



NATIONAL SPACE-BASED POSITIONING, NAVIGATION AND TIMING (PNT) ADVISORY BOARD

Ronald Reagan Building and International Trade Center
1300 Pennsylvania Avenue, NW, Polaris Suite
Washington, DC, 20004

March 29-30, 2007

MEETING MINUTES


James R. Schlesinger
Chair


P. Diane Rausch
Executive Director

**NATIONAL SPACE-BASED
POSITIONING, NAVIGATION, AND TIMING (PNT)
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*Meeting Report Prepared By:
David J. Frankel, Consultant*

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Board Convenes

Ms. P. Diane Rausch, Executive Director, National Space-Based Positioning, Navigation and Timing (PNT) Advisory Board (the "Board") convened the meeting at 9:00 am. She welcomed the Board members and public. She noted that the Board was mandated by the Presidential PNT Policy announced in December 2004, and that NASA is the official sponsor of the Board on behalf of seven Federal agencies: the Department of Defense, Department of Transportation, Department of Commerce, Department of State, Department of Homeland Security, Joint Chiefs of Staff and NASA. She noted the results of the Board would be in the form of findings and recommendations to the National Space-Based PNT Executive Committee (EXCOM), co-chaired by the Deputy Secretary of Defense and Deputy Secretary of Transportation. She announced that the Board was comprised of many distinguished PNT experts from around the world. Ms. Rausch informed the attendees that the Board is a Federal advisory committee under the Federal Advisory Committee Act (FACA), and that minutes of the meeting would be taken, published and posted on the PNT web site (www.pnt.gov). Ms. Rausch introduced the NASA meeting support team and provided administrative announcements. She then introduced the NASA Administrator, Dr. Michael Griffin.

Opening Remarks

Dr. Griffin welcomed everyone to the first meeting of the Board. He announced that the meeting was open to the public, unless restricted for national security or other reasons under FACA. He described the Board's Charter and noted that the Charter was specifically drafted to include international membership, whom he welcomed. Dr. Griffin described the Global Positioning System (GPS). It is a spaced-based system that provides accurate radionavigation and timing information anywhere in the world. The service is now equivalent to a public utility and we would have a hard time today getting along without it. President Reagan issued the original Directive to provide the service and specified that it be provided without charge to the public. GPS is now the best known acronym around the world. The market value for GPS will reach \$30 billion by 2008. Dr. Griffin stated that he had formerly served for 18 months as the Chief Technical Officer for Orbital Sciences Corporation, and served as the Chief Executive Officer for Orbital's subsidiary, Magellan. In that capacity, he became intimately familiar with GPS from both the commercial and industrial side. He described how GPS is being used more and more in space. The Space Station relies on GPS for orbit and attitude control. The new NASA Ares launch vehicles and Orion spacecraft, part of the US Vision for Space Exploration, will use GPS. As we return to the moon, a lunar navigation system, similar to GPS, will be used. He described how navigational skills have been changed by GPS, using his own personal history over several decades as a private pilot. He explained that a wide spectrum of expert advice is essential for the future of GPS, and that he appreciated the Board members for bringing that expertise to the meeting.

Announcements and Introductions

Dr. James R. Schlesinger, Board Chair, thanked Dr. Griffin for his remarks. Dr. Schlesinger noted that six Board members are from the international community, and he welcomed them to the meeting. At Dr. Schlesinger's request, the Board members and other participants introduced themselves.

Dr. Brad Parkinson, Board Co-Chair, described current issues regarding GPS, its constellation size, and its health. The average age of GPS satellites now on orbit is about 9 years. The next generation of satellites, called Block IIF is being developed. The current service constellation has 30 satellites in orbit and users are relying on that number. Block IIIA is now in the System Design Review stage. The Request for Proposal (RFP) for those satellites has been held up in the Pentagon and hopefully will be released soon.

Dr. Parkinson described five primary objectives and concerns for GPS:

1. Assured availability of GPS – a reasonable constellation size and reduced outages;
2. Resistance to jamming and interference – multiple signals;
3. Accuracy, measured to the 50th percentile – constellation size and geometry, more and improved signals, improved ranging errors;
4. Bounded inaccuracy to limit “wild points” (usually the 95th or 99th percentile) – the same as accuracy, but usually more stringent; and
5. Integrity – eliminating erroneous signals/independent cross checking with the Wide Area Augmentation System (WAAS), and satellite self-checking.

Dr. Schlesinger noted that WAAS points to a major challenge: the need to look at GPS from both a national perspective and an international view. He explained that the value of WAAS signals for the user could be enhanced with better integration across the federal government, and how the Board’s recommendations could encourage better integration among the federal agencies. He added that the users’ role here on earth and what is useful to them should receive as much attention as the satellites, and that the services should be available here on earth on a 24x7 basis. The US should retain a leadership role, and this calls for continued investments in GPS. Dr. Schlesinger described how the downing in the 1980’s of the Korean Airlines flight 007 over Russia caused President Reagan to declare that GPS would always be available to the world. Today, he observed, there are a number of other GPS-like service providers emerging, and GPS is no longer a national monopoly.

President’s 2004 PNT Policy

Dr. Philip L. Ritcheson, Director for Space Policy, National Security Council (NSC), briefed the Board on the President’s 2004 PNT Policy. After welcoming the Board members and its international participants, he described the national policy. He explained that the President, in 2004, issued a new national policy because GPS was both integral to national security and had turned into a global utility for other purposes. The Policy’s new features are being implemented today. Its’ scope focuses more directly on a full suite of activities, and its goals and objectives were clarified and refined. These include uninterrupted availability free of user fees, meeting growing requirements in the security and commercial arenas, improving the capability to deny hostile use, continued development at a steady pace—with sustained attention to improvement, a requirement that GPS exceed or be competitive with foreign PNT services, and encouragement to ensure that foreign systems are operable or compatible with GPS. The Policy provides for improved management. It establishes the National Space-based PNT Executive Committee (the “EXCOM”), the National PNT Coordination Office, and the National Space-Based PNT Advisory Board.

Dr. Ritcheson stated that the Policy was issued because other players within the PNT world were needed and new roles for participating agencies had to be defined to specify how they would execute their responsibilities. The Policy provides improved management and as a result, the US is now properly aligned to improve PNT availability with input from civil agencies. Dr. Ritcheson asserted that continual innovation is important in order to meet the challenge of protecting space assets, and because proliferation of space use is advanced and power is being diffused to a greater number of nations. He stated that our charge now is to continue to build on leadership and international engagement in order to produce greater precision, accuracy, availability, and access. He observed that the Board’s Charter calls for the Board to provide advice and recommendations and he described three topics suggested by the EXCOM: Leadership, Strategic Engagement and Communication, and Future Challenges. He is interested in deep thinking about these fundamental issues. He expressed appreciation to Dr. Griffin, Dr. Schlesinger and the Board members. He stated that his office would help the Board in any way and that he looks forward to hearing from the Board.

In response to a question from Mr. McGurn, Dr. Ritcheson identified the principals serving on the EXCOM. Mr. McGurn stated it is important to avoid ill-prepared planning. Dr. Ritcheson replied that he has observed sustained senior participation on how to implement the Policy, and how to identify and close the gaps. Mr. Logsdon asked if there were any plans to brief industry on implementation of the Policy or to involve industry. Dr. Ritcheson stated that there were no plans for his Office or the EXCOM to brief industry and that the Board could serve that role. Dr. Schlesinger observed that the issues are bigger than any one agency. He endorsed the NSC's continued activity to assure that "stovepipes" among separate federal agencies are discontinued and wants the NSC to stay involved. Dr. Ritcheson stated he would encourage that because he also dislikes stovepipes. He noted that the President's 2004 PNT Policy highlights what each agency should be doing. He has seen a lot of good cross-talk, and observed that a good plan is needed for the next Administration in order to assure a smooth hand-off.

Dr. Schlesinger asserted that undue dichotomy between civil and military is a problem. He observed that civilian agencies are involved in what are national security issues. While this increases the problem for the Air Force, he is confident they will handle it. In response to a question, Dr. Ritcheson observed that there has been an increase in augmentations around the globe with improvement in interoperability. He added that we continue to benefit from improved signal integrity and reliability. He asserted that the US is doing the right things. He noted that when users want a signal, they are getting it and that we are engaging internationally to assure interoperability. He warned that it is not all smooth sailing and that the US government agencies have to operate from the same sheet. Dr. Parkinson stated that he defines interoperability as interchangeable satellite signals. He noted that timing standards need to be completely synchronized and that this is an unresolved issue. Dr. Schlesinger thanked Dr. Ritcheson for his presentation.

Department of Transportation: PNT Challenges and Opportunities

Dr. Schlesinger introduced Mr. John A. Bobo, Jr., Acting Administrator, Research and Innovative Technology Administration (RITA), Department of Transportation (DOT). Mr. Bobo informed the Board that DOT's two main PNT goals are to improve safety and to mitigate congestion. He stated that DOT appreciates sharing a leadership role on EXCOM with the Department of Defense (DoD). He noted that funding is important, and he asserted that it would be appropriate for the Board to address the funding issue. Dr. Schlesinger observed that DoD has had the burden of funding GPS because the civilian agencies have not fully appreciated the importance of GPS, a situation that he hopes will be alleviated. Mr. Bobo acknowledged that DOT has a stewardship role to play. Dr. Herman asked whether the civil PNT architecture was intended to be global or U.S. only. Mr. Bobo answered that one goal is interoperability with others around the world. Dr. Parkinson noted that the term "interoperability" needs rigorous interpretation as "interchangeability." Capt. Richard Smith observed that where we are today is where we have not been in the past, and that we had been too wrapped up in the science. He asserted that what has taken place in the automotive world provides a better opportunity to understand the issues. In response to a question from Gen. McCarthy, Mr. Bobo described current GPS funding in the budgets for the Federal Aviation Administration (FAA) and the Coast Guard. Dr. Schlesinger thanked Mr. Bobo for his presentation.

Department of Defense PNT Challenges and Opportunities

Dr. Schlesinger introduced Dr. Linton Wells II, Principal Deputy Assistant Secretary of Defense (Networks and Information Integration), Department of Defense. Dr. Wells stated that we have to comply with national policy and retain GPS as the preeminent standard. He sees nothing on the horizon to jeopardize that. He noted that there is an increasing demand for precision and that the system must work in urban areas, as well as over open oceans. He stated that reliance on precision weapons can be improved down to cm (centimeter) level accuracy. Dr. Wells described several concerns. He discussed the proliferation of jamming capabilities and noted that improvised explosive devices cause jamming. He observed that there is an increasingly complicated spectrum problem and that there are concerns over M-code (military code) overlapping due to the emerging Chinese system. Dr. Wells stated that there is an increasing dependency on the timing function, which is something everyone must be aware of. He suggested that the exact degree of dependency on the timing function should be addressed by the Board. He discussed the issue of compatibility with international standards and noted that augmentation—GPS plus something else—is

probable. Dr. Wells described the opportunities. One is the clarification of roles among the federal agencies. He believes that the GPS program is getting back on track and moving forward, although it is still behind schedule. He expressed concern over the out year fiscal environment. Resources have been a hard fight, and tight budgets are expected. He described portfolio management as cause for optimism.

Dr. Schlesinger asked about the status of the Block IIF satellites, noting that he had heard there were cost-overruns. Dr. Wells explained that the program has turned around in the past year and that these satellites would be available for launch as planned. Dr. Herman asked about a need for a warning on funding reduction and whether there is a story-line or rationale. Dr. Wells replied that he does not see a rationale for reduced funding. He added that when the budget becomes more austere, GPS may become a source for offsets. He wants a rationale to maintain GPS funding in that event. He observed that the target is getting to better capability, not maintaining what we have.

Dr. Parkinson stated that he has been following with enthusiasm the progress on GPS III. He noted that the Air Force is doing well with GPS III. He expressed concerns over affordability and the fact that the RFP has not been released. He explained that “brown-outs” would result if delays caused the constellation to be reduced from 30 to 24 satellites. Dr. Parkinson stated that there is to be a nuclear detection system (NUDENT) on GPS III, and this should not constrain the primary PNT mission. He explained that there has to be a balance between fiscal realities and the need to get satellites launched quickly. Dr. Schlesinger stated that timing has two aspects. He noted that the clocks are not the same as the other providers of this service and that the US and international time are different. He added that there is some slack and that at the Naval Academy he was assured that there were back-ups. Dr. Schlesinger posed the question: “What confidence is there that we will be able to maintain GPS III as the standard grid?” He stated that he is no longer concerned about single points of failure since there is robustness. Dr. Parkinson explained that the issue is that different Earth reference frames are used by different systems, and that there is a need to come up with a single uniform system. There should be US encouragement for interoperability, or more specifically, interchangeability, but the Russians are not likely to go along with this.

Dr. Pace described possible solutions for future changes in the GPS Block III. Gen. Lord observed that we now see a premium in protecting space constellations and that everybody in the situation, military and civil, need to have compatibility. Accordingly, there is a need for everyone to be involved in understanding vulnerabilities. Dr. Wells concurred. Mr. Logsdon stated that it would make sense that with national security intertwined, industry should be included in war games to better understand the consequences of a degraded or absent GPS system. Dr. Wells said that was a terrific idea and he would follow-up on it. An observer noted that industry was recently included in war games. Dr. Wells explained that there had been U.S. inter-agency involvement in the recent Schriever War Games. Dr. Schlesinger asked whether industry partnership should include financial responsibility. He stated that industry has historically claimed GPS was a national security matter that the government should fund; however now GPS use is broader.

Mr. McGurn asked when the military M-code would be delivered. Dr. Wells said 2009-2011, and that additional funding is needed. He explained that there is going to be a draft document to fold into the 2009 budget and that the intention is for equipment to be rolled out in 2012-2013. Dr. Wells agreed that a mix is needed between “fast-movers” and troops on the ground. He noted that the first II R-M satellite is on orbit now, but that there are not enough satellites to provide a sustainable signal. Dr. Parkinson commended Dr. Wells for the progress that has been made. Dr. Schlesinger observed that space flight could become contested, now that China has intercepted one of its own satellites. Dr. Wells concurred that there is great concern about this. He added that sustainability is being closely examined with a variety of plans at the highest level. In response to a question from Dr. Schlesinger, he noted that programs and concepts at DoD would back up the Department of State. Ms. Ciganer noted that companies of the U.S. GPS Industry Council work hard to introduce new technologies that optimize the capabilities of the GPS signals. Dr. Wells discussed recent Defense Advanced Research Project Agency (DARPA) work on chip scale atomic clocks. Ms. Neilan noted that GPS PNT is used now in all timing labs. Dr. Schlesinger thanked Dr. Wells for his presentation.

Break

The Board adjourned for a short break and group portrait.

National Aeronautics and Space Administration: PNT Challenges and Opportunities

Dr. Schlesinger reconvened the meeting and introduced Dr. Scott Pace, Associate Administrator for Program Analysis and Evaluation (PA&E), NASA. Dr. Pace described NASA's reliance on GPS. He noted that STS-115 was the first shuttle to use GPS for navigation. GPS has now flown on many flights, enabling NASA to retire expensive radar systems. Dr. Pace observed that GPS is being used on sub-millimeter levels for gravity maps and he described several science applications that use GPS for probing the Earth – its ionosphere, oceans, atmosphere, and solid Earth. He explained how GPS is being augmented in space. Differential GPS corrections are made possible by the Tracking and Data Relay Satellite System (TDRSS) Augmentation Service for satellites (TASS). He noted that GPS is utilized for search and rescue operations on a prototype basis with a system called Distress Alerting Satellite System (DASS), and along with the Search and Rescue Satellite (SARSAT), has contributed to saving over 20,000 lives to date. DASS uses uplinks from 406 MHz beacons, and enables a position fix to be obtained within a 5.6 square meter area in only a few minutes. NASA has substantially completed research activities on this and is now handing it off to the Coast Guard and NOAA for operational implementation as part of GPS III.

Dr. Pace described another potential capability for GPS III that is somewhat different from gaining data via standard GPS signals: Satellite Laser Ranging using Satellite Laser Retro-Reflectors (SLR). He explained that this is independent of using radiometric GPS signals derived from the WGS-84 reference frame, and will enable performance improvements in GPS by providing an independent means to verify precise satellite orbits and improve the international terrestrial reference frame. Dr. Parkinson explained that this requires support from the GPS Block III managers. Dr. Beutler discussed the need to obtain accuracies to the sub-centimeter level. He stated that SLR is essential because it gives a different kind of measurement and provides a way to calibrate the system. Many satellites utilize SLR reflectors. The IGS is engaged with looking for subtle errors, and SLR is the only tool that enables an independent assessment. Dr. Pace concurred and compared it to the FAA's interest in integrity monitoring.

The signal side lobes from GPS antennas were discussed. The side lobe signals can be picked-up about one-third of the way to the moon. These can be exploited in GPS Block III. Dr. Pace explained that NASA is seeking to use standards similar to GPS in order to move seamlessly from Earth into space and to the Moon and beyond. For the Moon, they will use either small satellites, or beacons that will transmit GPS-like signals. He noted that landing the first time is not that hard; it is landing at the same place the next time that is a more demanding problem. He stated that a small constellation of a few satellites could be used around Mars. This is part of the long-range plan. He noted that GPS time is not tied to a particular planetary surface, and that there are relativistic effects on time to be taken into account, since there is movement. He explained that there are different reference frames calling for adjustments and that it is important to use a common time standard, such as solar system Zulu time. Dr. Schlesinger thanked Dr. Pace for his presentation.

Federal Advisory Committee Act (FACA) Briefing

Ms. Rausch noted that international members of the PNT Advisory Board are serving as duly appointed "Representatives" of their respective entities, and as such, they are not "Special Government Employees" (SGEs) subject to the U.S. ethics laws. It is understood that representatives from international arenas bring a specific point of view to the table that is extremely valuable in the Board's deliberations. She indicated the international Board members were encouraged to stay for the FACA briefing to gain an overall perspective of how U.S. Federal advisory committees operate, but noted that the Ethics briefing to follow was purely optional for them.

Ms. Rausch then briefed the Board on the Federal Advisory Committee Act (FACA). She informed the Board that she is the Designated Federal Official (DFO) for this specific PNT Advisory Board and is also NASA's Advisory Committee Management Officer (ACMO), providing management oversight and ensuring compliance for all of NASA's advisory committees. As background, the U.S Government has used outside expert advisory groups since the earliest days of the Republic (1793). In 1972, Congress

passed FACA to ensure that Executive Branch decision-making would be open and accessible to the public. Advisory committees automatically expire after two years, unless their term is extended. Ms. Rausch noted that the purpose of Federal advisory committees is to give advice, i.e., provide findings and recommendations, not to manage Federal programs. She stated that FACA is automatically triggered if there is one or more non-Federal employee(s) serve on an advisory committee, commission or panel. Ms. Rauch described the general FACA requirements:

- Develop and file a charter for the advisory committee with Congress;
- Maintain a balanced membership;
- Hold open meetings;
- Keep minutes or summaries of meetings;
- Allow public filing of written statements;
- Announce all meetings in the Federal Register; and
- Maintain all committee documents for public inspection.

She stated that each Federal agency is required to have an ACMO and that each FACA advisory committee must be supported by a DFO. The DFO performs the following functions:

- Calls, attends, and adjourns meetings;
- Works with the advisory committee Chair;
- Prepares Federal Register notices for meetings;
- Approves agendas, press releases, etc.;
- Maintains required official records, including minutes, membership, and cost records; and
- Maintains meeting records for availability to the public.

Ms. Rausch explained that some Board members are SGEs and others are Representatives. Members appointed as SGEs serve as subject matter experts and must file financial disclosure forms for review by the DFO and Office of General Counsel. Members appointed as Representatives are expected to represent and present official policies and views of the entity they represent; therefore, they have no requirement to file financial disclosure forms.

Ms. Rausch reviewed FACA's goals:

- Reduce inappropriate influence on government decisions;
- Eliminate decision-making behind closed doors;
- Improve public confidence in Agency decision-making;
- Allow public contemporaneous access to the decision process;
- Ensure positive public perception of the Executive Branch; and
- Help enable "good government."

She explained that closed meetings are permitted as exceptions to the public meeting requirement, provided they are planned in advance, reviewed by the ACMO and Office of General Counsel, and approved by the Agency Head in writing. Meetings may be closed for several reasons, including:

- National security;
- Trade secrets, or commercial or financial information;
- Criminal investigatory records;
- Issuance of subpoenas or litigation strategy;
- Purposes specifically exempted by statute; and
- Personnel issues.

Ms. Rausch explained that "non-FACA meetings" are activities that are not subject to FACA. A determination memo for non-FACA meetings is required in advance and must be signed by the DFO, the ACMO, and Office of General Counsel. Non-FACA meetings may be used for purely administrative sessions (schedule, membership, operating principles), preparatory meetings (drafting sub-groups), and purely fact-finding meetings (site visits, research, information-gathering).

Ethics Briefing for Special Government Employees (SGE's)

Ms. Rebecca Gilchrist, NASA Office of General Counsel, briefed the Board on Ethics requirements. She stated that she was presenting this briefing because NASA is the Board's sponsor. She noted that the ethics briefing is not mandatory for Representatives, and that SGEs are subject to some, but not all of the ethics laws that apply to full-time employees. A SGE is anyone who performs temporary duties for a period not to exceed 130 days (cumulative) out of any 365 days. Ms. Gilchrist described the basic ethics principles:

- Public service is a public trust;
- No conflicting financial interests;
- No improper use of nonpublic information; and
- Avoid even the appearance of impropriety.

Ms. Gilchrist reviewed the representational conflicts and financial conflicts that the ethics law prohibits. She described post-employment restrictions and standards of conduct. She noted that the Designated Agency Ethics Official is Michael C. Wholley, NASA's General Counsel. She stated that the NASA Headquarters Ethics Team is available to assist the Board. The team members are Rebecca Gilchrist, Adam Greenstone, and Katie Spear. They may be reached at (202) 358-2465 or at ethicsteam@hq.nasa.gov. Several Board members had questions concerning specific issues and those issues were addressed by Ms. Gilchrist.

Department of Commerce: PNT Challenges and Opportunities

Dr. Schlesinger introduced Mr. Edward Morris, Director Office of Space Commercialization, National Oceanic and Atmospheric Administration (NOAA), US Department of Commerce (DOC). Mr. Morris described DOC's involvement with GPS as a user, manager, provider, developer, and promoter. Dr. Parkinson stated that the International Traffic in Arms Regulation (ITAR) is a difficult regulation for universities to work with.

Mr. Morris described the key GPS tenets from DOC's perspective:

- Provide civil GPS and augmentations free of direct user fees on a continuous, worldwide basis;
- Provide open, free access to information needed to use civil GPS and augmentations;
- Improve performance of GPS and augmentations; and
- Seek to ensure that international space-based PNT systems are interoperable with civil GPS and augmentations or, at a minimum, are compatible.

Dr. Schlesinger asked for the DOC reaction to the announcement that Europe's Galileo GPS system intends to impose user fees. Mr. Morris responded that it would be difficult to successfully establish a concessionaire model. Dr. Parkinson expressed his encouragement for a clear L2C. Mr. Morris stated that DOC looks forward to working with the Board on commercial issues. Mr. McPherson asked whether Galileo might be imposed as a requirement on airplanes flying to European countries, and Mr. Morris explained that there is no indication at this time that this is contemplated. Dr. Schlesinger observed that there may be a temptation to impose that requirement in order to make the Galileo business model work. Mr. Murphy explained that this would not be accepted by the International Civil Aviation Organization (ICAO). Dr. Schlesinger thanked Mr. Morris for his presentation.

Department of State: PNT International Challenges and Opportunities

Mr. Ralph Braibanti, Director, Space and Advanced Technology, U.S. Department of State (DOS) briefed the Board. He stated that GPS has become a global utility and that we are moving from a system where the US had a near monopoly, to a system where there will be five other competitors (Europe, Japan, China, Russia, and India). He explained that the U.S. is seeking to maintain a leadership position while a global PNT "system of systems" materializes. In response to a question from Dr. Schlesinger, Mr. Braibanti explained that DOS only occasionally exercises budgetary leadership in GPS research and development. Dr. Parkinson noted that Mr. Braibanti is a national resource on GPS, who is soon to retire, and expressed concern that Mr. Braibanti's replacement has an adequate background. Mr. Trimble expressed appreciation for the work that Mr. Braibanti and DOS did in order to protect the radio spectrum needed for GPS.

Mr. Braibanti reviewed several DOS accomplishments involving GPS. Recently, the U.S. and the European Community signed a landmark agreement on GPS-Galileo cooperation. The agreement recognizes the importance of compatibility and interoperability. He noted that working groups have been established to continue this dialogue. Mr. Braibanti stated that Col. Ballenger from the Air Force has done a lot of work with the Japanese. Japan's status as a world leader in GPS applications and user equipment makes it an important partner. Discussion topics include Japan's regional augmentation system and interoperability between GPS and Japan's planned Quasi-Zenith Satellite System (QZSS). Dr. Parkinson emphasized that interoperability should be interpreted to mean interchangeable. Mr. Braibanti reviewed the status of discussions with Russia on its GLONASS system. Working groups are pursuing GPS-GLONASS interoperability. A U.S.-India Joint Statement on GNSS cooperation was issued in February 2007. In addition to augmentation, India has a plan to build a constellation of six satellites. Mr. Braibanti noted that there is a need to continue technical work to promote compatibility and interoperability. Consultations on PNT issues should be broadened to include more countries.

Mr. Braibanti stated that the current policy discourages new space cooperation with China, which is planning to build BEIDOU/COMPASS, a full constellation system. He opined that there should be a dialogue with China on that system, and he commented that the US is not doing anything now to initiate discussions on this with China. In his opinion, we need to get over that hump. In response to a question from Dr. Herman, Mr. Braibanti described the current policy concerning space cooperation with China. Basically, cooperation is limited to exchanging remote sensing data. The problem is that China is exporting objectionable items; hence, the official administration policy is to not initiate new space conversations with China. Mr. McGurn stated that Russia plans to have a full constellation by 2009. Mr. Braibanti observed that Russia's plan is basically a budget and resources question. Ms. Neilan asked about the prospects for other providers to engage in discussions with China. Mr. Braibanti stated that there are rational reasons for the existing policy, although there are now compelling reasons to find a way to initiate those conversations. Mr. McPherson conveyed Australia's appreciation for Mr. Braibanti's personal involvement and wished him well for his retirement. Dr. Schlesinger thanked Mr. Braibanti for his presentation.

Department of Homeland Security: PNT Challenges and Opportunities

Dr. Schlesinger introduced Capt. Curtis Dubay, P.E. Department of Homeland Security (DHS), Chief of the Systems and Architecture Office, U. S. Coast Guard. Capt. Dubay stated that the widening dependence on GPS systems has made them increasingly vulnerable. He explained that DHS is focusing planning efforts to coordinate US capabilities to identify, analyze, locate, attribute, and mitigate sources of interference to the GPS and its augmentations. He mentioned four phases of interference detection and mitigation techniques. In response to Dr. Parkinson's request for more details, Capt. Dubay explained that a formal plan has not yet been developed. Dr. Parkinson noted that there is urgency here. Mr. McGurn noted that he has heard about this and various plans for 20 years and that nothing will happen until someone is made responsible. Capt. Dubay stated that a PNT working group has been set up for that purpose. Dr. Parkinson asked how much money was available for it, and he observed that without funding it is not a real program. Capt. Dubay indicated that he would obtain that information. In response to a question from Gen. McCarthy, Capt. Dubay reported that better progress in implementing a plan is anticipated. Gen. McCarthy stated that the Department of Defense should be included. Gen. Lord stated that an attack on GPS would be insidious and there is a need to learn more on how DHS is proceeding. He asked how DHS would protect the constellation and assure continuity of service. He noted that an important step is being made here and indicated that he wants to know more about it. Capt. Dubay described "The National Infrastructure Protection Plan" as it relates to GPS. Dr. Schlesinger noted that the DHS Interference Detection and Mitigation (IDM) plan is oriented to the "homeland." He stated that it is essential to bring our efforts together because there are interdependencies that are not well understood. He added that stronger signal strength would be useful. Ms. Neilan stated that we want the world to use GPS and asked how the plan would affect the rest of the world. Capt. Dubay said that the Department of State should answer that question because DHS's mandate is to deal with the homeland. Mr. Braibanti commented that this is an important issue, but not much has been done internationally. Mr. McPherson noted that Australia has laws prohibiting interference devices and he suggested engaging other nations to help mitigate jamming and interference.

Capt. Dubay described how the nation's critical infrastructure relies on GPS. DHS is working to raise awareness about that reliance. Dr. Schlesinger expressed concern over the level of cooperation coming from the electric power industry. He noted that protection involves spending money; those that are regulated are reluctant to do so, and those who compete are concerned with costs. He added that for decades, the problems have been discussed, but there has been no action. Capt. Dubay responded that DHS is seeing increased "awareness." He discussed the need for a greater understanding about the risks. There is a complex array of overlapping authorities, capabilities, and procedures. DHS's objectives require education and a collaborative partnership with Air Force Space Command, the Federal Aviation Administration (FAA), National GPS Operations Control Center, the U.S. Coast Guard (USCG) Navigation Center, the Federal Communications Commission (FCC), the National Telecommunications and Information Administration (NTIA), the National Communications System, the National Coordination Center for Telecommunications, and the Department of Defense Joint Navigation Warfare Center. Capt. Dubay observed that the extent of U.S. GPS dependence is difficult to quantify. He stated that most end-users and service providers do not control all of the assets upon which they depend. He added that DHS's IDM planning builds resiliency into protection. He defined "resiliency" as the capability of a system to maintain its function and structure in the face of external forces and to retire gracefully when it must.

Dr. Schlesinger stated that the participation of the private sector is important and more difficult to obtain than government agencies. He identified the chemical industry as another such sector and asserted that this is a problem that is not being resolved. Dr. Hermann stated that incentive structures are not in place to accomplish what is needed. Bullying the private sector will not work – a different strategy is required. Dr. Schlesinger noted that proposed legislation would require industry to comply with orders where compliance has been difficult to obtain. In response to a question from Mr. Huber, Capt. Dubay acknowledged that there is much work remaining to be done. Dr. Parkinson expressed concern about the Wide-Area Augmentation System (WAAS). Gen. Lord stated that there is too much focus on the constellation and not enough on the service. Dr. Schlesinger thanked Capt. Dubay for his presentation.

GPS Service and Performance Overview

Dr. Schlesinger introduced Col. John Hyten (Brig. Gen. Select), Commander, 50th Space Wing. Col. Hyten explained that the 50th Space Wing is the Air Force organization responsible for all Air Force space systems and that their job as a Wing is to operate and protect the GPS service. He described the Air Force GPS mission: Provide the best space-based positioning, navigation, and timing capability in the world 24/7/365. He explained that the focus today is on delivery of terrestrial effects. He described past efforts. The primary concern initially had been satellite operations, not effects. The major constellation was put in place in 1991-1994, and those satellites are now being replaced. There have been "growing pains." Civilian users had been forced to work around selective availability (SA). Military user equipment demands grew faster than equipment could be supplied. He noted that in 1991 there were approximately 15,000 civilian receivers and the primary GPS uses were land surveying, maritime navigation, and precision timing. In Desert Storm, there were 10,000 civilian GPS units and 8,000 military GPS units. Dr. Parkinson expressed appreciation to Charles Trimble for providing GPS units to ground troops during Desert Storm. Col. Hyten stated that there is an ongoing transition from a satellite operations focus to a focus on effects-based operations. Increased accuracy and signal integrity is providing improved military effects. He stated that there is a lack of full synchronization across all system segments. He noted that in today's civilian market, there are over 15,000,000 receivers and that the primary uses are:

- Cell phone communication/ precision timing source;
- Navigational purposes (airlines, trucking, recreational);
- Surveying and geodesy (oil drilling, mapping);
- Precision agriculture;
- Intelligent railroads; and
- Just-in-time delivery.

Col. Hyten stated that GPS modernization is on line now and that he spends one third of his time focused on GPS problems. Thirty-one satellites are being flown, with one being a test satellite. He stated that September 11, 2001 changed GPS operations in a significant way: today, many users are first responders

who have embedded GPS capabilities in their first responder capabilities. He noted that there are over 100,000 GPS units in use today by the U.S. military. Col. Hyten described how a soldier on a mountaintop using GPS can now call in accurate military strikes. He stated that GPS has brought about a fundamental change in warfare and that the big challenge in the future is to bring about full system integration. There will be a need to integrate multiple military and civilian signals. He stated that it is important to maintain 30 satellites, which the Defense Science Board (DSB) has concluded is the number needed for accuracy. Dr. Schlesinger noted that the Air Force has been criticized because it only guarantees 24 satellites. Col. Hyten responded that the number of satellites is the wrong metric: that what is needed is to know the accuracy that is required globally, and then build that number. Dr. Schlesinger stated that 30 is the number needed to obtain the necessary accuracy. Col. Hyten described the problems involved in producing an accurate air drop strike in steep mountains and a busy electronic environment. There is a loss of GPS signal. They have developed an ideal flight plan to make it work. Dr. Parkinson stated that the way to arrive at 30 satellites is to look at the effects. Col. Hyten described the GPS operations center at Schriever Air Force Base and explained that it is focused on providing GPS to the world. The Center is now getting calls from FAA, Coast Guard and other non-military federal agencies. Sometimes, calls are received from commercial entities in the field, although they should be calling the FAA or Coast Guard NAVCEN. Col. Hyten noted that the timing signal from GPS is extremely important. He stated that the challenge in the future will be to integrate the many signals that will be coming on line.

Mr. McPherson asked if there is a tracking issue for more than 30 satellites. Col. Hyten stated that 170 can be flown, but the current ground system can't handle more than 32. Mr. Murphy stated that there was a problem with user equipment due to legacy effects. He added that there is a contrast between what is guaranteed by the Air Force and what is actually in place. Dr. Schlesinger observed that it is tragic when we turn on a new signal and fail to take advantage of it. Dr. Hermann asked whether this problem should be elevated to the EXCOM level. Dr. Parkinson stated that the Board is an advisor to the EXCOM. Mr. Trimble stated that the commercial sector does not care about what is guaranteed. It just cares about what is provided. He added that if more satellites are provided, the commercial sector will figure out a way to use them. Dr. Parkinson noted that there would be problems for commercial users if there was a drop in the number of satellites. Mr. Trimble stated that if a signal is provided, it will be used. He added that the Russian signal is not always strong enough or available. Mr. McPherson noted that regulatory requirements must be based on the guaranteed number. Dr. Parkinson asserted that the EXCOM is not populated with government representatives not terribly sensitive to these issues yet. Dr. Schlesinger suggested that this is a task for the civilian agencies because the Pentagon is not alert to things that are outside the Pentagon. He added that the civilian agencies are in a position to advertise what the realities are. Mr. McPherson asserted that there are many countries that would help if they knew that there was someone who would listen. He stated that other countries have problems using GPS and that those problems could be resolved if the guarantee was increased to 30 satellites. Mr. McGurn commented that the kind of receiver is critical, and Dr. Parkinson added that every meter of accuracy is worth striving for. Dr. Schlesinger thanked Col. Hyten for his presentation.

GPS Status and Modernization

Col. Allan Ballenger, Commander, GPS Wing, U.S. Air Force, gave a briefing on GPS status and modernization. Col. Ballenger explained that he is responsible for the GPS acquisition arm and that Col. Hyten is responsible for the GPS operations arm. He described the GPS Wing's mission: acquire and sustain survivable, effective, and affordable global positioning service for our customers. He stated that the total budget is \$900 million to \$1 billion a year. Col. Ballenger reviewed a chart describing the GPS system; as including a User Segment (M-Code, DAGR-Defense Advanced GPS Receiver, SAASM, CSEL and MAGR 2000), a 30 Satellite Space Segment (Block IIR/IIR-M, Block IIF, and Block III), the Control Segment (4 Ground Antennas, 11 Monitor Stations, and Schriever Master Control Station), and NDS (Nuclear Detection System). He stated that there are 30 healthy satellites and that the baseline is 24 satellites. Col. Ballenger described new acquisition strategies for the next generation GPS and noted that they include a back to basics approach. He explained that mission success is taken very seriously, and he described the key performance measures: accuracy, bounded inaccuracy, assured availability, integrity, and resistance to RF interference and jamming.

Dr. Parkinson complemented Col. Ballenger on the results. Col. Ballenger stated that user equipment has been a strong constraint. He explained that there are niche market opportunities for applications that cannot be fulfilled by GPS, for example, providing zero age of data. He added that combining GPS with IR or radar or chip scale atomic clocks can result in advanced equipment and applications. Prof. Enge concurred with the possibility for niche developments. He stated that civil aviation would be helped by more information on RMS URE.

Col. Ballenger described the overall GPS modernization program. "Job one" is assuring the availability of signals from space, and that capability is being modernized with new signals. The control segment is being transitioned from a legacy to a new architecture/system. This is expected to be completed in the summer of 2007. Dr. Herman asked if they are holding to two satellites per launch and explained that there are two camps: keep it simple vs. more capability. Dr. Parkinson stated that Block III will fit two satellites to a booster. Col. Ballenger stated that two per launcher is currently planned, but he added that this could constrain the ability to add future capabilities. Mr. McPherson asked whether SA would be installed on GPS Block III. Col. Ballenger responded that it is still included, but noted that the Presidential decision was to turn it off. Mr. McPherson opined that SA is a deterrent and should be removed. Dr. Schlesinger thanked Col. Ballenger for his presentation.

PNT Executive Committee Tasking and Discussions

Mr. Michael Shaw, Director, National Coordination Office (NCO) briefed the Board. Mr. Shaw explained that the NCO serves the National Space-Based Positioning, Navigation and Timing Executive Committee (EXCOM). The NCO and EXCOM were established by the same Presidential Policy that established the PNT Advisory Board. Mr. Shaw described three topics that the EXCOM would like the Board to address:

Topic 1 – Leadership: Recommend areas where GPS and its augmentations can be made more competitive

- a) Near Term (6 months): Examine navigation-communications services for civil applications, including the issues related to safety-critical certification requirements, the overall business case, technical feasibility, and analyses of potential alternatives.
- b) Mid Term (one year): Review and prioritize future GPS III satellite capabilities, expanded ground segment capabilities, and/or regional augmentations that would provide the greatest improvement and value relative to increased benefits to the global user community at reduced risk and cost.
- c) Long Term (two years): Identify actions that would enhance long-term economic and regulatory stability for the development of Global Navigation Satellite System (GNSS) capabilities and services in the national and international arenas.

Topic 2 – Strategic Engagement and Communication: Recommend ways to promote and demonstrate current and future capabilities of GPS and its augmentations to the U.S. and international communities

- a) Near Term: Develop options for promoting GNSS capabilities for domestic and foreign audiences.
- b) Mid Term: Identify actions the U.S. Government could take in international organizations, standards setting bodies, and/or foreign capitals to prevent attempts to mandate the exclusive use of any one GNSS system in specific geographic areas.
- c) Long Term: Propose approaches for maintenance and improvement of GPS's leadership and acceptance around the world.

Topic 3 – Future Challenges: Assess technology and market trends as the number of worldwide GNSS providers increase

- a) Near Term: Recommend steps agencies should take to achieve spatial interoperability, including harmonization of common grid operations that would be used to identify locations and coordinate time-critical operations.
- b) Mid Term: Assess the implications to the U.S. Government, public sector, and overall U.S. economy of multiple Global Navigation Satellite System (GNSS) providers.
- c) Long Term: Propose approaches on commercial trade issues to ensure a level playing field in the space-based PNT market place, i.e. prevent adverse restrictions.

A discussion ensued on Selective Availability (SA). Mr. Miller reported that other nations do not trust GPS because of the international perception that continuing with SA capability enables GPS to be turned off at any time by the DoD. He also reported that he had been informed by Galileo representatives that if the Galileo signal was to be used for a hostile action and turned off, Galileo would pay damages because it guarantees its' service. Mr. McGurn stated that SA will keep coming back as an issue due to vested interests. Dr. Herman observed that the ability to turn SA on and off suggests that someone will profit from the decision. He doesn't know any scenario in which it works and he noted that the opportunity of having internationals participate on the Board is to get the word out that GPS is stable. Mr. Shaw questioned the need for SA – if it isn't a real capability, then why keep it? Mr. McPherson stated that SA is a perception and an education problem. It is highly unlikely that the need to use SA will occur. He noted that there are other means to deny accessibility. Capt. Richard Smith stated that SA is misunderstood and that he would welcome a way to mitigate this.

Mr. Shaw stated that the EXCOM is interested in getting advice. This is a good window of opportunity. Dr. Schlesinger noted that there has been a steady stream of advice that SA makes no sense, yet it is still around. Mr. Shaw observed that the civil signal has never been deliberately degraded since 1990. Mr. Martin Faga stated that there is a powerful argument for not putting SA on future GPS satellites. Gen. Lord added that there are solutions that are more elegant. Dr. Beutler stated that SA has induced the development of differential GPS systems. Mr. Murphy asserted that the US has done a good job of being the steward of GPS performance, but has not done a good job of education. In response to a question from Mr. McPherson, Dr. Parkinson stated that there had been a Fault Modes Effects and Criticality Analysis (FMECA), but did not know whether the analysis had been shared. Mr. McPherson responded that the Imperial College is performing another FMECA because the other hadn't been shared. Dr. Parkinson noted that a FMECA was available in 1975. Dr. Schlesinger stated that SA made some sense when there was some plausibility of a nuclear missile exchange, but that he cannot conceive any scenario in which SA has any credibility today.

Afternoon “Wrap-Up” and Announcements

Ms. Rausch briefed the Board on the reception and dinner planned for that evening and the meeting was adjourned for the day.

March 30, 2007

Announcements

The Board meeting was reconvened at 9:00 am. Ms. Rausch provided the members with administrative information. Dr. Schlesinger stated that he wants to develop a clear understanding on what the Board wants to achieve by its next plenary meeting, which will be scheduled for the first week in October. He explained that chairs and co-chairs will be appointed for each topic given by the EXCOM. He anticipates that each panel would hold fact-finding sessions. Those sessions do not have to be open to the public, but the results of such fact-finding sessions would need to be briefed to the full PNT Advisory Board in public session. The output should be actionable recommendations that can be given to the EXCOM in the fall. He noted that the international members will be provided materials and need not attend the fact-finding meetings.

Defense Science Board Task Force on the Future of the Global Positioning System

Dr. Schlesinger briefed the Board on the work of the Defense Sciences Board (DSB) Task Force on the Future of the Global Positioning System. The Task Force has identified six national PNT objectives:

- Provide uninterrupted availability of positioning, navigation, and timing services;
- Meet growing national, homeland, economic security, and civil requirements, and scientific and commercial demands;
- Remain the pre-eminent military space-based positioning, navigation, and timing service;
- Continue to provide civil services that exceed or are competitive with foreign civil space-based positioning, navigation, and timing services and augmentation systems;
- Remain essential components of internationally accepted positioning, navigation, and timing services; and
- Promote U.S. technological leadership in applications involving space-based positioning, navigation, and timing services.

Dr. Schlesinger observed that the third objective, “remain the pre-eminent military space-based positioning, navigation, and timing service,” will require funding.

Dr. Schlesinger reviewed the salient points developed by the Task Force. Too much attention in the past has been focused on the space component, with insufficient attention on the other two components—ground control and the users, both too often forgotten in the budget process. He explained that the GPS system is a system of systems: ground control, user equipment, and satellites. A minimum constellation size of 30 satellites is needed to support ground forces in varied terrain and to support the other users. Dr. Schlesinger described how ambitious requirements are driving up the cost of GPS Block III. Weight must be controlled for cost purposes, as it is essential to maintain the flexibility to launch two satellites on the same launch vehicle. Emphasis should be relaxed on anti-spoof and increased attention paid to anti-jam. He reviewed a chart detailing GPS III launch costs and noted that the failure to have two satellites per launcher would cost an additional \$100 million per satellite. Mr. McGurn asked about the rationale for reducing the anti-spoof, specifically smart jamming. Dr. Parkinson noted that this was due to recent developments. He also noted that the military must be alert to capabilities being less than expected. Dr. Schlesinger commented that the emphasis is on the need to rebalance.

GPS Independent Review Team

Dr. Schlesinger introduced Major General “Rosie” Rosenberg, Chairman of the GPS Independent Review Team (IRT). Gen. Rosenberg described the independent review process. The IRT Mission is to identify opportunities and provide strategic and technical recommendations to Space Command for the successful development of future positioning and timing for service for all users. Gen. Rosenberg emphasized that this is for all users. He explained that this is a different world today where the military must work with civilian and coalition partners. The major challenge on the issue of vulnerability is that the client is concerned that solutions will cost money. He opined that much can be done by simply changing tactics and procedures to mitigate the vulnerability problem.

Gen. Rosenberg described the IRT’s vision and goals. Increased accuracy is needed for precision operations and situational awareness. GPS should be the signal of choice, although other systems are also required. Not all signals must be provided from space. The GPS system must be robust enough to be available in challenged environments – urban canyons, mountainous areas, heavy vegetation, and areas of significant RF interference.

Gen. Rosenberg described the “Big Five” performance measures of effectiveness:

- Assured availability of GPS signals for operations – including impaired situations;
- Resistance to jamming and interference (90dB of AJ);
- Accuracy – one meter for fixed (3 meter for moving) targets & other operations;
- Bounded inaccuracy – to meet critical safety of life limits, and to limit collateral damage and fratricide; and

- Integrity – eliminating erroneous signals.

He noted that there is an artificial requirement called “24 satellites on orbit.” He stated that all users today are used to 28-30 satellites and that a brown-out or reduction in that number would have the potential for an enormous adverse impact. He opined that the real requirement today is for more than 24 satellites. He noted that due to an antiquated ground system, every satellite is treated as IIA. This is a problem that must be fixed.

Gen. Rosenberg described the IRT’s themes. The first priority is ubiquitous 24/7 service to all users. There should be a concept change from technologies to a basic positioning and timing service. Signals should be fully enabled as soon as available. National security is more than offensive and defensive warfare; it includes economic well-being. The IRT feels it is important for the Defense Department to understand it is important to national security for the GPS signal to remain the service of choice around the world; this would keep the technology in the US. He observed that the real users do not fully understand the system and that there needs to be more effective dialog with them. He noted that ground forces’ requirements are not adequately reflected, and that smart weapons are not well integrated with GPS. There is a lack of horizontal integration understanding by the services, and there needs to be a better understanding of operational performance in stressed environments. He referred to this as marketing. The requirements process must be fixed. The satellite has to be kept simple to avoid additional payloads. There must be more effective user equipment transition plans. There should be built-in forward flexibility and back-ward compatibility. He noted that there are thousands of weapons in bonded storage with GPS chips that will never be changed. There should be continued improvement in service through “spiral development” of user equipment. There should be continual operational testing in stressed environments.

Gen. Rosenberg reviewed the IRT’s modernization concerns. There is a need to change the look of the whole set of requirements. By next year, 11 GPS satellites will have reduced capabilities. New services must be provided to users. New capabilities are being delayed or not provided. The number of satellites in the constellation may have to be reduced. Alternative system solutions are likely to be counterproductive, divisive, and could seriously delay needed capabilities. Cost is a major factor. Bigger satellites require bigger launchers. Funding will be limited and more must be done with the same or less funding.

Mr. Trimble queried as to how the Board could have any effect, since Gen. Rosenberg has been unable to change the system from the inside. Dr. Schlesinger responded that time will tell. He advised that we have to keep working at the problem, without assurance that there will be acquiescence, and trust that reason will eventually prevail. Dr. Parkinson added that winning is through a process of erosion; sometimes it takes a while to get traction. He noted the Board spans the entire user community and can be a powerful voice within the EXCOM. There has been motion, e.g., Dr. Ron Sega, Air Force Executive Agent for Space, has asked for 30 satellites. There has been success in getting the next block of satellites into a lean, affordable condition. Gen. Rosenberg explained that he focuses on shortfalls. Ms. Neilan stated that the requirements process is convoluted and asked what can be done to effect changes. Dr. Hermann commented that one cannot deal only with requirements; there must be trade-offs by people who are accountable and who are prepared to make executive judgments.

Dr. Schlesinger thanked Gen. Rosenberg for his presentation.

Round Table Discussion on Opportunities and Challenges

At Dr. Schlesinger’s request, the Board members shared their thoughts on the opportunities and challenges for GPS.

Dr. Hermann declared that there is an elephant in the room: dollars and resources. He believes that GPS is an important national interest and that funding needs to be obtained to match the objectives. Making users pay separately instead of handling the funding on a national level will result in failure. The EXCOM provides an opportunity to resolve the problem. There should be an exemplar way to move forward. While there is a policy in place and activities, there is not a business plan. Dr. Hermann agreed, and at Dr. Schlesinger’s request, will attempt to draft one for discussion. Dr. Hermann noted that there are some early

things that can be done. We can clarify for our own purposes that 30 satellites are needed. The same is true for the nuclear detection system. He agreed with Gen. Rosenberg that we can't afford to do all that is possible. We should work on creating a solution. Transparency to the rest of the world on how we can assure the system is important and is owed to the constituency.

Capt. Burns stated that GPS is a significant part of United Airlines' operation. The number one concern is protecting the spectrum. They are concerned about control and accuracy being degraded by interference. On the Galileo issue, interoperability is a big concern. They like the system that is there today. They do not like the Chinese plan to require using the Chinese system in China's airspace. They do not want to go down the path of dual stacking--the cost is prohibitive and there is no room to locate the equipment. At least 30 satellites are needed. They strongly support ground-based augmentation and are looking for auto-landing capability. They are concerned about proposals that could require redundancy in the signal.

Gen. Lord agreed with Dr. Hermann that an overall business plan would be a great way to approach the problem. "Work hard and advertise," he advised. He offered to help Dr. Hermann draft a plan. Consideration should be given to trading off SA for a pay-back from other agencies. Dr. Schlesinger noted that "without missionaries there can be no conversions", and suggested some missionary work at the senior levels by retired Air Force four stars.

Ms. Ciganer noted that the concern over who pays can lead to a solution where the winners are determined on the basis of who pays. She echoed the concern that Capt. Burns expressed over China's plans.

Mr. Hall asserted that there is a need to circumvent the perversity of the budget process. He wants the EXCOM to take a strong position. If everybody agrees with 30 satellites, eliminating SA, and eliminating Nuclear Detection Systems (NDS) from GPS III, then it should be done promptly. Dr. Hermann stated that there is value in NDS, but it is fool-hardy to use it without exploring alternatives. Dr. Schlesinger stated that interest in NDS has grown greatly. Dr. Parkinson added that the NDS situation has been studied in great depth and he would vote for constraining NDS. He suggested waiting for the NDS report from the IRT Task Force. Gen. Rosenberg noted that there are five missions: one classified, three relating to the Cold War, and one, for treaty-monitoring, that can be handled with other means. Mr. McGurn requested an opportunity to hear from NDS experts.

Gen. McCarthy stated that SA can be eliminated with the right set of arguments, which have not yet been made or articulated. He has gained appreciation for the needs of non-DoD users. The decision-makers in the DoD do not yet have a similar appreciation. There is no need for SA, although he would not have said this five years ago. He feels that the problem is that the message is not clear. Budget limitations cannot be ignored—without money, programs struggle and fail. The message must pay attention to financial consequences. Deputy Secretary of Defense Gordon England, Air Force Executive Agent for Space Ron Saga, the Commander of the Strategic Command, and Gen. Chilton, Commander of the Air Force Space Command, are the four people to whom he would bring this message. Another issue is that there is no process within existing budgets to prioritize requirements. Dr. Parkinson concurred and noted that there is no attribution for requirements. Dr. Schlesinger reminded everyone that turnovers and personnel changes lead to problems. Gen. McCarthy stated that we must be careful not to ignore that there is currently much capability. The tone used in the message is important.

Mr. McPherson noted that Australia must purchase licenses in order to protect frequencies. He stated that when two or three satellites are down, Australia suffers. Thirty satellites is a good number. He supports eliminating SA and believes that it works against the US internationally. General aviation depends on GPS and is concerned that SA might be turned back on. He stated that competing technologies are being tested that will provide indoor capabilities and also work in urban canyons. He has concerns over seeking something in exchange for SA deletion. He supported Mr. Hall's position on SA and additional satellites. When satellites are taken out for service, he would like for there to be an analysis on the consequences—a forecasting tool to show the impact on Australia, South America and Africa. He observed that space-based augmentations are not truly global and do not benefit the southern hemisphere.

Mr. Faga expressed his appreciation for being introduced to user communities that he did not know much about. He stated that we need a broader national program office. He noted the general concept that the government funds that which others won't. He cautioned that we should not look to the government to fund all the services that are desired.

Mr. Murphy stated that Boeing concurs with Capt. Burns' comments. Its vision for air traffic management is tightly wrapped around the notion that there will be a robust satellite navigation system. Boeing hopes there will be continuous improvement, without brown-outs. The existing system has proven itself in the field, yet there are many artificial barriers to its full implementation. This should be a concern in the national policy sense since it could prevent GPS from being recognized as the gold standard. He believes that the requirements process is broken—as it is on the aviation side—and needs to be focused upon. He feels that there is an opportunity to change the focus to an operational use frame, without impeding innovation. He recommends using a performance-based process. The commercial sector's innovation must not be impeded through over-specificity. Manufacturers need a special plan that they can design to over the next 10-15 years. They want a consistent, interchangeable system; not one that is regional. We should ride the wave of innovation by focusing on benefits at every step. The systems have to be integrated better. He supports the suggestion to move to 30 satellites and turning SA off. More investigation is needed on possible failures. There is a need for more State Department work at the international level. Dr. Parkinson commented that the number of satellites needed is 36. He added that he looks forward to Galileo and that a commonality of signals is desired. Dr. Hermann stated that the role played by sovereignty is important in understanding why other systems are being developed. Mr. Murphy emphasized that the user wants performance and does not care about separate systems.

Mr. Boyer stated that he represents the low-end user to whom four channels are adequate. As a marketer, he likes the concept of addressing GPS as a utility. It is a "silent" utility. It is time to come up with a way to market this silent utility to the general public. The general public has to realize that GPS affects everybody. A united effort is needed to let the American public know about GPS's importance. There is a mass audience. Dr. Schlesinger added that this is a splendid idea that should be developed and that there is a need to spread further awareness.

Mr. Huber stated that he represents General Motors' OnStar Corporation, whose service depends on accuracy. GPS's capability is the heart of OnStar and OnStar does not know what would happen in a degraded environment. Backward compatibility and interoperability are important from the commercial perspective. They are only familiar with GPS technology and, therefore, would benefit from its stability. He noted that GPS is critical to provide what people expect today. He observed that first responders are important users and that GPS helps them respond more effectively. In response to a question from Dr. Schlesinger, he described OnStar's position on SA: they are saving lives and there would be a high price due from applying SA. He noted that there has been a massive growth in the use of GPS by the civil sector and, as a result, turning on SA is not really a viable option. Ms. Neilan commented that GPS helped people to evacuate New Orleans during hurricane Rita.

Capt. Smith, speaking on behalf of the International Association of Institutes of Navigation, stated he sees the need for greater coordination among the government agencies. He is persuaded that there is a need for additional satellites to meet the current requirements. There should be a vigorous containment of the payload to the core needs. He suggested making sure the full costs for add-ons such as NDS are recovered from the using agency. World-wide standards are desirable and the unilateral imposition of carriage requirements should be opposed. He believes that international agencies can be helpful towards that end. He stated that removing SA would be perceived as an improvement. He added that there must always be a back-up for navigation and he suspects that will be Loran.

Mr. Logsdon suggested that the Board create a blue-print for a business plan that can be used beyond 2008. A clear mission statement is needed today, and it is important to develop it now because the next Board meeting will not take place until October. We need to reach out to all user communities and educate them with a full-fledged advocacy campaign for GPS. Eliminating SA is obviously a necessary improvement. The Board should have a liaison to the international community to work on the national security issues that Capt. Dubay described. Re-branding the GPS name is important. Stories should be told on how GPS

enhances business productivity. It is difficult to quantify GPS's economic effect. On the military side as well, GPS also should be re-branded. The military should never have to fight for a GPS budget. Stories should be told on how GPS has enhanced the soldier's productivity. Dr. Schlesinger suggested that the Department of Commerce should be more proactive.

Ms. Neilan agreed with the need to improve situational awareness and positional accuracy. She stated that the IGS uses both GLONASS and GPS, and intends to fully utilize Galileo. She is encouraged to see that the EXCOM is moving these issues to a higher level. She expressed appreciation to NASA for organizing the Board. She noted that we are at the nexus of positive improvements. She opined that the State Department's efforts have been stellar and asked the Board not to forget colleagues in developing countries.

Prof. Enge would like to see more satellites. The number that is assured is the driver of aviation navigation. He described how differential GPS systems overcome the problems caused by SA. He noted that the International Traffic in Arms Regulation (ITAR) is a modern day albatross and is difficult to understand with respect to GPS. Dr. Parkinson added that SA encourages others to develop competing technology.

Prof. Beutler stated that International Association of Geodesy (IAG) is responsible for defining reference systems and that time-keeping is highly important to them. They will use every signal that is made available. He observed that GPS is the leader and that its accuracy and impact can hardly be overstated. He cautioned that GPS will not be alone in the future. He would second the idea of removing SA and everything else that could be used as an argument against the system. Satellite laser ranging will be used by the competitors and should be made a mandatory part of the GPS system in order to obtain the highest possible accuracy. He stated that one geodesic coordination system should be recognized and that timing as a component will become more important in the future. He noted that the U.S. Naval Observatory is playing an important role here.

Mr. Trimble stated that from a commercial framework, the main driver is the military requirement. This explains why the Chinese are entering the field and why the Russians have not given up on GLONASS. He believes that a common denominator may be found in the political will to fund the military system. He opined that the Air Force, despite a budget problem, has done an excellent job to get the US into a leadership position on GPS. GPS is necessary for national security and the military should not have to be in a negotiating position for its requirements. He noted that the military clearly needs 30 satellites, but doesn't want to admit it because they don't want to have to pay for it. He stated that noise must be addressed and recommended more power on the existing frequencies. The commercial world will use whatever signals are available and it would make sense to guarantee 30 satellites and add a laser reflector for increased accuracy.

Mr. McGurn noted that the EXCOM is committed to being much more proactive in dealing with GPS and GNSS issues. He believes that SA should be removed and he will distribute to the Board a white paper on why SA serves no purpose and should be disabled. SA should be used as a bargaining chip. He observed that active countermeasures are needed to prevent hostile users from using GPS and the hacker is the one to worry about. Dr. Parkinson described the law of the conservation of enemies and remarked that Galileo is using GPS SA as a marketing feature. Dr. Schlesinger stated that although it is possible to design a way for SA to be useful, from a cost-benefit approach, the cost vastly exceeds the benefit. Mr. McPherson commented that the US should not expect to recover any costs for GPS from overseas. He noted that it would be difficult to penalize a country that refuses to pay. Ms. Neilan added that Galileo is completely stalled because they cannot identify a revenue stream.

Mr. Nishiguchi noted that after President Clinton issued his Presidential Policy Directive, the US GPS policy has been consistent, and he asserted that this consistency has been important to the users. He hopes to see the GPS systems be maintained forever. It may be necessary to assure interoperability on the ground control segment. He suggested linking the monitoring stations so that ground control data can be compared and evaluated to achieve a global world-wide network system. Some kind of GPS governance structure is needed. He indicated that he was puzzled to hear that SA is an issue, since President Bush declared that SA

would not ever again be invoked. Based on that declaration, Japan decided to stop differential GPS services. Mr. Nishiguchi observed that consistency is needed and that it would be deceptive to invoke SA.

Mr. Dimmen spoke on behalf of the maritime users around the world. He stated that GPS is necessary for mariners as well as port and harbor operations. Bounded integrity is more important than increased accuracy to mariners. He described the new automatic identification system, which relies on GPS. The system gives the master of a ship situational awareness of his surroundings and traffic on the coast. He explained that there is a need for back-up systems. Norway has the same concerns as Australia in the geographical areas above 67 degrees. He noted that it is hard to find someone to quantify the requirements for timing. Mr. McPherson added that there are driverless cranes on the wharves that are relying on GPS.

Dr. Parkinson stated that the ultimate compliment to GPS is that it is taken for granted. He explained that today there are 30 satellites and that allowing the number to go down to 24 would degrade the system. He remarked that with respect to integrity, the idea to permit GPS to self-certify would be abhorrent to the FAA. He described his three largest concerns: avoiding GPS “brown-outs” or going below 30 satellites; keeping GPS Block IIIA simple and affordable; and avoiding and mitigating interference. A contingency augmentation, like eLoran, is essential and would act as a deterrent to terrorism.

Dr. Schlesinger advised the Board that Federal advisory committees and their members may not “lobby” the Congress. He noted, however, that nothing precludes the Board’s military members from educating and influencing senior military officers.

Board Structure and Tasking Assignments

Dr. Schlesinger stated that the Board members will be divided into three fact-finding panels. Board members were assigned to the three Panels as follows:

Leadership Panel: Dr. Parkinson (Chair), Mr. Faga (Co-Chair), Mr. Hall, Gen. Lord, Mr. McPherson, and Mr. Murphy.

Strategic Engagement and Communication Panel: Ms. Neilan (Chair), Mr. Logsdon (Co-Chair), Dr. Beutler, Mr. Boyer, Mr. Huber, Mr. Kibe, Mr. McGurn, and Capt. Smith.

Future Challenges Panel: Mr. Trimble (Chair), Dr. Herman (Co-Chair), Capt. Burns, Ms. Ciganer, Mr. Dimmen, Prof. Enge, Gen. McCarthy, and Mr. Nishiguchi.

Ms. Cishke’s assignment will be determined after consulting with her as to her preference (she was absent on this day).

Future Panel meeting dates and locations are to be determined. At the request of Dr. Hermann, Ms. Rausch will ascertain and advise on the support that will be made available to the Panels.

Dr. Parkinson will send a list of possible issues to Dr. Schlesinger who will then distribute the issues among the panels.

It was agreed that the next Board meeting would be scheduled for October 4-5, 2007. Mr. Logsdon stated that the U.S. Chamber of Commerce would offer to host the meeting. Ms. Rausch will consult with NASA’s Office of General Counsel as to whether the offer may be accepted.

The meeting was adjourned.



**NATIONAL SPACE-BASED
POSITIONING, NAVIGATION, AND TIMING (PNT)
ADVISORY BOARD AGENDA**

**Ronald Reagan Building and International Trade Center
1300 Pennsylvania Avenue, NW, Polaris Suite
Washington, D.C. 20004
March 29-30, 2007**

THURSDAY, MARCH 29

9:00	BOARD CONVENES	Ms. Diane Rausch <i>Executive Director, PNT Advisory Board NASA</i>
9:00 – 9:15	Opening Remarks	Dr. Michael Griffin <i>NASA Administrator</i>
9:15 – 10:00	Announcements & Introductions	Dr. James Schlesinger, <i>Chair</i> Dr. Bradford Parkinson, <i>Vice-Chair</i>
10:00 – 10:25	President’s 2004 PNT Policy	Dr. Philip Ritcheson <i>White House/NSC</i>
10:25 – 10:50	DoD: PNT Challenges & Opportunities	Dr. Linton Wells <i>Principal Deputy Assistant Secretary, NII</i>
10:50 – 11:00	BREAK	
11:00 – 11:25	DOT: PNT Challenges & Opportunities	Mr. John Bobo <i>Acting Administrator, RITA</i>
11:25 – 11:50	NASA: PNT Challenges & Opportunities	Dr. Scott Pace <i>Associate Administrator, PA&E</i>
11:50 – 12:00	Morning “Wrap-Up” & Announcements	
12:00 – 1:30	WORKING LUNCH	
	FACA Overview	Ms. Diane Rausch <i>Executive Director, PNT Advisory Board</i>
	Ethics Briefing	Ms. Rebecca Gilchrist <i>Senior Ethics Attorney, OGC, NASA</i>
1:30 – 1:55	DOC: PNT Challenges & Opportunities	Mr. Edward Morris <i>Director, Space Commercialization</i>
1:55 – 2:20	State: PNT Challenges & Opportunities	Mr. Ralph Braibanti <i>Director, Advanced Technology</i>
2:20 – 2:45	DHS: PNT Challenges & Opportunities	Capt. Curtis Dubay <i>Chief, Systems & Architecture</i>
2:45 – 3:00	BREAK	

03:00 – 3:25	GPS Service & Performance Overview	Col. John Hyten (Brig. Gen. Select) <i>Commander, 50th Space Wing</i>
03:25 – 3:50	GPS Status & Modernization	Col. Allan Ballenger <i>Commander, GPS Wing</i>
3:50 – 4:50	PNT EXCOM Taskings & Discussion	Mr. Michael Shaw <i>Director, NCO</i>
4:50 – 5:00	Afternoon “Wrap-Up” & Announcements	
5:00	ADJOURNMENT	

Friday, March 30

9:00	BOARD CONVENES	Ms. Diane Rausch <i>Executive Director, PNT Advisory Board</i>
09:00 – 11:00	Board Member Feedback - “Round Table” <i>Building on DSB & IRT Efforts</i>	Dr. James Schlesinger, <i>Chair</i> Dr. Bradford Parkinson, <i>Vice-Chair</i>
11:00 – 12:00	Board Structure and Tasking Assignments <i>Set-up of Work Groups and/or Sub-Groups</i>	All
12:00 – 1:00	WORKING LUNCH – PNT Advisory Board “Wrap-Up” Discussions	
1:00	ADJOURNMENT	

ACRONYMS

DHS:	Department of Homeland Security
DOC:	Department of Commerce
DoD:	Department of Defense
DOT:	Department of Transportation
DSB:	Defense Science Board
EXCOM:	PNT Executive Committee
FACA:	Federal Advisory Committee Act
GPS:	Global Positioning System
IRT:	Independent Review Team
NASA:	National Aeronautics and Space Administration
NCO:	National Space-Based PNT Coordination Office
NII:	Networks and Information Integration
NSC:	National Security Council
OGC:	Office of General Counsel, NASA
PA&E:	Program Analysis & Evaluation, NASA
PNT:	Positioning, Navigation and Timing
RITA:	Research and Innovative Technology Administration

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March 29-30, 2007

Membership Roster

U.S. Board Members

Dr. James R. Schlesinger (Chair) – *Chairman, Board of Trustees, MITRE Corporation*

Mr. Phil Boyer – *Aircraft Owners and Pilots Association*

Capt. Joe Burns – *United Airlines*

Ms. Susan M. Cischke – *Ford Motor Company*

Ms. Ann Ciganer – *U.S. GPS Industry Council*

Dr. Per Enge – *Stanford University, Department of Aeronautics and Astronautics*

Mr. Martin Faga – *Former President and CEO of MITRE Corporation*

Mr. Keith Hall – *Booz-Allen Hamilton*

Dr. Robert Hermann – *Global Technology Partners, LLC*

Mr. Chet Huber – *OnStar Corporation/General Motors*

Mr. David Logsdon – *U.S. Chamber of Commerce*

Gen. Lance Lord – *Retired USAF, Former Commander Air Force Space Command*

Mr. Tim Murphy – *Boeing Commercial Airplane Group*

Mr. Terence McGurn – *Retired CIA (currently private consultant)*

Gen. James McCarthy – *Retired USAF (currently professor)*

Ms. Ruth Neilan – *Jet Propulsion Laboratory*

Dr. Brad Parkinson (Vice-Chair) – *Stanford University, Department of Aeronautics and Astronautics*

Mr. Charles R. Trimble – *Founder, Trimble Navigation (currently private consultant)*

International Board Members

Prof. Gerhard Beutler (Switzerland) – *Astronomical Institute, University of Bern*

Mr. Arve Dimmen (Norway) – *Director, Maritime Safety, Norwegian Coastal Admin.*

Dr. Suresh Kibe (India) – *Programme Director, SATNAV, Indian Space Research Organization*

Mr. Keith McPherson (Australia) – *Airservices Australia*

Mr. Hiroshi Nishiguchi (Japan) – *Secretary General of the Japan GPS Council*

Capt. Richard Smith (United Kingdom) – *President, International Association of Institutes of Navigation*

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MEETING ATTENDEES

Board Members

U.S. Members

Dr. James R. Schlesinger, <i>Board Chair</i>	Chairman, Board of Trustees, MITRE Corporation
Mr. Phil Boyer	Aircraft Owners and Pilots Association
Capt. Joe Burns	United Airlines
Ms. Susan M. Cischke	Ford Motor Company
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Prof. Per Enge	Stanford University, Department of Aeronautics and Astronautics
Mr. Martin Faga	Former President and CEO of MITRE Corporation
Mr. Keith Hall	Booz-Allen Hamilton
Dr. Robert Hermann	Global Technology Partners, LLC
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Mr. David Logsdon	U.S. Chamber of Commerce
Gen. Lance Lord	Retired USAF – Former Commander Air Force Space Command
Mr. Tim Murphy	Boeing Commercial Airplane Group
Mr. Terence McGurn	Retired CIA (currently private consultant)
Gen. James McCarthy	Retired USAF (currently professor)
Ms. Ruth Neilan	Jet Propulsion Laboratory
Dr. Brad Parkinson, <i>Board Vice-Chair</i>	Stanford University, Department of Aeronautics and Astronautics
Mr. Charles R. Trimble	Founder, Trimble Navigation (currently private consultant)

International Members

Prof. Gerhard Beutler	(Switzerland) Astronomical Institute, University of Bern
Mr. Arve Dimmen	(Norway) Director, Maritime Safety, Norwegian Coastal Administration
Dr. Suresh Kibe	(India) Programme Director, SATNAV, Indian Space Research Organization
Mr. Keith McPherson	(Australia) Airservices Australia
Mr. Hiroshi Nishiguchi	(Japan) Secretary General of The Japan GPS Council
Capt. Richard Smith	(United Kingdom) President, International Association of Institutes of Navigation

NASA Attendees

Adde, Barbara	NASA
Dakon, Kathy	NASA
Gilchrist, Rebecca	NASA OGC
Griffin, Mike	NASA
Hollanswatt, Jim	NASA
King, Marla	NASA
Miller, James	NASA
Mirelson, Robert	NASA/NCO

Mule, Doc	NASA/NCO
Nelson, Robert A.	NASA/SERC
Orin, A.J.	NASA/Overlook
Pace, Scott	NASA
Rausch, Diane	NASA

Other Attendees

Alexander, Ken	National Coordination Office
Allen, Leonard	DOT/FRA
Andren, Carl	Institute of Navigation
Augustine, John	USG/DOT
Ballenger, Col. Allan	GPS Wing Commander
Basneyeke, Chaminda	General Motors R&D
Beard, Ron	NRV
Bobo, John	R.I.T.A. US DOT
Bocek, Robert	Boeing
Brancato, Richard	DOT
Branut, Richard	DOT
Brennan, Shawn	NSSO
Cancel, Ray	SAF/USAL
Daniels, Charles	National Coordination Office
Dedz, George	Topcon Positioning System
Driver, J. B.	Consultant
Dubay, Curtis	USCF/DHS
Frankel, David	Consultant
Freer, Harrison	NGC
Grantham, Scott	OSD/NII/DoD CIO
Hothem, Larry D.	USGS/DOI
Hyten, Col. John	USAF
Kim, Jason Y	DOC
Klepczynski, Bill	USNO
Korbitz, Nat	NKA/NRAC
Lewis, L. Kirk	IDA
Madhavan, Sethu	OnStar
McKenzie	USAF
McNeff, Jules	OASD (NII)/Overlook
Peterson, Eric	Self
Poapaishev, Vladimir	RC
Ritcheson, Philip	NSC
Salvand, Daniel P.	FAA
Shaw, Michael E.	US Govt.
Stear, David	Jacobs Technology, Inc.
Swider, Ray	OSD
Thompson, Chuck	NCO (SAIC)
Turner, David A.	Aerospace Corp.
VanDyke, Kara	DOT/RITA/Volpe Ctr.
Weaver, Gregory	JHU/APL
Wong, Alice	DOS/OES/SAT
Yamamoto, Yukki	Interpreter for Mr. Nishiguchi

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LIST OF PRESENTATION MATERIAL¹

- 1) Introductory Comments [Parkinson]
- 2) NASA GPS Applications [Pace]
- 3) Federal Advisory Committee Act [Rausch]
- 4) Ethics Briefing for Special Government Employees Serving on NASA Advisory Committees [Gilchrist]
- 5) Commerce PNT Challenges and Opportunities [Morris]
- 6) PNT International Challenges and Opportunities [Braibanti]
- 7) DHS Challenges and Opportunities [Dubay]
- 8) GPS Operations – Past, Present and Future [Hyten]
- 9) GPS Status & Modernization [Ballenger]
- 10) National Space-Based PNT Advisory Board [Shaw]
- 11) Task Force on the Future of the Global Positioning System [Schlesinger]
- 12) GPS Independent Reviews [Rosenberg]

OTHER MATERIAL DISTRIBUTED AT THE MEETING

- 1) PNT Members' Biographies
- 2) Presenters' Biographies
- 3) Meeting Logistics Memorandum
- 4) Charter of the National Space-Based PNT Advisory Board
- 5) Organizational Structure Chart
- 6) Federal Register Notice of Meeting
- 7) Notice of Establishment of Advisory Committee
- 8) Announcement of Board Membership
- 9) NASA Staff Support Listing
- 10) GPS/Galileo Flyer
- 11) Final Report of the Defense Science Board Task Force on the Future of the Global Positioning System

¹ Unless otherwise indicated, all material distributed at the meeting is on file at NASA Headquarters, Office of External Relations, Advisory Committee Management Division, 300 E Street SW, Washington, DC 20546.