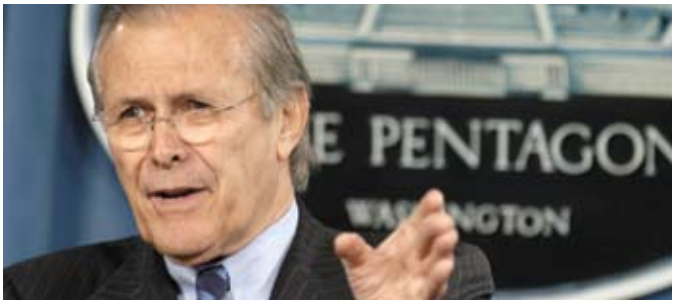
Bold Advice: The Defense Science Board Task Force on GPS

BY GLEN GIBBONS



Secretary of Defense Donald H. Rumsfeld
DoD photo by R. D. Ward

Recommendations now before Pentagon policy makers would introduce far-reaching changes in management of the leading U.S. asset for space-based positioning, navigation, and timing.

Recommendations from a high-level Defense Science Board (DSB) Task Force on the Global Positioning System, if implemented, would profoundly alter the way that GPS is managed and operated: a significantly redesigned and enlarged satellite constellation, a larger contractor role in running the system, more focused responsibility and authority for GPS, and permanent elimination of Selective Availability.

A memo from U.S. Secretary of Defense Donald Rumsfeld, drawing on the task force analysis and recommendations, has been drafted to provide guidance to departmental leaders and the Air Force officials responsible for overseeing and managing the program.

The DSB presented the group's analysis and recommendations in a 109-page report, "The Future of the Global Positioning System," signed by Under Secretary of Defense Kenneth Krieg and released publicly in early December. In a far-ranging critique, the report identifies potential gaps in sustainment of the GPS satellite constellation, delays in upgrading the operational control segment, and diffuse lines of authority within the Department of Defense (DoD). It calls for changes in how the United States funds GPS, how DoD manages the system and acquires military user equipment, and how the U.S. Air Force contracts for modernized GPS infrastructure and operates the satellites.

The ultimate significance of the report probably depends on the willingness and perseverance of its co-chairs, former defense and energy secretary Jim Schlesinger, and former National Reconnaissance Office director Robert Hermann, to advocate vigorously for the product of the task force's labors.

Schlesinger briefed Rumsfeld and Deputy Secretary of Defense Gordon England, who also co-chairs the National Space-Based Positioning, Navigation, and Timing (PNT) Executive Committee (NPEC). The DSB report was on the committee agenda for its January 26 meeting.

Established by Krieg's predecessor Michael Wynne, the task force's objective initially had been framed to address competitive concerns in light of Europe's move to implement its own GNSS, Galileo.

"Without significant DoD movement on GPS, the introduction of Galileo may marginalize GPS to an expensive military use only system," Wynne wrote in an April 9, 2004, memo to DSB Chairman William Schneider, Jr.

Within a couple of months, however, the signing of a US/EU agreement on cooperation in GPS and Galileo matters broadened the focus of the task force — fortuitously, one might argue. President Bush's policy directive on space-based positioning, navigation, and time further influenced the scope and emphasis of the group's work.

An impressive mix of old GPS hands and former defense leaders

DSB Task Force Members

CO-CHAIRMEN

Robert Hermann, Global Technology Partners, LLC

James Schlesinger, MITRE Corporation

TASK FORCE MEMBERS

John Darrah, Institute for Defense Analyses

William Delaney, MIT Lincoln Laboratory

Arnold Donahue, National Academy of Public Administration

Kirk Lewis, Institute for Defense Analyses

USAF Gen. James McCarthy (Ret), U.S. Air Force Academy

Steve Moran, Raytheon Corporation

Ruth Neilan, NASA Jet Propulsion Laboratory

Robert Nesbit, MITRE Corporation

Brad Parkinson, Stanford University

James Spilker, Stanford University

John Stenbit, Private Consultant, former Assistant Secretary of Defense for Networks and Information Integration (ASD NII)

USAF Gen. Larry Welch (Ret), Institute for Defense Analyses

EXECUTIVE SECRETARY

Ray Swider, ASD NII

NovAtel Inc.

The Defense Science Board (DSB) Task Force report focuses primarily on project strategies for correction of a number of known GPS deficiencies, with the impetus to fix things being driven by the potential future impact of Galileo. There are some good thoughts and several opportunities for improvement.

The President's U.S. Space-Based Positioning, Navigation, and Timing (PNT) Policy announced in December 2004 already highlights areas where GPS and GPS assets are vulnerable to jamming. The DSB Task Force report once again highlights this area of vulnerability, especially for civilian users. As the supplier of GPS reference receivers to the FAA Wide Area Augmentation System (WAAS) network and participant in the development and supply of the Galileo Reference Chain receivers for the Galileo ground control system, NovAtel has proposed an approach using a combination of antenna array and signal processing for protection of the NovAtel network reference receivers. These extensively tested and qualified national networks could substantially improve GPS signal monitoring – if only the GPS control segment could access data from the WAAS networks in US, Japan, Europe, India and even China.

NovAtel supports the initiative to permanently increase the GPS constellation to 30 satellites, and we are ready for the new L2C and L5 signals. More space vehicles means a greater probability of seeing good geometry signals, and more signals at different frequencies will improve system accuracy and signal reliability. The DSB report does not, however, appear to consider the combined use of Galileo and GPS, which together will provide up to 60 satellites. This will really improve signal reliability and usability!

Keeping pace with the coming of Galileo is a recurring theme and the threat of a competitive system runs throughout the report. However, it does not really support the need to actively monitor and use Galileo for national programs such as WAAS and Local Area Augmentation Systems (LAAS). NovAtel has already fielded a commercial dual-mode GPS/Galileo 16 channel receiver, which can provide users with the benefits of new signals and which works with both systems. Such receivers could be readily added to the existing WAAS reference receivers. Moreover, NovAtel expects to be deeply involved in Galileo and GPS receiver development for many years to come.

As the world moves into a GPS/Galileo dual-constellation environment, where dual use will be pervasive, it seems strange that the U.S. Department of Defense may have to remain reliant on single-mode GPS while the rest of us benefit from the improved accuracy and reliability which GPS and Galileo together will provide.

Tony Murfin
VICE PRESIDENT, BUSINESS DEVELOPMENT
NOVATEL, INC.

Lockheed Martin

The Defense Science Board report thoughtfully addresses many key issues as the government looks forward to and works to define future generations of the Global Positioning System. Many of the issues raised in the report have been examined by industry and the Air Force as part of the GPS III architecture and requirements studies.

The report will serve as an important resource as the Air Force finalizes its plans to acquire next-generation space and ground architectures. GPS III is a major focus area for Lockheed Martin, and we stand ready to help the Air Force create a next-generation system that will address the challenging military transformational and civil needs across the globe, including advanced anti-jam capabilities, improved system security and accuracy, and reliability.

Steve Tatum
Sr. MANAGER, COMMUNICATIONS
LOCKHEED MARTIN SPACE SYSTEMS CO.

comprised the task force — a gathering of what used to be known in less gender-sensitive days as "graybeards" or "wise men."

"It was a unique confluence of expertise and leadership that we won't have again for some time," says Jules McNeff, vice president of strategy and programs for Overlook Systems Technologies, Inc., who staffed the task force and oversaw the drafting of its report. McNeff himself has more than 20 years invested in GPS, both inside and outside of DoD.

Rattling Cages

After 18 months of study, more than a dozen outside briefings, and deliberations, this "unique" task force produced a trenchant volume of solidly reasoned findings and recommendations (The full report can be download from the Internet at <http://www.acq.osd.mil/dsb/reports/2005-10-GPS_Report_Final.pdf>.) Inevitably, such a collection of strong-willed, independent free-thinkers with a broad mandate produced some real zingers. Among those proposals:

- Permanently eliminate Selective Availability (SA), the ability to degrade positioning accuracy in open civil signals "with the objective of deleting the hardware and software overhead for its implementation from throughout the future system."
- Change the constellation to a three orbital plane configuration with 30 satellites, rather than the current requirement of 24.
- "Selectively" integrate technical personnel from private contractors into direct satellite monitoring and control operations at the Master Control Station at Schriever Air Force Base — a break from long-standing tradition of only uniformed Air Force personnel operating the satellites.
- Prepare for discussions regarding possible use of Galileo services for military purposes by NATO member nations.
- Require each U.S. military service to fund its own R&D program to best ensure position and timing information is integrated into equipment and operational capabilities. (The function is currently coordinated by the NAVSTAR GPS Joint Program Office.)
- Designate a single focal point within the Office of the Secretary of Defense responsible for all GPS policy and oversight matters.
- Limit GPS III satellite weight to permit launch of two satellites on a single mid-size launch vehicle, including the transfer, if necessary, of the Nuclear Detonation Detection System now on board GPS satellites to other host spacecraft.

Leadership and Capacity

Throughout the report's analysis and recommendations, two concerns stand out: the task force's strong desire to see a greater GPS system capability funded, built, and brought on-line in a timely fashion, and the perceived need to create a clear, unified line of authority and responsibility for GPS — what McNeff refers to as "a single belly button" that can be pushed to get GPS the attention it needs.

But just sustaining the GPS constellation at its current 24-satellite fully operational capability (FOC) level is at risk, according to the task force, as a result of budgetary uncertainty and delays in modernization programs. States of the task force findings: "The current on-orbit inventory is 28 satellites; however, with expected failures, the AF Space Command December 2004 PNT Functional Availability Report reflects a nominal probability between 5–20 percent and a worst-case probability between 20–40 percent that the constellation will fall to fewer than 24 satellites in the 2007–

EADS Space Services

The DSB Task Force report provides a very interesting and fair overview of the Global Positioning System challenges from a performance, competitiveness and governance point of view in view of the upcoming European alternative "Galileo." As a major actor of the future Galileo PNT system, EADS has a particular interest in the GPS evolutions and policy, especially in the field of cooperation with leading U.S. manufacturers.

The Task Force position is particularly appreciable for the navigation industry as it recommends promoting "opportunities for cooperation," "true civil interoperability," and considering "alternative means of funding and governance" for GPS to facilitate its international support. The underlying purpose of this collaborative approach is to improve the commercial and cost efficiency related to the PNT civil signals.

Through its recent site distribution agreement, Galileo has made a significant step forward and will provide in the near future increased satellite signal availability worldwide for navigation purposes. It is indeed a primary objective to promote the combination of the GPS and Galileo constellations for civil users in order to improve significantly the overall positioning accuracy and integrity.

Consequently, the report supports the definition of an international civil signal standardization allowing combined GPS-Galileo receivers. This common effort is necessary to facilitate a wide spread usage and certification of the signals in the commercial sector. Therefore, all parties should sustain the systems interoperability with the "full disclosure of an open signal structure" and well defined geodetic and time reference transformations in receivers.

EADS also welcomes the task force proposal to "explore cooperative exchange of monitoring information" provided by the WAAS and EGNOS systems as well as a "collaborative approach" to manage and monitor both systems for better performances.

Finally, we consider that the adoption of a separate strategy and governance for the GPS military and civil activities would facilitate the system modernizations, international cooperation, and augmentations focused on the civil particular interests, while maintaining a superior military capability.

To conclude, we regret that tangible directives have still not been issued by the U.S. authorities in the direction initiated by the US-EU agreement of June 2004. It would add great benefits to the user community to initiate the creation of joint entities aimed at addressing the performance, the standardization, and the vulnerability of the GPS and Galileo signals across the Atlantic.

Martin U. Ripple
DIRECTOR GALILEO PROGRAM
EADS SPACE SERVICES

The Boeing Company

We continue to execute on our commitment to GPS IIF production, with a goal to make the IIF the most capable and reliable navigation satellite to join the constellation. We also look forward to seeing the customer's requirements for GPS IIIA when the request for proposal (RFP) is issued. We're excited about the new IIIA program and await the competition.

I believe that the majority of the [DSB] comments relate to the future of GPS requirements and that is the purview of the GPS Joint Program Office (JPO). Boeing is ready to respond to the requirements, with whatever DSB recommendations are included. The job of the JPO is to take the opinions of all appropriate experts and meld them into a future roadmap and set of requirements which are sent to industry to propose and build. Again, Boeing stands ready to respond with a compelling proposal.

Mike Rizzo
DIRECTOR, NAVIGATION SYSTEMS
THE BOEING COMPANY

L-3/Interstate Electronics Corp.

In general, the DSB report is "right on." Their assessments regarding current shortfalls and urgent needs bring to light the vulnerabilities that our current war fighter is faced with when depending on GPS. It is true that improved satellite coverage is needed for challenged (e.g. urban) access, modernized GPS availability to the war fighter is too far out in time, and enhanced anti-jamming (AJ) capability is not being adequately funded or fielded.

The report makes a good point about the need for sufficient, but not excessive AJ capability in user equipment. Industry has demonstrated scalable, cost-effective AJ solutions that include hardware and software-only augmentations that satisfy the DSB's recommended minimum acceptable level of 90 dB jamming resistance. These capabilities are easily and readily incorporated into user equipment, yet there are few programs in place to incorporate and deploy it.

Agencies like the Office of Naval Research (ONR) and Air Force Research Lab (AFRL) are financing technology programs that include AJ improvements for GPS; however, these are not pointed at fielding new equipment for the war fighter. Case in point—the Modernized Receiver Card Development Program, which is in place to help establish "proof of design" for modernized GPS does not require this type of AJ enhancement. Hopefully, with the promulgation of the DSB report more military agencies will recognize the emerging jamming threat and programs will begin requiring the deployment of more AJ capability for GPS user equipment.

L-3/IEC agrees with the report's assessment that the new PRONAV security architecture is essential to providing the needed Information Assurance improvements to military GPS (although one might argue with the details in the DSB's comparison of performance benefits that PRONAV provides).

However, one must be cautious with considering the permanent removal of SA or, even more importantly, with opening up DoD acquisition policies to allow non-military GPS equipment. The gamble is the price our war fighter pays by having the wrong positioning, navigation, and timing (PNT) information because he's using vulnerable commercial GPS signals. That price can be the difference between life and death.

Carlton Richmond
CHIEF GPS TECHNOLOGIST
L3 COMMUNICATIONS, INTERSTATE ELECTRONICS CORP

2012 period based on current satellite replacement schedules."

Moreover, the capability to operationally control new GPS L2C and L5 signals will not be present in the GPS control segment until 2009 at the earliest, the report suggests.

Upgrading the Block IIR and IIF satellites to include M-code, L2C, and L5 signals, along with an annual rather than multi-year purchase strategy, nearly doubled the cost of those spacecraft. Looking ahead, the price tag for GPS III satellites will be nearly double that of the preceding generation. As a way to mitigate the expense of the GPS III program, satellites should be designed so as to allow two to be launched at the same time, even if this means eliminating unrelated functions such as NDS.

"The concern that the DSB has is that, if GPS III becomes another massive satellite, the department can't afford it," task force member Brad Parkinson told Inside GNSS. "GPS really needs 30 to 36 satellites, but the Air Force requirement is only 24." Increasing the strength of GPS transmissions should not pre-empt the goal of populating the constellation with more spacecraft, adds Parkinson, who was the first director of the GPS Joint Program Office. "Geometry is more important than extra power."

As for the leadership issue, one of the report's recommendations proposes, "The Secretary of Defense should also clarify lines of authority and responsibility within the Department to eliminate ambiguity regarding GPS responsibilities that hinders decision making internally and that perpetuates the perception externally that the DoD has lost sight of its GPS stewardship responsibilities."

Noting the President's creation of the PNT Executive Committee, which occurred during the task force's deliberations, the report says the new policy body "affords an opportunity for all stakeholders to correct deficiencies of the former Interagency GPS Executive Board [IGEB]." That assessment stems largely from the fact that the President's national security directive creating the executive committee also elevated the level of its leadership to deputy secretaries of transportation and defense.

Nonetheless, reflecting the difficulty of the IGEB to gain sustained participation from its co-chairs, the task force recommends, "If Deputies do not routinely participate, then designated representatives to the . . . PNT Executive Committee . . . must be formally empowered to speak for and act on behalf of their respective Deputies for all matters coming before the [committee]."

Says Parkinson, "The [PNT] executive committee can do some good if it gets the attention of people who can make some changes."

Mike Shaw, director of the National Space-Based PNT Coordination Office that will provide staff support for the executive committee, says he hopes the office will exercise "more insight responsibilities." By this Shaw means looking into the agencies involved with GPS and identifying "disconnects" the prevent a common exercise of GPS policy, and then putting this information "in front of senior people" who can make the needed changes.