IISL-99-IISL.2.02

SHOULD GNSS STANDARDS THAT ARE UNIFORM FOR ALL GNSS USERS BE ESTABLISHED, OR ARE UNIMODAL STANDARDS SATISFACTORY ?

Paul B. Larsen, Georgetown University Law Center *

I. Introduction

This paper's focus is on developing GNSS standards and recommended practices. Would a seamless, interoperable, standardized GNSS web including all GNSS systems make global GNSS most efficient and beneficial to all users? The objective of the paper is to examine the processes of GNSS standardization, to identify possible legal barriers to the success of GNSS and to consider mitigation or possible removal of such barriers.

II. Regulatory Activities of GNSS Providers

A. United States: Global Positioning System (GPS)

In July, 1999, the U.S. Department of Defense (DOD) issued a new space policy statement. 1/ Clearly, DOD does not want U.S. GPS to be use for hostile purposes against the United States. DOD operates, and maintains the GPS and to replace GPS satellites as necessary. The health of satellites is regularly monitored, corrective instructions are issued to correct malfunctions. Defective GPS satellites are taken out of service and replaced by healthy satellites which are already stored in space. New upgraded GPS satellites are being built for future launch into orbit. The GPS service is available continuously to all military and civilian users all over the world. However, the more accurate GPS, so-called Precise Positioning Service (PPS) is only available to military users. The standard GPS (SPS) is available to all users. This difference is called selective availability (SA). 2/ GPS is used not only by the U.S. military but also by foreign NATO military. NATO participants are expected to continue to use GPS. To do otherwise could interfere with coordination within NATO. The military has become more GPS dependent than the civilian sector. This has resulted in establishment of two new civilian radio signals effectively separating the civilian and the military GPS users. 3/

However, it would be a mistake to describe GPS as purely a military system. Civilian GPS uses gradually are becoming more extensive than military GPS uses. The increased civilian commitment to and investment in the GPS service caused the U.S. President to issue the 1996 Presidential Decision Document to sort out GPS responsibilities between DOD and the U.S. Department of Transportation (DOT) and to arrange civilian interface. When civilians, such as the maritime users, began to use GPS as their sole navigation system, it became more difficult for the military to discontinue GPS signals for testing or other purposes, because civilian users need a navigation system that is virtually available without interruption. (Available 99.7% of the time for maritime users. ICAO Annex 10 requires that aviation navigation systems be available 99.97% of the time). 4/

The 1996 Presidential Decision Document selected the DOT to be responsible for all civilian GPS matters. A permanent interagency GPS Executive Board (IGEB), jointly chaired by DOT and DOD, coordinates GPS. Serving on the Board are DOT and DOD executives, including the Joint Chiefs of Staff, as well as the Departments of Commerce, Interior, Agriculture and other U.S. agencies.

In this paper the term Global Navigation Satellite System (GNSS) includes all the satellite navigation and positioning systems, such as the Global Positioning System (GPS), GLONASS and Galileo, as well as their augmentations .

Many other U.S. Government regulatory activities affect civilian GNSS uses. Within DOT, the FAA and the Coast Guard are involved in GPS regulation . The Federal Railroad Administration (FRA) regulates use of GPS signals to separate trains. 5/ Furthermore, the Federal Communications Commission (FCC) regulates public safety radio frequencies. In 1998 the White House issued decisions regarding availability of the new second and third GPS radio frequencies. 6/ The Congress adopts legislation that funds GPS and its augmentation thus influencing the availability of GPS. Many other U.S. Government regulatory activities affect civilian GNSS uses.

B. Russia : GLONASS

Russia's GLONASS system is changing. On February 18, 1999 President Yeltsin decreed that the Russian military would share control over GLONASS with civilians. 7/ The decree creates a joint military - civilian board to operate GLONASS. Thus GLONASS is not purely a military system. Russia is open to the possibility that GLONASS may become the basis for a joint Russian and European Global Navigation Satellite System. Russia would benefit from European financial contributions to maintain the GLONASS system, however the extent to which operation of GLONASS would be turned over to a non-Russian operator remains uncertain. President Yeltsin's decree also opened the door for foreign private companies to invest in GLONASS. The possibility exists that GLONASS could disappear if outside funding is not provided. By a financial joinder with the Europeans, GLONASS would become subject to a joint control and regulation.

C. European Union (EU), the European Space Agency (ESA): Galileo

In 1994 the European Commission, EUROCONTROL and the European Space Agency (ESA) agreed on the European Geostationary Navigation Overlay System (EGNOS). 8/ EGNOS is a multimodal satellite augmentation system. It is scheduled to become operational in the year 2002. Furthermore, the European Commission and ESA have proposed an independent GNSS system called Galileo to be operational in the year 2008. Galileo would cost approximately $2 billion. The Commission proposed that the "the system should be global from the start in order to allow full development of the global market." 9/ Galileo may be joined with GLONASS if the parties can reach a satisfactory agreement. In May and June, 1999 the ESA governing body decided to proceed with the Galileo project, and the EU Council of (Transport) Ministers similarly approved Galileo funding. The EU Council of Ministers will make the final decision. 10/ In time EGNOS would transit into and become incorporated into Galileo.

D. INMARSAT

The International Maritime Organization (IMO) took the initiative to establish the International Maritime Satellite Organization (Inmarsat) in order to provide satellite communications for shipping worldwide. Inmarsat's satellites provide navigation differential correction for GNSS through navigation equipment on Inmarsat-3 satellites. "The Inmarsat-3 navigation payloads will be used in both the U.S. Wide Area Augmentation System (WAAS) and the similar European Geostationary Overlay System. WAAS will not provide integrity data for the GLONASS satellite, but EGNOS specifications do provide for GLONASS integrity data. Although each service provider has different design criteria and service intentions, it is absolutely critical that all such systems should be interoperable and that user receivers will function equally well in any one of the satellite-based augmentation systems." 11/ INMARSAT was privatized in 1999. 12/ In the future INMARSAT will therefore appear more as a private provider than as a regulator.

III. INTERNATIONAL COORDINATION OF GNSS

A. Technical Coordination among GNSS Services

Both the U.S. GPS and GLONASS can be used consistently by the same user. GNSS receivers are built to receive and use both systems. It is the intention of the Europeans that Galileo be designed for use consistent with both GPS and

GLONASS. 13/ Consequently, all GNSS services are and will be interoperable.

B. Coordination and Standardization of Global Navigation and Positioning Services

Both GPS and GLONASS are dual use services. That is, they serve both military and civilian users. Consequently, the military and the civilian authorities constantly have to coordinate. Furthermore, the civilian GNSS users have to coordinate and establish GNSS standards and recommended practices in order that the many categories of users know the exact nature of the navigation and positioning service as it applies to a particular category. There needs to be standardization within each user category such as aviation and maritime users; and also among the various categories of users. In regard to augmented GNSS there needs to be standardization in order to establish a seamless web of navigation and positioning. Furthermore, to avoid gaps in the web, augmented GNSS needs to be established in the countries which have not made plans for augmented service 14/

1. International Aviation

The International Civil Aviation Organization (ICAO) gives high priority to GNSS standardization. ICAO is authorized by the 1944 Chicago Convention to oversee international civil aviation. Article 37 of the Convention creates ICAO as the competent body to establish international minimum Standards and Recommended Practices (SARPs) for navigation of aircraft by GPS. 15/ In Art. 37 ICAO member states agree to secure the highest degree of uniformity by adoption of the SARPs. Art. 38 provides that only if States find it impracticable to comply with SARPs may a state deviate from an ICAO-agreed SARP. Article 38 imposes an obligation to provide adequate international notice of such departures from international standards. Deviations from uniform standards are very serious matters because they undermine air safety. Article 44 defined the ICAO Council's role to "promote safety of flight in international air navigation;" that is, through development of uniform international standards and recommended practices. U.S. courts have held that only ICAO member states which adopt the ICAO standards and recommended practices are entitled to recognition and reciprocity with other member states under the Chicago Convention. 16/ At UNISPACE III Mr. Reddy correctly points out that ICAO member states give up air sovereignty by subscribing to uniform international standards and recommended practices. 17/

ICAO actively establishes GNSS standards and has approved standards and recommended practices. ICAO established its FANS (Future Air Navigation System) committee in 1983 18/ to consider new forms of navigation, including satellite navigation. The FANS committee proceeded through three Phases. The third phase is directed towards establishing an international satellite navigation system. The FANS committee developed ICAO's Communication Navigation and Surveillance (CNS) system on the basis of which ICAO's Air Traffic Management (ATM) system operates. This is a high technology system which makes use of both ground-based and satellite-based navigation systems. 19/ A seamless web, rather than divided airspace regions, is fundamental to the CSN/ATM system. Legal authority exists in Article 28 of the Chicago Convention in which ICAO Member states agree to adopt standard air navigation systems; accordingly ICAO proceeded to adopt a policy statement implementing the CSN/ATM system. SARPs that describe the CNS/ATM are highly technical and complex. It needs hardly be mentioned that multiplicity of GNSS systems adds to the complexity and difficulty of writing GNSS SARPs. In fact the need for uniformity of the ICAO CNS/ATM system provoked the following comment from Mr. Reddy at UNISPACE III:

> The entire concept of future aeronautical safety, regularity and efficiency of the system depends on the safety regularity and efficiency of the system, which could be seriously undermined if the contracting states do not comply with the standards provided in Annex 10. There is not sufficient legal basis for the ICAO in Articles 37 and 44, or Annex 10 of the Chicago Convention, to force the states to use the new system. A new institutional framework has, therefore, to be considered.

ICAO Standards for GNSS are stated in Annex 10 to the Chicago Convention. Annex 10 contemplates use of GNSS for Category I flight (primarily flights over oceans) beginning in the year 2000 and for Category II and III flights (including landing airplanes by use of augmented GNSS) in the range of years 2005 - 2015. ICAO is establishing standards not only for GNSS but also for augmentation to GNSS (including WAAS and LAAS). Development of standards and recommended practices for GPS currently is more advanced than for GLONASS. It is expected that the first GNSS SARPs will be published in Annex 10 in the year 2000. 20/ The new standards take time to develop. GNSS technology is quite different from past navigation technology. Mr. Iatsouk, secretary of the ICAO GNSS panel, states: 21/

> The geometry-dependent performance of GNSS, which varies by time and by a user position relative to space- and ground-based elements, cannot be monitored using traditional methods of measurement and integrity monitoring. New concepts and techniques need to be developed and introduced to ensure the high levels of performance necessary for GNSS-based low-visibility operations.

The prospect of combined use of several GNSS systems (GPS, GLONASS, Galileo, and GNSS augmentation systems) adds to the difficulty of creating uniformity and standardization. 22/

Finally, ICAO's 1998 Charter on Rights and Obligations of States Relating to GNSS Services re-emphasizes ICAO's important role in standardizing aviation. 23/

2. International Maritime

The International Maritime Organization (IMO) is the maritime counterpart to ICAO. Like ICAO it establishes international navigation standards. Article 16 of the Convention on the Intergovernmental Maritime Organization (now IMO) gave IMO the function of creating international maritime safety regulations. IMO Resolution A.815(19) on the Worldwide Radionavigation System was adopted on 23 November, 1995; and IMO Resolution A.860(2) establishing maritime policy for future GNSS systems, was adopted on 27 November 1997. IMO standards require GNSS on board ships beginning in the year 2000.

3. International Telecommunication

GNSS satellites communicate with GNSS receivers by use of radio frequencies. GNSS signals are rather weak. Radio interference can be a problem. Radio frequencies used by GPS, GLONASS, and proposed mobile satellite systems (MSS) are all close to each other although, so far, interference does not appear to have been a problem. It is a cause of future concern, however. Augmentation of GNSS also requires use of radio frequencies. GNSS use of several radio frequencies causes manufacturers to build more complex receivers that can receive multiple frequencies, thus increasing the price of multiple receivers.

Radio frequencies are regulated within the ITU at World Radiocommunication Conferences (WRC). In the past the two international organizations have coordinated the ITU radio regulations with ICAO SARPs regarding use of the radio frequency spectrum. The result has been radio spectrum sufficient for international civil aviation. However, the increase in satellite broadcasting has placed pressure on the spectrum allocated to aeronautical services, so that GNSS services now have to struggle to maintain adequate radio frequency spectrum. 24/

In the year 2000 WRC the ITU will specially focus on radio spectrum allocation to GNSS operations. The GNSS users' main concern is that the mobile satellite system (MSS) operators would like to use or share the use of the GNSS radio spectrum, thus endangering the reliability of the GNSS signals. Later WRCs may bring even greater pressure on the spectrum allocated for aeronautical services. Consequently, "the traditional role of the Radio Regulations in providing long-term stability in frequency allocation and management is changing." 25/

Government representatives to the WRC, are seeking to join forces to protect the GNSS radio spectrum at the year 2000 WRC. An example of such joinder of forces is the coordination taking place among Europeans in the European

Conference of Postal and Telecommunications Administrations (CEPT). There is a natural alliance between the Europeans in CEPT with other states that are concerned with preserving radio frequencies for GNSS. This joinder of interests includes the United States which also is anxious to preserve and protect its current GPS frequencies and will need additional frequencies to meet future needs. 26/ GLONASS has a natural concurrence of interest with the Europeans if GLONASS and Galileo are joined in some form..

4. European Coordination and Standardization.

The need for unified regulatory coordination among the standard-setting organizations is recognized by the European Union. It is believed that there has not been significant standardization of the surface transportation uses, although the greatest future GNSS growth will be in automobile navigation. Neither has there been significant standardization in land survey and agricultural or other uses of GNSS. 27/ Consequently, there is need for coordination of the standards that are being established for the various modes of users. The Galileo report states: "Consideration need to be given to whether there is a need... to set up a European GNSS Regulatory Co-ordinator" to consider standardization for all users. 28/ The Galileo report continues: " The standard developed could then be incorporated into regulation by the appropriate bodies(e.g. ICAO, IMO, ISO, CENELEC, IEC, EUROCONTROL and ETSI)." The Coordinator "would have an important role to promote the introduction of harmonized regulatory performance requirements across transport modes and between user groups." 29/ Therefore the Galileo report proposes establishment of " **a GNSS Regulatory Co-ordinator to develop mandatory standards to be implemented by all Member States to satisfy the objectives of the Trans-European Positioning and Navigation Network."** 30/

Subsequently, the draft final report of the EU ad-hoc Working Group on the Set-up of an Organizational Framework for GNSS, May 1999, recommended establishment of

> [A] **GNSS Regulatory Coordinator** to develop mandatory standards to be implemented by all Member States and to facilitate GNSS certification for safety sensitive and other critical applications. acknowledging the urgent requirement vis-a-vis EGNOS, reflecting the multi-modal nature of GNSS and respecting the competences of the Member States and the Community.

The EU report emphasized the need for EU regional standardization to be consistent with international GNSS standards, such as those of ICAO. 31/ However, "to avoid GNSS being subject to contradictory requirements from different domains, there is a need for a GNSS Regulatory Coordinator to harmonize requirements, coordinate the regulation of GNSS and provide support to regulators, at the national and European level." Such a regulator could either involve a group of individual experts, or it could be reviewed by an approved body such as the classification societies used to inspect and approve ships. Such regulatory oversight would require support by a centralized EU secretariat. In fact, the GNSS Regulatory Coordinator, the GNSS service operator (the vehicle company), as well as the political support (GNSS Administration) would all be concerned with GNSS standardization. 32/ The GNSS Regulatory Coordinator would interface with ICAO, IMO, European Aviation Safety Authority (EASA), EUROCONTROL, JAA, European Conference of Postal and Telecommunications Administrations (CEPT), and with the State regulators. In the short term the regulatory coordination can be performed by the established standardization groups supplemented with experts from the modes. 33/ In the long terms, a multimodal secretariat will be established. 34/

5. United States Coordination and Standardization

The 1996 White House policy statement announced the following U.S. policy guideline: "We will advocate the acceptance of GPS and US Government augmentations as **standards** for international use." 35/ (emphasis added).

Europe rejected the option to accept GPS standard positioning service as the basis for all civil applications of the future GNSS. Europe is proceeding to build its own GNSS system.

Secondly, the White House policy statement gave DOT the task: "In cooperation with the Departments of Commerce, Defense and State, to take the lead in promoting commercial applications of GPS technologies and the acceptance of GPS and U.S. Government augmentations as **standards** in domestic and international transportation systems." 36/ (Emphasis added) It is noteworthy that the DOT task is to achieve acceptance of GPS and U.S. augmentations as standards in all transportation systems, not only aviation. The inclusion of all GPS stakeholders within DOT policy consideration is clearer in the 1998 White House statement which declares that the two new civilian GPS signals " will significantly improve navigation, positioning and timing services to millions of users worldwide -- from backpackers and boaters to farmers and fishermen, from airline pilots to telecommunications providers, and from scientists to surveyors." 37/

Success of U.S. GPS standardization is linked to the outcome of the GNSS international standardization efforts, in which the U.S. actively participates, in ICAO, IMO, ITU and other international fora. It is also dependent on continued strong GPS and GPS augmentation build-up and modernization. For example, U.S. delay in upgrade of GPS by postponing launch of the improved technology Block 2F GPS satellites (with the two new civilian frequencies) would be a signal to the world and to other GNSS providers that the United States is reducing its insistence on providing the lead in GNSS, thus leaving room for others like Galileo and GLONASS to step in. 38/

Within the U.S. DOT, the Secretary of Transportation, pursuant to statutory authority in 18 USC 301, has the function to coordinate and standardize the varying GNSS uses by the aviation, maritime, highway, rail, and other civilian transportation uses. While the modal GNSS uses are divided into the FAA for aviation, the U.S. Coast Guard for maritime, the Federal Highway Administration for highways, the Federal Railroad Administration for trains and yet another separate administration for transportation of hazardous materials, all these administrations are under the supervision of the Secretary of Transportation. It becomes the Secretary's responsibility to seek transportation system-wide coordination and standardization. Furthermore, the President also has delegated to the Secretary of Transportation to coordinate civilian GNSS use by non-transportation users. 39/ Thus it is the Secretary's function to provide overall coordination among all the civilian users. At the highest level coordination takes places in the interagency GPS executive Board (IGEB). The DOT's POS/NAV Executive Committee provides" a management level body which can, on a continuing basis, facilitate coordination of navigation and positioning planning on a multimodal basis." 40/ This committee also has interagency participation. At the POS/NAV working group levels, working groups may be established to focus on particular standardization issues. The Federal Radionavigation Plan (FRP) is an important instrument for continued review and update of all issues, including standardization, because the FRP states the current U.S. radionavigation policies. The FRP is supported by established U.S. standardization policies and practices, which include " Promotion of national and international standardization of civil and military navigation aids." 41/ Preparation of the FRP is based on public hearings. All the U.S. agencies have to agree on the stated policies. The difficult FRP coordination process is the cause of the constant delays in issuing the FRP which is supposed to be updated and re-issued every two years.

V. Multifaceted GNSS

Standardization of GNSS could develop in either of two ways: General standards for all GNSS uses or separate standards for each use or mode. This is an important legal issue because the individual categories of users are beginning to establish rules for their singular use without consideration for how those rules would affect other users.

GNSS has been approved as the primary means of air navigation in several parts of the world.

The number of aircraft equipped with GNSS receivers is growing rapidly. While it is not yet possible to land airplanes with GNSS, the FAA is moving rapidly towards that goal with its augmented GPS. GPS can become the primary air navigation system by using WAAS and LAAS. Other countries are moving in the same direction. So it is not surprising that the aviation mode feels that GNSS is predominantly for aviation and that the GNSS standardization should primarily benefit airplanes. 42/

The International Maritime Organization is establishing international maritime navigation standards. By use of augmented GPS, ships now navigate solely by GPS. Law suits for negligent navigation using GPS are beginning to appear in the courts. Thus maritime users have a strong feeling that GNSS is for maritime navigation. 43/

However, the largest growth in GPS use is in the automotive area. There are about 650 Million automobiles in the world. By the year 2025 there will be 1 billion cars, most of them with a GPS receiver. So this mode of transportation justifies attention as international laws and regulations are established for GNSS. 44/

Railroad authorities, such as the U.S. Federal Railroad Administration, are very actively promoting the use of GPS to monitor the location and speed of trains in order to improve the safety and efficiency of the railroads. With wider availability of Differential GPS (DGPS) throughout the United States, the beneficial effect of GPS on this mode of transportation exists and justifies attention.

Availability of accurate land surveys through GPS is altering the surveying business, saving cost of construction material and of labor, and producing greater accuracy. 45/ The surveying business depends on accuracy, so that any aspect of GPS that will promote that is of interest to the surveyors. Land surveying affects the legal process of conveyancing.

Agriculture, the fishing industry, recreation interests, telecommunications, outer space navigation, all have an active stake in GPS laws and regulations. They do not want to be left out or overshadowed by any one mode. They want to be part of the community that formulates these laws and regulations.

While each mode may view GNSS as their issue, GNSS clearly is multifaceted. There is danger of conflict between differing standards for GNSS. The larger GNSS constituency, rather than each modal constituency, could more effectively achieve the general standardization. The maritime, rail, automotive users and the farmers, fishermen and surveyors would certainly be unhappy to be subject to aviation standards and recommended practices

The 1999 UNISPACE III conference appeared in agreement about the importance of standardizing all the uses of GNSS. Such standardization would best take place in an impartial intermodal forum. 46/ The alternative may be that we be left with piecemeal, conflicting GNSS standards. To support multifunctional standards, coordination of technical standards among the regulatory organizations (ICAO, IMO, and others) is desirable.

FOOTNOTES

1. DOD Space Policy Statement, 9 July, 1999. Effective and efficient utilization of space is of vital U.S. national interest. GPS contributes significantly to over-all effectiveness of DOD space utilization.

2. Termination of selective availability (SA) was announced in the 1996 U.S. Presidential Decision Document (PDD). The PDD announced that SA will be turned off at the latest in the year 2006. In prior years, the President will evaluate each year whether SA can be turned off.

3. On March 30, 1998 the Vice President announced that the United States would add two new civilian frequencies to GPS.

4. Convention on International Civil Aviation (hereinafter Chicago Convention), 15 UNTS 295, Annex 10. See 1996 Federal Radionavigation Plan (FRP) issued jointly by DOD and DOT.

5. FRP, supra note 4, 2-32, 4-15,16.

6. Supra n. 3.

7. Space News, March 18, 1999 at 4.

8. European Commission, Galileo, Involving Europe'a in a New Generation of Satellite Navigation Services, at 12, 9 February, 1999 (hereinafter cited as Galileo).

9. Id. at 7.

10. Space News, May 24, 1999, at 1. Satellite Today, 21 June 1999.

11. George V. Kinal, Satellite Navigation Developments at Inmarsat, Paper presented to 1997 Gothenburg Conference, at 2 (hereinafter cited as Kinal).

12. See, David Sagar, Restructuring of Inmarsat, UNISPACE III paper.

13. Galileo supra n. 8, at v.

14. Kinal, supra n.11, at 9.

15. Chicago Convention, supra N. 4, Article 37 states that ICAO "shall adopt and amend from time to time, as may be necessary, international standards and recommended practices and procedures dealing with: (a) ....navigation aids; (b) airports and landing areas; (c) rules of the air and air traffic control practices....(k) other matters concerned with the safety, regularity, and efficiency of air navigation as may from time to time appear appropriate."

16. See British Caledonian Airways v. Bond, 665 F. 2d 1153 (DC Cir. 1981).

17. Reddy, Application of Satellite Technology in Civil Aviation: Emerging Legal Issues, UNISPACE III paper, at 11.

18. At about the same time U.S. President Reagan promised, after KAL flight 007 perished in the Sea of Japan, to make GPS available for civilian navigation.

19. Reddy, supra n. 17; Jiefang Huang, ICAO Panel of Experts examining the many legal issues pertaining to GNSS, ICAO Journal, vol. 53, No 5.

20. Victor Iatsouk, Development of ICAO Standards for the global navigation satellite system is moving ahead, ICAO Journal, Vol. 53, at 8. Mr. Iatsouk is secretary of the ICAO GNSS panel.

21. Id.

22. Id.

23. ICAO Doc. A32-WP/24, Appendix A; ICAO Doc. C-CW/11026. In 1998 ICAO's announced long term objective is to prepare an international convention for the purpose of elaborating an appropriate long-term framework to govern the operation of GNSS. The ICAO Assembly instructed the ICAO Council to have such a legal framework for presentation to the next ICAO Assembly (in the year 2001) . As an interim measure, ICAO adopted a Charter on Rights and Obligations of States Relating to GNSS Services. The Charter is similar to the UNGA Resolution establishing Principles Relating to Remote Sensing of the Earth from Outer Space, except that the Charter applies only to aviation.. The ICAO Charter provides that: (1) Safety is the paramount purpose of GNSS. (2) There shall be non-discriminatory access to GNSS (including augmented GNSS) under uniform conditions. (4) GNSS shall be standardized in accordance with ICAO minimum standards and recommended services: (5) States shall work together towards the greatest possible uniformity of GNSS services. (6) User charges shall be non-discriminatory. (7) GNSS shall provide mutual assistance and cooperation to other states in planning and implementing GNSS. (8) GNSS providers shall respect interests of other states; and (9) the possibility of jointly-provided GNSS shall not be inhibited.

24. Robert Witzen, Aviation sector must escalate effort to preserve frequency spectrum in face of intense competition, ICAO Journal, Vol. 52, No 5, at 21. Also see Report of AIAA, UN/OOSA, CESA, CEAS, CASI Workshop, April, 1999.

25. Id.

26. Galileo supra n. 8, at 23.

27. Id. at Annex IV(b).

28. Id. at 23.

29. Id. at 24.

30. Id. at 25.

31. Id.

32. Id.

33. Id. at 21 - 25

34. Id.

35. PDD supra n. 2.

36. Id.

37. Vice President Gore supra n. 3

38. See Space News, Sept. 13, 1999 p. 5, interviews with Stephen Moran, White House; also with Col. James Armor, systems director for the GPS Joint Program Office, saying "We don't want to see a lot of other systems out there."

39. Supra n. 2

40. Federal Radionavigation Plan supra n.4 at 1-18.

41. Id. at 1-5.

42. Larsen, GNSS International Aviation Issues, 41 Coll. on the Law of Outer Space.

43. See IMO Resolution A.815(19) on Worldwide Radionavigation System, adopted on 23 November, 1995, and IMO Resolution A.860(20) on Maritime Policy for a Future Global Navigation Satellite System (GNSS), adopted on 27 November 1997.

44. Future automobiles will be equipped with GNSS. 1 billion motor vehicles are predicted for the year 2025, Washington Post, July 11, 1995 at A 16.

45. Larsen,, Use of Global Navigation Satellite System (GNSS) for Land Surveys: Legal Acceptability, 38 Coll. on the Law of Outer Space.

46. Proceedings of the Workshop on Space Law in the Twenty-first Century, UNISPACE III, July 1999. See recommendations of AIAA, UN/OOSA,CEAS,CASI Workshop, supra n. 24. Kinal, supra n. 11, at 9, emphasizes the importance of standardization of integrity data between adjacent service providers and of satellite-based augmentation systems; he suggests that such multimodal standardization will probably best take place in an impartial forum.