Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

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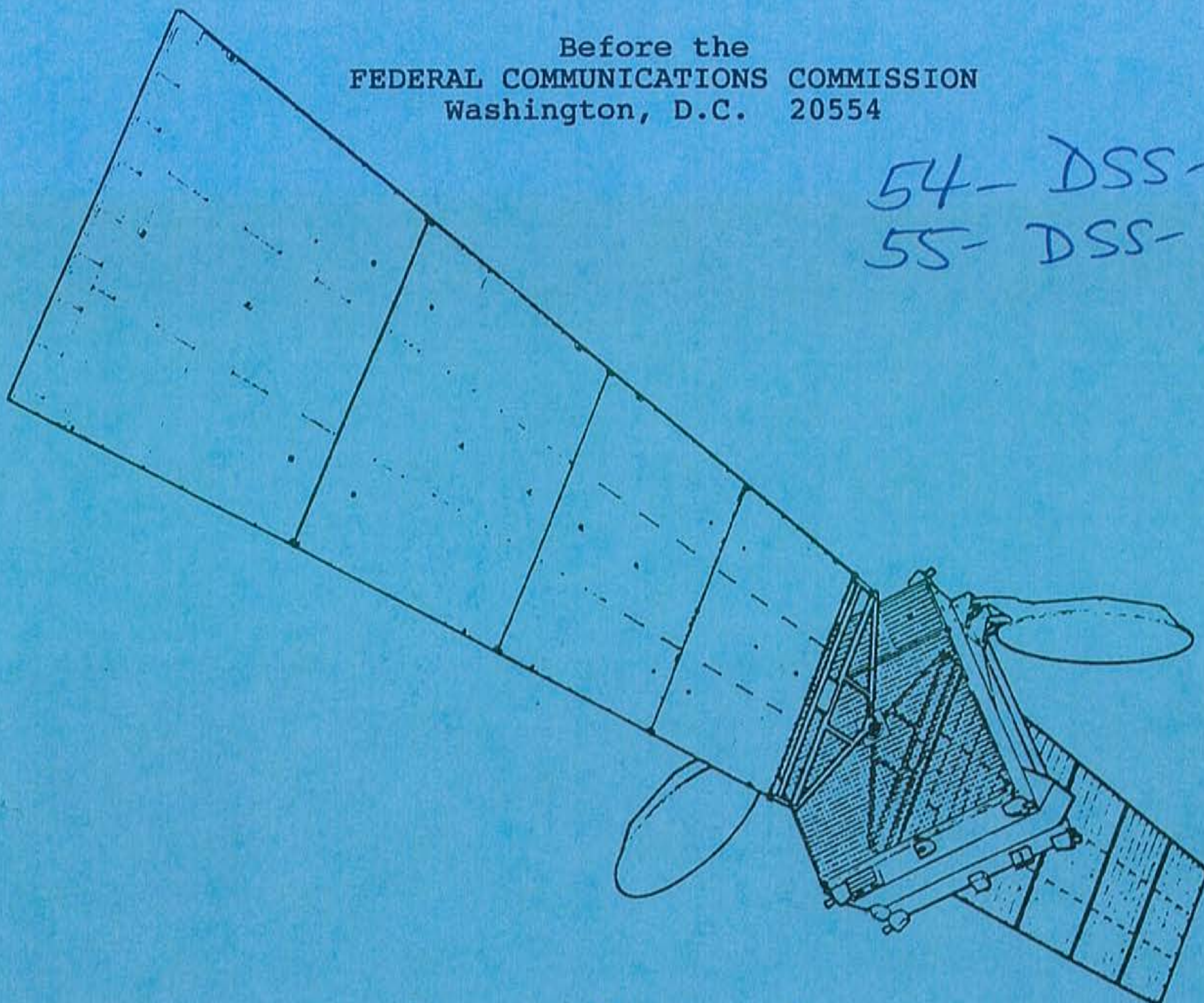

Application of

Norris Satellite Communications, Inc.

To Launch and Operate
Communications Satellites
in the Domestic Fixed-Satellite Service

July 16, 1990

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July 16, 1990

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LESLIE A. TAYLOR
President

July 16, 1990

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Domestic Facilities Division
Satellite Radio Branch

Ms. Donna R. Searcy
Secretary
Federal Communications Commission
1919 M Street, N.W.
Room 222
Washington, D.C. 20554

Re: Application to Construct, Launch and Operate Ka-band (30/20 GHz) Communications Satellites in the Domestic Fixed-Satellite Service

Dear Ms. Searcy:

Attached are an original and nine copies of the above-referenced application, along with the filing fee of $74,060. By separate filing, a portion of the application is being submitted with a request that it be withheld from public inspection.

In addition, by separate filing, a Petition for Rulemaking requesting the allocation of certain Ka-band frequencies to a General Satellite Service, along with a request for grant of a Pioneer's Preference, are being submitted.

If you have any questions, please contact the undersigned.

Sincerely yours,

Leslie A. Taylor

Leslie A. Taylor

Attachments

APPLICATION OF NORRIS SATELLITE COMMUNICATIONS TO CONSTRUCT, LAUNCH AND OPERATE COMMUNICATIONS SATELLITES

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Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of the Application of NORRIS Satellite Communications, Inc. For Authority to Construct, Launch and Operate a Communications Satellite in the Domestic Fixed-Satellite Service	)	File No.

Application of Norris Satellite Communications, Inc.

Norris Satellite Communications, Inc. ("Norris") pursuant to Sections 308, 309 and 319 of the Communications Act of 1934, as amended, hereby applies for authority to construct two and launch and operate one domestic-fixed communications satellites utilizing the 30 GHz and 20 GHz frequency bands.[1]

1.0 Introduction

1.1 Summary

Known as "NorStar," the proposed satellite system will be the first United States commercial satellite to provide service in the 30/20 GHz frequency bands. The use of this band represents a significant advance in satellite communications that will provide substantial flexibility and benefits to users and the public at large. Services provided on the NorStar system will enjoy an interference-free environment in an increasingly crowded orbital

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[1] Norris Satellite Communications, Inc. is currently evaluating options for obtaining services necessary to perform TT&C functions. Norris by separate application will seek authorization for construction and operation of such facilities.

arc. Furthermore, implementation of satellite service in this band in the United States will stimulate development of earth station and receiver equipment using a new frequency band.

The key features that will characterize the NorStar system are:

(1) the use of multiple Ka-band coverage patterns;

(2) on-board capability to provide higher power on an as-needed basis;

(3) spot-beam technology that will enable 50-state coverage of the United States as well as specific areas of service that will provide service to very small customer-premise earth stations, both receive-only and transit-receive;

(4) high-capacity and high-power through 24 transponders of 24 MHz bandwidth powered by 90 watt TWTAs.

The proposed satellite system was developed in response to customer demand to move to the next stage of satellite development --one which integrates the benefits of known technology with innovation to provide service in the public interest. The system is designed to provide a variety of satellite services--fixed, broadcasting, mobile and personal--from a single platform. As such, the proposed system responds to customer demand for satellite facilities: (1) operating in an interference-free environment; (2) providing additional satellite capacity for video, data and mobile communications services, and (3) enabling the transmission of information at extremely high data rates.

This application is divided into three sections. The first, Part I, contains a description of the proposed satellite, services to be provided, demand, projected costs and revenues, and provides the qualifications of Norris Satellite Communications, Inc. The second section, Part II, contains the detailed technical description of the proposed system. Part III contains the individual applications, as required by the FCC rules and regulations.

By separate application, Norris will apply for authority to utilize and/or construct appropriate TT&C facilities as a part of its proposed system.

1.2 Petition for Creation of General Satellite Service and Request for "Pioneer's Preference"

Contemporaneously with this application, Norris Satellite Communications has filed a Petition for Rulemaking requesting reallocation of the 19.7-20.2 GHz (downlink) and 29.5-30.0 GHz (uplink) bands to a General Satellite Service. The bands currently are allocated on a primary basis internationally and within the United States to the Fixed-Satellite Service and on a secondary basis to the Mobile Satellite Service. Norris urges the Commission to create a General Satellite Service in which fixed, broadcasting and mobile services can be provided on a co-primary basis.

Allocation of such a generic satellite service will serve the public interest by enabling rapid introduction of Ka-band satellite technology and rapid development of Ka-band ground segment and services.

Along with the Petition for Rulemaking requesting the creation of a General Satellite Service, Norris requests the grant of a "Pioneer's Preference" with regard to its application, recognizing the risk taken by an applicant which proposes the use of a heretofore unused frequency band. The Commission, in General Docket No. 90-217, has proposed "preferential treatment in its licensing process for parties requesting spectrum allocation rule changes associated with the development of new communications services."[2]

The Commission states further its belief that "(T)he proposed rules would help to ensure that innovators have an opportunity to participate in new services that they take a lead in developing."[3] Comments regarding the "Pioneer's Preference" generally have been favorable.[4]

In order to apply meaningfully the Pioneer's Preference to the instant application, Norris requests the Commission to process its application on its own merits rather than delaying its consideration to a processing group. And, as the Commission itself has suggested in its Pioneer's Preference proceeding,[5] the application should be processed at the same time as the Petition for Rulemaking in order to expedite Commission action. In addition, a "Pioneer's Preference" for initiating new satellite

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[2]FCC 90-141 Notice, para. 1.

[3]Id.

[4]See Comments of Leslie Taylor Associates filed June 29, 1990.

[5]FCC 90-217, para. 7.

service in a heretofore unused frequency band should confer a two-year, or at least a one-year, headstart over other potential applicants to provide such service.

In support of this application, Norris respectfully submits the following:

1.3 Description of Facilities

The satellites for which authority is requested will operate in the 30/20 GHz band, and contain power levels, coverage patterns and switchable beams to serve numerous telecommunications requirements.

The satellites will have the following characteristics:

(1) 24 24-MHz transponders;

(2) saturated output power of 90 watts per TWTA;

(3) eight antenna beams which will permit transponder outputs to be switched to provide EIRPs ranging from 53 dBW in the West to a maximum of 65 dBW in Florida. The antenna gains are weighted to provide higher power to the areas of the United States with the worst rainfall rates.

The coverage of the satellites will be 50 states. When operating with spot beams to facilitate coverage to specific areas or for specific applications, 50-state coverage may note be maintained at all times.

1.4 Orbital Location Requirements

Because of the unique service requirements of this satellite, Norris respectfully requests an orbital assignment of 90 W.L. The reasons for this request are as follows:

(1) the current design for the satellite provides for optimized performance from an orbital location in the range of 85 W.L. to 100 W.L.;

(2) because of the planned use of very small aperture antennas operating in the 30/20 GHz frequency bands, the satellite must be located near the center of the United States to achieve adequate elevation angles;

(3) assigning the satellite near the center of the orbital arc will maximize the ability of the satellite to overcome rain attenuation at 30/20 GHz;

(4) major customers of the NorStar system are designing their networks based on the assumption the satellite will be located near the middle of the United States.

In addition, an assignment of 90 degrees W.L. would be consistent with the Commission's policy of assigning, when possible "a new entrant in each frequency band at least one location in that band from which it can provide 50-state coverage." Assignment of Orbital Locations to Space Stations in the Domestic Fixed-Satellite Service, FCC 89-364, Memorandum, Opinion and Order (rel. Jan. 11, 1990) [hereinafter cited as 1990 Assignment Order]; accord, Assignment of Orbital Locations to Space Stations in the Domestic Fixed-Satellite Service, Memorandum, Opinion and Order, 3

FCC Rcd. 6972 (1988) "[W]e attempt to afford new entrants , when possible, at least one initial orbital location in the portion of the orbital arc that allows them to provide maximum quality service to all 50 states."

The Commission should note as well that the 90 degrees W.L. orbital location does not fall within the portion of the orbital arc earmarked for 12/14 GHz satellites that operate with power densities above those routinely authorized by the Commission. "Orbital locations from 74 degrees W.L. to 79 degrees W.L. in the eastern portion of the arc and from 133 degrees W.L. to 137 degrees W.L. in the western arc have been earmarked for 12/14 GHz satellites that are to operate with power densities above those that we routinely authorize." 1990 Assignment Order at 7, n.10. For the foregoing reasons, Norris respectfully requests assignment of its satellite to 90 degrees W.L.

1.5 Request for Prompt Commission Action

The Commission has repeatedly stated its support for applications of new telecommunications technologies. Rapid processing of the Norris application, along with an orbital assignment that will ensure the best possible service, is consistent with that commitment. As the Commission itself has noted, delay in regulatory proceedings delays the delivery of new[6]

[6]See, e.g., Inquiry into the development of regulatory policy in regard to Direct Broadcast Satellite for the period following the 1983 Regional Administrative Radio Conference, Report and Order, 90 FCC 2d 676, 683 (1982): "[B]ecause of the long lead times required for satellite construction, delaying the granting of

and innovative services to the public and thereby frustrates the Commission's mandate to "make available, so far as possible, to all the people of the United States a rapid, efficient, Nation-wide and world-wide wire and radio communication service." Communications Act of 1934, as amended, 47 U.S.C. Sec. 151 (1986).

As discussed in the Commission's Pioneer Preference proceeding and Norris's application for the grant of such a preference, it is in the public interest for the Commission to process the instant

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construction permits until after the 1983 RARC would probably mean that no DBS systems would go into operation until the end of this decade."

Amendment of Sec. 22.901(d) of the Commission's Rules to Eliminate Commission Review of Capitalization Plans for Mobile Radio Cellular Systems, CC Docket No. 87-274, Notice of Proposed Rulemaking, 5 Rad. Reg. (P&F) Current Service 74:53, 56 (1987): "[T]he need to obtain prior approval of capitalization plans may delay unduly the RBOCs' investments in cellular radio operation to the detriment of the users of those services."

An Inquiry Into the Use of the Bands 825-845 MHz and 870-890 MHz for Cellular Communications Systems, CC Docket No. 79-318, Report and Order, 469, 498 (1981) (Lengthy and time consuming "procedures for consideration of competing applications might cause significant delays in the implementation of cellular service. Such long delays could impose substantial burdens on the applicants, inconvenience the public and frustrate our goal of having cellular service available as rapidly as is practicably possible.") See also, Cellular Lottery Rulemaking, 98 FCC 2d 175 (1984);

Provision of Aeronautical Services via the Inmarsat System, CC Docket No. 87-75, 4 FCC Rcd. 6072, 6078 (1989): "The comments that we have received ... demonstrate not only the benefits that will result from making Inmarsat aeronautical services available to the U.S. aeronautical community, but also the need to expeditiously move ahead in view of potential foreign competition. ... [W]e believe that we should adopt a policy which will best promote and protect U.S. interests ... by ensuring the early introduction of ... services to the U.S. aeronautical community."

application on its own merits rather than holding such action for the formation of a satellite processing group. In the currently unused 30/20 GHz frequency band, the Commission does not face the possibility that it could not accommodate numerous applications. The bands in which NorStar will operate are already allocated to the Fixed-Satellite service. Consequently, should the Commission require additional time to evaluate Norris's frequency reallocation proposal, its application could nevertheless be granted with regard to the fixed-satellite service, subject to revision of the authorization at a later date to provide broadcasting and mobile satellite service on a co-primary basis.

2.0 Demand for the Service and Proposed Services

Norris has determined that there is significant demand for satellite service in the 30/20 GHz frequency band. The following factors will contribute to increasing demand for satellite transponders of all types in the 1990's:

(1) increased use of telecommunications facilities, in general, for voice, data and video transmissions;

(2) growth of VSAT networks as U.S. companies and the U.S. government increasingly require flexible solutions to data management and movement requirements;

(3) growth in services such as video-conferencing and business video, as transportation costs increase and as business trips become more complicated, frustrating and time-consuming;

(4) growth in use of facsimile machines, data information services and the penetration of these services to the home.

(5) development of compression techniques which promote the utilization of High-Definition Television.

The following are factors that will contribute to demand for services in the Ka-band on the proposed NorStar satellite:

(1) saturation of transponders in the C and Ku-band;

(2) increasing difficulties in coordinating satellites and earth stations in those bands;

(3) technological innovation provided by the Ka-band earth station, including possible use of such earth stations for fixed, broadcasting and mobile satellite applications;

(4) demand for mobile satellite service that cannot be met by L-band allocations.

2.1 <u>Synergies between NASA ACTS Program and Norris Proposal</u>

NASA is currently preparing to launch its Advanced Communications Technology Satellite (ACTS) in 1992. This satellite has a design life of two years. NASA is working with the public and private sector entities which propose to conduct experiments with ACTS. The program-specific goals of ACTS are:

♦ Support of innovative research in communications satellite technologies, the implementation of which in the national and international marketplaces will help maintain U.S. preeminence in space communications.

♦ Support of research into advanced science data networking (including technologies related to data management and visualization such as high definition television, signal compression, packet routing, etc.) using satellite communications.[7]

NASA states that "The ACTS Program is based on the alliance of private industry and Government," Research Announcement, Appendix A, p. 1.

NASA is urging government and commercial entities to invest in the development of ground segment for participation in the ACTS experiments. Assurance that follow-on commercial Ka-band satellite capacity will be available is likely to encourage more participants who will be able to use their facilities after the ACTS experiments are concluded.

Conversely, the ACTS experimenters will constitute a base of users who are likely candidates for service form the NorStar satellite. Thus, in analyzing the prospective market for NorStar, Norris has evaluated closely the prospective users of ACTS.

2.2 Overall Demand for Satellite Services

In 1983 Western Union commissioned a major demand forecast for the domestic fixed-satellite service. This study developed forecasts based on three alternative assumptions--aggressive, moderate, and low actual demand through the 1980's and 1990's. The actual use of transponders in the 1980's has been in the moderate

[7]Research Announcement, Advanced Communications Technology Satellite (ACTS), Systems Concept Development (ASCD) Program, NASA, NRA 90-OSSA-7, March 5, 1990.

range of the study's forecasts. For the 1990's, the study projects that, "assuming low-required and high-actual capacity [of C and Ku-band satellites], Ka-band will be needed around 1995." More recent analyses, including those of GTE Spacenet Corporation, indicate that demand for transponders will exceed supply in 1993 or 1994.[8]

Thus, the Norris proposal responds to the satellite market demand of the 1990's.

The markets for Ka-band satellite service such as ACTS and NorStar are a natural evolution of earlier markets created by C- and Ku-band satellites. Figure I-1 diagrams the key features of these markets. The total market for satellite communications systems and services has grown to more than $5 billion per year and is expected to top $40 billion by the year 2000.[9]

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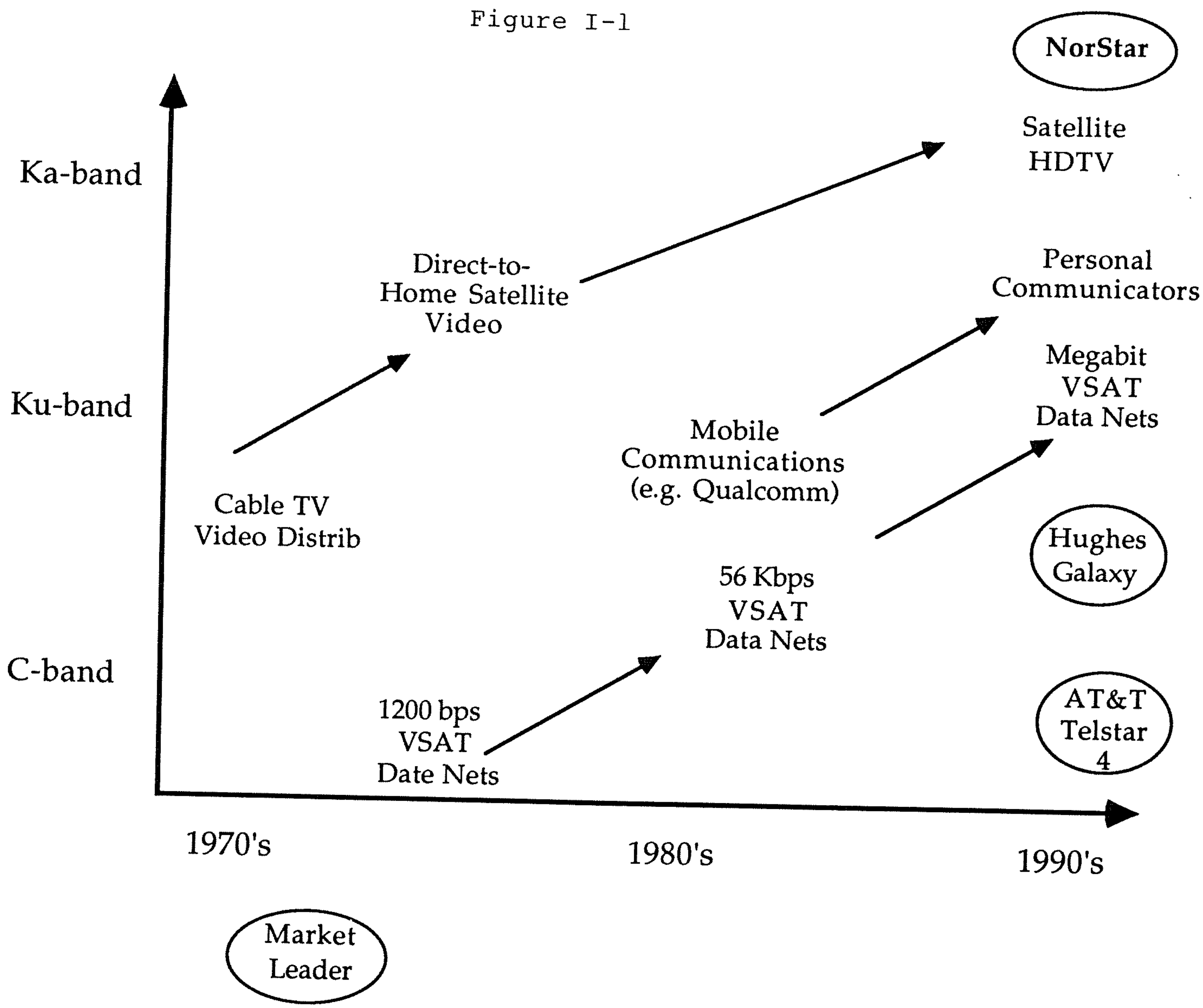
[8] See C.J. Waylan, "Satellite Markets--Opportunities and Challenges," Via Satellite, August, 1989.

[9] Communication Satellites, Guidelines for a Strategic Plan, NASA Advisory Council, 1989, p. 5.

Figure I-1



Evolution of NorStar Markets

2.3 Current Use of Facilities in the Domestic Fixed-Satellite Service

Today the U.S. domestic satellite market is characterized by intensive use of the 6/4 GHz and 14/12 GHz frequency bands. More than 25 satellites operating in the United States provide services in these bands to thousands of customers and millions of end users. More satellites were approved for construction and launch by the Commission in 1987 with orbital locations determined in 1988, 1989 and 1990. See, Assignment of Orbital Locations to Space Stations in the Domestic Fixed-Satellite Service, 3 FCC Rcd 6972 (1988), "1988 Assignment Order," and Assignment of Orbital Locations to Space Stations in the Domestic Fixed-Satellite Service, FCC 89-364, (released Jan. 11, 1990), "1990 Assignment Order." These satellites provide service over approximately 500 transponders. New satellites to be deployed in the 1990's will utilize higher-powered transponders, as well as more on-board capacity per satellite.

Because of extensive use by U.S. domestic satellites of these frequency bands, the FCC, in 1983, instituted a policy of reduced orbital spacing, in order to maximize the use of the geostationary-orbit resource. This policy is being implemented as increasing numbers of satellites are being deployed in these bands. As more satellites are operated, many thousands of additional earth stations also come into operation.

The growth in use of the C and Ku frequency bands, as well as the operation of satellites at closer orbital spacings, has led to significant requirements for coordination among satellite operators and among satellite operators and users. In many cases, cooperation has resolved interference problems, but coordination and cooperation have not come without cost. In order to prevent reception of alien signals, at times systems have had to employ larger, more expensive earth stations, and satellites have had to restrict the uses of certain transponders. In its 1990 Assignment Order the Commission addressed some of these issues when it reassigned certain satellites to new orbital locations, and in other instances indicated its reliance on satellite operators to avoid interference:

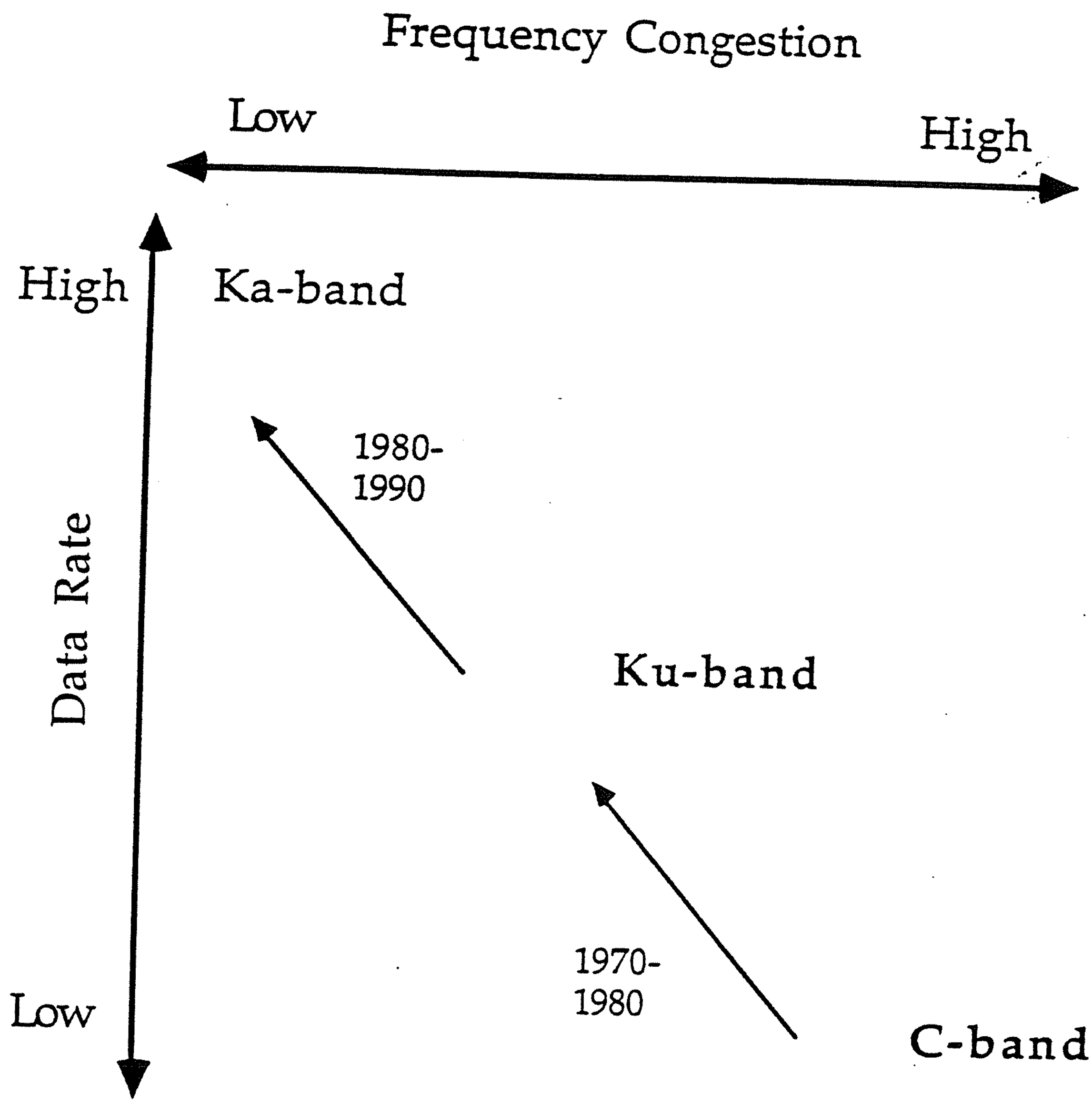
> We recognize that reassigning Satcom C-4 to 135 degrees W.L. will in all likelihood require Hughes to move Galaxy 1. While we seek to avoid in-orbit relocations whenever possible, we conclude that the public interest would be best served by allowing Satcom C-4 to be launched into 135 degrees W.L. in September 1992. 1990 Assignment Order, at 3.

In addition, the Commission has acknowledged that satellite operators and users face economic costs when addressing coordination:

> A real test of the ability of operators and users to coordinate satellites of disparate power levels and operational characteristics "[I]n order to operate at higher power densities, NEXSAT must bear the burden of obtaining operational agreements with adjacent licensees who are operating with routinely authorized power density levels. ... If NEXSAT cannot obtain an agreement, however, it will be required to reduce its power density levels ...." Id. at 2.

The saturation of the 6/4 GHz and 14/12 GHz band has taken almost 18 years. Undoubtedly, satellite operators and users will continue to utilize these frequency bands, and will continue to find means of utilizing space and earth segment techniques to

Figure I-2



"Ka-band is needed to continue satellite product-market evolution to the year 2000"

Ka-Band Product-Market Preference Grid

increase efficiency and reduce interference. However, the technology is now available to enable the U.S. commercial sector to utilize the 30/20 GHz band. Norris, through this application, proposes a satellite system which will make that technology available to the American public. Figure I-2 illustrates the factors involved in the evolutionary trend towards use of the 30/20 GHz frequency band.

2.4 Projected Service Demand for Ka-band Satellite Services

NorStar will achieve its business strategy by positioning its facilities as follow-on and growth capacity for today's fixed-satellite service users of video distribution and data networks. In addition, NorStar will provide optimal follow-on service for the video distribution, data network, personal satellite communications and government services markets developed by the NASA ACTS satellite. Figure I-3 illustrates the unique attributes of Ka-band that will enable it to attract a substantial customer base in the 1990's.

As for NorStar's position as ACTS follow-on capacity, it is working closely with the ACTS user community. Thus far, NASA projects that the ACTS will develop these markets as follows:

Market	ACTS Capability
Video Distribution	Videophone and videoconference capability to small customer-premises and home-based earth stations.
Data Networks	High-speed data networking, including broadband ISDN, to VSAT-sized terminals.
Government Services	Super-computing networks linking government agencies, corporations and universities.

Figure I-3

Unique Market Attributes of Ka-Band

Market	C/Ku	Ka
Video Distribution	Too much congestion for videoconference growth; Not enough power for HDTV to small dish	No congestion; High data rate
VSAT	Too much congestion for high data rate into small dish	No congestion
Government	Inadequate datarates for supercomputing and image transfer applications	Designed for high data rate
Personal	Coordination and congestion prevents; Inadequate bandwidth at L-band	Plenty of room for growth

Personal Communications	Two-way voice and slow-scan video telephony to hand-held personal communications terminals; space-casting direct to personal satellite terminals.

The NorStar system, building on the ACTS program which will familiarize users with the Ka-band technology and operating environment, proposes to address the video, data and mobile services market as described in the following sections.

2.5 Video Services

Service to video distribution markets is projected based on the following combination of factors:

Market	Factors
Entertainment Video	Largest use of satellites today; more than 120 channels in use; none with HDTV capability of NorStar NorStar's affiliate, Keystone Inspirational Network, has a long and successful experience in video broadcasting, resulting in a marketing edge, especially in religious broadcasting Although substantial existing facilities provide transmission of entertainment, NorStar will enable provision of service to a new market of users, those unable to use current C or Ku-band earth stations because of size, cost or interference

Market	Factors
Video-conferencing and Business TV	These services have experienced tremendous growth over the past few years and substantial growth is predicted through the 1990's. Satellite newsgathering will continue to grow and a Ka-band system would provide additional flexibility for transmissions in areas where Ku-band transmissions are difficult because of interference.

Videoconferencing is a rapidly growing segment of the telecommunications market but only Ka-band can relieve the congestion-induced constraints that now limit its growth.

Videoconferencing networks are largely new and not "locked in" to Ku or C-band technology.

ACTS will demonstrate broadband ISDN, which includes videoconferencing.

The following major users, each capable of using two transponders each, already have expressed interest in utilizing ACTS experiments because of its video capability:

(1) Amoco

(2) Mobil

(3) Burlington Northern

(4) The Austin Company (large construction contractor)

2.6 Data Networks

With regard to data networks, approximately 35,000 VSATs are in use in the United States today, and it is estimated that several hundred thousand will be in use by the end of the 1990's. However, none of these VSAT networks is designed to handle more than 56 kbps data rates. Ka-band is unique in being able to handle megabit (1000 mbps) rates into VSAT terminals. Implementation of Ka-band VSAT systems will be a necessity as interference and coordination difficulties intensify in Ku-band VSAT networks.

Approximately 120 transponders are currently planned for low data rate VSAT network usage in the 1990's as follows:

Carrier	VSAT Transponder Estimate
AT&T	40
Hughes	40
GTE	20
ASC	20
Total	120

Norris projects that NorStar, with its ten times greater data rate capability, will capture a 10% market share of the data services market. In addition, ACTS VSAT users will be built-in customers for NorStar.

2.7 Mobile and Personal Communications

One of NASA's main objectives in creating the ACTS program at Ka-band is to enable the creation of a personal satellite communications service addressing a mass consumer market. The objective of this service is ultimately to establish a "Dick Tracy" wristwatch videophone industry in the Ka-band.

Towards this end, NASA is spending several million dollars per year on personal satellite communications terminal development. See, "A Satellite-Based Personal Communications System for the 21st Century, Miles K. Sue, et al., Proceedings of the International Mobile Satellite Conference, Ottawa, 1990, reproduced as Appendix A to this application.

NASA is seeking to develop the Ka-band for personal satellite communications because other frequency bands lack the capacity needed for this service. The recently created American Mobile Satellite Consortium has advised the FCC that they require additional frequencies to satisfy fully near-term mobile satellite communications requirements for the trucking and airline industry, and that additional frequencies are needed.[10]

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[10]See, Comments of AMSC, in General Docket No. 89-554, In the Matter of An Inquiry Relating to Preparation for the International Telecommunication Union World Administrative Radio Conference for

As mobile satellite telecommunications requirements continue to be identified, the U.S. telecommunications policymaking community is coming to the conclusion that L-band allocations will be insufficient for mobile and personal satellite communications growth. The level of this growth has been estimated to be on the order of million of individual system users within the United States alone. Assuming that the Ka-band will be found practical for the provision of mobile satellite service, the demand will support the use of a portion of the NorStar transponders for personal satellite communications service.

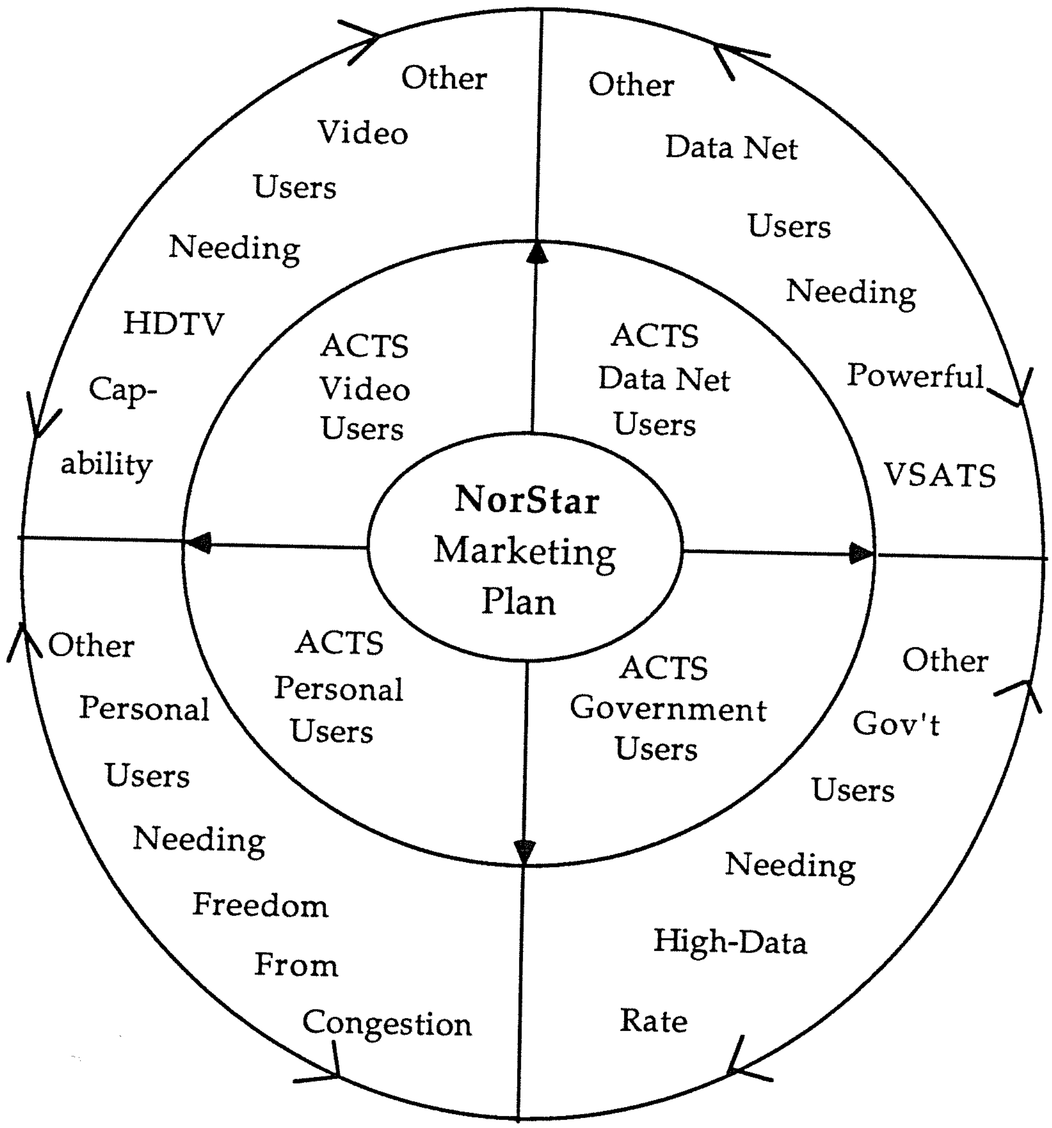
Norris's marketing plan has been carefully balanced to avoid excess reliance on any one market segment. In addition, there is a built-in community of customers--the ACTS users--that will need and desire follow-on Ka-band satellite capacity at the conclusion of the ACTS experiments. Figure I-4 provides a chart depicting Norris' planned marketing direction with regard to the ACTS user community.

3.0 Communications Payload Design

The following is a summary description of key technical components of the NorStar system. Part II provides a detailed technical showing and Exhibit A hereto provides the required engineering certification.

Dealing with Frequency Allocations in Certain Parts of the Spectrum.

Figure I-4



NorStar Marketing Direction

3.1 Design of Spacecraft

NorStar is a proposed U.S. domestic satellite designed to provide 24 channels of high power Ka-band service to the Continental United States, Alaska and Hawaii. The satellites are 3-axis stabilized and will be equipped with batteries for full operation during eclipse. The satellite mass in orbit at the beginning of life will be 1956 kilograms, including sufficient fuel for at least 10 years of operation.

The satellite is designed to receive in the band 29.3 -30.0 GHz and transmit in the band 19.5 - 20.2 GHz. At these high frequencies, the need to compensate for rain attenuation was given serious consideration in the design of the satellites. In addition, the requested orbital location of 90 ° W.L. will provide high earth station antenna elevation angles in the most severe rain areas of the United States, helping to reduce the effects of the rain.

The communications transponders will have a nominal bandwidth of 24 MHz with a spacing of 29.12 MHz. The transponder final output amplifier is a traveling wave tube adjusted to a saturated output of 90 watts. Power will be provided by solar panels during the time the satellite is exposed to the sun and batteries will provide power for full operation during solar eclipses.

The receive system will have a nominal G/T of -3 dB/K for continental U.S. coverage and +12 dB/K for spot beam uplinking. A key design feature is the capability to switch transponder outputs among eight antenna beams to provide EIRPs ranging from 53 dbW in the western United States to a maximum of 65 dbW in Florida. The antenna gains are weighted to provide higher power to the areas of the country with the worst rainfall rates. Switchable transponder outputs also will create flexibility for accommodating a variety of VSAT network configurations or other user requirements for higher power.

3.2 Communications Performance

The spacecraft are designed to be used for a wide variety of applications ranging from direct television broadcasting to data and digital sound distribution, high-speed and very high data-rate linking, mobile and personal communications service.

Television broadcast reception can be accomplished using small home terminals in sizes from 60 to 90 cm., similar to those planned for the broadcast satellite service. The NorStar frequency plan has the same channel bandwidth and spacing as the broadcast satellite service, so that filter and receiver technology developed for BSS can be applied directly to the NorStar system.

Availability of television reception is projected to range from 99.8 to 99.9% of time or better, but will depend on local rain rates and size of the home antenna. Uplinking for television will be into spot beams, and will require facilities with four-meter antennas and transmitters with a maximum output power of 200 watts.

The spacecraft will have the capability of providing for the distribution of data and digital sound in either a broadcast mode or in a fixed, point-to-point mode.

Transponders will be transparent to modulation type, so that they may accommodate multiple access TDMA, FDMA and FM video transmission with high quality audio subcarriers. As digital video techniques develop within the industry, including the development of compressed video, the NorStar system will be compatible with such innovations. Compressed video techniques also promise to reduce greatly the bandwidth requirements of video services. Current projections are that such compression may be able to double or triple the capacity of each transponder. Norris will be working with the developers of such techniques as well as earth station manufacturers, to ensure that its system will be able to provide maximum capacity and the highest-quality of service when implemented.

Part II of this application describes in more detail the system's capability with regard to high quality audio and video transmissions.

3.3 Transponder Frequency and Polarization Plan

The NorStar spacecraft will utilize 24 right-hand circularly polarized channels in the band 19,500 to 20,200 MHz. The corresponding spacecraft receive band is 29,300 to 30,000 MHz. Channels have a nominal bandwidth of 24 MHz with a spacing of 29.12 MHz between centers.

The NorStar spacecraft channel spacing and bandwidth are compatible with that in the Ku-band Broadcasting Satellite Service (BSS). Because of this compatibility, earth stations used for Ku BSS reception conceivably could be retrofitted for use with the

NorStar system. As in the BSS service, the orthogonal polarization remains available for future use, and could be utilized best with the same channel spacing and bandwidth, but with channels offset from NorStar by one-half the channel spacing, or 14.56 MHz.

While Norris proposes to construct both NorStar I and NorStar II with right-hand circular polarization, it could revise the polarization for NorStar II during the construction process to provide for left-hand circular polarization. If both satellites ultimately were placed in service, they could operate from the same orbital location, thus providing full frequency re-use and 48 transponders which could be accessed by the same earth stations.

At the inception of Ka-band satellite service, it would not be necessary from an orbit-conservation perspective to co-locate the first two commercial Ka-band satellites serving the United States. Nevertheless, Norris provides this information in order to assist the Commission in developing both short-term and long-range plans for use of Ka-band satellite service in the United States.

3.4 TT&C Frequencies and Polarizations

The NorStar spacecraft are designed to operate with a command channel within the receive band of the transponders. It will use the same polarization as the transponders and have a bandwidth no greater than 2 MHz.

A telemetry channel will transmit within the transponder band and will use the same polarizations as the transponder transmissions. The telemetry channel bandwidth will be no greater than 2 MHz and the beacon bandwidth no greater than 0.5 MHz.

3.5 Coverage Area and Antenna Beam Configurations

The NorStar spacecraft are designed to provide service to all of the contiguous United States (CONUS) with a total of eight beams. Groups of beams are associated with one of three sets of eight channels. Each beam can accommodate up to the maximum of eight channels assigned to the group. Because rainfall attenuation is a particularly significant consideration in the Gulf area, beams with smaller coverage areas and correspondingly higher EIRPs are planned for these areas. In addition to the CONUS beams, NorStar can use a small amount of power from one or two beams to feed spot beams to Alaska and Hawaii.

Uplinking is planned on a CONUS basis as well as from spot beams in the Southwest and the Northeast.

3.6 Interference Considerations

Norris submits that, in the case of a satellite to be implemented in an unused frequency band, and for multiple services as it has proposed, demonstration of compliance with the Commission's Reduced Orbital Spacing policies should not be required. Consequently, Norris requests a waiver of such requirements.

As to potential intersatellite interference, Norris does not foresee any harmful interference into or from the NASA ACTS facility, as discussed in Section 4.1 or Part II of this application. ACTS, while utilizing the frequency bands proposed for the NorStar system, as well as other frequencies[11], is planned for operation from 100 ° W.L. The 10 degree separation, along with the short projected life of ACTS (two to four years) will mitigate any potential interference.

Terrestrial interference considerations with regard to a portion of the frequencies (19.5 - 19.7 GHz downlink and 29.3 - 29.5 GHz downlink) proposed to be utilized by the NorStar system, are considered negligible and are discussed in Section 4.2 of Part II of this application.

4.0 Dates for Achievement of Significant Milestones

In order to meet already-identified customer demand for a high-powered satellite operating in the Ka-band, Norris proposes an

[11]ACTS will use the frequency bands 17.7-20.8 GHz (space-to-earth) and 27.5-30 GHz (earth-to-space).

aggressive timetable for construction, launch and implementation of its system. Recognizing the Commission's statement that practical "constraints require a minimum of 30 months between the execution of a spacecraft manufacturer's contract and launch of the satellites,"[12] Norris plans to proceed as soon as possible upon authorization to negotiate a construction contract for its satellites. Consequently, Norris requests that its authorization utilize the following timetable:

Construction Contract	FCC authorization date + 6 months
Construction Commences	FCC authorization date + 12 months
Construction Completed	FCC authorization date + 38 months
Launch Date	FCC authorization date + 42 months

As is apparent by this timetable, responsibility for moving forward the Norris project lies with Norris, the satellite manufacturer, launch services provider and the FCC. Because of the critical need to proceed expeditiously, Norris urges prompt FCC action on its application.

[12] 1985 Satellite Processing Order, FCC 85-395 (released August 29, 1985, at ftnte. 37.

5.0 Public Interest

Granting the authority requested herein would be in the public interest because it would make available to the American public needed telecommunications facilities, provide for commercial follow-on capacity to the NASA ACTS program, and promote the advancement of spacecraft and ground station technology through the use of the 30/20 GHz frequency band.

As discussed in this application, the use of this technology will enable the provision of satellite services both complementary and supplementary to services now provided. For example, NASA has already identified the capability of providing extremely high data rate services in the Ka-band. Other new services are likely to be identified during the ACTS experiments.

Implementation of the NorStar system will stimulate continued innovation and use of satellite services, resulting in higher quality service as well as lower prices.

Thus, for the reasons provided throughout this application, Norris submits that there is ample public interest for grant of authority to construct two and launch and operate a satellite operating in the 30/20 GHz frequency band.

6.0 Legal Qualifications

Attached to Part I as Exhibit I-B is Norris Satellite Communications' "Common Carrier and Satellite Radio License Qualification Report"--FCC Form 430.

7.0 Detailed Schedule of Estimated Investment Costs, Operating Costs, and Revenue Requirements for Proposed System by Year

Norris has developed the costs associated with the proposed satellite system, TT&C stations, network control center, marketing and management of the system.

A detailed schedule of the estimated investment costs and operating expenses for the NorStar system by year, including annual depreciation, is provided in Exhibit I-C. This Exhibit provides the year-by-year investment, expenses and revenue requirement information requested in the 1983 Orbital Processing Order and in Section 25.391(c) of the Commission's Rules and Regulations. These estimates are based on the best information available to Norris at this time.

8.0 Financial Qualifications

The following information is provided with respect to Norris Satellite Communications financial qualifications.

8.1 System Investment Costs

Norris projects that the capital costs of constructing and implementing its system are as follows:

Two Spacecraft	$ 115 million
Satellite Launch (1)	50 million
Launch Insurance	18 million
Total	$ 190 million

8.2 Sources of Funding and Request for Confidential Treatment for Certain Information

To fund the construction, launch and operation of the proposed satellite system, Norris will utilize financing from the following sources:

(1) sales of transponder capacity to prospective customers of the NorStar system;

(2) funds of the principal, John H. Norris, derived from sales of current assets, as required; [13]

(3) project financing to be provided by or raised by a financial institution.

In the present financial climate, with the savings and loan and banking industry in a state of turmoil, it has taken longer than anticipated for Norris to obtain a letter from a financial institution with regard to the third component listed above. Norris will file such a letter within 30 to 60 days of the filing of this application.

8.2 Projected Revenues

Revenues from lease reservations and the sale of transponders on the proposed NorStar I are projected to reach a total of $630 million for the life of the satellite. Projected revenues and expenses are detailed on a year-by-year basis in Exhibit I-F.

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[13] A financial statement of John H. Norris and Dorothy Norris, labeled Exhibit I-F, is provided as a separate document for the Commission's information, along with a request that the financial statement and information therein, not be made available for public inspection.

9.0 Request for Waiver of Strict Financial Qualifications Required in the Domestic Fixed-Satellite Service

Over the past few years the Commission has refined the financial qualifications for licensees in the domestic fixed-satellite service. These qualifications are discussed in detail in the Commission's 1985 Processing Order, CC Docket No. 85-135, Notice of Proposed Rulemaking, 50 Fed. Reg. 19413 (May 8, 1985), Report and Order, 50 Fed. Reg. 36071 (September 5, 1985) recon. den., 1 FCC Rcd. 686 (1986) and were codified in the Commission's Rules and Regulations at 47 C.F.R. § 25.391.

The application of strict financial qualifications for satellite licensees using the 6/4 GHz and 14/12 GHz frequency bands is well-founded. As these frequency bands become more congested, it is in the public interest for the Commission to utilize various means of assuring that all proposed satellite system operators are well-funded and able to proceed to utilize efficiently the remaining spectrum/orbit resource.

In an unused frequency band such as the 30/20 GHz band, however, such financial stringency is not required to protect the public interest. In fact, the opposite may be the case in order to encourage entrepreneurial enterprises to take risks to develop new frequency bands and services. Norris submits that this is the case with regard to its application.

As to conventional C- and Ku- band domestic fixed satellite service, the Commission has experimented with deviations from a rigorous, prima facie, financial qualifications burden. See Filing of Applications for New Space Stations in the Domestic Fixed Satellite Service, Memorandum, Opinion and Order, 93 FCC 2d 1260 (1983). In that satellite processing round the Commission tried to balance its concern over authorizing--even conditionally--applicants that did not meet strict financial qualifications requirements, with its recognition that "[e]xcessive administrative delays are likely to interfere with the timely availability of the proposed satellite facilities as well as frustrate the business plans of current applicants." Id.

In the case of the conditional authorizations granted in 1983 and later revoked when the conditional licensees were unable to demonstrate the necessary financial qualifications to proceed with construction of their proposed satellite systems, the Commission could have utilized strict due diligence requirements rather than licenses with conditions subsequent. See Advanced Business Communications, Inc., 94 FCC 2d 1 (1983), Rainbow Satellite, Inc. 94 FCC 2d 437 (1983), United States Satellite Systems, Inc., 94 FCC 2d 462 (1983).

The Commission response in these cases involving limited spectrum/orbit resources should not be applied as precedent to preclude the kind of innovation and experimentation that the Commission considered worth the effort in 1983 given "existing circumstances ... [making it possible for the Commission] to try." Licensing Space Stations in the Domestic Fixed-Satellite Service, CC Docket No. 85-135, 1 FCC Rcd. 682, 684 (1986) (order denying reconsideration).

The instant application can and should be considered much like one of the first domestic satellite applications in view of the proposed use of the Ka-band and its commensurately greater risks, the absence of other applicants and the lack of any required Commission adjudication between contestants for scarce orbital locations. Rather, the Commission should utilize this first application to use Ka-band frequency spectrum commercially as justification for a partial return to an "open skies" policy with its simple administrative and licensing burdens and a vastly lower threshold for evaluating applicants' financial qualifications. Establishment of Domestic Communications Satellite Facilities by Non-Governmental Entities, 35 FCC 2d 844 (1972).

Moreover, in evaluating the Norris application the Commission should not initiate a lengthy and time consuming rulemaking proceeding on the matter of what constitutes the appropriate standard for assessing Ka-band applicant financial qualifications. Rather, the Commission should recognize that the rationale that led to adoption of rigorous financial qualifications in the domestic fixed-satellite service is not applicable to this case.

Contrary to the 1983 domestic fixed- satellite processing round, or any of the subsequent processing rounds, the Commission does not face applications in excess of the number of orbital locations available. Nor does the Norris application present the opportunity for speculation or trafficking of orbital resources in view of the clear opportunity for other applicants to seek and receive a choice Ka-band orbital assignment.

Although Norris believes it can demonstrate adequate financial capability to construct and implement the proposed system, if the Commission does not deem its showing adequate, Norris respectfully requests a waiver of the Commission's rules in this regard for the reasons discussed above.

Norris proposes that, rather, in the case of applications for satellite service in the 30/20 GHz band, the Commission apply the financial qualifications standards utilized in the Direct Broadcast Satellite service, until such time as heavy utilization of the band may warrant application of a more stringent standard.

In the Direct Broadcast Satellite Service,[14] the Commission has not adopted the specific requirements applied in the Domestic Fixed-Satellite Service but rather approached each application on a case-by-case basis. Because the Commission believes it is in the public interest to encourage development of the Direct Broadcast Satellite Service, it has utilized an open-entry policy whereby licenses have been liberally granted:

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[14] See Docket No. 80-603, 90 FCC 2d 676 (1982).

> We remain convinced that it is in the public interest to impose a minimum of regulation during this experimental phase of DBS operations. We believe that this interim approach will best serve to encourage and facilitate the introduction of this new service, the likely nature of which we cannot predict with any certainty at this early stage. By imposing few regulatory restrictions, we will allow operators the flexibility to experiment with technical and organizational characteristics. Imposing minimal regulation will also allow us to gather information about the operation of the industry, which will allow us to make better-informed decisions about permanent regulatory policies. Direct Broadcast Satellite Service at 707-708.

Norris requests that the Commission take such an approach with regard to its application. The public interest will be served best if risk-taking entrepreneurs are allowed to go forward to obtain the necessary capital to construct, launch and operate their systems following the issuance of a construction permit and license. As a point of history, the liberal financial qualifications standard applied in DBS was derived from the Commission's initial domestic fixed satellite service standard, Direct Broadcast Satellite Services, Notice of Proposed Policy Statement and Rulemaking, 86 FCC 2d 719, 728 (1981) which states, "In essence, our policy, when considering such applications, will be to maintain a flexible and open approach that is patterned after the open entry policy we have used for the domestic satellite service."

This policy was discussed in CBS, Inc. et al, 92 FCC 2d 64 (1982), where the Commission acknowledged that:

it would not require stringent financial qualifications showings or subject such applicant showings to detailed analysis. Rather, the Commission would impose on each permittee an obligation to undertake the construction of their respective systems with due diligence ... [defined as] the construction of the required space craft, or completion of contracting for such construction within one year of the date of grant." Id. at 108.

Norris agrees with the Commission that "the true test of each applicant's ability to construct will be its performance of the due diligence requirement," Id. --something it can do only if the Commission grants an authorization subject to performance timetables.

Another analogy the Commission should consider is its financial qualifications requirements for international separate satellite systems. In authorizing the Pan American Satellite system to provide certain international services, the Commission established a relatively liberal financial qualifications standard in recognition of the "unique institutional and commercial obstacles to be faced by the separate systems applicants." Pan American Satellite, 2 FCC Rcd. 3803 (1987).

Norris submits that, while it may not face "unique institutional...obstacles," it surely faces unique "commercial" and technical obstacles as the pioneering commercial Ka-band domestic satellite service provider. These circumstances warrant application of a similarly liberal financial qualifications test. While the Commission may not want to utilize the conditional authorization approach utilized with the international separate satellite systems, it could utilize the due diligence requirements as discussed above and as applied in the Direct Broadcast Satellite Service. See also, Pan American Satellite, Request for Extension of Time To Demonstrate Permanent Financial Qualifications For the Construction and Operation of a Subregional Western Hemisphere Satellite System, 2 FCC Rcd. 3803 (rel. June 26, 1987) wherein the Commission granted an extension of time within which to demonstrate permanent financial qualifications for construction, launch and operation of an international satellite.

10. Technical Qualifications

John H. Norris, the Chairman of Norris Satellite Communications, Inc., has established a company with a capable and experienced board.[15] John H. Norris has 40 years experience as a successful broadcaster. Bob Davis, currently President and Director of E'Prime Aerospace, a U.S. commercial launch services provider, has more than 28 years experience in technology research, development, design, test and operations. Colin H. Weir has an extensive background in finance, within the Export-Import Bank and as a consultant. Wilbur Pritchard has almost 30 years involvement in the communications satellite field and is recognized as one of the field's leading technical experts. Matt Willard recently joined the firm of MARCOR, a technology development and project management firm, after serving as Director of Strategic Planning and Product Development of the Earth Observation Satellite

[15]Biographies of the Norris board members are contained in Appendix B.

Corporation (EOSAT). Leslie A. Taylor has been involved with the regulatory and commercial aspects of satellite systems since 1974. Dr. Mary Cathryne Park is an educator and author.

Norris will utilize its board members and their extensive contacts in the communications satellite field to build a team which will succeed in providing the first commercial Ka-band satellite service in the United States.

11. <u>Whether Satellite Operation Will be on a Common Carrier or Non-Common Carrier Basis</u>

NorStar hereby requests that its license permit it to operate on a non-common carrier basis. NorStar proposes non-common carrier operations in order that it may have maximum flexibility in tailoring its services to the needs of its customers. In addition, non-common carrier status provides maximum flexibility for the marketing of its facilities and services in such a manner as to obtain revenues to support its operation commensurate with the risk involved of providing service in a new frequency band.

NorStar submits that non-common carrier operation is in the public interest because ample satellite transponders are currently available on a common carrier basis. Moreover, numerous other telecommunications facilities and services are also available on a competitive basis. <u>See</u> <u>Domestic Fixed Satellite Transponder Sales</u>, 90 FCC 2d 1238 (1982), where the Commission states:

> In sum, the record shows that the certification of non-common carrier domsat systems is consistent with our policies fostering multiple satellite entry. They encourage additional entry, additional facility investment, more efficient use of the orbital and frequency spectrum and allow for technical and marketing

innovation in the provision of domsat services. Accordingly, we conclude that there is no legal compulsion that all domsat licensees serve the public indifferently [as common carriers]. Id. at 1255.

Moreover, the Commission recently authorized the provision of domsat service on a non-common carrier basis by AT&T which remains classified as a dominant carrier for most regulatory purposes. Such action indicates the Commission's belief that there are sufficient satellite facilities available to serve the public and that the public interest does not require that satellite operators provide service on a common carrier basis.

Finally, recent indictments of a domestic fixed-satellite service licensee for transmission of pornography demonstrates public interest benefits in allowing satellite operators to provide service on a non-common carrier basis. Such service would not be insulated from the defense of a common carrier which can argue that it may not exercise control over the content of its customers' transmissions. See, Communications Daily, February 21, 1990.

Since Norris is committed to carriage of family programming, it is important that it have the capability of ensuring that its customers adhere to requirements not to utilize NorStar facilities for the transmission of obscenity or pornography. If Norris is granted authority to operate on a non-common carrier basis, it will have the flexibility it needs to include such provisions in its contracts with users.

Consequently, for the foregoing reasons, Norris respectfully requests that the Commission permit it to operate the NorStar system on a non-common carrier basis.

12. <u>Section 304 Waiver</u>

As required by Section 304 of the Communications Act of 1934, as amended, Norris waives claim to the use of any particular frequency or of the electromagnetic spectrum as against the regulatory power of the United States because of the previous use of the same, whether by license or otherwise, and requests launch and operating authority in accordance with this application.

13. <u>Correspondence</u>

Correspondence concerning this application should be addressed to the following:

Leslie A. Taylor
6800 Carlynn Court
Bethesda, MD 20817
(301) 229-9341

14. Certification

Norris acknowledges that all of the statements in this application and in the exhibits and associated attachments are considered material representations, and that all the exhibits and attachments are a material part hereof, and are incorporated herein as if set out in full in this application.

The undersigned certifies individually and for Norris Satellite Communications, Inc. that the statements made in this application are true, complete, and correct to the best of his knowledge and belief, and are made in good faith.

Wherefore, Norris Satellite Communications, Inc. requests that the Commission authorize the construction, launch and operation of the satellites specified in this application.

Respectfully submitted,

NORRIS SATELLITE COMMUNICATIONS, INC.

By: John H. Norris

John H. Norris
Box 88
Red Lion, PA 17356
(717) 246-1681

Counsel:

Leslie A. Taylor, Esq.
6800 Carlynn Court
Bethesda, MD 20817
(301) 229-9341

July 16, 1990

EXHIBIT I-A

CERTIFICATION OF PERSON RESPONSIBLE
FOR PREPARING ENGINEERING INFORMATION
SUBMITTED IN THIS APPLICATION

I hereby certify that I am the technically qualified person responsible for preparation of the engineering information contained in this application and the exhibits attached thereto; that I am familiar with Part 25 of the Commission's Rules; that I ahve either prepared or reviewed the engineering information submitted in this application and the exhibits attached thereto; and that it is complete and accurate to the best of my knowledge.

By: ______________________________

W.L. Pritchard

Dated this July 11th, 1990

____
Notary Public
My Commission Expires: July 1990

EXHIBIT I-B

FCC 430

FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554

Approved by OMB 3060-0105
Expires 3/31/90

COMMON CARRIER AND SATELLITE RADIO LICENSEE QUALIFICATION REPORT

See reverse side for information regarding public burden statement.

INSTRUCTIONS

A. The "Filer" of this report is defined to include: (1) An applicant, where this report is submitted in connection with applications for common carrier and satellite radio authority as required for such applications; or (2) A licensee or permittee, where this report is required by the Commission's Rules to be submitted on an annual basis.

B. Submit an original and one copy (sign original only) to the Federal Communications Commission, Washington, DC 20554. If more than one radio service is listed in Item 6, submit an additional copy for each such additional service. If this report is being submitted in connection with an application for radio authority, attach it to that application.

C. Do not submit a fee with this report.

1. Business Name and Address (Number, Street, State and ZIP Code) of Filer's Principal Office:

Norris Satellite Communications, Inc.
Box 88
Red Lion, PA 17356

2. (Area Code) Telephone Number: (717) 246-1681

3. If this report supercedes a previously filed report, specify its date:

4. Filer is (check one):
☐ Individual ☐ Partnership ☒ Corporation
☐ Other (Specify):

5. Under the laws of what State (or other jurisdiction) is the Filer organized? Delaware

6. List the common carrier and satellite radio services in which Filer has applied or is a current licensee or permittee:

See Attachment A

7(a) Has the Filer or any party to this application had any FCC station license or permit revoked or had any application for permit, license or renewal denied by this Commission? *If "YES", attach as Exhibit I a statement giving call sign and file number of license or permit revoked and relating circumstances.* ☐ Yes ☒ No

(b) Has any court finally adjudged the Filer, or any person directly or indirectly controlling the Filer, guilty of unlawfully monopolizing or attempting unlawfully to monopolize radio communication, directly or indirectly, through control of manufacture or sale of radio apparatus, exclusive traffic arrangement, or other means of unfair methods of competition? *If "YES", attach as Exhibit II a statement relating the facts.* ☐ Yes ☒ No

(c) Has the Filer, or any party to this application, or any person directly or indirectly controlling the Filer ever been convicted of a felony by any state or Federal Court? *If "YES", attach as Exhibit III a statement relating the facts.* ☐ Yes ☒ No

(d) Is the Filer, or any person directly or indirectly controlling the Filer, presently a party in any matter referred to items 7(b) and 7(c)? *If "YES", attach as Exhibit IV a statement relating the facts.* ☐ Yes ☒ No

8. Is the Filer, directly or indirectly, through stock ownership, contract or otherwise, currently interested in the ownership or control of any other radio stations licensed by this Commission? *If "YES", submit as Exhibit V the name of each such licensee and the licensee's relation to the Filer.* ☒ Yes ☐ No

See Attachment B - Exhibit V

If Filer is an individual (sole proprietorship) or partnership, answer the following and Item 11:

9(a) Full Legal Name and Residential Address (Number, Street, State and ZIP Code) of Individual or Partners:

(b) Is individual or each member of a partnership a citizen of the United States? ☐ Yes ☐ No

(c) Is individual or any member of a partnership a representative of an alien or of a foreign government? ☐ Yes ☐ No

If Filer is a corporation, answer the following and Item 11:

10(a) Attach as Exhibit VI the names, addresses, and citizenship of those stockholders owning of record and/or voting 10 percent or more of the Filer's voting stock and the percentages so held. In the case of fiduciary control, indicate the beneficiary(ies) or class of beneficiaries.

See Attachment C - Exhibit VI

(b) List below, or attach as Exhibit VII the names and addresses of the officers and directors of the Filer.

See Attachment D - Exhibit VII

(c) Is the Filer directly or indirectly controlled by any other corporation? ☐ Yes ☒ No

If "YES", attach as Exhibit VIII a statement (including organizational diagrams where appropriate) which fully and completely identifies the nature and extent of control. Include the following: (1) the address and primary business of the controlling corporation and any intermediate subsidiaries; (2) the names, addresses, and citizenship of those stockholders holding 10 percent or more of the controlling corporation's voting stock; (3) the approximate percentage of total voting stock held by each such stockholder; and (4) the names and addresses to the president and directors of the controlling corporation.

(d) Is any officer or director of the Filer an alien? ☐ Yes ☒ No

(e) Is more than one-fifth of the capital stock of the Filer owned of record or voted by aliens or their representatives, or by a foreign government or representative(s) thereof, or by a corporation organized under the laws of a foreign country? ☐ Yes ☒ No

Is the Filer directly or indirectly controlled: (1) by any other corporation of which any officer or more than one-fourth of the directors are aliens, or (2) by any foreign corporation or corporation of which more than one-fourth of the capital stock is owned or voted by aliens or their representatives, or by a foreign government or representatives thereof. ☐ Yes ☒ No

(g) If any answer to questions (d), (e) or (f) is "YES", attach as Exhibit IX a statement identifying the aliens or foreign entities, their nationality, their relationship to the Filer, and the percentage of stock they own or vote.

11. CERTIFICATION

This report constitutes a material part of any application which cross-references it, and all statements made in the attached exhibits are a material part thereof. The ownership information contained in this report does not constitute an application for, or Commission approval of, any transfer of control or assignment of radio facilities. The undersigned, individually and for the Filer, hereby certifies that the statements made herein are true, complete and correct to the best of Filer's knowledge and belief, and are made in good faith.

WILLFUL FALSE STATEMENTS MADE ON THIS APPLICATION ARE PUNISHABLE BY FINE AND IMPRISONMENT (U.S. Code, Title 18, Section 1001) and/or REVOCATION OF ANY STATION LICENSE OR CONSTRUCTION PERMIT (U.S. Code, Title 47, Section 312(a)(1)).	Date: 7/16/90	Filer *(Must correspond with that shown in item 1)*: Norris Satellite Communications, Inc.	Typed or Printed Name: John H. Norris
	Signature: John H. Norris		Title: Chairman

NOTICE TO INDIVIDUALS REQUIRED BY THE PRIVACY ACT OF 1974 AND THE PAPERWORK REDUCTION ACT OF 1980

The solicitation of personal information requested in this form is to determine if you are qualified to become or remain a licensee in a common carrier or satellite radio service pursuant to the Communications Act of 1934, as amended. No authorization can be granted unless all information requested is provided. Your response is required to obtain the requested authorization or retain an authorization.

Public reporting burden for this collection of information is estimated to average 2 hours per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden to Federal Communications Commission, Office of Managing Director, Washington, DC 20554, and to Office of Management and Budget, Paperwork Reduction Project (3060-0105), Washington, DC 20503.

Form 430 - Attachment A

Common Carrier and Satellite Radio Services In Which Filer has applied or is a Current Licensee

1. This application - Domestic Fixed-Satellite Service

2. Keystone Inspirational Network, owned by the controlling party of Norris Satellite Communications, Inc., John H. Norris, operates a transmit-receive earth station (STA File No. 2842-SSA-88; NEW 0565) pursuant to Special Temporary Authority (STA).

Application for extension of the STA was filed July 9, 1990. The application for license is anticipated to be filed by September, 1990, upon conclusion of frequency coordination and clearances.

Exhibit I-C

NORSTAR
Schedule of Annual Investment,
Expenses and Revenue Requirements

	1991	1992	1993	1994	1995	1996	1997	1998	1999	Total
Capital Investment										
Satellite Construction:										
Norstar I	5.00	35.00	25.00	0.00	0.00	0.00	0.00	0.00	0.00	65.00
Norstar II		10.00	25.00	15.00	0.00	0.00	0.00	0.00	0.00	50.00
Satellite launch (1 sat.)	9.00	24.00	24.00	0.00	0.00	0.00	0.00	0.00	0.00	57.00
Launch insurance (1 sat.)	0.00	6.00	12.00	0.00	0.00	0.00	0.00	0.00	0.00	18.00
Total Capital investment	14.00	75.00	86.00	15.00	0.00	0.00	0.00	0.00	0.00	190.00
Depreciation	0.00	0.00	0.00	9.50	19.00	19.00	19.00	19.00	19.00	104.50
Operating Expenses:										
ACTS Experiments	1.00	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	3.00
Development	0.80	1.30	1.80	2.00	0.00	0.00	0.00	0.00	0.00	5.90
Marketing	1.00	1.80	2.00	2.60	3.50	4.20	5.00	6.00	7.20	33.30
Operations	0.50	1.20	3.50	7.00	8.50	10.00	11.20	13.00	14.50	69.40
Administration	0.50	1.00	1.30	1.60	2.00	2.50	2.80	3.30	4.00	19.00
TT&C Services	0.00	0.00	3.50	1.50	1.50	1.60	1.75	1.90	2.20	13.95
Total Expenses	3.80	6.30	13.10	14.70	15.50	18.30	20.75	24.20	27.90	144.55

Exhibit I-D

NORSTAR
Balance Sheet
(In millions)

	1991	1992	1993	1994	1995	1996	1997	1998	1999
Cash	22.23	15.75	-6.14	2.74	30.85	49.54	71.59	109.00	158.85
Other Current Assets	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Current Assets	22.23	15.75	-6.14	2.74	30.85	49.54	71.59	109.00	158.85
Capital Assets	14.00	89.00	175.00	190.00	190.00	190.00	190.00	190.00	190.00
Accumulated Depreciation	0.00	0.00	-11.20	-30.90	-50.60	-70.30	-90.00	-109.70	-118.21
Total Fixed Assets	14.00	89.00	163.80	159.10	139.40	119.70	100.00	80.30	71.79
Total Assets	36.23	104.75	157.66	161.84	170.25	169.24	171.59	189.30	230.64
Liabilities									
Account Payable	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Other Current Liabilities	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Current Liabilities	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Senior Project Financing	15.00	66.25	120.75	117.00	92.00	62.00	22.00	0.00	0.00
Total Liabilities	15.00	66.25	120.75	117.00	92.00	62.00	22.00	0.00	0.00
Common Stock	25.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00
Retained Earnings	-3.78	-11.50	-13.09	-5.16	28.25	57.24	99.59	139.30	180.64
Total Equity	21.23	38.50	36.91	44.84	78.25	107.24	149.59	189.30	230.64
Total Liabilities & Equity	36.23	104.75	157.66	161.84	170.25	169.24	171.59	189.30	230.64

Exhibit I-E

NORSTAR
Income Statement
(in millions)

	1991	1992	1993	1994	1995	1996	1997	1998	1999	Total
Revenues										
Video Distribution	0.00	0.00	20.00	30.00	40.00	30.00	25.00	20.00	10.00	175.00
Data Networks	0.00	0.00	10.00	20.00	30.00	30.00	30.00	25.00	20.00	165.00
Government	0.00	0.00	15.00	20.00	30.00	20.00	25.00	20.00	25.00	155.00
Personal Communications	0.00	0.00	0.00	0.00	5.00	15.00	30.00	40.00	45.00	135.00
Total Revenues	0.00	0.00	45.00	70.00	105.00	95.00	110.00	105.00	100.00	630.00
Operating Expenses										
ACTS Experiments	1.00	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	3.00
Development	0.80	1.30	1.80	2.00	0.00	0.00	0.00	0.00	0.00	5.90
Marketing	1.00	1.80	2.00	2.60	3.50	4.20	5.00	6.00	7.20	33.30
Operations	0.50	1.20	3.50	7.00	8.50	10.00	11.20	13.00	14.50	69.40
Administration	0.50	1.00	1.30	1.60	2.00	2.50	2.80	3.30	4.00	19.00
TT&C Services	0.00	0.00	3.50	1.50	1.50	1.60	1.75	1.90	2.20	13.95
Depreciation	0.00	0.00	11.20	19.70	19.70	19.70	19.70	19.70	8.51	118.21
Total Expenses	2.80	5.30	23.30	34.40	35.20	38.00	40.45	43.90	36.41	259.76
EBIT	-2.80	-5.30	21.70	35.60	69.80	57.00	69.55	61.10	63.59	370.24
Interest expense	0.98	8.61	15.70	15.21	11.96	8.06	2.86	0.00	0.00	63.38
Income taxes	0.00	-6.19	7.60	12.46	24.43	19.95	24.34	21.39	22.26	126.23
Total interest & taxes	0.98	2.42	23.29	27.67	36.39	28.01	27.20	21.39	22.26	189.60
Net Income	-3.78	-7.72	-1.59	7.93	33.41	28.99	42.35	39.72	41.33	180.64

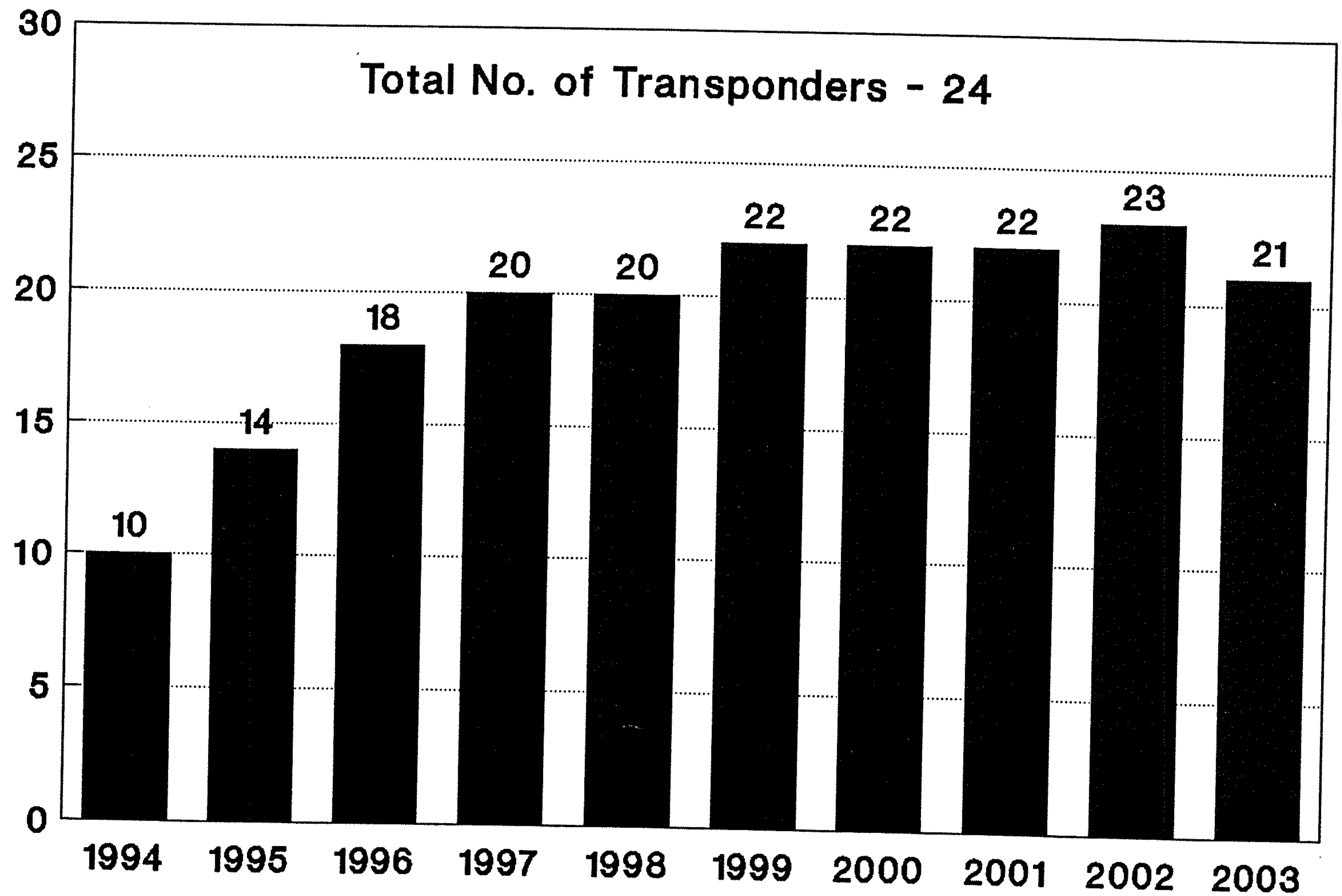
Exhibit I-F

Financial Statement of John H. and Dorothy Norris

Withheld from public inspection as privileged and confidential.

Figure I-G

Projected Utilization of NorStar I



In numbers of transponders

A Satellite-Based Personal Communication System for the 21st Century

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ABSTRACT

Interest in personal communications (PCOMM) has been stimulated by recent developments in satellite and terrestrial mobile communications. A personal access satellite system (PASS) concept has been developed at JPL which has many attractive user features including service diversity and a handheld terminal. Significant technical challenges have been addressed in formulating the PASS space and ground segments.

1.0 INTRODUCTION

The 1980's were clearly the decade when mobile satellite systems (MSS) advanced from initial concepts to practical system designs, technology development, and interim service demonstrations. Now, at the beginning of the 1990's, expectations are high for the successful implementation of MSS, in its many forms, at the national and international levels. While MSS is eagerly awaited on many fronts, interest in extending MSS to the personal level is already gaining significant momentum.

Although the implications of personal communications (PCOMM) will only become clearer to both users and the technologists alike as the last decade of the 20th Century unfolds, early concepts are emerging which will greatly influence current thinking on the shape of telecommunications in the 21st Century. The socio-economic consequences of PCOMM will inevitably become a major topic of discussion and, in real terms, will heighten the competition between fiber/wire, terrestrial and satellite communications.

The last decade of the 20th century might well become synonomous with the true arrival of the information age predicated on the reliable transfer of unprecedented quantities of data between diverse users located anywhere in the world [1]. Such a claim, and attendant requirements, can only be achieved through the existence of telecommunication resources capable of reaching individuals with useful and timely information. However, it is not sufficient to just place a communications device in a user's hand: the device, i.e the link, must meet user demands by allowing data access and exchange in a competitive and cost-effective manner.

In an effort to respond to this challenge, the Jet Propulsion Laboratory (JPL) has been investigating the concept of a personal access satellite system (PASS) [2,3] to enable individual users to share in satellite communications (SATCOM) technology. PASS would extend the primarily urban coverage of terrestrial cellular systems by providing similar services to less populous areas that are not commercially or technically practical for land-based communications networks.

Many innovative services could be supported by a PCOMM system of this type, including

- o direct personal voice and data
- o personal computer file transfer
- o data base inquiry and distribution
- o low-rate broadcast (voice, data, video)
- o telemonitoring and control
- o disaster and emergency communications

The objectives of the PASS program are to develop and demonstrate system concepts and high-risk technologies for a personal SATCOM system. Ka-band, with downlinks at 20 GHz and uplinks at 30 GHz, has two unique features compared to the lower frequencies currently in use in mobile satellite communications. First, this band permits small user terminals suited for PCOMM, particularly for hand-held operation. Second, ample bandwidth is currently available in that band. This should permit a system of significantly higher capacity than in currently utilized lower frequency bands. In turn, this should reduce eventual terminal cost, despite the higher frequency, and make it as affordable at the personal level as satellite terminals at lower frequencies. Thus, the potential for both enhanced user services and the development of new technology at higher frequencies have spurred the move to Ka-band.

Migration to high frequencies is certainly fraught with its unique difficulties and risks. The goal of this article, then, is to identify these challenges, and to present the early results of the research aimed at overcoming the hurdles to a cost effective realization of PASS.

In the following, the PASS concept and basic elements of its system design are first highlighted. Next the key challenges and risk areas are identified along with some possible approaches to resolving them. The relevant early research results are explained and their implications addressed. Finally, the present status and future plans are discussed.

2.0 PASS SYSTEM CONCEPT AND BASIC DESIGN FEATURES

PASS is a satellite-based PCOMM system that will offer users freedom of access and mobility. Equipped with a handheld or laptop terminal, a subscriber would have access to a host of voice and data services anywhere within the range of the associated satellite transponder. The system would be capable of handling data rates ranging from less than 100 bps for emergency and other low-rate services, to 4.8 kbps for voice communications and hundreds of kbps for computer file transfers.

As illustrated in Figure 1, PASS connects a network of private or public service providers with a large community of individual subscribers. The major elements of PASS include one or more satellites, a network management center (NMC), tracking, telemetry and command (TT&C) stations, supplier stations, and user terminals. The NMC and TT&C stations govern the operation of the system. As presently conceived, the user equipment falls into three categories: a basic personal terminal (BPT), an enhanced personal terminal (EPT), and telemonitors. The EPT is similar to today's very small aperture terminals (VSATs), whereas the BPT is a compact personal terminal that provides users greater freedom and mobility. The telemonitors are used for remote data collection and monitoring.

The fundamental elements of the PASS design rest on the utilization of a geostationary (GEO), bent-pipe satellite transponder with multiple, fixed spot beams to provide simultaneous up- and downlink coverage to users in the contiguous United States (CONUS). In addition, a single CONUS beam connects the satellite with the supplier terminals. A high power commercial satellite bus is also assumed. The multiple access techniques and concomitant modulation and coding schemes to be chosen on the forward (supplier-to-satellite-to-user) and return links need to support the highest possible overall system capacity without unduly complicating the user terminal. The BPT itself must be small (hand-held in size) and, as a minimum, capable of stationary operation. Ambulatory (talk-while-you-walk) operation is a desired option.

The basic features of the PASS design are highlighted in Table 1. The characteristics of the PASS satellite are given in Table 2 and the requirements for the BPT are listed in Table 3. Also to aid in placing the technological challenges in perspective, an abbreviated representative link budget is given in Table 4 for a data link requiring a 10^{-5} BER; this implicitly assumes the use of time division multiple access (TDMA) in the forward direction and single channel per carrier (SCPC) frequency division multiple access (FDMA) on the return. (Multiple access issues will be addressed in more detail later.)

3.0 HIGH-RISK ENABLING TECHNOLOGIES

Several high-risk enabling technologies have been identified. Some of these technologies are system architecture specific while others are not. The key enabling technologies are:

- o low-cost, compact, high-gain, tracking user antenna
- o low-cost user terminal frequency reference
- o MMIC transmitter
- o high-gain, low-noise MMIC receiver
- o VLSI-based integrated vocoder/modem
- o efficient multiple-access schemes
- o multi-beam satellite antenna and beam forming
- o Robust, power-efficient modulation and coding

Table 5 compares the state-of-the-art performance and PASS requirements for several key technologies. Timely development and validation of these technologies are essential to the successful implementation of PASS.

4.0 ADDITIONAL TECHNOLOGICAL CHALLENGES

In addition to the high-risk technologies described above, the PASS strawman design reveals a number of other challenges that are equally critical.

User Terminal Radiated Power Level

The transmitter and antenna of the user terminal need to produce an effective isotropic radiated power (EIRP) of about 17 dBW. One combination that can produce the required EIRP is 0.25 W transmit RF power and a 23 dBi antenna gain. An important consideration in determining the transmitter parameters and limitations is that the near- and far-field microwave energy levels comply with established safety standards.

System Reliability and Service Quality

The strawman design employs a combination of uplink power control on the forward link and adjustable data rate in both directions to combat rain attenuation. When increased uplink power from the supplier fails to fully compensate for rain degradation, the data rate can be reduced to close the link. This could conceivably result in a reduction of service quality, or even the suspension of certain services during severe rain conditions. Additional measures, such as the use of satellite on-board processing, could improve system reliability and service quality.

Non-Uniform Subscriber Distribution

Since the users are not likely to be uniformly distributed over CONUS, the available network capacity will be under-utilized unless this factor is properly accounted for in the design of the satellite. While this problem is common to all systems employing multiple spot beams, the large number of these, and correspondingly small footprints exacerbate this problem for PASS. If an acceptable adaptive power management scheme can be found, the improvement might be significant.

While these challenges are not necessarily show stoppers, they could be design drivers or result in serious operational constraints, performance degradation, and/or system capacity reduction.

5.0 SOLUTIONS

A number of studies have been performed in the past year to address these challenges. These efforts are intended to improve performance, increase capacity, alleviate operational constraints, and reduce the burden on the spacecraft and ground terminals. Some potentially promising remedies have been identified while other options that once seemed attractive have been eliminated.

5.1 OPTIMIZED MULTIPLE-ACCESS SCHEME AND SATELLITE DESIGN

Economical viability of a PASS-type system is a direct function of user terminal cost, which in turn is inversely proportional to system capacity, i.e., to the number of users who can be supported by the system. As mentioned earlier, one of the fundamental reasons for migrating to Ka-Band is the availability of bandwidth. A study has been performed to determine the bottlenecks limiting system capacity, and to determine the most effective design approach to ameliorate capacity limitations.

With a preset multi-beam spacecraft antenna architecture, and a user terminal of given capabilities, it is found that choices of multiple access technique, modulation and coding schemes, spacecraft total RF power, spacecraft link power allocation, channel rates and number of channels are all interrelated [4]. Analysis shows that the most serious bottleneck exists on the forward downlink to the user. Consequently an efficient TDMA scheme has been adopted for the forward link. On the return link it is found that either FDMA or CDMA (using direct-sequence spreading, i.e, SSMA) could be used effectively for maximum capacity depending on the nature of the traffic and the size of the satellite. FDMA is best with data traffic while CDMA is more suitable in a voice dominated system, particularly for a higher powered satellite. Table 6 summarizes some of the key results [4]. Capacities ranging between half and a full order of magnitude more than an L-band system could be achieved [5]. This requires an order of magnitude increase in bandwidth relative to L-band. This is, however, one of the primary reasons for a leap to Ka-band.

A result that appears to be particularly promising is the use of SSMA on the return link. Powerful convolutional codes and exploitation of voice activity combine to result in substantial capacity increases [4]. The use of SSMA can also realize the benefits of instant access to the system, minimum network control, and position determination. It also can make more feasible ambulatory operation by taking advantage of the inherent multipath rejection capability of SSMA.

Additional information on the proposed SSMA design can be found in [4,6,7]. A more definitive study will be conducted in the near future.

5.2 ALTERNATIVE ANTENNA COVERAGE CONCEPTS

Different CONUS cellular configurations have been studied as a means of alleviating the burden on user terminals and more effectively matching the satellite resources to the traffic demand arising from the previously discussed non-uniform user distribution. As stated earlier, PASS is more sensitive to traffic variations from cell to cell because of the relatively large number of spot beams. One way to alleviate this problem is to employ interbeam power management to dynamically adapt to traffic variations. Scanning/switched beams and hybrid fixed/switched beams are more amenable to such schemes by permitting variable dwell times. Results of initial studies indicate that while these approaches utilize the satellite capacity more efficiently, the benefits come at the expense of increased satellite complexity and user terminal EIRP. Some possible disadvantages include: increased complexity of the antenna beam forming network, increased message delay, increased user transmitted data rate and radiated power. At this point, these offsetting disadvantages appear to outweigh the potential benefits. Consequently, other methods of mitigating the possible effects of traffic variation are being explored.

5.3 THE USE OF NON-GEOSTATIONARY ORBITS

The potential advantages of elliptical and circular non-GEO orbits for PASS have been examined with the objective of reducing the user terminal EIRP requirements. Low-earth orbits (LEOs) have several potential advantages over their GEO counterparts: higher elevation angles and hence less multipath and rain attenuation, less space loss, and lower launch costs.

Analyses indicate that non-GEO orbits are not desirable for PASS because of the following negative factors: the large number of satellites required to provide continuous CONUS coverage, more complicated spacecraft antenna pointing requirements, increased satellite handover complexity, and ultimately, the small savings in link power requirement. It should be noted, however, that a combination of GEO and non-GEO satellites could be used to extend coverage to higher latitudes which is a consideration for global coverage applications.

5.4 USER TERMINAL RADIATION CONSTRAINTS

Many studies have concluded that potential harm to humans from microwave energy, including millimeter waves, is strictly due to thermal insult [8]. Radiation at 30 GHz is generally less difficult to manage than at L band or UHF. This is primarily due to its minimal penetration of human tissue, typically .77 mm. Studies have also found that because of the superficial nature of the exposure (i.e., similar to visible light) the eye, particularly the cornea, is the primary area of concern; this is because it lacks blood circulation which drains deposited heat. The ANSI standard for frequencies above 1.5 GHz is 5 mW/cm^2 averaged over a 6 minute period, which includes a factor of safety of 10 or more. Recent studies at 30 GHz (see references in [9]) have indicated that incident densities up to 100 mW/cm^2 did not cause any harm. Judicious PASS terminal design, however, dictates maintaining the average radiation level below the 5 mW/cm^2 in both the near and far fields. Preliminary computations on a 25 dBi antenna [9] have shown that the maximum radiation density is 153 x P mW/cm^2, where P is the average radiated power in watts. This occurs at a distance of 8 cm from the aperture and drops logarithmically with distance. With 0.2 W radiated power and 35% voice activity, the average maximum radiated density is about 10 mW/cm^2. This indicates the possible need for some additional transmit power restrictions if the ANSI standard is to be strictly followed. By exploiting a combination of duty cycles, call duration, and antenna pointing this problem can be safely resolved. The design of the user terminal will take this into consideration.

5.5 USER TERMINAL FREQUENCY REFERENCE

In mobile SATCOM systems, the dominant frequency uncertainty is due to Doppler. However, in the PASS environment, the motion of the user terminal is relatively insignificant so the critical frequency uncertainty component is the user terminal frequency reference.

Studies indicate that a demodulator frequency error equal to 10% of the bit rate (assuming binary modulation) will result in about a 0.5 dB performance degradation [e.g., 10]. For the baseline PASS data rate of 4.8 kb/s, this implies a receiver frequency stability of 1.6×10^{-8}.

A temperature-compensated (quartz) crystal oscillator (TCXO) could satisfy this frequency stability requirement, but it would exceed the cost (about $100) and power consumption (about 50 mW) constraints on the user terminal. The most viable alternative appears to be a microprocessor-compensated crystal oscillator (MCXO) operating at a fundamental frequency of 10 MHz that was recently developed for the U.S. Army [11]. Because of spectral purity deficiencies in this device and the need to operate at 20 and 30 GHz, the MCXO would have to be accompanied by a multiplier and phase-locked loop (PLL) clean-up circuit to meet the PASS specifications.

6.0 FUTURE PLANS

PASS is a satellite-based communications system designed to provide a variety of services ranging from low bit rate PCOMM to high bit rate computer file transfer. Media competition for the low-rate personal applications is already emerging in the form of terrestrial (microcellular) PCOMM Networks (PCNs). This will most likely lead to the integration of space and terrestrial networks, forcing each to play an optimized telecommunications role, which will ultimately benefit the user. Telecommunications in the 21st century will be characterized by diversity of services; choice of media; and user-transparent, optimized information routing. In recognition of these trends, a two-pronged approach has been adopted for the PASS Program with the following objectives.

The first objective is to continue the 20/30 GHz PASS system study and technology development with the goal of advancing Ka-band technology in general, and Ka-band mobile/personal technology in particular. Enabling technologies targeted for development are: user antenna; user terminal components (vocoder/modem, transceiver, MMIC front-end, and frequency reference); modulation and coding; rain compensation techniques; and multiple access schemes. Currently, the intention is to incorporate these technologies, to the extent possible, into a mobile terminal for use with NASA's ACTS. This terminal is being explored by JPL as way to demonstrate future Ka-band mobile applications.

The expansion of cellular phones suggests that they will play a significant role in personal communications in the 21st century. Considering this fact, and general telecommunications trends (technical and economic), the second objective is to specifically address the roles of communication satellites in PCOMM and to devise system concepts for an integrated satellite/ground PCOMM network. Such a network will provide choice of media and route selection. The key to integrating the characteristically and architecturally different space and terrestrial communications networks lies in networking protocol compatibility. The ultimate objective is to devise a system concept capable of providing PCOMM to the user using a truly universal personal terminal.

ACKNOWLEDGEMENT

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Table 1. Salient Features of PASS

OPERATING FREQUENCY	
UPLINK:	30 GHZ
DOWNLINK:	20 GHZ
COVERAGE CONCEPT	
SAT/SUPPLIERS:	CONUS BEAM
SAT/USERS:	142 SPOTBEAMS
GENERIC SERVICES	VOICE AND DATA
DATA RATES	
FORWARD:	UP TO 100 KBPS (BPT)
	UP TO 300 KBPS (EPT)*
RETURN (NORMAL):	4.8 KBPS (BPT)
RAIN COMPENSATION	
FORWARD:	UPLINK POWER CONTROL & VARIABLE DATA RATE
RETURN:	VARIABLE DATA RATE

* For EPT, the stated data rate includes built-in margin for rain compensation.

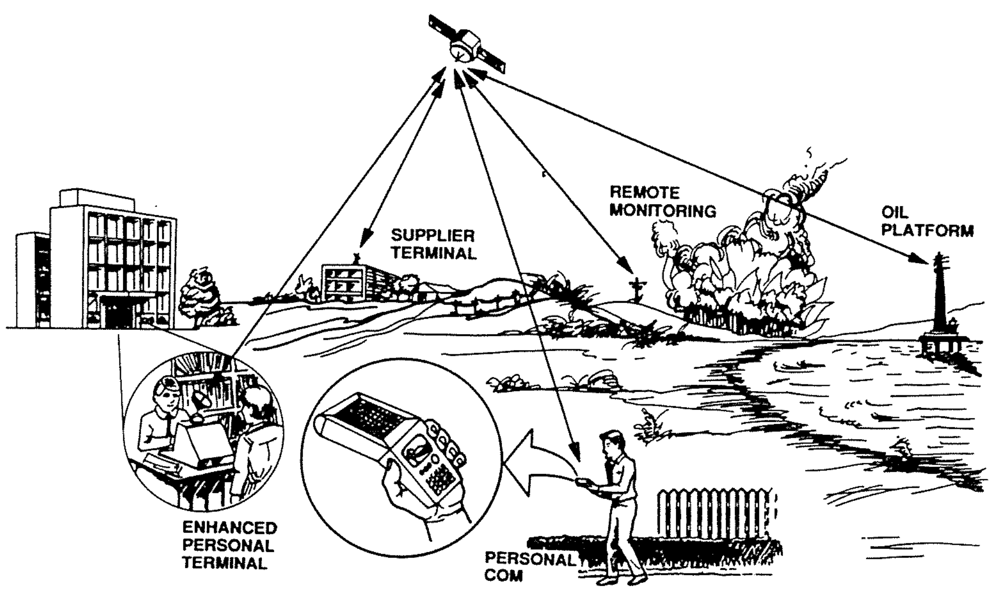


Figure 1. Personal Access Satellite System Concept

Table 2. Summary of Satellite Design

SPOTBEAM	
ANTENNA SIZE (TRANSMIT)	3 M
(RECEIVE)	2 M
NUMBER OF SPOTBEAMS	142
ANTENNA GAIN	52.5 DBI
ANTENNA BEAMWIDTH	0.35 DEG
SYSTEM G/T	23.4 DB/K
AVERAGE EIRP/BEAM	55 DBW
CONUS BEAM	
ANTENNA GAIN	27.0 DB
ANTENNA BEAMWIDTH	7.7 DEG
SYSTEM G/T	- 1.2 DB/K
EIRP	39 DBW
SATELLITE MASS (GTO)	7300 lb
SATELLITE POWER (EOL)	3.4 kW (for 520 RF watts)

Table 3. Design Requirements for the BPT

ANTENNA GAIN @20 GHZ	19.3 DBI
ANTENNA GAIN @30 GHZ	22.8 DBI
ANTENNA TRACKING/COVERAGE CAPABILITY	
AZIMUTH	360.0 DEG
ELEVATION	15-60 DEG
RECEIVE G/T	-9.0 DB/K
TRANSMIT POWER	0.3 W
NORMAL DATA RATES	
RECEIVE	100 KBPS
TRANSMIT	4.8 KBPS
OTHER REQUIREMENTS	
SIZE	HAND-HELD
MODEM	VARIABLE RATE

Table 4. Strawman Link Budgets for Basic Personal Terminal (Data Link with BER requirement of 1E-5; No Rain)

	FORWARD (SUPPLIER-SAT-USER) IN DB	RETURN (USER-SAT-SUPPLIER) IN DB
DATA RATE, KBPS	100	4.8
UPLINK:		
EIRP,DBW	60.7	16.8
PATH LOSS, DB	-214.0	-214.0
RX G/T, DB/K	-1.2	23.4
RCVD C/NO, DB-HZ	69.9	46.9
DOWNLINK:		
SAT EIRP,DBW	57.0	6.4
PATH LOSS, DB	-210.5	-210.5
RX G/T, DB/K	-9.0	30.3
D/L C/NO, DB-HZ	58.8	50.3
OVERALL C/NO, DB-HZ	57.4	44.2
REQ'D C/NO, DB-HZ	54.5	41.3
MARGIN, DB	2.9 (1.0*)	2.9 (1.1*)

NOTE: * ESTIMATED 1-SIGMA VALUE

Table 5. Comparison of State-of-the Art Performance and PASS Design Requirements for Selected Key Technologies

TECHNOLOGIES	PASS ASSUMPTIONS/ REQUIREMENTS	RELEVANT EXISTING CAPABILITY/ DEVELOPMENT GOAL
DEVICE/COMPONENT		
LNR NF @20 GHZ	3.0 DB (S/C) 3.5 DB (USER TERMINAL)	1.5 DB HEMT LOW NOISE DEVICE 3.5 DB LNR BEING DEVELOPED
LNR NF @30 GHZ	3.0 DB (S/C)	2.0 DB HEMT DEVICE 5.0 DB LNR (ACTS)
HPA EFF. @ 20 GHZ	50% @ 5W	15% SSPA (<=5W) 40-50% TWT
HPA EFF. @ 30 GHZ	20-30% @ 0.3 W	5-15% @ 1-2W (HEMT SSPA) 15-20% @ .2W (HEMT SSPA) 35% @ 250mW BEING DEVELOPED FOR PLANETARY APPLICATIONS
MULTIBEAM ANTENNA AND FEED		
ANT SIZE @ 20GHZ	3M	3.3 M (ACTS)
ANT SIZE @ 30GHZ	2M	2.2 M (ACTS)
NO. SPOTBEAMS	142	<=10
USER TERMINAL ANTENNA		
BPT TRACKING ANT. GAIN @ 20/30 GHZ	19/23 DBI	
USER TERMINALMINIMIZATION		
TERMINAL SIZE & TECHNOLOGIES	HAND-HELD MMIC FRONT END VLSI MODEM/CODEC	MMIC ARRAY, RX/TX MODULES, CHIP-SIZE MCXO CODEC ON 1 BOARD

Table 6. PASS Capacities for Different Multiple Access Scheme Choices (adapted from [4]) (Voice Links Assumed with BER = 1e-3 and a VOX factor of 0.35)

ACCESS SCHEMES	LINK Eb/NO dB	CODING (CONVOLUTIONAL)	CAPACITY (#CHANNELS) RETURN	FORWARD	BANDWIDTH (MHz) UP-LINK	DN-LINK	TOTAL	SAT RF POWER SPLIT(TOT/F/R)
FDMA (RET)/ TDMA (FWD)	3	R=1/2, K=7	8072	8216	111.8	110.3	222.1	410/390/20 W
"	2.3	R=1/3, K=7	9483	9653	183.4	181	364.4	410/390/20 W
CDMA (RET)/ TDMA (FWD)	2.3	R=1/3, K=7	10143	8452	65.1	183	248.1	410/335/75 W
"	1.5 (R)/ 2.3 (F)	SUP. ORTH.(K=10)/ R=1/3, K=7	10142	9331	69.1	180	249.1	410/375/35 W
....	....	....	....	....	....	....	....	....
FDMA (RET)/ TDMA (FWD)	3	R=1/2, K=7	10493	10433	142.3	143	285.3	520/494/26 W
"	2.3	R=1/3, K=7	12328	12258	233.6	234.6	468.2	520/494/26 W
CDMA (RET)/ TDMA (FWD)	2.3	R=1/3, K=7	12171	10565	78.6	206.4	285	520/425/95 W
"	1.5	R=1/3, K=9	13894	13523	99.8	258.2	358	520/470/50 W
"	"	"	19069	11411	85.1	225	310.1	520/390/130 W
"	1.5 (R)/ 2.3 (F)	S. ORTH.(K=11)/ R=1/3, K=7	17851	11411	101.8	356.3	458.1	520/460/60 W

Note: For a 10:1 data-to-voice traffic ratio, a 1.4 s average message delay, 2% voice blocking probability, 90 s/call/user/hr, 1000 bits/data message, one channel can servean average of 100 users

Appendix B

Norris Satellite Communications
Board of Directors

John H. Norris
Chairman, Norris Satellite Communications
Red Lion, Pennsylvania

John H. Norris is Chairman of Norris Satellite Communications, which was founded in 1989 to promote the utilization of cutting-edge technology to implement new telecommunications services.

Mr. Norris is president and owner of a combined operation of AM, FM, shortwave and television stations in Red Lion, Pennsylvania, including flagship radio station WGCB-AM, founded in 1950 as a religious broadcasting station by Mr. Norris's father, Rev. John M. Norris. In 1979, TV 49 signed on with a potential audience of 1.5 million.

Earlier, Rev. Norris had added an international shortwave station, WINB, in 1962; and in 1958 WGCB-FM went on the air, with a potential audience of 3 million.

John H. Norris has been general manager of the radio and television stations since 1950. He took over leadership of all operations when the TV station began operation in 1979.

In 1988, Mr. Norris added a large studio and auditorium to his TV facilities and formed the Keystone Inspirational Network, a nationwide satellite-delivered network of family and religious television programming. KIN in 1988 began operations with a shared transponder on SATCOM F4, moving to a 24-hour transponder on WESTAR IV in July 1989.

B.G. Davis
President and Director, E'Prime Aerospace
Melbourne, Florida

B. G. Davis is President and Director of E'Prime Aerospace, a commercial launch services company. He has 28 years research, development, design, test and operations experience, including thirteen years in aerospace. From 1970 through 1987, he was President of E'Prime Labs, a small private product development firm that developed simple devices, complete chemical and biochemical processes, and complete plans for energy conversion and recovery. He has some twenty granted or pending patents.

Until retiring in 1970 from Boeing Aerospace Corp., Mr. Davis was a member of the test team on the Minuteman missile, with responsibilities for conducting and supervision assembly, checkout and launch operations. He also coordinated interface problems between research and development and operational systems.

He was with the Lunar Orbiter program from inception to completion, 1965-67, where he worked on design, build-up, assembly, test and installation of all ground tracking and reconstruction equipment located in various countries.

On the Saturn program 1967-72, Mr. Davis was design engineering manager responsible for systems specifications and configurations on all Saturn V ground support systems.

Wilbur L. Pritchard
President, W. L. Pritchard & Company
Bethesda, Maryland

Mr. Pritchard is President of W.L. Pritchard and Co., Inc., a consulting engineering firm that provides technical and economic studies in the telecommunications field with a specialty in satellite communications.

Mr. Pritchard was formerly Chairman of the Board and CEO of SSE Telecom, Inc., a group of related satellite communications companies founded by him, which includes Satellite Systems Engineering, Inc., and SSE Technologies, Inc. Mr. Pritchard founded Satellite Systems Engineering, Inc., in 1974 to provide direction and systems engineering in satellite communications to governments and private companies.

Mr. Pritchard is also Professorial Lecturer at George Washington University and Adjunct Professor of Electrical Engineering at the Polytechnic University of New York where he teaches courses in satellite communications.

B.G. Pritchard has been identified with communications satellites since 1962 when he moved form the Raytheon Company to the Aerospace Corp. to direct the team that produced DSCS-1, the first operational military satellite system; the U.S. TACSAT satellite system; and the U.K. Skynet System.

In 1967, Mr. Pritchard came to Communications Satellite Corp. as its fist Director of COMSAT Labs, and later served as Vice President of the corporation. While at COMSAT, he also served as U.S. delegate to the Technical Subcommittee of INTELSAT for four years, representing COMSAT both it in capacity as U.S. Signatory to the INTELSAT agreement and as executive manage of the INTELSAT organization.

Mr. Pritchard has been a member of a number of study groups and task forces, among which are: National Academy of Engineering's task for the Voice of America (1986-89); NASA's Space and Earth Sciences Advisory Committee Task Fore on the Scientific Uses of the Space Station (1984-88); and The National Academy of Sciences Panel to Study Broadcast Satellites (1968, chairman).

He has received a number of awards in recognition of his contributions in the field of communications satellites, including fellowships in the Institute of Electrical and Electronics Engineers and in the American Institute of Aeronautics and Astronautics.

Mr. Pritchard received a B.E.E. degree in electrical engineering from the City College of New York in 1943, and pursued graduate studies at Massachusetts Institute of Technology from 1948 to 1952.

Matthew R. Willard
Vice-President, Business Development
MARCOR
Washington, D.C.

Matthew Willard joined MARCOR as Vice President, Business Development earlier in 1990. MARCOR is a technology development and project management company specializing in multi-technology products and services in the areas of spectrum management, marine electronics and digital audio broadcasting.

Dr. Willard previously served as Director, Strategic Planning and Product Development of the Earth Observation Satellite Corp. (EOSAT), a joint venture of Hughes Corp. and General Electric Corp. At EOSAT he had primary responsibility for market/new product development and interface to technical operations.

He has worked as an independent contractor to government and private sector clients on space remote sensing and communications systems, data base management, geographic information systems and market studies/business planning of new ventures.

Earlier in his career, Dr. Willard served as special assistant to the Directors of Satellite Communications and Technology Transfer Divisions of NASA.

He earned his Ph.D. in engineering and economics from Stanford University in 1982.

Dr. Mary Cathryne Park
Professor and Broadcaster
Merritt Island, Florida

Mary Cathryne Park is a world recognized educator and educational broadcaster. She serves as Professor of English at Brevard Community College.

As Professor in the Florida Institute for Continuing Education and University Studies, Florida Junior College Television Classroom, Dr. Park's programming is carried on Channel 3 in Tampa, Channel 2 in Orlando and Daytona Beach and carried on both commercial and educational TV throughout Florida since 1964. As an educational broadcaster, Dr. Park created the Humanities series broadcast in Florida in 1962-64; and the Series on Preventive Medicine, 1961-64. These series were recognized by NBC and given national awards of The American Cancer Society, TB and Respiratory Diseases Society and the American Heart Association.

Dr. Park also serves as adjunct professor of English at Shelton College, Cape Canaveral, FL and at Rollins College at Patrick Air Force Base. She has served as adjunct professor in the Graduate School of Business, Florida State University at Patrick Air Force Base.

Dr. Park has written numerous papers and articles for such groups as the Space Congress and Florida Academy of Sciences; she has also delivered speeches before more than 2,500 civic, cultural and professional groups in Florida.

She served several terms as chairman of the Florida Academy of Sciences between 1958 and 1968 and is a life member of the Space and Missile Pioneers.

Leslie A. Taylor
Communications Attorney and Consultant
Bethesda, Maryland

Leslie A. Taylor, in 1989, founded a telecommunications consultancy, Leslie Taylor Associates, specializing in international, satellite and new technologies. Since its formation, Leslie Taylor Associates has advised clients concerning acquisitions of telecommunications companies, developed strategies for entering overseas markets, and assisted clients with spectrum requirements for new services.

Prior to founding Leslie Taylor Associates, Leslie Taylor was Director, Government Affairs for GTE Spacenet Corporation in McLean, Virginia. In that position she formulated and executed the company's regulatory strategy, headed the customer contracts program and provided strategic input. Before going to GTE Spacenet, Leslie Taylor served in the U.S. government as an attorney.

Among the government positions held by Ms. Taylor were: Chief, International and Satellite Branch, Common Carrier Bureau; Legal Advisor to Commissioner Mimi Weyforth Dawson; Legal Advisor to Ambassador Abbott Washburn when he served as Director of the U.S. delegation to the 1983 Region 2 Broadcasting Satellite Conference. Ms. Taylor has served on numerous U.S. delegations to international conferences.

In 1989 FCC Chairman Al Sikes appointed Ms. Taylor to the FCC Industry Advisory Committee for the 1992 World Administrative Radio Conference. This Conference will address numerous frequency allocation questions, including High-definition television, satellite sound broadcasting, personal communications networks, aeronautical, maritime and land mobile satellite services and satellite services in the Ka-band.

In 1990 Leslie Taylor authored a book entitled The RHCs: International Ventures, Strategies and Opportunities, released by Phillips Publishing Company.

Part II

Technical Showing

List of Figures

Part II

Technical Showing

In this section of its application, Norris provides a full description of its proposed system. Descriptions of the spacecraft, uplinking requirements, receive-only stations and overall link performance are included. An artist's conception of the Norris spacecraft is shown in Figure 1.

1.0 SUMMARY

1.2 SPACECRAFT

NorStar is a proposed U.S. domestic satellite designed to provide 24 channels of high power Ka-band service to CONUS, Alaska and Hawaii. The satellite is 3-axis stabilized and is provided with batteries for full operation during eclipse. Its mass in orbit at the beginning of life is planned to be 1956 kilograms, including sufficient fuel for 10 years.

The satellite is designed to receive in the band 29.3-30.0 GHz and transmit in the band 19.5-20.2 GHz. At these high frequencies, rain attenuation is a serious consideration. The requested orbital location of 90 degrees west longitude provides high earth station antenna elevation angles in the most severe rain areas of the United States, thus reducing the effects of rain attenuation.

Communications transponders will have a nominal bandwidth of 24 MHz with a spacing of 29.12 MHz. The transponder final output amplifier is a travelling wave tube adjusted to a saturated output of 90 Watts. The receive system will system will have a nominal G/T of -3 dB/K for CONUS coverage and +12 dB/K for spot beam uplinking. Transponder outputs may be switched among eight antenna beams (Figure 9) to provide EIRPs ranging from 53 dBW in the West to a maximum of 65 dBW in Florida. The antennas gains are weighted to provide higher power to the areas of the country with the worst rainfall rates.

1.2 COMMUNICATIONS PERFORMANCE

The spacecraft may be used for a wide variety of applications ranging from direct television broadcast to data and digital sound distribution and high speed data linking.

Television broadcast reception can be accomplished using small home terminals in sizes from 60 to 90 cm, similar to those planned for the broadcast satellite service. The NorStar frequency plan has the same channel bandwidth and spacing as the broadcast satellite service, so that filter and receiver technology developed for BSS could be directly applied to the NorStar system. Availability of television reception is expected to range from 99.8 to 99.9% of time or better, and depends on local rain rate and the size of the home antenna. Uplinking for television would be into spot beams, and are expected to require facilities with 4-meter antennas and transmitters with a maximum output power of 200 Watts.

Data and digital sound may be distributed either in a broadcast mode or in a fixed, point-to-point mode. In the broadcast mode, receivers would be similar to television, but for point-to-point service, a greater reliability would usually require larger antennas.

1.3 INTERFERENCE

The only other U.S. spacecraft which has announced plans for operation in the 29/19 Ghz band is the NASA ACTS satellite, an experimental satellite planned to operate in the period 1992-1994. Interference into ACTS is expected to be negligible.

2.0 TECHNICAL DESCRIPTION

2.1 SPACECRAFT GENERAL DESCRIPTION

2.1.1 Mass and Propellant Allocations

NorStar is designed to be a geostationary spacecraft having a life of 10 years and a beginning of life mass of 1956 kg. The spacecraft may be launched using the Centaur, an Ariane 4 or a newer system such as E-Prime is making available. A preliminary breakdown of mass properties and propellant allocations is as follows:

SUBSYSTEM	MASS (kg)
Structure	219
Propulsion	110
Electric Power (122 A-H battery)	310
Solar Array (4 panel)	168
Communications Antenna	50
Communications Transponder	228
TC&R	16
ADCS	137
Thermal Control	97
Electrical	62
Mechanical	44
5% MARGIN	72
SPACECRAFT DRY MASS	1513
PROPELLANT (12 YEARS N/S)	439
PRESSURANT	4
BEGINNING OF LIFE MASS IN GEO	1956

2.1.2 Electrical Power

The spacecraft is designed to provide 24 transponders with 90 Watts saturated output power. Power is provided by solar panels during the time it is exposed to the sun. Batteries provide power for full operation during eclipse. A summary of power characteristics follows.

BATTERIES:

Required Battery Capacity	153.5 Amp-hrs/Bat.
Maximum Allowable DOD	70 %

SOLAR PANELS:

Panels	8
Length	2.630
Width	2.385
Array Area	50.18 square meters

TWTA POWER CONSUMPTION:

Number of Operating TWTAs	24 Ka-Band
Saturated Output Power	90 W
Tube Efficiency	45%
EPC Efficiency	91%

SPACECRAFT CONSUMPTION:

	END OF LIFE (10 YR) SYNCHRONOUS POWER		
	Autumnal Equinox	Summer Solstice	Eclipse
Comm Transponder	5439.0	5439.0	5439.0
T,C,& R	81.7	81.7	81.7
AOCS	67.8	67.8	67.8
Propulsion	3.6	3.6	3.6
Thermal Control	208.4	87.2	56.4
Harness Loss	29.5	28.3	28.0
Spacecraft Total	5830.0	5707.6	5676.5
Solar Array Cap.	6525.0	5947.0	
Req. Eclipse Power Cap. for 70% max DoD			5820.3
Battery Charging **	554.4	92.4	
Battery Harness Loss			18.5
Battery Interconn. Loss			25.0
PCU Harness & Diode Loss			84.2

PCU TLM and Control	16.8	16.8	16.8

POWER AVAILABLE:			
From PCU Terminals	5953.8	5837.8	5649.9
Margin (watts)	123.8	130.2	0.0
% Margin	2.1	2.2	0.0

** 6.6 amp recharge with battery heaters operating
1.1 amp battery trickle charge for solstice
Battery recharge time: 15.1 hours

Battery Harness Loss	18.49
Battery Interconn. Loss	24.97
PCU Harness and Diode Loss	84.15

2.1.3 Station Keeping

The spacecraft will maintain its position within plus or minus 0.05 degrees North-South and East-West during its lifetime.

2.2 SPACECRAFT COMMUNICATIONS SYSTEM DESCRIPTION

2.2.1 General

The NorStar System is planned to use Ka-band spacecraft for fixed service for business and broadcast applications. It is proposed to locate the spacecraft at 90 degrees West longitude. Norris plans to provide 24 high-power transponders for coverage of CONUS, Alaska and Hawaii. The system is planned to be operational in the mid 1990s.

The system will transmit in the currently almost vacant 19.25 GHz band, thereby avoiding the interference coordination common in lower bands. It will operate with EIRPs ranging from nominal values of 53 dBW per channel in dry areas of the Southwest to 65 dBW per channel in Florida. The system is planned for reception using antennas ranging in diameter from 30 to 120 cm.

Transponders are designed to be transparent to modulation type, so that they may accommodate multiple access TDMA, FDMA and FM video transmission with high quality audio subcarriers. As digital video techniques develop within the industry, the NorStar System will be compatible with them as well.

2.2.2 Transponder Frequency and Polarization Plan

The NorStar spacecraft are planned to transmit 24 right-hand circularly polarized channels in the band 19,500 to 20,200 MHz. The transmit plan corresponds in channel spacing and bandwidth assignment to the Broadcast Satellite Service (BSS) which is assigned to operate at a lower frequency band. The corresponding spacecraft receive band is 29,300 to 30,000 MHz. Channels have a nominal bandwidth of 24 MHz with a spacing of 29.12 MHz between centers. The detailed frequency plan is shown in Figure 2.

As in the BSS service, the orthogonal polarization remains available for future use, and could best be utilized with the same channel spacing and bandwidth, but with channels offset from NorStar by one half the channel spacing, 14.56 MHz.

2.2.3 TT&C Frequencies and Polarizations

Norris spacecraft are planned to operate with a command channel within the receive band of the transponders. It will use the same polarization as the transponders and have a bandwidth no greater than 2 MHz.

A telemetry channel and a beacon will transmit within the transponder band and will use polarizations corresponding to the transponder transmissions. The telemetry channel bandwidth would be no greater than 2 MHz and the beacon bandwidth no greater than 0.5 MHz.

2.2.4 Transponder Filter Characteristics

The NorStar spacecraft design is based on a dual conversion scheme: up at 29 GHz, intermediate frequency at 12 GHz, and down at 19 GHz. Transponders have an nominal bandwidth of 24 MHz.

Current plans assume a 12 GHz input multiplex consisting of a six-pole elliptic filter, a two-pole equalizer, a dielectric resonator and low Q equalizer. Its amplitude and phase characteristics are shown in Figures 3 and 4, and assume a 60 degree temperature swing and 1 MHz margin.

The 19 GHz output multiplex is expected to be a five-pole quasi-elliptic filter made of TE114 Invar. Its loss, not including the effects of isolators or harmonic filter is expected to be 1.7 dB. Relative amplitude and delay characteristics at 19 GHz are shown in Figures 5 and 6, and composite, 12 and 19 GHz, loss is shown in Figure 7.

2.2.5 Final Output Amplifier

The Norris spacecraft is designed to have 24 channels, each with a TWTA final output amplifier operated with a saturated output power of 90 Watts. The manufacturer of this tube has not yet been chosen, however two major contenders are the Hughes Model 986, and an AEG tube (without a model number) referred to as their "20-GHz 60-Watt tube." With minor adjustments, the AEG tube can operate over a range of output power up to 200 Watts.

2.2.6 Antenna Beam Configurations

NorStar spacecraft are designed to provide service to all of the contiguous United States (CONUS) with a total of eight beams. As shown in Figure 2, groups of beams are associated with one of three sets of eight channels. Each beam can accommodate up to the maximum of eight channels assigned to the group. Figure 8, the Communications Subsystem Block Diagram, shows how this is accomplished. Because rainfall attenuation is a particularly significant consideration in the Gulf area, beams with smaller coverage areas and correspondingly higher EIRPs are planned for these areas. In addition to the CONUS beams, Norris plans to use a small amount of power from one or two beams to feed spot beams to Alaska and Hawaii.

Uplinking is planned on a CONUS basis as well as from spot beams in the Southwest and Northeast. The spots are designated AZ/CA and NY in Figure 2. Although Figures 2 and 8 show each spot receive beam assigned to 12 of the total of 24 channels, the design of the system does not preclude uplinking up to the full compliment of 24 channels from any one spot beam or from CONUS. Such a design is necessary to provide full service in the event of storm damage or earthquake at a major uplinking facility.

2.2.7 Receiving System

CONUS reception is provided with a nominal antenna gain of 30 dBi. A receive system temperature of 2000 K yields a CONUS G/T of -3.0 dB/K. The receive spot beams will have a nominal gain of 45 dBi. The 2000 K receive temperature provides a spacecraft G/T of +12 dB/K.

2.2.8 Transponder Channel Gains and Controls

The beacon, and optionally, telemetry data may be used for uplink power control to limit the range of signal levels arriving at the spacecraft during rain conditions at uplinking facilities. Transponders will be individually adjustable in gain and level by ground command, and will also be equipped with an automatic level control (ALC) which may be turned on and off by ground command.

2.2.9 Coverage Patterns

Service will be provided to all of CONUS, Hawaii, and to the extent visible from orbit, Alaska. Coverage patterns showing EIRP for each beam are shown in Figures 8 and 9.

2.2.10 Spacecraft Technical Summary

The major communications parameters for the spacecraft are as follows:

TRANSMIT CHARACTERISTICS

Band Center Frequency	19.85 GHz
Antenna Diameter	120 cm nominal
Antenna Efficiency	50 %
Antenna Gain	44.7 dBi maximum
Transmit Line Losses	2.0 dB
Beamwidth	0.7 deg nominal
Coverage	CONUS, AK, HI

CONUS Antenna Beams:

Beam	1	2	3	4	5	6	7	8
RF Power	90W	90W	90W	90W	90W	90W	90W	90W

EIRP,dBW EOC*	60.5	56.5	55.0	55.0	54.5	53.0	53.5	53.0

RECEIVE CHARACTERISTICS

Band Center Frequency	29.65 GHz
Antenna Diameter	100 cm nominal
Antenna Gain	45.0 dBi EOC* Spot
Receive Temperature	2000 K
G/T	12.0 dB/K EOC Spot
	-3.0 dB/K CONUS
Coverage	CONUS (Spot and full CONUS Beams), AK, HI

TRANSPONDER CHARACTERISTICS

Number of Transponders	24
Transponder Spacing	29.12 MHz between centers
Transponder Bandwidth	24 MHz nominal
Transponder Output Amplifier	90 Watt TWTA

*EOC 2 to 5 dB down from maximum.

2.3 USER TERMINALS

2.3.1 Transmit Station Characteristics

Transmit Stations designed to accommodate carriers for the full transponder are currently planned for spot-beam uplinking. Tentative characteristics are planned around providing a power flux density in orbit of -98 dBW/square meter for 99.9 % of time. Preliminary station characteristics are:

Antenna Diameter	4 meters
Frequency	29.65 GHz mid band
Antenna Gain	60.0 dBi
Beamwidth	0.18 degrees
Transmit Line and Filter Losses	3 dB

Transmitter Power	6 Watts, clear sky 200 Watts, heavy rain
EIRP	65 dBW, clear sky 85 dBW, heavy rain
Power Flux Density in GEO	-98 dBW/sq. meter

Data received from the spacecraft telemetry channel and beacon will be used for uplink power control to maintain the power density in orbit at the required level.

2.3.2 Receive-Only Station Characteristics

Receive only antennas for full-transponder applications such as video reception are expected to range in size from 30 cm (1 foot) to 120 cm (4 feet), depending on the service requirements and rain statistics of the location. Typical receive television performance characteristics for these stations are as follows.

LOCATION	ANTENNA SIZE	G/T	AVAILABILITY
Miami	90 cm	17.0 dB/K	99.8 %
	120 cm	19.5 dB/K	99.9 %
Los Angeles	90 cm	17.0 dB/K	99.9 %
	120 cm	19.5 dB/K	99.9 %
Boston	90 cm	17.0 dB/K	99.8 %
	120 cm	19.5 dB/K	99.9 %

2.3.3. Small Data Link Terminals

Transmit/receive earth stations may be used with the spacecraft for data links. A typical example could employ 2.5-meter antennas with 50-Watt transmitters and a G/T of 25.6 dB/K. Such terminals could transmit and receive small digital carriers, on the order of 1.544 Mb/s in a frequency division multiple access mode with good availability. In a typical CONUS network, they could uplink into a CONUS receive beam with a gain setting corresponding to a single carrier saturation flux density of -85 dBW/square meter in GEO.

3.0 PERFORMANCE CALCULATIONS

3.1 TRANSMISSION CHARACTERISTICS, MODULATION PARAMETERS AND PERFORMANCE OBJECTIVES

It is expected that Norris will provide a wide variety of services with its spacecraft. The NorStar satellites will provide transponders with a 24 MHz bandwidth, a specific gain and saturation flux density in its uplink, and bandwidth, EIRP and coverage area on its downlink.

3.1.1 FM Video

In this section, performance calculations for a standard FM video transmission carrier with an 18 MHz receiver are provided. Results are shown in terms of carrier-to-noise ratio (C/N). Expected performance for NTSC FM Television with two audio subcarriers is derived from the relationship:

$$S/N_{tv} = 10\ \log_{10}\{12V_L^2 f_d^2 B_R/f_c^3\} + F_{dwtv} + C/N,$$

where S/N_{tv} = TV signal-to-weighted-noise ratio, dB

V_L = Amplitude of TV Luminance component (0.714 V)

f_d = Peak Deviation of 1 V peak-peak test tone at video preemphasis crossover frequency.

B_L = Receiver RF Bandwidth
= 18 MHz nominal.

f_c = Top Television Baseband Frequency
= 5.0 MHz (CCIR Rec. 586 for 525 line TV.

F_{dwtv} = Weighting and De-emphasis Improvement Factor
= 14.8 dB for 525 line TV

C/N = RF Carrier/Noise ratio in receiver bandwidth, dB.

For C/N = 10 dB, which corresponds to normal FM threshold, TV signal to weighted noise ratio = 44.6 dB, corresponding to a TASO rating of "excellent."

FM audio subcarriers will be multiplexed in the TV baseband in the region above the video. Audio performance is determined by the relationship:

$$S/N_a = 10 \log\{0.75(B_R/f_a)(D_s/f_s)^2(D_a/f_a)^2\} + F_a + C/N$$

where S/N_a = Audio RMS signal to noise ratio.

B_R = Receiver RF bandwidth

f_a = Top Audio Frequency

D_s = Peak Deviation of Main Carrier by Subcarrier

f_s = Subcarrier Frequency in Baseband
= 5.4 to 6.2 MHz range

D_a = Peak Deviation of Subcarrier by Audio

F_a = Audio Emphasis Improvement Factor
= 13.2 dB (75 microsec preemphasis)

3.1.2 Digital Video

Modern compression techniques are under development which promise NTSC quality video transmission with digital modulation using transmission rates on the order of 6-8 Mb/s.

For C/N = 12.7 dB in 24 MHz, data transmission rates on the order of 22 Mb/s can be transmitted at error rates of better than 10^{-10} using conventional error correction techniques. This corresponds responds to 3 multiplexed video channels with a bandwidth and power requirement comparable to one channel using conventional FM techniques.

3.1.3 Digital High Fidelity Audio

A practical digital high fidelity stereo audio transmission can be accommodated with characteristics similar to the following:

Top Audio Frequency	22 kHz
Sampling Rate	44 kHz
Sample	16 bits

Total Data Rate 0.7 Mb/s nominal

If the channels originate from different uplinking locations, frequency division multiple access techniques may be used to accommodate up to up to 10 or 12 such 700 kb/s transmissions. In the more favorable case where all transmissions can be uplinked from the same facility, transponder intermodulation noise is eliminated, resulting in greater capacity for a transponder. Transmission requirements for the case of 16 multiplexed channels on a single carrier is shown in the following table.

Number of 700 kb/s Transmissions	16
Total Multiplexed Data Rate	11.2 Mb/s
Modulation Type	QPSK
Coding	R-3/4
RF Bandwidth Requirement	7.5 MHz nominal
Error Rate Required	10^{-12}
E_b/No Required	14.0 dBHz
C/No Required	84.5 dB
C/N	10.6 dB in 24 MHz transponder

3.1.4 Data Transmission

Data circuits may be established using small carriers in a frequency division multiple access mode. Requirements for a T-1 carrier are as follows.

Data Rate	1.544 Mb/s
Error Rate	10^{-10}
Modulation Type	QPSK
Coding	R-3/4
E_b/No Requirement	13.0 dB
Channel Bandwidth	1000 kHz
Channel Spacing	1300 kHz
C/N Requirement	14.6 dB

3.2 LINK BUDGETS AND SYSTEM PERFORMANCE

Typical link budgets for the case of full-transponder transmissions in the broadcast mode considered in this section.

A major consideration in link performance calculation in this band is rain attenuation. We have used an attenuation model based on CCIR Report 563-4, Vol V, which depends primarily on rainfall rate at 99.99 % of time to develop attenuation statistics. Figure 11 shows a rainfall rate map used in this analysis.

Link budgets are shown in Figures 12 through 18. In this case, a video transmission is originated in Lancaster, Pennsylvania. Figure 12 shows the rain attenuation characteristics for Lancaster and the transmitter power required to maintain desired signal level at the spacecraft.

Figures 13 and 14 show overall link performance for reception in Miami, which is typical of the heaviest rain areas in the United States. A 90 cm antenna was chosen in this case, and a spacecraft EIRP of 62.1 dBW was chosen to represent typical Florida coverage (Miami would be near the center of the beam). Figure 13 shows overall link performance for clear-sky performance and Figure 14 shows receive performance statistics under rain conditions. Typical circuit availability of better than 99.8 % of time is shown for C/N = 10 dB. Comparable link performance near the edge of coverage for the Florida beam could be expected with in increase in antenna size to 120 cm.

Figures 15 and 16 show comparable performance for Los Angeles, and Figures 17 and 18 show Boston. Los Angeles, in the driest area of the country, was assigned the lowest EIRP beam, and Boston, which is representative of average rainfall, was assigned an intermediate power beam.

Figure 19 shows an example of frequency division multiple access data transmission using 2.5-meter antennas. In this case, uplinking is through the CONUS beam. Four simultaneous carriers are shown during clear sky conditions. Although in this particular example only a few carriers access the transponder, a link of this type could be expected to be available on the order of 99.99 % of time throughout CONUS.

4.0 INTERFERENCE

To minimize the effects of interference into other systems, the NorStar System is expected to operate with a minimum energy dispersal of 2 MHz during full transponder operation.

4.1 POTENTIAL INTERSATELLITE SYSTEM INTERFERENCE

The only U.S. spacecraft planned to operate in the 20/30 GHz band is the experimental NASA ACTS satellite. ACTS is an experimental spacecraft planned for launch in 1992 with a life of 2 years. Its planned location is 100 degrees West. Because ACTS is expected to be near end of life by the time NorStar is launched, we do not assume any interference will occur between the systems. The following information is provided nevertheless.

The proposed NorStar location is 90 degrees West, providing more than 10 degrees separation from ACTS as seen from the earth surface. On the uplink, the Norris 4-meter television transmitting stations provide an on-axis power flux density of -98 dBW/square meter at GEO, and corresponds to an on-axis antenna gain of 60.1 dBi. We assume that at an off-axis angle of 10 degrees, antenna gain will be isotropic, corresponding to a flux density of -158.2 dBW/square meter into ACTS. Energy dispersal will result in a flux density of -221.2 dBW/square meter/Hz into ACTS. In the case of data links, four simultaneously operating 2.5-meter antennas can be expected to provide an on-axis flux density of less than -85 dBW/square meter. This corresponds to a flux density of -141.0 dBW/square meter spread over a nominal 2MHz, or -204 dBW/square meter/Hz.

On the downlink, the worst interferer would be broadcast television and the worst beam would have an EIRP of 65 dBW in

Florida. At 10 degrees off axis, we assume a small ACTS antenna to be isotropic. Energy dispersal of 2 MHz would provide an equivalent rise in temperature of 20.5 dBK, or 113 K in selected 2-MHz bands into such a receiver, which is negligible.

4.2 TERRESTRIAL INTERFERENCE

We assume that interference into terrestrial facilities operating in the 19-GHz band is similar to the down-link ACTS case. Terrestrial antennas would typically point considerably off axis from the NorStar spacecraft, and 0 dBi gain is expected.

Figure 1. Artist's Concept of Spacecraft

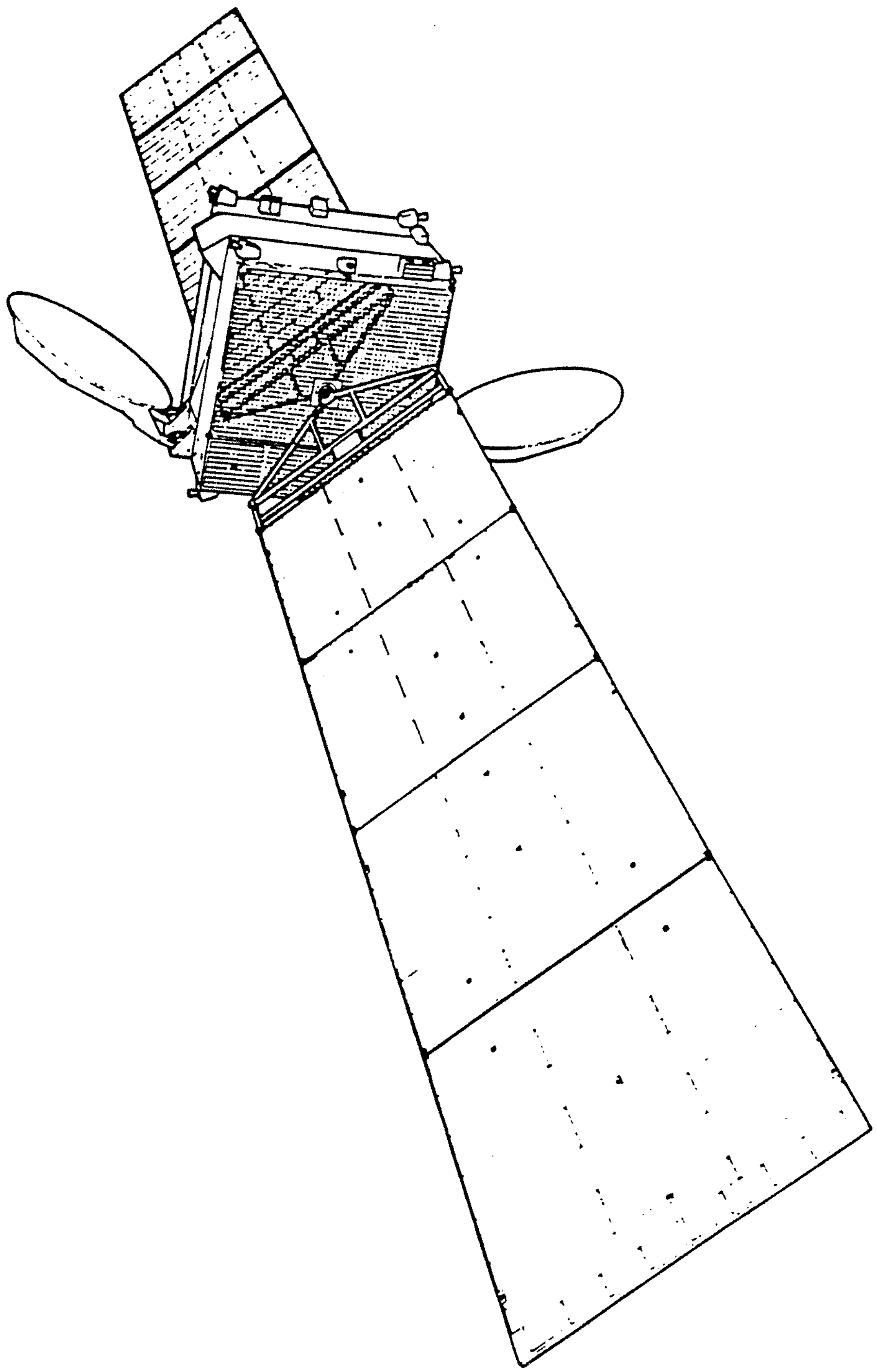
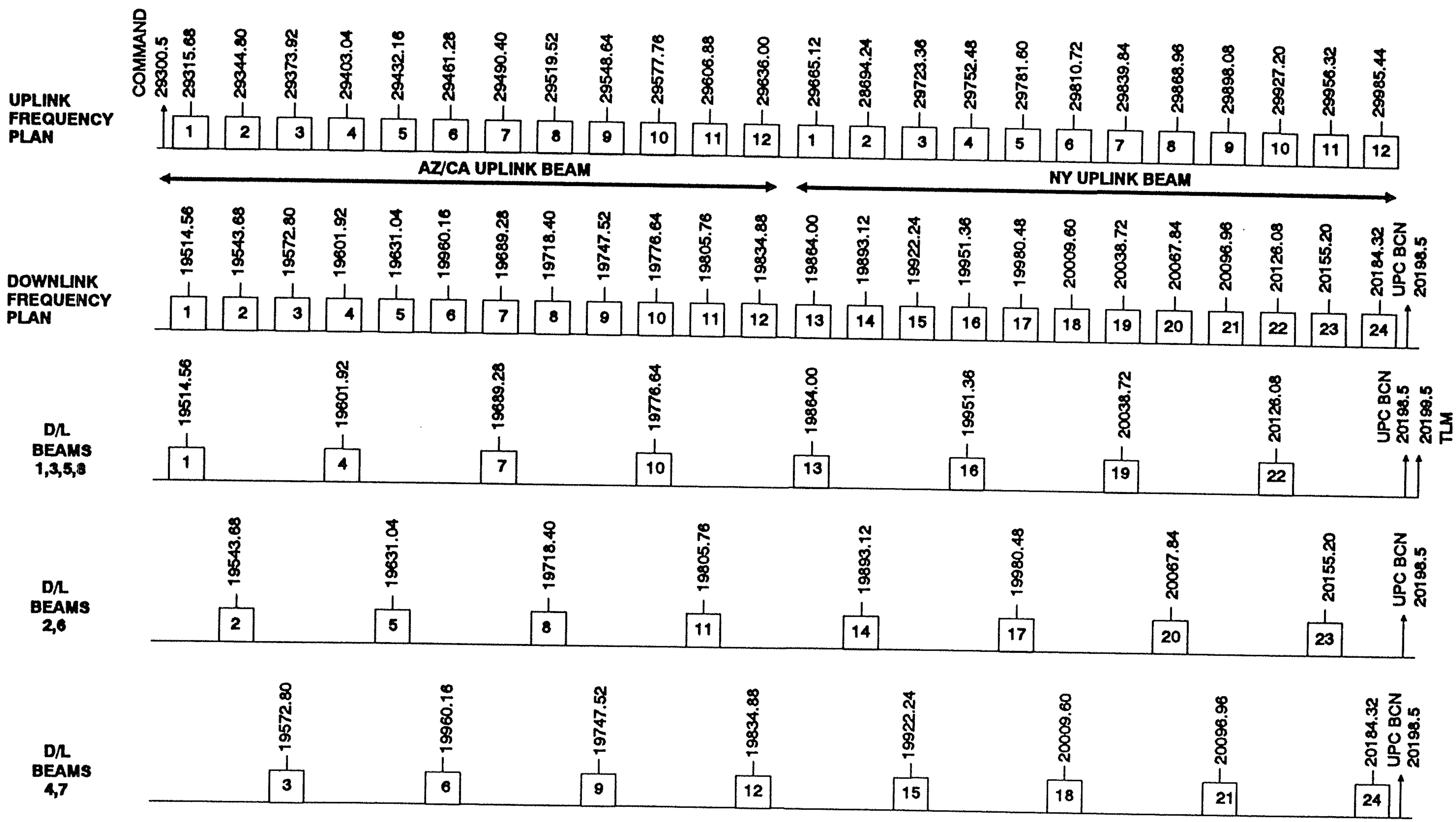


Figure 2. Frequency Plan



07/06/90

Figure 3. 12 GHz Multiplexer Amplitude Characteristics

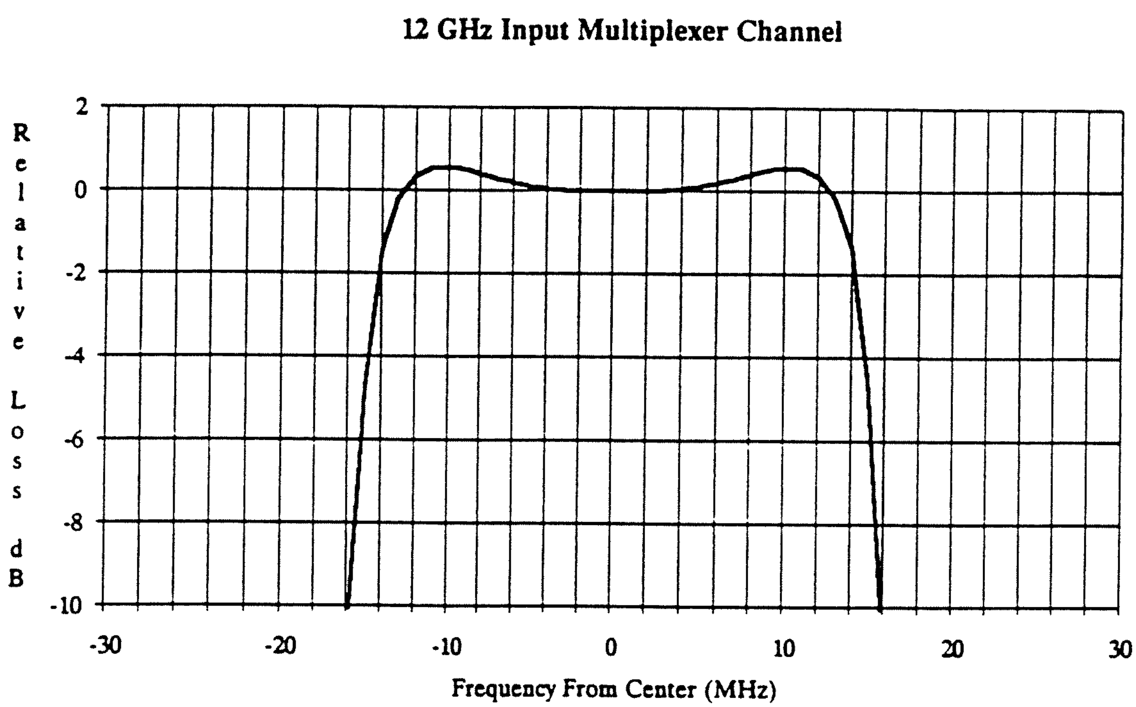


Figure 4. 12 GHz Multiplexer Delay Characteristics

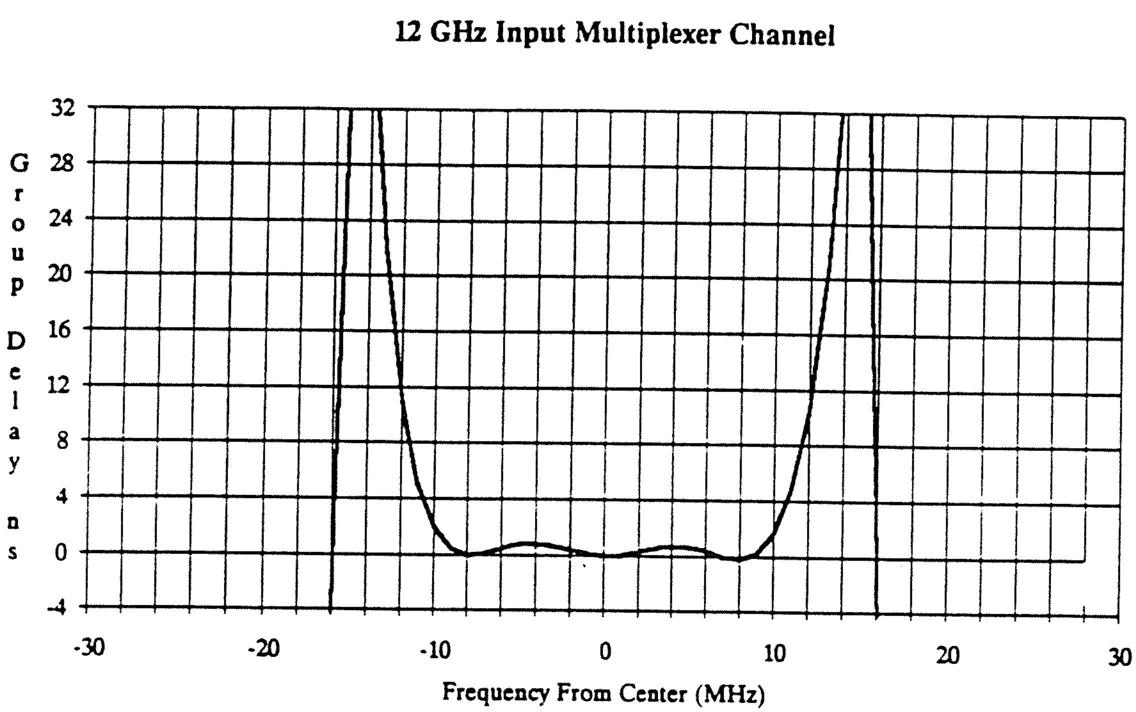


Figure 5. 19 GHz Multiplexer Amplitude Characteristics

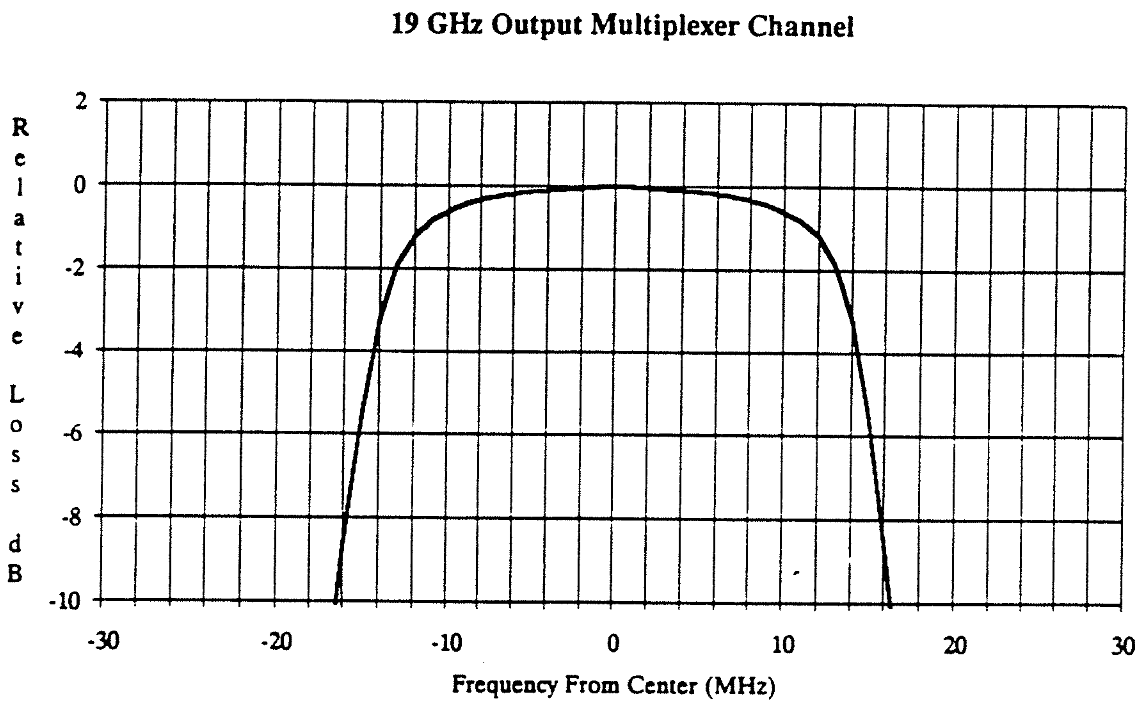


Figure 6. 19 GHz Multiplexer Delay Characteristics

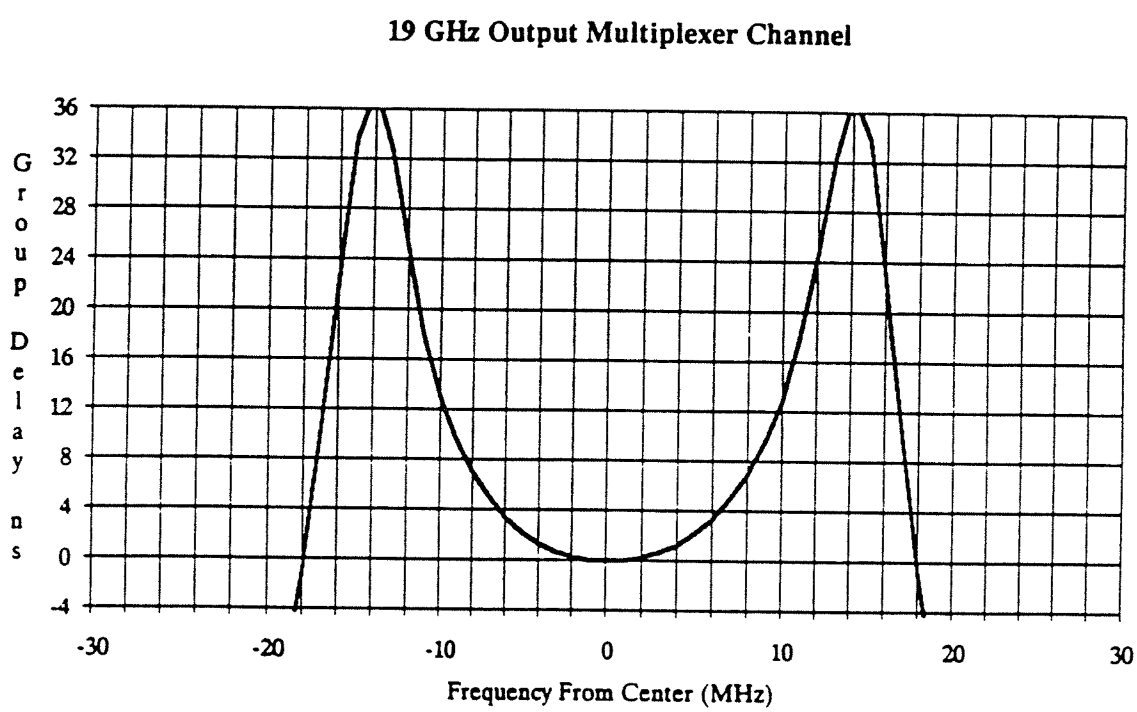


Figure 7. Composite, 12 and 19 GHz Amplitude Characteristics

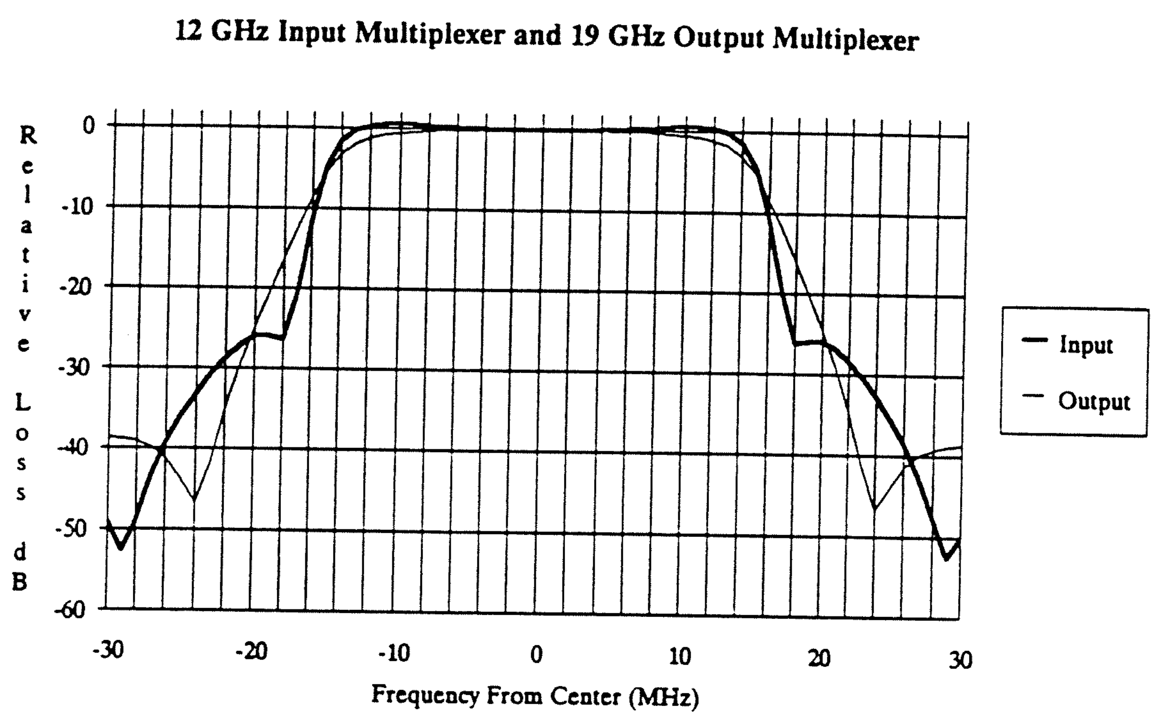


Figure 8. Spacecraft Communications Subsystem Block Diagram

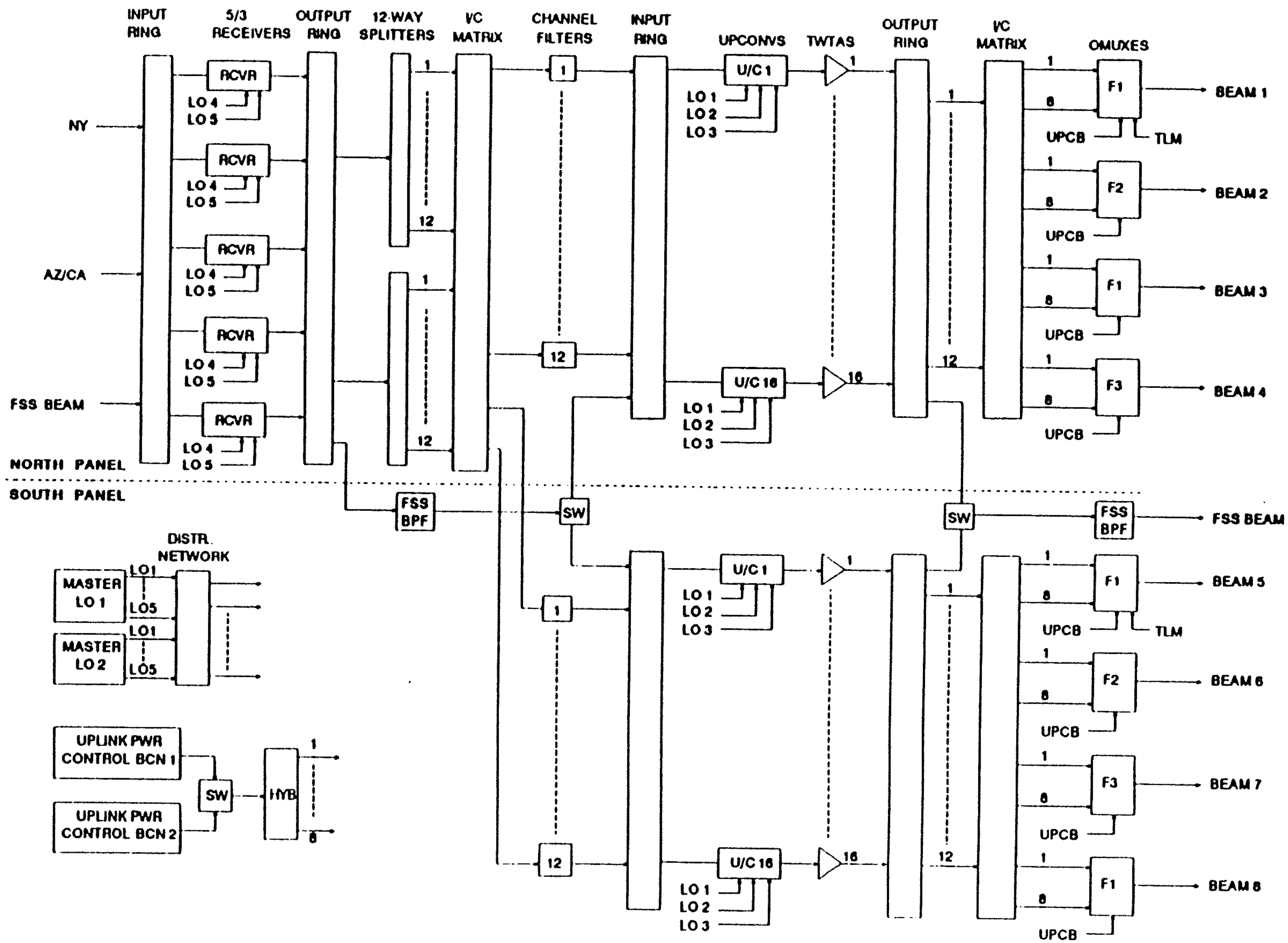


Figure 9. CONUS Coverage Contours
EIRP shown is Edge of Coverage,
2-5 dB below Maximum

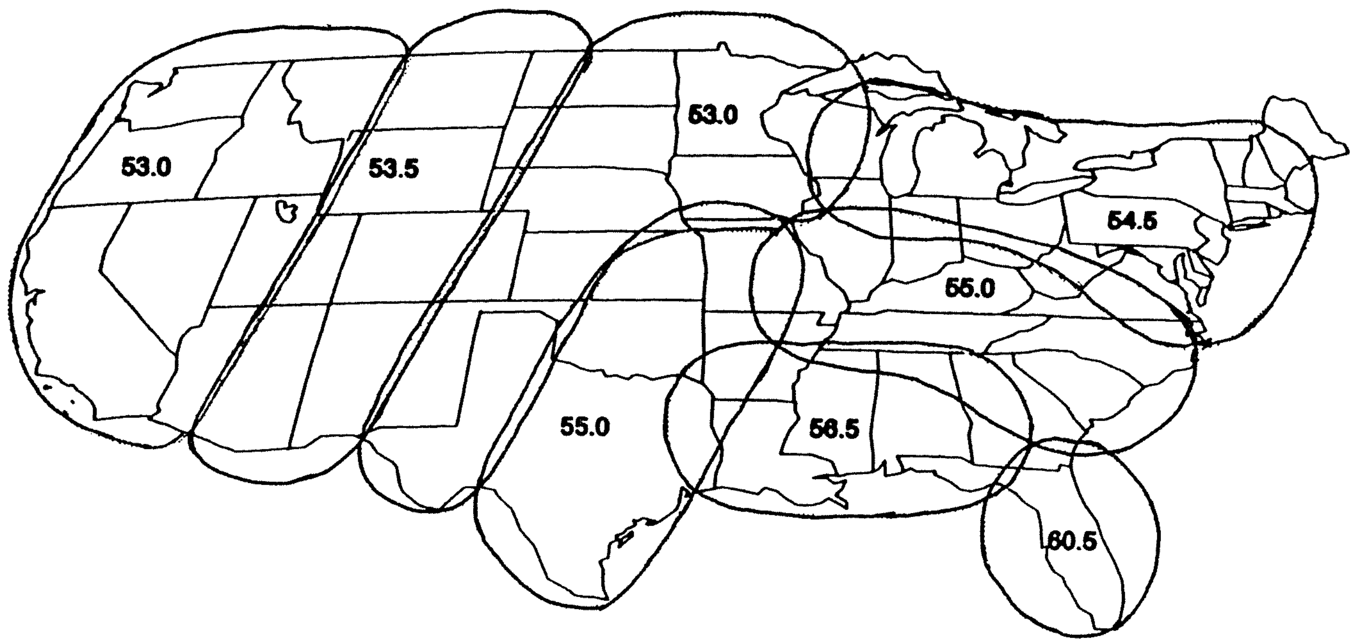


Figure 10. Alaskan Visibility

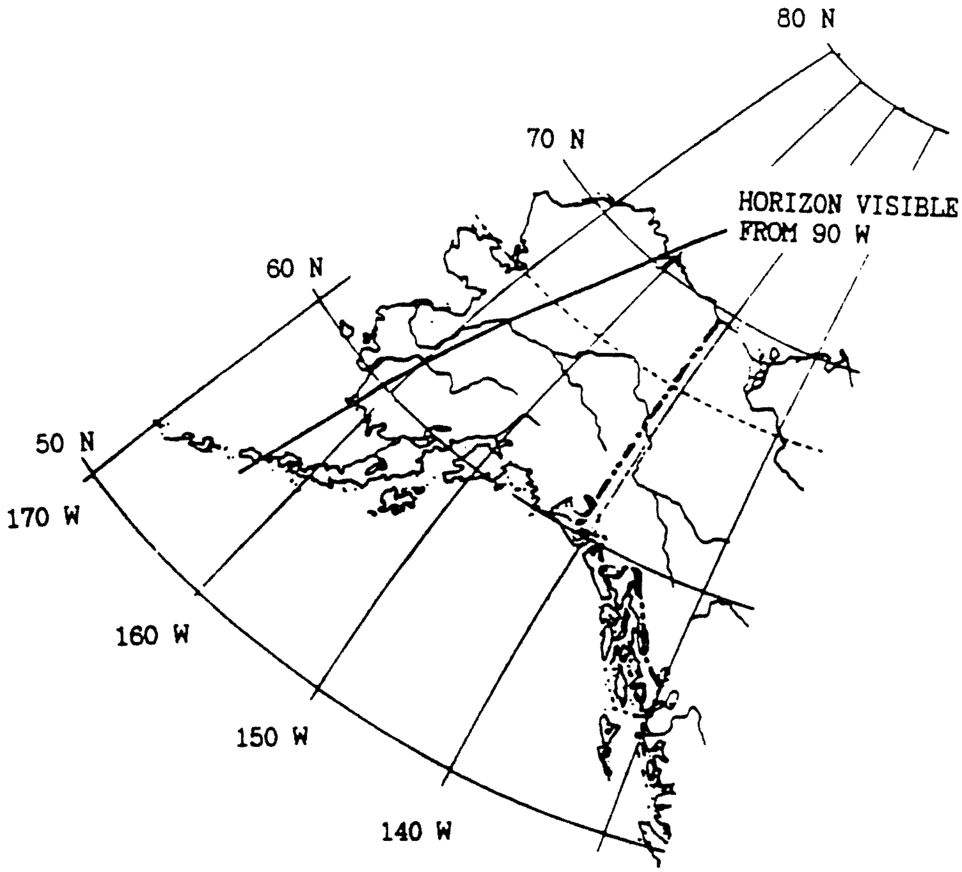


Figure 11. Rain Statistics

Note: Rainfall shown for 0.01 % of time in mm/hour. Source: CCIR Rep 536-3

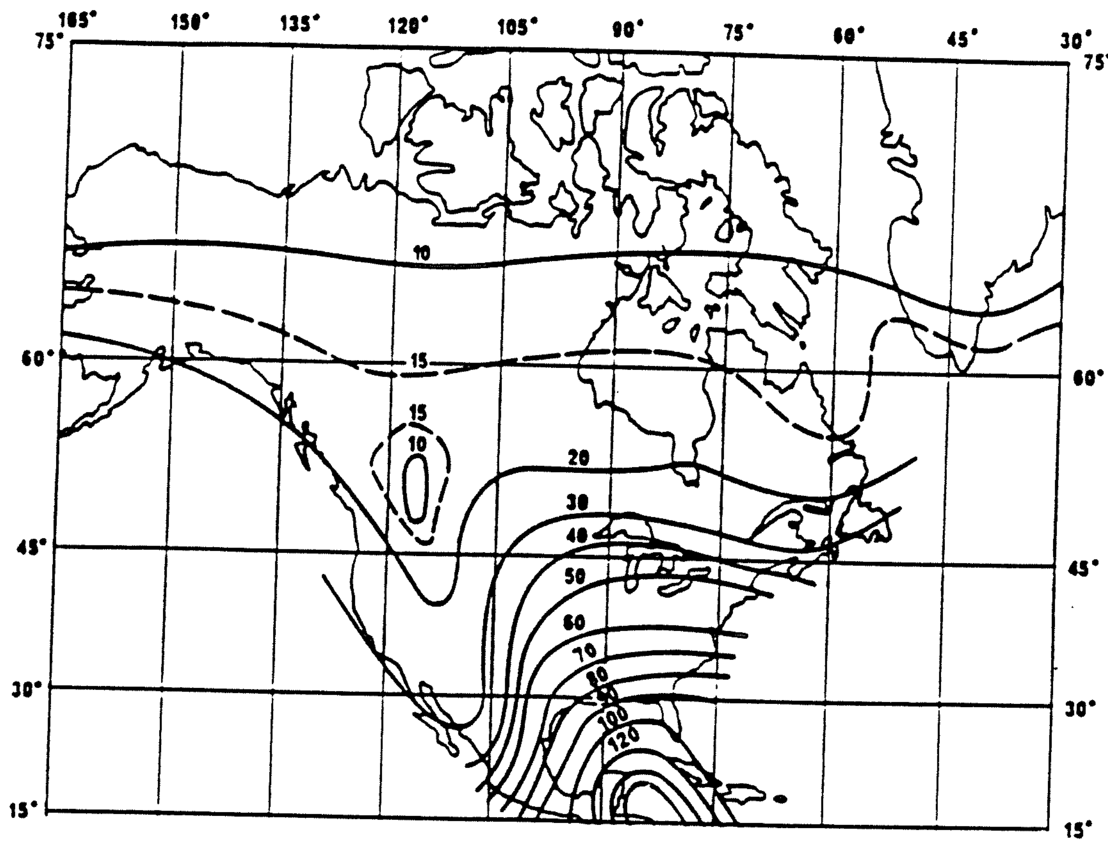


Figure 12. Transmit Station Characteristics, Lancaster

NORRIS 07-08-1990

TRANSMIT STATION RAIN ATTENUATION CHARACTERISTICS

BEAM 5
SPACECRAFT

Longitude, deg. W	90.0

TRANSMIT STATION
Lancaster

Latitude, deg N.	40.2
Rain, .01%, mm/hr	54
Antenna Elev, deg	41.4
Tx Frequency, GHz	29.65
Req'd E/S EIRP, dBW	64.8
Req'd E/S Tx Pwr, dBW	7.8

Time, %	Clear	99.00	99.50	99.80	99.90	99.95	99.98	99.99
Rain Loss, dB	0.0	5.3	7.6	12.1	16.7	22.8	33.5	43.7
Xmtr Power, dBW	7.8	13.1	15.4	19.9	24.6	30.7	41.3	51.6

Figure 13. Link Performance, Lancaster to Miami

NORRIS 07-08-1990

CLEAR SKY LINK PERFORMANCE

BEAM 1
SPACECRAFT

Longitude, deg. W	90.0		
Tx Frequency, GHz	19.85	Rx Frequency, GHz	29.65
EIRP, dBW	62.1	G/T, dB/K	12.0
Sat. Flx Dens. dBW/m2	-98.0	Xpndr Bandwidth, MHz	24.0

TRANSMIT STATION Lancaster		RECEIVE STATION Miami	
Latitude, deg N.	40.2	Latitude, deg N.	25.7
Longitude, deg W.	76.3	Longitude, deg W.	80.1
Antenna Elev, deg	41.4	Antenna Elev., deg	58.0
Range, km	37680	Range, km	36626
Tx Frequency, GHz	29.65	Rx Frequency, GHz	19.85
Antenna Diam., m	4.00	Antenna Diam., m	0.90
Antenna Efficiency, %	65.0	Antenna Efficiency, %	60.0
Antenna Gain, dBi	60.0	Antenna Gain, dBi	43.2
Antenna Line Loss, dB	3.0	System Temperature, K	400
Atmospheric Loss, dB	0.3	Atmospheric Loss, dB	0.3
		Clear Sky Eff Temp, K	21.4
		Clear Sky G/T, dB/K	17.0

CLEAR SKY SATURATED SINGLE CARRIER PERFORMANCE

Req'd E/S EIRP, dBW	64.8	Req'd E/S TX PWR, dBW	7.8
C/Nou, dB	91.6	C/Nod, dB	97.6
C/No, composite, dB	90.7		
C/Nu, dB	17.8	C/Nd, dB	23.8
C/N composite, dB	16.9		

Figure 14. Miami Rain Statistics

NORRIS 07-08-1990

RECEIVE STATION RAIN ATTENUATION CHARACTERISTICS

BEAM 1
SPACECRAFT
Longitude, deg. W 90.0

TRANSMIT STATION
Lancaster

RECEIVE STATION
Miami

Latitude, deg N.	25.7
Rain, .01%, mm/hr	120
Antenna Elev, deg	58.0
Rx Frequency, GHz	19.85
Clear Sky G/T, dB/K	17.0
C/N up link dB	17.8
C/N down link, dB	23.8
C/N composite, dB	16.9

Time, %	Clear	99.00	99.50	99.80	99.90	99.95	99.98	99.99
Loss, dB	0.0	4.2	6.1	9.6	13.4	18.2	26.7	34.9
Total Rec. Temp, K	421	601	640	680	698	707	711	711
G/T, dB/K	17.0	15.4	15.2	14.9	14.8	14.7	14.7	14.7
C/N down link, dB	23.8	18.1	15.9	12.1	8.3	3.4	-5.2	-13.4
C/N composite, dB	16.9	15.0	13.8	11.1	7.8	3.2	-5.2	-13.4

Figure 15. Link Performance, Lancaster to Los Angeles

NORRIS 07-08-1990

CLEAR SKY LINK PERFORMANCE

BEAM 8
SPACECRAFT

Longitude, deg. W	90.0		
Tx Frequency, GHz	19.85	Rx Frequency, GHz	29.65
EIRP, dBW	53.5	G/T, dB/K	12.0
Sat. Flx Dens. dBW/m2	-98.0	Xpndr Bandwidth, MHz	24.0

TRANSMIT STATION Lancaster		RECEIVE STATION Los Angel	
Latitude, deg N.	40.2	Latitude, deg N.	34.2
Longitude, deg W.	76.3	Longitude, deg W.	122.5
Antenna Elev, deg	41.4	Antenna Elev., deg	37.3
Range, km	37680	Range, km	37996
Tx Frequency, GHz	29.65	Rx Frequency, GHz	19.85
Antenna Diam., m	4.00	Antenna Diam., m	0.90
Antenna Efficiency, %	65.0	Antenna Efficiency, %	60.0
Antenna Gain, dBi	60.0	Antenna Gain, dBi	43.2
Antenna Line Loss, dB	3.0	System Temperature, K	400
Atmospheric Loss, dB	0.3	Atmospheric Loss, dB	0.5
		Clear Sky Eff Temp, K	29.5
		Clear Sky G/T, dB/K	16.9

CLEAR SKY SATURATED SINGLE CARRIER PERFORMANCE

Req'd E/S EIRP, dBW	64.8	Req'd E/S TX PWR, dBW	7.8
C/Nou, dB	91.6	C/Nod, dB	88.5
C/No, composite, dB	86.8		
C/Nu, dB	17.8	C/Nd, dB	14.7
C/N composite, dB	13.0		

Figure 16. Los Angeles Rain Statistics

NORRIS 07-08-1990

RECEIVE STATION RAIN ATTENUATION CHARACTERISTICS

BEAM 8
SPACECRAFT
Longitude, deg. W 90.0

TRANSMIT STATION
Lancaster

RECEIVE STATION
Los Angel

Latitude, deg N.	34.2
Rain, .01%, mm/hr	30
Antenna Elev, deg	37.3
Rx Frequency, GHz	19.85
Clear Sky G/T, dB/K	16.9
C/N up link dB	17.8
C/N down link, dB	14.7
C/N composite, dB	13.0

Time, %	Clear	99.00	99.50	99.80	99.90	99.95	99.98	99.99
Loss, dB	0.0	1.3	1.9	3.1	4.2	5.8	8.5	11.1
Total Rec. Temp, K	429	506	533	576	610	643	678	697
G/T, dB/K	16.9	16.2	16.0	15.6	15.4	15.2	14.9	14.8
C/N down link, dB	14.7	12.6	11.8	10.4	8.9	7.2	4.2	1.5
C/N composite, dB	13.0	11.5	10.9	9.7	8.4	6.8	4.1	1.4

Figure 17. Link Performance, Lancaster to Boston

NORRIS 07-08-1990

CLEAR SKY LINK PERFORMANCE

BEAM 5
SPACECRAFT

Longitude, deg. W	90.0		
Tx Frequency, GHz	19.85	Rx Frequency, GHz	29.65
EIRP, dBW	56.1	G/T, dB/K	12.0
Sat. Flx Dens. dBW/m2	-98.0	Xpndr Bandwidth, MHz	24.0

TRANSMIT STATION Lancaster		RECEIVE STATION Boston	
Latitude, deg N.	40.2	Latitude, deg N.	42.4
Longitude, deg W.	76.3	Longitude, deg W.	71.1
Antenna Elev, deg	41.4	Antenna Elev., deg	37.4
Range, km	37680	Range, km	37988
Tx Frequency, GHz	29.65	Rx Frequency, GHz	19.85
Antenna Diam., m	4.00	Antenna Diam., m	0.90
Antenna Efficiency, %	65.0	Antenna Efficiency, %	60.0
Antenna Gain, dBi	60.0	Antenna Gain, dBi	43.2
Antenna Line Loss, dB	3.0	System Temperature, K	400
Atmospheric Loss, dB	0.3	Atmospheric Loss, dB	0.5
		Clear Sky Eff Temp, K	29.4
		Clear Sky G/T, dB/K	16.9

CLEAR SKY SATURATED SINGLE CARRIER PERFORMANCE

Req'd E/S EIRP, dBW	64.8	Req'd E/S TX PWR, dBW	7.8
C/Nou, dB	91.6	C/Nod, dB	91.1
C/No, composite, dB	88.4		
C/Nu, dB	17.8	C/Nd, dB	17.3
C/N composite, dB	14.6		

Figure 18. Boston Rain Statistics

NORRIS 07-08-1990

RECEIVE STATION RAIN ATTENUATION CHARACTERISTICS

BEAM 5
SPACECRAFT
Longitude, deg. W 90.0

TRANSMIT STATION
Lancaster

RECEIVE STATION
Boston

Latitude, deg N.	42.4
Rain, .01%, mm/hr	50
Antenna Elev, deg	37.4
Rx Frequency, GHz	19.85
Clear Sky G/T, dB/K	16.9
C/N up link dB	17.8
C/N down link, dB	17.3
C/N composite, dB	14.6

Time, %	Clear	99.00	99.50	99.80	99.90	99.95	99.98	99.99
Loss, dB	0.0	2.5	3.6	5.7	8.0	10.9	15.9	20.8
Total Rec. Temp, K	429	557	594	642	673	696	712	717
G/T, dB/K	16.9	15.8	15.5	15.2	15.0	14.8	14.7	14.7
C/N down link, dB	17.3	13.7	12.3	9.8	7.4	4.3	-0.8	-5.8
C/N composite, dB	14.6	12.3	11.2	9.2	7.0	4.1	-0.9	-5.8

Figure 19. Data Link Performance

NORRIS 07-08-1990

CLEAR SKY LINK PERFORMANCE

BEAM 1
SPACECRAFT

Longitude, deg. W	90.0		
Tx Frequency, GHz	19.85	Rx Frequency, GHz	29.65
EIRP, dBW	62.1	G/T, dB/K	-3.0
Sat. Flx Dens. dBW/m2	-85.0	Xpndr Bandwidth, MHz	24.0

TRANSMIT STATION Boston		RECEIVE STATION Los Angel	
Latitude, deg N.	42.4	Latitude, deg N.	34.2
Longitude, deg W.	71.1	Longitude, deg W.	122.5
Antenna Elev, deg	37.4	Antenna Elev., deg	37.3
Range, km	37988	Range, km	37996
Tx Frequency, GHz	29.65	Rx Frequency, GHz	19.85
Antenna Diam., m	2.50	Antenna Diam., m	2.50
Antenna Efficiency, %	65.0	Antenna Efficiency, %	60.0
Antenna Gain, dBi	55.9	Antenna Gain, dBi	52.1
Antenna Line Loss, dB	3.0	System Temperature, K	400
Atmospheric Loss, dB	0.4	Atmospheric Loss, dB	0.5
		Clear Sky Eff Temp, K	29.5
		Clear Sky G/T, dB/K	25.8

CLEAR SKY SATURATED SINGLE CARRIER PERFORMANCE

Req'd E/S EIRP, dBW	78.0	Req'd E/S TX PWR, dBW	25.0
C/Nou, dB	89.6	C/Nod, dB	106.0
C/No, composite, dB	89.5		
C/Nu, dB	15.8	C/Nd, dB	32.2
C/N composite, dB	15.7		

MULTICARRIER PERFORMANCE PARAMETERS

Transponder Output Amplifier,	TWTA
Bandwidth of Carriers, kHz	1000
Channel Spacing, kHz	1333
Activity Factor (0 to 1)	1
Number of Carriers	4

Output B.O., dB	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0
Input B.O., dB	3.7	6.1	8.1	9.7	10.9	12.0	13.0	14.0
E/S Tx Pwr, dBW	15.3	12.9	10.8	9.2	8.0	7.0	6.0	5.0
C/Nup, dB	19.9	17.6	15.5	13.9	12.7	11.6	10.6	9.6
C/Ndn, dB	37.9	36.9	35.9	34.9	33.9	32.9	31.9	30.9
C/Nim, dB	16.5	18.2	19.7	21.2	22.7	24.1	25.6	27.1
C/Ntotal, dB	14.8	14.8	14.1	13.1	12.2	11.4	10.5	9.5

Part III

NorStar I

Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of the Application of Norris Satellite Communications Inc. For Authority to Construct, Launch and Operate a Domestic Communications Satellite in the 30/20 GHz Band	)))))))))	File No.

APPLICATION

Norris Satellite Communications ("Norris"), pursuant to Sections 308, 309, and 319 of the Communications Act of 1934, as amended, 47 U.S.C. §§ 308, 309, 319, hereby applies for authority to construct, launch and operate a domestic communications satellite that will operate in the 30/20 GHz frequency bands. The specific satellite for which authorization is being sought in this application is referred to as NorStar I. Norris requests that the Commission assign a geosynchronous orbital position at 90° W.L. for this satellite. In support of this application, Norris respectfully states:

A. Applicant

Norris Satellite Communications, Inc.
P.O. Box 88
Red Lion, PA 17356
(717) 246-1681

B. Correspondence

Correspondence with respect to this application should be sent to the following person:

Leslie A. Taylor, Esq.
Leslie Taylor Associates
6800 Carlynn Ct.
Bethesda, MD 20817-4302
(301) 229-9341

C. Technical Description Including Radio Frequency and Polarization Plan

The satellite for which construction, launch and operating authority is requested herein is an integral part of the NorStar domestic communications satellite system that is being proposed by Norris.

The technical description, radio frequency and polarization plan are contained in Part II of this application.

An analysis of potential inter-satellite interference due to the satellite's operation also is included in Part II of this application.

D. Orbital Location Information

NorStar is requesting an orbital assignment of 90° W.L. The reasons for this request are discussed in Parts I and II of this application.

E. Predicted Space Station Coverage Contours for each Antenna Beam at Nominal Orbital Location Requested

Coverage contours for each antenna beam are provided in Part II.

F. Physical Characteristics of Space Station.

1. Accuracy with Which Orbital Parameters Will be Maintained.

a. Orbital Inclination.

The NorStar satellites will be designed to maintain the inclination of the orbit to ± 0.05 degrees or less and the longitude position to within ± 0.05 degrees.

b. Antenna Axis Attitude/ Longitudinal Drift.

The propulsion subsystem will be sized for and loaded with sufficient propellant to maintain operational attitude and station-keeping control for at least 10 years. Additional propellant also will be incorporated to provide correction of the initially orbit, initial attitude acquisition, satellite spin or despin if required, and limited orbital repositioning during the lifetime of the satellite. Sufficient propellant will also be reserved for removing the spacecraft from orbit after its mission is complete.

2. Accuracy of Spacecraft Antenna Pointing Toward the Earth.

The NorStar satellites will be designed to maintain a pointing accuracy of .05° or less.

3. Estimated Lifetime of Satellite In-Orbit.

The satellites are designed for an operational and mission life of 10 years, which is determined primarily by the amount of station-keeping propellant that is carried.

4. Description of Spacecraft Attitude <u>Stabilization and Station-Keeping Systems</u>.

The satellites will be three-axis-stabilized. They will include an attitude control subsystem to provide pointing accuracies consistent with the achievement of the specified communications performance and inclusive of all error sources (e.g., attitude perturbations, thermal-induced distortions, misalignments, orbital tolerances, and perturbations produced by station-keeping maneuvers).

5. <u>Electrical Energy System Description.</u>

The electrical power subsystem will be designed so that at the end of the spacecraft life, sufficient power will be available to operate all transponders as well as the spacecraft bus. Sufficient battery capacity will be furnished to provide power for all housekeeping functions and the entire communications payload during the eclipse periods at the end of life.

The primary source of power will be solar cells with energy-storage batteries for eclipse operation. No single failure in the electrical energy system will cause spacecraft failure.

G. <u>Emission Limitations.</u>

The overall selectivity of the input and output filters and other circuitry will attenuate all spurious emissions from the NorStar satellite to values well below those specified in Section 25.202 of the FCC Rules and Regulations. Precise values of attenuation will be submitted to the Commission at the time a satellite vendor is chosen.

H. Dates by Which Construction will Be Commenced and Completed, Launch Date, and Estimated Date of Placement into Service.

A detailed schedule specifying concrete dates by which significant milestones in establishment of the NorStar I Satellite are planned to be achieved is included in Part I of the overall application.

I. Waiver of Claims.

The Applicant waives claim to the use of any particular frequency or of the electromagnetic spectrum as against the regulatory power of the Untied States because of the previous use of the same, whether by license or otherwise, and requests construction and launch authority in accordance with this application. All statements made in the attached exhibits are a material part hereof, and are incorporated herein as if set out in full in this application.

J. Public Interest Considerations.

Part I of Norris's application set forth the public interest considerations and the financial, legal and technical qualifications of the applicant, as well as other information pertinent to this Application, and that information is incorporated herein by reference.

K. Certification

The undersigned certifies individually and for Norris Satellite Communications that the statements made in this application are true, complete, and correct to the best of his knowledge and belief, and are made in good faith.

Wherefore, Norris requests that the Commission grant this application.

Respectfully submitted,

NORRIS SATELLITE COMMUNICATIONS

By: [signature]

John H. Norris
Box 88
Red Lion, PA 17356
(717) 246-1681

Counsel:

Leslie A. Taylor, Esq.
6800 Carlynn Court
Bethesda, MD 20817
(301) 229-9341

July 16, 1990

CERTIFICATION OF PERSON RESPONSIBLE
FOR PREPARING ENGINEERING INFORMATION
SUBMITTED IN THIS APPLICATION

I hereby certify that I am the technically qualified person responsible for preparation of the engineering information contained in this application and the exhibits attached thereto; that I am familiar with Part 25 of the Commission's Rules; that I have either prepared or reviewed the engineering information submitted in this application and the exhibits attached thereto; and that it is complete and accurate to the best of my knowledge.

By: W.L. Pritchard
W.L. Pritchard

Dated this July 11th, 1990

Notary Public
My Commission Expires: July 1990.

Part III

NorStar II

Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of the Application of Norris Satellite Communications Inc. For Authority to Construct, Launch and Operate a Domestic Communications Satellite in the 30/20 Ghz Band	)))))))))	File No.

APPLICATION

Norris Satellite Communications ("Norris"), pursuant to Sections 308, 309, and 319 of the Communications Act of 1934, as amended, 47 U.S.C. §§ 308, 309, 319, hereby applies for authority to construct a domestic communications satellite that will be designed to operate in the 30/20 GHz frequency bands. The specific satellite for which authorization is being sought in this application is referred to as NorStar II. In support of this application, Norris respectfully states:

A. Applicant

Norris Satellite Communications, Inc.
P.O. Box 88
Red Lion, PA 17356
(717) 246-1681

B. Correspondence

Correspondence with respect to this application should be sent to the following person at the above address and telephone number:

Leslie A. Taylor, Esq.
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The NorStar satellites will be designed to maintain the inclination of the orbit to ± 0.05 degrees or less and the longitude position to within ± 0.05 degrees.

b. Antenna Axis Attitude/ Longitudinal Drift.

The propulsion subsystem will be sized for sufficient propellant to maintain operational attitude and station-keeping control for at least 10 years.

2. Accuracy of Spacecraft Antenna Pointing Toward the Earth.

The NorStar satellites will be designed to maintain a pointing accuracy of .05° or less.

3. Estimated Lifetime of Satellite In-Orbit.

The satellites are designed for an operational and mission life of 10 years, which is determined primarily by the amount of station-keeping propellant that is carried.

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The satellites will be three-axis stabilized. The satellites will include an attitude control subsystem to provide pointing accuracies consistent with the achievement of the specified communications performance and inclusive of all error sources (e.g., attitude perturbations, thermal-induced distortions, misalignments, orbital tolerances, and perturbations produced by station-keeping maneuvers.

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The electrical power subsystem will be designed so that at the end of the spacecraft life, sufficient power will be available to operate all transponders as well as the spacecraft bus. Sufficient battery capacity will be furnished to provide power for all housekeeping functions and the entire communications payload during the eclipse periods at the end of life.

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The overall selectivity of the input and output filters and other circuitry will attenuate all spurious emissions from the NorStar satellite to values well below those specified in Section 25.202 of the FCC Rules and Regulations. Precise values of attenuation will be submitted to the Commission at the time a satellite vendor is chosen.

H. Dates by Which Construction will Be Commenced and Completed, Launch Date, and Estimated Date of Placement into Service.

A detailed schedule specifying concrete dates by which significant milestones in establishment of the NorStar satellite system are planned to be achieved is included in Part I of the overall application.

I. Waiver of Claims.

The Applicant waives any claim to the use of any particular frequency or of the electromagnetic spectrum as against the regulatory power of the United States because of the previous use of the same, whether by license or otherwise, and requests construction and launch authority in accordance with this application. All statements made in the attached exhibits are a material part hereof, and are incorporated herein as if set out in full in this application.

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Wherefore, Norris requests that the Commission grant this application.

Respectfully submitted,

NORRIS SATELLITE COMMUNICATIONS

By: [signature]

John H. Norris
Box 88
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Counsel:

Leslie A. Taylor, Esq.
6800 Carlynn Court
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July 16, 1990

CERTIFICATION OF PERSON RESPONSIBLE
FOR PREPARING ENGINEERING INFORMATION
SUBMITTED IN THIS APPLICATION

I hereby certify that I am the technically qualified person responsible for preparation of the engineering information contained in this application and the exhibits attached thereto; that I am familiar with Part 25 of the Commission's Rules; that I have either prepared or reviewed the engineering information submitted in this application and the exhibits attached thereto; and that it is complete and accurate to the best of my knowledge.

By: W.L. Pritchard
W.L. Pritchard

Dated this July 11th, 1990

Notary Public
My Commission Expires: July 1990.

Exhibit V

Form 430 - Attachment B

Interests of Filer in Ownership or Control of Other Radio Stations Licensed by the FCC

1. John H. (77.5%) and Dorothy Norris (22.5%) are the sole owners of Red Lion Broadcasting Company, Inc.

Red Lion Broadcasting Company, Inc. is the licensee of:

WGCB-TV
Channel 49
Red Lion, PA 17356

WGCB-AM
Red Lion, PA 17356

WGCB-FM
Red Lion, PA 17356

2. John H. (77.5%) and Dorothy Norris (22.5%) are the sole owners of World International Broadcasters, Inc.

World International Broadcasters, Inc. is the licensee of international high-frequency station - WINB, Red Lion, PA 17356.

Exhibit VI

Form 430 - Attachment C

Names, Addresses and Citizenships of Stockholders Owning of Record and/or Voting 10 percent or more of the Filer's Voting Stock

John H. Norris Box 88 Red Lion, PA 17356 U.S. citizen	51%
Mary Cathryne Park 450 Norwood Street Merritt Island, FL 32953 U.S. citizen	49%

Exhibit VII

Form 430 - Attachment D

Names and Addresses of Officers and Directors

John H. Norris Box 88 Red Lion, PA 17356	Chairman
Mary Cathryne Park 450 Norwood Street Merritt Island, FL 32953	President
Colin H. Weir 4 Petrea Terrace Ormond Beach, FL 32174	Director
Wilbur L. Pritchard W.L. Pritchard & Co. 7315 Wisconsin Avenue Bethesda, MD 20814	Director
Matthew Willard MARCOR 800 K Street, N.W. Washington, D.C. 20001-8000	Director
Leslie A. Taylor 6800 Carlynn Court Bethesda, MD 20817-4302	Director
B.G. Davis E'Prime Aerospace P.O. Box 792 Titusville, FL 32781	Director