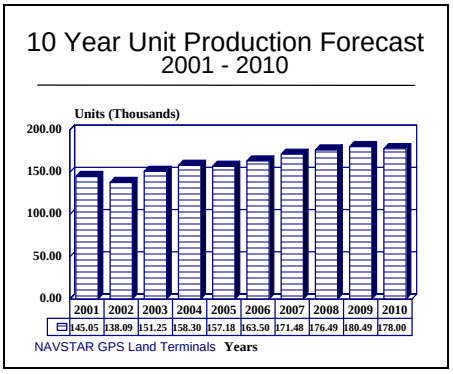
NAVSTAR GPS Land-Based Terminals – Archived 12/2002

Outlook

- Forecast International expects consumer demand for NAVSTAR GPS Land-Based Terminals to be strong from 2001 to 2010
- Anticipate an anti-jam antenna for the handheld PSN-11 Precision Lightweight GPS Receiver to be developed by 2002
- Look for research and development in support of the Defense Advanced Global Positioning System Receiver program to be completed by spring 2002



Orientation

Description. The Navigation Signal Timing and Ranging (NAVSTAR) Global Positioning System (GPS) is a constellation of orbiting satellites that provides navigation data to military and civilian users all over the world. The system is managed by the United States NAVSTAR GPS Joint Program Office at the Space and Missile Systems Center, Los Angeles Air Force Base, Calif.

Sponsor

US Air Force – Materiel Command
GPS Joint Program Office
Los Angeles, California (CA) USA
(Lead agency for the US Department of Defense)

US Army - Communications & Electronics Command
Fort Monmouth, New Jersey (NJ) USA
(Army GPS)

All US military services are involved, as well as the US Defense Mapping Agency, the US Department of Transportation, and the 13 members of NATO.

Prime Contractors

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Contractors

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Web site: http://www.aoa-gps.com
(Commercial GPS receivers)

Figgie International Inc
Interstate Electronics Corp
Anaheim, California (CA), USA
(GPS range equipment)

BAE Systems
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Standard Elektrik Lorenz AG (SEL)
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Wild Heerbrugg AG
Heerbrugg, Switzerland

Status. In production.

Total Produced. Through 2000, approximately 876,387 land-based (handheld, manpack and vehicular) GPS terminals have been produced.

Application. To provide navigation data to military and civilian users all over the world.

Price Range. Military units range from US$2,000 to US$7,000.

Technical Data

Design Features: Satellites. The NAVSTAR (Navigation System Time And Ranging) GPS (Global Positioning System) program is a constellation of 21 active and three spare satellites in 12-hour, 55° orbits. They are segregated into six equally spaced planes (60° separation) at 10,900 miles, with satellites evenly spaced (120° separation) in each of these planes. The GPS constellation system provides 24-hour positioning data accurate between 2 and 100 meters, depending on the user. In reality, thanks to technology advances, system accuracy can be enhanced beyond this value to less than one meter.

All GPS satellites are controlled over an S-band link; 2227.5 MHz for the uplink, 1783.74 MHz for the downlink. They transmit navigation data in spread spectrum using the L1 frequency band of 1575.42 MHz, and the L2 frequency band of 1227.60 MHz. The L2 band is encrypted and is intended for the sole use of the US DoD and authorized allies. Pseudo random noise techniques are used to encode the P (Precision) code for both the satellite's encoder and the receiver's encoder. However, in a cold-start situation (where the operator turns on his GPS set), all the receiver hears is gibberish from the noise coding, thus necessitating auto correlation. To speed the matching of codes, each satellite sends a second, less accurate and lower resolution signal on only one of the frequencies, because ionospheric correction is not needed. This signal is called the Coarse Acquisition or C/A signal. It serves to provide rough latitude and longitude data to the user's receiver. While a downgraded accuracy of 100 meters is claimed for the C/A signal, commercial receivers are able to get better accuracy.

The satellites are equipped with four onboard atomic clocks accurate to within one second every 300,000 years. Moreover, the NAVSTAR system is passive, has inherent anti-jam capability and is available continuously, regardless of weather conditions.

Ground Element. Ground stations located in friendly nations act as the control segment of the NAVSTAR system. The master control station (MCS) is located at the Consolidated Space Operations Center (CSOC) at Falcon Air Force Station, Peterson AFB, Colorado Springs, USA. The master control station maintains the accuracy of the atomic clocks housed within the satellites, making sure all are synchronized. The remote operated Monitor Stations are located on Ascension Island, in Hawaii, on the Kwajalein Atoll test range, CSOC, and Diego Garcia. Uplink antennas are located at Diego Garcia, Ascension Island, and Kwajalein Atoll. IBM is under contract by the USAF Systems Command to manage the GPS control element.

User Equipment Design Features. The user equipment segment is composed of the antenna, antenna control unit, the antenna preamplifier, receiver, and man/ vehicle control display. The pseudo-random noise code must be known by the user for real-time processing. (However, geologists have for many years now been able to get GPS accuracy of approximately one meter by processing hours of data for each location to be measured.) The receiver calculates pseudo-range and pseudo-range rate. Pseudo-range is the distance from each satellite to the receiver plus an offset due to clock bias. (Because this distance is not perfectly measured, it is called a pseudo-range instead of range.) Pseudo-range rate gives the velocity between receiver and satellite – again, with a clock offset.

Receivers. The three common groups of receivers are single-channel, two-channel and five-channel devices. A single-channel MAN/Vehicle (M/V) receiver takes the satellite signals in sequence. The critical dimension here is acceleration rather than velocity. Satellites can use single-channel receivers since there is no acceleration. Also, with inertial aiding there is no problem with acceleration. Dual-channel receivers need two channels at exactly the same time, but actually require four satellites for proper coverage. The two-channel receivers would be used by lower dynamic users such as helicopters or Army fixed-wing aircraft equipped with Doppler sensors. The higher channel receivers may receive data simultaneously from up to five GPS satellites. This is essential for high dynamic users such as fighter aircraft. The additional channels ensure a greater number of satellites being tracked, and therefore a more precise location and velocity value can be obtained. Logistics is the main driver, particularly if there is no aiding source or if alignment from sources such as INS is available. The higher channel receivers are more robust and have anti-jamming benefits, especially for higher dynamic users. Small, five-channel configurations will be available in later years as all the channels are put on a single chip.

Operational Characteristics. Based on tests conducted, using an initial constellation of seven satellites, the GPS demonstrated accuracy in position to within 10 meters for aircraft and ground vehicles. Speeds have been measured to within 0.1 knot, and time has been transmitted with an accuracy to within millionths of a second. The accuracy indicated are achieved through the use of two satellite channels simultaneously. Although NAVSTAR is available to

civil users, only one channel can be accessed, resulting in slightly reduced accuracy. Even so, position accuracy is expected to be within 30 meters, which is adequate for non-precision instrument approaches. Accuracy is not dependent on the number of channels; rather, it is a function of the time it takes to gain a fix and reacquire it.

There are six basic levels of navigational accuracy. They are:

1. Stationary Survey (highest level of accuracy)
2. Survey from moving platforms
3. Differential GPS (improved accuracy within several hundred kilometers of a surveyed monitor station)
4. Precise positioning service (US military and other DoD-approved users)
5. Standard positioning service (without the DoD selective availability degradation)
6. Standard positioning service for civil users with DoD degradation of the signal

The potential users of the NAVSTAR system include all aircraft, armored and soft-skinned vehicles, surface and subsurface vessels, as well as individual foot soldiers. The receiver processes the position and time signals produced by the satellites and displayed on the readout equipment. The various types of receivers installed on military and civilian equipment will scan the skies for a satellite signal. The more channels that are scanning, the more precise the type of information available to the user. The receiver measures the time delay between the signals received from the satellites within range, which gives range of the satellite from the receiver. If a time measurement outside the system is utilized by the user and altitude is known, the signal from two satellites will provide longitude and latitude.

Variants/Upgrades

Allen Osbourne GPS receivers use a Precise Position System Security Module and are capable of removing the errors in GPS due to Selective Availability and Anti-spoofing. They have been approved by the GPS Joint Program Office for use by the DoD, making Allen Osbourne the first GPS manufacturer to successfully complete the approval process.

Garmin International has introduced a military variant of its commercial GPS 100 receiver called the GPS 100 MIL. This military variant can operate with a helmet-mounted antenna. Garmin's MultiTrac facility enables the unit to use information from up to eight satellites at a time. This results in increased accuracy (15 m RMS for position, 15 m RMS for altitude, and 0.1 kt steady state for velocity).

Magellan Systems offers a wide variety of GPS receivers with numerous options, accuracy, and pricing options. A typical offering is the GPS 4000XL handheld GPS receiver, with a cold start of three-minutes for signal acquisition, signal tracking of up to 12 satellites, and accuracy within 15 meters. Weight is 10 ounces, including antenna and batteries. The price is US$249 (1997 dollars). Comparable units are available for vehicular, marine, and aviation applications.

Magellan military versions are also available, with prices believed to be between US$1,500 for handheld and US$3,500 for vehicular units. Typical military modifications include waterproofing and the ability to provide position readouts in latitude/longitude, and Military Grid Reference System or Universal Transverse Mercator coordinates. In addition, the receivers contain geodetic map datums as defined by the US Defense Mapping Agency.

NAVSTAR Electronics produces only one handheld unit (the NavSymm GPS Compass) for US$875. All other models are optimized for aviation, marine and land navigation with prices up to US$5,200 (1997 dollars). The receivers can track between 5 and 12 satellites.

The French firm NAVOCAP developed a specialized GPS receiver to be used by paratroopers. Designated OPANAS (Operational Paratroopers Navigation System), it was designed to aid in navigating paratroopers to their touchdown and rally points. The system is worn on the chest and consists of a Rockwell PLGR or PLGR+96 GPS receiver, compass, backlit LCD, and a navigational data-module. The unit has two settings, a specialized one to be used while descending, and a normal setting for use on the ground.

As one of the most active GPS developers, Rockwell Collins has a wide variety of GPS products. The Rockwell MMIC chip is being used in the two-channel, handheld, 100-cubic-centimeter GPS receiver that Collins has been developing in a technology demonstration for DARPA. The chipset (also including VHSIC and VLSI circuits) for the miniature receiver was formally demonstrated to DARPA in March 1989. The mil-spec receiver weighs eight ounces. The development work done for the miniature receiver has resulted in a generic set of chips that can be used without

modification in virtually any type of GPS receiver, whether single- or multi-channel.

Rockwell's User Equipment family offers one-, two-, and five-channel receivers that have applications onboard tanks, vehicles, submarines, surface ships, and aircraft, as well as manpack versions. Rockwell Collins has provided User Equipment for all three services, as well as for several foreign customers. As part of a miniaturization effort, the company has come up with a modification to the user equipment contract. This modification will result in a significant weight reduction of the processor assembly for the two- and five-channel receivers. One circuit board will be replaced with an embedded processor chip that incorporates VLSI/ CMOS technology. In the family, the 3S receiver is the basic shipboard receiver, while the M/V GPS is the basic manpack/vehicular configuration.

In 1993, Rockwell was awarded a contract to produce the Precision Lightweight GPS Receiver (PLGR) for use by dismounted forces. A need for such a system was demonstrated in Operation Desert Storm when the US DoD purchased thousands of commercial GPS receivers, Small Lightweight GPS Receivers (SLGRs), for use by dismounted forces. The PLGR is P/Y code capable, with an accuracy of <4 meters, a <60 second acquisition rate, and a weight of 2.5 pounds. A vehicle version (VPLGR) is also available. Unit price for the handheld PLGR is believed to be approximately US$1,800 (1997 dollars). An updated version of the PLGR, designated PLGR+, has been designed with increased capabilities. Unit price for the PLGR+ is believed to be approximately US$2,000 (1997 dollars).

In 1996, US Special Operation Command (USSOCOM) placed an order for the Rockwell Special Operations Lightweight GPS Receiver (SOLGR). The SOLGR is based on the PLGR, but it is smaller, lighter and thinner than the standard PLGR. It has P/Y code capability, a 30-second acquisition rate, weighs <1.5 pounds, is waterproof to an undisclosed depth, and will incorporate a floating antenna/connector device to circumvent signal degradation due to deep water. Unit price for the SOLGR is estimated at approximately US$3,000.

Signature Industries launched a GPS search and rescue beacon for civil and military aircrew in late 1994. The system is known as the SARBE-GPS. The unit tells search teams exactly where to look. Although already used by the military, this is the first such unit intended for civilian use. The size of a transistor radio, the unit broadcasts a data stream that includes a position information and a user-identification code. The transmitter operates over a range of at least 50 miles and can work with a variety of rescue homing systems. It is also waterproof and can be placed into a life jacket, survival pack, or inflatable raft.

Trimble Navigation has shown an excellent capability in the area of GPS and the company claims that its TRIMPAK receiver is smallest, lightest, lowest power military manpack GPS receiver available. The two-channel receiver was privately developed after the US Army requested that a readout display be added to the TANS (Trimble Advanced Navigation Sensor), already in use on the US Navy's Pioneer unmanned air vehicle. Featuring a built-in antenna, the TRIMPAK weighs a maximum of 4.2 pounds (two D-cell batteries), is about the size of a pair of binoculars, and costs well under US$10,000.

Since the advent of the TRIMPACK, Trimble has continued to refine its handheld line by dropping the size, weight, and price of its units while increasing overall capabilities. The Centurion, introduced in 1993, is slightly smaller than the TRIMPACK, weighs 30 percent less, and sells for roughly US$3,000 (1997 dollars). The MUGR, also introduced in 1993, is basically half the size and weight of the Centurion, but with a price of US$5,000 (1997 dollars). The newest version of the TRIMPACK, the TRIMPACK III, has just recently been released.

In April 1994, Trimble announced it had completed an order for 1,200 PSN-10 TRIMPACK GPS systems to the Saudi Arabian National Guard. The TRIMPACK units being installed in the LAV-25 armored vehicle can operate and display data in either Arabic or English and will interface with the KVH fluxgate compass as the vehicle's navigation system.

Trimble is also updating older, proven systems such as the 4000 ST Field Surveyor GPS survey system. These updated systems tend to be lighter, more accurate (especially the Differential GPS units), and of comparable price to other systems that perform the same functions. Many also have the ability to receive the P(Y) code-encrypted channel used by the US DoD and its allies. A typical example would be the Precise Positioning System (PPS) version of the 4000SSI GPS ground-based surveying equipment ordered by the US Marine Corps (USMC) and US Army. Price per unit is approximately US$31,000 (1995 dollars).

The German company Vallon is marketing an advanced metal detection system linked with a Differential GPS, which collects data on buried objects. The handheld Vallon EL 1302A1 ferrous metal detector is already in service with one undisclosed NATO country. For follow-up operations, a complete target list and map can be printed out in either meters or feet. The lists and the maps indicate the field and each target by its GPS position.

Program Review

Background. The Navigation Signal Timing and Ranging Global Positioning System is a constellation of orbiting satellites that provides navigation data to military and civilian users all over the world. The system is operated and controlled by members of the 50th Space Wing's 2nd Space Operations Squadron, located at Schriever Air Force Base, Colorado

The GPS constellation consists of a minimum of 24 satellites circling the globe every 12 hours. GPS provides 24-hour navigation services that include:

- Extremely accurate three-dimensional location (latitude, longitude and altitude), velocity, and precise time
- A worldwide common grid that is easily converted to any local grid
- Passive all-weather operations
- Continuous real-time information
- Support to unlimited number of users and areas
- Support to civilian users at a slightly less accurate level

GPS satellites orbit the earth every 12 hours, emitting continuous navigation signals. With the proper equipment, users can receive these signals to calculate precise time, location and velocity. The signals are extremely accurate. Time can be figured to within a billionth of a second, velocity within a fraction of a mile per hour and location to within a few feet. Receivers are available for use in aircraft, ships and land vehicles as well as for hand carrying.

The Delta II Expendable Launch Vehicle is used to launch GPS satellites from Cape Canaveral Air Force Station, Florida, into nearly circular orbits at about 11,000 nautical miles. The systems transmit signals on two different L-band frequencies. Their design life is seven-and-a-half years.

The GPS Master Control Station, operated by the 50th Space Wing's 2nd Space Operations Squadron at Schriever AFB, Colorado, is responsible for monitoring and controlling the GPS satellite constellation. The GPS-dedicated ground system consists of five monitor stations and four ground antennas located around the world. The monitor stations use GPS receivers to passively track the navigation signals on all satellites. Information from the monitor stations is then processed at the MCS and used to update the satellites' navigation messages.

The MCS operations crew sends updated navigation information to GPS satellites through ground antennas using an S-band signal. The ground antennas are also used to transmit commands to satellites and to receive satellites' state-of-health data (telemetry).

GPS promises to significantly enhance many of the functions provided by current positioning and navigational equipment and will result in greater accuracy at lower cost. Such functions as mapping, aerial refueling and rendezvous, geodetic surveys, and search-and-rescue operations benefit from GPS capabilities.

Such capabilities were put to the test during the US involvement in Operations Desert Shield and Desert Storm. Allied troops relied heavily on GPS to navigate the featureless Saudi Arabian desert. Forward air controllers, pilots, tank drivers and even cooks used the system so successfully that several US defense officials cited the GPS as key to the Desert Storm victory.

NAVSTAR Worldwide Access. The NATO GPS program was established in 1973, with the emphasis on providing information in regard to potential GPS applications by NATO members. In 1978, the following ten NATO members signed a GPS MoU: Belgium, Canada, Denmark, France, Federal Republic of Germany, Italy, the Netherlands, Norway, the United Kingdom, and the United States. Spain was added in 1987. Australia has also signed the MoU. Funding comes entirely from non-US NATO members. In early 1989, a NATO GPS steering committee made a formal request for unlimited access to GPS, since no such formal provision exists. In 1983, the US DoD decided that worldwide non-DoD users would be granted access to GPS by the time the system became fully operational.

US Air Force (USAF). The USAF is the lead agency and main supervisor of GPS. The USAF supervises numerous GPS ground stations and purchases land-based terminals for its own use. An example can be seen in the May 1994 contract awarded to Motorola to integrate GPS into its PRC-112 survival radio.

US Army. The US Army uses GPS receivers to support the Enhanced Position Location and Reporting System (EPLRS) to precisely locate EPLRS grid reference units. Other Army formations that use GPS include Special Forces, Rangers, Intelligence and Electronic Warfare, Transportation, Field Artillery, Air Defense Artillery and Aviation. The Special Forces and Ranger units use the lightest manpack receivers available for positioning and route guidance, but are

currently switching to handheld units. The total Army requirement is now put at 45,000+ receivers, up from previous estimates of 25,000. However, the actual procurement quantity is likely to go higher, since the Army claims to have identified over 150,000 potential GPS users through 2006.

US Marine Corps (USMC). The USMC and the Navy are working toward the integration of the GPS with the Position Location Reporting System (PLRS). PLRS is used by the Marine Corps to provide rapid position location information for all its units, as well as navigation information (for example, showing safe corridors for overflights). The integration of GPS PLRS will result in improved tactical awareness and a greatly enhanced capability to execute combined-arms operations. The new capability is especially beneficial for two critical mission areas: maneuver control and fire support coordination.

US Department of Transportation (US DOT). Acceding to the growing demand from civilian users, in the beginning of 1994, the Defense Department agreed to manage GPS jointly with the Department of Transportation. The announcement was made after a six-month study by a joint task force. Joint management was decided upon to give civil users a voice in the management and operation of GPS. While many international users would prefer to see GPS in the hands of an international governing body, the new agreement is a compromise between the needs of the DoD and the desires of civilian users. The task force concluded that GPS will continue to be funded largely by the US DoD, but the Transportation Department will finance augmentations to support special civil navigation needs.

Vehicle Navigation System. In May 1990, the US Army revealed that its Harry Diamond Laboratory was developing an advanced version of a low-cost alternative to GPS, possibly an adjunct, with the focus on truck and utility requirements. The autonomous system, called Vehicle Navigation Aid, is based on an inertial fluidics angular rate sensor (commercially manufactured by Honda and already used as the roll-rate sensor in the Copperhead artillery projectile). Initially, the user is required to input his correct location. The system then provides updated data on vehicle location and heading. Army vehicle users, including tankers, have expressed dissatisfaction with GPS because of dead spots caused by rock overhangs and foliage. This is a critical shortfall for tankers since their natural inclination is to seek positions that provide camouflage.

Differential GPS. To provide a higher degree of system performance and accuracy, GPS supporters are looking to a system called Differential GPS (DGPS). DGPS employs a fixed receiver at a known location to determine satellite positioning errors in real time. The errors are then broadcast on VHF frequencies to all users within the service area of the DGPS receiver. Applying the corrections to incoming satellite data, users can obtain more precise location accuracy. The US Army applied DGPS as part of its Precision Range Integrated Maneuver Exercise (PRIME) program for real-time monitoring of vehicles and immediate feed-back of crew performance. The Finnish and Swedish governments began operations of a DGPS-based marine navigation system consisting of six DGPS stations that cover the Baltic Sea.

Defense Advanced GPS Receiver (DAGR). The NAVSTAR Joint Program Office is currently working on an advanced GPS receiver initiative. DAGR is a hand-held GPS receiver, powered by AA batteries, and weighing less than two pounds. It is expected to be vehicle- and seacraft-mountable through use of a remote antenna and installation cables. DAGR is scheduled to replace the currently used Precision Lightweight GPS Receiver (PLGR) family of NAVSTAR GPS receivers.

Commercial GPS Usage. The success of GPS during Operation Desert Storm has generated a huge demand for receivers in the civilian marketplace as these units are incorporated into automobiles, marine vessels and civilian aircraft. In the early 1990s, the Intelligent Vehicle-Highway Systems (IVHS) Society of America submitted its Strategic Plan for IVHS to the US Department of Transportation. The strategy included plans for guidance research, development, and deployment of IVHS in commercial transportation applications during the next 20 years. The IVHS plan is a collection of technologies – information processing, communications, control, and electronics – which, when combined in the overall system, will assist drivers maneuvering in traffic. Some of the systems involve individual vehicles equipped with navigation systems that direct drivers to the best possible route. Others are designed with a focus on mass transit, such as equipping buses with sensors to allow central dispatch operators to monitor the buses from computers in their offices.

At the present time, some 35 IVHS operational test programs employing GPS for location determination information are going on throughout the country. Motorola Inc is working with the Illinois Department of Transportation in the Advanced Driver and Vehicle Advisory Navigation Concept (Advance) Program. In this program, private and commercial vehicles are equipped with onboard navigation and route guidance systems using GPS receivers to improve precise location identification.

Latest Information. On February 6, 2001, Rockwell Collins received a US$6.8 million contract from the US Global Positioning System Joint Program Office for the Ground Receiver Program (GPR). The GPR program is a 14-month research and development program that requires all receivers to utilize the next-generation Selectivity Availability Anti-Spoofing Module (SAASM), and to be dual frequency capable. Rockwell Collins will assist in defining the requirements for the high end Defense Advanced GPS Receiver. The company will also be researching the capabilities of the low-end receiver focused primarily toward the infantry.

In March 2001, Electro-Radiation Incorporated received a contract under the US Army's Advanced Concept Technology Program to develop an antijam antenna for retrofit on the handheld PSN-11 Precision Lightweight GPS Receiver (PLGR). The one-year program is expected to provide the technology for retrofitting over 75,000 legacy PLGR and potentially over 100,000 new handheld Defense Advanced GPS Receivers. The initial research contract is valued at US$236,000.

Funding

US PROCUREMENT FUNDING

	FY99		FY00		FY01	
	QTY	AMT	QTY	AMT	QTY	AMT
Procurement (US Army)						
NAVSTAR GPS[a]	-	8.0	-	6.5	-	21.7

	FY02(Req)		FY03(Req)		FY04(Req)		FY05(Req)	
	QTY	AMT	QTY	AMT	QTY	AMT	QTY	AMT
NAVSTAR GPS[a]	-	20.8	-	Unknown	-	Unknown	-	Unknown

All US$ are in millions.

Source: US Department of the Army FY2002 Procurement Program.

[a]The Bush Administration has not addressed FY2003-2007 requirements.

Recent Contracts

Contractor	Award ($ millions)	Date/Description
ERIM International	6.1	Feb 1998 – Unidentified funding to develop a GPS-based minefield detection system for the USMC. System will be primarily UAV mounted, but dedicated to ground forces. Funding began in 1999. IOC to be achieved by 2002.
Raytheon	18.5	Mar 1998 – The UK Mod awarded an FFP contract for the delivery of 1,000+ Tactical Air-to-Ground (TacGA) radios for UK armed forces.
Leica Technologies	92.0	Feb 1999 – Contract from the US Army Tank Automotive & Armaments Command for 85 Gun Laying Positioning System (GLPS) installations for use with towed and self-propelled howitzers, incorporating a GPS receiver.
Rockwell Collins	18.0	Feb 1999 – Contract to provide 3,400 PLGR II systems for mounting on variety of sea and land-based platforms, to include M113A1 armored personnel carriers and Leopard AS1 main battle tanks.

Contractor	Award ($ millions)	Date/Description
Contech Mobile Datacom	1.0	Jul 1999 – Part of a US$418.2 million, FFP, ID/IQ contract to provide GPS commercial computer equipment, system support software, installation kits, air time, integration, maintenance and support to a worldwide two-way data communications and geo-location capability between mobile units (handheld and vehicular mounted) and designated control stations. To be completed June 2007. (DAAB15-99-D-0014)
Lockheed Martin	53.0	Aug 2000 – CPIF contract for modernization changes, incorporating a second civil signal and a new military signal, for 12 NAVSTAR GPS Block IIR satellites. Completed September 2001. (F04701-00-C-0006)
Boeing	123.3	Aug 2000 – Contract modification for design and development enhancements of new military and civil signals into the NAVSTAR GPS IIF satellite. To be completed March 1, 2003. (F04701-96-C-0025-P00080)
Alliant Integrated Defense Co.	2.2	Mar 2001 – Alliant Integrated Defense Company receives a contract to provide research and development support for the Defense Advanced Global Positioning System Receivers program. The contract was awarded by the US Air Force's Space and Missile Systems Center. Expected to be completed by March 2002.
Raytheon Company	8.6	Mar 2001 – Raytheon Company receives a contract to provide research and development support for the Defense Advanced Global Positioning System Receivers program. The contract was awarded by the US Air Force's Space and Missile Systems Center and is expected to be completed by March 2002.
Allen Osborne Associates	2.2	Mar 2001 – Allen Osborne Associates receives a contract to provide research and development support for the Defense Advanced Global Positioning System Receivers program. The contract was awarded by the US Air Force's Space and Missile Systems Center. Expected to be completed by March 2002.
Rockwell Collins	20.1	May 2001 – Rockwell International Corporation, Collins Avionics and Communication Division, is awarded a US$20,143,860 contract to provide 13,825 Precision Lightweight Global Positioning System (GPS) receivers. Air Logistics Center, Robins Air Force Base, Ga., is the contracting authority (F04701-93-D-0001-0045).

Timetable

Month	Year	Major Development
Dec	1973	Milestone I – concept validation
	FY 1974	1st space contract to Rockwell; General Dynamics received control user contract (Phase 2)
	FY 1978	NAVSTARs 1 through 4 launched
	FY 1979	Phase 2 user set contract awarded; Milestone II achieved; Block 1 replenishment contract
	FY 1980	1st Minuteman 3 with NAVSTAR receiver launched; NAVSTAR 5 and 6 launched
Dec	1981	NAVSTAR 7 launched, destroyed in booster failure accident
Sep	1982	Rockwell awarded long-lead parts contract for Block 2 satellite production
	FY 1983	Block 2 satellite contract to Rockwell; 1st transatlantic flight using NAVSTAR made; NAVSTAR 8 launched; Congress asked for civilian use of NAVSTAR
	FY 1984	NAVSTAR 9 launched via an Atlas-E; NAVSTAR 10 launched
	FY 1985	1st user equipment contract to Rockwell; 1st NAVSTAR launch via the Space

Month	Year	Major Development
		Shuttle; NAVSTAR 11 launched; Navy chose five-channel receiver over the two-channel one for ships
	FY 1986	Collins manpack versions enter LRIP; EURONAV consortium Milestone IIIA
Sep	1987	1st Collins GPS user equipment delivered for integration by the USAF
	FY 1988	TI's M/V and five-channel receivers tested; negotiations to merge GPS and GLONASS
	FY 1989	Block II satellite launched; Milestone IIIB; Canadian Marconi and SCI receivers tested
Sep	1990	SCI awarded user equipment contract
Jul	1991	DEM/VAL for GPS/PLRS interface unit for Marine Corps
	FY 1992	GPS/PLRS interface units competitive contracts; 13th – 17th GPS satellites launched
	FY 1993	Launch of 18th through 23rd NAVSTAR GPS satellites
	FY 1994	Launch of 24th NAVSTAR GPS; Final operational capability of 24 satellites completed
	FY 1996	Launch of 25th NAVSTAR GPS; Boeing awarded contract for 33 Block IIF satellites
	FY 1997	1st Block IIR satellite destroyed when launched; delivery and launch of 2nd Block IIR
Sep	1997	Green light validation of Land Warrior electronics system including mini-GPS receiver;
Nov	1999	DAGR Draft RFP released; FMS questions about foreign language capabilities in DAGR
	FY 2000	Block IIF contract altered – Boeing to produce 12 IIFs; Lockheed Martin to upgrade IIRs
	FY 2000	Block III satellite plans announced – RFP released; Civil SA signals degraded
	FY 2001	Final Block IIR deliveries
	FY 2002	DAGR production deliveries scheduled to begin
	FY 2005	Scheduled start date for Block IIFs launches
	FY 2008	Block IIF satellites expected to be operational
	FY 2009	1st NAVSTAR GPS III satellite to be launched

Worldwide Distribution

Australia, **Belgium**, **Canada**, **China**, **Denmark**, **Estonia**, **Finland**, **France**, **Germany**, **Greece**, **Italy**, **Japan**, the **Netherlands**, **New Zealand**, **Norway**, **Portugal**, **South Africa**, **Spain**, **Turkey**, the **United Kingdom**, and the **United States**.

Forecast Rationale

The Navigation Signal Timing and Ranging (NAVSTAR) Global Positioning System (GPS) is a constellation of orbiting satellites that provides navigation data to military and civilian users all over the world. The system is managed by the United States NAVSTAR GPS Joint Program Office at the Space and Missile Systems Center, Los Angeles Air Force Base, Calif.

As indicated by the **Ten-Year Outlook** chart, Forecast International expects consumer demand for NAVSTAR GPS Land-Based Terminals to be strong from 2001 to 2010. This healthy purchasing behavior is driven by the superior navigation capabilities of the NAVSTAR Global Positioning System.

Imagine being the pilot of an F-18 Hornet carrying strike munitions. Your mission is to take out the headquarters of a well-known terrorist somewhere in central Asia. You are a few miles from your target. Suddenly, you fly into the thickest possible haze only to shoot up into cloud coverage. You have no idea whether you passed your target.

Such a scenario is history in the era of the NAVSTAR Global Positioning System. During the Gulf War, the US Army learned how heavily it can depend upon NAVSTAR GPS coordinates for maneuver and logistics effectiveness in featureless terrain. The US Air Force increased its bombing accuracy in Kosovo by using the NAVSTAR Global Positioning System.

Look for US armed forces to rely on the Navigation Signal Timing and Ranging Global Positioning System during Operation Enduring Freedom.

Ten-Year Outlook

ESTIMATED CALENDAR YEAR PRODUCTION

			High Confidence Level				Good Confidence Level				Speculative			
Designation	**Application**	**Thru 00**	**01**	**02**	**03**	**04**	**05**	**06**	**07**	**08**	**09**	**10**	**Total 01-10**
NAVSTAR GPS LAND-BASED	DAGR RECEIVERS (US ARMY)	40	8049	3092	15252	13303	12176	15500	22480	22485	22485	20000	154822
NAVSTAR GPS LAND-BASED	DAGR RECEIVERS (VARIOUS)	0	0	0	0	9000	10000	13000	15000	15000	14000	15000	91000
NAVSTAR GPS LAND-BASED	HANDHELD RECEIVERS (VARIOUS)	457000	50000	45000	45000	45000	40000	40000	40000	45000	50000	50000	450000
NAVSTAR GPS LAND-BASED	MANPACK RECEIVERS (VARIOUS)	113847	12000	10000	10000	10000	10000	10000	9000	9000	9000	8000	97000
NAVSTAR GPS LAND-BASED	VEHICULAR TERMINALS (VARIOUS)	305500	75000	80000	81000	81000	85000	85000	85000	85000	85000	85000	827000
Total Production		876387	145049	138092	151252	158303	157176	163500	171480	176485	180485	178000	1619822