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

Application 11-DSS-P-91

of

ELLIPSAT CORPORATION

For Authority to Construct

ELLIPSO® I

An Elliptical Orbit Satellite System

November 2, 1990

EXECUTIVE SUMMARY

In this application, Ellipsat Corporation seeks authority to construct ELLIPSO®I, an elliptical orbit satellite system consisting of six miniature Eyesat-class satellites. The ELLIPSO® system will offer radiodetermination satellite service and mobile voice services within the continental United States and domestic offshore points. The system is intended to complement, not compete with, existing and future cellular systems.

The ELLIPSO® system is highly innovative from a technical and design standpoint. Among the benefits of the system are "seamless" roaming and interconnection with the public telephone network. Highlighted below are these and other significant public interest benefits of the system.

A. ELLIPSO® COMBINES STATE-OF-THE-ART TECHNOLOGY IN A UNIQUE FASHION

ELLIPSO® is highly innovative in overall system design, spacecraft and constellation architecture.

System Design. The system is designed to use the latest digital technologies, including CDMA or spread spectrum techniques, to ensure transparent interconnection with the public telephone network and "seamless" roaming by cellular users. To provide radiodetermination service, ELLIPSO® uses a unique satellite-based ranging system, called Geobeacon, developed at MIT.

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Spacecraft. ELLIPSO® proposes the first commercial use of miniature Eyesat-class satellites. These satellites can be built and launched rapidly, at a fraction of the cost of a comparable geosynchronous system.

Constellation Architecture. The constellation design, using elliptical orbits, is unique. This design ensures continuous coverage over the United States without the need for satellite-to-satellite cross-links. The elliptical orbit also ensures that the percentage of time spent over the Northern Hemisphere is increased relative to the total orbital period.

B. ELLIPSO® IS DESIGNED TO ENSURE RAPID MARKET ACCEPTANCE

ELLIPSO® is designed to ensure rapid market acceptance and development.

User Equipment. User equipment is designed for ease of use and cost sensitivity. Users of existing cellular systems need only add an RF unit and antenna to existing equipment, for a nominal price of about $300, to receive the benefits of satellite service and extend the range of operation. New users may purchase a combined satellite/cellular unit that is expected to retail for approximately $1,000. The geo-location service does not require any additional hardware.

Cost of Service. The cost of service to the end-user is expected to be comparable to current cellular service, approximately 40-50 cents per minute. A profit margin of twenty-to-thirty percent is projected for retailers of ELLIPSO®
service.

New Service. The system will provide service to presently unserved target populations, primarily roamers outside metropolitan areas and rural users. No current system meets this existing need.

Broad Range of Services. ELLIPSO® offers a combination of satellite-based position determination and mobile voice services for the first time. The system will provide users with the option of transparent interconnection to the public telephone network and the advanced services it offers.

Participation by Value Added Partners. The ELLIPSO® system is based on active participation by Value Added Partners (VAPs), with Ellipsat acting as the system organizer. The VAPs, who will provide ELLIPSO® service to end-users, may be cellular companies or companies serving specialized industries.

C. ELLIPSO® PROVIDES OTHER PUBLIC INTEREST BENEFITS

ELLIPSO® provides other significant public interest benefits that further FCC policies and objectives in the satellite field.

Multiple Entry. Other systems can co-exist with ELLIPSO® in the same frequency band, providing opportunities for multiple entry.

Efficient Use of Spectrum. Through CDMA, spread spectrum techniques, ELLIPSO® will efficiently use available spectrum.

Provision of RDSS. ELLIPSO® will provide publicly beneficial satellite position determination services using the innovative Geobeacon technique.

Non-interference to Other RDSS Systems. ELLIPSO® is compatible with and will not cause interference to Geostar or other licensed RDSS systems.

New Entrants. The proposed system represents the kind of technological innovation that the Commission seeks to encourage with its policies favoring open entry in the field of domestic communications satellites. Although Ellipsat is a new entrant, the company's principals have extensive experience in the development and marketing of satellite technology and services.

Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554

In re Application of	)	
	)	
ELLIPSAT CORPORATION	)	
	)	
For Authority to Construct	)	File No.
ELLIPSO®I, An Elliptical Orbit	)	
Communication Satellite System	)	
in the 1610-1626.5 MHz and	)	
2483.5-2500 MHz Bands	)	

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November 2, 1990

Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20544

In re Application of ELLIPSAT CORPORATION For Authority to Construct ELLIPSO®I, An Elliptical Orbit Satellite System in the 1610-1626.5 MHz and 2483.5-2500 MHz Bands	)))))))))	File No.

APPLICATION

Ellipsat Corporation (hereinafter "Ellipsat" or "Applicant") hereby applies for authority to construct ELLIPSO®I, an elliptical orbit domestic satellite system.

I.

SUMMARY AND OVERVIEW

Ellipsat requests authority in this application to construct ELLIPSO®I, an elliptical orbit satellite system consisting of six satellites. The ELLIPSO® system, which will ultimately include a full complement of twenty-four satellites, will operate in the 1610-1626.5 MHz (uplink) and 2483.5-2500 MHz (downlink) bands.[1] The satellites will utilize an elliptical orbit providing continuous coverage of the continental United States and domestic offshore points.

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[1] The ELLIPSO® system consists of two constellations, ELLIPSO®I and ELLIPSO®II. Information about the ELLIPSO®II system is provided in this application solely for the purpose of providing an overview of the applicant's business plans. Prior to implementing ELLIPSO®II, appropriate applications will be filed with the Federal Communications Commission.

The business purpose of the applicant is to provide radiodetermination satellite services within the continental United States, and cellular services on an ancillary basis. Ellipsat anticipates that its service will complement the existing cellular network by providing coverage of unserved areas. Ellipsat, in effect, will be the network organizer providing space segment capacity and related ground facilities to "value added partners" for resale to end-users.

The ELLIPSO® system is highly innovative in overall system design, constellation architecture and spacecraft technology.[2] It uses state-of-the-art technology in all system components. This application represents the first commercial proposal for an elliptical orbit satellite system, and the first commercial use of miniature Eyesat-class satellites. The ELLIPSO® satellites will orbit the Earth in four inclined orbits, ensuring maximum duration of coverage over the United States without the need for satellite-to-satellite cross-links. As a result of low orbital characteristics, and the proposed use of Code Division Multiple Access (CDMA) techniques, also known as spread spectrum, the system will facilitate "seamless" roaming between terrestrial and satellite cellular systems. Moreover, the benefits of the ELLIPSO® system will be available

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[2] Ellipsat is applying concurrently to the United States Patent Office to protect the proprietary aspects of the ELLIPSO® system.

expeditiously and economically, because of time and cost savings achieved through the use of small satellites.

In this application, Ellipsat supplies comprehensive details about its proposed ELLIPSO®I satellite system, including the information required for domestic satellite space station applications as appropriate. See Appendix B of Space Station Application Filing Procedures, 48 Fed. Reg. 40256 (September 6, 1983). Included is a description of all pertinent technical and operational aspects of the system, the proposed services, and the applicant's ability to proceed expeditiously with construction and launch of the system. Separate applications for the six satellites comprising ELLIPSO®I, are attached. Because of the innovative nature of the service and technology, Ellipsat requests a "pioneer's preference" and sets forth in this application all pertinent information specified in proposed Rule 1.402 for claiming that preference. See Establishment of Procedures to Provide a Preference to Applicants Proposing an Allocation for New Services, General Docket No. 90-217, 5 FCC Rcd 2766 (1990).[3]

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[3] This application is being filed in response to the Commission's Public Notice, Report No. DS-999, released September 4, 1990, in which applications of Geostar Positioning Coporation ("Geostar") were accepted for filing. In that the Geostar applications involve substantial and material modifications of its authorized system, Geostar has effectively applied for a new satellite system. Accordingly, pursuant to Commission Rule 25.392(b), the September 4, 1990 Public Notice establishes a sixty day cut-off period for the filing of applications to be considered in conjunction with the Geostar applications. The subject application is timely filed and entitled to be considered concurrently with the Geostar applications. See Ashbacker Radio Corporation v. FCC, 326 U.S.

II.

SYSTEM PROPOSAL AND DESCRIPTION

A. APPLICANT INFORMATION

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327 (1945).

B. GENERAL DESCRIPTION OF
<u>OVERALL SYSTEM FACILITIES</u>

The ELLIPSO® system consists of three major segments: Space Segment, Ground Segment and User Segment. The operation of these segments is depicted in Figure 1 and fully described below.

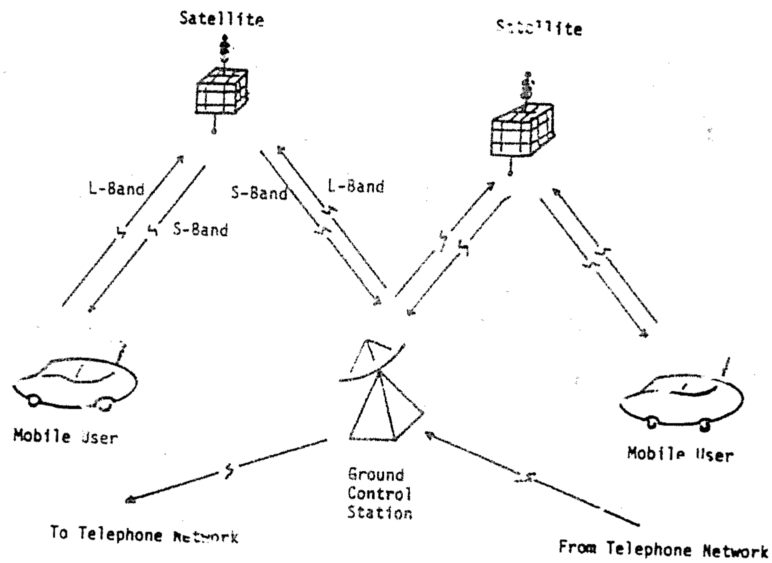


Figure 1.

1. <u>Space Segment</u>

The ELLIPSO® space segment will ultimately consist of a constellation of twenty-four Interferometrics Eyesat-class satellites located in elliptical orbits. The ELLIPSO® I constellation consists of six satellites, orbiting the Earth in an inclined elliptical orbit. The elliptical orbit provides continuous coverage of the United States and its territories, and increases the percentage of time spent over the United States relative to the total orbital period.

The ELLIPSO® spacecraft orbits are elliptical, with the apogee over the Northern Hemisphere. The eccentricity of the ellipse is equal to 0.0517, with an apogee of 1250 km above the Earth and a perigee of 500 km. The speed of the satellites increases as they approach the perigee point, located below the Equator, and decreases as they reach apogee, a point that remains in the Northern Hemisphere. The center of the Earth is located at one of the foci of the ellipse. Figure 2 illustrates a representative orbit.

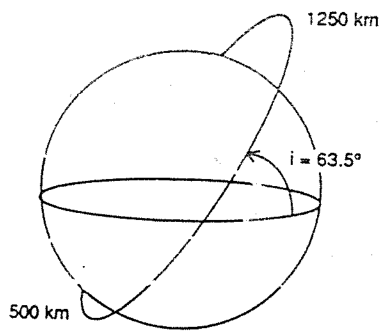
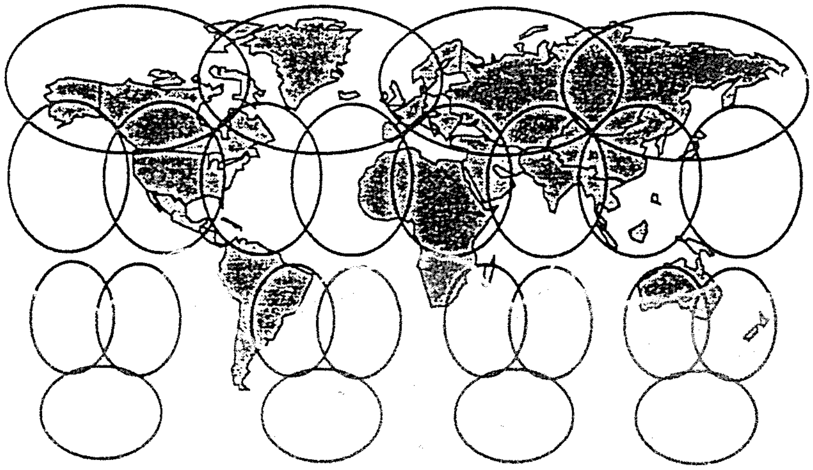


Figure 2.

The six ELLIPSO® I satellites are equally spaced within the orbit. The four elliptical planes are phased 90 degrees apart. A typical footprint over the United States having a diameter of 5355 miles is shown in Figure 3.

Figure 3.

The ELLIPSO® I constellation will provide sufficient coverage of the entire United States, including Hawaii, for initial service. Due to the partial complement of satellites, there may be gaps in coverage relative to time during initial operation. Beginning in 1995, six enhanced additional spacecraft will be added to the constellation every four months, to complete the ELLIPSO® constellation. A depiction of the global coverage provided by the twenty-four satellite ELLIPSO® II constellation is shown in Figure 4.



Ellipso coverage with 24 satellites

Figure 4.

2. Ground Segment

The ELLIPSO® ground segment consists of Telemetry, Tracking and Control (TT&C) facilities (primary and redundant) and Ground Control Stations (GCS). The GCS, which will number up to twelve, contain the necessary ground segment equipment: antenna, up and down converters, high power and low noise amplifiers, baseband processing equipment, and call processor computer. Each GCS is connected to a Telephone Interconnection Facility (TIF) which, in turn, is linked to the public telephone networks with total signalling system compatibility. Private Interconnection Facilities (PIFs) will allow interconnection between ELLIPSO® and private customer-owned facilities.

The TIF adds a dimension to the traditional satellite network ground station in that it has a Signalling Transfer Point (STP) module. The STPs in public telephone networks route the signalling information through a packet switched network, in order to provide session control, routing and many other subscriber services such as calling party identification. The STPs retrieve network information, such as credit card validation, from Signalling Control Points (SCPs) that contain databases, dynamically updated through the STP network. The protocol governing these interactions is called Signalling System 7 (SS7). A "slave" STP module, compatible with SS7, is included in the TIFs to allow a complete interconnection in real-time with the telephone network and with similarly designed cellular systems. The diagrams below illustrate a GCS and its connection to the TIFs.

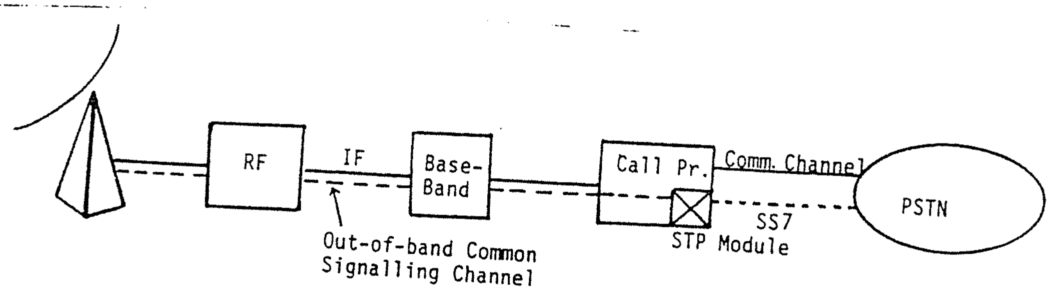


Figure 5

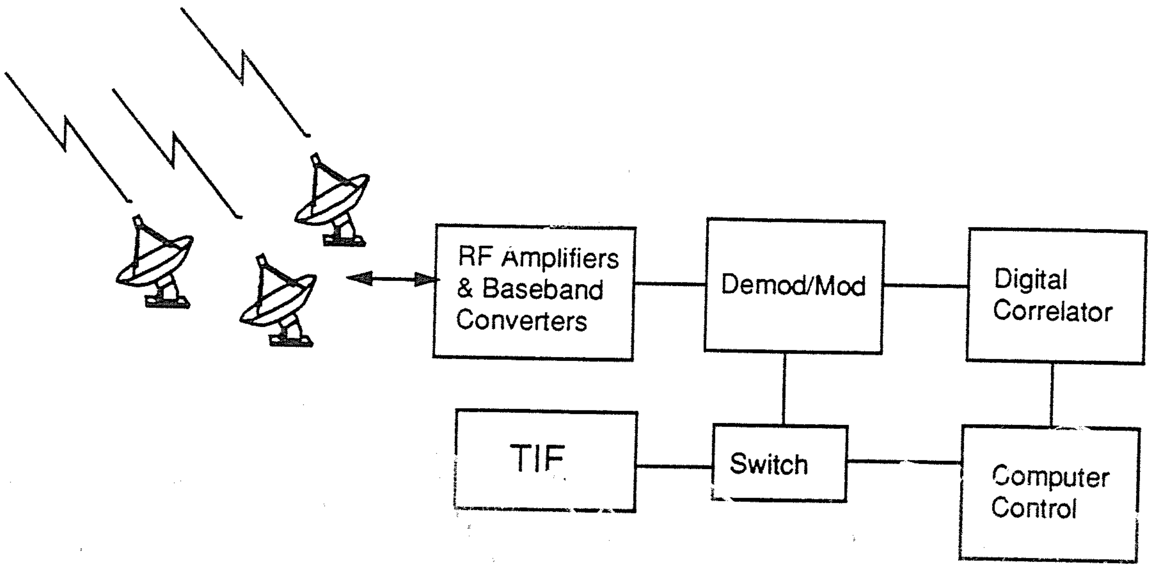


Figure 6

ELLIPSO® will use a combination of Frequency Division Multiple Access (FDMA) and Code Division Multiple Access (CDMA) to carry its services to digital telephones so equipped. The frequency plan is based on this FDMA/CDMA approach. Ten 1.6 MHz CDMA channels are frequency-divided within the available L-and S-bands. Eight CDMA channels are used for communications and two channels are used for signalling. One signalling channel supports the uplink, while the other supports the downlink. The diagram below depicts the channel organization:

Channel[4]	1	2	3	4	5	6	7	8	9	10
L Band	C	C	C	C	Su	Sd	C	C	C	C
S Band	C	C	C	C	Su	Sd	C	C	C	C

3. User Segment

The user segment consists of universal cellular/satellite user units (UNICELL®s) and satellite-only user units (SKYCELL®s). Users that already have a digital CDMA cellular telephone can upgrade their equipment to a UNICELL® by purchasing an "add-on" RF-antenna unit. The UNICELL® unit combines both satellite and terrestrial capabilities. Other users can purchase a complete SKYCELL® unit. Typically, equipment and service will be offered by Value Added Partners (VAPs), as detailed below, who resell ELLIPSO® service to the end-user.

The mobile users are connected with the nearest regional Ground Control Stations (GCS) through the most optimally located satellite in view. When more than one satellite is capable of relaying the transmission between the user and the GCS, only one will be assigned to transfer the call based on a

4 C = Communications CDMA Channel, Voice or Data;
Su = Uplink Signalling Channel;
Sd = Downlink Signalling Channel;
Voice communications channels are voice activated.

common algorithm which is computed by all the satellites. The algorithm divides the footprint of the satellite into geographical "regions" which are then dynamically assigned to the satellites. The satellites will hand off the calls as they pass in and out of view of the user and the GCS. Each region will be assigned one of the ten L-band and S-band channels. Depending on location, the mobile user will select the assigned regional channels for transmission through the appropriate relay satellite to the GCS. The GCS will process the call and route it to the telephone network or to an ELLIPSO® satellite if the call is to another ELLIPSO® mobile user in the same region.

UNICELL® and SKYCELL® modules possess dual transmit and receive antennas. The antenna is a radiating patch optimized to provide symmetrical azimuthal coverage within elevations from 5 degrees to 90 degrees above the horizon. The effective antenna gain within this region is 5dBic after antenna resistive and polarization losses. Feeder and matching losses at the receive S-band antenna account for 5dB which yield a G/T of - 20.0 dB/K in combination with a low noise amplifier (LNA) with input noise temperature of 80° Kelvin. The cable losses between the solid state power amplifier (SSPA) and the L-band antenna are 1.5dB in order to permit the remote installation of the SSPA (in the trunk of a car, for example, with other cellular electronic components).

SSPA's with nominal output power of 3 watts are the basis of the transmit module. These consist of single transistor output Class-C amplifiers with DC to RF efficiency exceeding 60 percent. The output power of the SSPA is power controlled within range of 8dB in steps of .5dB by controlling the output voltage at the power supply. The power control is an "open loop" based on the signal strength of the forward signalling channel.

The forward signalling channel is continuously received by the mobile receiver Satellite Acquisition and Signalling Unit (SASU). In addition to uplink power control, the SASU provides the required frequency compensation of Doppler frequency shifts introduced by the satellite moving in its elliptical orbit, as well as the reception of satellite network commands and network management information. The SASU is mounted inside the vehicle together with the SSPA, up-converter, down-converter and synthesizer as shown in the diagram of the SKYCELL® unit below.

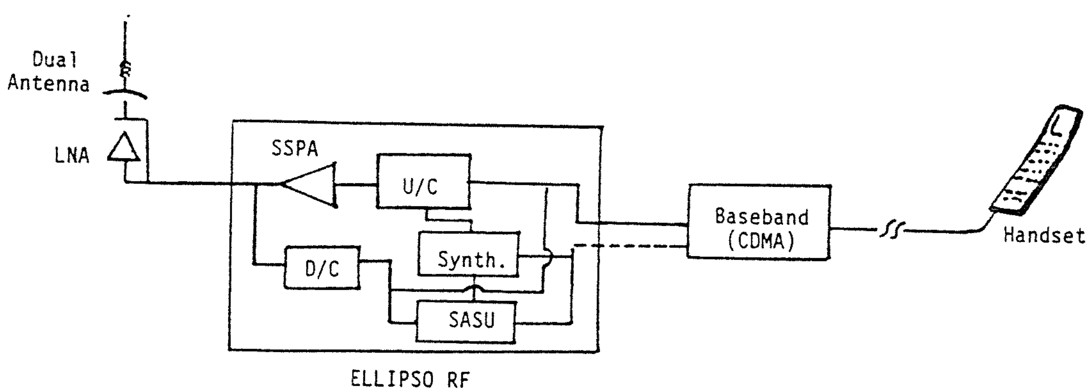


Figure 7

In a universal cellular-satellite configuration, the 800 MHz cellular RF may constitute an IF stage to the satellite RF, with an electronically activated switch (when out of the cellular service area for example) that is "on" for satellite use and "off" for cellular use. The diagram below shows a possible implementation of the UNICELL® unit.

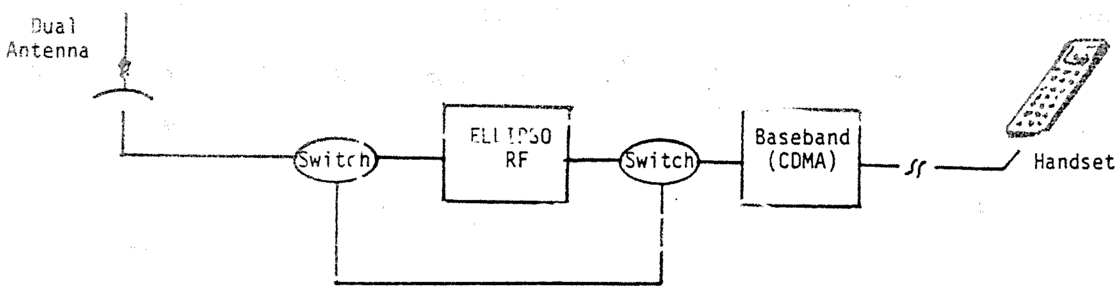


Figure 8

The general mounting configuration on a passenger automobile is depicted below.

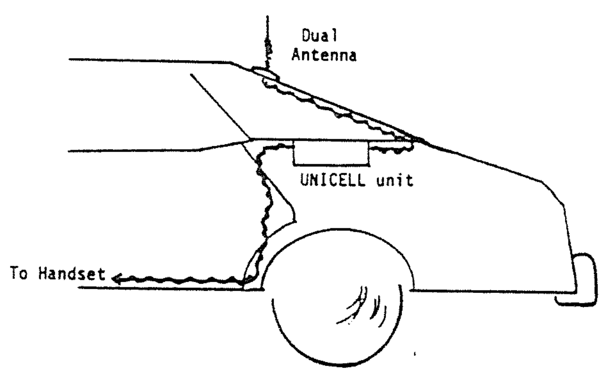


Figure 9

C. GENERAL TECHNICAL INFORMATION

The ELLIPSO® I spacecraft is a modified version of the Interferometrics Eyesat design, with the added features of gravity gradient stabilization, higher gain antenna, attitude control and increased solar power. Interferometrics is the licensed manufacturer and distributor of this lightsat design, which was launched by AMSAT in January 1990 and is presently being used for packet messaging and electronic mailboxes. The proposed version of this Eyesat-class satellite with its gravity gradient boom and S-Band/L-Band antenna is shown in Figure 10. The ELLIPSO® II spacecraft will be an enhanced version of the Eyesat design, with greater transmitter power and throughput capacity. The enhanced spacecraft, depicted in Figure 11, will weigh approximately 150 pounds and generate 170 watts of electrical power. Detailed technical information about the spacecraft is provided in Appendix A.

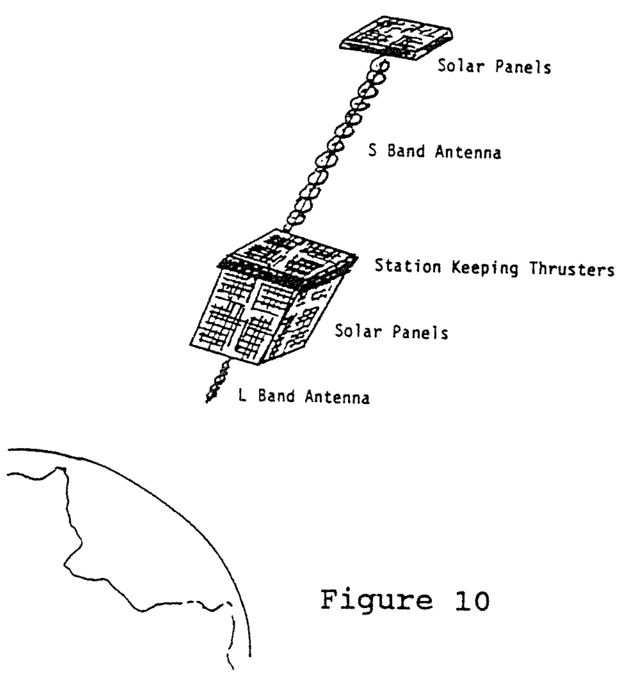


Figure 10

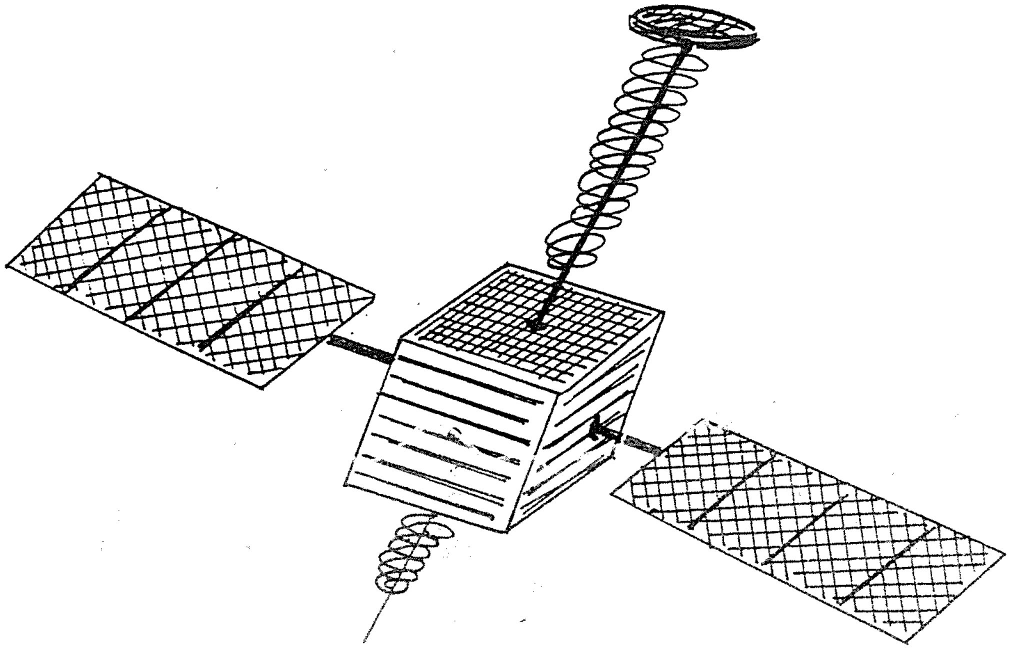


Figure 11

The enhanced spacecraft will use three-axis stabilization, with a gravity gradient boom for roll and a momentum wheel for the other two axis. Cold gas thruster fed by nitrogen bottles will be used for station-keeping. Two deployable solar array panels using high efficiency solar cells will provide primary power to the spacecraft. The rotating arrays will be mounted on each side of the spacecraft and oriented toward the sun during daylight hours. The continued output power of the solar arrays will be approximately 200 watts at the beginning of life and 160 watts at the end of life. Nickel cadmium batteries will provide secondary power during eclipse. The batteries will also be used to provide increased power to the spacecraft transmitters while it is over the United States. Thus, the solar energy accumulated by the solar panels and stored in the batteries during its total orbital travel of 100 minutes is released during its 15 to 20 minute pass over the United States service area.

D. DESCRIPTION OF SERVICES

ELLIPSO® offers an innovative solution to the problem of providing cost effective and accurate position information to mobile transceivers by satellite. In addition, the system concurrently provides nationwide, satellite-based voice service uniquely capable of interconnecting with the Public Switched Telephone Network (PSTN) and the cellular Mobile Telephone Switching Office (MTSO) via a user transparent interface. Through this efficient use of spectrum, ELLIPSO® offers a variety of services to support emergency, safety, and personal communication needs on a nationwide basis. It achieves these public interest benefits at a cost comparable to current cellular systems. The publicly beneficial services offered by ELLIPSO® are described below.

1. Position Determination By Satellite

ELLIPSO® provides accurate positioning information by satellite. The Commission has acknowledged the public interest benefits of, and the many services potentially provided by, radiodetermination. See Report and Order, Gen. Docket No. 84-689, 58 R.R.2d 1516 (1985). Safety-of-life and law enforcement applications of RDSS include emergency locator services, nationwide car theft prevention, and motorist roadside assistance. Other uses include resource management, navigation, and exploration.

To provide these RDSS services, ELLIPSO® uses Geobeacon, the satellite-based ranging system developed by Professor C. C. Counselman of the Massachusetts Institute of Technology (MIT), to locate transmitters in its system. The technology to implement this system is available today, and Interferometrics has implemented a version of the Geobeacon system using adjacent geosynchronous satellites. Interferometrics has demonstrated and patented a transmitter locator system that uses Time Difference of Arrival (TDOA) and Frequency Difference of Arrival (FDOA) techniques to recover extremely weak signals (less than 40 db below noise level) in the presence of strong digital and video traffic. A simplified version of this system using CDMA signals and a digital correlation processor will determine a line of position of the mobile transmitter for each satellite pair measurement. The process is similar to that used in making GPS range measurements. The strong CDMA signals greatly simplify the geo-location correlation and data processing task, allowing rapid determination of the locations of the transmitter in the system. A simplified block diagram of the ground processing scheme is shown in Figure 12.

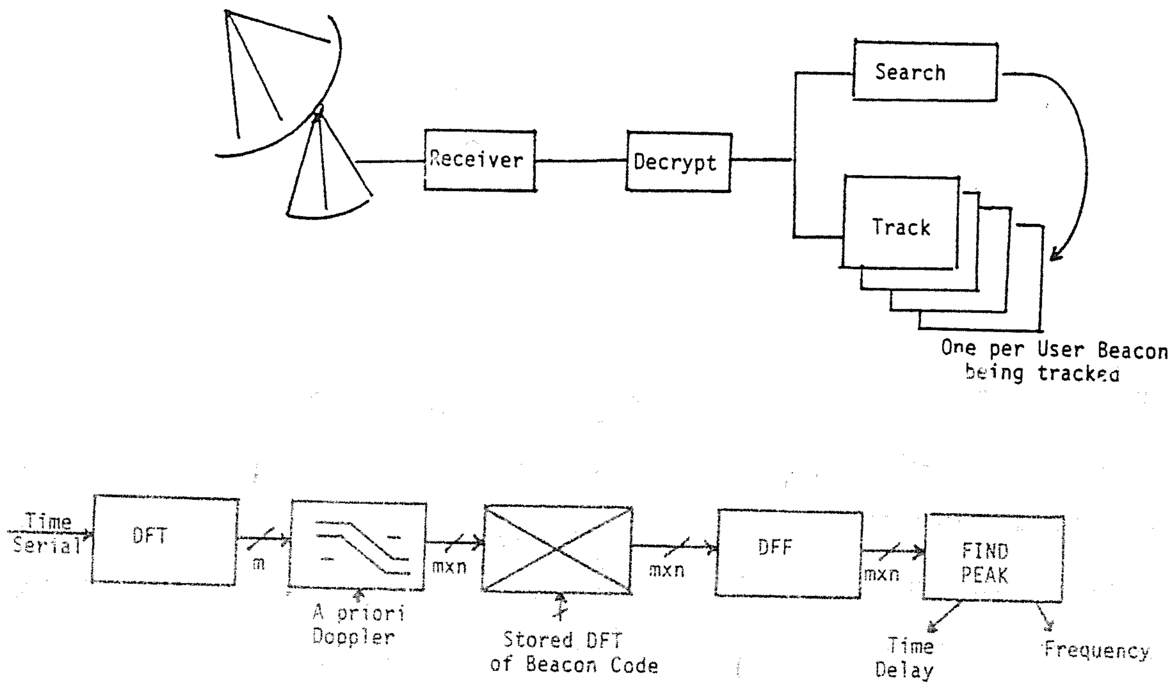


Figure 12

A simplified diagram of the satellite relay operations needed to perform the geo-location measurements is shown in Figure 13.

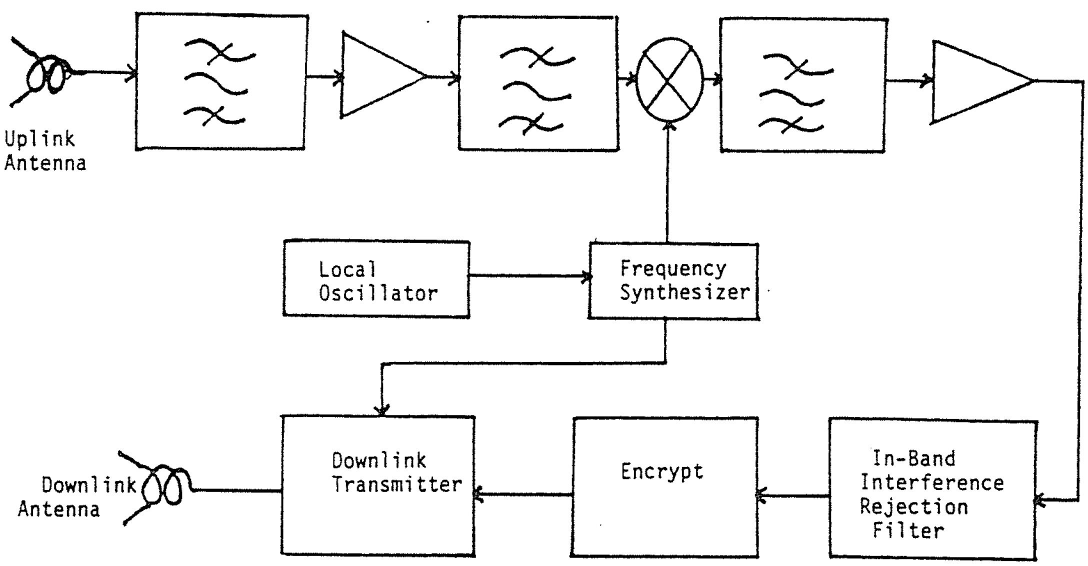


Figure 13

The low-power radio transmitters required to implement the Geobeacon system are incorporated into the UNICELL® and SKYCELL® units. No additional hardware will be needed. The signals from all transmitters in view will be repeated by the satellites to the Ground Control Station where detection, measurement, and data processing take place. Tracking algorithms based on a stochastic description of the kinematics and ionosphere contributions of the received signal frequencies and phases have been developed. Highly accurate position determination is easily achievable given good satellite geometry and detection circuitry.

2. Voice Services

During ELLIPSO®I, nationwide, satellite-based mobile voice services will be gradually introduced and perfected. The ELLIPSO® system is intended to complement, not compete with, terrestrial cellular telephone systems. It will offer direct and transparent interconnection with terrestrial cellular systems and the telephone network. These highly innovative features are built into the system design. Among the benefits of the system to the user are (1) highly competitive equipment and service charges; and (2) equipment design that provides ease of use and integration with other electronic components in the vehicle. Because of its innovative satellite and constellation design, ELLIPSO® can provide the proposed services technically and economically. This should lead the way to faster user acceptance, rapid technology innovation, and enhancement of American leadership in space science and technology.

Contributing to user acceptance of the system is the ease of implementation. As proposed, existing cellular user units will not need to be replaced by users who want to use the satellite mode. To expand the capabilities of current units, only the RF components and antenna need to be added. Of course, a user will be able to purchase a new unit that combines both satellite and terrestrial capabilities. Figures 7 and 8 in the preceding section illustrate the typical UNICELL® and SKYCELL® user units.

ELLIPSO® uses CDMA or spread spectrum technology for efficient access and spectrum utilization. CDMA combines the benefits of frequency division and time division access methods through a series of codes associated with each transceiver. Silences are integrated and utilized totally; no bandwidth is wasted. As a result of CDMA, the efficiency of the system increases with the number of users, in contrast to other systems. CDMA technology also allows easy adaption to variable loads, to accommodate demand. Figure 14 illustrates the well-known technique.

services that are consistent with the primary purpose of the frequency band.

Recent low earth orbit satellite service applications indicate demand for emergency locators, messaging devices and low data rate transmission to be between 5 and 10 million users. See, e.g., Application of Orbital Communications Corporation, FCC File No. 22-DSS-MP-90(20); Application of Starsys, Inc., FCC File No. 33-DSS-P-90(24). Ellipsat proposes to address a more limited market, namely, users of digital cellular systems that require position location. This market is estimated to be approximately 500,000 users.

(b) Voice Services

Reflecting the demand for cellular service, the number of cellular telephones now exceeds 7 million. However, the territorial coverage of cellular service is expected to reach only 45 to 65 percent of the continental United States by the mid to late 1990's. This projection leaves a large population unserved by cellular telephone service or any other economical means of mobile communication. This target population includes (1) unserved rural users; and (2) roamers into unserved areas. ELLIPSO® service can be used by rural users to complement local telephone service in a transparent fashion, with built-in compatibility to the public telephone network.

The unserved target population is currently estimated at 100 million. Assuming that one third of the market is addressable by technologies other than cellular telephony, a target population of about 35 million now exists. The target population requires an economical voice system that provides transparent, uninterrupted roaming. Demand exists for services provided at an end-user price comparable to existing cellular systems.

Ellipsat's market analysis is based on the assumption that the unserved target population will decline by the end of the century as new technologies come on line. As a result, by the time of deployment of ELLIPSO® II, it is assumed that there will be an available pool of about 18 million potential subscribers who will form the main target population for the proposed voice services. A summary of Ellipsat's market data is provided below.

MARKET ANALYSIS AND FORECAST

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
RDSS										
Addressable Pop.	80,000	140,000	210,000	320,000	420,000	500,000	560,000	610,000	650,000	680,000
ELLIPSAT Plan			3,000	16,000	32,000	45,000	54,000	60,000	64,000	68,000
CELLULAR										
US Population (M)	260	264	268	273	277	281	286	291	295	300
Served Pop. (M)	160	180	200	210	220	228	236	244	254	266
Userved Pop.	100	84	68	63	57	53	50	47	41	34
Cellular Pool (M)	4.20	5.04	6.05	7.26	8.71	10.45	12.54	15.05	18.06	21.67
Penetration (%)	0.03	0.03	0.03	0.03	0.04	0.05	0.05	0.06	0.07	0.08
ELLIPSO Penet.(%)	0.00	0.00	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.03
Ellipsat Target	33	28	23	21	19	18	17	16	14	11
Ellipsat Address	0.00	0.00	0.23	0.24	0.25	0.27	0.30	0.32	0.33	0.31
Ellipsat Plan (in thousands)	0	0	3,000	10,000	30,000	80,000	120,000	200,000	200,000	200,000

4. Areas and Entities to be Served

The continental United States (CONUS) and domestic offshore points will be covered by the ELLIPSO® I constellation as more fully detailed in Section II B, above. Because of the advantageous selection of orbital parameters, Hawaii, Alaska and Puerto Rico, the Virgin Islands, and coastal areas will be served with virtually the same coverage, availability, elevation angle, and other quality attributes as any other point in CONUS. Moreover, ELLIPSO® offers the potential for expanding service to adjacent areas, such as Mexico and Canada.

As indicated above, the end-users of ELLIPSO® will be primarily current and future subscribers of mobile communications services who roam beyond their area of coverage, and unserved rural users. Access to the system will be through the value added partners (VAPs) who sell ELLIPSO® services to end-users. The VAPs may be cellular carriers, including rural carriers, and/or other entities serving specialized industries. These may include: wireline and non-wireline cellular companies, mobile communications equipment manufacturers and distributors, organizations offering services to motorists, rental car industry, government users, local and state agencies, and auto manufacturers.

5. Technical Attributes

Technical attributes of the system, including transmission characteristics, performance objectives, link noise budget, earth station parameters, modulation parameters and link performance analysis, are detailed in Appendix B hereto.

6. Transponder Capacity Estimate

Ellipsat estimates that the average user will use the system for 74 minutes per month, with an average of two calls per day. This leads to an average utilization of .00268 Erlangs per user if a fifty percent peak-to-nonpeak ratio is assumed. The ultimate constellation will have an average of 2.8 satellites effective at any one time leading to a per satellite requirement of 191.18 Erlangs to support 200,000 users. This will be achieved with about 200 CDMA carriers per satellite and an average power requirement per satellite of 170 watts. With ELLIPSO®I, approximately one-eighth of that capacity will be deployed. Appendix F provides a more detailed analysis of capacity requirements.

E. INTERFERENCE ANALYSIS, SYSTEM RELIABILITY, LAUNCH AND TT&C

1. Interference Analysis and Compatibility with Licensed RDSS Systems

The ELLIPSO® system does not interfere with similar services in the specified frequency bands. It can coexist with current and future RDSS licensees, through the use of CDMA techniques. The ELLIPSO® system uses spread spectrum technology and is compatible with other users in the bands, provided the orthogonality of the codes is assured. ELLIPSO® will be tailored to accommodate the parameters of existing RDSS licensees. In fact, the system can support existing RDSS users very efficiently, as the 40 Watt Geostar RDSS signal spread over 16MHz can be accommodated by a system based on a 3 to 4 Watt and 1.6MHz spread.

The orbital parameters of ELLIPSO® render the two degree spacing requirement inapplicable.

2. System Reliability

The system is designed to ensure optimum service. Relevant design criteria are provided below.

Satellite: 3 years life time

Earth Stations: 99%, MTBF=30,000 Hours

User Terminals: 99%, MTBF=30,000 Hours

Orbit Gaps: Minimal

3. Launch Vehicle

Ellipsat plans to launch the six ELLIPSO® I satellites in a single Ariane ASAP platform. The next available ASAP launch is scheduled for 1993. There are six launch stations available for boosting the satellites into a sun-synchronous orbit. Four of the Eyesat-class spacecraft were launched on a similar Ariane vehicle in 1990. The interfaces and qualification test requirements have already been approved for the proposed satellites. An alternative launch vehicle for the ELLIPSO® satellites is the Orbital Sciences Pegasus vehicle.

Only one launch will be required for the six ELLIPSO® I satellites. Pegasus, for example, is capable of boosting as many as sixteen Eyesat-class satellites at one time, as described in the attached paper by King, Beidleman and Stoltz: "A Multi-User Carrier Structure for Deploying Pegasus-Launched Micro-Satellites". See Appendix C.

4. Telemetry, Tracking and Control (TT&C)

The TT&C system consists of redundant telemetry, tracking and control capabilities both on the spacecraft and on the ground. The TT&C uplink and downlink share the L-band and S-band frequencies with the voice and RDSS functions. Two command receivers, decryptors and decoder/encoders are contained on each satellite.

Two TT&C ground stations based in the United States will monitor the satellites' functions, track the satellites' position, and provide essential commands and computer program modifications. The master control station signals will be used to determine precisely, using interferometric ranging techniques, the position and velocity of each satellite. The coded radio signals emanating from these fixed, known ground transmitters are used to calibrate the offset in the satellite's local oscillator and to remove the atmospheric delay uncertainties prior to computing an accurate geo-location for the unknown mobile subscriber. The TT&C operations will be conducted simultaneously with communications operations, with no interruption.

F. SATELLITE LOCATIONS AND CONSTELLATION

A detailed explanation of satellite locations is provided in Section II.C., above. The applicable parameters are summarized below.

Satellite Altitude: 500 km perigee, 1250 km apogee

Satellite Inclination: 6.35 degree for major axis of orbit with eccentricity equal to .0517

Orbital Period: 102.5 minutes

Duration of US illumination: 10 to 20 minutes depending on orientation and direction of satellite pass.

Satellite Planes: ELLIPSO®I: 1 plane; ELLIPSO® II: four planes

Satellites/Plane: six

Number of ELLIPSO® I Satellites: six

Number of ELLIPSO® II Satellites: twenty-four

Area of continuous coverage: Northern Hemisphere above 25 degrees latitude

The reasons for the above constellation are to achieve: (1) optimum duration of US coverage per single satellite; (2) optimum elevation angle; (3) optimum utilization of the system for the United States; (4) rapid return from perigee; and (5) optimum conditions for control of orbit precession.

G. PROGRAM SCHEDULE AND MILESTONES

Ellipsat anticipates that its ELLIPSO® system can be constructed within twenty-four months after FCC authorization is received. The following schedule assumes, for purposes of developing milestone dates, that grant of the subject application will occur by September 1991.

Authorization Granted to Construct ELLIPSO® I Satellite System	Sept. 1991
Application Filed for Launch and Operation of ELLIPSO® I	Oct. 1991
Spacecraft Construction Commences	Nov. 1991
Launch Services Contract Executed	Mar. 1992
ELLIPSO® I Spacecraft Construction Completed	May 1993
Launch of ELLIPSO® I Constellation	Sept. 1993

The following preliminary schedule for ELLIPSO® II is provided for informational purposes only:

ELLIPSO® II Application Filed	Mar. 1991
Authorization Granted to Construct, Launch and Operate ELLIPSO® II	Sep. 1991
Start Construction of ELLIPSO® II Constellation	Apr. 1993
Launch of ELLIPSO® II Constellation (First Complement)	May 1995
Launch of ELLIPSO® II Constellation (Second Complement)	Sept. 1995
Launch of ELLIPSO® II Constellation (Third Complement)	Jan. 1996
Launch of ELLIPSO® II Constellation (Fourth Complement)	May 1996

H. INVESTMENT AND OPERATING COSTS

A detailed schedule of estimated investment and operating costs, depreciation, maintenance, and annual revenue requirements is provided in Appendix D.

I. FINANCIAL QUALIFICATIONS

Ellipsat is financially prepared to construct, launch and operate the ELLIPSO®I system for one year. The system will be funded from estimated income or revenues from the proposed operation of the satellite system. In addition, Ellipsat has received assurances that adequate financing can be arranged for its system. Letters to that effect from Venture First

Associates, the Southeast's largest high technology early stage venture capital firm, and ITR Group, Inc. which also specializes in the financing of high technology ventures, are attached as Appendix E.

1. Source and Amount of Estimated Revenues From Proposed Satellite Operations

Ellipsat intends to sell capacity options to the VAPs during the pre-operational phase in order to finance ELLIPSO® I. The cost of constructing the six satellites and related ground facilities is estimated at $9.7 million, including pre-operational expenses. Ellipsat's forecast for capacity option sales is $10 million over the first three years of pre-operation. This is a conservative projection based on approximately 10,000 user-years.

At system maturity, user expenditures are expected to generate a net revenue for Ellipsat of $140 million, based on an average price of $.35 per minute to the Value Added Partners (VAPs). Ellipsat has based its estimated revenues on end-user costs of $0.40-0.50 per minute. Ellipsat expects to generate consolidated revenues of about $700/year per subscriber. Ellipsat intends to "wholesale" capacity to the VAPs, who, in turn, will have an average profit margin of twenty-two percent. The actual margin per VAP will depend on volume, time and duration of the commitment for services.

Financial projections for the system are attached as Appendix D.

2. Source and Amount of Committed or Potential Financing

Ellipsat has received assurances from two highly respected venture capital firms, Venture First Associates and ITR Group, Inc., that sufficient financing can be arranged to finance the proposed satellite system. Letters of assurance from these firms are attached as Appendix E.

3. Other Resources

A pro forma balance sheet for Ellipsat is submitted in Appendix E. Although Ellipsat Corporation is a newly-formed corporation, its principals have extensive experience in developing and marketing communication technologies. For example, Interferometrics, one of the principal stockholders of Ellipsat, is an employee-owned technology and engineering company, founded in 1982 with sales of $7 million. The company is well known for its work in locating and tracking satellites, locating interference to satellites, and transmitter location (Geobeacon). Of particular relevance here, Interferometrics is licensed to manufacture and sell the Eyesat-class satellites as noted above. Further information about the company's capabilities is provided in Appendix F.

J. LEGAL QUALIFICATIONS

Legal qualifications of the applicant are set forth in FCC Form 430, attached hereto as Appendix G.

K. REGULATORY STATUS

In the RDSS Licensing Order, Radiodetermination Satellite Service, 60 R.R.2d 298 (1986), the FCC decided not to impose common carrier obligations on RDSS providers. See also Qualcomm, Inc., 4 F.C.C. Rcd 1543, 1545 (1989). Consistent with this regulatory approach, Ellipsat proposes to structure its service offerings on a private carrier or shared private network basis to meet the needs of individual customers, specifically the Value Added Partners of the ELLIPSO® service described above. Although Ellipsat believes that the regulatory policies underlying the RDSS and Qualcomm decisions are applicable here, if the FCC should conclude otherwise, Ellipsat is willing and able to operate as a common carrier. In that event, however, Ellipsat contends that forbearance would be appropriate because the possibility of multiple systems in the RDSS band ensures that no one system will be dominant.

III.

PUBLIC INTEREST BENEFITS OF THE ELLIPSO® SYSTEM

The proposed satellite system will further the Commission's policy goals and public interest objectives in the following ways.

First, the ELLIPSO® system is highly innovative from a technical standpoint. The use of elliptical orbits, in particular, is a novel feature that will facilitate nationwide coverage. Other unique aspects of the system include the provision of geo-location using the Geobeacon ranging system; the first commercial use of Eyesat class, miniature communication satellites; and a built-in design for transparent interconnection permitting "seamless" roaming and integration with the public telephone network.

Second, ELLIPSO® is spectrum efficient. Although CDMA or spread spectrum is not new, the technique is used in the ELLIPSO® system to maximize spectrum utilization. In fact, the efficiency of the system increases with the number of users, in contrast to other systems. CDMA also allows the system to use efficiently an existing spectrum allocation without any displacement of existing users.

Third, the ELLIPSO® system will achieve nationwide coverage of the United States within twenty-four months after grant of authorization. This rapid introduction of service will provide the benefits of nationwide coverage for position determination and voice services more efficiently and less expensively than any known technology.

Fourth, the ELLIPSO® system complements and enhances existing and proposed cellular service. It is intended to provide an additional, not competitive service, for cellular companies, including rural cellular carriers. For a marginal added cost, a modified RF and antenna package can be added to existing system to allow use of both cellular and satellite systems, or a new combined cellular-satellite unit can be purchased. The ELLIPSO® system offers a critical role for cellular companies and other service providers as Value Added Partners of the system.

Fifth, the proposed system will achieve the public benefits envisioned for RDSS, by providing the economic base of support it requires. Although valuable L-Band spectrum has been allocated to RDSS, subsequent events have raised questions about whether the market demand for RDSS, standing alone, is sufficient to support the existing allocation. Ellipsat has proposed a system that will offer RDSS, as authorized by the FCC, while utilizing the spectrum for publicly beneficial ancillary services.[5] The system uses an

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[5] Ellipsat proposes to provide voice services on an ancillary basis pursuant to Rule 25.392(d). It is noteworthy in this regard that projected annual revenues attributable to RDSS and voice services are comparable for the ELLIPSO®I system. See Appendix D. Ellipsat believes that voice services are permissible as ancillary to the radiodetermination service within the meaning of Rule 25.392, and are, therefore, a conforming use of the frequencies. The Commission has expressly allowed for the possibility of combined voice/RDSS services in

accurate, spectrum efficient, economical and highly innovative RDSS method developed at MIT and implemented by Interferometrics.

Sixth, consistent with the FCC's domestic satellite policy goals, the ELLIPSO® system will provide opportunities for new and multiple entry. Through the use of CDMA technology, the ELLIPSO® system can coexist with Geostar and also permit licensing of additional users in the frequency band. Moreover, this application proposes the kind of novel, cost-effective and technologically innovative system that the

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the RDSS bands. See Radiodetermination Satellite Service, 60 R.R.2d 298, 304-305 (1986). This application contains ample demonstration that, in this case, the combined services would best serve the public interest. If, however, the proposed voice services were considered to be non-conforming, the Commission has also previously held that non-conforming uses of the RDSS frequency band may be permitted where there is no prospect of causing interference to conforming operators, and compelling justification has been shown. See id. at 306. See also Qualcomm, 4 F.C.C. Rcd 1543, 1544 (1989); Rural Cellular Service, 58 R.R.2d 517, 519 (1985); DBS Systems, 92 F.C.C. 2d 64, 68 (1982). As demonstrated herein, Ellipsat's system will not interfere with licensed RDSS service in any respect, and compelling public interest reasons exist for authorizing the ELLIPSO® system. Ellipsat's provision of voice service therefore meets the applicable criteria for non-conforming use of the specified frequencies. In the event, however, that Commission Staff were to conclude that a waiver of existing rules (Rule 25.392(d) and/or other applicable provisions) is necessary to grant of this application or to permit voice service as a non-conforming use, it is requested, in accordance with Rule 1.3, that this application also be construed as a request for such waiver, which is fully supported by the data in this application, and that no separate waiver request be required in the interests of administrative convenience and prompt initiation of service to the public.

Commission seeks to encourage with its pro-competitive domsat policies.[6]

Seventh, the ELLIPSO® system is an American system. Its primary focus is on United States service, and can therefore be implemented without direct involvement of foreign governments. It will also permit domestic companies to assume a leadership role in developing this new technology.

Eighth, the ELLIPSO® system is cost effective. As detailed herein, significant economies will be achieved through the use of microsatellites. The cost of constructing and launching the entire ELLIPSO® satellite system is only a fraction of the cost that would be incurred to construct and launch a geosynchronous system with comparable capabilities. As a result of these economies, the cost of the system to VAPs is projected to be $0.35 per minute, which will enable them to provide this service on a competitive basis. Economies to the end-user will also result from the low orbital characteristics; for example, existing cellular equipment can be modified at a nominal cost (estimated at $300) for use in conjunction with the ELLIPSO® system.

In short, ELLIPSO® offers a unique combination of technical, design and other innovations that ensures significant public interest benefits.

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[6] See Establishment of Domestic Communications-Satellite Facilities by Non-Governmental Entities, 35 F.C.C.2d 844, 847 (1972).

IV.

WAIVERS AND CERTIFICATIONS

Pursuant to Section 304 of the Communications Act of 1934, as amended, Ellipsat hereby waives any claim to the use of any particular frequency or of the ether against the regulatory power of the United States because of the previous use of the same, whether by license or otherwise.

The applicant's submission reflects a serious and conscientious effort to answer all of the Commission's filing requirements as fully and completely as presently possible. While the applicant believes that it has fully complied with all pertinent Commission rules and policies, and has supplied all the information, as appropriate, requested by Appendix B of Space Station Application Filing Procedures, it hereby requests that, to the extent it has not satisfied the applicable requirements, a waiver be granted.

The applicant certifies that all of the statements made in this application are true, complete and accurate to the best of its belief and knowledge, and are made in good faith.

V.

CONCLUSION

For reasons detailed herein, the ELLIPSO® system will provide significant public interest benefits, including use of highly innovative technology, provision of radiodetermination satellite services, availability of nationwide cellular coverage economically and expeditiously, "seamless roaming" and integration with the telephone network. Accordingly, Ellipsat Corporation requests that the Commission authorize construction of ELLIPSO®I, and the public benefits it will provide, as expeditiously as possible.

Respectfully submitted,

ELLIPSAT CORPORATION

By ______________________
Dr. David Castiel
Chairman and
Chief Executive Officer

Of Counsel:

Jill Abeshouse Stern, Esq.
Miller & Holbrooke
1225 19th Street, N.W.
Suite 400
Washington, D.C.

November 2, 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, that I am familiar with Part 25 of the Commission's Rules and Regulations, that I have either prepared or reviewed the engineering information submitted in this application, and that it is complete and accurate to the best of my knowledge.

By: [signature]
Dr. Dino A. Lorenzini
Executive Vice President
Interferometric, Inc.

APPENDIX A

APPENDIX A

TECHNICAL INFORMATION

1. Radio Frequency Plan

Frequencies: 1610 to 1626.2 MHz uplink from mobile or GCS
2483.5 to 2500 MHz downlink to mobile or GCS
10 segments of 1.6MHz each in each band

Bandwidth: 16 MHz in each direction

Emission Designator: 16MHz at 1610, 16MHz at 2500

Power into Antenna: 13-15 dBW

Satellite Antenna Gain Contour: see Figure A-1.

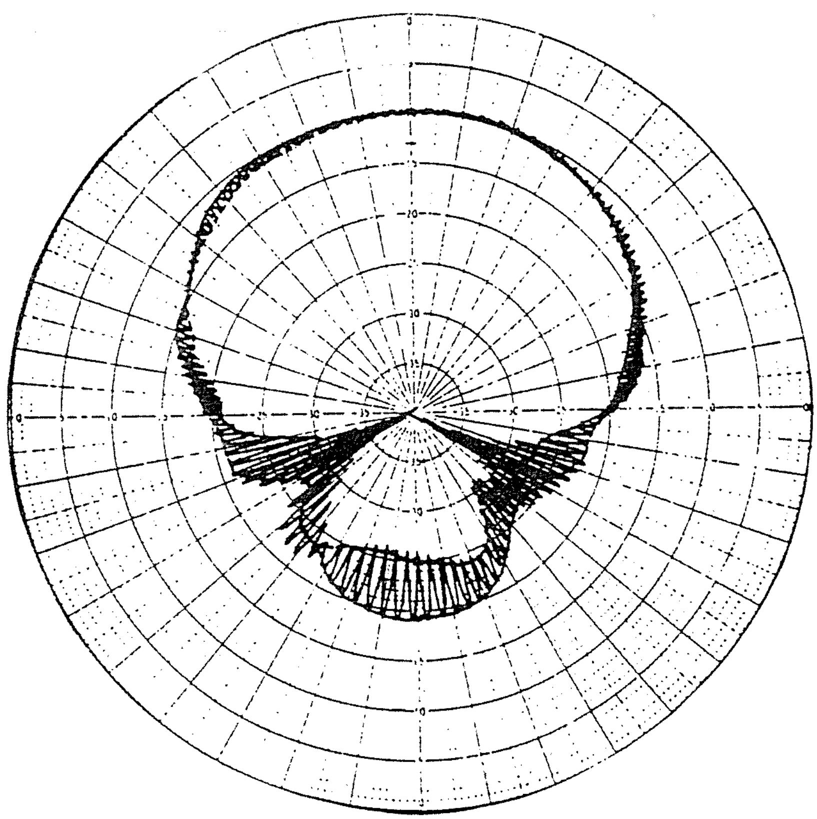


Figure A-1

2. Power Flux Density Levels:

At Earth: -256 $dBW/m^2/4KHz$

3. Number of Satellites

(a) In orbit: 6 ELLIPSO® I

(b) On-the-ground spares: None

4. Estimated Number of Earth Stations

(a) Transmit and Receive: 10

(b) Receive Only: None

(c) Transmit Only: None

5. Characteristics of the Space Station

(a) Weight : 30 lbm

Dimensions: 9 x 9 x 13 inches, plus antenna

Solar Power: 15 watts

Transmitter Power: 25 watts peak, 14 dBW

(b) Estimated Operational Lifetime: 3 years.

A summary of the enhanced spacecraft characteristics is provided in Table 1.

TABLE 1.

SUMMARY OF ENHANCED SPACE STATION CHARACTERISTICS

Orbit	63.5° inclination elliptical orbit 500 km Perigee; 1250 km Apogee
Number of Satellites	24; 4 planes with 6 satellites/plane
Mass in Orbit (Boc)	150 lbs.
Size	18 x 18 x 18 inches + boom
Stabilization	Gravity Gradient 3-Axis Magnetic torquing & damping
Station keeping	± 5 degrees In plane ± 2 degrees Out-of-plan
Mission life	5 years
Eclipse Capability	50 percent
Earth Coverage	5,555 km at 5° elevation angle
Power Nominal Peak	120 watts at BOL 360 watts at BOL
Polarization	Circular
Uplink Channels	10 at 1.6 MHz BW; 1610 MHz-1626 MHz
Downlink Channels	10 at 1.6 MHz BW; 2484 MHz-2500 MHz
Transmit EIRP	27 dBW @ 2500 MHz
Satellite G/T	-2.0 dB/K @ at 2500 MHz
Power Flux Density	-256 dBW/M2 /4KHz

APPENDIX B

APPENDIX B

TECHNICAL SYSTEM SPECIFICATIONS

1. Performance Objectives

Performance objectives are 99% service when mobile transceivers are in line of sight of an ELLIPSO® satellite.

2. Link Noise Budget

RDSS

	Return Channel	Forward Channel	
Transmit Power	3.3	20	dBW
Antenna Gain	5	27.1	dBi
EIRP/user	8.3	26.1	dBW
Path Loss	164.9	166.7	dB
Other Losses (Atmospheric...)	1	1	dB
Satellite Transponder Gain	147.8	147.8	dB
Satellite Antenna Gain	12.0	12.0	dBi
Receiver G/T	6.2	-20.0	dB/K
Effective Downlink C/No (including Multiple Access Interference)	40.4	41.5	dBHz
Margin	0.6	0.5	dB

3. Earth Station Parameters

Tx Power	100w
Antenna Gain	27.1 dBi
G/T	-14.7 dB/K

4. Modulation Parameters

Access Method FDMA/CDMA

Modulation: Direct Sequence BPSK

Spreading @ 1.28 Mcps

FEC decoder by soft decision

FEC encoder Rate 1/2, K=7

4800 bps voice-activated transmission

RDSS through Geo-beacon code detection and interpretation

SPECIFICATIONS

EYESAT

Physical: 23 cm cube: 9.5 kg

Average Power: 8 to 10 watts

Payload Power: 4 watts continuous; 50 watts max

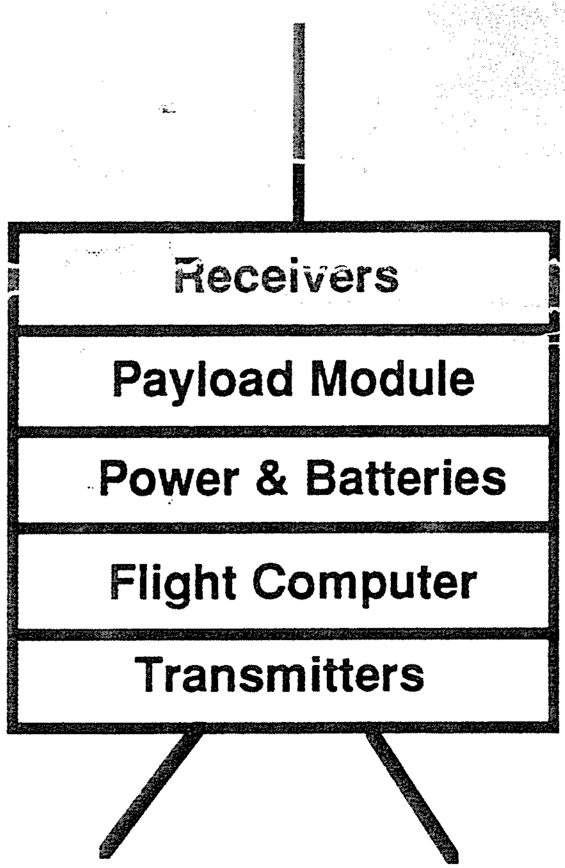
Stabilization: Passive magnetic with solar spin

Operating Frequecy: UHF, VHF & S-Band downlink
VHF uplink

Available Channels: 5 Receivers
1200 to 9600 baud
2 Transmitters
PSK Modulation at 9600 baud

Power Requirements: RF output: 2 to 4 watts
at > 75% eff. (300 to 1000 MHz)
CPU: 2 watts peak
Receiver: 260 milliwatts

Computer: CMOS V-40 microprocessor
10 Megabytes RAM; 9.2 MHz oscillator
256K RAM EDAC memory
Multi-tasking environment
Direct Memory Access



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FOR ADDITIONAL INFORMATION:

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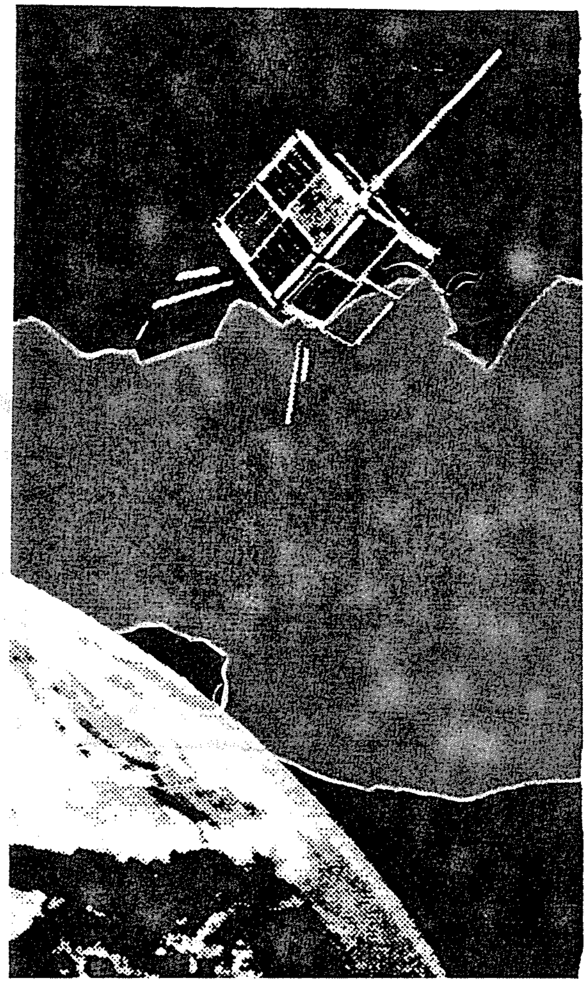

EYESAT

Description

EYESAT is a compact (21 lbs, 9 inch cube) highly efficient satellite that embodies significant advances in low-cost engineering. Configured in a modular (expandable) stack arrangement, EYESAT can support a variety of missions, from store-and-forward communications to specialized scientific applications. Intended for low Earth orbit, EYESAT brings a new level of performance, low cost and flexibility to the satellite user community.

Applications

- Store-and-Forward Communications
- Earth Imagin
- Remote Data Relay
- Scientific Payloads

Features

- Low cost design uses "off-the-shelf" standards for interfaces, protocols, software, and system test.
- Spacecraft Local Area Network (LAN) minimizes wiring harnesses.
- Maximizes use of Computer Aided Design for efficiency and low cost.
- Modular Design allows simple growth, low-cost fabrication, and a variety of payloads.
- Alternative configurations, stabilization methods, and missions are possible.
- CPU controls spacecraft. Uploadable onboard commands modify mission data.

APPENDIX C

A MULTI-USER CARRIER STRUCTURE FOR DEPLOYING PEGASUS-LAUNCHED MICRO-SATELLITES

J. A. King, N. J. Beidleman, Dr. P. M. Stoltz[1]

Now that the viability of the Pegasus air-launched booster has been demonstrated, it is possible, and indeed appropriate, to devise methods for exploiting the launcher so that it can launch multiple micro-satellites. Such spacecraft may be launched for a single user, or the capacity of a single launcher may be divided among multiple users. In fact, not all of the satellites on a single launch need to be placed into the same orbit.

This paper describes a concept, developed by OSC, to place multiple micro-satellites into various orbits using a single Pegasus launch vehicle. The concept makes use of separable "pallets" which may be stacked, one on top of the other within the Pegasus fairing. Each pallet can have an integral propulsion system and may transport from one to six micro-satellites into an orbit modified from the reference orbit provided by the launch vehicle. Examples are given as to how the system may be used to implement a variety of mission options. If a constellation of communications satellites are deployed by this approach, global coverage can be provided at what is believed to be the lowest cost available today.

The mechanical and propulsion system designs of the pallet are discussed and user constraints are reviewed. The performance capability of the Pegasus vehicle is reviewed as it impacts the individual micro-satellite payload mass.

The successful flight of Pegasus F-1 has verified that the price per kilogram of mass to low earth orbit can be maintained even when the total mass of the satellite system being launched is low. This places options in the hands of small

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1 Members of the technical staff, Orbital Sciences Corp., Space Technology Laboratory, Boulder, Colorado

satellite designers that have never before been available. Orbit choices, launch window decisions and deployment strategies have never been choices for small satellites that have heretofore been flown as secondary payloads on large launch vehicles. For example, Pegasus has made viable the concept of a distributed LEO network of multiple satellites in multiple orbit planes in order to provide continuous global coverage. While the concept has been known and studied since the beginning of the space era, until now this approach to satellite networks has been cost prohibitive. By using a single Pegasus launch vehicle per spacecraft or per orbit plane, the aggregate cost of a network is of the same order as that of a global geostationary network. Similarly, fractions of such a network (that can demonstrate the whole network), satellites that fly in formation (clusters), and mother/daughter mission concepts can be implemented more effectively with a flexible, low cost, launch capability.

As a parallel development, micro-satellite technology has advanced so that significant communications and scientific payloads can be incorporated into spacecraft with masses as low as 10 to 20 lbm. Such spacecraft may be ideal for a thin-route global data communications network, however, it is important to observe that the value of the technique (and in a communications sense, its capacity) comes from the aggregate of the satellites, not from the value or capacity of any single member satellite in the network. This point has been frequently missed by those reviewing the design of a single micro-satellite which, for all its "cuteness," is not physically impressive. There is a tendency to think of a micro-satellite as a toy. Indeed, taken by itself, such a device is only a piece of an engine, not the car itself.

Using a single launcher to place a significant number of small satellites into orbit has only been done infrequently. Creating an entire global LEO network of small satellites has not yet been achieved by any launch means, although it has been studied may times and is now being proposed by a variety of commercial entities. Pegasus could be used to distribute multiple satellites around a single orbit plane, or it is possible to do even better. An entire global network of micro-satellites, in multiple orbit planes may be orbited by a single launch vehicle. Indeed, a number of variations in the network are possible, depending on the needs of a particular customer (or customers) and the characteristics of the orbit.

SWARMS, PALLETS AND STACKS

The following terminology will be used to explain the technique for deploying multiple micro-satellites from Pegasus:

Swarm: The entire group of micro-satellites incorporated on the launcher will be referred to as the swarm once they are deployed.

Pallet: A sub-group of spacecraft that are intended for the same specific orbit may be placed on a frame structure to be known as a pallet.

Stack: The pallets are placed one on top of the other to form a stack. The stack is the entire set of hardware launched by Pegasus.

MISSION HARDWARE

Mechanical Design

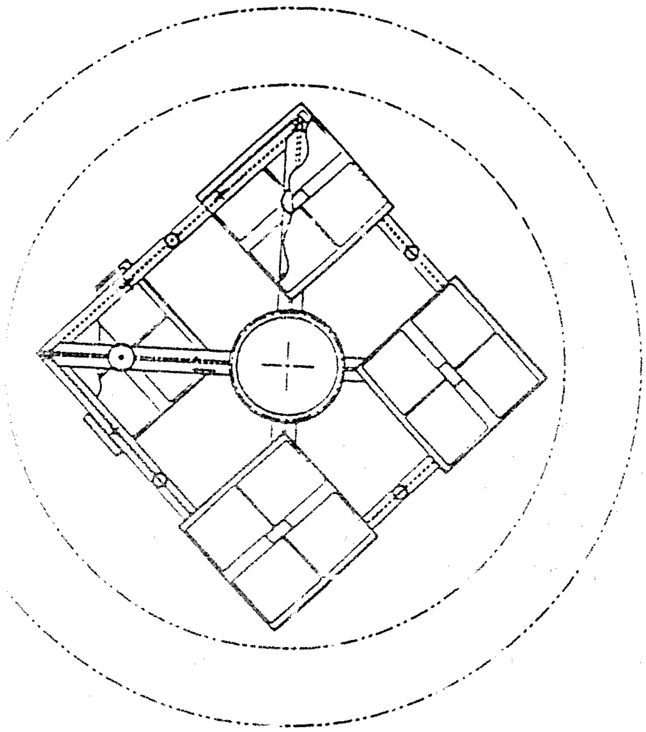
Figure 1 shows a single pallet carrying four individual satellites. The pallet structure itself consists of a lightweight aluminum frame cantilevered from a central support cylinder. The frame shown is square and supports four very small satellites. It would also be possible to have a hexagonal platform supporting six small spacecraft. The satellites shown are the same size as the AMSAT Microsats using the extended module configuration (like Webersat). Spacecraft with a larger base dimension could be used and the cantilevered platform could be extended outward, provided that the particular pallet was carried low in the stack so that it is positioned away from the Ogive portion of the launch vehicle fairing. Spacecraft that are configured as hexagonal, octagonal or circular cylinders can just as easily be flown in these same positions.

A separation system similar to that used on Microsat is also shown in the pallet design. A single tie-down bolt centrally located in the bottom surface of each spacecraft passes through a machined fitting on the pallet. A bolt cutter is contained on the pallet side of the interface. The spacecraft sits on four or more locator pins which fit into mating locator pads properly positioned on the pallet. These pins/pads also provide shear load support for the spacecraft during launch. Single or redundant bolt cutter designs are possible. A compression spring, concentric to the tie-down bolt pushes the spacecraft away from the pallet at the instant of separation.

Shown in Figure 1 are four thin walled tubes extending from the bottom side of each pallet. The tubes are connected only to the bottom side while the tube ends which separate from the pallet below are fitted onto tappered locating mounts. The tubes are intended to reduce the lateral bending (and increase the first mode resonant frequency) of the entire stack during launch.

The central support cylinder may contain a single, small solid propellant kick motor. A Thiokol TE-M-790-1 motor (STAR 6B) is shown in Figure 1. Larger motors with more propellant are also possible or the cylinder need not

Figure 1 - Pallet Configuration and Pegasus Envelope



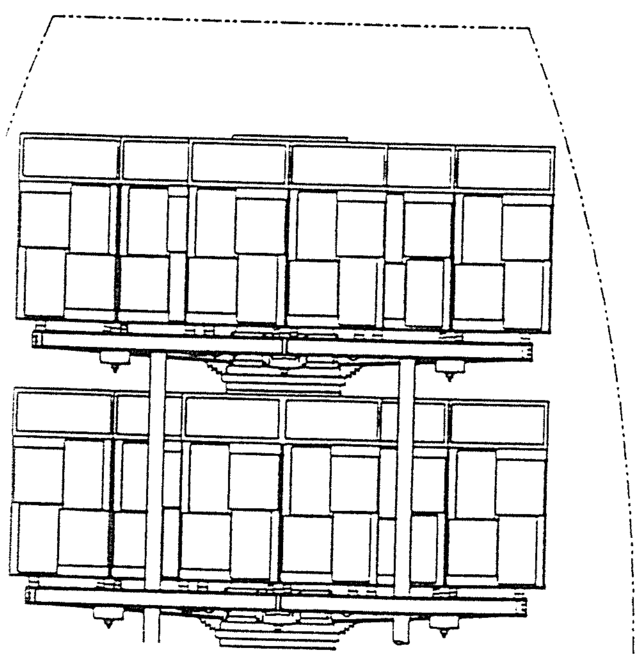


Figure 2a - Stack Configuration and Pegasus Envelope

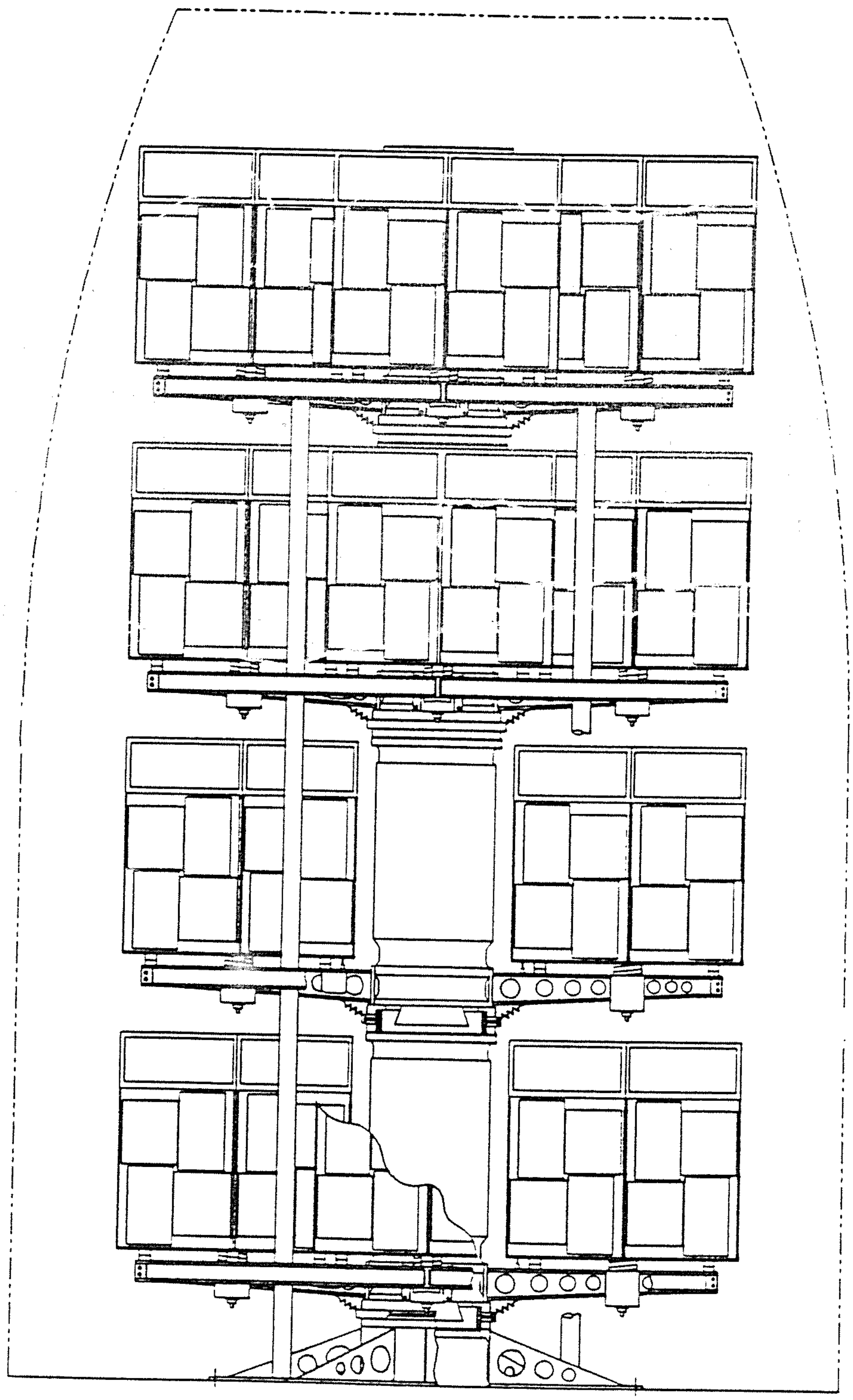


Figure 2b - Pallet Deployment Sequence

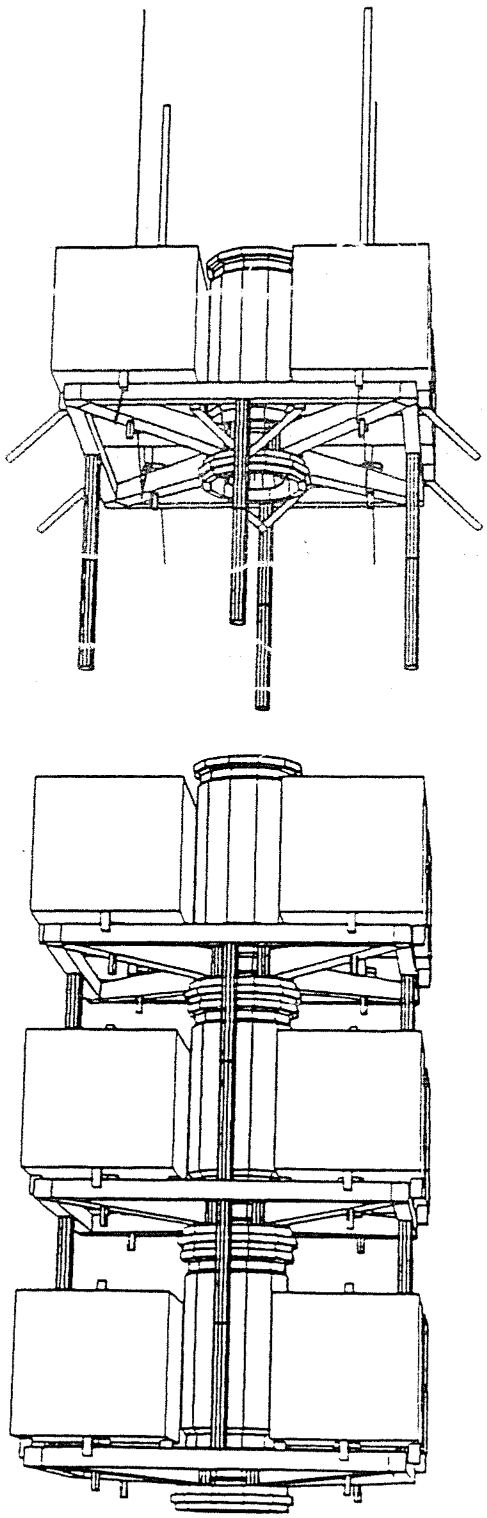


Figure 2c - Stack Configuration in Fairing Half

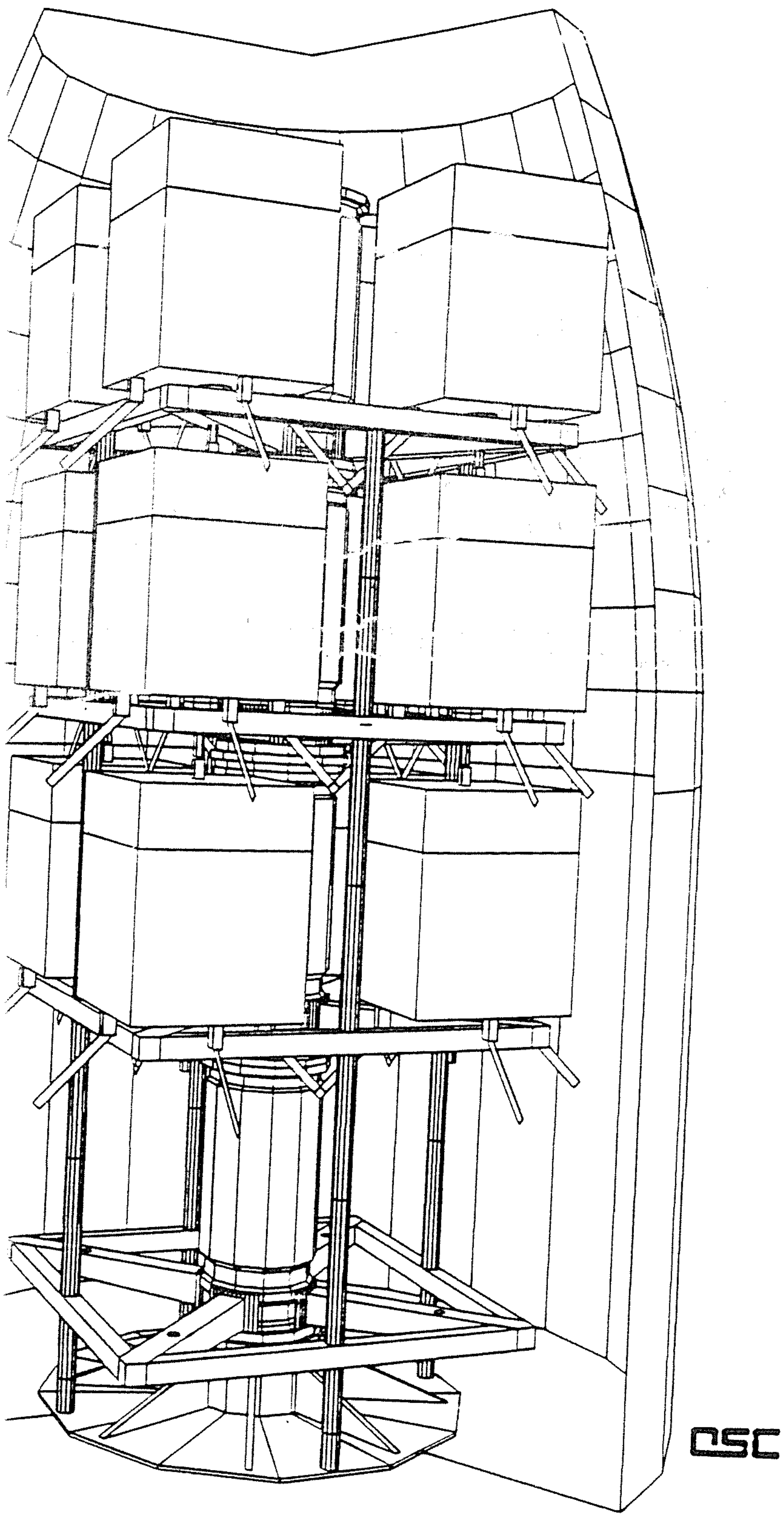
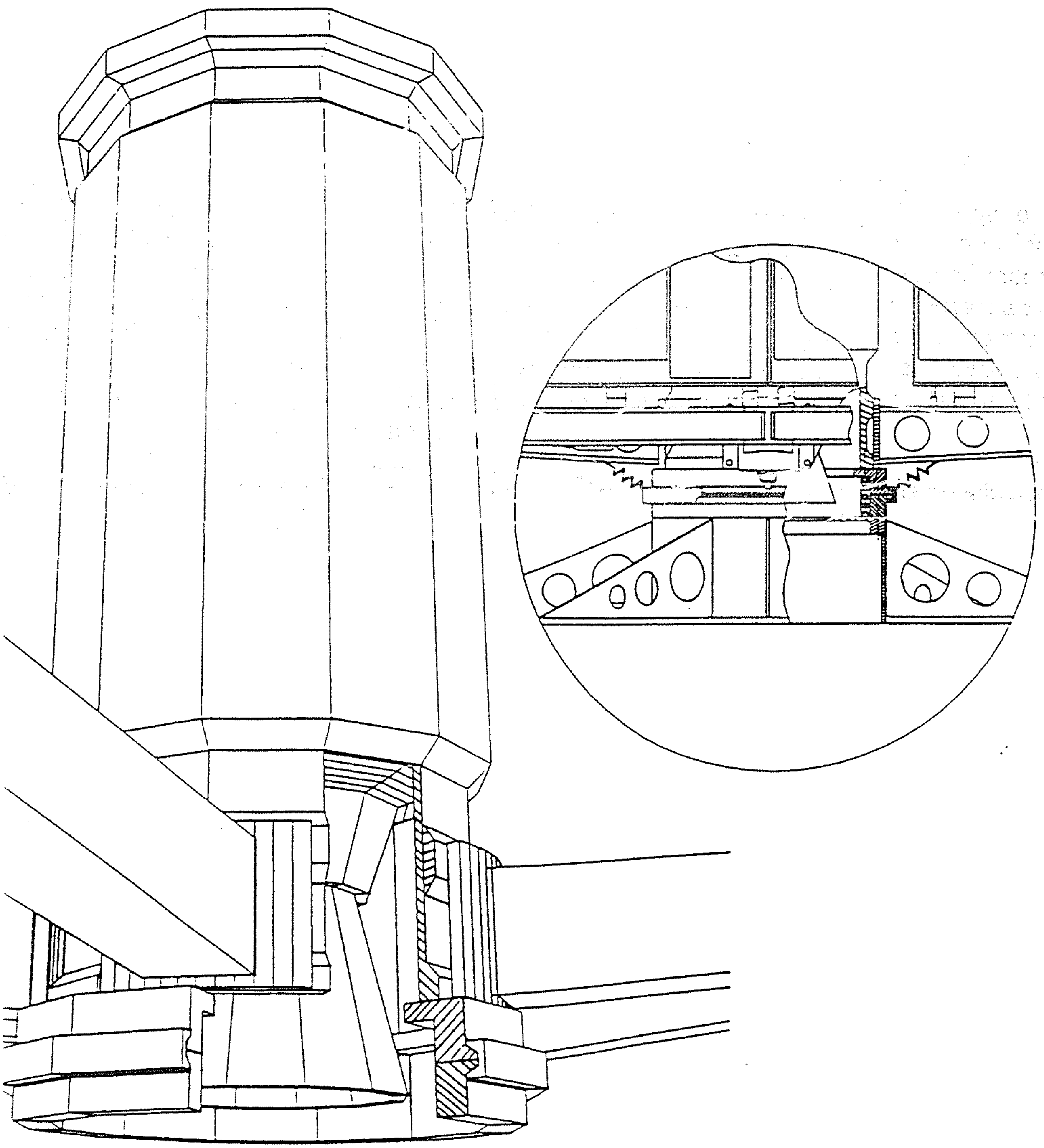


Figure 3 - Marmon Clamp Assembly Detail



contain a kick motor at all. A desirable property of the STAR 6B is that the motor casing may be used as the central support cylinder itself with only slight modifications. This reduces the mass of the overall pallet. The pallets are separated from the stack, one at a time, starting from the top. A marmon clamp separation system with spring is envisioned for this task. The clampband assembly is located at the lower end motor interface. Figure 2-a shows a stack of four pallets. Figure 2-b shows the separation of the first pallet from the top of the stack. Figure 3 shows the detail of the proposed marmon clamp assembly.

Electronic Design

The design of the electronics (or avionics) to support this approach is somewhat a function of individual mission requirements. In all cases, however, it has been assumed that there is more than the average amount of interaction between the spacecraft and the launch vehicle. In the simplest case, the launcher and the pallet structures are used as a carrier until orbit is achieved. No propulsion from the pallets is necessary. It is only necessary for the launcher to issue separation commands. Initially, the first four spacecraft are separated, then the empty pallet is jettisoned. This is followed by the second four satellites and the second pallet. And so it goes until "everyone is off the bus." In between pallet separation events it is possible for Pegasus to perform a re-orientation maneuver that will maximize the miss distance of the individual satellites. In this simplest of cases, no roll-up of the launcher would be required. The sequencing operation is accomplished by the launch vehicle flight computer and a ordnance box known as the Pyrotechnic Driver Unit (PDU). Each PDU is capable of 12 outputs to fire standard initiators (5A for 75 mS). The input to the PDU is a serial bit stream from the flight computer. If each of 16 spacecraft takes two redundant ordnance lines for separation and if each pallet takes two more, then the total ordnance count is 24, thus two PDUs must be added to the third stage electronics to support the mission.

For other types of missions, however, the situation is more complex. For missions where each pallet has propulsive capability and the satellites are separated considerably after separation from the launcher, each pallet must carry its own PDU. This, in turn, implies that power and sequencing signals must be supplied by electronics on-board the pallet. It may even be necessary for some attitude control capability to also be added. Since each pallet contains several spacecraft, none of which are likely to be particularly busy, it is proposed that power and serial communications interfaces be created between the spacecraft electronics and the PDU. Continuous power is likely to be available since the solar arrays on each spacecraft will be illuminated, even though shadowing will be more frequent. The spacecraft (one or more for redundancy) may be used to sequence separation and kick motor ignition. This may be done via a timer initiated by one of the spacecraft computers or via ground command to one or more of the satellites.

Normally, the pallet and its spacecraft would comprise a stable spinner. Spin would be provided to each pallet by executing a pre-programmed launcher roll-up maneuver. In some multi-mission scenarios the pallets may keep their spacecraft for a long period of time. In this case, re-pointing of the spin vector may be required. Two methods of accomplishing this have been considered. In the best case (lightest weight solution), if sensors and torquer coils or small momentum wheels are already available for attitude control on one to several of the spacecraft, they may be used to orient the pallet. If this is not the case then a single torquer coil, a flux gate magnetometer and possibly a simple sun sensor may be added to the pallet. In any case, it has been assumed that the "loop will be closed" by making use of one of the spacecraft computers. Both the spin rate and the direction of the spin vector of the pallet can be controlled with a single torquer coil in a LEO spinning body. While details must be worked out, the principle is straight forward. OSC has developed various forms of light weight, low cost serial data and power interfaces for use across the separation plane between spacecraft and pallet.

SOME APPLICATIONS FOR THE MULTI-USER CARRIER STRUCTURE

With a pallet and stack approach to launching micro-satellites, there are truly many ways in which this capability can be exploited. The possibility exists to divide the capacity of the vehicle among multiple customers each with multiple satellites or it might be used to put an entire network of satellites in place for a single customer.

In order to provide estimates of capability, it's necessary to provide mass estimates for the pallet hardware. A mass budget for the pallet shown in Figure 1 is given in Table 1. The values are for the pallet without motor propellant but, with the motor casing (acting as a structural member). The pallet can take larger motors with different casing masses so one needs to keep track of this factor. The pallet masses then must be subtracted from the total mass available to the micro-satellites.

A study orbit has been picked that is good for demonstrating the usefulness of this concept. The orbit is 460 km X 1000 km X 55 degrees inclination. The perigee of the reference orbit is high enough to be out of the serious part of the drag region, the apogee height is "about right" for various LEO communications and earth observation missions and the inclination is high enough to provide coverage of most of the earth. In some cases it is desirable to circularize this

ch. Arms	2.68 lbm
pport Struts	2.60
amp Band	1.85
tor Hardware	2.00
tor Casing (STAR 6B)	9.17
paration Spring	1.50
ner Hardware/ Misc.	5.20
tal Pallet Mass	25.00 lbm = 11.33 Kg.

Table 1 - Pallet Mass Estimate

llets	No. S/C Per Pallet	Mass Per Pallet
:	2	259 lbm (117.6 Kg)
	4	"
	6	"
	2	165 lbm (74.7 Kg)
	4	"
	6	"
	2	118 lbm (53.5 Kg)
	4	"
	6	"
	8	"

Table 2 - Possible Pallet Configurations

bit. For example, if four micro-satellites each weigh 11.3 Kg (25 lbm) then, unting the pallet mass, about 3.0 Kg of solid propellant in the STAR 6B motor required to circularize the above orbit (delta-V applied at apogee). Table 2 ovides some of the options for the pallet and stack system. The masses shown the third column must be treated with some care. First of all, they are based trajectory analysis runs using Pegasus data provided prior to our F1 flight. ijustments to the vehicle performance need to be made based on F1 ormation plus upgrades presently being made to Pegasus which improve rformance over the F1 version of the vehicle. The net sum of these may be se to or even above the values given in the table but, the table should be nsidered preliminary.

gle Orbit Plane - Twelve to Sixteen Spacecraft

discussed above, the simplest approach is to use pallets as carriers to place all ellites into the same orbit. The separation sequence has already been cribed. The satellites will all separate out slowly within the same plane. The l orbit is 460 km X 1000 km X 55 deg. Orbital velocities of the spacecraft uld differ only by the "delta-V" of the separation springs. If four pallets are d as shown in Figure 1 and if no mass is used for propellant, then the satellites each weigh 13.4 Kg (29.5) lbm. Similarly, if three pallets are used with four llites per pallet then the satellite mass goes up to about 18.7 Kg (41.2 lbm). volume available for each spacecraft is approximately consistent with the ent values for the mean density of electronics and the available mass per ecraft.

satellites on each pallet, or on different pallets need not be of the same mass ie spacecraft are deployed from a non-spinning Pegasus. Gross imbalance, ever, should be avoided.

le Launch Satellite Network - Multiple Orbit Planes; Twelve to Sixteen ecraft

scenario is similar to the first, however, each pallet now makes use of the R 6B motor as shown in Figures 1 and 2. OSC has developed a proprietary od for placing each pallet and its associated satellites into a different orbital e. The planes may be equally spaced or staggered relative to one another. inal orbits of the satellites are a function of the quantity of propellant loaded the STAR 6B motors and the final satellite masses, however, it is assumed one of the more useful final orbits (per this example) would be circular at km altitude and 55 degrees inclination. By making use of this unique re, it becomes possible to launch an entire global LEO network with a single sus launch vehicle. It is believed that this is the lowest cost method of ding global communications coverage via satellite available today.

each pallet should have balanced mass properties so the pallet is
er. It must act as a spinning body until after motor burn-out and
ition.

- Eight Spacecraft

t is assumed there are two different customers each with multiple
th different orbit requirements. User A wants to place four
circular orbit at 1000 km and 55 degrees inclination while User
a circular orbit at 55 degrees inclination and also proposes to
es on his pallet. Each user shares a ride to the common
ven above and each has a total mass of 117.6 Kg or 259.5 lbm.
p and released first and at the apogee of the orbit fires his kick
sus vehicle has given the pallet an orientation so that the motor
th the velocity vector, increasing the velocity of the orbit at
ass of the propellant is trimmed to 6.62 Kg (max. propellant for
.11 Kg) and the mass of the four spacecraft are each 27.75 Kg
e delta-V provided by the motor is 141 m/s which circularizes
m altitude. User B is also spun up and released but, is aligned
e motor aimed against the velocity vector of the orbit. This
User B at the perigee of the orbit. The propellant for this
mmed to 6.75 Kg and each of the satellites must weigh 27.71 Kg
vill result in a delta-V of -144 m/s ("-" indicates velocity is
e orbit) which will circularize the initial orbit at 460 km.

's) Mission

missions it is useful to launch two or more spacecraft together
er and then split the spacecraft apart. One spacecraft may go
cal orbit while the other may stay in a lower circular orbit.
perform correlative scientific experiments using orbits that
ent vantage points. The NASA/MPI mission known as APEX
SA/ESA International Sun/Earth Explorer mission are two
of this approach. In this example, suppose that a single
; 90 Kg (198 lbm) is to be placed into an orbit 460 km X
grees inclined. The other spacecraft (four micro-satellites) are
n a circular orbit 460 km in altitude. The initial reference
100 km X 55 degrees as before. If a STAR 13A motor is used
aft and fired at perigee (motor aligned with the orbit velocity
e 33.1 Kg of propellant (Isp = 286.5 sec) will place that
rrect 460 km X 10,000 km orbit. A single pallet containing the
; is then aligned against the velocity vector of the orbit at
Pegasus and released. The motor on the pallet is then fired
e orbit. The delta-V required for the maneuver is -144 m/s

in the previous example). In this case, we need slightly more
an can be accommodated by a STAR 6B motor. Instead, we assume
aded STAR 10 motor is used. The normal propellant loading for
.9 Kg while the fuel required for the circularization burn is 8 Kg. It
med that the dry pallet mass has now increased to 16 Kg in order to
additional stiffness for the added spacecraft plus motor mass and to
heavier motor casing. The mass remaining can then be divided
g the four micro-satellites (which are not so "micro") giving a mass
t of 33.25 Kg (73.3 lbm). The initial elliptical orbit has now been
t the perigee altitude of 460 km and the four small scientific
deployed from the pallet.

SPACECRAFT/PALLET INTERFACES

et and stack approach to launching multiple satellites on Pegasus has
been done, it is perhaps a bit early to be proposing specific
early, considerable mission analysis and mechanical and structural
eeds to be completed before a configuration could be finalized.
a few useful inputs are in order.

nterfaces

f the micro-satellites to the pallet should conform to some standard
or no other reason than to reduce costs and shorten integration
r mechanical attachment of the spacecraft to the pallets it is
:

S/C > 20 Kg Mass: Use Standard Delta/STS 9" Marmon Clamp.

S/C < 20 Kg Mass: Use Single Tie-Down Rod/
ssion Spring Separation System (See Above).

mp is a very reliable, secure separation system. One of two
t cutters will separate a single spacecraft. A 9" clampband will
200 Kg and is almost overkill for this application. Marmon clamps
micro-satellites consume considerable vertical height, which is in
ithin the Pegasus fairing. For this reason marmon assemblies are
missions requiring three pallets or less where more height per pallet
able.

e specific method proposed, using a tie-down rod or bolt, is an old but, well oven concept. It was originally used for Agena-launched secondary payloads ck in the early 1960's. The approach is simple, low cost and can be made very able by using two bolt cutters and a single tie-down rod.

ctrical Interfaces

ndards for electrical separation of the spacecraft are also important to review. inance devices using standard NASA initiators are strongly recommended. It roposed for both marmon separation systems and for the lighter weight tie-n rod system, a cutter/power cartridge like the Hi-Shear SL-1034/PC19-19, be d. For a typical mission, OSC would furnish the cutters and perform the hanical and electrical operations associated with mating the spacecraft to the ets.

rder to achieve compatibility between spacecraft and pallet electronics (for e complex missions requiring the pallet to fire kick motors and orient itself in e) significant electrical interfaces between the spacecraft and pallets will have volve. While it is too early to be specific, two general comments are offered :

1) Small spacecraft frequently benefit from having lower voltage power es. The mass of even smaller capacity battery cells becomes significant when volt bus is used. It is suggested that battery strings that produce voltages in ange from 10 to 14V would be best. If this can be agreed upon, then the t electronics can be designed for the same range.

2) Serial data interfaces should be used to communicate data to and from craft via umbilical lines or for data intended between pallet and spacecraft. ndard such as RS-422 or the multi-drop version of same, RS-485, should be ed.

MARY AND CONCLUSIONS

cal argument raised against deploying multiple satellites with a single ier is related to the risk of launch failure (the old problem of putting all of ggs in one basket). One must remember, however, that these are small both physically and fiscally). A rule-of-thumb which is sometimes used for missions is that the cost of the payload should not exceed the cost of the vehicle itself. Larger launchers like Ariane, however, carry payloads in excess of two times that of the launcher. If we apply this sort of rule to s, then the aggregate payload should not be valued at more than say $8M on one's willingness to take risk. This amount can, in fact, network of micro-satellites. Further, using the pallet concept, ; is possible so that the risk of failure taken on any one i by several groups.

: has been presented for users to share a Pegasus launch ely, use it to deploy a variety of different satellite networks. ots presented are not exhaustive and OSC would like to hear ow this idea can be expanded. Perhaps, most importantly, ıching secondary payloads provides flexibility that has never e to a "lightsater." It's also worth noting:

spacecraft is a primary payload.

ENTS

ers of the small satellite community for suggesting several of ed in this paper.

ors, Thiokol Inc., Aerospace Group, Elkton, MD, June, 1987

)esign Restraints, DAC 61687D, McDonnell Douglas Corp., CA, July, 1980 or latest Rev., pp 3-6 to 3-11.

iystem/Spacecraft Interface Control File, DCI/393 00, Issue ace, Evry, FR, November, 1989, p 4.19, p 6.04.1

COMMERCIAL CONTRACTS

Customer	Products/Services Provided
American Rocket Company	• Design, develop, integrate and operate guidance, control and avionics systems for first commercial launch vehicle from VAFB
National Research Council, Italy	• Construction of VLBA recorder
E'Prime Aerospace Corp	• Mission analysis for placing geosynchronous satellites into orbit • Calculate launch trajectories for new commercial rocket
Grumman Aircraft Corp	• Analysis of Neutral Particle Beam Design
Institute for Applied Geodesy, FRG	• Install VLBI Mark III system, interface antenna, and upgrade software • Construction of VLBA terminal
INTELSAT	• Study measuring antenna figure of merit using sun and moon • Test interference location concepts with satellite simulator
Martin Marietta	• Provided technical support for the Anti-Armor Weapon System • Performed a summary analysis of the Integrate Logistics Support Plan
Max Planck Institute for Radio Astronomy	• Construction of VLBA terminal
MCI - COMSAT	• Demonstrate satellite interference location system with operating satellites
National Radio Astronomy Observatory	• Diagnose problems with fiber optics IF signal transmission system
SED Systems, Inc	• Absolute gain determination for two BrazilSat earth station antennas
University of Manchester (Jodrell Bank)	• Construction of VLBA terminal

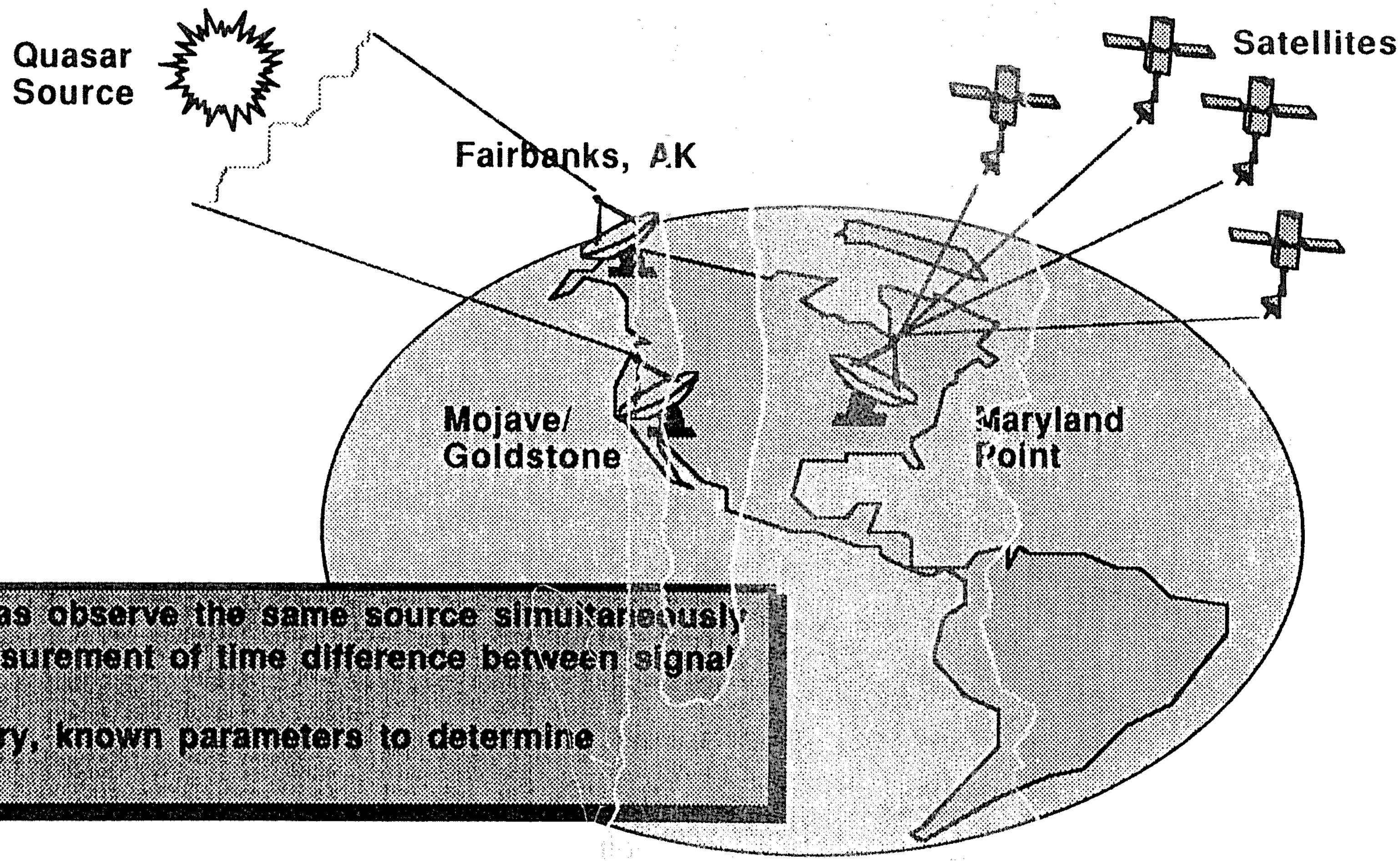
U.S. GOVERNMENT CONTRACTS

Customers	Products/Services Provided
Balanced Technology Initiative Office	•Technical Support for the Short Range Anti-tank Weapon Program
Bendix Field Engineering Corp	• VLBI and conventional interferometric tracking of NASA's TDRS
Computer Sciences Corp	• Systems Engineering & Analysis Support Services for the Advanced TDRS
DARPA	• SETA Support for Kinetic Energy Program
General Science Corp	• Support MODIS Data System development
Grumman Space Station	• Systems engineering and cost analysis • Communication & data management system analysis
Jet Propulsion Laboratory	• Port VLBI Mark III field system software to new computer • Construction of Mark III terminal • SBIR Phase 1 TOPEX Transponder Design
NASA/GSFC	• Crustal Dynamics Project VLBI support • CD-ROM development for data archiving • Design of satellite position measurement systems (SBIR Phases I and II)
Naval Research Laboratory	• Interferometric tracking of satellites & Optical Interferometry • Software development for NRL Solar Ultraviolet Spectral Irradiance Monitor • VLF propagation modeling analysis & experimental support • Ionospheric and HF/VHF Propagation modeling and analysis
TRW	• Data Systems design for EOS/DIS
United Technologies Corp	• Refine interferometric tracking concept for Strategic Defense applications • Evaluate millimeter wave interferometer for Neutral Particle Beam Experiment

CORE TECHNICAL PROGRAMS

- Very Long Baseline Interferometry (VLBI)
- Digital Signal Correlator
- High Density Digital Tape Recorder
- Holographic Antenna Calibration and Alignment
- Transmitter Location Service (TLS)
- Precision Satellite Tracking
- Eyesat Microsatellite

INTERFEROMETRY - WHAT IS IT?



- Two antennas observe the same source simultaneously
- Precise measurement of time difference between signal arrival times
- Use geometry, known parameters to determine unknowns

CRUSTAL DYNAMICS PROJECT OVERVIEW

Project Goal	Measure positions on the earth to a few mm precision Measure relative motion to a few mm/year Improve VLBI & SLR techniques to achieve goals
Global Motions	Confirm Tectonic Plate Theories
Regional Deformations	In California & Alaska record shifts due to earthquakes
R & D 1989 Program	Results - "Best Ever" Geodetic measurements 4 mm repeatability in height 2 mm repeatability in baseline length Approaching project goals
Precision	Level determined by the repeatability of measurements Typical as of 1988 3-5 cm in vertical 1 cm in baseline length for continental length baselines 1 mm/year in site motion

VERY LONG BASELINE ARRAY EQUIPMENT

Recorder Items Available

- Standard VLBA recorder for field use
- 220VAC conversion for European stations
- Playback version for correlators
- Conversion of Mark-III/IIIA
- Plug-in modules for upgrades to 2, 3, or 4 recording headstacks
- Extended warranty/service contract arrangements
- Technical consultation and planning services

Additional Hardware & Services

- Data Acquisition Rack in 8- or 14-BBC configuration
- Separate modules for DAR expansion
- VLBA station computer with customized version of NRAO software and special software
- Low-noise cryogenic receivers
- Delay calibrators
- Antenna holography correlator and analysis software
- Antenna and other equipment interfacing
- Coordination of observatory activities, operator training, technical support

APPENDIX D

BUSINESS PLAN SUMMARY

ASSUMPTIONS

Users	200,000	
nutes/user/month	74.00	
nutes/User/day	3.08	(@ days/month 24)
Call /day	2	
peak-calls/hour/day	0.04	(Peak/Non-Pk ratio 50%)
ll Duration in hours	0.06	
langs/User	0.00268	
langs in System	535	
Effective Satellites	2.8	
lang Requirements/Sat.	191.18	
CDMA carriers/Sat.	200	(Efficiency 96%)
ower Req./Sat. (in Watts)	170	(Avg. Watt/Carrier 0.85)
RP/Sat (dBW)	22.31	
ser expenditures($/month)	37	(Price/Minute 0.5)
AP Usage Revenue ($M/year)	89	
ubscription Fees ($M/year)	48	(Monthly Subs. Fee $20)
on Peak Revenues ($M/year)	13	(Non-Peak Ratio 15%)
Total VAP Revenues ($M/yr)	150	
LLIPSO RDSS Revenues ($M)	22	(@ $30/month/user, end-user)
LLIPSO Voice Revenues ($M)	117	(Wholesale Margin 22%)
Total ELLIPSO Revenues($M)	139	(at constellation maturity)

FINANCIAL SUMMARY
(in 1990 $1000s)

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Use of Funds										
Pre-Ops Exps	100	300	500	100						
R$D	50	250	2000	3000	200	100	100	100	100	100
Sat Construction	0	0	7200	0	54000	18000	0	0	0	0
Sat Launch	0	0	2000	0	12000	4000	0	0	0	0
Insurance	0	0	736	0	7920	2640	0	0	0	0
TIFs R$D	0	50	1000	800	0	0	0	0	0	0
TIFs Deployment	0	0	650	2000	2000	2000	0	0	0	0
PIFs R$D	0	0	0	1000	0	0	0	0	0	0
UNICELLs/SKYCELLs	0	0	500	500	750	3000	4000	4000	4000	4000
Operations			600	3000	4000	4000	6000	6000	6000	6000
	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Total Uses	150	600	15186	10400	80870	33740	10100	10100	10100	10100
Source of Funds										
Capacity Options	1000	3000	6000	6000	2000	1000	1000	1000	1000	1000
Capacity Sold	0	0	1766	5886	17657	47084	70626	117710	117710	117710
RDSS Services	0	0	1080	5760	11520	16200	19440	21600	23040	24480
Financing					46000					
	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Total Sources	1000	3000	8846	17646	77177	64284	91066	140310	141750	143190
Net Cash Flow	850	2400	-6340	7246	-3693	30544	80966	130210	131650	133090
Cumulative CF	850	3250	-3090	4155	462	31006	111972	242182	373832	506922
Cum. CF Net of Ops	850	3250	746	8655	25132	44646	121972	252182	383832	516922
Acc. Depreciation	0	0	1604	1961	13154	17469	18040	18611	19183	19754
Options Executed			4000	6000	6000	2000	1000	1000	1000	1000

<------------------- ELLIPSO I ------------------>

ASSUMPTIONS

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
No Satellites	0	0	6	0	18	6				
Satellite Costs	1200	1200	1200	3000	3000	3000	3000	3000	3000	3000
Launch Cost/Sat	333	333	333	667	667	667	667	667	667	667
Insurance Costs	8%	8%	8%	12%	12%	12%	12%	12%	12%	12%
GCS/TIF R&D		50	1200	800						
GCS/TIF Const.			650	2000	2000	2000				
PIFs R&D				1000						
UNICELLs/SKYCELLs				250	750	3000	4000	4000	4000	4000
No Users RDSS	0	0	3,000	16,000	32,000	45,000	54,000	60,000	64,000	68,000
No Users Voice	0	0	3,000	10,000	30,000	80,000	120,000	200,000	200,000	200,000

APPENDIX E

VENTURE FIRST ASSOCIATES

October 26, 1990

Ellipsat Corporation
2420 K Street NW
Washington, DC 20037

Gentlemen:

It is our understanding that Ellipsat Corporation will be filing an application for authorization to construct and operate a domestic communications satellite system with the Federal Communications Commission. We further understand that the FCC requires satellite applicants to demonstrate financial qualifications, among other criteria.

Venture First Associates is the Southeast's largest high technology early stage venture capital firm. We wish to advise you that, should Ellipsat obtain authorization for the proposed satellite system, we believe that, if properly structured, a financing package in an amount sufficient to construct and operate Ellipsat's proposed satellite system could be successfully arranged.

Sincerely,

W. Andrew Grubbs

W. Andrew Grubbs
General Partner

12408 BUTTERNUT CIRCLE
KNOXVILLE, TN 37922
(615) 966-4397

1400 LAKE HEARN SUITE 205
ATLANTA, GA 30319
(404) 843-5545 FAX (404) 843-5543

5408 PURLINGTON WAY
BALTIMORE, MD 21212
(301) 323-6900 FAX (301) 323-6901

ITR Group, Inc.

October 26, 1990

Ellipsat Corporation
2420 K Street, N.W.
Washington, DC 20037

Gentlemen:

It is our understanding that Ellipsat Corporation will be filing an application for authorization to construct and operate a domestic mobile communications satellite system with the Federal Communications Commission. We further understand that the FCC requires satellite applicants to demonstrate financial qualifications, among other criteria.

The ITR Group, Inc. is engaged in mergers, acquisitions and investments primarily in the communications industry. We wish to advice you that should Ellipsat obtain authorization for the proposed satellite system, we believe that, if properly structured, a financing package in the order of magnitude of $50,000,000 could be successfully arranged.

Very truly yours,

Neel H. Howard, Jr.
Chairman

4641 Montgomery Avenue, Suite 300 • Bethesda, Maryland 20814
(301) 951-1022 • FAX: (301) 654-5231

ELLIPSAT CORPORATION

Current
Balance Sheet

Assets	20,000
Liabilities	0
Stockholders Equity	20,000

Operating Statement

(Operations have just commenced.)

APPENDIX F

INTERFEROMETRICS INC.

CORPORATE CAPABILITIES

COMPANY PROFILE

Founded: 1982

Purpose: Provide a company environment where leading scientists and engineers could be free to develop new technologies unencumbered by the pressure to achieve short-term profits.

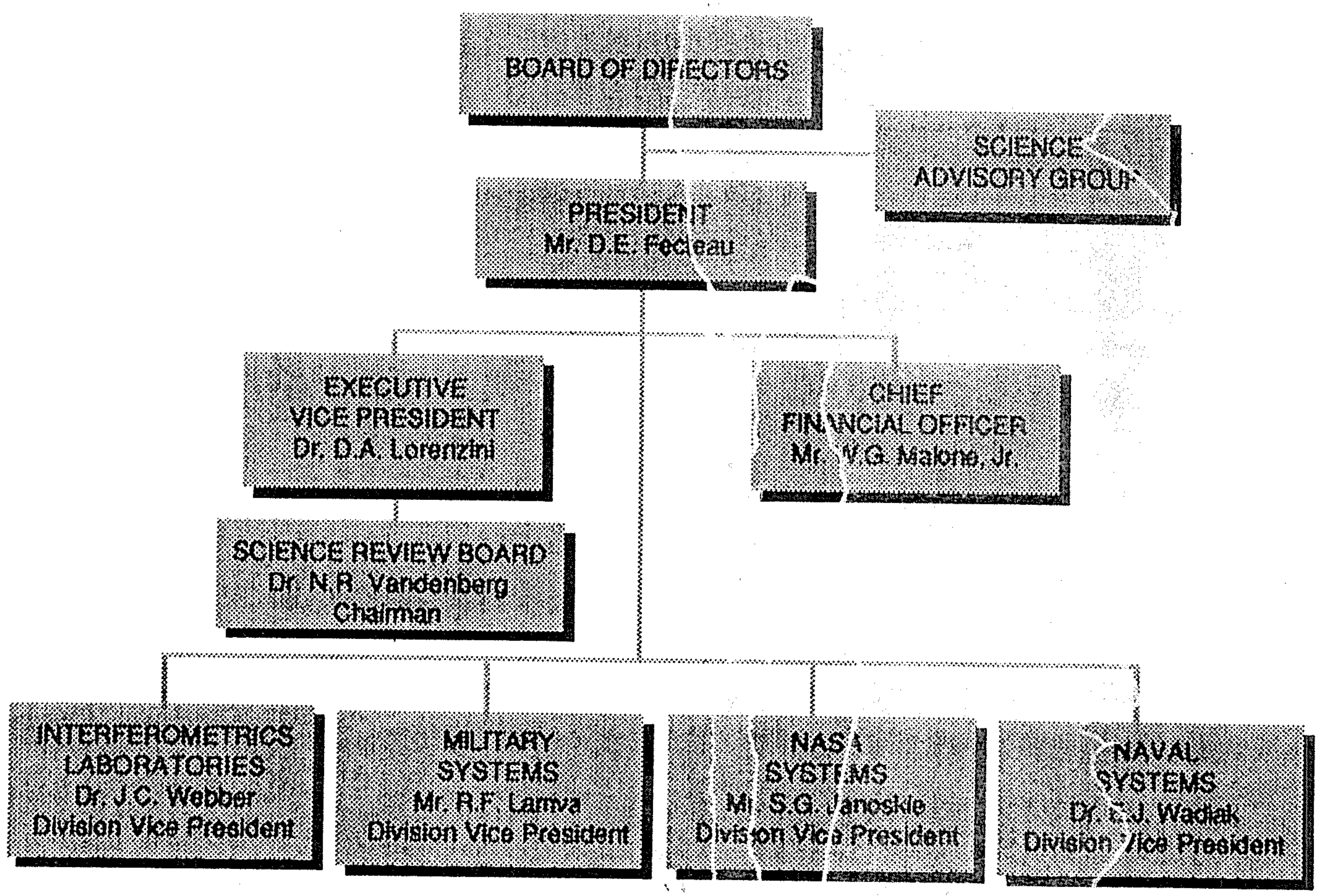
Structure: Four Divisions

- NASA Systems
- Naval Systems
- Military Systems
- Interferometrics Laboratories

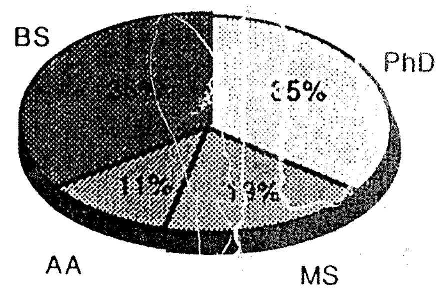
Size: $7.0 Million Annual Revenue (1990)
85 Employees

Disciplines: Radio Astronomy
Applied Physics
Interferometry

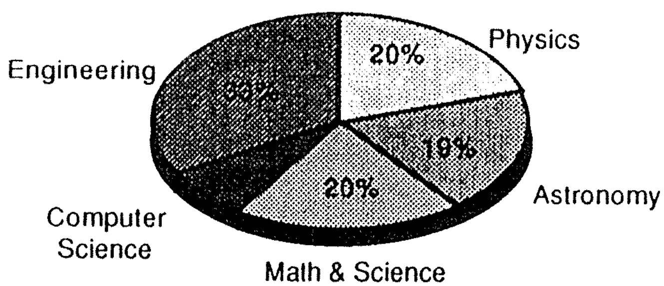
ORGANIZATION



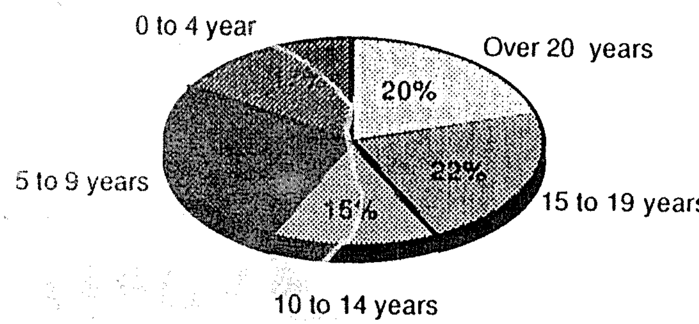
PROFESSIONAL STAFF



DEGREES



ACADEMIC FIELDS

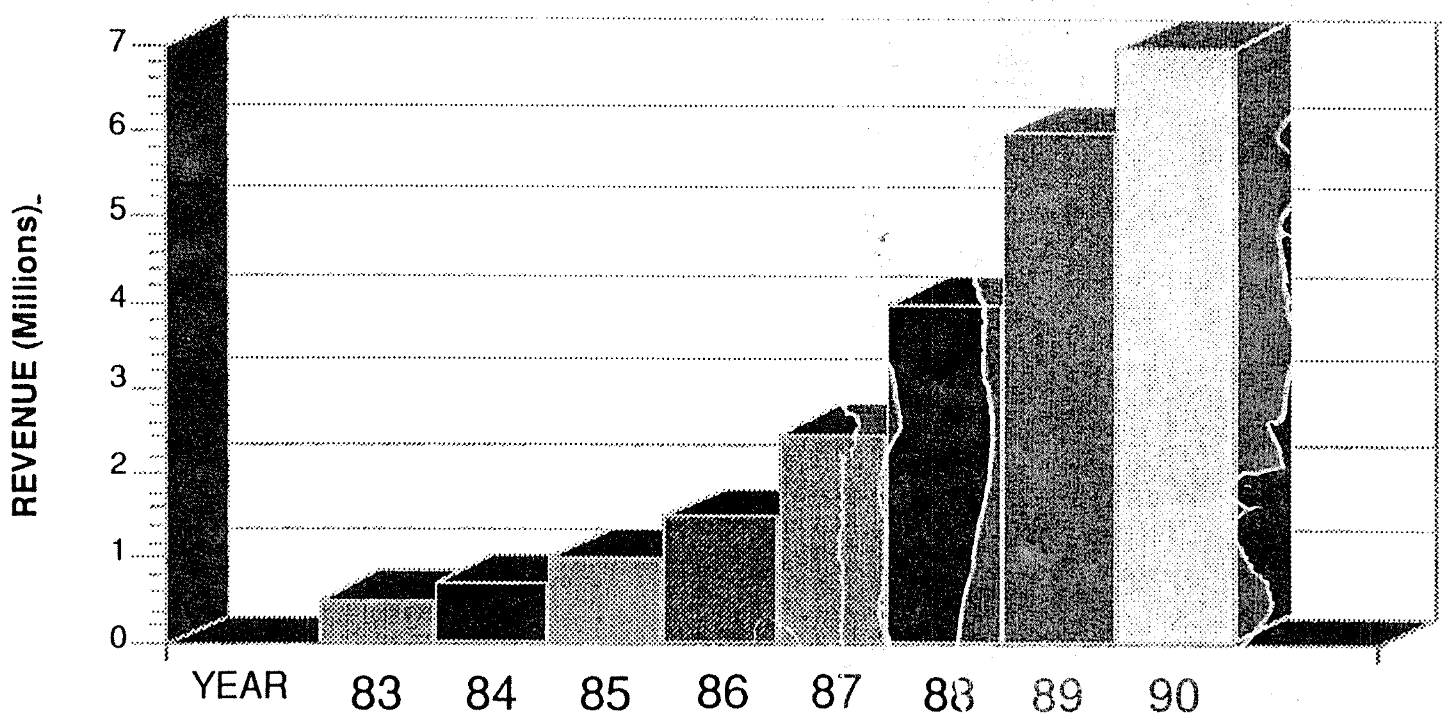


EXPERIENCE

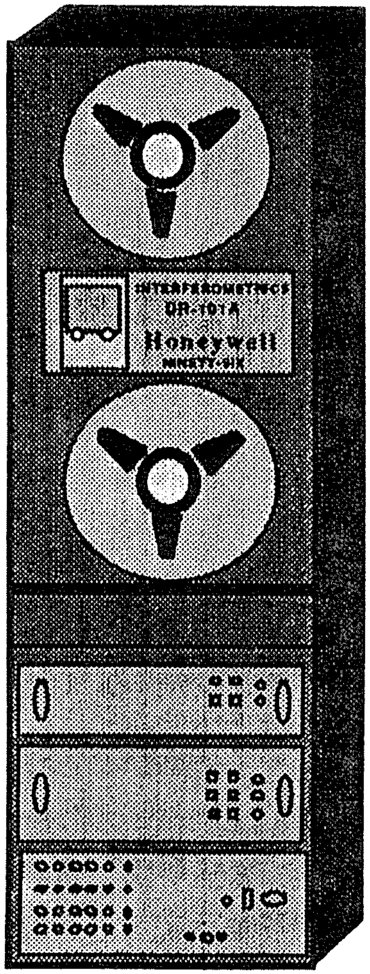
CORPORATE STRATEGY

- Build upon recognized scientific expertise
- Continue to acquire and challenge the best professional people
- Promote positive reputation in the engineering, scientific and business communities
- Establish mutually supportive business relationships in space and defense activities
- Seek controlled growth to generate expanding opportunities
- Bring our unique technical strengths to the international community

CORPORATE GROWTH



HIGH DENSITY DIGITAL TAPE RECORDER



Features

- Up to 1 Terabyte of data on one 16" reel
- 1 inch video or D1-type tape
- Area bit density: 27 Mbit/square inch
- 36 tracks per headstack
- Record rate: 315 Mbit/sec unformattted
- Modular expansion to 1300 Mbit/sec
- Selectable playback rates down to 4 Mbit/sec

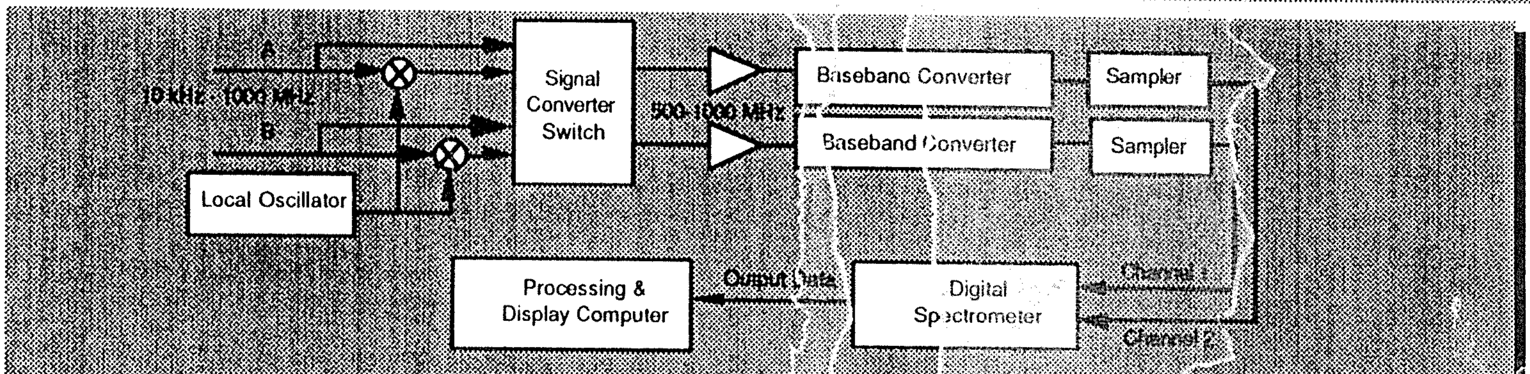
Applications

- Wide bandwidth recording
- Data archiving
- Scientific data storage & retrieval
- Tape consolidation

Customers

- Institute for Applied Geodesy (Frankfurt, Germany)
- Max-Planck Institute for Radio Astronomy (Bonn, Germany)
- University of Manchester (Jodrell Bank, England)
- National Research Council (Bologna, Italy)
- Helsinki University of Technology (Finland)
- National Geodetic Survey (Maryland, USA)

DIGITAL SIGNAL CORRELATOR

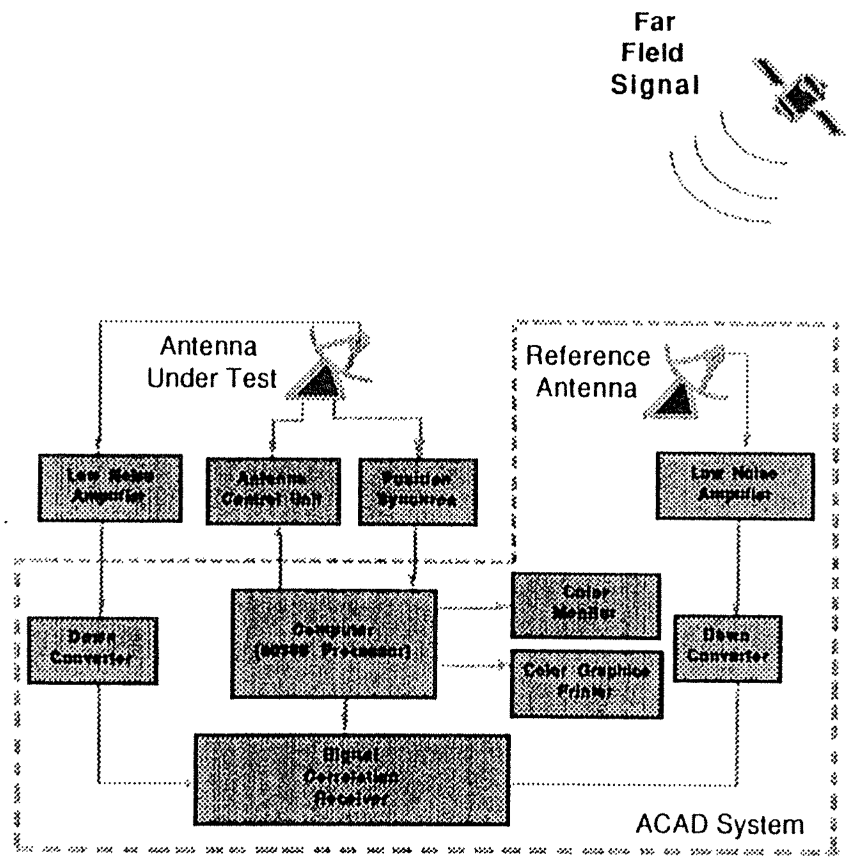


BLOCK DIAGRAM OF DIGITAL SIGNAL PROCESSOR

Features

- Multi Channel Digital Spectrometer
- Cross-Spectral Signal Analysis
- High Signal-to-Noise Ratio
- Wide Bandwidth (Several Hundred MHz)
- Extracts All Information In Signal
- VME Controller
- 1024 Correlation Channels

HOLOGRAPHIC ANTENNA CALIBRATION



ACAD S-3 System Block Diagram

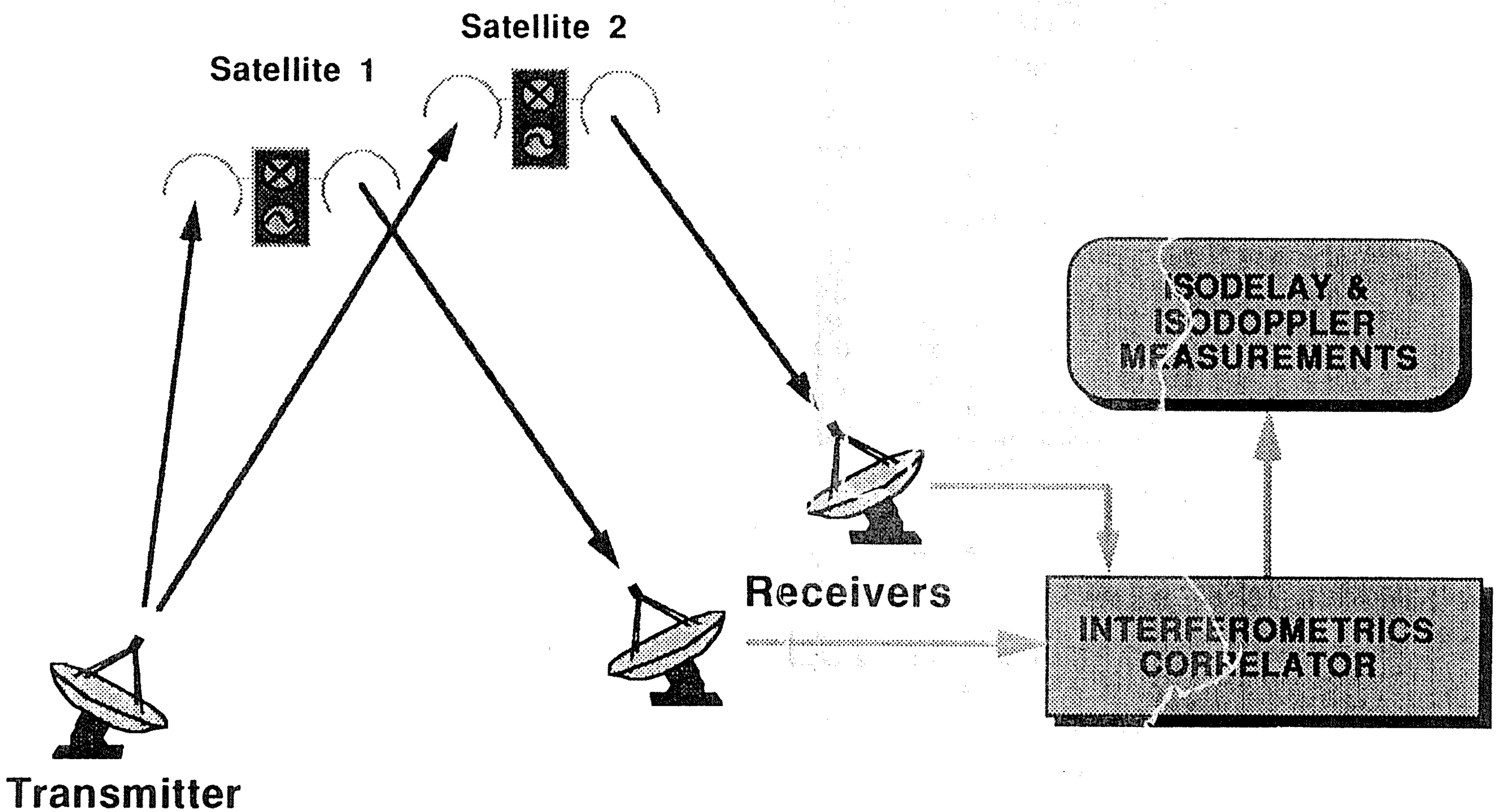
Applications

- Antenna Calibration and Alignment
- Problem Indentification and Analysis
- Panel, Strut and Feed Adjustment
- Performance Verification

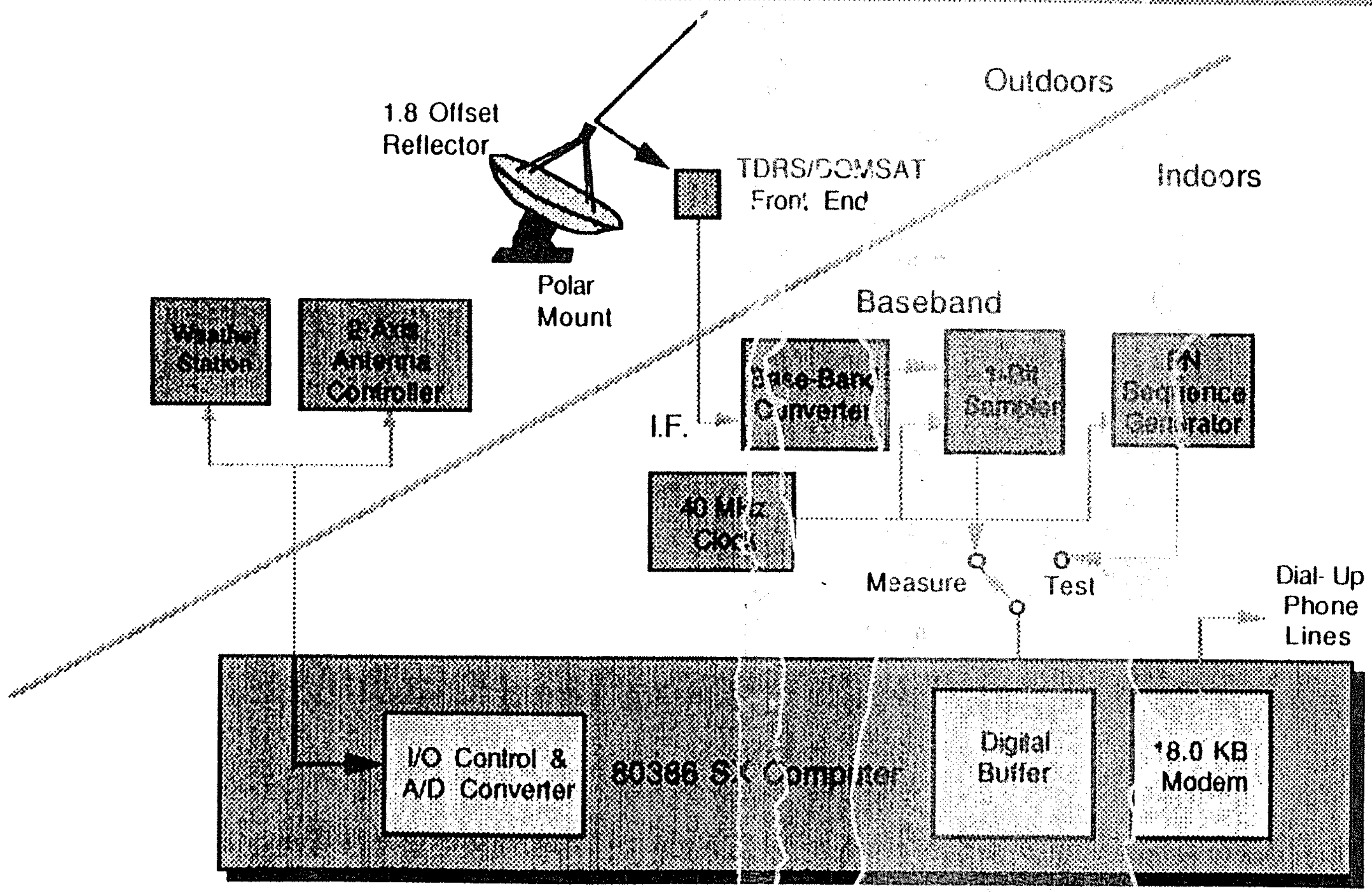
Features

- **Rapid** – Typical measurements take only a few hours.
- **Accurate** – Measures RF pattern, not the mechanical surface.
- **Comprehensive** – High resolution maps and computer diagnostics.

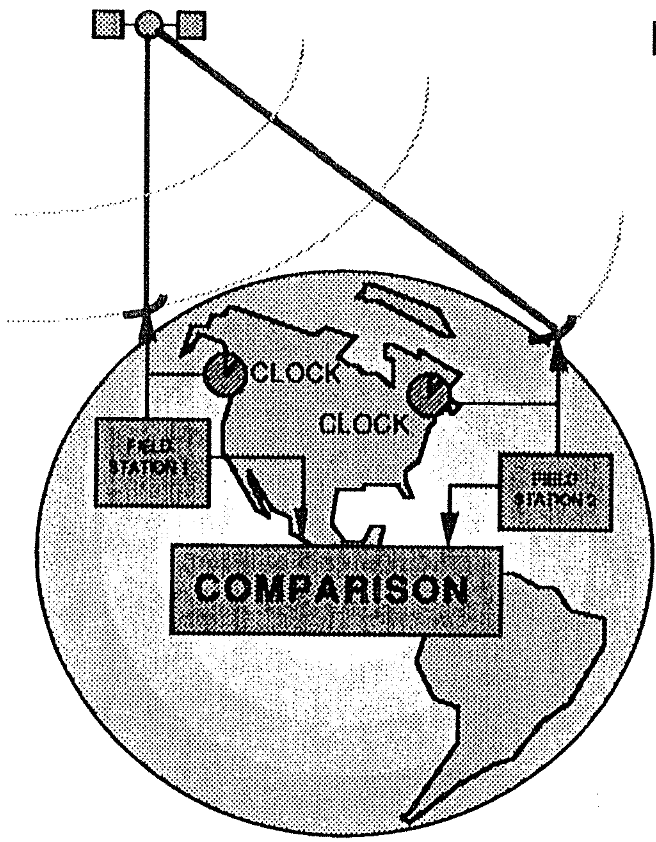
TRANSMITTER LOCATION SERVICE (TLS)



PRECISION SATELLITE TRACKING



SATELLITE TRACKING INTERFEROMETER

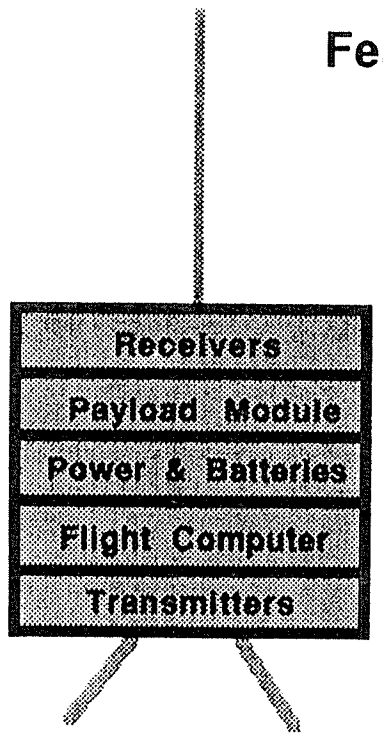


Features

- System Cross-Correlates Signals Received at Stations 1 and 2 to Determine Extra Transit Distance to Within 0.01 Wavelengths
  - These Measurements Yield Satellite Orbit
- Techniques for Reducing Error Sources are Well Established
  - Mechanical and Atmospheric Delays
  - Clock Synchronization
- Low Altitude Satellites Can Be Tracked in 3 Dimensions

EYESAT MICROSATELLITE

EYESAT is a compact (21 lbs, 9 inch cube) highly efficient satellite that embodies significant advances in low-cost engineering. Configured in a modular (expandable) stack arrangement, EYESAT can support a variety of missions, from store-and-forward communications to specialized scientific applications.



Features

- Low cost design uses "off-the-shelf" standards.
- Spacecraft Local Area Network minimizes wiring harnesses.
- Maximizes use of Computer Aided Design for efficiency and low cost.
- Modular Design allows simple growth, low-cost fabrication, and a variety of payloads.
- Alternative configurations, stabilization methods, and missions are possible.
- CPU controls spacecraft. Uploadable onboard commands modify mission data.

Applications

- Store-and-Forward Communications
- Earth Imaging
- Remote Data Relay
- Scientific Payloads

NEW PRODUCT DEVELOPMENTS

- Optical Interferometer
- Precision Transponder for Satellite Altimeter
- Phase Stable Fiber Optics
- Speech Recognition Technology
- Advanced Cryogenic Detectors

OPTICAL INTERFEROMETER

Technology

- Laser Metrology
  - 10 nm Position Measurement
  - 8 m/s Velocity
- Atmospheric Seeing Sensor
  - Portable, Automated, Economical
- Image Processing and Analysis
  - Image Reconstruction, Deblurring & Enhancement
  - Interferometer Performance Modeling

Applications

- Ultra High Resolution Imaging
  - Ground-Based Systems
  - Space-Based Systems
- European Southern Observatory Very Large Telescope Project
  - Interferometer Capability Being Planned
- Optical Telescope Holography
  - Determine Mirror Deformation
  - Optimize Large Mirror Mount Adjustments in the Field

PRECISION TRANSPONDER FOR SATELLITE ALTIMETER

- 1991 or 1992 Launch

- Altitude 1334 km

  Roundtrip travel time = 8.9 msec to nadir

- Precise Ocean Heights and Wave Heights

  Relative altitude 1-2 cm (few parts in 10^9)
  Define Ocean currents

- Chirped Radar at Ku- and C-Bands

  Chirp: 320 MHz linear sweep in 102.4 microsec
  Interpulse of 112.4 microsec
  40 pulses = 8.6 msec

- Needs Ground Truth

  Absolute height calibration to about 1-2 cm
  To be provided by our transponder

PHASE STABLE FIBER OPTICS

Features

- Precise Distribution of Phase/Time Information Over Long Distances
- High Reliability Unattended Operation

Applications

- Phased Array Transmitter Phase Control
- Connected Element Interferometry
- Reference Time Distribution

SPEECH RECOGNITION TECHNOLOGY

Features

- Silicon Micro-Machined Acoustic Resonance Devices
- Large Scale Arrays of Acoustic Resonators
- Real Time Processing of Acoustic Signals

Applications

- Real Time Speech Recognition
- Implantable Pressure, Temperature, Density, & Viscosity Sensors
- Voice-Activated Appliances & Devices
- Acoustic Computer Input

ADVANCED CRYOGENIC DETECTORS

Features

Flexibility
- Visible, UV, X-Ray, Gamma Ray, or Energetic Particles

High Quantum Efficiency

High Energy Resolution ($dE/E < 1\%$)

Extreme Radiation Hardness

Applications

Photon and Particle Detectors for Astronomy

Biomedical Detectors for Positron Emission Tomography and Immunoassay

Spatial Light Modulators for Optical Computing

INTERFEROMETRICS EUROPEAN OBJECTIVES

- Establish a Strategic Alliance With a Compatible European Partner.
- Position Interferometrics to Sell Its Products and Services to the European Common Market.
- Establish a Base of Operations to Service European Customers.
- Create New Business Opportunities in Europe
- Participate in Joint Ventures for New Product Development.

CORPORATE EXPERIENCE

SCIENCE:	Crustal Dynamics Very Long Baseline Interferometry Optical Interferometry Radio Astronomy and Cosmology
ENGINEERING:	Antenna Holographic Calibration System High Speed Digital Tape Recorder Millimeter Atmospheric Sounder Instrument Kinetic Energy and Penetration Physics Satellite Instrument Integration and Test Support
SYSTEMS:	Interferometric Satellite Tracking System Satellite Interference Location System Communications Satellite and Ground Station Fiber Optic Reference Phase System Design Solar Instrument Flight Controller Software

APPENDIX G

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:

Ellipsat Corporation
2420 K Street, N.W.
Washington, D.C. 20037

2. (Area Code) Telephone Number:

(202) 337-2493

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

N/A

4. Filer is (check one):

☐ Individual ☐ Partnership ☒ Corporation

☐ Other (Specify):

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

District of Columbia

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

Ellipsat is filing currently, herewith, an application for a new domestic satellite system.

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

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 Exhibit VI

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

See 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 fo the president and directors of the controlling corporation.

See Exhibit VIII

(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

(f) 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: Nov. 2, 1990	Filer *(Must correspond with that shown in item 1)*: Ellipsat Corporation	Typed or Printed Name: David Castiel
	Signature: [signature]		Title: Chief Executive Officer

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.

Ellipsat Corporation
FCC Form 430
Question 10(a)

EXHIBIT VI

Listed below are the names, addresses, citizenship of, and percentage of stock held by, those stockholders owning of record and/or voting 10 percent or more of Ellipsat Corporation's voting stock.

Name and Address	Percentage of Stock Held	Citizenship
Mobile Communications Holdings, Inc. 2420 K Street, N.W. Washington, D.C. 20037	80 percent	United States
Interferometrics, Inc. 8150 Leesburg Pike Suite 1400 Vienna, Virginia 22182	20 percent	United States

Ellipsat Corporation
FCC Form 430
Question 10(b)

EXHIBIT VII

The officers and directors of Ellipsat Corporation are as follows.

Board of Directors

David Castiel 2420 K Street, N.W. Washington, D.C. 20037	Chairman and Treasurer
Michael Stone, Esq. 1818 N Street, N.W. Washington, D.C. 20036	Secretary
Dino A. Lorenzini 8150 Leesburg Pike Suite 1400 Vienna, VA 22182	

Officers

David Castiel 2520 K Street, N.W. Washington, D.C. 20037	Chief Executive Officer
Robert G. Perry 2420 K Street, N.W. Washington, D.C. 20037	President and Chief Operating Officer

Ellipsat Corporation
FCC Form 430
Question 10(c)

EXHIBIT VIII

Mobile Communications Holdings, Inc. (MCHI) owns 80 percent of Ellipsat Corporation. MCHI is, in turn, wholly owned by David Castiel, 2420 K Street, NW, Washington, D.C. 20037. Mr. Castiel, a United States citizen is the President and Director of MCHI. The other Director of MCHI is Michael Stone, Esquire, 1818 N Street, NW, Washington, D.C. 20036. MCHI is involved in the acquisition and development of high technology ventures related to the communications industry.

The following is a brief resume of key principals of Ellipsat Corporation.

Dr. David Castiel is President of Mobile Communications Holdings Inc., a principal stockholder of Ellipsat Corporation. He is a Director and President of Ellipsat Corporation. Dr. Castiel has broad experience in the information and communications industries. Before founding MCHI, Dr. Castiel was Vice President of Marketing and Business Development at American Mobile Satellite Corporation (AMSC). Dr. Castiel oversaw the development of AMSC's business strategy, including the definition of the basic product features, the initial development of value added products and the establishment of a pricing and marketing strategy. Dr. Castiel also created the initial AMSC sales force and brought several agreements with major partners, in automotive and trucking services. Prior to AMSC, Dr. Castiel was Director of Marketing for Satcom at Hughes Network Systems, a subsidiary of Hughes Aircraft Corporation. At HNS, he oversaw the development of the Mobile Satellite Services strategy that culminated in contracts for the two MSS data services in North America, the Canadian Telesat Mobile Inc. and AMSC. Dr. Castiel also oversaw at HNS the design of the Ford Motor Company X.25 packet network.

Prior to these endeavors, Dr. Castiel consulted in telecommunications for Booz, Allen and Hamilton and held Network Product Management and Applications Engineering positions at General Electric Information Services Company (GEISCO). At GEISCO, he developed the Yamaha Order Entry and Inventory Control System. He was a post-doctoral research fellow at the University of California at Irvine where he conducted research in Surface Solid State Physics. He received his Doctorate in Theoretical Solid State Physics, with High Distinction, and his graduate business degree form the University of Paris, France. He attended McGill University for an MS program in Solid State Physics and received his BS in Physics from the University of Montreal. He has published numerous scientific, technical and business papers, and is a regular speaker at various industry events.

Dr. Dino Lorenzini is Executive Vice President at Interferometrics Inc. His present responsibilities include the management and direction of all technical activities within the company. These operations include the production of Ultra High Bandwidth Digital Tape Recorders, development of high speed digital calculators, a precision satellite tracking system and a potential transmitter location system. He is also responsible for the implementation and manufacture of the unique Eyesat-class maritime satellite system, originally developed by the Radio Antenna Satellite Corp. He has extensive experience in the design of satellite systems and components. As a chief architect of the SDI space-based system, Dr. Lorenzini directed many of the initial concepts and analyses for understanding multiple low earth orbit satellite constellations. Dr. Lorenzini holds a PhD in Astronautical Engineering from the Massachusetts Institute of Technology and an MBA in Business and Management from Auburn University. His 28 year career includes assignments as the Director of Integration of the NAVSTAR Global Positioning System, Director of the SCI Pilot Architect Study, and Vice President and General Manager of the Washington Operations Division of SRS Technologies.

Dr. Lorenzini serves as a Director of Ellipsat Corp. and will be responsible for the Space and Satellite Control Segment of the ELLIPSO® system.

Robert G. Perry is the Chief Operating Officer of Ellipsat. Mr. Perry's professional experience includes twenty years with AT&T where he held a variety of executive positions beginning with line and staff responsibilities in the sales, operations, and marketing areas. Mr. Perry also held executive positions in the public affairs and corporate planning departments. In this capacity Mr. Perry had extensive contact with members of Congress and senior agency officials to develop corporate public and government relations strategies.

Mr. Perry's expertise and talents were sought by The White House as he was appointed to The President's Executive Exchange Program as a one year executive participant. Responsibilities in this position included assisting the Departments of Agriculture, State and Treasury in strategic assessment of U.S. economic involvement in the Caribbean Basin and Middle East.

Additionally, Mr. Perry has served on numerous educational boards and councils including current positions on the Board of Trustees of The George Washington University, Washington, D.C., and the Board of Trustees of Fork Union Military Academy, Fork Union, Virginia. In the past, he has held positions on the Council of Education for Kansas City, Missouri, and the Management Task Force for the Washington, D.C. public school system. He has chaired both the Fork Union Annual Fund Program and The George Washington University Annual Fund Drive utilizing his marketing and financial development expertise. He was the annual fund chairman for a $75,000,000 comprehensive campaign for The George Washington University.

As President of Complete Communications Inc., a Washington, D.C. Public Affairs, Marketing, Public Relations firm, Mr. Perry has created business opportunities that involve multinational high technology corporations, such as

Xerox, as well as The White House, The Department of State, and several organizations that require a full range of local, state and Federal government services.

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

In re Application of ELLIPSAT CORPORATION For Authority to Construct the Fourth of Six Elliptical Orbit Satellites Comprising the ELLIPSO® I System	))))))))	File No.

APPLICATION

Ellipsat Corporation ("Ellipsat" or "Applicant") hereby applies for authority to construct the fourth of six elliptical orbit satellites comprising the ELLIPSO® I System.

I.

PURPOSE OF APPLICATION

A. Authorization Requested

Ellipsat requests authority to construct the fourth of six ELLIPSO® I elliptical orbit satellites. The satellites will operate in the 1610-1626.5 MHz (uplink) and 2483.5-2500 MHz (downlink) bands, in an inclined orbit providing continuous coverage of the United States. The satellites are identical and will be launched simultaneously. This application covers all pertinent technical and operational information for authority to construct the fourth of the six satellites.[1] Separate applications for the five additional satellites are being filed concurrently herewith.

B. Summary of Proposed Service

The applicant will provide radiodetermination satellite service and ancillary cellular services. Service will be provided to the continental United States, territories and domestic offshore points where service is desired. Applicant will offer capacity on a private carrier or private shared network basis to value added partners.

C. Applicant Information

The applicant's name and address is:

Ellipsat Corporation
2420 K Street , NW
Washington, DC 20037

Correspondence and communications concerning the application should be addressed to:

Mr. Robert Perry
Ellipsat Corporation
2420 K Street, NW
Washington, DC 20037
(202) 337-2493

and/or directed to applicant's attorney:

---

1 Detailed information about the satellites is provided in the comprehensive proposal for the entire system submitted with this application. Information in the system proposal is incorporated by this reference.

Jill Abeshouse Stern, Esquire
Miller & Holbrooke
1225 19th Street, N.W.
Washington, D.C. 20036
(202) 785-0600

II.

TECHNICAL INFORMATION

Technical information about the satellites is provided in Exhibit I attached hereto.

It is anticipated that construction of the six satellites will be commenced by November 1991, construction completed by May 1993, the spacecraft launched by September 1993, and commercial service offered by October 1993.

III.

WAIVERS AND CERTIFICATIONS

Pursuant to Section 304 of the Communications act of 1934, as amended, Ellipsat hereby waives any claim to the use of any particular frequency or of the ether against the regulatory power of the United States because of the previous use of the same, whether by license or otherwise.

The applicant's submission reflects a serious and conscientious effort to answer all of the Commission's filing requirements as fully and completely as presently possible. While the applicant believes that it has fully complied with all pertinent Commission rules and policies, and has supplied all the information, as appropriate, requested by Appendix B of Space Station Application Filing Procedures, it hereby requests that, to the extent it has not satisfied the applicable requirements, a waiver be granted.

The applicant certifies that all of the statements made in this application are true, complete and accurate to the best of its belief and knowledge, and are made in good faith.

IV.

CONCLUSION

Wherefore, Ellipsat Corporation requests that the Commission grant its application for authority to construct the fourth of six elliptical orbit satellites comprising ELLIPSO® I.

Respectfully submitted,

ELLIPSAT CORPORATION

By: ______________________
Dr. David Castiel
Chairman and Chief
Executive Officer

Of Counsel:

Jill Abeshouse Stern
Miller & Holbrooke
1225 19th Street, N.W.
Suite 400
Washington, D.C.

November 2, 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, that I am familiar with Part 25 of the Commission's Rules and Regulations, that I have either prepared or reviewed the engineering information submitted in this application, and that it is complete and accurate to the best of my knowledge.

By: [signature]
Dr. Dino A. Lorenzini
Executive Vice President
Interferometric, Inc.

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

In re Application of	)	
	)	
ELLIPSAT CORPORATION	)	
	)	File No.
For Authority to Construct the Fifth of Six Elliptical Orbit Satellites Comprising the ELLIPSO® I System	)	

APPLICATION

Ellipsat Corporation ("Ellipsat" or "Applicant") hereby applies for authority to construct the fifth of six elliptical orbit satellites comprising the ELLIPSO® I System.

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PURPOSE OF APPLICATION

A. Authorization Requested

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[1] Detailed information about the satellites is provided in the comprehensive proposal for the entire system submitted with this application. Information in the system proposal is incorporated by this reference.

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B. Summary of Proposed Service

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Washington, DC 20037
(202) 337-2493

and/or directed to applicant's attorney:

Jill Abeshouse Stern, Esquire
Miller & Holbrooke
1225 19th Street, N.W.
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The applicant's submission reflects a serious and conscientious effort to answer all of the Commission's filing requirements as fully and completely as presently possible. While the applicant believes that it has fully complied with all pertinent Commission rules and policies, and has supplied all the information, as appropriate, requested by Appendix B of Space Station Application Filing Procedures, it hereby requests that, to the extent it has not satisfied the applicable requirements, a waiver be granted.

The applicant certifies that all of the statements made in this application are true, complete and accurate to the best of its belief and knowledge, and are made in good faith.

IV.

CONCLUSION

Wherefore, Ellipsat Corporation requests that the Commission grant its application for authority to construct the fifth of six elliptical orbit satellites comprising ELLIPSO® I.

Respectfully submitted,

ELLIPSAT CORPORATION

By: ______________________
Dr. David Castiel
Chairman and Chief
Executive Officer

Of Counsel:

Jill Abeshouse Stern
Miller & Holbrooke
1225 19th Street, N.W.
Suite 400
Washington, D.C.

November 2, 1990

EXHIBIT I

EXHIBIT I
TECHNICAL INFORMATION

A. Radio Frequency and Polarization Plan

Center of Frequency and Polarization:	Uplink 1618/MHz, Linear, Cross-Polarized Downlink 2492/MHz, Circular
Emission Designator or Allocated Bandwidth of Emission:	16MHz at 1610/MHz 16MHz at 2500/MHz
Power Amplifier Output Power per Satellite:	14dBW
Antenna Beams:	Single
Receiving System Noise Temperature:	-24dB/K @ 1610 -24dB/K @ 2500
Gain of Each Transponder Channel:	15dB

B. Orbital Locations: Low Earth Inclined Orbits, 63.5 degrees

Apogee at 1250 km in Northern Hemisphere

Perigee at 500 km

C. Elliptical Orbit: 500 km x 1250 km

Eccentricity: .0517

Semi-major axis:	7253 km
Period:	102.5 minutes
Area of Coverage:	3472 miles or 5,555 km @ 5°
	2778 miles or 4,444 km @ 10°

D. Predicted Space Station

Coverage Contours: See Figure A

1. Receiving Antenna Gain	12dBic
2 Transmitting Antenna Gain	12dBic
3. Receiving System sensitivity (G/T)	-24dB/K
4. Saturation Power Flux Density	$-256 dBW/m^2/4 KHz$
5. EIRP	12dBW
6. Functional Block diagram:	See Figure B

E. Physical Characteristics of Space Station

1. Accuracy with Orbital Parameters will be Maintained

   +/- 5 degree In-Plane

   +/- 2 degree Out-Of-Plane

2. Accuracy of Antenna Pointing toward the Earth

   Multiple frequency quadrifilar antenna

3. Estimated Life of Satellite In-Orbit: 3 years

4. Spacecraft Attitude Stabilization Systems

Gravity Gradient/with 3-axis-Magnetic Stabilization

5. Electrical Energy System Description

- Primary and Secondary Power Systems
- 2 solar array panels
- Combined Output 120 Watts
- NiCad batteries for eclipse operation and to increase transmitter power over the service area
- Power Control through computer-controlled Battery Control Regulation Module

F. Emission Limitations

ELLIPSO® uses CDMA, spread spectrum techniques across all ten channels of the requested frequency bandwidth. Therefore the level of spurious emissions will be negligible. ELLIPSO® will also minimize any anomalies that might occur in the operation of its system

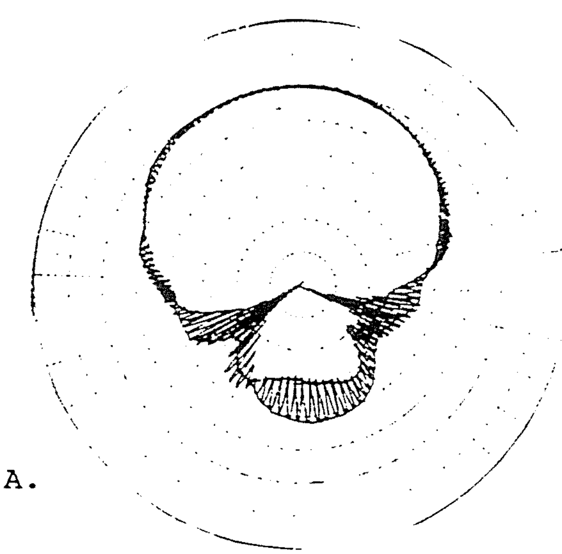

Figure A.

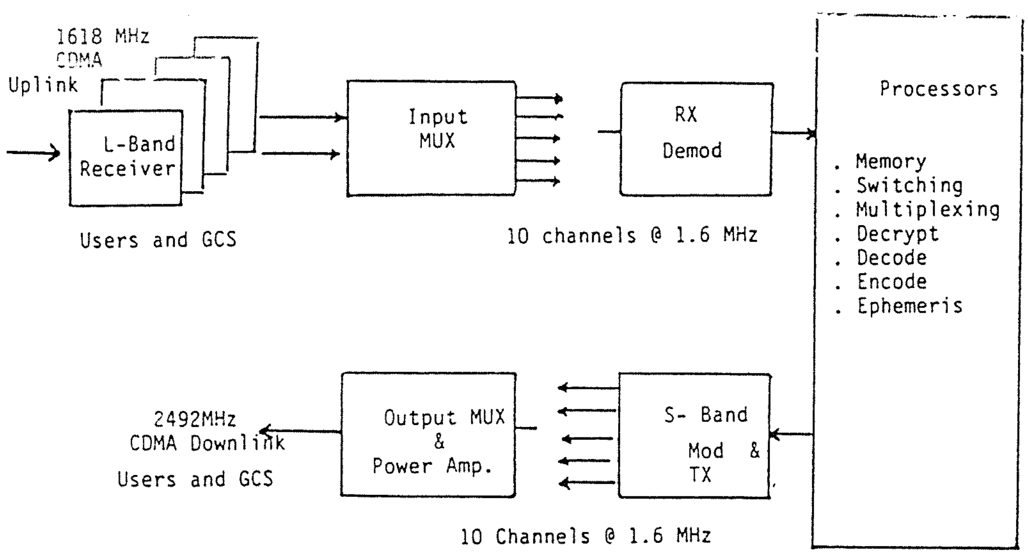
1618 MHz
CDMA
Uplink
L-Band
Receiver
Users and GCS
Input
MUX
RX
Demod
10 channels @ 1.6 MHz
Processors
. Memory
. Switching
. Multiplexing
. Decrypt
. Decode
. Encode
. Ephemeris
2492MHz
CDMA Downlink
Users and GCS
Output MUX
&
Power Amp.
S- Band
Mod &
TX
10 Channels @ 1.6 MHz

Figure B

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, that I am familiar with Part 25 of the Commission's Rules and Regulations, that I have either prepared or reviewed the engineering information submitted in this application, and that it is complete and accurate to the best of my knowledge.

By: [signature]
Dr. Dino A. Lorenzini
Executive Vice President
Interferometric, Inc.

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

In re Application of ELLIPSAT CORPORATION For Authority to Construct the Sixth of Six Elliptical Orbit Satellites Comprising the ELLIPSO® I System	)	File No.

APPLICATION

Ellipsat Corporation ("Ellipsat" or "Applicant") hereby applies for authority to construct the sixth of six elliptical orbit satellites comprising the ELLIPSO® I System.

I.

PURPOSE OF APPLICATION

A. Authorization Requested

Ellipsat requests authority to construct the sixth of six ELLIPSO® I elliptical orbit satellites. The satellites will operate in the 1610-1626.5 MHz (uplink) and 2483.5-2500 MHz (downlink) bands, in an inclined orbit providing continuous coverage of the United States. The satellites are identical and will be launched simultaneously. This application covers all pertinent technical and operational information for authority to construct the sixth of the six satellites.[1]

---

1 Detailed information about the satellites is provided in the comprehensive proposal for the entire system submitted with this application. Information in the system proposal is incorporated by this reference.

Separate applications for the five additional satellites are being filed concurrently herewith.

B. Summary of Proposed Service

The applicant will provide radiodetermination satellite service and ancillary cellular services. Service will be provided to the continental United States, territories and domestic offshore points where service is desired. Applicant will offer capacity on a private carrier or private shared network basis to value added partners.

C. Applicant Information

The applicant's name and address is:

Ellipsat Corporation
2420 K Street , NW
Washington, DC 20037

Correspondence and communications concerning the application should be addressed to:

Mr. Robert Perry
Ellipsat Corporation
2420 K Street, NW
Washington, DC 20037
(202) 337-2493

and/or directed to applicant's attorney:

Jill Abeshouse Stern, Esquire
Miller & Holbrooke
1225 19th Street, N.W.
Washington, D.C. 20036
(202) 785-0600

II.

TECHNICAL INFORMATION

Technical information about the satellites is provided in Exhibit I attached hereto.

It is anticipated that construction of the six satellites will be commenced by November 1991, construction completed by May 1993, the spacecraft launched by September 1993, and commercial service offered by October 1993.

III.

WAIVERS AND CERTIFICATIONS

Pursuant to Section 304 of the Communications act of 1934, as amended, Ellipsat hereby waives any claim to the use of any particular frequency or of the ether against the regulatory power of the United States because of the previous use of the same, whether by license or otherwise.

The applicant's submission reflects a serious and conscientious effort to answer all of the Commission's filing requirements as fully and completely as presently possible. While the applicant believes that it has fully complied with all pertinent Commission rules and policies, and has supplied all the information, as appropriate, requested by Appendix B of Space Station Application Filing Procedures, it hereby requests that, to the extent it has not satisfied the applicable requirements, a waiver be granted.

The applicant certifies that all of the statements made in this application are true, complete and accurate to the best of its belief and knowledge, and are made in good faith.

IV.

CONCLUSION

Wherefore, Ellipsat Corporation requests that the Commission grant its application for authority to construct the sixth of six elliptical orbit satellites comprising ELLIPSO®I.

Respectfully submitted,

ELLIPSAT CORPORATION

By: ______________________
Dr. David Castiel
Chairman and Chief
Executive Officer

Of Counsel:

Jill Abeshouse Stern
Miller & Holbrooke
1225 19th Street, N.W.
Suite 400
Washington, D.C.

November 2, 1990

EXHIBIT I

EXHIBIT I

TECHNICAL INFORMATION

A. Radio Frequency and Polarization Plan

Center of Frequency and Polarization:	Uplink 1618/MHz, Linear, Cross-Polarized Downlink 2492/MHz, Circular
Emission Designator or Allocated Bandwidth of Emission:	16MHz at 1610/MHz 16MHz at 2500/MHz
Power Amplifier Output Power per Satellite:	14dBW
Antenna Beams:	Single
Receiving System Noise Temperature:	-24dB/K @ 1610 -24dB/K @ 2500
Gain of Each Transponder Channel:	15dB

B. Orbital Locations: Low Earth Inclined Orbits, 63.5 degrees

Apogee at 1250 km in Northern Hemisphere

Perigee at 500 km

C. Elliptical Orbit: 500 km x 1250 km

Eccentricity: .0517

Semi-major axis:	7253 km
Period:	102.5 minutes
Area of Coverage:	3472 miles or 5,555 km @ 5°
	2778 miles or 4,444 km @ 10°

D. Predicted Space Station

Coverage Contours: See Figure A

1. Receiving Antenna Gain	12dBic
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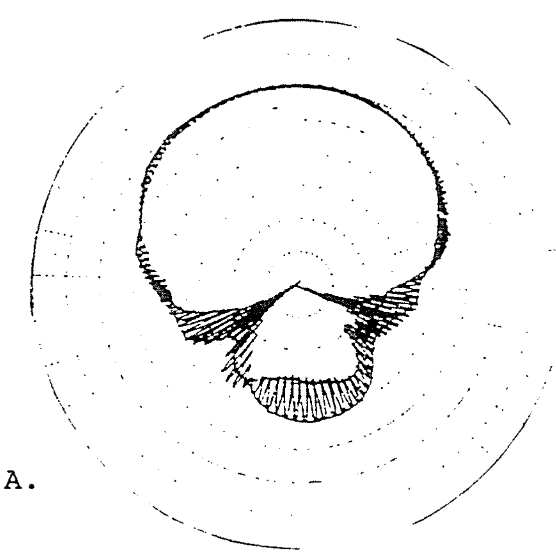

Figure A.

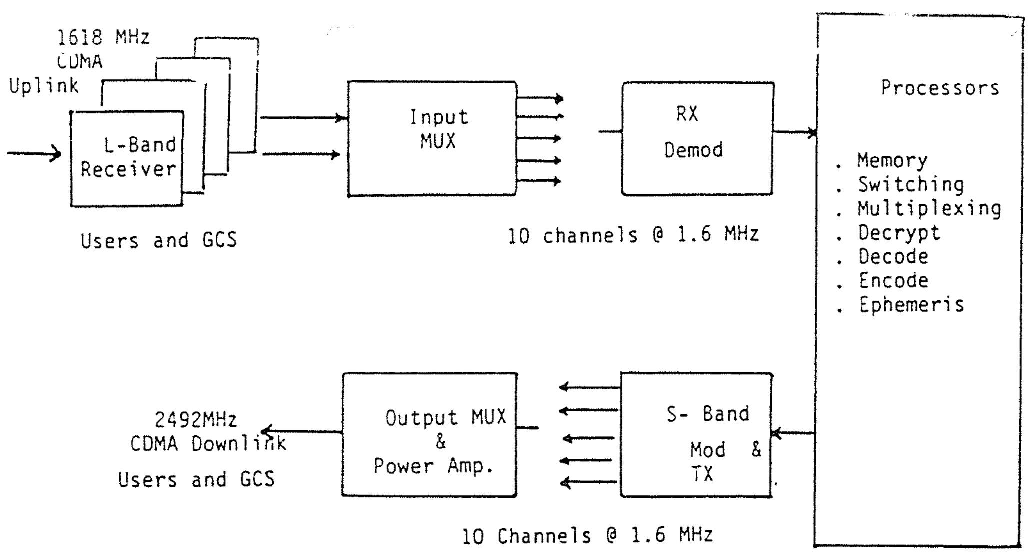

Figure B

TECHNICAL.EXH

CERTIFICATION OF PERSON RESPONSIBLE
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