SPACE-BASED POSITIONING NAVIGATION & TIMING

NATIONAL ADVISORY BOARD

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

Sixth Meeting
November 5-6, 2009

Hilton Old Town Alexandria

1767 King Street

Alexandria, Virginia 22314

Meeting Minutes

James R. Schlesinger
Chair

P. Diane Rausch
Executive Director

Thursday, November 5, 2009

9:00 – 9:05	**BOARD CONVENES** *Call to Order and Welcome*	Ms. Diane Rausch, *NASA* *PNT Advisory Board Executive Director*
9:05 – 9:20	Introductions, Announcements, & Agenda *What we want to accomplish – Goals for 6th Mtg*	Dr. James Schlesinger, *Chair* Dr. Bradford Parkinson, *Vice-Chair*
9:20 – 9:45	U.S. Update on GPS, PNT Policy, & PNT EXCOM *PNT EXCOM Expectations, Transition Status*	Col. Robert Hessin, *Acting Director, National Coordination Office for Space-Based PNT*
9:45 – 10:00	Evolution of National Space-Based PNT Policy: *"Lessons Learned"*	Mr. Mike Shaw, *Director, Navigation Global Business Development Lockheed Martin Space Systems (former NCO Director)*
10:00 – 10:20	GPS Views from the White House Office of Science and Technology Policy (OSTP)	Mr. Damon Wells, *Senior Policy Analyst, WH Office of Science and Technology Policy*
10:40 – 11:00	U.S. International Initiatives and Opportunities: *Bilateral and Multilateral Developments*	Mr. Dave Turner, *Deputy Director, Office of Space and Advanced Technology, Department of State*
11:00 – 11:30	International Member Regional Updates ▪ Gerhard Beutler ▪ Arve Dimmen ▪ Hiroshi Nishiguchi ▪ Richard Smith	(at member's discretion) *Switzerland* *Norway* *Japan* *United Kingdom*
11:50 – 12:00	DoD GPS Management & Authorities *Progress in providing GPS services*	Lt. Gen. Larry James, *Commander, Joint Functional Component Command for Space/ Commander 14th Air Force*
	Morning "Wrap-Up" *Plans for afternoon session*	Dr. James Schlesinger, *Chair* Dr. Bradford Parkinson, *Vice-Chair*
12:00 – 1:00	**LUNCH**	
1:00 – 1:30	Use of GNSS for Future Space Ops & Science Missions	Dr. Frank Van Graas, *Ohio University, ION Science & Technology Policy Fellow*
1:30 – 1:50	Preserving the Environment through GPS Applications	Mr. Jeff Hamilton, *Director, Strategic Partnerships, Trimble*
1:50 – 2:10	FAA, Next Generation Air Transportation System	Ms. Pamela Gomez, *NextGen Office, FAA*
2:10 – 2:20	Improving Aeronautical Operations through *NextGen* *A User's Perspective*	Captain Joe Burns, *United Airlines, PNT Board Member*
2:20 – 2:35	Message to the Congress on GPS as a National Asset	Mr. Chet Huber, *PNT Board Member*

2:35 – 2:50	Perspective on GPS from Space Enterprise Council	Mr. Dave Logsdon, *Executive Director, Tech America's Space Enterprise Council*
2:50 – 3:10	**BREAK**	
3:10 – 3:35	PNT Evolution: *Future Benefits and Policy Issues*	Dr. Scott Pace, *Director, Space Policy Institute, The George Washington University*
3:35 – 3:50	Thoughts on GPS Interference Detection & Mitigation	Mr. Terry McGurn, *PNT Advisory Board Member*
3:50 – 4:10	Leadership Panel Update/Discussion	Dr. Parkinson & Mr. Faga, *Panel Leads*
4:10 – 4:30	Strategic Engagement and Communications Panel Update/Discussion	Ms. Ruth Neilan, *Panel Lead*
4:30 – 4:50	Future Challenges Panel Update/Discussion	Dr. Robert Hermann, *Panel Lead*
4:50 – 5:00	Afternoon "Wrap-Up" Discussion & Announcements	All PNT Advisory Board Members
5:00	**ADJOURNMENT**	

Friday, November 5, 2009

9:00 – 9:05	**BOARD CONVENES** *Call to Order*	Ms. Diane Rausch, *NASA* *PNT Advisory Board* *Executive Director*
9:05 – 9:15	Introductions, Announcements, & Agenda Thoughts from Oct. 5 discussions --	Dr. James Schlesinger, *Chair* Dr. Bradford Parkinson, *Vice-Chair*
9:15 – 9:45	International Update on Satellite Laser Ranging	Dr. Mike Pearlman, *Harvard- Smithsonian* *Center for Astrophysics*
9:45 - 11:00	Board Member "Round Table" Discussion *Individual PNT Advisory Board Member Feedback*	PNT Advisory Board
11:00 – 11:15	**BREAK**	
11:15 – 11:45	Chair/Vice-Chair "Follow-Up" on PNT Board Report Implementing *Advisory Board Recommendations*	Dr. James Schlesinger, *Chair* Dr. Bradford Parkinson, *Vice-Chair*
11:45 – 12:00	PNT Advisory Board Priorities & Plans for 2010	All PNT Advisory Board Members
12:00 – 1:00	**WORKING LUNCH** *Ethics Briefing by Adam Greenstone,* *NASA Office of the General Counsel*	All PNT Advisory Board Members

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Session of Thursday, November 5, 2009

The meeting was called to order at 9:00 a.m.

Board Convenes:
Ms. Diane Rausch

Ms. Rausch, National Space-Based Positioning, Navigation and Timing [PNT] Advisory Board Executive Director, welcomed all to the sixth meeting of the National Space-Based PNT Advisory Board. She noted that the body had been established in March 2007; the body, she said, is an Advisory Committee that acts in an advisory capacity in implementing the national policy on Positioning, Navigation and Timing as outlined by the President. She also noted her role as manager of advisory councils for the National Aeronautics and Space Administration [NASA], the Board's official sponsor. She listed the nine federal agencies that are co-sponsors. She noted that the PNT Advisory Board had three panels – Leadership, Strategic Engagement and Communications, and Future Challenges. The chairs of each panel would be reporting to the full body at this session. Ms. Rausch said she was looking forward to both the interesting conversations and concrete outcomes of the Advisory Board session.

Ms. Rausch noted that as this was a FACA [Federal Advisory Committee Act] meeting. While the session, therefore, was public, audience members were asked not to interrupt speakers or Board members. She noted that all comments were on the record and that formal minutes were being kept. Individual board members, she reported, were either SGEs [Special Government Employees] or Representatives. The former represent their individual expertise; the latter represent a given industry or sector. SGEs were subject to federal ethics requirements and are required to file financial disclosure statements. She noted that the annual ethics briefing for the SGEs was scheduled on Friday, November 6, at noon. She reminded SGEs that they were responsible for recusing themselves from discussion of any matter that might involve a conflict of interest.

Welcome and Announcements
Dr. James Schlesinger
Chair

Dr. Schlesinger said he was particularly pleased to welcome the foreign participants to the session. He also said the Board was particularly pleased by the presence of General Larry James, commander of the StratCom Joint Functional Component for Space and well as the commander of the Fourteenth Air Force.

Dr. Schlesinger noted that the newly-constituted PNT Executive Committee [EXCOM] had meet for the first time in June 2009. During that session, the new members were introduced to EXCOM history and informed of the body's accomplishments. He had presented a review of the prior recommendations of this board; to remove the Selective Availability [S/A] capability from all future systems; begin transmitting navigation messages on the L2C signal; support the EXCOM decision to designate e-LORAN as a necessary backup system to the Global Positioning System [GPS]; place GPS-III quickly under contract; and take the needed actions to maintain the current level of GPS service. He noted there would be further discussion of these matters at this meeting. Further, Dr. Schlesinger expressed to the EXCOM the view of the Board that the policy of an open signal, free of direct user charges, be continued; with GPS to maintain itself as the signal of first use, and seek international collaboration to that end. He noted that to ensure transparency in the future use of GPS, the Board urged that laser reflectors be implemented on GPS III. Finally, for national security infrastructure, it is necessary to develop the means to detect, measure, locate and mitigate radio interference in near-real time. He noted that the day before a signal disruption episode had occurred near Seattle, Washington

Dr. Schlesinger noted that EXCOM would next meet on November 19, 2009. He noted that while the Board should be prepared to respond to areas of interest, it would do well to present its own ideas on what matters EXCOM should address. He had therefore set aside time during the session to discuss such matters, which he would present at the November 19, 2009.

Dr. Schlesinger then welcomed comments from those at the table, noting that the international representatives would be queried later.

Dr. Bradford Parkinson, vice chair, said he believed the important portions of the agenda were those items that had not as yet "seen the light of day" at higher levels.

Dr Hermann raised a procedural matter: He noted Dr. Schlesinger's report on the recommendations that had been forthcoming from this body; and asked whether it would be possible to learn what actions had been taken on these recommendations or if there had been any reasons raised why a given recommendation should not be followed. Further, he asked, were there cases in which agreement occurred by no action followed?

Ms. Neilan said there was a fairly wide-area signal disruption event in Seattle on Wednesday, November 3. A variety of agencies were involved in investigating the cause; the matter was evolving.

Dr. Schlesinger expressed the hope that a comprehensive report might be ready in time for the EXCOM's November 19 session.

Dr. Parkinson suggested that Gen James might be in a position to provide further information.

Gen James said he had been notified of a widespread outage within cell phone companies; it appeared that all those affected had CDMA-type receivers. The matter was being investigated; GPS ground segment testing had been done yesterday. Work continued with the cell phone providers: a telecon with them had taken place just thirty minutes ago. The cell phone operators were uncertain why they were losing timing at the various cell phone towers. He said the integrity of the GPS signal and the timing signal had been verified. One postulation, for which he could not vouch, was that there receivers in operation that did not meet the Interface Specification (IS) requirements. He said he expected further updates during the day.

Mr. Huber announced that he would give a report on jamming and interference later in the session.

Mr. Hall said he thought the Seattle example was relevant, as it raised the question of situational awareness.

Gen James, updating, said that Verizon still had 104 tower alarms; 34 of which were critical. Sprint recovered last night; some of those towers recovered on their own. A further telecon was set for later in the day. He affirmed that the Board now had all information that was in his possession.

Gen Lord said he regarded it as honor to be present: he expressed sympathy for Gen James. The situation underscored the need for having someone "connect all the dots." The circumstance also underscored how important it was for all others in the group to understand the critical nature of cooperation within day-to-day operations.

Captain Burns said he would address matters relevant to the airlines industry, particularly NextGen, during the afternoon session.

Ms. Ciganer noted that the U.S. GPS Industry Council, which includes the major aerospace contractors, is concerned whether after two decades of operational success in making GPS serve the public good this will continue to be the case. The group placed a high priority on the consistency of policy recommendations, and was present to support this priority.

Captain Murphy echoed Captain Burns' comments that NextGen was high important; he was encouraged by the rapid response to the Seattle event. He noted that recent evidence suggested that the satellite constellation might not be as robust as had been thought; he believed this should be a major focus.

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U.S. Update on GPS, PNT Policy & PNT EXCOM
Col Robert Hessin, acting director
National Coordination Office for Space-Based PNT

Col Hessin noted that he was acting director of National Coordination Office [NCO], having replaced Michael Shaw in June 2009. He said he would address the 2009 EXCOM work plan; accomplishments since last meeting; NCO transition status and space-based PNT expectations. The 2009 work plan, he said, was an opportunity to bring together the 2004 National PNT Policy implementation and to identify and track major activities. The year opened with 11 action items, to which 22 had been added; of these, 13 had been closed; 20 remained. Dr. Parkinson noted earlier conversation on whether the recommendations made by the Advisory Board were tracked; did NCO do this? Col Hessin said this was done.

Col Hessin reported on key accomplishments since the May 2009 Advisory Board session. These included the launch of GPS IIR-21[M]; the Air Force release of the future GPS Operational Control Segment [OCX] request for proposal;

and the transfer of $20.7 million in civil GPS funding from the Federal Aviation Administration [FAA] to the Air Force. That final process, he said, involved a number of challenges whose resolution process would prove advantageous in years ahead. Dr. Hermann asked what the issues in question had been. Col Hessin said that difficulties lay in the large number of iterations and inter-agency processes that were required to be solved. In part, this reflected the fact that the amount being transferred was considerably in excess of the $7.2 million transferred the previous year. Dr. Hermann asked where this posed issues. Col. Hessin said the "wickets" had primarily occurred within the Department of Transportation [DOT].

Col Hessin reported on actions to be completed. These included the conducting of an interference detection system "proof of concept;" the task of transferring $43.4 million for Fiscal Year [FY]'10 in civil funding from FAA to the Air Force; the completion of the GPS Interagency Forum for Operational Requirements [IFOR] analysis on Satellite Laser Reflectors on GPS III; and the need to determine the future institutional sponsorship of the Advisory Board. Further, he noted that rapid action was needed to fill the directorship and other staff positions at NCO. Col Hessin then presented current staffing information for the NCO.

Dr. Parkinson commented that the "interference detection system" was notably missing an emphasis on the mitigation of interference. The Advisory Board, he said, had repeatedly suggested that if was not enough to know the source of interference; what was needed is to be able to mitigate it. Col Hessin agreed that mitigation should be part of that action. Mr. Hall asked about the status of the Department of Homeland Secretary [DHS] effort in this area; Col Hessin said he had no information beyond the effort being in its final coordination. Mr. Hall asked if Col Hessin knew what aspects of interference detection the DHS effort included; Col Hessin said these could be obtained. Col Hessin said the hope was that a director for NCO would be named in time for the November 19 EXCOM meeting. Col Hessin said the NCO's short-term focus was to complete its own staffing; the mid-term focus was to assess the first five years of EXCOM; and the long-term focus was to maintain the National Space-based PNT perspective and guide the pursuit of goals and objectives.

Dr. Schlesinger said that any assessment of national performance raised the question of e-LORAN; the Seattle episode, he added, underscored the need for e-LORAN as a backup system. Could Col Hessin report on the status of this issue? Col Hessin said the language related to the future of e-LORAN was being closely monitored; responding to a query from Dr. Schlesinger, he said he believed the EXCOM co-chairs were well aware of the issue. Dr. Schlesinger noted that funding for e-LORAN would run out in less than two months. Dr. Hermann said that Col Hessin appeared to be identifying a "wait and see" decision; which, he said, strongly suggested that nothing would be done. Col Hessin said the determination would depend on the final language developed. Dr. Hermann asked if this item was on the November 19 EXCOM agenda; Col Hessin said it did not. Dr. Schlesinger inquired of Col Hessin's reading of the hazards e-LORAN was intended to address. Col Hessin said that there was no denying that vulnerabilities to GPS existed; however, he said there was a need to compile additional information on what reliance was being placed on GPS across various user sectors. He commented that getting appropriate data was a problem.

Dr. Parkinson characterized this as a delaying action. He called attention to the independent review board: initially, he said, he and perhaps half of the board members had been skeptical of the value of e-LORAN. Nonetheless, eventually the conclusion was reached that e-LORAN represented an inexpensive [~$20m/annually] approach and that if the U.S. were to back the system there would be a substantial market for it. He believed that either leadership did not grasp this or was deliberately ignoring the issue.

Mrs. Ruth Neilan asked what the FAA funding to the Air Force was for. Col Hessin said it was primarily for civil unique requirements; there was, he said, a list of items included in civil monitoring.

Dr. Schlesinger noted that he had stressed to the EXCOM that e-LORAN was not a departmental issue but a national issue; everyone recognized that a backup was needed but they were not willing to pay for it.

Gen Lord commented that the future transfer of FAA funds might be facilitated if information was supplied to the FAA on the uses to which the funds had been put.

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Evolution of National Space-based PNT Policy: Lessons Learned
Mike Shaw, Director
Navigation Global Business Development
Lockheed Martin Space Systems

Mr. Shaw noted that he was no longer director of the National Coordination Office [NCO] and, instead, was now employed by Lockheed Martin Space Systems and that his presentation represented only his personal opinions. He viewed this as an appropriate moment at which to review how national GPS policy had evolved over time. He believed the general success of the GPS system could be attributed to system performance; policy openness; and the entrepreneurship of private industry. Mr. Shaw identified three periods of national policy development on GPS.

Mr. Shaw noted that initial GPS operating capability was in 1993; full operating capability came in 1995. Prior to 1996, he said, no concerted national policy on GPS or space-based PNT existed; GPS was widely perceived as a military system with a growing interest from various civil departments, notably the FAA. While GPS was a growing utility, he said, "rules of the road" were lacking for how various departments should interact. He noted the introduction of Selective Available [S/A] in 1996. He thought it interesting that, through S/A, GPS was the first system considered so threatening that its capabilities were deliberately degraded. During this period, participation in decision making by civil equities was limited.

Between 1996 and 2004, Mr. Shaw stated, the first national GPS policy was established; this policy called attention both to national security and economic competitiveness concerns. He noted that as there was no civil funding for Air Force execution of GPS policy, little influence on Air Force actions was exerted by the civil agencies. Dr. Schlesinger noted that, at one point, the director of OMB, having concluded that the processes involved were too complicated, decided to add money to the Department of Defense [DoD] budget to cover what it might reasonably be receiving from the civil agencies. Mr. Shaw acknowledged this, but noted that there had been no traceability of that funding. Finally, Mr. Shaw said, the late 1990s witnessed the emergence of independent international efforts, leading to an era of multiple Global Navigation Satellite Systems [GNSS] systems.

In the post-2004 era, Mr. Shaw said, a comprehensive and prescriptive national policy for space-based PNT was created – this ten-page policy statement, issued in December 2004 had replaced a two-page statement. This policy created the National Space-Based PNT Executive Board [to be composed of deputy secretaries rather than assistant secretaries] and the NCO. GPS was acknowledged to be "no longer the only game in town" -- the U.S. needed a policy statement of how GPS would relate to other national systems. He noted that while the policy was released in December 2004, the NCO was not established until November 2005. He noted the execution civil funding: something, he said, many had thought could not be accomplished. Part of the problem, he said, was that as various departments were under continuing resolution and the transfer occurred very late in the fiscal year. A way was needed, he said, to perform these transfers earlier in the fiscal year.

Dr. Hermann cited experience with consolidated programs, where entries from various government departments were aggregated into a functional area program. What this did was to allocate resources in a formalized way, and then be placed into the Congressional budget justification at the same time. Dr. Hermann felt Mr. Shaw did not have such a formal consolidated program but, rather, a process of staff-driven iterations. Mr. Shaw noted that the amount of money to be transferred was estimated by the GPS Wing [GPS-W]; that the requisite civil agencies put these amounts in their budgets, which went to the Office of Management and Budget [OMB] and then to Congress. When, however, a civil budget goes under continuing resolution, the amount of money it may transfer is based on the previous year's appropriation. Indeed, the rule is that the transfer may not exceed 40 percent of the previous year's allocation; as the previous transfer was $7.2 million, 40 percent of this "doesn't get you very far." Dr. Hermann commented that this may be true only if each year started from scratch; that if a consolidated program existed, the head of that program would have seen those funds placed in the budget at the national level. He restated the view that departmental rather than national judgment was being rendered on e-LORAN, a matter of national rather than department concern. Dr. Hermann said there was a national policy and there should be a national authority empowered to proceed in such a direction as that policy indicated, including e-LORAN. Dr. Schlesinger said no such authority existed. Two authorities existed – the executive and the legislative. In the case of e-LORAN, he added, DHS said it was prepared to take over e-LORAN from the US Coast Guard [USCG], but Congress could not agree. Dr. Hermann said the task of a national authority would have be to say that it had no objection to the Coast Guard operating the system, provided the USCG did not decide that unilaterally. Dr. Shaw noted that civil contributions [$43.4 million in FY'10] were becoming a significant part of the GPS budget.

Mr. Shaw noted continued proliferation of international GNSS systems. This requires stability of policy requirements, funding and leadership, which in turn requires the engagement of senior leadership. From a practical perspective, he believed the success of GPS followed from the existence of an "action list." One aspect of leadership, he noted, was that ability to influence decision-making through such a list without having direct authority for those decisions.

Dr. Parkinson thanked Mr. Shaw for his excellent work at NCO. He believed that at one point civil authorities felt they were being shut out; now, he believed, there was a sincere effort to present the technical requirements so that all concerned could be clear on what those requirements were. Mr. Shaw commented that things had become more prescriptive: prior to the December 2009 policy statement, there had been full discussion within the government on whether the policy was too detailed. The winning argument had been that the technology involved required this level of detail; he believed higher levels of details would follow in future policy. Dr. Parkinson said he hoped a civil, governmental and other working group could be created in which changes could be discussed to avoid surprises on anyone's part.

Ms. Ciganer noted the comment that national leadership needs maneuvering room: she was concerned that when there was, at the national level, a statement of stability then a lower level discontinuity communicated something to the worldwide user base; e.g. a technical decision made at a level lower than that of national leadership. Mr. Shaw acknowledged Ms. Ciganer's point; he believed, however, that the NCO created an avenue through which such matters could be addressed. Ms. Neilan asked, given the change in administration and Mr. Shaw's own departure, how did he view the commitment toward maintaining and strengthening the NCO? Mr. Wells said he was out of touch with recent events, but was encouraged by the level of interest among senior people. He placed priority on filling the empty posts within NCO; he believed getting annual funding was a challenging process.

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GPS Views from the White House
Mr. Damon Wells
Senior Policy Analyst
White House Office of Science and Technology Policy [OSTP]

Mr. Wells said he would speak in two ways to the OSTP perspective on GPS. The first related to policy documents; the second related to issues going forward. The first document, in 1996, established some key objectives, but left much to be resolved. He called attention to the President Bush W. administration having established in 2002 a "rolling review" of its space policies. He believed there was broad agreement that improvements were needed in inter-agency coordination and clarification of the civil v. military roles. Further, he noted that reliance on GPS had increased; the global market had exploded; non-US systems had emerged and the risks of interference, intentional or not, had increased. These themes, he said, could be tracked through current policy.

This, he said, led to the question of issues going forward. The major points he cited included the view that EXCOM has proven to be a success, with the group maintaining its high level involvement. He believed the NCO had done a much better than anticipated job of maintaining policy discipline across various agencies. He noted broad efforts to work toward compatibility and interchangeability. He believed progress had been made on detection and mitigation, noting the Advisory Board's view that mitigation was the object of detection. He reported the continued growth in GPS value-added applications; this, he noted, was a continuing phenomenon. He believed that the Advisory Board was necessary – it provided an external viewpoint on matters of considerable complexity.

Challenges, however, remained. First, he noted the need to preserve and protect the spectrum, which he said was under increasing attack. Second, be urged continued international discussion on interoperability. Third, he said attention needed to be paid to a national policy that permitted the introduction of new capabilities while protecting existing applications, thereby encouraging innovation and securing what already existed. He noted that he had little to add to the e-LORAN subject; it was an issue on which he did not have a clear path forward. Dr. Schlesinger said what the Advisory Board wanted from OSTP on e-LORAN was action. Mr. Wells said the range of agencies involved lacked consensus on how e-LORAN should be utilized. Dr. Schlesinger said the agencies indeed had a consensus; that consensus being: "We don't want to pay."

Dr. Hermann asked, first, if Mr. Wells would be drafting the policy statement for the new administration and, second, would he agree that OSTP was accountable for the existence of a national policy on PNT. Responding to the first point, Mr. Wells said there may be no change in policy: it was up to the new administration's policy to decide if it wanted one. Dr. Hermann commented that even the issuance of a statement: "the current policy looks okay" would be advantageous. Responding to Dr. Hermann's second point, Mr. Wells noted that OSTP was one of several entities within the White House engaged in space-based PNT: OSTP was a part of the administration process for developing policy in the area.

Mr. Hall noted that the 2004 Presidential directive carried with it a fact sheet, to be used for departmental guidance and asked whether the policy came from OSTP. Mr. Wells said the policy had come out of the White House; if, he said, the

question was whether that policy was still applicable, the answer was: Yes. Gen James commented that the Air Force was engaged in a space policy review, which, in line with general administration objectives, would look to a high level of international cooperation across all space programs. Mr. Wells said the administration had from the campaign on made clear its strong interest in international dialog and cooperation; he noted the U.S.-EU GPS-Galileo agreement, which he regarded as a landmark. He believed, however, that international issues needed to be approached on a 'case-by-case' basis.

Dr. Schlesinger noted that White House level discussions of space policy tended to focus on space; what was often forgotten, he said, was that the purpose of all space activities was to be of service to things on Earth. Mr. Wells acknowledged that he encountered that perspective; many people took the view that space was "the difficult part."

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U.S. International Initiatives and Opportunities
Mr. David Turner
Deputy Director
Office and Space and Advanced Technology
Department of State

Mr. Turner said he would speak to responsibilities, goals and objectives; international systems; multilateral discussions and bilateral discussions as these related to space-based PNT and the Department of State. Given U.S. Space-based PNT goals, Mr. Turner said, the task of the Department of State (DOS) was to promote the use of civil GPS and its augmentation services with foreign countries and to take the lead in negotiations with foreign governments regarding civil PNT. The prime objectives were to ensure compatibility and achieve interoperability, to be accomplished through bilateral and multilateral cooperation. He noted that DOS believed in the value of a spectrum separation between military and non-military signals and that interoperability for the U.S. focused on the L1C and L5 signals.

Mr. Turner described planned GNSS systems. He noted that Galileo would be reducing its original size from 27 to 22 satellites; but there is a chance this might not be permanent. Dr. Schlesinger asked if there had already been a decrease in Galileo from 30 to 27; Mr. Turner said the original figure had been 27 plus three. He noted, also as new, a Global Indian Navigation System, which was to be a 24-satellite system that followed on from India's regional navigation system. Mr. Turner identified current international signal plans; while a decision pending, it appeared likely that India would use the LIC and L5 signals. Dr. Parkinson said he had heard of an apparent commitment by GLONASS to CDMA; was this the case? Mr. Turner said that appeared to be the plan, but details were uncertain. GLONASS, he added, had yet to decide whether to establish an equivalent of EXCOM. Mr. Hall noted that GLONASS [the Russian Global Navigation Satellite System] had reduced its constellation commitment: a failure in one satellite had led to three others being returned to the laboratory to ascertain possible production run defects.

Mr. Turner said the primary venue for DOS activities was the International Committee on GNSS [ICG], whose history, membership, work plan and accomplishments he briefly reviewed. He believed each meeting had produced progress. He noted that at the third ICG, discussion of the definitions of interoperability and interchangeability was reopened; although some persons viewed this as backsliding. Mr. Turner said such discussion was an unavoidable aspect of international bodies. Dr. Parkinson asked whether a particular participant had disowned its previous position; Mr. Turner affirmed this: considerable effort had been required to overcome this change. Pressed to "name names." Mr. Turner said the DOS view was that there were right and wrong times to create public embarrassment. Dr. Schlesinger suggested that the DOS view was that there was rarely a right time to embarrass people in public.

Mr. Turner reported on the fourth ICG meeting, held September 2009 in St. Petersburg, Russia, where, he said, "we were able to hold serve" on the positions of interoperability and compatibility. Further, consensus was reached on the wording of "transparency," as it applies to the various open systems. Dr. Parkinson asked if the definition was sufficiently strict to allow manufacturers to build to a given standard; Mr. Turner said it was not: he believed, however, that establishing the high level agreement was the first step. He noted that the fifth ICG meeting was scheduled for Turin, Italy in October 18-22, 2010.

Ms. Ciganer commented that DOS had, previous to these meetings, done an excellent job of outreach to interested parties. Mr. Turner noted that he would distribute an updated questionnaire – he welcomed comments.

Dr. Hermann asked whether judgment about the dependability of various national systems entered into the calculations. Mr. Turner said this was definitely a part of the dialog; he noted that the question had been raised whether a system that provided a poor signal should be credited as interoperable. Dr. Parkinson asked if Mr. Turner had attended a session in Munich on legal liability; Mr. Turner said he had. Dr. Hermann said legal liability was not the only question – the question, he said, was whether nations felt required to describe their systems in ways so brittle they would be inclined to fail. Mr. Turner said the U.S. had sought a stronger statement on transparency than that agreed to. Mr. Hall said the U.S. must undertake onto itself the issue to address variance in system performance, including the

differences between announced performance and actual performance. Dr. Parkinson noted that the Wide Area Augmentation System [WAAS] provides continuous updates of GPS integrity; and this could readily be extended to other systems. Mr. Hall said he was less concerned about the method employed to distribute the updates than that this actually being done.

Mr. Turner said worldwide service performance accuracy monitoring was needed. This has two aspects. First, is the system providing the service it is supposed to? Second, is monitoring for interference occurring? He said little discussion of this had yet occurred; he regarded the topic as difficult. Dr. Parkinson believed that all systems should as part of their monitoring activities monitor the activities of all other systems. Mr. Turner noted that the Japanese government was executing the first agreement to perform multinational monitoring of all GNSS systems within range.

Dr. Beutler noted that the International GNSS Service [IGS] now had 100 combined GPS and GLONASS receivers in the network; as other systems become openly available and receivers available these will be automatically added to the network. Ms. Neilan pointed to the growing international acceptance of the ICG as a vehicle for providing a "way forward" for success with multiple GNSS. Ms. Ciganer asked if the IGS was moving in a direction of encourage mutual monitoring: Mr. Neilan said the topic had been discussed at the ICG meeting in Russia.

Mr. Turner briefly reviewed DOS multilateral and bilateral efforts, closing with three summary points. First, international cooperation with space-based PNT was a top priority of his department; second, the U.S. was actively pursuing bilateral and multilateral cooperation; and, third, that as new systems emerged, interoperability was encouraged for "success for all."

Mr. Hall asked if Mr. Turner had any further information on the global navigation system from India. Mr. Turner said the system had been presented at various international bodies, but little had been said about its timing, details and schedule. Mr. Hall said a paper recently received by Dr. Suresh Kibe provided some detail. Ms. Neilan asked what the prospects were for "direct negotiation" – that is, beyond the operator-to-operator stage -- with the Chinese over Compass (Chinese GNSS). Mr. Turner said bilateral negotiation was in progress, involving across-the-table discussions of compatibility issues. There may be need for an additional venue, but he could not speculate when that might happen.

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International Member's Comments:

Mr. Hiroshi Nishiguchi
Japan

Mr. Nishiguchi said he was pleased to brief the Advisory Board on the Quasi-Zenith Satellite System [QZSS], a Japanese regional space-based navigation and timing system. The system is to consist of three satellites in geosynchronous inclined orbit, each making a figure-8 ground-track pattern. At all times, he said, at least one satellite would be at least within a 60 degree angle over Japan. The second satellite would be in a separate plane of 120 degrees on the left ascension while ascending north; and the third would be in 120 agrees on the right ascension. In this way, he said, all three satellites could be in use at all times. He noted that QZSS would be effective not only in Japan, but over Australia and East Asia as well. The belief, he said, is that the high angle employed by the satellites will improve GPS services even within urban canyons and mountainous areas. He presented an animation showing how QZSS would improve GPS coverage, showing how many satellites would be visible in an urban canyon and then an animation of how many satellites could be seen from downtown Tokyo. Mr. Nishiguchi described the signals which the QZSS system would use. The first satellite, he said, would be launched in summer 2010; tests were now in progress.

Dr. Beutler complimented the undertaking, saying it was excellent to have an augmentation system composed of satellites with different orbits. This approach, he thought, could in principle be expanded across all ranges of latitude. Mr. Murphy noted with interest that Japan's satellites would be GPS compatible: was there any plan to offer QZSS as a partner with the International Civil Aviation Organization [ICAO] to be used as part of aviation? Mr. Nishiguchi said there were no plans to do so at present.

Dr. Gerhard Beutler
Switzerland

Dr. Beutler said he was representative of the International Association of Geodesy [IAG] and had served on the governing board of the IGS Governing Board since its inception; he also served on the Galileo science advisory committee. He noted that IAG was the home organization for GNSS, with more than 200 members from 90 countries and a global network of more than 400 receivers, including 100 for dual GPS/GLONASS tracking. These systems enable considerable science to be done relative to climate, sea level, tsunamis and other events.

Recent events included the IAG Scientific Assembly in Buenos Aires; the Second International Colloquium on the Scientific Aspects of the Galileo program; and a meeting in Frankfurt on the global observing system. Dr. Beutler reviewed the essential topics of the Buenos Aires conference – he noted that the solution to each program required GNSS. He pointed to one area: gravity field determination. The present, he said, was a "golden age" in that field, as three space missions were currently in operation: CHAMP; GOCE and GRACE A&B. All of these missions have GPS on board.

Dr. Beutler presented a chart showing the accuracy GPS provides to users in space, and how it was possible to reconstruct low earth orbits to one cm. accuracy, which he regarded as remarkable. Dr. Beutler described the discussion of Buenos Aires of Global Geodetic Observing System [GGOS], which is the global observing system of the IAG. He wished to point out that one result of GGOS was a 200-page book, "The Global Geodetic Observing System: Meeting the Requirements of a Changing Planet in 2020."

Dr. Beutler then referred to the Second International Colloquium on the Scientific Aspects of Galileo; the sessions held were similar to those held in Buenos Aires. The final discussion showed that the scientific community was anxious to use the two Galileo Giove satellites in orbit which have what he believes are likely the most accurate space-qualified clocks in existence.

Dr. Beutler observed that, unfortunately, no successful effort had ever been made to bring all the key sponsoring agencies to one table and commit them to a concept of global geodetic tracking for science purposes. This, he believed, may happen at a conference set for Frankfurt during the current week. He noted that one outcome of the Frankfurt meeting was that the GGOS 2020 document was adopted as the reference for all GGOS-related issues; second, IGS products are to be promoted as GGOS products; third, a GGOS intergovernmental committee will be created which, as an initial step, will create an inter-agency committee to further develop geodesy.

Dr. Parkinson asked if Dr. Beutler knew the stability of the Giove clocks over a day: he said he believed it was an order of magnitude better than the GPS clocks.

Mr. Arve Dimmen
Norway

Mr. Dimmen said he would address e-navigation, a concept for increased navigational awareness on both ship and shore, and how those may be tied together. Positioning and timing, he said, were central parts to this, and the availability of a reliable PNT system was mandatory. Therefore, the future of safe and efficient maritime traffic was even more dependent on PNT in the future.

On EGNOS [European Geostationary Navigation Overlay Service], Mr. Dimmen reported that system architecture had been declared operational in October 2009; certification continued; and the system was expected to be up and running by mid-2010. He noted there was no maritime version of EGNOS, but the possibility of creating some integration of EGNOS with GPS for maritime users was under discussion. He hoped the Satellite-Based Augmentation Systems [SBAS] could be tied together, particularly in the Arctic. Mr. Dimmen noted that blockage of satellite signals could occur in the open sea, due to canyons caused by offshore structures or fjords. He noted that, through the use GLONASS and GPS, positioning accuracy had notably improved over the past year. He reported on recent improvements in the GLONASS operation. GLONASS, he noted, had 17 satellites currently in operation; its goal was to have 30. Dr. Schlesinger asked by what date the larger number would be in orbit. Mr. Dimmen said his understanding was 2020.

Dr. Beutler said the first goal for GLONASS was to have 24 satellites in orbit by the end of this year; though he thought mid-2010 was more likely. GLONASS and GPS would offer multiple systems from which one could independently derive calculations. Dr. Parkinson said that while he wished the Russians well, he questioned the longevity of GLONASS satellites. GPS satellites had a lifecycle of 10-12 years; with GLONASS, two or three years appeared to be the norm. To maintain the numbers in orbit discussed, this would require launching eight or more satellites a year. The Russians should either develop longer duration satellites or potentially face disaster. Dr. Beutler believed the goal of 24 satellites by next year would be achieved.

Captain Richard Smith
United Kingdom

Capt Smith noted that, relative to suggestions made at the previous Advisory Board meeting, the British government had seen letters in support of e-LORAN to the White House, the Department of Transportation and the deputy secretary for DHS.

He reported on the highlights of the triennial conference on international navigation held the previous week in Stockholm, Sweden. The keynote speaker there had addressed a new era for the navigator; and pointed out the rise of criminal abuse of GPS which included efforts to disrupt receivers so as to complicate future criminal investigations. The matters involved ranged from the incidental, such as the avoidance of road tolls, to serious felonies.

Capt Smith said the Galileo program manager made a presentation somewhat at odds with the one the Advisory Board had received in May 2009. It appeared, he thought, that the "mantra" that Galileo would adhere to published specifications was no longer current. Funding was one issue: the budget cobbled together when Galileo had become a European Union project was no longer sufficient to achieve FOC [Fully Operational Capability] by the planned date. Therefore, FOC would be delayed until the next EU budget cycle. Existing funds would be used to create the maximum number of satellites possible by 2013; he suggested a partial constellation of 18 satellites. Two would be launched experimentally; followed by two more; followed by twelve or more. He noted, as a change in policy, that the Galileo Interface Control Document [ICD' to help ensure compatibility and interoperability will be publicly available and free of charge within several weeks.

Capt Smith noted that the ICG had been privileged to receive a presentation from Ken Hodgkins of the U.S. Department of State. He believed it important that ICG's work should be presented to international audiences; ICG was committed to assisting developing countries in its use. One important aspect of this will be to make maximum use of the GPS signal to help people on the ground. He noted that at the e-LORAN session held at Stockholm delegates were very uncertain as to U.S. intentions. He believed the studies of e-LORAN matter had been too narrowly focused, as they failed to consider the importance of e-LORAN to activities outside navigation. He noted that the next triennial conference was set for Cairo, Egypt, in 2012.

Mr. Hall called attention to an additional paper that had been presented at the conference, a Chinese paper with their first observations on clock stability.

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Afternoon session

Progress in Providing GPS Services
Lieutenant General Larry James, Commander
Joint Functional Component Command for Space/14th Air Force
DoD GPS Management & Authorities

Gen James noted that the Joint Functional Component Command for Space was responsible for GPS and all DoD systems that operate in space; it combined Army, Navy and Air Force activities. He reported that the Joint Navigation Warfare agency also reported to his command; he believed the Advisory Board was a great tool for educating people in issues related to possible navigational warfare.

Gen James spoke, first, on maintaining and improving current services and, second, on future capabilities. He noted that the GPS IRT [Independent Review Team] had been reviewing the question of how performance could be improved; in general, the answer lays in increasing the number of GPS slots. Currently, there are 24 slots, with 31 operational satellites. The question, he said, was whether one could manage the constellation for 27 slots, which might be more productive. For example, in Afghanistan, which was a challenging GPS environment, improved slot management would likely lead to better performance. Dr. Schlesinger asked if a decision on the 27-slot constellation was still pending. Gen James said it was.

On operational risk assessment, Gen James noted the recommendation that an effort was needed to "stand back" in order to better understand the risks GPS faced from a global perspective. This, he noted, was now an ongoing activity. Dr. Hermann asked whether GPS considered a critical infrastructure; he did believe it was so. Gen James said he was not aware of discussions that included GPS within the national critical infrastructure. He stated that an operational risk assessment would be completed in early 2010; next, with the overall risk environment identified, decisions would follow on where best to locate resources to mitigate that risk. Gen James noted that three residual satellites were now being flown: these were navigationally functional and provided important flexibility should any complications arise.

Regarding future civil signal capabilities, Gen James reported that Air Force Space Command was developing a signal transition plan with the civil community; it was important to assure the community at large where things were heading. He noted that the 1st GPS II-F launch was still scheduled for June 2010. Regarding military capabilities, he reported on the Selective Availability Anti-Spoofing Module [SAASM], which places cryptography into all the receivers for military use. That capability would be coming on line. Dr. Schlesinger asked what principal operational risks had been identified under the assessment discussed above. Gen James said he could not answer; the results were due early next year. Gen Lord asked what the "tenor" in the Pentagon in respect to GPS and the future. Gen James said he believed the tenor in the building was pretty strong for staying on track; he was aware of no substantive programmatic issues. Mr. Hall called Gen James attention to National Security Presidential Directives [NSPD] 39: that document, he said, appeared to place a variety of responsibilities with DoD; further, those responsibilities were often prefaced with words like "facilitate" and "coordinate." His questioned whether this was practical, a point he would address in his own presentation. Ms. Neilan asked if the satellites that were in Launch Earth Orbit Anomaly and Disposal Operations [LADO] were currently broadcasting; Gen James said they were not.

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"Morning" Wrap-up
Dr. Bradford Parkinson

Dr. Parkinson noted the following:

First, a system was needed to track the Advisory Board's recommendations. The board's recommendations, he noted, were not action items per se.

Second, he noted the difficulties in transferring money from the civil authorities to the Air Force; issues around continuing resolutions played a part. He noted Dr. Hermann's suggestion that some sort of lump sum allocation could be made.

Third, he noted the pending cancellation of e-LORAN.

Fourth, he made reference to Dr. Beutler's comments that precision was an international endeavor; progress had been good; other systems have been using retro-reflectors; and that the payoff from use of retro-reflectors appears to be quite high.

Fifth, he noted that Captain Smith's remainder of that Galileo faced major budgetary issues.

Sixth, he noted the dismay on anything that might raise the costs of GPS-III. Dual launch, he said, might save $50 and $75 million per launch. Captain Smith said Galileo was launching in pairs during its trial phase. Four were to be launched in the next two years; if this proved successful, then perhaps a dozen more would be launched. Capt Smith noted that Galileo had discussed the possibility of launching satellites two to a booster; GLONASS launches three to a booster.

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Use of GPS for Future Space Operations and Science Mission
Dr. Frank Van Graas
ION Science and Technology Policy Fellow
Ohio University

Dr. Van Graas said that, during his tenure as a fellow at the Institute of Navigation, he undertook to review NASA's current use of GPS. This involvement included, but was not limited to, NASA use of GNSS for autonomous navigation and experiment control; reliance on GPS for functionality in ten pending space missions; and support/enabling of such things as smart sensor webs, advanced climate studies and a range of other activities.

Dr. Van Graas noted that while most satellites operate at up to 3000 km, an increasing number of missions operate either in highly elliptical or geosynchronous orbits. Beyond the GPS orbit, signal reception and processing becomes more difficult. He reported that through 2027, all but five percent of satellites would operate within the GPS Space Service Volume. He provided further detail on NASA use of GPS/GNSS; on current GPS-dependent missions and programs; on applications to upcoming missions through 2016; and on the emerging space use of GPS/GNSS. He noted that while the number of users might not be large, they tended to be high-value users. Dr. Van Graas identified GPS/GNSS risk areas. He stressed that a very large effort was continuing in standards, testing and monitoring, and listed areas of focus. He noted that if a new international docking system was created, it should be standardized on a signal – maybe L1C – with agreed and proper standards.

Mr. Hall asked if thought had been given to adding backplane antennas to satellites so they could look directly into space. Dr. Van Graas said that concept had been under intermittent discussion, but he did not know that it was part of any current plan. Dr. Beutler noted that Dr. Van Graas had stressed the important of GNSS tracking for occultation; he believed it was also of great importance for precise determination of orbits. Dr. Van Graas agreed. Dr. Parkinson asked if any agency was at work on developing a mercury-ion space-qualified clock; he was informed that the NASA Jet Propulsion Laboratory [JPL] and the Applies Physics Laboratory [APL] are doing so. Dr. Parkinson asked if the clock technology was hardened to GPS altitude requirements; Dr. Van Graas said he did not know. Mr. Miller said an experiment was pending.

Ms. Neilan asked if the recently initiated solar cycle would have any affect on GNSS. Dr. Van Graas said that, depending on what prediction was made, the current solar cycle would have its maximum in 2010, 2011 or 2012. A recent experiment had demonstrated that electron density had already begun to increase. This was a matter of concern to him; in particular, as clearly we "didn't do very well" during the previous solar cycle. He believed that while

multiple frequencies might help, this did not necessarily solve the problem, as there was no certainty which of the various models available was the right one. As a practical matter, this depended on the latitude at which one was positioned. His "best hope" was that during the current solar cycle, sufficient data could be gathered, particularly at the lower frequencies, so that the best possible receiver architecture can be designed to survive the next cycle. His view was that it was likely that the next cycle would be somewhat worse than had been anticipated. He believed the concerns were more to be directed to geostationary satellites than to GPS satellites. Ms. Neilan said he was mindful of the problems that had affected the airlines during the previous cycle and she was therefore curious how aware the airlines might be of the possible impacts of the forthcoming cycle. Dr. Van Graas noted that the question of the radiation safety of airline passengers during solar bursts was a topic of concern that was often an overlooked subject.

Mr. Miller expressed his pleasure that an "outsider" like Dr. van Graas was working with NASA in order to provide a "professional audit" of all NASA programs using GPS.

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Preserving the Environment through GPS Applications
Mr. Jeff Hamilton, Director
Strategic Partnerships, Trimble

Mr. Hamilton noted that as an archeologist he had spent years in northern California using GPS for research on ancient trade routes. That work had been directed at preserving the past; the day's presentation was directed at preserving the future. Mr. Hamilton noted that key concepts for sustainability were measurement, verification and process innovation. Mr. Hamilton said measurements provided information not only on where an event occurred but its relationship to other events, such as plumes, oil spills, and carbon sink status. He identified GPS as important to verifying fleet management; biomass calculation; fuel use; agricultural tillage methods and agricultural herbicide/nutrient application.

Mr. Hamilton provided case studies on GPS use in this area:

To provide cabin electricity, 458,000 heavy-duty trucks idle their engines an average of five hours a day while burning one gallon of fuel per hour. Alternative approaches, he said, could save 598 million gallons of fuel annually and lead to 1.6 million ton reduction in annual carbon dioxide release. Dr. Schlesinger asked how GPS would contribute to this; Mr. Hamilton said the embedded GPS would monitor and report system use to operator.

In heavy construction, GPS-provided data permitted far more accurate positioning when digging, reducing re-work and excavation requirements. Mr. Hilton cited an experiment involving two road cuts: one by conventional means, the other with GPS-assisted design. The latter provided a 70 percent increase in productivity and significant greenhouse gas reduction through reduced vehicle use. Responding to Dr. Parkinson, Mr. Hamilton said such systems were currently installed on thousands of vehicles. Further responding, Mr. Hamilton said such systems were currently available for purchase.

Turning to agriculture, Mr. Hamilton described systems which, rather than employ disk plowing to till an entire field, tilled only the soil actually required. He noted the value of not disturbing excess soil, which was a valuable carbon sink. If, he added, this allowed use of smaller tractors, air pollution would be reduced. He described systems which could examine field plants, distinguish between weed and desirable, and apply herbicide or fertilizer as appropriate, reducing inputs of each. In sum, Mr. Hamilton said GPS was a very powerful tool for environmental sustainability, one whose potential was only beginning to be realized.

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Midterm NextGen Concepts
Pamela Gomez
FAA NextGen Integration and Implementation

Ms. Gomez said she would address NextGen, which was a redesign of the entire national airspace system, moving from a ground-based system to a space-based system. Today, she said, there were repeated delays in passenger travel – the current effort included forecasting passenger demand and make improvements to the automation and surveillance system. NextGen is intended to improve efficiency, add capacity, and address a number of flight safety and environmental issues. Ms. Gomez noted that Ground-Based Augmentation System [GBAS] implementation was proceeding: design approval had been achieved in September 2009, which she regarded as a major step forward. She believed the first GBAS system would be installed in Newark Airport and would be flight checked and published by 2010. Ms. Gomez said that, in general, air traffic communication would be moving from voice-based to digital communication, with a netcentric system replacing currently disconnected systems. Further, she said, a single shared authoritative source for weather data will be created.

Ms. Gomez presented information on the NextGen management governance structure and on the integration and management office; she stressed that considerable effort was being made to avoid the creation of "stovepipes." Instead, she said, a system of operationally-based "portfolios" was being created; all budgeting following 2011 would be portfolio-based. She described creation of the NextGen implementation plan, which would go out in 2010. The NextGen office, she said, was organized into seven solution set categories, each representing a group of operational benefits. One such solution set concerned high density airports, which included the 35 busiest airports in the world. She reported that efforts would be made to improve trajectories by allowing an aircraft to fly its own trajectory. A second solution set was collaborative air management, which ensured that all involved were receiving the same information. She noted work under way with the National Weather Service. Dr. Parkinson asked if the ionosphere would be included in the weather picture. Ms. Gomez said this was being looked at, but would not happen in 2011. Capt Burns said his organization had asked for the inclusion of space weather, as this had impact on polar routes. Ms. Gomez reported on the concept of transforming facilities, which, she said, meant that ideally air traffic could be managed from any site.

Ms. Gomez noted that prior to going into use, all FAA systems had to go through a safety management review; this was to assure that the system's operation would have no negative impact on anything else. This was, she said, a difficult requirement when multiple changes were being made simultaneously. She noted that environmental performance would require such things as environmental impact statements if flight paths were redefined over new property. Ms. Gomez described other aspects of NextGen, including separation management – the ability to operate on closely spaced runways. The goal was to demonstrate operational capability of this by 2015. Dr. Parkinson asked what assumption was made during the pre-planning of Receiver Autonomous Integrity Monitoring [RAIM] in terms of the masking angle associated with the aircraft. Mr. Murphy said a five degree masking angle was used; he added that Boeing aircraft had used angles down to two degrees. In terms of issues, Ms. Gomez said that as things are moving toward Area Navigation (RNAV) / Required Navigation Performance (RNP), that a near-term study was needed to look at the vulnerabilities of surveillance sources, all of which were reliant on GPS. Dr. Parkinson said the reason the IRT pressed so hard to go from 24 to 27 slots was that the latter number created a much more robust system. He asked if Ms. Gomez was in a position to assess the value of this trade; he believed her presentation reinforced the case for the higher number of slots – 27 slots, he said, created a major break point with most visibility curves. Ms. Gomez said this may be interest. Capt Burns commented that if one moved below 27 slots, one actually lost spacing separation based to today's radar separation.

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Improving Aeronautical Operations Though NextGen: A User's Perspective
Captain Joe Burns
United Airlines

Capt Burns said NextGen had two important aspects: improving efficiency and increasing capacity in crowded air spaces. He noted the experience of ASPIRE [Asian Pacific Initiative to Reduce Emissions], which was based on employing all the best available techniques: he noted that this has led a fuel savings of 8,500 pounds on Sydney to Los Angeles flights. NextGen, he said, was really about GPS – he described the supporting systems that would be involved and were ones for which GPS was required. He thought it entirely unrealistic that progress could be made with less than a robust constellation. He noted that 'data points' representing flights increased consistently by seven percent a year. Dr. Schlesinger asked, given the recession and the rise in fuel prices, whether he believed that the seven percent growth would continue. Capt Burns said the data point growth would continue, even if the passenger demand did not keep pace. Dr. Parkinson noted that the demand for increased efficiency would continue, separate from passenger demand.

Capt Burns reported on an aspect of the NextGen plan – Tailored Arrivals – now principally used on trans-Atlantic arrivals, and which was producing a saving of at least 1,000 pounds of fuel a flight; this system was GPS dependent. This helped show how a business case could be made for various new technologies. Dr. Parkinson asked if this was a four-dimensional system; that is, one involving both a position and a time. Capt Burns said it was. He described an RNP arrival in San Francisco. Dr. Parkinson asked if the system could conceivably be used on parallel runways. Capt Burns said that was possible. Describing various capabilities, Capt Burns presented information on tracking turbulence/weather using GPS. This system, he said, provides fresh information every two minutes with information on the jet stream, which permitted the more efficient selection of heights and altitudes. Additionally, Capt Burns presented information on the surface moving map and on Runway Awareness and Advisory System [RAAS] in action, which provided immediate alert to a taxiing aircraft of how much runway it had remaining, notifying the craft it insufficient runway remained.

Capt Burns said that for the airlines, GPS meant precision navigation, precision timing, position awareness, reduced fuel burns, reduced block times and more. Dr. Parkinson said the presentation was "wonderful" – if he made this presentation to Congress, could he include an urging for 30 satellites? Capt Burns said it would so. He noted that the various GPS-dependent systems resulted in a 6 percent reduction in fuel use, which he considered a staggering number. Dr. Schlesinger noted that much of this was in planning; presumably a significant investment was required of the airlines in concert with the FAA. How did Capt Burns believe the FAA was doing with this? He noted that NextGen was due for deployment in 2015; would a robust constellation exist by that time? Capt Burns noted that 2015 was a "sliding scale" for NextGen, depending on the availability of funds. He added that much of the technology referred to was already installed on the aircraft; part of the effort was to get the FAA to approve its use.

Dr. Schlesinger said NextGen depended on Congressional appropriations; what might be expected in an unpromising budget environment? Capt Burns said if focus was placed on the procedural matters, which were not manpower intensive, then he was optimistic about progress. He affirmed Dr. Schlesinger's comment was that the airlines had already made major capital outlays.

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Message to the Congressional Hearings
Chet Huber

Mr. Huber reported that he had testified to Congress earlier this year – specifically, to the U.S. House of Representatives Committee on Oversight and Government Reform; Subcommittee on National Security and Foreign Affairs. The hearing title was: "GPS: Can we avoid a gap in service?" The hearing objective was to review the satellite constellation and to talk on private sector GPS reliance. Mr. Huber said he talked about OnStar – currently, it has six million subscribers; 2,200 employees, 2,000 crash responses a month and had handled 10,000 emergency events. He believed subscribers would reach ten million in three years. He noted that the system had sent out 3.4 million diagnostic emails. Of possible interest, it had subscribers in every congressional district.

Mr. Huber said he made three recommendations:

First, address the health of the current constellation;
Second, formally commit to preserving signal and backward compatibility for legacy operations;
Third, commit to maintaining the current PRN code as satellites are replaced in primary orbital slots.

Mr. Huber noted a growing awareness in Congress of the important of GPS to the private sector; he found this heartening. He thought it was clear that more education of Congress was needed; he felt too many people were unaware not only of what was planned for the future but what available today. Dr. Schlesinger said the way to influence Congress was to influence staffers; eight or ten staffers interested in an idea could have considerable influence on members of Congress, who often had too much on their plate to be better informed. Dr. Schlesinger asked if GPS was dependent on the timely arrival of II-F; this was affirmed. Ms. Neilan asked what the outcome of this testimony was. Mr. Huber said that in additional to bringing the General Accounting Office [GAO] report to greater prominence, the subcommittee had expressed interest in follow-up information. He believed interest was sufficient that the subcommittee would remain with the issue throughout the current Congress. Dr. Schlesinger said the ultimate payoff was whether the Appropriations Committee was persuaded to provide the cash. Dr. Parkinson said the two viewpoints on "robustness" miss each other. The current provider was the Air Force, who was committed to fewer GPS satellites than they have. When, he said, the Air Force said: "Trust us with what we have," they were referring to a metric of 21 plus 3. On the other hand, the user community makes reference to 31, even if they are being flown in 24 slots. Dr. Parkinson noted that Gen James had said the Air Force would uphold its commitment; what was not noted, he added, was that the current situation is better than what has been committed to.

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Perspective on GPS from the Space Enterprise Council
Mr. David Logsdon
Technical Director
America's Space Enterprise Council

Mr. Logsdon noted that he was a former member of the Advisory Board. The central question, he said, was what GPS needed to do to remain the 'Gold Standard' in GNSS. He noted that the Space Enterprise Council had been formed out of the U.S. Chamber of Commerce in 2000; he became its head in 2003. The Space Enterprise Council consisted of 24 diverse mission companies; its mission was to advocate for space and commerce. He noted that the group had hosted a "GPS Media Day", in which various companies focused on how they planned to use the L2C signal. They had been pursuing the forum theme of "A Day Without Space."

Mr. Logsdon stated that people stand up and listen when you take things away from them – such as, for example, if Verizon were to deprive him of his capacity to text message. Presentations included the consequences that would follow if the GPS signal were compromised for a period of time. He believed the message was slowly trickling into Congress. Mr. Logsdon said awareness was required of the current national economic environment and space environment; policy decisions, he said, needed to be based on budget realities. He noted having once pointed out to Dr. Schlesinger that programmatic discussions meant little because no money to pay for the program existed. Budget realities had to be acknowledged.

Mr. Logsdon noted that all program have problems; it concerned him, however, that there was widespread complacency about problems associated with space: people understood, but did not seem to care, because they did not realize what would be lost to them in the event of a failure of GPS. The necessary advocacy was not reaching the public, the Executive Branch or the Legislative Branch. Mr. Logsdon identified some implications, among them:

There was a tendency to focus on the "stovepipe" aspects of PNT, rather than on the whole.

Certain themes must be continuously emphasized, including policy stability, requirements stability, funding stability and leadership stability.

Finally, transparency must be assured at all levels to maintain a high order of trust in stewardship.

Mr. Logsdon emphasized the importance of international cooperation and engagement, and presented the 2006 International Space Policy. He noted that individual users would all opt to use the system that best suited their needs; in twenty years, he said, users would not particularly care whether that system was GPS, Galileo, or some other. Dr. Schlesinger noted that the policy being quoted was full of government equivocations – 'will pursue,' 'as appropriate,' 'encourage,' etc. He believed a conflict existed: the United States had sovereign requirements as related to national security; these were in conflict with good service to the user community. He believed this a very difficult conflict to resolve. Dr. Hermann suggested there was not so much a conflict between these as a tension: he did not believe it was necessarily a case in which one side won and one side lost. Dr. Schlesinger responded that the reality was there would be unavoidable conflict over the question of budgeting. Dr. Hermann said that did not eliminate the possibility of some accommodation; Dr. Schlesinger agreed. Mr. Logsdon expressed the view that the current definition of national security was decades out of date; today, national security should mean not simply defense security but economic security.

Mr. Logsdon presented suggestions for a path towards strategic engagement. Among these, he urged that the number of Advisory Board meetings be increased and be on web feed [Mr. Logsdon noted that the Advisory Group met twice yearly, while innovation was occurring on an almost daily basis]; that a strategic engagement review team involving domestic, foreign, public and private participants be created; and that efforts be made to further utilize the "Day Without Space" concept, emphasizing to the government the consequences to agriculture and other fields if GPS service failed. He urged someone be tasked with capturing information on all the technology advances that had occurred in the past decade. Mr. Logsdon urged that the question of GPS status as a critical infrastructure be reexamined; it had, he said, been nearly a decade since this question was last reviewed.

Dr. Schlesinger urged the 24 members of the Space Council to take the initiative to visit the television networks and major newspaper to press upon people the consequences of "A Day Without Space." He believed it was a very good subject. Dr. Logsdon noted, at the same time, that while the group needed to reach out, it also needed to pay attention to the policy messages it would be delivering. Dr. Schlesinger said the general point was to emphasize the public's dependence in space-based assets. Capt Murphy urged creation of a list of the benefits GPS provides to aviation, banking, agriculture, construction and other fields.

Mr. Hall asked if current export restriction on technology created a tension for the Space Enterprise Council. Mr. Logsdon said the "dirty little secret" was that export policy was of significant effect largely to second- and third-tier suppliers. He acknowledged that if current policy remained in place, some of these suppliers would be driven out of business.

Ms. Neilan queried whether the Advisory Board should advance a recommendation that GPS be declared part of the critical national infrastructure. Further, she felt the fact that not one person from DHS was present for this meeting was a matter that needed to be addressed.

Mr. Hall said he was reading the National Infrastructure Protection Plan. Generally, there was a paragraph about each infrastructure considered critical. GPS was present because it was defined as a necessary support to critical infrastructures, but was not considered critical in its own right. This, he said, struck him as trivial. Mr. Hall asked if anyone present supported the DHS approach to GPS. No one indicated so.

Dr. Schlesinger noted that Lockheed Martin, which was a member of the Council, had been more successful seeking extended funding for the F-22 fighter than for the GPS system. The F-22 was absolutely dead, Dr. Schlesinger said, and yet Lockheed Martin's people on Capitol Hill were still pushing it. What was needed, he said, was to get people in the space area working Capitol Hill with the same energy as displayed in regard to military hardware.

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PNT Evolution: Future Benefits and Policy Issues
Dr. Scott Pace, director
Space Policy Institute
The George Washington University

Dr. Pace noted this talk had already been presented in South Korea, where there was considerable interest in space policy and exploration. Responding to Dr. Schlesinger, he was uncertain GPS should be declared a critical infrastructure: he said DHS had the matter under review. Dr. Parkinson commented that he regarded that as ridiculous. Whenever the issue of mitigation was raised, he said, the response was that someone was working with cell phone companies to create a database: unless those responsible "don't start walking the long journey" they will never get anywhere. Dr. Pace said that rather than have a policy debate, he wished to address the concrete task of addressing mitigation from a Spectrum and Regulatory perspective. Dr. Parkinson said he was concerned that if the Federal Communications Commission [FCC] had the requisite technical capability, that was fine; however, the FCC position when asked would probably be that they're not not navigation; they're communications. Dr. Pace said he was not opposed to GPS being so designated; his question was whether the Advisory Board could make better progress in other areas. The question was: who would get the assignment and the resources to work the issue. Dr. Parkinson said he believed any approach would suffice provided it was a solution. Dr. Hermann sought Dr. Pace's assessment: was it possible that even though some things were listed as part of a critical infrastructure, with people assigned responsibilities for them, that not much was actually taking place? Was there, he added, any metric for measuring progress? Dr. Pace said he was largely a bystander to this. Dr. Hermann asked if Dr. Pace was aware of what actually happened when a responsibility was assigned to DHS; it was, he said, difficult to assess.

Dr. Pace noted that emerging systems were coming into view. He said the chief U.S. objectives with other GNSS providers were to ensure compatibility and to see that they were market-driven as opposed to being government-driven. Dr. Pace said he believed the ICG has been generally effective; nonetheless various GNSS policy challenges existed. He believed that spectrum protection and standards and trade relations were highly important. However, Dr. Pace thought the most critical aspect was system modernization, which meant international acceptance of new signals. That a new signal was available, he said, did not mean that people would use it – the Russians had learned this. Market acceptance of a new signal requires both reliable performance to published standards and the interface specifications required to build these systems.

Regarding spectrum protection, he noted that over time, as new systems came into operation, the user community had attempted to accommodate the new system while protecting the spectrum environment; specifically, the noise floor. He said no one country could assure spectrum protection; he noted that the U.S. precedence was that it was necessary to work with other countries in terms of their own commercial devices. He believed the pressure for wireless spectrum would continue – the rolling out of broadband, he noted, was a "hot topic." Many people were enamored by new electronic devices; but one could foresee conflicts in this area, particularly as they might affect Radio Navigation Satellite Service [RNSS]. He did not believe a single solution was possible for all time; rather, he anticipated a step by step process.

Dr. Pace recalled previous discussion of the possible Galileo overlay of the M-code; this had led to the U.S.-EU agreement of 2004. The Chinese appear to be in compliance regarding M-code; however, they were now likely to have overlay issue with Galileo. This, he said, is an issue between China and the EU. The U.S., he added, may become involved to support the view that the spectrum be utilized as a rules-based system. He noted that as Beidou/Compass became more complex; a wider spectrum may be in use. He was uncertain what exactly may be dealt with in this area.

Dr. Pace then summarized the Report to the U.S. Congress on U.S. Industry Equipment Access to the Galileo Program, which focused on three topics: lack of information on securing a license; lack of access to testing equipment;

and lack of information on other PNT services. The good news, he said, was that the licensing requirement has been dropped and the shipping of Galileo test equipment to the U.S. had commenced. The issue remaining was the definition of "other PNT services." He longer these were not defined, the longer it would be before anyone began building equipment; this would delay use of Galileo receivers.

Dr. Pace noted that GNSS innovated most rapidly in areas that were not heavily regulated. Taken to an extreme, he said, a regulatory environment could preclude innovation. Regulations driven by customized local requirements, he said, had the effect of "Balkanizing" the market; it was harder to attract investment if that investment was restricted to one market niche.

Gen Lord said he saw a blurring between administration communications and mission communications; the cell phone, he noted, had become mission essential. As a result, the wide-area outage experienced yesterday was now a national security issue. Gen James and his colleagues needed to own this problem; they needed to understand what mitigating steps could be taken. At the same time, he said, he believed the commercial model needed to be followed because that was where innovation was going to take place. He urged that the Advisory Board endorse Dr. Pace's continued involvement with the issues.

Dr. Pace commented that he did not think it possible to distinguish between the civil and the military portions of space. It has, he said, become clear to industry and government, he said, that deep interrelationship of the industrial base meant the civil and military were interrelated. While civil and military could not be separated, he said, it was important to remember that each had its own tasks and that neither side should attempt to undertake the work of the other. He noted that he had some disagreement on this with European colleagues who preferred a tighter connection between civil and military.

Gen Lord said he believed trust was a critical point. He believed international cooperation was being slowed down by uncertainty over what the U.S. was going to do with GPS. Air Force Space Command had to do what it was told; and make sure that this was communicated. Dr. Pace said he believed they had done this. There was a distinction, he said, between the here and now, and things that might occur in the future. He believed it was more important that one's system do no harm than it accommodate the latest "bell and whistle" that someone might wish to add.

The Thursday, November 5 session of the PNT Advisory Board adjourned at 5:05 p.m.

* * *

The Friday, November 6 session was convened at 9 a.m.

Thoughts of GPS Interference, Detection and Mitigation
Mr. Terry McGurn
PNT Advisory Board member

[Mr. McGurn indicated he was not speaking for the Advisory Board.]

Mr. McGurn said that while the problem of mitigation was often viewed as a chore, it was a fascinating technical problem. He described the background document –NSPD-39, December 2004 – as essentially a statement of "shalts": the two principal directives by that the U.S. government was to maintain continuity of use for legitimate users and to deny hostile use. This language, he said, was open to various interpretations and had directed the program in the wrong direction. He believed more specific direction was needed. Denial of service to those who would harm the country, he said, was an important problem, but not the sole focus. Denial of hostile use, he said, is also an intelligence function. Both DHS and contractors he had contacted had been very forthcoming in providing information on their activities; he noted, however, that he differed markedly with them as to the proper approach – which, he believed, would fall outside of DHS.

Mr. McGurn discussed the issue of what actions were being taken to develop the sensors needed to identify source of interference. No specific agency, he noted, was charged with this task: this assumed that the necessary resources were in place, but were in need of effective coordination. While existing assets could indeed be formed into a program, this topic received only passing attention.

Dr. Parkinson said identifying the location of an interference event required the presence of a local sensor. Mr. McGurn agreed. He believed priority was being placed on funding "the big solution," as though in ten years a system would exist that would accomplish everything. He did not believe that was how answers occurred -- rather, one "picked around" with what one has and sees what progress can be made.

Mr. McGurn believed the present GPS approach was "putting the cart before the horse," in that it sought to develop a data repository without first developing the sensors that would inform that repository. The sensors themselves, he added, should dictate the degree of processing that takes place in the field. Restating, he said DHS was

inclined to view this as a macro problem; he thought it was three smaller problems: intentional jamming; unintentional jamming; and spoofing [note: the first line of defense against spoofing was the user equipment itself, not something in the field]. These, he said, were basically different problems. DHS should address the pieces of the problem rather than take a "one size fits all" approach. At present, unintentional jamming was the most common cause of signal loss; the results, however, were just as serious as if the jamming intended actual harm.

Mr. McGurn presented recommendations:

First, responsibilities should be defined – perhaps by EXCOM – for each network component.

Second, several small studies should be funded.

Third, the responsible agency should have the necessary engineering support; the first problem addressed should be that of unintentional jamming.

He believed that while the issue had been made "DHS's problem," he doubted that agency had an appropriate culture for addressing it.

Dr. Hermann noted that DHS lack specialized in-house assets, but could these be farmed out to someone else? He believed national intelligence assets should be used to identify intrusions in this important infrastructure. Mr. McGurn said he was tempted to ask how many Advisory Board members had actually read NSPD-39. Dr. Hermann asked if the document was unclassified. Mr. McGurn said it was. Mr. McGurn said he thought it was a terrible document – little read, through in the public domain. The intelligence community, he said, had assets, but there were likely to be directed toward the denial of hostile use.

Dr. Parkinson asked if Mr. McGurn had ever seen bureaucrats assume responsibility on their own accord. There was, he said, no leadership accountability: the Advisory Board could try to designate DHS as that lead but DHS would probably not recognize this. The second issue, he said, was that the "powers that be" had assigned little real priority to the problem. The third issue was resources. Here, he saw little being assigned. He felt the Advisory Board needed some way to break this logjam. Dr. Hermann said he saw little point in saying: "Somebody ought to do something." Instead, it should present something it regarded as a workable solution, identify its elements and determine responsibilities. Dr. Schlesinger asked to whom such a program would be sold? The EXCOM? Dr. Hermann suggested that would be an appropriate starting place.

Gen Lord suggested assembling a GPS operation where, for example, users would call 1-800-GPS if something went wrong. This would create a feedback loop; it would provide a means to build on an existing structure. Dr. Schlesinger said a "three pager" was needed to describe the problem and identify what needed to be done. Dr. Hermann agreed. He added that while such a statement is advisory, ideas have a power of their own over time and people come to believe them. Mr. Murphy noted that the FAA was responsible for protecting aircraft by mitigating interference with GPS, and asked whether FAA activities were coordinated with DHS? Mr. McGurn said DHS may have *de jure* responsibility, but did not have yet the 'corporate culture' to proceed effectively.

In regards to unintentional jamming, Mr. McGurn called attention to a case in Butte, Montana, where the WAAS system had failed five times. An engineer was sent to investigate. One thing he discovered was that every time a runway light failed, it sent a signal notification on 409 Mz. As it happened, this was precisely one-third of the 1227 megahertz signal that would shut down the WAAS system at the airport. There were, he said, many opportunities for losing the extremely weak WAAS signal. What was needed, he said, was something that would detect interference within the GPS signal. McGurn presented a schematic of a typical digital GNSS receiver block diagram; he described this as an inexpensive device. Unintentional interference might be detected, he said, by looking at the locally logical sources of such interference – e.g., the WAAS array.

Mr. McGurn offered several final thoughts, including:

Where possible, interference should be geo-located and prosecuted.

Failing that, backup system was required – including inertial, e-LORAN [which provided high availability and good time performance], and smart receivers for situational awareness. He believed e-LORAN was the only backup system that provided sufficient timing accuracy to permit operation without GPS.

Additionally, he underscored as a problem the circumstance that "when everyone is in charge, no one is in charge." He believed mitigation was a difficult problem, but could be tackled bit-by-bit if the specific threats were separated.

Dr. Schlesinger asked what Mr. McGurn meant by "inexpensive" whenreference to "the digital GNSS receiver". Mr. McGurn speculated its cost at several hundred dollars.

Mr. Huber said no guidance was being given to companies reliant on GPS to undertake any particular type of solution. Such customers – for example, OnStar – had become a meaningful part of the system and outages could leave tens of thousands, or more, customers without service.

Mr. McGurn suggested that the appropriate first step to addressing mitigation was to get together "a bunch of people" interested in the problem and ask how they would address the problem. In doing this, he said, he would not approach one large contractor, but talk to a number of people who have thought the subject through as a matter of personal expertise. He added: somebody has to be in charge.

Mr. Kirk Lewis said he had, with others, visited nine state governments. His impression was that each state had a first-line responder who might have knowledge to pass up the line. Most interference events, he said, start with a local occurrence of jamming: mitigation has to be undertaken locally. Attention needed to be paid to what possible solution sets existed. The various state governors, he added, were indeed worried about the consequences of electrical towers going out of service. If the problems were going to be local, then each locale needed to make an assessment of what hazards it faced, and how to respond.

Various incidental comments followed: McGurn noted that technicians reading reports of outages often wondered if they were the source of those outages. Ms. Ciganer asked if the FCC had the authority to take legal action against jammers and, if so, did they do so. Dr. Schlesinger asked who, if anyone, was involved in prosecuting unintentional interference. Mr. McGurn responded that, in general, a cease and desist order could be issued.

* * *

International Update on Satellite Laser Ranging
Dr. Michael Pearlman, director
Central Bureau
International Laser Ranging Station

Dr. Pearlman described satellite laser ranging (SLR) as a straightforward technique also used for environmental monitoring including applications such as sea level height, ice coverage thickness, and ocean circulation. Dr. Parkinson commented that the military was not enthusiastic about this procedure, as they did not appreciate its value. He suggested Dr. Pearlman weave into his presentation comments on the benefits this provided to the military.

Dr. Pearlman said International Laser Ranging Service [ILRS] oversaw international activities, ranging from the coordination and sharing of information through the creation of such products including update and maintenance of the International Terrestrial Reference Frame (ITRF), Earth orientation and rotation parameters, relativity measurements, and science. He provided a chart of the current ILRS network and a list of SLR developments. One new item he cited was optical transponder work, which included one-way ranging to the Lunar Orbiter now underway.

Dr. Pearlman described the value of SLR Tracking of the GNSS. Within geosciences, this included improving the ITRF to measure global change over space and time; provide the most stringent requirements for ocean surface and ice budget; improve precise orbit determination, and others. Within the GNSS SLR provided independent quality assurance to assure interoperability amongst GPS, GLONASS, Galileo and Compass; to provide independent range for time transfer; and other activities. [Dr. Pearlman noted that GNSS orbit accuracy could not be validated directly from GNSS data itself; an independent standard was needed to compare optical and radiometric measurements].

Dr. Parkinson invited ideas on why the military would welcome this information. Dr. Hermann whether the military benefits needed to be spelled out more clearly. Were he an officer it'd be difficult based on this presentation alone to link specific operational applications to the underlying geodetic science. That official, he said, needed someone in higher authority to clarify the importance of the information and how it might be implemented in action. The problem, Dr. Parkinson said, was that "the train has left the station" – in his view, the Air Force had sufficiently dragged its feet that altering the design of GPS-III was no longer possible. Dr. Herman said he accepted that; however, in the absence of contrary direction, the Air Force undertakes to do what makes sense to the Air Force. This, however, should be decided not by the Air Force but by DoD. Mr. Miller noted that NASA had been leading an interagency team to identify future GPS geodetic requirements and add laser retro-reflectors to future GPS satellites. They had learned, he said, that one must progressively "educate up" each level of command. Currently matters were at the Strategic Command[STRATCOM] level. Dr. Hermann said it was structurally unsound to imagine that the Warfighter had to decide whether to proceed with what was fundamentally a scientific based principal. Dr. Parkinson said the Joint Program Office [JPO] would not move until it received direction from STRATCOM; Dr. Hermann responded that STRATCOM would take no action absent direction from DoD. He characterized the circumstance: a group in suite 1205 of the Titanic was discussing what to do if the ship hit an iceberg; however, as there was no steering mechanism in 1205, the discussion was irrelevant. Dr. Schlesinger commented that no steering mechanism might exist anywhere. Dr. Hermann commented that EXCOM was the responsible body, as its two co-chairs each directed major agencies of the Federal government.

Dr. Beutler said that, for example, SLR observations could be used to show that the current model for radiation patterns was no longer adequate – this might be of military interest. He added that SLR was the only independent validation technique for microwave measurements derived from GPS signals. If, he said, one used the precise coordinates from the laser observatories, one could yield a result correct to the centimeter. In fact, there were biases on the 10 cm. level; people think we are precise on the 1 cm. level, he said, but it is not so.

Dr. Parkinson said that, unfortunately, the Air Force view was that what existed was sufficient. The Advisory Board, he said, was engaged in attempting to place a permanent impression in a lake; they were faced with a bureaucratic back-fighting from people who were good at it. Mr. Neilan said this topic returned to the presentation the

Advisory Board had received on the "broken requirements process." She felt it was embarrassing for the group's international partners to view how decisions were made. Dr. Parkinson said "we are past embarrassment." In the absence of other direction, the Air Force would, as steward, decide how to proceed: their position was that this was not of consequence to the warfighter. The Air Force, Dr. Parkinson added, was bound and determined not to reopen the contract on GPS-IIIA. As a delaying action, the Air Force approach had been highly successful. Dr. Hermann commented that because no other entity was strong enough to have forced itself into the decision requirements, no one had pressured the Air Force to reach any other decision. Dr. Schlesinger commented that one can fight the bureaucracy; one can curse the bureaucracy – but in neither case was it going away. He quoted former Secretary of Defense Robert McNamara as saying that one can slay only so many dragons a day. What the Advisory Board needed was to establish a priority list of what it regarded as most important – perhaps only two or three of these would be accomplished, but that was important. He suggested that cursing the bureaucracy may be a relief to persons outside the bureaucracy, but it did not bother the bureaucracy in the slightest. Dr. Schlesinger suggested that Dr. Pearlman obtain from Dr. Parkinson slides on the possible military impacts of these matters; these he could present not as an expert but as sourced from an expert.

Dr. Pearlman said the gist of the argument was that the current GPS system limitations are due to the systematic errors, and SLR provide an independent measurement techniques to measure them. Dr. Beutler said the question of detecting orbital errors was not perceived as a military issue and that the errors were of the greatest importance to those who required the highest accuracy from GPS. He believed both civil and military sides should be concerned with this. Dr. Schlesinger asked if this was a task for OSTP. Dr. Hermann asked if he meant OSTP should be the advocate. Dr. Parkinson said he believed NASA had been as effective as it could be and, yes, this was the case.. The problem, he said, was that the military resists taking action and the civilians do not know how to get inside the military decision-making. Mr. Miller commented that he doubted the analysis done on this could be improved upon. At this stage, he said, it had become a political decision – a national decision. This will be a discussion item at the November 19, 2009 EXCOM meeting. The substantive question was whether STRATCOM would drop its opposition.

Mr. Hall offered Dr. Parkinson a hypothetical: if one could frame benefits not just in terms of 'precise orbit ranging' but, also, improvements to clock accuracy then perhaps this would be come more significant to the military or to the GPS program. Dr. Parkinson said some persons believed this to be so, but that those who were opposed did so on other matters. Mr. Hall said a recent paper from the Shanghai Observatory described the use of laser ranging not just in terms of orbit determination. but, also to determine transit time between pulses. Thus knowing the ranging distance from to the retro-reflector enables to determine the total transit time. Dr. Parkinson characterized it as "really a neat idea." Mr. Hall noted that this approach would provide both orbit ranging and clock accuracy; he expressed praise for the paper.

* * *

Reports from Advisory Board Standing Committees

Dr. Schlesinger made the admonition that while the scientific community might be greatly interested in the fact that one could obtain a one-third cm. improvement in accuracy, but it was unlikely to interest anyone outside the scientific community, unless some benefit to the persons paying the bills could be identified.

Dr. Parkinson said he believed the costs of the laser reflectors would be born by NASA. Mr. Miller said the costs would be covered by NASA and the five other agencies that advocated their use.

Ms. Neilan noted the presence of Dr. Linda Thomas from the Naval Research Laboratory (NRL) and Jim Slater of the National Geospatial-Intelligence Agency (NGA) and requested that the Advisory Board listen to their views.

Dr. Thomas said that her agency had for two years worked with the GPS-W on the retro-reflector issue and all technical issues had been resolved to a first order level. Her agency had identified where the reflectors could be located on the current III-A satellite and also identified a reflector array smaller than the one proposed for Galileo. Further, they had identified a candidate method by which ILRS would be engaged and data would flow to the to help with the maintenance and improvement of the terrestrial reference frame. This approach would be coordinated by NASA. She believed the technical analysis was sound and hoped the retro-reflectors would be included in GPS starting with block IIIB satellites. Dr. Parkinson asked when the first GPS IIIB satellite would orbit. Dr. Thomas said beyond 2016. Dr. Slater said the question that constantly came up was: how can we help the warfighter? That same question had been asked not that long ago when sub-meter accuracy was sought. Similarly, the set of geodetic requirements supporting SLR had been defined for the years 2025 to 2030 and that what may be perceived as 'science' now may become operations in the future.

Gen Lord asked what percentage of total payload costs were represented by the retro-reflectors? Dr. Thomas said the retro-reflectors costs are marginal. It requires no deployment mechanism and poses no energy drain. Ms. Neilan asked if Dr. Thomas could say where on the GPS IIIA reflectors could be located. Dr. Thomas said IIIA was

less populated than IIIB; therefore, any space available on IIIB was available on IIIA. Dr. Parkinson expressed the view that the reflectors should be placed on IIIA. Dr. Schlesinger noted that the contract on IIIA was completed, and would have to be re-opened. Gen Lord suggested this was a practical test of who was in charge of the program.

Ms. Neilan said the Strategic Engagement Panel had two slides to present.

First, Dr. Beutler presented an update on the GLONASS system, noting that systematic errors could be identified using the SLR technique he had already explained. This information, he noted, was valuable and could lead to improvements. Without SLR, he said, one was essentially blind in the modeling of the non-gravitational forces. Dr. Hermann offered a "technically naïve" question. He believed there were ways to formulate a picture of GPS in orbit, from the ground; if so, such a picture would place the spacecraft in relative reference to something. How precise could that picture be? Was a retro-reflector needed to provide the accuracy he sought? He believed that in many spectrum domains one could range and discriminate the objects in space sufficiently so that one would know the object's position with some precision. Would the precision that this technique provided be less than that which a retro-reflector might provide? Dr. Parkinson said the difficulty was that one had a changing center of reflection. Dr. Thomas [NRL] said that taking pictures of a satellite from the ground was likely to produce a "nice fuzzy blob" at 22,000 km. Dr. Hermann noted that there was techniques other than straight aperture imagery – his concern, he said, was not with determining whether his approach was right but with whether it had been fully considered. Mr. Miller reported that alternatives had been considered. Dr. Hermann said, given the failure to get retro-reflectors on the satellites, did any other ground-based means exist that would still provide useful information? Dr. Beutler said the errors involved might be as a great as 10 meters, and any associated data was therefore of essentially no value.

Ms. Neilan said that unlike other panels, her's did not meet on tasks between sessions, but rather reflected the perspective of a wide range of international members. She said the basis of PNT was its interoperability and interchangeability. She noted that the retro-reflectors, which would be used by all other systems, were a way to cross-validate between various systems. She reported on the ICG Working Group D established at the September 2009 session; task forces were established on geodesy, geodetic, and timing references. She believed it was an important step that providers from the GNSS systems were designating their experts to meet with an expert panel. She also noted the challenges faced by Africa, which was larger than Europe, China and the U.S., and which has only twenty or so receiving stations. This required further attention.

Bob Hermann said the Future Challenges Panel had met informally. His group wished to commend the GPS_W for re-establishing the public Interface Control Working Group [ICWG] and ; further, he commended the establishment of the National PNT Engineering Forum [NPEF] and encouraged continued engagement. He believed a Federal Register notice on GPS modernization existed on the current interface specification for L2C: he believed the latter needed to be updated. He regarded this matter as of sufficient consequence to be tracked by the NCO and, if necessary, taken to this Advisory Board. Further, he commended the GPS-W for its actions in addressing the phase relationship issue on L1C. Finally, he said it was his group's view that more was to be gained from further international cooperation. He said the Futures panel wished to identify topics for possible future action, not as a formal report but simply for discussion. He identified the following:

First, have the Homeland Security defense needs been adequately considered as a national circumstance? Dr. Schlesinger asked if this was still to be regarded as an open question; Dr. Hermann said it was.

Second, should GPS he viewed as a critical infrastructure? What were the liabilities of the GPS system and what were their mitigations. He did not believe these questions were being addressed as aggressively as a national program required; he questioned whether the timing system was adequately defended.

Third, noting comments by Mr. McGurn and Dr. Parkinson, he agreed it appeared "no one was in charge." Was it desirable, he asked, to strengthen the national management structure?

Fourth, he believed the EXCOM was well situated; involved the right people; and represented a sensible governance model.

Fifth, he queried whether – given the importance of international efforts on interoperability and compatibility – whether some larger or different set of actions was required to advance things?

Dr. Hermann noted that his group had earlier presented a vision that that rested on multiple PNT systems, with user equipment performing seamlessly. He believed creating this system required conscious interference with the current process by which things simply seemed to happen. He noted that Mr. Trimble, an Advisory Board member, had been philosophically opposed to creation of "an international order," believing that government action caused more trouble than it cured. He said it appeared four separate GNSS systems with 100+ satellites would be in orbit. He still believed there was a better way to work this out. Might not, he speculated, a President wonder if this made sense. He affirmed that the foregoing did not represent a formal statement from his committee.

Dr. Parkinson asked what opinion NASA held of the future of the Advisory Board. Mr. Miller commented that the matter had been discussed by the deputy secretaries. NASA had asked if some other agency wished to become chief sponsor: the FAA and the Department of Commerce had expressed interest. However, such transfer was unlikely in the current transition period. NASA would therefore continue sponsorship for a transition year. This topic, he said, was likely to be discussed at the November 19 EXCOM. Mr. Miller regretted not being more definitive; however, he

said NASA was very proud to have served as sponsor and would work to support a smooth transition. Mr. Faga asked if the reason for the transition was to have a rotation among the relevant agencies; Mr. Miller said it was.

Mr. Hall said considerable detail on the proposed GNSS system by India – currently a regional system of 7 to 11 satellites to be expanded into a 24–satellite system – was available in a recent paper presented by Dr. Suresh Kibe. He described it as "a pretty rich paper."

Dr. Beutler commented that GLONASS appeared to be stable at the 17-19 satellite level over the summer; currently, 16 satellites were in operation due to the loss of one satellite the previous week. He believed the planned September 2009 launch may be postponed until February of next year.

Mr. Nishiguchi noted that GPS policy had been enhanced over time; he wished to share information on Japanese enhancements. He noted efforts to encourage the Japanese government to get involved. Promoting and supporting GPS discussion between the U.S. and Japan had resulted in the political statement of September 1998. Further, subsequent actions by President Clinton and the U.S. Congress had helped allay concerns that American policy might change with a new administration. Reassured, large corporations in Japan felt comfortable about entering the GPS market, particularly that for automotive navigation. President Bush and his updates on GPS policy and modernization had furthered this. He noted, however, that President B. Obama had identified "change" as a hallmark of his campaign; this, he said, prompted in Japan some media speculation that changes for the worse might follow. He noted that Japan, too, had a new federal administration. Whatever changes might occur, he said, the most important policy aspect was consistency and the fortitude to maintain that policy. He hoped the board could convey this view to EXCOM.

The Friday, November 6, 2009 meeting of the PNT Advisory Board adjourned at 12:00 p.m.

SPACE-BASED POSITIONING NAVIGATION & TIMING
NATIONAL ADVISORY BOARD

Sixth Meeting
November 5-6, 2009

Hilton Old Town Alexandria
1767 King Street
Alexandria, Virginia 22314
Salon A and B – 1st floor, adjacent to main entrance
(King Street Metro Station)

Appendix A: ACRONYMS

ACRONYMS	
AU:	Australia
APL:	Applied Physics Laboratory
ASPIRE:	Asian Pacific Initiative to Reduce Emissions
CH:	Switzerland
DAA:	Deputy Associate Administrator
DHS:	Department of Homeland Security
DOC:	Department of Commerce
DoD:	Department of Defense
DOS:	Department of State
DoT:	Department of Transportation
EGNOS:	European Geostationary Navigation Overlay Service
EXCOM:	National Space-Based PNT Executive Committee
FAA:	Federal Aviation Administration
FACA:	Federal Advisory Committee Act
FCC:	Federal Communications Commission
FY:	Federal Year
FOC:	Fully Operational Capability
GAO:	General Accounting Office
GBAS:	Ground-Based Augmentation System
GGOS:	Global Geodetic Observing System
GLONASS:	Russian Global Navigation Satellite System
GNSS:	Global Navigation Satellite System
GPS:	Global Positioning System
GPS-W:	GPS Wing
HQ:	Headquarters
IAG:	International Association of Geodesy
ICAO:	International Civil Aviation Organization
ICD:	Interface Control Document

ICG:	International Committee on GNSS
ICWG:	Interface Control Working Group
IFOR:	Interagency Forum for Operational Requirements
IGS:	International GNSS Service
ILRS:	International Laser Ranging Service
IN:	India
IRT:	Independent Review Team
IS:	Interface Specification
ITRF:	International Terrestrial Reference Frame
JPL:	Jet Propulsion Laboratory
JP:	Japan
JPO:	Joint Program Office
LADO:	Launch Earth Orbit Anomaly and Disposal Operations
LORAN:	LOng RAnge Navigation (e-LORAN: modernized LORAN)
MhZ:	Megahertz
NASA:	National Aeronautics and Space Administration
NCO	National Coordination Office
NGA:	National Geospatial Intelligence Agency
NII:	Networks and Information Integration
NO:	Norway
NPEF:	National PNT Engineering Forum
NRL:	Naval Research Laboratory
NSTP:	National Security Presidential Directives
NTIA:	National Telecommunications and Information Administration
OCX:	Future GPS Operational Control Segment
OMB:	Office of Management and Budget
OSD:	Office of the Secretary of Defense
OSTP:	Office of Science and Technology Policy
PNT:	Positioning, Navigation, & Timing
QZSS:	Quasi-Zenith Satellite System
RASS:	Runway Awareness and Advisory System
RAIM:	Receiver Autonomous Integrity Monitoring
RAAS:	Runway Awareness and Advisory System
RNAV:	Radio Navigation
RNP:	Required Navigation Performance
RNSS:	Radio Navigation Satellite Service
S/A:	Selective Availability
SAASM:	Selective Availability Anti-Spoofing Module
SBAS:	Satellite-Based Augmentation Systems
SGE:	Special Government Employees
SLR:	Satellite Laser Ranging
STRATCOM:	US Strategic Command
USAF:	United States Air Force
USCG:	United States Coast Guard
UK:	United Kingdom
WAAS:	Wide Area Augmentation System

Appendix B: Membership

Space-Based Positioning, Navigation and Timing Advisory Board

Special Government Employees

- James R. Schlesinger (Chair), MITRE and Barclays Capital
- Bradford Parkinson (Vice Chair),
- Joseph D. Burns, United Airlines
- Per K. Enge, Stanford University
- Martin C. Faga, Former President & CEO, MITRE
- +Keith R. Hall, Booz-Allen Hamilton
- Robert J. Hermann, Global Technology Partners, LLC
- Chester A. Huber, OnStar Corporation
- Lance Lord, Former Commander, Air Force Space Command
- James P. McCarthy, U.S. Air Force Academy
- Terence J. McGurn, Private consultant (retired CIA)
- Timothy A. Murphy, The Boeing Company
- Ruth Neilan, Jet Propulsion Laboratory
- Charles R. Trimble, Chairman, U.S. GPS Industry Council

Representatives

- Ann Ciganer, U.S. GPS Industry Council
- Gerhard Beutler, International Association of Geodesy (Switzerland)
- Arve Dimmen, Norwegian Coastal Administration (Norway)
- Suresh V. Kibe, Indian Space Research Organization (India)
- Hiroshi Nishiguchi, Japan GPS Council (Japan)
- Richard A. Smith, International Association of Institutes of Navigation (U.K.)

Appendix C: Attendees

Thursday, November 5, 2009

PNT Advisory Board members:

James R. Schlesinger, chair	MITRE and Barclays Capital
Bradford Parkinson, vice-chair	Stanford University
Gerhard Beutler	Intl. Assoc. of Geodesy [Switzerland]
Joseph D. Burns	United Airlines
Ann Ciganer	U.S. GPS Industry Council
Arve Dimmen	Norwegian Coastal Administration
Per K. Enge	Stanford University
Martin C. Faga	Former President & CEO, MITRE
Keith R. Hall	Booz-Allen Hamilton
Robert J. Hermann	Global Technology Partners
Chester A. Huber	On-Star Corporation
Lance W. Lord	Air Force Space Command
James R. McCarthy	U. S. Air Force Academy
Terrence McGurn	Consultant [retired CIA]
Tim Murphy	Boeing Airlines
Ruth Neilan	NASA Jet Propulsion Laboratory
Hiroshi Nishiguchi	Japan GPS Council
Richard Smith	International Association of Institutes of Navigation

Other NASA attendees:

A. J. Oria	NASA
Beryl Brodsky	NASA
Brian Ramsay	NASA
Diane Rausch	NASA
Tom von Deak	NASA

Other attendees, Thursday, November 5

Carl Andren	ION
Mark Bernstein	self
C. Chaplain	General Accountability Ability
J. R. Deirer	self
Brian Foster	NNSA
Pamela Gomez	Federal Aviation Administration
Scott Grantham	OSD/NII
Jeff Hamilton	Trimble Associates
Robert Hessin	National Coordination Office
Cyndee Hoagland	Trimble Associates
Ken Hodgkins	U.S. Department of State

Other attendees, Thursday, November 5, continued

Chet Huber	self
Gen. Larry James	U. S. Air Force
Jason Kim	U. S. Department of Commerce
L. Kirk Lewis	IDA
David Logsdon	SEC
Jules McNeff	OSD/NII
Lenore Marantelle	OSI
Ed Morris	ITT
Mitchell Narins	Federal Aviation Administration
Dr. Robert A. Nelson	SERC
David Oslon	Federal Aviation Administration
Richard Orr	SATEL
Scott Pace	George Washington University
Elizabeth Roper	AFSPL/ASP
Robert Rosenberg	GPS/IRT
Michael Shaw	Lockheed Martin
Hank Skalski	MS DOT
Jim Slater	NGA
Dough Taggert	Overlook
K. Thummalai	GMU
Frank Van Graas	Ohio University
Maureen Walker	U.S. Department of State
Stephanie Wan	George Washington University
Joseph Welhberg	NNSA
Damon Wells	Office of Science and Technology Policy
Rebecca Wilson	Government Accountability Office

Other attendees, Friday, November 6:

Mark Bernstein
Charlie Daniels
Harrison Freer
Robert A. Nelson
Mike Pearlman
Robert Rosenberg
Hank Skakski
Jim Slater
Linda Thomas
Joseph Wehlberg
Rebecca Wilson
Tom VonDeak

Appendix D: Papers Presented:

National Space-Based PNT Advisory Board/Col. Robert M. Hessin

Evolution of National Space-based PNT Policy: Lessons Learned/Michael E. Shaw

Progress in GPS Services/Gen. Larry James

Update on U.S. GNSS International Cooperation Activities/David A. Turner

Quazi-Zenith Satellite System Program Updates/Hiroshi Nishiguchi

PNT Advisory Board Report, November 2009/Arve Dimmen

Use of GNSS for Future Space Operations and Science Missions/Frank van Graas

Preserving the Environment Through GPS Applications/Jeff Hamilton

Midterm NextGen Concepts/Pamela Gomez

NextGen Dependence on GPS/Capt. Joe Burns

Space Enterprise Council: Presentation to the PNT Advisory Board/David Logsdon

PNT Evolution: Future Benefits and Policy Issues/Scott Pace

A US Program to Indentify, Geolocate and Mitigate Sources of GPS Interference/Terry McGurn

International Update on Satellite Laser Ranging/Michael Pearlman

All presentations are available online at http://pnt/gov/advisory/2009/11