



**SPACE-BASED POSITIONING
NAVIGATION & TIMING**

NATIONAL ADVISORY BOARD

**NATIONAL SPACE-BASED
POSITIONING, NAVIGATION, AND TIMING [PNT]
ADVISORY BOARD**

Third Meeting

Embassy Suites

1250 22nd Street Northwest

Washington, D.C. 20037

March 27-28, 2008

MEETING MINUTES


James R. Schlesinger
Chair


P. Diane Rausch
Executive Director

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MEETING REPORT

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*Meeting Report Prepared by:
Mark Bernstein, Consultant*

Thursday, March 27, 2008

Board Convenes:

Diane Rausch, NASA
PNT Board Executive Director

Ms. P. Diane Rausch, Executive Director, National Space-Based Positioning, Navigation and Timing [PNT] Advisory Board [the 'Board'] convened the meeting at 9:00 a.m., and welcomed members to their third meeting. She noted it was peak cherry blossom time in Washington, D.C., and expressed the hope that all would get to see the display. She observed that the Board was a Presidential Advisory Board, responsible for implementing the National PNT [Positioning, Navigation, and Timing] Policy announced in December 2004. NASA acted as official sponsor of the PNT Board on behalf of nine federal agencies: Defense, Transportation, State, Commerce, Homeland Security, the Joint Chiefs of Staff, NASA and two new agencies, Interior and Agriculture. All Board members were proposed by the various agencies and vetted by the NASA Administrator Dr. Michael Griffin. Ms. Rausch noted that the group had established three panels: Leadership, Strategic Engagement and Communications, and Future Challenges. She anticipated the meeting would involve stimulating discussion and encouraged concrete outcomes.

Ms. Rausch noted that the PNT Board had been established under the Federal Advisory Committee Act of 1972 [FACA]; therefore, the meeting was open to the public. Audience members were asked not to interrupt speakers. She noted that minutes for the meeting would be posted on the U.S. Government website [www.pnt.gov]. Ms. Rausch noted that that FACA statute establishes two categories of membership: representatives and special government employees [SGEs]. The former were appointed to the Board to represent the views and policies of a specific organization, entity or sector; the latter were appointed due to their specific expertise in the field of GPS. The latter were subject to U.S. ethics laws and financial disclosure requirements, and were required to recuse themselves from the meeting should a potential conflict of interest arise. The mandatory annual ethics briefing for SGEs would take place over lunch by Ms. Rebecca Gilchrest, Senior Attorney, NASA Office of General Counsel.

Ms. Rausch introduced the meeting's formal sponsor, Mr. Badri Younes, Deputy Associate Administrator for Space Communication and Navigation, NASA Space Operations Mission Directorate. In his position, Mr. Younes was responsible for overseeing all NASA telecommunications and networks, including the Deep Space Network, space network, near-Earth network and integrated services network. He was a recipient of a 2005 Meritorious Presidential Rank Award.

Welcome and Opening Remarks

Mr. Badri Younes
NASA Deputy Associate Administrator
Space Communications and Navigation

On behalf of NASA Director Michael Griffin, Mr. Younes welcomed all present, in particular those who had traveled internationally. He noted that his was a newly-created position that integrated into one office those space communications and navigation [SCAN] activities previously divided across several NASA Mission Directorates. This marked the first time NASA had brought technology oversight and policy activities into a single office. Mr. Younes noted NASA's long-term reliance on GPS [Global Positioning Systems] and GNSS [Global Navigation Satellite System]: both were critical to space exploration. NASA has taken these capabilities from the ground to low-earth orbit, and would be taking them to the Moon. He noted that in 1991 NASA had worked to secure and protect the spectrum necessary for GPS and GNSS; and, subsequently, had taken the lead in space-to-space applications. He added that NASA was currently engaged in multiple activities to improve system accuracy and would be collaborating with many present in that effort. Mr. Younes closed by wishing all a productive session.

Mr. Logsdon, Executive Director of the Space Enterprise Council of the U.S. Chamber of Commerce noted that his organization was working with NASA on development of its lunar architecture, which includes navigation. He asked how his body could assist Mr. Younes in defining standards and technology requirements. Mr. Younes noted that the architecture includes navigation requirements such as in-space navigation, rendezvous, and landing among others. The specific requirements, he said, are in the process of being defined. When these are ready Mr. Younes said NASA would welcome Mr. Logsdon's help in executing them. The preliminary architectural roadmap was anticipated in the next several months; the final report was due December 31, 2008.

Introductions, Announcements & Agenda:

Dr. James R. Schlesinger
Chair

Dr. Schlesinger noted that on March 27, 1908 – exactly 100 years ago – the First Lady of the United States and the wife of the Japanese Ambassador to the United States planted at the Tidal Basin the first two of the cherry trees that were a gift from Japan. He expressed his pleasure that Mr. Nishiguchi could be present for this centennial.

Dr. Schlesinger reviewed the Board activities over the past year. The Board had pushed to formalize the widely welcome demise of selective availability [SA] capabilities on GPS satellites. The PNT Executive Committee [EXCOM] had acted to support the contract award for GPS III at the earliest date possible. Dr. Schlesinger credited this decision to Mr. Gordon England, Deputy Secretary of Defense, who assisted through the bureaucratic hurdles. He announced that the Department of Homeland Security [DHS] had decided to continue supporting the transition of Loran to Enhanced Loran [eLoran]. This, he said, would strengthen adherence to GPS standards by establishing a backup capability.

This meeting, Dr. Schlesinger said, would include updates on U.S. Government actions and briefings on Board work; certain issues needed to be addressed prior to the Board's October 2008 meeting so its views could be expressed to the PNT EXCOM. In less than a year, he noted, the Board would be dealing with a new Presidential Administration; Presidential transitions tended to create an administrative vacuum. The Board needed to act quickly on any matter needing action from the current Administration; further, it should ensure creation of relevant transitional documents for the incoming Administration. Dr. Schlesinger closed by introducing Mr. Michael Shaw, Director of the National Coordination Office [NCO].

U.S. Update on GPS, PNT Policy and PNT EXCOM

Mr. Michael Shaw

Director

National Coordination Office for Space-Based PNT

Mr. Shaw began by reviewing the PNT EXCOM's activities since the previous Board meeting; the EXCOM had met in November 2007 and March 20, 2008, with Dr. Schlesinger representing the Board. He expressed his thanks to Deputy Secretaries Gordon England [DoD] and Admiral Thomas Barrett [DOT], both of whom he described as active and interested. Mr. Shaw identified the following accomplishments: first, the upgrade of the Operational Control Segment [OCX] of GPS had been awarded (divided between ground- and space-based components). Second, the National Coordination Office had completed its Five-Year [2008-2012] Plan for Space-based PNT, forwarding it to the White House. This, he termed the first comprehensive look at the full range of activities on which the federal government had expended \$8.6 billion over the past four years. Third, he noted completion of the FY 2009 budget assessment. Responding to a question, Mr. Shaw said both the five-year plan and FY 2009 budget document included an assessment and a resources allocation.

Mr. Shaw noted that in September 2007 the Federal Aviation Administration (FAA) Administrator wrote the International Civil Aviation Administration [ICAO] to reiterate the U.S. government offer on the GPS positioning service, extending it to the Wide-Area Augmentation System [WAAS]; both free of direct user charges. This offer was accepted in December 2007. He further noted that three satellites had been launched in the past five months. On the international side, Mr. Shaw reported on the GNSS Providers meeting held in Vienna in February 2008; that forum, he added, was part of the International Committee on GNSS. Mr. Shaw noted continued work on the PNT architecture; nineteen recommendations were under final consideration. He noted that the 2007 annual report for the executive committee and coordination office had been published. He reported that he had visited the Navigation Center [NAVCEN] south of Washington, where a Maritime Information Operations Center had been upgraded. Finally, he reported DOT's decision to continue the inland component of nationwide GPS; two components exist – the maritime and the inland; this will expand service to surface users coast-to-coast. Mr. Shaw said he was aware that 'a decision was a hallucination' until it was funded; attention was being paid to securing necessary budget support.

On future matters, Mr. Shaw noted completion in August 2007 of the 2008 work plan: the plan targeted 50 items for completion by the close of the current Administration; 30 percent of these were now complete. Given the pending Presidential transition, the National Coordination Office would compile a transition book on space-based PNT; Shaw asked if the Board wished a section of that book devoted to its activities.

Dr. Parkinson expressed concern that money was not following mandates and some areas were not receiving adequate funding. Further, he thought some activities were not being adequately tracked, e.g. determining where interference occurred and what could be done about it. Mr. Shaw responded that all departments were currently building their FY 2010 budgets; the FY 2009 budget before Congress contained only 'placeholder' money. The FY 2010 budgets would show which decisions were being implemented. The November 2008 EXCOM meeting would review the FY'10 budget work before it goes to the President. Ms. Ciganer asked if the Interference Detection and Mitigation [IDM] implementation strategy was being coordinated with the Really Simple Syndication [RSS] experts group and the National Telecommunications and Information Administration [NTIA]. Mr. Shaw said he would find out.

Dr. Hermann noted the Federal government's goal of ensuring civilian GPS service remains equal to, or better, than that provided by foreign entities. Given that such charge was no single department's task, he asked how decisions related to maintaining long-term competitiveness were made. Mr. Shaw said knowledge of what was happening internationally was readily available; there were few surprises, he said, as schedules rarely 'moved to the left' but 'often moved to the right' – e.g. Galileo originally was to be at full capability by 2008; the current target date was 2014. Given planned launches, the U.S. would remain competitive; GPS was the 'gold standard' and he expected it to remain so.

Mr. McGurn said the Department of Homeland Security (DHS) Interference Detection and Mitigation effort appeared directed largely toward mitigation: were efforts underway to improve detection? Mr. Shaw said such efforts were limited; the question would be addressed in the DHS FY 2010 budget. Mr. Hall asked if the Board had a role to play in budget-making. Mr. Shaw said Federal departments regarded their unreleased budget figures as highly sensitive and, thus, it had been difficult for NCO to secure budget information. Mr. Hall expressed the hope that some Board subgroup might review the relevant budgets; policy statements have little weight without adequate budget support. Dr. Schlesinger noted that GPS-related funding falls within multiple departments; that each department's budget might be reviewed by a different Congressional committee and that all committees were not equally generous to GPS. He believed EXCOM's senior leadership could help reinforce the requests.

Dr. Schlesinger noted the longstanding objective that there should be no degradation in service due to funding issues; this tied to issues of GPS performance standards. He invited Mr. Shaw to comment. Mr. Shaw first commented on Federal budget support: FY 2008 marked the first year funding lines appeared in civil budgets for GPS civil capabilities: this included \$7.2 million in the DOT, split equally between the FAA and the Federal Housing Administration [FHA]. The FY 2009 figure was \$27.0 million in the FAA budget. Mr. Shaw agreed that complications occurred when a program was divided into multiple departments; he affirmed that his office would support the general effort. Regarding degradation of services, he said that from the civil perspective, one key issue was to promote compatibility with other constellations; interoperable signals would prevent service degradation.

Dr. Schlesinger said he appreciated Mr. Shaw's circumstance; coordinating Federal government agencies was akin to 'herding cats.' He urged that, in its dealings with providers, the Department of State [DOS] not settle just for compatibility with Galileo, but seek interoperability, as well. Dr. Parkinson urged a third criterion: interchangeability. One should, he said, be able to substitute a Galileo-based signal for a GPS-based signal with no loss of accuracy; this required addressing relevant concerns up front. Ms. Neilan asked that of three key GPS documents – the performance standard, the architecture, and the interference detection work, which one(s) were public? Mr. Shaw said the first would be public when published; he would check about the other two.

Update and Regional Reports

Dr. James Schlesinger welcomed reports from international members.

Mr. Beutler [International Association of Geodesy (IAG) Switzerland] said he would explain the relationship of IAG and GNSS, and express specific concerns related to the satellite constellation, and to reflectors on satellites. GNSS, he said, played an essential role in geodesy in maintaining and densifying the International Terrestrial Reference Frame (ITRF); monitoring earth rotation; atmosphere monitoring; and Precise Orbit Determination (POD) of Low Earth Orbit (LEO) satellites. He anticipated this role would continue for 30 years or more. Mr. Beutler noted that the International GPS Service for Geodynamics [IGS] provided ephemerides for all currently active GNSS satellites, both the U.S. GPS and Russian GLONASS, and other functions. Many important space/Earth science programs – including CHALLENGING Mini-satellite Payload [CHAMP], Gravity field and steady-state Ocean Circulation Explorer [GOCE] and Gravity Recovery and Climate Experiment [GRACE] A & B – could not function without the highly accurate information the International GNSS Service [IGS] provided.

Mr. Beutler next addressed constellation issues. GPS was based on a daily repeat orbit; in consequence, a specific receiver in Australia might never see a particular satellite. He regarded this as a problem of the constellation. He noted that GLONASS satellites presented a different pattern, as they operated on an eight-day repeat cycle. Any receiver anywhere in the world would see every satellite in an eight-day period. He commented that calculations of performance (number of simultaneously visible satellites at 9x% of time in a latitude band of ±xy degrees) between the actually maintained 30-satellite configuration (in 24 orbital slots) and the 'guaranteed' 24-satellite constellation were not insignificant. Also, 30-satellite in 30 orbital slots configurations made, at least on paper, GPS look not as good as other GNSS proposals with 30 satellites. In practice, however GPS to this day still remains the 'gold standard' since the other systems are not in full service yet. He also argued that, to be 'really useful for science,' all GNSS system providers should share full technical information on the space segment and signal structure. Further, he reported that the scientific community, organized in IAG, was committed to exploiting the full potential of all GNSS systems: this, he said, required combining all systems measurements in a single analysis; placing laser reflectors on all GPS/GNSS satellites; and expanding the GPS constellation to 30-plus equally-spaced satellites.

Dr. Hermann asked whether GLONASS contributed to the overall accuracy of the system, or was burden of accuracy being carried by GPS. Further, did the availability of GLONASS affect discussions on the need for 30 satellites? Mr. Beutler said both the number of satellites in space and the number of receivers tracking them were important: currently, 400+ receivers tracked GPS; only 30-40 receivers tracked both GPS and GLONASS. He believed a 30-satellite constellation was needed to address many biases in the system. Dr. Hermann asked the reason for the low number of GLONASS monitors. Mr. Beutler commented that the number had been increasing for the past three years.

Ms. Ciganer noted Mr. Beutler's statement on the 'utility of making information available.' Was he presenting this perspective to the International GNSS committee? Mr. Beutler said this was a key issue: without receipt of comprehensive information. The combination of signals from different systems would be very difficult. He believed the establishment of a single system reference frame was crucial. Ms. Ciganer urged that it be emphasized to providers at the International GNSS committee that system utility was improved when transparency was established.

Dr. Parkinson expressed strong support for laser reflectors on GNSS satellites to meet future geodetic requirements: these, he noted, were completely passive and weighed only a few kilograms. He added that NASA was generally prepared to pay for the acquisition of reflectors. Mr. Beutler affirmed these statements; reflectors, he said, would become more important in the future when multiple systems were operating. Dr. Parkinson suggested the Board consider this information in terms of what statement Dr. Schlesinger might wish to make.

Mr. Younes asked what role IGS might play in the development of an integrated ground receiver network that could monitor all GNSS constellations. Mr. Beutler said IGS had a working group addressing this specific point: this work was proceeding in concert with the receiver manufacturers as it could not be achieved without the willingness of industry to produce combined receivers. Mr. Trimble noted that the Novatel company was committed to providing receivers; currently, it was producing Galileo receivers for the European Space Agency [ESA]. He believed ground equipment would be available. Mr. Trimble suggested that few ground-based GLONASS receivers had been established because, first, the constellation had originally had limited commercial utility; and, second, because the Russians lacked a good track record on maintaining a given number of satellites in orbit.

Mr. Nishiguchi [Secretary General; Japan GPS Council] reported that the basic Japanese law promoting the utilization of geospatial information utilization had been established in May 2007. The implementation plan following from that basic law will be published in March 2008; it awaits only Cabinet approval. Mr. Nishiguchi said the law's importance was that, first, it legislated PNT utilization in terms of monitoring the security of the nation and its borders; and, second, it recognized the importance of looking in four dimensions, rather than the two-dimensional view traditional to Japan. He noted that this law placed definitions of the geospatial service, Geographic Information Systems [GIS] and space-based PNT within a legal framework. Mr. Nishiguchi noted the existence of a Japanese counterpart to EXCOM. He stated that to make effective use of GNSS (including GPS), the government needed to provide stable service of space-based PNT. This, he said, would assure Japanese citizens of continuity in PNT services. Mr. Nishiguchi said the next step for those in the private sector was to promote a further law – the basic law for space utilization – which has been heavily discussed within the ruling Liberal Democratic Party. He would be making the case for the importance of space-based PNT at a special committee meeting to be held on the subject (his presentation was included in those materials).

Mr. Dimmen [Director, Maritime Safety Division; Norwegian Coastal Administration] said he wished to address two issues. The first, which he regarded as 'minor for illustrative,' was the GPS 'event' involving satellite SVN23 on February 26, 2008, at which time the satellite gave out erroneous position information. Several maritime Automatic Identification System [AIS] users noticed this immediately; the problem affected only a few ships in limited areas. Nonetheless, this pointed to potential problems which, he said, underscored the need for transparency and for the industry to pay attention to its responsibilities.

Second, Mr. Dimmen noted that, at the previous Board meeting in October 2007, he had presented a map showing diminishing Arctic ice coverage. With that diminishment, the Northwest Passage, Northeast Passage or the "direct Polar route" would likely emerge as an important global shipping route within the lifespan of GPS III. Safety of navigation in that region will be of increasing importance. A challenge existed, he said, given the orbits GNSS satellites undertook, the data for this region was better for horizontal accuracy than for vertical accuracy; things were further complicated by the sparse distribution of reference stations. He suggested two strategies: first, add more stations or; second, improve network interchangeability. Constellation size was also important, he said, given the issues of terrain masking common along the Norwegian coast. Dr. Schlesinger noted reports that ice coverage in the Arctic had increased since the previously-shown photograph had been taken. Mr. Dimmen said that while he was not certain of that, measurements of stationary ice made over time showed that ice to be progressively thinner.

Mr. McPherson [Manager GNSS; Airservices Australia] briefed the Board on the status of the Ground Based Augmentation System [GBAS] in Australia. He reported that a pre-certification GBAS has been operational with some restrictions at Sydney International Airport since November 2006; nearly 1,000 landings had occurred using the system. He described how GBAS worked, and noted that a single GBAS ground station provides precision approach paths to all six runway ends at Sydney. Mr. McPherson stated that 'the GBAS era is here.' He believed its value was well understood by all pertinent parties; he reported that

there were four GBAS manufacturers in the world; one of which [Honeywell] would be certified by the end of 2008; and noted that the airborne equipment rate was increasing. Experience to date, McPherson said, showed that the benefits derived were specific to each setting; that is, the advantages accruing in Sydney might not be the same as those achieved elsewhere. He noted the pre-certification systems were in use at Sydney, Australia [Qantas], Bremen, Germany [TUIfly] and Guam [Continental Air Micronesia]. Another system was at Malaga, Spain for testing.

Capt. Smith [President, International Association of Institutes of Navigation] reported that his organization had been ‘spreading the word’ about the work of the PNT Board. (Most particularly, he said, this had been done in a meeting with the chair of the British Parliamentary Committee on Transport). In consequence of such efforts, he said, persons outside the board were now better informed about GPS. The most common queries received regarded implementation of GPS III. Capt. Smith said there was in Europe a continuous and he believed deliberate mislabeling of GPS as a military system; he underscored this point by quoting several comments to this effect. He believed those who advanced this view were not susceptible to yielding it. Separately, he said the decision to proceed with eLoran had been widely welcomed.

Capt. Smith then spoke as a private citizen with regard to Galileo. He noted the falling out that had occurred last year between the project’s public and private partners. At that time, he said, he had not been sanguine that the effort to ‘re-jig’ the European Union’s budgets would indeed supply the additional funds needed to proceed with Galileo. In this, events had proven him wrong: 2.1 billion Euros – the largest sum that could be shifted without re-drafting the entire six year budget – had been moved from agricultural accounts to Galileo; funds from other sources had brought the total to 2.4 billion Euros. He termed the funds transferred to Galileo to be ‘just enough’ to allow the project to proceed, but noted German press reports that an additional 1.5 billion Euros would be needed in 2012. He identified two additional problems: first, a new governance structure for the project had to be created; and, second, the perennial issue of how to spread procurement across the six participating nations remained. In sum, he believed a ‘spurt’ on Galileo may occur, but doubted the project would be completed on its current schedule.

Dr. Schlesinger said the description of GPS as totally subject to military control without considering civil users is a gross distortion of reality.

Presentation: U.S. Department of State GPS Initiatives

Mr. Ken Hodgkins, Director
Space and Advanced Technology
U. S. Department of State

Mr. Hodgkins said he would address U.S. Department of State [DOS] activities in support of PNT. For context, he quoted the goal statement from the 2004 U.S. PNT Space-Based Policy. The plans for GNSS – many systems, many satellites – would give civil users tremendous capacity, he said. The primary objective was compatibility [‘the ability of U.S. and non-U.S. space-based PNT services to be used separately or together without interfering with each individual service or signal’]. ‘Almost as important’ was interoperability [‘the ability of civil U.S. and non-U.S. space-based PNT services to be used together to provide the user better capabilities than would be achieved by relying solely on one service or signal’]. There was, he said, no current definition of interchangeability. The two definitions given, he said, were very close to those in the GPS agreement with Galileo and close to the language in other pending agreements.

Mr. Hodgkins summarized activities with Europe, Russia, Japan, India and Australia. The 2004 agreement signed with Europe, focused on GPS and Galileo, had led to working groups on near-term technical issues, longer-term technical issues, trade and security. Dr. Schlesinger referred to Capt. Smith’s comments that Europeans were dismissing GPS as a military system; had this attitude affected the task forces work? Mr. Hodgkins said ‘no’: technical cooperation had not been affected. He noted that cooperative discussions with Russia followed from a 2004 joint statement; he would attend a pending satellite conference in Moscow. Regarding Japan, he reported that the QZSS system, developed there, was the most interoperable with GPS: all frequency bands were compatible. Mr. Hodgkins said India had completed an augmentation system and initiated design of a regional system, GPS-IRNSS. Dr. Schlesinger asked if the Indian system extended to Pakistan. Mr. Hodgkins said publicly-available Indian documents included Pakistan in India’s satellite footprint. Mr. Hodgkins termed Australia a good example of cooperation with a nation that provided important ground support: he noted the April 19, 2007 signing of a joint U.S./Australian Statement on Civil Use of GPS. Mr. Hodgkins discussed the International Committee on Global Navigation Satellite Systems [ICG], a voluntary, multinational body where providers and users address such topics as compatibility and interchangeability. Dr. Schlesinger said the ICG goal of ‘encouraging’ compatibility was at variance with U.S. policy of ‘ensuring’ compatibility. Mr. Hodgkins said ‘encouraging’ was the goal the international community had unanimously adhered to; not all nations placed the same emphasis on compatibility as did the U.S. Mr. Hodgkins said the U.S. would host the third ICG meeting at the NASA Jet Propulsion Laboratory near Pasadena, California, in December 2008.

Mr. Hodgkins said ideal interoperability allowed navigation to occur with one signal from each of four different systems with no additional receiver cost of complexity. Dr. Parkinson offered an alternative definition: that any four GNSS satellites would

provide seamless positioning with no loss of performance. 'No loss of performance,' he said, set a more rigorous standard and should be adhered to. Mr. McGurn noted the Russian launch of its second generation of GLONASS: if they had not already made a decision on interoperability, he doubted they would do so soon. He urged Mr. Hodgkins to press interoperability at the pending Moscow meeting. Mr. Hodgkins said the Russians had yet to decide whether to pursue Code Division Multiple Access [CDMA] signals and place them on U.S. frequency bands: this had major programmatic implications for them and may be a difficult decision. He thought Russian 'engineers' may support this approach, but 'politicians' opposed it. Mr. McGurn noted that as Russia was a less open society, communications with them were often difficult; still, he urged pursuing the matter. Next, Mr. Hodgkins noted the general difficulties of negotiating with China; however, the U.S. was required to have discussions on compatibility with any nation planning to put signals into the same band. One operator-to-operator meeting with Chinese engineers had been held. Discussions of interoperability were more difficult, though the Chinese had agreed to adopt the principals of the first provider forum. Mr. Hodgkins said agreement in principle might not frame the actual design and engineering of the Chinese system.

Ms. Ciganer asked if, as the ICG matured, it would establish a mechanism for private sector participation, similar to that of the International Telecommunications Union (ITU). This, he said, would help identify unintended consequences for the private sector that might flow from government actions. Mr. Hodgkins said he believed this would happen; however, nothing had yet been organized on the international level as 'complicated' as the ITU process to which Ms. Ciganer referred. He welcomed industry participation at the pending Pasadena conference.

Dr. Schlesinger, noting the incomplete satellite coverage over Australia, asked whether the U.S. would improve such coverage if the Australian government formally requested it. Mr. Hodgkins said DOS would 'of course engage in a dialogue' to see if such a request was consistent with U.S. policy; he doubted the U.S. government would be 'opposed in principal' to such an action.

Presentation: FAA NAS Modernization

Mr. Leo Eldridge

GNSS Group Manager

Air Traffic Organization, FAA

Mr. Eldridge said the FAA was critically dependent on GPS performance; he credited the U.S. Air Force with doing an outstanding job managing the constellation. Mr. Eldridge described his own function as manager of all GPS-related activities. GPS was by itself suitable for non safety-of-life applications; however, the FAA's prime objective was to provide precision approaches; therefore, two augmentation systems were at play. The first, the Wide-Area Augmentation System [WAAS], would be fully operable this year for en-route navigation. The second, Local Area Augmentation System [LAAS], would provide landing services down to zero visibility. LAAS was currently provided throughout North America; 50 airport facilities use it to provide much higher service than came from existing legacy services. He described an additional non-precision capability, Required Navigation Performance [RNP], a two-dimensional service for which WAAS provided coverage: no RNP monitoring stations currently existed in the southern hemisphere. Dr. Parkinson asked whether WAAS had been utilized in his own recent flight out of Quito, Ecuador. Mr. Murphy of Boeing confirmed that WAAS would not have been used.

Mr. Eldridge presented the WAAS enterprise schedule; the second of four phases was now being completed. Responding to a question, he said the final target date for the future dual-frequency system L1/L5 was difficult to define; completion would come five years after a full constellation of 24 satellites with L1-L5 was available. He noted that aircraft equipment generally had a 10 to 15 year lifecycle; system changes should not present too complicated an upgrade path.

Mr. Eldridge reported on a study of GNSS architecture, whose goal was to provide a worldwide capability of LPV-200; this would allow an aircraft to descend to 200 feet above the runway. He noted that it was difficult to prove an aviation system would not fail: one had to account for everything that might go wrong during an expected 40-year existence. He described a study that assessed the options for determining integrity with aircraft-based, ground-based and satellite-based approaches; the conclusion, he said, was that a 'layered approach' made the most sense. The satellite approach offered the best way to eliminate errors that might contribute to time-to-alarm; ground-based offered greatest accuracy; aircraft-based offered greatest flexibility. The question, then, was what trades should be made to produce the best system. Mr. Eldridge discussed alternatives: GPS Integrity Channel [GIC]; Relative Receiver Autonomous Integrity Monitoring [RAIM] and Absolute RAIM. He noted that Relative RAIM was effective when 27 or more satellites were available; Absolute RAIM required 30 satellites.

Dr. Schlesinger asked if DOS succeeded in bringing about interoperability, could the FAA achieve its needed higher confidence levels with the number of satellites now in orbit. Mr. Eldridge said that depended on the details; necessary engineering work would be required. He explained that having at present 30 to 32 flying satellites meant there were that many to ensure population of 24 orbit slots. To provide full benefits would require a satellite pattern of 6 x 5, with 36 satellites in orbit to maintain the 30 orbit slots.

Dr. Parkinson suggested the answer to Dr. Schlesinger's question was that while, theoretically, 24 fully interchangeable satellites might be sufficient, it remained to be proven in practice. For one thing, he said, it would require running the control segments of Galileo through 'all the snares and traps' that had been run on GPS. Dr. Parkinson called interchangeability a 'noble goal,' but doubted the needed political will existed to create it. Mr. Eldridge agreed in substance, adding that the details would remain crucial. Dr. Enge described GPS as an extraordinarily well operated and maintained system. In the past 10 to 20 years, he said, there had been 60-70 'notable events' – caused either by "mother nature" or by system faults – that could have caused hazardously inaccurate information to be relayed to aircraft. Had there been ten times as many, he commented, neither he nor Mr. Eldridge would be present, as the system would not be trusted. If there had been one-tenth as many, he and Mr. Eldridge would not be present, as augmentation would not be required. His point, he said, was that it was the existence of such rare events that prompted Mr. Eldridge to be cautious.

Mr. McGurn asked how WAAS had responded to the 'event' that occurred on October 8, 2007: Mr. Eldridge said it had been flagged immediately; no interruption of service had taken place.

Presentation: Department of Commerce GPS Priorities

Mr. Ed Morris, Director
Office of Space Commercialization
Department of Commerce

Mr. Morris said he would briefly review the role of the Department of Commerce [DOC]. He noted that DOC use of PNT extended, among others, to the National Oceanic and Atmospheric Administration [NOAA]; the National Institutes of Standards and Testing [NIST] and the Census Bureau. He described the Department's role as a space-based PNT provider and developer, which included the National Continuously Operating Reference Stations (CORS) network; the Online Positioning User Service (OPUS); and as Analysis Center Coordinator for the International GNSS Service (IGS). In these activities the DOC has provided atmospheric modeling; guidelines for real-time networks; and research and development related to the atomic clocks and frequency standards. He next described DOC's role as a promoter of space-based PNT, noting that the Department was a member of the PNT EXCOM, hosted the NCO; represented commercial and civil interests in PNT policy processes, and other matters.

Mr. Morris said DOC was particularly aware of the economic value of space-based PNT, and that the Department continued to advocate modernization funding. Mr. Morris said no DOC agenda for 2008 was more important than ensuring U.S. industry of access to the Galileo markets – for equipment, infrastructure and value-added activities. The second priority, he said, was to undertake studies that would tell the broad story of GPS benefits to national security, civil life and economic progress, with emphasis placed on the third. Next, he called attention to a bill now before Congress whose goal was to ensure that DOC's work relative to PNT would be written into law. Among other things, this bill would provide a 'permanent home' for the National Coordination Office and ensure that the current PNT-related activities were carried into the next Administration.

Dr. Schlesinger said one NTIA responsibility was to protect the radio spectrum from the commercial activities to which the 'Federal Communications Commission [FCC] was highly partial.' Similarly, he believed there was concern that DOC might lean too far in the direction of promoting economic benefits at the expense of protecting the spectrum. Mr. Morris noted a DOC action item to work on this particular issue; he added that Mr. Shaw's office was tracking the matter to ensure continued GPS frequency bands protection. Mr. Trimble asked if DOC was taking the position that the commercial practice precludes out-of-band emissions specifications should be the standard. Mr. Morris said: no, adding that he was not familiar with the details. Ms. Ciganer asked if the next Working Group B meeting would include representation from Galileo. Mr. Morris said it would.

Presentation: Protecting RNSS Spectrum

Mr. Karl Nebbia
Associate Administrator
NTIA Office of Spectrum Management

Mr. Nebbia said he would address Radio Navigation Satellite Services [RNSS] spectrum protection, domestically and internationally. NTIA, he stressed, took a different approach to the RNSS wavelength than to that used with any other radio activity. Historically, NTIA set emissions limits consisting of an on-channel power level, along with limits on out-of-band transmissions. Commonly, the latter had been set at 40 or 60 dB down from the main signal, and without reference to other radio signals. These standards, Mr. Nebbia added, were accepted domestically and internationally. However, as RNSS was subject to continuous technological change, provision for its protection was likely to conflict with existing generic standards. This, in turn,

required other members of the radio community to adjust their practices. The Communications Act of 1934 established the Federal Communications Commission (FCC) and NTIA as co-equal regulators: the first for non-federal users; the second for federal users. He emphasized that this was *shared* management; consequently, NTIA lacked the authority to dictate processes and procedures favorable to GPS. Mr. Nebbia described NTIA's efforts in developing rules for new technologies and in responding to aspects of FCC rulemaking that might impact RNSS or the GPS system, e.g. when mobile satellite service first appeared, NTIA set limits for those services to protect GPS reception in the aviation environment.

Ms. Ciganer said the scenario Mr. Nebbia cited had been developed in 1994; GPS was then only an emerging application. The scenario, she added, was theoretical: it concerned landing an aircraft with an antenna on its top at an airport with 10 degrees of masking angle, and with a single unlicensed Mobile Satellite Service (MSS) emitter within a 100 meter radius. Prior to 2000, she said, the ITU had lacked necessary information on a civilian GPS receiver to do the needed interference analysis. When that interference analysis was done, the MSS community at the ITU had agreed that this particular scenario (-70 dBw per megahertz for out of bandwidth emissions) should be limited to the big LEO [Low-Earth Orbit]. Further, the ITU had concluded that any additional new service or new entrant technology would require additional study to determine appropriate standards. Yet, she added, despite this, the FCC for each new entrant technology continued to put forward the -70 dBw standard, e.g. this had been used when the FCC had a rulemaking introducing ATC [Ancillary Terrestrial Component] into the mobile satellite service bands. The ITU industry council negotiated with the sole U.S. MSS operator and reached an agreement to improve the -70 standard to -90 or -95 for handsets, while maintaining the -70 for satellite phones. She commented that when a negotiated agreement was reached with the sole member of an industry, the proposed rule based on that negotiation was adopted. However, in this instance, the NTIA and the FCC had continued use of the -70 standard. In consequence, the NTIA now had more work to do because rules must be individually negotiated with each individual proponent. This was done, he said, because such proponents had GPS in their products.

Dr. Parkinson said Ms. Ciganer had described a potentially severe problem: was there a lever for resolving it? Mr. Nebbia said the administration could apply pressure; he believed resolving the matter was in everyone's interests. He noted that every company doing Mobile Satellite Service/Ancillary Terrestrial Component [MSS/ATC] had come to NTIA, which had devised a pertinent answer. He said NTIA had two options for protecting RNSS: either it could take focused steps to manage the spectrum, or it could entirely recast the management of the spectrum. Ms. Ciganer said she was uncomfortable with the 'one size fits all' approach to out-of-band emission limits for RNSS to protect the noise floor; innovation in GPS continued to operate below the noise floor. She believed that having a 'rational case-by-case approach' promoted the introduction of the new technology without risking GPS innovation.

Mr. Nebbia described the development of ultra-wideband [UWB] rules; such devices, he said were difficult to develop without impinging on other bands. NTIA undertook to negotiate an agreement that set a number of limits: significantly, the previous standards for unwanted emission levels had been changed to create limits specifically designed to protect something specific, i.e. performance of RNSS. This, he said, constituted an exception level of protection, as NTIA had not acted to prevent other issues from interference from these devices. He noted that, as Ms. Ciganer had said, part of the issue was that the GPS requirements on the receiver side continued to change; for example, the discussion on protecting the aviation environment had occurred before GPS devices were common in automobiles, cell phones and elsewhere. One reality, he added, was that one 'simply could not change the rules for the radio community every year.'

Next, Mr. Nebbia commented on MSS/ATC service rules. He noted that MSS was no longer just a few handsets talking to satellites; rather, MSS was, potentially, a whole environment of cell phones connected into the system. He reported that the FCC had stalemated on the question of the value to be set for protection. NTIA and FCC, he said, had agreed that the -70 dB standard would remain for the present. All new systems needed to come to NTIA for approval; Mr. Nebbia said, 'We don't say "yes" until they give us the number we are looking for.' Dr. Parkinson asked why the FCC resisted creating a blanket policy. Mr. Nebbia responded that there had been considerable debate over what protection levels were required, particular in relation to UWB. In part, he said, this reflected hesitancy over addressing the matter in open discussion. Mr. Nebbia said 'rational heads' had opposed undertaking open rulemaking, believing that firming up the GNSS protection requirements needed to occur first. For the manufacturers, he adds, the issue was not one of the requirements themselves, which Mr. Nebbia said the manufacturers could meet, but with the consequences of 'drawing a line in the sand.'

Ms. Ciganer commented that GPS was a global utility; at the recent World Radiocommunication Conference [WRC], a proposal that ATC be added to the MNSS band had been introduced rather late in the proceedings. At that time, rules for more than one MNSS providers carried the improved out of bandwidth emission limits [-90, -95], but that the FCC had removed them, saying it lacked technical information for any basis other than -70. She noted that adding ATC to the GPS II band affected GLONASS, COMPASS and Galileo raise the level of noise floor within that band. Ms. Ciganer said she regretted that the benefits of the U.S. rules could not be carried into the international arena. Mr. Nebbia said the commission did not wish to place into international rules something that was still unsettled domestically. Dr. Enge said he found the persistence of the -70 standard to be distressing. He noted that a 6-foot separation scenario produced a figure of -105. He urged Nebbia to work to rid U.S. regulations of the -70 standard.

Mr. Nebbia then addressed GPS Re-radiators: NTIA addressed this topic, he said, because these were being sold as unlicensed devices, which are not permitted to operate in restricted bands. GPS Re-Radiators had been removed from retail shelves and their manufacturers 'clearly informed' that they could be sold in the U.S. only to specifically authorized individuals. Mr. Nebbia noted that many requests for exceptions came in; no sufficient justifications had been presented. Ms. Neilan asked if such devices were still sold internationally. Mr. Nebbia said they were; in practice, a limited number were available from non-U.S. firms through the Internet.

Dr. Schlesinger observed that NTIA was supposed to be the guardian of the Federal spectrum; as was generally known, he said, budget authorities cast 'a greedy eye' on the spectrum, viewing it as something to be auctioned. He observed that it was NTIA's responsibility to protect the necessary Federal uses of the spectrum; he added that that statement was not a question. Mr. Nebbia said it was indeed NTIA's goal to do this.

Presentation: Space-Based Positioning, Navigation & Timing

Dr. Steven Huybrechts
Director, Space Systems
Office of the Secretary of Defense

Dr. Huybrechts said he would address the recently issued directive [4650.05] on PNT governance within DoD. Little in this directive was new, he said: foremost, it realigned existing functions among new entities and reflected the 2006 memorandum from the Deputy Secretary of Defense that recommended that a single office be responsible for PNT. The directive, he added, establishes 'who does what' with policies and procedures. One highlight was that Assistant Secretary of Defense (Networks and Information Integration) [ASD/NII] has been put in charge of PNT policy and all aspects of GPS; this does not affect the Air Force's responsibilities for GPS acquisition and operation. Further, additional responsibilities were added related to navigational warfare; approval and publication of Precise Positioning Service [PPS] Performance Standards [PS]; and oversight on behalf of DoD of the interagency PNT Architecture effort. Dr. Schlesinger asked if this last point meant the undersecretary's role in architecture policy was substantially reduced: Dr. Huybrechts agreed it had been, adding however that his body coordinated with the undersecretary for policy and followed his direction on international matters. Overall, Dr. Huybrechts said, the new directive's effect was limited to realigning within the Secretary of Defense's office various activities to reflect 'facts of life.' He doubted it contained anything very substantial for the outside community. Dr. Schlesinger asked if this body had policy direction with GPS III; Dr. Huybrechts said it did. Dr. Schlesinger asked if JPO [Joint Program Office] understood that fact; Dr. Huybrechts said his office had a very good working relationship with JPO.

Presentation: GPS III Requirements Development Process

Lt. Col. Harold Martin

Col. Martin said he would address the GPS III requirements process. This, he said, was an interagency process: all engaged were attempting to make GPS better. Dr. Hermann asked if the requirements related only to performance, or to scheduling as well. Col. Martin said schedule was addressed to an extent; in practical terms, schedule was generally driven by budget. Dr. Hermann termed it distressing that budget was not closely related to performance; Col. Martin noted that performance was a central focus of discussion.

Col. Martin presented graphic description of the interagency process, calling attention to the 'touch points' between military and civilian participants. As a detailed example, he discussed how the geodetic requirement had proceeded through the process; this had included identification of laser reflectors. Dr. Parkinson said the target of adding laser reflectors to GPS IIIB meant they would be lost to GPS IIIA; Dr. Parkinson said he was 'grieved' that so complicated a process was required to accomplish something he thought so simple. This, he added, was an instance of a 'broken' requirements process: he considered the objections to placing reflectors on GPS IIIA were 'ridiculous' and believed all present agreed. Dr. Hermann asked Col. Martin if requirements constrained him from proceeding without a consensus of all participants. Col. Martin said reflectors could not be placed on GPS IIIA without a validated requirement. Dr. Hermann asked if a validated requirement was needed for every system aspect; Col. Martin: Yes. Dr. Parkinson noted that the geodetic matter was 'not even at PDR [Preliminary Design Review], much less CDR [Critical Design Review].' He described the process as 'technical, operational and scientific foolishness.' Dr. Hermann asked Dr. Schlesinger whether he, as Board Chair, might wish a discussion of whether this should be brought to EXCOM; Dr. Schlesinger said he would, suggesting such discussion could be held during Friday's general session. Dr. Schlesinger said adding requirements would very substantially raise the cost of each satellite; cost increases on individual satellites worked against the goal of having more satellites. He asked if requirements were added at the 'simple behest' of an organization. This would undercut the ability to field an adequate constellation. Mr. Younes noted that NASA had originally argued for placing reflectors on GPS IIIA; however, the Secretary of the Air Force had deferred doing so in hopes of launching GPS IIIA sooner. Mr. Younes said he was 'second to none' in opposition to overly complex requirements; however, this process

had been an experiment in blending civil and military needs. He stressed the importance of moving forward through bureaucratic issues to the underlying technical issues; when this was done, he said, solutions tended to be obvious.

Col. Martin presented a history of GPS III capabilities development and described how the Interagency Forum for Operational Requirements [IFOR] was addressed for GPS III. Dr. Hermann noted the Defense Science Board's desire to limit each satellite's mass to permit dual launch; this would reduce launch costs, thereby permitting deployment of additional satellites. He asked if mass restrictions were part of the requirements. Col. Martin said he believed they were not in the Capabilities Development Document [CDD]. Dr. Hermann asked if one should therefore conclude that dual launch was not an objective. Col. Martin said that, in practice, a single satellite was launched to replace one that had failed; satellites generally did not fail at the same time. Dr. Schlesinger said \$60 million should not be added to future launch costs simply on the basis of past practice. Dr. Parkinson said the statement 'we've been putting them up one at a time,' did not 'hold water,' as a single launcher could put two satellites into different planes: \$60 million per satellite was involved. He expressed doubt that the Board's views were being taken seriously. Col. Martin said cost issues were very important to the process. Dr. Hermann challenged this: cost issues, he said, were apparently not being considered with reference to add-on requirements. Dr. Schlesinger defined the general problem: early decisions forced cost increases; these acted to reduce the number of satellites in the constellation, which worked against the desired outcome. Col. Martin said nothing in the strategy was designed to reduce the number of satellites.

Col. Martin reviewed the activities of the High Performance Team [HPT]. Dr. Parkinson asked if any venue for commercial entities existed. Col. Martin deferred the question to the DOC. Dr. Parkinson said that when the FAA undertook to define interfaces and specifications, all were welcome. He suggested that if commercial entities were engaged early, that could well head off things that might otherwise subsequently become complaints. Col. Martin said both headquarters and the acquisition wing worked to maintain good contact with contractors. Col. Martin next summarized interagency GPS IIIA requirements and presented a notional GPS III Timeline. Dr. Parkinson asked the date of the PDR; Col. Martin he believed it would be March 2009, but would check to be certain. Dr. Parkinson said civil agencies could benefit greatly by attending the PDR; he urged Col. Martin to invite them formally: they might, he suggested, become a 'cheering section' for the project. Col. Martin said efforts were being made to involve the civil agencies early and often. Mr. Hall asked the status of the Nuclear Detection Sensors [NDS] on GPS III; Col. Martin said NDS was a validated requirement.

Ms. Neilan commented that the requirements process seemed unbelievable to her. Col. Martin said the process came down from Office of the Secretary of Defense [OSD]. Some well-defined DoD requirements process had existed for 40 years; the current process had followed from thorough negotiation. Dr. Hermann asked if relevant requirements processes had considered the cost implications of NDS, and had decided to proceed knowing that this would add \$60 million per satellite. Cost, he said, was extraordinary crucial to the overall system, but the process appeared to proceed satellite by satellite: he doubted cost and scheduling concerns were being seriously considered. Col. Martin commented that NDS had its own validated requirements document, which had concluded that GPS was the most effective way to get the NDS mission in space. Dr. Hermann questioned this statement; Col. Martin affirmed it; it was, he said, cheaper than using an NDS satellite. Dr. Schlesinger said that while this might be less expensive for DoE, it was not less expensive for the Air Force.

Dr. Parkinson noted Col. Martin's statement of commitment to maintaining the constellation: what number of satellites did this suggest? Col. Martin said 'the only number out there' is 24, the current military requirement. Dr. Parkinson asked if this was stated as 24, or 21 plus three spares. Col. Martin said no the relevant document stated no exact number; rather, it focused on the accuracy the system was expected to provide. Dr. Parkinson noted that many public and private agencies were pushing for a 30-satellite (equally spaced) standard. Assuming, he said, a 12-year lifespan, raising the standard from 24 to 30 would cost about \$100 million annually. He believed many would regard that as money well spent. Dr. Schlesinger said one way to control costs was to limit satellite weight; instead, the Department of Energy [DOE] continued to design a heavier package to put on the satellite. This raised weight, which increased costs, which acted to reduce the satellites in the constellation. He did not believe the requirements process should give DOE a free ticket: weight requirements should be set and met. Col. Martin said work was proceeding with DOE Sandia to constrain the weight of GPS IIIA to no more than that of GPS IIF. Mr. Trimble asked if DOE was paying the associated launch costs. Col. Martin deferred that question; Dr. Schlesinger said DOE was paying for 'the package,' but not for the lift. Mr. Trimble asked why the Air Force cared whether the FAA could pay for its requirements, when it was not requiring DOE to do so. Dr. Parkinson suggested the answer might involve a number of questions best left unaddressed in a public forum. However, he noted considerable concern that the NDS was an 'unbounded' addition whose costs were being absorbed by others.

Mr. McPherson asked how foreign countries and users might input requirements into the IFOR process. He noted 'major problems' with open pit mining in Australia that additional satellites would resolve. Mr. Shaw said IFOR did not permit international participation. Mr. McPherson asked where U.S. open pit companies might go to suggest requirements; Dr. Parkinson said that as a practical matter they accepted the system as a constraint. Mr. McPherson then questioned the role of the Civil GPS Service Interface Committee, which was intended to provide foreign countries with an interface to the US Government on GPS issues. Mr. Shaw commented it was not a formal advisory board, but an avenue where other nations could represent their interests. In theory, he added, DOT and DOC take information presented there and fold it into their representation of civil needs. Mr. McPherson said that, having been invited to represent foreign interests, he and others were being told no process existed for

providing that input. Mr. Shaw said that while no formal method existed, informal methods did. Dr. Schlesinger recalled that at the Board's first meeting in March 2007, Mr. McPherson had advocated eliminating Selective Availability [SA] capabilities; that this had been done showed that input was received.

Dr. Hermann noted the requirements process was internal to DoD; did this mean there was, in effect, a Joint Chiefs of Staff [JCS] requirements process that unilaterally affected an internationally used system? He cited the NDS decision as one such impact. Mr. Shaw said the chart on interagency requirements process showed how military and civil perspectives were melded; the decision to separate NDS from EXCOM had been made in the White House. Col. Martin said concerns about that decision needed to be addressed to the White House.

Panel 1 – Leadership: Fact-Finding Report (The ‘Big Five’)

Dr. Bradford Parkinson
Department of Aeronautics and Astronautics
Stanford University

Dr. Parkinson, Panel Chair, said the Independent Review Team [IRT] had identified the ‘Big Five’ essential GPS performance criteria: assured availability; resistance to interference; accuracy; bounded inaccuracy [in particular, the limit on the ‘wild result’]; and integrity. He would attempt to connect these performance criteria to prospective mission needs; particularly, for those missions that would be ‘envelope pushing.’ He would suggest what these missions might require from GPS, and then discuss how those various mission requirements might frame tradeoffs system designers might face. One example offered was an ‘obscured visibility problem’ – that is, a U.S. Ranger in a mountainous area who wished to call in an Air Force-delivered weapon on a target across a valley one kilometer distant. Dr. Parkinson identified four key design tradeoffs: number of satellites; satellite ranging area; jamming resistance, and integrity. One measure of effectiveness, he said, would be how many sorties were required to produce a 95 percent probability that the bomb would land within a specified radius. The constraints were: mountainous terrain; desired all-weather availability; possible enemy countermeasures; possible collateral damage [missed distance exceeding one percent] and system integrity [a time to alarm of less than 6 seconds]. Design choices related to the satellite constellation; the weaponry employed; and jamming interference. He then described how each constraining condition was influenced by the design choice made.

Dr. Parkinson said ‘envelope’ missions constituted the missions that actually drove the system. In general, he said, such missions were very sensitive to the number of satellites. He believed there was a ‘knee in the curve,’ and suggested that 30 satellites provided a significant difference; for example, in achieving the 95 percent probability with a single sortie. More generally, he said that making assessments of design choices versus measures of effectiveness would give a systems designer a handle on how to consider systems tradeoffs. He noted that the data presented related only to a small set of specific missions.

Dr. Schlesinger said ‘collateral damage’ was a rather bland phrase, as what it meant was death and destruction through friendly fire: it had a tremendous psychological effect on the public and on others in a given mission. Dr. Parkinson noted that his intention had not been to set military standards; rather, it had principally been done in association with the IRT's efforts to ‘come to grips’ with the Big Five.

Capt. Burns from United Airlines commented that the improvements in civil aviation expected from a space-based air traffic control system would not be realized with the current constellation. Dr. Parkinson urged civil aviation to undertake and make public a cost/benefit analysis on the subject: he asked Capt Burns how many satellites he believed were required. Capt. Burns said at least 27, preferably 30. Ms. Neilan said it appeared all present believed 30 satellites were needed. She asked Dr. Parkinson if his analysis had been intended to prompt persons at DoD to reconsider whether the 21 plus 3 constellation was indeed adequate to their needs. Dr. Parkinson said he did not know what affect his study might have.

Dr. Hermann asked Capt. Burns if the need was for 30 satellites, or 30 satellites plus WAAS. Capt. Burns said no WAAS receivers were currently available to him. Dr. Hermann asked why the need for 30 satellites was being pressed when aircraft were not being fully equipped. Capt. Burns said WAAS was a U.S.-centric system: he operated internationally, and carrying equipment useable only in the U.S. made limited sense. Mr. McPherson observed that SBAS was not a global system; it only covered the northern hemisphere. Dr. Parkinson suggested it could be expanded; Mr. McPherson said that had been studied; the cost of expanding SBAS to Australia was under consideration. Dr. Hermann commented that if GPS was improved to accommodate approach and landing in the absence of WAAS, then WAAS might not be needed: this might present a financial calculation that could have political impact. Mr. McPherson said Australia was already achieving this with the required navigation performance (RNP) also known as performance-based navigation (PBN), a global capability. Dr. Hermann commented that while this may have fixed Australia's local problem, it did not fix the problem of an airlines like United that operated into Australia and was required to carry multiple systems. Mr. McPherson responded that RNP/PBN was a global capability in aircraft and not a local system. Dr. Hermann commented that he had begun by asking why not put the receivers in;

he had been told the aircraft could not carry a variety of only locally-useable equipment. He said he did not know what the solution to that was, but he suggested a solution had not been reached.

Mr. Shaw commented that to meet a 30-satellite standard, 34 to 36 satellites would be required. Dr. Parkinson said he believed 33 would be sufficient; at present, he said, the commitment to 24 was not always maintained. Dr. Parkinson added that if the Federal government committed to 30, and didn't always make it, 'we would forgive you.' Mr. Murphy said it was not only a question of the number of satellites in existence; one needed authorization to use them. He reported having heard 'disquieting conversations' that Galileo might not be authorized in U.S. airspace. Nations, he noted, had the sovereign right to determine what could fly in their airspace; as a global operator [Boeing], however, the first nation that required use of their specific SBAS 'puts me in a world of hurt.'

Dr. Schlesinger noted, relative to fuel costs, that when commercial airlines saved fuel, it was at about \$3.50 a gallon. Within the U.S. Air Force, he said, the 'fuel burden' cost of operations was \$85 a gallon, from tanker costs on down the line: fuel costs 'are eating the Air Force out of house and home.' For the Army, fuel burden costs include the casualties taken on the supply chain that delivers the fuel to bases in Iraq. One consequence, he said, was that the 'cost per sortie' to the Air Force was enormously higher than one might think. Capt. Burns noted the Boeing had made its internal business case for adopting RNP based on fuel costs that were only half what they are now.

Panel 2 – Strategic Engagement and Communication: Fact-Finding Report (Update and Recommendations):

Ms. Ruth Neilan
NASA Jet Propulsion Laboratory

Mr. David Logsdon
Space Enterprise Council

Ms. Neilan, Panel Chair, said the Mr. Logsdon would report on 'PNT Hill Day,' which he had co-chaired. Before beginning, Mr. Logsdon expressed the view, as Co-Chair of the Panel, that achieving a buy-in from GPS international partners would be difficult if they had no way to comment on the requirements process. Mr. Logsdon said 'PNT Hill Day' held separate panels for U.S. government users and private industry users. Both enjoyed capacity crowds at the Rayburn House Office Building, with many Capitol Hill staffers from appropriate committees attending. Congressman Mark Udall; Chair, House Science Committee, Space and Aeronautics Subcommittee, had given the opening remarks.

Mr. Logsdon commented on the January 22, 2007, San Diego, California, interference event. He found it astonishing no one was injured during this four-hour anomaly; he had queried whether OnStar was notified of the anomaly: the answer was that it had not. He hoped the DHS Interference Detection and Mitigation [IDM] plan would permit commercial and civil users a voice; otherwise, he would regard it as flawed. Dr. Parkinson noted a business opportunity: OnStar, he said, could with few changes instigate an interference reporting system. Responding to Mr. Parkinson's question, Mr. Huber [of OnStar] said five million vehicles were currently equipped; that number would double in three years. He noted OnStar already did reporting for Verizon.

Mr. Logsdon presented the IDM implementation actions, including a 30+-satellite constellation and near-term placement of laser retro-reflectors on GPS satellites. He presented a chart which, he said, underscored the need for 30 satellites: the constellation was aging; a GPS 'brownout' was likely to occur soon; 15 satellites were on the final string. He said that in recent decades GPS-related innovation had driven return-on-investment (ROI) in several industry sectors. For U.S. government users, he said, modernization was the key criterion; for commercial users, a robust signal provided with no user fees was crucial, as the no user fee policy allowed funds to be transferred into innovation. He said his group favored full funding of eLoran and would act to help secure the necessary funding.

Mr. Logsdon said the 'PNT Hill Day' made clear that GPS had many champions, including those willing to speak on GPS' behalf at industry sector forums, energy conferences, climate conferences and similar events. He recommended the U.S. Chamber of Commerce convene panels on such 'hot button issues' as the economy, energy and climate; conferences should be held on how PNT related to each. Mr. Logsdon then asked Capt. Burns to make the presentation he had given at the 'PNT Hill Day.'

Capt. Burns said he had spoken on GPS use by civilian aviation. GPS, he said, allowed greater capacity operations; improved all-weather operations; provided better timing through better flow management; and brought improvements in position awareness, which meant better safety. He credited GPS with reduced fuel burn and reduced block times. Mr. Logsdon cited such current uses as GPS-augmented Area Navigation [RNAV] this, he noted, permitted much better path control, thereby allowing more aircraft to operate in the same airspace. In Atlanta, he said, RNAV had permitted a five-minute reduction in block time per aircraft. Mr. Logsdon described the Regional Area Augmentation System [RAAS]. This system, he said, provided precise positioning for aircraft on the ground, which was as important as positioning in the air: 44 percent of runway incursions followed

from a loss of position awareness. RAAS addressed this; the system reported to the pilot where the aircraft was on which runway and how much runway remained: installation begins in April 2008.

Capt. Burns commented that Automatic Dependent Surveillance-Broadcast [ADS-B] was significant because GPS would be used both by the pilot and on the ground. Previously, he noted, if a pilot lost GPS, the ground had some independent means of rendering assistance. He asked how redundancy issues were being addressed. Mr. Logsdon said this was still unclear; he believed, however, that once pilots became accustomed to flying the new system, few would wish to go back. Mr. Murphy said that eventually the realization would come that an independent surveillance system was needed: otherwise, 'everything was hung' on a single system. He believed ADS-B technology would be helpful only if the technology was used to reform how the airspace was used, e.g., by allowing aircraft to fly closer together or to fly routes not previously possible because radar would not support them. Mr. Murphy said he liked aspects of ADS-B, but wondered if it would ever be used for crucial functions. Dr. Parkinson said Mr. Murphy had raised good points: he suggested that a 'supposedly independent and un-jammable system' – such as eLoran – might be on the horizon.

Dr. Schlesinger said Mr. Burns might be understating the aviation benefits of GPS. If, he said, a cap-and-trade program was instituted, airlines would not only save on fuel purchases, but would be spared the requirement to buy allowances; indeed, they might be able to sell them to others. Mr. Murphy said a Boeing team had addressed the impact of various fuel-saving measures; these, he said, aggregated to an annual savings of \$100 million. Responding to Mr. Trimble's question, Mr. Murphy said that in a marginal year, that sum could be the difference between profit and loss.

Ms. Neilan noted that the March 26, 2008 meeting of *Panel 2 – Strategic Engagement & Communication*, had been attended by Dr. Beutler, Mr. Logsdon, Ms. Adde, Mr. McGurn and herself. She called attention to two pending events. The first was the International Committee on GNSS [ICG] meeting in Pasadena, California in December 2008. This, she said, will draw wide participation from industry, Federal agencies, research organizations and internationally, and should be an excellent forum at which to promote GPS. The second was the Asia Pacific Economic Cooperation [APEC]/GNSS Implementation Team meeting in Bangkok in May 2008, which will address transport, economic and technology issues; her Panel had pledged assistance to this gathering in identifying speakers.

Next, she invited Mr. McGurn to comment on the panel's discussion of situational awareness. Mr. McGurn said a significant problem was at issue; that is, how to know when 'bad stuff was out there'; where it was originating; and what mitigating measures could be taken. He noted that DHS had a working group that is developing a plan; his understanding from DHS sources was that the plan would focus on coordinating information on detection, not on identifying the interferer. He believed the past record on interference was mixed. He noted that the San Diego incident was first identified not by the system's stewards but by the system users who were causing the interference. Similarly, he said, 10 years ago, antenna testing at the Rome [New York state] Air Force Base had caused interference, which affected air traffic coming into Albany, New York. Again, the interference was discovered by those creating it. He did not regard this as a satisfactory way to identify interference. While he welcomed the DHS actions, he felt DHS was not addressing the tougher issue of identifying and localizing the source. Perhaps, he said, this was because those engaged were looking for the 'big solution.' He proposed that an individual who had developed a device for measuring interference relative to background noise might make a presentation at the next Board session. There was a question, he said, of where to deploy such a device; while cell phone towers might contribute to the solution, the technical details of this were unknown. He said one large unresolved question was who should undertake the R&D in this area. He noted that the FAA had a culture of addressing such matters; on the other hand, it was not simply an FAA problem. Was there a role for DHS?

Ms. Neilan said the Panel had three recommendations to present. First, the panel regarded the 30-plus satellite constellation as critical for availability, accuracy and integrity. She urged, further, that alternate constellation orbit designs be reviewed to determine how they compared in compatibility and interoperability. The panel believed that six or more additional satellites would be critical to all users. Further, the panel strongly recommended that retro-reflectors be placed on GPS satellites as soon as possible; she endorsed the view expressed by Dr. Gerhard Beutler; namely, that individual accuracy tests should be considered mandatory, not a luxury.

Second, with regard to situational awareness, the Panel recommended two actions. One will be to review the DHS plan on this matter; Mr. McGurn will lead a small group to review instrumentation in this area. The second was to call attention to the importance of the common reference frame and timing. She believed it difficult to craft a specific recommendation in this area; however, exploration of the terrestrial reference frame in terms of the GPS to Galileo timing offset was needed.

Third, the Panel urged efforts be made to assure adequate funding for space and ground-based infrastructure.

Ms. Neilan next discussed GPS and Africa, noting that technical training coordination meetings had been held in June 2007. GPS-related work in Africa was moving very slowly; it was difficult, she said, to obtain adequate resources to address GPS needs of developing countries. She noted the longstanding U.S./China protocol on earthquake research. Within China, she said, the seismic network had been given responsibility for the GPS network. She called attention to a bilateral U.S./China workshop to be held in May 2008; she will be part of the U.S. delegation, which is composed largely from the United States Geological Survey [USGS] and the National Science Foundation [NSF]. Ms. Neilan said that at this meeting the U.S. delegation would urge

China to provide more open station data access. Ms. Neilan made several suggestions for the Board's October 2008 session: first, that a U.S. Department of Agriculture representative be invited to repeat its presentation from the 'PNT Hill Day' on GPS use in understanding climate change; and, second, that a Galileo expert be invited to report on options for independent monitoring. Ms. Neilan offered a comment on the assertion that GPS was a military system. She showed a copy of 1980 document that referenced an interagency coordination plan for GPS, which outlined the responsibilities of DoD, NASA, the National Oceanic and Atmospheric Administration [NOAA], and the United States Geological Survey [USGS]. Dr. Parkinson stressed that GPS had been a civil/military system from the first day; he believed the first civil receiver to lock on to the system had been a group of students at Leeds University, United Kingdom.

Finally, Ms. Neilan noted that the National Weather Service used data from a variety of sources. This, she said, means they had trained ordinary people to report on weather conditions, which gave them a greater density of information. Analogously, she said, there were so many stations with data freely and opening available that she believed some sort of 'neighborhood watch' on GPS performance could be created.

Ms. Ciganer noted that there was a relationship between establishing a regulatory framework and interference mitigation. She believed it was highly important to preserve the noise floor. She reported that, several years ago, NASA and Stanford University undertook a noise floor study that looked at the GPS L1 Band (1563.42 – 1587.42 MHz), the Unified S-Band (2025 – 2110 MHz), the unregulated 2.4 GHz Industrial, Scientific and Medical (ISM) Band (2400 – 2482.50 MHz), and the 23.6-24.0 GHz Passive Sensing Band. She said the fundamental question the study had posed was: does regulation work? The conclusion, she said, was the regulation was worth the effort.

Mr. McGurn commented that, to him, interchangeability meant that four satellites of any time would provide a solution. Did that not require that, when multiple PNT systems were involved, each satellite carried the time message of each system? Parkinson said that, at minimum, it meant information of the time offset had to be available. He said the important criteria was not that any four satellites could provide a solution was provided, but that the solution provided was as good as one that four separate GPS sites would provide. He believed that the time offset issues that affected interchangeability would be difficult to address politically.

Mr. Beutler said progress was being made toward creating a system with a common reference frame. He believed a much better job could be done with the timing systems; now, this was being done in an independent way. He believed coordination could be much better in the 'future world.'

Dr. Schlesinger noted that as the day's meeting had run past its scheduled time, the planned 'wrap up' would be omitted. He noted that considerable wrapping up had been achieved in discussion.

The Tuesday, March 27, 2008 session adjourned at 5:10 p.m.

* * *

Friday, March 28, 2008

Call to Order

Ms. Rausch called the meeting to order at 9:00 a.m.

Dr. Schlesinger noted that discomfort had been expressed the previous day on how GPS issues would be addressed within the DoD, and whether the DoD was in fact listening. He told of a gathering of World War I veterans, one of whom related that the saltpeter he had been fed years earlier was finally having an effect. His point, he said, was that advocacy directed at the Federal government took time to bear a result. He doubted the DoD would commit to a 30-satellite constellation in the near term; however, time and continued advocacy would change this. Dr. Parkinson suggested delaying his presentation on the 2008 priorities and work plan until after the 'Future Vision' presentation. He noted that his earlier presentation addressed the need for 30 satellites from the military perspective; 'Future Vision' would do so from a civilian perspective.

Panel 3: Future Challenges: Fact-Finding Report ('Future Vision')

Mr. Charles Trimble

Mr. Trimble said the vision he would present was tangible and realizable. Its central characteristics were a world with multiple, space-based PNT systems; user equipment that leveraged multiple systems; and a ubiquitous and seamless integration of space-based PNT as part of the daily lives of users worldwide. From a GPS-specific perspective, he said the U.S. would manage the transition to GPS III to maintain trust among its international user base; GPS would continue to provide free, stable and reliable

GNSS service based on a constellation of 30 or more satellites. In consequence, GPS will remain the ‘gold standard’ for PNT. Mr. Trimble expressed the view that this vision was ‘totally ours to lose.’

Mr. Trimble identified short term issues. The first – amend the Standard Positioning Service Performance Standard [SPS PS] to incorporate the currently provided level of service – was the only that would require ‘heavy lifting.’ The SPS PS should, he said, establish performance levels; define the process for changing the commitment over time with the FRP; and specify how these commitments and changes would be funded, scheduled and communicated. Mr. Trimble identified further steps as important but inexpensive. These included: turn on the navigation message on L2C; solidify schedule for L5 with the navigation message; pursue interoperability between augmentation systems; and restore the ICD [Interface Control Document] process from the current IS [Interface Specification] process. Asked to clarify the meanings of ICD and IS, Trimble said that while the U.S. had maintained trust in the system, foreign visitors were likely unaware of the ‘diving catches’ needed to achieve this. ICD and IS, he said, were DOS processes that defined the activity of particular satellites: the former required inputs from outside DOD prior to decisions; the latter did not. Ms. Ciganer noted that ICD was the technical specifics used to build any product; now called the IS. The earlier had shared military/civilian authority; the latter was military. Mr. Trimble noted as the military paid most of the expense, its preferences tended to dominate.

Mr. Trimble presented ‘Transition Paper Inputs.’ He urged that actions be taken to build civil and commercial trust in GPS domestically and internationally. He urged use of the Federal Radionavigation Plan [FRP] to report broad national policy decisions. Dr. Parkinson asked if the FRP overlapped with the recently issued DoD policy letter or, if not, which document was the “governing” document. Mr. Trimble said he did not know; FRP had for several decades been an important source of information. An audience member reported that FRP would continue to be the form in which policy decisions were elucidated.

Mr. Trimble said the least expensive way to sustain current GPS utility was to protect the RNSS noise floor. He noted that a policy of opposing the misuse of unintentional emission limits that would enable intentional emissions into RNSS bands was likely to be the easiest and least expensive way to gain foreign advice on the subject. Mr. Trimble urged that the FCC be pressured to adopt commercial practice band emissions specifications for MSS and to abandon the decades-old MSS Out-of-Band Emission [OOBE] accommodation. Asked if there was ‘pushback’ on this, Mr. Trimble said there was some from the FCC; all others realized this approach was in their interest. Cellular phone companies, he said, had learned that the best way to maximize the spectrum was to provide decent channel separation; those who manufacture the equipment had no problem meeting that standard.

Mr. Trimble, while noting ‘some frustration’ on this point, opposed separating the National Telecommunications and Information Administration [NTIA] from the Executive Branch of the Federal government; he believed only the military had sufficient weight to influence the FCC. The only alternative – which he thought unlikely – would be for Congress to give the FAA or DOT veto power over any action that might imperil air traffic safety. Mr. Logsdon noted that GPS was a critical national infrastructure; could not DHS declare it to be such, thus preventing interference with the system. Mr. Trimble said he would welcome such a step.

Mr. Trimble said one central factor – not widely understood – was the signal-to-noise problem; as GPS signals were below the level of noise, they were pulled out for the PNT utility. While one could address this by putting more power on the satellites, the less expensive approach would be simply to prevent emissions into the band. GPS, he noted, was the most protected U.S. frequency band; by its nature, it needed to be. Dr. Hermann asked how U.S. practice differed from other nations. Mr. Trimble said the ITU provided more protection than the FCC; Europeans, he said, were both more sensitive to spurious emission and anxious to protect the requirements of Galileo. He thought U.S. problems followed from the 1996 Telecommunications Act, which stripped the FCC of its technical capabilities; the agency, therefore, lacked the ‘horsepower’ to understand 21st century technical questions. A further influence was that the FCC had been directed to listen to its constituency base, i.e., the broadcasters.

Mr. Trimble reported additional transition needs, including: strengthen check-and-balance mechanisms to ensure broad trust and support for U.S. actions; strengthen U.S. outreach and transparency to domestic and international users; and formalize the coordination of private sector input for U.S. positions in domestic and international forums (beyond the ITU) which impact GPS. Mr. Trimble described the Panel’s conclusions as a consensus; this was so, he said, even though the conclusion differed from the initial individual views of the Co-Chairs. He credited inputs received – particularly those from Dr. Hermann – with producing a stronger report than he had anticipated. Mr. Trimble noted the Panel’s strong international participation.

Ms. Neilan asked whether the statement, ‘formalize the coordination of private sector inputs’ [above], addressed the circumstance that the FCC does not do this. Mr. Trimble said the FCC was ‘totally off the table’ in this regard; this was addressed to the ITU. Dr. Parkinson asked if responsibility should be assigned for the ‘actionable items’ in Mr. Trimble’s report. Mr. Trimble said he thought the value of an advisory committee did not lie in its issuing a report that probably went unread, but in the consequences that followed from gathering together various stakeholders. Dr. Hermann said the Board’s client was EXCOM: the question was how the Panel should structure the information it gave its client. Dr. Parkinson said Dr. Schlesinger was the ‘filter’ on that. Dr. Hermann acknowledged that, on some points, the Panel had ideas of who should tell what to whom. Dr. Parkinson welcomed

such statements, saying that the Chair could determine what to do with the information. Dr. Hermann suggested Mr. Trimble informally present his ideas on those recommendations. Mr. Trimble responded that while Dr. Hermann understood the workings of the Federal bureaucracy, he did not. Therefore, he doubted the usefulness of this advice.

Dr. Schlesinger expressed the view that the DOT and other civil agencies had considerably more authority in this area than they had chosen to use: 99 percent of what GPS did touch the civil side, yet little attempt is made by those being affected to press their case upon the respective departments. He believed such departments should be more responsive to their constituents' concerns; lacking such action, authority would be exercised by DOD. Dr. Schlesinger called attention to the 'separation of powers' clause in the Constitution. The 'problem' of divided authority within the U.S. government was not going to be resolved; resolution followed upon communication between the executive and legislative branches: more specifically, between the FCC and NTIA. He noted the bulk of authority rested with the White House, as reflected in the President's statement on the spectrum. He believed that while not all issues could be resolved in ways that satisfied one's rational impulses, it remained possible to muddle through.

Dr. Beutler praised the report: that the future would entail multiple PNT systems was, he said, an important message; dissemination of that message would encourage belief that the Board was open-minded. Dr. Parkinson invited Dr. Beutler to draft such a statement; Dr. Beutler said he could not do so at the present moment. Dr. Schlesinger, noting recent political events in Asia, asked if collaborative efforts would include the Chinese. Dr. Hermann said it would; Mr. Trimble noted 'one does not have to trust someone to use their lighthouses.' Dr. Hermann commented that, if one wished United Airlines to be able to land in Beijing, collaborative arrangements were needed. Mr. Trimble said international cooperation would be encouraged if the world believed the vision presented was being realized. Dr. Parkinson asked if the Panel intended to present a written summary of its views. Dr. Hermann said that, while his initial thought a year ago was to establish a set of useful outcomes, the panel had in fact identified a series of issues. He did not think it trivial to write national policy in that way; the immediate question was how the Panel's work might be turned into effective advocacy. He doubted that the remaining months of the current Administration was the best time to do this, but the decision was not his. Dr. Parkinson urged the Board to accept the Panel's report, consider it, and plan on saying 'this is our vision' at its October meeting. Dr. Hermann noted that the report included action items that Dr. Schlesinger might wish to take to the next EXCOM meeting. Dr. Hermann commented that the Board could only influence those who wished to be influenced by it; when a decision was reached to deal with these matters, the structure existed that could deal with these. Dr. Parkinson agreed, but added that if, in presenting a recommendation, one suggests to an organization how that recommendation might be achieved, that does not assume one is directing the organization in question.

Mr. Trimble said the only difficult problem was to secure six additional satellites. The alternatives were limited. First: this or the next Presidential Administration would say it was worth the additional \$100 million annual cost. Second: they would not be willing to fund six, but would fund three. At that point, DOT would decide whether 27 satellites were sufficient, or, if not, did it wish to pay for the three additional. Third: they are not willing to fund any. In that case, DOT or some other agency would decide whether to provide funding. Or, if not that, then various agencies could go to Congress and ask for six, three or none. There was, he said, general agreement that GPS III would solve everyone's problems provided there were enough of them. Dr. Parkinson agreed.

Dr. Parkinson commented that the issue today was the same as in 1972: do GPS or not? At that time, he commented, many people thought GPS would be a good thing if someone else would pay for it. Similarly today, those who favor the system are unwilling to provide funding. Dr. Hermann said that, given the way authority in the area has been chopped up, resolution requires Executive-level leadership. This, Dr. Parkinson observed, had been what had happened in 1972, when the decision to proceed with GPS turned on the leadership of Mel Curry. He noted that nearly every 'envelope mission' required 30 satellites; what was needed, he said, was Executive leadership that said: "We are going to remain the 'gold standard' – here is how we will do it." Dr. Hermann doubted the 30-satellite goal would be achieved by trying to please every relevant government department; rather, executive action was needed. Mr. Trimble said that GPS touched the lives of every constituent of every member of Congress; this was not true five years ago. Dr. Parkinson noted the absence of public pressure, saying he would welcome seeing a bumper sticker: 'I want 30 satellites.' Mr. Trimble commented that GPS was user-free not so much as a gift, but as way of financing a military system through the income tax, which increased in line with the productivity improvements that GPS brought. He believed GPS greatly more than paid for itself; OMB and GAO accepted the argument that GPS provided productivity improvements. Dr. Parkinson said many people were deaf to that argument. Dr. Schlesinger said Mr. Trimble was on the right track: the financial impact of GPS was both immense and unappreciated. He believed the Air Force was part of the problem, as he believed a 30-satellite constellation would save the Air Force enormous sums in fuel and other costs. The task, he added, was to educate those who used GPS on how they were benefiting in dollars-and-cents terms.

Dr. Schlesinger asked if the international partners had any perspective to share on this. Mr. Nishiguchi asked to correct a statement he had made the previous day. Japan, he said, was moving toward planning; that planning had been assisted by the transparency in the U.S. system. Regarding the U.S., he believed it was best for a single Federal agency to take responsibility in this area; once that agency was selected, however, it had to come up with the money and manpower required. In Japan, he said, industry and academia came together to persuade political leaders of the subject's importance. Then, a steering committee including academics, technical people, politicians, industrialists and bureaucrats was established within the ruling Liberal

Democrat Party: this steering committee then produced the basic law. The establishment of this law prompted Japan's bureaucrats to take action; this, he said, was characteristic of the Japanese system: planning followed enactment of the basic law. Dr. Schlesinger noted that while American processes tended to be directed toward decision-making, Japanese processes tended to orient to consensus-building; this, he suggested may be why the Japanese get results more quickly.

Roundtable Discussion

Dr. James Schlesinger invited comments from attendees.

Mr. Dimmen said the acknowledgement that multiple PNT systems would exist was very important. He said that while it was difficult for outsiders to track the morning discussion of U.S. government procedures, he noted that no presentation had been made from the military operations side. It might be useful to hear the 'warfighters' perspective directly. Dr. Schlesinger welcomed this suggestion. He noted that he had discussed the subject with the Army Chief of Staff and Marine Corps Commandant, who, Schlesinger believed, had a stake in a more robust constellation. The individuals mentioned agreed, but did not pursue the subject. What was needed, Dr. Schlesinger said, was to gain their serious engagement over an extended period; otherwise, the normal bureaucratic processes would prevail. Dr. Schlesinger added that it was often easier to work with military rather than civilian agencies, as military agencies generally had more knowledgeable individuals.

Capt. Smith praised the 'Future Vision' presentation made by Mr. Trimble; he hoped the Board would make public use of its opening paragraph. He acknowledged, however, that the morning's discussion had left him uncertain on how to proceed. He noted the observation that civilian agencies were making poor use of their leverage; could the EXCOM tactfully raise this point? He noted the group's interest in the Galileo project, suggesting early 2009 would be an appropriate time for a presentation from that project. Dr. Schlesinger clarified his statement: it was the *constituencies* of various agencies that should be more active. The Federal government, he added, was often criticized for its responsiveness to special interests; however, if one could orchestrate those groups in the right direction, things did get done. He noted two DoD contributions that had transformed the economy – the Internet and GPS. He continued to find it puzzling that the tremendous contribution GPS had made was so little recognized.

Dr. Enge said the 'Future Vision' presentation had been a highlight. He expressed concern that making the Interface Control Document [ICD] an Interface Specification [IS] meant that peer review had been 'shot down.' He praised Dr. Parkinson's presentation, suggesting that the 'golden hour' physicians referred to as crucial in delivering emergency medical care be added to the measures of effectiveness. He thought GPS could speed patient transport to hospital. Further, he noted that the 'noise floor' has been rising for the past decade; he regarded this as a concern.

Mr. Huber noted an 'amazing consistency' at the Board's first three meetings: agreement on the right thing to do; frustration on how to achieve it. He was pleased that commercial enterprises that rely on GPS continued to find ways to innovate around problems. He believed publicizing the benefits that GPS had produced was a priority. This fall, he reported, General Motors (GM) would place its Stolen Vehicle Slowdown technology, which provided the ability to stop high-speed chases, in 1.9 million vehicles. GM's earlier announcement of this technology had received enormous press coverage, extending to Europe and China. However, his 'passionate plea' on behalf of GPS that had made as part of that announcement had been largely omitted from press coverage. GM, he said, was putting an embedded communications capability in 90 percent of its vehicles; other manufacturers averaged 18 percent: competitive dynamics would raise that 18 percent to 90. Dr. Schlesinger commented that one consequence of more rapid communication was a shorter public attention span: one needed to repeat, repeat and repeat. Mr. Huber acknowledged this, saying that GM planned a 25-city tour to show police and emergency services the advantages of its new system. Dr. Parkinson asked if any insurers offered discounts to drivers of vehicles so equipped. Mr. Huber said he did not know. However, one major insurer offered 'low mileage' rates: miles driven were verified by a wireless technology that validated odometer readings.

Mr. McGurn said the central need was for 30 satellites: until these existed, 'that tail will wag the capability dog.' He suggested that public support for GPS had been undermined by the system's success. While he had seen headlines announcing that GPS would introduce a new era of travel, he did not see headlines that this would require six additional satellites. Perhaps, he suggested, the public will not focus on the needs of GPS until system performance deteriorates. Dr. Schlesinger said the press had been laggard on this issue; the *Wall Street Journal* was showing insensitivity to the needs of the business community. He believed those affected by GPS should express their concerns to press and public; unfortunately, those aware of the problem talked primarily to each other.

Mr. Logsdon urged supporting publicity by linking the Board's website to those of other pertinent groups, and posting videos that had been shown. Second, noting that the 'G' in GPS stood for global, he urged integrating the concerns of international allies into system requirements. Third, he urged creation of a 'neighborhood watch' mechanism whereby users could help identify flaws in the system. Fourth, he said he was discussing with the National Geographic Society the undertaking of forums on energy and climate; these would showcase satellite-based applications and their impacts. National Geographic Society was, he said, a very good place to have a global impact in a neutral environment. He suggested that Dr. Schlesinger or the Secretary of

Energy might deliver the keynote address for this activity. Finally, he believed the case for 30+ satellites was clear; a better linkage with the DHS might advance the argument.

Mr. Trimble had no comment.

Mr. Hall said the relevant issues fell into two categories. The first set were EXCOM-worthy; these included 30 satellites; placement of NDS on GPS satellites; and dual launch of satellites. He noted that while achieving a 30-satellite constellation would cost about \$100 million annually, little of this figure was near-term money. The second set – including technical exchanges with the user community; transparency; laser retro-reflectors – could likely be handled by the office of Mr. John Grimes, Deputy Assistant Secretary of Defense. He added that transparency was always important, it would be more so as GPS III moved into Preliminary Design Review [PDR] and Critical Design Review [CDR]. He recognized that as DOD was paying the largest share, it would likely have the largest say; still, a technical exchange could be accomplished at little cost. Dr. Schlesinger, picking up on an earlier comment, asked Mr. Trimble if he could elaborate on his comment that the Joint Program Office [JPO] had been ‘ordered’ not to do something; Mr. Trimble said he was unwilling to name names, but he believed that Mr. Grimes’ office held the key.

Dr. Hermann urged the EXCOM to approach the national objectives for PNT as ‘a full set,’ rather than as an aggregation of individual departmental wishes. He suggested further attention be directed at how the ‘Future Vision’ statement might be used: five countries proceeding independently would lead to 150 satellites, which no sensible world leader would want. He noted the general question of government negotiation versus market forces; the current circumstance required governments to act. He believed there was an opportunity for leadership and for longer-term savings. Dr. Hermann expressed the view that transition documents were treated with more importance by the outgoing than by the incoming Administration. He urged that an effort be made to identify the agenda of the incoming Administration; then determine what could be offered as readily acceptable to that agenda and of use to PNT. Whoever wins the election, he believed the new Administration would place greater emphasis on international cooperation and on American competitiveness: PNT could offer steps in both areas. The new Administration might find such steps to be of immediate political use. Finally, he noted that GPS was deeply embedded in the issue of network-centric warfare. America appeared to be ‘muddling’ toward a network-centric force structure: this, too, would attract attention to GPS. Dr. Schlesinger commented that the limit on network-centric warfare was that persons aware of U.S. expertise in this area did not challenge it; rather, they pursued urban guerilla warfare, against which network-centric warfare was less effective. He agreed that incoming Administrations did not treat transition documents with great respect; nonetheless, those reliant on GPS should still talk to the new Administration.

Ms. Rausch had no comment.

Mr. Miller [NASA] noted that in his role as NASA’s subject matter expert, he was an observer to the PNT Board, rather than a participant. It is the perspectives of those outside government that the PNT Executive Committee is most interested in understanding. He added, however, that only one Board meeting remained before its Charter expired. His task would be to present the Board’s results and ask if NASA wished to continue sponsorship. That task would be assisted if the Board could crystallize its results to date, preferably, before its October 2008 fourth meeting. Dr. Hermann said the approach should not be made to NASA, but to the EXCOM, which was the body that would determine the Board’s continuation. Mr. Miller said when the PNT Board was created, it was NASA and the DOC that expressed specific interest in providing sponsorship for a two year period, and if NASA did not continue its initial sponsorship, the activity would need to be “handed-off” to another agency early in a new Administration. Dr. Hermann recommended that the existing EXCOM decide soon if the group should continue; if so, then its continuation could be addressed now, rather than in the early days of an Administration finding its footing. The central question, he thought, was not who might pay for the activity, but whether the activity was of value to the EXCOM. Dr. Schlesinger commented that the Board now had the support of the EXCOM and sponsorship from NASA: while he hoped that both would continue, these were separate issues. He agreed that advisory reports and transition documents were often shelved; at the same time, National Security Presidential Directives [NSPD] were also often shelved. The PNT Board operated under an NSPD from President George W. Bush; that fact may not appeal to the next Administration. NSPD’s, he added, were not engraved in stone either; they are political statements made at a point in time. Unless the White House continued to push a given NSPD statement, various Federal departments acted only on selected items of interest to them.

Mr. Lewis [Institute for Defense Analyses] offered three comments. First, he believed that initiating international collaboration, formal or informal, was highly important: efforts to date had assisted in establishing the international acceptability of GPS. Second, he believed it crucial that EXCOM address the continuation of the PNT Board; he noted that the title ‘space-based’ was narrower than the matter at hand. Third, he said Mr. Shaw’s report on EXCOM progress persuaded him that the PNT Chair and Co-Chair should have access to the relevant documents in case the opportunity presented itself to further the case. He believed the Board should formally state its support for this access.

Mr. Faga said the meeting had further underscored his appreciation of the need for 30 satellites. He said he thought it ludicrous that development of a national utility was being constrained by DoD review mechanisms. Two mechanisms were needed – first, one that permitted all users to come to the table and be heard; and, second, one that provided an adequate funding mechanism.

He noted there was great support for developing GPS and relatively little support for funding it. Dr. Schlesinger commented 'GPS constituencies' should stress GPS was more than space-based system; it provided enormous benefits on Earth.

Capt. Burns said the airlines industry could not achieve the promise of space-based operating systems without a 30-satellite constellation. He characterized the airplane industry as a sleeping giant; now, however, it was awakening to the benefits of GPS and to such mandates as runway incursion prevention. He noted that, historically, the airlines and the FAA had focused on systems approaches to problems, rather than on sensors; sensors were now becoming the more important part of the puzzle. Capt. Burns suggested that if a vacuum in GPS service occurred, someone else would fill it: foreign carriers would turn to other constellations. This, he added, would place U.S. carriers at a competitive disadvantage. Dr. Schlesinger commented that this point should be made to the U.S. government. Capt. Burns identified prospective benefits of further GPS development: First, fuel savings of ten or hundreds of millions of dollars. Second, environmental issues: if carbon trading schemes were adopted, the airlines could get ahead of the curve and benefit financially. Third, and most important, safety: newly emerging system required the precision of GPS. Capt. Burns said his task was to rally the Air Transport Association [ATA] and the 19 carriers that comprised it.

Ms. Ciganer said that the Internet private sector and telecommunications private sector had understood the importance of raising peer review above the ICD. They had created a way to facilitate and strengthen the civilian voice of the individual agencies; at the same time, there was an interagency process that represented all the civilians. Unlike these private sector arrangements, no industry technical advisory committee existed through which the GNSS/GPS private sector could make available cross-constituent expertise at a working level. She noted that cost-effective models for doing this existed within the DOS; the question, she said, was whether it was within the charter of the Board to establish such a cross-sector working group. She noted that the DOS was already involved in issues related to compatibility; interoperability and interchangeability.

Mr. Murphy said that while the Board had achieved greater clarity on the need for 30 satellites, they were no closer to making it happen; this, he found this to be dispiriting. He favored preparing a report on the Board's activities: while it might be ignored the Board's work would certainly be lost if not prepared. He agreed that GPS was the victim of its own success. He found it difficult, he said, to persuade management about future risks, as management tended to focus on how well things worked at present. He believed the Board should be continued; in any case, a formal report of its findings should be made. Dr. Hermann offered a clarification: eight years ago, when the Defense Science Board assembled a document, it was an objective description of what a committee had done, not an advocacy document. This, he observed, was an important distinction. Mr. Trimble asked if Dr. Hermann believed a historical description had value, separate from advocacy. Dr. Hermann said he believed so: ideas had a life of their own; if repeated sufficiently often, people came to believe them. Rarely, he added, was it true to say: 'we wrote this and they did that.' Mr. Miller acknowledged Hermann's point; however, the Board had identified many justifications for 30 satellites: the task now was to capture all the constituencies involved and create a credible piece that provided the rationale for 30 satellites. He believed the lead members of the three Panels should combine their work into a single piece. Dr. Parkinson cautioned that GPS III was not yet 'a done deal' – resistance remained. He believed the argument for 30 satellites would be won through 'erosion.' Mr. Murphy closed with praise for the 'Future Vision' presentation. There would, he said, be multiple systems in the future; if these were not interchangeable, the resulting fragmentation would be bad for him as a user. Mr. Trimble commented that if the U.S. did the 'right things nationally' with GPS, international cooperation would come more readily.

Mr. McPherson reported that use of RNP/PBN with GBAS navigation facilities at Sydney International Airport was saving 250 kgs of fuel per approach: this could equate to a saving of nearly \$1 million per airplane per year if GBAS was used widely. He noted that one Australian carrier would have 160 GPS-equipped aircraft in five years. Second, he expressed concern about the potential for GPS 'brownouts'. He commented that the costs of creating a 30-satellite array would be more than offset by the \$4-5 billion that would otherwise be spent on various augmentation systems worldwide trying to achieve the same outcome that can be derived from a 30-satellite constellation. Brownouts would have effects outside aviation: a \$1 million piece of equipment in an open pit mining operation could be lost due to a five-to-ten minute brownout. He urged that if the 30-satellite constellation was created, the satellites be placed in optimal orbital positions; but he recognized this was sometimes not possible. Finally, he urged that any cost-benefit analysis of the 30-satellite constellation include all relevant economic sectors – mining, maritime, banking, etc.

Ms. Neilan called attention to the U.S. hosting of the International Committee for GNSS meeting in December 2008. Providers from other systems and the press would be present; she believed it would be a tremendous opportunity for all concerned to have an impact. Next, she noted that the latest policy on GPS focused on improving governance and creating this panel. She believed the Board should commend EXCOM for what it and the National Coordination Office had accomplished. She noted that the 'Future Vision' was a shared vision; she believed many people worldwide would embrace the statement. Finally, she noted that an analysis workshop would be held in Miami in early June 2008.

Dr. Beutler endorsed the idea of Board presenting a set of recommendations. Next, he urged action on the laser retro-reflector issue. This, he believed, was an inexpensive and necessary step; if it was not undertaken, some years would pass before it would be possible to independently gauge the orbit accuracy of the system. He endorsed the 'Future Vision' statement on multiple systems; he believed that statement should be paired with the statement that the committee believed 'PNT systems as basic

infrastructure operated to the benefit of society.’ If, he added, one believed in multiple PNT system; then one must believe in common standards. He urged the Board should emphasize this.

Mr. Nishiguchi observed that everything -- trees, flowers and birds included – has position; when it moves, navigation is required. This was the starting point. Second, while everyone in the world benefited from the Internet and GPS, the benefits of the latter were not as widely recognized: GNSS was an important 21st century infrastructure. The Board had the task of clearly articulating this importance to the public. He believed that the U.S. GPS was the only system in the world that uniquely satisfied all needs; he hoped the next Presidential Administration will maintain the robustness and completeness of the GPS system.

Closing Comments and Adjournment

Dr. Schlesinger proposed the dates of October 15-17, 2008 for the Board’s next meeting; there was no objection.

As a closing comment, Dr. Schlesinger credited recent progress on GPS-related concerns to the efforts of Deputy Secretary of Defense Gordon England. When, Dr. Schlesinger said that when Deputy Secretary England made a decision, DoD tended to fall into line. He said that while GPS was clearly a national and international asset, it was important to understand the DoD perspective. While many people stood to benefit from GPS, the principal costs for the system fell into the U.S. Air Force budget; this caused some disquiet. He noted that questions were raised in Congress as to why the Air Force was funding this activity; DoD did not enjoy being in the position that, whatever was decided, it would be picking up the tab.

The meeting adjourned at 12:10 p.m., Friday, March 28, 2008

**NATIONAL SPACE-BASED POSITIONING, NAVIGATION,
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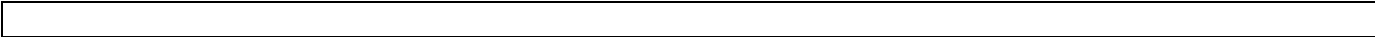
March 27-28, 2008

Appendix A: MEETING AGENDA

Thursday, March 27

9:00 – 9:05	BOARD CONVENES <i>Call to Order</i>	Ms. Diane Rausch, <i>NASA</i> <i>PNT Board Executive Director</i>
9:05 – 9:15	Welcome & Opening Remarks	Mr. Badri Younes, <i>NASA DAA</i> <i>Space Communications and Navigation</i>
9:15 – 09:30	Introductions, Announcements, & Agenda <i>What we want to accomplish</i>	Dr. James Schlesinger, <i>Chair</i> Dr. Bradford Parkinson, <i>Vice-Chair</i>
9:30 – 09:50	U.S. Update on GPS, PNT Policy, & PNT EXCOM	Mr. Michael Shaw, <i>Director - National</i> <i>Coordination Office for Space-Based PNT</i>
9:50 – 10:30	International Member Updates and Regional Reports (at members' discretion) <ul style="list-style-type: none"> • Gerhard Beutler (CH) International Association of Geodesy (IAG) Switzerland • Arve Dimmen (NO) Maritime Safety of the Norwegian Coastal Administration • Suresh Kibe (IN) Indian Space Research Organization (ISRO) • Keith McPherson (AU) Airservices Australia • Hiroshi Nishiguchi (JP) Secretary General of the Japan GPS Council • Richard Smith (UK) International Association of Institutes of Navigation 	
10:30 – 10:45	BREAK	
10:45 – 11:00	U.S. State Department GPS Initiatives <i>International Cooperation/ICG</i>	Mr. Dave Turner, <i>Deputy Director</i> <i>Space & Advanced Tech., DOS</i>
11:00 – 11:20	DOD GPS Management & Authorities <i>Military Priorities & Coordination</i>	Dr. Steve Huybrechts, <i>Director</i> <i>Space Systems, OSD/NII, DOD</i>
11:20 – 11:40	FAA NAS Modernization <i>GNSS Evolutionary Architecture Study</i>	Mr. Leo Eldridge. <i>GNSS Group Manager</i> <i>Air Traffic Organization, FAA</i>
11:40 – 12:00	Department of Commerce GPS Priorities <i>Level-Playing Field & Open Access</i>	Mr. Ed Morris, <i>Director</i> <i>Office of Space Commercialization, DOC</i>
12:00 – 1:00	WORKING LUNCH – FACA Ethics Briefing	Ms. Rebecca Gilchrest, <i>Sr. Attorney</i> <i>Office of General Counsel, NASA</i>

1:00 - 1:30	Protecting RNSS Spectrum	Mr. Karl Nebbia <i>Associate Administrator Domestic & International Activities Office of Spectrum Management, NTIA</i>
1:30 – 2:00	Update on GPS Performance Standards <i>Process for Civil/Industry Input</i>	Lt. Col. Bob “Iggy” Ingegneri, <i>Chief Space-Based Navigation & Timing Ops USAF HQ</i>
2:00 - 2:30	GPS III Requirements Development <i>Process for Civil/Industry Input</i>	Lt. Col. Harold “Stormy” Martin <i>Air Force Space Command - GPS</i>
2:30 – 2:45	BREAK	
2:45 – 3:45	Panel 1: Leadership <i>Updates & Recommendations</i>	Dr. Bradford Parkinson, <i>Stanford University</i> Mr. Martin Faga, <i>former CEO MITRE</i>
3:45 – 4:45	Panel 2: Strategic Engagement and Communication <i>Updates & Recommendations</i>	Ms. Ruth Neilan, <i>Jet Propulsion Laboratory</i> Mr. David Logsdon, <i>Space Enterprise Council</i> U.S. Chamber of Commerce
4:45 – 5:00	Afternoon “Wrap-Up” Discussion & Announcements	
5:00	ADJOURNMENT	



Friday, March 28

9:00 – 9:05	BOARD CONVENES <i>Call to Order</i>	Ms. Diane Rausch, <i>NASA</i> <i>PNT Board Executive Director</i>
9:05 – 9:15	Chair/Vice-Chair Feedback <i>2008 Priorities & Work Plan</i>	Dr. James Schlesinger, <i>Chair</i> Dr. Bradford Parkinson, <i>Vice-Chair</i>
9:15 – 10:15	Panel 3: Future Challenges <i>Future Vision</i> <i>Updates/Recommendations & Discussion</i>	Mr. Charles Trimble <i>Founder, Trimble Navigation</i> Dr. Robert Hermann, <i>Global Technology Partners</i>
10:15 – 10:30	BREAK	
10:30 - 12:00	Board Member “Round Table” Discussion <i>2008 Board Assignments & Panel Taskings</i>	All
12:00 – 1:00	WORKING LUNCH – PNT Advisory Board “Wrap-Up” Discussions	
1:00	ADJOURNMENT	

ACRONYMS

AOPA:	Aircraft Owners and Pilots Association
APEC:	Asia Pacific Economic Cooperation
ATA:	Air Transport Association
AU:	Australia
CDD:	Capabilities Development Document
CDR:	Critical Design Review
CH:	Switzerland
CHAMP:	CHALLENGING Mini-satellite Payload
DAA:	Deputy Associate Administrator
DAS:	Deputy Assistant Secretary
DHS:	Department of Homeland Security
DOC:	Department of Commerce
DoD:	Department of Defense
DOE:	Department of Energy
DOI:	Department of Interior
DOS:	Department of State
DOT:	Department of Transportation
ESA:	European Space Agency
EXCOM:	National Executive Committee for Space-Based PNT
FAA:	Federal Aviation Administration
FACA:	Federal Advisory Committee Act
FCC:	Federal Communications Commission
FRP:	Federal Radionavigation Plan
GBAS	Ground Based Augmentation System
GIC	GPS Integrity Channel
GLONASS:	GLOBAL'naya NAVigatsionnaya Sputnikovaya Sistema
GNSS:	Global Navigation Satellite System
GOCE:	Gravity field and steady-state Ocean Circulation Explorer
GPS:	Global Positioning System
GRACE:	Gravity Recovery and Climate Experiment
HQ:	Headquarters
HPT:	High Performance Team
IAG:	International Association of Geodesy
IATA:	International Air Transport Association
ICAO:	International Civil Aviation Administration
ICD:	Interface Control Document
ICG:	International Committee on GNSS
IDM	Interference, Detection, and Mitigation
IFOR:	Interagency Forum for Operational Requirements
IGS:	International GNSS Service
IN:	India
IS:	Interface Specification
ITU:	International Telecommunications Union
JP:	Japan
JPL:	Jet Propulsion Laboratory, NASA
JPO:	Joint Program Office
LAAS:	Local Area Augmentation System
LEO:	Low Earth Orbit
LPV-200	Approach with Vertical Guidance – 200 ft minimum
NAS:	National Airspace System
NASA:	National Aeronautics and Space Administration
NCO	National Coordination Office
NDS:	Nuclear Detection System

NII:	Networks and Information Integration
NO:	Norway
NOAA:	National Oceanic and Atmospheric Administration
NSPD:	National Security Presidential Directive
NTIA:	National Telecommunications and Information Administration
OCX:	Operational Control Center
OSD:	Office of the Secretary of Defense
PDR:	Preliminary Design Review
PNT:	Positioning, Navigation and Timing
POD:	Precise Orbit Determination
PPS	Precise Positioning Service
PS	Performance Standard
RAAS:	Regional Area Augmentation System
RAIM:	Receiver Autonomous Integrity Monitoring
RITA:	Research and Innovative Technology Administration
RNAV:	Area Navigation
RNP	Required Navigation Performance
RNSS:	Radio Navigation Satellite Service
SA:	Selective Availability
SGE:	Special Government Employee
SPS PS:	Standard Positioning Service Performance Standard
USAF:	United States Air Force
USDA:	United States Department of Agriculture
USGS:	United States Geological Survey
UK:	United Kingdom
UWB:	Ultra Wideband
WAAS:	Wide-Area Augmentation System
WRC:	World Radiocommunication Conference

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Appendix B: PNT ADVISORY BOARD MEMBERSHIP

U.S. Board Members

Dr. James R. Schlesinger (Chair)	Chairman, Board of Trustees, MITRE Corporation
Dr. Bradford Parkinson (Vice-Chair)	Stanford University, Department of Aeronautics and Astronautics
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
Mr. Keith Hall	Booz-Allen Hamilton
Dr. Robert Hermann	Global Technology Partners, LLC
Mr. Chet Huber	OnStar Corporation, General Motors
Mr. David Logsdon	Space Enterprise Council, U.S. Chamber of Commerce
Gen. Lance Lord	Retired U.S. Air Force, Former Cmdr, Air Force Space Command
Mr. Tim Murphy	Boeing Corporation, Commercial Airplane Group
Mr. Terence McGurn	Retired Central Intelligence Agency (currently private consultant)
Gen. James McCarthy	Retired U.S. Air Force (currently professor)
Ms. Ruth Neilan	NASA Jet Propulsion Laboratory
Mr. Charles R. Trimble	Founder, Trimble Navigation (currently private consultant)

International Board Members

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

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Appendix C: MEETING ATTENDEES

U.S. Board Members

Dr. James R. Schlesinger (Chair)	Chairman, Board of Trustees, MITRE Corporation
Dr. Bradford Parkinson (Vice-Chair)	Stanford University, Department of Aeronautics and Astronautics
Capt. Joe Burns	United Airlines
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
Mr. Keith Hall	Booz-Allen Hamilton
Dr. Robert Hermann	Global Technology Partners, LLC
Mr. Chet Huber	OnStar Corporation, General Motors
Mr. David Logsdon	Space Enterprise Council, U.S. Chamber of Commerce
Mr. Tim Murphy	Boeing Corporation, Commercial Airplane Group
Mr. Terence McGurn	Retired Central Intelligence Agency (currently private consultant)
Ms. Ruth Neilan	NASA Jet Propulsion Laboratory
Mr. Charles R. Trimble	Founder, Trimble Navigation (currently private consultant)

International Board Members

Dr. Gerhard Beutler (Switzerland)	President, International Association of Geodesy
Mr. Arve Dimmen (Norway)	Director, Maritime Safety Div, Norwegian Coastal Administration
Mr. Keith McPherson (Australia)	Manager GNSS, Airservices Australia
Mr. Hiroshi Nishiguchi (Japan)	Secretary General, Japan GPS Council
Capt. Richard Smith (United Kingdom)	President, International Association of Institutes of Navigation

NASA Attendees

Adde, Barbara	NASA HQ – Space Operations Mission Directorate
Brodsky, Beryl	NASA HQ – Overlook Systems Technologies, Inc (contractor)
Gilchrest, Rebecca	NASA HQ – Office of General Counsel
Hollansworth, Jim	NASA HQ – Space Operations Mission Directorate
Miller, James	NASA HQ – Space Operations Mission Directorate
Nelson, Robert	NASA HQ – SERC (contractor)
Oria, A.J.	NASA HQ – Overlook Systems Technologies, Inc (contractor)
Pace, Scott	NASA HQ – Program Analysis and Evaluation
Rausch, Diane	NASA HQ – Office of External Relations
Schuchuz, Leonard	NASA HQ – Space Operations Mission Directorate
Wan, Stephanie	NASA HQ – Office of External Relations
Younes, Badri	NASA HQ – Space Operations Mission Directorate

Other Attendees

Abner, Milton	NSSO
Alexander, Ken	Federal Aviation Administration
Andren, Carl	Institute of Navigation
Badbance, Anne	European Space Agency (ESA)
Basneyeki, Chaminde	General Motors/Research and Development
Bocek, Robert R.	Boeing
Daniels, Charlie	PNT National Coordination Office
Didelot, F.	French National Center for Space Studies (CNES)
DePietro, Dave	Department of State
Eldridge, Leo	Federal Aviation Administration
Freer, Harrison	Consultant; Freer Ideas
Grantham, Scott	OASD NII
Huybrechts, Steve	NII
Kohlase, Christian	Embassy of Germany
Kim, Jason Y.	Department of Commerce
Lewis, L. Kirk	IDA
Madhavan, Sethu K.	General Motors/OnStar
Madison, E.	CMC
Martin, Stormy	AFSPS/ASP
Mashle, Kay	Boeing
Matsaius, Demetrius	USNO
McNeff, Jules	OSD NII
Morris, Ed	Department of Commerce
Narins, Mitch	Federal Aviation Administration/Navigation Services
Negron, David	NGC
Nordwald, Frederic	European Space Agency (ESA)
Reiner, William	Boeing
Salvano, Dan	Federal Aviation Administration/Navigation Services
Shaw, Michael	National Coordination Office
Skalski, Hank	Department of Transportation
Sonnefeld, Fred	JS/JGCS
Stear, David	Jacob Technology Inc.
Swider, Ray	OASD
Thirumalas, K.	STI
Van Dyke, Karen	Department of Transportation/Volpe Center

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Appendix D: LIST OF PRESENTATION MATERIAL

- 1 National Space-Based PNT Policy Update [Mr. Michael Shaw]
- 2 GPS and GNSS from the International Geosciences Perspective [Dr. Gerhard Beutler]
- 3 Japanese Status on GNSS Utilization [Mr. Hiroshi Nishiguchi]
- 4 PNT Advisory Board [Mr. Arve Dimmen]
- 5 Ground Based Augmentation System [Mr. Keith McPherson]
- 6 U.S. Space-Based PNT International Cooperation [Mr. David A. Turner]
- 7 Department of Commerce Priorities [Mr. Ed Morris]
- 8 Protecting RNSS Spectrum: Domestic and International Activities [Mr. Karl Nebbia]
- 9 Global Positioning System (GPS) III Requirements Process [Col. Harold Martin]
- 10 Department Defense Directive 4650.05: Position, Navigation, and Timing [Dr. Steven Huybrechts]
- 11 *Panel 1 – Leadership: GPS ‘Big Five’ Contribution to Users Needs* [Dr. Bradford Parkinson]
- 12 March 14th 2008: PNT Hill Day Report [Mr. David Logsdon]
- 13 *Panel 2 - Strategic Communication and Engagement* [Ms. Ruth Neilan]
- 14 *Panel 3 – Future Challenges* [Mr. Charles Trimble]
- 15 Ethics Briefing for Special Government Employees Serving on NASA Advisory Committees [Ms. Rebecca Gilchrist]

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.