



**SPACE-BASED POSITIONING
NAVIGATION & TIMING**
NATIONAL ADVISORY BOARD

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

Fourth Meeting

October 16-17, 2008

Hilton Arlington

901 North Stafford Street

Arlington, Virginia 22203

MEETING MINUTES


James R. Schlesinger
Chair


P. Diane Rausch
Executive Director

**Fourth Meeting
October 16-17, 2008**

Gallery II – Second Floor
Hilton Arlington
901 North Stafford St.
Arlington, Virginia 22203
(Ballston-MU Metro)

Thursday, October 16, 2008

9:00 – 9:05	BOARD CONVENES <i>Call to Order & Welcome</i>	Ms. Diane Rausch, <i>NASA</i> <i>PNT Board Executive Director</i>
9:05 – 09:15	Introductions, Announcements, & Agenda <i>What we want to accomplish</i>	Dr. James Schlesinger, <i>Chair</i> Dr. Bradford Parkinson, <i>Vice-Chair</i>
9:15 – 09:45	U.S. Update on GPS, PNT Policy, & PNT EXCOM <i>PNT EXCOM Expectations, Transition Planning</i>	Mr. Michael Shaw, <i>Director -</i> <i>National Coordination Office for Space-</i> <i>Based PNT</i>
9:45 – 10:15	U.S. International Initiatives <i>Update on Intl. Committee on GNSS (ICG)</i> <i>Galileo, GLONASS, & COMPASS</i>	Mr. Dave Turner, <i>Deputy Director</i> <i>Space and Advanced Technology</i> <i>U.S. State Department</i>
10:15 – 10:30	International Member Regional Updates (at member’s discretion): Gerhard Beutler (CH) Arve Dimmen (NO) Hiroshi Nishiguchi (JP) Richard Smith (UK)	International Association of Geodesy (IAG) Switzerland Maritime Safety of the Norwegian Coastal Administration Secretary General of the Japan GPS Council International Association of Institutes of Navigation
10:30 – 10:45	BREAK	
10:45 – 11:10	GPS in the National Airspace System <i>WAAS, LAAS and ADS-B</i>	Leo Eldredge, <i>SAT/NAV Program Manager</i> <i>Federal Aviation Administration (FAA)</i>
11:10 – 11:30	GPS Space Service Volume (SSV) <i>New Capabilities for Space Users</i>	Dr. Michael Moreau, <i>Constellation Manager</i>
11:30 – 11:50	GPS and Homeland Security <i>Interference Detection & Mitigation (IDM) Plan</i>	John Merrill, <i>Manager</i> <i>DHS Geospatial Management Office</i>
11:50 – 12:00	Morning Session Discussion & Announcements	All
12:00 – 1:00	LUNCH	
1:00 – 1:30	Pseudolites – <i>Augmenting GPS in Regions</i> <i>Of Reduced Geometric Availability</i>	Dr. Bradford Parkinson, <i>Vice-Chair</i> <i>Stanford University</i>
1:30 – 1:50	Distress Alerting Satellites System [DASS] <i>Advantages of a MEOSAR System NOAA</i>	Chris O’Conner, <i>NOAA</i> <i>SARSAT Program Manager</i>

PNT Advisory Board Meeting

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1:50 – 2:30	Civil Input to GPS III <i>IFOR Update – SLR & DASS Examples</i>	Hank Skalski, <i>Civilian Liaison, AF Space Command</i> Col. Dave Buckman, <i>USAF, AF Space Command</i>
2:30 – 2:45	BREAK	
2:45 – 3:30	“Big 5” and Civilian Service <i>Panel Findings</i>	Dr. Bradford Parkinson, <i>Vice-Chair</i> <i>Stanford University</i>
3:30 – 4:00	Future GPS & Free Services <i>PNT Policy Lessons Learned</i>	Dr. Scott Pace, <i>Director</i> <i>Space Policy Institute, GWU</i>
4:00 – 4:45	Getting to 30+ satellites <i>Panel Discussion – Next Steps</i>	All
4:45 – 5:00	Afternoon “Wrap-Up” Discussion & Announcements	
5:00	ADJOURNMENT	

Friday, October 17, 2008

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 – 10:15	Messages for the Transition Team <i>Finalizing 2007-08 PNT Board Report</i>	Dr. James Schlesinger, <i>Chair</i> Dr. Bradford Parkinson, <i>Vice-Chair</i>
10:15 – 10:30	BREAK	
10:30 – 11:30	Transitioning & Strengthening the PNT Advisory Board <i>Panel Work Assignments - Preparation for 2009 -10</i>	All
11:30 – 1:00	WORKING LUNCH – PNT Advisory Board “Wrap-Up” Discussions	
1:00	ADJOURNMENT	

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*Meeting report prepared by:
Mark Bernstein, consultant*

Session of Thursday, October 16, 2008:

Board Convenes:

Diane Rausch, Executive Director
National Space-Based Positioning, Navigation and Timing Advisory Board

Ms. Rausch, Executive Director, PNT Advisory Board, thanked all for attending. She noted that this was the group's fourth meeting since March 2007. She reported that NASA was honored to serve as the prime sponsor of the Advisory Board, on behalf of nine federal agencies. She noted that all members had been appointed to the board by Dr. Michael Griffin, the NASA Administrator. She noted that the Advisory Board had been organized into three panels, respectively on Leadership, Strategic Engagement and Communications, and Future Challenges. This meeting, she said, would focus on the Advisory Board presenting concrete outcomes. Ms. Rausch noted that the Advisory Board was organized through the Federal Advisory Committee Act [FACA] of 1972. As such, the meeting was public and on the record; formal minutes would be published. She noted that any audience member wishing to speak must obtain the permission of the meeting chair. As a FACA committee, the Advisory Board membership was divided between Representatives, who represent an organization or entity, and Special Government Employees, who speak as experts. The latter were subject to federal ethics standards and were required to recuse themselves from any topic in which they saw a potential conflict of interest for themselves or their employer.

Opening Remarks:

Dr. James Schlesinger, Chair
National Space-Based Positioning, Navigation and Timing Advisory Board

Dr. Schlesinger, Chair, welcomed all to the meeting. He expressed pleasure at the presence of the international members. Dr. Schlesinger said that he had had the opportunity to brief the PNT Executive Committee [EXCOM] on the issues raised by the Board at its March 2008 meeting. At that session, he focused on the need for earlier enabling of a navigation message on the L2C civil signal. The IIR(M) satellites, he reported, had been broadcasting a signal without a navigational message. The first IIR(M) had been launched in 2005 but the navigation messages is not been scheduled to be enabled until the fourth quarter 2011. That, he said, would mean that six of the satellites' expected twelve-year lifespan would pass without this enabling capability. He was pleased to report that a navigation message was now set to be enabled on all IIR(M) satellites on May 2009. This, he said, would provide manufacturers with the opportunity to fully test new designs in a real world environment. He suggested that the Advisory Board might re-examine its position on the policy that established when full capability of a satellite should be fully enabled. He observed that in the current global environment, with systems to be provided from other countries, the timing of the implementation of new capabilities would be important to continued U.S. leadership.

Dr. Schlesinger said he anticipated one further meeting of the Advisory Committee before its charter expired. The current meeting would, therefore, include both updates from the previous meeting and briefings on topics to be addressed by the next meeting. He noted that following the presidential election, the Board would be advising a new administration. He hoped that at the current meeting, the Board would compile comments to go to the EXCOM meeting on November 5, 2008, and to be included in the transition plan for the new administration. He had, he said, asked each of the Board's three panels to review and comment on the summary statement of the Board's activities that would be presented to the EXCOM.

Dr. Schlesinger asked if anyone wished to make an addition to the agenda. None was suggested. Dr. Hermann stated that Panel III [Future Challenges] desired a better theory of how the international PNT infrastructure would evolve, and of how the various national systems would be integrated and made interoperable. The panel, he said, was unaware of anyone who could present a theory on that topic. He wondered if the Board itself should attempt to create such a description, adding that this effort might be premature.

Dr. Schlesinger said he regarded this as a good potential topic for transition discussion. Dr. Parkinson termed it an outstanding topic, but not one the Board had addressed in depth. He believed a technical committee existed that was operating at the international level; he thought the Board would do well to hear from this group. Responding to a question, Dr. Parkinson said he did not know the name of this committee. He believed the key word was interchangeability – the ability to interchange a Galileo or another satellite with a U.S. satellite in the solution; in current circumstances, he said, it did not appear that such interchange would result in a seamless projection of accuracy.

Presentation: U.S. Update on GPS, PNT Policy & PNT EXCOM

Mr. Michael Shaw, Director

National Coordination Office for Space-Based PNT

Mr. Shaw said his presentation would cover the 2008 EXCOM Work Plan; the Advisory Board tasking of March 2007, and the ‘Way Ahead.’ He reported that the EXCOM Work Plan was approved in August 2007; that it carried 61 items -- 44 from the original plan, 17 added since. He was responsible for providing a monthly status report to the Executive Steering Group, which operated a level below the EXCOM. He noted that the Work Plan was intended to provide a smooth transition into the next administration. He reported that 42 of the items on the list had been accomplished; six were on schedule; two were ‘at risk’, and eleven were overdue.

Dr. Hermann noted that, characteristically, not all items on a list were of equal importance: was there a ‘cover story’ of how complete the overall task was? Mr. Shaw acknowledged Dr. Hermann’s point, and said that some of the final items would be difficult to achieve. Dr. Hermann asked if that information was available to the Board. Mr. Shaw said the information was not publicly available; however, as he presented the list, members could make their own assessments of the importance of given items. Dr. Hermann said it would be advantageous to have the actual list for review. Dr. Schlesinger termed this ‘unarguable,’ adding that he thought EXCOM would not object to making the non-classified information available. Mr. Shaw said he believed that could be done.

Mr. Shaw presented [slides #5-6] fifteen key accomplishments that had occurred since the Advisory Board’s March 2008 session. Mr. Shaw recalled the 2004 decision that FY’08 would be the first year in which civil funding for GPS was to be provided to the Air Force. Following from this, the Department of Transportation [DOT] had completed transfer of \$7.2 million to the Air Force. While this was a small portion of the Air Force GPS budget, he considered it an important first step. The pending FY’09 budget figure was \$20.7 million; the FY’10 budget figure was \$40.4 million. Mr. Shaw cautioned that as those latter budget years fell in a new administration they were tentative.

Dr. Hermann asked if, in theory, the civil agencies were to cover the costs of civil peculiar issues with their own funds. Mr. Shaw said they were: civil unique capabilities beyond the current 2004 program baseline were to be covered. The DoD budget would still fund IIR(M); IIF to include the L2C; and a third civil signal on L5. Civil agencies were to fund capabilities beyond that; those currently at issue were the fourth civil signal on L1C and the Civil Performance Monitoring. DoD had costed funding lines for these: the first year funding profile of \$7.2 million was covered by the DOT transfer referenced above; the following year’s figure of \$20.7 million was reflected in the pending FY’09 budget.

Dr. Hermann noted the execution of the President’s mission to make GPS available to public and private users internationally was ‘not in any one job jar.’ Mr. Shaw agreed; he confirmed Dr. Hermann’s statement that a baseline for civil funding that extended into the future had been created. He noted that while DOT was the lead agency, funding need not be in DOT’s budget. The DOT decision for FY’08 was that \$3.6 million would be provided by each the Federal Aviation Authority [FAA] and the Federal Highway Administration [FHWA]; the decision for FY’09 was for \$20.7 million to come from the FAA budget. Dr. Hermann asked if this financial requirement applied also to the Department of Energy [DoE]. Mr. Shaw said it did in theory, but noted that DoE is not, at this time, an EXCOM member.

Dr. Enge noted discussion with Mr. Shaw of the semi-codeless issue; he suggested the December 31, 2020 transition date could be delayed if L5 was not adequately on line. Mr. Shaw noted that any delay in the new civil signal would prompt a reassessment of the transition date.

Mr. Shaw presented a chart detailing the recently-released GPS performance standard. The chart identified five metrics: global accuracy; worst site accuracy; user range error; geometry, and constellation availability – giving the standards established in 1998, 2001 and 2008. He believed the recently released standard was a better representation of what GPS was actually delivering. Mr. Trimble asked how the standards differed from actual performance – by a factor of two; a factor of ten? Mr. Shaw said there was considerable reason for being conservative: some currently orbiting satellites were in their later stages; no IIF satellite was currently ready for launch. He said the standards

represented a 'conservative but realistic estimate' of system capability. Dr. Parkinson said that what he termed the 'factor of three' conservatism meant civilians were not getting 'a fair shake.' If, he added, civil agencies worked to the performance standard rather than to actual performance, they would be held far below what they could actually achieve. He urged 'pushback' on the Air Force over this circumstance, which he believed cost considerable time, effort and money, particularly within civil aviation. Mr. Shaw said such 'pushback' had already occurred; the reported standards represented the judgment of DoD and the Air Force as to the requisite conservatism.

Mr. Trimble asked if this point belonged in the transition report. Dr. Parkinson said he believed it was below the level the transition team would likely consider. Dr. Hermann said the performance levels were fixed by the Air Force, which did not have sensitivity to the issues Dr. Parkinson was raising. He asked whether the question should be addressed at a higher level; he noted that the tradeoffs that existed were not entirely technical. Mr. Shaw said the performance standard included daily observed performance; he believed this would improve with new systems and signals. At the same time, he said, because of uncertainties that stretched into the future, it was important not to over-promise. He believed the announced service standard was what the Air Force had concluded it could reasonably provide for the near-term. Dr. Hermann noted that the U.S. provided transparency on the service level it provided; he was not persuaded that it should be for the Air Force to decide what service level could be depended upon. Based on available data, he said, FAA or DOT could make their own assessment.

Dr. Parkinson expressed agreement; he thought it unfortunate that the RAIM algorithms currently in use had been designed around use of Selective Availability [SA]. In consequence, he said, airplanes were being denied service that it was 'by orders of magnitude' clear they should be able to undertake. He believed Air Force conservatism on performance standards had a bad effect on many users. Mr. Shaw asked why RAIM was still being fielded with SA algorithms. Mr. Murphy said that while he wished it were not the case, many GPS manufacturers continued to produce RAIM systems with SA algorithms; he estimated that 80 percent of the receivers in the field operated as though SA were still on. He regarded the most important performance standard to be the figures for Constellation Availability. It would be most useful to him, he said, if in addition to supplying information on the 90 degree confidence level, he could receive information on the 50 percent confidence level. Mr. Shaw said that if the matter was of such importance, he believed the first appropriate step would be to have the algorithms changed to eliminate SA.

Dr. Parkinson said this underscored the concern: enormous delay and enormous expense was entailed in swapping out equipment; the longer the Air Force took to report 'the truth' about system capabilities, the harder this would be to accomplish. Dr. Hermann said an agency could, if it wished, make its own assumptions of the system. He noted that the Air Force was being transparent about its effort; that, however, did not mean others should necessarily rely on the judgments the Air Force made.

Dr. Schlesinger suggested that perhaps the 'messenger' was being shot. Dr. Parkinson acknowledged that but, noting Dr. Hermann's point, asked why the 'standards people' did not meet to devise their own standard. Mr. Trimble suggested that might be because the Air Force was easier to criticize than the FAA. Dr. Parkinson characterized the current standard as '200 percent' conservative; he thought considerable progress would be achieved by making it '100 percent' conservative. He questioned whether users could create a separate standard, as that amounted to saying: 'The provider says this, but we're going to assume that it is twice as good.' Mr. Shaw said he believed the Air Force had proceeded in good faith in adjusting the standards over time.

Mr. Faga raised a related point: if system delivery indeed exceeded requirements, then that might be argued as a reason to reduce program funding. Mr. Shaw termed this a good point. Mr. Trimble said the need for a margin or safety was unquestioned; the issue was what did that margin need to be? Mr. Murphy said it would help his planning purposes if he knew not only the 'high confidence' figure for system availability, but also an expected value. That, he said, would permit him to plan for a needed level of augmentation.

Ms. Ciganer offered a comment on semi-codeless transition. The underlying understanding is that there will be phase continuity on the modernized GPS signals. She noted that her panel had 'drilled down' to the level of the Interface Specifications (IS), formerly known as Interface Control Documents (ICD). While Phase continuity is reflected in the IS-GPS-800 (L1C) it is not yet reflected in the IS-GPS-200 (L2C). Mr. Shaw said this would need attention.

Mr. Shaw presented a list of tasks to be completed by the end of the calendar year. He noted the Board's current charter expired in March 2009; given the uncertainty likely to characterize a new administration, he hoped that charter could be renewed before the end of the calendar year. He noted that, consistent with the publication of the performance standard for GPS, a revised performance standard for WAAS was due out this month. He noted that DoD, DOT and DHS were to publish the 2008 Federal Radio Navigation Plan, which he described as the senior-most plan, established back in 1978. He noted that an International Committee on GPS session would be held in December at JPL in Pasadena, California; 150-200 people were expected to attend. Finally, DHS was to complete the update of the vulnerability studies.

Mr. Shaw noted that Dr. Schlesinger would be reporting to the November 5, 2008 EXCOM meeting. If it wished, he added, the Board could contribute to the transition book being compiled by the National Coordination Office. Dr. Parkinson said he thought Mr. Shaw had rendered 'admirable service' to PNT; in particular in identifying needed tasks and pressing for their completion. Mr. Shaw introduced various people who had worked with him.

* * *

Presentation: U.S. International Initiatives

Mr. David Turner, Deputy Director
Space and Advanced Technology
U.S. State Department

Dr. Parkinson asked if Mr. Turner would address Dr. Hermann's concern about the degree of coordination in international PNT efforts. Clarifying, Dr. Hermann said his concern was that some statement should be made on how international efforts could be shaped. If, he said, the United States, Europe, Russia, China and, to some extent, India each pursued their own proprietary systems, then perhaps 150 satellites would be orbiting. He did not see how that number would provide a significant advantage to the average citizen. How could one proceed, he asked, so that both legitimate national interests and collective global interests may be served? He said there was no theory of how all this might be fitted together. He believed there was a larger collective view that the U.S. might act to shape.

Mr. Trimble acknowledged Dr. Hermann's point: the reality, he said, was that the national systems were being driven by military security reasons. Shaping the international system, he added, required that one respond to those competitive military equities that did not exist on the civil side of the equation. This, he said, greatly complicated things. In some cases, he said, the U.S. had encouraged cooperation through financial inducements; he did not believe the U.S. should pay people to be compatible. Dr. Hermann said he was aware of the complications Mr. Trimble cited; still, he believed it to be the task of the Advisory Board to deal with those complications. Mr. Trimble asked what U.S. government agency was to be tasked with determining how international efforts should be shaped. Dr. Hermann acknowledged the difficulty, but said the absence of such an effort was 'unseemly' of the leadership role of the United States. He was aware that Mr. Trimble had doubts about government leadership; however, such leadership had in the past accomplished some good and important things.

Mr. Turner offered to address Dr. Hermann's question. He presented slide #3 [Planned GNSS], noting that four global constellations were planned, along with two planned regional constellations and five augmentation systems -- 120 satellites in all. Mr. Turner said the U.S. State Department regarded shaping strategies as important and was pursuing them. He presented slide #4 [U.S. Objectives in Working with Other GNSS Service Providers]. He added, however, that as the U.S. could not tell other nations that they may not field a satellite system, the goal of U.S. PNT policy was to ensure compatibility of systems and to achieve interoperability. Dr. Parkinson noted that the word 'interchangeable' had not yet been adopted. Dr. Hermann said it might be useful to have a vision of what things would look like in ten years if U.S. policy was successful: creating such a vision would make it possible to identify priorities. He believed that what was being presented was simply a list.

Mr. Turner presented slide #5 [The Goal of RNSS Civil Interoperability], which stated: 'Ideal interoperability allows navigation with one signal each from four or more systems with no additional receiver cost or complexity.' He termed this a statement of success and would be, for 98 percent of users, a vision of the future. Dr. Hermann said it appeared to be Mr. Turner's view the one should accept that the 120 satellites he listed would all exist in the next fifteen years, as opposed to the view that action based on the idea that that number was not needed should be taken before that date. Mr. Turner said he doubted attempting to limit the GNSS satellites in use would be fruitful: things could only be shaped so far. If systems were designed for both civilian and military use, then other nations would have reasons for creating them which fell outside the persuasive range of the U.S. Dr. Hermann said he would make no further response, but did not accept that the current approach was wise.

Dr. Parkinson urged that the phrase 'with no degradation of accuracy' be added to the definition of interchangeability. Mr. Turner called this a fair point; the broad idea, he added, was that all systems should work better collectively than any system worked alone. He noted that the U.S. had a performance system; other providers, however, did not -- the Russians, he believed had data, but had not as yet published it. The U.S., he said, had encouraged all other systems to establish and publish performance standards; once that was achieved, a collective performance system could be created. Dr. Parkinson said any airlines would be unwise to use any GNSS system that was not committed to a performance standard.

Mr. Turner presented slide #6 [Progress on Interoperability]. This, he noted, included bilateral discussions with Russia, Japan, India and the European Union. He noted that three bilateral meetings had been held with China. Dr. Schlesinger asked if discussions with China had gone into ‘deep freeze’ following the announced U.S. arms sale to Taiwan. Mr. Turner said they had not, noting that these discussions were limited to ITU-R compatibility issues. He termed these discussions ‘surprisingly cooperative and successful.’

Mr. Trimble said great mutual interest existed in making various systems work together; further, he believed other nations developing systems could learn a great deal from the U.S. He had faith such efforts would proceed cooperatively, noting that they concerned matters separate from any country’s national defense. Mr. Turner said such work was proceeding within the Asia Pacific Economic Cooperation (APEC) and the International Committee on GNSS/Providers Forum. Mr. Turner noted the work of the International Committee on Global Navigation Satellite Systems (ICG), which he termed an important venue for discussing both technical and service provision issues. The second ICG Conference in India in September 2007 had established a providers’ forum to address common issues. He urged attendance at the third ICG meeting at JPL [NASA Jet Propulsion Laboratory] in Pasadena in December 2008; that invitation was also being extended to industry.

Mr. Turner presented slide #9 [ICG Global Providers Forum], noting that the six space segment providers were represented: the forum’s first meeting had established consensus on general definitions for compatibility and interoperability. This, he said, was as an example of U.S. efforts to shape the system. Mr. Turner asked Dr. Hermann what he thought was lacking from the effort as described. Dr. Hermann said he thought cooperation would emerge, because otherwise the outcome would be ‘too bizarre.’ He noted that Mr. Turner was not trying to deal with military aspects. Mr. Turner said this was so; military matters extended well beyond his office. Mr. Trimble thanked Mr. Turner for his efforts; he was extremely pleased with the consensus achieved with interoperability and compatibility. Mr. Turner acknowledged that further efforts were needed.

Dr. Enge referenced Mr. Turner’s term: ‘interchangeability at the performance level.’ While, he said, this was important for GPS to be used for safety of life purposes, agreement was also needed on interchangeability of integrity and interchangeability of continuity. If accomplished, he said, other national systems could also be used for safety of life.

Ms. Neilan said that following the September 2007 ICG meeting in India, the Russians -- who had been casting ephemeris in their own particular PZ-90 – began to broadcast in high tariff, which was compatible with WS84. She offered this as an example of the value of the ICG discussions.

* * *

Presentation: International Member Regional Updates

Mr. Hiroshi Nishiguchi
Secretary General of the Japan GPS Council

Mr. Nishiguchi said his presentation would summarize two acts enacted in Japan to secure the synergistic effectiveness of the PNT system and space-based utilization. These acts, he said, had grown out of interactive discussions by the major parties in the Japanese Diet, where consensus had been reached. The first was the Principle Act on the Promotion of National Spatial Data Infrastructure [NSDI] passed in May 2007; the second, the Principle Act on Space Development & Utilization, passed in May 2008. The NSDI Implementation Plan had been published in April 2008 with Cabinet approval; the implementation plan for the Space Principle Act is in preparation and will be published in March 2009, pending Cabinet approval.

Mr. Nishiguchi explained the relationship between these two pieces of legislation. The Space Act established a commanding body to promote the integrated and planned exploration of space; this body had been established in September 2008. The body was now undertaking its organization, a task in which Mr. Nishiguchi would share as an ex-officio member. He noted that the NSDI Act called for the promotion of the geospatial data infrastructure and appropriate measures for GIS and PNT in an integrated and systematic manner, through use of the GNSS technology, which played an important role in providing precise timing information. Relative to NSDI, Mr. Nishiguchi said that satellite positioning was a powerful means for space utilization. Therefore, the act called for communication and coordination regarding satellite positioning technology and R&D.

Mr. Nishiguchi described the background to the Principle Space Act. This, he said, turned on the interpretation of a phrase in the 1969 Resolution on the Basics of Space Exploration and Utilization; that is – that it be done only for ‘peaceful purposes.’ At that time, he noted, the principal space-based uses in the world were military. However, he noted, with the end of the Cold War, the uses to which space-based activities were being put had been extended – to

include the prevention of terrorism, response to natural disasters, assessment of global warming and other tasks. These tasks, he noted, involved no invasion of another country's borders. In this new setting, he said, various agencies of the Japanese government had to act in concert to create a new policy.

Mr. Nishiguchi presented the objectives of the Principle Space Act as the improvement in human life, development of economic security and the promotion of world peace and human welfare. The basic concepts of that Act, he said, were to utilize space for peaceful purposes; enhance standards of living; foster industry; develop space science R&D; promote international cooperation and consider environmental preservation. Mr. Nishiguchi described the administrative structures established by the political leadership to further national policy. He noted that the Space Act established a Command Center, chaired by the Prime Minister and co-chaired by the Director of Cabinet Secretariat and the Space Exploration Minister, to develop basic plans. He noted that additional legal framework would be required, for such things as international treaties.

Mr. Turner thanked Mr. Nishiguchi for his presentation. He noted that bilateral discussions with Japan were scheduled for November 2008. Dr. Schlesinger commented that the presentation was a reminder of the continuing close relationship of the United States and Japan.

Gerhard Beutler
International Association of Geodesy [IAG] [Switzerland]

Dr. Beutler said he would report on IAG and its connection with the Advisory Board. Geodesy, he said, was concerned with three aspects of earth – orientation, geometry and the earth's gravity field; space tools were routinely used to perform these tasks. GNSS tools were very important to this effort; they could be expected to remain in use at least 20 years. He detailed the GNSS role to maintain and densify the International Terrestrial Reference Frame [ITRF]; monitor earth rotation; monitor the atmosphere; determine highly precise Low Earth Orbiter [LEO] orbits, and determine the earth's gravitational field.

Dr. Beutler began the update portion of his presentation by noting that GLONASS, which had 25-28 monitoring stations available in 2006, had a combined 53 stations today; his submitted written report detailed the global products being generated. Dr. Beutler said IGS strove to aid civilian users of the enlarged GNSS community by creating the highest level of accuracy. This, he said, required the study of systematic errors; system peculiarities, and of how different GNSS systems could combine for user benefit. This perspective explained why the International GNSS Service [IGS] insisted on laser retroreflectors for all GNSS systems to enable Satellite Laser Ranging (SLR). To support improved service, he noted that IGS made available to the full GNSS community precise GPS, GLONASS and (he hoped in the future) Galileo orbits and clocks in one and the same reference frame.

Dr. Beutler noted that effective combined GNSS operation required the separate systems to operate on a common reference frame. He observed that the GPS and GLONASS constellations differed considerably in inclinations and in repeat orbits (one-day for GPS; eight-day for GLONASS). Dr. Beutler compared standard azimuth elevation diagrams for GPS and GLONASS, noting that both had a gap at their north ends. He added that GPS satellites had essentially the same track each day, while the GLONASS track 'moved all over the place' following an eight-day cycle.

Dr. Beutler presented slide #18 [Case for 30+ Satellites]. From this diagram, he said, one could extract the information that a return to a 21- or 24-satellite constellation would produce rather poor performance. He believed that cooperation was needed at both the technical level and the political level: he said IAG had a role to play in this. [He noted he was no longer a member of the IAG]. In this context, he called attention to the importance of the International Committee on Global Navigation [ICG] workshop in December.

Dr. Beutler offered several comments on the work of the Advisory Board. He praised the opportunity the Board gave for participation from the international community; he believed that this would promote increased cooperation in Europe in the near future. He said he was very pleased that issues raised by international members had been included in the Board's draft report.

Dr. Parkinson noted GLONASS satellites would not be placed into synchronous orbits; consequently, they would slide. He noted there had been speculation as to why GPS had not been done this way. The reason, he said, was that the U.S. had wished to undertake an extensive test program; this had required that the six initial satellites converge over the instrumented test area once a day. To do this required that they be sidereally synchronous. The alternative "sliding orbits" suggested by Galileo will not have that capability. A tradeoff had occurred; he said, commenting that when GLONASS was introduced, it would be a challenge to get six satellites together in an area that had been instrumented. Dr. Beutler said he was aware that the U.S. had had this reason; at present, he believed that GPS had moved beyond the test phase. He believed the GPS approach had drawbacks: for example, the system was longitudinally dependent,

rather than latitudinally dependent. Dr. Parkinson said this was correct: the GPS arrangement accentuated resonances that would otherwise be smoothed out. While, he said, resonances may be exaggerated, this provided an opportunity to learn them thoroughly. Dr. Beutler said it was unfortunate that the scientific community had yet to make use of this fact.

Mr. Miller said he thought great strides had been made since 2007 in the effort to add retro-reflectors to GPS: he had been part of a presentation on this topic to EXCOM; an interagency team (NASA, NOAA, IGS, NGA, USNO and NRL) was working on the question. He believed the U.S. government was currently considering installing retro-reflectors on the GPS III. Dr. Beutler welcomed Mr. Miller's statement, but asked when the first GPS III might fly. Mr. Miller commented that Col. Buckman, U.S. Space Command, would update that subject later in the day.

Arve Dimmen, Director
Maritime Safety of the Norwegian Coastal Administration

Mr. Dimmen said he would focus on his second topic, Special Category-I [SCAT-1] in Norway, the system and its certification. He said SCAT-1 was unique. Norway had nine international airports, nine medium-sized airports and 28 regional airports – these last were small, but had regular commercial traffic and were important to local communities. He reported that two lethal aircraft accidents in the late 1980s and early 1990s prompted the decision to install better systems. He noted that many regional airports were located in topographically difficult settings. He described the information SCAT-1 would provide. The system was inaugurated in October 2007 and was certified for 17 types of aircraft. He believed it was the first certified SCAT-1 system in the world. The decision to implement the system was made in 1996: at present, two airports have been certified; the remaining 26 were to be certified over the next three years. He noted that the system's development would be described in detail at the International GPS/GNSS Symposium in Tokyo, November 2008. The process, he said, had been long and tedious, but the result was pleasing.

Dr. Parkinson commented that, from his perspective, the time taken had been quite short; he believed all involved in its execution should be congratulated.

Capt. Richard Smith
International Association of Institutes of Navigation

Capt. Smith stated that the International Associations of Institutes of Navigation [IAIN] existed to exchange information on navigation; to that end, the group supported various activities, including ICG. He expressed his appreciation to Mr. Shaw for the latter's support of the activities involved. Currently, the said, IAIN was focused on its three-yearly conference, which allowed participants to gather information on the world's GNSS systems,

Capt. Smith recalled that at the March meeting of the Advisory Board he had listed problems related to Galileo: these included the then-recent collapse of Galileo's public/private partnership; the subsequent decision by the European Union [EU] to proceed notwithstanding, and the EU's allocation of 3.46 billion Euros to the project. He had also suggested that governance, organizational and procurement issues remained. Today, he said, the picture was improved: the European Commission was clearly in charge of the project as Galileo's owner; the aim remained the same – to establish a 30 satellite constellation [including three spares]. Services were to remain similar: the open service; the commercial service [rules yet to be released]; a safety of life service; the public regulated service, and the search and rescue service, which was to contain certified and regulated beacons. He said the second test satellite, launched in April, was working at expectations. On procurement, contract notices had been issued July 1, 2008 under EC procurement rules – he considered EC rules important as they introduced competition into the process. The competitive dialog phase of procurement began in September 2008. He expected contracts to be signed in the first half of 2009, with the system fully operational by 2013.

Capt. Smith offered a personal observation: Based on public statements made by various parties involved, it had been recognized that this was the last chance to get Galileo up and running; thus far, revised plans appeared to be working well. Some prime contractors, he noted, felt procurement was moving too slowly to permit the target date of 2013 to be met. He urged the Advisory Board to seek a project update on Galileo in 2009; he believed Galileo's development would have a downstream influence on GPS decisions.

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Presentation: Update on eLORAN

Dana Goward
Director, Maritime Domain Aware
U.S. Coast Guard
Department of Homeland Security [DHS]

Mr. Goward stated that continuing efforts were being made to refine thinking on LORAN and GPS. He said the longstanding 'hanging chad' was whether GPS required a systemic backup; DHS had thought so in the past, viewing eLORAN as the only practical system. He noted that LORAN systems had been in use for several decades and were now almost ubiquitous – China, the North Atlantic and the Middle East being exceptions. The cost estimate for developing eLORAN from the existing LORAN system had been revised downward from \$400 million to \$200 million. He added that it had recently been realized that if system modernization included the replacement of the solid state devices now in use, this would permit a reduction in staffing at those sites. Further savings should follow from the more precise signal eLORAN would permit. Combined, he said, these might make the introduction of eLORAN possible within existing appropriation levels.

Mr. Goward suggested a paradox: the statements just made suggested an improved 'way forward' on eLORAN. However, other recent discussions questioned the operative assumptions. First, the need for systematic GPS backup had been questioned; many users reported sufficient backup to handle an outage. Second, if backup was needed, was eLORAN the appropriate solution? These questions required affirmative answers before eLORAN would be pursued. He hoped that planned senior level meetings would resolve those questions before the November 5 EXCOM meeting.

Dr. Parkinson said that as chair of the independent review team on eLORAN, he had had reservations as to the need; however, the cost of taking out this 'insurance policy' was so small as to be compelling. Mr. Goward said this meeting was an opportunity for the Advisory Board to give the government advice on the matter; he suggested that the documents used in the IDA review had been somewhat unclear. Dr. Parkinson said the IDA report had come from a group that included many originally opposed to the proposal; that being the case, he thought their unanimous endorsement of eLORAN as a prudent measure was notable. Mr. Goward said he believed the IDA report had never gone beyond being a PowerPoint presentation to being a published document. Dr. Parkinson suggested this 'ducked the issue.' He expressed the hope that the group Mr. Goward said would be convening had adequate technical expertise to make the decision.

Mr. Lewis asked if the central issue was simply the question of who was going to carry the expense in their budget. That, he said, did not affect what was the overall need of the nation. Dr. Parkinson asked who would be making the decision. Mr. Goward said the principal players were DHS, DOT and the White House; the meeting would be called by the President's office. Dr. Schlesinger asked if the expense would be carried in the DHS budget. Mr. Goward said it was currently within the Coast Guard's budget; he believed eLORAN could be implemented within the existing line.

Mr. Goward identified what he regarded as the key consideration: for the previous decade, he said, the argument had been made: 'If the LORAN system is to be terminated, why improve it?' If that argument was answered, he said, he believed things could be accomplished. He noted that projected annual operating costs for eLORAN were \$25 to \$30 million. Dr. Parkinson termed this very inexpensive for an insurance policy; he was 'almost disbelieving' the issue remained unresolved. Mr. Goward noted that while everyone agreed GPS backup was needed, they also asserted they themselves had a backup. Dr. Parkinson said GPS would never have been created without 'adult civilian leadership' at DoD; the individual services, he said, had opposed the idea out of fear they would have to finance it. Dr. Parkinson said the broader view had prevailed; he hoped the same would happen in the group that was to be convened. Dr. Schlesinger expressed that view that 'you can't afford *not* to have this insurance' – he suggested that, given the size of the DHS budget, the funds could be found. Mr. Goward asked if the Advisory Board supported a backup system for GPS and believed eLORAN should be that system. Dr. Schlesinger said the Advisory Board was firmly of those beliefs. Mr. Trimble said if eLORAN could be financed from current budgets, it would be foolish not to do so.

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Presentation: GPS in the National Airspace System

Leo Eldredge, Manager
GNSS Group

Mr. Eldredge said he would specifically address WAAS [Wide Area Augmentation System] and LAAS [Local Area Augmentation System] systems. The FAA undertook these systems, he reported, when GPS, which then had 21

satellites with 98 percent assured use, was not sufficient to provide for all the navigational needs. WAAS, he noted, provided regional coverage and an approach service down to 200 feet above a runway; LAAS provided coverage down to the surface for category III operations. WAAS was in deployment; LAAS was in its early approvals.

Mr. Eldredge presented slide #7 [WAAS Avionics Status], detailing the services provided to general aviation, business and regional aviation and others. He noted, as a measure of system acceptance, that 37,000 units of the required avionics had been sold. He identified two additional products coming on line in 2009; these, he believed, would raise the rates of acceptance among business aircraft. Additionally, he noted that as WAAS could provide approach information to a rooftop, interest in its use was growing among helicopter manufacturers.

Mr. Eldredge presented slide #8 [WAAS Approach Procedures], noting that there were 1,333 WAAS LPV approach procedures, a figure that exceeded the number of instrument landings. Dr. Parkinson termed this an astonishing rate of progress. Mr. Eldredge said the goal was to have a published WAAS procedure for every instrument runway in the nation by 2018. Dr. Schlesinger asked if publishing was occurring in Canada and Mexico. Mr. Eldredge said publishing in Canada was close to the U.S. level; Mexico lagged, though a team would be meeting with Mexican officials in November. Responding to a question from Mr. Lewis, Mr. Eldredge said signal coverage in Canada was very good; required U.S. operations in Canada had been placed further north to strengthen the Canadian system. He said coverage in Mexico was good; but noted that the system began to break down near the equator.

Mr. Eldredge presented slide #9 [WAAS Enterprise Schedule], outlining the implementations of Phases II – now complete -- III and IV. Dr. Parkinson asked if the real milestone might be defined as ‘two years after FOC on L5.’ Mr. Eldredge acknowledged that if L5 was delayed, a reassessment of final WAAS availability would be required. As an augmentation system, he said, WAAS was constricted by whatever affected the GPS system itself. Mr. Eldredge presented slide #10 [Long Term Schedule]. On Phase III, he noted that five years would be required to develop the relevant standards and five years for the associated avionics to be complete. He termed this ‘a bit of a challenge.’ The question had been raised, he noted, of whether GPS III completion would remove the need for WAAS. According to the current master plan, he said, GPS could meet aviation needs by about 2030; ten additional years would likely be required to transition user equipment. Mr. Eldredge acknowledged that while that might seem a lengthy time, GPS had been approved in 1995 not all aircraft were as yet equipped 13 years later. These figures, he said, suggested a 12-year extension on the current lifecycle for WAAS was reasonable. He believed a reassessment would be appropriate between 2015 and 2020.

Mr. Eldredge then addressed LAAS [slide #12], which he said would provide accuracy three to four times higher than WAAS; that it was less susceptible to outages caused by ionospheric storms, and would permit greatly increased surveillance capabilities. He anticipated design approval of the Cat-I prototype system being operated in Memphis by Federal Express early next year; with Cat-III prototype validation in 2010, and system design approval in 2012. Mr. Eldredge then addressed the activities [slides #16-19] of the Aviation Rulemaking Committee, currently considering 36 recommendations, 26 of which needed to be resolved before further rulemaking could be achieved. He identified those particularly relevant to his topic, and provided the timetable for rulemaking procedures.

Capt. Burns said that he, as an airlines operator engaged in a significant GPS implementation, found it difficult to know how to proceed because deadlines kept changing. He believed other carriers felt likewise. For his airlines, he said, WAAS installation was simple, but the schedule had been progressively pushed back. His airlines was about to make a massive investment in avionics, but he was uncertain of how to proceed. He regarded LAAS as attractive, but the 2012 availability prompted hesitation. He would welcome Mr. Eldredge’s overall thoughts. Mr. Eldredge said he faced a continual need to reinforce the original vision -- WAAS and LAAS; he noted that makers of some high-end aircraft said they did not require WAAS, which was for them to determine. Based on production rates for the procedures, however, he believed acceptance was being rapidly achieved. He acknowledged gaps in the available guidance materials; he noted efforts to resolve this. He noted something as not clear: if WAAS was put on an aircraft, exactly how would it be used to fly an RMP approach; he believed this was being clarified. Further, he believed steps now being taken would make it easier to equip an aircraft. Capt. Burns suggested that, nonetheless, considerable confusion remained.

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Presentation: GPS Space Service Volume

Dr. Michael Moreau
Constellation Program
NASA Goddard Space Flight Center

Dr. Moreau noted that many NASA and DoD applications use GPS for spacecraft positioning, navigation and timing. Significant interest in much higher orbit activities exists; his presentation would characterize those environments. Dr.

Moreau noted that up to 3,000 kilometers, performance was very similar to that for terrestrial users in availability and signal levels. Between 3,000 and 8,000 kilometers, the signal dropped off: GPS signals may be received in cases where the satellite is crossing over the limb of the earth; further, signals were weaker due to radiation effects. Above 8,000 kilometers virtually all signals arrived over the limb of the earth and periods occurred when no GPS satellites were in view. Consequently, a specially designed receiver was required, with performance dictated by receiver sensitivity and other factors.

Dr. Moreau presented slide #9 [High Earth Orbit GPS Timeline]; this described the GIOVE-A satellite, launched in 2005 with an experimental GPS receiver. He next reported on the AO-40 experiment: this satellite operated in a highly elliptical orbit well above GEO and had been able to collect data through the full orbit. This data, he said, made it very clear that significant variations occurred in the constellation in terms of service levels to space users – among them: orbit performance of GPS varied from block build to block build. From this data, Space Service Volume [SSV] requirements for GPS were developed: because there would often not be four signals available, these were specified in terms of pseudo-range accuracy, received power and signal availability. He then presented slides #17-19, detailing each of these three. Following his discussion, he presented [slide #20] the GPS III Minimum Availability Requirements. The work he described, he said, was permitting NASA to proceed on various missions – including the Constellation program and lunar missions -- with the assurance that GPS would be available to augment ground-based tracking. This, he said, would improve navigation, increase on-board autonomy, and reduce the burden on the NASA-operated communication-channel tracking networks.

Summarizing, Dr. Moreau was NASA and other space users regarded GPS as an important component of space positioning, navigation and timing infrastructure. He added that the space user community had been vulnerable to design changes; that user requirements based on altitude had been identified, and that these had been baselined into GPS III. Most important, he said, this provided a ‘green light’ for the high priority missions mentioned above to rely on GPS. He believed there was a great opportunity for interoperability among space users if similar such requirements were incorporated by others, including Galileo. He believed it would be easy to document these capabilities for Galileo.

Ms. Neilan asked for further comment on the Navigator receiver that was in development. Dr. Moreau said that GSFC began five years ago to develop a new space receiver designed for geostationary and other high earth orbits; it had the ‘horsepower’ to acquire a GPS signal. That capability, he added, could undertake weak signal tracking techniques. The receiver offered an estimated 10dB improvement over previous systems; it was scheduled for inclusion in several pending missions.

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Presentation: Distress Alerting Satellite System [DASS]

Chris O’Conner, Program Manager
Search and Rescue Satellite-Aided Tracking [SARSAT]
National Oceanographic and Atmospheric Administration [NOAA]

Mr. O’Conner noted that SARSAT was one component of the national search and rescue response efforts; DHS coordinated these efforts. As lead agency, NOAA worked with NASA, others domestically and 38 countries around the world. Asked to define ‘timely’ response, Mr. O’Conner said time requirements were set by those rescue forces that were system customers: several set it at five minutes; the objective was to reduce this to one minute. He described the participation of U.S., European and Indian satellites; while there was agreement for Russian participation, no Russian polar-orbiting satellite was currently available: the launch of two such satellites was anticipated next year.

Mr. O’Conner identified four major classes of distress beacon users: maritime, commercial fishing, aircraft and, beginning in 2003, personal locator beacons – the last named group was expanding at 20 percent annually. He said the satellite constellation provided very good coverage between 60 degrees north and 60 degrees south; beyond that, issues of topographic shading occurred. At present, Mr. O’Conner said, it took 47 minutes to fix a location near the equator, which was the slowest time. This, he noted, was well above the standard suggested by IMO and ICAO. In rescue situations, the first hour was critical: to spend 47 minutes to locate the distress site limited what else could be accomplished in that time. The system, he said, was credited with annually saving 300 lives in the U.S. and 1300 worldwide, with over 22,000 lives saved internationally since 1982.

Mr. O’Conner displayed a typical Personal Locator Beacon [PLB]. Mr. Shaw asked if PLBs were available to commercial users. Mr. O’Conner said they were; many pilots carried them to supplement ELTs. He noted that some hikers carried PLBs. Responding further to Mr. Shaw, Mr. O’Conner said the cost of PLBs containing a GPS chip ranged from \$600 to \$1,000; those without, from \$300 to \$600. He noted that on February 1, 2009, international use of

121.5/243 MHz would be terminated; efforts had for a decade been made to switch user to 406 MHz, which produced fewer false alerts. Responding to false alerts, he noted, often placed rescue personnel at hazard. Mr. O'Conner described [slides #12-15] the systemic limitations of the LEO satellite constellation: SARSAT was not the primary function of the NOAA weather satellites used; therefore, a single failure created risks. Second, extensive problems had occurred in securing the Russian commitment of two satellites. Third, the long time between satellite passes contributed to delays in determining the distress location. Fourth, the LEO environment was subject to problems of topographic shading. He reported as an additional concern that the French government had announced in 2004 that it would no longer donate the processing instrument used on the satellites; in doing so, it had suggested an alternate approach to be carried as a secondary payload on Galileo. The French contribution would end in 2017; service degradation would begin then, with complete failure in 2020. That, he said, might leave millions of people with no way to send a signal.

Mr. O'Conner reported that efforts to develop DASS [Distress Alerting Satellite System] began about the time of the French announcement. Nine DASS-capable satellites were operating; a DASS constellation of 22 was foreseen. Mr. O'Conner said DASS would reduce response time from 47 minutes to 12 – perhaps to 5; improve accuracy from 3-5km to 1.7 km or less; eliminate terrain masking; raise redundancy, and permit the number of ground stations to be reduced. In sum, he believed a NEO-based approach to distress efforts offered significant benefits. He noted that in July 2008 a set of requirements had been submitted to IFOR, and were now under review. He reported that Canada, which currently provided the repeaters on the geostationary satellites, had offered to supply repeaters for the full constellation, a \$70-\$90 million commitment that would considerably reduce costs to the U.S. government. The new constellation would be fully compatible with current beacons; no current users would be left behind.

Mr. Shaw asked if the prospective Galileo search and rescue package operated at 406 MHz. Mr. O'Conner said it would. Ms. Neilan asked the size of the search and rescue payload. Mr. O'Conner said he did not know, but it was not a 'real power hog.' Mr. Lewis asked how many satellites were required. Mr. O'Conner said the modeling concluded that 24 were needed; they could be 'any 24.' Mr. Shaw asked if Galileo was operational with 30 satellites in 2014, and each satellite carried the needed repeater, would the requirements for global search and rescue be met. Mr. O'Conner said they would be. Mr. Miller asked if the U.S. should defer to Galileo, or maintain its own capability. Mr. O'Conner said the least expensive option was to do nothing and hope that Galileo came through; from the U.S. standpoint, he thought GPS was the best option. Mr. Shaw noted that if DASS went on GPS, it would be in a non-DoD budget. Mr. O'Conner noted that search and rescue was a joint military and civilian need.

Dr. Enge noted that the Advisory Board favored use of lightweight satellites, so they could be launched two at a time; he requested weight information on DASS. Mr. O'Conner said he would supply that information.

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Presentation: Civil Input to GPS III

Col. Dave Buckman
U.S. Air Force Space Command

Col. Buckman identified himself as the PNT Command Lead at U.S. Air Force Space Command, a position recently created as the single point of contact for PNT activities. Responding to a question from Dr. Schlesinger, Col. Buckman said Space Command would issue a press release on the L2C turn-on in the next several days; Dr. Schlesinger commented that one should never bury good news. Responding to questions from that morning, Col. Buckman reported that IIR(M) satellite #20 was scheduled to launch March 24, 2009; IIR(M) satellite #21 was scheduled for August 14, 2009. The first IIF satellite was to be available for launch in April 2009, with launch in September-October 2009; IIF launch was being driven by another launch on the manifest. Dr. Schlesinger asked if Space Command would immediately turn on the L5 signal with a navigation message; Col. Buckman said it would.

Col. Buckman then made his presentation on the Interagency Requirements Process [IRP] and the position of Space Command on SLR and DASS. Col. Buckman presented [slide #4] a schematic of the requirements process and [slide #5], showing the Nominal IFOR Approval Cycle. The IFOR process had been approved in summer 2007, he said; subsequent experience provided lessons that needed to be incorporated. He reported that an effort to 'scrub and improve' the process would begin soon. Relative to IFOR, Col. Buckman said its most important points were cost and funding; a security assessment, and a technical assessment. When IFOR is completed, a proposal goes to the JCIDS [Joint Capabilities Integration and Development System] process.

Dr. Hermann asked the time required for the JCIDS process. As an example, Col. Buckman presented [slide #7] the GPS IIIB CDD approval schedule. This JCIDS process, he said, had reached a decision point: was this a secondary

payload? If so, further authority was required to include it in GPS. Dr. Parkinson asked if cost, schedule, additional weight, power and other factors were included. Col. Buckman these were addressed in the IFOR prior to the JCIDS process; due diligence within IFOR was appropriate before embarking on the complicated JSIDS process. Dr. Parkinson said the Advisory Board had expressed concerns on the NDS payload relative to making a true cost assessment. Col. Buckman acknowledged this: he believed opportunity costs needed to be addressed; at present, consideration occurred in something of a vacuum.

Col. Buckman said the goal for the JCIDS timeline was 229 days; a more realistic assessment was 340 days. Mr. Trimble asked if any review had ever been completed in nine months. Col. Buckman said he was new to his position and could not say; however, he regarded nine months was optimistic. He said the current GPS IIIA review would provide additional experience, though he expected this to be less contentious. Mr. Lewis said it appeared from the process diagram that a General Officer was not involved sufficiently early; Col. Buckman said the schedule steps were generic; Gen. Robert Kehler, commander, Air Force Space Command, would be involved prior to the initiation of JCIDS.

Dr. Parkinson said he believed 'these paper trails' were the major impediment to building a satellite: GPS I, he said, had gone from approval to launch in 44 months; now, the time involved might be 14 years. He acknowledged that indecision had been a reason, but he thought paperwork was the larger factor. He questioned whether a sufficient sense of urgency existed to tighten approval processes so that completion dates were not progressively extended. Col. Buckman noted that the General Accountability Office [GAO] had queried why approvals took so long. GPS, he said, was not unusual in this regard: process length reflected such standard things as requirements stability, funding stability, technical readiness levels; etc.

Dr. Parkinson recalled meetings on GPS at the Pentagon where he had asserted that no one in that building appeared to evidence a sense of urgency; instead, a 'marching army was being ground up.' This, Gen. Lord believed, made the project a target for continued cost reductions: it was easy to hit a slowly moving project. He thought the necessary approvals could be achieved in two months; GPS III was essential both militarily and economically and should be so presented. Dr. Parkinson asked whether the Air Force was ready to address what he termed the real danger, that of brownouts. He believed a 'train wreck' was pending as the number of operating satellites decreased, and that the lack of urgency was contributing to it. Col. Buckman noted that Gen. Kehler had identified 'brownouts' as a subject for review in the coming year.

Next, Col. Buckman addressed the status of GPS III Geodetic Requirements and DASS. Originally, requirements for Geodetic Requirements, and recommendation of implementation through Satellite Laser Ranging (SLR), were submitted in April 2007; IFOR approval for Geodetic Requirements for GPS IIIB followed. On August 2007, GPS Wing was requested to review the Geodetic Requirements for impacts on the GPSIII vehicle and that analysis was completed in June 2008. A joint AF/NASA-led IFOR working group was currently working to address technical issues that had been identified; the expected completion date was December 1, 2008. Ms. Ciganer noted that completion would be followed by JCIDS review, which could take nearly a year. Col. Buckman said that was the case. Mr. Trimble asked if any doubt existed that the review would be favorable; Col. Buckman said he was uncertain.

Col. Buckman then addressed DASS status [slide #13]. The requirements package had been distributed for IFOR review on August 1, 2007; the response – which included the statement that DASS would be a secondary payload – was received July 28, 2008. Cost and technical analysis and national security analysis were in process.

Dr. Hermann suggested the Advisory Board note that the arduous requirements process was not peculiar to GPS III. Two years, he said, would likely pass before financial planning could begin and programmatic decisions made; this, he believed, meant there was no way funds could subsequently be spent rapidly enough to be effective. He suggested that Board, in its transition document, call attention to this 'bizarre circumstance' – which, he said, was 'sufficiently outrageous as to create outrage.' Mr. Trimble said the time involved might be reasonable if the problem was complicated, but since what was at issue was a decision to attach a laser retro-reflector to a satellite, it was hard to understand. Ms. Ciganer reiterated a point Dr. Beutler had made that morning: a long gap would be created because there would be no laser retro-reflectors on IIIA; it would be IIIB before any could be in use. She noted that such retro-reflectors were now on Compass; they will be on Galileo: she believed the circumstance made the U.S. effort look bad to the international community. Dr. Schlesinger commented that during the Second World War, the Pentagon had adopted the 'concurrency' system, which required any number of signoffs on every step. He related an anecdote regarding Gen. Creighton Abrams, who, tasked with determining the post-World War II role of the horse cavalry, spent a year garnering the necessary agreements that the horse cavalry had no function.

Turning to DASS, Col. Buckman said its deadline was December 2008, which, he said, might be 'aggressive.' He said he understood the urgency related to the Canadian offer to supply the receivers. Mr. Lewis asked about requirements growth – were GPS satellites regarded 'as' trucks that should be loaded until full? Col. Buckman said Gen. Kehler

shared the concern with requirements growth, and had instructed Col. Buckman to so inform the Advisory Board. Gen. Lord asked to what extent delay reflected the fact that milestone decision authority did not rest in the Air Force. Col. Buckman called this a very significant factor. Gen. Lord further suggested the Board's transition report might urge that decision authority be moved to the organized, trained and equipped services. Col. Buckman noted that the recent trend had been in the opposite direction.

Mr. Miller noted that in his four months on the job, Col. Buckman had executed the communications and collaboration effort on two difficult payload issues. Mr. Miller regarded that as impressive. Col. Buckman said he thought the civilian community might be being inadequately informed of process success criteria; he believed that until the larger process problems were addressed, improved communication was needed.

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Presentation: 'Big Five' and Civilian Service

Dr. Bradford Parkinson, Co-chair
Stanford University

Dr. Parkinson said he would update the 'Big Five' presentation made at the March 2008 meeting; it was a work in progress and he wished to keep the Board current. The purpose, he said, was to relate system characteristics to such measures of effectiveness as assured availability; resistance to interference; accuracy; bounded accuracy and integrity – these, in aggregate, created the performance envelope. His approach was to hypothesize 'envelope-stretching' missions and see what tradeoffs might exist for their execution. His example missions included a CAT-3 aircraft landing; FAA ATC modernization for ADS-B; and target designation in a visually impaired region. The third example concerned a military observer on a steep hillside trying to direct delivery of a small bomb to an enemy structure. In various cases, the slope was 45 or 60 degrees, with either a 24- or 30-satellite constellation available, and with given satellites not operating. Dr. Parkinson reported that a 'dramatic increase' in accuracy when a 30- rather than 24-satellite constellation was employed -- with GPS III added, accuracy neared 100 percent. Responding to a question, Dr. Parkinson said he had factored in the accuracy of the bomb guidance system and use of an improved target locator. Responding to a question from Mr. Trimble, Dr. Parkinson said he was addressing measures of effectiveness – trying to determine the consequences on accuracy of the satellite population, the deployment of GPS III and other factors. If, he said, two satellites in a 24-constellation array were not functioning, the results were 'virtually hopeless.'

Dr. Hermann asked if Dr. Parkinson could determine effectiveness relative to time. Dr. Parkinson said he could, but suggested that one lacked the luxury of assuming that the target would remain available. Capt. Burns asked if Dr. Parkinson had computed single-shot capabilities. Dr. Parkinson said that these could be derived by dividing the results for 1000 cases by 1000. Capt. Burns said collateral damage and the sorties required for success needed to be played back into the system; Dr. Parkinson agreed. His question, he said, was if this was a worthwhile approach to demonstrating the advantages of a 30- over a 24-satellite constellation.

Dr. Schlesinger said that Dr. Parkinson's case was hypothetical: data was presented for when two satellites were out, but the percentage of time in which this occurred had not identified. How often was there a military observer on a 60 degree slope? And, more generally, what was the advisability of basing expenditures on the needs of that single individual? He thought measures of merit should be based on more likely real world proportions. Dr. Hermann said that while tactical circumstances were dictated by the command needs of the moment, investment decisions should be made on an aggregate of cases. The capability Dr. Parkinson described might not be available for ten years; should, he asked, a long-term investment decision be based on a current tactical need in Afghanistan. Dr. Parkinson said it was one measure; further, he did not think the example used was an unlikely future mission. His intention, he said, was to study hypothetical missions that pushed the envelope so that informed choices could be made between options; the Afghan example was a concrete case in point. He reported that commanders in Afghanistan were faced with 'keep out' areas in which the GPS system did not work sufficiently well. Authority above him, he said, would need to determine whether the performance difference a larger satellite array would provide justified the investment that array would require.

Dr. Schlesinger observed that Dr. Parkinson was making a case based on military capability; however, he noted, the Army and Marines were not involved in using that argument to advance the case for 30 satellites. He believed the burden of argument for 30 satellites rested on those who would benefit from such a system. Dr. Parkinson suggested that many such people were unaware of the pertinent information; 30 satellites were not needed by persons on the plains of Kansas, but by persons operating on the edge of the performance envelope. Dr. Hermann commented that Dr. Parkinson's analysis required a larger analytical context, one that would, for example, address the question of how many F-22s should be purchased v. how many satellites should be put in the air. He therefore thought Mr. Parkinson

analysis, while precise, was insufficient. Mr. Trimble asked if determinations of sorties required and fuel consumed might give a better view of the economic return. Dr. Parkinson responded that Mr. Trimble might be right; however, the actual situation came down to a Special Forces officer saying: 'For that cost, I'd like to see it done.'

Dr. Schlesinger commented that while future involvement in Afghanistan was plausible, it was considerably less than certain: he suggested that other scenarios be developed. Dr. Hermann suggested a scenario of an urban terrorist incident occurring amidst tall buildings that might restrict GPS use. Mr. Trimble commented that worked examples existed of GPS use by police and fire departments in urban setting. Dr. Hermann raised an additional issue: was it Dr. Parkinson's intention that the problem, whatever it was, would be handled solely by GPS? Was something else required? And, if 'else' was required, how much requirement would be left for GPS? Answers to these questions should be entered into investment decisions. Dr. Parkinson said one needed to illuminate multiple cases, identify the alternatives that might provide the needed result, and then determine how these played off against each other. Dr. Hermann said that this was not how GPS was created; GPS, he said, came about because a number of people 'stuck to their guns.' He believed good decisions were likelier to be made in that way than by 'dumping a lot of stuff into a JCIDS funnel' to see what consensus ensued.

Dr. Parkinson said the case he offered provided a plausibility argument: a 30-satellite constellation provided huge advantages over a 24-satellite one. Dr. Hermann said he thought Dr. Parkinson's analysis was true and useful; however, he thought it was not conclusive, and would simply be fed into the next process. Dr. Schlesinger noted that recent legislation required the Armed Forces to include fuel burden costs. If, he said, a larger GPS system could cut the number of sorties by five, that would reduce such requirements – which were now a legally required mandate in assessing capabilities.

Dr. Parkinson then introduced the civilian envelope mission [slide #19], CAT III Precision Landing. The measures of effectiveness employed [slide #20] were the long-term probability that CAT III was available without RF interference; the longest interval of unavailability; the loss-of-continuity problem when RF interference was suddenly introduced, and the availability probability when RF interference persisted. Dr. Parkinson presented [slide #21] data 12 named American airports, based on 24, 23, 22, or 21 satellites operating; commonly, he said, one or two satellites were out of operation. The data [slide #21] showed a significant drop in availability as the number of satellites decreased. He noted [slide #23] that a 30-satellite array provided all airports with 99.9 percent availability at all times.

Dr. Parkinson presented [slide #28] information on his fourth envelope mission: ADS-B support of air traffic control. He noted that air traffic operations demanded a level of system performance; if the system could not provide it, the system could not be used. His data [slide #29] showed that as the number of satellites fell, a substantial drop in RRAIM and ARAIM integrity occurred.

Gen. Lord asked if calculations had been made of how tighter flying in the airspace affected fuel burden. Dr. Parkinson said he had made none. Mr. Murphy suggested that the central limiting factor was on the ground in terms of tools for doing air management. Dr. Schlesinger reminded the Board that the case for 30 satellites should be made by its beneficiaries: specifically, by the airlines and the FAA. Mr. Miller noted that Dr. Schlesinger had been invited to speak at a gathering of airline CEOs.

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Presentation: Future GPS and Free Services

Dr. Scott Pace, Director
Space Policy Institute
George Washington University

Dr. Pace said he would discuss why GPS services were free, and what policy lessons followed from this. He observed that the relevant physics and economic facts of GPS had not changed since the mid-1990s when the commitment to free GPS service was made. He noted that GPS funding issues were framed by the military requirement that the receiver be passive. Consequently, he said, GPS was akin to a super-lighthouse that the U.S. built and provided as a charitable act. GPS could accommodate an infinite number of users; the marginal cost was zero; and use was difficult to monitor.

Dr. Pace identified three funding options: First, that DoD would pay; second, that various government or foreign agencies would undertake cost-sharing; and third, that users would somehow be charged. Regarding the second option, he said the U.S. was highly dependent on GPS; spreading control through multiple agencies or permitting control to leave the U.S. would be dangerous. The fact that GPS was free protected the system, he said, as it meant a competitor would either have to charge 'less than nothing' or establish restrictions that required use of another system. Regarding the third option, he said excise taxes on GPS-related equipment would be difficult to collect; the market for such

equipment was highly price sensitive and taxation might simply send business offshore. Dr. Pace said the optimal cost for something was equal to its marginal cost; with GPS, marginal cost was zero. Dr. Schlesinger commented that the optimal cost was marginal cost, provided overall costs were covered.

Next, Dr. Pace addressed the liability issues of GPS. The U.S. government, he said, could face lawsuits for failures in GPS services; warning notices on equipment were an important protection against this. As a related issue, he identified integrity monitoring as important to maintaining international trust. He expressed, however, two doubts. First, integrity monitoring was technically difficult. Second, integrity monitoring of GPS conducted by the U.S. might appear self-serving, and not overcome the skepticism of other nations. Maintaining trust in the system, he said, required a government, military, civilian dialog, of which the Advisory Board was an example.

Dr. Pace noted the 'free rider' question: 'Why should others freely benefit from a system the U.S. paid for?' The economic argument, he said, was that protecting the utility of the system was more important than any fees one might collect. The national security argument was that keeping the system free of interference was more important than charging for its use.

Capt. Burns asked whether discussions in the mid-1990s anticipated issues of future compatibility with other nations. Dr. Pace said they had; there had been no expectation that GPS would remain a U.S. monopoly: open international standards were considered. He called two things striking: first, the effort in the late 1990s to re-allocate safety of life spectrum; and, second, the extent to which Europe sought its own system. He understood that other countries might want their own integrity systems or to compete in the open market. However, he thought the European Commission rated the integrative and political cohesion value of Galileo more highly than he would have.

Dr. Hermann asked if Dr. Pace had a plan for future GPS. Dr. Pace said his plan was very straightforward: Don't mess it up. He urged that planned signal modernizations be completed; that backwards compatibility be maintained; and that European countries publish their standards. Dr. Pace next addressed the 30 satellite issue. He believed U.S. air navigation concerns were crucial; the question was how to finance the additional six satellites. He did not foresee DoD paying for all six; perhaps some 'horse trading' within the federal government would resolve the matter. Regarding coordination with other national systems, Dr. Pace said he would argue against an international system that had the 'right' number of satellites; he thought a more diffused interoperable system was preferable.

Dr. Hermann referenced Dr. Pace's statement that a robust system was of high military and economic importance: he thought the fact that the system was in no single cabinet secretary's 'job jar' was a detail; no individual secretary carried the entire set of national objectives. Dr. Pace said this tied to the question of GPS funding: he believed GPS paid for itself in DoD terms. He had no objection to DoD financing all of it, but he thought various DoD budget pressures made this unlikely. He urged political discussion of how to finance additional satellites. Dr. Schlesinger said the only party objecting to DoD financing all of it was DoD. Dr. Schlesinger requested further information about liability: if the United States was sovereign, how could it be sued? Dr. Pace said the U.S. could allow itself to be sued, though various warnings mitigated that risk. He thought lawsuits were more a danger to private operators.

Capt. Burns asked if Dr. Pace knew of studies of the impact of GPS on GDP. Dr. Pace said he did not; he noted that to extent GPS contributed to economic growth, that growth was reflected in tax revenues. Mr. Logsdon cited two estimates of GPS value to agriculture; one of \$4 billion a year, the other of \$40 billion. Dr. Schlesinger noted the importance of GPS to aircraft, which were the nation's leading export.

* * *

Presentation: Pseudolites -- Augmenting GPS in Regions of Reduced Geometric Availability

Dr. Bradford Parkinson, Vice Chair
Stanford University

Dr. Parkinson said he would summarize studies of alternatives to ranging signals. He noted [slide #2] the suggestion that the need for 30 satellites could be met through pseudolites on the ground or carried by blimp; by Galileo; or by some other national system. To assess this argument, he would insert each option into the mix at their optimal performance to see how this compared with the cost of creating a 30-satellite constellation. He noted that pseudolites were used in capturing blind aircraft landings and occasionally in open pit mining. Dr. Parkinson assessed [slides #7-9] ranging accuracy, signal geometry and operations for pseudolites. He identified various issues: Does the signal help the solution? Was the geometry of signal source of use (or was there already a satellite there)? He noted limitations: a given pseudolite tends to benefit only a narrow area; pseudolites need to be supported, so users can be informed of the

necessary corrections; and receivers need to be specially configured. In his view, he said, a 'satellite-oriented' person would conclude that satellites had the high ground.

Dr. Schlesinger asked if pseudolites were used in airports in mountainous areas. Mr. Murphy said an update to the ICAO standards was in process; all references to pseudolites were being removed, including placeholder references. Dr. Hermann asked if anyone considered pseudolites a legitimate alternative. Mr. Trimble said: no. Dr. Parkinson agreed, but believed others were owed an analysis of the matter. Capt. Burns said use of pseudolites required locating an antenna on the underside of the aircraft; placing an antenna on a large aircraft cost \$10,000. Mr. Murphy identified niche markets for pseudolites, including open pit mining where the pit screened the GPS signal. Dr. Hermann said they could not compete with the inherent advantage of GPS; namely, that it was free. Capt. Smith reported that the U.K. lighthouse authority had undertaken a trial on Scotland's west coast: five pseudolites, favorably placed, had been used. His assessment was that pseudolites might be fine for an emergency in a benign setting, but not otherwise.

* * *

Discussion: Getting to 30+ Satellites

Advisory Board

Dr. Schlesinger noted that Dr. Pace had advanced two propositions for getting to 30 satellites: first, that DoD could pay for them; second, that he did not believe DoD would pay. These, he noted, combined to establish a barrier to further discussion. Dr. Hermann said that if one specified a U.S. national objective, but said it could only be reached if all relevant agencies independently agreed on a course of action, then there was no point to proceeding. He believed that answers reached in the past had not been 'bottoms up' answers. If, he added, investment resources were put to a fragmented purpose, one ended up with fragmented resources. Dr. Parkinson saw an analogy to the 'tragedy of the commons' – a common objective would be reached, he said, only if someone with sufficient power decided to make it happen. Dr. Hermann noted that, in time of war, decisions were not compartmentalized; a coherent way that rose above departmental concerns was needed to deal with national level problems.

Mr. Trimble commented that energy independence was a major issue; 30 satellites were going to be required for putting the aviation system together – these outcomes, he said, were clearly in the national interest. Dr. Parkinson said Mr. Trimble's comment was intuitive; however, most people were censors: they say: 'That looks nice, now prove it.' He believed the best approach was for a range of people to press the case; if, he added, the Board continued to shoot water at the rock, then eventually the rock would erode. Dr. Parkinson said no national authority existed to force an outcome.

Dr. Hermann said the country indeed had a national authority – the executive branch; the legislative branch. He asked what Dr. Parkinson meant by the phrase. Dr. Parkinson said he meant someone who controlled 'the gold,' other than DoD. Dr. Hermann commented that a decade ago, the Republican Party ran on the premise that the country needed missile defense; when the new secretary of defense reached office, he did not consult the Joint Chiefs on the issue, the decision had been made. In that case, he noted, 'national authority' had been an elected President and an appointed secretary of defense. While he acknowledged that not all problems were handled that way, some were: the current fractioning of authority might be something to be offended by, he added, but not necessarily something to accept. Dr. Parkinson said that lacking a national authority, things were left to various constituents, and that process produced the 'tragedy of the commons.' Dr. Hermann said the problem was not resolvable within the context of the 'commons.'

Mr. Trimble said he understood the Advisory Board's general task to be that it would sit down together and spend two years producing a thoughtful set of recommendations as to what the nation should do with GPS; then present those recommendations to a new administration in the hope that some political appointee would read them and get inspired. Dr. Parkinson said that had indeed been done on the question of 30 satellites; further, the Board had 'driven a stake through the heart of SA' – which he regarded as of both symbolic and real importance. He suggested he may have failed to make the argument for 30 satellites. Mr. Trimble said the consensus at the table favored 30 satellites.

Gen. Lord noted that tremendous wealth had become concentrated in non-government organizations – e.g., the Bill and Melinda Gates Foundation. Was there merit in seeking a public-private partnership on the additional satellites, based in part on the savings those satellites would produce for the private parties? Dr. Hermann said the satellites were not a charitable item, but something the U.S. Government should do.

Dr. Schlesinger said it may be easier to fund six satellites than to find 'adult leadership.' It was true, he said, that the Secretary of Defense could order the Air Force to so act; however, the Secretary had limited political capital, and would have to be persuaded that this was the issue on which to expend it. Further, whatever one said to the President, others could similarly say: 'Mr. President, you have a limited amount of political capital, you must husband it -- six

satellites are just not that important.’ He suggested that favorable executive action was likeliest to come at the start of an Administration.

Dr. Hermann said a new President might observe that decision-making was flawed, not simply on GPS, but generally. A general revision of the decision-making process would be a more generic approach to obtaining the additional satellites -- it was destabilizing to make everything a ‘heroic cause.’ He noted that U.S. decision making processes had been changed at various times; perhaps an incoming President would address the matter afresh. He did not believe success would come by badgering Air Force colonels.

Dr. Parkinson commented that he was not intending to badger colonels, but to educate them. He believed that eventually he would find individuals of rank who agreed on the 30-satellite issue; he acknowledged that their agreement might not be sufficient to make it happen. Dr. Hermann said the issue was what more the Advisory Board could do as a body. Mr. Trimble said the ‘pushback’ to Dr. Parkinson was not over whether his argument was necessary, but whether it was sufficient. Mr. Logsdon said the most persuasive case for 30 satellites had been advanced by Capt. Burns and aviation; he urged that representatives of agriculture, energy and other fields should address the cost savings that would stem from 30 satellites.

Dr. Schlesinger called attention to the acronym for: Keep It Simple, Stupid [KISS]. He believed energy security was the issue of the day; further, that energy efficiency was a goal strongly endorsed by both political parties. He believed the case for GPS could be advanced by tying it to the general need; energy efficiency was the vehicle by which this proposal might be put through. Mr. Lewis commented that if the needed leadership was not forthcoming, one outcome would be ‘WAAS forever.’ If the fight between civil agencies over which would finance GPS continued, then perhaps an argument would be made that all civil and military information should be flown on the aircraft WAAS system. He said little analysis had been done on alternate approaches to providing a 30-satellite service level.

Mr. Trimble observed that in five years, when the 36-satellite Chinese system was operating, competition would set in. Dr. Schlesinger noted that, at present, such a system was only a statement of Chinese intention; he acknowledged, however, that the Chinese government seemed very interested in international prestige, e.g. the Olympics. He then referred back to decision-making processes: he believed that a decision by then-Secretary of Defense Donald Rumsfeld to speed GPS development had in fact slowed it down, as ‘112 offices’ had been asked to comment. A Secretary of Defense, he said, needed to believe in was not necessary to seek everyone’s permission before proceeding. Dr. Parkinson expressed agreement.

The Thursday, October 16 session adjourned at 5:05 p.m.

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The session of Friday, October 17, 2008 began at 9:00 a.m.

Call to Order:

Diane Rausch, Executive Director
National Space-Based Positioning, Navigation and Timing Advisory Board

Ms. Rausch called the meeting to order, and reminded all present that their financial disclosure forms [Form 450] were due. A Board member suggested the forms would be easier to complete if last year's form was made available; Ms. Rausch said she would attempt to retrieve those forms from NASA Headquarters.

* * *

Discussion: Board Recommendations

Message for the Transition Team

Dr. Schlesinger noted that Mr. Shaw had on the previous day recounted the Board's accomplishments; second, Col. Buckman had confirmed that when IIF was flown, the L5 signal would be turned on. He noted the observation of Victor Hugo, that there was a time when an idea becomes irresistible. He believed the idea of 30 satellites would become irresistible. For the moment, he urged that the Board not 'push on a closed door' – the 'door' at DoD was closed, he suggested; continued efforts to secure funding would be unproductive in the near term and might increase resistance in the long term. He believed the Board should tie the case for additional satellites to the 'banner of energy efficiency.' Eventually, he said, the savings in energy costs that a 30-satellites constellation would provide would prove appealing. He thought these savings would have direct appeal to U.S. Air Force, which had a significant fuel bill.

Dr. Parkinson entertained discussion of the draft report of the Board's recommendations; the executive summary had been reviewed by his panel [Panel 1 - Leadership], which had concluded that the summary accurately reflected the group's thinking. He asked for changes or suggestions. None was made.

Ms. Neilan said that her panel [Panel 2 - Strategic Engagement and Communications] regarded the executive summary as in good shape. She urged that rather than grouping the recommendations under each panel, those that reflected a Board consensus should be presented as such. Second, she noted that the Board, from its first meeting, had expressed considerable concern with the difficulties of the requirements process; she thought it advisable that this be stated. Third, she urged the report give recognition to those things that were going well – for example, that the NCO had been a useful undertaking. Dr. Parkinson agreed.

Dr. Hermann said his panel [Panel 3 - Future Challenges] believed the report should have a covering executive summary that conveyed in strategic terms the work of the Board. He characterized the current document as primarily a listing of what the various panels had compiled. An executive summary should present a 'story line' that framed those things that the Board considered most important, with suitable references to supporting documents. He thought a three-page executive summary would be the document most likely to be read. Dr. Parkinson suggested members review the draft to identify any disagreement with the key recommendations; no disagreements were noted.

Dr. Hermann suggested a modification: the Board had spent considerable time constructing a Vision Statement; at present, that statement appeared in the draft as a single sentence. He believed the Vision Statement should be presented as a prime product of the committee. Dr. Parkinson agreed: The Vision Statement was the 'skeleton upon which everything else hung.'

Mr. Miller noted that Dr. A.J. Oria [Overlook Systems Technologies, Inc., support to NASA] had helped him pull together the draft from the Board's meeting minutes and the presentations that had been made. He noted that 'redline' edits were requested prior to Dr. Schlesinger's briefing of the EXCOM on November 5, 2008.

Dr. Beutler said he thought the Vision Statement was excellent, and should be included in the report's summary. Dr. Hermann quoted the draft Vision Statement language from page 55 of the draft report:

'The ideal U.S. vision for the PNT world with multiple space-based systems; user equipment that leverages multiple systems, and a ubiquitous and seamless integration of space-based PNT as part of the daily lives of users worldwide.'

Dr. Parkinson said he liked the balance of the paragraph, which made reference to GPS remaining the 'Gold Standard.' Dr. Hermann said the balance of the paragraph moved out of vision and into tactics, which he did not believe were

'vision lofty.' Gen Lord seconded Dr. Hermann's view that the Vision Statement should be used separately, so that that statement was clear to all reading it, before the U.S. position was introduced.

Dr. Parkinson suggested that it was the sense of the group to revise the executive summary; place the Vision Statement prominently within it; place those panel recommendations that were unanimous, and celebrate the successes that had been achieved. Mr. Lewis asked how the executive summary would tie to the transition statement. Dr. Parkinson said the executive summary would report what had and what had not been achieved; that would flow naturally into the transition document. A prior task, he said, was to make sure the basic document was correct; that should be done before editorial changes were undertaken. Dr. Parkinson asked how long it would take to present a revised document; Mr. Miller said a report involving the changes identified in the previous paragraph could be completed by mid-week; work would then begin on the presentation to be made November 5 to EXCOM.

Dr. Hermann presented a second possible modification which related to international shaping strategy. The previous day's State Department presentation, he said, had failed to comment on how international cooperation was to be reconciled with the security concerns of various nations. 'Tactical vectors' had been presented, he said, but no overall strategy. Did the Advisory Committee, he asked, see merit in attempting to articulate an international shaping strategy? Mr. Trimble said he believed this would open 'a Pandora's box' – he questioned whether outsiders such as the Board could usefully contribute to finding ways to align the military equities of possible future combatants into a total solution. The international civil community, he said, had a commonality of interest that he did not believe was shared by various militaries; the motivation for the new satellite systems was military, not civil: he saw many complications following the path Dr. Hermann suggested.

Dr. Hermann said he and Mr. Trimble had differing views of how nations ought to behave. He suggested that Mr. Trimble, based on experience in international gatherings, believed that if you held a 'constitutional convention,' much mischief will occur. Mr. Trimble suggested that 'mischief' was internal: 'we have met the enemy and he is us.' International discussions, he suggested, were not open and transparent, but characterized by the 'winking and nodding' of mid-level bureaucrats over deals that had been cut. He was not opposed to trying to move from an 'Articles of Confederation' to a 'Constitution,' but that what Dr. Hermann suggested represented went too far.

Dr. Hermann said that if the Advisory Board's client was an executive authority that viewed the world in Mr. Trimble's terms, then the Board was in no position to contradict it. His own view was that the U.S. did better when it made clear what the country wanted and then proceeded intelligently to secure it. He was prepared to yield to Dr. Schlesinger's view on the advisability of pursuing the direction he, Dr. Hermann, had suggested. However, if he was that executive authority – and an advisory board presented no clear understanding on how the country ought to proceed relative to international developments – then he would be dissatisfied. He believed the client in question should want such a thing, and the advisory committee should articulate it. Mr. Trimble likened Dr. Hermann's approach to that of a planned economy. He believed other models had worked well in the past. For example, the Internet model had successfully permitted evolution in unanticipated ways: it was a capitalistic model. The question, he said, was not whether the Advisory Board should take responsibility for advocating a model for international GNSS development, but whether there was any intrinsic value in investing energy in advocating a planned economy as that model.

Dr. Parkinson said he believed current activities were moving toward interchangeability. Two alternatives existed: first, devise a grand plan for international GNSS; second, devise a strategy for how best to capitalize on a world in which interchangeability was a given. He believed it was as yet uncertain how far interchangeability would proceed. Dr. Parkinson suggested that Dr. Hermann's proposal could be addressed in the transition document; for the moment, a placeholder could be created while the Advisory Committee determined to what degree it wished to pursue the planned economy model.

Dr. Hermann said GPS was a 'top down 100 percent Government provided utility.' Dr. Parkinson disagreed strongly: while the enabling signals had come from government, he said, GPS had responded to a diverse entrepreneurial impulse. Dr. Hermann said the infrastructure was provided by U.S. public dollars; the actual or prospective European, Russian and Chinese systems were also financed by public expenditure. He agreed that the space segment offered an entrepreneurial context, but did so only because governments had funded its creation. Dr. Parkinson offered an analogy: lighthouses may have enabled nineteenth century seagoing traffic, but it was the entrepreneurial spirit that produced trade. Dr. Schlesinger noted that the lighthouse did not create the shipping industry, which existed previously.

Mr. Trimble commented that discussions of interoperability were basically about the civil signal. The U.S. GPS system had been created top-down, with military concerns primary. He believed the U.S. military had done 'yeoman's duty' in making the system available to the civil community; still, the fundamental GPS decisions had been made for military reasons. Returning to the question of a placeholder, Mr. Trimble said that the problem with creating a 'box' [placeholder] was that it allowed that box to be opened. Dr. Parkinson said that creating a placeholder that would allow

the advisory committee to delve further into whether the international question was appropriate. He acknowledged Mr. Trimble's comments about the dangers of 'mischief,' but said he believed those dangers existed in any case.

Mr. Logsdon referenced an earlier comment made by Dr. Schlesinger that what was needed was 'adult supervision' -- with such supervision, he said, much mischief went away. He urged that discussion proceed from the need to move from interoperability at the signal level to interoperability at the performance level; he believed that was vital. Dr. Parkinson said that such a discussion would represent a 'pooling of ignorance,' as not enough was known about what would happen. Dr. Hermann acknowledged Dr. Parkinson's point, but said one could still exercise independent judgment as to what one thought should happen. Dr. Schlesinger noted that there were two points of view: he believed the report should contain bracketed statements from advocates of each, and then a judgment made between the two.

Dr. Parkinson asked for additional comments on the draft summary report. Ms. Neilan said her panel had been tasked with looking at detection and mitigation of interference; they had not made great progress. The panel remained unclear as to DHS intentions in this area. She urged the Board recommend that this matter needed addressing. Dr. Parkinson termed this important. He recalled the discussion of eLORAN: one might not like eLORAN, he said, but at present it was the only backup available. He believed the DHS report failed to investigate this matter in sufficient depth. He suggested that those involved in the effort be invited to the Advisory Board's next meeting. Mr. Logsdon reported that he sat on the DHS communications sector coordinating committee; that group would meet the following week and he would raise the topic at that time. On another point, Dr. Hermann suggested that seeming harm came from two statements: first, the U.S. policy stating that aircraft safety would be achieved through GPS alone; second, the separate part that guaranteed one was unlikely ever to achieve certification with GPS alone. He believed this needed to be addressed at a plenary level. Dr. Parkinson said this would be added to the list of transition issues.

Dr. Hermann then called attention to the fact that it remained published U.S. policy that the U.S. reserved the right to turn GPS off. Clearly, he said, the U.S. had that right, but he thought it pejorative to say so in this instance: he believed such an announcement undercut U.S. efforts to make GPS the Gold Standard for the world. Dr. Parkinson noted Dr. Hermann's view, but said he believed any effort to eliminate that statement would be met with 'a sheet of steel.'

Capt. Burns said the aviation sector believed 21 or 24 satellites were insufficient for safety if GPS was to be the only safety system to be relied on. Dr. Parkinson said his own advocacy was to dig a series of 'wells' [scenarios], each of which required 30 satellites; while a given listener might not be concerned with all scenarios, each would likely be concerned with one. He said he would welcome an updated statement on aviation safety from Capt. Burns; Capt. Burns said he would be pleased to present one.

Ms. Neilan reported another issue that had been raised by her panel. Much, she said, was happening with GPS internationally: how could persons on the civil side internationally make useful contact with colleagues and peers in the military? She believed this needed to be addressed. Dr. Parkinson commented that one useful thing the Advisory Board had done was to give international partners a seat at the table; the Advisory Board had supported agendas that had reached it from those partners.

Dr. Parkinson said he believed GPS was in more perilous condition than was commonly appreciated: he cited issues of interference; the shortage of satellites, and the possibility of a brownout. He believed the number of satellites could drop below 24 for reasons that had not been acknowledged: the chance that 2S, once launched, developed problems; unavailability of launch vehicles; damage to the launch pad. He did not believe the statement that such things were impossible was reassuring.

Returning to international matters, Dr. Parkinson urged that the Advisory Board's report call attention to the value of international cooperation; further, it should state that the Board served an important purpose and should be continued. Dr. Hermann questioned whether it was appropriate for a committee to recommend its own continuation. Dr. Schlesinger suggested that rather than speak in the report of its own 'successes,' it would be more appropriate to observe, 'with pride and enthusiasm,' that the government had moved in directions recommended by the Board.

Ms. Neilan said that her interactions in international settings confirmed that the Board gained respect by including international representatives. She asked Dr. Beutler whether the Galileo panel would include international representatives. Dr. Beutler said international participation in this Board was highly valuable; it placed a pressure on parallel bodies elsewhere to do likewise. He believed the role international partners played with this body should be highlighted in its report. Dr. Schlesinger commented that greater international support and understanding was required for GPS to remain the Gold Standard; in the past, he added, the U.S. had been insufficiently alert to international public relations.

Dr. Parkinson said the report should state the composition of the committee -- a combination of technical specialists, stakeholders and influencers -- and explain why this combination was important. Dr. Schlesinger suggested care be

used with the word 'influencers.' Mr. Miller said that if the presence of international members on the Board encouraged the Europeans to have U.S. representation on Galileo, then that was an important achievement that should be highlighted as one of the Board's successes. Mr. Miller added that a revised draft would be ready for review by the following Monday; he emphasized that the report would reflect the board's sentiments, not those of those who prepared it.

Gen. Lord suggested that shorter was tremendously better, especially with the transition paper. The executive summary and the transition statement, he added, should be similar and compatible; the transition statement should consist of the Vision Statement and a few bulleted points. Dr. Parkinson said the transition document should highlight the major issues to be studied; the value the Board has had; and its wish to go forward with its current balance of membership. Dr. Parkinson foresaw a two or three page document. Mr. Trimble suggested that a single page would be more effective. Dr. Parkinson agreed: the transition document should be a single page, with the executive summary as an appendix.

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Discussion: Transitioning & Strengthening the PNT Advisory Board

Dr. Parkinson opened the floor for comments. He noted that if the Advisory Board was re-chartered, there would be some change in membership. Mr. Logsdon urged representatives be added from energy and agriculture; these, he said, could provide validation beyond that coming from the aviation industry. Dr. Parkinson said he hoped representation would be continued from both a working airline and an aircraft builder. He anticipated that Board members who had not regularly attended would resign.

Dr. Hermann asked about feedback to the Advisory Board. Commonly, he said, advisory panels worked hard to provide a report, but most such reports met with little formal response. He noted feedback from Dr. Schlesinger on EXCOM meetings and from Mr. Shaw. He had no recommendation to offer, but saw merit in receiving client feedback. Dr. Parkinson agreed. Dr. Schlesinger said DoD had provided good feedback; however, in giving advice to the White House, he said one should expect little beyond a 'thank you.'

Mr. Miller he believed the feedback Dr. Schlesinger received at EXCOM meetings had been positive. He had, he noted, queried members on their interest in continued Advisory Board service; he suggested that any new administration would wish flexibility about its actions. He stated that NASA was a proud sponsor of the Advisory Board. Its membership, he said, had come from names advanced by the various PNT executive agencies; these had been widely circulated within the government. He anticipated something similar if the Board's charter was renewed. The existing charter expired March 2009; the current board would exist until that date. He anticipated that the Advisory Board's future would be discussed at the November 5, 2008 PNT EXCOM meeting; the result would be reported to current members.

Responding to a question from Mr. Lewis, Mr. Miller said time remained under the existing charter for another meeting. He reported that Mr. Shaw was scheduling a January meeting of the executive steering group to determine if an EXCOM meeting of the new deputy secretaries could be held in March. He recommended the Advisory Board schedule another meeting, with the caveat that chartering issues remained.

Mr. Lewis said such a meeting could address the question of what a new NSPD should look like. Dr. Parkinson offered two topics: first, a technical and policy review of interference and mitigation efforts; second, a presentation on international efforts on interoperability and interchangeability. Capt. Burns seconded that suggestion. Dr. Parkinson suggested that Capt. Burns present an update on the satellite slots required for aircraft safety; Capt. Burns affirmed interest in doing so.

Gen. Lord said that some statements made in Advisory Board meetings needed to be communicated more rapidly to the operating level; they may affect Air Force decisions. He did not wish to preempt Dr. Schlesinger's role in communicating the board's views; however, he wished certain matters to be communicated more quickly. Dr. Parkinson said the Board's formal communication consisted of its meeting minutes. Mr. Miller said that, additionally, press releases could be issued, but these needed to be drafted by the board.

Next, Dr. Parkinson suggested further consideration of the executive summary. He noted the Board's role in removing SA from the GPS IIIA satellites; this, he said, greatly aided the standing of GPS with the international community. Mr. Nishiguchi recommended the executive summary 'note with enthusiasm' the removal of SA; he regarded that removal as a major contribution to the perception of GPS as the Gold Standard of the world. Dr. Parkinson said SA should be addressed in the executive summary, though not in the transition letter.

Dr. Beutler endorsed highlighting the action on SA; he suggested consideration be given to urging removal of the statement on the U.S. prerogative to turn off GPS. Dr. Parkinson said turning off the GPS system would be more hurtful to the United States than to any other country. However, there were 'sleeping dogs' he thought it unwise to poke. Dr. Hermann disagreed; he thought urging the statement be withdrawn would be good advice to someone who wanted good advice; the merit that existed in making written statements should not be foregone just because one could imagine objections. Dr. Parkinson said that; first, the matter had not been thoroughly discussed by the Board; second, prominently urging a change in the policy statement would likely inflame a discussion he did not believe needed to be inflamed. Dr. Hermann asked who would be inflamed. Mr. Trimble said it was generally known the United States could turn the system on and off; the real issue was not the international community, but that urging the withdrawal of statement would only inflame the U.S. military. Mr. Lewis said the GPS signal should be treated as all other critical technologies; the only advantage he saw to a special National Security policy statement was that some people might draw comfort from this policy being affirmed. Queried by Dr. Parkinson, Lewis said his advice was that the sentence on withdrawal should be removed. Mr. Trimble agreed. Dr. Hermann asked if the reason against putting good advice into a report was that someone might notice it. Dr. Parkinson asked how much of its political capital did the Advisory Board wish to devote to this matter. Dr. Hermann said he did not believe this was a 'lay down your life' piece of advice, but he thought it should be given. Dr. Parkinson suggested, as a compromise, that the Advisory Board verbally instruct its Chairman to raise the point that the statement was needless and tended to antagonize international partners if the opportunity to do so presented itself at EXCOM. Dr. Schlesinger agreed.

Mr. Faga said he believed policy was that if the U.S. planned to drop GPS, it was mandated to provide six years' notice to users. Mr. McNeff [audience member; Overlook Systems Technologies, Inc., support to OSD-NII] said no policy existed for turning the system off temporarily; rather, it was that any country that decided to abandon a navigation service was obligated to give six years notice to ICAO or IMO. Dr. Hermann noted that a military decision to remove the effectiveness of GPS in a local military conflict was a different issue from whether one was going to close down the system generally. Dr. Parkinson said that the statement that the U.S. reserved the right to deny service regionally had been on the table for some while. Mr. Lewis said this policy related to every type of signal the U.S. had. Dr. Parkinson said clarification was needed: he urged that the Advisory Board get the pertinent documents, determine their actual statement, and then decide if any Board action was warranted. Until that occurred, he was unwilling to advise either way.

Dr. Schlesinger sought clarification of Mr. McNeff's statement: one needed to give six years warning before removing a navigation service. This statement was affirmed. Dr. Schlesinger said that, this being the case, the Advisory Board might consider the following statement: 'while we recognize that under the ICAO the U.S. must give six years warning if it planned to turn off a navigation aid, the U.S. government has no intention of terminating GPS service.' Such a statement, he added, should cover the concerns expressed by members of the Advisory Board, while 'finessing' the announced concerns of the military. Dr. Parkinson welcomed the approach, saying that it made a positive statement. He asked for objections; none were stated.

Mr. McNeff said such a statement had been made to ICAO ten years ago, had been reaffirmed to it in 2007, and made to IMO in 2008. Dr. Parkinson characterized Dr. Schlesinger's statement as a reaffirmation of that policy, and should be clearly stated. Noting Mr. McNeff's statement, Dr. Schlesinger suggested the Board might wish to add the following to the statement he had offered: 'we take note that this assurance has been given repeatedly, and we reiterate that assurance.' He thought it advantageous to affirm that view, as he believed there were people around the world who thought the U.S. would not maintain the system because it was under military control. Dr. Parkinson endorsed the additional wording.

Dr. Schlesinger offered thoughts on the Presidential Transition. Following the election, he said, the persons who would fill various posts in the new administration would begin to be identified; each new appointment would create a somewhat different situation. As this occurred, the Board's understanding of future prospects and intentions would improve. He believed one should neither announce in advance nor freeze in advance what one intended to say in the new situation; rather, one should hold that expression until one knew more about the nature of the new Administration.

Dr. Parkinson expressed gratitude to Mr. Miller and those assisting him and to Ms. Rausch and those assisting her for the orchestrating of the session. He gave particular thanks to those international members who had traveled considerable distances to be present.

Mr. Miller announced the Board's current charter expired on March 8, 2009; the tentative date for the next meeting should be set prior to that. He noted that the November 5, 2008, EXCOM meeting would be reviewing the Board's recommendations; if the response was positive, it would be advantageous to the group to have a meeting scheduled. Possible meeting dates were discussed. Ms. Neilan noted that the Munich satellite navigation summit would be held the first week in March. Mr. Lewis asked if a Monday/Tuesday session was easier for the international representatives

than a Thursday/Friday session; no preference was reported. Dr. Parkinson suggested that Dr. Schlesinger consult his schedule, and possible dates be drawn from there.

The Friday session was adjourned at 11:20 a.m.

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

**Fourth Meeting
October 16-17, 2008**

Gallery II – Second Floor
Hilton Arlington
901 North Stafford St.
Arlington, Virginia 22203
(Ballston-MU Metro)

Appendix A: ACRONYMS

ACRONYMS

AU:	Australia
CH:	Switzerland
DAA:	Deputy Associate Administrator
DHS:	Department of Homeland Security
DOC:	Department of Commerce
DOT:	Department of Transportation
EXCOM:	National Executive Committee for Space-Based PNT
FAA:	Federal Aviation Administration
FACA:	Federal Advisory Committee Act
GPS:	Global Positioning System
HQ:	Headquarters
ICG:	International Committee on GNSS
IN:	India
JP:	Japan
NAS:	National Airspace System
NASA:	National Aeronautics and Space Administration
NII:	Networks and Information Integration
NO:	Norway
NTIA:	National Telecommunications and Information Administration
OSD:	Office of the Secretary of Defense
PNT:	Positioning, Navigation, & Timing
RITA:	Research and Innovative Technology Administration
RNSS:	Radio Navigation Satellite Service
SES:	Senior Executive Service
USAF:	United States Air Force
UK:	United Kingdom

Appendix B: 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
Mr. Phil Boyer	Aircraft Owners and Pilots Association
Capt. Joe Burns	United Airlines
Ms. Ann Ciganer	U.S. GPS Industry Council
Ms. Susan M. Cischke	Ford Motor Company
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 USAF, Former Commander, Air Force Space Command
Mr. Terence McGurn	Retired CIA (currently private consultant)
Gen. James McCarthy	Retired USAF (currently professor)
Mr. Tim Murphy	Boeing Corporation, Commercial Airplane Group
Ms. Ruth Neilan	Jet Propulsion Laboratory and Astronautics
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 Division, 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

Appendix C: MEETING ATTENDEES

U.S. Board Members:

Dr. James R. Schlesinger	Chairman, Board of Trustees, MITRE Corporation
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
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	Former Commander, Air Force Space Command
Mr. Tim Murphy	Boeing Corporation, Commercial Airplane Group
Ms. Ruth Neilan	Jet Propulsion Laboratory and Astronautics
Dr. Bradford Parkinson (Vice-Chair)	Stanford University, Department of Aeronautics
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 Division, Norwegian Coastal Administration
Mr. Hiroshi Nishiguchi (Japan)	Secretary General, Japan GPS Council
Capt. Richard Smith (United Kingdom)	President, International Association of Institutes of Navigation

NASA Attendees:

Diane Rausch	PNT Advisory Board, Executive Director, NASA
James Hollansworth	NASA
James Miller	NASA
Michael Moreau	NASA
A. J. Oria	Overlook Systems Technologies (NASA contractor)
Tom van Deak	NASA
Dennis Woodfork	NASA

Other Attendees:

Thursday, October 16:

Carl Andrew	ION
Karen Barker	Office of Space Command
Chaminde Basngeke	General Motors
David Buckman	United States Air Force/AFSPC
Jason Burch	USAF/A30
Chuck Daniels	National Coordination Office
Keith Ellis	NGA
Chet Huber	General Motors OnStar
Navin Jerath	Northrop Grumman Corporation
Steve Fisher	IGS/NASA Jet Propulsion Laboratory
Larry Hothem	United State Geological Survey/DOI
Jiyum Lee	AMTI/Federal Aviation Administration

L. Kirk Lewis
Sethu Madhavan
John Merrill
Jules McNeff
Robert Mirelson
Tony Russo
Michael Shaw
Vaughn Standley
David Turner
Karen van Dyke
Joseph Wellburg

IDA
General Motors
Department of Homeland Security
Overlook Systems Technologies
PNT National Coordination Office
PNT National Coordination Office
PNT National Coordination Office
Department of Energy
Department of State/OES
Department of Transportation/RITA
Department of Energy/NASA

Friday, October 17:

Ken Alexander
Lewin Dai
Harrison Freer
Dana Goward
Ron Hatch
Jason Kim
Frank Lorge
Mitch Narm
Chris O'Connors
Mark Rousma
Stephanie Wan
Kenneth Ward

Federal Aviation Administration
NavCom Technology
Consultant
Department of Homeland Security/U.S. Coast Guard
NavCom Technology
Department of Commerce
FAA
Federal Aviation Administration
Department of Commerce/NOAA
JS
George Washington University
Federal Aviation Administration

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Appendix D: List of Presentations

1. U.S. Update on GPS, PNT Policy & PNT EXCOM/ Mr. Michael Shaw
2. U.S. International Initiatives /Mr. David Turner
3. Principle Act for GNSS Utilization in Japan/ Mr. Hiroshi Nishiguchi
4. International Association of Geodesy (IAG): GPS and GNSS for Science/Dr. Gerhard Beutler
5. PNT Advisory Board – October 2008/ Mr. Arve Dimmen
6. Update on eLORAN/ Mr. Dana Goward
7. GPS in the National Airspace System/ Mr. Leo Eldredge
8. GPS Space Service Volume/Dr. Michael Moreau
9. Distress Alerting Satellite System [DASS]/Mr. Chris O’Conner
10. Civil Input to GPS III/Col. Dave Buckman
11. ‘Big Five’ and Civilian Service/Dr. Bradford Parkinson
12. Future GPS and Free Services/Dr. Scott Pace
13. Pseudolites -- Augmenting GPS in Regions of Reduced Geometric Availability/Dr. Bradford Parkinson

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.