LEO

Commercial Market Projections

Office of the Associate Administrator
for Commercial Space Transportation

Federal Aviation Administration

Department of Transportation

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EXECUTIVE SUMMARY

PROJECTED SATELLITE DEMAND

Based on the information provided in this report, the Federal Aviation Administration's Associate Administrator for Commercial Space Transportation (AST) has developed two scenarios describing LEO satellite and launch services demand in the 1997 to 2006 time frame: a "modest growth" scenario and a "high growth" scenario. This approach is similar to the one used to prepare the 1996 LEO Commercial Market Projections report. The modest growth scenario is based on relatively conservative assumptions regarding market demand and is considered to be more likely than the high growth scenario.

- Modest Growth: AST projects that four big LEO (including MEO) and two little LEO systems will be deployed from 1997 to 2006.
- High Growth: AST projects that five big LEO systems, one broadband LEO (formerly referred to as a "mega" LEO), and three little LEOs will be deployed from 1997 to 2006.

It appears that demand in the commercial remote sensing market will be capable of supporting as many as four of the proposed ventures to provide commercial high-resolution imagery (containing between one and four satellites each). Thus, commercial remote sensing ventures — along with a steady requirement for commercial launch of scientific and microgravity payloads — could represent a secondary source of demand for LEO satellites and launches.

PROJECTED LAUNCH DEMAND

Based on AST's satellite demand projections, the demand for commercial launches to LEO for the "modest growth" scenario should be 9 to 14 annual medium-to-large-class launches (payloads greater than 10,000 lbs.) through the year 2000, decreasing to 2 to 4 launches per year from 2001 to 2002, surging to 11 to 14 per year in 2003 to 2004, and dropping to 4 to 6 per year for the remainder of the forecast period. Demand for small launches (payloads of 10,000 lbs. or less) will vary between 9 and 14 annual launches, except for a surge in demand to between 13 and 17 launches from 2001 to 2002. The deployment of a broadband LEO constellation — the primary demand driver for AST's "high growth" scenario — will increase demand for medium-to-large commercial launches to between 14 and 24 annual launches from 2001 to 2004.

IMPLICATIONS OF ADDITIONAL GROWTH IN DEMAND

AST also considered the implications of extremely dramatic growth in the market for LEO satellite services by analyzing a "what if" case. This case, comprised of six big LEO systems, two broadband LEO systems, and six little LEO constellations, represents a boundary condition based on very optimistic assumptions regarding market demand. As such, the "what if" case is considered to be even less likely than the high growth scenario. Analysis of this case indicates that aggregate demand for launch services could peak at between 18 and 24 medium-to-heavy-class launches from 2003 to 2004 and between 28 and 32 small launches from 2005 to 2006.

LEO COMMERCIAL MARKET PROJECTIONS

I. INTRODUCTION

The Federal Aviation Administration's Associate Administrator for Commercial Space Transportation (AST) has prepared projections of the low Earth orbit (LEO) commercial payload and launch markets for the period between 1997 and 2006. This assessment includes market projections for all commercial systems in orbits other than geostationary Earth orbit (GEO), including systems planned for LEO, medium Earth orbits (MEO) and elliptical orbits (ELI).[1] This report was developed based on AST research and discussions with industry, including satellite service providers, satellite manufacturers, launch service providers, and independent analysts.

This assessment represents an update of prior AST studies of the LEO market conducted in March 1994, May 1995, and April 1996. These studies have facilitated a variety of Administration efforts, including Interagency Working Groups reviewing U.S. space transportation issues. The study results do not indicate FAA support or preference for any particular proposal or system. Rather, the information provided reflects an AST assessment of overall trends in the LEO commercial satellite markets, with the ultimate purpose of projecting future space transportation needs to LEO. The LEO system characteristics critical to making such projections (such as the number of payloads and launch schedule) are representative of systems that are in development or that have been proposed by the satellite services industry.

II. PROPOSED LEO SYSTEMS

To assess the size of the overall LEO commercial market, it is first necessary to understand the range of proposed LEO satellite constellations. These multi-satellite systems — dedicated primarily to serving telecommunications markets — will produce the highest level of demand for LEO satellites and launch services during the forecast period.

Figure 1 lists the publicly announced proposals for LEO communications systems currently under development in each of three market categories:

- "Big" LEO systems typically operate in the 1 to 2 GHz range and provide voice and data communications, particularly mobile telephony. Big LEO systems will compete with GEO and ground-based providers of mobile telephony services.
- "Little" LEO systems will operate at frequencies below 1 GHz and provide data communications such as e-mail, two-way paging, and messaging, typically in locations that are difficult to serve through terrestrial data systems (e.g., rural settings).
- Broadband LEO systems will provide high-bandwidth data communications, including videoconferencing, voice, and high-speed data services. Broadband LEO systems will compete with GEO-based data relay systems, primarily using the Ka-band frequency range.

[1] Circular LEO orbits generally have altitudes up to 1250 miles; circular MEO orbits have altitudes ranging from 1250 miles to 22,264 miles (the altitude of geostationary orbit). ELI orbits vary in altitude, with a perigee (lowest part of the orbit) no lower than 100 miles, and an apogee (highest point in the orbit) as high as 100,000 miles.

SYSTEM	OPERATOR	MANUFACTURER	OPERATIONAL SATELLITES PLUS ON-ORBIT SPARES	PER SATELLITE MASS (lbs.)	ORBIT (1)	FIRST LAUNCH	STATUS
BROADBAND LEO							
Celestri	Motorola	TBD	63+7	7000	LEO (2)	2001	FCC application submitted
Skybridge	Alcatel Espace	TBD	64+4	1770	LEO	2002	FCC application submitted
Teledesic	Teledesic Corp.	TBD	288+12	2850	LEO	2001	Licensed; in planning
BIG LEO							
Constellation	Constellation Communications	Matra Marconi	47+7	775	LEO	2000	2nd round FCC license approved
Ellipso	Mobile Comm. Holdings Inc.	Spectrum Astro	18+4	1550	LEO & ELI	2000	2nd round FCC license approved
Globalstar	Loral Qualcomm	Alenia Spazio	48+8	985	LEO	1997	Licensed; development and launch contracts signed
ICO	ICO Global Communications	Hughes	10+2	6050	MEO	1998	Development and launch contracts signed
Iridium	Motorola	Lockheed Martin	66+6	1500	LEO	1997	Licensed; launching
Odyssey	TRW	TRW	12+0	4880	MEO	2000	Licensed; in planning
LITTLE LEO							
E-Sat	E-Sat, Inc.	TBD	6+0	250	LEO	2000	2nd Round Little LEO applicant
Faisat	Final Analysis Communications	Final Analysis, Inc.	26+0	332	LEO	1999 (3)	2nd Round Little LEO applicant
GEMNet	CTA Space Systems	CTA Space Systems	38+TBD	100	LEO	2000	2nd Round Little LEO applicant
Gonets D	Smolsat (Russia)	NPO-PM	36+0	500-550	LEO	1997	Launching
IRIS	SAIT-Systems (Belgium)	OHB-Systems	2+0	144	LEO	1998	In development
LEO One USA	LEO One USA	TBD	40+0	275	LEO	2000	2nd Round Little LEO applicant
Orbcomm	Orbital Communications	Orbital Sciences	28+0	95	LEO	1995 (4)	Licensed; in development
SAFIR	OHB Teledata (Germany)	OHB -Systems	6+0	132	LEO	1997	In development
Starsys	GE/Starsys	Alcatel	24+TBD	165	LEO	1999	Licensed; in planning
Temisat	Telespazio (Italy)	Kayser-Threde	7+0	88	LEO	1997	In development
Vitasat	Volunteers in Tech. Assistance	Final Analysis, Inc.	2+0	198	LEO	1999 (5)	Licensed; in planning

(1) Low Earth Orbit (LEO); Medium Earth Orbit (MEO); Elliptical Orbit (ELI).
(2) CELESTRI application includes integration with Motorola's GEO broadband data system.
(3) FAISAT is currently operating one satellite under an experimental license, a second experimental satellite is scheduled for launch in 1997.
(4) ORBCOMM launched two demonstration satellites in 1995; their full constellation is scheduled to begin deployment in 1997.
(5) VITASAT is currently leasing transponder space on FAISAT's experimental satellite.

Figure 1: Summary of LEO/MEO Communications Systems Under Development

Several of the LEO constellations listed in Figure 1 have been proposed by non-U.S. companies that do not require licensing by the FCC. Many of these non-U.S. systems have reached relatively advanced stages of development and can be expected to launch during the forecast period. In most cases, these systems consist of a small number of lightweight satellites designed for deployment as secondary payloads. They do not represent a significant driver of demand for U.S. commercial launch services.

In addition to these systems, there are many proposals for LEO constellations that remain at comparatively early stages of authorization, financing, and development. These systems are listed in Figure 2.

SYSTEM	OPERATOR	MANUFACTURER	OPERATIONAL SATELLITES	PER SATELLITE MASS (lbs.)	ORBIT	FIRST LAUNCH	STATUS
BROADBAND LEO							
M-Star	Motorola (U.S.)	TBD	72	3000	LEO	TBD	In Planning
WEST/MEO	Matra Marconi (France)	Matra Marconi	9	8800	MEO (1)	2003	In Planning
BIG LEO							
AMSC	AMSC Subsidiary (U.S.)	TBD	12	5500	MEO	TBD	In Planning
Gonets R (Mobile radio)	Smolsat (Russia)	NPO-PM	48	2200	LEO	1998	Unknown
Marathon/Mayak	Inforkosmos(Russia)	NPO-PM	10	5533	ELI	1998	Unknown
Signal	KOSS Consortium (Russia)	NPO Energia	48	680	LEO	TBD	Delayed
LITTLE LEO							
Courier/Convert	ELAS Courier Complex (Russia)	Moscow Institute of Thermotechnics	12	1107	LEO	2000	Unknown
Elekon	NPO-PM/Elbe Space (Russia/Germany)	NPO-PM	7	TBD	LEO	TBD	Unknown
KITComm	KITComm Pty. (Australia)	Aero Astro	8	TBD	LEO	1998	In Planning
LEO One Panamerica	LEO One Panamerica (Mexico)	CTA Space Systems	24	330	LEO	TBD	In Planning

(1) System will also include GEO satellites.

Figure 2: Proposed LEO/MEO Communications Systems Not Yet Under Development

While communications satellites will be the primary driver of demand for commercial launch services to LEO, the aerospace industry has produced a variety of proposals for commercial remote sensing[2] systems that will contribute to demand, particularly for small launch vehicles. Several proposed commercial remote sensing systems are listed in Figure 3. In addition to these payloads, international research organizations generate a low but steady level of demand for commercial launches of payloads to conduct scientific research, including microgravity and life sciences investigations.

[2] The term “remote sensing” encompasses a range of passive and active space-based techniques for observing the Earth. Passive systems collect energy reflected or emitted from the Earth, while active systems such as radar illuminate targets on Earth and collect reflected energy. While pioneered by government space programs for national security, scientific and meteorological applications, remote sensing images are increasingly available in the commercial marketplace. Proposed commercial remote sensing systems will gather information on conditions on Earth, including its oceans, atmosphere, land, vegetation, and human artifacts.

SYSTEM	OPERATOR	MANUFACTURER	OPERATIONAL SATELLITES	PER SATELLITE MASS (lbs.)	FIRST LAUNCH	STATUS
CRSS/SIS	Space Imaging EOSAT	Lockheed Martin Corporation	2	1800	1997	Scheduled for 12/97 launch
EarlyBird	EarthWatch, Inc.	CTA Space Systems	3	686	1997	First satellite delivered for launch
EROS	Core Technologies/ Israel Aircraft Industries (U.S./Israel)	IAI	8	598	1998	First two spacecraft are in development
QuickBird	EarthWatch, Inc.	Ball Aerospace	2	2000	1998	Satellite development underway
OrbView	Orbimage	Orbital Sciences Corporation	3	607	1995	OrbView 1 (Microlab) in operation
Resource-21	Resource-21	TBD	5	TBD	1999	In planning

Figure 3: Commercial Remote Sensing Systems

III. MARKET DEMAND SCENARIOS

Assessment Criteria

The AST forecast of demand for commercial launch services began with an assessment of the key drivers that affect the size and timing of LEO satellite development. AST assessed potential demand in each LEO market based on:

- the projected customer demand for target services (e.g., mobile telephony, data communications, remote sensing imagery)
- the potential effect of various competing technologies (e.g., cellular phones, GEO-based broadband data systems, aircraft-based remote sensing systems) on customer demand
- the government authorization/licensing process, and (as appropriate) the availability of frequency spectrum necessary for the operation of LEO systems
- potential limitations on the availability of capital for space-based systems
- the status of contracting for satellite development/production and launches.

Key Findings

AST research generated a series of key findings regarding each market segment (summarized below).

Big LEO — Since the release of the 1996 LEO Commercial Market Projections report, significant progress has been made by the first-round Federal Communications Commission (FCC) big LEO licensees[3] in terms of technical development, contracting, and financing. At the time of this forecast, several of the first-round big LEO licensees either have begun, or are about to begin, deployment of satellite constellations. Further, the second-round applicants have considerably strengthened their applications and, in late June 1997, both were granted licenses by the FCC. Based on this progress, AST has revised its projections to reflect the deployment and operation

[3] The FCC has accepted two rounds of applications for licenses to build and operate big LEO and little LEO systems. First-round big LEO licenses were granted to the operators of the Globalstar, Iridium, and Odyssey systems in early 1995. Second-round big LEO licenses were granted to the operators of the Constellation and Ellipso systems in late June 1997. First-round little LEO licenses were granted in late 1995 to the operators of the Orbcomm, Starsys and Vitasat systems. Second-round little LEO applicants include the operators of the Faisat, GEMnet, E-Sat, and LEO One USA systems.

of four big LEO constellations during the forecast period in its modest growth scenario. AST's high growth scenario is based on the deployment of five big LEO constellations as well as an additional broadband LEO constellation (discussed below).

While the proposers of big LEO systems face many challenges in preparing for system deployment, the critical issues for this class of satellite are the long-term sustainability and profitability of each system in its chosen market segment. Most of the big LEO systems seek to position themselves in the potentially lucrative mobile telephony market, as well as the emerging market for providing fixed phone services to locations that are currently unserved or underserved by terrestrial systems (e.g., rural villages in the developing world). In pursuing this market, the big LEO operators face competition from regional GEO providers of mobile telephone services (e.g., Satphone and the Asia Cellular Satellite (ACeS) consortium), as well as ongoing buildout of terrestrial telecommunications infrastructure. This forecast assumes that the big LEO providers are able to compete effectively in their selected markets, sustaining operations and replenishing their satellite constellations prior to the end of their scheduled service periods.

In addition to the big LEO systems currently under development, a number of the proposed systems listed in Figure 2 may also be deployed during the forecast period. Several of these systems (e.g., those being developed by Russian consortia) will probably not use U.S. commercial launch services.

Broadband LEO — Since the 1996 assessment, leading competitors for the broadband LEO market have made considerable progress in development, licensing, and financing. While these systems face unusual management and technical challenges, they are emerging as potential competition for GEO-based broadband data services. In this forecast, AST's high growth scenario projects the launch of one large broadband LEO system in addition to the big LEO systems discussed above.

Little LEO — As described in the 1996 forecast, spectrum availability, "market timing," and concerns about alternative terrestrial and space-based services continue to be critical issues facing the proposers of little LEO systems. To date, only one of the first-round licensees has proceeded with development of its proposed system (a second is proceeding by leasing transponder space, rather than by developing a dedicated satellite system). A variety of second-round little LEO applicants await FCC licensing decisions before proceeding with system financing and development. Due to the limited spectrum availability, the success of the second-round applicants depends on their ability to develop a viable spectrum sharing plan, not only with each other, but also with the first round of licensees. Given the limited progress in the last year for most of the little LEO proposers, AST projects deployment of two little LEO constellations for its "modest growth" scenario, and three little LEO constellations for its "high growth" scenario. This projection is unchanged from the 1996 AST LEO Commercial Market Projections.

With regard to non-U.S. LEO systems, it is likely that some of the proposed little LEO systems listed in Figures 1 and 2 will be partially deployed during the forecast period. As previously

discussed, many of these systems are planned for launch as secondary payloads and are not significant drivers of demand for U.S. commercial launch services.

Remote Sensing / International Scientific & Microgravity — AST reviewed both publicly available and proprietary sources of information to assess the status of the international remote sensing market. Based on this research, it appears that a number of proposed commercial providers of remote sensing have the resources to deploy initial systems. In addition, industry assertions that such ventures will be able to sustain operations throughout the 1997 to 2006 time frame appear to be credible, assuming demand increases as the price for high-resolution imagery falls. Thus, commercial remote sensing ventures could represent a secondary source of demand for small LEO satellites and launch services.

In addition to these remote sensing payloads, international research organizations will continue to demand commercial launches of payloads to conduct scientific research in LEO, including payloads for microgravity and life sciences investigations. An assessment of the demand for these commercial launches has also been incorporated into the projections in this report.

Market Scenarios

Figures 4 and 5 present AST projections of LEO payloads under the two different scenarios, with four market segments identified for each: big LEO communications systems, little LEO communications systems, broadband LEO communications systems, and the more general segment of remote sensing, international scientific, and microgravity payloads. In addition, Figures 4 and 5 separately identify the number of payloads required to support operations and maintenance (O&M) (e.g., failure replacement) for each scenario. The deployment approaches presented for big and little LEO systems in the two scenarios are representative of the constellation characteristics described in current industry plans and are not intended to signify AST support for any individual system or proposal.

The modest growth scenario (Figure 4) projects the deployment of four big LEO systems and two little LEO systems. The 512 total payloads included in this year's modest growth scenario is nearly identical to the 518 total payloads projected in the modest growth scenario in last year's version of the Commercial Market Projections. This scenario, based on relatively conservative assumptions regarding market demand, is considered more likely than the high growth scenario described below.

MARKET SEGMENT	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Broadband LEO	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Big LEO	46	73	16	12	6	0	38	43	36	12
Little LEO	8	20	6	6	6	14	20	0	0	6
Remote Sensing / International Scientific & Microgravity	7	10	6	6	6	7	7	7	7	7
LEO "O&M" Support	0	0	3	12	15	13	7	2	10	12
TOTAL	61	103	31	36	33	34	72	52	53	37

Figure 4: Projected Annual Payloads – Modest Growth Scenario

The high growth scenario (Figure 5) projects the deployment of five big LEO systems, three little LEO systems, and one broadband LEO system. The 980 total payloads projected represent net growth of over 60% over last year's high growth forecast, nearly all of which is attributable to the inclusion of the broadband LEO constellation in this year's high growth scenario.

MARKET SEGMENT	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Broadband LEO	0	0	0	0	64	128	108	0	0	0
Big LEO	46	73	16	18	12	18	50	55	42	18
Little LEO	8	20	6	12	6	14	20	0	6	6
Remote Sensing / International Scientific & Microgravity	7	10	6	6	6	7	7	7	7	7
LEO "O&M" Support	0	0	3	12	15	14	7	23	44	46
TOTAL	61	103	31	48	103	181	192	85	99	77

Figure 5: Projected Annual Payloads – High Growth Scenario

Both scenarios assume ongoing operations and maintenance (O&M) of each constellation of satellites that is launched. AST's assessment of O&M includes representative failure rates associated with satellite launch, "turn on", and end-of-life. Each proposed system possesses somewhat different failure recovery capabilities, relying on constellation redundancy, on-orbit sparing, and ground spares to ensure that service characteristics remain largely unchanged. For the purpose of this forecast, AST modeled O&M launches separately, based on representative failure-recovery plans defined by the various system developers.

AST also assumed in both scenarios that all of the systems deployed during the forecast period will undergo a full block replacement at the end of system design life, using the same number of satellites and a similar deployment scheme (hence the apparent "cyclical" variation in the number of satellites projected during the 10-year forecast period). Due to the rapid evolution of satellite technology, it is likely that second-generation LEO systems may have substantially different satellite characteristics. As a result, out-year LEO satellite demand could be quite different from what is currently projected.

Finally, as described above, the market for LEO satellite services is clearly entering a phase of fierce competition. Research on the demand for communications services suggests that satellite-based systems provide unique attributes (e.g., "bandwidth on demand") that will allow them to compete effectively with terrestrial service providers. However, the outcome of the competition among LEO systems and between LEO- and GEO-based services remains less clear. This competition will ultimately be resolved on the basis of price, quality and flexibility of service, market timing, and relative business strategies. Following initial system deployment, it is likely that some of the proposed LEO systems will consolidate or that second-generation systems will be reshaped to focus on particular market niches. Again, the outcome of this competition may significantly alter out-year demand projections.

IV. LAUNCH DEMAND

An assessment of the launch approaches planned for the various LEO constellations indicates that most big LEO proposers currently plan to deploy their satellites initially on medium, intermediate, and heavy-lift commercial vehicles.[4] For failure replacements, big LEO system developers generally plan on using a mix of small and medium launch vehicles, usually launching clusters of two or three satellites (at most) during operations and maintenance.

Little LEO proposers currently intend to conduct both initial deployment and failure replacement launches on small launch vehicles due to the relatively small size of these payloads (typically between 100 and 350 lbs. per satellite). Also, most organizations planning remote sensing, international scientific, and microgravity payloads are planning to use single- or dual-manifested small launch vehicles.

Launch approaches for deployment and operation of proposed broadband LEO constellations remain less clear. The primary competitors in this market have publicly discussed using a mix of medium, intermediate, and even heavy-lift launch vehicles to deploy their constellations. For the purpose of this forecast, AST has created a model broadband LEO constellation and deployment scenario based on available information.

Based on this information, the demand for commercial launches to LEO for the modest growth scenario (Figure 6) is estimated to average:

- 9 annual medium-to-large launches, with a peak of between 11 and 14 annual launches in 1997-1998 and 2003-2004, and a low of 2 to 4 annual launches in 2001-2002.
- 11 annual small launches, with a peak of between 13 and 17 annual launches in 2001-2002, and a low of 8 to 11 annual launches in 1999-2000 and 2003-2004.

Year-to-year variability in the demand for commercial launch services is driven largely by AST's assumption that there will be sufficient demand for satellite services to support the operations, maintenance, and eventual replacement of all systems.

VEHICLE SIZE	MODEST GROWTH SCENARIO				
	1997-1998	1999-2000	2001-2002	2003-2004	2005-2006
SMALL LAUNCHES	9 to 12 per year	8 to 11 per year	13 to 17 per year	8 to 11 per year	10 to 14 per year
MEDIUM-TO-LARGE LAUNCHES	11 to 14 per year	9 to 12 per year	2 to 4 per year	11 to 14 per year	4 to 6 per year
PROJECTED TOTAL LAUNCHES	40 to 52	34 to 46	30 to 42	38 to 50	28 to 40

Figure 6: Projected Demand for LEO Launch Services – Modest Growth Scenario

[4] For the purpose of this forecast, AST defines "small" launch vehicles as those capable of lifting payloads of 10,000 lb. or less to LEO. "Medium to large" launch vehicles are those capable of lifting payloads greater than 10,000 lb. to LEO. This definition is the same as that used to prepare the 1996 LEO Commercial Market Projections Report.

The demand for commercial launches to LEO for the high growth scenario (Figure 7) is estimated to average:

- 13 annual medium-to-large-class launches, with peaks of between 14 to 18 annual launches in 2001-2002 and between 18 to 24 annual launches in 2003-2004.
- 15 annual small launches, with a low of 9 to 12 annual launches in 1999-2000, growing to between 19 to 25 launches per year at the end of the forecast period.

VEHICLE SIZE	HIGH GROWTH SCENARIO				
	1997-1998	1999-2000	2001-2002	2003-2004	2005-2006
SMALL LAUNCHES	9 to 12 per year	9 to 12 per year	16 to 21 per year	13 to 17 per year	19 to 25 per year
MEDIUM-TO-LARGE LAUNCHES	11 to 14 per year	10 to 13 per year	14 to 18 per year	18 to 24 per year	7 to 9 per year
PROJECTED TOTAL LAUNCHES	40 to 52	38 to 50	60 to 78	62 to 82	52 to 68

Figure 7: Projected Demand for LEO Launch Services – High Growth Scenario

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

The substantial increase in demand for commercial launch services in the high growth scenario is driven primarily by the requirements for deployment of the broadband LEO systems proposed by industry. Note that the inclusion of a single broadband LEO constellation in the high growth scenario is responsible for 63% of the increase in projected launches over the modest growth scenario. Should such systems fail to reach the deployment phase, demand for launch services in the high growth scenario would remain constant at around 10 to 15 medium-to-heavy launches per year from 2001 through 2004.

V. GROWTH IN DEMAND FOR LAUNCH SERVICES IN EXCESS OF THE HIGH GROWTH SCENARIO

AST's high growth scenario represents a substantial increase in the number of projected satellites and launches over high growth scenarios from previous reports, largely due to the inclusion of a large broadband LEO constellation. Given the growing demand for launch services by providers of GEO-based satellite services, it is likely that some increase in commercial launch capacity will be necessary to support continued growth in both the LEO and GEO markets. Of particular interest to the U.S. Government and industry is the question of whether sufficient launch capacity exists to support growth in the number of satellite systems deployed during the forecast period beyond the high growth scenario.

Figure 8, below, presents the potential payload demand based on a "what if" exercise to assess the upper limits of demand for satellite services. This attempt to establish "boundary conditions" is based on the successful launch and deployment of six big LEO, six little LEO, and

two broadband LEO constellations, as well as an ongoing level of commercial remote sensing, international scientific, and microgravity missions.

MARKET SEGMENT	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Broadband LEO	0	0	0	18	98	144	108	0	0	0
Big LEO	46	73	16	29	18	21	52	55	53	24
Little LEO	8	20	18	62	38	22	28	12	56	38
Remote Sensing / International Scientific & Microgravity	7	10	6	6	6	7	7	7	7	7
LEO "O&M" Support	0	0	3	12	15	17	16	35	50	52
TOTAL	61	103	43	127	175	211	211	109	166	121

Figure 8: Projected Annual Payloads – "Boundary Condition" Exercise

This exercise assumes that all of the LEO communications systems currently under development will successfully launch their satellite constellations and maintain/replenish these systems (recall that these systems are listed in Figure 1). As such, this case is considered highly unlikely and is included only to explore the limits of demand for launch services.

The inclusion of these LEO communications systems increases the total number of payloads in the "what if" exercise by 35% over the high growth scenario (Figure 9).

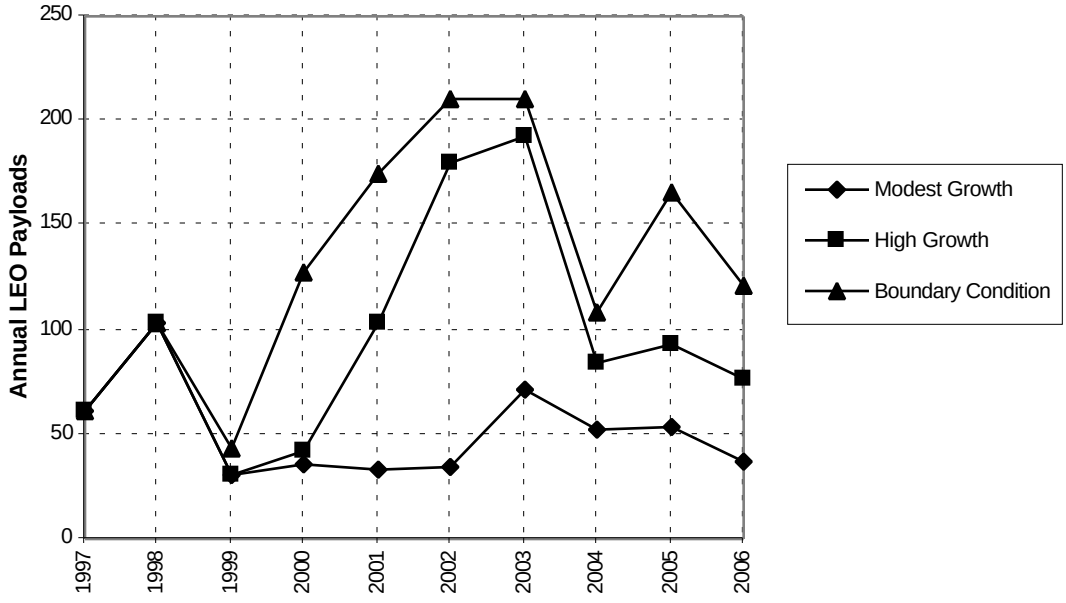

Figure 9: Projected Annual Payloads – Comparison of Forecasts

The resulting total demand for small launches increases 31% (Figure 10) over the high growth scenario, and increases 14% for medium-to-heavy launch services (Figure 11).

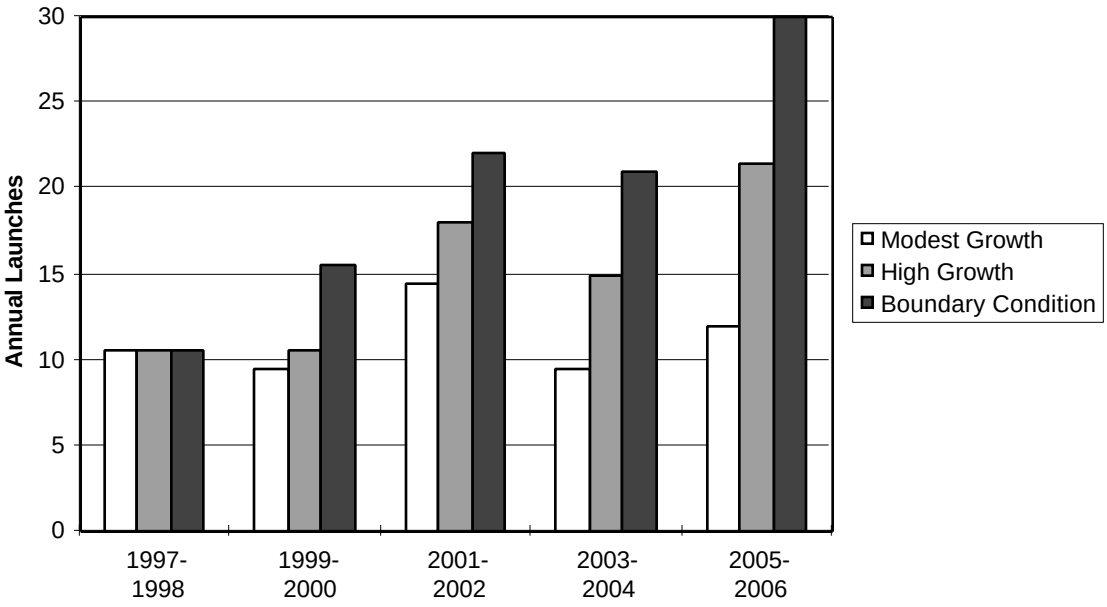

Figure 10: Projected Annual Demand for Small Launches – Comparison of Forecasts

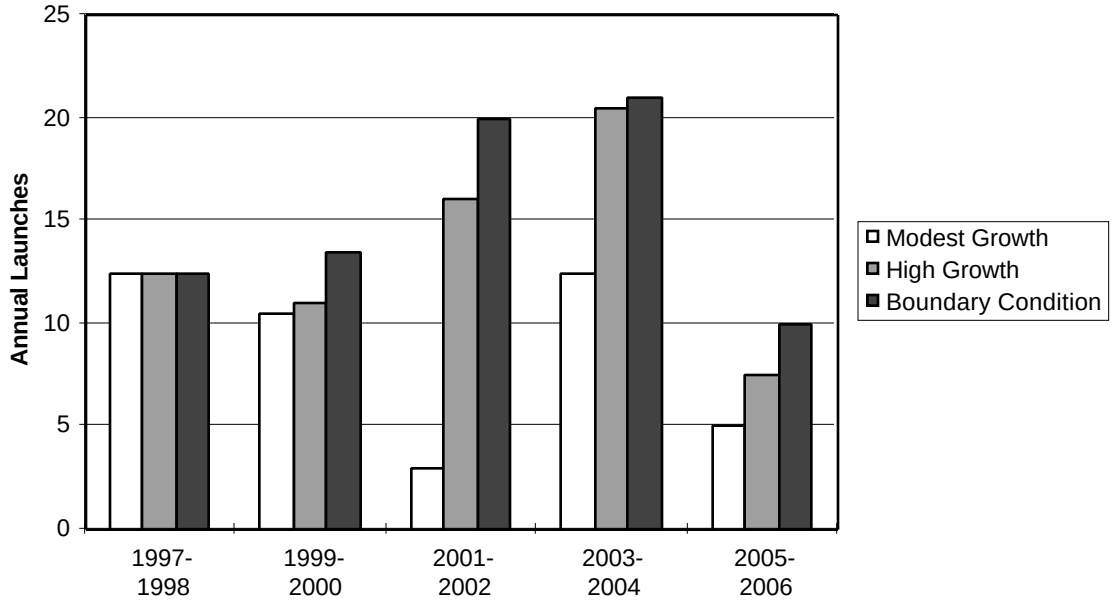

Figure 11: Projected Annual Demand for Medium-to-Large Launches – Comparison of Forecasts