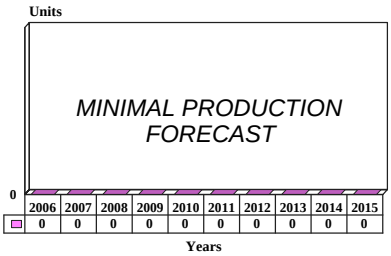
Boeing-376 - Archived 1/2007

Outlook

- No firm orders on the books
- Commercial communications satellite market sales trends exhibit a continuing shift toward spacecraft larger than the BSS-376
- Barring future opportunities, Forecast International expects Boeing to retire this model in the near future

10 Year Unit Production Forecast
2006 - 2015



Orientation

Description. The Boeing-376, formerly the HS-376, is a geosynchronous commercial communications satellite.

Sponsor. Sponsor varies depending on application.

Status. In production.

Total Produced. Approximately 58 Boeing-376 satellites have been produced.

Application. The Boeing-376 satellite model is intended to meet current communications and direct broadcasting market requirements.

Price Range. Approximately $60 million, depending on application.

Contractors

Boeing Satellite Development Center, http://www.boeing.com/defense-space/space/bss/flash.html, 2260 East Imperial Highway, El Segundo, CA 90245 United States, Tel: + 1 (310) 662-9000, Prime

Honeywell Space Systems, http://content.honeywell.com/dses/space, 13350 US Highway, 19 North, Clearwater, FL 33764 United States, Tel: + 1 (727) 539-4000 (Reaction Control Wheel)

Eaton Corporation, http://www.eaton.com, 1111 Superior Ave, Cleveland, OH 44144 United States, Tel: + 1 (216) 523-5000, Fax: + 1 (216) 523-4787 (Thruster Valves)

Spectrolab Inc, http://www.spectrolab.com, 12500 Gladstone Ave, Sylmar, CA 91342-5373 United States, Tel: + 1 (818) 365-4611, Fax: + 1 (818) 361-5102 (Solar Array Panel)

L-3 Communications - Spar Aerospace Ltd, http://www.spar.ca, 7th Avenue and Airport Service Road, Edmonton International Airport, Edmonton, T5J 2T2 Alberta, Canada, Tel: + 1 (780) 890-6300, Fax: + 1 (780) 890-6547, Co-producer

Technical Data

Design Features. All Boeing 376 models are drum-shaped, spin-stabilized satellites with two telescoping cylindrical solar panels. Before launch, the top cylinder is telescoped into the bottom and the main communications reflector is stowed. The compact configuration was originally designed to allow the satellite to be stored upright in the payload bay of the Space Shuttle; however, all Boeing-376 launches now take place on expendable launch vehicles, primarily the Delta and Ariane boosters.

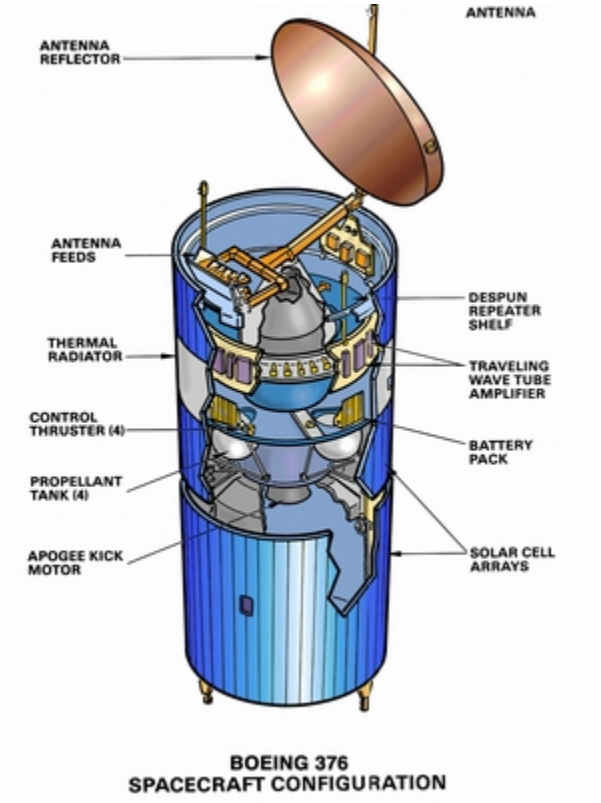
Boeing-376

Depending on the application, the Boeing-376 can feature C-band or Ku-band transponders. In a hybrid configuration, it features both. Applications include audio, video, and data transmission services. The BSB satellite was the first Boeing-376 to offer a Direct Broadcasting Service (DBS) of TV channels to viewers' homes in the United Kingdom.

Early versions of the Boeing-376 came with traveling wave tube amplifiers (TWTAs) exclusively, but beginning with Telstar 3 in 1983, the satellite can feature a mix of TWTAs and solid-state power amplifiers. It also comes with improved nickel-cadmium batteries.

On board the Boeing-376 are four reaction control system thrusters that use hydrazine propellant. Four tanks supply fuel to the thrusters.

	Metric	**U.S.**
Dimensions (Telstar 3)		
Body diameter	2.16 m	7.08 ft
Height (stowed for launch)	2.74 m	9.0 ft
Height (deployed)	6.84 m	22.4 ft
Weight		
Mass in orbit	653 kg	1,438 lb
Performance		
Power supply		
(Beginning of life)	917 W	
Battery type	Nickel-cadmium	
Design life	10 yr	
Number of active transponders	24, 6/4 GHz C-band	



Source: Boeing Satellite Systems

Variants/Upgrades

Boeing-376W (Widebody). Improved, more powerful and longer-life version featuring an advanced propulsion system, batteries, solar panels, and a 12-year life.

Boeing-376L. Satellite ordered for the Measat program (see **Program Review**) is a growth version of the Boeing-376, with two major enhancements over the standard model. It delivers 40 percent more payload power (more than 1,100 watts) through the use of gallium arsenide solar cells, as opposed to silicon. It was the first Boeing-376 model to use a lightweight, high-gain, shaped antenna, with a specially contoured surface that eliminates the need for multiple feedhorns.

Boeing-376HP. High-power version; first application was the Norwegian Thor IIA; features 1,200 to 1,400 watts of power.

Program Review

Background. In the late 1970s, Satellite Business Systems, a joint venture of IBM, COMSAT General Corp, and Aetna Life and Casualty, ordered three of the new Boeing-376 communications satellite spacecraft. The first two satellites were launched by a Delta expendable launch vehicle in 1980 and 1981. The third spacecraft went into space in 1982 and was the Space Shuttle's first satellite on its inaugural commercial flight. Among other firsts, the SBS series included the first satellites dedicated to providing secure voice, video, high-speed-data, and facsimile communications among businesses in the United States. In 1985, MCI acquired Satellite Business Systems from IBM.

The first Boeing-376 went into space on a McDonnell Douglas Delta vehicle, the workhorse of the small commercial communications satellite fleet. However, of the more than 35 Boeing-376 satellites put into space, nearly half were carried into low-Earth orbit on NASA's Space Shuttle. The remainder used either the Delta or the Arianespace Ariane boosters. Since the Challenger accident in 1986 and subsequent policy transferring commercial payloads from the Shuttle, the Boeing-376 has used ELVs exclusively.

Communications Satellites Using the Boeing-376 Bus. To date, more than 58 Boeing-376 satellites have been produced. Hughes had occasionally teamed with a non-U.S. partner to produce the spacecraft. For example, the Anik C and Anik D systems for Canada were built with the cooperation of Spar Aerospace Ltd of Canada. Spar was also a primary partner in the production of the first two Brasilsat satellites. Promon Engenharia SA of Sao Paulo is a major partner in the development of the two Brasilsat B satellites that use the Boeing-376W bus.

Satellite programs using the Boeing-376 include the following:

SBS (Satellite Business Systems). Five satellites produced for the first all-digital domestic satellite system operating in the 14/12 GHz Ku-band. SBS satellites, jointly owned by subsidiaries of IBM, Comsat General Corporation, and Aetna Life and Casualty, began service in 1981, delivering integrated voice, data, electronic mail, and video communications transmissions. Launch dates: SBS-1, 1980 (Delta); SBS-2, 1981 (Delta); SBS-3, 1982 (Shuttle); SBS-4, 1984 (Shuttle); and SBS-5, 1988 (Ariane).

Anik C. Three satellites produced for Canada's first dedicated point-to-point satellite system operating in the 14/12 GHz Ku-band. Anik C-3 rode into space (along with the SBS-3) on the maiden commercial flight of the Space Shuttle. Launch dates: Anik C-3, 1982 (Shuttle); Anik C-2, 1983, (Shuttle); and Anik C-1, 1985 (Shuttle). Anik C-2 and Anik C-1 were later sold to Loral. Anik C-2 was de-orbited in 1998 after 14 years of service.

Anik D. Two satellites produced. Equipped with 24 transponders, Anik D-1 expanded television coverage in Canada, providing 6/4 GHz C-band service nationally and regionally. After two years of in-orbit storage, Anik D-2 began providing voice and data traffic in 1986. Launch dates: Anik D-1, 1982 (Delta); and Anik D-2, 1984 (Shuttle).

Palapa B. Four satellites produced. Second generation of communications satellites for Indonesia, providing telephone, television, facsimile, and data transmission services. Each satellite features 24 active and six spare transponders operating in the 5.925 to 6.425/3.72 to 4.16 GHz C-band. Launch dates: Palapa B1, 1983 (Shuttle); Palapa B2, 1984 (Shuttle); Palapa B2P, 1987 (Delta); and Palapa B4, 1992 (Delta).

Palapa B1 was retired in 1991 and sold to Pasifik Satelit Nusantara (PSN); it then provided Pacific Rim services from 145° E through 1995. The B2's PAM upper stage motor failed, leaving it in a low-Earth orbit; the Shuttle Discovery rescued B2 in November 1984. Refurbished and renamed B2R, it was launched on a Delta rocket in

1990. The B2R was preceded into orbit by Palapa B2P. Palapa B4 was planned for launch in 1995 but launched three years early to handle the increase in Indonesian telecommunications traffic.

Aussat. Three satellites were produced for what was Australia's first satellite program. Aussat satellites (now called Optus) carry 15 Ku-band channels, each 45 MHz wide. Four channels use high-power, 30-watt traveling wave tube amplifiers to provide radio and television services to remote areas; the remaining 11 channels have 12-watt TWTAs. Launch dates: Aussat A1, 1985 (Shuttle); Aussat A2, 1985 (Shuttle); and Aussat A3, 1987 (Ariane).

Galaxy. Eight BSS-376 satellites have been produced for Hughes Communications Inc, which merged with PanAmSat in 1997. The satellites provide transmission for cable television and network broadcasters; Video Timesharing Service (VTS) for occasional users; data, digital voice, and teleconferencing applications; and corporate video. Launch dates: Galaxy I, 1983 (Delta); Galaxy I-R, 1992 (mission failure when Atlas I veered off course); Galaxy II, 1983 (Delta); Galaxy III, 1984 (Delta); Galaxy V, 1992 (Atlas I); Galaxy VI, 1990 (Ariane 4); a replacement for Galaxy I-R, Galaxy I-R(S), 1994 (Delta II); and Galaxy IX, 1996 (Delta II). (Galaxy IV and Galaxy VII use the Boeing-601 design.)

In late 2002, Galaxy XIII, a BSS-601, was planned to replace capacity on the Boeing 376-based Galaxy IX, which will be moved to a new orbital position and continue to provide services. Galaxy XIII was successfully launched in October 2003.

British Satellite Broadcasting. Two satellites produced the first television Direct Broadcast Service (DBS) in the United Kingdom; each satellite had three 110-watt channels. Launch dates: BSB-1 (Marcopolo 1), 1989 (Delta); and BSB-2 (Marcopolo 2), 1990 (Delta). The two satellites became redundant following the merger in 1990 of British Satellite Broadcasting and Sky Television. The new entity, BSkyB, switched from the BSB satellites to SES' Astra 1B spacecraft.

BSB-2 was sold to Norwegian Telecom in 1992 for about $58 million. The agency is using the satellite to provide DBS services to most of Scandinavia. BSB-1 was put up for sale in 1992 and bought by Swedish Space Corp to serve as a backup to the Tele-X broadcasting satellite.

Morelos. Two satellites produced. This is a Mexican telecommunications satellite, providing educational television, commercial programs, telephone and facsimile services, and data and business transmissions. Morelos was the first use of the Boeing-376 as a C-band/Ku-band hybrid. Launch dates: Morelos A, 1985 (Shuttle); and Morelos B, 1985 (Shuttle).

Telstar. Three satellites produced for AT&T satellite system. The satellites were designed to last 10 years (versus the seven years of earlier models) with improved nickel-cadmium batteries and solid-state amplifiers in place of traveling wave tubes (TWTs) for 18 of 30 high-power transmitters. Each satellite was equipped with 24 6/4 GHz C-band transponders. Launch dates: Telstar 3A, 1983 (Delta); Telstar 3C, 1984 (Shuttle); and Telstar 3B, 1985 (Shuttle).

Brasilsat. Six satellites produced. The C-band spacecraft provide public telephone circuits, military communications links, and general telecommunications traffic. Brasilsat A1 and A2 were built by Spar Aerospace using the Boeing-376 bus. Launch dates: Brasilsat A1, 1985 (Ariane) and Brasilsat A2, 1986 (Ariane).

Hughes was selected in 1990 to build Brazil's second-generation satellite communications system, Brasilsat B. The GM unit received a $155 million contract from the Brazilian government to build two widebody Boeing-376W satellites and make improvements to the existing ground control station outside Rio de Janeiro. Each satellite features 28 C-bands plus one military X-band, and is designed to last 12 years. Brasilsat B1 was launched in 1994 on an Ariane 4, followed by Brasilsat B2 in 1995, also on an Ariane 4 (see the report "Brasilsat/Star One" in this Tab).

Brasilsat B3 is a Boeing-376W general communications satellite that, like the other two, carries voice and data communications, business networks, and television over 28 C-band transponders. Unlike the others, however, B3 does not have an X-band payload for government use. It carries one C-band beam for national service, and a second C-band regional beam that focuses higher power on the major urban areas. The B3 satellite design provides nearly 20-percent higher signal power and more than 12 years of mission life. It was launched on an Ariane 44LP in February 1998.

Embratel exercised an option for a fourth satellite in June 1998. Brasilsat B4 is the same as the B3 model. It was launched alongside Nilesat 102 aboard an Ariane 44LP in August 2000, and replaced Brasilsat B2.

AsiaSat. One satellite produced. Satellite was originally earmarked for use as Westar VI, but was stranded in a useless orbit, shortly after launch in 1984 from the Space Shuttle, when its PAM motor failed to ignite properly. It was rescued in 1984 during a subsequent Shuttle mission, refurbished, renamed AsiaSat 1, and launched on a Long March 3 booster in 1990.

Westar. Three satellites produced, including Westar VI, which later became AsiaSat 1 (see above). Once part of the Hughes Communications system, Westars provided broadcasting and cable TV distribution, along with voice and data traffic. Launch dates: Westar IV, 1982 (Delta); Westar V, 1982 (Delta); and Westar VI, 1984 (Shuttle).

Thaicom. Two satellites produced. In June 1991, Shinawatra Computer Co Ltd, a private telecommunications company chosen by Thailand's Ministry of Transportation to operate the country's first domestic satellite system, selected a lightweight version of the Boeing-376. Hughes supplied a pair of satellites 25-percent lighter (400 kilograms without fuel) than previous Boeing-376 designs, meaning they carry more stationkeeping fuel and thus have a longer service life. Each satellite features 10 C-band and two Ku-band transponders to provide voice, video, and data communications throughout Thailand. Thaicom 1 was launched in 1993 and is collocated with Thaicom 2, launched in 1994, at 78.5° E.

Measat. Two satellites produced. Binariang Sdn Bhd of Kuala Lumpur signed a Memorandum of Understanding (MoU) with Hughes in 1991 to purchase two Boeing-376s for a program called Malaysian East Asian Satellite (Measat). Malaysia currently uses capacity on the Palapa and AsiaSat satellites, but is moving toward development of its own regional network.

One Boeing-376 satellite was launched on an Ariane 4 in 1996; the spacecraft will provide 12 years of service. An option for a backup satellite was exercised in 1995, and the satellite was launched in late 1996.

Measat offers both direct-to-user (DTU) service in Malaysia and general communications services in the region from Malaysia to the Philippines and from Beijing to Indonesia. DTU services include television programming delivered to small, 48-centimeter-diameter home antennas. General communications services include telephone, television, data transmission, and business networks.

Each Measat spacecraft has four high-power (110-watt) Ku-band transponders for the DTU service. The regional service is provided on 12 transponders in C-band, powered by 11-watt solid-state transponders.

BSAT. Broadcasting Satellite System Corp (BSAT) of Tokyo ordered two -376 satellites for delivery in 1997 and 1998. BSAT-1A was launched on an Ariane 44LP rocket in 1997, replacing BS-3, which was used for direct broadcast services to more than 10 million customers in Japan. BSAT-1B was launched on an Ariane 44P in 1998.

From their location at 110° E, the satellites provide broadcasting services in Japan for NHK and Japan Satellite Broadcasting Inc. Each spacecraft has four active Ku- band transponders, using 106-watt TWTAs.

ApStar. APT Satellite Co Ltd, an Asian company owned by a Chinese consortium, ordered a Boeing-376 satellite in 1992 for services in the Pacific Rim. ApStar was launched on a Chinese CZ-3 rocket in 1994. The satellite's footprint from a 138° E orbital slot covers China, Japan, Korea, and portions of Southeast Asia.

In 1995, Hughes landed a contract for ApStar 1A, a spacecraft nearly identical to ApStar 1 and based on the Boeing-376. Featuring 24 C-band transponders, the satellite's coverage area from 134° E is somewhat larger than ApStar 1's, including not only China and Central and Eastern Asia, but also all of India and portions of the Middle East. This satellite was launched on a Long March 3 in 1996.

ChinaSat. Hughes received an order for one ChinaSat communications satellite from the company by the same name, which is part of the Ministry of Posts and Telecommunications. The spacecraft featured 24 C-band transponders and was to provide coverage for China and the South China Sea regions; however, it was placed in a useless orbit in 1996 after a Chinese Long March 3 (CZ-3) rocket's third stage failed.

Thor II, III, and IV. Hughes provided a television satellite called Thor II to Telenor Satellite Services AS of Oslo, Norway. The satellite, a high-power version of the Boeing-376 model, was launched on a Delta II booster in 1997 and located at 1° W.

Thor II is equipped with 15 40-watt Ku-band transponders and delivers direct-to-home television programming to Scandinavia and Northern Europe. The spacecraft uses gallium arsenide solar cells to generate more than 1.4 kilowatts of payload power, and is expected to operate for more than 11 years.

Telenor ordered another Boeing-376HP in 1997, which was launched on a Delta II rocket the following year. Designated Thor III, it is collocated with the other Thor satellites at Telenor's Nordic Hot Bird position at 1° W, providing direct-to-home television programming to the Nordic countries and Central and Eastern Europe. Thor III has 14 active 47-watt transponders in the Ku-band and produces 1.4 kilowatts using gallium arsenide solar cells. The order contained an option for an additional satellite, Thor IV, which would be larger than the previous Thors, and capable of covering most of Europe. Forecast International spoke with Erling Thune, a Telenor Investor Relations representative, in late October 2003, and was told that Thor IV would not

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be built and that Telenor has no plans to produce any further satellites.

What Mr. Thune should have said was that Telenor had no further plans to contract production of Boeing satellites. This point was made abundantly clear in September 2005 when Telenor contracted Orbital Sciences to build the Thor IIR – a replacement for Thor II.

Sirius. Hughes received a contract for Sirius 3, a direct-to-home spacecraft, in 1997 from Nordiska Satellitaktiebolaget (NSAB), a joint venture of Swedish Space Corporation, Tele Denmark A/S, and Teracom AB. The satellite was launched on an Ariane 44L in 1998.

Sirius 3 has 15 Ku-band transponders and uses gallium arsenide solar cells to produce 1.4 kilowatts of spacecraft power. The spacecraft is expected to operate at its 28.2° E orbital slot for 15 years.

In addition to Sirius 3, the current NSAB constellation includes the Sirius 1, a Boeing-376 model originally built in the late 1980s for British Satellite Broadcasting and sold to NSAB in-orbit in 1993, and the Sirius 2, a Spacebus 3000 built by Aerospatiale (now Alcatel Alenia Space) and launched on an Ariane 44L in 1997. Both satellites operate from 5.2° E.

Bonum. Media Most, a private Russian media group, ordered one Boeing-376 in 1997, the first spacecraft built by an American company for Russia. Equipped with eight active Ku-band transponders, Bonum-1 is capable of providing up to 50 channels of digital direct-to-home programming. The satellite was launched in 1998 on a Delta II booster and operates from 36°E.

Astra 2D and 3A. Société Européenne des Satellites (SES) (now SES Astra) of Luxembourg ordered the Astra 2D from Hughes in 1999 to help meet growing demand for digital satellite services at SES' second orbital slot, 28.2° E. Astra 2D is a Boeing-376HP, the first spinning-style satellite procured by SES. Launched on an Ariane 5 in December 2000, it will operate 15 active Ku-band transponders throughout its 12 years in orbit, providing direct digital TV broadcast services for Europe, particularly the U.K. and Ireland.

BSS was contracted to build the Astra 3A in December 2000. The spacecraft carries 24 Ku-band transponders and operates from 23.5° E in a geostationary orbit. Astra 3A was launched successfully in May 2002 aboard an Ariane 4 from Kourou, French Guiana. SES of Luxembourg accepted the Astra 3A satellite on April 23. It is the 10th satellite Boeing has built for SES, and will help meet growing demand for SES' digital satellite services to the German-speaking markets of Germany, Austria, and Switzerland.

e-Bird. In February 2001, Eutelsat ordered a Boeing-376HP to provide Internet services to Great Britain, Scandinavia, and Western and Eastern Europe. Called e-Bird, the spacecraft will carry 20 active Ku-band transponders, each powered by 32-watt traveling wave tube amplifiers. The Ku-band transponders are connected to four spot beams over the European region.

The e-Bird was launched by an Ariane 5 rocket from Kourou, French Guiana, in September 2003. After a series of in-orbit tests, the satellite entered service in November 2003 at 33° E in order to provide coverage of Europe and Turkey. The e-Bird spacecraft operates at 25.5°E above Central Africa and has a design life of 10 years. Launch of e-Bird on an Ariane 5 was delayed from the second quarter of 2002.

Brasilsat-A1 Goes to the Graveyard. After more than 17 years of service and double the contract life, the Brasilsat 1A entered a "graveyard" orbit. The Boeing-376 used by the satellite was the 31st of the series to exceed its contract life.

Recent Activity

Satellite Development Center. In 2005, Boeing restructured its satellite manufacturing unit by eliminating the Boeing Satellite Systems division and folding this capacity into a new Satellite Development Center. The SDC falls under Boeing's Space and Intelligence Systems.

The move was made in order to separate Boeing's struggling commercial satellite business from the company's strong government-satellite work. Boeing was quick to reassure customers that the name change would not impact client relations nor did it signal a retreat from the commercial satellite sector.

Timetable

Month	Year	Major Development
Nov	1980	SBS-1 launched on Delta, first Boeing-376 launch
Sep	1981	SBS-2 launched on Delta
Aug	1982	Anik D-1 launched on Delta
Nov	1982	Anik C-3 and SBS-3 launched from Space Shuttle

Month	Year	Major Development
Jun	1983	Anik C-2 and Palapa B1 launched from Space Shuttle
		Galaxy I launched on Delta
Jul	1983	Telstar 3A launched on Delta
Sep	1983	Galaxy II launched on Delta
Feb	1984	Palapa B2 and Westar VI launched from Space Shuttle
Aug	1984	SBS-4 and Telstar 3C launched from Space Shuttle
Sep	1984	Galaxy III launched on Delta
Nov	1984	Anik D-2 launched from Space Shuttle
Feb	1985	Brasilsat A1 launched on Ariane 3
Apr	1985	Anik C-1 launched from Space Shuttle
Jun	1985	Morelos A and Telstar 3B launched from Space Shuttle
Aug	1985	Aussat A1 launched from Space Shuttle
Nov	1985	Aussat A2 and Morelos B launched from Space Shuttle
Mar	1986	Brasilsat A2 launched on Ariane 3
Mar	1987	Palapa B2P launched on Delta
Sep	1987	Aussat A3 launched on Ariane 4
Sep	1988	SBS-5 launched on Ariane 4
Aug	1989	BSB-1 launched on Delta
Feb	1990	Westar IV launched on Delta
Apr	1990	AsiaSat 1 launched on Long March 3
Aug	1990	BSB-2 launched on Delta
Oct	1990	Galaxy VI launched on Ariane 4
Mar	1992	Galaxy V launched on Atlas I
May	1992	Palapa B4 launched on Delta
Jun	1992	Westar V launched on Delta
Aug	1992	Galaxy I-R launched on Atlas (failure)
Dec	1993	Thaicom 1 launched on Ariane 4
Feb	1994	Galaxy I-R(S) launched on Delta II
Jul	1994	ApStar 1 launched on Long March 3
Aug	1994	Brasilsat B1 launched on Ariane 4
Oct	1994	Thaicom 2 launched on Ariane 4
Mar	1995	Brasilsat B2 launched on Ariane 4
Jan	1996	Measat 1 launched on Ariane 4
Apr	1996	ChinaSat 7 launched on Long March 3 (failure)
May	1996	Galaxy IV launched on Delta II
Jul	1996	ApStar 1A launched on Long March 3
Nov	1996	Measat 2 launched on Ariane 4
Apr	1997	BSAT-1A launched on Ariane 4
May	1997	Thor II launched on Delta II
Feb	1998	Brasilsat B3A launched on Ariane 4
Apr	1998	BSAT-1B launched on Ariane 4
Jun	1998	Thor III launched on Delta II
Oct	1998	Sirius 3 launched on Ariane 4
Nov	1998	Bonum-1 launched on Delta II
Aug	2000	Brasilsat B4 launched on Ariane 44LP
Dec	2000	Astra 2D launched on Ariane 5
May	2002	Astra 3A launched on Ariane 4 alongside JCSAT-8
Sep	2003	e-Bird launched on Ariane 5

Boeing-376

Forecast Rationale

When the first BSS-376 launched in 1980 it was considered to be one of the largest and most advanced satellites of the time. In the new millennium, as commercial communications spacecraft continue to grow both in size and capacity, the -376 is considered small. With the larger Boeing-702 established as the breadwinner for Boeing Satellite Systems, both the Boeing-376 and the -601 will continue to suffer from a dearth of sales in this tight market. Communications satellites are not only becoming larger than the -376 but also more complex, leaving smaller satellite platforms to target the scientific and remote sensing markets.

To keep pace with this trend, Boeing could gain some international interest by marketing a derivative of the -376 as a remote sensing satellite, much as competing company EADS Astrium did when it shifted the Leostar small communications satellite platform over to remote sensing.

Only two BSS-376 satellites were delivered in 2002, and one in 2003. There are no orders on the books for the Boeing-376, and production levels are expected to remain very low. Replacement orders for existing spacecraft are likely to crop up here and there, but we don't anticipate production of more than one spacecraft every other year on average through 2007. At that point, Boeing may just decide to retire this model.

Ten-Year Outlook

ESTIMATED CALENDAR YEAR PRODUCTION

		High Confidence Level				Good Confidence Level			Speculative			
Space System	**thru 05**	**06**	**07**	**08**	**09**	**10**	**11**	**12**	**13**	**14**	**15**	**Total 06-15**
BOEING SATELLITE SYSTEMS												
BOEING-376 (ANIK C) (a)	3	0	0	0	0	0	0	0	0	0	0	0
BOEING-376 (ANIK D)	2	0	0	0	0	0	0	0	0	0	0	0
BOEING-376 (APSTAR 1)	1	0	0	0	0	0	0	0	0	0	0	0
BOEING-376 (APSTAR 1A)	1	0	0	0	0	0	0	0	0	0	0	0
BOEING-376 (ASIASAT 1)	1	0	0	0	0	0	0	0	0	0	0	0
BOEING-376 (ASTRA 3A)	1	0	0	0	0	0	0	0	0	0	0	0
BOEING-376 (BONUM-1)	1	0	0	0	0	0	0	0	0	0	0	0
BOEING-376 (BRASILSAT	2	0	0	0	0	0	0	0	0	0	0	0
BOEING-376 (BSAT 1A & 1B)	2	0	0	0	0	0	0	0	0	0	0	0
BOEING-376 (CHINASAT)	1	0	0	0	0	0	0	0	0	0	0	0
BOEING-376 (E-BIRD 1)	1	0	0	0	0	0	0	0	0	0	0	0
BOEING-376 (GALAXY)	8	0	0	0	0	0	0	0	0	0	0	0
BOEING-376 (MEASAT-1/2)	2	0	0	0	0	0	0	0	0	0	0	0
BOEING-376 (MORELOS I/II)	2	0	0	0	0	0	0	0	0	0	0	0
BOEING-376 (NEWSAT-1)	1	0	0	0	0	0	0	0	0	0	0	0
BOEING-376 (OPTUS A)	3	0	0	0	0	0	0	0	0	0	0	0
BOEING-376 (PALAPA) (b)	4	0	0	0	0	0	0	0	0	0	0	0
BOEING-376 (SBS)	5	0	0	0	0	0	0	0	0	0	0	0
BOEING-376 (SIRIUS 1)	1	0	0	0	0	0	0	0	0	0	0	0
BOEING-376 (SIRIUS 3)	1	0	0	0	0	0	0	0	0	0	0	0
BOEING-376 (TELSTAR)	3	0	0	0	0	0	0	0	0	0	0	0
BOEING-376 (THAICOM 1/2	2	0	0	0	0	0	0	0	0	0	0	0
BOEING-376 (THOR I)	1	0	0	0	0	0	0	0	0	0	0	0
BOEING-376 (WESTAR)	2	0	0	0	0	0	0	0	0	0	0	0
BOEING-376HP (ASTRA 2D)	1	0	0	0	0	0	0	0	0	0	0	0
BOEING-376HP (THOR II)	1	0	0	0	0	0	0	0	0	0	0	0
BOEING-376HP (THOR III)	1	0	0	0	0	0	0	0	0	0	0	0
BOEING-376HP (THOR IV)	0	0	0	0	0	0	0	0	0	0	0	0
BOEING-376W (BRASLST B3/4	2	0	0	0	0	0	0	0	0	0	0	0
BOEING-376W BRASLSAT B1/2	2	0	0	0	0	0	0	0	0	0	0	0
Total Production	58	0	0	0	0	0	0	0	0	0	0	0

(a) Anik C1 transferred to Loral and renamed Brasil 1(T).
(b) Palapa B2R transferred to NewSat-USA LLC in 2001 and renamed NewSat-1.