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

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Domestic Facilities Division
Satellite Radio Branch

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| In the Matter of the Application of<br><br>ORBITAL COMMUNICATIONS CORPORATION<br><br>For Authority to<br>Construct a Low-Orbit Mobile<br>Satellite System | File Nos.<br><br>22-DSS-P/L-90 |

Orbital Communications
Corporation
12500 Fair Lakes Circle
Fairfax, Virginia 22033

Albert Halprin
Stephen L. Goodman
Verner, Liipfert, Bernhard
McPherson and Hand, Chartered
Suite 700
901 15th Street, N.W.
Washington, D.C. 20005-2301
(202) 371-6009

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ORBITAL COMMUNICATIONS CORPORATION

MOBILE SATELLITE SYSTEM

## EXECUTIVE SUMMARY

On a winter night near Detroit, a young man driving home from work fell asleep at the wheel and plunged down an embankment. Alive, but unable to move or call for help, he was found frozen to death the next morning.

Nine teenagers were trapped on Mt. Hood in an unexpected snow storm; search teams spent days frantically looking for the lost teenagers, but were unable to find them in time.

Four skiers lost their lives in Colorado after being buried by an avalanche.

These stories, unfortunately, are all true, and not unique. What makes them even more tragic is that they did not have to turn out as they did. Each of the individuals might have survived if only they had possessed the ability to transmit a simple message calling for help and if their location could have been quickly determined by their rescuers.

This application requests the Federal Communications Commission to grant authority for the construction of a pioneering low-earth orbiting satellite system that will meet such critical communications and position determination needs for millions of Americans.

THE APPLICANT

Orbital Communications Corporation ("ORBCOMM") was formed by its parent company, Orbital Sciences Corporation ("OSC"), to enter the mobile satellite services business. Founded in 1982, OSC is one of the country's leading commercial space technology companies. It is engaged in design, manufacturing, testing and operation of space launch vehicles and suborbital boosters, orbit transfer vehicles, space payloads, and satellite tracking and data systems. OSC's revenues in 1989 were approximately $80 million. OSC currently has roughly 600 employees, and has been identified as one of the fastest growing high technology companies in the United States.

OSC's experience includes systems engineering and program management for the Transfer Orbit Stage (TOS®), the largest commercial space project ever carried out apart from traditional communications satellites. OSC privately raised about $60 million in research and development funds for the TOS project. In 1992, two of OSC's TOS vehicles are scheduled to lift NASA's Advanced Communications Technology Satellite (ACTS) to geostationary orbit and the Mars Observer satellite on its interplanetary mission.

The company also conceived and designed Pegasus™, the first all-new unmanned space booster to be introduced in the U.S. in over 20 years. OSC raised approximately $40 million for research and development of Pegasus, which is being managed under a joint venture with Hercules Incorporated. Pegasus will be

launched for the first time in the Spring of 1990. It and similar small launch vehicles are ushering in a new era of low cost launch services to low-earth orbit, making the use of small satellites a practical reality. OSC also is designing and building a derivative of Pegasus called Taurus™ that will provide significantly enhanced payload capability to low-earth orbit as well as geostationary capability for small payloads. OSC has privately funded the development of the TOS, Pegasus and Taurus vehicles. In addition, OSC has the capability for design, development and manufacture of space payloads and small communications satellites.

THE SYSTEM

ORBCOMM proposes to construct, launch and operate an innovative system of 20 satellites placed in circular orbits approximately 970 kilometers (600 statute miles) above the earth, and having store and forward capabilities. (ORBCOMM has filed with the United States Patent Office to protect the proprietary aspects of its satellite system.) Two will be placed in polar orbits, and 18 in 40-degree inclined orbits. The system will provide critical two-way data communications and position determination services primarily to mobile subscribers throughout the 50 states, Puerto Rico, the Virgin Islands, and the U.S. Pacific Islands plus the polar regions of the earth. The system also inherently provides coverage throughout the rest of the world.

Use of the new Pegasus launch vehicle will permit the cost-effective deployment of a commercial low-earth orbiting communications satellite system. Such a satellite system has numerous advantages over a more traditional geostationary system. The low altitude of the satellites decreases the beamed power required for communications by a factor of between 150-1,000 as compared with geostationary satellites, and makes practical the use of VHF and UHF frequencies for portable and mobile satellite services. At these frequencies, subscriber equipment can be built taking advantage of existing high volume, low cost VHF and UHF components and simple, small antennas to achieve unit retail prices below $50 for a basic communications terminal and under $150 for a combination communications/position determination terminal. The use of low-earth orbit also intrinsically provides for worldwide re-use of the orbiting constellation as the satellites overfly all the earth's surface. Similarly, the use of low-earth orbiting satellites provides Doppler frequency shift that will be used in the baseline ORBCOMM system to compute the location of a subscriber terminal.

The ORBCOMM satellite constellation will provide geographic coverage of every spot on earth. In the coverage area between 70 degrees north and south latitudes (north and south of the respective arctic circles), subscriber access to and from the satellites will exceed 95% in terms of time. Any availability delays will be occasional, spread throughout the 24 hour day, and of very short duration, typically on the order of one minute. As

one satellite proceeds out of view, another will come into view to provide the communications coverage. ORBCOMM plans to deploy three satellite planes with six satellites each in inclined orbits, and two satellites, one each in two polar orbit planes.

Each satellite will weigh approximately 330 pounds with fuel at the beginning of life. The satellites will be three-axis body stabilized and will maintain precisely their relative position in the constellation and pointing accuracy throughout their seven year lives. Communications between the satellites and earth stations will operate at VHF and UHF frequencies using a total of 898 KHz of bandwidth, potentially serving between ten and twenty million subscribers, depending on the usage mix.

Subscriber terminals will transmit to the satellites at 1,200 bps over twenty 15 KHz channels at 2 watts for portable and 5 watts for mobile terminals. Typical subscriber message length is expected to be less than 30 characters, taking about three-tenths of a second to transmit to the satellite. Subscriber terminals will receive from the satellites at 4800 bps over eight 27 KHz channels. Communications between nine U.S. Regional Gateways (earth station hubs) and the satellites will operate at 56 kbps over 100 KHz channels. A 50 KHz UHF downlink channel will be used to retransmit Global Positioning Satellite (GPS) time, a standard frequency, and satellite position coordinates to terminals for use in calculating subscriber geographic position. The time, accurate to one-millionth of a second, will be made available worldwide without user charges through licensing

arrangements with manufacturers that will use this capability in a broad variety of applications. The Gateways will be linked in a star network by terrestrial facilities to the Network Master Control Center in Virginia.

THE SERVICES

The two-way communications and position determination services proposed by ORBCOMM will fill major service, geographic and economic gaps in the existing telecommunications network. Using a terminal about the size of a pocket calculator, a subscriber will be able to send short alphanumeric messages to, and receive messages from, any other location in the country. The system's data communications and position location capability will support a wide variety of applications, falling under the general categories of Emergency Services, Data Acquisition Services, Tracking Services, and Message Services. The large demand projected for these services results from the unique features and benefits of ORBCOMM's low-earth orbiting system:

- Two-way Digital Communications (Including Acknowledgement of Message Receipt)
- Intrinsic Position Determination Capability
- Pocket Portability of Subscriber Terminals (Including Small and Inexpensive Antennas)
- Subscriber Equipment and Usage Charges One-Tenth of Alternative Satellite-Based Systems
- Global Geographic Coverage Including Areas Not Covered By Any Reliable Communications System
- Long Battery Life Resulting from Low Power Requirements, Light Duty Cycle and Short Message Lengths

ORBCOMM projects that a significant number of customers will subscribe to emergency "911" type services, where a subscriber requires assistance and is not able to make use of a telephone or another communications device. For example, terminals will be installed in automobiles, connected to the air bag trigger. In the event of an accident severe enough to set off the air bag, the terminal would automatically report the accident and transmit the car's position. In addition, using a small keyboard and display, the driver will be able to send a call for roadside assistance or to send other brief messages. Based on design and manufacturing studies, ORBCOMM projects that the basic emergency communications and position determination terminal will have a suggested retail price of less than $200 installed in a car (either by the factory or by an after-market service facility), and under $50 per year in subscription fees.

The same communications and positioning capability of the ORBCOMM will also be applied to search and rescue services, medical emergency services, collection of environmental data, recovery of stolen vehicles, tracking of valuable cargo, communications for the handicapped, and personal and business communications where short, yet critical information can be transmitted by no other means or only at much higher cost.[1/]

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[1/] In applications requiring immediate and highly accurate position determination, such as vehicle navigation, ORBCOMM could be used in conjunction with LORAN-C or GPS receivers to transmit position information.

THE PUBLIC INTEREST

The proposed ORBCOMM system represents the innovative application of breakthrough launch vehicle and spacecraft technology and advances in electronics and computer science. This pioneering service will be the first to make practical use of the low-earth orbit to provide new low-cost communications services. The FCC recognizes that the public interest is well served by accelerating approval and introduction of pioneering technologies that improve service and enhance U.S. worldwide competitiveness. By this application and accompanying rulemaking petition, ORBCOMM requests that the Commission expeditiously complete the necessary national and international regulatory steps that would allow ORBCOMM to proceed with construction, launch and operation of its low-earth orbiting system.

Significant and in some cases unique public benefits warrant expedited consideration and approval of the proposed system:

- The systems will help save lives, reduce automotive theft and abandonment, help in monitoring the environment, improve transportation efficiency, improve communications for the handicapped and increase industrial and business productivity through low-cost, two-way data communications.

- The low-earth orbiting satellites and the design of the system will make available for the first time nationwide two-way data communications and position determination capabilities at subscriber terminal costs estimated to be as little as one-tenth that of geostationary satellite systems. This will open the way to meet the needs of unserved and underserved segments of the population as well as to create numerous new applications.

- The two polar orbiting satellites will provide reliable telecommunications coverage to the polar regions for the first time. This capability will serve the needs of scientific research, provide expanded search and rescue service, and provide basic communications capability to an unserved area.

- Using only 898 KHz of bandwidth, the proposed system will have the potential to serve between 10 and 20 million U.S. subscribers, depending on the mix of subscribers by service offering. This implies between 10,000 and 20,000 subscribers per KHz; a ratio of subscribers to bandwidth that is believed to be far superior to any other two-way communications service. Digital data communication is inherently efficient, and ORBCOMM will employ polling, channel scanning, and slotting techniques to achieve high packing densities per unit of bandwidth. In order to maximize system efficiencies, ORBCOMM will not incorporate voice service capabilities.

- The pioneering ORBCOMM system also will increase competition in mobile communications, resulting in improved services for the public and lower prices. ORBCOMM's system is believed to have inherent costs an order of magnitude below the costs of geostationary satellite systems, and will have geographic coverage clearly superior to that of any terrestrial system. ORBCOMM plans to address and stimulate markets that are out of reach from a cost or geographic coverage standpoint to other mobile service providers.

- Beginning with the launch of the very first satellites, the proposed system will meet and, in some respects exceed the functional requirements for the recently proposed personal emergency locator and transmitter service ("PELTS"), sooner, at far lower cost to users, and with uniform and ubiquitous coverage of the entire U.S. land and coastal areas, including Alaska, Hawaii, Puerto Rico, U.S. possessions, and Antarctica. Using packetized digital, alphanumeric messages, the ORBCOMM system will provide more efficient utilization of available spectrum than the voice service proposed in the PELTS NPRM. While both systems will provide two-way communications essential to effective search and rescue operations, including the capability to assure the

subscriber that the call for assistance has been received and help is on the way, the ORBCOMM system will not require implementation by multiple jurisdictions and organizations.

In addition, ORBCOMM will provide position determination of the subscriber's location rather than relying on verbal descriptions and homing devices. Further, it appears that ORBCOMM's subscriber terminals will be considerably less expensive, smaller, and lighter weight than those proposed for PELTS service.

While ORBCOMM will initially provide service in the U.S. market, it will also seek authority to provide service throughout the world, to take advantage of the global coverage of the low-earth orbiting satellites. Because the satellite constellation will be reusable by each participating country, the number of potential subscribers that can be served by the ORBCOMM satellite system (estimated to cost approximately the same as one modern high capacity U.S. domestic geostationary satellite) is unparalleled on a capital-to-potential-subscriber ratio compared to any other communications system ever built. ORBCOMM estimates that if foreign service is provided over its system, revenues flowing into the U.S. from international service could exceed $650 million in the period 1994-2001, and that between $100 and $200 million in equipment and system software could be exported, not including subscriber terminal units. Exports could exceed $3 billion if international revenues in total reach the level anticipated for the U.S. However, time is of the essence in clearing the way for worldwide deployment. Other countries are known to be developing low-earth orbit launch capabilities, and satellite systems will follow. Regulatory

delay will jeopardize the preeminent role of the U.S. for this technology and the attendant foreign trade benefits.

THE MARKET

ORBCOMM proposes to offer subscriber services in the U.S. on a common carrier basis, both directly to subscribers and to organizations that will retail the services and provide on-going customer service. ORBCOMM also plans to make this service available in other countries through the licensing of local foreign companies. Low subscriber equipment and user charges, which are the key design goal of the ORBCOMM system, are expected to appeal to millions of potential customers across a broad range of applications. Indeed, ORBCOMM conservatively projects that it will serve between five and ten million subscribers.

The predominant subscription demand is expected to be for ORBCOMM's SecurNet℠ Emergency Services. ORBCOMM will provide a range of services under the SecurNet service mark customized to specific requirements, including automotive emergency road service, search and rescue, and medical emergency. It is projected that these services will account for approximately 85% of the subscriber base. ORBCOMM also will provide tailored communications and position determination services for collecting data from multiple and widely distributed locations, under the name DataNet℠ Data Acquisition Services; for tracking mobile assets, under the name MapNet℠ Tracking Services; and for personal and business messaging, under the name VitalNet℠ Message Services.

Each of the latter three categories of services will be targeted at applications where existing services do not meet subscriber needs or new capabilities are clearly required. For example, DataNet services will provide the EPA, the National Weather Service and state environmental agencies with a long sought after capability to monitor thousands of sites continuously, expeditiously and inexpensively. MapNet services will help to recover stolen and abandoned automobiles and other property quickly before the property is destroyed or broken into parts. VitalNet services will be aimed at providing personal, handicapped, and business subscribers with a convenient, hand-held communications terminal when telephones may not be available.

ORBCOMM, with input from several major multinational companies, has completed extensive market analyses to determine the size and requirements of the various market segments. In the U.S. alone, it is estimated that the addressable market exceeds several hundred million potential subscriber terminals. ORBCOMM has established and is continuing to develop contractual relationships with major potential users and service marketing organizations to develop cooperatively the system specification and service offerings to best meet the needs of potential customers. Such relationships are either in place or are being discussed with automotive, shipping, recreation, law enforcement, hearing impaired, insurance, road service, and telecommunications companies, as well as Federal government agencies. Several

organizations, including Sea-Land Service, Inc. and the National Park Service, have entered into Joint Research Agreements for experiments with and evaluation of the proposed system. These organizations and ORBCOMM also can be expected to jointly develop service applications meeting the needs of their respective fields. The studies and discussions conducted with these organizations establish interest in the ORBCOMM proposed service based on the ORBCOMM system's cost and service features.

THE SPECTRUM PROPOSAL

ORBCOMM proposes to utilize a total of 848 KHz of bandwidth, transmitting from Space-to-Earth in underutilized VHF frequencies bands at 137-138 MHz (370 KHz of bandwidth requested) and from Earth-to-Space at 148-149.9 MHz (478 KHz of bandwidth requested), and retransmitting GPS time and satellite position coordinates at 400 MHz (50 KHz of bandwidth requested). These bands are allocated domestically and internationally for satellite services. The ORBCOMM service is not currently specified in these bands, and ORBCOMM is concurrently filing a petition for rulemaking so that the service can be authorized using these frequencies.

ORBCOMM also proposes in this application to make use of 50 KHz of bandwidth at 400.075 to 400.125 MHz to transmit GPS time signals and a standard frequency in accordance with the use specified in the ITU and U.S. Tables of Frequency Allocations. The proposed usage is consistent with existing worldwide ITU allocation of this spectrum for Standard Frequency and Time

Signal by satellite. On this channel, ORBCOMM will transmit time signals accurate to one microsecond and a stable reference frequency that will be available to the public on an unrestricted basis. ORBCOMM intends to coordinate the use of this spectrum with the National Institute for Standards Technology so as to maximize the benefit of this offering. The provision of this service will reduce the cost of receiving extremely accurate time signals and may in itself stimulate a variety of new services for public benefit.

The frequencies being sought by ORBCOMM were selected with great care. It is critical to the economics and operating efficiencies of the ORBCOMM system to operate in the VHF and UHF bands. Frequencies below 100 MHz encounter severe propagation problems resulting in poor system reliability and availability. Operating above the UHF spectrum requires inordinate bandwidth for Doppler compensation and eliminates the efficiencies associated with the enormous low-cost VHF and UHF components manufacturing base. Also, use of higher frequencies would require more expensive antennas and eliminate the possibility of shared use of a common antenna with automotive entertainment radio.

ORBCOMM requests the Commission to authorize ORBCOMM to operate the proposed system on a "Modified Primary" basis in the U.S. Under Modified Primary status, ORBCOMM will operate in a manner that will not cause harmful interference to currently authorized users in these bands, but would be granted Primary

status versus any new services or users proposed in these frequencies. Presently, only NASA, NOAA, military mobile radio and a few non-government users are authorized to operate in these VHF bands. The specific frequencies and channel bandwidth used by the ORBCOMM system will be compatible with existing users and will not cause harmful interference. The Modified Primary status will allow ORBCOMM to expand greatly the use of this underutilized spectrum, without displacing the present licensees.

In sum, the ORBCOMM system will be extremely spectrum efficient for several reasons. First, the system will make use of under-utilized and unutilized spectrum for the provision of critical and valuable services, but without displacing current authorized users. Second, in terms of the ratio of potential subscribers served to required bandwidth, there is no other system of which we are aware that approaches the ORBCOMM spectrum efficiency. Third, the communications system is designed to use satellite/subscriber transmissions only where absolutely necessary, i.e., for occasional communications to and from subscribers rather than frequent or continual use.

## THE READINESS OF ORBCOMM TO PROCEED

ORBCOMM has completed intensive market and technical analyses (partly in conjunction with major potential users and suppliers), and has used these studies to specify the communications system capacity and design and in conducting cost studies. There is a high confidence that the satellite system proposed will meet the requirements of the markets for which it

is designed. Other low-earth orbit satellite systems have operated successfully in the past (albeit not on a commercial basis), providing additional technical and operational bases for ORBCOMM's confidence.

Substantial ORBCOMM system pre-program engineering and planning activities have been and continue to be funded by OSC, in addition to continued work on the Pegasus launch vehicles and related satellite technologies. The company already has spent several million dollars on the studies, research, facilities, prototypes, and development of the ORBCOMM system, and plans to spend comparable amounts on the project in 1990. OSC has 200 engineers and 100 technicians with hundreds of years of space and communications experience. OSC's commitment to this low-earth orbiting satellite technology is exemplified by its construction, launch and testing of the 25 pound DataSat-X experimental satellite. In 1989, the Commission granted experimental licenses for the DataSat-X satellite, which will be used to test and develop data collection, communications and position determination capabilities. The satellite will have the capability to send and receive data and messages from small terminals and will be used to calculate the position of users. As a pathfinder for the ORBCOMM satellites to follow, DataSat-X will be equipped with a GPS receiver, the output of which will be used in calculating accurately the position of the spacecraft and, in turn, subscriber terminals.

If the Commission authorizes the ORBCOMM system, the company will raise the required $283 million in capital (plus $37 million in capitalized interest) and will proceed rapidly with system engineering, construction, launch and operation. In order to preserve the market timing and technical advantages that ORBCOMM and the U.S. presently possess, it is essential that engineering and construction of the system begin as soon as possible. To this end, ORBCOMM requests the Commission to act as expeditiously as possible. In addition, ORBCOMM is filing, concurrent with this application, a request for Section 319(d) waiver to start detailed design and preliminary construction by April 1990.

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# I. INTRODUCTION

## A. Telecommunications Industry Perspective

Telecommunications in the U.S. have evolved over the last century from visual signals, telegraph lines and copper wire to satellites and fiber optics. The vast majority of the investment in this industry has gone to implement and expand the capability for voice communications between any two fixed points. Yet there has always also been a market for communications between any two points, one or both of which are not in a fixed location. This land mobile segment of the industry traditionally has been dominated by business and public safety users including dispatch, construction, package tracking, paging, police, fire departments and military.

In the early 1980s, two major new developments occurred that for the first time offered the prospect of lower cost and readily available communications to a wider segment of mobile customers.[2/] First, cellular mobile telephone service was introduced, and, second, mobile communications services via satellite became practical. These new services were made possible by the rapidly declining size and cost of user electronics, significant decreases in the cost of computers coupled with dramatic increases in capabilities, refinement of digital communications techniques, and, in the case of geostationary satellites, the launch of higher power and higher

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[2/] Limited commercial mobile satellite communications were introduced earlier with the MARISAT satellites, but the size and cost of the terminals restricted the markets that could viably be served by that system.

frequency spacecraft. These new capabilities, in turn, have fostered a new multi-billion dollar mobile communications industry segment providing individual voice communications, and stimulating new data transmission service offerings and applications, such as position determination, interstate trucking operations management, nationwide paging, and digital dispatch systems. So far, the investment in these new satellite services totals over $2 billion, and confirms the generally held view that the market for mobile communications services is very large.

Notwithstanding these significant improvements in mobile communications services, their development also has raised awareness of certain important limitations of these services. Terrestrial radio systems have limited range and require hundreds of transmit and receive stations to achieve nationwide or regional geographic coverage, and even then major portions of the U.S. have no coverage whatsoever because it is uneconomical to build radio sites in light traffic areas. Geostationary systems have greater geographic coverage than terrestrial systems, but they involve very costly satellites, and require high beam power densities as well as high cost subscriber terminals and antennas to operate with those satellites. Finally, one desirable feature, determination of the position of the mobile user, requires either the addition of relatively expensive electronics[3/] or highly specialized satellites.

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[3/] E.g., the mobile user would need to incorporate Long Range Navigation ("LORAN") or Global Positioning System ("GPS") receivers.

By contrast, a constellation of small, low-earth orbiting satellites offers the potential to overcome these deficiencies by providing low-cost, two-way data communications and position determination capabilities, along with the capability of worldwide coverage. Figure I-1 depicts the system's global coverage. Such a system is only now becoming technically and financially feasible, as a result of miniaturized and highly capable electronics and new developments in composite materials and rocket technology. These technological and cost breakthroughs have led to the development of new small launch vehicles such as Pegasus, which, in turn, make practical and cost-effective the launch of multiple small satellites into low-earth orbit.

Use of the low-earth orbit, some 95% closer to the user than geostationary satellites, permits VHF and UHF frequencies and low power levels to be used, resulting in low-cost subscriber equipment and simple antennas. Figure I-2 depicts the relative altitude and coverage of ORBCOMM low earth satellites, geostationary satellites and terrestrial systems. Indeed, the low altitude of the satellites decreases the beam power densities ®required for communications by a factor of approximately 150-1,000 compared to geostationary satellites. Notwithstanding the considerably lower costs of VHF and UHF electronics, perhaps the

biggest difference is in the size and cost advantage of the mobile antennas (and hence of the terminals).[4/]

Low-earth orbiting satellite systems can provide a new and unique combination of pocket portable terminals, low subscriber costs and universal geographic coverage. ORBCOMM's satellite system[5/] will fill remaining gaps in the existing communications system, complement and extend the reach of the public switched network ("PSN"), and stimulate a host of new services to meet the needs of personal and mobile communications customers for short but critical communications and position determination using low-cost, pocket-portable equipment.

B. Regulatory Issues

In order to bring the benefits of the low earth orbiting satellite system to the public, ORBCOMM is filing this application and a petition for rulemaking. In addition, with respect to international mobile satellite issues, the Commission established a proceeding in order to generate public comment regarding preparations for an International Telecommunications Union (ITU) World Administrative Radio Conference (WARC) in 1992 for dealing with frequency allocations in certain parts of the

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4/ A comparison between a typical terminal used with geosynchronous satellites (costing between $1,000 and $4,000 and weighing several pounds), with the pager-class ORBCOMM terminal demonstrates the compelling reason why ORBCOMM will be attractive to a much broader market.

5/ ORBCOMM has filed with the United States Patent Office to protect the proprietary aspects of its satellite system.

spectrum.[6/] In the NOI, the Commission requests comment on "what other issues, consequential to allocating spectrum for mobile services, may need to be addressed at WARC-92." ORBCOMM seeks to have the U.S. position at WARC include a proposal to adopt footnote changes to the International Table of Frequency Allocations to allow Mobile Satellite Services to be offered in two VHF bands already allocated to satellite services for meteorological, space research, and space operation purposes, which would enable ORBCOMM's satellite system to be used worldwide.

One of the prime functions of ORBCOMM's system is communication and position determination for search and rescue. With respect to this capability, the Commission recently proposed to establish a Personal Emergency Locator Transmitter Service (PELTS) "to provide individuals in remote areas a means to alert others of an emergency situation and to help search and rescue personnel locate those in distress."[7/] ORBCOMM agrees with the Commission that such a service for use by the public and private sectors is required. We also support the stated objectives of establishing this new service,

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[6/] An Inquiry Relating to Preparation for the International Telecommunications Union World Administrative Radio Conference for Dealing with Frequency Allocations in Certain Parts of the Spectrum, Gen. Docket No. 89-554, FCC 89-329, released December 13, 1989.

[7/] Amendment of Parts 0, 1, 2 and 95 of the Commission's Rules Regarding the Establishment of a Personal Emergency Locator Transmitter Service, PR Docket No. 89-599, FCC 89-342, released December 20, 1989 ("PELTS NPRM").

> (1) to provide for an area wide, centrally-coordinated radio communications capability for use by the general public in remote areas for the purpose of reducing response time in emergency situations and (2) to reduce the illegal use of ELTs and EPIRBs as personal locating beacons.[8/]

We believe that the ORBCOMM system will meet these needs more efficiently and more effectively than the suggested terrestrial radio proposal in the PELTS NPRM. The ORBCOMM system will provide clearly superior emergency service in terms of geographic coverage, uniform availability across the country (both on land and offshore areas), earlier availability, lower subscriber equipment costs, and the capability to determine quickly the location of the party needing assistance. We therefore urge the Commission to authorize the ORBCOMM system as a means of fulfilling the need for a personal emergency locator system, notwithstanding FCC actions with regard to PELTS.

### C. Format And Content Of The Application

This application is presented in six sections and six appendices. Section I provides an overview of the development of the communications industry and sets the context of the application with respect to history, technology trends, and other FCC proceedings. Section II demonstrates that authorizing the proposed ORBCOMM system is clearly in the public interest, and that expedited consideration and authorization is essential if the U.S. is to benefit from the technological advances made

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[8/] Id. at para. 16.

possible by the system. Section III describes the large potential market for ORBCOMM services, the ORBCOMM service offerings, the variety and functions of subscriber terminals that will be available, and the basis for the projected low subscriber equipment costs. Section IV discusses the proposed low-earth orbit locations and the benefits in terms of opening up new orbit resources for use in the U.S. (and internationally). Section V describes the satellite system, communications and position determination capabilities, and launch plans. Section VI demonstrates OSC's and ORBCOMM's legal, financial and technical qualifications to construct and operate the satellite system.

Appendix A provides an interference analysis verifying that the ORBCOMM system will not cause harmful interference to other users of the proposed spectrum. Additional appendices include OSC financial statements, FCC Form 430, a description of the DataSat-X experimental satellite program and its relevance to ORBCOMM system developments, and applications for satellite radio authorizations.

We have sought to provide all relevant, available information. This application is intended to be, "a concrete, comprehensive proposal for its proposed system and services, describing in detail all pertinent technical and operational aspects of the proposed system," consistent with Commission requirements for satellite applications.[9/]

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[9/] Space Station Application Filing Procedures, 93 FCC 2d 1260 (1983).

## II. PUBLIC INTEREST CONSIDERATIONS

### A. The ORBCOMM System Will Save Lives

Millions of Americans are on the move every moment of every day. While most of these trips are successfully completed without incident, many are not: cars break down, accidents occur, boats are stranded offshore, and people become lost. In most cases help can be summoned using a telephone, a cellular phone, CB radio or even a shout for assistance. Yet this is not always the case. Virtually everyone in the U.S. will, at one time or another in their lives, wish that he or she had a way to call for help in a lonely or dangerous situation and would take comfort in an acknowledgement that the call is heard.

The communications and position determination system proposed in this application will, for the first time, make available for service anywhere in the U.S. pocket portable, very low-cost subscriber terminals that can be carried easily by an individual or packaged into an automobile or boat. The base model two-way communications-only subscriber terminal will weigh 5 ounces and be about the size of a pocket calculator. It will have a suggested retail price of under $50. With the addition of position determination capability, the base terminal will cost about $150. Subscriber fees will be $30 to $50 a year. At these prices and with these features, the service will appeal to the mass U.S. market. We also expect that the terminals will be installed as standard equipment on at least some models of

automobiles and trucks, and hikers and boaters routinely will carry a terminal.

In addition to search and rescue functions, the system will serve the needs of handicapped persons and provide communications for medical emergencies. ORBCOMM also plans to offer a more sophisticated personally portable communications device. Weighing about 10 ounces and priced under $300, the terminal will permit a hearing impaired person to communicate alphanumeric messages created on a small keyboard and to receive messages on the same terminal. Likewise, those with medical infirmities will be able to summon help easily without having to be within reach of the PSN.

The Commission has acknowledged the growing need for a personal emergency communications system in the PELTS NPRM. The ORBCOMM system will better meet the requirements set out in the PELTS NPRM; it will feature lower subscriber costs, will cover the entire U.S. uniformly, will use lighter weight and smaller terminals, can be deployed throughout the U.S. significantly ahead of the proposed terrestrial system, will be superior with respect to autonomous and rapid determination of the position of the individual requiring assistance, and will provide reassurance to the party in trouble. Further, ORBCOMM will be a privately developed system, and will not rely upon government for constructing and operating terrestrial radio base stations. Finally, the ORBCOMM emergency service will be available throughout the U.S., including remote and urban areas.

The need for emergency communications does not arise solely when hiking or camping. Breaking down in a car in one of the Nation's cities or driving into a ditch off a suburban road can pose significant threat to life, and warrants treatment equal to that proposed for the remote hiker or camper in the PELTS system.

The ORBCOMM system can begin providing coverage throughout the U.S. (and indeed the world, including the polar regions) 32 months after receipt of the license to construct. The system coverage in terms of availability or access to a satellite will increase steadily until the full constellation is in place 42 months after receipt of the license. In contrast, the proposed PELTS radio systems are not likely to achieve such universal coverage and probably will cost the user more for equipment and service.

Another application of ORBCOMM terminals suggested by a potential shipping company customer is for installation in all survival suits and life rafts. The small size of the terminals, low cost, long battery life, and simple antenna requirements makes it practical to consider such an application.

ORBCOMM will establish a customer service center staffed 24 hours per day, 365 days per year. This center will receive, relay and follow-up emergency requests. The service center will provide high quality service to all subscribers no matter where in the country they are located. This will permit an ORBCOMM subscriber to use the same terminal equipment while

hiking, or going to and from work, thus maximizing the utility of the subscriber terminals and the ORBCOMM system.

B. The ORBCOMM System Will Help Reduce Crime

Any new system that has a realistic prospect of helping to reduce crime in America should be welcomed. ORBCOMM communications and position determination capabilities are designed to deter theft and to recover stolen mobile property (particularly automobiles and boats), to summon help if the user is attacked, and to help interdict and track shipments of illicit goods.

ORBCOMM terminals installed in automobiles and attached to the airbag trigger can be used automatically to alert the system to a severe accident, and the communications capabilities can also call for roadside assistance. In addition, the same hardware can be used to track the automobile if the car is stolen. In the event an owner reports his vehicle missing and presumed stolen, instructions will be sent through the satellite to the vehicle-mounted terminal, causing the equipment automatically to calculate and transmit the car's position. In this manner a stolen automobile will be tracked until it is apprehended by the appropriate law enforcement authorities. The terminals will be installed so that efforts to disable the system will result in incapacitating the vehicle.[10/]

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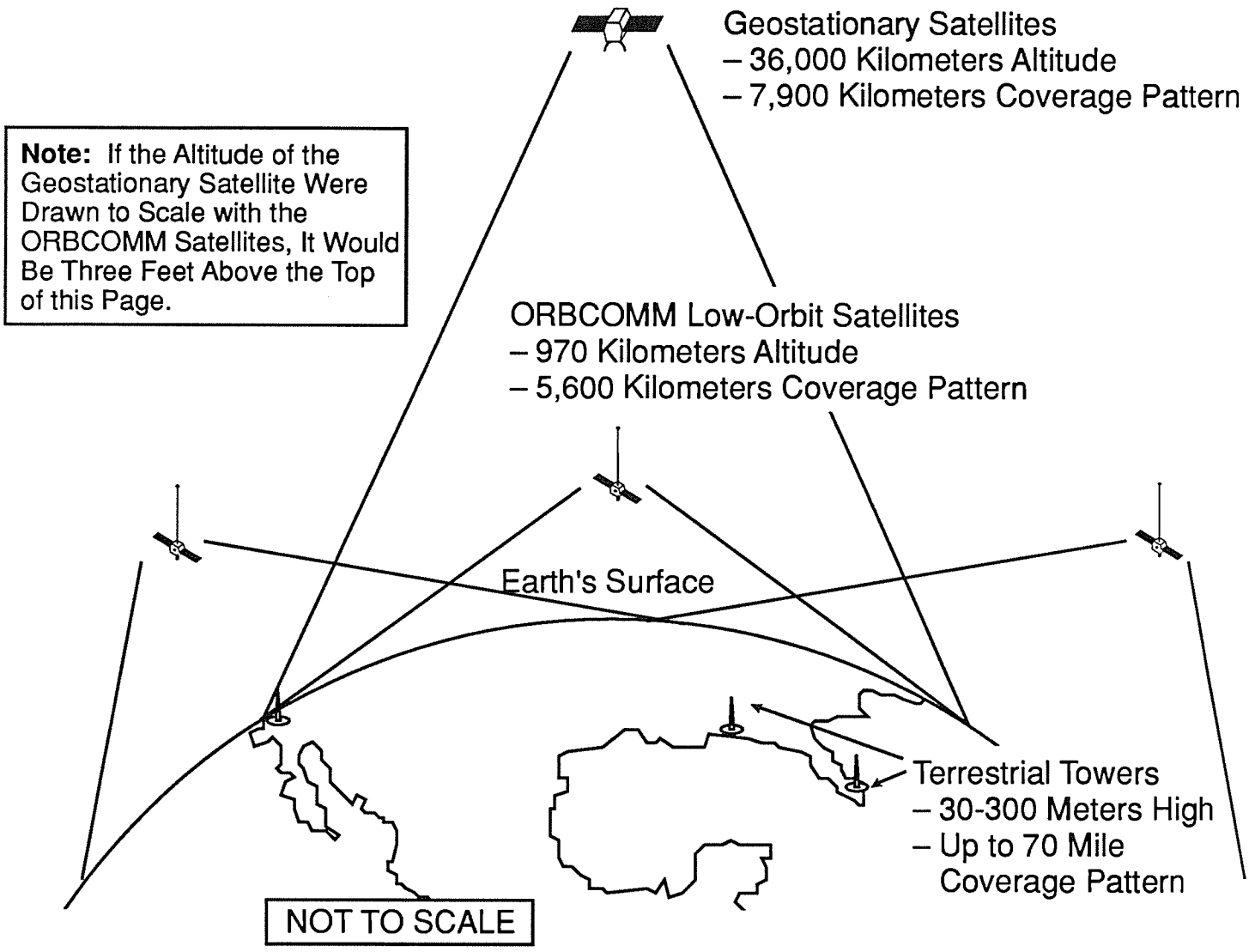
10/ Discussions with a major automotive insurance carrier confirm significant interest in the technology based on the low cost of the equipment and the accurate and timely position determination (continued...)

# Figure I-2
# Low-Orbit, Geostationary and Terrestrial Systems



Deterrence of car theft is not the only role for ORBCOMM in fighting crime. Unfortunately, violent crime is a substantial threat to many Americans. These concerns have driven the development of a multi-billion dollar security industry providing everything from guard services to home security systems. The ORBCOMM system will provide a cost effective way to call for help, whether one is walking down the street, at home, or sitting in an automobile. This "911" capability, coupled with the ability to determine automatically the position of the caller, should be of great value to potential subscribers and to the police, who need to know when and where someone needs help.

The crisis of drugs in America and the need to stop it is of the highest priority among the Nation's citizens. Technology cannot solve the problem, but it can help. ORBCOMM terminals are small and lightweight. They can be used to track the route of a truck or boat suspected of transporting drugs. They can be installed in containers and triggered to identify when and where a container is illegally opened. They can be deployed as part of sensor fields to detect and report motion across wide areas. The low cost of the terminals makes them easily deployed in large numbers, and their small size renders them difficult to detect. They can be radio silent unless triggered from space with a special code. No other communications system offers the potential of ORBCOMM for

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10/ (...continued)
capability. Owners whose vehicles are equipped with the system may qualify for lower insurance premiums.

commercial and industrial use in curtailing the shipment of drugs.[11/]

### C. The ORBCOMM System Will Help Improve The Environment

Monitoring air and water quality and basic ecological systems is essential for knowledgeably setting public environmental standards and enforcing the laws. Major deficiencies with current data collection systems have been cited. The costs of dispersing large numbers of sensors over wide areas is great, and systems for collecting data are not uniformly available. States vary widely in their data collection practices and rural areas are often not monitored at all.

The ORBCOMM system will reduce the cost of locating sensors and simplify data collection throughout the world. ORBCOMM will provide more capacity than existing satellites systems, and the system availability will be superior. ORBCOMM terminals will be attached to existing buoys and built as free-floating units to measure and report salinity and water levels. Air quality sensors will be able to report results to central analytical centers at an affordable cost. The ORBCOMM capability to over-fly the sensor fields and to poll each terminal for data

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[11/] Discussions with a major international shipping company have confirmed use of ORBCOMM terminals in a drug interdiction role as attractive. Such companies are enthusiastic participants in the war on drugs, and are subject to heavy fines if they are found to have exercised less than due diligence in preventing illegal use of their facilities and services. ORBCOMM will allow these companies to monitor their equipment to ensure that is not being coopted by drug smugglers.

on a schedule set by the customer will make efficient use of the space segment resource and serve to preserve valuable battery life. The on-board memory capability of the satellites will permit store-and-forward operation, meaning that data sent to the satellite, for example over the north or south pole, can be stored and later delivered through a U.S. Regional Gateway hub station. These capabilities are believed to have potentially high value in the international, U.S.-supported global change research, such as the Government's Mission to Planet Earth initiative, which will collect data on thousands of parameters associated with global warming, water quality, and atmospheric pollutants.

### D. The ORBCOMM System Will Increase U.S. Productivity

The growing acceptance of the mobile messaging and position location services offered by QUALCOMM, GEOSTAR, and other companies verify that a large market exists for communicating with vehicles and tracking them when they are on the road as a means to improve productivity, reduce costs and improve service. Major investments are being made by trucking companies to manage drivers' routing, to track their position in real time, and to eliminate the requirement to stop for telephone communications with the dispatch office. One major difficulty with existing services is that the in-vehicle equipment costs are very expensive, reportedly exceeding $4,000 per vehicle. In contrast, ORBCOMM projects the cost of its in-vehicle equipment

to be about one-tenth of current system costs (or roughly $400) with usage charges no higher than under the present systems. The ORBCOMM equipment will not require a special, separate antenna. Importantly, the ORBCOMM system will provide availability of the communication link superior to these geostationary satellite based systems, because the "look angle" of ORBCOMM's satellites relative to the truck will be changing constantly. This means that communications will be possible with vehicles in cities where tall buildings frequently prevent communications with geostationary satellites.

ORBCOMM seeks to appeal to the smaller truck fleet operators that either do not need the high frequency of transmissions provided by the more expensive systems and/or cannot afford them. The ORBCOMM system can be viewed as an evolutionary tracking and communications system for mobile vehicles, fitting under the current systems in terms of cost and throughput. Taken together, the performance and cost advantages associated with the ORBCOMM system will encourage much broader application of fleet communications systems, with resulting improvements to productivity.

In addition to the trucking sector, ORBCOMM has identified a large market for a low-cost communications and position determination terminal that can be attached to rail cars, containers and other shipping equipment. Shipping companies are anxious to know the location of high value assets when they are not in company control. They want to know the

operating status of mobile generator sets, how much fuel they have remaining, and where they are located. These data will be used to improve operations planning and facilities utilization and to avoid losses of refrigerated foods.

There are numerous other potential applications for ORBCOMM's two-way data capabilities. Insurance adjusters will be able to access a central data base from a disaster site, loggers will be able to engage in communications with their home bases, law enforcement personnel will be able to communicate silently during a critical operation, and business persons will be able to coordinate their activities when out of range of a cellular system.

ORBCOMM will fill an important gap in the U.S. communications system at very low user charges and subscriber terminal cost. No other system will provide the universal coverage at rates that will be within reach of millions of Americans.

### E. The ORBCOMM System Will Improve Communications For The Handicapped And Infirm

Handicapped persons and those with medical problems are dependent on the telephone system and mobile extensions thereto for communications. In most cases this is sufficient. However, these persons face significant problems in communicating even the simplest messages when outside carefully structured environments. For example, when a person with a hearing impairment is traveling and arrives at a hotel and wishes to inform someone at home of

his or her arrival, unless the person has a Telephone Device for the Deaf ("TDD") terminal readily available, sending that message is very inconvenient and involves the cooperation of others. More importantly, if someone at home wishes to send a message to the traveling hearing impaired person at the hotel or elsewhere, it may be impossible without special equipment.

The ORBCOMM system will provide a low cost and easy-to-use capability for use by the hearing impaired and others who have difficulty reaching a telephone. The ORBCOMM alphanumeric terminal will permit messages to be prepared and transmitted to a remote party and will confirm receipt. Likewise, the terminal will permit a response to be received and will alert the subscriber with a message received light. Persons confined to wheel chairs would find this capability to be of particular value. This communication capability will be affordable for most Americans, with the terminal having a retail price under $300 and a monthly service charge (usage based or fixed-fee) of $35 to $50. By way of comparison, the monthly costs will be approximately equal to those presently charged for one-way national paging.

### F. ORBCOMM's Satellite System Makes Efficient Use Of The Frequency Spectrum

ORBCOMM proposes to use 898 KHz of bandwidth in the VHF and UHF frequency bands as shown in the following table:

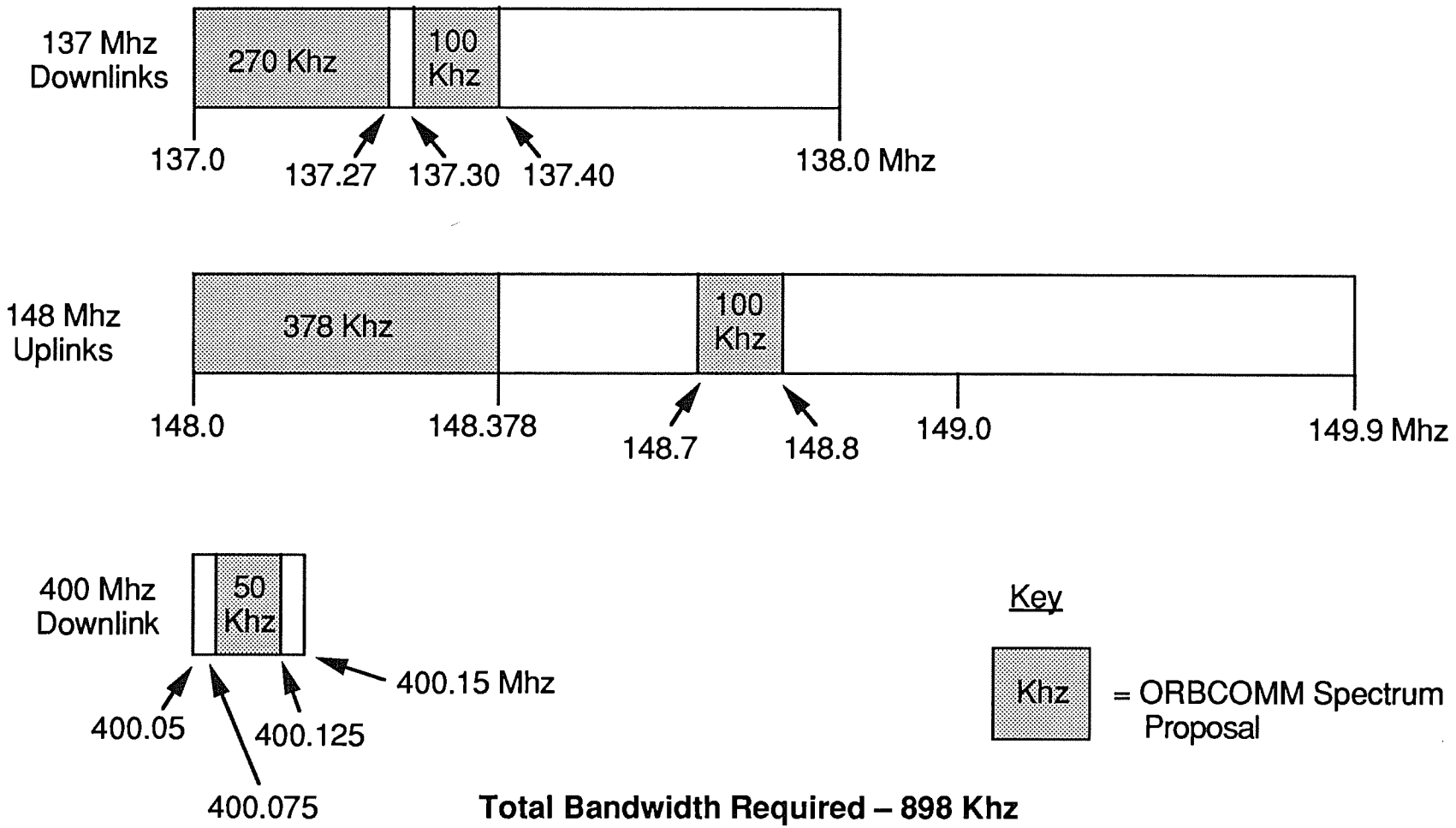
Proposed Frequency Plan

| | Frequency(MHz) | Channels | Required Bandwidth Occupied KHz Per Channel | Total KHz |
|---|---|---|---|---|
| Downlink | | | | |
| Subscrib Term | 137.000-137.270 | 8 | 27 | 270 |
| Regional Gtwy | 137.300-137.400 | 1 | 90 | 100 |
| Time/Frequency | 400.075-400.125 | 1 | 40 | 50 |
| Uplink | | | | |
| Subscrib Term | 148.000-148.378 | 20 | 15 | 378 |
| Reg Gateway | 148.700-148.800 | 1 | 90 | 100 |
| | | | TOTAL | 898 |
| Memo: Inter-Satellite Link | | | | |
| GPS Sat (Receive Only) | 1,575.42 | | | |

Figure II-1 shows ORBCOMM's frequency plan relative to the bandwidth of the three affected bands.

By using digital packet switching technology and confining the system to non-voice, low-speed, alphanumeric transmission only, the system ultimately will have the capability of serving between 10 and 20 million U.S. subscribers, over 85% of whom fall into the emergency services category. This means that the system will support approximately 10,000 to 20,000 subscribers per kilohertz of bandwidth; a subscriber to bandwidth ratio that ORBCOMM believes is unmatched by any other communications service. For example, a service such as that offered by GEOSTAR Messaging Corporation (GMC) proposes to use 28 MHz of bandwidth in the L-band for that messaging service, and the Commission has authorized American Mobile Satellite Corporation

# Figure II-1
# ORBCOMM Spectrum Proposal




**Total Bandwidth Required – 898 Khz**

00208.13

(AMSC) to use 27.9 MHz of bandwidth in the L-band for its mobile telephone, mobile radio, mobile data, aeronautical, paging, and transportable services. Using the equivalent of only 3% of the spectrum bandwidth already assigned to a geosynchronous satellite system serving higher-priced markets, ORBCOMM will offer a pioneering service that will be available worldwide, and with the potential to meet the needs of tens of millions of subscribers.

The proposed frequencies were selected because they meet the technical and economic requirements of the system: they are presently underutilized or not used at all; they are already allocated for satellite service; and they are allocated for shared government and non-government use. The services planned by ORBCOMM fall under the definition of Mobile Satellite Services, so that the only changes needed to pave the way for U.S. and international assignment of the frequencies to the ORBCOMM service are to allocate the frequencies for Mobile Satellite Service in addition to the existing services. Moreover, by granting ORBCOMM a "Modified Primary" status, the benefits of this new use will be gained in the U.S. without displacing current licensees.

The ORBCOMM system will provide both two-way data communications and position determination using the same

bandwidth. The system will use the Doppler effect of the low-orbit satellites -- the change in frequency of an approaching and departing radio signal relative to any point on earth -- to calculate geographic position. Essentially the position determination capability due to the Doppler principle is a free side-benefit of the architecture of the system.

As an additional benefit of the frequency plan, ORBCOMM proposes to provide to any user, free of charge, a stable 400 MHz frequency source and time signals accurate to one microsecond (one-millionth of a second). Each satellite will be equipped with a Global Positioning System ("GPS") receiver that will obtain highly accurate time signals from GPS satellites. This time information will be used for position determination in ORBCOMM's subscriber equipment, and will be made available to others as a public service.[12/] We envision that many potential uses for this reliable time and date information, including automatic update of VCRs and automotive clocks, automatic correction for time zone changes and changes from standard to daylight time, etc. Users will be able to select the time accuracy suitable to their application, up to the one microsecond maximum accuracy.

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12/ One possibility is to have the manufacturers of equipment designed to take advantage of this service pay a small royalty to ORBCOMM to help offset the costs associated with maintaining the system and integrating this feature into the manufacturer's equipment.

G. The ORBCOMM System Will Capitalize On New U.S. Technology To Reduce The Trade Deficit

The Commission is keenly aware of the current telecommunications trade deficit. In a recent speech, the Chairman observed that:

> We must make substantial progress in reducing the trade deficit ... One new FCC goal, for example, calls for increased awareness of the international competitiveness implications of FCC actions. What we decide -- and how quickly we decide it -- often has a direct and immediate impact on the ability of American companies to compete effectively against foreign-based firms, both at home and abroad. Maybe we could afford the cost of delays in the past. But we can't afford them today. Nor can we afford to slow-down the introduction of new services domestically and, by doing so, affect the ability of our companies to export those offerings abroad.[13/]

The ORBCOMM system has the capability of serving both the U.S. and every other country around the world. Global coverage is intrinsic to a low-earth orbiting satellite system. ORBCOMM plans to make use of this worldwide capability to license use of the system in foreign markets, with attendant foreign trade benefits. ORBCOMM projects that foreign revenues from license fees, technical assistance, and royalties at a minimum could exceed $650 million over the operating life of the ORBCOMM system. Also, U.S.-made computers, terminals, displays, software, antennas and transmission equipment valued at $100 to

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13/ Remarks of The Honorable Alfred C. Sikes, Chairman of the Federal Communications Commission, before Telocator's 41st Annual Convention and Exposition, October 5, 1989.

$200 million could be sold with foreign systems to equip their Network Control and Operations Centers.

ORBCOMM will license manufacturers of subscriber equipment to encourage establishment of a strong domestic manufacturing base.[14/] Shipments of U.S. made subscriber equipment, potentially valued at several hundred millions of dollars, would result. Additional benefits to domestic manufacturers are likely to result from the authorization of the ORBCOMM system, because we expect that the satellites, launch vehicles, and equipment for the Satellite Control, Network Master Control and System Operations Centers will be obtained from U.S. manufacturers.

Before any of these foreign trade benefits are possible, however, ORBCOMM must be granted authority in the U.S., and the frequency allocations must be in place worldwide to permit development of overseas markets. In this regard, time is of the essence. Concurrent with the filing of this application, foreign governments and companies will become aware of the ORBCOMM concept and can be expected to try to copy it.[15/] ORBCOMM's current developmental lead, which would allow it to be the first to introduce the service, will be severely eroded by delays in authorization. It clearly is in the public interest to

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[14/] Given the number of potential qualified domestic manufacturers, we expect that the licensing agreements will be entered into with U.S. companies.

[15/] Indeed, activities are already underway in several foreign countries to develop low-orbit launch and small satellite capabilities.

be the first country to deploy this new capability, and thereby to secure for the U.S. the major economic and social benefits of this technological breakthrough.

H. ORBCOMM's Market Entry Will Increase Competition

In the last ten years, the Commission has acted to make available additional spectrum for a variety of mobile communications services, including cellular telephone service, nationwide paging, RDSS services and MSS services. The public has affirmatively responded with demand for each of these services as they were brought to market. To some extent, the ORBCOMM system will compete within these markets, and will thereby put pressure on all service providers to reduce costs, improve service and reduce prices. This is the marketplace at work. As a result of this potential competition, we expect that this application will be opposed by many service providers who will consider the ORBCOMM system to be a threat to their market positions.

ORBCOMM prefers to compete in the marketplace (not at the Commission), and ORBCOMM is willing to put its capital at risk to meet the needs of unserved and underserved markets. No other system provides the unique combination of features ORBCOMM will provide. We intend to reach consumers at the low end of the price scale with services not available to them now and unlikely to be provided in full by any other technology. Also, ORBCOMM will try to stimulate a host of new service applications. If theory holds true, competitors will respond with variations of

their offerings, thereby widening consumer choice and enhancing competition, all to the benefit of the public.

## III. TELEMOBILE SERVICE MARKETS AND DEMAND

### A. Introduction

ORBCOMM perceives a strong demand for the particular services it will offer. The total U.S. addressable market for ORBCOMM services is estimated to exceed several hundred million potential subscribers. Virtually every car, truck, boat, intermodal container, refrigerated box car or van, hiker, handicapped person, environmental monitoring station and individual is a potential "platform" for a terminal. ORBCOMM is specifically designed to provide the capability to send and receive simple, yet critical, brief communications and to calculate and transmit the location of the subscriber unit. Projecting the market for services as low-priced and pioneering as those proposed by ORBCOMM is difficult using traditional analytical methods (i.e., analysis of existing demand for like services and extrapolation into the future). This approach inevitably underestimates demand for such a radically new communications capability, because it does not account for the vast, untapped market for new, not yet conceived applications.

ORBCOMM is targeting price-sensitive, short message, thin-route mobile and fixed data communications markets, which we categorize into four service groups: Emergency Service, Data Acquisition, Tracking, and Messaging. The major applications,

customers, competitors, and addressable markets in each category are shown in Table III-1 and discussed below.

B. ORBCOMM Markets

1. Emergency Services Market

a. Search and Rescue

There are an estimated 10 million pleasure boats over 12 feet in length registered in the U.S., and currently there is no emergency assistance communications service available other than that accessible by marine or CB radio.[16/] Use of ELTs and EPIRBs in conjunction with the COSPAS/SARSAT systems is restricted to aircraft and ships not for personal use. Similarly, there are estimated to be "over 8 million active campers, hikers, and the like who would be potential users" of a search and rescue communications and position determination system.[17/] There are 10 million visitors to U.S. national parks and 12 million visitors to U.S. forest service wilderness and backlands areas annually, and the number is increasing. Potential customers for a very low cost, light-weight search and rescue system include national and state parks, expedition organizations, wilderness areas, outfitters and individuals.

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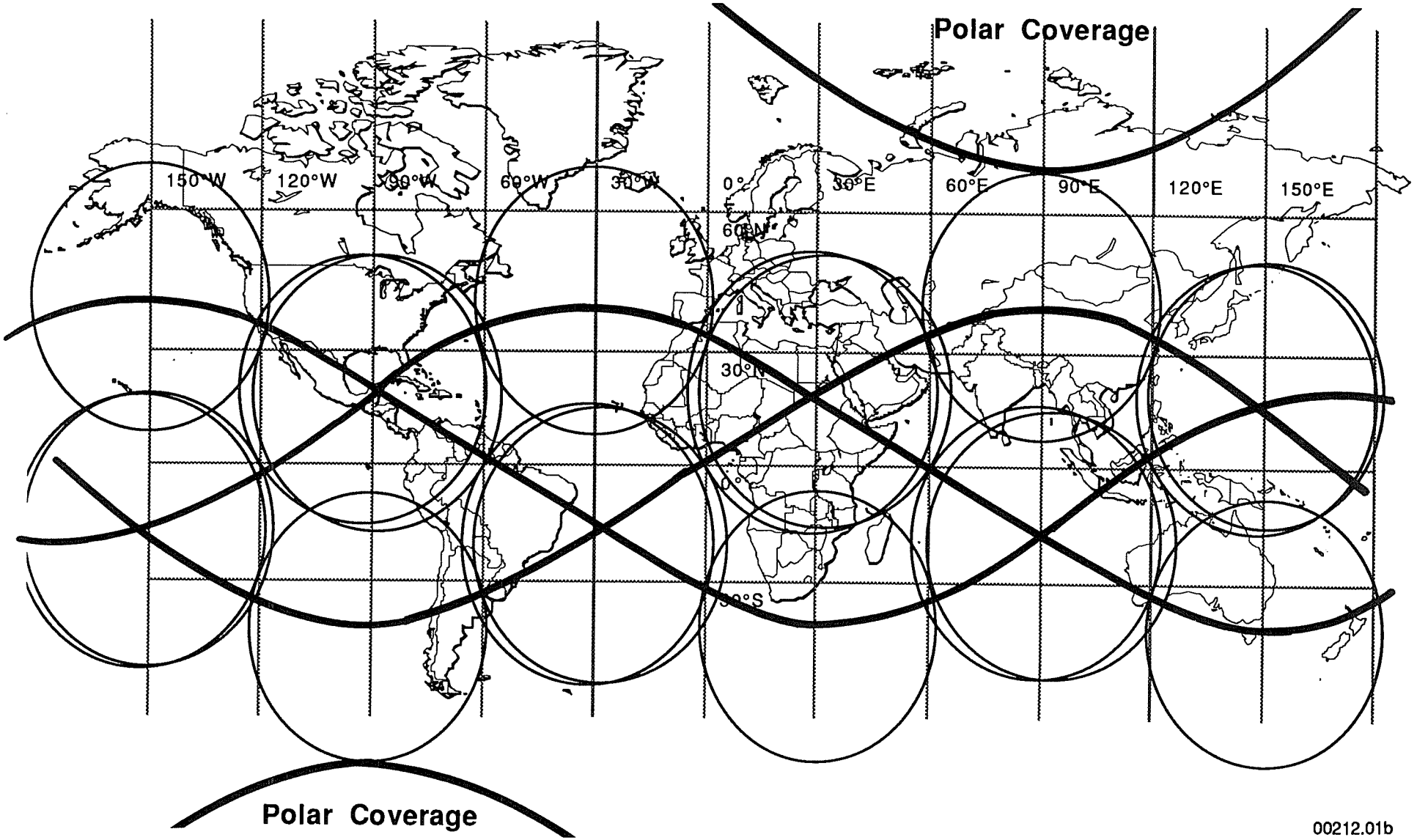
16/ INMARSAT provides reliable service to boats, but until recently the cost and size of the terminals made them impractical for pleasure boats. The new Standard C terminals, although smaller and less expensive than previous ship earth stations, will still be out of the price range of most casual boaters.

17/ PELTS NPRM at para. 8.

# Figure I-1
# ORBCOMM Satellite System Coverage




00212.01b

# Table III - 1

## Market Segment Description

| Service Category and Characteristics | Segments | Potential Customers | Major Service Providers | | Total Addressable U.S. Market |
|---|---|---|---|---|---|
| | | | Existing | Projected New Entries | |
| Emergency Service | Emergency road service | AAA, Sears,Amoco MotorClubs,General Driving Public | PSTN<br>Cellular<br>CB Radio | N. American Teletrack, AMSC<br>Am. Mobile Data<br>GMC | 48 million members subscribing to emergency road service<br><br>15 million new vehicles sold each year |
| | Search & rescue | Outdoorspeople Hikers, Scouts | COSPAS/SARSAT | GMC | 22 million visitors to National & U.S. Forest Service Parks |
| | Emergency Medical | Elderly, handicapped, persons with medical conditions | Amer. Med. Alert<br>Lifeline Systems<br>PSTN | CT2 and PCN | 12 million people over 65 with serious health problems |
| Data Acquisition | Environmental monitoring | State & Federal agencies | ARGOS<br>SUTRON<br>SNOTEL | GMC | 100,000 data stations operated by U.S. Government |
| | Industrial & utilities monitoring | Petroleum companies<br>Utility companies<br>Remote storage facilities | PSTN<br>VSAT | AMSC, GMC | 151 million meters and oil wells |
| | Remote asset monitoring | Vacation homeowners<br>Yacht owners<br>Private property owners | PSTN<br>Marine Radio<br>VSAT | GMC | 270,000 vacations homes and other remote properties |
| Tracking | Boxcars & containers | Railroads & container transport and shipping companies | GEOSTAR | GMC | 5 million boxcars & containers |
| | Stolen Property Recovery | Car and Boat owners<br>Constructions Co's.<br>Farmers<br>Airplane Owners | LoJack<br>Teletrack | GMC | 182 millions licensed motor vehicles and boats |
| | Customs & international shipment security | U.S. Customs<br>Shipping Companies<br>National Governments | GEOSTAR<br>QUALCOMM | None | Over 500,000 (Est.) U.S. Containers |
| | Animal tracking | State & Federal agencies<br>Universities<br>Research Institutes | ARGOS | None | 5,000 Argos terminals sold to date worldwide |
| Messaging | Personal & Business | Individuals, business persons, contractors, travellers | Celluar<br>Paging<br>Mobitex<br>SMR | INMARSAT, GEOSTAR, AMSC, GMC, CT2, PCN | 7.5 million pagers (15 million 1995)<br>2 million cellular phones (15 million 1995) |
| | Handicapped | Handicapped individuals and relatives/friends, schools | PSTN<br>TDD | AMSC, CT2, PCN, GMC | 2 million deaf persons |
| | Trucking | Trucking companies | GEOSTAR<br>QUALCOMM<br>TRANSTRACK<br>SMR<br>Cellular<br>Pegasus | AMSC | 1.3 million long and medium haul trucks |
| | SCADA | Petroleum & gas co's.<br>Utility companies | VSAT<br>PSTN<br>QUALCOMM | AMSC, SMR, GMC | 15,000 existing terminals |
| | Hazardous materials transport | DOE, Do, Co's. that ship hazardous materials | Sames as trucking | Same as trucking | 18,000 shipments of HAZMAT in 1988 |

GMC = GEOSTAR Messaging Corporation
AMSC = American Mobile Satellite Corporation
PSTN = Public Switch and Telephone Network
SMR = Specialized Mobile Radio
CT2 and PCN = Personal Communications Network
VSAT = Very Small Operature Terminals
TDD = Telephone Devices for The Deaf

b. Emergency Road Service

The market for emergency road services is most clearly defined by the estimated 48 million members of automotive road service clubs. Each year these members pay, at a minimum, between $30 and $50 for towing and other road-side service coverage. Approximately half of the estimated 30 million annual calls for emergency assistance are made from the home or office, with the other half made by the vehicle owner leaving the vehicle and making his or her way to a telephone or waiting for a police car to pass. Unfortunately it can be dangerous to leave the disabled vehicle to seek help, and in such situations ORBCOMM would be a safer way to summon assistance. Moreover, the ORBCOMM system has the advantage of position determination capability, so that help can be provided even if the motorist is not sure of his or her location.

Road service club members, by virtue of their memberships, are viewed as prime candidates for an in-car emergency communications service as a complement to their existing services. In addition to current auto club members, there are about 100 million other motor vehicles in the U.S. that are candidate subscribers for ORBCOMM emergency services. The number of new vehicles registered each year in the U.S. is about 15 million, and each is a potential "platform" for factory installation of an ORBCOMM terminal.

c. Emergency Medical

There are an estimated 12 million people living in the U.S. who are over 65 years of age and have a serious health problem. These persons may be confined to a wheel chair or not be able to move with full freedom. Although most are within ready reach of a telephone (fixed, portable, or cellular) or a connecting service such as LifeCall, ORBCOMM will provide another option for those persons who want the comfort of always being able to communicate and to have their position determined if necessary.

2. Data Acquisition

a. Environmental Monitoring

This market is comprised of organizations involved in the collection of data from numerous remote sensors for the purposes of assessing soil, water, and climate conditions, as well as for ocean surveillance, weather forecasting and geological surveyance. The U.S. Government currently operates over 100,000 data gathering stations. Data is collected over an extended period of time on an intermittent basis. Data priority is typically such that it can be stored and relayed over the ORBCOMM system during off-peak hours.

This service is currently provided by a number of techniques which include visual inspection, terrestrial radio transmitters, and use of ARGOS equipped satellites. Yet there are intense pressures to improve remote date collection

capability.[18] ORBCOMM's low-cost service could make it practical to automate environmental testing processes. Potential customers include the U.S. Navy, U.S. Army, U.S. Geological Survey, National Oceanographic and Atmospheric Administration, Environmental Protection Agency, Department of Agriculture, Department of Interior, and state and local governments.[19]

b. Industrial and Utilities Monitoring

Approximately 150 million electric, gas and water meters are operated by over 200 local utility companies in the U.S. There are 600,000 artificial-lift oil wells in the U.S. with a greater than 50% annual breakdown rate. Pumping stations, wells, storage facilities, power generating equipment and substations, energy load management and control equipment and other systems are often distributed over a broad geographical area and located in remote regions. At present, the process of monitoring some of these systems is both very labor-intensive and expensive. The current monitoring uses the PSN, microwave radio, and VSAT systems. In many instances, ORBCOMM will support the

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[18] The January 18, 1990 edition of The New York Times contained a story describing the plight of shell fishermen who are not permitted to harvest because the waters have not been tested due to lack of inspectors. At least 5 samples are required from each of 1,000 sites and there are only five full-time employees to do it. ORBCOMM could facilitate the low cost, continuous monitoring of these sites.

[19] OSC is conducting an experiment in conjunction with the State of Virginia that involves, inter alia, environmental monitoring in the Chesapeake Bay watershed via a low-earth orbiting satellite. See Appendix E for a more detailed description of that program.

monitoring and control of remote stations within these networks more efficiently. Customers will include public and private utilities, petroleum and other energy production and transmission companies, and large corporate and industrial facilities.

c. Remote Asset Monitoring

There are estimated to be 270,000 remotely situated vacation homes and remote properties in the U.S. Many of these assets are located in areas geographically removed from the owners, with no telephone service, and are visited on an infrequent basis. There is, therefore, no means to monitor for fire, flood, and break-ins. ORBCOMM's proposed service will help guard the integrity and security of vacation homes, yachts, farms, and other remote property. Customers would include individuals, yacht charter operations, and rural home security service companies. The low-power nature of the subscriber equipment permits even solar-powered units.

3. Tracking

a. Boxcars and Containers

There are approximately 1.3 million freight "boxcars" in service in the U.S. There are over 5 million multimode containers in service worldwide with over 100,000 of indeterminate location at any given time. The container tracking market is promising because intermodal containers (e.g., those traveling by rail, truck, and sea) move great distances through a variety of ports and vehicles while loaded with valuable cargo.

Container location is not always certain after unloading at the dockside or freight yards, or when moving by truck or train. Container companies also have an interest in knowing status and location because with such information they can provide a better and faster end-to-end service to their customers.

b. Stolen Property Recovery

There are over 1.3 million car thefts, 180,000 truck and bus thefts, 25,000 pleasure boat thefts and 2,000 major construction equipment thefts in the U.S. annually. There are 182 million vehicles and boats registered in the U.S., and each is a candidate for installation of ORBCOMM terminals and services. In addition, the 15 million new cars and trucks sold each year in the U.S. creates a market for OEM factory installations. Vehicle tracking and theft protection for automobiles, construction and farm equipment, boats, airplanes, and over-due rental cars will offer a large market for low cost ORBCOMM services.[20/] These services could be marketed in tandem with insurance companies so as to offer reduced premiums for persons subscribing to the ORBCOMM theft protection service.

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20/ Currently, the Massachusetts-based LoJack offers effective automobile theft protection, on a city-by-city basis. Perhaps in cooperation with LoJack, ORBCOMM could offer such services in much broader geographic and demographic markets.

### c. Customs and International Shipment Security

ORBCOMM could improve the effectiveness of current efforts to monitor movement of goods in international commerce by means of an ORBCOMM transmitter attached to those goods. Governments and private companies could determine whether classified or sensitive materials had reached their intended destination, while customs and law enforcement officials would be able to track the transport of contraband. At the low-end of the market, given the low costs of the services, individuals might even enclose units in suitcases to be used in the event luggage was lost.

### d. Animal Tracking

The current small market for animal tracking systems is largely concerned with further understanding of migration, behavioral habits, and environmental threats to animals and the preservation and well-being of animal species. This is currently done using the ARGOS system, requiring about 10-15% of the ARGOS capacity, but a more flexible system with more frequent satellite passes and better spectrum utilization efficiency is desirable.[21/] Over and above any commercial market potential is the need to provide a better way than is presently available for tracking wildlife. Monitoring wildlife is regarded by researchers to be

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[21/] In addition to the advantages of better coverage, the ORBCOMM system will be provided by an American company (as opposed to the foreign-based ARGOS system), and thereby help offset the telecommunications trade deficit.

critical to preservation of species and the environment.[22/] Customers for such service would include the Department of Interior, Bureau of Land Management, Department of Fish and Game, other government entities, non-profit organizations and universities.

4. Messaging

a. Personal and Business

This market is perhaps the most difficult to assess. The market is comprised of those persons who would carry a pocket-portable user terminal for two-way communications -- the ability conveniently to send and receive "personal telegrams" (i.e., short, critical messages) to and from any other terminal immediately, without requiring use of a telephone, and without knowing the location of the other terminal. Cellular and paging services partially address this requirement, but fall short in terms of geographic coverage or absence of two-way communications capability. As one measure of the potential market, it is estimated that in 1988 there were 7.5 million pagers and 2 million cellular phones in service. The pagers and cellular phones are projected to increase to a total of 30 million by 1995.[23/]

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22/ An unknown and untapped potential market is for tracking livestock and pets. The ORBCOMM devices will be small and light enough to be carried by even small animals. ORBCOMM thus envisions use by ranchers and pet owners.

23/ Telocator, January 1990. While there are currently no organizations offering a service directly comparable to ORBCOMM's, (continued...)

Another potential application of the messaging terminal is its use as a highly convenient input/output device for connection to database systems (with store-and-forward capabilities as an added feature). In this mode, the ORBCOMM system provides a portable and mobile extension of these databases for limited, brief usage. Remote claims processing, paging, stock market quotes and transactions, and tie-in to E-mail services are among the many applications that will be served in this manner.

b. Handicapped

There are approximately two million people in the U.S. with severe hearing impairments. For these persons communications could be made more convenient and efficient using ORBCOMM's two-way messaging. At present it is often difficult for deaf individuals to contact other parties using traditional methods of communications such as the telephone. ORBCOMM can provide two-way communications for the deaf with alphanumeric readouts, and for the blind with synthesized voice messages.

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23/ (...continued)
INMARSAT is planning a higher cost version of such a service in the next few years using Standard-C and follow-on systems, AMSC proposes to develop a more sophisticated voice and data service, and other types of proposals are likely to arise. ORBCOMM will seek to investigate whether its proposed services can be offered as supplements to these higher-cost services in cooperation with such organizations.

### c. Trucking

There are an estimated 1.3 million medium- and long-haul trucks in service in the U.S. Some companies are installing systems in trucks and dispatch centers to provide messaging and position location capabilities to and from vehicles while they are on the road. The truck-mounted terminals and the service charges for two-way messaging and location are currently expensive, and it is expected that their use will be restricted to larger fleets and to those operations requiring frequent communications and possibly the transfer of lengthy files.

ORBCOMM will reduce the equipment prices to as little as 10% of the cost of current alternatives, a feature that is projected to appeal to smaller, less well financed fleets. The ORBCOMM system is not designed or suitable for operations requiring transmission of more than a few short messages per day (including position). It is the intent of ORBCOMM to serve those fleet operations that find the current satellite-based services unaffordable and in excess of their communications and position determination requirements.

### d. SCADA (Supervisory Control and Data Acquisition)

The SCADA market is for fixed location communications presently provided to the petroleum and energy industry by VSAT terminals using GEO satellites, by the public switched telephone network, and SMR-type systems. SCADA is most often associated with monitoring and controlling liquid petroleum pipelines and

other valuable systems, and therefore requires split-second response and very high reliability, but it is also cost-competitive. ORBCOMM may prove attractive at lower cost compared to other systems based on the low equipment and service charges, albeit limited to low data rate and infrequent service. Customers would include petroleum and energy companies, petroleum service companies and utilities.

e. Hazardous Materials Transport

Federal regulations require the Department of Energy to track spent nuclear fuel and radioactive waste. QUALCOMM's OmniTracs system is used in conjunction with the DOE's own monitoring system for hazardous materials tracking. However, other transporters and government organizations such as the Department of Transportation, Environmental Protection Agency and the Department of Defense may also be interested in ORBCOMM services as a less expensive way to track hazardous materials, sensitive equipment and munitions.

C. Proposed ORBCOMM Services And Subscriber Terminals

1. Description of Services

ORBCOMM will offer the following services tailored to meet specific subscriber needs in the four major market segments described above:

- **SecurNet**[sm] Emergency Services
- **DataNet**[sm] Data Acquisition Services
- **MapNet**[sm] Tracking Services

. **VitalNet℠** Message Services

The data communication and position determination capabilities of the ORBCOMM system will be used in all four services. The differences between service offerings primarily will hinge on subscriber terminal equipment and system operations. For example, DataNet Data Acquisition Services typically will operate as a polled service whereby the terminals will be instructed to transmit on command from the network, and the information can be transmitted on a store-and-forward basis. In contrast, SecurNet Emergency Services will provide instant access to the system on a random priority basis. These differences among the services impact subscriber equipment and service costs significantly.

a. SecurNet Emergency Services

SecurNet services, as the name implies, will be tailored to meet the needs of persons urgently in need of assistance of some kind who lack access to a telephone. These individuals may or may not be conscious; they may be lost or unable to communicate their location. Figure III-1 shows the three major service applications in this segment and the characteristics of each: Emergency Road Services, Search and Rescue Services, and Emergency Medical Services. The key benefits to the subscribers and the estimated size of the U.S. addressable markets are also shown.

Emergency service subscribers require a highly reliable, real-time, two-way priority communications system analogous to "911" services. To be attractive to the large