MODERNIZATION OF THE GLOBAL POSITIONING SYSTEM[1]

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Abstract

More than two decades have now passed since the construction of the GPS operational control segment (OCS), including the Master Control Station (MCS) at Schreiver AFB, Colorado and worldwide monitoring stations, and launch of the first GPS satellites. During that time, several generations of satellites have been designed, built, and launched, and operations are routinely supported by the OCS.

Today, Global Positioning System (GPS) is entering into the new millennium with a far-reaching program to modernize the system on the ground and in space. This paper describes the goals, requirements, design objectives, and plans for implementing a $1 billion-plus modernization program in the coming decade.

INTRODUCTION

The Department of Defense (DoD) originally conceived the Global Positioning System (GPS) in the 1970s as a satellite-based navigation system for joint-service military applications. Beginning in 1980, federal radionavigation planning conducted jointly by the DoD and the Department of Transportation (DOT) forever transformed this system into a global utility for positioning, navigation, and timing (PNT).

In 1996, federal policy and planning for GPS and its augmentations were significantly strengthened with the release of the Presidential Decision Directive (NSTC-6) "U.S. Global Positioning System Policy." The PDD provides the strategic vision for the management and use of GPS, addressing a broad range of military, civil, commercial, and scientific interests, both national and international. Further, specific roles and responsibilities were assigned to the DoD, DOT, and the State Department. The PDD also established the DoD-DOT-chaired Interagency GPS Executive Board (IGEB) to manage the GPS and its U.S. Government augmentations.

[1]A version of this paper appeared in the September 2000 (Vol. 11, No. 9) edition of *GPS World Magazine* and this paper was previously presented at ION-GPS 2000, 13th International Technical Meeting of the Satellite Division of the Institute of Navigation, 19-22 September 2000.

The first meeting of the IGEB took place the following year. The major topic of discussion at that meeting was the need for additional civil GPS signals to improve services provided to a vast array of civil and commercial users. As a result, the IGEB a greed to identify a second civil frequency within a year. Combined with an effort already underway within the Air Force to incorporate both civil and military requirements into an updated GPS operational requirements document (ORD), these activities established the foundation of the current GPS modernization program.

MODERNIZATION GOALS

Civil Goals

The GPS Standard Positioning Service (SPS) refers to the signal-in-space provided free of direct user charges for peaceful civil, commercial, and scientific use on a continuous, worldwide basis. Today, only one fully accessible signal (the C/A-coded signal at L1) is available for civil applications through the SPS. Therefore, the principal objective of modernization from a civil perspective is to provide additional coded civil signals.

In 1998, Vice President Gore announced that a second civil signal would be broadcast at the 1227.6 MHz frequency, known as the GPS L2. Only a P (Y)-code, used by the U.S. military and other authorized users, is currently modulated on this frequency. (The Y-code refers to the encryption of the precise P-code to make it available only to authorized users.) The Vice President also stated that a third civil signal specifically designed for safety-of-life services would be broadcast beginning in 2005. Backed by the intense labors of interagency working groups formed under the auspices of the IGEB, the frequency of the third civil signal, now known as L5, was selected in January 1999. The L5 will be at 1176.45 MHz in a portion of the spectrum that is allocated for aeronautical radionavigation services (ARNS). The ARNS allocation is required for any signal used in support of any aviation safety-of-life application. The resulting changes to the GPS signal structure are illustrated in Figure 1.

For stand-alone (non-differential) real-time users of GPS, the addition of a second and third civil GPS signal will: provide signal redundancy, improve positioning accuracy, improve signal availability and integrity (timely notice of an "unhealthy" signal), improve continuity of service, and improve resistance to radio frequency (RF) interference.

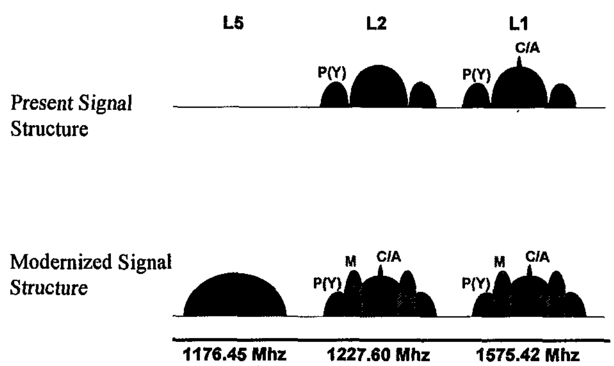

Figure 1
Current and Modernized Signal Structures

The two new additional coded civil signals (the C/A-code on the L2 frequency and the new signal at L5) will also assist high-precision (often called real-time kinematic) short- and long-baseline differential applications – such as aircraft precision approach and landing, mapping, surveying, precision farming, machine control, and earth science studies – by calibrating the spatially uncorrelated components of the ionosphere seen across the baseline and by speeding up ambiguity resolution to get accuracies of a decimeter or better.

Miltary Goals

In addition to providing an SPS, the 1996 GPS PDD and subsequent legislation [2] also committed the U.S. government and the DoD to providing a Precise Positioning Service (PPS) for U.S. military and other authorized users. Further, the policy also called for the development of measures to prevent the hostile use of GPS and its augmentations, thus ensuring that the United States and its allies retain a military advantage without unduly disrupting or degrading legitimate, peaceful civil GPS uses.

This has been translated into what is often referred to as the 3 P's:

- Protection of military service in a theater of operation
- Prevention of adversarial exploitation of GPS services
- Preservation of civil service outside a theater of operations.

To successfully accomplish the 3 P's, the military must have the ability to selectively and locally deny GPS signals which could be potentially misused, while ensuring that authorized PPS users can continue military operations. Spectral separation of civil signals from military signals represents a key component of this capability. As a result, defense-oriented GPS modernization focuses on providing new military codes, referred to collectively as M-code, that will "reuse" portions of the radio spectrum already assigned to the L1 and L2 frequencies while remaining spectrally distinguishable from the L1 and L2 C/A-codes (see Figure 1).

The new military signal and code structure will also have improved cryptographic protection and changes in the broadcast data message. Based on validated military requirements for higher signal power, future GPS satellites will also be designed to broadcast the new M-code signals on a regional basis, when necessary, at 20 dB greater power (-138 dBW) than the existing P (Y)-code. These improvements will provide the U.S. military and its allies with both increased anti-jam capability and enhanced signal security for military worldwide operations.

SIGNAL STRUCTURE

Implementation of a new signal structure represents the cornerstone of improved GPS services for both military and civil communities. For civil users, however, the first real step towards modernizing GPS took place earlier this year when President Clinton directed that the intentional degradation of the GPS Standard Positioning Service (SPS), known as Selective Availability (SA), be discontinued at midnight Eastern Daylight Time on 1 May 2000. Figure 2 below illustrates the impact of this "magic moment."

Since SA was discontinued, GPS users have routinely observed horizontal SPS accuracy values of less than 10 meters. However, more conservative accuracy estimates (based on the conditions and constraints described in Ref. [2]) would be 22 meters horizontal (95% of the time), 33 meters

[2]National Defense Authorization Act for Fiscal Year 1998, Public Law 105-85, sec. 2281, 18 November 1997

vertical (95%), and 200 nanoseconds (95%) relative to Coordinated Universal Time (UTC), the international standard for timekeeping. The corresponding GPS horizontal positioning error budget is shown in Table 1.

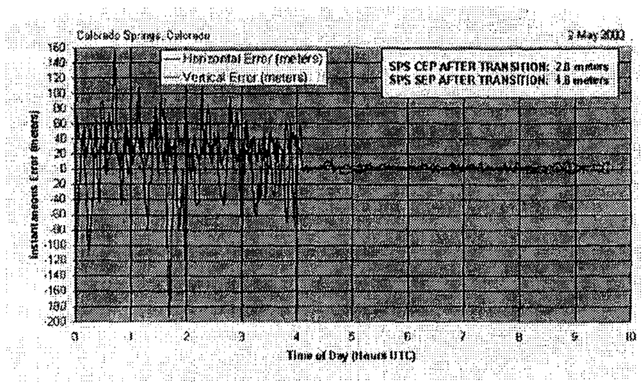

Figure 2
Performance with SA off

Table 1
GPS Error Budget with and without SA

Error Source	Typical Range Error Magnitude (meters, 1σ)	
	SPS with SA	SPS with SA set to zero
Selective Availability	24.0	0.0
Atmospheric Delay		
Ionospheric	7.0	7.0
Tropospheric	0.2	0.2
Clock and Ephemeris Error	2.3	2.3
Receiver Noise	0.6	0.6
Multipath	1.5	1.5
Total User Equivalent Range Error (UERE)	25.0	7.5
Typical Horizontal DOP (HDOP)	1.5	1.5
Total Stand-Alone Horizontal Accuracy, 95%	75.0	22.5

Without any additional equipment costs to users, discontinuing SA brings tangible benefits to millions of GPS users throughout the world in a wide range of applications. Some of these benefits are described below.

Car Navigation

Previously, GPS-based car navigation could give the location of the vehicle to within a hundred meters. This was a problem, for example in areas where multiple highways run in parallel, because the degraded signal made it difficult to determine which highway the car was on. Discontinuing SA will minimize such problems, leading to greater consumer confidence in the technology and higher adoption rates. It will also simplify the design of many systems (e.g., eliminating the need for certain map matching software), thereby lowering their retail cost.

Enhanced-911

The FCC will soon require that all new cellular phones be equipped with more accurate location determination technology to improve responses to emergency 911 calls. Removing

SA will boost the accuracy of GPS to such a degree that it could be come the method of choice for implementing the 911 requirements. A GPS-based solution might be simpler and more economical than alternative techniques such as radio tower triangulation, leading to lower consumer costs.

Hiking, Camping, and Hunting

GPS is already popular among outdoorsmen, but the degraded accuracy has not allowed them to precisely pinpoint their location or the location of items (such as game) left behind for later recovery. With 20-meter accuracy or better, hikers, campers, and hunters should be able to navigate their way through unmarked wilderness terrain with increased confidence and safety. Moreover, users will find that the accuracy of GPS exceeds the resolution of U.S. Geological Survey (USGS) topographical quad maps.

Boating and Fishing

Recreational boaters will enjoy safer, more accurate navigation around sandbars, rocks, and other obstacles. Fishermen will be able to more precisely locate their favorite spot on a lake or river. Lobster fishermen will be able to find and recover their traps more quickly and efficiently.

SPS SIGNAL SPECIFICATION

The GPS SPS Signal Specification is the definitive source regarding the expected performance levels of the civil GPS navigation service. While important to all civil users, these performance levels are particularly crucial in determining the system design for civil GPS augmentation systems that are required to meet the stringent performance criteria for safety-of-life use.

The current signal specification was published in 1995. Many of the performance parameters in that document – such as coverage, availability, and reliability – originated prior to the GPS constellation reaching initial operating capability in December 1993. Consequently, the SPS Signal Specification needs to be updated to reflect operational experience and observed performance over the last 6.5 years and to include the dramatic change in accuracy resulting from the discontinuation of SA. The DOT and DoD are working to revise the specification in a manner that reflects accurate yet consistently obtainable GPS service. The next version of (Edition 3) of Ref. [2] is expected to have been released by the end of 2000.

OVERCOMING THE ATMOSPHERE

With the elimination of SA, the next largest contributor to the GPS positioning error budget is the signal delay caused by the Earth's atmosphere (see Table 2). Since the military currently has full access to two signals and frequencies through the PPS, military users can correct the ionospheric error by forming a linear combination of L1 and L2 pseudorange measurements to mathematically estimate and remove almost all the ionospheric bias from the L1 measurements. To compensate for the ionospheric error in limited civilian applications, some receiver manufacturers have developed innovative techniques for using components of the encrypted Y-code signal to calculate the ionospheric effects. However, to function effectively, these so-called "semi-codeless" receivers require a signal-to-noise ratio (SNR) for the L2 signal that is considerably higher than the SNR required by a dual-frequency military PPS receiver.

As a result, although the higher SNR can be achieved in stationary positioning applications, many situations preclude effective use of these techniques. For example, when a receiver is in a moving vehicle or ionospheric scintillation is present, the receiver may lose its ability to track incoming signals and take several minutes to recover the signal needed for precise positioning. The same is true when the receiver must view satellites through foliage or in the presence of multipath signals. As a result, civilian access to additional coded signals will enable improved accuracy through ionospheric corrections for dynamic applications even in sub-optimal environments with RF interference and multipath (reflected GPS signals).

As shown in Table 2, the use of C/A-code on the L2 frequency in conjunction with L1 will reduce the typical ionospheric error of 7.0 meters to 0.01 meters (1 σ). This will result in a stand-alone accuracy as low as 8.5 meters (95%) compared with approximately 22.5 meters (95%) with L1 alone.

Table 2
SPS with Two Coded Civil Frequencies

Error Source	**Typical Range Error Magnitude (meters, 1σ)**	
	SPS with SA set to zero	**SPS with two coded civil signals**
Selective Availability	0.0	0.0
Atmospheric Delay		
Ionospheric	7.0	0.1
Tropospheric	0.2	0.2
Clock and Ephemeris Error	2.3	2.3
Receiver Noise	0.6	0.6
Multipath	1.5	1.5
Total User Equivalent Range Error (UERE)	7.5	2.8
Typical Horizontal DOP (HDOP)	1.5	1.5
Total Stand-Alone Horizontal Accuracy, 95%	22.5	8.5

To implement C/A-code on L2, the GPS Block II Replenishment (Block IIR) satellite contract will be revised to direct Lockheed Martin to modify the last 12 Block IIR satellites. New earth-coverage military codes on L1 and L2 will also be added to these same satellites, as shown in Figure 3.

ADDING THE THIRD CIVIL SIGNAL

During the IGEB's civil signal selection process, it became clear that simply adding C/A-code to L2 would not be sufficient to allow its use for civil aviation safety-of-life applications because of

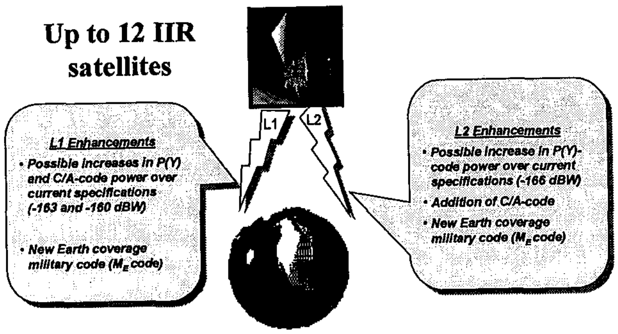

Figure 3
GPS Block IIR Satellites with New Signals

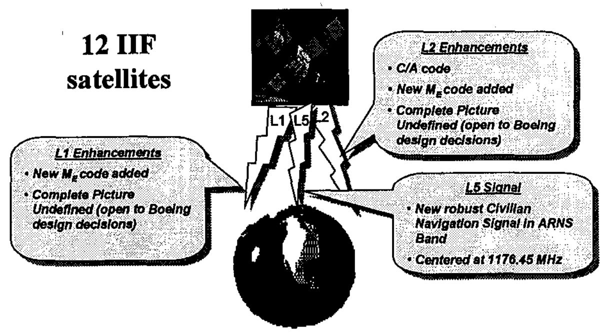

Figure 4
GPS Block IIF Satellites with New Signals

potential interference from existing ground radars that broadcast in and near the GPS L2 band. Obtaining an internationally accepted ARNS designation for L2 (necessary for all aviation safety-of-life applications) would require that many of these systems would have to be moved out of the band. U.S. agencies evaluated this approach, but concluded that the cost would be too high.

Instead, a new wide-band GPS signal offered the best option for civil aviation in the band from 1164-1188 MHz, a portion of the spectrum that already had an ARNS allocation. However, a new allocation, an RNSS (Radio Navigation Satellite Service – space to earth) allocation would have to be approved. That new allocation was thought to be attainable, and in May 2000, the World Radio Conference approved an RNSS allocation for the frequency band from 1164 to 1215 MHz.

The third civil signal at 1176.45 MHz, or L5, will be added to the first Boeing Block IIF satellite along with C/A-code on L2 and M-code on L1 and L2, as shown in Figure 4.

The L5 signal has been specifically designed to improve performance over the current L1 C/A-code signal in several ways. L5 power will be increased 6 dB compared to the current L1 signal (-154 dBW vs. -160 dBW). This is equally split between an in-phase (I) data channel and a quadrature (Q) data-free channel which will improve resistance to interference, especially from other pulse-emitting systems in the same band as L5 such as Distance Measuring Equipment (DME) systems already used for en-route and terminal area air navigation, and the military Joint Tactical Information System (JTIDS) used for critical military command and control communications. The data-free component of the new signal also provides for more robust carrier-phase tracking, which is desirable for many applications. A minimum 20-MHz broadcast bandwidth and a higher chipping rate will provide greater accuracy in the presence of noise and multipath. Finally, a longer code than the L1 and L2 C/A-codes will reduce system self-interference caused by CDMA cross-correlation. (See Ref. [1] for a full discussion of the L5 signal.)

The benefits of multiple ARNS signals in space will be significant. For instance, use of dual-frequency L1/L5 avionics will allow direct measurements of ionospheric delays directly by avionics equipment on-board aircraft. This will allow seamless global navigation and precision approach capability with minimal investment in ground infrastructure by many countries for

Space-based Augmentation Systems (SBAS). Less reference stations might be required for a worldwide SBAS coverage to meet navigational requirements for civil aviation as a result of availability of dual frequency avionics.

The Federal Aviation Administration (FAA) also plans to broadcast L5 from its SBAS known as the GPS Wide Area Augmentation System or WAAS. A design for the WAAS L5 signal structure has been proposed that is similar to the GPS L5 signal, except that only a single-channel carrier will be used (no Q channel), and the data rate will be increased.

As shown in Figure 5, L5 will be available for en-route navigation across the vast majority of the world even if the current worldwide DME infrastructure is maintained. Exceptions are limited to portions of the U.S., Europe, and Japan, which have a high density of DMEs. The FAA plans to reassign DMEs as necessary to protect L5 use at high altitudes in the U.S. national airspace system. At the surface of the earth, where the vast majority of non-aviation users of GPS reside, interference to L5 from DMEs is essentially nonexistent, as shown in Figure 6.

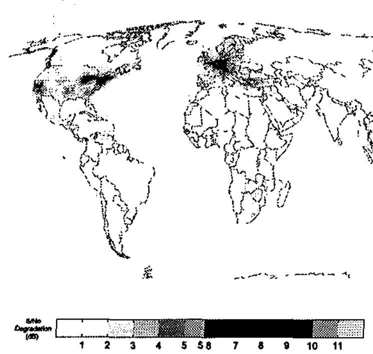

Figure 5
Interference to L5 Service at High Altitude (40,000 Ft)

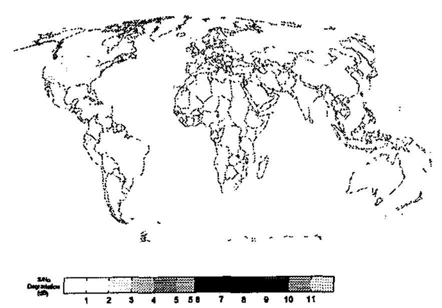

Figure 6
Interference to L5 Service at Approximately 5,000 Ft And Below

GROUND CONTROL NETWORK

Upgrading the operational control segment (OCS) as shown in Figure 7, represents an often overlooked but essential component of the overall modernization program. A number of improvements are under way that will improve the capability to monitor all signals broadcast from the constellation, make the control network more robust, improve the positioning accuracy of both the civil and military services, and add new functions that are necessary to control the modernized satellites. These improvements include:

- Upgrading the dedicated GPS monitor stations and associated ground antennas with new digital receivers and computers
- Replacing existing MCS mainframe computers with a distributed architecture
- Implementing the Accuracy Improvement Initiative (AII), Air Force Satellite Control Network integration, and full IIR capabilities
- Completing a fully mission-capable Alternate Master Control Station (AMCS) at Vandenberg Air Force Base

- Adding IIF command and control functionality.

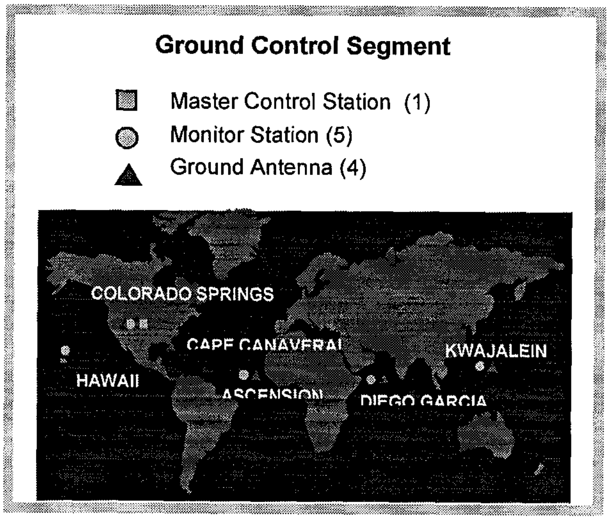

Figure 7
The GPS Ground Control Network

Table 3
SPS and PPS with the Implementation of the Accuracy Improvement Initiative

Error Source	Typical Range Error Magnitude (meters, 1σ)	
	SPS with two or more coded civil signals	SPS and PPS with the AII
Selective Availability	0.0	0.0
Atmospheric Delay		
Ionospheric	0.01	0.1
Tropospheric	0 2	0 2
Clock and Ephemeris Error	2 3	1.25
Receiver Noise	0.6	0.6
Multipath	1.5	1.5
Total User Equivalent Range Error (UERE)	2.8	2 0
Typical Horizontal DOP (HDOP)	1.5	1.5
Total Stand-Alone Horizontal Accuracy, 95%	8.5	6.0

In addition to other operational functions, such as satellite health monitoring and routine maintenance, the ground control network determines the ephemeris (orbital position) and clock parameters of the satellites in the GPS constellation and uploads these data to the GPS spacecraft. In its current configuration, the MCS uses individual "mini Kalman filters," known as partitions, to estimate the orbit and clock errors for each of the GPS satellites as well as the clock errors for the monitor site receivers. Updated orbit and clock corrections are uploaded to each satellite at least once a day.

Once atmospheric errors have been eliminated (by the dual-frequency methods discussed earlier), ephemeris and clock errors become the largest contributors to the GPS positioning error budget. With the current GPS constellation, the clock and ephemeris errors contribute approximately 1.8 and 1.4 meters (1 σ), respectively, to user equivalent range error (UERE) for a combined error of 2.3 meters (1 σ), as shown in Table 3. A new technique, called the Accuracy Improvement Initiative (AII), is expected to reduce the GPS clock and ephemeris contribution to UERE to approximately 1.25 meters. This will be accomplished by incorporating data from 6 to 14 additional monitoring stations operated by the National Imagery and Mapping Agency (NIMA) into a new, fully correlated, single-partition Kalman filter at the GPS Master Control Station. This is projected to result in stand-alone horizontal accuracies for all GPS users of 6 meters (95%) or better. (See Ref. [3] for more information about AII.)

GPS BLOCK III PROGRAM

The current GPS modernization efforts should carry the constellation through approximately the year 2010 (using up to 12 GPS Block IIF satellites). To meet military and civil requirements through 2030, the IGEB has accepted a DoD recommendation to develop a new generation of satellites (GPS Block III) and associated ground control network for use beyond 2010.

The objective of the GPS III program is to deliver a GPS architectural solutions that will satisfy the current and evolving military and civilian needs. The DoD is initiating a study in late summer of 2000 that will examine candidate acquisition and architectural concepts that refine and validate the system requirements trade space. For the military, a key requirement that will not be met until the Block III satellites are in orbit is the need for a higher power M-code signal (-138 dBW vs. -158 dBW) to further improve resistance to both intentional and unintentional interference in a geographically limited area of operations.

The GPS III architecture study will also address concepts that optimize cost (to include economic benefits), schedule, performance, risk, and technology insertion. These concepts will consider alternative solutions and interfaces both inside and outside the traditional GPS, including interoperability with, incorporation of, and/or utilization of various existing or developing military and civil systems.

IMPLEMENTATION TIMETABLE

The current schedule for GPS Modernization activities is depicted in Table 4. Using this timetable, an initial operational capability for dual-frequency navigation, would occur in 2008, which is based on a constellation of 18 properly placed satellites broadcasting C/A-code on L2. Similarly, the L5 signal should be available on 18 GPS satellites by approximately 2012. Reaching this service level will require the launch of 6 to 12 GPS III satellites. Operational Control Segment improvements will be carried out in multiple stages from 2000 through 2008 in support of the evolution of GPS IIR, IIF, and Block III.

SUMMARY

GPS is being modernized in order to further improve positioning, navigation, and timing capabilities for both civil and military users. The first step in the modernization process, the elimination of Selective Availability, will be followed by a series of steps that include:

- The near-term revision of the GPS SPS signal specification
- The addition of C/A-code to L2 and M-codes on both L1 and L2 beginning in 2003
- The addition of a third civil signal (L5) designed with aviation and other safety-of-life users beginning in 2005
- Ground Control Network upgrades to improve operational robustness and system accuracy
- A GPS Block III program to add more power to the military M-code signals and to address additional civil and military positioning, navigation, and timing requirements unmet by the current program.

As shown in Figure 8, these actions will improve the stand-alone GPS horizontal accuracy for all users from 100 meters to 6 meters or better. For non-dynamic or non-real-time scientific and survey applications, centimeter-level accuracies should be achievable more quickly and cost effectively than is possible today through the existence of three frequency "wide lanes" (L1 - L5, L1 - L2, and L2 - L5) to resolve integer ambiguities in making precise carrier-phase measurements. Most importantly, the existence of three spectrally separated civil frequencies, when combined with improved signal design characteristics, will significantly reduce the chance of unintentional interference to GPS services.

Table 4
GPS Modernization Schedule

Activity	Implementation Date
SA set to zero	May 2000
GPS IIR Enhancements - C/A Code on L2 - M-code on L1 & L2	2003 – 2006
GPS IIF Enhancements - C/A Code on L2 - M-code on L1 & L2 - L5	2005 – 2010
GPS III Enhancements - C/A Code on L2 - M-code on L1 & L2 with greater power - L5 - Future Capabilities	2010 – TBD
OCS Enhancements	2000 – 2008

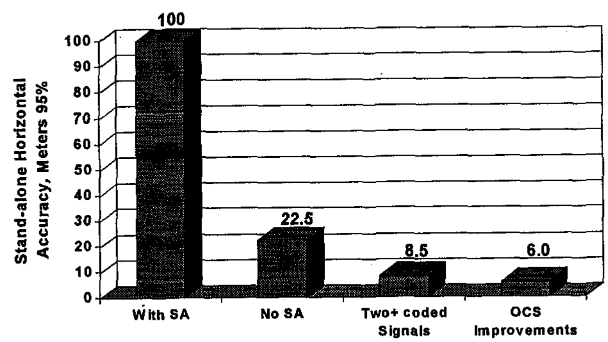

Figure 8
Improvements in GPS Accuracy

The spectral separation of civil and military GPS services through implementation of new military signals is an additional improvement. It will provide operational benefits to all users of GPS and will help to maintain the system's dual role as a military force multiplier and as a global information utility for peaceful civil use throughout the globe. The modernization of GPS will be a challenging endeavor that will demand the full commitment and dedication of the entire military and civil GPS communities. However, given the tremendous potential for both civil and military benefits, it will be well worth the effort for future generations.

REFERENCES

[1] *"Innovation"* column, GPS World, September 2000.

[2] *Global Positioning System Standard Positioning Service Signal Specification*, Second Ed., 2 June 1995.)

[3] *"Innovation"* column, GPS World, June 2000.

Questions and Answers

MARC WEISS (NIST): Could you say something about the jam resistance for civilians in GPS modernization?

MIKE SHAW: There are a number of factors that go into jam resistance, and I'm glad you used the word "resistance" rather than "prevention." But, as we look at the power increases, on L5 as well as possibly on the other signals, that will certainly increase the jam resistance. If you look at the improved bandwidth, if you will, on L5 as well as the code lengths and all that, that will again make it more resistant to jam. And just by virtue of fact that you had more than one signal certainly improves resistance to jamming or the unintentional interferer, as we talked about.

Again, there is not a way, if you will, to prevent totally the ability for an intentional interferer to interfere on any of these. What you've got to do is implement backup systems, whether it's through multiple signals coming through GPS; alternative technologies, in particular in the use of safety of life; internal reference systems; or other ground radio systems. It's a combination of all that. Does that answer your question?

WEISS: It answers it. There's a lot more I would like to know, but it is a good start.

SHAW: There's a lot more we would all like to know.

THOMAS CLARK (NASA Goddard Space Flight Center): This is a slight follow-on on the last question. You're showing that in the GPS III constellation, that the M-code power will be increased. That could very easily become a source of jamming for the civilian users, especially if you turn up the M-code by 20 dB. Is that problem being considered in all of this new design work?

SHAW: Absolutely. I mean, as we find out in this interesting dual-use system, there's a balance here. What is good for one often affects the other and visa versa. We clearly understand that as we increase the power on the M-code, the desire is to increase that power in the theater of operations. We would like to minimize, if you will, the impact on the rest of the world that's not in that theater of operations. The problem, of course, is that radio signals don't necessarily, in fact, rarely recognize borders, and so that is a problem with the implementation. Certainly as we implement M-code, it complicates just by virtue of the fact they're on the same signals, or it's the same frequency as the L1 and L2.

CLARK: Is it the civil or military community that is to be kept in balance?

SHAW: I think it will be a balance between both interests, and it's my hope that we will make the best decision in the nation. How's that?

CLARK: Sounds like a political answer.

SHAW: But that's the truth.

WILLIAM KLEPCZYNSKI (Innovative Solutions International): But Tom, there is no M-code on L5, so that signal won't be affected at all.

CLARK: But it affects both L1 and L2. We ultimately rely on L1 band, and L2 or L5 to do the ionosphere corrections. Part of the reason I asked.

SHAW: I gave you a political answer, but I also think a very truthful answer. But I also say that we know that that's a very trying issue. Right now, the DoD has been very proactive in including the civil community in their acquisition, if you will, of the modernized capability in the GPS III. I'm going to use a term that I don't necessarily like to use; it's called the "acquisition program baseline," which, if you will, is the report card by which we will judge success on modernization in GPS III. One of those issues in there that we're struggling with, even as we speak today, is the term of backward capability. To ensure that as we bring on new modernized capability, we don't unduly, negatively impact the current capability that is there, which is what the issue is that you talk about. But in the final analysis, the GPS is a dual-use system that is fielded both for national security reasons as well as, I would say, our economic security reasons. And we've got to achieve an equitable balance between those. We are aware, very, very intimately, with the detail that you talked about.