GNSS Soft Law Standards Are Developing in the United Nations

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Introduction

A. Need for International Coordination of Global Navigation Satellite Systems (GNSS)

GNSS is one of the great technological developments of our times. It is a rapidly burgeoning technology. The hard laws include the existing space law treaties [1] and the ITU legal regime,[2] as well as national enabling laws and regulations. [3] People used to think of GNSS as predominantly military. It is dual use; however, while military authorities continue to maintain significant control of GNSS, it is now mainly used by civilian users. GNSS is inherently international. The satellites exist in non-sovereign outer space. GNSS provides service not only in the country of the provider State but also around the globe. It is fragile because it depends on communication by use of radiofrequencies

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[1] Under the Outer Space Treaty, Art. VI, the GNSS provider State ("the appropriate State") assumes international responsibility for its GNSS activities in outer space. The State must assure that national activities comply with the Outer Space Treaty. When the State itself is the provider of GNSS (USA, Russia, or China) then the Party State must assure its own compliance. However, if a GNSS satellite is transferred to a non-governmental entity then the appropriate Party State would assure compliance through the licensing process. A State will not only issue a license, but must continuously supervise compliance with the Outer Space Treaty under its Article VI. Enforcement of compliance with the space law treaties rests with the member States .

[2] http://www.itu.int/about/basic-texts/indes.aspx. Radiofrequencies and orbital slots are registered with ITU.

[3] See Larsen, Regulation of Global Navigation and Positioning Services in the United States, in Jakhu, National Regulation of Space Activities (Springer 2010)

authorized and supervised by the International Telecommunication Union (ITU). Interference with the radio signals is very easy. Nevertheless we depend on GNSS for safe navigation of air planes, ships and a host of safety-related activities.

GNSS service is becoming increasingly complex, not only because of the technology, but also because there will soon be 4 global GNSS providers (GPS, GLONASS, Beidou and Galileo). Each of them have 25 – 30 satellites in mid-Earth orbit (MEO). They tend to provide the same kind of service. The GNSS users do nssot really care which GNSS service they use. They just need a reliable service. Being inherently international, GNSS services need to be regulated internationally. That is the subject of this paper. It describes present GNSS coordination activities in the United Nations and in UN-related fora. In contrast to hard law such as the Outer Space Treaty or national law, the present activities in the UN and UN-related fora tend to be soft law in the form of developing guidance and practices based on consensus of the experts who are involved in the operation and use of GNSS.

B. Case-in-Point

Global GNSS operations require the systems to be checked and monitored not only nationally but also globally. That presents a problem for the national GNSS providers because they need the cooperation of other nations for international monitoring. Thus GPS requires monitors in the Eastern hemisphere and GLONASS requires monitors in the Western atmosphere. The need for monitors on the earth's surface is particularly necessary for GNSS augmentations such as the US Wide Area Augmentation Service (WAAS), the European EGNOS and the Russian System of Differential Correction and Monitoring (SDCM). The Russian SDCM would serve the dual purpose of augmentation as well as monitoring and collecting performance data. [4]

International monitoring of GLONASS illustrates the problems of international GNSS coordination. It is an example of how soft law regulation may work better than hard law for international GNSS monitors.[5] Both SDCM and GDGPS report monitoring data to the International GNSS Service (IGS), a voluntary organization linked to the UN International Committee on GNSS (ICG). Russia approached the United States as well as 30 other States around the globe for permission to place SDCM monitors in

[4] Gibbons, GNSS Monitoring Stations Slide into U.S.-Russia Rift, InsideGNSS Magazine, http://www.insidegnss.com/node/4067

[5] Id. The SDCM monitors can monitor accuracy of both GLONASS and GPS satellites just like the Global Differential GPS System (GPGPS) monitor can monitor GLONASS.)

their countries. [6] Russia has not yet disclosed the exact scope of such monitoring. [7]

In the context of the Russia's problems in Ukraine the US Congress became concerned that Russian SDCM monitors located in the United States could be used to spy on the United States defense equipment. Therefore Congress adopted a provision in the 2014 Defense Authorization Act requiring the President to obtain certificates from the Defense Department and the CIA before giving permission for construction of Russian SCDM monitors within the United States. The law was signed by the US President and is in effect. In retaliation, Russia now requires any US GPS monitoring stations in Russia to be closed. [8] The over-all adverse effect on accuracy and consistency of global GNSS is evident.

These reciprocal curtailments of GNSS monitoring undermine the accuracy of GPS and GLONASS. Fortunately a fall-back monitoring service is available. It is not controlled by the provider States, and is thus less satisfactory. A voluntary IGS service, linked to the UN International Committee on GNSS, continues to operate around the globe monitoring both GLONAS and GPS accuracy performance. Thus the drastic effect of the US decision is ameliorated by the IGS according to its voluntary service and guidelines. [9]

The following discussion will focus on the very active and successful international GNSS coordination monitoring activity taking place within and related to United Nations GNSS activities. It will also show how its soft law guidelines and standards substitute for hard law rules and can be used to circumvent those hard law rules

I The UN International Committee on GNSS (ICG)

The 1999 UNISPACE III Resolution 54/68 recommended international coordination of GNSS. [10] Consequently the UN Committee for Peaceful Uses of Outer Space (COPUOS) was instrumental in organizing the special International Committee on GNSS (ICG) to promote international GNSS coordination and to be an international forum for discussion of GNSS issues. In 2004 UNGA Resolution 59/2 agreed to the establishment of such a

6 Id.
7 Id.
8 Id.
9 Id. See also Russians Consider IGS as Congress Moves to Limit GLONASS, Foreign GNSS Monitoring Stations on U.S. Soil. InsideGNSS Magazine, 12/18/2013, https://www.insidegnss.com/node/3830 "On April 1, 2013, the IGS launched its Real-Time Service (RTS) for GLONASS as a beta service with full operational capability expected by the end of the year. The RTS will provide free access to and free use of real-time GLONASS orbital ephemerides and clock products.
10 See Terms of Reference of the International Committee on Global Navigation Satellite Systems, UN Doc ICG/TOR/2013.

committee. In 2005 the ICG was established as an informal forum for the purposes of promoting international GNSS cooperation, coordination and interoperability on a voluntary basis, as follows:
The goal of the ICG is to promote the greater use of GNSS capabilities to support sustainable development and to promote new partnerships among Committee members and institutions, particularly taking into account the interests of developing nations. [11]
Afterwards the UN-based GNSS activities grew rapidly. In 2005 the ICG agreed to be administered within the UN Office of Outer Space Affairs (UNOOSA). Consequently UNOOSA administers the annual meetings of the ICG and of the related GNSS Providers' Forum. In its administrative role, UNOOSA also is a point of information about IGC activities. It informs other international conferences about ICG activities. [12] UNOOSA also provides GNSS education. In 2014 it issued its Education Curriculum on Space Law which includes a special module on GNSS. The curriculum is taught at the UN regional centers [13]
Each year the IGC reports to the COPUOS Scientific and Technical Subcommittee on progress made by the committee towards interoperability and compatibility. The Scope of these meetings include all the different GNSS activities from transportation, to agriculture. For example, the International Space Weather Initiative is one active area of interest. [14]
The informal IGC and its related international bodies are active sources of "soft" law regulation of GNSS. The member States and GNSS organizations tend to be represented in UN GNSS fora by technical experts rather than by lawyers. The technical experts are motivated toward practical problem-solving for GNSS development.
At its 2007 meeting in Bangalore, India, the IGC divided its work program among four working groups: Compatibility and Interoperability; Enhancement of Performance of GNSS Services; Information Dissemination and Capacity Building, Including GNSS education and Training; and

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11 UN Doc. A/AC.105/1059, 29 November 2013, at 1. Furthermore
Among the core missions of ICG are to encourage coordination among providers of global navigation satellite systems (GNSS) regional systems and augmentations, in order *to ensure greater compatibility, interoperability and transparency, and to promote the introduction of utilization* of those services and their future enhancements, including in the developing countries, through assistance, if necessary, with the integration into their infrastructure. ICG also serves to assist GNSS users with their development plans and applications by encouraging coordination and serving as a focal point for international information exchange. (Id. at 12)

12 http://www.unoosa.org/unoosa/en/SAP/gnss.html See also 10 Years of Achievement of the United Nations on Global Navigation Satellite Systems, New York (2011).

13 www.unoosa.org.

14 Id

Reference Frames, Timing and Applications. Ongoing work in the working groups includes the following: [15]

(1) Working Group on Compatibility and Interoperability

GNSS Interoperability is an important issue because of increasing availability of diverse GNSS providers. GPS is the most widely used GNSS system. GLONASS is second. Both have been in existence for a long time. GNSS users have become dependent on availability of GPS and their receivers are GPS-capable. Galileo and Beidou are gradually coming on line. The existing augmentations systems, WAAS, EGNOS, GAGAN and MSAS are all GPS capable. Increasingly receivers are interoperable, that is, they can access several of the GNSS systems

An important justification for multiple GNSS systems is that if one GNSS system is incapacitated then use of alternative systems is readily available. The added safety of multiple GNSS systems motivates countries to support international coordination.

The ICG Interoperability Working Group reported to the 2013 ICG regarding protection of the spectrum against radio signal interference, open service performance and monitoring the open services. Recommendations were also made to improve interoperability [16]

This working group most recently discussed coordination of satellite based augmentation systems at its meeting in New Delhi India, 5 -7 February, 2014. The GPS is augmented in the United States by the Wide Area Augmentation System (WAAS), in Europe by EGNOS, in Japan by the Multifunctional Satellite Augmentation System (MSAS) and in India by GAGAN. The other 3 GNSS systems (GLONAS, Galileo, and Beidou) are on line and require augmentation. The working group aims to establish standardized augmentation that will serve all four GNSS systems. The plan is to propose interoperable, standardized augmentation systems to the International Civil Aviation Organization's Radio Technical Commission for Aeronautics for approval. The goal is to establish interoperable augmentation for aviation by 2020. Ideally all the GNSS receivers should be able to receive signals from all the providers. However, some GNSS equipment operators may be reluctant to build receivers with access to all four GNSS systems due to the extra cost. They may plan for only two options. Because it is the latecomer, Galileo is concerned that it may be left out. Therefore the EU is considering mandating that Galileo be made one of the two available GNSS options within the EU. However, such a regulation may require international

[15] UNOOSA, 10 Years of Achievement of the United Nations Global Navigation Satellite Systems, supra n. 13 at 6.

[16] UN Doc. A/AC.105/1059, at 7.

consultations because that may be contrary to IGC recommendation for augmentation serving all the GNSS systems.[17]

(2) Working Group on the Enhancement of Performance of GNSS Services. [18]

The work of this group is closely related to that of the interoperability working group. The working group on enhancement of performance reported to the 2013 ICG, that it had made considerable progress on interoperability of all the GNSS services. Significantly, all the participants in this working group agreed "that a fully interoperable GNSS space service would result in significant benefits for future space users, as it would allow performance that no single system could provide on its own." The group will continue its work on interoperability.

(3) Working Group on Information Dissemination and Capacity Building, including GNSS Education and Training. [19]

This working group recognized the value of the UN regional centers for space science and technology as well as the special Global Navigation Satellite Systems Education Curriculum now taught at these centers.[20] The working group agreed that these programs were the most effective way to train people. The working group recommended that new GNSS educational opportunities be provided, particularly in the developing countries.

(4) Working Group on Reference Frames, Timing and Applications [21]

This Working group reported progress in establishing geodetic and timing references, particular related to the International Terrestrial Reference System and timing references to Coordinated Universal Time.
The ICG is having success in motivating countries to establish GNSS-based international references systems for land surveys. Previously countries had national reference systems that stopped at the border. That made cross-border surveys and planning difficult. GNSS is a basic ingredient of the World Geodetic System 1994 (WGS84) which is operationally based on a world that is assumed to be round, rather than flat, as previous surveys assumed. Therefore, GNSS land surveys are now more accurate. The WGS84 based on GNSS, is keyed to the International Terrestrial Reference System used by the International Association

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17 See de Selding, Europe Weighs Galileo-compatibility Mandate for Smartphones, Space News, April 21, 2914, at 5. The equipment manufacturers' plans and the EU reaction would also both be contrary to current plans in the Providers' Forum, section II(ii) infra.
18 A/AC.105/1059, at 7.
19 Id.
20 UN Doc.ST/SPACE/59.
21 UN Doc A/AC.105/1059

of Geodesy . National land surveys are being made to conform with the GNSS-based survey, for example the US land survey which, previous to GPS, used Washington DC as the original reference point, and assumed the Earth to be flat. This resulted in subsequent land surveys in the Western parts of the United States to be skewed by several feet. New surveys, using GPS as reference points, corrected the erroneous surveys [22]

(5) Conclusion on UN ICG Activities

Mandates of the working groups overlap somewhat. Occasionally several groups join on issue of common interest. Furthermore, the ICG works closely with its related GNSS interest groups, including the GNSS Providers Forum described immediately below. At its 2013 annual meeting the ICG agreed to meet regularly with these related entities as well as with associate members and observers, enabling these groups to report to the ICG on progress made, and to exchange views on GNSS issues. The ICG also encourages ICAO and IMO to participate in IGC discussions of GNSS navigation issues. [23]

II GNSS Providers Forum[24]

In 2007 the ICG established a voluntary but separate GNSS Providers Forum. The ICG and the GNSS Providers have much in common and can lean on each other to remedy weaknesses in their global systems. The objectives of the Providers Forum are to promote compatibility and interoperability among present and future GNSS providers. The Providers Forum is not intended to be a policymaking group; it is a discussion venue for the providers to coordinate agreed guidelines for the open GNSS services. It is a meeting place for providers to exchange information about their operative systems in order to avoid conflicts and to make them interoperable. The ICG has delegated to the Forum those issues on which the ICG needs detailed GNSS information. All four GNSS Providers as well as the augmentation services participate in the Providers Forum. The UN Office of Outer Space Affairs (UNOOSA) serves as the secretariat for the Providers Forum. The Forum meets at least once a year but can meet more often as need arises. [25] Although the Providers Forum is only consultative, the GNSS industry participants are rather freewheeling and stray easily into formulation of voluntary guidance principles which may be considered as soft law.
In 2008 the GNSS providers, including the augmentation providers, agreed in the Providers Forum that all GNSS signals and services should be compatible

[22] Id.
[23] UN Doc.A/AC.105/1059, at 4-5.
[24] See Terms of Reference of the Providers' Forum UN. Doc. ICG/PF/TOR/2013.
[25] UN 10 Year Review of GNSS, supra at n. 13.

with each other. It was further agreed that all the open GNSS signal and systems should be interoperable to provide the best possible service to all GNSS users. Thus the Forum decided to focus on interoperability[26] and compatibility. [27]

The original members of the Providers Forum were China, India, Japan, Russia, the United States and the European Union. Other States have also become members. Each time it meets, the Forum selects a chairperson by consensus. The Forum reports its actions to the ICG. The Provider's Forum is primarily concerned with improving their open signals. For that purpose they agreed to coordinate in the following areas: [28]

(i) Compatibility and interoperability of GNSS systems: The Providers Forum exchanges information about their plans and operations including the policies and procedures governing their services in accordance with the original work plan established at the initial meeting of the Providers Forum in 2007 in Bangalore, India. In brief, the providers agree to support the discussions of the ICG on compatibility and interoperability, but from the Providers' point of view. Each provider has agreed to prepare individual reports on their particular service and their policies and procedures for reaching their objectives. These reports are being

[26] Id, Interoperability refers to the ability of global and regional navigation satellite systems and augmentations and the services they provide to be used together to provide better capabilities at the user level than would be achieved by relying solely on the open signals of one system:
(a) Interoperability allows navigation with signals from different systems with minimal additional receiver cost or complexity;
(b) Multiple constellations broadcasting interoperable open signals will result in improved observed geometry, increasing end-user accuracy everywhere and improving service availability in environments where satellite visibility is often obscured;
(c) Geodetic reference frames realization and system time steering standards should adhere to existing international standards to the maximum extent practical;
(d) Additional solutions to improve interoperability should be encouraged.

[27] Id. Compatibility refers to the ability of global and regional navigation satellite systems and augmentations to be used separately or together without causing unacceptable interference and/or other harm to an individual system and/or service: The International Telecommunication Union provides a framework for discussions on radiofrequency compatibility. Radiofrequency compatibility should involve thorough consideration of detailed technical factors including effects on receiver noise floor and cross-correlation between interfering and desired signals; Compatibility should also respect spectral separation between each system's authorized service signals and other systems' signals. Recognizing that some signal overlap may be unavoidable, discussions among providers concerned will establish the framework for determining a mutually acceptable solution.

[28] UN Doc A/AC.105/901; that document was updated in 2008, ICG/PF/WP/DEC2008.

consolidated and maintained by the ICG Executive Secretariat for use in the Providers Forum. [29]

(ii) Open service information dissemination: Each provider agrees to complete transparency of its systems and signals in order to enable manufacturers of receivers to build receivers that do not discriminate among the GNSS services. Thus the Provider's Forum plans to develop a template for sharing and disseminating information about all provider signals and specifications.[30]

(iii) Service performance monitoring: The providers are developing joint plans for monitoring performance of their open signals for the purpose of improving performance of timing and positioning accuracy and the availability of service. This is consonant with the GNSS providers policy of transparency in providing the open services.[31]

(iv) Spectrum protection: In detection of interference and mitigation of radio interference, providers agree to use domestic rules and regulations to protect the GNSS radiofrequencies. Their spectrum protection activities may include resort to the ITU For better spectrum protection. The providers will also support the IGC working groups on compatibility and interoperability. [32]

The 2013 meeting of the Providers Forum was held in conjunction with the regular ICG meeting in Dubai, thereby illustrating the close relationship between the two groups. Noticeably, the working groups of the ICG and the Providers Forum work on similar and related issues. The Providers Forum reports to the IGC and its working groups. Clearly the Providers Forum is valuable support for the IGC.

III. The International GNSS Service (IGS)

Under the auspices of the International GNSS Committee the IGS participants have established a voluntary monitoring system for all the GNSS systems. IGS includes more than 200 government and private institutional bodies. The participants maintain coordinating references points and monitoring stations including an archive, that track GNSS activities all over the world. In order to enable all the four main providers as well as GNSS augmentation providers to operate accurately, the participants have established a voluntary international network of reference and monitoring stations. The network currently includes 368 stations around the globe, which track the services of the GNSS providers, such as GPS and GLONASS,

[29] Id.
[30] Id.
[31] Id.
[32] Id.

and check the quality of GNSS receivers and other GNSS products. The accumulated information is essential for navigation and positioning safety and is also a check on GNSS signal quality. NASA's Jet Propulsion Laboratory in California hosts the international GNSS Service. The IGS system will support all the GNSS services, including GLONASS. [33] In 2013 a special checking and monitoring service was arranged for GLONASS.[34] The voluntary IGS "is fully committed to expand to a true multi-GNSS service."[35]
IGS Multi-GNSS Project(MGEX):[36] The IGS is currently conducting its Multi-GNSS Experiment (MGEX) for the purpose of transitioning the IGC into a more permanent global tracking and testing organization to standardize and test all aspects of GNSS. Signal standardizing, testing, and monitoring is particularly important at this point in time when new GNSS systems, Galileo, Beidou, Gagan , and other systems (including space-based augmentation systems), are coming on line and the existing systems, GPS and GLONASS, are being updated. [37]
Based on its 20 year experience in checking, monitoring and archiving GNSS performance data, the IGS has now decided to establish a comprehensive all-inclusive international GNSS service. On that basis it has started the Multi-GNSS Experiment (MGEX) which is being coordinated by its Multi-GNSS working group. [38] This kind of cooperation among the GNSS services is necessary in order to fully realize and enjoy the advantages of all GNSS systems supplementing and supporting each other in building the most dependable international positioning navigation and timing service. The multiplicity of GNSS signals leads to less ambiguity from the signals. Furthermore "the simple increase in the number of available satellites not only enhances navigation applications, but also offers an increased number of

[33] See Russians Consider IGS as Congress Moves to Limit GLONASS, foreign GNSS Monitoring Stations on U.S. Soil, INSIDE GNSS, 12.18.13, supra at n. 10

[34] Id, On April 1, 2013 the IGS launched its Real Time Service (RTS) for GLONASS as a beta service with full operational capability expected by the end of [2013]. The RTS will provide free access to and free use of real time GLONASS orbital ephemerides and clock products. It is possible to use the real-time GLONASS observations collected by the IGS to improve instantaneous estimates of the onboard clock effect.

[35] See Montenbruck, Seifenberger, Khachigan, Weber, Langley, Mervart, and Hugentobler, 'IGS-MGEX Preparing the Ground for Multi-Constellation GNSS Science, www.insideGNSS.com, January February 2014. This paper was presented at the 4th International Colloquium on Scientific and Fundamental Aspects of the Galileo System, Prague, Dec 4 – 6 ,2013.See sldo http://igs.org/mgex

[36] Id.

[37] Id.

[38] It was thus the obvious alternative for Russian GLONASS to resort to when GLONASS was unable to build its own GLONASS monitoring stations in the United States. Forster, U.S. Sanctions, Russian Response Fraying Once-strong Space Ties, Space News, May 19, 2014, at 1.

signals for space weather applications that employ occultation techniques and ray tracing of the neutral atmosphere and ionosphere." [39]
Currently the main objective of both the IGC and of the IGS is to solidify the Providers Forum and its ancillary bodies thus promoting interoperability as well as the ability of the four GNSS systems to supplement each other and to back each other up when other GNSS systems fail. It is suggested that ultimately the IGC should establish a world standard which can be used to monitor all GNSS systems and which can become the common standard for all GNSS operations. Such a standard, even if voluntary, could be as important as the common performance standards maintained by the International Civil Aviation Organization (ICAO) for aviation operations.[40]
Within the framework of the IGS, the GMEX working plan is to create a comprehensive GNSS that will [41]

- expand tracking
- include more GNSS constellations
- develop a multi-GNSS multi signal differential code
- standardize GNSS antennas, and establish common standards for orbit and clock products.
- develop quality control tools

The GMEX plans illustrate that the GNSS industry needs standards to achieve maximum accuracy, safety and efficiency. It is interesting that the standardization initiatives originate directly from participants who tend to represent industry rather than government. They tend to be more technical rather than political. The initiatives constitute guidance leading to international technical uniformity. This kind of regulation, when observed internationally by the GNSS industry can constitute soft international GNSS law.

IV. Conclusion

The case-in-point about GLONASS illustrates the need for international checking and monitoring of GNSS. GLONASS sought and was denied

[39] Montenbruck, supra n. 36, at 43.

[40] Id. It is with the objective of becoming a multi-GNSS service that the IGS is initiating its MGEX experiment. The project is coordinated by an IGS working group. The project is informational and educational. It has established a GNSS network for the purpose of tracking and is additional to independent tracking and monitoring systems maintained by the GNSS providers themselves. The need for tracking and monitoring arises not only from the increasing multitude of GNSS operators and satellites, but from the individual GNSS systems themselves which are becoming more complex. For example both GPS and GLONASS are adding a frequency for search and rescue services. Initially the new signals will be ambiguous, but through testing and monitoring these signals will become more accurate.

[41] Id.

monitoring stations in the United States. The participants in the UN International Committee on GNSS and its closely related GNSS Providers Forum and International GNSS Service are sensitive to the needs for international monitoring. They are motivated to provide international checking and monitoring of global GNSS. Thus they collect and analyze data on the various GNSS systems, including GLONASS. In doing so they are establishing international guidance that comes close to being standards. They are establishing soft international soft law on GNSS. The States can establish 'hard' law such as the US statutes preventing GLONASS monitoring stations in the United States; of course the soft law has to accommodate the hard law. But the GNSS experience shows that the soft law, established in the United Nations can accommodate the hard law. The soft law approach is flexible and can circumvent and accomplish what the hard law cannot accomplish.

The United Nations fora are uniquely suited to formulate soft law GNSS standards. Whether those standards can eventually approach the mandatory standards formulated by ICAO for aviation remains to be seen. Military acceptance of civilian coordination and monitoring in the civilian ICG remains yet another issue. The Military has grown to tolerate civilian coordination of non-sovereign airspace by ICAO, including mandatory standards. The civilian standards apply only to civilian aviation but the military accepts them. A similar military attitude might be adopted for civilian soft law rules for international GNSS.