rodríguez-Acosta, "Frequency Agile Microwave Components using Ferroelectric Materials," SPIE 9th International Conference on Remote Sensing, Crete, Greece, September 2002, [4881-40]
- J. Colom-Ustariz, R. Rodríguez-Solís, S. Vélez, S. Rodríguez-Acosta, "Frequency Agile Microwave Components using Ferroelectric Materials," SPIE
- N.D. López-Rivera and R.A. Rodríguez Solís, "Impedance Matching Technique for Microwave Folded-Slot Antennas," 2002 IEEE Antennas and Propagation International Symposium, San Antonio, TX, June 2002, vol. III, pp. 450-453.
- R.A. Rodríguez Solís, Ana M. Medina, Néstor López, Norma Y. Soto, "Microstrip Patch Antenna Encircled by a Trench," IEEE Antennas and Propagation International Symposium, Salt Lake City, UT, July 2000, pp. 1620-1623.
- J.G. Colom Ustáriz, R.A. Rodríguez Solís, R.J. Luebbers, "Undergraduate Research using the Finite Difference Time Domain Method for Electromagnetics," 2001 ASEE Annual Conference and Exposition Proceedings, June 2001, Albuquerque, NM.
- J.G. Colom Ustáriz, R.R. Barton, L.A. Carpenter, R.A. Rodríguez Solís, "A Novel Graphical Technique for Selection of a Robust Design Point," 2001 ASEE Annual Conference and Exposition Proceedings, June 2001, Albuquerque, NM.

Synergistic Activities

- *Wideband Slot-like Antennas and Enhancement of Applied Electromagnetics Education at UPRM.* NSF CAREER Award ECS-0093650
- *Electroceramic Antennas and Devices*. NASA Tropical Center for Earth and Space Studies
- UPRM CenSSIS Education Thrust Leader
- Faculty advisor to student branch of IEEE Communications Society
- Developed laboratory exercises and demonstrations in electromagnetics fields and waves for electrical engineering juniors taking Engineering Electromagnetics II and for the Pre-College Engineering Program participants.
- Developed graduate course on microwave antenna engineering and revised Antenna Engineering and Microwave Engineering courses at UPRM.
- Advised 22 undergraduate students on 10 different undergraduate research projects.
- ABET Team member for the EE program and coordinator for the ECE Applied Electromagnetics Commitee.

Collaborators

Dr. Sandra Cruz-Pol, Department of Electrical and Computer Engineering, UPRM
Dr. José G. Colom-Ustáriz, Department of Electrical and Computer Engineering, UPRM
Dr. Zoya Popovic, Department of Electrical Engineering, University of Colorado at Boulder
Dr. James Breakall (Ph. D. Advisor), Department of Electrical Engineering, Penn State University
Dr. William Eisenstadt (M.S. Advisor), Department of Electrical Engineering, University of Florida

Graduate Students

- Snaider Rodríguez-Acosta, M.S. - University of Puerto Rico at Aguadilla
- Advisor to 4 graduate students: Jorge Salazar-Cerreño, Ileana Carrasquillo-Rivera, Néstor D. López-Rivera, Amada Castro-Vilaró, all currently at UPRM.

Kathleen G. Rubin
Assistant Dean for College Outreach
131 Marston Hall
rubin@ecs.umass.edu
413-545-4757 (office)

Kathleen Rubin, Assistant Dean for Outreach in the College of Engineering at UMass Amherst has had over ten years' experience working with industry, educators, and higher education to develop programs that increase the pipeline of future engineers and scientists. Dean Rubin is currently Program Director and a Co-PI in the NSF CSEM Scholarship Program, awarded $ 895,000 to date, serving economically disadvantaged undergraduates in computer science, engineering and math. Dean Rubin has led a number of other programs and collaborations for the professional development of K-12 teachers. These include a five-year partnership with Raytheon; a partnership with the NSF Science, Technology, Engineering and Mathematics (STEM) Institute at UMass that developed "Science and Engineering Saturday Seminars"; and development of a three-credit graduate course for teachers, "Engineering for Classroom Teachers" offered in 2002. Kathleen Rubin also developed and manages a dual-degree program with Mt. Holyoke College that brings female students into the engineering pipeline.

Education:

M. Ed., 1988, Instructional Technology, University of Massachusetts Amherst
B. S., 1974, Education, Iowa State University, Ames, Iowa

Professional Experience: College of Engineering, University of Massachusetts Amherst

- Assistant Dean for College Outreach (1997 to present)
- Director, Marketing and Recruitment (1990 to 1997)
- Director, Engineering Computer Services (1987-1990)

Honors and Awards:

- Distinguished University Outreach Citation, 2001 and 2002
- Chancellor's Citation, May 2000
- Dean's Service to the College Award, 1990

Professional Activities:

- National Science Teacher Association (NSTA) national conference session presenter, 2002
- WEPAN Conference (Women in Engineering Programs Advocates Network), December 2000, Seattle, WA and Puerto Rico, June 2002.
- American Society for Engineering education (ASEE) Regional Conference (Host Institution, Co-Chair), Amherst, MA 1998

Teaching and Research:

- Co-Pi and Program Director on CSEMS NSF grants, totaling $895,000, awarded to develop a scholarship program serving economically disadvantaged students (2000-2004, 2002-2006); (PI – Professor Donald St. Mary, Mathematics Department, UMass Amherst)
- Teach a one-credit course for the UMass Amherst Commonwealth Honors College (spring 2002, fall 2002).

Outreach:

- Currently direct the Raytheon/K-12/Engineering Collaboration for the Amherst campus. This Collaboration is an outreach partnership between all UMass campuses, K-12 and Raytheon Corporation to increase the number of students in Massachusetts, particularly women and minorities, to pursue careers in engineering.
- Partner with Amherst campus, NSF funded STEM Institute (Science, Technology, Engineering and Mathematics) in developing "Science and Engineering Saturdays" professional development programs for middle school teachers. Offered every semester since 2000.
- Coordinator of a three credit graduate course called "Engineering for Classroom Teachers" offered August 2002.
- Implemented the 3-2 dual-degree program with Mt. Holyoke College to bring female students into the engineering pipeline.
- Hosted the Mass Technology Engineering/Education Collaboration (MassTEC) annual conference for 140 technology education teachers, November 2002.

Steven A. Rutledge, Ph.D.
Professor and Head, Department of Atmospheric Science
Colorado State University, Ft. Collins, CO 80523
Scientific Director, CSU-CHILL National Radar Facility
(970) 491-8283

Professional Preparation

B.S. (1978) -	Physics, University of Missouri - St. Louis, St. Louis, Missouri
Ph.D. (1983) -	Atmospheric Science, University of Washington, Seattle, Washington

Appointments

1999 -	Professor and Head, Department of Atmospheric Science, Colorado State University
1994 -	Professor of Atmospheric Science, Colorado State University
1990-1994	Associate Professor, Colorado State University
1988-1990	Assistant Professor, Colorado State University
1983-1988	Assistant Professor, Oregon State University
1978-1983	Graduate Research Assistant, University of Washington

Dr. Rutledge's interests are in mesoscale meteorology, atmospheric electricity, radar meteorology and cloud physics. He is a member of the TRMM Science Team. He was a Co-chair for the MCTEX Experiment and the STERAO-A Deep Convection Experiment. He was the Lead Scientist for the TRMM-LBA Field Campaign in Brazil. He also serves as the Scientific Director of the CSU-CHILL National Radar Facility.
He is a member of the NSF Facilities Advisory Council. He is an Associate Editor for JGR-Atmospheres.

Five relevant publications

Brunkow, D., V. N. Bringi, P. C. Kennedy, S. A. Rutledge, V. Chandrasekar, E. A. Mueller, and R. K. Bowie, 2000: A Description of the CSU-CHILL Radar Facility. *Journal of Atmospheric and Oceanic Technology*, **17**, 1596-1608.

Carey, L. D., S. A. Rutledge, and D. A. Ahijevych, 2000: Correcting Propagation Effects in C-band Polarimetric Radar Observations of Tropical Convection Using Differential Propagation Phase. *Journal of Applied Meteorology*, **39**, 1405-1433.

Kennedy, P. C., S. A. Rutledge, W. A. Petersen, and V. N. Bringi, 2001: Polarimetric Observations of Hail Formation, *Journal of Applied Meteorology*, **40**, 1347-1366.

Lang, T. J., and S. A. Rutledge, 2002: .Relationships Between Convective Storm Kinematics, Microphysics, and Lightning. 2002, *Monthly Weather Review*, **130**, 2492-2506.

Petersen, W. A., S. W. Nesbitt, R. J. Blakeslee, R. Cifelli, P. Hein, and S. A. Rutledge, 2002: TRMM Observations of Intraseasonal Variability in Convective Regimes Over the Amazon, *Journal of Climate*, **15**, 1278-1294.

Synergistic Activities

As Director of CSU-CHILL Radar Facility, promote science-related outreach activities with the broader community (K-12 students, volunteer weather observers, other science and engineering academic programs outside of CSU)

Obtained fellowship support for several minority students in the Department of Atmospheric Science Served as mentor to students during the STEPS 2000 field campaign

Introduced realtime data from CHILL radar into classroom

Co-teaching AT741 (Radar Meteorology) with Prof. V. N. Bringi of CSU's Dept. of Electrical and Computer Engineering.

Graduate students advised

Theses or dissertations completed since 1991:

Scott Randell, M.S., 1991
Kevin Manning, M.S., 1992
Erik Rasmussen, Ph.D., 1992
Nicolas Powell, M.S., 1992
Walter Petersen, M.S., 1992
Lawrence Carey, M.S., 1994
James Scott, M.S., 1994
Robert Cifelli, Ph.D., 1995
Charlotte DeMott, Ph.D., 1996
Tom Rickenback, Ph.D., 1996
Jonathon Erdman, M.S., 1996
Tom Saxen, M.S., 1997
Terry Schuur, Ph.D., 1997
Walter Petersen, Ph.D., 1997
Timothy Lang, M.S., 1997
Bard Zajac, M.S., 1998
Christy Butler, M.S., 1998
Rita Roberts, M.S., 1998
David Ahijevych, M.S., 1998
Lawrence Carey, Ph.D., 1998
Jesse Ryan, M.S., 1999
Michael Gauthier, M.S., 1999
Lawrence Belcher, M.S., 2000
Timothy Lang, Ph.D., 2000
Steven C. Cabosky, M.S., 2001
Andrea G. Williams, M.S., 2002

Ph.D. Advisor

Prof. Peter V. Hobbs, University of Washington

Collaborators in last 48 months

Rit Carbone, NCAR
James Dye, NCAR
Paul Krehbiel, New Mexico Institute of Mining and Technology
Donald MacGorman, NSSL
David Rust, NSSL
Steven Sekelsky, UMASS
Earle Williams, MIT
Edward Zipser, University of Utah

Stephen M. Sekelsky
170 E. Hadley Road #104, Amherst, MA 01002,
tel:413/253-4948, email:sekelsky@mirsl.ecs.umass.edu

EDUCATION

Rensselaer Polytechnic Institute, Troy, NY	Electrical Engineering	B.S., May 1989
University of Massachusetts, Amherst, MA	Electrical Engineering	Ph.D., May 1995

RESEARCH EXPERIENCE

Research Assistant Professor, **University of Massachusetts, Microwave Remote Sensing Lab (MIRSL), Amherst, MA**. July 1998 - present

Research focuses on development of medium and high altitude airborne and multi-wavelength ground-based radar systems. Research interests include atmospheric remote sensing, digital signal processing, embedded computing and autonomous sensor operation. Currently assisting with preparation of a multi-disciplinary proposal for an NSF Engineering Research Center (ERC) for Extreme Weather Events. This ERC will promote development of new remote sensors and take advantage of recent advances in networking technologies and reconfigurable logic for acquiring, processing and disseminating remote sensing data.

Adjucnt Professor, **Univ. of Puerto Rico, Electrical Engineering Dept., Mayaguez, PR**. October 2001 - present

Initiated collaborations in remote sensing research and education with UPRM faculty. Presented short courses on radar meteorology hosted undergraduate and graduate engineering students from UPRM for summer research. I am currently serving on thesis committees for four UPRM M.S. students.

*Research Fellow***, University of Massachusetts, MIRSL, Amherst, MA.** May 1997 - July 1998

Published first multi-wavelength radar measurements at 915 MHz, 2.8 GHz, 33 GHz and 95 GHz and analysis relating non-Rayleigh scattering to cloud and precipitation particle size. This research required developing realistic finite element electromagnetic models of ice crystals. Managed NASA-sponsored airborne cloud radar program. Lead scientist for NASA-sponsored field campaign directing and coordinating the operation of the NASA DC-8 airborne laboratory and ground-based radars.

Research Engineer, **University of Massachusetts, MIRSL, Amherst, MA**. May 1995 - May 1997

Managed various field research programs and mentored graduate students.

Research Assistant/Ph.D. Candidate, **University of Massachusetts, MIRSL, Amherst, MA**. Sept. 1989 - May 1995

Ph.D. dissertation describes development of a dual-frequency (33 GHz/95 GHz) single aperture polarimetric cloud radar. As a graduate student I managed a large team of junior graduate students, undergraduates and visiting scholars over a three year period in designing CPRS and fabricating various electronic and mechanical sub-systems. I was also responsible for managing a $750 hardware budget.

Designed first airborne W-band polarimetric cloud radar with funding from NSF. This same design was later used to produce a radar that currently serves as a NSF facility instrument on the University of Wyoming King Air aircraft.

INDUSTRIAL EXPERIENCE

Senior Research Engineer, **Quadrant Engineering, Inc., N. Amherst, MA** May 1996 - Dec 1999

Developed first commercial FM-chirp pulse compression 35 GHz cloud physics research radar for the USAF Phillips Laboratory. Responsible for overall technical financial management of $900K project budget.

Consultant, **Quadrant Engineering, Inc., N. Amherst, MA** December 1992 - March 1996

Developed first commercial ground-based polarimetric 95 GHz cloud physics research radar for the University of Utah. This radar has become a key product for Quadrant engineering, which continues to sell radars based on its design.

FUNDED RESEARCH

PI of more than $2 M of cumulative research funding. Managed research and commercial development totaling more than $5.1 M.

Current research projects include:

- Development of an Advanced Multi-Frequency Radar (AMFR) for Atmospheric Research, PI, National Science Foundation ($ 1.4 M)
- Airborne Cloud Radar Studies: CloudSat Calibration and Cloud/Precipitation Retrieval Algorithm Development, NASA ($69 K)
- A High Altitude Compact Millimeter-wave Radar for Cloud Studies, PI, Sandia National Laboratory ($270K)
- Multi-wavelength Radar Algorithms for Estimating Cloud Microphysics, PI, U.S. Dept. of Energy- awarded ($ 294 K)

GRADUATE STUDENTS

Lihua Li, Ph.D. 2000, *Retrieval of Atmospheric Attenuation Using Ground-based and Airborne Millimeter-wave Cloud Radar Measurements*

Marc Bergada, M.S., 2001 *Ka-band Radar Low Noise Receiver and Calibration Loop Design and Implementation*

Ninoslav Majurec, Ph.D., anticipated 2003 Advanced Multi-frequency Atmospheric Radar Design

Jorge Roman-Nieves, M.S., anticipated 2003, *Operational 95 GHz Cloud Radar for Unmanned Aircraft*,. Awarded 3 year NASA Earth Science Enterprise Fellowship.

RELEVANT PUBLICATIONS

Sekelsky, S.M. and E.E. Clothiaux, "Parallax Errors and Corrections for Dual-Antenna Millimeter-wave Cloud Radars" Journal of Atmospheric and Oceanic Technology, Vol. 19, No. 4, pp. 478-485, 2002.

Sekelsky, S.M., "Near-Field Reflectivity and Antenna Boresight Gain Corrections for Millimeter-wave Atmospheric Radars", Journal of Atmospheric and Oceanic Technology, Vol. 19, No.4,pp. 468-477, 2002.

Sekelsky, S.M., W.L. Ecklund, J.M. Firda, K.S. Gage, and R. E. McIntosh, "Particle size estimation in ice-phase clouds using radar reflectivity measurements collected at 95 GHz, 33 GHz and 2.8 GHz", Journal of Applied Meteorology, 38(8), pp. 5-28, 1999.

Firda, J.M., S.M. Sekelsky, and R.E. McIntosh, "Application of Dual-Frequency Millimeter-waveDoppler Spectra for the Retrieval of Drop Size Distributions and Vertical Air Motions in Rain", Journal of Atmospheric and Oceanic Technology, 16(2), pp. 216-236, 1999.

Sekelsky, S.M., and R.E. McIntosh "Cloud Observations with a Polarimetric 33 GHz and 95 GHz Radar", Meteorology and Atmospheric Physics, vol. 58 pp. 123-140, Jan. 1996.

Other significant publications

Austin, R.T., G.L. Stephens, S.D. Miller, S.M. Sekelsky, F Li, W Min. 2002. "Retrieval of Stratus Cloud Microphysical Parameters Using Millimetric Radar and Visible Optical Depth in Preparation for CloudSat. Part II. Algorithm Evaluation." J. Geophys. Res. In press.

Jensen, M.P., T.P. Ackerman, S.M. Sekelsky, "Radiative Impacts of Anvil Outflow During the Maritime Continent Thunderstorm Experiment", Journal of Applied Meteorology, 41: 473-487, 2002.

Lihua, L., S.M. Sekelsky, S.C. Reising, C.T. Swift, S.L. Durden, G.A Sadowy, S.J. Dinardo, F.K. LiA. Huffman, G.L. Stephens D.M. Babb, and H.W. Rosenberger "Retrieval of Atmospheric Attenuation Using Combined

Ground-based and Airborne 95 GHz Cloud Radar Measurements", Journal of Atmospheric and Oceanic Technology, , 18, pp. 1345-1353, 2001.

Stephens, G.L., R.G. Ellingston, J. Vitko, W. Bolton, T. Tooman, P.J. Valero, P. Minnis, P.Pilewskie, G.S. Phipps, S.M. Sekelsky, J.R. Carswell, S.D. Miller, A. Benedetti, Re. McCoy, and R. McCoy, "The Department of

Energy Atmospheric Radiation (ARM) Unmanned Aerospace Vehicle(UAV) Program", Bulletin of the American Meteorological Society, 81(12), pp. 2915-2938, 2000.

Keenan, T., S. Rutledge, R. Carbone, J. Wilson, T. Takahashi, P. May, N. Tapper, M. Platt, J.Hacker, S. Sekelsky, M. Moncrieff, K. Saito, G. Holland, A. Crook, K. Gage, "The Maritime Continent Thunderstorm Experiment (MCTEX): Overview and Some Results", Bulletin of the American Meteorological Society, 81(10),pp. 2433-2455, 2000.

Paula L. Sturdevant Rees

Assistant Professor, Department of Civil and Environmental Engineering
18 Marston Hall, University of Massachusetts, Amherst, Massachusetts 01003.
Email: rees@ecs.umass.edu, Phone: (413) 577-2337, Fax: (413) 545-2202.

(i) Professional Preparation

University of Iowa	Civil Engineering	B.S., 1992
Princeton University	Civil Engineering	M.A., 1994
Princeton University	Civil Engineering	Ph.D., 1997
Princeton University	Woodrow Wilson School	STPP* certificate, 1998
Princeton University	Extreme Flood Hydrology	Postdoctoral, 1997 – 1999

* Science Technology and Public Policy

(ii) Appointments

Assistant Professor, Department of Civil and Environmental Engineering, University of Massachusetts at Amherst (1999 - present).

Postdoctoral Associate, Department of Civil Engineering and Operations Research, Princeton University (1997 – 1999).

(iii) Publications

Smith, J. A., Baeck, M. L., Morrison, J. E., Sturdevant-Rees, P., Turner-Gillespie, D. F., and P. Bates, 2002. The regional hydrology of extreme floods in an urbanizing drainage basin. *Journal of Hydrometeorology*, 3, 267 – 282.

Sturdevant Rees, P., Smith, J.A., Morrison, J., and M.L. Baeck, 2001. Tropical storms and the flood hydrology of the central Appalachians. *Water Resources Research,* 37(8), 2143 – 2168.

Smith, J. A., Baeck, M. L., Morrison, J. E., and P. L. Sturdevant Rees, 2000. Catastrophic rainfall and flooding in Texas. *Journal of Hydrometeorology*, 1 (February), 5-25.

Holman-Dodds, J.K., Bradley, A.A., and P.L. Sturdevant Rees. 1999. Effect of temporal sampling of precipitation on hydrologic model calibration. *Journal of Geophysical Research*, 104(D16), 19645-19654.

Georgakakos, K. P., Carsteanu, A. A., Sturdevant, P. L., and J. A. Cramer, 1994, Observation and analysis of Midwestern rainrates, *Journal of Applied Meteorology*, Vol. 33, No. 12, 1433-1444.

(iv) Synergistic Activities

Contribution to the Science of Learning:

"Expanding a General Framework for Inquiry Learning", by Beverly Woolf, Paula Rees, John Reid, and Daniel Murray. Funded U.S. Department of Education grant through the Fund for the Improvement of Postsecondary Education (FIPSE). Development of hydrology/hydrometeorology and water quality modules to promote inquiry-based behavior and active student learning.

Service to the Outside Scientific and Engineering Community:

- Member of the Integrated Water Resources Management Task Committee, sponsored by the Environmental and Water Resources Institute of the American Society of Civil Engineers
- Contributor to the Consortium of Universities for the Advancement of Hydrologic Science, Inc. (CUAHSI)

- University of Massachusetts delegate to the Universities' Council on Water Resources (UCOWR)
- Member of American Geophysical Union, Hydrology Section, Policy Sciences Technical Committee
- NIWR-USGS National Competitive Grants Program proposal ad-hoc reviewer, 2000 & 2001.
- NASA NRA-01-OES-05, Solid Earth and Natural Hazards Research and Applications Program (SENH), proposal ad-hoc reviewer, 2002.
- UCOWR Ph.D. dissertation awards referee, 2002.

(v) Collaborators & Other Affiliations

(a) Collaborators and Co-Editors:

David Ahlfeld, U. of Massachusetts
Mary Lynn Baeck, Princeton U.
Paul Barten, U. of Massachusetts
Paul D. Bates, U. of Bristol
Allen Bradley, U. of Iowa
Jennifer K. Holmann-Dodds, U. of Iowa
Sharon Long, U. of Massachusetts
Julia Morrison, McKinsey and Company
Daniel Murry, U. of Rhode Island
David Reckhow, U. of Massachusetts
John Reid, Hampshire College
James A. Smith, Princeton U.
John Tobiason, U. of Massachusetts
Beverly Woolf, U. of Massachusetts

(b) Graduate and Postdoctoral Advisors:

James A. Smith (currently Princeton University)
Andy J. Miller (currently University of Maryland Baltimore County)

(c) Thesis Advisor and Postgraduate-Scholar Sponsor:

Kavitha Ambikadevi – current M.S. student
Gokhan Askar – M.S. CEE September 2000; current affiliation unknown
Daniel Bourdeau – current M.S. student
Frances Cameron – M.S. EVE September 2002, UMass; currently with Tighe and Bond
Joshua Cobb – M.S. EVE Spetember 2002, UMass; currently with Woodard & Curran
Jeff DiStasi – M.S. CEE May 2001, UMass; current affiliation unknown.
Jennifer Mackey – M.S. EVE February 2002 UMass; current affiliation unknown.
Michell Miteo – M.A. Natural Resources Sep. 2002, UMass; current affiliation unknown.
Rebecca Baker – current Ph.D. student
David Senus – M.S. EVE September 2001, UMass, currently with Woodard & Curran
Total of 10 graduate students advised to date.

Russell Tessier attended Rensselaer Polytechnic Institute in Troy, N.Y. from 1985-1989 and received a BS in computer systems engineering in 1989. From 1989-1998, he was a graduate student at the MIT Laboratory for Computer Science, where he received his MSEE in 1992 and Ph.D. in 1998. In 1994, he was one of three founders of Virtual Machine Works, Inc., a logic emulation company. VMW was acquired by Ikos Systems in May 1996. In January 1999, he assumed his current position in the Electrical and Computer Engineering department at the University of Massachusetts. Dr. Tessier is currently the head of the UMass Reconfigurable Computing Group. His research interests are in reconfigurable computing, particularly in the area of novel application development.

Dr. Tessier was the Publicity Chair for FPGA'2001 and FPGA'2002. Currently, he is the Technical Program Chair for FPGA'2003. Dr. Tessier has served as co-editor of a special issue of the Journal of VLSI Signal Processing. He received the IEEE Outstanding Faculty Award for Computer Engineering at the University of Massachusetts, Amherst in 2001.

a. Professional Preparation

Ph.D., Electrical Engineering and Computer Science, MIT, February 1999.

M.S., Electrical Engineering and Computer Science: MIT, June 1992.

B.S., Computer Systems Engineering, Rensselaer Polytechnic Institute, May 1989.

b. Appointments

Assistant Professor, Department of Electrical and Computer Engineering, University of Massachusetts - Amherst, 1999-present.

Consultant: Ikos Systems, Inc. (1996-present), Altera Corporation (2001-present), BBN (1992-1994), Data General (1989).

Founder and Principal Engineer: Virtual Machine Works (1994-1996).

c. Publications

Related to this Proposal

[1] M. Kudlugi and R. Tessier, "Static Scheduling of Multiple Asynchronous Domains for Fast Functional Verification", *IEEE Transactions on Computer-Aided Design of Integrated Circuits and Systems*, vol 21, no. 11, November 2002

[2] I. G. Harris and R. Tessier, "Testing and Diagnosis of Interconnect Faults in Cluster-Based FPGA Architectures", *IEEE Transactions on Computer-Aided Design of Integrated Circuits and Systems*, vol 21, no. 11, November 2002

[3] N. Vemuri, P. Kalla, and R. Tessier "BDD-based Logic Synthesis for FPGAs", in *ACM Transactions on Design Automation of Electronic Systems*, vol. 7, no. 4, October 2002.

[4] R. Tessier, "Fast Placement Approaches for FPGAs", in *ACM Transactions on Design Automation of Electronic Systems*, April 2002, volume 7, number 2, pages 284-305.

[5] R. Tessier and S. Jana, "Incremental Compilation for Parallel Logic Verification Systems", to appear in *IEEE Transactions on VLSI Systems*.

Other Significant Publications

[1] I. G. Harris and R. Tessier "Diagnosis of Interconnect Faults in Cluster-Based FPGA Architectures", in *Proceedings: International Conference on Computer Aided Design*, San Jose, California, November 2000, pp. 49–54.

[2] S. Krishnamoorthy, S. Swaminathan, and R. Tessier, "Area-Optimized Technology Mapping for Hybrid FPGAs", 10th International Conference on Field Programmable Logic and Applications, August 2000, pp. 181-190.

[3] R. Tessier, "Frontier: A Fast Placement System for FPGAs", 10th IFIP International Conference on VLSI, December 1999, pp. 125-136.

[4] W. Burleson, R. Tessier, D. Goeckel, S. Swaminathan, P. Jain, J. Euh, S. Venkatraman and V. Thyagarajan, "Dynamically Parameterized Algorithms and Architectures to Exploit Signal Variations for Improved Performance and Reduced Power," in *Proceedings of the International Conference on Acoustics, Speech, and Signal Processing, 2001 (ICASSP'01)*. Salt Lake City, Utah, May 2001 (available from: "http://www.ecs.umass.edu/ece/tessier/icassp01.pdf").

[5] J. Babb, R. Tessier, M. Dahl, S. Hanono, D. Hoki, and A. Agarwal, "Logic Emulation with Virtual Wires", book section in **Readings in Hardware/Software Co-Design,** DiMicheli, Ernst and Wolf, ed., Morgan Kaufman, New York, N.Y., 2002. pp. 625-642. *Originally appeared in IEEE Transactions on Computer-Aided Design of Integrated Circuits and Systems, June 1997*.

d. Synergistic Activities

[1] Reconfigurable Computing Group: Dr. Tessier is the head of the UMass Reconfigurable Computing Group. He is currently supervising researchers exploring reconfigurable computing applications, computer-aided design for FPGAs, reconfigurable architectures, and logic emulation. This work is currently supported by NSF, the US Air Force Research Lab, and several corporations.

[2] Patents: Anant Agarwal, Jonathan Babb, and Russell Tessier, "Virtual Interconnection for Reconfigurable Logic Systems." U.S. patent 559674.

e. Collaborators: J. Babb (MIT), V. Betz (U. Toronto), W. Burleson (UMass-Amherst), S. Desu (UMass-Amherst), D. Goeckel (UMass-Amherst), D. McLaughlin (UMass-Amherst), J. Rose (U. Toronto).

Graduate Research Advisor: S. Ward (MIT).

Graduate Advisees: L. Atieno (UMass-Amherst), S. Krishnamoorthy (UMass-Amherst), M. Kudlugi (UMass-Amherst), J. Liang (UMass-Amherst), R. Ramanarayanan (UMass-Amherst), D. Jasinski (UMass-Amherst), S. Swaminathan (Intel), N. Vemuri (Intel), W. Xu (UMass-Amherst).

Don Towsley has been working on issues related to modeling, analysis, and control of networks since receiving his PhD. His current interests include modeling of complex networks, network tomography, and peer-to-peer networks.

Don Towsley is the co-recipient of the1998 IEEE Communications Society William Bennett outstanding paper award and runner up for the same prize in 2000. He has also been the co-recipient of three ACM SIGMETRICS best paper awards in 1987, 1996, and 2000. He has been elected Fellow of the IEEE and of the ACM for his contributions to network modeling and analysis. He is currently on the Editorial Board of the *Journal of the ACM* and has been on the Editorial Boards of numerous journals, including *IEEE Transactions on Communications* and *IEEE/ACM Transactions on Networking*. He has regularly been on the program committees of INFOCOM, ACM SIGCOMM, and ACM SIGMETRICS.

Professional Preparation:

B.A., Physics, University of Texas, 1971
Ph.D., Computer Sciences, university of Texas, 1975

Appointments:

Professor, Dept. of Computer Science, Univ. of Massachusetts, 1988 to present.

Visiting Member of Technical Staff, AT&T Research Labs, 1997.

Visiting Research Scientist, INRIA, Sophia-Antipolis, 1996.

Visiting professor, Laboratoire MASI, Université Pierre et Marie Curie, 1989-1990.

Associate Professor, Dept. of Computer Science, Univ. of Massachusetts, 1985-1988.

Associate Professor, Dept. of Electrical and Computer Engineering, Univ. of Massachusetts, 1981-1985.

Visiting Scientist, T.J. Watson IBM Research Center, 1982-1983.

Assistant Professor, Dept. of Electrical and Computer Engineering, Univ. of Massachusetts, 1976-1981.

IBM Postdoctoral Fellow, Dept. of Computer Science, University of Texas, 1975-1976.

Five most relevant publications to this proposal:

R. Cáceres, N.G. Duffield, J. Horowitz, D. Towsley. "Multicast-based inference of network-internal loss characteristics," *IEEE Transactions on Information Theory*, **45**, 7, 2462-2480, November 1999.

T. Bu, N. Duffield, F. LoPresti, D. Towsley. "Network Tomography on General Topology," *Proc. ACM SIGMETRICS 2002*, JUNE 2002.

N. Duffield, J. Horowitz, F. LoPresti, D. Towsley. "Multicast Topology Inference from Measured End-to-End Loss," *IEEE Transactions on Information Theory*, January 2002.

N. Duffield, J. Horowitz, D. Towsley, W. Wei, T. Friedman. "Multicast-based loss inference with missing data," *IEEE Journal of Selected Areas of Communications*, to appear.

N. Duffield, F, LoPresti, V. Paxson, D. Towsley. "Inferring Link Loss Using Striped Unicast Probes," *Proceedings of IEEE Infocom 2001*, April 2001.

Five other significant publications:

M. Yajnik, S.B. Moon, J. Kurose, D. Towsley. "Measurement and modeling of the temporal dependence in packet loss*," Proc. IEEE Infocom99*, New York, March 1999.

M. Yajnik, J. Kurose, D. Towsley. "Packet Loss Correlation in the Mbone Multicast Network," *Proceedings of the IEEE Global Internet'96*, London, U.K., November 1996.

Adams, T. Bu, R. Cáceres, N. Duffield, T. Friedman, J.Horowitz, F. LoPresti, S.B. moon, V. Paxson, D. Towsley. "The use of end-to-end multicast measurements for characterizing internal network behavior," *IEEE Communications Maga*zine, **38**(5), 152-159, May 2000.

M. Adler, T. Bu, R.K. Sitaraman, D. Towsley. "Tree Layout for Internal Network Characterization in Multicast Networks*," Proc. Third International Workshop on Networked Group Communication*, Nov. 2001.

T. Friedman, D. Towsley. "Multicast Session membership Size Estimation," *Proc. IEEE Infocom '99*, March 1999.

Synergistic Activities:

1. Co-organizer of the first NSF/ARO workshop on systems and control methods in communication networks in 1996 which had a significant impact in the area of network modeling and control.
2. Organizer and PI for an NSF Research infrastructure sponsored project on integrated wireline/wireless networks. This has had a significant impact on generating collaborative efforts among computer scientists and electrical engineers at the UMass Amherst campus.
3. Organizer of a joint networking/control/mathematics seminar series that brings mathematicians, electrical engineers, physicists, and computer scientists together at UMass to explore problems at the interfaces of these areas.

List of Collaborators in last 48 months on books, articles, papers, proposals:

M. Ammar (Georgic Tech), R. Cáceres, J.-Y Cai (U. Wisconsin), B. Cain, J. Carbonell (CMU), C. Casetti (Politecnico Torino), R. Cole (Colorado), B. DeCleene (Alphatec), J Dey (GTE), L. Dondetti (Nortel Networks), C. Diot (INRIA), B. Duffield (AT&T), J. Fortes (U. Florida), R.H, Hwang (National Cheng Chung Univ. Taiwan), A. Feldmann (Saarbrucken), V. Firoiu (Nortel Networks), M. Furini (U. Bologna), L. Golubchik (U. Maryland), R. Guerin (U. Penn), T. Hardjono, G. Hyamtylsson, A. Hordijk (Leiden U.), G. Koole (Free Univ. of Amsterdam), T. LaPorta (Bell Labs), J-Y. LeBoudec (EPFL), Z. Liu (IBM), F. LoPresti (U. Aquila), J.C.S. Liu (CUHK), R.R. Muntz (UCLA), P. Nain (INRIA), D. Nicol (Dartmouth), J. Padhye (Microsoft), V. Paxson (ICIR), R. Ramjee (Bell Labs), J. Rexford (AT&T Labs), R. Srikant (UIUC), J. Stankovic (U. Virginia), W. Willinger (AT&T Labs), S. Zabele (Alphatec), Z.L. Zhang (U. Minnesota).

Research Advisees in last five yeas (not including current students); S. Bhattacharyya (Sprint Labs), T. Bu (Bell Labs), J. Dey (startup), V. Firoiu (Nortel Networks), T. Friedman (U. Paris VI), Y. Guo (UMass-Amherst), S. Kasera (Bell labs), S.B. Moon (Sprint Labs), J. Padhye (Microsoft), D. Rubenstein (Columbia Univ.), S. Sahu (IBM Research), S. Sen (AT&T labs).
Total number of graduates: 22, postdoctoral sponsorships: 5.
Graduate advisors: J.C. Browne (U. Texas), M. Chandy (CalTech).

Baxter E. Vieux, Ph.D., P.E. (SS: 513-60-9190)
Professor, School of Civil Engineering and Env. Sci.
University of Oklahoma
202 West Boyd Street, Room CEC334
Norman, OK 73019
Homepage: http://www.coe.ou.edu/emgis
Email: bvieux@ou.edu
(405) 325-3600 (phone) (405) 325-4217 (fax)

A. Professional Preparation

Post Doctoral Michigan State University, 1998-1990.
Ph.D., 1988 Agricultural Engineering, Michigan State University, Dissertation: *Finite Element Analysis of Hydrologically Homogeneous Subwatersheds Using GIS.*
M.S., 1982 Civil Engineering, Kansas State University
B.S., 1978 Civil Engineering, University of Kansas

B. Appointments

Director—International Center for Natural Hazards and Disaster Research, National Weather Center, University of Oklahoma, 1998-present.
Director—Environmental Modeling and GIS Laboratory, 1990-present.
Full Professor—School of Civil Engineering and Environmental Science University of Oklahoma, July 1, 2000 – present
Associate Professor—School of Civil Engineering and Environmental Science University of Oklahoma, June 10, 1995 –June 31, 2000
Assistant Professor, School of Civil Engineering and Environmental Science, University of Oklahoma, 8/15/90--8/15/95.
Visiting Assistant Professor, Department of Resource Development, Michigan State University, 1988-1990. Research and teaching in watershed management.
Various positions, State Engineer, Assistant State Engineer, and PL-566 Watershed Flood Control Project Engineer for in various positions in Kansas and Michigan with the USDA-Soil Conservation Service.

C. Publications

Vieux, B.E., F. Moreda, (2002). Physics-based Distributed Parameter Model Calibration—Theory and Application. Chapter 20 in, *Amer. Geophys. Union, Advances in Calibration of Watershed Models*, eds. Q. Duan, S. Sorooshian, H. Gupta, A. Rousseau, R. Turcotte.
White, L.W., B.E. Vieux, D., Surface Flow Model: Inverse Problems and Predictions. *J. Advances in Water Resources*, 25, pp. 317-324.
Vieux, B.E. Distributed Hydrologic Modeling Using GIS, Submitted manuscript to Kluwer Academic Publishers, Water Science and Technology Series, Vol. 38, pp. 320. Research monograph, July 2001.
Vieux, B.E. "Radar Rainfall Applications in Hydrology", Chapter in 3rd edition: *Hydrology and Floodplain Management*, in Bedient and Huber, November, 2001.
Vieux, B.E. "GIS Applications in Hydrology", with H. Rifai, Chapter in 3rd edition: *Hydrology and Floodplain Management*, in Bedient and Huber, November, 2001.

Other Publications

Ross, Randall R. and B.E. Vieux (2000). "A Probabilistic Method for Estimating Monitoring Point Density for Contaminant System Leak Detection." *Ground Water* 38(4). July-August, pp. 533-

540.
Vieux, B.E., P.B. Bedient, (2001), “A Billion Dollar Flood: How The Texas Medical Center Coped With Tropical Storm Allison.” Abstract in proceedings of the 2001 Annual Hazards Research and Applications Workshop, Natural Hazards Research and Applications Information Center, University of Colorado, Boulder, CO. pp. S01-09.
Bedient, P.B., B.C. Hoblit, D.C. Gladwell, B.E. Vieux, (2000) "NEXRAD Radar for Flood Prediction in Houston," ASCE J. of *Hydrologic Engineering*. Vol. 5(3), July, pp. 269-277.
Vieux, B.E., and P.B. Bedient, (1998), "Estimation of Rainfall for Flood Prediction from WSR-88D Reflectivity: A Case Study, 17-18 October 1994." Amer. Meteoro. Soc., J. of Weather and Forecasting, Vol. 13, pp. 126-134.
Nakakita, E., S. Ikebuchi, K. Nakagawa, T. Sato, B.E. Vieux, and T. Takasao, (1995), "Utilization of Vertical Profile of DSD into Building up an Algorithm for Estimating Ground Rainfall Amount Using Radar," Proceedings of III Int. Symposium on Hydrological Applications of Weather Radars, August 20-23, Sao Paulo Brazil.

D. Synergistic Activities

- Director International Center for Natural Hazards and Disaster Research, 1998-present. Participating unit in the National Weather Center.
- Courses taught include graduate level courses in CE5843-Hydrology, CE5020-Geographic Information System applications, and CE5873-Water Quality Modeling, and undergraduate courses in CE2553-Surveying (Geomatics) and ENGR1001-Introduction to Computing.
- Collaborator with the Disaster Prevention Research Institute, Kyoto, Japan (numerous student and post-doctoral exchanges), Institute de Researche en Developement, Montpellier France, sabbatical 1998-99 at the NOAA-National Severe Storms Laboratory, Norman Oklahoma.
- Fellow of the Cooperative Institute for Mesoscale Meteorological Studies, School of Meteorology.
- International Association of Hydrological Sciences (IAHS) co-convener of the HS03 Information from Weather Radar and Distributed Hydrological Modelling. IASH General Assembly, Sapporo (Japan), 3-11 July 2003. [With Tachikawa, Nakakita, and K.P. Georgakakis).

E. Collaborators & Other Affiliations

Collaborators: Claude Duchon, Mark Meo Robert Knox, Randall Kolar, University of Oklahoma; Phillip Bedient, Rice University.

Graduate and Post Doctoral Advisors-- Ph.D. Committee Vincent F. Bralts, Purdue (Chair), Jon Bartholic, Larry Segerlind, Michigan State University, Donald Edwards, Univ Nebraska

Graduate Students--Gaur, N.; Nickisch, D; Abraham, D.; Mubaraki, A.; Tangella, S.; Farajalla, N.; Johnston, A.; Nguyen T.; Khakpour, R.; LeDimet, E.; Jones, A.T.; Cox, G., M.S.; Hodgeden, K.; Ross, R.; Gopal, M., G. Kesavamurthy, Z. Cui, and F. Moreda.

LUTHER W. WHITE
Samuel Roberts Noble Presidential Professor
Department of Mathematics, University of Oklahoma, Norman, Oklahoma 73019

Professional Preparation

Oklahoma Baptist University, Mathematics and Physics, B. S. 1972

University of Illinois, Champaign, Illinois, Mathematics, M.S.1973

University of Illinois, Champaign, Illinois, Mathematics, Ph.D. 1977

Academic and Professional Appointments

Samuel Roberts Noble Presidential Professor, University of Oklahoma, 2000-2004

Visiting Professor, University of Joseph Fourier, May-July, 2002

Visiting Scientist, Institut National de Recherche en Informatique et en Automatique, Visiting Scientist, May-July, 1998.

Institute for Applied Mathematics, University of Minnesota, Minneapolis, Visiting Professor, November 1992.

Departement de Mathematiques Appliquees, Universite Blaise Pascal, Clermont-Ferrand, France, Visiting Professor, June 1988.

Institut fur Mathematik, Karl-Franzens-Universitat, Graz, Austria, Visiting Professor, May 1987.

Aerospace, Mechanical and Nuclear Engineering Dept., University of Oklahoma, Associate Professor, June-July 1983.

Institute for Computer Applications in Science and Engineering, NASA Langley Research Center. Visiting Scientist, July 1983, June 1984, June 1985.

Cooperative Institute for Mesoscale Meteorological Studies, Visiting Scientist, August 1982, August 1983, June 1984.

Institute National de Recherch d'Informatique et d'Automatique, Visiting Scientist, April-June 1980.

Professor, Mathematics, University of Oklahoma, 1985- present

Associate Professor, Mathematics, University of Oklahoma, 1981- 1985

Assistant Professor, Mathematics, University of Oklahoma, 1977-1981

Graduate Assistant, Mathematics, University of Illinois, 1972-1977

ORAU Research Trainee, Oak Ridge National Laboratory, 1971

5 Publications Relevant to this Proposal

"Resolution of Regularized Output Least Squares Estimation for Parabolic Problems,"
with Ying-jun Jin, Numerical Control Theory, W. Hager, ed., Kluwer, 1998.

"The Adjoint Newton Algorithm for Large-scale unconstrained Optimization in Meteorology Applications," with Z.Wang and K.Droegemeir, J. Computational Opt. And Appl., v10, pp283-320, 1998.

"Application of a New Adjoint Newton Algorithm to the 3-D ARPS Storm Scale Model Using Simulated Data," with Z.Wang, K.Droegemeier, and M.Navon, Monthly Weather Review, v 125, pp 2460-2498, 1997.

"Elevated CO2 Differentiates Ecosystem Carbon Processes: A Deconvolution Analysis of Duke Forest FACE data," with Y.Luo, L.Wu, J.A.Andrews, R.Matamala, and W.H.Schlesinger, Ecological Monographs, 71,pp 357-376, 2001b.

"Surface Flow Model: Stochastic Inversion and Prediction," with B.Vieux and D. Armand, Advances in Water Resources, 25(2002),pp317-324.

5 Other Significant Publications

“Resolution of Regularized Output Least Squares Estimation Procedures,” J. Appl.Math. and Comp., v.81, pp 139-172, 1997.

“Fluid Accumulation and Flow in a Three Dimensional Porous Media Model,” with Hong Li and M. Zaman, Applied Mathematics and Computation, 108(2000),pp177-196.

"An Elementary Nonlinear Plate Theory with Finite Buckling Deformation Properties,I," with D.L.Russell, Cybernetics and Control, Dec. 1999.

"Estimation of carbon transfer coefficients using Duke free-air CO2 enrichment data," with Y. Luo, Applied Mathematics and Computation, 130(2002),pp101-120.

"Stochastic Fluid Modulus Inversion," with John Castagna, Geophysics, in press.

Synergistic Activities

Faculty Associate, Institute for Exploration and Development Geosciences,2000-present.
Member of Committee to Evaluate Oil Tanker Environmental Performance, National Research Council, 1999-2001.
Office of Business Interaction and Cooperation, Faculty Associate, 1986-87.

Recent Collaborators

David Russell, David Armand, Francois LeDimet, Michael Navon, Leslie Davidson, Musharraf Zaman, Yiqi Luo, Baxter Vieux, Josep Canadell, Evan DeLucia, David Ellsworth, Adrien Finzi, John Lichter, William Schlesinger

Graduate Advisor

Dr. T.W.Ting, Professor of Mathematics, University of Illinois at Urbana-Champaign

Graduate Students Supervised

Graduate Students (5 degrees completed), Jing Zhou, Curt Holman, Jing-jun Jin, Hong Li, Leslie Davidson.

Current & Pending Support for Research Faculty

Current and Pending Support
(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: Philip B. Bedient	Other agencies (including NSF) to which this proposal has been/will be submitted. none

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Flood Alert System (FAS2) for the Texas Medical Center and Brays Bayou

Source of Support: FEMA and the Texas Medical Center

Total Award Amount: $300,000 Total Award Period Covered: 2002-2003

Location of Project: Rice University, Houston, TX

Person-Months Per Year Committed to the Project. Cal: Acad: 1 Sumr:

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Chlorinated Solvent Impact and Remediation Strategies in the Dry Cleaning Industry

Source of Support: Gulf Coast Hazardous Substances Research Center

Total Award Amount: $149,400 Total Award Period Covered: 2000-2003

Location of Project: Houston, TX

Person-Months Per Year Committed to the Project. Cal: Acad: 1 Sumr:

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Flood Alert System - Maintenance and Support

Source of Support: Texas Medical Center

Total Award Amount: $271,000 Total Award Period Covered: 1998-2002

Location of Project: Rice University, Houston, TX

Person-Months Per Year Committed to the Project. Cal: Acad: 1 Sumr:

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Enhanced Flood Warnings for theTexas Medical Center, A Second Generation Flood Alert System

Source of Support: Texas Water Resources Institute, Texas A&M University

Total Award Amount: $5,000 Total Award Period Covered: 2003

Location of Project: Rice University, Houston, TX

Person-Months Per Year Committed to the Project. Cal: Acad: 1 Sumr:

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Enhanced Flood Alert Warnings Using Real-Time Hydrologic Modeling

Source of Support: CITI, Rice University

Total Award Amount: $19,981 Total Award Period Covered: 2003

Location of Project: Rice University, Houston, TX

Person-Months Per Year Committed to the Project. Cal: Acad: 1 Sumr:

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*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

Current and Pending Support
(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: Michael I. Biggerstaff	Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:
Dynamics of severe weather and heavy rain producing convective storms

Source of Support: National Science Foundation
Total Award Amount: $1,139,033 Total Award Period Covered: 15 May 2003 - 14 May 2007
Location of Project: University of Oklahoma
Person-Months Per Year Committed to the Project. 2 Cal: Acad: Sumr:

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:
Improvement of Rain Estimation in Tropical Cyclones

Source of Support: NASA
Total Award Amount: $375,000 Total Award Period Covered: 1 July 2001 – 30 June 2004
Location of Project: University of Oklahoma
Person-Months Per Year Committed to the Project. 1 Cal: Acad: Sumr:

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:
Validation of TRMM Rainfall and Heating Estimates

Source of Support: NASA
Total Award Amount: $535,000 Total Award Period Covered: 1 Nov. 2000 - 30 Sept 2004
Location of Project: Uiversity of Oklahoma
Person-Months Per Year Committed to the Project. 2 Cal: Acad: Sumr:

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:
SMART-Radar Rebuild
Source of Support: NOAA
Total Award Amount: $75,500 Total Award Period Covered: 1 July 2002 – 30 June 2003
Location of Project: Texas A&M University
Person-Months Per Year Committed to the Project. 2 Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:

Source of Support:
Total Award Amount: $ Total Award Period Covered:
Location of Project:
Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

NSF Form 1239 (10/99) USE ADDITIONAL SHEETS AS NECESSARY

Current and Pending Support
(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: Howard B. Bluestein

Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:
Studies of Severe Convective Storms and Tornadoes

Source of Support: National Science Foundation
Total Award Amount: $489,057 Total Award Period Covered: 06/01/00-05/31/03
Location of Project: Norman, OK
Person-Months Per Year Committed to the Project. Cal: 0.00 Acad: 0.50 Sumr: 2.00

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:
Severe Convective Storms and Tornadoes

Source of Support: National Science Foundation
Total Award Amount: $692,400 Total Award Period Covered: 02/01/03-02/28/06
Location of Project: Norman, OK
Person-Months Per Year Committed to the Project. Cal: 0.00 Acad: 1.00 Sumr: 2.00

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:

Source of Support:
Total Award Amount: $ Total Award Period Covered:
Location of Project:
Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:

Source of Support:
Total Award Amount: $ Total Award Period Covered:
Location of Project:
Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:

Source of Support:
Total Award Amount: $ Total Award Period Covered:
Location of Project:
Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

NSF Form 1239 (10/99) USE ADDITIONAL SHEETS AS NECESSARY

Current and Pending Support
(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: V.N. Bringi	Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:
Advanced Hydrometeor Identification of Severe Storms During STEPS

Source of Support: NSF
Total Award Amount: $ 303,055 Total Award Period Covered: 5/1/00-4/30-03
Location of Project: Colorado State University
Person-Months Per Year Committed to the Project. Cal: Acad: Sumr: 1

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:
The CSU-CHILL Radar Facility

Source of Support: NSF
Total Award Amount: $ 1,227,699 Total Award Period Covered: 9/1/01-8/31/06
Location of Project: Greeley, Colorado
Person-Months Per Year Committed to the Project. Cal: Acad: 1 Sumr: 1

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:
Field Studies of Raindrop Axis Ratio and Orientation Distributions using an Improved 2D video disdrometer
Source of Support: NSF
Total Award Amount: $ 327,000 Total Award Period Covered: 5/1/02-4/30-05
Location of Project: Colorado State University and Graz, Austria
Person-Months Per Year Committed to the Project. Cal: Acad: 1 Sumr:

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:
Development of a High Performance Dual-Offset Gregorian Antenna for the CSU-CHILL Facility
Source of Support: NSF
Total Award Amount: $ 1,406,010 Total Award Period Covered: 8/15/02-7/31/04
Location of Project: VertexRSI, Killgore TX and Greeley, Colorado
Person-Months Per Year Committed to the Project. NoCost Cal: Acad: Sumr:

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:
Improving TRMM Ground Validation and Field Campaign Goals using Polarimetric Radar Analysis…..
Source of Support: NASA
Total Award Amount: $ 306,488 Total Award Period Covered: 11/1/98-6/1/03
Location of Project: Colorado State University
Person-Months Per Year Committed to the Project. Cal: Acad: 1 Sumr:

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

NSF Form 1239 (10/99) USE ADDITIONAL SHEETS AS NECESSARY

Current and Pending Support

(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: V.N. Bringi	Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Polarimetric Radar Observations of Precipitation: Measurement, Analysis and Modelling

Source of Support: NOAA

Total Award Amount: $ 49,998 Total Award Period Covered: 7/1/02-6/30/03

Location of Project: Colorado State University

Person-Months Per Year Committed to the Project. NoCost Cal: Acad: Sumr: 1

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. NONE Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project: Colorado State University

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

NSF Form 1239 (10/99) USE ADDITIONAL SHEETS AS NECESSARY

Current and Pending Support

(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: Burleson, Wayne

Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☐ Current X Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:
EXCITE: Enabling X-Campus Information Technology Education

Source of Support: NSF
Total Award Amount: 599768 Total Award Period Covered: 5/4/03-5/3/06
Location of Project: University of Massachusetts Amherst
Person-Months Per Year Committed to the Project. Cal: Acad: Sumr: 0.75

Support: X Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:
Current-Mode Circuits for Global Interconnect

Source of Support: SRC
Total Award Amount: $300000 Total Award Period Covered: 2/1/00-1/31/03
Location of Project: University of Massachusetts Amherst
Person-Months Per Year Committed to the Project. Cal: Acad: Sumr: 2.0

Support: X Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:
Adaptive Systems-on-a-Chip for Low Power

Source of Support: NSF
Total Award Amount: $324919 Total Award Period Covered: 7/15/00-6/30/03
Location of Project: University of Massachusetts Amherst
Person-Months Per Year Committed to the Project. Cal: Acad: Sumr: 1.0

Support: ☐ Current Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:
Total Award Amount: $ Total Award Period Covered:
Location of Project:
Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:
Total Award Amount: $ Total Award Period Covered:
Location of Project:
Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

NSF Form 1239 (10/99) USE ADDITIONAL SHEETS AS NECESSARY

Current and Pending Support
(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: Jose G. Colom

Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:
CenSSIS

Source of Support: NSF/UPRM
Total Award Amount: $ Total Award Period Covered: Sept 1, 2001 to July 31, 2003
Location of Project: University of Puerto Rico Mayaguez
Person-Months Per Year Committed to the Project. Cal: Acad: 1.5 Sumr: 1

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:

Source of Support:
Total Award Amount: $ Total Award Period Covered:
Location of Project:
Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:

Source of Support:
Total Award Amount: $ Total Award Period Covered:
Location of Project:
Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:

Source of Support:
Total Award Amount: $ Total Award Period Covered:
Location of Project:
Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:

Source of Support:
Total Award Amount: $ Total Award Period Covered:
Location of Project:
Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

Current and Pending Support

(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: Walter Díaz | Other agencies (including NSF) to which this proposal has been/will be

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: Multidisciplinary E-government Research and Education as a Catalyst for Effective Information Technology Transfer to Regional Governments

Source of Support: National Science Foundation

Total Award Amount: $1,453,279 Total Award Period Covered: Aug. 01, 2003 – July 31, 2006

Location of Project: University of Puerto Rico Mayagüez

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr: 2

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: Center for

Source of Support:

Total Award Amount: Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Period Covered:

Location of Project: :

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

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*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

NSF Form 1239 (10/99) USE ADDITIONAL SHEETS AS NECESSARY

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Current and Pending Support
(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: Theodore E. Djaferis

Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:
General Dynamics MS Program

Source of Support: General Dynamics Advanced Information Systems
Total Award Amount: $161,000 Total Award Period Covered: 2002-2005
Location of Project: University of Massachusetts Amherst
Person-Months Per Year Committed to the Project. Cal: 1 Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:

Source of Support:
Total Award Amount: $ Total Award Period Covered:
Location of Project:
Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:

Source of Support:
Total Award Amount: $ Total Award Period Covered:
Location of Project:
Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:

Source of Support:
Total Award Amount: $ Total Award Period Covered:
Location of Project:
Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:

Source of Support:
Total Award Amount: $ Total Award Period Covered:
Location of Project:
Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

NSF Form 1239 (10/99) USE ADDITIONAL SHEETS AS NECESSARY

Current and Pending Support

(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: Stephen J. Frasier	Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Remote Sensing of Waves and Currents in the Nearshore Zone During NCEX

Source of Support: Office of Naval Research

Total Award Amount: $450,000 Total Award Period Covered: 1/1/02-9/30/04

Location of Project: University of Massachusetts

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr: .50

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Dual-Beam Interferometer (DBI) Development and Validation

Source of Support: Office of Naval Research

Total Award Amount: $560,663 Total Award Period Covered: 5/1/98-5/31/04

Location of Project: University of Massachusetts

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr: .50

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

4D-Radar/Acoustic Measurement of Atmospheric Turbulence in the Stable Boundary Layer

Source of Support: Department of Energy

Total Award Amount: $477,643 Total Award Period Covered: 9/1/99-10/31/03

Location of Project: University of Massachusetts

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr: .75

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Validation of Volume-Imaging UHG Radar and S-band Profiles of the Atmospheric Boundary Layer

Source of Support: Army Research Office

Total Award Amount: $278,150 Total Award Period Covered: 3/1/03-2/28/05

Location of Project: University of Massachusetts

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr: .25

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Equipment for Bistatic Microwave Sounding of the Atmospheric Boundary Layer

Source of Support: Army Research Office

Total Award Amount: $186,000 Total Award Period Covered: 4/1/03-3/31/04

Location of Project: University of Massachusetts

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

NSF Form 1239 (10/99) USE ADDITIONAL SHEETS AS NECESSARY

Current and Pending Support
(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: Dennis Goeckel

Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:
Macroscopic Space-Time Systems (sole-PI)

Source of Support: National Science Foundation
Total Award Amount: $312,779 Total Award Period Covered: 07/01/03-06/30/06
Location of Project: University of Massachusetts - Amherst
Person-Months Per Year Committed to the Project. Cal: Acad: Sumr: 1.00

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:
CAREER: Coded Modulation for High-Speed Wireless Communications(sole-PI)

Source of Support: National Science Foundation
Total Award Amount: $200,000 Total Award Period Covered: 07/01/99-6/30/03
Location of Project: University of Massachusetts - Amherst
Person-Months Per Year Committed to the Project. Cal: Acad: Sumr: 2.00

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:
Analog Devices Fellowship at UMass-Amherst

Source of Support: Analog Devices, Inc.
Total Award Amount: $50,000 Total Award Period Covered: 09/01/01-08/31/03
Location of Project: University of Massachusetts - Amherst
Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:
MURI: Short-Range Ultra-Wideband Systems (Co-PI)

Source of Support: Army Research Office (sub-contract from USC)
Total Award Amount: $829,039 Total Award Period Covered: 05/01/01-4/30/04
Location of Project: University of Massachusetts - Amherst
Person-Months Per Year Committed to the Project. Cal: Acad: Sumr: 1.00

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:
Signal Processing for Radar and Communication Systems (sole PI)

Source of Support: M/A-COM, Inc.
Total Award Amount: $70,000 Total Award Period Covered: 10/01/01-12/31/03
Location of Project: University of Massachusetts - Amherst
Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

NSF Form 1239 (10/99) USE ADDITIONAL SHEETS AS NECESSARY

Current and Pending Support

(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: Dennis Goeckel	Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Research Infrastructure: Infrastructure to Support Research in Mixed Wired/Wireless Information Systems (Co-PI)

Source of Support: National Science Foundation

Total Award Amount: $992,585 Total Award Period Covered: 9/15/00-8/31/05

Location of Project: University of Massachusetts - Amherst

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Propagation and Capacity Studies for Multi-Polarized MIMO Systems (Co-PI)

Source of Support: National Science Foundation

Total Award Amount: $498,377 Total Award Period Covered: 04/30/03-04/29/06

Location of Project: University of Massachusetts - Amherst

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr: 1.00

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Dynamic End-to-End Quality-of-Service (QoS) Management in Wireless Ad Hoc Networks (Co-PI)

Source of Support: Office of Naval Research

Total Award Amount: $900,000 Total Award Period Covered: 07/01/03-06/30/06

Location of Project: University of Massachusetts -Amherst

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr: 1.00

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

NSF Form 1239 (10/99) USE ADDITIONAL SHEETS AS NECESSARY

Current and Pending Support

(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: Weibo Gong

Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: X☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Vulnerability Assessment Tools for Complex Information Networks

Source of Support: ARO/subcontract from Harvard University

Total Award Amount: $591,246 Total Award Period Covered: 05/14/01 – 04/30/06

Location of Project: University of Massachusetts/Amherst

Person-Months Per Year Committed to the Project. Cal: Acad: 0.69 Sumr: 1.00

Support: X☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Fluid Methods for Solving Large, Heterogeneous Networks

Source of Support: NSF/Co-PI

Total Award Amount: $970,629 Total Award Period Covered: 04/20/00 – 04/19/03

Location of Project: University of Massachusetts/Amherst

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr: 1.00

Support: X☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Internet Congestion Control: Design, Modeling & Analysis

Source of Support: NSF/Co-PI

Total Award Amount: $300,000 Total Award Period Covered: 06/15/00 – 05/31/03

Location of Project: University of Massachusetts/Amherst

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr: 0.30

Support: ☐ Current X☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

A Research Supported Course in Network Security

Source of Support: NSF/ Subcontract with Umass/Dartmouth

Total Award Amount: $105,381 Total Award Period Covered: 06/01/03 – 05/31/06

Location of Project: University of Massachusetts/Amherst

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr: 0.50 lst yr.

Support: ☐ Current X☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Next Generation MAC Protocol for Multimedia Wireless Networks

Source of Support: NSF/ Co-PI

Total Award Amount: $351,238 Total Award Period Covered: 05/01/03 – 04/30/06

Location of Project: University of Massachusetts/Amherst

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr: 1.00

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*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

NSF Form 1239 (10/99) USE ADDITIONAL SHEETS AS NECESSARY

Current and Pending Support

(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: Robert W. Jackson	Other agencies (including NSF) to which this proposal has been/will be submitted. None

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Integrated Active Antennas for Millimeter Wave Wireless

(R. Janaswamy, PI)

Source of Support: National Science Foundation

Total Award Amount: $323,117 Total Award Period Covered: 10/99-9/04

Location of Project: University of Massachusetts

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr: 1.0

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Microwave Amplifier Linearization Techniques

Source of Support : R.F. Micro Devices

Total Award Amount: : $60,000 Total Award Period Covered9/1/01-8/31/03

Location of Project: University of Massachusetts

Person-Months Per Year Committed to the Project. Cal: 1.0 Acad: : 0.5 Sumr:

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: Industry-University Consortium for RF/Microwave Integrated Cricuit Design

Source of Support : TriQuint, Philips, Global Communications Devices

Total Award Amount$270,000 Total Award Period Covered: $270,000

Location of Project: University of Massachusetts

Person-Months Per Year Committed to the Project. Cal: Acad0l5 Sumr: 0.5

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support

Total Award Amount: Total Award Period Covered: $

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

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*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

Current and Pending Support

(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: Ramakrishna Janaswamy	Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Active Integrated Antenna Arrays for Millimeter Wave Wireless Communications

Source of Support: National Science Foundation

Total Award Amount: $264,176 Total Award Period Covered: 09/01/01-08/31/04

Location of Project: University of Massachusetts, Amherst

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr: 1.00

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Numerical Modeling of RF Propagation Over the Rough Ocean Surface

Source of Support: Office of Naval Research

Total Award Amount: $160,000 Total Award Period Covered: 07/15/02-09/30/04

Location of Project: University of Massachusetts, Amherst

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr: 1.00

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Propagation and Capacity Studies for Multi-Polarized MIMO Communication Systems

Source of Support: National Science Foundation

Total Award Amount: $498,377 Total Award Period Covered: 04/01/03-03/31/06

Location of Project: University of Massachusetts, Amherst

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr: 1.00

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

Current and Pending Support

(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: Israel Koren	Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Collaborative Research: Adaptive Performance and Power Management for Real-Time Systems

Source of Support: NSF (with C.M. Krishna)

Total Award Amount: $300,000 Total Award Period Covered: 9/15/01-8/31/04

Location of Project: University of Massachusetts

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr: 0.85

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Incorporating Fault Tolerance at the Application Level

Source of Support: NSF (with C.M. Krishna)

Total Award Amount: $210,600 Total Award Period Covered: 9/1/01-8/31/03

Location of Project: University of Massachusetts

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr: 0.85

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Security Tradeoffs in NEST

Source of Support: DARPA (with Krishna, Moritz, Ganz and two other co-PIs)

Total Award Amount: $930,000 Total Award Period Covered: 9/1/02-8/31/05

Location of Project: University of Massachusetts

Person-Months Per Year Committed to the Project. Cal: Acad: 0.9 Sumr:

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

ITR: Statically Speculative Power-Aware (SPA) Architectures

Source of Support: NSF (with C.M. Krishna and C.A. Moritz)

Total Award Amount: $400,000 Total Award Period Covered: 9/1/02-8/31/05

Location of Project: University of Massachusetts

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr: 0.6

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Achieving and Validating High Dependability Through Host and Network Processor Collaboration

Source of Support: NSF (with C.M. Krishna)

Total Award Amount: $400,000 Total Award Period Covered: 9/1/02-8/31/06

Location of Project: University of Massachusetts

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr: 0.0

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

NSF Form 1239 (10/99) USE ADDITIONAL SHEETS AS NECESSARY

Current and Pending Support
(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: Israel Koren | Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:
Yield Estimation and Enhancement Prior to Routing

Source of Support: NSF
Total Award Amount: $290,000 Total Award Period Covered: 9/1/03-8/31/06
Location of Project: University of Massachusetts
Person-Months Per Year Committed to the Project. Cal: Acad: Sumr: 0.1

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:

Source of Support:
Total Award Amount: $ Total Award Period Covered:
Location of Project:
Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:

Source of Support:
Total Award Amount: $ Total Award Period Covered:
Location of Project:
Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:

Source of Support:
Total Award Amount: $ Total Award Period Covered:
Location of Project:
Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:

Source of Support:
Total Award Amount: $ Total Award Period Covered:
Location of Project:
Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

NSF Form 1239 (10/99) USE ADDITIONAL SHEETS AS NECESSARY

Current and Pending Support

(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator:Mani Krishna	Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Collaborative Research: Adaptive Performance and Power Management for Real-Time Systems

Source of Support: NSF (with I. Koren)

Total Award Amount: $300,000 Total Award Period Covered: 9/15/01-8/31/04

Location of Project: University of Massachusetts

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr: 0.85

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Incorporating Fault Tolerance at the Application Level

Source of Support: NSF (with I. Koren)

Total Award Amount: $210,600 Total Award Period Covered: 9/1/01-8/31/03

Location of Project: University of Massachusetts

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr: 0.85

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Security Tradeoffs in NEST

Source of Support: DARPA (with Koren, Moritz, Ganz and two other co-PIs)

Total Award Amount: $987,818 Total Award Period Covered: 9/11/02-9/10/05

Location of Project: University of Massachusetts

Person-Months Per Year Committed to the Project. Cal: Acad: 0.9 Sumr:

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

ITR: Statically Speculative Power-Aware (SPA) Architectures

Source of Support: NSF (with I. Koren and C.A. Moritz)

Total Award Amount: $400,000 Total Award Period Covered: 9/1/02-8/31/05

Location of Project: University of Massachusetts

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr: 0.6

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Achieving and Validating High Dependability Through Host and Network Processor Collaboration

Source of Support: NSF (with I. Koren)

Total Award Amount: $400,000 Total Award Period Covered: 9/1/02-8/31/06

Location of Project: University of Massachusetts

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr: 0.0

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

Current and Pending Support
(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator:Mani Krishna [page 2]

Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:
CRCD Curriculum Development and Infrastructure for an Advanced Systems Laboratory (with 4 co-PIs)
Source of Support: NSF
Total Award Amount: $499,997 Total Award Period Covered: 10/1/00-9/30/03
Location of Project: University of Massachusetts
Person-Months Per Year Committed to the Project. Cal: Acad: Sumr: 0

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:
Rapid Recovery Management for Hierarchical and Heterogeneous Systems (with I. Koren)
Source of Support: DARPA (proposed subcontract from UCLA)
Total Award Amount: $590,000 Total Award Period Covered: 3 yrs
Location of Project: University of Massachusetts
Person-Months Per Year Committed to the Project. Cal: Acad: Sumr: 1

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:
Source of Support:
Total Award Amount: $ Total Award Period Covered:
Location of Project:
Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:
Source of Support:
Total Award Amount: $ Total Award Period Covered:
Location of Project:
Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:
Source of Support:
Total Award Amount: $ Total Award Period Covered:
Location of Project:
Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

NSF Form 1239 (10/99) USE ADDITIONAL SHEETS AS NECESSARY

Current and Pending Support

(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator:J. MacGregor Smith

Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: ***ITR Collaborative Proposal: The Protein Folding Problem and Topological Network***

Source of Support: NSF

Total Award Amount: $167,053 Total Award Period Covered: 06/01/03-05/31/06

Location of Project: University of Massachusetts, Amherst, MA

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr: 3

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: ***Stochastic and Dynamic Models of Multi-Story Building Evacuations***

Source of Support: NSF

Total Award Amount: $109,765 Total Award Period Covered: 06/01/03 - 05/31/05

Location of Project: : University of Massachusetts, Amherst, MA

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr: 2

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

NSF Form 1239 (10/99) USE ADDITIONAL SHEETS AS NECESSARY

Current and Pending Support

(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: LIONEL R ORAMA

Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Title 5

Source of Support: DE

Total Award Amount: $2,000,000 Total Award Period Covered: 1999-2004

Location of Project: UPRM

Person-Months Per Year Committed to the Project. Cal: 2.0 Acad: Sumr:

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Collaborative Adaptive Sensing of the Atmosphere (CASA)

Source of Support: NSF

Total Award Amount: $3,710,427.14 Total Award Period Covered: 2003-2008

Location of Project: University of Puerto Rico at Mayaguez

Person-Months Per Year Committed to the Project. Cal: 5.0 Acad: Sumr: 2.0

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

NSF Form 1239 (10/98) USE ADDITIONAL SHEETS AS NECESSARY

Current and Pending Support

(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: **Andrew Pazmany**

Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **Dual Frequency Doppler Radar Observations of Tornadoes**

Source of Support: **National Science Foundation**
Total Award Amount: $ **378,947** Total Award Period Covered: **06/01/00 - 05/31/03**
Location of Project: **University of Massachusetts**
Person-Months Per Year Committed to the Project. Cal:**3.00** Acad: **0.00** Sumr: **0.00**

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **Collaborative Research: An Airborne Radar Study of Cloud Structure and Composition**

Source of Support: **National Science Foundation**
Total Award Amount: $ **176,807** Total Award Period Covered: **03/01/01 - 02/28/04**
Location of Project: **University of Massachusetts**
Person-Months Per Year Committed to the Project. Cal:**1.50** Acad: **0.00** Sumr: **0.00**

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **4D-Radar/Acoustic Measurement of Atmospheric Turbulence in the Stable Boundary Layer (Co-PI)**

Source of Support: **Department of Energy**
Total Award Amount: $ **624,183** Total Award Period Covered: **09/01/99 - 10/31/03**
Location of Project: **University of Massachusetts**
Person-Months Per Year Committed to the Project. Cal:**2.00** Acad: **0.00** Sumr: **0.00**

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **Improved Cloud Radar Ice and Water Estimation (Co-PI)**

Source of Support: **Department of Energy**
Total Award Amount: $ **264,687** Total Award Period Covered: **11/01/99 - 10/31/02**
Location of Project: **University of Massachusetts**
Person-Months Per Year Committed to the Project. Cal:**0.50** Acad: **0.00** Sumr: **0.00**

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:
Total Award Amount: $ Total Award Period Covered:
Location of Project:
Person-Months Per Year Committed to the Project. Cal: Acad: Summ:

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*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

Current and Pending Support

(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: D. M. Pozar	Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Short Range Ultra Wideband Systems

Source of Support: Army Research Lab (DoD MURI)

Total Award Amount: $870,000 Total Award Period Covered: 5/01 - 4/04

Location of Project: University of Massachusetts

Person-Months Per Year Committed to the Project. Cal: 3 Acad: Sumr:

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Design and Development of Low-Loss Microstrip Arrays

Source of Support: DSO Singapore

Total Award Amount: $95,000 Total Award Period Covered: 5/00 - 12/01

Location of Project: University of Massachusetts

Person-Months Per Year Committed to the Project. Cal: 1 Acad: Sumr:

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Conformal RF Antennas

Source of Support: Triton Systems, Inc

Total Award Amount: $30,000 Total Award Period Covered: 9/02 - 3/03

Location of Project: University of Massachusetts

Person-Months Per Year Committed to the Project. Cal: 1 Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

NSF Form 1239 (10/99) USE ADDITIONAL SHEETS AS NECESSARY

Current and Pending Support

(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: Steven C. Reising	Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Long-Term Multifrequency Polarimetric Observations of the Sea Surface Emission

Source of Support: Office of Naval Research

Total Award Amount: $358,513 Total Award Period Covered: 05/01/00 - 04/30/03

Location of Project: University of Massachusetts

Person-Months Per Year Committed to the Project. Cal: 0 Acad: 0 Sumr: 1.75

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

A Detailed Study of the Effect of Breaking Waves on Polarimetric Microwave Emissivities

Source of Support: Office of Naval Research

Total Award Amount: $231,728 Total Award Period Covered: 10/01/02 - 7/31/04

Location of Project: University of Massachusetts

Person-Months Per Year Committed to the Project. Cal: 0 Acad: 0 Sumr: 1.25

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Synthetic Aperture Radiometry Measurements for Soil Moisture

Source of Support: USDA

Total Award Amount: $22,000 Total Award Period Covered: 09/01/01 - 08/31/06

Location of Project: University of Massachusetts

Person-Months Per Year Committed to the Project. Cal: 0 Acad: 0.5 Sumr: 0

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

CAREER: Three-Dimensional Measurements of Atmospheric Water Vapor using Miniaturized Microwave Radiometers

Source of Support: National Science Foundation

Total Award Amount: $451,200 Total Award Period Covered: 03/01/03 - 02/28/08

Location of Project: University of Massachusetts

Person-Months Per Year Committed to the Project. Cal: 0 Acad: 0 Sumr: 2.0

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

NSF Form 1239 (10/99) USE ADDITIONAL SHEETS AS NECESSARY

Current and Pending Support
(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: Havidán Rodríguez	Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:
Integrating Census Data Analysis into the Curriculum

Source of Support: National Science Foundation
Total Award Amount: $439,000 Total Award Period Covered: 2002-2005
Location of Project: American Sociological Association and the Univ. of Michigan
Person-Months Per Year Committed to the Project. Cal: 1 Acad: Sumr:

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:
"Minority Access to Research Careers (MARC): Program Evaluation

Source of Support: MARC through the National Institutes of Health
Total Award Amount: $90,575 Total Award Period Covered: 2001-2005
Location of Project: Univ. of Puerto Rico-Mayaguez
Person-Months Per Year Committed to the Project. Cal: Acad: 1 Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:

Source of Support:
Total Award Amount: $ Total Award Period Covered:
Location of Project:
Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:

Source of Support:
Total Award Amount: $ Total Award Period Covered:
Location of Project:
Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:

Source of Support:
Total Award Amount: $ Total Award Period Covered:
Location of Project:
Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

NSF Form 1239 (10/99) USE ADDITIONAL SHEETS AS NECESSARY

Current and Pending Support

(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: Rafael A. Rodríguez	Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

CAREER: Wideband Slot-like Antennas and Enhancement of Applied Electromagnetics Education at UPRM

Source of Support: NSF

Total Award Amount: $584,346 Total Award Period Covered: 06/01/2001-05/31/2006

Location of Project: UPRM

Person-Months Per Year Committed to the Project. Cal: Acad: .25 Sumr: .5

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Electroceramic Antennas and Devices - NASA Tropical Center for Earth and Space Studies

Source of Support: NASA

Total Award Amount: $174,975 Total Award Period Covered: 10/01/2000-09/30/2005

Location of Project: UPRM

Person-Months Per Year Committed to the Project. Cal: Acad: .11 Sumr:

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Center for Subsurface Sensing and Imaging Systems - UPRM Education Thrust

Source of Support: NSF

Total Award Amount: $175,000 Total Award Period Covered: 09/01/2000-08/30/2005

Location of Project: UPRM

Person-Months Per Year Committed to the Project. Cal: Acad: .25 Sumr: .5

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Multi-beam antenna arrays with fine beam positioning for formation flying satellites

Source of Support: NASA

Total Award Amount: $194,039 Total Award Period Covered: 08/01/2003-07/31/2006

Location of Project: UPRM

Person-Months Per Year Committed to the Project. Cal: Acad: .25 Sumr: .5

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

NSF Form 1239 (10/99) USE ADDITIONAL SHEETS AS NECESSARY

Current and Pending Support
(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: Kathy G. Rubin

Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:
NSF Computer Science, Engineering, and Mathematics (CSEM) Scholarship Program
Source of Support: National Science Foundation
Total Award Amount: $495,000 Total Award Period Covered: 1/00-1/04
Location of Project: University of Massachusetts, Amherst
Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:
NSF Computer Science, Engineering and Mathematics (CSEM) Scholarship Program
Source of Support: National Science Foundation
Total Award Amount: $400,000 Total Award Period Covered: 2002-2006
Location of Project: University of Massachusetts, Amherst
Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:
Source of Support:
Total Award Amount: $ Total Award Period Covered:
Location of Project:
Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:
Source of Support:
Total Award Amount: $ Total Award Period Covered:
Location of Project:
Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:
Source of Support:
Total Award Amount: $ Total Award Period Covered:
Location of Project:
Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

NSF Form 1239 (10/99) USE ADDITIONAL SHEETS AS NECESSARY

Current and Pending Support

See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: Steven A. Rutledge	Other agencies (including NSF) to which this proposal has been/will be submitted. NSF

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:
The CSU-CHILL Radar Facility

Source of Support: NSF
Total Award Amount: $3,508,448 Total Award Period Covered: 9/1/01 to 8/31/06
Location of Project: Colorado State University
Person-Months Per Year Committed to the Project. 2 mos. Cal: 2 Acad: 1 Sumr: 1

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:
Analysis of Data from TRMM/LBA to Validate TRMM Satellite Algorithms and Models

Source of Support: NASA
Total Award Amount: $413,673 Total Award Period Covered: 6/1/00 to 5/31/03
Location of Project: Colorado State University
Person-Months Per Year Committed to the Project. 1 mo. Cal: 1 Acad: 1 Sumr:

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:
Shipboard Radar Observations of Precipitating Convection in EPIC

Source of Support: NSF
Total Award Amount: $515,870 Total Award Period Covered: 3/1/01 to 2/28/04
Location of Project: Colorado State University
Person-Months Per Year Committed to the Project. 1 mo. Cal: 1 Acad: Sumr: 1

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:
Dynamical, Microphysical and Electrical Studies of Convection in STEPS

Source of Support: NSF
Total Award Amount: $370,532 Total Award Period Covered: 4/1/00 to 3/31/03
Location of Project: Colorado State University
Person-Months Per Year Committed to the Project. 1 mo. Cal: 1 Acad: Sumr: 1

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:
ITR/AP: Sensor Fusion and Networking of Radars over the Internet

Source of Support: NSF
Total Award Amount: $231,094 Total Award Period Covered: 10/1/01 to 9/30/06
Location of Project: Colorado State University
Person-Months Per Year Committed to the Project. .6 mos. Cal: .6 Acad: .6 Sumr:

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

Current and Pending Support

See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: Steven A. Rutledge	Other agencies (including NSF) to which this proposal has been/will be submitted. NSF

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Major Research Equipment (Subcontract w/UMASS)

Source of Support: NSF

Total Award Amount: $112,034 Total Award Period Covered: 9/1/01 to 8/31/06

Location of Project: Colorado State University

Person-Months Per Year Committed to the Project. 1 mo. Cal: 1 Acad: 1 Sumr:

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Resident Instruction Support

Source of Support: Colorado State University

Total Award Amount: $ Total Award Period Covered:

Location of Project: Colorado State University

Person-Months Per Year Committed to the Project. 5.4 mos Cal: 5.4 Acad: 5.4 Sumr:

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

CoCoRaHS: Science Education Through Participation in Community-Based Research

Source of Support: NSF

Total Award Amount: $899,000 Total Award Period Covered: 1/1/03 to 12/31/05

Location of Project: Colorado State University

Person-Months Per Year Committed to the Project. 0 Cal: 0 Acad: Sumr:

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Development of a High Performance Offset Gregorian Antenna for the CSU-CHILL National Radar Facility

Source of Support: NSF

Total Award Amount: $1,404,875 Total Award Period Covered: 8/15/02 to 7/31/04

Location of Project: Colorado State University

Person-Months Per Year Committed to the Project. 0 Cal: 0 Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

NSF Form 1239 (7/95) USE ADDITIONAL SHEETS AS NECESSARY

Current and Pending Support

(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: Stephen M. Sekelsky	Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

An Advanced Multi-Frequency Radar for Atmospheric Research

Source of Support: NSF

Total Award Amount: $1M Total Award Period Covered: 9/1/01-8/31/04

Location of Project: UMass Amherst

Person-Months Per Year Committed to the Project. Cal: 3.0 Acad: Sumr:

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Performance Upgrade and Reconfiguration of the CMR Instrument

Source of Support: U.S. Dept. of Energy

Total Award Amount: $270,823 Total Award Period Covered: 12/18/01-1/31/03,

Location of Project: UMAss Amherst

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Supplement to Performance Upgrade and Reconfiguration of CMR Instrum

Source of Support:

Total Award Amount: $37, Total Award Period Covered: 6/19/02-6/30/03

Location of Project: Livermore, CA

Person-Months Per Year Committed to the Project. Cal: .75 Acad: Sumr:

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Multi-wavelength Radar Algorithms for Estimating Cloud Microphysics

Source of Support: U.S. Dept. of Energy

Total Award Amount: $297,679 Total Award Period Covered: 11/1/02-10/31/05

Location of Project: UMass Amherst

Person-Months Per Year Committed to the Project. Cal: 3.0 Acad: Sumr:

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

AQUA Validation Campaign

Source of Support:

Total Award Amount: $30,000 Total Award Period Covered: 9/1/02-8/31/03

Location of Project: NASA Wallops

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

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*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

NSF Form 1239 (10/99) USE ADDITIONAL SHEETS AS NECESSARY

Current and Pending Support
(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: Paula L. Sturdevant Rees	Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:
Event-based transport of cryptosporidium, Giardia, & source-specific indicator organisms from agricultural and residential areas
Source of Support: AWWARF
Total Award Amount: $647,500 Total Award Period Covered: 01/01 - 05/04
Location of Project: U. Massachusetts
Person-Months Per Year Committed to the Project. Cal: 1.20 Acad: Sumr:

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:
Watershed model evaluation and development, Prj 2 of full proposal "Water Quality in MDC Reservoirs: 2001-2003"
Source of Support: Metropolitan District Commission, Commonwealth of Massachuset
Total Award Amount: $145450 Total Award Period Covered: 07/01 - 06/03
Location of Project: U. Massachusetts
Person-Months Per Year Committed to the Project. Cal: 1.03 Acad: 0.34 Sumr: 0.69

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:
Expanding a General Framework for Inquiry Learning
Source of Support: U.S. Department of Education
Total Award Amount: $599,993 Total Award Period Covered: 9/01 - 8/04
Location of Project: UMassachusetts
Person-Months Per Year Committed to the Project. Cal: 1.6 Acad: - Sumr: 1.6

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:
Watershed sources and long-term variability of BDOM and NOM as precursors
Source of Support: AWWARF
Total Award Amount: $569,535 Total Award Period Covered: 01/03 - 12/05
Location of Project: U. Massachusetts
Person-Months Per Year Committed to the Project. Cal: 1.96 Acad: Sumr:

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:
Pavement runoff constituents in closed highway drainage systems
Source of Support: Massachusetts State Highway Department
Total Award Amount: $ Total Award Period Covered:
Location of Project:
Person-Months Per Year Committed to the Project. Cal: 2.31 Acad: .87 Sumr: 1,44

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

NSF Form 1239 (10/99) USE ADDITIONAL SHEETS AS NECESSARY

Current and Pending Support
(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: Paula L. Sturdevant Rees (Pg 2)

Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☐ Current ☐ Pending ☒ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:
Engineering Research Center for Extreme Weather Events, Center for Collab

Source of Support: NSF
Total Award Amount: $ Total Award Period Covered:
Location of Project:
Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:

Source of Support:
Total Award Amount: $ Total Award Period Covered:
Location of Project:
Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:

Source of Support:
Total Award Amount: $ Total Award Period Covered:
Location of Project:
Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:

Source of Support:
Total Award Amount: $ Total Award Period Covered:
Location of Project:
Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:

Source of Support:
Total Award Amount: $ Total Award Period Covered:
Location of Project:
Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

NSF Form 1239 (10/99) USE ADDITIONAL SHEETS AS NECESSARY

Current and Pending Support

(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator:Russell Tessier	Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Adaptive Fault Tolerance for Networked Digital Systems

Source of Support: National Science Foundation

Total Award Amount: $184000 Total Award Period Covered: 09/01/00 to 08/31/03

Location of Project: University of Massachusetts

Person-Months Per Year Committed to the Project. Cal: 0 Acad: 0 Sumr: 0

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Adaptive Systems on a Chip: Architectures, Algorithms and Applications

Source of Support: National Science Foundation

Total Award Amount: $300388 Total Award Period Covered: 07/01/00 to 06/30/03

Location of Project: University of Massachusetts

Person-Months Per Year Committed to the Project. Cal: 0 Acad: 0 Sumr: 0

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Incremental Synthesis and Physical Design for FPGAs and ASICs

Source of Support: National Science Foundation

Total Award Amount: $319,202 Total Award Period Covered: 07/01/03 to 06/30/06

Location of Project: University of Massachusetts

Person-Months Per Year Committed to the Project. Cal: 0 Acad: 0 Sumr: 1

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Application Synthesis and Incremental Compilation for Reconfigurable Sys

Source of Support: National Science Foundation

Total Award Amount: $319,202 Total Award Period Covered: 07/01/03 to 06/30/06

Location of Project: University of Massachusetts

Person-Months Per Year Committed to the Project. Cal: 0 Acad: 0 Sumr: 1

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

NSF Form 1239 (10/99) USE ADDITIONAL SHEETS AS NECESSARY

Current and Pending Support

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: Towsley, Don

Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: XCurrent ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:
CISE Research infrastructure: Infrastructure to Support Research on Mixed Wire/Wireless Information Systems (J. Kurose, PI)
Source of Support: NSF
Total Award Amount: $2999002 Total Award Period Covered: 9/1/00-8/31/05
Location of Project: University of Massachusetts Amherst
Person-Months Per Year Committed to the Project. Cal: 0 Acad: 0 Sumr: 0

Support: X Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:
Proxy Services in Wide-Area Networks
Source of Support: NSF
Total Award Amount: $1010263 Total Award Period Covered: 9/15/99-8/31/03
Location of Project: University of Massachusetts Amherst
Person-Months Per Year Committed to the Project. Cal: 0 Acad: 0 Sumr: 0

Support: X Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:
Specialized Active Network Technologies
Note: this grant expires prior to the start of this proposal
Source of Support: Northrup Grumman Info. Tech. (DARPA subcontract)
Total Award Amount: $454000 Total Award Period Covered: 8/31/02-12/31/02
Location of Project: University of Massachusetts Amherst
Person-Months Per Year Committed to the Project. Cal: 0 Acad: 0 Sumr: 0

Support: ☒ Current Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:
Transnational Digital Government
Source of Support: NSF (subcontract with Univ. of Florida)
Total Award Amount: $210000 Total Award Period Covered: 6/11/02-4/30/05
Location of Project: University of Massachusetts Amherst
Person-Months Per Year Committed to the Project. Cal: 0 Acad: 0 Sumr: 1 week

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:
ITR:SII – Scalable QoS Control for the Next Generation Internet….
*1 month year 2; 2 mos years 3, 4, 5
Source of Support: NSF
Total Award Amount: $1248439 Total Award Period Covered: 9/1/00-8/31/05
Location of Project: University of Massachusetts, Amhest
Person-Months Per Year Committed to the Project. Cal: 0 Acad: 0 Sumr: 2

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

NSF Form 1239 (10/99) USE ADDITIONAL SHEETS AS NECESSARY

Current and Pending Support

(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: Towsley, Don

Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: X Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:
Fluid Methods for Modeling large, Heterogeneous Networks

Source of Support: DARPA

Total Award Amount: $970629 Total Award Period Covered: 4/20/00-4/20/03

Location of Project: University of Massachusetts Amherst

Person-Months Per Year Committed to the Project. Cal: 0 Acad: 2.00 Sumr: 0

Support: X Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:
Secure Group Communications in Mobile Networking Environments
J. Kurose, PI; D. Towsley , B. Levine, CoIs

Source of Support: Northrup Grumman Info. Tech. (DARPA subcontract)

Total Award Amount: $343675 Total Award Period Covered: 5/25/00-5/24/03

Location of Project: University of Massachusetts Amherst

Person-Months Per Year Committed to the Project. Cal: 0 Acad: 1.25 Sumr: 0

Support: X Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:
Internet Congestion Control: Design, Modeling and Analysis

Source of Support: NSF

Total Award Amount: $300000 Total Award Period Covered: 6/15/00-5/31/03

Location of Project: University of Massachusetts Amherst

Person-Months Per Year Committed to the Project. Cal: 0 Acad: 0 Sumr: 1.00

Support: ☒ Current Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:
NSF-CNPq – Application level Adaptation and Control for Retrieval and Delivery of Continuous….

Source of Support: NSF

Total Award Amount: $59215 Total Award Period Covered: 10/1/00-9/30/03

Location of Project: University of Massachusetts Amherst

Person-Months Per Year Committed to the Project. Cal: 0 Acad: 0 Sumr: 0

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:
ITR: Research Needed to Enable Americas' Multilingual Information Grid Alliance (AMIGA)

Source of Support: NSF (subcontract with Univ. of Florida)

Total Award Amount: $662714 Total Award Period Covered: 5 years

Location of Project: University of Massachusetts Amherst

Person-Months Per Year Committed to the Project. Cal: 0 Acad: 0 Sumr: 1

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*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

Current and Pending Support

(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: Towsley, Don	Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

A Modeling Methodology for Network Vulnerability Evaluation (WB Gong, ECE, PI)

Source of Support: NSF

Total Award Amount: $424193 Total Award Period Covered: 3 years

Location of Project: University of Massachusetts Amherst

Person-Months Per Year Committed to the Project. Cal: 0 Acad: 0 Sumr: 1

Support: Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Measurement from the Middle
J. Kurose, PI

Source of Support: NSF

Total Award Amount: $455857 Total Award Period Covered: 3 years

Location of Project: University of Massachusetts Amherst

Person-Months Per Year Committed to the Project. Cal: 0 Acad: 0 Sumr: 1

Support: Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Dynamic End-to-End quality of Service (QoS) Management in Wireless Ad Hoc Networks
*.95 mo yr 2; .90 mo yr 3; 1.2 mos final 6 mos

Source of Support: ONR (subcontract with Alphatec, Inc.)

Total Award Amount: $765000 Total Award Period Covered: 3.5 yrs

Location of Project: University of Massachusetts Amherst

Person-Months Per Year Committed to the Project. Cal: 0 Acad: 0 Sumr: 1*

Support: ☐ Current X Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

(this proposal)

Source of Support: NSF

Total Award Amount: $ Total Award Period Covered:

Location of Project: University of Massachusetts Amherst

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

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*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

NSF Form 1239 (10/99) USE ADDITIONAL SHEETS AS NECESSARY

Current and Pending Support

(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: **Baxter Vieux**	Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **Continued Development of the Web-EH Interface and Integration with Emerging Cluster and Data Mining Technologies**

Source of Support: **NCSA/NSF subcontract**

Total Award Amount: $ **100,000** Total Award Period Covered: **01/01/02 - 12/31/02**

Location of Project: **University of Oklahoma**

Person-Months Per Year Committed to the Project. Cal: **0.00** Acad: **0.00** Sumr: **0.50**

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **Hydrologic Evaluation of Dual Polarization Quantitative Precipitation Estimates**

Source of Support: **NSF**

Total Award Amount: $ **438,318** Total Award Period Covered: **01/01/03 - 06/30/05**

Location of Project: **University of Oklahoma**

Person-Months Per Year Committed to the Project. Cal: **0.00** Acad: **0.00** Sumr: **1.00**

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Summ:

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

Current and Pending Support
(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator:Luther William White	Other agencies (including NSF) to which this proposal has been/will be submitted. none

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:
Modeling Studies in the Duke Forest Free-Air CO2 Enrichment (FACE) Progra

Source of Support: DOE
Total Award Amount: $732,000 Total Award Period Covered: 2002-2005
Location of Project: University of Oklahoma
Person-Months Per Year Committed to the Project. 1 Cal: Acad: Sumr: 1

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:

Source of Support:
Total Award Amount: $ Total Award Period Covered:
Location of Project:
Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:

Source of Support:
Total Award Amount: $ Total Award Period Covered:
Location of Project:
Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:

Source of Support:
Total Award Amount: $ Total Award Period Covered:
Location of Project:
Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:

Source of Support:
Total Award Amount: $ Total Award Period Covered:
Location of Project:
Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

NSF Form 1239 (10/99) USE ADDITIONAL SHEETS AS NECESSARY