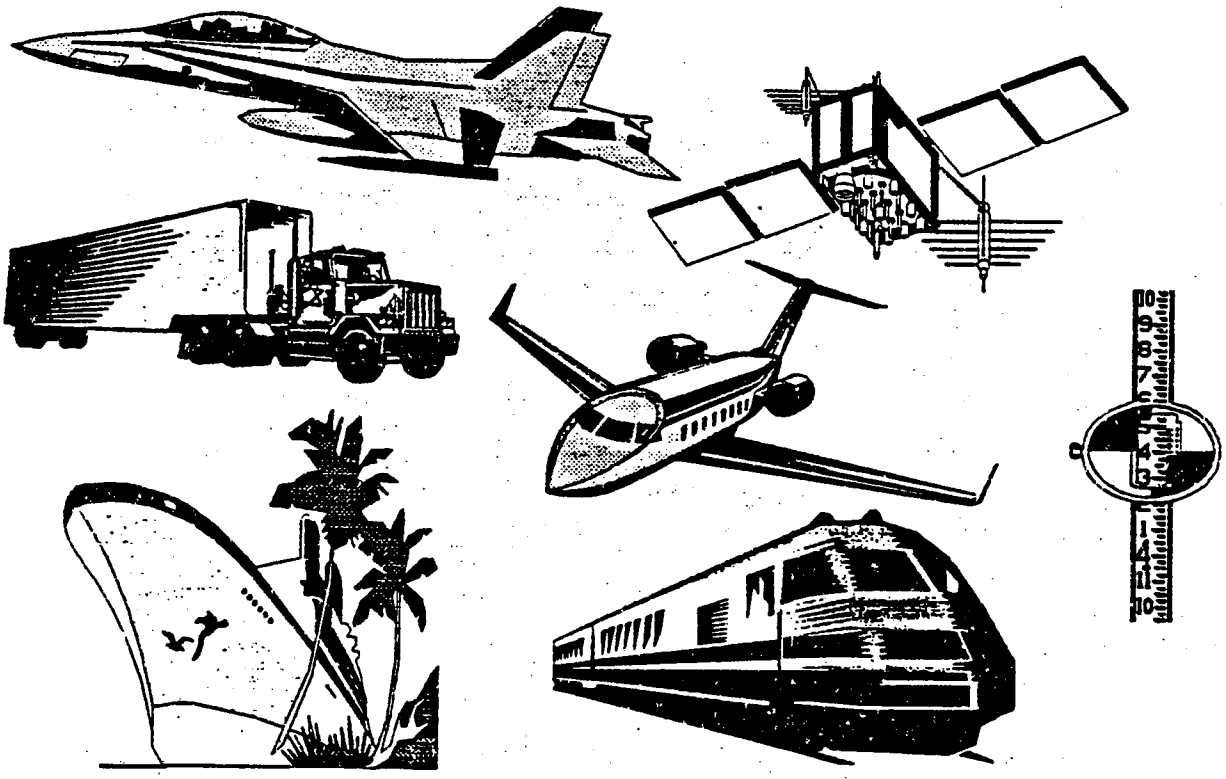
The Global Positioning System: Management and Operation of a Dual Use System



Joint DOD/DOT Task Force

A Report to the Secretaries of Defense and Transportation

December 1993

Joint DOD/DOT TASK FORCE ON GPS

MEMORANDUM FOR THE SECRETARIES OF DEFENSE AND TRANSPORTATION

This report documents the findings and recommendations of the Joint DOD/DOT Task Force on the Global Positioning System.

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Foreword

This report represents the results of a joint Department of Defense/Department of Transportation study addressing the management of the U.S. Global Positioning System (GPS). This system, funded and operated by the Department of Defense, provides worldwide navigation capabilities and is expected to support a broad spectrum of civilian transportation needs as well as military missions throughout the world.

The management structure and technical considerations outlined in this report, when implemented, will provide for full representation of civilian interests in the policy management of the GPS. It will ensure that policy decisions affecting the GPS are made with full consideration of civil interests. This report recommends a mechanism which can be used to efficiently resolve differences between civil and military interests, if any were to occur. These recommendations will also provide for an integrated national approach for GPS services.

The study team recognizes the growing importance of space-based navigation technology to a host of military and civilian applications and believes that these recommendations, when implemented, will enable this system to play a major role in worldwide navigation operations.

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Executive Summary

BACKGROUND

Early in 1993, the Secretaries of Defense and Transportation discussed the growing benefits of the Navstar Global Positioning System (GPS) for both military and civil users. The Secretaries concluded that it is in the best interest of the United States to encourage maximum civil use of the system consistent with national security needs. As a result, they directed the establishment of a Task Force to evaluate the services derived from GPS and the ability of GPS to support increasing civil use.

The GPS is a satellite-based radionavigation system deployed and operated by the Department of Defense (DOD). When fully operational, GPS provides highly accurate three-dimensional position, velocity, and time to users worldwide. Since its inception in the early 1970s, GPS was envisioned and has proven to be a significant means of enhancing the war fighting capability of U.S. and allied military forces.

GPS was conceived, developed, and fielded as a military system; specific civil requirements were not included in its design specifications. Nevertheless, civil use of the system has always been an implicit consideration. Civil use is growing in importance and integral to the development of policies under which GPS is operated and made available by the cooperative effort of the DOD and Department of Transportation (DOT).

Widespread civil and military use of the system is occurring. U.S. and coalition military forces achieved significant military advantage through the use of GPS in Operation Desert Storm. Worldwide civil applications of GPS for navigation, positioning, and timing are increasing at a rapid rate. Although not yet widely operational in civil aviation, GPS is generally recognized as having the potential to provide the greatest enhancements to aviation system capacity, efficiency, and safety since the introduction of radio-based navigation more than 50 years ago. Civil exploitation of GPS offers significant improvements to the national infrastructure derived from economy, safety, and efficiency in transportation and commerce.

TASK FORCE

At the direction of the Secretaries, the Task Force was jointly chaired by the Deputy Assistant Secretary of Transportation for Policy and International Affairs and the DOD Director of Theater and Tactical Command, Control, and Communications. The Task Force membership was drawn from offices throughout both Departments.

In its deliberations, the Task Force considered all identified concerns and suggestions, which it consolidated into seven core issues. For the purposes of its discussions, the Task Force defined *issues* as

> *areas where GPS does not currently meet civil user expectations or where alternate management strategies have been recommended.*

The Task Force considered the following core issues:

- Management Structure
- Funding
- Accuracy
- Integrity and Availability
- Regulation of GPS Augmentations
- International Acceptance
- Spoofing and Jamming

In evaluating options, the Task Force agreed to a series of ground rules. It unanimously agreed that the worldwide, all-weather availability of precise positioning, velocity, and time has significant military utility. The Task Force, therefore, weighed the security implications of the options along with the public safety and economic benefits offered by GPS. Further, the Task Force recognized that recommendations must be tempered by fiscal reality and should not put U.S. users and manufacturers at a competitive disadvantage in the worldwide marketplace. Finally, the Task Force took into consideration prior U.S. Government commitments regarding GPS as well as government policy against proliferation of radionavigation systems.

The Task Force met regularly over an eight-month period. Its deliberations were supported by a working group with broad-based experience within the two Departments.

RECOMMENDATIONS

The Task Force evaluations resulted in the following recommendations which were fully coordinated through both Departments.

Management

- **A Joint DOD/DOT Executive Board should be established to resolve overall GPS policy and management issues.**
  - The GPS Executive Board should be composed of the Chairmen and Executive Secretaries of the DOD and DOT Positioning and Navigation (Pos/Nav) Executive Committees. It should:
    - meet when required to resolve issues that cannot be decided by routine interaction of both Pos/Nav Executive Committees,
    - resolve issues by consensus.
  - A DOT Pos/Nav Executive Committee should be created by reorganization of the present DOT Navigation Council. The DOD

Pos/Nav Executive Committee will continue as established by DOD directives.

- Both Committees will interact regularly to discuss GPS policy and management issues.

- An Assistant Secretary of Transportation should be designated Chairman of the DOT Pos/Nav Executive Committee and be delegated authority to:

  - speak on behalf of the civil GPS user community,

  - make decisions for the DOT regarding civil GPS services, and

  - maintain an outreach program to ensure that the needs of other federal agencies, state, and private sector users are addressed in future GPS decision-making processes.

- The current Civil GPS Service Interface Committee should be designated a Federal Advisory Committee.

Funding

- **The basic GPS, which supports war fighting missions, should continue to be financed through DOD appropriations from the general fund.**

- **Federal augmentations to GPS, which support civil navigation needs, should be financed by DOT through appropriations from the general fund and indirect fees.**

- **The DOD and DOT Pos/Nav Executive Committees should evaluate equitable cost recovery mechanisms to finance GPS services.**

Accuracy

- **Differential GPS (DGPS) services should be implemented for those civil applications requiring accuracy better than that provided by GPS SPS, with or without Selective Availability (SA) or by GPS Precise Positioning Service (PPS).**

- **A study of all DGPS services under development or deployment is required to determine the optimum integrated system to provide GPS augmented services. This assessment will investigate the performance, economic benefits, and security implications of all wide/local area DGPS service options. This study will be formalized in a new annex to the DOD/DOT Memorandum of Agreement (MOA) on Use of GPS and be completed as soon as possible but not later than September 30, 1994.**

  - Current federal agency development and deployment of GPS accuracy enhancements should continue pending completion of this work. The Task Force's opinion is that near-term benefits outweigh any costs that may be saved by delaying or deferring GPS accuracy enhancement development. New federally established DGPS navigation systems

would be deployed in accordance with the approved recommendations resulting from the above study.

Integrity and Availability

- **A wide area broadcast using communications satellites should be implemented as an expeditious way to rapidly improve GPS integrity and availability for aviation users, and possibly other modes of transportation. This wide area broadcast should include both integrity and ranging components.**

- **Integrity information should be provided along with all DGPS services.**

Regulation of GPS Augmentations

- **Common, government-wide GPS augmentations should be implemented.**

  - An annex to the MOA described above will be developed to provide a mechanism for evaluation of possible consolidation of independent initiatives for government-provided augmentations.

  - In the interim, ongoing, individual agency DGPS programs should continue to provide information for evaluation and to minimize disruption of systems now in operation.

- **Private sector-provided DGPS services not used for navigation purposes should not be regulated. However, the government should retain the option to regulate private sector-provided DGPS services should they be used for navigation in the future.**

International Acceptance

- **Ongoing U.S. Government initiatives to promote international acceptance of GPS should be continued.**

  - The DOT should begin now to assess additional initiatives as may be necessary to enhance international acceptance of GPS. Recommendations will be coordinated with the DOD Pos/Nav Executive Committee.

Spoofing and Jamming

- **Ongoing DOD and DOT technical assessments of potential spoofing and jamming threats and their impacts, if any, on use of GPS should be completed. Results should be reported to the DOD and DOT Pos/Nav Executive Committees for further consideration.**

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Current Situation

1.1 INTRODUCTION

This part of the report provides information on the current operation, management, policies, and uses (military and civil) of GPS and is divided into five sections. Sections 1.1 and 1.2 provide an introduction and background. Section 1.3 describes the GPS system, including system components, GPS services, and GPS augmentations such as integrity and DGPS. Section 1.4 discusses GPS applications--military, civil, and dual uses. Applications include both current and planned uses of the system. Section 1.5 covers the current management, funding, and policies regarding the operation and use of GPS and includes a discussion of joint radionavigation planning and joint military/civil agreements.

1.2 BACKGROUND

In the early 1970s, the DOD began developing the GPS as a space-based pos/nav system to provide precise, three-dimensional position, velocity, and time; to reduce vulnerability to attack over existing land-based navigation systems; and to provide users with increased freedom from detection. GPS signals are continuously available on a worldwide basis, at any altitude, and in any weather. The satellites which supply the navigation message and precise time, the basis of the GPS concept, are located 11,000 nautical miles above the earth in a widely dispersed constellation. To access the system, users have only to turn on a GPS receiver, like a normal radio, with the antenna exposed to the sky.

Though GPS was developed as a military system and, therefore, did not include specific civil requirements in its contractual design specifications, civil use of GPS has been an implicit consideration since its inception. Civil use has played a significant role in the development of policies under which GPS is operated and made available by the DOD, driven largely by GPS support to civil aviation and maritime navigation.

In 1978, DOD and DOT began formal joint planning to reduce the need for many land-based radionavigation systems used for military and civil applications. In 1983, following the downing of Korean Airline Flight 007, President Reagan directed that the DOD-operated GPS be made available by the DOT for international civil use. Subsequently, the DOD formally requested that the DOT assume responsibility for interfacing with the civil community and work closely with the DOD to ensure proper implementation of GPS for civil use. Several DOD/DOT agreements have been established for this purpose and are discussed in Section 1.5 of this paper.

Based upon recommendations of the International Civil Aviation Organization (ICAO) Special Committee on the Future Air Navigation System and to further the development of the ICAO Communications, Navigation, and Surveillance/Air Traffic

Management system concept, the U.S. decided to make available the Standard Positioning Service (SPS) of the GPS at the Tenth Air Navigation Conference in September 1991. The U.S. offer at the Tenth Air Navigation Conference was: "SPS is planned to be available beginning in 1993 on a continuous, worldwide basis with no direct user charges for a minimum of ten years. The service will provide horizontal accuracies of 100 meters (2 drms - 95% probability) and 300 meters (99.99% probability)." In September 1992, at the 29th ICAO Assembly, the U.S. extended the 1991 offer and offered SPS to the world for the foreseeable future and, subject to the availability of funds, to provide a minimum of six-year advance notice of termination of GPS operations or elimination of the SPS.

Although GPS is planned for initial civil operating capability in late 1993 and Full Operating Capability in 1995, widespread use is already occurring. GPS demonstrated its value to U.S. forces and coalition partners in Operation Desert Storm. Successful execution of operational plans and effective use of precision weapons were keyed by the data provided by GPS. In the civil community, GPS has demonstrated its widespread utility in surveying, timing, and maritime applications.

1.3 SYSTEM DESCRIPTION

1.3.1 System Components

The GPS consists of the space, control, and user equipment segments. This section provides a management and financial overview of the space and control aspects of GPS operation. Detailed technical descriptions of the segments are available elsewhere.

The GPS space segment consists of 24 satellites operating at semi-synchronous altitude in six orbital planes. The satellites contain atomic clocks and processors to minimize the extent of ground contact necessary to maintain accuracy. This feature minimizes military vulnerability but increases the relative cost of the satellites over simple transponder systems. GPS satellites also host sensors and communications packages for a Nuclear Detonation Detection System. Operational satellite subsystems are designed to last for 7.5 years leading to a statistically estimated satellite life of 6 years. These factors are important in determining the cost of GPS satellites and the frequency with which they must be replaced to maintain minimum basic system availability requirements.

All GPS satellites are operated from a control segment with a Master Control Station (MCS) at Falcon Air Force Base, Colorado, and a worldwide network of five signal monitor stations and three uplink ground antennas. A fourth antenna is available but generally used only for ground checkout of satellites prior to launch. The monitor stations collect and send GPS navigation signal data to the MCS for evaluation and determination of any corrections required to the navigation packages onboard each satellite. Corrections to individual satellite atomic clocks or orbital parameters are relayed from the MCS to the satellites via the ground antennas. The MCS also monitors normal satellite telemetry via separate downlinks to assess state of health of other satellite subsystems such as power, thermal balance, and attitude. The control segment is sized to accommodate up to three contacts per satellite per day to maintain system accuracy requirements. At present, two contacts per satellite per day are the norm. However, older satellites or satellites with control problems require more contacts to maintain optimum performance.

To meet minimum operational requirements, the DOD will operate a 24-satellite constellation to ensure 21 satellites are available 98 percent of the time. The cost of sustaining minimum GPS services, once the complete constellation is established, is approximately $400 million per year (FY1993 dollars). This cost is driven by the acquisition costs of satellites ($30-$40 million each) and boosters ($30-$40 million each), and by the launch costs ($15-$20 million per launch). At current estimates of satellite life on-orbit, somewhere between three and four launches per year will be required to sustain minimum GPS availability. The present satellite design fully uses the capabilities of an enlarged Delta II booster for launch into semi-synchronous orbit. Higher altitudes or heavier satellites would require more expensive boosters and launches. The cost of control segment manning and worldwide maintenance (software and hardware), as well as provision for future MCS upgrades or changes to satellite data interfaces, is approximately $30 million per year.

Rockwell built the original 11 research and development (Block I) satellites. While these satellites do not have a SA or an Anti-Spoofing (A-S) capability, they transmit a useful navigation signal. Three of the satellites are still operating. Rockwell is also building 28 operational (Block II) satellites. These satellites transmit a useful navigation signal and have SA/A-S capability. Twenty-three of these satellites have been launched and are still operating. The last Block II satellite should be launched in 1996. Martin Marietta is building the follow-on satellites (Block IIR). DOD is procuring 20 Block IIR satellites between FY92-FY96 as part of a multiyear contract and has an option to buy one additional satellite in FY95. With nominal lead time of four years between satellite procurement and delivery, DOD will launch these satellites from FY96-FY01.

As the provider of civil radionavigation services, and by agreement with DOD, the DOT is the federal government point of contact for civil use of GPS. There are three agencies within DOT that interface with DOD on GPS matters: the U.S. Coast Guard (USCG), Federal Aviation Administration (FAA), and the Research and Special Programs Administration (RSPA). The Coast Guard is the lead DOT agency for civil GPS service operations and the government interface with civil users of GPS. FAA is responsible for aviation matters, and RSPA coordinates issues and planning of an intermodal nature.

To support the civil use of the system, the DOT established a Civil GPS Service Interface Committee to address the needs of civil GPS users. This committee, composed of representatives from industry and user groups, both national and international, as well as from DOT, DOD, and other federal agencies, meets regularly to discuss civil GPS issues and concerns. In addition, the Coast Guard operates a GPS Information Center (GPSIC) through which all users can obtain general and status information for the GPS as well as for other Coast Guard-operated radionavigation systems. The GPSIC is operated 24 hours per day to serve the needs of all GPS users. The Coast Guard is establishing a program office to process applications for civil access to the PPS described below. In accordance with interagency agreements on operation and employment of GPS, federal civil agencies are responsible for budgeting funds or providing resources necessary to conduct the above activities or to modify or enhance the capabilities of the GPS to meet unique civil requirements. For example, the Coast Guard DGPS network is being installed to meet a previously unsatisfied 8-20 meter harbor and harbor approach navigation requirement.

1.3.2 GPS Services

Government policy defines two levels of GPS accuracy, a Precise Positioning Service (PPS - military) and a Standard Positioning Service (SPS - civil). The PPS consists of a navigation message transmitted at two frequencies and provided through two digital codes, the Coarse/Acquisition Code (C/A Code) and the Precise Code (P-Code). The transmission frequencies are in the L-band, designated as Ll (1575.42 MHz) and L2 (1227.60 MHz). An encrypted form of the P-Code, called the Y-Code, is also included in the PPS as are the factors necessary to correct for SA effects, described below. The Y-Code is designed to prevent hostile forces from spoofing, or fooling, authorized PPS users by copying or re-broadcasting GPS signals. This code encryption technique is called A-S. The SPS consists of the navigation message and the C/A Code transmitted at the Ll frequency and available free of direct charges to any user in the world. SA has been employed since November 1991, and A-S will be activated at GPS Initial Operating Capability (IOC).

The PPS is available to only the DOD and other authorized users and is denied to nonauthorized users through cryptography. PPS will be made available to U.S. and allied federal government (civil and military) users through special agreements with the DOD. Limited private sector civil use of PPS, both domestic and foreign, may be granted to users meeting certain criteria by applying to the Civil PPS Program Office (PPSPO) that will be operated by the USCG.

Since the late 1970s, the U.S. has had agreements with the NATO nations and Australia concerning GPS. These cooperative development agreements are being replaced with more operationally oriented agreements for PPS security, availability, and access. The extent of international participation is being broadened to include nations such as Israel, Japan, and Korea. Additionally, U.S. Civil Government agencies are authorized access to PPS, and agreements for such access have been completed to meet specific requirements in the Department of Energy, National Oceanic and Atmospheric Administration, National Aeronautics and Space Administration, and the Drug Enforcement Agency.

The DOD is preparing a GPS-SPS signal specification which describes the signals and services to be made available for civil use at IOC. The SPS accuracy, established at a peacetime level of 100 meters, is created through implementation of SA which affects the basic parameters of the navigation message processed by user equipment. Although SA affects both the C/A-Code and the P-/Y-Code, PPS users overcome these errors through encrypted correction terms in the navigation message. By decision of the President, the SPS accuracy can be degraded beyond 100 meters, if necessary, for national security purposes. Such action would be taken only under dire circumstances, since SA actions affect all SPS users around the world.

1.3.3 GPS Augmentations

The accuracies of the SPS and PPS do not satisfy the needs of some civil users even if SA and A-S were not applied to GPS signals. As a result, there has been a continuing investigation of methods to improve basic GPS accuracy and reliability. The most promising options for civil users are GPS augmentations. To date, the most promising augmentation is DGPS.

DGPS uses fixed ground reference stations at precisely known locations to monitor GPS satellite signals and determine the errors in those signals. Corrections are then

derived and transmitted to DGPS user equipment to yield a more accurate position. DGPS corrections can be transmitted via a separate communications path over limited distances (local area DGPS) or over satellite links to much greater distances (wide area DGPS). In general, the accuracy improvement capability of DGPS decreases with distance from the reference station(s). By continually monitoring and correcting satellite range errors, DGPS offers the added benefit of providing an integrity check on the GPS satellites. (Integrity is the ability to provide timely warnings to users when a satellite should not be used for navigation.) When a problem causes a GPS satellite to transmit bad data, DGPS can continue to provide corrections or it can provide a message to not use the satellite in positioning or navigation computations. While the MCS may take several hours to discover and correct such a problem, DGPS can provide system integrity by notifying users immediately that a satellite problem exists in its area of coverage.

The DOD has thus far expressed no objections to the development of DGPS augmentations by the civil user community. As documented in the Federal Radionavigation Plan (FRP), a growing number of civil users have accuracy requirements beyond what the basic GPS was designed to provide, even for military uses. Because of DGPS's reliance on fixed ground stations and separate communications paths, features the basic GPS was designed to avoid for military purposes, DGPS has not been of significant interest for most military applications.

1.4 GPS APPLICATIONS

Although GPS was developed as a force multiplier (to significantly increase effectiveness of existing resources) for U.S. and allied military users, widespread civil use has been anticipated since program inception. Civil users already far outnumber military users. During the development phase, Congressional support for GPS increased as a result of testimony indicating that less-capable pos/nav systems, used by both the civil and military communities, could begin phasing out when GPS became operational. The following paragraphs review anticipated military, civil, and dual uses of GPS.

1.4.1 Military Use

From its beginning, the GPS architecture was directed toward minimizing the risks to U.S. and allied military users. It is designed to serve an unlimited number of users possessing receive only equipment. Military users' vulnerability to enemy detection is minimized since they do not have to transmit signals to synchronize themselves with the system or to provide a source for geolocation processing elsewhere. This capability is enormously important in military operations where silence translates into survival.

GPS is a force multiplier for military war fighting missions requiring delivery of troops or munitions, including operations with diverse types of forces. It maintains a common reference for positioning, navigation, and time, thus promoting interoperability among forces and directly enhancing the efficiency and effectiveness of joint and combined operations. In Operation Desert Storm, GPS was essential in providing a "common grid" that enabled coordination of fire and maneuver for U.S. forces in joint operations and synchronization of U.S. forces with those of our coalition partners in combined operations. Successful execution of U.S. doctrine and operational plans, as well as effective use of battle-decisive precision weapons, was keyed by the navigation and timing data provided by GPS.

The common grid provided by GPS will become even more important in the future as U.S. forces, based increasingly in the continental U.S., conduct worldwide operations with allied or friendly forces. It will be central to the ability of the U.S. to rapidly, accurately, and effectively project global power. Provision of this common grid, through GPS, is a military capability unique to the U.S.

In terms of accuracy, the military GPS capability, intended for use directly from the GPS satellites and without any intervening ground-based activity, was maximized to support a wide range of military operations and, specifically, to support flight operations in the en route and nonprecision approach phases of flight. Its design and structure did not extend to providing direct signals to support the precision approach phase of flight, which was addressed by other systems such as the Microwave Landing System (MLS).

GPS user equipment is being installed in virtually all major DOD platforms (ships and aircraft) as the primary source of radionavigation information. It is being closely integrated with, but will not replace, internal positioning sensors such as inertial navigation units and altimeters. In its handheld or detachable configuration, GPS user equipment supports land movements of troops and vehicles. GPS survey equipment supports rapid battlefield mapping for artillery emplacement and resupply. In addition to supporting communications antenna positioning, GPS timing capabilities directly aid in synchronizing military communications networks.

GPS provides timing and spatial coordination between ships, aircraft, and land units which may require logistical or active fire support during any phase of military operations. GPS aids in all aspects of military combat operations from designation of precise target coordinates to delivery of conventional munitions with extreme accuracy under any conditions of target visibility (e.g., night, clouds, smoke, dust). Its passive use feature supports covert activities in the areas of special operations, escape and evasion, and search and rescue. Its precision supports a wide range of mapping, charting, and weapons delivery functions.

The essence of military GPS use, inherent in the precise signals which are its fundamental feature, is that GPS provides a direct, unambiguous correlation between a target point and the weapon intended to hit the target point. This translates directly into increased probability of kill for any particular weapon, into increased force employment efficiency for military mission planners, and into overall lower risk for the individual military members and units who must execute the missions. To the extent a target point is defined and a weapon is guided by precise GPS signals, the probability that the target will be hit despite any other circumstances that exist is significantly higher with GPS than with any other combination of targeting and positioning technologies. It is this precise positioning capability, common to both target and weapon, that is both the basic military strength and fundamental military threat of GPS.

1.4.2 Civil Use

1.4.2.1 Aviation and Space

GPS provides the greatest opportunity to enhance the U.S. aviation system since the introduction of radio-based navigation more than 50 years ago. Satellite navigation using GPS presents opportunities for standardized worldwide civil aviation operations using a common navigation receiver with resulting improvements in

safety, capacity, service flexibility, and operations costs. The combined impact of GPS in conjunction with data link and Automatic Dependent Surveillance (ADS) represents an enormous economic benefit to the U.S. aviation industry--perhaps billions of dollars a year. The challenge will be to implement this remarkable technology as quickly and efficiently as possible so that real, near-term benefits can be achieved in the safety, efficiency, capacity, and cost of our National Airspace System (NAS).

The SPS signal satisfies the civil aviation accuracy requirements for oceanic, en route, terminal, and nonprecision approach operations. For precision approach and landings, and airport surface traffic control, the basic SPS signal does not satisfy requirements in the areas of accuracy, coverage, and integrity. However, investigations are underway to determine the potential for augmented GPS to meet the civil requirements for these more exacting phases of flight operations.

The civil use of GPS for oceanic and domestic en route flight offers significantly better navigation accuracy than previously possible. When combined with ADS, it will allow a pilot to fly an optimum route to a destination, subject only to weather and the presence of other aircraft. This optimum routing will provide considerable time and fuel savings in managing the rapidly expanding oceanic and domestic en route air traffic. As with oceanic and en route flight, GPS will allow pilots to fly nonprecision approaches to potentially every runway in the NAS. This will provide a major stimulus for civil aviation while reducing or eliminating the need for additional navigation upgrades.

In an effort to provide a complete spectrum of approach navigation services, research on the potential use of augmented GPS in the precision approach phase of flight is being conducted. Preliminary results indicate Category (CAT) I operations may be achievable. A determination on CAT II and III feasibility is scheduled for 1995. Augmented GPS will also have a significant role in airport surface traffic control. It will be used for accurate surface position determination as an integral part of an ADS-based airport surface traffic control system. This will result in significant safety improvements in airport surface operations (e.g., reduced number of runway incursions).

The implementation of GPS also offers the potential for the eventual deactivation of many ground-based navaids (e.g., Omega, Very High Frequency Omnidirectional Range-Distance Measuring Equipment (VOR-DME), VORTACs, and NDBs). In addition, the deployment of the MLS may be modified subject to the research being done on precision approach and landing using augmented GPS. Finally, investigations are needed to assess the possible deactivation of primary radar sites.

In the U.S. space program and the growing commercial space industry, GPS is used to satisfy positioning and timing requirements for earth-orbiting space systems, including Space Shuttle operations. Additionally, GPS will be used for determining position and attitude of spaceborne remote sensing instruments; positioning and guiding low, earth-orbiting spacecraft; and navigating interplanetary spacecraft while they are close to the earth.

1.4.2.2 Marine

SPS will provide marine navigators with the first precise, worldwide, continuous positioning and timing service. As a result, commercial shipping will be safer, more efficient, reliable, and economical. SPS, augmented with DGPS, will satisfy the

stringent marine accuracy requirements for harbor and harbor approach navigation, that have previously been unattainable with other radionavigation systems.

DGPS, combined with the developing Electronic Chart Display and Information System, will significantly improve waterway and harbor safety. The safety benefits of these systems are so pronounced that the Coast Guard is expected to require them on certain categories of vessels entering U.S. ports. This will be a major improvement in avoiding collisions and groundings, and the resulting human and environmental losses such events cause.

DGPS, electronic charts, and various data link systems will provide the capability to develop shore-based ADS systems that will be used to track the location of vessels at any time and to provide an improved USCG Vessel Traffic Service. This capability can also be applied to enhance the productivity of the Saint Lawrence Seaway shipping activities in times of adverse visibility.

The Coast Guard intends to use DGPS in icebreaking activities, navigation and positioning, and search and rescue. Maintenance of channel marker buoys can be done at substantial cost savings as demonstrated after major storms. The increased accuracies of GPS and DGPS will provide emergency response units with more accurate information for responding to, tracking, and containing hazardous materials or oil spills.

The National Oceanic and Atmospheric Administration will use DGPS to conduct hydrographic surveys leading to the development of improved nautical charts.

1.4.2.3 Land

Land applications of SPS are expected to comprise the largest category of GPS users. Although not traditional radionavigation system users, they are expected to employ various systems being developed to enhance the economic efficiency and safety of all land modes of transportation. GPS signals will be used to provide position and time data to many vehicle tracking and Geographic Information Systems (GIS). Examples of applications are:

Intelligent Vehicle Highway Systems (IVHS) will combine GPS with communications, controls, navigation, and information systems to improve highway safety, ease traffic congestion, and reduce harmful environmental effects.

Vehicle tracking systems will use GPS for commercial fleet management; hazardous material monitoring; tracking and controlling movements of railroad equipment; and automated dispatch of fire, paramedic and police units. GPS will also assist transit operators in the maintenance, operation, and emergency response of transit systems.

Use of GPS in geographic information system applications will permit state and local governments to more efficiently coordinate roadway maintenance and construction in rural areas, provide efficient means of maintaining roadway data bases, and maintain accident location inventories.

GPS is also used in surveying, telecommunications and electric power synchronization, agriculture and forestry, census taking, meteorological radiosondes, and backpacking.

1.4.2.4 Dual Use

In general, military users use PPS and civil users use SPS. However, there will be examples of military use of SPS and DGPS, and civil use of PPS. But there is a reluctance to equip military platforms with SPS or DGPS because of their vulnerability to attack, spoofing, and jamming.

1.5 MANAGEMENT AND FUNDING POLICIES

The GPS is managed by the DOD in cooperation with the DOT through interdepartmental agreements and implementation of federal planning documents.

Financing to support the basic GPS is appropriated in the DOD budget. The Air Force plans, programs, and budgets all funding for procurement and launch of the GPS satellites and for the control segment. Additional funding is provided by the Department of Energy to procure some payloads. Federal civil agencies are responsible for budgeting funds or providing resources to modify or enhance the capabilities of the GPS to meet unique civil requirements. Each agency is responsible for procuring user equipment to satisfy its mission needs.

The policies which govern and define the PPS are based on the ability of GPS to provide a continuous, worldwide positioning signal as a force multiplier and weapons delivery enhancement for the DOD. Consequently, PPS creates a valuable military benefit for anyone who can receive it. Many active combatants and potential adversaries, including terrorists, would be capable of directly exploiting the more precise GPS signals should SA be removed or A-S not imposed. In addition to increasing GPS utility for scientific, commercial, and other peaceful civil activities, elimination or wide-area negation of SA may dramatically and indiscriminately increase worldwide accessibility to GPS for military and other hostile purposes.

The policy governing the availability of SPS responds to the large civil safety and economic-related benefits associated with the U.S. and worldwide availability of a dependable navigation signal.

GPS was primarily designed to improve the military effectiveness of U.S. forces and their ability to protect the global interests of the United States. Therefore, in its long-term management of GPS, the U.S. Government will consider fully the consequences of all its potential uses and will exercise extreme care to appropriately balance the major economic and safety benefits of GPS to the civil sector with its unique national security advantages. In particular, maintaining the ability to deny to an enemy in time of conflict a significant military benefit from GPS signals will remain a central objective in the national management of the system.

The following describes the planning documents and agreements governing the management and implementation of the GPS.

1.5.1 Federal Radionavigation Planning

The federal policy for use of radionavigation services by civil and military users and by many modes of transportation is stated in the FRP. The FRP is jointly drafted and published biennially by DOD and DOT. In direct response to Congressional direction in the International Maritime Satellite (Inmarsat) Act of 1978, the FRP is a top-level plan for joint coordination, implementation, and operation of military and

civil radionavigation systems by the federal government. It provides the policy and planning framework for making cost-effective decisions regarding federally supported radionavigation systems employed by the U.S. in worldwide operations. The objective of the FRP is to ensure the DOD and the DOT are working together to meet their needs, yet avoid unnecessary duplication.

Publication of the FRP involves several formal structures within the DOD and the DOT. Official staffing and coordination is accomplished through the DOD Pos/Nav) Executive Committee and the DOT Navigation Council. The FRP is signed by both Department Secretaries.

1.5.2 Joint Military/Civil Agreements

Detailed deliberations and discussions during FRP preparation are the responsibility of a joint DOD/DOT working group. This joint activity is promoted and formalized through a MOA on Coordination in Federal Radionavigation Planning, signed by the Deputy Secretaries of the two Departments. The DOD also maintains separate interdepartmental agreements with the FAA, the USCG, and the DOT on GPS roles, responsibilities, and procedures. These include:

- An agreement between the DOD and the FAA, signed in 1990, regarding international civil aviation use of GPS. This agreement establishes policies for civil use of GPS and for promoting acceptance of GPS as a worldwide satellite navigation capability for international civil aviation use. It also defines a six-step process for developing a civil signal standard applicable to civil user equipment operation with GPS and the Russian Global Navigation Satellite System (Glonass).

- An agreement between the DOD and the FAA, signed in 1992, defining the roles and responsibilities of both agencies with regard to GPS use in the NAS. In addition, it establishes the accuracy of the civil GPS signal and precludes changes to civil GPS technical parameters without FAA approval, except under conditions of national emergency.

- An agreement between the Coast Guard and the U.S. Space Command, signed in 1992, defining responsibilities for an information exchange to make GPS operations status available to civil users.

- An agreement between the Coast Guard and the Air Force Space Command, signed in 1992, defining format and timeliness of GPS status information to be relayed to civil users.

- An agreement between DOD and DOT, signed in 1993, defining overall roles and responsibilities of the two departments. An annex to this agreement will provide full-time DOT representation at the DOD GPS Joint Program Office and the Air Force Space Command.

2

Issues And Options

2.1 INTRODUCTION

In accordance with the Inmarsat Act of 1978, the government is committed to selecting radionavigation systems which meet diverse user requirements for accuracy, reliability, coverage, integrity, and cost while eliminating unnecessary duplication of services. GPS is recognized as the one common system that can meet the widest range of both military and civil needs and is a key consideration in navigation system consolidation as presented in the FRP.

Future decisions affecting the management and financing of GPS will be influenced by its ability to meet both military and civil needs, especially the ability to eliminate redundant, less-capable positioning and radionavigation systems. In fact, the 1992 FRP established target phaseout dates for several systems because of the implementation of GPS.

The Task Force considered all identified concerns and suggestions, which it consolidated into seven core issues. For the purposes of this report, issues are areas where GPS does not currently meet civil user expectations or where alternate management strategies have been recommended.

As the Task Force evaluated the issues, it applied certain constraints to the consideration of options. The Task Force unanimously agreed that the worldwide, all-weather availability of precise positioning (better than 100 meters), velocity, and time has significant military utility and it is essential that the national security interests in the system be preserved. Therefore, since security features were designed into the basic GPS, the security implications of each of the options were considered. Balanced against these national security concerns are the public safety and economic benefits of the GPS. Additionally, the Task Force recognized that recommendations must be tempered by fiscal reality and should not put U.S. users and manufacturers at a disadvantage when compared to foreign users and manufacturers. Prior commitments regarding GPS made by the U.S. Government, both domestically and internationally, as well as the policy against proliferation of radionavigation systems, were also considered in evaluating the options.

Section 2.2 discusses each issue and option and provides recommendations.

2.2 ISSUES

The Task Force considered the following core issues:

- Management Structure

- Funding
- Accuracy
- Availability and Integrity
- Regulation of GPS Augmentations
- International Acceptance
- Spoofing and Jamming

2.2.1 Issue 1: GPS Management Structure

Should the current GPS management structure be changed to meet evolving civil needs?

A. Discussion

The DOD currently acquires, operates, and establishes policy for GPS. Some aspects of GPS policy which affect civil access to the system are made in cooperation with the DOT. However, even on those policy decisions which the DOD coordinates with the DOT, the DOD retains final decision authority. The DOD Pos/Nav Executive Committee is the DOD element responsible for major policy decisions regarding system implementation and operation.

Within DOT, GPS and other radionavigation system policy and planning recommendations are coordinated through the DOT Navigation Council. DOT agencies conduct individual programs that promote and facilitate use of GPS.

Several memoranda of agreement between DOD and DOT, as described in Part I, define cooperation on the civil use of GPS and development and publication of the FRP. DOT has organized a Civil GPS Service Interface Committee (CGSIC) to allow user groups to exchange information regarding GPS. Although the information exchange has been useful, the CGSIC, as currently constituted, cannot make formal recommendations regarding GPS issues and user concerns. To serve in an advisory capacity, the scope of the CGSIC would need to be expanded to bring it under the purview of the Federal Advisory Committee Act. DOT also operates a GPSIC to make available to users information on the status of the constellation and precise satellite ephemeris data.

Despite excellent DOD/DOT cooperation to date, the civil community continues to perceive GPS as a predominantly military system and lacks confidence in the ability of the current GPS management structure to satisfy evolving civil needs. Some representatives of civil organizations such as the ICAO, the International Maritime Organization (IMO), the Air Transport Association, the Airplane Owners and Pilots Association, and GPS manufacturers, have formally expressed concerns that the DOT has no substantive role in major decisions on tailoring the basic system to meet evolving civil needs[1]. Although DOD has an established internal process to translate military mission requirements into system procurements for military purposes, it cannot fund system improvements designed to satisfy purely civil requirements. While there are procedures for transferring funds between Departments to satisfy department-unique purposes, they have not been exercised on GPS. The DOD and DOT need to improve the institutional framework for responding to diverse and rapidly changing civil public and private sector demands for GPS services.

In 1985, the Senate Armed Services Committee formally requested a review of the GPS management and funding structure to determine if management and operation should be retained by DOD or transferred to another federal agency. The report concluded that DOD should continue to exclusively manage and fund GPS until the system becomes operational and widespread civil use is evident, at which time joint

1 RTCA Task Force Report on the GNSS, September 1992, and informal discussions at ICAO and IMO Subcommittee meetings.

civil/military management and funding should be reexamined[2]. GPS is expected to be operational in 1993 and civil use is growing worldwide. In addition, some members of Congress have again raised the management structure issue and the need for a greater civil role in GPS.

Civil user organizations are also concerned about the current DOT internal management structure for making GPS policy and planning decisions. While an Assistant Secretary of Defense with decision authority is the focal point in DOD, there is no single counterpart in DOT at a comparable level of authority. Currently, there are three independent focal points within DOT (RSPA, FAA, and Coast Guard) for GPS matters. Consequently, the concern among civil users, as expressed in the RTCA GNSS Task Force 1 Report, is that the management structure within DOT is inadequate to properly address the political, technical, and economic issues that impact civil use of GPS.

B. Options

The following options have been considered as a means of addressing this issue:

- Establish a joint DOD/DOT Executive Board.
- Establish an Interagency GPS Management Council.
- Transition GPS management from DOD to another government agency or corporation.
- Establish a public management body.
- Turn over GPS management to a private sector organization.
- Establish an international body to manage GPS.

2.2.1.1 Option 1 - Establish a Joint DOD/DOT Executive Board

A. Discussion

As discussed in Part I, Section 1.5, GPS is managed by the DOD in cooperation with the DOT through interdepartmental agreements and implementation of federal planning documents. In the view of several civil user organizations and DOT officials, DOT should improve its ability to represent the interests of civil users. Under this option, the existing management infrastructure and operating procedures would change to increase the level of authority for GPS within the DOT and to provide a means of addressing overall civil needs.

Overall GPS policy and management issues would be addressed in a GPS Executive Board that would be composed of Assistant Secretaries of Defense and Transportation and the Executive Secretaries of the DOD and DOT Pos/Nav Executive Committees. To ensure effective civil leadership for GPS matters, an Assistant Secretary of the DOT (or equivalent Office of the Secretary of Transportation officer) would be delegated the authority to speak on behalf of the civil GPS community and make decisions in the Executive Board affecting civil GPS services. This officer would also chair a new DOT Pos/Nav Executive Committee that would be formed from the current DOT Navigation Council. The DOT officer would also be responsible for the civil input to the FRP and for maintaining an outreach program to ensure that the civil radionavigation and positioning needs of

2 Global Positioning System Management: DOD Retention or Transfer to Another Federal Agency, A Report to the Senate and House of Representatives Committees on Appropriations and Armed Services, January 1985.

other federal agencies, state and local governments, the private sector, consumers, and international users are appropriately addressed in the GPS decision-making process through a mechanism such as a GPS Interagency Advisory Council.

The GPS Executive Board would be structured to provide assurance that:

1) GPS competitive war fighting advantage in support of worldwide DOD operations would continue as a fundamental consideration.

2) Civil users would have a voice in the management and operation of a reliable and dependable GPS-SPS as defined in the FRP and the GPS-SPS Signal Specification.

Routine coordination and management decisions would be facilitated by increased cooperation between the DOD and DOT Pos/Nav Executive Committees.

In addition to the establishment of the Executive Board, the current Civil GPS Service Interface Committee should be designated a Federal Advisory Committee. This Committee, which would represent the interests of all nongovernment civil users, would provide official inputs through the DOT Pos/Nav Executive Committee.

B. Evaluation

Pros	Cons
Retains familiar ways of operating. Minimal program disruptions in adapting to new management infrastructure and new operating procedures.	Other federal government agencies may desire more direct participation.
Formalizes civil participation in GPS management and policy formulation.	International user concern regarding single state control remains.
Addresses civil user perceptions of unilateral DOD control.	

2.2.1.2 Option 2 - Establish an Interagency Management Council

A. Discussion

An even broader base of program direction can be achieved by establishing a GPS Management Council to serve as the executive management agency for GPS. The Council would include Assistant Secretary-level membership from other Cabinet-level agencies (e.g., Defense, Transportation, State, Commerce) having an interest in GPS. The Council might be supported by working group structures similar to those established by the DOD/DOT MOA on Federal Radionavigation Planning.

B. Evaluation

Pros	Cons
Provides for broadest federal participation in GPS management.	Decision-making slow and cumbersome. Too many agencies involved at the executive level without direct program responsibilities.
Addresses user perceptions of unilateral DOD management and control.	Disruptive to ongoing GPS operations.
	Still would not involve non-Cabinet level federal agencies with interest in GPS.
	International user concern regarding single state control remains.

2.2.1.3 Option 3 - Transition GPS Management From DOD to Another Government Agency

A. Discussion

Under this option, overall management responsibility for GPS would transition from the DOD to another government agency, e.g., DOT. There is precedent for shifting programs between agencies. In 1967 when the DOT was formed, in addition to shifting entire agencies, programs were moved from the Interstate Commerce Commission and other agencies to DOT.

Interagency agreements between the DOD and the other government agency would need to be established. These agreements would require preservation of GPS security features, i.e., SA and A-S, and continued operation of the system to support military missions in accordance with existing DOD plans, policies, and procedures.

B. Evaluation

Pros	Cons
Addresses user perceptions of unilateral DOD control.	Disruptive to ongoing GPS operations.
Facilitates implementation of user charges to reduce general taxpayer burden.	Requires new management agency to duplicate elements of DOD's existing acquisition and operations infrastructure.
Demonstrates government commitment to maximizing civil benefits.	Places major burden on any existing non-DOD agency to staff and fund GPS operations.
	Lengthy time line expected for full transition.
	Potential de-emphasis of military security interests in the face of increasing pressures from civil users for unlimited access to full system accuracy and services.

2.2.1.4 Option 4 - Establish a Public Management Body

A. Discussion

Under this option, an independent government body similar to the U.S. Postal Service, Tennessee Valley Authority, or St. Lawrence Seaway Development Corporation would be set up to serve as the management agency for GPS. This organization, the GPS Corporation, would be responsible for all aspects of GPS management and operation.

Organizations of this type typically have a chief executive who is appointed for a fixed term, subject only to removal by the President "for cause." They may also have a governing board or commission that is selected to represent the various interests with a stake in the service provided by the agency. A noteworthy feature of these organizations is that they are typically separated from the Congressional appropriations process. Their revenues are derived from direct charges to or agreements with their customers. In this way, they operate similar to a business enterprise responding to market forces. However, they are still subject to the basic governing statutes under which they were formed.

The GPS Corporation's charter would include provisions specifying the operation of the national security features of the system as determined by the Secretary of Defense.

B. Evaluation

Pros	Cons
Addresses user perceptions of unilateral DOD control.	Disruptive to ongoing GPS operations.
Improves civil users' opportunity to have a more direct input to GPS management decisions.	Requires new management agency to duplicate elements of DOD's existing acquisition and operations infrastructure.
Focuses management on maximizing GPS benefits for all users.	Lengthy time line expected for full transition.
More responsive to market forces.	Increases DOD concern for continued viability of national security features.
Facilitates implementation of user charges to reduce general taxpayer burden.	Requires implementation of user charge rationale and infrastructure upon establishment of new management agency.
Enabling legislation provides for government control.	

2.2.1.5 Option 5 - Turn Over GPS Management to a Private Sector Organization

A. Discussion

Under this option, management of GPS would be privatized. The overall system would be owned and operated by a nongovernment entity, which would operate the system on a commercial basis for profit. All government agencies, including the DOD, would subscribe to and pay for GPS services, as would all other nongovernment users. Return on investment, recovery of costs, and profit would be primary motivations in the operation of GPS diminishing the importance of national security considerations. Since the private sector operator would, in effect, enjoy a monopoly, some form of government regulation of its operations and fee structure would be required.

B. Evaluation

Pros	Cons
Addresses user perceptions of unilateral DOD control.	Disruptive to ongoing GPS operations.
Improves civil users' opportunity to have a more direct input to GPS management decisions.	Requires private corporation to duplicate elements of DOD's existing acquisition and operations infrastructure.
More responsive to market forces.	Compensation required for existing U.S. taxpayer investment.
System no longer funded by U.S. taxpayer.	Lengthy time line expected for full transition.
Allays some concerns of international users regarding U.S. Government control.	System viability dependent on profits causing DOD and other government agencies concern about availability of GPS.
Provides motivation to establish a comprehensive, worldwide cost recovery system.	Requires complex government regulations, and some government agency would have to assume regulatory responsibility.
	Safety of navigation could be jeopardized.
	No incentive to retain national security features in the face of increasing pressure from civil users.

2.2.1.6 Option 6 - Establish an International Body to Manage GPS

A. Discussion

Under this option, an international consortium, similar to Intelsat or Inmarsat, (government or private sector) would be established to manage and operate GPS. The consortium would operate the system for profit as an international commercial venture. Like all other users worldwide, U.S. Government users, including the DOD, would pay a fee for GPS services. Management decisions would be made by the consortium members with voting powers probably a function of the amount of funding the member nation contributes. National security interests of any individual member nation would not be a consideration in the management decisions and day-to-day operations of the system.

B. Evaluation

Pros	Cons
Addresses international user concerns regarding unilateral U.S. control.	International charter likely to prohibit military applications requiring DOD to develop and implement a replacement capability.
Improves civil users' opportunity to have a more direct input to GPS management decisions.	Disruptive to ongoing GPS operations.
Cost of system shifts to international body.	Requires new international body to duplicate existing acquisition and operations infrastructure.
	Lengthy time line expected for full transition.
	Public perception of U.S. giveaway of a national resource.
	Unlikely that any consideration will be afforded to U.S. national security concerns.
	Jeopardizes competitive advantage for U.S. industry.

C. Recommendation

The Task Force recommends Option 1 as the most effective means of achieving balanced civil/military management of the basic GPS and its augmentations. This management structure would enable DOT to have a more substantive role in major decisions regarding civil use of GPS. In addition, it is the least disruptive to current operations and is cost effective. The Option 1 organizational relationships are presented in Figure 1. Figure 1 identifies the major divisions of responsibility for GPS. The DOD retains operational and financial support for the basic GPS and control of the PPS and military uses of the system. The DOT retains responsibility for navigation augmentations of the SPS, support to civil GPS users, and implementation of cost recovery for such services, where appropriate.

The Task Force determined that, although the management of GPS was not as unilateral as perceived by the civil user community, positive steps must be taken to enhance civil participation in the development of GPS policy and in the management of the basic system and planned augmentations. Because of the significant war fighting capabilities of the basic system, the Task Force determined that the DOD must remain directly involved in the management and operation of the system.

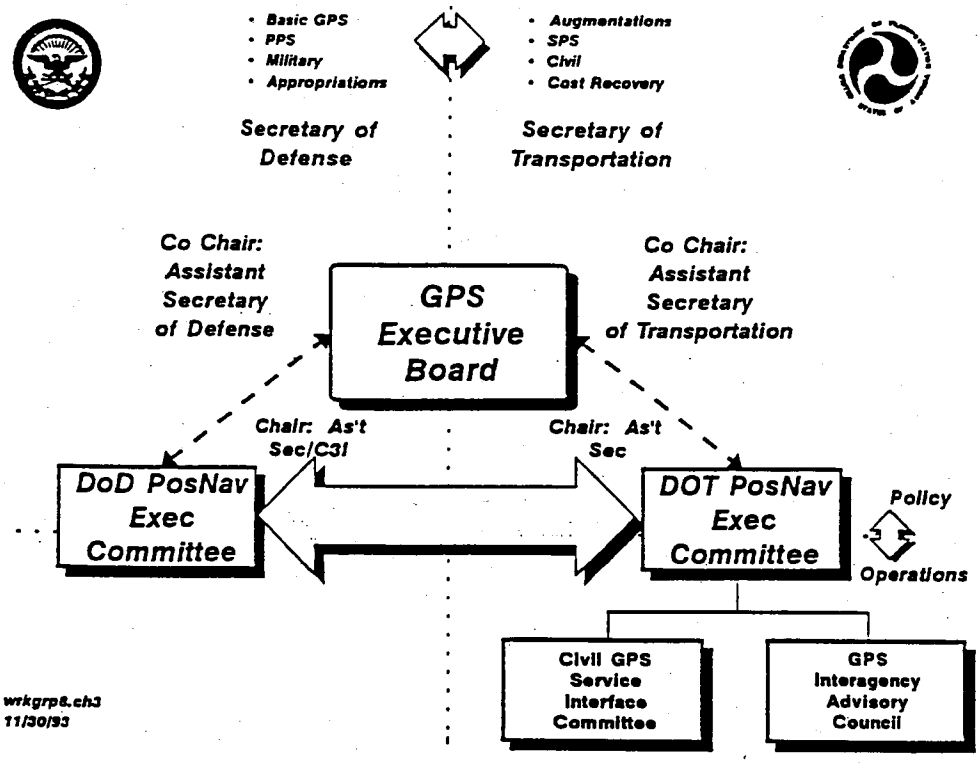

Figure 1. Management Structure

The Task Force considered establishing an all encompassing, top to bottom, management infrastructure with civil government participants in each of the appropriate functions (Option 2). This management infrastructure would require either augmenting existing DOD agencies with additional staff from civil organizations or establishing new organizational entities jointly staffed by DOD and civil agency personnel. However, the Task Force concluded that such an all encompassing management infrastructure change would prove too cumbersome and would hinder efficient operations.

Transition of GPS management from DOD to another government agency or government corporation, at this time, would be disruptive and would compromise the need for continued DOD involvement in system management and operations.

Options concerning sharing management with international agencies or turning over GPS to a private corporation or organization do not recognize or support the need for continued DOD involvement, and are, therefore, not appropriate at this time. When planned augmentations have been fielded, the U.S. has operational experience with full GPS capability, and operations are routine, it may be appropriate to consider other management options.

2.2.2 Issue 2: GPS Funding

How can budgeting and financing be structured to ensure sustainment of GPS services?

A. Discussion

All funding to date for the basic GPS has been provided by the DOD. Continued military use of GPS helps ensure DOD funding for the foreseeable future. The U.S. Government has promised in international fora that GPS-SPS would be provided free of direct user charges for the foreseeable future. In addition, augmentations to the system to address specific needs where a higher level of accuracy is required are being researched, are under development, and in some instances have been implemented by both the federal and private sectors. Given that expanded use of GPS will benefit both military and civil users, adequate funding of the basic system, plus all required augmentations, must be sustained for the foreseeable future. Further, as benefits derived by various users become more widespread and quantifiable, it may be appropriate to implement a means of shifting at least a portion of the cost of the system from the general taxpayer to the users benefiting from the system.

Current federal policy, as promulgated by legislation, generally calls for the recovery of the costs for government services under certain conditions. As examples, most of the federal as well as state expenditures on the highway infrastructure are recovered in the form of fuel taxes (federal taxes support the Highway Trust Fund), tolls and other fees on motorists and truckers. FAA expenditures for its facilities and equipment, and most of the cost of the operation and maintenance of the air traffic control system, are recovered from the Airway Trust Fund comprised of taxes on airline passenger tickets, general aviation fuel, cargo waybills and international departures. The Coast Guard is recovering many of its expenses for ship inspections and mariner licensing in the form of fees charged per service (although no fees are currently being charged for navigation signals). The Federal Railroad Administration is recovering the cost of its safety inspections from railroads.

If GPS charges are to be implemented, then rates should be cost based. However, cost recovery is not always completely equitable to each user as individual costs may be greater or less than the group average. Administrative costs for a complex system to relate costs to levels of use can be significant.

The fact that GPS is a worldwide system with international users complicates the fair allocation and recovery of government costs. Private sector provision of GPS augmentation services may also affect the need for (and cost recovery of) government-provided services. Government provision of augmentation services without charge may also adversely affect private sector investment in innovative technology and services.

B. Options

The following options have been considered:

- Continue current funding concept
- Share appropriated funding for basic system

- Implement direct user charges for basic system
- Expand cost recovery through additional indirect user fees

(These options are not mutually exclusive.)

2.2.2.1 Option 1 - Continue Current Funding Concept

A. Discussion

Continue funding the basic GPS from the general fund through direct appropriations to the DOD. Fund planned augmentations through DOT appropriations, which are in part derived from transportation trust funds which are supported by indirect user charges.

B. Evaluation

Pros	Cons
No disruption to current operations, plans, procedures.	General fund bears a large share of the cost.
Existing system adequately funds the services provided.	No cost recovery from foreign or domestic civil users who make private gain from the use of government systems.
Cost of augmentations funded by civil agencies in proportion to their use.	
Maximizes likelihood that war fighting capability provided by basic system will be sustained.	

2.2.2.2 Option 2 - Share Appropriated Funding for Basic System

A. Discussion

Fund the basic GPS and government-provided augmentations through direct appropriations to the DOD, DOT, and other departments and agencies of the federal government (Interior, Commerce, NASA, etc.). This is a variation of Option 1, requiring that federal civil agencies bear a portion of the basic system cost.

B. Evaluation

Pros	Cons
Addresses perception that GPS is totally controlled by DOD.	Complicates an already complex budget process.
Lessens impact on system if future DOD budgets are reduced.	Introduces possibility that the sustainment of the basic system could be jeopardized by failure of one Department or Congressional Committee to support GPS appropriations.
Broadens support for GPS through financial stake of supporting organizations.	
Increased opportunity for cost recovery from existing trust funds	

2.2.2.3 Option 3 - Implement Direct User Charges for the Basic System

A. Discussion

Over time, improved security devices should be available which could permit increased civil access to PPS. Those users who choose the increased benefits of PPS, including foreign users, they could be charged. SPS users should also be subject to a direct charge. Modifications to the basic system will be required to create a means of implementing a direct SPS user charge.

B. Evaluation

Pros	Cons
Addresses perception that GPS is totally controlled by DOD.	Expected proliferation of DGPS services reduces likelihood of a viable PPS marketplace. All direct fees would have to come from SPS and government-provided augmentations.
Provides an enforceable user fee capability for GPS services.	Necessitates costly redesign of system to implement effective (non defeatable) user charge scheme.
Conforms to federal policy.	Increases cost and complexity of receivers.
Provides capability to collect fees from both domestic and foreign users.	Security and technology risks.
Provides more equitable balance of cost sharing between U.S. taxpayer and GPS user community.	Imposition of direct user charges on SPS violates U.S. policy.
	Administration of the direct user charge system could become complex and expensive.
	Retards growth of user base and global market, inhibiting technical innovation in applications.
	Decreases the likelihood of widespread international adoption of GPS which would result in higher overall costs. U.S. users would have to equip for both foreign and domestic systems.

2.2.2.4 Option 4 - Expand Cost Recovery Through Additional Indirect User Fees

A. Discussion

Transition to a cost recovery mechanism that apportions costs between government users and others for both the basic system and augmentations. The government share would be provided by direct appropriation and the remainder by indirect user fees. Either trust or revolving funds, or budget offsets, could be used in accounting for indirect user fees. The FCC may also be involved because of its oversight function regarding the use of radio frequencies and the charging for their use. DOT also has statutory responsibility for promoting U.S. aerospace that could be used in justifying indirect cost recovery. A revolving fund could provide for flexibility in collecting indirect user fees, including contributions from foreign governments or foreign users, and then applying these financial resources to development, procurement, and operation of GPS.

B. Evaluation

Pros	Cons
Cost recovery currently exists for aviation, waterways, ports and highways and could be extended to other applications.	Foreign users avoid fees except for travel to/from U.S., unless foreign users provide indirect contributions.
Complies with federal policy.	Risk of reducing U.S. unilateral control to greater international influence if fees are collected from foreign users.
Users pay for services received.	Implementation and accounting for indirect user fee structure could become complex and expensive.
Provides more equitable balance of cost sharing between U.S. taxpayer and user community.	To the extent that the basic system is funded by other than DOD appropriations, increases the risk that the GPS war fighting capability may be diminished.

C. Recommendation

The Task Force recommends Option 1. The current budgeting and financing arrangements are sufficient to ensure sustainment of GPS services. Further, the Task Force recommends, as part of the strengthened working relationship between DOD and DOT and the management structure described in Issue 1, that improved means of financing GPS, as presented in Options 2 and 4, continue to be developed. Proper allocations of costs among user groups should be explored and means of cost recovery through indirect fees or domestic and international contributions should be defined through continuing efforts of the DOD and DOT Positioning/Navigation Executive Committees. The Task Force also recommends that the Committees consider developing a comprehensive legislative proposal for implementation as early as the FY 1997 budget, that would address cost recovery allocations among user groups, provide for expanded cost recovery through indirect fees or contributions, and provide a revolving fund structure to facilitate financial management of GPS. The Task Force did not consider Option 3 to be supportable on either economic or policy grounds.

When a government system can be used for direct benefit by identifiable groups or for private gain, it is more appropriate to shift costs from the taxpayers at large to those users who gain from the service provided by the system[3]. Product pricing mechanisms should be developed that properly allocate costs to entities that directly use and benefit from the system service.

The basic system supports a war fighting potential that contributes significantly to the national defense. National defense, which benefits the general population, should continue to be funded from the general fund. However, the augmentations to GPS,

3 The National Transportation Policy, released by the President on February 26, 1990.

and perhaps eventually, some or all of the cost of the basic system itself, should be funded by expanded use of indirect user fees paid by those deriving beneficial use of the system.

A reimbursable revolving fund is one of several mechanisms to provide financial flexibility for collecting resources from diverse sources and then applying those resources to the development, procurement, and operation of the GPS.

2.2.3 Issue 3: GPS-SPS Accuracy

How can the accuracy of the GPS-SPS be improved to provide operationally and economically effective solutions to existing and potential civil pos/nav requirements and needs without compromising national security?

A. Discussion

As defined in the FRP, GPS-SPS provides horizontal positioning accuracy within 100 meters (95% probability) and 300 meters (99.99% probability), vertical positioning accuracy within 140 meters (95% probability), and timing accuracy within 340 nanoseconds (95% probability).

The GPS-SPS, as specified above, meets civilian requirements for accuracy except for those needs and requirements identified below. Civil needs, in many cases, are driven by economic considerations and are not always expressed formally in terms of requirements documents. The Task Force concentrated on the needs and requirements of navigation users recognizing that there are numerous users of navigation systems for other purposes, e.g., time, survey.

Aviation:

As defined in the FRP, precision approach and landing requirements are specified according to approach CAT. These are:

CAT	Horizontal Accuracy (Meters)	Vertical Accuracy (Meters)
I	17.1	4.1
II	5.2	1.7
III	4.1	.6

The Instrument Landing System (ILS) and the MLS both meet the above requirements. However, use of GPS has been proposed as a lower cost alternative. Airport surface traffic control (a new requirement not specified in the FRP) requires horizontal positioning accuracy within 2 meters.

Marine:

As specified in the FRP, harbor and harbor approach and inland waterway navigation operations require an accuracy of 8-20m (varying from one harbor to another). Radar and short-range visual aids currently meet these requirements in some harbors.

Land:

Plans to improve the safety and efficiency of land transportation will require the following positioning/navigation system accuracies:

		Meters
Highways:		
	Navigation and route guidance	5-20
	Automated vehicle monitoring	30
	Automated vehicle identification	30
	Public safety	10
	Resource management	30
	Accident or emergency response	30
	Collision avoidance	1
	Geophysical survey	5
	Geodetic control	Submeter
Rail:		
	Position location	10-30
	Train control	1
Transit:		
	Vehicle command and control	30-50
	Automated voice bus stop annunciation	25-30
	Emergency response	75-100
	Data collection	25-35

B. Options

The following options were considered to improve the accuracy of GPS-SPS:

- Turn Off SA
- Expand Civil Access to GPS-PPS
- Develop DGPS Services

2.2.3.1 Option 1 - Turn Off Selective Availability

A. Discussion

Turning off SA means setting the indices for the signal components of SA to zero in each GPS satellite. This is a current system capability. The satellites would transmit GPS-SPS navigation messages with no intentionally induced degradation. GPS-SPS solutions would then be affected only by random errors in the navigation message components and by normal electromagnetic propagation effects. GPS-SPS accuracy would improve to approximately 54 meters (95% probability).

B. Evaluation

Pros	Cons
No cost to implement.	Does not meet any significant additional accuracy requirement.
The availability of an improved GPS velocity vector could lead to the development of cheaper and more accurate inertial systems.	Dilutes a current U.S. military advantage.
Simplifies operation and reduces cost of augmentation schemes.	Reimplementation during a crisis is politically difficult.
	Does not reduce requirement for GPS augmentations.
	Increased cost to develop military countermeasures.

2.2.3.2 Option 2 - Expand Civil Access to GPS-PPS

A. Discussion

The DOD is currently investigating improvements to GPS cryptology. These include unclassified keying devices, receivers equipped with tamper-proof chips that permit the receiver to operate in an unclassified mode when keyed, and electronic key management technology. If these efforts are successful, it may be possible to permit more general civil access to PPS. Civil users are currently authorized access to GPS-PPS, but access requirements and security procedures are stringent. With PPS access, and depending on receiver design, accuracy will improve to 21 to 54 meters. GPS signal availability and coverage remain the same.

B. Evaluation

Pros	Cons
Satisfies some civil requirements for increased accuracy.	Enabling technology is under development and not currently available.
Protects against spoofing and jamming.	Increased cost and complexity of receivers.
Provides means for cost recovery.	Required security control measures increase administrative costs.

2.2.3.3 Option 3 - Develop Differential GPS Services

A. Discussion

Differential techniques achieve substantial improvements in position accuracy. Corrections computed at a surveyed monitor site are transmitted to properly

equipped users for improvement of basic GPS position. Differential techniques have been applied to Omega, Loran-C, and Transit as well as GPS.

All DGPS systems have three basic components:

1. A land-based receiver that monitors and collects GPS satellite data and compares received data with information known by the receiver.

2. A means to transmit corrections generated either at the monitor/reference site or at a central control station in a network of monitor/reference sites.

3. User equipment that has the hardware necessary to receive the DGPS correction messages and the software necessary to apply the corrections to the information received from GPS satellites.

As a rule, the accuracy that can be obtained from DGPS is proportional to the distance from the user to the monitor/reference site. Stationary users, less than a mile from the DGPS site, are able to arrive at position solutions, over time, that have errors measured in centimeters, while mobile users can expect errors of 2-3 meters (ships and autos) or 3-5 meters (aircraft).

There are several transmission media that can be used to transmit DGPS data to users. The terms "wide area" and "local area" are often used when describing differential systems. These terms are derived from the DGPS transmission media coverage. Wide area differential GPS (WDGPS) broadcasts corrections over a broad geographic area. When satellites are used, coverage can be nearly hemispheric. Coverage provided by local area differential GPS (LDGPS) can vary from a few miles to about 150 miles, depending on the transmission media selected, e.g., LF, MF, VHF, FM. Selection of the transmission media must include consideration of interference effects on basic GPS signals, especially if DGPS corrections are transmitted on GPS frequencies. A goal of all currently planned differential systems is to avoid requiring the user to purchase additional receivers or hardware interfaces.

The cost to deploy DGPS services depends upon the number of monitor/reference stations required, the transmission media selected, and the resulting effect on user equipment.

B. Evaluation

Pros	Cons
DGPS can satisfy position accuracy requirements for all transportation modes.	Precise positioning data transmitted over wide areas is a security concern.
Wide area differential provides precision landing capability with a minimum number of ground-based facilities.	DOD must develop countermeasures to deny DGPS military utility to adversaries.
	DGPS increases spoofing threat.
Existing communications media provide transmission flexibility.	Transmissions on GPS receiver frequency may interfere with the basic GPS signal.

C. Recommendations

The options listed above describe ways to improve the accuracy of GPS. The first option, removal of SA from direct SPS satellite transmissions, although simple and inexpensive, would not produce signals of sufficient accuracy to meet identified civil needs nor would it improve signal availability. It would, however, provide direct and indiscriminate access to militarily useful GPS capabilities. The Option 2 proposal to expand civil access to GPS-PPS, which would provide increased accuracy, has considerable technical risks and is not recommended, even though it provides a limited capability for cost recovery.

The Task Force determined that DGPS would satisfy most accuracy requirements and, therefore, recommends Option 3. However, DGPS and the position accuracy it affords is a military threat when used by hostile forces. The DOD has accepted as a reality the expanding use of LDGPS, acknowledging its inherent military vulnerabilities. Additional security concerns arise when precise positioning data are transmitted from satellites over wide (near hemispheric) areas. These concerns may be mitigated if the threat can be dealt with in local areas where U.S. forces may be involved in combat operations.

The Coast Guard is installing a DGPS network which will cover the coasts of the U.S.--including the Great Lakes, much of the coasts of Alaska and Hawaii, and U.S. inland waterways. Nine stations are currently broadcasting differential corrections. The Coast Guard DGPS will satisfy current marine navigation requirements and has potential utility for land users within range of the signal. The Task Force recommends that deployment continue.

The FAA is pursuing both local area and wide area differential technologies to improve accuracy for conducting precision approaches at any properly equipped runway within the differential coverage area. Currently, CAT I precision approaches using LDGPS may be approved on a case-by-case basis. This practice will be expanded in the future, to make CAT I capability available at a greater number of airports. WDGPS is also expected to offer the capability to perform CAT I precision approaches. Studies and demonstrations are in progress to determine the feasibility of DGPS technologies to meet the accuracy requirements for all precision approach categories. These differential technologies may provide the opportunity to avoid the

costly requirement to transition from ILS to MLS. The Task Force recommends that the FAA continue to develop the differential service component of its Wide Area Augmentation System (WAAS). Additionally, the Task Force recommends that the FAA should continue to work with the civil aviation community to develop and deploy LDGPS systems under FAA's Special Category 1 Program as justified on a case-by-case basis. Any new federally owned and operated LDGPS systems would be deployed in accordance with the approved recommendations resulting from the study described below.

The land modes should evaluate the capabilities of the current DGPS augmentations (USCG, FAA) for use to address their individual needs. This evaluation shall consider the results of the independent study (see below). The DGPS system(s) used by the land modes must satisfy the needs of highways, rail, and transit.

Concurrent with present DGPS programs, and to avoid unnecessary duplication of DGPS services, the Task Force recommends the development of an annex to the existing DOD/DOT GPS MOA to provide a framework for joint development and agreement on a recommended course of action for government DGPS programs. The Task Force further recommends that responsibility for the annex be assigned to the Chairman of the DOT Pos/Nav Executive Committee, in cooperation with the DOD. The annex will be structured to determine the optimum integrated system to provide GPS augmented services. It will describe ongoing activities (studies and tests), responsibilities, and schedules for all major federal agencies involved in DGPS. A study of all DGPS services under development or deployment is required to determine the optimum integrated system to provide GPS augmented services. This assessment will investigate the performance, economic and safety benefits, and security implications of all wide/local area DGPS service options. This study will be formalized in a new annex to the DOD/DOT MOA and be completed as soon as possible but not later than September 30, 1994.

Current federal agency development and deployment of GPS accuracy enhancements should continue pending completion of this study. The Task Force's opinion is that near-term benefits outweigh any costs that may be saved by delaying or deferring GPS accuracy enhancement development. Upon completion of the study, recommendations will be presented to the DOD and DOT Pos/Nav Executive Committees. New federally established DGPS navigation systems would be deployed in accordance with the approved recommendations resulting from the above study.

2.2.4 Issue 4: Integrity and Availability

How can the integrity and availability of GPS be improved to provide operationally and economically effective solutions to existing and potential future civil requirements and needs without compromising national security?

A. Discussion

Integrity is the ability of a system to provide timely warnings to users when the system should not be used for navigation. Integrity requires that a continuing capability be available for the user to determine GPS signal acceptability. Notification or other indications must be available to the user within a specified time.

The five satellite monitoring stations in the GPS Ground Control Segment do not "see" all of the satellites in the GPS constellation all of the time. More than 30 minutes may elapse before the GPS MCS is aware of a particular satellite malfunction and corrective action or notification begins. This exceeds most integrity requirements. For example:

As defined by the FRP, integrity limits for each phase of flight for civil aviation are:

Phase of Flight	**Seconds**
Oceanic	30
Domestic En route	30
Terminal Area	10
Nonprecision Approach	10
CAT I	6
CAT II	2
CAT III	2

The above time limits are documented requirements with the exception of oceanic and domestic en route which are being validated for GPS. The GPS augmented system must match the availability requirements of current precision approach systems at major airports (99.995% of the time).

The most stringent maritime integrity requirement (for harbor/harbor approach areas) is 10 seconds from failure to user notification. Systems must be available 99.7% of time.

The integrity needs for land-based users generally range between 1 and 15 seconds and are summarized in the following table:

Highways

Navigation and route guidance	Note 1
Automatic Vehicle Monitoring and Identification (AVM/AVI)	Note 1
Public safety	Note 1
Resource management	Note 1
MAYDAY relief coordination	Note 1
Collision avoidance	Note 2

Rail

Position location	5 seconds
Speed determination	5 seconds
Train control	5 seconds

Transit

Vehicle command and control schedule adherence	Note 3
Automated bus stop annunciation	Note 3
Emergency response and breakdown	Note 3
Data collection	Note 3

Notes:

1. GPS integrity requirements for IVHS functions are dependent on resolution of final system architecture issues, which are under study at this time. Values will probably range between 1 and 15 seconds, depending on function.

2. GPS will not be the sole source of positioning data for collision avoidance systems, since the distance separations needed are in the order of meters. GPS may be used for speed and direction checking, reducing integrity requirements to the same range as for other IVHS functions.

3. Under study and not available at this time.

GPS, at published accuracy levels, is considered available when at least 4 GPS satellites (transmitting usable signals) are in view of the receiver, are at least 5 degrees above the user's horizon, and are widely dispersed throughout the user's field of view. Current availability over a typical 24-hour interval (averaged over any 30-day period) is 0.9985 globally or 0.9916 at any given location[4].

4 DOD GPS-SPS Signal Specification.

B. Options

The following options were considered:

- Provide real-time reaction capability to the GPS Control Segment.
- Add additional satellites to the GPS constellation.
- Implement a WAAS using geosynchronous satellites.
- Develop local area DGPS.
- Install pseudolites.

2.2.4.1 Option 1 - Provide Real-Time Reaction Capability to the GPS Control Segment

A. Discussion

GPS monitor stations that are a part of the GPS Control Segment do not monitor all of the GPS satellites in the constellation all of the time. There are times when a satellite may be unmonitored for more than an hour. After the MCS detects a malfunction, it may be up to 30 minutes before corrective action begins. Full-time monitoring and real-time reaction to malfunctions were not designed into the basic GPS.

To achieve a real-time response capability, additional monitoring stations would have to be built or additional in-place resources would have to be modified to perform the GPS monitoring mission. If continuous monitoring and commanding of all satellites were available, software and revised procedures could be developed to ensure that erroneous signals from any GPS satellite would not be used in a position solution by any receiver. This could be achieved by directing an errant satellite to transmit a nonstandard code until the Control Segment could determine why the satellite had exceeded a preset tolerance. When a satellite transmits a nonstandard code, receivers do not use that satellite to develop a position. This option has no effect on availability.

B. Evaluation

Pros	Cons
Improves GPS satellite reliability.	Cannot meet requirements for high precision applications.
May satisfy some civil requirements.	Removes a satellite from use that may be satisfactory for some use.
Satisfies military requirement for system with minimum ground support.	Requires extensive redundancy in Control Segment.

2.2.4.2 Option 2 - Add Additional Satellites to the GPS Constellation

A. Discussion

A method of determining when a GPS satellite should not be used for a position solution is receiver autonomous integrity monitoring (RAIM). RAIM, a receiver software program that assists in the detection of a satellite that is transmitting erroneous data, requires 6 satellites in view above a 5-degree mask angle, in good geometric position, to achieve an acceptable worldwide reliability level. Given the 6-satellite minimum requirement, initial estimates indicate that a 30-satellite constellation would be required.

An opportunity may exist to use civil signals from other satellite navigation systems, such as Glonass, should they become available and approved for international use.

A 30-satellite constellation would provide a 99.99 percent probability that 6 satellites will be in view, above a 5-degree mask angle, with acceptable geometry, at any point on the earth.

B. Evaluation

Pros	Cons
Will improve basic GPS reliability and coverage.	Approaches maximum capacity and coverage for the current GPS Control Segment.
Should provide an acceptable solution to the civil and military requirement for integrity, without the addition of complicated GPS augmentations.	High acquisition and sustainment costs.

2.2.4.3 Option 3 - Implement a GPS Integrity Broadcast and Ranging Signal Using Geosynchronous Satellites

A. Discussion

This option requires ground, space, and user segments. The ground segment is a network of reference stations, master stations, and earth stations suitably deployed throughout the coverage area. The ground network continuously collects GPS satellite data, computes an integrity message for each satellite, and uplinks the message to the space segment for broadcast over a wide area. The space segment consists of a number of geosynchronous satellites continuously broadcasting over a near hemispheric area. In addition, a ranging signal is broadcast with the integrity message, thus improving availability by providing additional signals in space. If security concerns are satisfied, a DGPS message may also be broadcast.

Properly equipped users are then capable of receiving and processing the broadcast integrity message. The GPS L1 frequency is preferred for the wide area broadcast to simplify users' equipage needs.

B. Evaluation

Pros	Cons
Enables primary GPS navigation for most civilian applications.	Does not enable primary GPS navigation for precision civilian applications.
May accelerate decommissioning of existing ground-based navaids, e.g., Loran-C, VOR, DME, nondirectional beacon (NDB), resulting in significant cost savings.	May not satisfy all integrity requirements.
May stimulate significant cost savings due to improved transportation efficiency, and user equipage simplification.	

2.2.4.4 Option 4 - Develop Local Area Differential GPS

A. Discussion

Differential systems monitor GPS satellites, determine user range errors and user range rates, and transmit correction data to GPS users. It is technically simple and relatively inexpensive to provide an integrity warning that a particular satellite should not be used in the receiver's position solution, if a differential monitor station observes that a satellite has exceeded predetermined tolerances. Existing DGPS data protocol includes such GPS satellite status messages. This option has no effect on availability.

B. Evaluation

Pros	Cons
Improves integrity at a modest cost if a differential system is deployed.	Difficulty in applying integrity criteria to different applications.
Reduces requirement for additional GPS satellites.	

2.2.4.5 Option 5 - Install Pseudolites

A. Discussion

A pseudolite is a ground-based transmitter that imitates a GPS satellite. The pseudolite generates its own position and time data stream. The transmitted signal appears to be another satellite transmission, in that a GPS signal is used to permit local user equipment to obtain an additional measurement to the transmitting antenna. Being ground-based, the pseudolite must be located such that it is in view of the user GPS antenna.

The accuracy of a pseudorange local area DGPS system should be better than 3 meters when the user is within 30 nm of the transmitting pseudolite.

B. Evaluation

A pseudolite can improve GPS availability and integrity for local users in its line of sight. A major problem facing pseudolite signal designers is potential interference with satellite signals, particularly the C/A Code. Signals from satellites nearly 11,000 miles from the user are small compared to signals from the pseudolites. To avoid this "near-far" problem, pseudolite signals must be designed for low cross-correlation with satellite signals. Given that a solution to the "near-far" problem is technically feasible, the system would be relatively inexpensive to the user. The expense to the provider would be determined by the number of psuedolites required.

Pros	Cons
Improves availability and integrity at less cost than additional satellites.	Coverage limited to line of sight.
No modifications to user equipment required.	Potential interference with GPS satellite signals.

C. Recommendation

Option 1, providing a real-time reaction capability to the control segment, and Option 2, adding GPS satellites to the current 24-satellite constellation, are expensive and are not recommended at this time. The pseudolite option, Option 5, has technical objections and does not provide significantly improved performance over differential data transmitted from either local or wide area systems.

The addition of integrity functions to differential systems, both wide and local area, is an inexpensive and technically feasible undertaking and should be required for any federally approved GPS augmentation.

The Task Force recommends that a wide area broadcast using communication satellites (Option 3) should be implemented because it is an expeditious way to improve GPS integrity and availability for aviation users in the near term. The FAA should continue to develop and field the integrity and availability components of its WAAS). It satisfies aviation requirements for all phases of flight except precision approach and satisfies requirements for broad ocean and coastal marine navigation. It may satisfy many land navigation requirements.

The Task Force also recommends that local area DGPS, when implemented for accuracy purposes, provide integrity information sufficient for aviation precision approach/landing and marine harbor/harbor approach operations.

2.2.5 Issue 5: Regulation of GPS Augmentations

To what extent should the federal government 1) centralize development and operation of government-provided GPS augmentations and 2) regulate GPS augmentations developed by U.S. private sector companies or organizations?

A. Discussion

The federal government operates radionavigation systems, including DGPS, for safe economic transportation, commerce, and national security. The government is accountable for the navigation signals it provides to ensure adequate and consistently available coverage and accuracy. Unregulated systems could introduce hazards to navigation. DOT is responsible under 49 USC 301 for ensuring safe and efficient transportation. 14 USC 85 empowers the Coast Guard to prescribe and enforce rules and regulations relating to private maritime aids to navigation. These rules and regulations prohibit the operation of private electronic aids to maritime navigation, with the exception of radar beacons (racons) and shore-based radar stations. The use of private radionavigation services for aviation use is strictly controlled by the FAA. Stringent certification standards must be met. The FAA has granted some airport operators authority to employ privately owned radionavigation aids for air traffic control. This practice is expected to expand with the increased use of DGPS.

The government provides radionavigation services to meet unique defense needs, but has established a policy of dual use to avoid unnecessary duplication. Ensuring systems meet the needs of as many modes of navigation as possible supports that policy. Government agencies that operate radionavigation services are subject to the emergency powers of the President. During a dire national emergency, the President may direct agencies to cease operations or change characteristics and signal formats of radionavigation systems. All licensed communication links, including those used to transmit DGPS corrections, are subject to the direction of the President.

In addition to government-provided DGPS, a number of private sector companies (e.g., Accupoint, Racal, John E. Chance & Associates) have established DGPS networks and are providing DGPS positioning services (not certified for navigation) on a commercial basis. As demand for DGPS grows, the number of DGPS providers in the private sector will undoubtedly continue to grow.

Where safe navigation is important, i.e., marine harbor navigation and aircraft approach to landing, several factors come into play with respect to DGPS:

Equipment: Carriage requirements have recently been mandated by the Congress for maritime DGPS. It may also be necessary to mandate DGPS equipment for civil aviation use.

Services: For marine navigation, an IMO agency has determined that DGPS signals provided by governments should be sent over the marine radiobeacon band. Civil aviation and land transportation agencies are now evaluating DGPS transmission media and formats for use by their user communities. Decisions on standardization of services for multiple applications have not been made, as sufficient information is not yet available to support the decisions.

Liability: A commercial service provider would be vulnerable to lawsuit in the event of an accident or incident. Therefore, insurance may be required to maintain continuity of commercial services. To protect the public interest, the government may need to assume liability under the Federal Tort Claims Act (28 U.S.C. 2671 et seq). The government may need to establish mechanisms such as insurance pools to cover catastrophic losses.

B. Options

In view of the factors above, the Task Force considered the following options for government and private DGPS services:

Government-Provided DGPS

- Maintain the status quo (i.e., individual government agencies provide individual differential services with ad hoc interagency cooperation).
- Develop and provide common, government-wide differential services.
- Government purchase of DGPS services from contractors.

Private Sector-Provided DGPS

- Maintain the status quo (i.e., no regulation).
- Regulate private sector DGPS.

2.2.5.1 Government-Provided DGPS

2.2.5.1.1 Option 1 - Maintain the Status Quo (i.e., individual government agencies provide individual differential services with ad hoc interagency cooperation)

A. Discussion

Under this option, individual agencies continue to develop specialized DGPS capabilities using their own networks of reference stations and their own communications links. Cooperation among the individual agencies and transportation modes is on an ad hoc basis.

B. Evaluation

Pros	Cons
Minimal disruption to ongoing or planned differential programs permits fielding differential capabilities and realizing benefits at the earliest possible date.	Establishing multiple independent DGPS infrastructures is the least efficient way to provide DGPS services.
Differential services tailored to the needs of individual modal users.	Proliferation of federal radionavigation systems.

2.2.5.1.2 Option 2 - Develop and Deploy the Optimum Integrated System to Provide GPS Augmented Services

A. Discussion

This option entails the development by the government of an optimum integrated network of reference stations. Communications systems needed to provide DGPS corrections to users may either be common or unique to the different modal users. The federal DGPS reference network data could be leased to private sector DGPS providers for their own commercial uses.

B. Evaluation

Pros	Cons
Increases efficiency by consolidating efforts of individual agencies.	Services may not be optimized for individual transportation modes.
Provides standards for private sector DGPS services through use of federal network.	Requires individual agencies to agree on standards and specifications for services which could slow implementation of DGPS services.

2.2.5.1.3 Option 3 - Government Purchase of GPS Services From Contractors

A. Discussion

Under this option, the government would invite private DGPS providers to bid on navigation services for the individual DOT modal agencies. The agencies would certify the private DGPS systems, assuming liability for their use. Individual agencies may discontinue ongoing or planned DGPS developments.

B. Evaluation

Pros	Cons
Reduces government expense.	No assurance that required augmentations will be available in the necessary timeframe.
Competition leads to lower costs.	No assurance that private sector, profit-making organizations will accept government regulation to the degree needed for safety of life services.
May accelerate implementation of augmentations through use of existing systems.	Blurs responsibility between government and providers in the event of major liability claims.

2.2.5.2 Private Sector DGPS

2.2.5.2.1 Option 1 - Maintain the Status Quo (i.e, no regulation)

A. Discussion

Under this option, private sector differential stations would be unregulated with the exception of the usual FCC license restrictions and certification of private provider navigational services. The private sector would provide or expand DGPS services based upon market incentives.

B. Evaluation

Pros	Cons
No additional regulatory infrastructure required.	Unregulated private sector DGPS services could proliferate availability of high accuracy signals, increasing threat of hostile use.
Consistent with the philosophy of a free market economy.	Promotes inappropriate use of commercial positioning services for navigation.

2.2.5.2.2 Option 2 - Regulate Private Sector DGPS

A. Discussion

Under this option, U.S. private sector differential services capable of being used by mobile platforms for navigation purposes would be regulated by the federal government.

B. Evaluation

Pros	Cons
Provides increased measure of control over availability of high accuracy signals.	Requires establishment of new regulatory body or additional tasking for existing body and development of complex rules.
Could provide additional mechanism for cost recovery by the government.	

C. Recommendations

Government-Provided DGPS

The Task Force determined that Option 2, Development and Deployment of the Optimum Integrated System to Provide GPS Augmented Services is preferred.

Therefore, the Task Force recommends that federal agencies coordinate requirements and plans and mutually determine the most cost-effective approach to, and time line for, integrating government-wide DGPS services. In the interim, ongoing, individual agency DGPS programs should continue to assure that benefits will be available to users at the earliest possible date.

The Task Force further recommends development of an annex to the existing DOD/DOT GPS MOA to provide a framework for joint development and agreement on a recommended course of action to government DGPS programs. Other Departmental participation will be through the proposed GPS Advisory Council.

Private Sector-Provided DGPS

The Task Force concluded that private sector DGPS providers are not, and cannot by regulation, offer navigation services. However, the government should maintain the option to regulate these services should they be used for navigation in the future.

2.2.6 Issue 6: International Acceptance

(1) To what extent should the U.S. promote international acceptance of GPS and (2) how should the U.S. respond to international concerns affecting acceptance?

A. Discussion

It is in the U.S. national interest to have GPS and U.S.-developed GPS augmentations accepted internationally in order to limit the amount of expensive equipment that U.S. ships and aircraft must carry and to prevent duplication of systems at U.S. airports and harbors. Historically, the U.S. has enjoyed a position of preeminence in providing radionavigation services. This position as well as other national goals such as balance of payments, international competitiveness, and technological innovation could be enhanced by U.S. Government initiatives to promote and enhance the current position of U.S. technical leadership in satellite navigation.

In international fora, a number of foreign representatives have expressed a reluctance to accept GPS because it is a U.S. system. The international community has expressed concern that the U.S. may unilaterally decide to degrade current GPS-SPS accuracy. The concern is particularly manifest when foreign nations consider removing their own ground-based navigation systems and begin relying solely on GPS for their transportation infrastructures (a self-imposed requirement). This apprehension diminishes their willingness to proceed rapidly with GPS implementation.

It is clear to most U.S. users, but perhaps less obvious to others, that the likelihood of the U.S. degrading civil use of the GPS system beyond that specified in the FRP is minimal. Such action would be undertaken only at the direction of the President. The economic impact on U.S. civil users and the potential international political impact of such an occurrence make the event virtually inconceivable. Without satisfactory guarantees, however, the implementation of GPS on an international scale may be slower than desired by users and industry in the U.S.

To support a seamless international aviation architecture, the U.S. has agreed to cooperatively work with ICAO in the development of a GNSS, in which GPS is an integral component.

B. Options

The following options have been considered:

- Pursue current initiatives for international acceptance.
- Adopt strategy to strengthen international acceptance.

2.2.6.1 Option 1 - Pursue Current Initiatives for International Acceptance

A. Discussion

Under this option, U.S. Government agencies will continue unilateral efforts and participate in international fora, such as ICAO, addressing the definition of long-

term GNSS standards. Within the framework of GNSS, the U.S. Government supports GPS as a foundation for these standards to satisfy global required navigation performance criteria (i.e., assure GNSS components are compatible with GPS). Further, international users are expected to gravitate to GPS use since it is available to them free of direct charges. Nevertheless, other users or nations may continue to promote separate satellite-based navigation systems (that may be incompatible with GPS) for their own purposes.

B. Evaluation

Pros	Cons
May extend and strengthen worldwide U.S. air traffic control preeminence.	May not satisfy all international concerns.
Retains existing levels of U.S. flexibility regarding U.S. policy and operations.	
Provides time to assess effects of changes being implemented in the management and operation of the system.	

2.2.6.2 Option 2 - Adopt Strategy to Strengthen International Acceptance

A. Discussion

Under this option, the U.S. Government would adopt a formal, coordinated strategy of actively promoting international acceptance of GPS. Rather than unilateral initiatives, individual agency efforts would be part of a coordinated U.S. Government master plan. U.S. representatives in all-appropriate international fora would seek formal adoption of GPS as an international standard.

The U.S. has already provided, in the FRP, assurance that civil users worldwide may rely upon the availability of GPS signals and services at specified accuracy levels. Only in the event of national emergency would the U.S. degrade the accuracy and availability of GPS-SPS signals. Any such accuracy degradation would be undertaken only at the direction of the President of the United States. Because of the implications of such action and in light of U.S. policy to make GPS-SPS continuously available worldwide, the likelihood of any such action is extremely remote. Nevertheless, reservations regarding GPS availability continue to arise in international circles despite assurances provided in FRP policy statements. Additional assurance may be necessary to mitigate foreign concerns. One possible assurance is in the form of a Presidential proclamation that GPS-SPS will be provided on a worldwide basis for peaceful purposes.

Some additional options for overcoming international reluctance to accept GPS are:

- Codify GPS policies, published in the FRP, into law.
- Propose treaties with interested governments.

- Develop memoranda of agreement with international organizations or interested nations.

B. Evaluation

Pros	Cons
Accelerates cost savings to U.S. aircraft and ships through international use of GPS.	Introduces potential for reduced U.S. flexibility in operating GPS.
Promotes U.S. economic interests through additional sales of U.S.-produced GPS receivers.	Increases pressure for further U.S. concessions.
May provide a mechanism for negotiating cost sharing arrangement.	

C. Recommendation

The Task Force has determined that the U.S. is already taking a leadership role in promoting international acceptance of GPS. Current international initiatives should lead to acceptable international standards. Therefore, the Task Force recommends continuation of these initiatives (Option 1) for the near term. In addition, the Task Force believes that the recommendations presented elsewhere in this report should encourage further international acceptance.

The Task Force recommends the DOT Pos/Nav Executive Committee continue to assess international assurances identified in Option 2 for potential future implementation. In the event that further steps may be necessary in the future, the Task Force recommends the DOT Pos/Nav Executive Committee begin now to assess international assurances identified in Option 2 for potential implementation. Any implementation recommendations will coordinated with the DOD Pos/Nav Executive Committee.

2.2.7 Issue 7: Spoofing and Jamming

What actions, if any, should be taken to counter the threat of jamming and spoofing GPS signals?

A. Discussion

To use the GPS satellite signals, the GPS receiver requires a minimum ratio between the received satellite signal power and the background noise power. If the noise level in the receiver is increased enough through outside interference (intentional jamming or unintentional interference), the receiver loses lock on the satellites. In this case, the receiver will warn the user that it is not receiving the satellite signals. While all radionavigation signals can be jammed, the nature of other systems (such as the ILS or Loran-C) are such that the jammer would have to be more powerful and the transmitting antenna would have to be large.

Several applications for use of frequencies adjacent to GPS have been submitted and this encroachment of the band originally allocated to radionavigation satellite systems, if approved, could lead to interference. A similar situation is being experienced with the ILS due to interference from FM broadcasts. GPS is more susceptible to interference than is ILS.

Spoofing is the deliberate transmission of false signals to fool the GPS receiver. A spoofer would have to act like a satellite that is continuously moving in a GPS satellite orbit. This is hard to do from the ground and expensive to do from space. Spoofing would require several hundred thousand dollars worth of equipment.

Loss of the use of GPS, or any other radionavigation signal, due to jamming or spoofing in the approach and landing or harbor and harbor approach phases of air and maritime navigation could significantly affect navigation safety.

B. Recommendation

Jamming and spoofing questions involve complex and detailed technical considerations. The DOD and DOT have independent technical assessments underway to assess to what extent, if any, these threats could impact use of GPS. Because of the complex technical nature of these issues, the Task Force does not consider it appropriate to recommend specific actions. Rather, the Task Force believes that the involved agencies should complete their respective technical analyses and report their findings through existing agency channels to the DOD and DOT Pos/Nav Executive Committees.

3

Summary

This section summarizes recommendations made by the joint DOD/DOT Task Force on GPS.

The Task Force determined that the current management structure of GPS should be changed. There is a general perception, both in the federal government and the civil sector, that GPS is managed by the DOD as a military radionavigation system. This is of particular concern at a time when civil use of GPS is expanding and the Coast Guard, FAA, DOD, and other federal agencies are planning to phase out current radionavigation systems in favor of GPS. GPS uses are expanding across the transportation modes as well as in positioning and other applications not traditionally considered as users of federal radionavigation systems.

To enhance civil influence in federal radionavigation system planning, the Task Force recommends that the DOT reorganize the DOT Navigation Council and establish a DOT Pos/Nav Executive Committee. The Executive Committee should be chaired by an Assistant Secretary of Transportation with appropriate authority to act for the Department. This Committee should also coordinate the requirements of federal users outside the DOT and in the private sector who use radionavigation systems for endeavors other than navigation.

The DOD and DOT should establish a GPS Executive Board. The Board will be composed of the Chairmen and Executive Secretaries of both the DOD and DOT Pos/Nav Executive Committees. This Board will meet, as required, to resolve issues between the Departments which cannot be decided by routine interaction of the Pos/Nav Executive Committees. Issues will be resolved by consensus.

The above initiatives will provide a structure for DOT to have a more substantive role in major decisions regarding civil use of GPS. They will strengthen the current partnership in federal radionavigation system planning, and will, among other things, increase the likelihood that GPS will gain additional international acceptance.

The Task Force agreed that current budgeting and funding arrangements are satisfactory. The DOD will continue to fund the basic GPS and the DOT will fund augmentations to the GPS. In addition, the Task Force supports the use of indirect fees for GPS augmentations. Further, direct fees for the basic GPS signals should not be implemented. Additionally, the DOD and DOT Pos/Nav Executive Committees should evolve equitable cost recovery mechanisms and develop joint legislative proposals as necessary for implementation. The Executive Committees should pay particular attention to the development of costs recovery mechanisms that properly allocate funds to users that directly benefit from the system services.

The three separate issues related to GPS accuracy, integrity/availability, and augmentations are complex and interrelated. They involve factors of technical

viability and utility, economy and security, timeliness, and redundancy. A common thread tying the issues together is the transmission of additional data to satisfy civil user needs. These data include DGPS, integrity status, and additional ranging signals.

There are two general types of DGPS services: LDGPS is normally designed to cover ranges up to approximately 150 miles. WDGPS may have nearly hemispheric coverage when using geosynchronous satellites.

There are two problems with the DGPS solution--national security and proliferation. Precise positioning information has significant military utility which the DOD intends to deny to any adversary. The DOD has accepted as a reality the expanding use of LDGPS, acknowledging its inherent military vulnerabilities. However, additional security concerns arise when precise data are transmitted from satellites (WDGPS). Proliferation of independent, nonstandard DGPS services raises issues of both security and economy to the extent the services are redundant or incompatible.

The Task Force recommends that DGPS services be implemented for civil applications requiring accuracy better than that provided by even the PPS. Additionally, integrity information should be provided along with all DGPS services.

Because several augmentation alternatives are under development to support multiple applications, a study of all such alternatives is required to develop an optimum integrated system to provide GPS augmented services. This assessment will investigate the performance, economic benefits, and security implications of all wide/local area DGPS service options. This study will be formalized in a new annex to the DOD/DOT MOA and be completed as soon as possible but not later than September 30, 1994.

Current federal agency development and deployment of GPS accuracy enhancements should continue pending completion of this work. The Task Force's opinion is that near-term benefits outweigh any costs that may be saved by delaying or deferring GPS accuracy enhancement development. New federally established DGPS navigation systems would be deployed in accordance with the approved recommendations resulting from the above study.

A wide area broadcast using communications satellites should be implemented as an expeditious way to rapidly improve GPS integrity and availability for aviation users, and possibly other modes of transportation. This wide area broadcast should include both integrity and ranging components.

The DOD and DOT Pos/Nav Executive Committees will determine the composition of the federally-provided DGPS service mix. This mix will become a U.S. standard and must be used for navigation. The Task Force concluded that private sector DGPS providers are not, and cannot by regulation, offer navigation services. However, the government should maintain the option to regulate these services should they be authorized for navigation use in the future.

The Task Force determined that U.S. initiatives regarding acceptance of GPS have been successful as evidenced by growing foreign use. Additionally, the proposed changes to GPS management should encourage foreign acceptance. The DOD and DOT Pos/Nav Executive Committees should assess further assurances as may be necessary.

GPS, like any other radionavigation system, is vulnerable to jamming and spoofing. Both Departments are conducting studies and analyses of jamming and spoofing effects. When completed, the results will be presented to both Pos/Nav Executive Committees. The Task Force recommends no action at this time.

Appendix A

Glossary

A-S	Anti-Spoofing
ADS	Automatic Dependent Surveillance
C/A Code	Course/Acquisition Code (GPS)
CAT	category
CGSIC	Civil GPS Service Interface Committee
DGPS	differential GPS
DME	Distance Measuring Equipment
DOD	Department of Defense
DOT	Department of Transportation
drms	distance root mean squared
FAA	Federal Aviation Administration
FM	frequency modulation
FRP	Federal Radionavigation Plan
Glonass	Russian Global Navigation Satellite System
GNSS	Global Navigation Satellite System (ICAO)
GPS	Global Positioning System
GPSIC	GPS Information Center (USCG)
ICAO	International Civil Aviation Organization
IMO	International Maritime Organization
Inmarsat	International Maritime Satellite
IOC	Initial Operating Capability
IVHS	Intelligent Vehicle Highway Systems

LDGPS	local area differential GPS
MCS	GPS Master Control Station
MHz	megahertz
MLS	Microwave Landing System
MOA	memorandum of agreement
NAS	National Airspace System
NDB	Nondirectional Beacon
Pos/Nav	positioning and navigation
PPS	Precise Positioning Service
RAIM	receiver autonomous integrity monitoring
RSPA	Research and Special Programs Administration (DOT)
SA	Selective Availability
SPS	Standard Positioning Service
TACAN	Tactical Air Navigation
USC	United States Code
USCG	United States Coast Guard
VOR	Very High Frequency Omnidirectional Range
VORTAC	combined VOR and TACAN
WAAS	Wide Area Augmentation System
WDGPS	wide area differential GPS

Appendix B

Definitions

Accuracy - The degree of conformance between the estimated or measured position and/or velocity of a platform at a given time and its true position or velocity. Radionavigation system accuracy is usually presented as a statistical measure of system error and is specified as:

- Predictable - The accuracy of a radionavigation system's position solution with respect to the charted solution. Both the position solution and the chart must be based upon the same geodetic datum.
- Repeatable - The accuracy with which a user can return to a position whose coordinates have been measured at a previous time with the same navigation system.
- Relative - The accuracy with which a user can measure position relative to that of another user of the same navigation system at the same time.

Availability - The availability of a navigation system is the percentage of time that the services are usable. Availability is an indication of the ability of the system to provide usable service within the specified coverage area. Signal availability is the percentage of time that navigational signals transmitted from external sources are available for use. Availability is a function of both the physical characteristics of the environment and the technical capabilities of the transmitter facilities.

Coverage - The coverage provided by a radionavigation system is that surface area or space volume in which the signals are adequate to permit the user to determine position to a specified level of accuracy. Coverage is influenced by system geometry, signal power levels, receiver sensitivity, atmospheric noise conditions, and other factors which affect signal availability.

Differential - A technique used to improve radionavigation system accuracy by determining positioning error at a known location and subsequently transmitting the determined error, or corrective factors, to users of the same radionavigation system, operating in the same area.

Distance Root Mean Square (drms) - The root-mean-square value of the distances from the true location point of the position fixes in a collection of measurements. As used in this document, 2 drms is the radius of a circle that contains at least 95 percent of all possible fixes that can be obtained with a system at any one place. Actually, the percentage of fixes contained within 2 drms varies between approximately 95.5 percent and 98.2 percent, depending on the degree of ellipticity of the error distribution.

Full Operational Capability (FOC) - For GPS, this is defined as the capability that will occur when 24 operational (Block II/IIA) satellites are operating in their assigned orbits and have been tested for military functionality and meet military requirements.

Initial Operating Capability (IOC) - For GPS, this is defined as the capability that will occur when 24 GPS satellites (Block I/II/IIA) are operating in their assigned orbits and are available for navigation use.

Integrity - Integrity is the ability of a system to provide timely warnings to users when the system should not be used for navigation.

National Airspace System (NAS) - The NAS includes U.S. airspace; air navigation facilities, equipment and services; airports or landing areas; aeronautical charts, information and service; rules, regulations and procedures; technical information; and labor and material used to control and/or manage flight activities in airspace under the jurisdiction of the U.S. System components shared jointly with the military are included.

Nonprecision Approach - A standard instrument approach procedure in which no electronic glide slope is provided (e.g., VOR, TACAN, Loran-C, or NBD).

Precision Approach - A standard instrument approach procedure in which an electronic glide scope is provided; e.g., the Instrument Landing System (ILS).

1. ILS Category I (CAT I) - An ILS approach procedure that provides for approach to a height above touchdown of not less than 200 feet and with runway visual range of not less than 1,800 feet.

2. ILS Category II (CAT II)- An ILS approach procedure that provides for approach to a height above touchdown of not less than 100 feet and with runway visual range of not less than 1,200 feet.

3. ILS Category III (CAT III)

    a. IIIA - An ILS approach procedure that provides for approach without a decision height minimum and with runway visual range of not less than 700 feet.

    b. IIIB - An ILS approach procedure that provides for approach without a decision height minimum and with runway visual range of not less than 150 feet.

    c. IIIC - An ILS approach procedure that provides for approach without a decision height minimum and without runway visual range minimum.

4. GPS Special Category I - A special issuance instrument approach procedure with minima not lower than 200 feet height above touchdown zone or runway visual range of not less than 1,800 feet. Special instrument approach procedures are approved by the FAA for individual operators, but are not published in federal aviation regulations for public use.

Radionavigation - The determination of position, or the obtaining of information relating to position, for the purposes of navigation by means of the propagation properties of radio waves.

Appendix C

Task Force Charter

CHARTER

Joint DOD/DOT Task Force on GPS

Statement of Purpose:

The Secretaries of Transportation and Defense have agreed to examine the operational, technical, and institutional implications of increased civil use of the Global Positioning System (GPS). They have established a Task Force to:

- Evaluate the services derived from GPS signals.
- Evaluate the ability of GPS, as managed and operated by the DOD, to meet the needs of civil users.
- Assess the importance of GPS services to civil, commercial, and national security objectives.
- Assess the long-term U.S. Government sustainment of GPS as a national resource.

Membership:

The Task Force will be jointly chaired by the Deputy Assistant Secretary of Transportation for Policy and International Affairs and the DOD Director, Theater and Tactical Command, Control, and Communications. DOT members of the Task Force will include representatives from the Federal Aviation Administration, Coast Guard, Research and Special Programs Administration, and the Office of the Secretary of Transportation. DOD members of the Task Force will include representatives from the OSD staff, the Joint Staff, and the Air Force. Administrative and technical assistance will be furnished through a joint Task Force working group whose membership mirrors the joint Task Force.

Tasking:

The Task Force will:

- Determine the process by which issues will be identified and addressed.
- Conduct a thorough analysis of U.S. Government policy and security questions regarding the use of GPS for civil applications.
- Define the civil requirements for GPS and identify any factors in the current system which preclude their satisfaction. Analyze any factors identified, and develop recommended solution options with necessary implementation actions.
- Prepare a written report for the Secretaries of Task Force findings and recommendations for long-term sustainment of GPS.

Assistant Secretary of Defense for
Command, Control, Communications
and Intelligence (Acting)
Department of Defense

May 26, 1993
Date

Administrator,
Research and Special Programs
Administration (Acting)
Department of Transportation

MAY 19 1993
Date

Appendix D

Task Force Terms of Reference

TERMS OF REFERENCE

DOD/DOT TASK FORCE ON GLOBAL POSITIONING SYSTEM (GPS)

INCREASED CIVIL PARTICIPATION

I. Purpose

The Secretaries of Transportation and Defense have agreed to examine the operational, technical, and institutional implications of increased civil use of the Global Positioning System (GPS). They have established a Task Force to:

a. Evaluate the services derived from GPS signals;

b. Evaluate the ability of GPS, as managed and operated by the DOD, to meet the needs of civil users;

c. Assess the importance of GPS services to civil, commercial, and national security objectives;

d. Assess the long-term U.S. Government sustainment of GPS as a national resource.

II. Background

Members of the DOD Positioning/Navigation (POS/NAV) Executive Committee and the DOT Navigation Council met and agreed that:

a. Discussions be limited to DOD and DOT representatives with participation by other Federal agencies, as necessary;

b. Coordination be accomplished in accordance with processes established in the DOD/DOT Memorandum of Agreement titled "Coordination of Federal Radionavigation System Planning";

c. A joint Working Group support the Task Force;

d. Periodic reviews be conducted of Working Group progress.

III. Task Force Membership

DOD		DOT
Director, Theater and Tactical Command, Control, and Communications (OSD)	Co-Chairs	Deputy Assistant Secretary of Transportation (Policy and International Affairs)
Joint Staff/J61		RSPA/DRA-1
OUSD(P)		FAA/ASD-1
OSD Comptroller		USCG/G-N
SAF/AQS		OST/B
USAF/XOO		OST/S-3
SAF/SX		

IV. Objective

The primary objective of the Task Force is to develop a consensus between the Departments of Defense and Transportation regarding the issues and recommendations for using GPS as a national resource to satisfy civil and national security requirements.

V. Work Plan

To achieve its objective, the Task Force will:

a. Define the current situation. Describe the basic GPS, including services and policies. Provide a synopsis of government agreements and approved planning documents which relate to the implementation and operation of GPS, including all agreements regarding civilian use of GPS services. Describe how national radionavigation policy is developed and approved. Describe specific responsibilities for funding and operation of GPS, including costs and manpower associated with development, procurement, operations, and maintenance of the GPS satellite and control segments.

b. Describe areas in which the above defined current situation does not satisfy the full range of national requirements for GPS services as delineated in the Federal Radionavigation Plan.

c. Identify and analyze policy, management, and funding factors and develop options to meet the civil and national security requirements for GPS.

d. Prepare a report for the Secretaries describing options considered, providing recommendations, and suggesting implementation actions.

VI. Schedule

The Task Force will complete its activities by November 1, 1993.

Richard G. Howe MAY 28 1993
Director, Theater & Tactical C3,
OASD(C3I)
Co-Chairman

Joseph F. Canny MAY 26 1993
Deputy Assistant Secretary
of Transportation (Policy and
International Affairs)
Co-Chairman