

Global Positioning System: Political Support, Directions of Development, and Expectations

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ABSTRACT: Over the last decade the Global Positioning System has become a global, multifunctional tool which provides services that are an integral part of U.S. national security as well as the security of other highly developed countries. Economic development, transport security as well as homeland security are important elements of the global economic infrastructure. In 2000 the United States acknowledged the growing significance of GPS for civilian users and stopped intentionally degrading accuracy for non-military signals that are known as "Selective Availability". Since then, commercial applications of satellite systems have been proliferating even more rapidly, and therefore, their importance in everyday life has greatly increased. Currently, services that depend on information obtained from the Global Positioning System are the driving force behind economic growth, economic development and the improvement in life safety. This economic development would not be possible without the financial and political support of the US government to maintain the operation of the GPS system. Therefore it is important to have knowledge about the intentions of the US government how system GPS will be developed in the future. Decisions taken in the last 3 months are the subject of this article.

1 INTRODUCTION

Over the last decade the Global Positioning System has become a global, multifunctional tool which provides services that are an integral part of U.S. national security as well as the security of other highly developed countries. Economic development, transport security as well as homeland security are important elements of the global economic infrastructure. In 2000 the United States acknowledged the growing significance of GPS for civilian users and stopped intentionally degrading accuracy for non-military signals that are known as "Selective Availability". Since then, commercial applications of satellite systems have been proliferating even more rapidly, and therefore, their importance in everyday life has greatly increased.

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The document titled "U.S. Space-Based Positioning, Navigation, and Timing Policy", which was signed by the President of the United States on December 15, 2014, states that the U.S. Congress intends to continue to develop services based on the Global Positioning System; this document also points to the possible risks and threats to national security as well as economic security. The widespread and constantly growing dependence on satellite systems as well as military, civil, and commercial systems and infrastructure makes these systems more vulnerable to unexpected interruptions to the process of

performing standard services. The United States must and wants to continue to improve and maintain the Global Positioning System by expanding backup functions in order to meet the growing needs related to the safety of using this system for military, civil, economic and scientific purposes.

Moreover, since there are different requirements for different applications, there is a need for stable policy that would be implemented through flexible management strategies. The document dated December 15, 2014 defines the extent to which national and GPS management policies are to be modified. These policies are aimed to support the system's capability to meet the growing, diverse domestic and international requirements. This document defines the basic goals and objectives of this policy: "(...) The fundamental goal of this policy is to ensure that the United States maintains space-based positioning, navigation, and timing services, augmentation, back-up, and service denial capabilities that:

- 1 provide uninterrupted availability of positioning, navigation, and timing services;
- 2 meet growing national, homeland, economic security, and civil requirements, and scientific and commercial demands;
- 3 remain the pre-eminent military space-based positioning, navigation, and timing service;
- 4 continue to provide civil services that exceed or are competitive with foreign civil space-based positioning, navigation, and timing services and augmentation systems;
- 5 remain essential components of internationally accepted positioning, navigation, and timing services;
- 6 promote U.S. technological leadership in applications involving space-based positioning, navigation, and timing services.(...)"

These goals will still be pursued by using the existing organizational structure (Fig. 1).

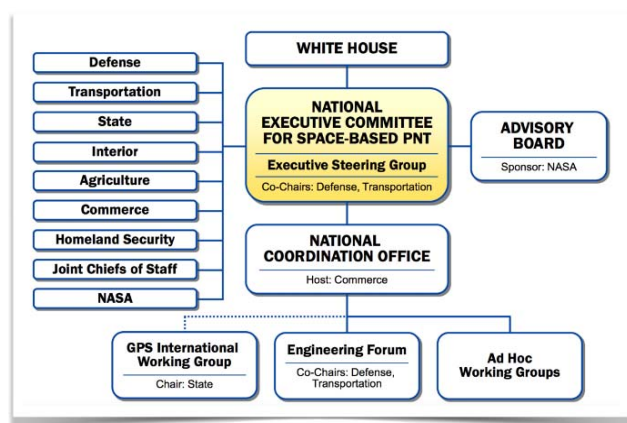


Figure 1. GPS management structure [4].

The National Executive Committee For Space-Based PNT is the most important body in this structure. This body ensures that scientific and business communities follow the U.S. government's guidelines and fulfill its expectations. The National Space-Based Positioning, Navigation, and Timing (PNT) Advisory Board provides independent advice to the U.S. government on GPS-related policy through the Executive Steering Group. What is more, it also

manages programs and funding profiles connected with the current state of national and international services provided by the GPS system.

2 CURRENT ACTIVITY OF THE U.S. NATIONAL SPACE-BASED POSITIONING, NAVIGATION, AND TIMING (PNT) ADVISORY BOARD

Apart from managing current programs, the PNT Advisory Board mainly deals with planning and monitoring the development of domestic and international services related to using satellite navigation. It is commissioned to explore research topics and carry out other tasks by the Space-Based PNT National Executive Committee. The National Space-Based PNT Advisory Board's members are non-governmental experts on satellite systems who are elected for a term of two years. The Advisory Board is currently composed of:

- 1 experts from industry and academic communities, who are given the status of federal employees during the Advisory Board's meeting:
 - Bradford Parkinson (Chairman), Stanford University,
 - Thad Allen, Booz Allen Hamilton,
 - Penina Axelrad, University of Colorado,
 - John Betz, MITRE,
 - Dean Brenner, Qualcomm,
 - Joseph D. Burns, Sensurion Aerospace,
 - Per K. Enge, Stanford University,
 - Martin C. Faga, MITRE,
 - James E. Geringer, ESRI,
 - Ronald R. Hatch, consultant to John Deere,
 - Rajiv Khosla, Colorado State University,
 - Peter Marquez, Planetary Resources,
 - Terence J. McGurn, private consultant (retired CIA),
 - Timothy A. Murphy, The Boeing Company,
 - Ruth Neilan, Jet Propulsion Laboratory,
 - T. Russell Shields, Ygomi;
- 2 international representatives who have been appointed to speak on behalf of particular interest groups:
 - Gerhard Beutler, International Association of Geodesy (Switzerland),
 - Elizabeth Cannon, Canadian Aeronautics and Space Institute (Canada),
 - Ann Ciganer, GPS Innovation Alliance,
 - Arve Dimmen, Norwegian Coastal Administration (Norway),
 - Matt Higgins, International GNSS Society (Australia),
 - Hiroshi Nishiguchi, Japan GPS Council (Japan),
 - Rafaat M. Rashad, Arab Institute of Navigation (Egypt).

The Advisory Board's meetings have been held every six months since 2007. On December 10-11, 2014 the U.S. National Space-Based Positioning, Navigation, and Timing (PNT) Advisory Board held its 14th meeting in Washington. During these two days, a total of 27 presentations were given. These were performance progress reports concerning tasks that had been assigned to working groups as well as information about the current scope of activities carried out by institutions that cooperate with the PNT Advisory Board or are its subsidiaries.

The meeting was opened by Chair, Prof. Bradford Parkinson, who presented a summary of the PNT Advisory Board's previous activities, the major threats to GPS systems as well as the scope of actions that should be undertaken to make GPS invulnerable to modern threats.



Figure 2. Meeting of the U.S. National Space-Based Positioning, Navigation, and Timing (PNT) Advisory Board (author's archive).

Among the most interesting presentations that were made on the first day of the meeting were reports prepared by working groups. The results achieved by the first working group, i.e. "Assured Availability", were presented by:

- Ms. Ann Ciganer and Mr. Ron Hatch, who gave a presentation titled "Protect the Clear and Truthful Reception";
- Dr. John Betz and Dr. Per Enge, who gave a presentation titled "Toughen Users' Receivers";
- Mr. Matt Higgins and Mr. Terry McGurn, who made a presentation titled "Augment or Substitute PNT Sources".

The results of activities carried out by the second working group, i.e. "Economic Value of PNT", were presented by Gov. Jim Geringer. Moreover, Director of the GPS Directorate, Col. William T. Cooley described the current state of GPS modernization activities and future plans for modernizing this system. Currently there is a constellation of 30 operational satellites in orbit:

- four GPS IIA satellites – signals at L1 C/A, L1 P(Y), and L2 P(Y) frequencies;
- twelve GPS IIR satellites – broadcasting the same signals as the IIA block;
- seven GPS IIR-M satellites – with additional L2C, L1M, and L2M signals;
- seven GPS IIF satellites – with an additional signal at L5 frequency.

Moreover, a total of eight additional satellites are in test status and one satellite from block IIF-8 is in early orbit test. There were four successful satellite launches in 2014:

- on February 20: block IIF-5,
- on May 16: block IIF-6,
- on August 1: block IIF-7,
- on October 29: block IIF-8.

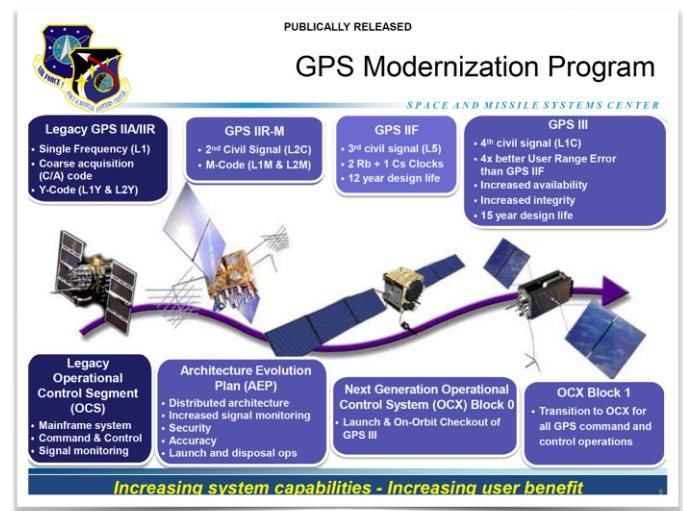


Figure 3. GPS modernization program [1].

Then, the directors:

- Mr. Harold "Stormy" Martin Director, National Coordination Office for Space-Based PNT;
- Mr. Kenneth Hodgkins, Director, Office of Space & Advanced Technology, State Department;
- Ms. Karen Van Dyke, Director for PNT, DOT Office of the Secretary, Research and Technology presented tasks that are currently being performed by the institutions that they lead.

Ms. Paige Atkins and Mr. Ron Repasi described the priorities related to and prospects for spectrum management in the United States.

On the second day of the meeting, the Advisory Board's international members presented information about the current state of their research activities in particular areas. Presentations were given by:

- Dr. Gerhard Beutler (Switzerland),
- Mr. Arve Dimmen (Norway),
- Mr. Matt Higgins (Australia),
- Dr. Rafaat Rashad (Egypt).

At the end of the meeting, further research directions were defined and a total of five research areas were identified:

- Anti-Spoofing Authentication Codes,
- "Toughening" Techniques for Commercial Receivers,
- FCC Licensing of non-U.S. GNSS Services,
- Criteria for U.S. use of other GNSS systems,
- Strategies for International Engagement.

3 ELORAN IN THE TERRITORY OF THE UNITED STATES

Along with the Advisory Board's meeting, a meeting of the United States Congress was held. The U.S. Congress made many important decisions concerning the United States; one of them, however, is particularly important for the community of navigators around the world. On December 10, 2014, the U.S. Congress passed legislation that would preserve the nation's Loran infrastructure and assign the task of converting it into an eLoran system to a given body under a cooperation agreement. This bill was adopted only several weeks after the U.S.

Administration had begun to seriously consider the possibility of developing a non-satellite navigation system, including eLoran, so as to supplement the GPS system.

The Senate adopted bill number HR 5769, "The Howard Coble US Coast Guard Authorization Act of 2014", and sent it to President Barack Obama for signature. As regards the eLoran system, the act reads:

3.1 "(...) Section.229. E-LORAN

3.1.1 *In general*

The Secretary of the department in which the Coast Guard is operating may not carry out activities related to the dismantling or disposal of infrastructure that supported the former LORAN system until the later of—

- 1 the date that is 1 year after the date of enactment of this Act; or
- 2 the date on which the Secretary provides to the Committee on Transportation and Infrastructure of the House of Representatives and the Committee on Commerce, Science, and Transportation of the Senate notice of a determination by the Secretary that such infrastructure is not required to provide a positioning, navigation, and timing system to provide redundant capability in the event GPS signals are disrupted.

3.1.2 *Exception*

Subsection (a) does not apply to activities necessary for the safety of human life.

3.1.3 *Agreements*

The Secretary may enter into cooperative agreements, contracts, and other agreements with Federal entities and other public or private entities, including academic entities, to develop a positioning, navigation, and timing system, including an enhanced LORAN system, to provide redundant capability in the event GPS signals are disrupted.(...)"

The U.S. Congress took this action after representatives of the Federal Aviation Administration had delivered their speeches at a PNT Symposium at Stanford University on October 10, 2014. The Space-Based Positioning, Navigation & Timing National Executive Steering Group established the CPNT Tiger Team. The team's tasks were clearly defined:

- to explore the possibility of using eLoran as a backup system for the GPS technology;
- to evaluate other technologies as backups to GPS;
- to test the feasibility of providing fully functional components of PNT, i.e. P – positioning, N – navigation, and T – timing, separately.

The CPNT Tiger Team was given a very short time frame to complete this task. The team presented its conclusions at the U.S. National PNT Advisory Board's meeting in December 2014. The task had been carried out and the conclusions were so optimistic that the United States Senate passed the above-mentioned bill.

4 SUMMARY

Satellite positioning systems are a civilizational achievement without which people's everyday life would be much harder. In recent years, terrorist groups have begun to intensify their activities aimed at jamming or interfering with the operation of satellite systems, which is why it is extremely important to ensure safe functioning of these systems. Therefore, it is very positive news that the U.S. government made the strong and long-awaited pronouncement in "U.S. Space-Based Positioning, Navigation, and Timing Policy".

A continuous modernization of GPS, which would be carried out on a yearly basis, will guarantee that the system will still function reliably for many years to come. The process of supporting satellite positioning systems by using ground-based radio-navigation systems, especially eLoran, exemplifies a new approach to ensuring continuity and reliability of the process of determining an object's position on the Earth's surface. Currently, there is a great need to create systems which would support GPS's functioning and which would make it more difficult to interfere with the system and to jam the GPS signal. Therefore, all initiatives of the U.S. government, including the one that is described in law No. S.2444 [3], which additionally fulfills the directive of the President of the United States dated 2004, should be perceived as very positive steps in the right direction.

The navigation community is eagerly awaiting information that the eLoran system is in a state of operational readiness in the territory of the United States.

REFERENCES

- [1] Cooley William T. 2014. *GPS Update for PNT Advisory Board*. PowerPoint presentation, Washington.
- [2] U.S. *Space-Based Positioning, Navigation, and Timing Policy*, December 15, 2014, Washington.
- [3] S.2444 – *Howard Coble Coast Guard and Maritime Transportation Act of 2014*, Washington.
- [4] www.gps.gov
- [5] www.rntfnd.org