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Global Positioning System (GPS): Defining the Legal Issues of Its Expanding Civil Use

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GLOBAL POSITIONING SYSTEM (GPS): DEFINING THE LEGAL ISSUES OF ITS EXPANDING CIVIL USE

JONATHAN M. EPSTEIN*

TABLE OF CONTENTS

| | | |
|------|--|-----|
| I. | INTRODUCTION: THE BRICK MOON— SCIENCE FICTION TO MODERN REALITY..... | 244 |
| II. | OVERVIEW: DEVELOPMENT AND CIVIL USES OF THE GPS SYSTEM | 247 |
| A. | DESCRIPTION AND DEVELOPMENT OF GPS AS A MILITARY SYSTEM | 248 |
| B. | CURRENT INTERAGENCY COORDINATION AND U.S. GOVERNMENT PLANS FOR AUGMENTATION | 251 |
| 1. | <i>U.S. Coast Guard Initiatives</i> | 252 |
| 2. | <i>Federal Aviation Administration (FAA) Initiatives</i> | 254 |
| 3. | <i>Federal Highway Administration (FHWA) Initiatives</i> | 255 |
| 4. | <i>The Future Expanded Use of a Satellite Navigation System</i> | 256 |
| C. | THE JOINT DOD/DOT TASK FORCE AND THE TRANSITION FROM A MILITARY CONTROLLED GPS TO A CIVIL INTERNATIONAL GLOBAL NAVIGATION SATELLITE SYSTEM (GNSS) | 258 |
| III. | ASSESSING LIABILITY ISSUES FOR THE U.S. GOVERNMENT WITH THE EXPANDED CIVIL USE OF GPS | 262 |
| A. | LIABILITY OF THE U.S. GOVERNMENT UNDER EXISTING STATUTES | 264 |
| 1. | <i>Federal Torts Claim Act (FTCA)</i> | 264 |

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| | | |
|-----|--|-----|
| 244 | <i>JOURNAL OF AIR LAW AND COMMERCE</i> | [61 |
| | 2. <i>Suits in Admiralty Act</i> | 266 |
| | 3. <i>Foreign Claims Act & Military Claims Act</i> ... | 268 |
| | B. LIABILITY OF THE U.S. GOVERNMENT UNDER INTERNATIONAL LAW..... | 268 |
| IV. | BUILDING THE LEGAL ARCHITECTURE FOR A WORLDWIDE GLOBAL NAVIGATION SATELLITE SYSTEM (GNSS)..... | 271 |
| | A. INTERNATIONAL ACCEPTANCE OF PREVIOUS RADIONAVIGATION SYSTEMS..... | 272 |
| | B. CREATING A GLOBAL NAVIGATION SATELLITE SYSTEM..... | 274 |
| | 1. <i>The Hinson Letter: A First Step Toward Creating a GNSS</i> | 274 |
| | 2. <i>Intelsat/Inmarsat: Would an International Organization Work for GNSS?</i> | 277 |
| | 3. <i>An International Convention on GNSS Could Borrow from Past Conventions</i> | 279 |
| | a. Using Existing Expertise and Models from the United Nations..... | 279 |
| | b. Dealing with Liability Issues for GNSS | 281 |
| | c. Setting International Technical Standards For GPS/dGPS Receivers and Related Avionics/Electronics.... | 282 |
| | 4. <i>The Peaceful Use of GNSS</i> | 283 |
| V. | CONCLUSION: OPENING THE DOOR TO THE FUTURE..... | 284 |

INTRODUCTION: THE BRICK MOON—SCIENCE FICTION TO MODERN REALITY

IN 1869, Edward Everett Hale, in a science fiction story “The Brick Moon,” postulated sending up a brick sphere into orbit 4,000 miles over the Greenwich Meridian to serve as an artificial star to greatly aid navigators in determining their position at sea.¹ Today’s reality is far beyond anything conceived twelve decades or even twelve years ago and will likely relegate celestial navigation, along with a host of modern aids to navigation for aircraft and ships, obsolete. The enormous capabilities of the

¹ Edward E. Hale, *The Brick Moon*, cited in ARTHUR C. CLARK, THE PROMISE OF SPACE 8-9 (1968) (originally published in the *Atlantic Monthly* in 1869). His idea was that a satellite orbiting the Greenwich Meridian could be used by mariners to determine their longitude, thus necessitating only a single sight for celestial navigation.

Global Positioning System (GPS) have brought about this new reality.

Since the beginning of recorded history, mankind has sought, with varying degrees of success, to determine where he is in relation to other persons or things. Happily, it is now possible to determine instantaneously, continually, and exactly where any one or anything is, anywhere in the world or its surrounding atmosphere, repeatedly and reliably.

This has been made possible through the deployment by the United States of a constellation of satellites commonly known as the Global Positioning System.²

During Operation Desert Shield, the world witnessed the first high visibility demonstration of the GPS system's capabilities. This satellite navigation system gave U.S. forces precise global location information that enabled ships and submarines to accurately launch cruise missiles. The system further enabled military units in the vast desert to pinpoint and report their location, thus clearing some of the "fog" of war.³

Why is there a commercial interest in the military navigation system? The reason lies in the many potential civilian and commercial uses of GPS. These many uses include precision navigation of commercial aircraft, fast and accurate surveying, navigation and control of ocean vessels, generation of automotive electronic maps, and dynamic routing of automobile traffic.⁴ "[GPS] technology [is] now poised to leap into virtually every facet of the American economy [and] is expected to create a \$5 billion to \$10 billion industry by the end of this decade and more than 100,000 jobs."⁵

At a recent conference, Mr. Richard Arnold, from the Federal Aviation Administration (FAA), framed the need for GPS in very human terms. Mr. Arnold stated that worldwide, in the last five years, there have been thirty-nine commercial aircraft accidents resulting in over 1800 deaths due to "controlled flight into ter-

² *The Global Positioning System: What Can't It Do? Hearing Before the House Subcomm. on Technology, Environment and Aviation, 103d Cong., 2d Sess. 27 (1994) [hereinafter Technology, Environment and Aviation Subcommittee Hearings] (GPS: Continental Airlines Position Paper) [hereinafter Continental Position Paper].*

³ See generally JOINT DOD/DOT TASK FORCE REPORT, THE GLOBAL POSITIONING SYSTEM: MANAGEMENT AND OPERATION OF A DUAL USE SYSTEM 5-6 (Dec. 1993) [hereinafter JOINT DOD/DOT REPORT] (describing the use of GPS during Operation Desert Storm and other military applications).

⁴ See *infra* Part II (describing in detail both federal civil and commercial uses of GPS, both current and future).

⁵ Ralph Vartabedian, *Eye in the Sky*, L.A. TIMES, May 1, 1994, at D1.

rain [CFIT]."⁶ Such CFIT crashes occur due to human rather than mechanical error when the pilot flies her plane into a hill or other terrain, often due to poor navigation when descending to land.⁷ Mr. Arnold went on to explain that many of these accidents could have been avoided if the pilot had better known her position.⁸

The GPS system, as developed by the U.S. Department of Defense (DOD), can, through the use of relatively inexpensive receivers onboard aircraft, provide the accurate positioning information necessary to avoid these kind of disasters. In fact, President Reagan directed that GPS be made available for international civil use⁹ following the Korean Airlines Flight 007 (KAL 007) incident where the KAL pilot accidentally strayed off course into Soviet airspace and was shot down.¹⁰

The legal questions surrounding the system are as numerous as its uses. Who is liable for a system malfunction? What are the legal implications of the intentional degradation and errors introduced by the DOD for national security reasons? Who should pay for the ongoing monitoring and maintenance of the system? What are the implications of foreign governments relying on a U.S. system?

Jim Landry, President of the Air Transportation Association, recently put the issue squarely on the table, emphasizing that the airlines want and need the system now; that these legal/liability issues should not impede the implementation of civil applications of GPS; and that the legal community has an

⁶ Richard Arnold, Statement at *The Annual Georgetown Law Center Conference on the Law and Outer Space, Doing Business in Outer Space: The Role of Satellites in Telecommunications Policy and Business* (Nov. 4, 1994) [hereinafter *Space Law Symposium 1994*] (notes taken by the author on Mr. Arnold's remarks and other symposium materials are on file with the author). A Flight Safety Foundation task force study recently predicted that CFIT accidents "could be halved if airport letdown and approach procedures were flown using GPS navigation, rather than existing non-precision navigation aids. . . ." David Learmount, *Task Force Plans to Halve CFIT Incidents . . .*, FLIGHT INT'L, Nov. 9, 1994, available in WESTLAW, PTS-ADMT Database. The study also noted that "the majority of fatal errors involved deviation below glideslope [on approach to landing], rather than a lateral navigation error, with most impacts occurring within 200 ft. (60m) of the terrain top." *Id.*

⁷ *Id.*

⁸ Arnold, *supra* note 6.

⁹ JOINT DOD/DOT REPORT *supra* note 3, at 1.

¹⁰ *Id.*

opportunity to develop a framework in advance of the commercial (civil) use of this system.¹¹

This Comment surveys these concerns and attempts to provide a framework for understanding and addressing the legal issues that have arisen or are likely to arise as government agencies and commercial entities begin to rely on GPS and look to it as the cornerstone of a Global Navigation Satellite System (GNSS).¹² Part II provides an overview of the GPS system, its development, and its current and future uses. This background details not only the magnitude of the benefits that could accrue through civil use of GPS, but also lays out the crucial role of various agencies within the government in defining, operating, and funding this system. Part III examines the issue of U.S. government liability, looking both to domestic statutes and international law. Finally, Part IV looks toward the shape of a future legal regime for an international GNSS, addressing both the liability aspects and the need for international instead of unilateral action to facilitate the use of this new technology.

The lessons learned in the internationalization of satellite communication should not be forgotten here. The United States, and in particular its legal community, has an opportunity to lead, not only in providing the technology, but also in structuring a sound legal regime that can gain international acceptance.

II. OVERVIEW: DEVELOPMENT AND CIVIL USES OF THE GPS SYSTEM

A fishing vessel is sinking off the New England Coast. As it sinks below the water an electronic device is automatically released in response to the increasing water pressure. The electronic device floats to the surface and starts transmitting a mayday signal—not S-O-S, but a complex signal containing the vessel's name and exact location as determined by a tiny GPS receiver in the electronic device. The signal, received by an overhead satellite, is transmitted directly to the U.S. Coast Guard. The Coast Guard dispatches a rescue helicopter, whose onboard

¹¹ Jim Landry, Statement at the *Space Law Symposium 1994*, *supra* note 6.

¹² As will be discussed later, providing basic positioning information with GPS is seen as only one component of a GNSS system. A comprehensive system may include the Russian GLONASS system (similar to GPS), as well as augmentation and communication systems. See Bruce D. Nordwall, *Nausat Users Want Civil Control*, AVIATION WK. & SPACE TECH., Oct. 18, 1993, at 57 (discussing the use of a combined GPS/GLONASS system to meet civil needs).

GPS receiver allows the pilot to fly to the exact location of the transmitter. Once on scene (in minutes rather than hours) the pilot locates and recovers the fisherman from the cold waters of the North Atlantic, where the difference between life and death is measured in minutes.¹³

In this new technology lies the future of air-sea rescue and scores of other uses, some not yet contemplated. Unveiling the how and why of GPS's creation will help explain some of the complex issues with its civil application.

This Part first describes in non-technical terms how GPS functions. It then discusses the movement among U.S. government agencies to enhance and develop civil uses of GPS. Next this Part highlights some concerns that other nations have raised about reliance on the GPS system. Finally it provides a brief survey of current and future civil applications of GPS, illustrating that, at present, only a small number of the many potential uses of GPS technology have been developed.

A. DESCRIPTION AND DEVELOPMENT OF GPS AS A MILITARY SYSTEM

One of the key difficulties in addressing civil legal issues is that, although civil uses were contemplated when development began in the 1970s, GPS was developed as a military system by the Department of Defense (DOD).¹⁴ Its purpose was to provide military forces with precise information for navigation, targeting, and troop coordination, thereby reducing reliance on land-based navigation systems.¹⁵ Given the extreme usefulness of GPS navigation to U.S. forces, and the powerful use an opposing military could make of GPS, the DOD has been understandably reluctant to make the full military GPS system available to commercial users. As will be described below, the DOD has released only a degraded GPS system for widespread use.

It is foreseeable that errors induced by such a degraded GPS may cause accidents. An issue addressed by this Comment is whether the U.S. government may be held responsible for accidents caused by reliance on this degraded GPS system.

¹³ While this is a hypothetical, commercial fishing vessels do carry a device called an EPIRB (Emergency Position Indicator Radio Beacon), which sends a radio signal that can be triangulated by satellites. EPIRBs that incorporate GPS receivers are also commercially available.

¹⁴ See JOINT DOD/DOT REPORT, *supra* note 3, at 1 (describing the purposes and development of the GPS system).

¹⁵ *Id.*

Unfortunately, in order to understand the legal implications, one must first understand some of the technical aspects of the GPS system. The Global Positioning System can best be described in three components: the space component, the receiver/user component, and the control component. The space component consists of a constellation of twenty-four satellites orbiting the earth,¹⁶ each with its own atomic clock, broadcasting positioning signals over a broad area as it circles the earth.¹⁷ The receiver segment consists of GPS receivers and antennas on ships, planes, or any other platform that receive signals from multiple GPS satellites and convert these signals into geographic positions. Although the technical aspects of the system are difficult to understand, the basic theory is simple. Imagine each GPS satellite is a foghorn, and each sends out a signal at exactly the same time. Because sound travels 340 meters per second, the mariner can time how long it takes for each foghorn signal to arrive at his location. Knowing how fast sound travels he can determine how far away he is from each foghorn and knowing the positions of the foghorns can thus determine his own position. In the GPS system, satellites orbiting the earth transmit radio signals (rather than sound signals) but the concept is the same.¹⁸ The geographic position may then be displayed as a digital readout of latitude and longitude, or in conjunction with a computer based charting/mapping system may be used to display the ship's or plane's position on an electronic chart. The earth-based control segment consists of monitoring and satellite control facilities run by the DOD. This segment is crucial for monitoring the "integrity"¹⁹ of the system, correcting the posi-

¹⁶ These satellites orbit at an altitude of approximately 11,000 miles and thus are not in geosynchronous orbit, as are many communication satellites.

¹⁷ JOINT DOD/DOT REPORT, *supra* note 3, at 2.

¹⁸ *See id.* The satellite signal includes a timing component from its atomic clock. The receiver receives signals from multiple satellites and measures the time differential between signals received from different satellites and calculates its position. For an excellent description of how GPS technology works and the foghorn analogy, see GPS NAVSTAR USER'S OVERVIEW 28 (ARINC Research Co. 5th ed., 1991) (booklet distributed by the Coast Guard Information Center, Alexandria VA) [hereinafter NAVSTAR OVERVIEW].

¹⁹ Two technical terms that appear in the debate are "accuracy" and "integrity." For purposes of this Comment "accuracy" is how exact a position the GPS system can provide (e.g. 100 meter accuracy); "integrity" refers to the checks in the system that prevent an erroneous position from being sent and the ability of the system to provide timely warnings to users when the signal should not be used. *See* U.S. DEP'T OF COMMERCE, A TECHNICAL REPORT TO THE SECRETARY OF TRANSPORTATION ON A NATIONAL APPROACH TO AUGMENTED GPS SERVICES, NTIA

tion of satellites, generating time signals, and procuring and launching new satellites to replace older satellites.²⁰

One of the concerns in developing the GPS system was that potential enemies not be able to use the precise navigation information for targeting. As such, the system sends out two different signals and has other features designed to limit its military use by hostile forces. GPS has a Precise Positioning Service (PPS) providing a highly accurate position which, through the use of encryption, is available only to the U.S. military and other select users.²¹ A second service, the Standard Positioning Service (SPS) provides lesser accuracy and can be accessed with commercially available GPS receivers worldwide. Since November 1991, the DOD has further degraded the SPS signal available to civilian users through introduction of intentional errors in the signal called Selected/Availability (SA).²² Although the DOD guarantees that even with SA on the SPS accuracy is still within 100 meters, this accuracy and lack of integrity of the signal is not precise enough for many civil applications. For example: "In October, 1992 an upload to a GPS Satellite contained an ephemeris (orbital data) error of over 2000 meters causing a horizontal position error in excess of 300 meters for all standalone GPS users."²³

In response to the need to provide accuracies better than that gained through the SPS or even PPS signal, as well as to provide a separate integrity monitor, several U.S. government agencies have developed, or are developing, augmentation systems—the

94-30, App. B-1, B-3 (Dec. 1994) [hereinafter TECHNICAL REPORT ON AUGMENTED GPS SERVICES] (providing detailed technical definitions of integrity and accuracy).

²⁰ See JOINT DOD/DOT REPORT, *supra* note 3, at 3. The control segment consists of a Master Control Station at Falcon Air Force Base in Colorado, five monitoring stations, and three uplink antennas located around the globe. *Id.* at 2. The annual cost of maintaining the system is estimated at \$400 million per year, with all but approximately \$30 million of that used for acquisition and launch of new satellites. *Id.*

²¹ JOINT DOD/DOT REPORT, *supra* note 3, at 4. The PPS signal, which is probably accurate to within 20 meters or less, has been made available to allied military forces, as well as to certain civilian applications through a request process administered by the U.S. Coast Guard. *Id.*

²² *Id.* The SPS signal accuracy is 30 meters, but with Selective Availability (SA) this signal is degraded to 100 meter accuracy. D.H. Alsip et al., *Implementation of the U.S. Coast Guard's Differential GPS Navigation Service 1-2* (June 1993) (Paper distributed by the Coast Guard GPS Information Center).

²³ Alsip et al., *supra* note 22, at 2.

most prevalent of which is called differential GPS (dGPS).²⁴ In a dGPS system, a ground reference station at a known geographic location receives the GPS (SPS) signal and compares the position derived from the SPS signal with the reference station's known location. The reference station then transmits a correction on a separate frequency over the local area. DGPS receivers aboard planes or ships in the transmission area receive this correction signal and automatically correct their own GPS position accordingly. Using dGPS the accuracy of the SPS can be improved from one hundred meters to less than five meters.²⁵ In an October 1992 error incident, those units with dGPS corrections were given an instantaneous correction by the dGPS signal.²⁶

In sum, the military heritage of GPS, with multiple signals and protections, has complicated its civil use. Further, as will be discussed in the next section, the need to provide augmented signals for certain civil uses has led to increased coordination between various civil agencies and the DOD.

B. CURRENT INTERAGENCY COORDINATION AND U.S. GOVERNMENT PLANS FOR AUGMENTATION

The U.S. government has seized on GPS as one of the true "peace dividends" of the cold war. Particularly within the Department of Transportation (DOT), agency officials are responding to the perceived need for access to an accurate GPS signal and addressing domestic and international concerns about GPS. For example, Federal Aviation Administrator, David Hinson has committed the United States to provide GPS standard positioning services (SPS) to the international community for ten years with no user costs.²⁷ This statement, recently received support from the President of the United States, who, in

²⁴ See *infra* section II.B. (discussing specific augmentation systems being developed by the U.S. Coast Guard, FAA, and other agencies).

²⁵ TECHNICAL REPORT ON AUGMENTED GPS SERVICES, *supra* note 19, at 22. The existing Coast Guard dGPS system is designed for five meter accuracy, but consistently provides three meter accuracy. *Id.*

²⁶ Alsip et al., *supra* note 22, at 2.

²⁷ Letter from David H. Hinson to the International Civil Aviation Organization (Oct. 14, 1994) (on file with author) [hereinafter Hinson Letter to ICAO]. See *infra* subsection IV.B.1. (discussing the enforceability of this letter as an international agreement). This written assurance replaced oral assurances given by former FAA Administrator, James Busey. Hale Montgomery, *After GPS, What?*, GPS WORLD, Jan. 1992, at 12.

a letter to the International Civil Aviation Organization (ICAO) wrote:

Satellite-based positioning and navigation technologies will play pivotal roles in the global aviation system of the future. This technology, available today through the U.S. Global Positioning System (GPS), can serve to improve safety and reduce costs for operators of all types of aircraft. . . . The United States remains committed to provide GPS signals to the international aviation community and to other peaceful users of radio navigation and positioning systems.²⁸

This section first addresses interagency coordination as well as ongoing and planned projects, and second it briefly discusses international concerns about the future of GPS.

Two agencies within the DOT, the Coast Guard and the FAA, have taken the lead in facilitating use of GPS and developing dGPS-based augmentation systems to meet the needs of the civil maritime and aviation communities. Further, a joint DOD/DOT task force has been studying the joint military/civilian use of GPS and has put forward recommendations regarding control, funding, and augmentation of the original GPS system. The task force has also made recommendations with respect to dGPS augmentation systems currently being developed.²⁹ A November 1994 study prepared for the Secretary of Transportation addressed in detail the specific technical accuracy and integrity needs of land, air, sea, and non-mobile GPS users.³⁰

1. U.S. Coast Guard Initiatives

The Coast Guard, as a military service within a civilian agency (the DOT), and as the traditional provider of maritime radionavigation services,³¹ was perhaps best situated to develop civil ap-

²⁸ Letter from President Clinton to the ICAO (Mar. 16, 1995) (on file with author) [hereinafter Clinton Letter to ICAO]. This letter was "addressed to delegates from more than 150 nations gathered . . . to determine the global air navigation systems of the future." Press Release: President Clinton Commits to GPS Worldwide (U.S. Dep't of Transp. Mar. 27, 1995) (on file with author).

²⁹ See generally JOINT DOD/DOT REPORT, *supra* note 3 (addressing problems and proposing recommendations concerning dual civilian/military use of GPS).

³⁰ See generally TECHNICAL REPORT ON AUGMENTED GPS SERVICES, *supra* note 19.

³¹ The Coast Guard maintains long-range radionavigation systems such as Omega and Loran-C which provide similar, but less accurate positioning information to mariners, as well as local radio-beacons. See generally ELBERT S. MALONEY, DUTTON'S NAVIGATION AND PILOTING 434-88 (14th ed. 1985) (describing how existing marine radionavigation systems, including radio-beacons, Loran-C, Omega, and Navsat operate and how they are utilized by the mariner).

plications for GPS. With a mandate under the Federal Radionavigation Plan and federal statutes³² to provide precise positioning for harbor approach and harbor navigation,³³ the Coast Guard began placing dGPS beacons along the coastline of the United States, providing five-meter accuracy. DGPS for harbor approach and for coastal and ocean navigation will likely make redundant existing radionavigation systems, such as Loran-C, Omega, and radio-beacons.³⁴ Other Coast Guard initiatives include:³⁵ (1) a Navigation Information Service (NIS), for distributing information on GPS and other electronic navigation systems to the public by means of computer bulletin boards;³⁶ (2) an Automatic Dependent Surveillance System (ADSS) for tankers navigating Prince William Sound, Alaska, wherein each tanker will have a dGPS receiver linked to a transmitter, which will update a Coast Guard Vessel Traffic Service Center as to the exact position of the tanker as it transits this environmentally sensitive area; (3) a Coast Guard vessel that is equipped with advanced electronic chart equipment and dGPS to test computerized chart displays; (4) a Laptop Automatic Aid Positioning System (LAAPS) that can take positions from dGPS to position and check buoys; (5) a modified carriage requirement, developed soon after GPS was declared Initial Operational Capability (IOC) in December 1993, to allow vessels to carry GPS in lieu of other electronic positioning devices;³⁷ and (6) use of dGPS for search and rescue and icebreaking.

³² See 14 U.S.C. § 81 (1994) (mandating that the Coast Guard implement, maintain, and operate electronic navigation aids meeting the needs of U.S. military and commercial users); 33 U.S.C. § 2734 (Supp. V 1993) (providing, under the Oil Pollution Act of 1990, that the Secretary of Transportation "acquire, install, and operate [equipment such as] satellite tracking systems" to increase the ability to monitor traffic in Prince William Sound).

³³ Gene W. Hall, *USCG Differential GPS Navigation Service* (Feb. 1995) (paper distributed by the Coast Guard GPS Information Center).

³⁴ TECHNICAL REPORT ON GPS AUGMENTATION, *supra* note 19, at 22. This system will be fully operational by 1996. Due largely to the use of existing radio-beacon facilities already owned by the U.S. government, the hardware cost for the 45 dGPS coastal sights was only \$1.6 million. Montgomery, *supra* note 27, at 18.

³⁵ For an overview of U.S. Coast Guard initiatives using dGPS technology, see Alsip et al., *supra* note 22, at 2-3.

³⁶ U.S. Coast Guard, 28 RADIONAVIGATION BULL., Fall-Winter 1994.

³⁷ Announcement of Global Positioning System (GPS) Initial Operational Capability (IOC) and Its Impact on Vessel Carriage Requirement Regulations, 59 Fed. Reg. 13,757 (1994).

2. Federal Aviation Administration (FAA) Initiatives

The FAA has approved the use of GPS equipment meeting certain specifications for supplemental use in flying ocean and domestic routes and as a supplemental system for terminal and non-precision approaches.³⁸ To meet accuracy and integrity requirements for use as the primary navigation tool in civil aviation, and for use during precision approaches, the FAA is planning a two-tiered system. First, a Wide Area Differential GPS (WADGPS) will use satellites in geosynchronous orbit to provide a differential signal, which will increase accuracy and integrity for navigation and non-precision approaches.³⁹ Second, local integrity beacons located at airports will provide a higher level of accuracy and integrity for precision approach and landing.⁴⁰ Integral to this system would be communication systems designed to provide positioning data to air traffic controllers for routing, separation of planes, and collision avoidance.⁴¹ An air navigation system based on GPS will make

³⁸ *Future Uses of Satellite Technology in Aviation, Hearing Before the Subcomm. on Aviation, 103d Cong., 1st. Sess. 34 (1994)* [hereinafter *Aviation Subcommittee Hearings*] (Letter from David R. Hinson, Administrator of the FAA, to Rep. William F. Clinger, Jr. of the Aviation Subcomm. (Oct. 25, 1993)) [hereinafter *Hinson Letter to Congress*] (responding to questions posed by the subcommittee).

³⁹ *Id.* The FAA is planning to place the space component of this system aboard four INMARSAT-3 satellites scheduled for launch during 1995, thus reducing costs to \$10 million per year for lease of space on the four satellites as opposed to an estimated \$400 million to build and launch four dedicated satellites. *Id.* at 33. See also Edward H. Phillips, *FAA Opens Bidding for Wide-Area GPS*, AVIATION WK. & SPACE TECH., June 13, 1994, at 34 (providing details on the planned implementation of the FAA's wide area GPS system and its operational capabilities).

⁴⁰ FAA-stated requirements for Cat III landings are 0.6 meter vertical and 4.1 meter horizontal accuracy with signal availability at 99.999%. TECHNICAL REPORT ON AUGMENTED GPS SERVICES, *supra* note 19, at 12. These local integrity beacons have, however, demonstrated accuracy of 1-2 centimeters. In tests with multiple antennae on the aircraft, such systems can measure aircraft attitude to one-tenth of a degree—raising the possibility of completely automated landings using a dGPS signal. *Technology, Environment and Aviation Subcommittee Hearings, supra* note 2, at 15 (statement of Bradford W. Parkinson). See also *GPS 'Pseudolites' Offer Promise for Approaches*, AVIATION WK. & SPACE TECH., Oct. 18, 1993, at 60 (discussing technical details and testing of one type of integrity beacon).

⁴¹ See *Hinson Letter to Congress, supra* note 38, at 26. The FAA plans on deactivating long-range surveillance radars, in anticipation of GPS-based Automatic Dependant Surveillance (ADS) technology, whereby planes will transmit their position automatically to ground stations. ADS technology is expected to provide controllers with a comprehensive picture of the location, altitude, speed, and course of the aircraft. *Id.* The FAA is also considering an Airport Surface Traffic Automation (ASTA) system, which would use similar dGPS technology and

redundant many current air navigation aids such as VOR, DME, ADF, ILS, and MLS⁴² with enormous cost savings.

3. Federal Highway Administration (FHWA) Initiatives

As part of an Intelligent Vehicle and Highway System (IVHS) project designed to improve safety and efficiency, the government has committed \$659 million over six years to various projects.⁴³ Accurate positioning information, such as that provided by GPS/dGPS, is critical for several of the major projects. Specifically, these projects include: (1) vehicle-based collision avoidance systems; (2) systems that optimize bus movements by allowing managers to track bus positions and that also allow automated bus/rail stop announcements; (3) Automated Vehicle Identification/Automated Vehicle Location (AVI/AVL) systems that allow improved fleet management and tracking of hazardous materials being transported; (4) distress systems that emit a distress alert with a vehicle's location when an emergency situation is detected; and (5) onboard navigation and route guidance computers with positioning information provided by GPS.⁴⁴ A trial of such a system, having onboard navigation and route guidance computers, is currently underway in Orlando, Florida.⁴⁵ Each vehicle in this system is equipped with an advanced traveler information and route guidance system.⁴⁶ FHWA is also testing an automated system, aboard thirty commercial trucks, that uses a GPS/computer system to calculate miles driven in each state. The computer system sends this in-

datalinks to provide pilots and ground controllers with an electronic map of the airport showing the real time locations of all aircraft. James Baumgardner, *GPS/Data Link to Improve Airport Surface Operations*, AVIATION WK. & SPACE TECH., May 16, 1994, at 54.

New Zealand has already awarded a contract for a GPS-based air traffic control system that will cover most of the South Pacific. This system will use a satellite datalink to allow New Zealand controllers to monitor and communicate with planes over this region. With this GPS-based air traffic control system, New Zealand expects increased route capacity along with reduced delays and flight times. *CAE to Supply Satellite-Based Oceanic Control System*, AVIATION DAILY, Nov. 9, 1994, at 228.

⁴² *Aviation Subcommittee Hearings*, *supra* note 38, at 196 (statement of David W. Minek).

⁴³ See TECHNICAL REPORT ON AUGMENTED GPS SERVICES, *supra* note 19, at 8 (discussing the six major IVHS program areas).

⁴⁴ *Id.*

⁴⁵ Hale Montgomery, *Nonprecision Approaches, GPS in IVHS, and New Federal Policy*, GPS WORLD, Mar. 1993, at 18.

⁴⁶ *Id.*

formation to a central receiving station for calculation of fuel taxes, eliminating paperwork, reducing unreported mileage, and allowing accurate allocation of taxes to appropriate states.⁴⁷

4. *The Future Expanded Use of a Satellite Navigation System*

GPS is like the Internet in that many of its future uses have not yet been conceived, but the potential uses are numerous. The following are just a few diverse examples.

In aviation, aside from routing and precision landing uses, future applications might include: (1) use of a GPS/transmitter system as an Emergency Locator Transmitter (ELT); (2) use of the time signal from GPS for standardizing timing between aircraft and ground controllers; (3) use by airline companies to track aircraft location to enhance efficiency and expedite rerouting and repairs; and (4) use of GPS aboard aircraft to calculate winds aloft data and transmit it to ground stations so that other aircraft can predict air speed/fuel usage in these areas.⁴⁸

Orbital Sciences is developing a combined handheld GPS receiver and satellite communications transmitter that can be placed on freight or trucks so that shipping and freight companies can track the exact location of their goods.⁴⁹ The Volpe Transportation Center recently tested a similar system for tracking containers containing sensitive military payloads.⁵⁰

"Utility crews, for example, climb up the wrong power pole 10% of the time, a mistake that will be eliminated as poles are indexed by GPS location."⁵¹

Trimble Navigation, a manufacturer of GPS, posted sales of \$150 million. A large portion of Trimble's sales were for GPS-based surveying devices, which are replacing optical devices. Trimble recently introduced a floating receiver that can be dropped on oil spills to track the spread of oil contamination.⁵²

Future non-transportation related federal uses include: (1) use of GPS remote sensors to gather weather data and monitor geo-

⁴⁷ *Id.*

⁴⁸ *Continental Position Paper, supra* note 2, at 29.

⁴⁹ See Kathleen Day, *Orbital to Buy Positioning Firm*, WASH. POST, Nov. 29, 1994, at C3 (describing Orbital Sciences acquisition of Magellan, a GPS receiver manufacturer and its plans to build handheld GPS receivers/communication transmitters).

⁵⁰ David Hughes, *Patriot Shipment Watched Closely*, AVIATION WK. & SPACE TECH., May 16, 1994, at 59.

⁵¹ Vartabedian, *supra* note 5, at D4.

⁵² *Id.*

logical shifts or other environmental conditions; (2) use of GPS aboard aircraft using photography to produce accurate maps; and (3) use of the very accurate timing signal transmitted by GPS in synchronizing scientific experiments, for astronomical research, telecommunications, power utilities, and other purposes that require precise time synchronization.⁵³

Predictions not only for the growth of GPS related technologies, but also of potential cost savings are staggering. Senator Exon, then Chair of the Senate Armed Services Committee, Subcommittee on Strategic Forces and Nuclear Deterrence, stated in a speech before the Senate:

I am astonished almost daily at news of some new advance in GPS navigation technology or its application to civil and commercial uses. It appears to me that GPS is rapidly becoming a key element of the basic infrastructure of the world's economy and holds the promise for dramatic increases in productivity.⁵⁴

Current sales of GPS equipment increased 600% between 1989 and 1992 and rapid continued growth in sales of receivers and related equipment is predicted.⁵⁵ In aviation, in addition to increased safety, cost savings through closer separation of aircraft, more direct routing of aircraft, fewer diversions due to poor weather, and removal of need for costly precision landings systems at airports are enormous. The International Civil Aviation Organization (ICAO) estimates a five to six billion dollar annual savings from satellite navigation use in worldwide commercial aviation.⁵⁶ The FAA estimates that U.S. airlines will realize ten billion dollars in savings over the next twenty years from Trans-Atlantic and Trans-Pacific route flights alone.⁵⁷

⁵³ TECHNICAL REPORT ON AUGMENTED GPS SERVICES, *supra* note 19, at 13.

⁵⁴ 139 CONG. REC. S5274 (daily ed. Apr. 30, 1993) (statement of Sen. Jim Exon, The Future of the U.S. Global Positioning System), *reprinted in* GPS WORLD, July 1993, at 44.

⁵⁵ *Finding the Future*, ECONOMIST, Nov. 6, 1993, at 115. According to a California consulting firm, sales of GPS hardware rose from \$20 million in 1989 to \$121 million in 1992 and sales of digital maps based on GPS was estimated at \$1.8 billion. *Id.*

⁵⁶ Paul B. Larsen, *Positioning Satellites: Current Institutional Issues in Space Law Symposium 1994*, *supra* note 6.

⁵⁷ Martin T. Pozesky, *GPS Implementation for Use by Civil Aviation is on a Fast Track*, ICAO J., Dec. 1993, at 18. David Hughes provides a good example of how this cost savings is realized:

Today the North Atlantic [air routes] are revised daily to take advantage of the best tailwinds heading East and the weakest headwinds heading West. The best routes are in this corridor, and aircraft that fly routes outside this organized track system usually

C. THE JOINT DOD/DOT TASK FORCE AND THE TRANSITION
FROM A MILITARY CONTROLLED GPS TO A CIVIL
INTERNATIONAL GLOBAL NAVIGATION
SATELLITE SYSTEM (GNSS)

As can be seen from the discussion above, various agencies are moving forward to expand the civil uses of GPS. However, the DOD and the DOT have only recently proposed a comprehensive architecture for GPS control, funding, and augmentation. This architecture is designed to meet the needs of civil users in aviation, maritime, and land transportation.⁵⁸ This interagency coordination is critical for a GPS-based Global Navigation Satel-

operate in less favorable winds. Currently each route is separated from the next one by about 60 naut. mi., but when GPS tracking comes in this spacing will be reduced. Thus more aircraft will fly nearer the most favorable wind and burn less fuel on the crossing.

David Hughes, *Air Navigation Due for Dramatic Change*, AVIATION WK. & SPACE TECH., Oct. 31, 1994, at 51.

⁵⁸ There are at least five existing interagency agreements providing policy guidance:

Memorandum of Agreement between the Department of Defense and the Department of Transportation — Civil Use of the Global Positioning System (Jan. 8, 1993) (defining responsibilities of both departments and placing a DOT representative on the DOD GPS Joint Program Office of the Air Force Space Command).

Memorandum of Agreement between the U.S. Coast Guard and the U.S. Space Command — Distribution of Navstar Global Positioning System Status Information (Feb. 12, 1992) (providing a mechanism for the Coast Guard to pass operational status information to civil users).

Support Agreement between the U.S. Coast Guard and the U.S. Space Command — Distribution of Navstar Global Positioning System (GPS) Status Information (July 31, 1992) (defining the format and timeliness of GPS status information to be made available to civil users).

Agreement between the Department of Defense and the Federal Aviation Administration (1992) (establishing the accuracy of the civil (SPS) signal and precluding changes to this signal without FAA approval, except in case of national emergency).

Agreement between the DOD and the FAA (1990) (establishing "policies for civil use of GPS and for promoting acceptance of GPS as a worldwide satellite navigation capability for international civil aviation use.").

JOINT DOD/DOT REPORT, *supra* note 3, at 10 (summarizing these five agreements). See also *Aviation Subcommittee Hearings*, *supra* note 38, at 110 (John M. Beukers, *Administrative Procedures and Agreements Governing Global Radionavigation*) [hereinafter Beukers, *Global Radionavigation*] (providing a list of interagency agreements on radionavigation).

lite System (GNSS)⁵⁹ to be implemented, not only to meet accuracy and integrity needs for national and international civil use, but also to ensure that the security concerns are addressed.⁶⁰

A joint DOD/DOT task force formed in January 1993 examined seven critical issues concerning civil use of GPS: (1) who should manage the GPS system; (2) how continued operation of GPS and augmentation systems should be funded; (3) the accuracy of the civil signal; (4) integrity and availability concerns; (5) regulation of GPS augmentation; (6) international acceptance; and (7) risk of spoofing or jamming of the GPS signal.⁶¹ The following summarizes the task force's conclusions:

Management. The task force recommended creation of a joint GPS executive board consisting of the chairpersons from both the DOD's Positioning/Navigation Executive Committee and a newly created DOT Positioning/Navigation Executive Committee.⁶²

Funding. DOD should continue funding the existing GPS system, while DOT should fund augmentation systems, and both DOD/DOT should evaluate means, including fees, for financing GPS services.⁶³

Accuracy. Neither the accuracy of the SPS signal, nor the PPS signal meets the accuracy requirements necessary for certain civil applications (e.g., precision landing) therefore a technical study should be completed to determine an optimum plan for dGPS augmentation.⁶⁴

Integrity and Availability. A wide area broadcast is necessary to meet civil aviation needs.⁶⁵

⁵⁹ Although the terms GPS and GNSS are sometimes used synonymously, GNSS refers to a comprehensive worldwide navigation system that would use GPS and possibly GLONASS (a Russian Satellite Navigation System similar to GPS) as well as the augmentation systems.

⁶⁰ For example, a Spanish defense company is developing a ground attack missile that may use GPS for targeting. Craig Covault, *Spanish Ground Attack Missile Design Advances*, AVIATION WK. & SPACE TECH., Nov. 21, 1994, at 103. Unlike earlier navigation systems, GPS may provide the pinpoint accuracy a future adversary could use to target U.S. forces.

⁶¹ JOINT DOD/DOT TASK FORCE REPORT, *supra* note 3, at ES-2. Because of the weakness of the signal provided from the satellite, intentional jamming (deliberate broadcasting of a stronger signal on the same frequency as the GPS broadcast) or unintentional interference from a stronger signal on an adjacent frequency could prevent reception of the GPS signal. *Id.* at 48. Spoofing refers to the deliberate transmission of a false signal, which could pass false positioning data to a receiver and cause it to give inaccurate positioning data. *Id.*

⁶² *Id.* at 20-21.

⁶³ *Id.* at 26.

⁶⁴ *Id.* at 32.

⁶⁵ *Id.* at 39.

Regulation of GPS Augmentation. Government GPS augmentation should be implemented, but private sector dGPS services should not presently be used for navigation.⁶⁶

International Acceptance. The DOT should consider initiatives to enhance international acceptance.⁶⁷

Spoofing and Jamming. The task force recommended more study of this technical issue.⁶⁸

This document, released in December 1993, is praiseworthy for its considerations of a range of options including establishment of a public management body like the U.S. Postal Service and even turnover of the system to an international body like Intelsat or Inmarsat—an option that the task force ultimately rejected based primarily on security considerations.⁶⁹

Eleven months later, in November 1994, a DOT-sponsored technical study was released.⁷⁰ This study, made in response to a request by the Joint DOD/DOT task force, first looked at the technical parameters, accuracy, time to alarm, availability, and coverage area required for various civil uses—air, land, and sea transportation, as well as non-transportation uses such as surveying.⁷¹ The study confirmed the earlier joint task force finding that an unaugmented GPS signal could not meet the very precise needs of some civil applications.⁷² The study looked at six options, involving combinations of possible augmentation architectures, and made the following recommendations:

The FAA's Wide Area GPS (WAAS) and Local Area GPS (LAGPS) augmentations should continue to go forward.⁷³

DOT in coordination with the Department of Commerce should install and maintain a dGPS beacon system with nationwide coverage expanding that coverage already being implemented by the Coast Guard.⁷⁴

Recommendations concerning data-formats, continuance of the Coast Guard's Navigation Information Center (then called the GPS Information Center), and recommending further technical

⁶⁶ JOINT DOD/DOT REPORT, *supra* note 3, at 43-44.

⁶⁷ *Id.* at 47.

⁶⁸ *Id.* at 48.

⁶⁹ *Id.* at 17, 19.

⁷⁰ TECHNICAL REPORT ON AUGMENTED GPS SERVICES, *supra* note 19.

⁷¹ *Id.* at 7-16.

⁷² *Id.* at 17-18.

⁷³ *Id.* at 7-16. See *supra* subsection I.B.2 (describing the FAA's proposed WAAS and LADGPS systems).

⁷⁴ TECHNICAL REPORT ON AUGMENTED GPS SERVICES, *supra* note 19, at 7-16.

study on the issue of the system's vulnerability to jamming and spoofing.⁷⁵

If implemented, the recommended augmentation schemes would meet virtually all the foreseeable requirements for civil users in, over, or near U.S. territory.⁷⁶ Also notable, is that only for general ocean maritime routes, where the basic SPS signal is sufficient, does the recommended architecture meet civil user requirements worldwide.⁷⁷ Another issue is whether the exclusion of international participants from the discussion creates a barrier to international acceptance of the system. Absent some international accord, a commercial airliner may have to carry dGPS equipment compatible with U.S. WAAS and LAGPS systems as well as separate systems, such as Microwave Landing System (MLS) equipment, when entering or landing in foreign airspace.

In summary, as can be seen from the myriad of uses, GPS technology is one of the true peace dividends of Cold War research. Civil users in the aviation and maritime industry are eager to reap the benefits of this system. Recent initiatives by the Coast Guard and FAA, as well as the recent, comprehensive architecture developed by the joint DOD/DOT task force, will significantly enhance the civil utility of GPS. But two issues remain paramount. First, what liabilities does the United States government incur in providing this new service to the civil sector and how can this liability be mitigated? Second, how and when can GPS or a nationally-oriented satellite system of augmentation be expanded into a Global Navigation Satellite System that is accepted worldwide?

⁷⁵ *Id.* at 67-68; *id.* at app. E (giving an in-depth technical analysis of the inherent vulnerability of GPS and dGPS signals to jamming and spoofing); *see also* Bruce D. Nordwall, 'Worm Holes' in GPS Coverage Raise Interference Concerns, AVIATION WK. & SPACE TECH, June 5, 1995, at 32 (discussing FAA tests of GPS coverage that showed interference with the GPS signal over some areas in the United States).

⁷⁶ Two applications that this architecture would not meet are highway collision avoidance and railroad collision avoidance, because of the high accuracy (1 meter) needed to determine in which lane cars are travelling and on which set of parallel tracks a train is rolling. TECHNICAL REPORT ON AUGMENTED GPS SERVICES, *supra* note 19, at Executive Summary xv.

⁷⁷ *Id.* at 11. The FAA's satellite based WAAS would likely provide coverage over the "contiguous U.S., Alaska, Hawaii, Puerto Rico, the Pacific Ocean to Hawaii, the Atlantic Ocean off the Coast of the U.S., and much of the Gulf of Mexico." *Id.* at 35.

III. ASSESSING LIABILITY ISSUES FOR THE U.S. GOVERNMENT WITH THE EXPANDED CIVIL USE OF GPS

Civil aviation and maritime users already depend upon GPS and are eager for the U.S. government to alter regulations and implement augmentation plans to expand its use further. However, whenever the government provides a service upon which the public relies, whether a lighthouse or air traffic control services, it then faces potential liability for the negligent acts of civil servants. The Coast Guard and the FAA, the two providers of navigation aids, have faced countless suits and are understandably cautious about providing a new service without being able to ensure the integrity of the system. Thus far, the government has avoided suits based on navigation errors caused by GPS.⁷⁸

Currently the U.S. government, by only guaranteeing the reduced accuracy and integrity of GPS, faces limited exposure to liability. But even before more precise augmented systems come online, the U.S. government and the manufacturers of GPS-based navigation equipment may have to deal with the liability issues. To explore the liability implications, this Part poses the following hypothetical:

An airborne medical transport helicopter (air ambulance) carrying a critically-injured patient crashes as it attempts to land on a hospital heli-pad in poor weather—relying on GPS for its approach and descent.⁷⁹ A check with the Coast Guard's Navigation Information Center reveals that at the approximate time of the crash there were a limited number of satellites within the horizon of the helicopter's receiver. Checking against a dGPS reference, it appears that the intentional error transmitted near the time of crash was close to the one-hundred yard maximum, rather than the much more accurate signal on which the pilot

⁷⁸ The only federal case raising the issue of GPS accuracy or integrity is *Conaghan v. Maxus Exploration Co.*, 1992 WL 535618 at *6 (D. Wyo. Feb. 4, 1992), *aff'd*, 5 F.3d 1363 (10th Cir. 1993) (dismissing the accuracy of a survey done using GPS because GPS "is only an aid in mapping"). Interestingly, a search of the Westlaw database of federal cases revealed no cases involving older electronic navigation systems (Loran-C, Transit, Omega) where the accuracy or integrity of the system was challenged.

⁷⁹ The FAA has issued special procedures to allow a GPS equipped air ambulance to use the GPS for non-precision approaches to a Chattanooga, Tennessee hospital. Use of the GPS system has saved an estimated 14 lives relative to the alternative ground transport procedures that would have otherwise been used in poor weather conditions. *Global Positioning System*, WKLY. BUS. AVIATION, Nov. 14, 1994, at 217.

may have relied on. The pilot, though he knew that use of GPS for precision approaches was not authorized, had not realized the ground fog was so bad until he was in his final descent, and was then faced with the option of aborting and taking his critically-injured patient to an airport with a precision landing system or using his GPS and altimeter for landing.

Looking to the receiver, did it meet FAA standards for GPS avionics? Was it a cheaper or earlier model capable only of receiving several satellite signals at once? If the GPS receiver interfaced with other avionics to provide airspeed, altitude, or heading—was this authorized and did it meet established accuracy standards?⁸⁰ Finally, if the GPS provided location input to an electronic air chart or map and how accurate was the map—how recently had it been updated?

The permutations of such a hypothetical might change if an FAA-approved augmented GPS signal were used, but this hypothetical illustrates some of the issues that may arise in future litigation.⁸¹ This Part first explores potential avenues for liability against the U.S. government under the Federal Tort Claims Act⁸² and the Suits in Admiralty Act,⁸³ and administrative relief under the Foreign Claims Act⁸⁴ or Military Claims Act.⁸⁵ Part B examines how liability may accrue through treaty or other international law conventions, specifically the 1967 Outer Space Treaty⁸⁶ and the 1972 Convention on International Liability for Damages Caused by Space Objects.⁸⁷ While issues of liability of manufacturers of satellites or related ground GPS equipment and of a future, non-governmental bodies that may one day control GNSS are raised by the above hypothetical, these issues are

⁸⁰ For example, in the maritime arena, where GPS is currently authorized for use as the sole electronic navigation device onboard vessels over 1600 gross tons, operators are not authorized to use GPS to replace gyro-compasses for heading information, or conventional speed logging devices for speed. Depending on the algorithm used by the receiver for calculating and averaging speed or heading, it is unclear how accurately a particular GPS receiver would track a ship (or aircraft) in a hard turn or other radical maneuver.

⁸¹ See also Kevin K. Spradling, *GPS and the Law*, GPS WORLD, Nov.-Dec. 1990, at 48 (posing a hypothetical involving a tanker using GPS for navigation to discuss government liability).

⁸² 28 U.S.C. §§ 1346(b), 2671-2680 (1988).

⁸³ 46 U.S.C. app. §§ 741-752 (1988).

⁸⁴ 10 U.S.C. § 2734 (1994).

⁸⁵ *Id.* § 2733.

⁸⁶ Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies, Oct. 10, 1967, 18 U.S.T. 2410 (1967).

⁸⁷ 24 U.S.T. 2391 (1972) [hereinafter Liability Convention].

not addressed by this Comment. Rather, the Comment focuses on potential U.S. government liability in the current environment to illustrate the role that liability has played in slowing the implementation of civil uses of GPS and also to show how the resolution of liability concerns will be crucial in gaining international acceptance of a GNSS.

A. LIABILITY OF THE U.S. GOVERNMENT UNDER EXISTING STATUTES

While generally sovereign immunity prevents tort claims against the U.S. government,⁸⁸ there are several statutes under which the United States has waived immunity. Unless a claim is made under one of these statutes, it will likely be dismissed for want of jurisdiction. Accordingly, these statutes are likely avenues for claims arising from civil use of GPS.

1. *Federal Torts Claim Act (FTCA)*⁸⁹

Under the FTCA the government has waived immunity for claims of money damages where the loss was caused by a negligent or wrongful act or omission of a government employee acting within the scope of his office.⁹⁰ Claims must be brought in federal court, but liability is established under the law for the jurisdiction where the act occurred.⁹¹ However, this waiver is tempered by sections of the Act limiting liability in three areas.

The first area where the government does not waive immunity is where the act involves a "discretionary function" of the government. In a seminal decision, *Dahelite v. United States*,⁹² the Supreme Court held that the cabinet level decision to institute fertilizer exports and the failure to discover the explosion hazard of shipping fertilizer in a specially-designed vessel were discretionary functions rather than execution of policy.⁹³ Thus the United States could not be held liable for tort damages when a ship carrying fertilizer exploded.

⁸⁸ See ALFRED C. AMAN, JR & WILLIAM T. MAYTON, ADMINISTRATIVE LAW § 14.1, at 525 (1993) (stating that "sovereign immunity" . . . has become a fixture of American law").

⁸⁹ 28 U.S.C. §§ 1346(b), 2671-2680 (1988).

⁹⁰ *Id.* § 1346(b).

⁹¹ *Id.*

⁹² 346 U.S. 15 (1953).

⁹³ *Id.* at 45.

The courts however, have narrowed the availability of this "discretionary function" exception⁹⁴ by differentiating discretionary from operational functions. For example, in *Ingham v. Eastern Airlines*⁹⁵ the Second Circuit held that the failure of an air-traffic controller to provide accurate, current weather forecasts was the proximate cause of a crash and was not a discretionary function.⁹⁶ The court reasoned that while the establishment of an air traffic control system was a discretionary act, once the system was established, employees were required to act in a reasonable manner, and the government was liable for failure to do so.⁹⁷ Clearly analogous, once the U.S. government provides a GPS signal for a particular purpose, it would be liable if failure of the signal was the proximate cause of a crash. However, the decision to establish such a signal, or provide a particular level of accuracy would probably be characterized as discretionary.⁹⁸

A second area where the government does not waive immunity involves claims arising in a foreign country.⁹⁹ While this could be construed to limit accidents in foreign airspace, Kevin Spradling points out that where the claim "arises" is not always the scene of the accident. Spradling provides the following example: A civil GPS user in Norway, who relies on erroneous GPS data and negligently uploads at the Master Control Station in the United States, may sue in the United States under the FTCA even if the injury he suffers actually occurs in Norway.¹⁰⁰ This is consistent with *In re Paris Air Crash of March 3, 1974*,¹⁰¹ in which

⁹⁴ 28 U.S.C. § 2680(a) (1988) provides that the Act does not apply to claims "based upon the exercise or performance or the failure to exercise or perform a discretionary function or duty on the part of a federal agency or an employee of the Government; whether or not the discretion involved being abused." *Id.*

⁹⁵ 373 F.2d 227 (2d Cir.), *cert. denied*, 389 U.S. 931 (1967).

⁹⁶ *Id.* at 237.

⁹⁷ *Id.* at 238.

⁹⁸ See Kevin K. Spradling, *The International Liability Ramifications of the U.S.' NAVSTAR Global Positioning System*, in PROCEEDINGS OF THE THIRTY-THIRD COLLOQUIUM ON THE LAW OF OUTER SPACE 93, 95 (1990) (discussing U.S. liability for GPS under the FTCA). Spradling points out that:

should an individual claim that his injuries would not have occurred had he had PPS information instead of SPS, [his claim would] still be barred. . . . On the other hand if the U.S. negligently degrades the SPS signal—say for exercise purposes and without notice to civil users—such a decision may be actionable."

Id. at 95.

⁹⁹ 28 U.S.C. 2680(k) (1988).

¹⁰⁰ Spradling, *supra* note 98, at 96.

¹⁰¹ *In re Paris Air Crash of Mar. 3, 1974*, 399 F. Supp. 732 (C.D. Cal. 1975).

the fact that a plane crash occurred in France did not bar suit in the United States because the "act" (wrongful approval of a certificate of inspection) was alleged to have taken place in California.¹⁰²

The third exception pertains to injuries suffered as a result of combat activities of the armed forces during a time of war.¹⁰³ This exception may completely absolve the U.S. government from liability under the FTCA if it degrades or turns off the SPS signal in a time of national emergency.

In the hypothetical air ambulance crash, what if the helicopter was using FAA-approved dGPS equipment, but there was evidence that a nearby radio tower may have interfered with reception of the signal? A claim may exist, but compared to the broad extent to which the government has been held liable for air traffic controllers failing to warn of wake turbulence or provide adequate ground control, the integrity of the GPS signal may be a more narrow nexus on which to establish causation of a crash.¹⁰⁴

2. *Suits in Admiralty Act*¹⁰⁵

The Suits in Admiralty Act also waives the sovereign immunity of the United States for injuries caused on the high seas or navigable waters of the United States.¹⁰⁶ In order to bring a suit "in admiralty" a plaintiff must show admiralty jurisdiction. The current *Sisson* test requires that the accident (1) arose on the high seas or navigable waters of the United States; (2) posed a potential threat to maritime commerce; and (3) was substantially related to traditional maritime activity.¹⁰⁷ With few exceptions,¹⁰⁸ *Sisson* limits the applicability of the statute to ships or other wa-

¹⁰² *Id.*

¹⁰³ 28 U.S.C. § 2680(j) (1988).

¹⁰⁴ See generally Seti K. Hamalian, *Liability of the United States Government in Cases of Air Traffic Controller Negligence*, 11 ANNALS AIR & SPACE L. 55 (1986) (detailing the expansion of liability of the U.S. government under the FTCA for various aspects of air traffic control).

¹⁰⁵ 46 U.S.C. app. §§ 741-752 (1988).

¹⁰⁶ See *McCormick v. United States*, 680 F.2d 345 (5th Cir. 1982).

¹⁰⁷ *Sisson v. Ruby*, 497 U.S. 358 (1990).

¹⁰⁸ See *Executive Jet Aviation, Inc. v. Cleveland*, 409 U.S. 249, 268 (1972) (holding that the in-water crash of an airplane on takeoff did not create admiralty jurisdiction because there was no "significant relationship to traditional maritime activity"). However, in dicta the Court noted: "[O]f course, under the Death on the High Seas Act, a wrongful-death action arising out of an airplane crash on the high seas beyond a marine league from the shore of a state may clearly be brought in a federal admiralty court." *Id.* at 271 n.20.

tercraft and some overwater flights.¹⁰⁹ Further, although the Suits in Admiralty Act does not contain the statutory discretionary exceptions contained in FTCA, courts have construed similar constraints:

By overwhelming authority, there is no liability on the part of the United States for failure to embark upon regulatory activity, and a discretionary function exception applies to suits [in admiralty]. Once the government takes an action, such as marking a reef or placing a navigation aid, however, it must act reasonably with respect to those who are likely to rely upon it.¹¹⁰

Nevertheless, just as the government has faced suits for a wide range of issues dealing with air traffic control, it has faced a similar array with respect to maritime aids to navigation. For example, in *Indian Towing Co. v. United States*¹¹¹ the Supreme Court held that the government would be liable for an accident caused by the Coast Guard's negligence in allowing a lighthouse light to go out and in failing to provide warning that it was not functioning. In *Universe Tankships, Inc. v. United States*,¹¹² the court held the government solely liable for the grounding of a vessel because a buoy in the river was out of position.¹¹³ This was despite evidence that the ship attempted to navigate in a blinding snowstorm¹¹⁴ and the Coast Guard's stated policy that buoy positions are approximate and should not be used as the sole means of fixing a position.

These types of cases have led to stringent procedures within the Coast Guard for placing and maintaining buoys and other aids to navigation—and certainly must color the Coast Guard's desire to provide an added level of integrity to the GPS system through their dGPS beacons.

¹⁰⁹ See, e.g., *Miller v. United States*, 725 F.2d 1311, 1315 (11th Cir. 1984), cert. denied, 469 U.S. 821 (1984) (holding the crash of a small private jet en route between the Bahamas and the United States to fall within admiralty jurisdiction because this trip "has traditionally been accomplished by ship"); *McPherson v. Union Oil Co.*, 628 F. Supp. 265, 268 (S.D. Tex. 1985) (holding the crash of a helicopter carrying crew out to an oil rig in the Gulf of Mexico fell within admiralty jurisdiction).

¹¹⁰ THOMAS J. SCHOENBAUM, *ADMIRALTY & MARITIME LAW* § 19-1, at 598 (1987).

¹¹¹ 350 U.S. 61, 69 (1955); see also *Drake Towing Co. v. Meisner Marine Constr. Co.*, 765 F.2d 1060, 1066 (11th Cir. 1985) (holding the U.S. government liable where the Coast Guard negligently failed to ascertain that a channel where construction had occurred was safe before marking the channel with buoys).

¹¹² 336 F. Supp. 282 (E.D. Penn. 1972), *aff'd*, 506 F.2d 1053 (3d Cir. 1974).

¹¹³ *Id.* at 296.

¹¹⁴ *Id.* at 291-92.

3. *Foreign Claims Act*¹¹⁵ & *Military Claims Act*¹¹⁶

These two statutes do not waive sovereign immunity per se, but rather provide an administrative means for individuals to file claims for damages caused by United States armed forces. The Foreign Claims Act allows agencies to settle claims by inhabitants of foreign countries for non-combat damages caused by members or civilian employees of the U.S. armed services, whether or not they are acting within the scope of their official capacity.¹¹⁷ While the United States has been very liberal in paying claims, the government has no legal obligation to do so.¹¹⁸ The Military Claims Act provides similar relief for those U.S. citizens and others that do not fall under the Foreign Claims Act; however, agencies have typically required that the military member causing the injury: (1) was acting in an official capacity, (2) acted negligently, and (3) that the act was not a discretionary function.¹¹⁹

B. LIABILITY OF THE UNITED STATES UNDER INTERNATIONAL LAW

Under existing multilateral treaties, there is no direct mechanism by which a nation or party could hold the United States liable for damage caused by an incorrect signal.

The 1967 Outer Space Treaty¹²⁰ Articles VI & VII generally provide that nations are liable for damage caused by objects placed in space by that government or from non-governmental agencies.¹²¹ While applicability of Article VII seems focused on

¹¹⁵ 10 U.S.C. § 2734 (1994).

¹¹⁶ *Id.* § 2733.

¹¹⁷ See Spradling, *supra* note 98, at 96 (detailing filing procedures under the Foreign Claims Act).

¹¹⁸ *Id.*

¹¹⁹ *Id.* at 97 (providing details of claims under the Military Claims Act).

¹²⁰ Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies, Oct. 10, 1967, 18 U.S.T. 2410 (1967).

¹²¹ Article VI provides:

State Parties to the Treaty shall bear international responsibility for national activities in outer space . . . whether such activities are carried on by governmental agencies or by non-governmental entities . . . responsibility for compliance with this Treaty shall be borne both by the international organization and by the Stated Parties to the Treaty participating in such organization.

Id. at 2415. Article VII directly addresses liability during space launch:

Each State Party to the Treaty that launches or procures the launching of an object into outer space . . . is internationally liable for

risk of direct physical damage resulting from launch of a spacecraft, Article VI lays important groundwork for binding a future international corporation like Inmarsat or Intelsat to meet the responsibilities of the Treaty. The 1972 Convention on International Liability for Damage Caused by Space Objects (Liability Convention)¹²² more specifically sets out liability for those who place objects in space. The Liability Convention is accordingly a much more likely avenue for international claims.

This Convention provides: "A launching State shall be absolutely liable to pay compensation for damage caused by its space object on the surface of the Earth or to aircraft in flight."¹²³ Interestingly, the launching state, which is otherwise absolutely liable, is exonerated to the extent it can show that the damage was caused by the gross negligence of the claimant, or its natural or juridical persons.¹²⁴

While essentially establishing strict liability for the launching state, neither the convention language, deliberations on the treaty, or commentators indicate that this convention was meant to cover anything other than direct physical damage at the earth's surface caused by a malfunctioning launch vehicle or a space vehicle/satellite that did not burn up on reentry. The only claims made to date under the Liability Convention were for damages resulting from the 1978 breakup of COSMOS, which spread radioactive debris over a large area of Northern Canada.¹²⁵ Congressional documents indicate that the United States interpreted the Liability Convention to not include "indirect damages" or electronic interference.¹²⁶ Similarly, Bruce Hurwitz, in his book covering the Liability Convention, doubts whether it would apply to economic damages caused by direct broadcast satellites or use of remote sensing to exploit another country's natural resources.¹²⁷

damage to another State Party to the Treaty or its natural or juridical persons by such object or its component parts on the Earth, in air space or in outer space

Id. at 2415.

¹²² Liability Convention, *supra* note 87.

¹²³ *Id.* at art. II, 24 U.S.T. 2392.

¹²⁴ *Id.* at art. VI.1, 24 U.S.T. 2394.

¹²⁵ BRUCE A. HURWITZ, STATE LIABILITY FOR OUTER SPACE ACTIVITIES IN ACCORDANCE WITH THE 1972 CONVENTION ON INTERNATIONAL LIABILITY FOR DAMAGE CAUSED BY SPACE OBJECTS 3-4 (1992).

¹²⁶ Spradling, *supra* note 98, at 97.

¹²⁷ HURWITZ, *supra* note 125, at 18-19.

Kevin Spradling, addressing the issue of economic damages, states:

The U.S. would probably refuse to recognize the validity of a claim filed against it for damages arising indirectly from incorrect GPS data. This would be consistent with the conclusion reached by Professor Gorove and comport with the U.S. view that indirect damages were deliberately left out of the recovery scheme, and are consequently not covered in any way by the convention.¹²⁸

Other experts argue that if a plaintiff could show causation, they could sustain a claim under this Convention.¹²⁹ Regardless, one of the key limitations is that claims must be made by State Parties, thus an individual would have to file with his country and await the diplomatic process for resolution.¹³⁰

Although this Part has shown the narrow scope of liability risk that the United States currently faces because of its operation of GPS, it does highlight the need for U.S. agencies to ensure that if they authorize certain uses of GPS they can guarantee the integrity of the system through augmentation. Kevin Spradling, in his comprehensive review of U.S. government liability for GPS, points out some of the liability risk under the current unaugmented GPS. He notes that "the U.S. has a duty to warn civil users of problems with the system that can have an adverse impact on them" and warns of the "current inability to detect and report in real time certain anomalies for 15 to 20 minutes."¹³¹ The United States is also likely to be liable for accidents caused by omissions or negligent acts by government employees in maintaining the integrity and accuracy of the GPS system, such as allowing the SA to degrade accuracy beyond tolerances without adequate warning or the negligent entry of false information into the system.¹³²

To date, the U.S. government has been miserly in allowing civil users to rely on GPS, limiting its use solely to a secondary system for aviation and to open ocean navigation in maritime

¹²⁸ Spradling, *supra* note 98, at 98 (citing Stephen Gorove, *Some Comments on the Convention on International Liability for Damage Caused by Space Objects*, PROCEEDINGS OF THE SIXTEENTH COLLOQUIUM ON THE LAW OF OUTER SPACE 254 (1973)).

¹²⁹ See Paul B. Larsen, *Legal Liability for Global Navigation Satellite Systems*, PROCEEDINGS OF THE THIRTY-SIXTH COLLOQUIUM ON THE LAW OF OUTER SPACE 69, 70 (1993) (concurring with Professor Bin Cheng who reaches a similar conclusion about liability under the Convention).

¹³⁰ Spradling, *supra* note 98, at 98.

¹³¹ *Id.* at 100.

¹³² *Id.*

applications. This, in large part, may reflect the hesitancy of agencies to have air and marine carriers rely on the GPS system until integrity and accuracy can be assured—even though the basic unaugmented GPS signal is arguably a better navigation tool for many purposes than any of the “approved” navigation systems. If, in fact, government agencies hesitate because of doubts about the GPS signal, what about a foreign government? The next Part addresses the roadblocks and issues in moving from a national navigation system to an international one, such as foreign governments’ doubts and unwillingness to subject themselves to liability for something they cannot control.

IV. BUILDING THE LEGAL ARCHITECTURE FOR A WORLDWIDE GLOBAL NAVIGATION SATELLITE SYSTEM (GNSS)

Advocates of an expanded international GNSS based on GPS tend to fall into two categories: those who see the short term safety and cost benefits available today with existing technology;¹³³ and those who want those same benefits, but fear that a headlong rush to implement a system without the necessary domestic structure and international conventions in place may be detrimental. For example, John Beukers points out that other nations may have viewed oral assurances by U.S. government officials with some skepticism absent formal agreements, especially in light of the United State’s past track record.¹³⁴ He

¹³³ See Landry, *supra* note 11 (referring to foreign concerns about United States military control of GPS as “overblown” and pointing out that the Commander in Chief of the U.S. military is a civilian, the President). The Joint DOD/DOT Task Force in recommended formation of joint executive board control:

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.

JOINT DOD/DOT TASK FORCE REPORT, *supra* note 3, at 13.

¹³⁴ *Aviation Subcommittee Hearings*, *supra* note 38, at 99 (statement of John M. Beukers); The FAA subsequently provided written assurances to ICAO. Hinson Letter to ICAO, *supra* note 25. In addition, the President has gone on record in support of providing GPS for civil aviation use. Clinton Letter to ICAO, *supra* note 28. The binding effect of these written and oral statements on the United States is discussed in subsection III.B.1.

points out that it was the United States that pushed ICAO to adopt the Microwave Landing System (MLS) but that even before implementation of MLS, the United States abandoned it in favor of GPS-based systems.¹³⁵ Likewise, the FAA supported LORAN-C for general aviation use and non-precision approaches, but now with more than 120,000 aircraft using Loran-C, the FAA is apparently abandoning this system in favor of GPS.¹³⁶

Though the 1993 Joint DOD/DOT Task Force recommended only a first substantive step—Joint military/civil control. The task force also considered what may be viable long-range alternatives, particularly establishment of a private sector organization, like Comsat, or an international body, such as Intelsat, to maintain a Global Navigation Satellite System (GNSS) for international civil use.¹³⁷ This Part examines how previous U.S. radionavigation systems and satellite communication systems gained international acceptance, and then provides recommendations about specific legal aspects of a future GNSS.

A. INTERNATIONAL ACCEPTANCE OF PREVIOUS RADIONAVIGATION SYSTEMS

Omega and Loran-C are two land-based radionavigation systems, that, while providing lesser accuracy and thus lesser utility than GPS, are exemplary of the process for international acceptance. Omega, a worldwide radionavigation system with considerably less accuracy (four nautical miles)¹³⁸ than GPS, but also developed by the DOD (the Navy), took twelve years to move from a purely military system to a civilian (U.S. Coast Guard controlled) system for civil users worldwide.¹³⁹ This process involved numerous bilateral and regional agreements, with the

¹³⁵ *Id.* See also Philip J. Klass, *FAA Cancels MLS in Favor of GPS*, AVIATION WK. & SPACE TECH., June 13, 1994, at 33 (describing the impact of this cancellation on Canada's and Great Britain's plans to install MLS at airports).

¹³⁶ *Aviation Subcommittee Hearings*, *supra* note 38, at 100 (statement of John M. Beukers).

¹³⁷ JOINT DOD/DOT TASK FORCE REPORT, *supra* note 3, at 18-19.

¹³⁸ U.S. COAST GUARD, OMEGA FACTS & FIGURES (1994).

¹³⁹ Beukers, *Global Radionavigation*, *supra* note 58, at 107. The United States has signed bilateral agreements or memoranda of understanding concerning use or establishment of Omega systems with Argentina, Australia, Canada, Chile, Egypt, France, Federal Republic of Germany, Japan, Liberia, New Zealand, Norway, and South Africa. 2 IGOR I. KAVASS, A GUIDE TO THE UNITED STATES TREATIES IN FORCE 391-93 (ed. 1994).

U.S. government retaining complete control.¹⁴⁰ Loran-C, though lacking worldwide coverage, provides improved accuracy (up to 500 yard accuracy depending on proximity of Loran-C stations).¹⁴¹ Its evolution from a military to international system has a thirty year history (1964-1994) of bilateral and regional international agreements, and only in the last few years has the U.S. Coast Guard turned over physical control of certain Loran-C stations overseas to other nations.¹⁴² In comparing GPS to these systems, John Beukers points out that “[t]echnological advance and operational requirements [will] more than likely take [a] back seat” to issues of funding.¹⁴³ He notes that these agreements obligated other nations to little or no cost, which was a significant factor in their acceptance of the systems. Both Omega and Loran-C were operational long before they became fully accepted by the air and maritime communities.

International acceptance of GPS in many ways appears to be following a three phase path similar to that followed by these previous systems:

- Phase One: development for military use;
- Phase Two: turnover to civil control and growing bilateral/multilateral agreements with other nations; and
- Phase Three: international agreements and, in the case of Loran-C, joint control.

According to this model, GPS is leaving phase one and moving into phase two—with joint military/civilian control and implementation of limited civil use. After the United States implements its own national augmentation plan (perhaps with bilateral agreements with Mexico and Canada, who will likely be able to take advantage of some of the augmentation provided by the FAA’s Wide Area Augmentation System (WAAS)), one could envision a series of bilateral or regional agreements for countries or regions such as the EEC to set up their own augmentation systems.

While this approach may lead in the short term to a more rapid integration of GPS technology into the U.S. transportation sector and other civil uses, it essentially would require continued funding and control of the GPS satellite constellation by the United States and leave foreign nations with virtually no control

¹⁴⁰ Beukers, *Global Radionavigation*, *supra* note 58, at 107.

¹⁴¹ U.S. COAST GUARD, *supra* note 138.

¹⁴² Beukers, *Global Radionavigation*, *supra* note 58, at 107.

¹⁴³ *Id.*

over critical aspects of navigation in their airspace and waters. In addition, recent action by the ICAO, the European Union transport ministers, and foreign transportation experts indicates that this option may be unacceptable for other countries.¹⁴⁴ Perhaps the model of Intelsat or other international treaties may provide a better guide for developing a truly global navigation satellite system.

B. CREATING A GLOBAL NAVIGATION SATELLITE SYSTEM

1. *The Hinson Letter: A First Step Toward Creating a GNSS*

In October 1994 David Hinson, director of the FAA, sent a letter to the president of the ICAO reiterating an oral offer by the United States to provide the GPS SPS signal to the world community at no charge for ten years.¹⁴⁵ This was followed several months later by a letter from President Clinton lending support in broad terms: "The United States looks forward to the growing use of GPS and to its incorporation in an integrated global navigation satellite system. The United States remains committed to provide GPS signals to the international civil aviation community and to other peaceful users of radio navigation and positioning systems."¹⁴⁶ By using letters in lieu of a formal agreement,¹⁴⁷ the FAA and the administration may be walking a fine line between demonstrating a firm commitment by the

¹⁴⁴ See ICAO Panel's *Precision Guidance Draft Mirrors Europe's Pro-ILS Position*, AVIATION EUR., Oct. 20, 1994, at 2 (supporting continued use of ILS/MLS systems until an international GNSS system is developed instead of reliance on a U.S. GPS-based system); *Transport Ministers Back European GNSS But Will Stay in Step With ICAO*, AVIATION EUR., Nov. 17, 1994, at 2 (discussing plans for a European Navigation Satellite System taking into account ICAO concerns to avoid creating a duplicative system). Walter Blanchard, president of the U.K. Royal Institute of Navigation stated: "Today, countries control and accept liability for the radio navigation systems that aircraft use in their airspace . . . which nation would assume financial responsibility if an aircraft accident occurred in a country that had no control over a stand-alone satellite navigation system and the satellite performance were implicated." Nordwall, *supra* note 12, at 57 (paraphrasing statements made by Walter Blanchard).

¹⁴⁵ Hinson Letter to ICAO, *supra* note 27.

¹⁴⁶ Clinton Letter to ICAO, *supra* note 28.

¹⁴⁷ Hinson's letter stated:

I would be grateful if you could confirm that the International Civil Aviation Organization is satisfied with the foregoing, which I submit *in lieu of an agreement*. In that event this letter and your reply will comprise mutual understandings regarding the Global Positioning System between the Government of the United States of America and the International Civil Aviation Organization.

United States and executing a formal executive agreement that might have domestic political consequences. Unfortunately, the question regarding whether these documents represent a unilateral policy statement or an international agreement seems to rest on whether or not the parties intend it to be legally binding or not.¹⁴⁸

Under international law, four factors are generally considered when deciding whether an international agreement is binding:

- (1) the parties intend the agreement to be legally binding and the agreement is subject to international law;
- (2) the agreement deals with significant matters;
- (3) the agreement clearly and specifically describes the legal obligations of the parties;
- (4) the form indicates an intention to conclude a treaty, although the substance of the agreement rather than the form is the governing factor.¹⁴⁹

Facially, the exchange of letters seems to fail on these factors. While clearly dealing with significant matters, it does not describe legal obligations in detail. In form the letters are clearly not a "treaty" and most important, if intended to be legally binding, proper United States procedures for entering executive agreements would have to be followed. This would involve following the procedures for review by the State Department and the Case-Zablocki Act as set forth in State Department Circular 175.¹⁵⁰ Further, where, as in the case of GPS, the agreement obligates funds outside the agency entering into the agreement,

Hinson Letter to ICAO, *supra* note 27 (emphasis added). The ICAO in December of 1994 accepted this offer. Letter from Philippe Rochat, Secretary General International Civil Aviation Organization, to the ICAO (Dec. 13, 1994).

¹⁴⁸ *Treaties and Other International Agreements: The Role of the United States Senate, A Study Prepared for the Comm. on Foreign Relations, United States Senate* xvi, 103d Cong., 1st Sess. (Nov. 1993) [hereinafter *Senate Study*]. The study points out that:

International law makes no distinction between treaties and executive agreements. Executive agreements, especially if significant enough to be reported to Congress under the Case-Zablocki Act, are to all intents and purposes binding treaties under international law. On the other hand many international undertakings and foreign policy statements, such as unilateral statements of intent . . . are not intended to be legally binding and are not considered treaties.

Id. at xvi.

¹⁴⁹ *Id.* at xv-xvi.

¹⁵⁰ See *Department of State Circular 175 Procedures on Treaties, in Senate Study, supra* note 148, app. 4 at 301-17 (setting forth the procedures for entering into treaties and executive agreements).

consultation with the Office of Management and Budget is required.¹⁵¹

The only counterargument would be that this action is a minor agreement pursuant to the duties of the United States as a member of the International Civil Aviation Organization under the Chicago Convention. However, though Congress has provided that “[t]he Secretary of Transportation is empowered and directed to encourage and foster the development of civil aeronautics and air commerce in the United States and abroad”¹⁵² and to “acquire, establish, and improve air-navigation facilities wherever necessary,”¹⁵³ this delegation does not circumvent established procedures for entering into binding executive agreements. This exchange of letters would likely be characterized as a non-binding international agreement. A recent study by the Congressional Research Service prepared for the U.S. Senate Foreign Relations Committee states that these non-binding agreements,

[s]ometimes called political agreements . . . are not considered treaties under international law. They are not enforceable in courts, and rules concerning compliance, modification, and withdrawal from treaties do not apply. Nevertheless, these agreements may be considered morally and politically binding by the parties, and the President may be making a type of national commitment when he enters one. Moreover, *such agreements are occasionally later converted into legally binding executive agreements.*¹⁵⁴

Thus, even though with regard to United States law this exchange is probably not legally binding, it represents a sound policy decision appropriate at this stage and can be followed with a formal agreement when the parameters of GNSS are more fully developed.

While under U.S. law this exchange appears non-binding, under international law through unilateral acts “[a] state may bind itself by other clear one-sided statements to a certain be-

¹⁵¹ State Department regulations provide:

If a proposed agreement embodies a commitment to furnish funds, good, or services that are beyond or in addition to those authorized in an approved budget, the agency proposing the agreement shall state what arrangements have been planned or carried out concerning consultation with the Office of Management and Budget for such commitment.

22 CFR § 181.4(e) (1995).

¹⁵² 49 U.S.C. app. § 1346 (1988).

¹⁵³ *Id.* app. § 1348(b)(1).

¹⁵⁴ *Senate Study, supra* note 148, at xxxvii-xxxviii (emphasis added).

havior."¹⁵⁵ For example, the International Court of Justice held that statements made by France that it would cease nuclear testing in the Pacific had legally binding consequences.¹⁵⁶ However, under the Vienna Convention on the Law of Treaties, Article 46:

A State may not invoke the fact that its consent to be bound by a treaty has been expressed in violation of a provision of its internal law regarding competence to conclude treaties as invalidating its consent unless that violation was manifest and concerned a rule of its internal law of *fundamental importance*.¹⁵⁷

This does not answer the question of whether the Hinson letter, though not following proper internal procedures for executive agreements, would be valid; rather it raises the question of what constitutes "fundamental importance."

The Hinson letter to ICAO thus represents, if not an enforceable international agreement, a strong commitment on the part of the United States to play a major role in developing a GNSS by providing the basic navigation signal necessary for such a system to function.

2. *Intelsat/Inmarsat: Would an International Organization Work for GNSS?*

There are many who recommend that an international organization be formed, like Intelsat or Inmarsat, to control GPS/GNSS.¹⁵⁸ While this may be the best long-term solution, neither Intelsat or Inmarsat originated from dedicated military applications and neither were developed overnight.

The Intelsat Agreement, which entered into force in 1973,¹⁵⁹ was the culmination of a decade of negotiations and multilateral agreements following the Communications Satellite Act of

¹⁵⁵ INGRID DETTER, *THE INTERNATIONAL LEGAL ORDER* 192 (1994).

¹⁵⁶ *Id.* at 193 (discussing *Nuclear Tests*, ICJ Reports 253 (1974)).

¹⁵⁷ Vienna Convention on the Law of Treaties, in *Senate Study*, *supra* note 147, app. 5, art. 8, at 331 [hereinafter Vienna Convention] (emphasis added). The United States has not ratified the Convention in part because of this provision. *See id.* at xxxiii-xxxiv.

¹⁵⁸ *See Nordwall*, *supra* note 12, at 57 (discussing proposals for an international organization); Montgomery, *supra* note 27, at 12 (discussing proposals for a future system modeled after Inmarsat). *Cf. Larsen*, *supra* note 56 (proposing that the United Nations Committee for the Peaceful Uses of Outer Space (UNCOPUOS) should establish guidance principles for development of GNSS).

¹⁵⁹ Agreement Relating to the International Telecommunications Satellite Organization, Aug. 20, 1971, 23 U.S.T. 3813 (entered into force Feb. 12, 1973) [hereinafter Intelsat Agreement].

1962.¹⁶⁰ The result of President Kennedy's 1961 offer of United States leadership in providing satellite communications to the world¹⁶¹ was an act creating COMSAT, a heavily regulated U.S. corporation. COMSAT provided a U.S. institution on which to model the international organization, and which largely controlled Intelsat until 1979.¹⁶² Inmarsat, an international agency modeled after Intelsat, was created at the behest of the International Maritime Organization to provide critical communication and search-and-rescue capabilities at sea.¹⁶³

Could such an organization be established for GNSS? As a preliminary matter, one would have to separate GPS control from control of a GNSS because U.S. security interests will almost certainly preclude the total relinquishment of control of the current GPS satellite constellation system to an international or private body. Not only is there a continuing need for U.S. forces to have a secure means of positioning, but these satellites probably have capabilities beyond those touted to the open press. A useful distinction can be drawn with civil, commercial satellite communication systems like Inmarsat, and Intelsat, which though probably derived from U.S. military satellite communications technology, never replaced military systems. The DOD retains its own secure military satellite communications capability.

While in theory a GNSS organization could procure and launch its own satellite system, up-front funding of such a venture is unlikely. However, if such an organization reached a formal agreement with the United States guaranteeing the GPS signal for ten years, as discussed in the previous section, it could move ahead with developing a global system. Such organization, with a structure similar to Intelsat might function as follows:

Basic Signal

The basic signal would be provided by United States controlled GPS until 2005 with gradual phase in of GNSS space components placed aboard dedicated navigation satellites or as payload aboard communication or other satellites.

¹⁶⁰ Communications Satellite Act of 1962, 47 U.S.C. § 701 (1988).

¹⁶¹ Bert W. Rein & Carl R. Frank, *The Legal Commitment of the United States to the INTELSAT System*, 14 N.C. J. INT'L L. & COMM. REG. 219, 219 (1989).

¹⁶² See Alexandra M. Field, *Moving Forward Into A New Century: INTELSAT at a Crossroads*, 25 LAW & POL'Y INT'L BUS. 1335 (1994) (providing an overview of the development of INTELSAT).

¹⁶³ See *id.* at 1343-44 (discussing the creation of Inmarsat).

Augmentation

Augmentation could be provided in the short term using dGPS transmitters aboard communication or other satellites similar to the WAAS system being deployed by the FAA. LADPGS for precision landing at airports would be operated and funded by the national aviation authorities, within each state, although the technical aspects of such systems would be standardized through ICAO.

Sources of Funding

While limited seed money may need to be provided by member nations, funding could be provided through various means.

(1) *Fee Sharing Arrangements with Communications Corporations.* Since air-traffic control/remote tracking and many other GNSS applications will require datalink communication of object position, typically using existing satellite communication links, the GNSS organization could offer to share fees with the lowest bidder among competing providers of satellite communications.

(2) *Licensing Fees.* Currently, in the United States the FCC requires operators of certain electronics, radar, radios (capable of transmission on certain frequencies), and other equipment to pay licensing fees, which essentially serve only to generate revenue. A percentage of such a license fee charged to the operator of either the receiver or the transmitter could be designated for the GNSS organization.

(3) *Joint Funding by Party States.* Party States could collect revenues from domestic users in any number of fashions. There is some precedence to this with earlier Air Navigation Services over the North Atlantic.¹⁶⁴

3. *An International Convention on GNSS Could Borrow from Past Conventions*

a. *Using Existing Expertise and Models from the United Nations*

The United Nations Committee for the Peaceful Uses of Outer Space (UNCOPUOS), which drafted not only the 1967 Outer Space Convention, but more recently a resolution providing guidance for remote sensing satellites, could provide the

¹⁶⁴ See Gerald F. Fitzgerald, Q.C., *ICAO and the Joint Financing of Certain Air Navigation Services*, 11 ANNALS AIR & SPACE L. 17 (1986) (the second part to this Article was published in 12 ANNALS AIR & SPACE L. 33 (1987)). Fitzgerald notes that in 1986 ICAO and its predecessor had participated in joint financing, installation, and maintenance of air navigation services in the North Atlantic for 40 years under the Convention on International Civil Aviation, Dec. 7, 1944, 15 U.N.T.S. 295.

broad consensus necessary for an international system.¹⁶⁵ Professor Larsen, in emphasizing the need for U.N. participation in creating a truly international GNSS, notes: "[N]one of the domestic [U.S.] institutions are competent to look at all GPS uses and all needs. Only one international institution has a mandate broad enough to encompass all GPS uses. That is the United Nations Committee for the Peaceful Uses of Outer Space."¹⁶⁶ Professor Larsen applies the broad guidance provided by UNCOPUOS in the context of remote sensing to the establishment of a GPS based GNSS. Some of the key principles set out by Professor Larsen are: ensuring availability of positioning data on a nondiscriminatory basis at a reasonable cost, resolution of disputes through established procedures, and international responsibility for the positioning of satellites.¹⁶⁷ A resolution by the U.N. providing general guidance facilitate creation of a truly global international system by laying the foundation upon which an international organization or corporation can be constructed.

¹⁶⁵ See Larsen, *supra* note 56 (discussing the role of UNCOPUOS).

¹⁶⁶ *Id.*

¹⁶⁷ The fifteen guidance principles forwarded by Professor Larsen are:

1. The extent to which the operator of positioning satellites should be permitted to process data received by the positioning system.
2. Access to positioning satellite systems.
3. Application of international law to positioning satellite systems.
4. Prohibition on discrimination regarding availability of information based on a country's stage of economic or scientific development.
5. International cooperation.
6. Adequate storage of information for later use.
7. Technical assistance to other interested States on mutually agreed terms.
8. Technical assistance by the relevant specialized institutions, such as ICAO and IMO.
9. Distribution of information regarding unusual events involving positioning satellites.
10. Protection of the earth's environment.
11. Warning of approaching disasters.
12. Availability of positioning information on a non-discriminatory basis and on reasonable cost terms.
13. Consultations upon request.
14. International responsibility for the activities of positioning satellites.
15. Resolution of disputes through established procedures for the peaceful settlement of disputes.

Id.

b. Dealing with Liability Issues for GNSS

As discussed in Part II, liability of the United States or a private entity operating the GNSS system can be reduced as a concern once accuracy and integrity concerns are met through use of augmentation. But without a convention dealing with liability, many nations' sovereign immunity laws would bar tort actions for negligence by government employees.¹⁶⁸ In the United States, plaintiffs may be barred from claims against other governments by the Foreign Sovereign Immunities Act of 1976 (FSIA),¹⁶⁹ which generally bars suits against other sovereign nations unless the claim falls within a prescribed exception.¹⁷⁰ This Act largely reflects the international law doctrine of restrictive immunity of sovereigns for public acts.¹⁷¹ Any international agreement reached will face a host of practical issues such as:

1. *Waiver of sovereign immunity.* For example the Convention on International Liability for Damage Caused by Space Objects (Liability Convention) provides recovery primarily through diplomatic channels. Thus a foreign plaintiff's ability to recover from another nation is de facto limited by national policy considerations and the inevitable bureaucratic delay.¹⁷²
2. *Jurisdictional issues for private party defendants.* For example, should Hughes, the builder of a GPS satellite, or Magellan, the builder of a particular GPS receiver, be subject to suit in a foreign nation? Certainly it would be foreseeable that the service would be used worldwide.

¹⁶⁸ Hamalian, *supra* note 104, at 55.

¹⁶⁹ 28 U.S.C. § 1330 (1988).

¹⁷⁰ The five exceptions are:

1. Where the sovereign has waived immunity, as the United States has under the FTCA and Suits in Admiralty Act.
2. The action is result of commercial activity in the United States or has a direct effect in the United States.
3. Claims concerning property taken in violation of international law.
4. Claims concerning immovable property located in the United States, or
5. Certain tort claims.

SCHOENBAUM, *supra* note 110, § 19-3 at 601.

¹⁷¹ See Charles N. Brower et al., *The Foreign Sovereign Immunities Act of 1976 in Practice*, 73 AM. J. INT'L L. 200 (1979) (discussing the FSIA and detailing the doctrine of restrictive immunity).

¹⁷² Article XI does not prevent an individual of one country from pursuing a claim in another State's courts. Thus a foreign citizen would likely be able to bring a claim against the United States under the FTCA or Suits in Admiralty Act. Liability Convention, *supra* note 87, at 2397.

3. *Strict liability or negligence.* The Liability Convention imposes absolute liability for damage caused by space objects. However, where there is a GPS signal degradation, for example, should strict liability be imposed, or should a negligence standard be adopted? What if a problem with the GPS signal was only a contributing factor?

4. *Alternative dispute resolution—liability of international organizations.* If an international organization is formed, its liability and contribution by signatory States will have to be addressed and will likely be patterned after those provisions in the Liability Convention and Intelsat Treaty providing for dispute resolution through arbitration or other mechanisms.¹⁷³

As a future GNSS takes shape, liability concerns will need to be addressed to provide assurances to States about the scope of their potential liability. Addressing these concerns will also encourage GPS-related technological advances because the parties working on such advances will not be faced with chilling liability concerns. Nonetheless, any legal system that is developed must provide an adequate means for injured parties to claim redress.

c. **Setting International Technical Standards For GPS/dGPS Receivers and Related Avionics/Electronics**

Both the Coast Guard and the FAA have considerable experience working through international bodies to develop standards for electronic equipment and avionics. In fact, ICAO has begun to work seriously with technical GPS issues, establishing standards on flight navigation, communication, surveillance, and traffic management for providers and users of positioning satellites. The International Maritime Organization (IMO) has begun a similar process for ship navigation.¹⁷⁴ International and national industry standards organizations such as the International Society of Electrical Engineers (ISEE) or in the United States the RTCA should be involved in creating standards for safety and interoperability. International as opposed to unilateral standards are crucial, both in terms of capitalizing on efficiency and preventing redundant equipment, as well as ensuring safety. Even the highly accurate signal provided through dGPS is of little use if the electronic devices for which it provides an input do not provide accurate, usable information to the airplane pilot or ship captain.

¹⁷³ Intelsat Agreement, *supra* note 159, at art. XVIII(c) (providing for arbitration of disputes).

¹⁷⁴ Larsen, *supra* note 56.

4. *The Peaceful Use of GNSS*

The security issues surrounding use of the United States' GPS system, as well as development of a GNSS based on U.S. military technology, raise a number of issues for the United States as well as other nations.

Military control of GPS worries foreign nations who are understandably reluctant to rely on a signal that the U.S. government could simply switch off or seriously degrade during a time of U.S. military emergency.¹⁷⁵ Senator Exon believes this is a red herring, stating:

It is increasingly clear that the selective availability feature built into the GPS satellites has been rendered all but meaningless by the march of technology—much of it sponsored and used by other departments and agencies of the U.S. Government. Various differential correction schemes will provide universal access to extremely precise navigation services within at most a few years. It is unrealistic to imagine that the Department of Defense would ever turn off or seriously degrade the GPS signal available to the public in any but the most grave and dire circumstances because of the large number of innocent lives that will be depending on GPS at any given moment the world over.¹⁷⁶

Senator Exon raises the point addressed at the 1994 Space Law Symposium: Why would the DOD intentionally degrade the signal but then allow other U.S. agencies to, in effect, negate this degradation at further taxpayer expense?¹⁷⁷ Joseph Canny, Deputy Assistant Secretary of Transportation, generally stated that DOD representatives were assured that they could meet security needs.¹⁷⁸ This implies that the military GPS satellites may have some "bells and whistles" that have not reached the open press.¹⁷⁹ However, the means by which the DOD could deny the signal to a particular area or user without degrading other users is unclear.

¹⁷⁵ See *Transportation, Defense Depts. Reach Accord on GPS Use*, AVIATION WK. & SPACE TECH., Jan. 3, 1994, at 32 (noting that prior to the January 1994 agreement there was a "growing unease about worldwide aircraft navigation relying on a system whose accuracy was controlled solely by the U.S. military.").

¹⁷⁶ Exon, *supra* note 54, at 46.

¹⁷⁷ *Space Law Symposium 1994*, *supra* note 6 (the questions were posed to Joseph F. Canny, Deputy Assistant Secretary of Transportation, who spoke on GPS issues).

¹⁷⁸ *Id.* (There was no recording or transcript of this question and answer as Mr. Canny spoke at the symposium luncheon).

¹⁷⁹ This is a hypothesis only.

In order to create a GNSS in the near future, reliance on the United States' GPS will be essential. Even if the U.S. military retains its own separate and secure GPS system (as was done in the conversion of the worldwide satellite communications system), security concerns remain in that GNSS could be used by other nations for warlike purposes. One method to deal with this problem would be to create a specific provision within the Convention detailing the peaceful use of the GNSS system. Specifically, this position would prohibit the use of GNSS for weapon guidance. Just as the U.S. military used Inmarsat and Intelsat systems for communications during Operation Desert Storm, it is unrealistic to restrict military aircraft and ships from using GNSS for navigation. However, a weapon guidance system exclusion, backed by sanctions, such as restrictions on use would deter those in the arms industry who are already producing or testing high-tech weaponry utilizing this system.¹⁸⁰ Further, countries could be threatened with restrictions on purchase of GNSS related equipment if they develop such weapon guidance systems. This would at least make difficult the development of a GNSS guided SCUD missile or similar weapons of mass destruction.

In summary, the technical and competing issues faced in the national implementation of civil use of GPS pale when considering how to turn this national system into an international GNSS. However, while the technology is new, the processes and historical precedent for creating an international organization, setting general guidance principles, and ironing out the details on liability and technical issues on related equipment are present.

V. CONCLUSION: OPENING THE DOOR TO THE FUTURE

From Edward Hale's imaginary Brick Moon to the reality of a constellation of GPS satellites capable of vastly improving the world's transportation infrastructure, GPS technology has arrived. Voices in Congress, in the executive agencies, and among

¹⁸⁰ See Covault, *supra* note 60, at 103 (discussing a Spanish company's development plans for a GPS guided missile); Brad Graham, *Missile Project Became a \$39 Billion Misfire*, WASH. POST, Apr. 3, 1995, at A1, A8 (discussing the failure of a United States designed missile also using GPS for guidance); William B. Scott, *Tests Show DGPS Imposes Bomb Accuracy*, AVIATION WK. & SPACE TECH., Aug. 21, 1995, at 69 (detailing tests of DGPS corrected bombs); *B-2 Drops First GPS-Aided Munition*, AVIATION WK. & SPACE TECH., July 31, 1995 (noting U.S.A.F. testing of GPS guided bombs).

the aviation community have recognized the scope of this revolution. Unfortunately, developing the technology may pale in comparison to the time and difficulty in integrating GPS into a global navigation system. Recent initiatives by the U.S. Coast Guard and FAA to establish augmentation systems and recent studies on a national architecture provide a step in the right direction. Further, existing treaties and the U.S. government's experience with both radionavigation systems and satellite communications may serve as the building blocks for the next step—the establishment of an international organization or corporation to oversee a GNSS that will save lives in the air and on the seas, as well as provide future, unknown benefits to humanity.

