U.S. Department of Transportation
Office of the Secretary of Transportation

400 Seventh St., S.W.
Washington, D.C. 20590

MAY 16 1995

Dear Colleague:

Following the issuance of an April 1995 Federal Register Notice requesting data on the Low Earth Orbit (LEO) commercial satellite and launch vehicle market, Office of Commercial Space Transportation (OCST) staff prepared the enclosed projections of the number of small commercial satellites to be launched to LEO in the period 1995-2005. For purposes of this assessment, the LEO market was defined to include all systems operating in either Low or Medium Earth Orbits (MEO). A discussion of the related demand for LEO launch services is provided in the accompanying text, along with assumptions and factors used in developing the projections.

These projections represent an update to a prior assessment of the LEO market conducted by OCST in March 1994. As with the former assessment, the updated market study was developed to assist OCST in supporting a variety of Administration efforts, including Interagency Working Groups that review U.S. space transportation issues. Our intent was to further clarify near-term commercial space transportation needs for launching small satellites to LEO, particularly given recent developments in the dynamic LEO market segment. Due to the evolving nature of this market, OCST will continue to monitor LEO commercial activities and prepare additional updated projections, at least annually, as new information becomes available.

I appreciate all of the input and assistance provided to facilitate this effort.

Sincerely,

Frank C. Weaver

Frank C. Weaver, D.Sc.
Director, Office of Commercial
Space Transportation

Enclosure

LEO Commercial Market Projections

I. Introduction

The attached charts contain projections of the Low Earth Orbit (LEO) commercial payload and launch markets for the period between 1995 and 2005. The information in the charts was developed by the Department of Transportation's (DOT) Office of Commercial Space Transportation (OCST) on the basis of responses to an April 1995 Federal Register Notice (issued by OCST) requesting data on the LEO commercial market, as well as publicly available information and OCST research. This latest assessment represents an update to a prior study of the LEO market that OCST conducted in March 1994 to facilitate a variety of Administration efforts, including Interagency Working Groups reviewing U.S. space transportation issues. Given the dynamic and somewhat uncertain nature of this market segment, further efforts will be made, at least annually, to update the projections and/or account for new activities as the market continues to develop.

The results presented in this study do not indicate DOT support or preference for any particular proposal or system. Rather, the information provided reflects an OCST assessment of overall trends in the mobile communications services and LEO commercial satellite markets, with the ultimate purpose of projecting future space transportation needs to LEO. System characteristics necessarily utilized in making such projections (such as number of payloads, launch schedule, etc.) are representative of proposals currently under consideration in industry.

II. Proposed LEO Communications Systems

Table 1 provides a listing of the various publicly announced proposals for LEO communications systems currently under development within the industry. The systems are listed as "Little," "Big," or "Mega" LEO constellations, depending on the capabilities provided by the system. Little LEOs would provide mobile data messaging and position determination services on a global level, while Big LEOs would add mobile voice and fax capabilities; Mega LEOs would provide wireless video, voice, and broadband, high-speed data services to small satellite dishes.[1] Such a list is critical to a study of the potential size of the LEO satellite and/or small vehicle launch market, as LEO constellations will in all likelihood provide the highest level of demand for satellites and launch services for this market segment. The orbit altitude and inclination for the various systems are provided in Table 2.[2]

III. Market Scenarios

Many of the systems listed in Table 1 were under consideration by industry at the time of OCST's 1994 assessment. Nonetheless, given the uncertain status of many of the efforts and the apparent impact of various market and regulatory factors at that time, OCST determined that one to two Big LEO systems and one Little LEO system might ultimately be deployed in the 1994-2005 time frame (these potential outcomes were described in terms of two market scenarios).

Since that time, however, significant progress has been made by a number of system proposers in terms of regulatory approval, technical development, contracting, and financing. Moreover, several new proposals for LEO

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[1] For purposes of this assessment, Medium Earth Orbit, or MEO, systems providing global, mobile communications services have been listed as Big LEOs.

[2] Although a number of non-U.S. LEO constellations have been discussed conceptually or proposed by other nations, most are not listed due to their comparatively early stage of development and/or authorization.

constellations have been formally announced within the last year, substantially increasing the number of potential participants in the market for mobile, satellite-based communications services (particularly in the case of Little Leo systems). Given these developments, OCST again undertook a review of potential commercial demand in this market, utilizing certain assumptions and completed studies concerning:

1) the projected customer demand for personal communications services;

2) the potential effect of various competing technologies (e.g., cellular phones, GEO-based mobile communications services) on that market;

3) potential limitations on the availability of capital for such projects; and

4) the government authorization/licensing process, and the availability of frequency spectrum necessary for the operation of LEO systems.

Particular attention was also paid in the assessment to the status of contracting for the various proposals, in terms of both satellite development/production and launches.

On the basis of these considerations, OCST determined that *at least* one Little LEO and two Big LEO systems would probably be deployed in the 1995-2005 time frame (the more optimistic scenario from the 1994 assessment), and that additional Big and Little LEO systems might also reach operational status. Although some data obtained by OCST staff indicated that as many as four Big LEO proposals, and several Little LEO proposals, *might* eventually take further steps toward market entry, the most likely "high-end" scenario appeared to be that three Big LEO systems and two of the larger Little LEO constellations would be deployed and would sustain operations in this time frame.

Accordingly, Tables 3 and 4 present OCST projections of small commercial satellite demand under two different scenarios, with three market segments identified for each scenario (Big LEO communications systems, Little LEO communications systems, and the more general category of remote sensing, international scientific, and microgravity payloads). For clarity, the charts also contain separate projections of on-orbit failure replacement/Operations & Maintenance (O&M) payloads for both classes of LEO systems.

Consistent with the above discussion, Scenario 1 projects that two Big LEO systems and one Little LEO system will be deployed, while Scenario 2 (the high-end outcome) projects three deployed Big LEO systems and two deployed Little LEO systems. As with the 1994 assessment, Mega LEO systems have not been included in either scenario at this time due to the unusual challenges involved in their design, deployment, and financing, and to the current lack of contracts for satellite production and launches for such systems. However, OCST will continue to pay close attention to such proposals as the projections presented in this document are updated in coming months. It should also be noted (as stated earlier) that the projections and deployment schemes provided for Big and Little LEO systems in the two scenarios are representative of the characteristics described in various proposals currently under consideration by industry, and are not intended to signify OCST support for any individual system or proposal.

IV. Launch Demand

An assessment of the launch schemes for the various LEO constellations indicates that most Big LEO proposers currently plan to deploy the bulk of their satellites on medium-to-large commercial launch vehicles (capable of launching at least 10,000 to 20,000 pounds to LEO). However, Big LEO proposers apparently intend to conduct at least some portion of their failure replacement launches on small launch vehicles, usually in clusters of two or three satellites.

Little LEO proposers currently intend to conduct both deployment and replacement launches on small launch vehicles due to the relatively small size of these payloads. Also, organizations planning remote sensing, international scientific, or microgravity payloads will most likely use single-manifested small launch vehicles.

Based on these assumptions, the resulting Scenario 1 demand for commercial launches to LEO for the period between 1995 and 2005 should be approximately:

- 5 to 10 medium-to-large launches per year *during deployment phase*s (1996-1998, 2002-2005), depending on the system and the particular launch scheme; and

- 8 to 12 small vehicle launches per year (but with only four launches occurring in 1995).

The resulting Scenario 2 demand for commercial LEO launches for the same period should be approximately:

- 5 to 10 medium-to-large launches per year during deployment phases, with the number of launches most likely falling in the high end of this range during the years 1996-1998 and 2002-2003, and in or near the low end of this range during the years 1999-2000 and 2004-2005; and

- 9 to 14 small vehicle launches per year (but again with only four launches occurring in 1995).

More specific estimates of LEO launch demand for the two market scenarios are provided in Table 5 with respect to year (or range of years) and vehicle class.

Based on available information, the competitions for these launches should in most cases be open to bids from all international commercial launch service providers.

Table 1

PROPOSED LEO COMMUNICATION SATELLITE SYSTEMS[1]

TYPE	SYSTEM	OPERATOR	MANUFACTURER	OPERATIONAL[2] SATELLITES	SATELLITE MASS (lbs)	DEVELOPMENT COST ($B)	PROPOSED 1st LAUNCH [3]
"MEGA" LEO	Teledesic	Teledesic Corp.	TBD	840	1716	9	1999
BIG LEO	AMSC	AMSC Subsidiary Corp.	TBD	12	5000 - 5500	Unknown	1998 - 1999
	Constellation	Constellation Comm.	Lockheed Martin	46	1160	1.7	1998
	Ellipso System	Mobile Comm. Holdings	Fairchild	16	1430	0.9	1998
	Globalstar	Loral Qualcomm	SS/Loral	48	990	1.9	1997
	Inmarsat P	Inmarsat Affiliate	TBD	10	5500	2.6	1999
	Iridium	Motorola	Lockheed Martin	66	1500	3.4	1996
	Odyssey	TRW	TRW	12	4225	2	1998
	Signal (Glonass)[4]	Russia	NPO Energia	48	680	Unknown	1995 - 1996
LITTLE LEO	E-Sat	E-Sat, Inc.	TBD	6	250	Unknown	1997 - 1998
	FAISAT	Final Analysis Comm.	Final Analysis, Inc.	26	220 - 250	0.14	1997
	GE Americom	GE American Comm.	TBD	24	33	0.189	1997 - 1998
	GEMNET	CTA	CTA (D.S.I.)	38	99	0.10+	1997 - 1998
	Leo One	Leo One Panamer.	CTA (D.S.I.)	12 - 24	330	Unknown	1997
	Leo One USA	Leo One USA	TBD	48	274	0.2	1997 - 1998
	Orbcomm	Orbital Comm.	Orbital Sciences	36	87	0.17	1995
	Starsys	Starsys	TBA	24	165	0.25	1997
	Taos[4]	CNES	Matra Marconi	12	330	Unknown	1996
	Vitasat	VITA	Surrey Sat.	2	300	Unknown	1995

(1) Proposals for systems in intermediate circular or MEO orbits (such as AMSC, Inmarsat P, and Odyssey) have also been included in the study.

(2) The proposals for Big LEO systems generally entail initial deployment in clusters on large vehicles. Failure replacement/O & M launches would in most cases utilize small launch vehicles. The systems generally assume a satellite failure rate of approximately 10%. (Most of the proposals involve the launch of spares in the initial deployment, which are not reflected in the table.)

(3) The proposals typically call for deployment in 2 to 3 years.

(4) These foreign LEO systems would probably be launched on foreign launch vehicles. (Other foreign LEO systems are under discussion, but are not listed due to their comparatively early stage of authorization and development.)

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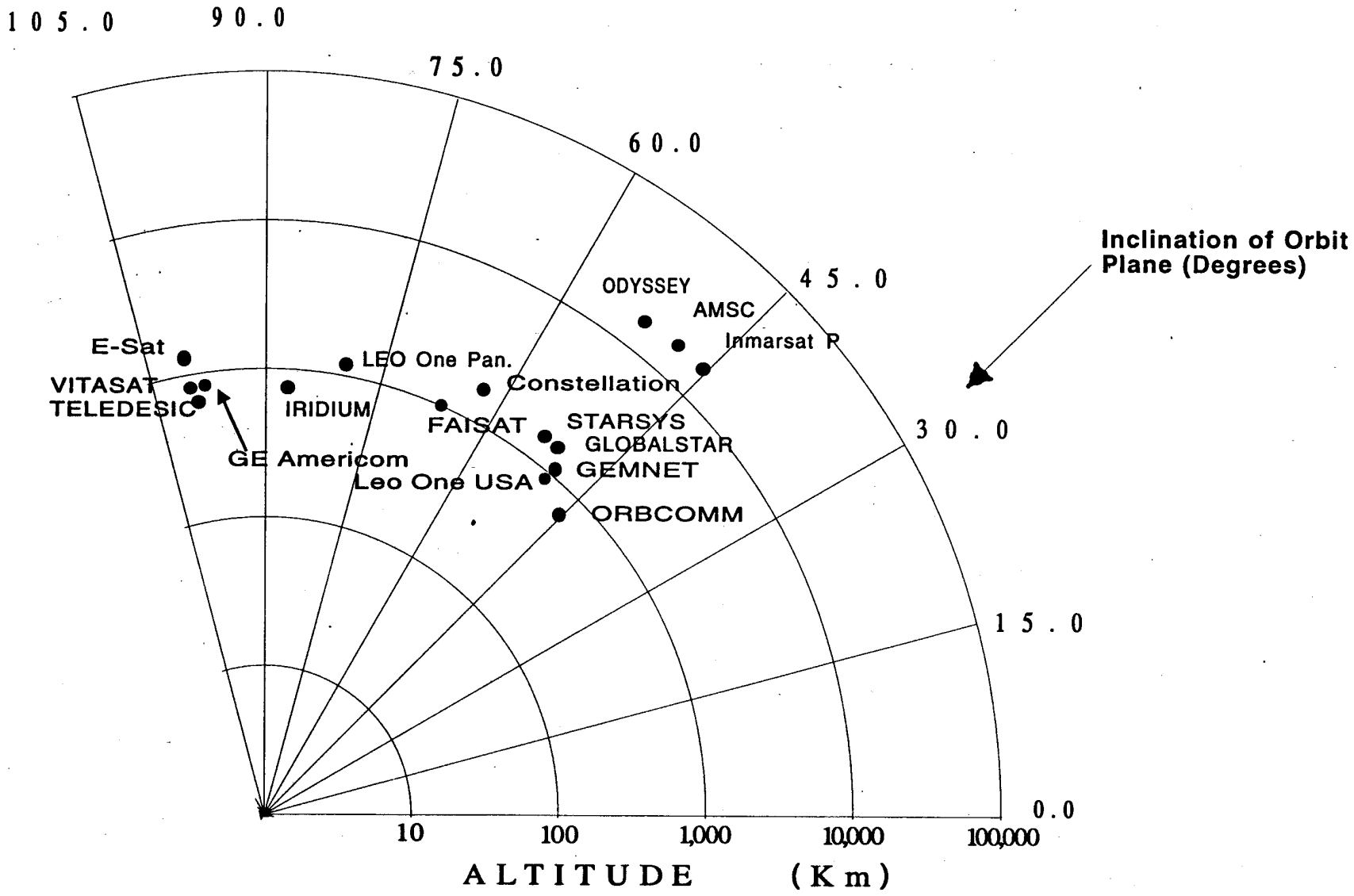
Table 2

PROPOSED LEO SYSTEM ORBITS



NOTE: Systems are not listed if the orbit characteristics are either undefined or unknown. In cases where the system uses planes of different inclinations (e.g., an equatorial plane and inclined planes) the listing corresponds to the location of the majority of the satellites in the system. Ellipso is not listed because it uses elliptical orbits that do not apply to this format.

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Table 3
LEO COMMERCIAL PAYLOAD PROJECTIONS (SCENARIO 1) [1]

MARKET SEGMENT	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Big LEO	0	21	67	41	0	0	0	43	30	24	32
Little LEO	2	16	18	0	0	18	18	0	0	0	18
(2) Big/Little LEO "O & M" Support	0	0	2	10	8	8	11	8	8	8	10
(3) Remote Sensing/ Int'l Scientific/ Microgravity	3	5	7	7	4	2	2	6	8	5	2
TOTAL:	5	42	94	58	12	28	31	57	46	37	62

NOTES:

1. Scenario 1 assumes that two Big LEO and one Little LEO system will become operational. The projections and deployment schemes shown are representative of current proposals for LEO systems, and include the launch of spares.

2. Numbers are approximations based on estimates of satellite failure rates for the three systems.

3. Where appropriate, a 5-year on-orbit life cycle/system replacement phase was assumed for these classes of payloads. U.S. Government military and civil payloads have not been included.

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Table 4
LEO COMMERCIAL PAYLOAD PROJECTIONS (SCENARIO 2) [1]

MARKET SEGMENT	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Big LEO(s)	0	21	67	41	6	6	0	43	30	24	32
Little LEO	2	16	24	6	12	18	18	12	12	0	18
(2) Big/Little LEO "O & M" Support	0	0	2	11	9	8	11	8	10	9	10
(3) Remote Sensing/ Int'l Scientific/ Microgravity	3	5	7	7	4	2	2	6	8	5	2
TOTAL:	5	42	100	65	31	34	31	69	60	38	62

NOTES:

1. Scenario 2 assumes that three Big LEO and two Little LEO systems will become operational. The projections and deployment schemes shown are representative of current proposals for LEO systems, and include the launch of spares.

2. Numbers are approximations based on estimates of satellite failure rates for the five systems.

3. Where appropriate, a 5-year on-orbit life cycle/system replacement phase was assumed for these classes of payloads. U.S. Government military and civil payloads have not been included.

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Table 5

POTENTIAL LEO LAUNCH DEMAND FOR THE TWO MARKET SCENARIOS

	SCENARIO 1					SCENARIO 2					
	1995	1996-98	1999-01	2002-03	2004-05	1995	1996-98	1999-00	2001	2002-03	2004-05
SMALL VEHICLE LAUNCHES	4	8-12/yr	8-12/yr	8-12/yr	8-12/yr	4	9-14/yr	9-14/yr	9-14/yr	9-14/yr	9-14/yr
MED -TO- LARGE VEHICLE LAUNCHES	0	5-10/yr	0	6-9/yr	4-6/yr	0	5-10/yr	3-6/yr	0	6-9/yr	4-6/yr

NOTE: **The launch ranges presented above are estimates only, and will in the end depend greatly on the particular system and launch scheme.**

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