NASA Conference Publication 3302

26th Annual Precise Time and Time Interval (PTTI) Applications and Planning Meeting

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Proceedings of a meeting sponsored by the U.S. Naval Observatory, the NASA Goddard Space Flight Center, the NASA Jet Propulsion Laboratory, the Space and Naval Warfare Systems Command, the Naval Research Laboratory, the U.S. Army Research Laboratory, and the Air Force Office of Scientific Research and held at the Hyatt Regency Hotel Reston, Virginia December 6- December 8, 1994

National Aeronautics and Space Administration

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Superintendent
United States Naval Observatory

to

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Director of Time
U.S. Naval Observatory

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Jules G. McNeff
Navigation and Air Control Systems
Office of the Assistant Secretary of Defense (C31)
Pentagon, Washington, DC

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Gernot M. R. Winkler

PTTI DISTINGUISHED SERVICE AWARD

Presented by
Captain Richard E. Blumberg
Superintendent
United States Naval Observatory
Washington, DC 20392–5420

to

Dr. Gernot M.R. Winkler
Director of Time
U.S. Naval Observatory

Distinguished visitors, fellow scientists, ladies and gentlemen.

Today, it is my pleasure to preside over the inaugural PTTI Distinguished Service Award Ceremony and I am pleased to present the award to someone whose life's work has earned him an international reputation in the field of precise time.

The criteria for the award are that the award shall recognize an individual for any of the following contributions to the field of PTTI:

a. provided exceptional leadership and demonstrated ability and ingenuity in the development or application of PTTI over a number of years;

b. designed or developed a significant PTTI system.

It is my personal pleasure to present this first PTTI Distinguished Services Award to Dr. Gernot M.R. Winkler, Director of Time, U.S. Naval Observatory.

Dr. Winkler is renowned worldwide for his knowledge of precise time and his accomplishments in establishing and maintaining, at the U.S. Naval Observatory, the most accurate time standard in the world.

Early in his career, Dr. Winkler recognized the requirements for and importance of worldwide time synchronization. He pioneered the development of the "flying clock" in conjunction with Very Low Frequency (VLF) monitoring projects studying propagation path delays. His work laid the foundation for the use of VLF for timing and navigation (e.g., using Navy VLF Communications Stations to supplement the Omega Navigation System). His most important

achievement has been the development of the most stable and universally accessible atomic timescale in the world. This timescale has become the primary vehicle for the formulation of International Atomic Time. The statistical basis of this timescale, the development of the algorithm for its implementation, and its practical utilization were performed with his guidance and participation every step of the way.

Throughout his career, Dr. Winkler has cooperated not only with other Federal agencies, but also with private industry, to improve the accuracy and timeliness of the dissemination of precise time. One of his most outstanding contributions to both government and the private sector was his establishing the annual Precise Time and Time Interval Applications and Planning Meeting. These meetings have increased knowledge and cooperation and have reduced markedly the duplication of effort among various national and international agencies and organizations, both public and private. He persuaded the Coast Guard to synchronize its Loran–C Navigation System and was also successful in bringing about the synchronization of the OMEGA Navigation System. He has worked with the Global Positioning System (GPS) Program Office in coordinating the timing of the NAVSTAR GPS. Synchronization of these systems improved significantly, the long–range navigation precision for strategic and tactical weapon systems. Dr. Winkler has also worked closely with a number of organizations – the Naval Astronautics Group in timing the worldwide Navy Navigation Satellite System (TRANSIT); with the Applied Physics Laboratory, Johns Hopkins University, on LORAN–C timing; with the National Security Agency on special experiments; with the National Aeronautics and Space Administration in timing its worldwide tracking network, and with the National Institute of Standards and Technology and Hewlett–Packard in solving timing problems of mutual concern to ensure the nation has a single time standard.

Through his efforts, Dr. Winkler has brought international recognition to the U.S. Naval Observatory by providing timely and accurate publication and distribution of time–related data and information. Each year, ten different Time Service announcements, comprising more than 150,000 pages, are composed, printed and distributed to more than 1200 users worldwide. As the need for "real time" access to USNO timing data has grown, Dr. Winkler has developed a system for distributing timing data on acomputer–to–computer basis.

Dr. Winkler is widely recognized as the preeminent world leader in precise time, time interval, timescales and time distribution. He has established the United States Navy, through the Naval Observatory, as the largest single contributor (currently at 38%) to the international time standard, Universal Time Coordinated. He thus ensures that satellite, navigation, command, control, and communications systems are all operating on precise, accurate time standards; absolutely vital for data synchronization in the information age. His leadership as Chairman of the Subcommittee on International Atomic Time (TAI) of the International Consulting Committee for the definition of the second for atomic time and active coordination with other national Time Services have ensured that international standards for time and frequency measurements are strictly adhered to, thus guaranteeing the stability of time for DoD, the United States, and the world.

Dr. Winkler has played a critical role in a new initiative to improve the accuracy of the Global Positioning System (GPS). Air Force Space Command specifically requested Dr. Winkler's technical expertise and willing assistance in designing, and planning an upgrade to the timing

systems at the GPS Monitor Stations, The project, a joint venture with the Naval Research Laboratory and U.S. Air Force, is proceeding, with software development almost complete, hardware on order and installation scheduled to begin shortly. His thorough knowledge of this national asset illustrates the global breadth of Dr. Winkler's interests and willingness to pursue a vital project. Not only will the project improve GPS timing signals to better than 10 nanoseconds, but we anticipate improved position accuracy as well.

Visionary and tireless, with unsurpassed expertise, Dr. Winkler is a world leader, and national asset. A renowned scientist he deals routinely, on a global scale, coordinating national and international efforts in support of the DoD. His diplomatic skills, ability to work cooperatively with other national time service organizations and to make continuous improvements in precise time and time interval even in the face of declining resources are a tribute to his skill, leadership, and scientific excellence. He deserves the highest recognition that the PTTI community can bestow.

KEYNOTE ADDRESS GLOBAL POSITIONING SYSTEM (GPS) STATUS AND FUTURE PLANS*

Jules G. McNeff
Navigation and Air Control Systems
Office of the Assistant Secretary of Defense (C3I)
Pentagon, Washington, DC

Abstract

This presentation will update the status of GPS policy development within the Department of Defense and between the Departments of Defense and Transportation. Subjects discussed will be several studies currently underway on aspects of GPS management, financing, operations, security, contributions to national competitiveness, the broad acceptance of GPS as a global military force enhancement system, and the implications of that acceptance for operational planning. Also included are highlights of important near–term issues which will contribute to continued successful implementation of GPS by the DoD.

Before I get into any prepared remarks I had, I would like to be among the first to publicly congratulate Dr. Winkler on being the recipient of the award. I think if there's anybody in the world you can pick for an introductory award such as this, Dr. Winkler is certainly the right choice. So congratulations, Doctor.

I would like to start by first of all welcoming all of you to Washington. For those of you who came from out of town, I hope you understand that what you are seeing here is just a typical December day, sunny and in the 70s. We do this all the time here.

I would like to personally thank you for inviting me to kick off your PTTI planning meeting. It's a great honor for me to be able to begin the festivities and the round of discussions that will continue. As Ron said, I work in the Office of the Assistant Secretary of Defense for Command Control Communications and Intelligence. As such, I am really just kind of a minor cog in the great machine that's the Department of Defense (DoD) of the United States. I am very proud of the fact that the great machine has been the producer of a number of tremendous systems like LORAN and TRANSIT and GPS. In fact, GPS is what I will talk about a little later here today.

Really, in comparison to all of the assembled scientists in this august body, I'm just a layman when it comes to the timing business. As I thought about what kind of things I could say in

*This is an editorial transcript of the Keynote Address given by Mr. McNeff

a keynote address for this conference, I was really perplexed as to what sorts of things I as a layman could offer to a group such as this. I really think that's one of the reasons we are here today in this meeting, is to bring what is really a very esoteric technology, in some cases a difficult to understand technology, down to layman's terms.

So to start with, I would like to offer a few of my observations about time that I've picked up here as I've worked through GPS and dealing with a number of you folks. To you, though, many of these observations may sound patently obvious and pedestrian. However, to the person who views time as most people do, kind of akin to air and sunlight which are free and always available, they may not be so obvious. People tend to expect time to be a resource that's always there in abundance and to be used whenever they feel like it. As you all know, that's not necessarily the case.

I do have another agenda. It is one that I've pushed several times before to many of you; and that is we all need to make time and timing familiar to the program management people, to the system designers who produce systems that depend on time and time interval, so they can understand how PTTI can both contribute to the systems, but also limit the ability of their systems to do everything that they want to do. In addition, the knowledge of PTTI needs to be accounted for in all stages of system design and operation. In fact, we're finding that out as we enter the operational stage of GPS in its day-to-day operations. I'll talk a little more about that when I get to the GPS part.

First of all, my basic perspective says that time is the ultimate, nonrenewable resource. We try to save it; we try to make it; and we certainly spend it. In fact, we really can't save time because it moves inexorably onward, and once it passes, it's gone. Anyone who has ever faced a deadline knows that once that time is up, it's up; and you don't get it back again. We can't make more of it, much as we'd like to, so we try to shave it into its smallest possible components, and then do everything faster, on the theory that ultimately this will make more time available to us.

With regards to time and that kind of technology, my observation is that in the last year, in my office, I've had a simple word processor replaced with two extremely powerful computers – one, so I can deal with classified and the other so I can deal with unclassified, both of which I used to deal with in my word processor. My telephone with human answering support has been replaced with voice mail, on the presumption that all of this high–speed, high–powered technology and electronics will give me more time to be efficient. Frankly, I don't necessarily find that to be the case. What I do find is that some of these timesaving devices enable us to put more volume into less space at a faster rate; but at some point we need to step back and take a look at the utility of what we're doing in all this flurry of activity and make sure that when it comes down to the end user, it really is useful to him/her. Again, I expect that is why we need conferences like this – not only to show each other how we're pressing the limits of technology in a particular area of PTTI, but also so the decision–makers and the laymen in the business (if you will) can see the human–useful results in ways that we can grasp and then apply.

So now I get to using time, or "spending it," more properly said. We need to think about that as if we're spending it out of our own pockets. Because, as I said before, it is our most

valuable resource: it's nonrenewable and it's a resource for which even the best technology today cannot create a substitute. That is why I continue to be concerned with time and time's contribution to GPS and all its facets – in fact, concerned to the extent that right now my watch says it's 9:26; and if any of you are hooked up to GPS time, you know that's about five minutes or so fast. The reason is that I don't want to be late to things and waste my time or the time of others; but it's also a measure of the way we think about these kinds of things that makes me concerned when I look at my watch and I wonder if it's "just" five minutes fast; it could maybe be four minutes and 50 seconds fast, or five minutes and 10 seconds fast. So even trying to measure with a micrometer and cut with an ax, we still tend to think in terms of micromanaging time. So, enough of that general pedestrian observation.

Let me move now to a discussion of current applications of time and, specifically, time in the way it applies to GPS, and of a GPS status update in general. I put this slide (Figure 1) up to give you all an indication of the way we do GPS today. GPS isn't just a DoD program; it's not just a military program; although it's called the "Positioning System," it's not just a positioning or navigation system. It is, in fact, a commodity resource. It's a dual–use system for use by civil, commercial, scientific enterprises as well as by military users in the U. S. and abroad.

What I would like to run through today in this part of the discussion is a general program status, and draw some particular references to PTTI in a GPS context. I put this slide (Figure 2) up not to show you how GPS works – because most all of you know how GPS works – but to highlight the key component of GPS, and that's time. A lot of people who think about GPS in the Washington area, at a policy level or just generically, don't really think of time; they think of location, position. They don't understand that, fundamentally, GPS is a timing system; that timing is absolutely key to GPS, the way it works, what makes it successful, and ultimately the range of benefits that will be obtained from GPS.

I would just like to quickly run through our current policies so that everyone knows where we're coming from policy–wise. This really isn't a policy discussion per se, though. I'll talk a little bit about our extensive involvement with the civil community; and then some current updates on a number of studies that are in progress looking at the GPS. How is long–term use affected by initiatives in a civil community anxious to use GPS? A quick military perspective on how GPS plays in a tactical environment; and finally, some conclusions.

Policy statements that deal with GPS you've seen many times before. I just put them up here to remind you of what they are. We have two different services in GPS: a Precise Positioning Service (PPS) available to U. S. and allied military, which is defined as a positioning accuracy of 16 meters, 50 percent spherical error probability; and we also have a widely – available, generally – available Standard Positioning Service (SPS), defined at a positioning error of 100 meters, 95 percent probability, which was established based on civil aviation requirements for non–precision approach; but today we see many, many civil requirements that are far in excess of 100 meters, and, in fact, far in excess of the 16 meters that we provide or that the system expects to provide to military users; and so, drives a number of civil initiatives in the GPS area. We do continue to put protection on the GPS signals, both selective availability and anti–spoofing, which are implemented continuously on all the operational satellites. The PPS, as I said, is available to U. S. and allied military, and, with memoranda of agreement with our office, to a variety of other users. We have a number of agreements in place with foreign

militaries, and also with federal civil agencies in the United States. Of course, the Standard Positioning Service is available to everyone.

Our work with the civil community has been long–term. (Figure 3) We've been involved with the Department of Transportation (DOT) in production of federal radionavigation plans for over 10 years. The latest iteration, the 1994 edition of the Federal Radionavigation Plan, is in the final stages of staffing, prior to signature by the Department's secretary. We have agreements in place with the DOT on civil use of GPS, and we've got provisions for civil DOT representatives to take positions at both Air Force Space Command (AFSPACECOM) and at the Joint Program Office. In fact, the AFSPACECOM slot has just been filled, Mr. Hank Skalski from the DOT has been designated to take that position out in Colorado Springs. Hank, would you stand up? Hank will be the senior DOT representative in the DoD GPS community. He'll represent civil interests at AFSPACECOM, at the Operations Center, in the requirements development process which leads to satisfying future civil requirements and future versions of GPS development. So Hank will be a very important contributor and representative of the civil community within the GPS business. In fact, he will be holding a meeting tomorrow on civil GPS requirements.

Also with the DOT, as most of you probably know, we had a rather extensive task force that reported out last year in a variety areas on management financing and operation of GPS. The DOT has put several of those management recommendations into practice already. The Federal Aviation Administration (FAA) is actively pushing a wide–area technique for integrity and availability improvement, and also looking at ways to improve GPS accuracy for precision approach and other applications. I will talk a little bit more about that in just a minute.

Those are the parts of the civil augmentation initiatives that are growing like mushrooms out there. Every time you turn around, there's a new initiative underway to improve on the performance of GPS or to use GPS in some new way. There is a tremendously broad civil user community, both in the government and out in the private sector. You only have to read GPS World Magazine or just turn on your television and see the rental car advertisements. I just got a copy of an off–road magazine from Japan, and the center section had to do with after–market GPS navigation equipment that you can put in your off–road vehicle over there. There were probably 10 or 15 different manufacturers marketing little video screens and GPS receivers, along with CD ROMs with all the pertinent games and navigation data. There was even one company that had one called "Karaoke Navigator." You spend a lot of time in your cars in Japan, I guess, and so you need something to divert yourself besides finding your way around. It is a tremendous market and growing all the time.

Even though we in the DoD and DoT sort of thought we had all the answers last year, there were others that thought that it would be a better idea if other agencies took an independent look at the answers we came up with and saw whether they were truly the right answers; or whether there were other things that needed to be looked at in terms of how GPS will contribute to U. S. competitive advantage and to the quality of life for all of us here for the next 20 or 30 years or more. So there were a number of other studies that were undertaken, and some of them are starting to show results.

First of all, (Figure 4) there was a study run by the Institute of Telecommunication Sciences (ITS)

on GPS augmentations, looking at how the Federal Government can best provide augmented GPS services. This was really an outgrowth of our task force of last year. This particular study started early in '94 and is now in sort of the final stages of reporting out; the Secretary of the DOT reviewed the report in November; it's being briefed right now, and I expect it will be released shortly by the DOT. It was performed by ITS, which is part of the NIST under the Department of Commerce; but the contract was awarded by DOT and we participated in that work. It did look toward the differential services that are being provided to augment GPS by the Coast Guard, by the FAA, Planned Applications by Highways and other federal agencies.

At the same time, on the military side of things, the Defense Science Board last spring started to look at GPS, particularly as GPS was going to be used in Precision–Guided Munitions. Some folks in the PGM world were surprised, I guess, to learn that the GPS has some vulnerabilities in the jamming area. When you really think about it, a radionavigation system, a radiopositioning system that depends on electromagnetics is going to be susceptible to jamming. Once you get past that basic idea that GPS does have some jamming susceptibility, then you can start looking at what does it take to make it as robust as we need to have it in a tactical environment. Frankly, until GPS began to become operational and be considered for some of these tactical applications, people hadn't really started thinking about it in a total tactical environment; but we are now. I will cover more about that in a little bit.

One of the aspects of GPS robustness that the Defense Science Board is looking at is the contribution of timing for that tactical robustness. How can we use time, which is again the fundamental driver of GPS, to make the system more robust, to enable us to operate longer at Y–code, to enable us to re–acquire Y–code or to acquire Y–code faster in competitive situations and those kinds of things? So timing has a direct tie–in to some of the work that the Defense Science Board and some of the recommendations coming out of the Defense Science Board in looking at improvements to GPS.

We also have the National Academy of Public Administration and National Academy of Science in a Congressionally–directed joint study, looking at the totality of GPS. The National Academy of Public Administration is looking at management and financing of the system, governance, international aspects; the National Academy of Science is looking at some of the technical issues associated with the operation of GPS, and also, by the way, with the features of selective availability and anti–spoofing. That report is due out in April.

At the same time, also based on some congressional language, the Office of Science and Technology Policy, a White House office, has initiated a separate study of GPS through Rand Critical Technologies Institute to look at GPS competitive advantages and vulnerability. These include military advantages and vulnerabilities, but they also include some of the more macro–issues of GPS contributions to United States economic competitiveness, technical competitiveness in the world market, and those kinds of things. Also, by the way, looking at GPS as a specific contributor to the national information infrastructure (NII) in where (at least in some people's minds) the less well–known timing aspects become very critical. When you are talking about moving millions of bytes of data at very high data rates, your ability to time those transfers and to synchronize your computers, and all that, becomes key. So here GPS again is shaving time to nanoseconds and is a very significant contributor of that kind of technology.

What the results of those studies will be I can't forecast at this point. We don't in the DoD, even though we've paid for most of them (other than the Defense Science Board), we don't have the inside story on what the National Academy of Public Administration (NAPA), the National Academy of Sciences and Rand ultimately will come out with in terms of recommendations. That, frankly, is part of the business we're in. If we need to learn how to best operate a system like this for the national good, we need to be able to stand the scrutiny of independent groups and deal with the recommendations that come out of those groups. So we're looking forward with great anticipation to the completion of the NAPA, NAS, as well as the Rand studies next spring.

At the same time the studies are going on, GPS, for all intents and purposes, is in fact operational. We have a number of other civil initiatives that are going on and have been for some time. (Figure 5) The Coast Guard, for several years now, has been working on radio beacon–based differential; and, in fact, putting in place differential stations around the coastline of the United States; and now working with the Army Corps of Engineers to put differential stations in the Mississippi and Missouri watersheds. So through the Coast Guard and the Corps of Engineers, virtually the entire coastal area, plus a good bit of inland U. S., will be covered with radio beacon–based differential signals in the very near future.

Civil aviation is pursuing several different initiatives. First of all, there is an international construct called a "global navigation satellite system" (GNSS), which uses signals from GPS and its augmentations, plus other signals as may be available at some point in the future, to take care of global international civil aviation. At the same time, they're looking at augmentations to that to improve accuracy to precision approach levels and also to improve the integrity and availability of the GPS signals at the levels where civil aviation can operate safely with them, even on the most precise stages of flight. They're also looking at local area differential and pseudolites to aid in the most critical Cat II and III precision landings, and also for airport surface control.

At the same time, highway systems are looking at using GPS; transit systems – not the Transit Satellite System, but Metrobus and other transit systems – are looking at GPS for fleet management and control. GPS is being used in farming to control applications of fertilizers and pesticides. And also in construction, in quite a variety of high precision applications. So again, the market is mushrooming.

I will now move back to the military perspective. Whenever I talk to the operational guys in the services, this is a slide (Fiure 6) I intend to use. I have used it out in the Operational Users Conference in Colorado Springs, and I will continue to use it time and time again as we talk about GPS and the tactical environment, because it's something that we need to think thoroughly through as we apply GPS for our military purposes.

We need to consider a whole range of users of GPS out there. Of course, the U.S. and Allied Military Forces were the intended recipients of GPS improvements, and so will be using them for a tremendously wide variety of missions. We will use Precise Positioning Service equipment with Selective Availability and Anti–Spoofing capabilities in virtually all combat and combat–support missions. So GPS will in a tremendously wide use in the military services of the U.S. and our allies. At the same time, we know that commercial equipment will be present

in whatever theater we're engaged in; and, frankly, to the extent it is, it will probably be a hazard to users and a problem for planners because the same commercial equipment that our guys will have access to, our adversary will quite likely have access to as well. And so for that reason, we're working very hard to equip all of our forces with PPS equipment and to get away from the commercial SPS equipment.

Because, when we get down to the next bullet, we recognize right now that our adversaries and other forces around the world are also devising ways to use GPS. We see evidence of it every day. You only have to pick up the latest international defense review, or any other sort of arms market publication, or general avionics military kind of publication and you will see that GPS is coming into wide use in militaries around the world. There will be militarized commercial SPS receivers in use in any theater you can pick; there will likely be SPS guided weapons in use, not today, but in the very near future; and those will be augmented by differential GPS wherever it's available. That's a reality that our own tactical planners will have to account for as they think about tactics and contingencies down the road.

At the same time, we have to take into account civil use and adjacent non–combatants. The fact that what is a military SPS advantage to an adversary is also in use right next to the theater for a wide variety of peaceful transportation and commerce. It will also be in use with available DGPS. So there's a distinction that we'll need to make between adversaries and non–related neighbors when we deal with GPS in hostile situations. Frankly, as I said before, that message hadn't really been internalized too much among much the planners until just recently, that we are starting to work within the Joint Staff, and where the operations plans are done, to take some of these global kinds of issues into consideration in the future.

For conclusion, I put up a couple of what I call "Obvious Statements of the Week." (Figure 7) As I said in the beginning, GPS isn't just any one thing, a positioning or navigation system or whatever; it's an information resource. I borrow that term, that characterization from Charlie Trimble, who runs Trimble Navigation, and some of the presentations he's made to the National Academy of Sciences and other panels. A lot of the manufacturers feel the same way; GPS is a resource to be used; it provides a whole variety of information, position, velocities, time, a number of things that can be used for a whole variety of purposes other than just knowing exactly where you are.

At the bottom, PTTI is fundamental to the effectiveness of GPS. If we don't continue to take account of time and time interval in GPS and its applications, then we limit the benefits that we're going to get out of it. In the operational environment, timing is critical to satellite operations and control. We've got a number of initiatives underway to look at managing time, and managing time better, and the contributions of time within the control segment functions. We're looking, as I said during the DSB discussion, at the contribution of time to improving the tactical robustness of user equipment and the responsiveness with which it deals with the Y–code. Of course in science and National Information Infrastructure (NII) and commerce, time is equally important along with the other positioning and velocity solutions that you get from GPS. Also, looking at the strategic environment, this is a truly dual–use resource. It's in use globally. We need to recognize that. We need to do the best we can to balance the competing objectives of science and commerce against security.

With that, I'll close my introductory remarks. I hope that the Planning Conference is a great success. I appreciate all of you devoting your attention to me this morning.

GLOBAL POSITIONING SYSTEM

A NATIONAL / INTERNATIONAL

DUAL-USE COMMODITY

PROGRAM STATUS & THE PTTI CONNECTION

- PRESENTATION BY
  - JULES McNEFF
  - OASD(C3I)

FIGURE 1

GPS DUAL USE
DISCUSSION OUTLINE

- CURRENT POLICIES
- CIVIL INVOLVEMENT IN GPS
  - MANAGEMENT
  - USE
- GPS STUDIES IN PROCESS
- CIVIL USE INITIATIVES
- GPS TACTICAL ENVIRONMENT
- CONCLUSION - IMPLICATIONS FOR PTTI

FIGURE 2

GPS SECURITY POLICY
POLICY STATEMENTS

- DIRECT ACCESS SERVICES
  - PRECISE POSITIONING SERVICE (PPS) - 16 M (C/A, P, Y CODES)
    - » FORCE ENHANCEMENT REQUIREMENTS - MILITARY
  - STANDARD POSITIONING SERVICE (SPS) 100 M (C/A ONLY)
    - » CIVIL AVIATION REQUIREMENTS
- IMPLEMENTATION OF PROTECTION
  - SELECTIVE AVAILABILITY AND ANTI-SPOOFING ON
    - » CONTINUOUS – ALL OPERATIONAL SATELLITES
- ACCESS
  - PPS - AVAILABLE TO U.S./ALLIED MILITARY
    - » FOREIGN / CIVIL USE REQUIRES MOA WITH ASD(C3I)
  - SPS - AVAILABLE WORLDWIDE FOR CIVIL USE

FIGURE 3

GLOBAL POSITIONING SYSTEM
CURRENT CIVIL INVOLVEMENT

- 1992 FEDERAL RADIONAVIGATION PLAN (DOD / DOT)
  - 1994 EDITION NEARLY COMPLETE
- DOD / DOT MOA ON CIVIL USE OF GPS (JAN 93)
  - CIVIL REPRESENTATIVES AT AFSPACECOM & GPS JPO
  - AFSPACECOM SLOT FILLED – MR. HANK SKALSKI
- DOD/DOT TASK FORCE REPORT - DEC 93
  - MANAGEMENT
  - FUNDING
  - STANDARD POSITIONING SERVICE ACCURACY
  - INTEGRITY AND AVAILABILITY
  - REGULATION OF AUGMENTATIONS
  - INTERNATIONAL ACCEPTANCE
  - SPOOFING AND JAMMING
- CIVIL GPS AUGMENTATION INITIATIVES
- BROAD CIVIL USER COMMUNITY (GOV'T / PRIVATE)

FIGURE 4

GLOBAL POSITIONING SYSTEM (GPS)
STUDIES – DECEMBER 1994

- INSTITUTE OF TELECOMM SCIENCES (NOV / DEC 94)
  - » GPS AUGMENTATION
  - » CONTRACTED BY DOT (DOD PARTICIPATING)
- DEFENSE SCIENCE BOARD (JAN 95)
  - » GPS USE IN PGMs
  - » ROBUSTNESS IN TACTICAL ENVIRONMENT
  - » CONTRIBUTION OF TIMING TO ROBUSTNESS
- NATIONAL ACADEMY OF PUBLIC ADMINISTRATION / NATIONAL ACADEMY OF SCIENCE (APR 95)
  - » CONGRESSIONALLY DIRECTED
  - » STUDY ON THE FUTURE OF GPS
- OFC OF SCIENCE & TECHNOLOGY POLICY (JUN 95)
  - » RAND CTI
  - » GPS COMPETITIVE ADVANTAGES & VULNERABILITIES
  - » GPS IN THE NII

FIGURE 5

GLOBAL POSITIONING SYSTEM (GPS)
CIVIL INITIATIVES (TRANSPORTATION)

- US COAST GUARD DIFFERENTIAL (COASTAL BEACONS)
- USCG / ARMY COE DIFFERENTIAL (INLAND RIVERS)
- CIVIL AVIATION
  - GLOBAL NAVIGATION SATELLITE SYSTEM (GNSS) - ICAO
    - » GPS + GLONASS + AUGMENTATIONS TO EITHER
  - WIDE-AREA AUGMENTATION SYSTEM (WAAS) - FAA
    - » NEAR CATEGORY I PRECISION APPROACH
    - » INTEGRITY, AVAILABILITY (+ DIFFERENTIAL GPS)
  - LOCAL AREA DIFFERENTIAL GPS / PSEUDOLITES
    - » CATEGORY II / III PRECISION APPROACH, LANDING
    - » AIRPORT SURFACE CONTROL
- INTELLIGENT VEHICLE HIGHWAY SYSTEMS, TRANSIT, FARMING
  - USE AVAILABLE DIFFERENTIAL GPS SERVICE(S)

FIGURE 7

GPS DUAL USE
TACTICAL ENVIRONMENT

- U.S. /ALLIED MILITARY FORCES
  - PPS EQUIPMENT IN GENERAL USE
    - » SA AND A-S CAPABILITIES (L1 AND L2?)
    - » ALL COMBAT / COMBAT SUPPORT MISSIONS
  - COMMERCIAL SPS EQUIPMENT PRESENT
    - » HAZARD TO USERS / PROBLEM FOR PLANNERS
- ADVERSARIES / OTHER FORCES
  - MILITARIZED COMMERCIAL SPS RECEIVERS IN USE
  - SPS GUIDED WEAPONS LIKELY
  - AUGMENTED BY DGPS WHERE AVAILABLE
- CIVILIANS / ADJACENT NON-COMBATANTS
  - SPS WITH AVAILABLE DGPS IN WIDESPREAD USE
  - PEACEFUL TRANSPORTATION AND COMMERCE

GPS DUAL USE
CONCLUSION
IMPLICATIONS FOR PTTI PLANNERS

- OBVIOUS STATEMENTS OF THE WEEK
  - *GPS IS AN INFORMATION RESOURCE*
  - *PTTI IS FUNDAMENTAL TO THE EFFECTIVENESS OF GPS*
- GPS OPERATIONAL ENVIRONMENT
  - SATELLITE OPERATIONS / CONTROL
  - USER EQUIPMENT TACTICAL ROBUSTNESS
  - ROLE IN SCIENCE / NATIONAL INFORMATION INFRASTRUCTURE / COMMERCE
- GPS STRATEGIC ENVIRONMENT
  - GLOBAL, DUAL USE RESOURCE
  - SCIENCE, COMMERCE AND SECURITY MUST BE BALANCED

FIGURE 8

QUESTIONS AND ANSWERS:

JIM WRIGHT (CSR): Is there a published doctrine, or will there soon be a published doctrine, that suggests that DoD activities used in GPS will have to have Y–code receivers?

JULES McNEFF: Within the DoD there is already published guidance that says that we expect the services to use Y–code equipment and not commercial equipment. Unfortunately, that is contained in some otherwise classified documents so I don't that it's published. It's in our security policy document, which is a classified document for other reasons. It's in some other correspondence.

It is in an unclassified letter we sent to the services back on the 30th of April, '92. This sort of fundamentally lays out a whole range of user equipment procurement guidance that applies to GPS equipment, such as that the services will use PPS equipment for all of combat and combat–related missions; and only consider SPS for missions that don't involve combat, such as training, some developmental work, and things like that where the platforms won't stand a chance of being involved in combat and a bunch of other things.

So it has been published. That memo's been pretty widely distributed throughout the DoD. But not publicly per se.

JIM WRIGHT: How can one get a copy of that memo?

JULES McNEFF: Give me a call.

JOHN VIG (ARL): A great deal of money has been spent on developing GPS and the PTTI aspects of GPS. But most of that money was spent on the satellite clocks. Do any of those studies that you mentioned address the role of PTTI in the user segment? And are there any plans for using better clocks in the user equipment to acquire the Y–code, for example, and things like that?

JULES McNEFF: The study that would look at that is, I would say, is the Defense Science Board Study where they are looking at ways to improve the individual performance of user equipment in a face of jamming or other loss of signal. But what recommendations they're going to come out with in terms of upgrading the user equipment with different on–board timing sources, I don't know. That's the one study that would likely address that aspect of it.

JOHN VIG: Do you know who the technical experts are in that study? Is there any way of getting to them to let them know what might be do–able?

JULES McNEFF: I'll tell you who they are. We can do that off line. In fact, Dr. Winkler briefed the DSB group here a couple of months ago, I guess, on some aspects of time, related to the issues that they were looking at.