THE GLOBAL NAVIGATION SATELLITE SYSTEM (GNSS) AND THE EUROPEAN GALILEO PROGRAMME: LEGAL ISSUES

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"..."terras licet" inquit "et undas obstruat:et caelum certe patet; ibimus illac: omnia possideat, non possidet aera Minos"dixit et ignotas animum dimittit in artes naturamque novat..."*

Ovid, Metamorphoses, book VIII 185-189

* "... "Though he may block escape by land and water",he said, "yet the sky is open, and by that way I will go.Though Minos rules over all, it does not rule the air." So saying, he saids his mind at work upon unknown arts, and changes the laws of nature..."

ABSTRACT

The Global Navigation Satellite System (GNSS) is the main element of the CNS/ATM system elaborated by the International Civil Aviation Organization (ICAO).

The US GPS and Russian GLONASS are the two existing systems. Both of them were created by the military.

Europe is currently developing a civil navigation satellite system: Galileo.

This thesis will present some legal issues of the GNSS discussed in the framework of ICAO: sovereignty of States, universal accessibility, continuity and quality of the service, cost recovery and financing, certification and liability.

It will also present some legal issues due to the creation of the European Galileo program. The financing, organizational framework, certification and liability will be examined.

Finally, ICAO's Charter on the Rights and Obligations of States Relating to GNSS Services will be considered.

RÉSUMÉ

Le Système Global de Navigation par Satellites (GNSS) constitue la pierre d'angle du système CNS/ATM élaboré par l'organisation de l'aviation civile internationale (OACI).

A l'heure actuelle deux systemes d'origine militaire sont opérationnels: le système americain GPS et le système russe GLONASS.

L'Europe, à son tour, a pris récemment la décision de lancer un système civil de navigation par satellites, dénommé Galileo.

Cette thèse traitera de quelques problèmes de droit que pose le GNSS et les réponses qu'y apporte l'OACI.

Seront envisagés: la souveraineté des Etats, l'accès universel au service, la continuité et qualité du service, le financement, l'homologation et enfin la responsabilité.

Cette thèse exposera par ailleurs les problèmes juridiques que rencontre la conception du système européen Galileo. Le financement, le cadre institutionnel ainsi que l'homologation et la responsabilité seront traités.

Enfin il convient d'étudier la Résolution élaborée par l'OACI à propos du GNSS et connue sous le nom de « Charter on the Rights and Obligation of States Relating to GNSS Services ».

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TABLE OF ABBREVIATIONS

ACAC	Arab Civil Aviation Commission
ADS	Automatic Dependant Surveillance
AFCAC	African Civil Aviation Commission
AMSS	Aeronautical Mobile Satellite Services
ARTEMIS	ESA's Advanced relay and Technology Mission Satellite
ARTES	Advanced Research Telecommunications Systems
ATC	Air Traffic Control
ATFM	Air Traffic Flow Management
ATM	Air Traffic Management
ATN	Aeronautical Telecommunications Network
ATS	Air Traffic Service
BNSC	British National Space Center
C/A-Code	Coarse/Acquisition Code
CAS	Controlled Access Service
CHA	Channel of High Accuracy
CNES	Centre National d'Etudes Spatiales
CNS/ATM	Communications, Navigation, Surveillance/Air Traffic Management
COCESNA	Central American Corporation for Air Navigation Services
CSA	Channel of Standard Accuracy
CTS	Command Tracking Station
DGPS	Differential GPS
DME	Distance Measuring Equipment
DoD	Department of Defense
DoT	Department of Transport
EBRD	European Bank for Reconstruction and Development
ECAC	European Civil Aviation Conference
EGNOS	European Geostationary Navigation Overlay System
EIB	European Investment Bank
ESA	European Space Agency
EU	European Union
EUROCONTROL	European Organisation for the safety of Air Navigation
FOC	Full Operational Capability
FAA	Federal Aviation Administration
FANS	Future Air Navigation System
FMS	Flight Management System
FTCA	Federal Tort Claim Act
GAs	Ground Antennas

GEO	Geostationary Earth Orbit
GES	Ground Earth Station
GLONASS	Global Orbiting Navigation Satellite System
GNSS	Global Navigation Satellite System
GNSSP	Global Navigation satellite System Panel
GPS	Global Positioning System
HF	High Frequency
IATA	International Air Transport Association
ICAO	International Civil Aviation Organization
IFR	Instrument Flight Rules
ILS	Instrument Landing System
IRS	Inertial Reference System
IMO	International Maritime Organization
INMARSAT	International Maritime Satellite Organization
INS	Inertial Navigation System
IOC	Initial Operational Capability
ITU	International Telecommunication Union
JAA	Joint Aviation Authorities
JCBA	Japan Civil Aviation Bureau
IGSO	Inclined Geosynchronous Orbit
LACAC	Latin American Civil Aviation Commission
L1	Link 1
L2	Link 2
LORAN	Long-Range Aids to Navigation
LTEP	The Panel of Legal and Technical Experts on the Establishment of a Legal Framework with regard to GNSS
MEO	Medium Earth Orbit
MHz	Megahertz
MLS	Microwave Landing System
MSs	Monitor Stations
MTSAT	Multi-Function Transport SATellite
MSAS	MTSAT Satellite-based Augmentation System
NDB	Non Directional Beacon
OAS	Open Access Service
P-Code	Precision Code
PMB	Programme Management Board
PPP	Public Private Partnership
PPS	Precise Positioning Service
RAIM	Receiver Autonomous Integrity Monitoring
RNP	Required Navigation Performance
SA	Selective Availability
SARPs	Standards and Recommended Practices
SCC	System Control Center
SITA	Société internationale de Télécommunications aéronautiques
SPS	Standard Positioning Service
SSR	Secondary Surveillance Radar

TEN	Trans-European Network
TT/C	Tracking, Telemetry and Command
UHF	Ultra High Frequency
VHF	Very High Frequency
VOR	VHF Omni-directional Range
WAAS	Wide Area Augmentation System

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Introduction

History is replete with travelers using the stars to chart their destination.

Whoever these travelers were and whatever their reasons for travel, they used the sky as a guide, as an aid.

At the dawn of the new millennium, people are still using the sky to chart their course. For centuries the sky was considered inaccessible to man. Today mankind works with the sky. Mankind is in the sky. Mankind flies.

The development of aviation during the last century has been rapid. It is now common to fly over continents and oceans.

The need for people on the ground, on oceans, and now in the sky, to know their position and to guide themselves to their destination still exists.

The sky has unfathomable resources. Man uses these resources more and more. Mankind mastered flying in the sky. He is now beginning to work with resources in outer space. Mankind even leaves prints of his passage in outer space which will help him on Earth. Mankind leaves satellites.

As the stars helped man for centuries, now satellites will help man to chart his position and to guide himself towards his destination.

Man now benefits from positioning and navigation tools offered by satellites.

The Global Navigation Satellite System[1] is a major technical innovation.

[1] Hereinafter GNSS.

The number of applications done with GNSS is increasing every day. The aviation sector is not the only user of this new technology and is becoming dwarfed by every increasing number of other users.

However, in the aviation sector, GNSS is an extremely useful new means of navigation.

Even if major technological improvements were done to ground-based aids, the shortcomings and limitations of these aids are evident: the ground-based aids are often inaccurate. They are dependant on weather conditions and, moreover, they have a limited geographical coverage.

The advantages of navigation by satellites are therefore unquestionable.

These advantages justify the examination of the GNSS.

The International Civil Aviation Organization[2] included the GNSS in its CNS/ATM[3] system. GNSS is actually the essential part of that system.

It is, therefore, enlightening to examine this system.

Chapter I will deal with this issue by providing a brief history of the CNS/ATM system, describing this system, its components (communications, navigation, surveillance and air traffic management) and benefits. It will conclude by insisting on the need of a global dimension to that system.

Chapter II will provide generalities about GNSS.

The GNSS concept will be defined as well as the four GNSS parameters: accuracy, reliability, integrity and availability.

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[2] Hereinafter ICAO.

[3] Communication, Navigation, Surveillance/Air Traffic Management. Hereinafter CNS/ATM.

The applications from aviation to leisure-related activities will be stressed to show the importance of GNSS in many sectors.

A description of the satellite navigation systems will be given in Chapter III.

The US Global Positioning System[4], the Russian Global Orbiting Navigation Satellite System[5] are the two existing satellite systems. Both of them are, for the moment, military systems.

The American system is actually much more successful than its Russian competitor for several reasons. But, even if GPS works very well, some augmentations systems are needed to improve the accuracy of the system. This is for several reasons, one of them being the Selective Availability put into place by the US Government.

The Navigation Augmentation Systems will be also examined.

If, until recently, the American GPS and the Russian GLONASS were the only navigation satellite systems to exist, a third actor is appearing: Europe.

The European Union[6] recently made the decision to create an European navigation satellite system.

This project currently developing is called Galileo.

> "The technology is not 'self-implementing' – it works only within the social context and for its useful operation requires the human element and creates social relations among different entities – physical persons, corporate bodies and States. Such social relations are marked by

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[4] Hereinafter GPS.

[5] Hereinafter GLONASS.

[6] Hereinafter EU.

conflicting interests in the society and require regulation by law to maintain a balance of such conflicting interests and to harmonize the social relations created by the technology."[7]

Chapter IV will address some of the legal issues raised by GNSS.

Specific reference needed will deal with some of the legal issues which were raised and examined by ICAO. Legal issues addressed are: the sovereignty, authority and responsibility of States, universal accessibility without discrimination, continuity and quality of the service, cost recovery and financing, certification and liability of GNSS.

The next part will concentrate on legal issues appearing with the creation of the European Galileo program, the financing and the organizational structure of Galileo.

This thesis will also explain briefly the view held by the European Commission on certification and liability issues.

The last Chapter will focus on the Charter on the Rights and Obligations of States Relating to GNSS Services[8] adopted by ICAO's Assembly. This "Charter" establishes only well-established guidelines and principles for future reference.

This resolution does not create anything and can only be considered as the first step to a legal framework which would deal specifically with GNSS and would take the form of a Convention.

[7]M. Milde, "Institutional and Legal Problems of the Global Navigation Satellite System (GNSS) - Solutions in Search of a Problem?" (Casebook of Public International Air Law, McGill University, 1997) at 314.

[8] See *Charter on the Rights and Obligations of States Relating to GNSS Services*, 1998, ICAO Resolution A32-12 [hereinafter *Charter*].

Chapter I. The GNSS, new navigation technology of the CNS/ATM system

Before examining the GNSS concept, the current existing navigation satellite systems, and, finally the legal issues of the GNSS and of the European program Galileo, it is important to note that the Global Navigation Satellite System is the essential part of the "CNS/ATM system" created by ICAO.

The navigation system of the "CNS/ATM system" will be based on the concept of Required Navigation Performance[9], which will be met by the implementation of the GNSS.

A. A brief history of the CNS/ATM system

In the early eighties ICAO realized that the existing air navigation systems were becoming less efficient in terms of reliability, coverage and accuracy.

There was an urgent need to update them in order to meet the 21st Century challenge: a tremendous growth of the air traffic.

The need was not only to improve the navigation system but also to improve the Communications and Surveillance systems for a better management of air traffic; these 3 systems being interconnected.

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[9] Hereinafter RNP.

In 1983 ICAO established a special Committee: the Future Air Navigation Systems (FANS) Committee, to identify the new techniques developed at that time and to make recommendations in terms of communications, navigation and surveillance in order to improve air traffic management.

Five years later this Committee (FANS Phase I) identified the necessity to develop some new systems to overcome the limitations of the existing systems.
The use of satellites was identified as the means to enhance communications, navigation as well as surveillance performances for aircraft navigation.
Satellite technology, consequently, was identified as the means to develop a global air traffic management.

Another Committee, the Special Committee for Monitoring and Co-ordination of Development and Transition Planning for the Future Air Navigation System (FANS Phase II)[10] was created by ICAO in July 1989 to assure the international coordination between the actors concerned and to create a Transition Plan.

The concept of this new system -the FANS Concept- was endorsed in 1991 by the states and international organizations at the 10th Air Navigation Conference was approved by ICAO Council and was endorsed by the 29th Session of the Assembly in 1992 as the so-called "ICAO CNS/ATM system."

[10] FANS Phase II completed its work in 1993 by recognizing that the implementation of new technologies and expected benefits would evolve over a period of time.

This new system involves, as previously described, the use of satellites technologies.

Its purpose is to meet the navigation needs, to create a global system with a seamless coverage[11] and to overcome the limitations of the present systems.

These limitations include:

a) The limitation of the ground-based system to the line-of-sight technology[12],

b) The difficulty to implement ground-based systems on some parts of the earth because of the difficulty of certain siting positions,

c) The failings of the voice transmissions which do not permit high rates of information transmission and

d) The lack of automation.

The use of satellites technologies will permit using a few satellites (instead of thousands of ground-based facilities) to obtain extended arcs of coverage without having to face the difficulties inherent to the use of ground-based facilities.

Moreover, the digital technologies and the automation inherent to the use of satellites technologies will offer easier, better and more reliable data transmissions.

In 1993 the first plan of action, the Global Co-coordinated Plan for transition to ICAO CNS/ATM systems was completed followed by a progressive development of SARPs[13],

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[11] Called also "single continuum of airspace." A. Kotaite, "ICAO Ushers in a Revolution in Global Navigation Technology" (1994) XIX, Part I *Annals of Air and Space Law* 337, at 338.

[12] The ground-based navigation aids can only be used over a limited portion of the surface of the earth not blocked by a high terrain or the horizon. These systems were created in the forties and need lots of ground-based relay stations and lots of ATC units.

[13] Concerning the communications systems and the air navigation aids, International standards and Recommended Practices (SARPs) are adopted from time to time by ICAO following the Article 37 of the Convention on International Civil Aviation.

PANS[14] and guidance material as well as the CNS/ATM Regional Planning and Implementation.

In 1996 ICAO Council urged the ICAO Secretariat to revise the Plan

> as a "living document" comprising technical, operational, economic, financial, legal and institutional elements, offering practical guidance and advice to regional planning groups and States on implementation and funding strategies, which should include technical co-operation aspects[15]

to guide the international aviation community in the implementation of the CNS/ATM systems.

That was done in the Global Air Navigation Plan for CNS/ATM Systems[16], which was accepted in 1998 by the Council of ICAO.

See *Convention on International Civil Aviation*, 7 December 1944, ICAO Doc.7300/6, 15 U.N.T.S. 295, art.37 [hereinafter *Chicago Convention*].
The authors have several opinions about the validity of SARPs: for Bin Cheng, ICAO Council has a quasi-legislative function because a State does not have to apply the International Standards if it does not want. International Standards are not binding. For this author, the Article 38 of the Chicago Convention is proof of his theory. However he maintains the existence of an indirect legal duty to comply with them in one case.
For Buergenthal, there is no obligation to comply with the international standards except the international standards adopted in relation to Art12, 29 and 34, 33 of the Chicago Convention.
See B.D.K. Henaku, *The Law on Global Air Navigation by Satellite, A Legal Analysis of the ICAO CNS/ATM System* (AST,1998) 32, at 33.

[14]The Art 37 (a) of the Chicago Convention allows ICAO to adopt International Standards and Recommended Practices (SARPs) but also to approve procedures (PANS) dealing with communications systems and air navigation aids. See *Chicago Convention, supra* note 13, art.37.

[15] See *Executive Summary of the Global Plan*, World-wide CNS/ATM Systems Implementation Conference, Rio de Janeiro, 11-15 May 1998, at 3 [hereinafter *Executive Summary of the Global Plan, Rio Conference*].

[16] The Global Plan describes an ATM operational concept and is divided into two parts, volume I guides further developments of the operational requirements and planning criteria of the regional air navigation

In 1998 a major event in the matter occurred: the first-ever World-wide CNS/ATM Systems Implementation Conference convened by ICAO was held in Rio de Janeiro, 11 to 15 May 1998[17].

At the official opening of the Conference, Mr. Jack Howell, Director of the Air Navigation Bureau of the ICAO, underlined the need of a real improvement in the matter by saying that "the supporting air navigation infrastructure of our aviation system is reaching its limits and is becoming increasingly strained in terms of safety, regularity and efficiency."[18]

The two main issues of the Conference were the financing mechanisms and the institutional frameworks required to implement the new systems.

The technical co-operation, as well as the legal and the training aspects of the systems implementation were also discussed.

The results of the work of the Panel of Legal Experts on the Establishment of a Legal Framework with regard to GNSS[19] were presented to the conference.

Amongst them a draft Charter on the Rights and obligations of States Relating to GNSS Services was presented.

This Charter was officially adopted in 1998.[20]

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plans, volume II forms the framework to guide the implementation of CNS/ATM systems on a global basis. See *ibid.*, at 5.

[17] Around 800 representatives coming from 123 contracting states attended to the Conference as well as 59 aviation, financial and industry organizations.
See "ICAO world-wide conference produces strong recommendations for financing and managing CNS/ATM systems implementation» Press release PIO 3/89 http://www.icao.int/allpirg/press.htm

[18] He even used the strong term "crisis".
See Address by the Director of the Air Navigation Bureau of the International Civil Aviation Organization (ICAO) Mr. Jack Howell at the Official Opening of the World-wide CNS/ATM Systems Implementation Conference (Rio de Janeiro, 11 May 1998), at 1.

[19] Hereinafter LTEP. The LTEP was created by ICAO Council in 1995.

B. Description, elements and benefits of the CNS/ATM systems

ICAO concept of the CNS systems takes for granted the existing CNS technologies and improves them. It combines the use of satellites technologies with traditional systems to achieve a better ATM.

1. Description of the CNS/ATM systems

The CNS/ATM systems are defined as: "Communications, navigation, surveillance systems, employing digital technologies, including satellite systems together with various levels of automation, applied in support of a seamless global air traffic management system."[21]

Such a global and seamless ATM enables the aircraft operators to meet their departure and arrival planned times as well as to adhere to their preferred flight profiles without compromising the safety requirements.

The use of satellites technology improves undoubtedly Air Traffic Management.

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[20] See *Charter, supra* note 8. The Charter will be examined further in the thesis, see Chapter V below.

[21] See *Executive Summary of the Global Plan, Rio Conference, supra* note 15.

2. Elements and benefits of the CNS/ATM systems

The major components of the new system are: communications, navigation and surveillance.

(i) Communications

The need for the crew on board an aircraft to communicate with other aircraft and services on the ground is obvious in terms of safety and efficiency of civil aviation.

The communications element involves both information and voice links between the aircrafts and the ground.

In the new system, communications will increasingly take place via digital data link. This type of link will lead to a high information transfer rate, will increase integrity and reliability of the information transferred and will improve the frequency spectrum utilization as well as the interface with the automated system.

Satellite data and voice communications capable of global coverage are introduced via the Aeronautical Telecommunications Network[22] which will integrate several means of communications such as the Airborne Mobile Satellite System[23], the Very High Frequency [24] data link and the Secondary Surveillance Radar [25]Mode S [26]data link.

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[22] Hereinafter ATN.

[23] Hereinafter AMSS.

[24] Hereinafter VHF.

[25] Hereinafter SSR.

Finally, the use of voice communications HF will disappear.[27]

Satellite communications using the AMSS frequencies will be useful for air circulation services, the control of the aeronautical operation, the administrative communications of the airlines and, finally, the passengers' communications.

Some benefits[28] of such a new communications system will be:

a) A more direct and efficient air-ground linkages: the aeronautical automatized systems used in the aircrafts and on the ground will be interconnected.

b) An improvement of the information's handling and

c) A reduction of communications errors, channel congestion and communications errors

(ii) Navigation

Navigation refers to the ability to determine a position and the course to follow in order to arrive at a specific destination.

Navigation will be improved with the introduction of area navigation (RNAV) capabilities, along with a worldwide system determining the position and the time: the GNSS provides a worldwide navigation coverage by providing accurate navigation signals all around the earth.

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[26] The SSR mode S is often used for surveillance in high density airspace but can also transmit digital data between air and ground.

[27] Except perhaps on the polar area and on some other areas for economic and/or technical reasons until a satisfactory system will be available.

[28] As foreseen in the Global Plan. *Executive Summary of the Global Plan, Rio Conference, supra* note 15, at 4.

Two systems are already used for accurate positioning: the US Global Positioning System (GPS) and the Russian Global Orbiting Navigation Satellite System (GLONASS). These systems are used for worldwide en-route navigation and for non-precision approaches. The more accurate precision approaches[29] will also be supported by these systems with appropriate augmentation systems to satisfy the specific needs of these phases of flight. The GNSS is composed of satellites constellations, receptors in the aircrafts and an integrity control system.

The benefits of this new navigation system are numerous:

a) The GNSS will assure worldwide navigation services with a high level of integrity and accuracy for the classical approaches, for the Category I approaches and landings and for all-weather navigation.

b) The States providing the ground navigation aids will achieve significant cost reductions because of the reduction or non implementation of ground-based navigation aids

c) Better uses of airport and runways

d) Reduced pilot workload

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[29] Such as terminal area maneuvers, approaches and landings, including Category I.

(iii) Surveillance

The new data communications and the accurate new navigation systems will enable automated surveillance to be performed.

The traditional secondary surveillance radar modes will continue to be used for surveillance, along with the gradual introduction of Mode S in terminal areas and high-density continental airspace.

The FANS Committee developed the Automatic Dependant Surveillance[30] concept. The operators will be able to use the ADS to transfer data[31] automatically via satellite to Air Traffic Control[32]units.

The benefits of the new surveillance system are evident:

a) The reduction of the separation between the aircraft permitted by better surveillance will be the solution to the growth of air traffic and lead to the diminution of delays and of operation costs.
b) A reduced error in position reports
c) A surveillance in oceanic area, distant areas[33] and non-radar airspace

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[30] Hereinafter ADS.

[31] Such as their position, their heading speed and other informations contained in the Flight Management System.

[32] Hereinafter ATC.

d) An improvement of the emergency assistance

e) The controller will respond more effectively to flight profile changes

(iv) ATM

The ATM is the system that keeps the aircrafts separated from each other and directs them through the skies optimizing the "traffic flow".

The ATM can be seen as "the end product of the combination of the CNS systems"[34]; indeed, the purpose of the new systems is to obtain a seamless ATM.

The advancements in communications, navigation and surveillance technologies support ATM in terms of efficiency. The future concept of ATM is much broader than the ATC.

It includes also Air Traffic Services[35], Air Traffic Flow Management[36], airspace management and ATM-related aspects of flight operations.

The benefits of the new systems regarding to the ATM are the following:

a) Delays as well as the flight operating costs will be reduced.

   The system capacity will increase because of the reduction of the separations between the aircraft and a more efficient use of airspace

b) The controller's workload will be reduced

c) The flight planning will become more dynamic because of the possibility for the operator to use his preferred flight profiles

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[33] Where primary and secondary radar do not exist or are at least not economically justified.

[34] See Kotaite, *supra* note 11 at 340.

[35] Hereinafter ATS.

[36] Hereinafter ATFM.

d) And, last but not least, safety will improve because of the improvement in the detection and solution of conflicts.[37]

C. Need of a global CNS/ATM system

The CNS/ATM system will bring economic savings as well as increasing the efficiency, the accuracy and safety of air traffic.

To optimize the benefits the new CNS/ATM system has to be implemented as a global system. Only a seamless and global ATM system will improve the present levels of safety. "ATM is a part of civil aviation that is more suitable to co-operation and cohesion than to competitive advantage. Indeed, the entire civil aviation community has a vested interest in the globally co-coordinated approach", wrote Mr. Kotaite[38].

There is an obvious need for co-operation in the setting up of the new system: the states, industry, users and service providers are the actors involved in the establishment of the new system, they need to co-operate in its setting up.

That is why the list of participants to the Rio Conference is so diversified.

The Conference brought together "123 contracting States, 27 international organizations[39] and 38 industry[40] delegations."[41]

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[37] Indeed the data exchange will allow the transmission of conflict free clearances or in case of potential conflict give the means to adapt quickly the flight to changing traffic requirements.

[38] See Kotaite, *supra* note 11 at 342.

[39] Among others IATA, SITA, Eurocontrol, ECAC, the European Commission, ESA, the European Community, Inmarsat, AFCAC, ACAC, LACAC, COCESNA.

See Report of the World-wide CNS/ATM Systems Implementation Conference, ICAO Doc. 9719, at ii-14, dated 15 May 1998 [hereinafter *Rio Conference Report*].

The absence of any co-operation would lead to the following result: a non –compatibility of the systems or their costly duplication which would impede the attainment of the global and seamless ATM which is the ultimate purpose of the new system.

The co-operation in the setting up of the system is nevertheless insufficient: indeed once the setting up is done; there is also a need of co-ordination in the implementation of the new system.

Indeed if some countries decide to go alone[42] in the implementation of the system, the afore mentioned benefits will never be achieved.

It will lead to the fragmentation of the Global Plan and to additional implementation costs.

This fragmentation will jeopardize the safety of the air traffic.

A worldwide co-ordination effort is essential in the implementation, even if the needs of the countries or regions involved are different from one another.

Some countries[43] can see in the new satellite-based system the opportunity to be at the forefront of the technology in the management of their airspace.

Consequently, they can be in a hurry to implement the new system

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[40] Among others Alcatel Espace, Bombardier, British Airways PLC, British Telecom, Canadian Marconi, Dassault Electronique, Lockheed, Lufthansa, Nav Canada, Raytheon, The Boeing Company. See *ibid.*

[41] *Rio Conference Report*, *supra* note 39, at ii-1.

[42] In terms of implementation of the new system at the national level.

[43] The developing countries can see in GNSS the opportunity to be at the forefront of the technology.

Some other countries can be more reluctant to implement the new system or, at least, will need more time to implement it because of the fact that they would prefer to amortize firstly the current equipment they use.

The timing of the implementation will then differ from one country to another.

ICAO developed for this reason the Regional Air Navigation Plans[44], which are the key to obtain a worldwide-harmonized CNS/ATM.

The States agreed to give to ICAO the planning, the co-ordination and the control of the implementation.

The ICAO Council established a High Level Task Force[45] to provide advice to the Council on the best means of assisting the states in the timely and cost-effective implementation of CNS/ATM.

The international community had to be convinced of the real necessity and relevance of the new global system and the need to implement it globally.

Apparently, all the actors involved understood these critical elements, the Rio Conference being the proof of this understanding.

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[44] Inspired by the work of the regional planning and implementation groups.

[45] The Task Force's first meeting was held in 1994 and was attended by all parties involved in the new system (States, users, service providers, financiers, manufacturers...).

Chapter II. Generalities about the GNSS

A. Definition of the GNSS

The GNSS are

> "Space-based radio positioning systems that provide 24 hour three-dimensional position, velocity and time information, in any weather conditions, to suitably equipped users anywhere on the surface of earth, as well as airborne and space users. GNSS use satellites as reference points to calculate positions accurate to within meters or, with advanced techniques, to within a centimeter."[46]

It can also be defined more precisely as

> "An electronic type of Radio navigation and positioning based on the range measurement from a satellite signal (timed by a precise atomic clock) whose arrival timing is measured by high precision GNSS receivers; by measuring the arrival time of the signal from three or more satellites (the position of which is known with precision), the receiver can determine its range from those satellites and hence its position in three dimensions and in real time.

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[46] *Draft Report of the Third United Nations Conference on the Exploration and Peaceful Uses of Outer Space* ,A/CONF.184/3, Distr. General 16 April 1999, at 32 [hereinafter *Draft Report 3nd UN Conference*].

The GNSS is considered as the backbone of the CNS/ATM system and is expected to evolve as the sole means of navigation on the global basis for en route, terminal, non precision approach and landing and -with appropriate augmentations and overlays (provided by a Wide Area augmentation System, Local Area Augmentation and differential reading) – precision approach and landing."[47]

The GNSS is thus a positioning system. Its data will be used mainly for navigational purposes and also for surveillance purposes.

The satellite navigation operates by means of satellites constellation[48], receivers on the ground, on boats, in aircraft, ground monitoring stations and integrity monitoring systems.

The satellites constellation operates in " (1) circular, inclined orbits, (2) highly elliptical inclined orbits or (3) in geostationary orbit."[49]

The information on satellites position is broadcast from the satellites to the receivers.

The time required for the signal to be received and the speed of the receiver's motion will be taken into account to define a three-dimensional position in real time.

[47] See Milde, *supra* note 7, at 315.

[48] Two circular orbital systems are for the moment operational: the US Global Positioning System (GPS) and the Russian Global Orbital Navigation Satellite System (GLONASS).

[49] See Henaku, *supra* note 13, at 171

B. GNSS parameters

The navigation satellite system as the traditional navigation systems is defined in terms of parameters.

These parameters are the main features of the system: accuracy, reliability, integrity and availability.

The advantage of the satellite navigation with regard to the traditional navigation systems is that a significant level of these parameters is obtained which, in terms of safety, is of critical relevance.

1. Accuracy

The term "accuracy" was defined by ICAO as

> The degree of conformance between the estimated or measured position and/or velocity of a platform at a given time and its true position and/or velocity. Radio navigation system accuracy is usually presented as a statistical measure of system error and is specified as:
>
> a) *Predictable*. The accuracy of a position with respect to the geographic or geodetic coordinates of the Earth;
>
> b) *Repeatable*. The accuracy with which a user can return to a position whose coordinates have been measured at a previous time with the same navigation system; and

c) *Relative*. The accuracy with which a user can determine one position relative to another position regardless of any error in their true positions.[50]

The US Federal Radio navigation Plan defines it as follows:

" In navigation, the accuracy of an estimated or measured position of a craft (vehicle, aircraft, or vessel) at a given time is the degree of conformance of that position with the true position of the craft at that time." [51]

2. Reliability

ICAO defined the reliability in these terms:

"A function of the frequency with which failures occur within the system. The probability that a system will perform its function within defined performance limits for a specified period under given operating conditions. Formally, reliability is one minus the probability of system failure."[52]

The US Federal Radio Navigation Plan defines the term by using the same words.[53]

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[50] *Guidelines for the Introduction and Operational Use of the Global Navigation Satellite System (GNSS)*, 1996, Circular 267-AN/159, at 97 [hereinafter *Guidelines for GNSS*].

[51] Department of Defense and Department of Transportation, *Federal Radionavigation Plan*, 1996 , at Appendix 2 & 3 [hereinafter *Federal Radionavigation Plan*].

[52] See *Guidelines for GNSS, supra* note 50, at 101.

[53]See *Federal Radionavigation Plan, supra* note 51at Appendix 4.

3. Integrity

ICAO and the US Federal Navigation Plan use the same terms to define the integrity. "Integrity is the ability of a system to provide timely warnings to users when the system should not be used for navigation."[54]

4. Availability

> The availability of a navigation system is the percentage of time that the services of the system are usable by the navigator. Availability is an indication of the ability of the system to provide usable service within the specified coverage area. Signal availability is the percentage of time that navigational signals transmitted from external sources are available for use. It is a function of both the physical characteristics of the environment and the technical capabilities of the transmitter facilities.[55]

[54] See *Guidelines for GNSS, supra* note 50, at 100.
See also *Federal Radionavigation Plan, supra* note 51,at Appendix 4.

[55] See *Guidelines for GNSS, supra* note 50, at 98.
See also *Federal Radionavigation Plan, supra* note 51, at Appendix 3.

C. Applications

Several applications are done with the GNSS.

Indeed, the GNSS technology has matured far beyond its original goal, which was to procure an accurate navigational system.

As was previously mentioned, the GNSS is a positioning system and its data is used for navigation and surveillance.

Some of the applications described hereafter use the GNSS not to navigate but to specify a position. It is interesting, nevertheless, to know them as well as the several navigation uses.

The applications can be classified as follows: transportation applications, scientific applications, timing application, space-related applications, military applications, public safety applications and leisure-related applications.

1. Transportation applications

Satellite navigation increases the efficiency of public transport, improves the movement of freight and speeds up road delivery services[56].

All sectors of the transportation are concerned with the creation and the development of a GNSS.

People might think that only the aviation sector is concerned but reality shows that the maritime sector as well as the land transportation makes extensive use of satellite navigation. In fact, it should be noted that aviation is and will remain a minority user of the GNSS capabilities.

(i) Aviation transportation

The use of satellite navigation in the aviation field will definitely increase the safety and efficiency of flying.

The GNSS, as previously stated, is the main element of the ICAO CNS/ATM system.

This system provides a worldwide satellite navigation coverage which will be applied to all phases of flight, eventually even to landings[57].

The GNSS is even expected to succeed the Instrument Landing System[58].

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[56] Ambulance, police and fire department vehicles are dispatched on emergency calls more rapidly and accurately.

[57] With Augmentation Systems, the GNSS will be used for approach and landing where precision is needed (With Augmentation Systems, GNSS will provide gate-to-gate navigation and all-weather operation capabilities).

The high accuracy of the satellite navigation will allow a reduction of the separation between the aircrafts while in flight. This fact signifies that the use of airspace will be more efficient and that traffic capacity on busy air routes[59], over the oceans...will be increased.

The optimization of flight profiles[60] will save fuel for the operators, reduce flight times as well as reduce noise impact for cities by using the Curved Approaches Technique, which is impossible with the ILS.

(ii) Maritime transportation

The GNSS is used in the maritime field for accurate navigation.

Accurate navigation is critical in and around the harbors, as well as through waterways [61].

Another function of the GNSS in the maritime field is that the GNSS permits to determine the positioning of fishing vessels (and, at the same time, the verification of their positions) as well as movements of ships carrying dangerous goods.

(iii) Land transportation

Land transportation means the use of cars or lorries as well as the use of trains.

The use of the GNSS will permit the driver whose car has such equipment to select the most efficient route to follow. This will lead to a reduction of traffic congestion and safety improvement on roads.

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[58] Hereinafter ILS.

[59] Such as the European routes.

[60] Produced by a point-to-point navigation.

[61] Where the radio navigation accuracy is insufficient because of their narrowness.

It will also permit a company to know the exact position of its vehicles and employees on the roads[62].

Recently the satellite navigation system was used with car-mounted cellular phones to determine the position of vehicles involved in a car accident[63]: "In this system, a microcomputer monitors the airbag deployment system installed in new cars. If it detects that the airbag has deployed, the computer calls a service center over the cell phone of the car, passing to it the last known location of the car as determined by the GPS receiver, The service center then passes the information to local emergency services, which can then respond."[64]

2. Scientific applications

(i) Atmosphere-related applications

The American system GPS is used for sensing atmosphere properties because of its sensitivity to the "refractive index of the atmosphere" which is a function of pressure, temperature and moisture."[65]

One of the relevant atmosphere properties is the atmospheric water vapor. Its study has important implications in meteorology as well as in the improvement of the satellite-based surveying.

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[62] For more details about the fleet tracking, see *Third United Nations Conference on the Exploration and Peaceful Uses of Outer Space*, 27 May 1998, background paper 4 "Satellite Navigation and Location Systems", A/CONF.184/BP/4, at 13 [hereinafter *3d UN Conference*].

[63] This application was done by the use of the US Global Positioning System.

[64] This example was given in the *Third United Nations Conference*, *supra* note 62, at 13.

[65] See *ibid.*, at 15.

(ii) Meteorological applications

The GPS is, for the moment, the primary system for determining positioning information for balloon soundings. The balloon height and the wind-speed information obtained is relevant meteorological information.

The ground-based receivers can provide an estimation of the precipitable water and the latent heat available.

Satellite-based receivers [66]are used in long-term climate monitoring to give regional and global temperatures which cannot be obtained from earth-based sensors.

Measuring stratospheric temperatures will be of particular importance for achieving a better understanding of the ozone problem and contributing to the study of gravity waves.

(iii) Earth science applications

The use of satellite navigation and positioning system is also of particular importance in the study of phenomenon such as earthquakes, ice and volcanic processes, sea-level changes and sea-floor geodesy.

All these phenomenon are dependant on the plate tectonic process which can be more efficiently studied by the satellite navigation and positioning system.

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[66] The space-based application of the GPS is named GPS/MET.

(iv) Surveying applications

Accurate positioning is of great importance for land and offshore surveyors.

For many years, optical instruments (requiring a direct line of sight from the instrument to the target) were used by surveyors for land surveying.

satellite positioning is very useful in that field because it does not require the establishment of a line of sight between the instrument and the target for a precise positioning; moreover, it does not require that the surveyors pass physically through the terrain to measure the distance between the two points.

Concerning offshore surveying, oil and gas recovery is completely dependent on accurate navigation and positioning.

The rate of finding new oil and gas locations is largely dependant on the accuracy with which seismic exploration vessels can operate.

A few meters error can have disastrous consequences in terms of expenses.

It is noteworthy that in the first week of November 1999 it was announced that, with the use of GPS, the real height of Mt. Everest was corrected by some 2 meters.[67]

(v) Mineral-related applications

The GPS is frequently used to prospect the mineral with the use of aircrafts.

Accurate positioning of the flight path is required to assess the exact location and the size of the mineral deposits.

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[67] The Gazette, Nov 10, 1999.

(vi) Agriculture-related applications

The satellite positioning reporting systems of the GNSS will permit to farmers to make a map of the exact yield of the fields they cultivate.

" Tout fermier croit connaître ses champs. Je savais de tout temps avoir une zone inondable. Mais la cartographie par GPS m'a indiqué à quel point cela affectait mes rendements. Plus encore, ce que je croyais être une tache, à l'œil nu, est en fait bien plus conséquent" declared a French farmer.[68]

They will then be able to modify the types of plantings they used to improve the yield of their fields.

This system will also permit farmers to know exactly which fertilizers and/or pesticides to use to fit most soil properties and to distribute with precision a specific quantity.[69]

Of course a precise distribution of the fertilizers will have environmental as well as economic consequences: the farmers will not use amounts of substance exceeding what they need. This will constitute a real benefit for the environment.

The farmers, by knowing exactly the type of substance to spray and the exact quantity to spray, will realize substantial financial savings.

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[68] "Machinisme agricole: satellites et ordinateurs sont prêts à révolutionner les fermes", Le Monde, August 24, 1999.

[69] The pre-programmation of some spraying equipment is possible to stop after a certain distance the spray of the fertilizers and/or pesticides. The pre-programmation of the amount of substance to spread in a certain type of soil is also possible.

3. Timing application

As said in the GNSS definition, the GNSS is "timed by a precise atomic clock."[70]

The GNSS receivers on the ground have to be synchronized with it.

"That means that every GPS receivers is, in essence, an atomic accuracy clock."[71]

To use such a precise time is really useful to banks, radio, television companies, computer networks...

4. Space-related applications

(i) Telecommunications

Telecommunications companies use the precision of the system in terms of timing to get their land-based telecommunications networks synchronized.

Mobile communications are improved by such information such as precise timing and accurate positioning. The controller of the network can provide the best qualities of communications and avoid the disadvantages of the landform geometry by knowing the exact position of the user.

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[70] See Milde, *supra* note 7, at 324.

[71] See *3d UN Conference*, *supra* note 62, at16.

(ii) Spacecraft navigation

Some studies currently use the GPS in spacecraft navigation.

Studying the launch, the trajectory and the re-entry of the vehicle will be done by using the satellite navigation and positioning system.

Huge savings will be achieved, thanks to the use of the GNSS.

Indeed a GNSS receiver can do the same work as many orbital positioning spacecrafts sensors.

5. Military applications

Military applications were originated by the USA[72] and the USSR[73].

Although still used predominantly by the Americans and the Russians other nations have begun using and will be very interested in the non-military use of the GNSS.

Military forces use satellite positioning for defensive purposes and their military activities, but they also use the satellite navigation to aid civilians dropping supply and food by air in case of wars and other critical situations[74] such as rescue and search missions carried out by military forces.

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[72] With GPS.

[73] With GLONASS.

[74] As it was done by the Allied Air Force during the war in former Yugoslavia.

6. Public safety applications

The system is also used by police departments as well as by fire and ambulance departments to pinpoint the exact position of accidents as well as their fast response vehicles. This immediate responsiveness will undoubtedly save many lives.

7. Leisure-related applications

Private pilots, boat owners, mountain climbers and hikers make extensive use of satellite navigation.

Even some golfers use the system to define an accurate yardage of the golf course.

The number of applications made with the GNSS shows very well its importance in every day life.

New applications of the GNSS continue to be developed and its future has no limits.

Some people even use the sentence: " Soon the GPS [and the GNSS] will become a universal utility."[75]

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[75] See *3d UN Conference*, *supra* note 62, at 5.

Chapter III. Description of satellite navigation systems

A. The Primary Navigation Satellite Systems: the existing GNSS Systems

There are currently two global satellite navigation systems: the United States' Global Positioning System and the Russian Federation's Global Orbiting Navigation Satellite System, both of them being satellite constellation elements of GNSS.

1. The U.S. Global Positioning System (GPS)

GPS is the most widely used GNSS system.

GPS originated as a military satellite navigation system.

It has been operational since the declaration of Initial Operational Capability (IOC) on December 8, 1993.

On July 17, 1995 the Department of Defense Full Operational capability (FOC) was announced.[76]

The GPS is free of charges to the end-user for a minimum period of 10 years.
President Clinton confirmed in May 1996 the offer to provide the GPS free of charge to civil aviation and other peaceful users.

It can be defined as follows:

> The basic GPS is defined as the constellation of satellites payloads which produce the GPS signals, ground stations, data links, and associated command and control facilities which are operated and maintained by the Department of Defense; the Standard Positioning System (SPS) as the civil and commercial service provided by the basic GPS; and augmentation as those systems based on the GPS that provide real-time accuracy greater than the SPS.[77]

GPS has three major segments: space segment, control segment and user segment.

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[76] See *Federal Radionavigation Plan, supra* note 51, at 3-6.

[77] *US Policy Statement on the GPS*, March 29, 1996 [hereinafter *GPS Statement*] cited by Milde, *supra* note 7, at 327.

The space segment involves technically "21 [operational] satellites and 3 [active] spares on 6 orbital planes [inclinated by 55 degrees to the equator] and 12 hours [11 hours 56 minutes exactly[78]] circular orbit at an altitude of 20,183 kilometers."[79]

The design life of a satellite is 7.5 years.[80]

GPS uses the Navigation Satellite Providing Time and Range Satellites.[81]

GPS control segment is composed of five monitor stations placed all around the earth (which means that at any time each satellite is monitored at least by one station), one master control center in Colorado Springs and three ground antennas.

GPS receivers, processors and antennas utilized for positioning and timing, compose GPS user segment. The user's receiver measures the time delay for the signal to reach the receiver. By knowing the distance to four points (the satellites) in space, the GPS receiver is able to triangulate a three-dimensional position (latitude, longitude and height).

The size and price of GPS receivers was so reduced that technical progress is now available to everyone at reasonable costs.

The satellites emit on the same frequencies: L1 (1575.42 MHz)[82] and L2 (1227.6 MHz).[83]

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[78] See *Guidelines for GNSS*, *supra* note 50, at 13.

[79] See Milde, *supra* note 7, at 325.

[80] See *Guidelines for GNSS*, *supra* note 50, at 13.

[81] Which are called NAVSTAR Satellites.

[82] See N.Warinskostna, « Du GPS au GNSS le point de vue sur la situation internationale » (June 13, 1995) *Le Transpondeur*, at 22.

There are two levels of services provided: the Standard Positioning Service (SPS) emitted on L1 and the PPS (Precise Positioning System) emitted on L2.

There are two levels of services provided because of its dual use, civilian and military.

The GPS is actually a military navigation satellite system managed by the system operator, the U.S. Air Force for the U.S. Government.

"The GPS is owned, operated and controlled by the air forces of the individual states..."[84]

The PPS is the service only available for military users.

The GPS was also offered to the entire civil community.[85]

The SPS is the service provided to civil users and became operational for all uses in 1993.

ICAO Council accepted the United States' offer[86] to use the GPS as a standard positioning system for the international aviation community.

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[83] See *ibid.* at 22.

[84] See Henaku, *supra* note 13, at 171.

[85] President Ronald Reagan offered the use of the GPS to the use of civilian users for the first time in 1983 after the destruction of a Korean Airlines Boeing 747 by the Soviet military.
See Warinskostna, *supra* note 82, at 19.

[86] The US FAA Administrator, David Hinson formalized the US offer on October 14, 1994 and March 5, 1996 in these terms: "I would like to take this opportunity to reiterate my Government's offer of the Standard Positioning Service (SPS) of the US GPS for use by the international community".
See ICAO, *State Letter LE4/49.1-94/89.*
About the legal significance of the exchange of letters between US, Russia and ICAO, see Henaku, *supra* note 13, at 182.

"[GPS] signals are modulated in two codes- the P (Precision) mode [code] [emitted on L2 frequency] and the C/A (Coarse Access [Acquisition]) [emitted on L1 frequency] mode [code] that provides the Standard Positioning Service (SPS)-the only element of the GPS offered to civil aviation."[87]

The SPS requires the reception of the C/A signal emitted on L1.

The PPS uses a second frequency, the L2 frequency, and requires the reception and the decoding of the signal Y emitted on L2.

"The military has encrypted the P-codes by altering the underlying mathematical formula and only authorized users know what the change is. As a consequence, civilian users cannot observe the P-codes directly."[88]

GPS can provide a high degree of accuracy but its accuracy was limited for civil uses by the US Department of Defense through Selective Availability to a 100 meters horizontal position accuracy and 156 meters vertical position accuracy.[89] The Selective Availability is actually a policy.[90]

The PPS was degraded to the SPS for civil users which resulted in many controversial discussions.

Civil users paid highly to obtain a more accurate system and it cost the military users a great deal to degrade the system's accuracy.

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[87] See Milde, *supra* note 7, at 325.

[88] See *3d UN Conference, supra* note 62, at 6.

[89] See *Guidelines for GNSS, supra* note 50, at 13.

[90] The Selective Availability is officially sanctioned. See *3d UN Conference, supra* note 62, at 6.

Civil users claimed access to the PPS but the response of the U.S. Department of Defense was always the same: the degradation is a matter of national security for the U.S. However the PPS will become more accessible by 2006.[91]

Indeed, after 2000 the US President will have to examine annually the need to limit the accuracy of the GPS to 100m[92] for civilian users. If there is no good reason to limit the access of civilian users to SPS, he will have to declare the PPS available to all.

Till then, the creation of Augmentation Systems answers to the needs of civil users (and especially those of civil aviation[93]) in this matter.[94]

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[91] P.B. Larsen, "GNSS Augmentation: Legal Issues", 48th International Astronautical Congress, Proceedings of the Fortieth Colloquium on the Law of Outer Space, International Institute of Space Law of the International Astronautical Federation (October 6-10, 1997) Turin, Italy, published and distributed by the American Institute of Aeronautics and Astronautics, at 271.

[92] "Beginning in 2000, the President will make an annual determination on continued use of GPS Selective Availability. To support this determination, the Secretary of Defense, in cooperation with the Secretary of Transportation, the Director of Central Intelligence, and heads of other appropriate departments and agencies, shall provide an assessment and recommendation on continued SA use» *US Policy Statement on the GPS*, *supra* note 77, at 328.

[93] In phases such as precision approaches.

[94] The discussion is today more about the control of the military on these civil Augmentation Systems if a conflict arises.

2.The Russian Global Orbiting Navigation Satellite System (GLONASS)

GLONASS was developed initially by the USSR military and continued by the Russian Federation.[95]

It provides identical information as the U.S.GPS and has the same level of accuracy as the GPS operating on the C/A code.

GLONASS was offered as GPS to the civil community, free of charge for a period of 15 years.

In the field of Civil Aviation, ICAO Council accepted the offer[96] made by Russia.

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[95] Since a Decree of February 18, 1999, GLONASS is no longer a military Satellite Navigation System. It is operated by a joint board composed of military and civilians.
See P.B. Larsen, "Future GNSS Legal issues", paper presented at the Conference UNISPACE III, Vienna July 1999, at 6.

[96] This offer signed by N.P. Tsakh was formalized on October 14, 1994 and March 5, 1996 (just as the American offer) and used the following terms "Using the powers conferred on me, I would like to confirm, on behalf of the Government of the Russian Federation, the proposal made at the Tenth Air Navigation Conference concerning the provision of a standard accuracy GLONASS channel to the world aviation community on a non-discriminatory basis for a period of at least 15 years with no direct charges collected from users, subject to the allocation of resources under the legislation of the Russian Federation".
See *State Letter LE 4/49.1-96/80*, at Attachment A & B.
See also "ICAO prepares to accept Russia's GLONASS System on equal footing with GPS", Aviation Daily, March 19, 1996, at 443 .

The space segment consists in "24 satellites operating in 11hours and 15 minutes orbits at an altitude of 19,100 kilometers."[97]

These satellites are deployed in 3 orbital planes inclinated by 65 degrees to the equator.

The satellites emit on 12 frequencies (1602.5625-1615.5MHz).[98]

GLONASS control segment is composed of a system control center (SCC) and command tracking stations (CTS).

GLONASS is not intentionally degraded for civil use as is GPS.

Nevertheless GLONASS has also two levels of service: the Channel of Standard Accuracy (CSA) and the Channel of High Accuracy (CHA) for authorized users only.

The first one is available to the civil users and provides vertical position accuracy of 75 meters and horizontal accuracy position of 60 meters.[99]

Even if there is no Selective Availability, GLONASS is much less successful than its American competitor.

Indeed for a long time only a few satellites were operating[100]; moreover, the design life of the Russian satellites is less than three years.

The ground segment is limited to the territories of the former USSR.

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[97] See Milde, *supra* note 7,at 325.

[98] See Henaku, *supra* note 13, at 172.

[99] See *3d UN Conference*, *supra* note 62, at 8.

[100] GLONASS had a full constellation of 24 operational satellites since January 1996 but in the beginning of 1998 only 13 were still operational because no satellites launching was done in 1996 nor in 1997, see *3d UN Conference*, *supra* note 62, at 8 .

This means that the monitoring of the satellites and the intervention in case of problems is limited.

This fact seriously delays warnings in case of a system failure.

Practically, compared to millions of GPS receivers used all over the world, there is only a limited number of users using GLONASS receivers.

Moreover, there is not a reliable commitment of the Russian Federation[101] to maintain and develop the GLONASS system. The GLONASS receivers are not compatible with GPS and their supply is very limited.

GLONASS is seen much more as the GPS complement than as a competitor to GPS.

"Combined application of the GLONASS and GPS navigation fields allows to improve navigation measurement accuracy and reliability, as well as to increase integrity of the navigation system and implement the RAIM[102] mode."[103]

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[101] In particular in view of their economic difficulties.

[102] Receiver Autonomous Integrity monitoring.

[103] Y., Gusev & M., Lebedev, « Développement futur du système de navigation a satellites GLONASS et son association avec les aides a la navigation étrangère », *Revue Navigation*,(July 1996), Vol. 44 Nr. 175, at 267.

B. The Navigation Augmentation Systems

In spite of their high accuracy, reliability and integrity, neither GPS nor GLONASS is sufficiently accurate to meet either RNP aviation requirements, performance requirements for harbor entrance, or many land transportations applications.

Both GPS and GLONASS have major disadvantages: a deficiency in integrity, in accuracy and in the lack of international control.

Concerning integrity, both of them have a limited capacity to warn users in case of system failures. GPS and GLONASS satellites can emit inaccurate information during a few hours[104] before their isolation, identification and resolution of the problem.

Concerning accuracy, the GPS and GLONASS systems are not sufficiently accurate[105] in the aviation field for the precision phases of the flight[106] and for Category III phases of

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[104] It can take two hours before the Department of Defense detects some failures in the GPS. See H., Thomas, "Can GPS Become Even Better ?", *Rotor and Wing*, (February 1995), vol. 29 nr. 2, at 37.

[105] Even the abolition of the Selective Availability in the GPS and the use of the PPS would not solve that problem. The Category I approach specifications would not be met by the PPS.

[106] An insufficient accuracy does not concern the aviation community exclusively. Cars in towns as well as vessels on narrow waterways and harbors need a high degree of accuracy

flight.[107] Harbor entrance and approach phases in marine navigation as well land transportation also need further refinement of the systems.

The third problem is that both systems are national systems; the GPS is American and GLONASS, Russian. These two providers maintain absolute control of their systems.

Some parts of the world, such as Europe, would like to be more actively involved in these navigation systems.

Some systems were created to avoid the first two problems, to increase both accuracy and integrity. There are called Augmentation systems. Relating to civil aviation, three types of Augmentation systems exist: on-board augmentation, ground-based augmentation and satellite-based augmentation.

1. On-board Augmentation

Several types of on-board augmentations exist.

First of all there is the Receiver Autonomous Integrity Monitoring (RAIM).[108]

RAIM augments the integrity of the primary signals but has also severe limitations.

The RAIM[109] is not always available because of its dependence on several parameters such as phase of flight, satellite outages, mask angle and geographic position.

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[107] There are four types of phases which can be summarized as follows: the en-route phase which includes the flight upon the ocean; the Category I phase which is a non precision phase; the Category II which is precision phase and the Category III which covers the landings. Eventually a fourth Category could be created for the operations of the aircraft on the ground, such as taxiing.

[108] See Henaku, *supra* note 13, at 173.

[109] For more details about RAIM, see *Federal Radionavigation Plan*, note 51, at 3-9.

Another on-board augmentation is the Aircraft Autonomous Integrity Monitoring, (AAIM) such as the inertial navigation system.

2. Ground-based augmentation

The ground-based augmentation systems are also called Local Area Augmentation Systems (LAAS).

LAAS enable GPS to meet RNP for terminal, non-precision approach, precision approach, auto land and ground taxi phases of flight

They improve the primary systems more significantly than do the on-board augmentation.

They can support the Category III precision approach.

These systems work as follow:"...a monitor is located at or near the airport where precision operations are desired. Signals are sent to aircraft in the vicinity (out to approximately 37km (20 NM). These signals provide corrections to increase the position accuracy locally along with satellite integrity information. To do this it is necessary to have a data link between the ground and the aircraft. Many such systems have been proposed and tested using different techniques and frequency bands."[110]

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[110]See *Guidelines, supra* note 50, at 16.

3. Satellite-based augmentation

The satellite-based augmentation is also called Wide Area or Regional Augmentation and consists in the use of satellite to transmit augmentation data.

Three[111] Regional Augmentation Systems[112] are relevant: the US FAA-sponsored Wide Area Augmentation System (WAAS) to enhance the accuracy and integrity of the primary navigation systems over North America, the European Geostationary Overlay Service (EGNOS) set up by the European Union (EU), the European Space Agency (ESA) and EUROCONTROL to enhance the accuracy and integrity of GPS and GLONASS over Europe and; finally, the Japanese MTSAT[113] Satellite-based Augmentation System (MSAS)[114].

WAAS and EGNOS are designed to operate with Inmarsat III [115], Inmarsat III being the space segment capacity provider for these systems.[116]

Two Inmarsat III satellites are used in WAAS and EGNOS systems.[117]

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[111] Other countries such as China and India are interested in GNSS and its augmentation. China, for example, developed the system TWIN-STAR.
See B., Kantasuk, *General issues concerning GNSS and the impact on developing countries*, (LL.M. Thesis, Montreal: Institute of Air and Space Law, McGill University, 1997), at 21.

[112]Each of them using the geostationary satellites to broadcast augmentation information over their respective regional areas.

[113] Multi-Function Transport SATellite.

[114] Russia is also examining a civil follow-on to GLONASS.

[115] Inmarsat III is also an Augmentation System. " The Inmarsat III augmentation system was to constitute the first of a four waypoint Inmarsat programme aimed at establishing an internationally managed civil GNSS. The new system would have consisted of 30 satellites in intermediate circular orbit (ICO) and six to eight in geostationary orbit and would offer performance similar to that of augmented GPS..." Henaku, *supra* note 13, at 174.

[116] Each Inmarsat III satellite is equipped with a navigation transponder, which is an integral part of WAAS and EGNOS.

MTSAT is designed to operate with two Japanese geostationary satellites.

(i) WAAS

WAAS is a method conceived by FAA to augment the GPS to meet civil safety standards.

WAAS employs ground stations[118] all over US and Canada[119] to monitor the integrity of GPS signals.

WAAS provides three basic services[120]:

a) It provides additional integrity. It monitors GPS performance and provides timely warnings to users. If there is any failure, the ground station will detect it and transmit it to the satellites which will then broadcast the information back to earth on the GPS frequency, signifying that the information of the failure will be received by every GPS receiver.

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[117] A third satellite will be added to the EGNOS system. This satellite is called Artemis (ESA's Advanced Relay and Technology Mission Satellite) and will be launched in early 2000.

[118] 24 ground reference stations, one master station and one ground earth station.
See Henaku, *supra* note 13, at 174.

[119] And even has the ambition to create a worldwide augmentation system. *Ibid.*, at 175.

[120] For more details see Loh, R., "GPS Wide Area Augmentation System (WAAS)", *The Journal of Navigation* (May 1995), Vol. 48, nr.2, at 181.

b) It increases the GPS accuracy. It achieves the accuracies required for the RNP for en-route, terminal, non-precision approach and precision approach (even the Category I precision approach) phases of flight.

The augmentation improves signal accuracy from 100 meters to less than 10 meters.

c) It expands the number of satellite ranging signals to increase navigation system availability. WAAS satellites will continuously transmit GPS signals, meaning that WAAS satellites appear on GPS receivers as additional GPS satellites. This is important because the coverage of the 24 GPS satellites is not total. There can be some gaps at certain places and times.

WAAS is a necessary augmentation of GPS but is also expected to be certified in 2002 as the primary means of navigation for en-route phase of flight (including over the ocean) and non-precision approach, the Category I phase of flight[121]. The category II and III phases of flight are still excluded.

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[121] See Warinskostna, *supra* note 82, at 25. See also Henaku, *supra* note 13, at 174.

(ii) EGNOS

EGNOS set up by the European Tripartite Group[122] is a European[123] based Wide Area Augmentation System for satellite navigation.

It is an augmentation of the existing GPS and GLONASS systems.

European intervention in satellite navigation will be carried out in two stages: GNSS1 and GNSS2.

The purpose of GNSS1 is to augment the systems GPS and GLONASS[124] by creating EGNOS.

EGNOS is planned to be used for en-route phases of flight (including oceanic) as well as for the Category I phases of flight.

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[122] EU, ESA and Eurocontrol. "The institutional responsibilities are as follows: ESA is responsible of the EGNOS ground network and also in charge of preparatory work onGNSS2. EUROCONTROL provides the civil aviation requirements and prepares guidelines for the validation and certification of EGNOS while the European Commission coordinates the European Tripartite Group (ETG), provides political framework for ETG actions, provides for a definition of user requirements for all modes of transport, implementation of a legislative framework and provides for access to the Inmarsat III navigation payloads".
See Henaku, *supra* note 13, at 175(note 457).

[123] Countries other than the EU Members are associated with the programme, such as: Switzerland and Norway. Other countries, such as Canada, East-European countries, African, Middle East, South American and Asian countries will probably also participate in the programme.

[124] Whereas both WAAS and MSAS rely exclusively on GPS.

GNSS2, the second generation system, as it will be examined further, will enable Europe to become an actor (by creating Galileo) in the setting up of a civilian satellite system[125] which will be available for civil aviation as well as for maritime and land users and which will be used in the aviation sector for all phases of flight.

The architecture and functioning of EGNOS is the same as for WAAS.[126]

As for WAAS it will improve the integrity, accuracy and availability of the existing satellite navigation systems. The three basic services provided are:

a) The EGNOS integrity service will enable the users to know in 10 seconds if there is any failure in the system.

b) The accuracy is increased to 5 to 10 meters.

c) The ranging service will enable EGNOS transponder to broadcast GPS-like navigation signals. The satellites will offer more sources of information for the users that cover the critical information gaps of GPS and GLONASS existing at certain times and places.

EGNOS is gradually deployed.

The beginning of the ranging service[127] started in 1998.

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[125] Galileo will be under civil operation and control.

[126] See R., van Dam, "Recent developments at the European Organization for the Safety of Air Navigation (EUROCONTROL)" (1998) XXIII, *Annals of Air and Space Law*, at 318.

The integrity and wide-area differential services were introduced in 1998 and will be further expanded upon in 2000. This means that EGNOS will reach Advanced Operational Capability in 1999.

The gradual deployment is done to provide fast benefits to users and to limit technical risks.

Full Operational Capability will be reached in 2002.

(iii) MTSAT Satellite-based Augmentation System (MSAS)

MTSAT is a system set up by the JCAB[128], operated by the Japanese Ministry of Transport and covers the Asia/Pacific Region.[129]

It was created to assure safety and efficiency of air transport in a region where air traffic demand grows quickly.

It will be a key component of the CNS/ATM system in that region.

MTSAT has two payloads, one meteorological and one aeronautical, which provides the AMSS[130] function and the GNSS Augmentation function called MSAS providing a GPS augmentation signal.

This Augmentation system is composed of two geostationary satellites[131], two GES located in Kobe and Ibaraki and two Tracking, Telemetry and Command (TT/C) Stations.

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[127] The French Company Thomson-CSF was chosen to develop the ranging function. Thomson-CSF choose subcontractors in UK, Germany, Spain, France, Norway and Switzerland.

[128] Japan Civil Aviation Bureau.

[129] And covers also a part of Alaska and Russia.

[130] Aeronautical Mobile Satellite Services.

MSAS "provides additional GPS-like ranging signals, GPS integrity information and wide-area differential corrections."[132]

MSAS has identical system architecture as WAAS and EGNOS.[133]

The originality of MSAS is that this program includes the launching of the satellites and does not rent the satellites as WAAS and EGNOS do by renting INMARSAT satellites.

MSAS is reserved for air transportation[134] and covers CNS/ATM by providing communication, navigation and also meteorological services.

C. A new developing GNSS system: the European Galileo Program

As previously mentioned, GPS and GLONASS are the two existing and operating navigation systems and are part of the GNSS.

Europe took the decision to play an active role in the development of the next generation of satellite navigation systems by developing "a new satellite navigation constellation combined with appropriate terrestrial infrastructure: Galileo."[135]

Galileo will be an element of the GNSS and also an important element of the Trans-European Network[136] for positioning and navigation objectives.

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[131] One of them was launched in 1999, the other will be launched in 2004. See Warinskostna, *supra* note 82, at 27.

[132] A., Shimamura, "MSAS (MTSAT Satellite-based Augmentation System) Project Status", *Air and Space Europe* (March-April 1999), Vol.1, Nr.2, at 64.

[133] About a description of MSAS System and subsystem, See *ibid.*

[134] Which is not the case of EGNOS.

[135] *Communication from the European Commission, Galileo, Involving Europe in a New Generation of satellite navigation Services* (10 February 1999), Brussels, COM/99/54/fin, at iv [hereinafter *EU Communication*].

A European Council Resolution of July 19, 1999[137] formally establishes the involvement of Europe in a GNSS by the creation of a new generation of European satellite navigation services: Galileo.[138]

1. The European organizations in charge of Galileo's creation

The European Space Agency (ESA), the European Community (EC)[139] and the European Organization for the safety of Air Navigation (Eurocontrol), forming the "European Tripartite Group" (ETG) decided together to contribute to the creation and development of the European element to GNSS.

The ETG is in charge of both EGNOS[140] and Galileo programs.

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[136] Hereinafter TEN.

[137] *Council Resolution on the involvement of Europe in a new generation of satellite navigation services – Galileo – Definition Phase* (July 19, 1999), OJ C221/1(August 3, 1999) [hereinafter *Galileo Council Resolution*].

[138] This European Council Resolution was preceded by many European Union initiatives: the most important acts are a Council Resolution of November 19, 1994 on the European contribution to the development of a GNSS, the European Commission's Communication "Towards a Trans-European positioning and Navigation Network – including a European strategy for Global satellite Navigation Systems (GNSS)" of January 1998 concerning the potential applications and economic opportunities.
On March 17, 1998 the EU Council of Ministers requested the Commission to present recommendations on the future European approach to global satellite navigation, the Council approved the Tripartite Agreement on July 10 1998. A European Parliament Resolution was adopted on January, 13 1999 and called upon the Member States of the European Union to convene a European Space Council at the Head of State or Government level and requested the Commission to present a coherent strategy for the development of a Trans-European positioning and navigation network. On February 2, 1999, the European Commission made the Communication "Galileo, involving Europe in a New Generation of Satellite Navigation Services". This Communication went through a first review at the Transport Council on March 29th and the Council Resolution of July 19, 1999 gave finally the green light to begin the definition phases in July 1999 with a target completion date in December 2000.

[139] The European Commission is very active in the matter as the EC's executive body.

[140]The parties' contributions to GNSS 1 (EGNOS) are provided by the article 4 and the Annex II of the *Agreement between the European Community, the European Space agency and the European Organization*

Briefly, ESA is in charge of the management of the program development and technical validation activities.

ESA's contribution will be done through its Advanced Research in Telecommunications Systems (ARTES) program.

The European Commission is responsible for institutional and policy matters. It has to be certain that the views of all potential users are taken into account in the framework of the overall program.

Eurocontrol defines the mission requirements for civil aviation in co-operation with the relevant national and supra-national aviation authorities. It will test and verify the validation phase of system deployment.

2. The reasons and benefits for Europe to create a European element to GNSS.

The satellite timing, positioning and navigation system is a challenge for Europe in terms of safety, independence, economic prosperity, promotion of industry and employment.

The need to procure for European users a system with a high level of reliability, accuracy[141] and efficiency which would remedy current GPS and GLONASS

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for the Safety of Air navigation on a European Contribution to the development of a global navigation satellite system (GNSS), Official Journal L 194 (10/07/1998), at 16.

[141] "A world-wide requirement of 10 meter horizontal accuracy is the minimum standard which Galileo would need to meet if it is to be accepted as an inherent component of a world-wide radio-navigation system". *EU Communication, supra* note 135, at 9.

shortcomings is one of the reasons Europe created a new dimension to the worldwide GNSS.

A high level of development of these parameters insures a high degree of safety which is very important in transportation sector.

The creation of Galileo will, undoubtedly, help the Member States of the European Union to fulfill their public obligations to provide safe navigation services and to procure safety in all forms of transportation.

The creation of a European element in GNSS fulfills the need of Europe independence with regard to other nations, such as US.

Initially, Europe wanted to develop GNSS jointly with an international partner such as the US.

The US, however, did not want to share GPS ownership and control, primarily for military reasons. Europe could not agree to be totally dependant on a foreign authority controlling navigation in Europe for security reasons.

Moreover, Europe had to protect the European consumers against excessive future charges for GNSS services that the probable dominant position, if not monopoly, that the US would most likely have on satellite navigation.

European economic prosperity and promotion of European industry are also good reasons for Europe to create Galileo.

This does not satisfy the US which would like Europe to accept GPS SPS as the basis for applications of GNSS. See *Ibid.*, at 5.

Satellite navigation will play a very important role in the integrated European Transport System which is a determinant element of the single market of which the purpose is to provide a certain level of economic prosperity to the European Member States.

GNSS-based services are increasing quickly and the potential market is estimated to reach 40 billion Euros by 2005.[142]

Europe has large space technological capabilities. The creation of a European satellite timing, positioning and navigational system offers to European industries huge economic opportunities by building and maintaining the satellite system, the receivers and the infrastructure needed to the satellite system functioning.

Employment created by the establishment of Galileo will be important.

The setting up of the satellite system is estimated to support 20,000 jobs and its operation is estimated to create 2,000 permanent jobs.

Equipment production and sale will also create employment.[143]

3. International co-operation

Once Europe took the decision to play a role in the future generation of satellite navigation systems, the European Commission examined several options related to its intervention in GNSS.

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[142] The ESA-funded GNSS-2 Comparative System Studies identified a 40 billion benefit from equipment sales and 40 billion benefit from value added services for European companies over the period 2005-2023. See *Ibid.*, at 3 (note 5).

[143] The ESA-funded GNSS-2 Comparative System Studies foresees an augmentation of employment from 25,000 based upon GPS to 70,000 based upon GPS and Galileo in 2008. It estimates that 100,000 jobs will depend by 2008 on Galileo. See *Ibid.*, at 4 (note 9).

Three options were actually examined by the European Commission:

"- A joint global system with all the major players

- The EU developing a GNSS with one or more international partners (particularly, the US or Russia)

- Independent development by the EU of its own system." [144]

The Commission recognized that joint development of GNSS would be the most cost-effective option.

However, the Commission stated clearly the need for a co-operation, respecting certain conditions such as: the guarantees against disruption and the certainty for Europe to have a role to play in the design, operation, and control of the system.

As was aforementioned, the US did not want to participate in a shared control and ownership of GPS.[145]

This excludes one single and joint EU-US satellite navigation system.

However, a certain degree of co-operation between EU-US satellite systems could benefit both partners in terms of an increasing robustness and performance of the overall GNSS system.

The two independent systems could even become sole means of navigation.[146]

This type of co-operation is, at present, under study.

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[144] See *Ibid.*, at v.

[145] Discussions took place in May, July and November 1998.

[146] Sole means of navigation means in the aviation field that the aircraft meets for a certain 'operation or phase of flight all four navigation system performance requirements: accuracy, integrity, availability and continuity of the service".Whyte, J, "Satellite Navigation, information/discussion paper", Air Navigation Commission, ICAO, unpublished.

The decision was taken to develop Galileo as an independent system from GPS but fully compatible and interoperable with GPS.

To the contrary, the Russian Federation held a positive view to a joint development and offered a full partnership to develop a new international civil system from GLONASS. Control, ownership and management of the new system would be joint.

This could permit Europe to develop Galileo more quickly and to benefit from the valuable GLONASS frequency band allocation.[147]

Japan, as well as other countries,[148] are interested in Galileo.

The participation of other countries in Galileo would help to reduce the costs that Europe would bear to build Galileo.

Several scenarios are then possible.

One is definitely rejected: the zero option.

This option would lead to the abstention of Europe from having any role to play in the future GNSS and the reliance of Europe on the US GPS or Russian GLONASS or any new system created. The US would maintain their dominant position in the field.

This scenario was raised to give up with the creation of a new system and to concentrate on the augmentation of GPS. However, the reasons and benefits explained here above spoke in favor of the creation of Galileo.

In conclusion, Galileo is developed as an independent but fully compatible and interoperable with GPS, open to the participation of partners, especially The Russian Federation.

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[147] Discussions took place in May, July and October 1998.

[148] Such as Canada, Switzerland, Iceland, South America, Africa, Australia, India, China.

4. Technical data and architecture of Galileo

Galileo will include a core constellation of satellite[149] in Medium Earth Orbit[150] which represents low technical risk and known performance capabilities.

The performances of Galileo would be a three-dimensional performance over landmasses, an approximate accuracy of 10 meters horizontally[151] and a universal independent time reference on a global basis.

As previously mentioned, the use of GLONASS constellation is an option.

The European Commission considers EGNOS as the first step to Galileo: EGNOS will probably evolve towards a regional element of Galileo.[152]

Galileo will include "other global, regional and local elements, either satellite based or ground based."[153]

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[149] The ESA developed two options: either a core constellation of 21 MEO satellites with integration of GPS and local area augmentation in a total system approach to meet European requirements or a core constellation of 36 MEO satellites meeting independently and completely European requirements.
A complement of 9 GEO (Geostationary Earth Orbit at 36,000Kmin the equatorial plane) satellites or 3 IGSO (the Inclined Geosynchronous Orbit is a variation on GEO at 36,000Km) satellites is considered. See *EU Communication, supra* note 135, at 10.

[150]MEO (between 5000 and 20,000Km) is used also for both GPS and GLONASS but WAAS, EGNOS and MSAS use the Geostationary Earth Orbit (GEO). See "Galileo: System Architecture and Technical Features" (March-April 1999), Air and Space Europe, Vol.1, Nr.2, at 30.

[151] Which is approximately the same performance to GPS, Block IIF, the next generation of GPS.

[152] But will remain an augmentation to GPS.

[153] "The Galileo Program and its Impact on Long-Term GNSS", ICAO, Montreal (12-23 April 1999) GNSSP/3-WP/65 at 3.2.2 [hereinafter GNSSP/3].

The ground segment will be used to provide integrity monitoring, to determine the orbit, to synchronize timing and to manage the overall system operation.

The ground infrastructure of EGNOS will be reused by Galileo.

5. Navigation services

Galileo would provide three levels of services with several types of service areas[154].

Level 1 would be the service provided to the mass market.

It would be an Open Access Service.[155]

There would be universal and free access to this basic service.

Europe had to create a level free of direct users charges to compete with the GPS system which is free of charges.

Level 2 and 3 are Controlled Access Services.[156] These levels are certifiable services. They would not be offered for free to the mass market. The users would be charged for their uses.

These levels would use another signal and, for these levels, availability as well as accuracy would be guaranteed.

Liability and certification also would be guaranteed.

The controlled access signal uses would be either optional[157] or mandatory[158].

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[154] From worldwide coverage to local coverage.

[155] Hereinafter OAS.

[156] Hereinafter CAS.

[157] As for applications such as agriculture, in-car navigation *etc.*

Level 3 is specific to safety of life and security related services.

The guarantee of continuous availability is an essential element at this level.

The third level of signal is limited to a definite number of users, civil aviation being one of them.

The users would be charged for the services of Levels 2 and 3.[159]

Chapter IV. Some legal issues of GNSS

This part will be divided into two sections.

The first section will address some legal issues raised by ICAO concerning the GNSS and will examine the current works of ICAO concerning them.

The second section will address some legal issues related to the creation of the European program Galileo and will examine the European documents relevant to them.

[158] As for applications such as gas and oil exploration, fisheries surveillance *etc.*

[159] This creates reactions among the airlines.

A. Some legal issues raised by ICAO concerning the GNSS

1. Sovereignty, Authority and Responsibility of States

The concept of sovereignty of States is a basic axiom of international law and can be defined as follows:

"Sovereignty is the right of a State to freedom from foreign intervention in its internal affairs."[160]

The principle of airspace sovereignty of States is a principle long well established.

In Roman times, this principle existed under the Latin maxim "Cuius est solum, eius est usque ad caelum et ad inferos."

It became a principle of customary international law.

In the aviation field this principle was first recognized in the 1919 Paris Convention on International Air Navigation.[161] It was later confirmed in 1944 in the Article 1 of the Chicago Convention in these terms:

" The contracting States recognize that every State has complete and exclusive sovereignty over the airspace above its territory."

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[160] M. Jankovic, "Public International Law", (1984), Transnational publishers, Inc, Dobbs Ferry NY, at 114.

[161] *Convention Portant Reglementation de la Navigation Aerienne*, Paris, October 13, 1919.
This Convention was the first air law document to enter into force. For details see I.H. Diederiks-Verschoor, "History and Development of Air law" cited by Milde, *supra* note 7. See also Henaku, *supra* note13, at 2.

The concept of the territory of a State is defined in Article 2 of the Chicago Convention as "the land areas and territorial waters adjacent thereto under the sovereignty, suzerainty, protection or mandate of such a State."

The appearance of satellite navigation gives rise to the following question: does the GNSS violate the well-established principle of States' sovereignty?

Two situations have to be described: the first one is the state of availability of GNSS and the second one is the use of the signals emitted from the navigation satellites systems.

The simple fact of the GNSS being available can in no way be considered a violation of the States' sovereignty principle.

Indeed the satellite navigation system is based upon satellites which, in the case of GPS, are located at 20.183 Km; and, in the case of GLONASS are orbiting at 19.100 Km.

These positions are far beyond what practice calls the national airspace[162].

There is no question of sovereignty at such an altitude.[163]

The second situation is more complex.

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[162] Even if the boundary between air space and outer space is still not determined with scientific precision, the location of GPS and GLONASS satellites is, without any doubt, much further beyond the States airspaces.

[163] At that altitude it is the Outer Space and the Article II of the *Treaty of 1967 on principles governing the activities of States in the exploration and use of outer space, including the moon and other celestial bodies* (hereinafter called the *Outer Space Treaty*) which provides that "Outer space, including the moon and other celestial bodies, is not subject to national appropriation by claim of sovereignty, by means of use or occupation, or by any other means".

Indeed the current actors of the GNSS providing satellite navigation are the US GPS and the Russian GLONASS.

As was mentioned earlier, both of these are national programs. One is provided by the US and the other by the Russian Federation.[164]

The fact that the signals come from these national systems could lead to the question as to whether there is any breach and violation of other States' sovereignty.

It could appear that there is an American or Russian intrusion in other States' sovereignty.

Moreover, anyone (such as States[165] and other potential users) equipped with a GPS or GNSS receiver can have access to the data.

This situation, also, seems to constitute a violation of the sovereignty of the State concerned.

There is actual no violation of any State sovereignty.

Indeed, as previously explained, the GPS and GLONASS systems provide positioning data.

To provide positioning data can, in no case, constitute a violation of any State's sovereignty.

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[164] Concerning the providers Mr. Henaku pointed a very interesting point.
He confirmed that the provider states are not obliged to provide the signals and that if a State decides to do so (and by that fact to exercise its sovereignty) they have to do it in respect of the Latin maxim "Sic utere tuo ut alienum non laedas". Indeed the exercise of a right can never cause injury to the right of another legal personality. The difficulty faced by the provider appears if there is any malfunction in the satellite system which causes damage as a crash or a collision because, in that case, the provider, being in his rights by providing the signals, infringes the Latin maxim. See Henaku, *supra* note 13, at 196.

[165] By their air army for example.

What could constitute a violation of a State sovereignty is the following situation: a State would determine the air traffic facilities or services on the territory of another State without that States' consent.

Indeed Article 28 of the Chicago Convention provides that:

> Each contracting State undertakes, so far as it may find practical, to:
>
> (a) Provide, in its territory, airports, radio services, meteorological services and other air navigation facilities to facilitate international air navigation, in accordance with the standards and practices recommended or established from time to time, pursuant to this Convention....

The Annex 11[166] to the Chicago Convention mentions moreover that

> Contracting States shall determine, [...] those portions of the airspace and those aerodromes where air traffic services will be provided. They shall thereafter arrange for such services to be established and provided in accordance with the provisions of this Annex, [...]

The Article 28 establishes the principle that the States undertake to provide air navigation facilities if such is their will.

They do not, however, have the obligation to provide them. The article uses the terms "[...] so far as it [the State] may find practical, [...]."

The fact of providing air navigation facilities or not is the exercise of the State's sovereignty.

If the State chooses to provide such facilities, it will exert sovereign authority over them.

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[166] *International Standards and Recommended Practices – Air traffic Services, Annex 11 to the Convention on International Civil Aviation*, Tenth Edition – July 1994 Chapter 2, 2.1.1 [hereinafter *Annex 11*].

No other State can interfere in overseeing these facilities without violating the sovereignty of the other State.

The air traffic facilities include the ATS which themselves include the ATC.

The States then have sovereignty, authority and responsibility in the control of air navigation as well as in the promulgation and enforcement of safety regulations.[167]

GNSS will never infringe on this sovereignty. The fact that the signals give a position, a location does not have anything to do with the control of air navigation.

The sovereignty of the States is in no way violated by the GNSS.

The principle of sovereignty of States over the airspace above their territory already mentioned in an ICAO Council Statement in 1994[168] was reaffirmed in 1998 in the Charter on the Rights and Obligations of States Relating to GNSS Services, which provides that:

> Every State preserves its authority and responsibility to control operations of aircraft and to enforce safety and other regulations within its sovereign airspace. [[169]]
>
> [And that] The implementation and operation of GNSS shall neither infringe nor impose restrictions upon States' sovereignty, authority or responsibility in the control of air navigation and the promulgation and enforcement of safety regulations. States' authority shall also be preserved

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[167] J.,Huang, "Sharing benefits of the Global navigation Satellite System within the framework of ICAO", Ram Jakhu , Space Applications (1997), Institute of Air and Space Law, McGill University, at 316.

[168] *ICAO Council Statement of ICAO Policy on CNS/ATM Systems Implementation and Operation*, (March 9, 1994) ICAO Doc. LC/29-WP/3-2 [hereinafter *ICAO CNS/ATM Council Statement*].
Of course this Policy ICAO Council Statement is not a binding instrument.

[169] *Charter, supra* note 8, at paragraph 3.a).

> in the co-ordination and control of communications and in the augmentation, as necessary, of satellite-based air navigation services. [[170]]

It is important to mention here that the Charter, despite the content that such a word could mean, is only a resolution of the ICAO Assembly.

Every State may then preserve its sovereignty, authority and responsibility in the control of the aircrafts' movements and in the establishment and enforcement of safety regulations.[171]

Before continuing, it is important to stress the fact that if the principle of States' sovereignty upon their territories is a well-established principle, nevertheless a State is always free to waive it, if such is its will.

Indeed, the States made a first step in the erosion of the principle of States' sovereignty in the aviation field by creating together a certain movement of globalization and liberalization of the air transport. It is important to underline that they chose to do so.

The States sovereignty principle was not violated in the true meaning of the term. It was more accommodated within a certain context, which, in the case of the globalization and liberalization, were the benefits that such a system could provide to the national airlines.

Concerning Air Traffic Services, such as ATC or ATM, a State can agree to have its sovereignty accommodated. It is not derogation of the principle of sovereignty but an accommodation of it.

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[170] *Ibid.*, at paragraph3.b).

[171] See also Rio Conference WW/IMP-WP/10 (11/5/98), Item 5, at 3.

Some countries, for example,[172] decided to hand over the management of ATS to private companies.

Another example is the existence of regional ATM arrangements. These situations function well because some States agreed to accommodate their sovereignty by these means.

The Annex 11 foresees expressly this situation in these terms:

"Except that, by mutual agreement, a State may delegate to another state the responsibility for establishing and providing air traffic services [[173]] in flight information regions, control areas or control zones extending over the territories of the former [[174]]."

The note about this provision recalls that

" If one State delegates to another State the responsibility for the provision of air traffic services over its territory, it does so without derogation of its national sovereignty."

No violation will ever be tolerated if it is against the political will of the State concerned.

The consequence of an accommodation is that the State concerned will have to bear the disadvantages of the sovereignty losses but will also benefit from the co-operation.

Professor Wassenbergh accurately summarized the situation very well with these words:

" States are free to choose what they feel is right...The ultimate choice is between absolute independence and "national" freedom on the one hand and international

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[172] As New Zealand, Australia and Britain. See W. Guldimann, & S. Kaiser, "Future Air Navigation Systems, Legal and Institutional Aspects"(1993), Martinus Nijhoff Publishers, Dordrecht, Boston, London, at 184.

[173] ATS includes the ATC service, the flight information service and the alerting service. See *Annex 11, supra* note 166, at Chapter 2, paragraph 2.3.

[174] *Ibid.*, Chapter 2, paragraph 2.1.1.

economic, financial, technological, social and environmental inter-dependence and international co-operation."[175]

To conclude on that legal issue, the GNSS can in no way constitute a violation of the centuries-old principle of sovereignty of States.[176]

2. Universal accessibility without discrimination

Another legal issue about the GNSS is that an universal access to the services provided by the GNSS has to be guaranteed: the access to the GNSS services has to be maintained without any discrimination.[177]

This principle seems logical in a system which has the purpose to be global and universal. Co-operation is the key to success.

The Rapporteur of the Panel of Legal and Technical experts on the establishment of a legal framework with regard to GNSS[178] reminded to the participants that "it was not

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[175] A. Kotaite, "Sovereignty under great pressure to accommodate the growing need for global co-operation" (December 1995), *ICAO Journal*, Vol.50, Nr.10, at 21.

[176] It is interesting to mention that Europe is aware in the creation of Galileo of the need to preserve sovereignty of States in the provision and control of radionavigation services and mentioned that this fact was an element of the political dimension of GNSS.See *GNSS High Level Group, Ad-Hoc working Group on the Set-Up of an organizational framework for GNSS, Draft Final Report May 1999*. [hereinafter *GNSS High Level Group Draft Final Report*].

[177] It may be interesting to recall that the principle of non-discrimination governs also the exploration and use of Outer Space. Article I of the *Outer Space Treaty*, *supra* note 163.

[178] LTEP/2 Montreal, 6-10 October 1997.

discriminatory to treat differently persons who were not in the same position, but it was discriminatory to treat differently persons who were in the same position."[179]

The Article 15 of the Chicago Convention establishes the principle of non discrimination in the following terms "The like uniform conditions shall apply to the use, by aircraft of every contracting State, of all air navigation facilities, including radio and meteorological services, which may be provided for public use for the safety and expedition of air navigation."

The principle of non-discriminatory access to air navigation assistance is then well established internationally.[180]

The non-discriminatory access to GNSS does not seem therefore to raise any objection.

Moreover, ICAO Council already mentioned the principle of universal access in 1994 in a Policy Statement related to the CNS/ATM[181] but this instrument does not have any legal binding force.

The providers of these services themselves declared the application of the principle of universal accessibility without discrimination. Indeed the existing components of the GNSS, the US GPS and the Russian GLONASS, were declared in 1994 by their respective governments as being available "on a continuous world-wide basis" and "on a non-discriminatory basis to all users of civil aviation."[182]

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[179] *Ibid.*, at 1:29.

[180] As well as nationally. See US national Courts cases such as Aerlineas Venezulana v. dade country airport, 1960 cited by P.B. Larsen, *supra* note 95.

[181] ICAO had already declared this principle. See *ICAO CNS/ATM Council Statement*, *supra* note 168.

[182] See Letter from the Administrator of the FAA to the President of ICAO Council (October14, 1994)– Attachment 1 to State Letter LE4/49.1 – 94/89 (undated) cited Milde, *supra* note 7, at 317.

Of course this type of commitment is an unilateral statement issued to ICAO, which does not possess any legal authority to enter into a formal agreement concerning the GNSS. ICAO reaffirmed this principle in the Charter in these terms:

"Every State and aircraft of all States shall have access, on a non-discriminatory basis under uniform conditions, to the use of GNSS services, including regional augmentation systems for aeronautical use within the area of coverage of such systems."[183]

Of course the Charter is only a resolution adopted by ICAO Assembly.

The principle of good faith appears to constitute the only guarantee from which the international community benefits.

It is interesting to note that universal access is also established for the Communications sector.

But in that field the guarantee of good faith is made stronger by the existence of another guarantee: competition in the market.

Indeed, the pressure of the market is really present in the field of communications.

If a provider limits the access to the services he proposes, the user will choose another provider, which guarantees him access without discrimination.

It is the law of the market.

Moreover the satellite communications providers mention expressly in their constitutional acts that they guarantee universal accessibility without discrimination.[184]

In the field of the navigation, the pressure of the market does not constitute a real safeguard for the user.

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[183] See *Charter, supra* note 8, at paragraph 2.

[184] J. Huang, "A legal framework for GNSS, in Integrating Global Air Traffic Management, Guiding Civil Aviation into the 21st Century" (1998), published by ISC and ICAO, at 157.

Indeed, until now, there were only two satellite navigation systems, GPS and GLONASS. The US and Russia are the only signals providers and the only States to control the space segments. The other user States do not control them.

Moreover, as was aforementioned, GPS is the only one actually reliable.[185]

Competition in this market was, for that reason, non-existent.

The situation is changing with the setting up of the European Galileo program, which will come on the market to compete with GPS.

Creation of the European element in the GNSS will guarantee, undoubtedly, more non-discriminatory access to the GNSS.

3. Continuity[186] and quality[187] of the service

The service provided has to be reliable and available on a continuous basis.

The continuity of a service has two definitions: a legal one and a technical one.

The LTEP/1 being, of the opinion that the principle of "continuity" in both technical and legal senses had to be affirmed, defined these terms as follows:

> In the narrow technical sense, continuity may refer to effective arrangements to minimize the operational impact of unavoidable system malfunctions or failure and achieve expeditious service recovery.

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[185] GLONASS is indeed less reliable technically as well as politically than GPS.

[186] The continuity is very close to the concept of availability of the service concerned.

[187] The quality of the service is related to the accuracy, reliability and integrity of that service.

> In a wider legal sense, continuity may also mean the principle that the services are not to be interrupted. Modified, altered or terminated for military, budgetary or other non-technical reasons.[188]

The technical sense of the term "continuity" means that some arrangements have to be undertaken to "minimize the operational impact of unavoidable system malfunctions or failure and to achieve expeditious service recovery."[189]

The legal sense of that term means that the services will not be interrupted "for military, budgetary or other non-technical reasons."[190]

Unfortunately, at the present stage, the assurance of continuous service cannot be guaranteed for two reasons.

The first is that the GNSS was always declared to have the obligation to respect the provisions of the Chicago convention.

Now the Article 89 of the Chicago Convention[191] provides that the States have a freedom of action in case of war and declared national emergency[192]. Therefore, the service provider of signals could interrupt the provision of the service in case of war or declared national emergency.

The term of war is quite clear and limited.

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[188] LTEP/1 (November25-30,1996), Montreal, at 3.5.

[189] See Milde, *supra* note 7, at 320.

[190] See *ibid.*, at 321.

[191] The Article 89 of the *Chicago Convention* provides that: " In case of war, the provisions of this Convention shall not affect the freedom of action of any of the contracting States affected, whether as belligerents or as neutrals. The same principle shall apply in the case of any contracting State which declares a State of national emergency and notifies the fact to the Council."

[192] The *Vienna Convention on the Law of Treaties* of 1969 provides a similar provision in its article 73.

"War may be described as the defense of the interests of one or more States or the pursuance of objectives by means of armed forces. This is a de facto situation in the relations between States in which means of force are used."[193]

But the declared national emergency is not so clear and can cover a large number of situations.

The second reason is that the principle of continuity of the service was affirmed in documents which are not binding.

The assurance of continuous service was indeed affirmed in the ICAO Council Statement in 1994 and reiterated in the Charter in 1998 in the following terms:

> Every State providing GNSS services, including signals, or under whose jurisdiction such services are provided, shall ensure the continuity, availability, integrity, accuracy and reliability of such services, including effective arrangements to minimize the operational impact of system malfunctions or failure, and to achieve expeditious service recovery. Such State shall ensure that the services are in accordance with ICAO Standards. States shall provide in due time aeronautical information on any modification of the GNSS services that may affect the provision of the services.[194]

As was aforementioned, the Charter in a simple Resolution.

The guarantee to provide a continuous service is then in no cases a real legal obligation.

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[193] See M. Jankovic, *supra* note 160, at 349.

[194] See *Charter, supra* note 8, at paragraph 4.

That fact can have serious consequences because the GNSS is becoming the primary means of navigation and may, perhaps, become, one day, the sole means of navigation. Indeed, a single provider could paralyze, by its unilateral decision, the whole worldwide air transport system using GNSS by interrupting the provided service.

There is, for the moment, no guarantee for the users to benefit from a continuous service. There is a need to affirm this principle in a legal framework, with perhaps some exceptions, to avoid any contradictions with the Article 89 of the Chicago Convention.[195]

As Professor Dr Milde wrote, it is not only an act of God that may disrupt the GNSS services but also any "vital interests" or "act of self-preservation" of the States concerned or simply "lack of funds."[196]

Concerning the quality of the service, the idea is to assure the integrity, the accuracy and the reliability of the service to the users.

The current existing systems by themselves cannot provide alone such a quality of service.

Additional systems, as previously examined, provide integrity monitoring as well as augmentations and meet, consequently, the integrity, accuracy and reliability requirements needed to assure the quality of the service.

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[195] However, there was no unanimity in the LTEP/1 concerning the fact whether the legal framework would or would not contain exceptions to the principle of continuity by allowing interruptions or suspension of the service for non-technical reasons.

[196] See Milde, *supra* note 7, at 320.

4. Cost recovery and financing

Financing and cost recovery issues, with respect to GNSS, are difficult issues.

In ICAO there is a special Panel in charge of these delicate issues, the Air Navigation Services Economics Panel (ANSEP).

ANSEP's role is to provide "guidance on funding, charging and cost recovery as well as related organizational and managerial aspects [...]" of GNSS provision and operation.[197]

However, the Panel of Legal and Technical Experts on the establishment of a legal framework with regard to GNSS (LTEP) examined also the financing and cost recovery of GNSS by dealing with the legal aspects, but only the legal aspects, to avoid any overlap with ANSEP.[198]

From a financial point of view, GNSS is just another navigation aid.

The texts applicable to navigation services apply to GNSS.

Two texts are of particular importance: the Chicago Convention[199] which is the basic policy and its Article 15 related to airport and similar charges;[200] and, ICAO Statement[201] on Charges for Air Navigation Services which gives more detailed policy guidance.[202]

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[197] *Air Navigation Services Economics Panel, Report on financial and related organizational and managerial aspects of GNSS* (May 1996), ICAO Doc 9660, at iii [hereinafter *ANSEP Report*].

[198] See *LTEP/1, supra* note 188, Agenda Items 5 & 6, at 5.5.4.

[199] It has to be recalled that the Chicago Convention is binding between the Member States.

[200] The term "similar charges" includes air navigation services charges. See *Manual on Air Navigation Services Economics* (1997), Third Edition, ICAO Doc 9161/3 [hereinafter *Manual*].

The Manual on Air Navigation Services Economics[203] is also useful.

GPS and GLONASS are, as previously mentioned, currently free of user charges.[204] The States' intention is moreover to continue to provide the services free of charge.

The States providers, the US and the Russian Federation, bear the total cost of the systems.

In the case of the US, the GPS system is financed through general tax revenues as well as through air transportation trust funds that are supported by a fuel tax or value added tax.[205]

The US and the Russian Federation promise to continue to provide GPS and GLONASS free of charge, however, the future could be different.

Furthermore, the augmentations systems are not free of costs and the development of the CNS/ATM, of which the main element is GNSS as well as the European Galileo System, also, will not be free of charges either.

For this reason it is interesting to examine how ICAO deals with the financing and cost recovery of GNSS.

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[201] Unlike the Chicago Convention, the Statement is not binding but imposes on States a strong moral obligation.

[202] *Statement by the Council to Contracting States on charges for Airports and Air Navigation Services* (1997) Fifth Edition, ICAO Doc 9082/5 [hereinafter *Statement on Charges*].

[203] See *Manual, supra* note 200.

[204] As a reminder, GPS was offered free of costs to the users for 10 years and GLONASS for 15 years.

[205] See Larsen, *supra* note 95.

(i) Basic principles

There are two basic principles relevant to this matter.

The first general principle establishes that "where air navigation services are provided for international use, the providers may require the users to pay their share of the related costs [...]"[206]

It is also repeated in the Manual on Air Navigation Services Economics as follows: "All States are fully within their rights to recover the costs of the services they provide to aircraft operators through charges."[207]

It is thus established that for any service provided the provider may charge the users for the service provided.

The second principle is the non-discriminatory principle for charges.

ICAO's idea is that charges have to be imposed in a non-discriminatory way.

The 1994 ICAO Council Statement provided that "any recovery of costs incurred in the provision of CNS/ATM services shall be in accordance with Article 15 of the Convention [...]."[208]

The Air Navigation Services Economics Panel in its Report on financial and related organizational and managerial aspects of Global Navigation Satellite System (GNSS) provision and operation.[209]

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[206] See *Statement on Charges, supra* note 202, at paragraph 32.

[207] See *Manual, supra* note 200, at paragraph 1.5 in fine.

[208] See *ICAO CNS/ATM Council Statement, supra* note 168. The Council statement provided also that the cost recovery has to be in accordance to the Statements by the Council to Contracting States on charges for Airports and Air Navigation Services. However this last document does not have the force of law and constitutes only a guideline, a moral obligation on the States only. See Milde, *supra* note 7, at 321.
See also Rio Conference, WW/IMP WP/8 (23/2/98), item 3 at 3.3.

The LETP/1 repeated, "The Article 15 was generally applicable to the costs recovery scheme of GNSS services."[210]

The Charter in 1998 reconfirmed the same idea in these terms: "States recognize that any charges for GNSS services shall be made in accordance with Article 15 of the Chicago Convention."[211]

The Article 15 of the Chicago Convention, which is binding on the signatory States, provides the non-discrimination principle for charges for all air navigation facilities provided for public use in the territory of a particular State.

If the application of the first principle to GNSS does not cause any trouble, the application of the second needs some clarifications.

If ICAO is so sure about the application of the Article 15 of the Chicago Convention to GNSS, however, caution is essential.

Indeed, the application of this provision to GNSS cannot be made automatically[212].

GNSS is a service provided on a global basis. GNSS is a worldwide system. One single system does not cover any more definite national territories.

The provision of Article 15 is related to the charges of all air navigation facilities provided for public use in the territory of a particular State.

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[209] See *ANSEP Report, supra* note 197, at 3.4.

[210] LTEP/1 at 3.28

[211] See *Charter, supra* note 8, at paragraph 6.

[212] See Milde, *supra* note 7, at 321.

ICAO's will to apply the non-discrimination principle to the charges in GNSS is laudable but to base the application of this principle to GNSS on Article 15 seems to exceed the meaning of Article 15.

The application of such a principle to the GNSS charges is essential but this application has to be adapted to the global nature of such a service. For this reason, it cannot be based automatically on Article 15 of the Chicago Convention.

(ii) ICAO's method to determine GNSS financing and cost-recovery

As previously mentioned, the panels in charge of ICAO for financing and cost-recovery related to GNSS are ANSEP. LETP is in charge of the legal aspects.

The ANSEP panel examined five sources of GNSS components funding[213]: direct contribution from Governments[214], debt financing[215], internally generated resources[216], equity financing and leasing[217].

It stresses the need of co-operation among States in the recovery of the costs and also the fact that other major users of GNSS, other than the aviation sector, exist.

ANSEP established also a cost-recovery methodology for GNSS.[218]

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[213] See *ANSEP Report, supra* note 197, at 3.3.

[214] Which would depend on two elements: the organizational form of the GNSS services providing and the types of GNSS components involved.

[215] That will depend on the volume and strength of the traffic to determine if that option will service the debt.

[216] This term means depreciation and retained profits.

[217] This option could apply to integrity monitoring, to augmentations (wide or local area) by the leasing of for example computers.

It defined two categories of charging methods for GNSS.

The first method states that the users would be charged directly by the satellite service provider on the basis of the amount of service received and the second states that the users would be charged through ATS provider or State. ANSEP mentioned the difficulties of implementation that such a method would face.

Some methods were suggested for the second category: charges levied on users of air traffic services (air navigation charges)[219], royalty payments[220], licence fees[221], levies on passengers, freight and/or fuel.[222]

ANSEP made five recommendations related to the financing and cost-recovery issues[223].

The first recommendation is related to the guarantees of servicing and repayment of loan. The second recommendation refers to the cooperation among the States in cost recovery. The third recommendation relates to the financial imperatives for accelerating the amendment procedures for regional air navigation plans. The fourth one relates to the allocation of GNSS costs attributable to civil aviation among user States. The fifth recommendation deals with the role of ICAO in financial and administrative aspects of GNSS.

The ICAO Council approved these recommendations.

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[218] See *ANSEP Report, supra* note 197, at 18.

[219] This method would have the advantage to be closely related to the users, their demand and use of the service.

[220] Which would be a royalty fee imposed on equipment on initial purchase.

[221] This would take the form of an annual service charge imposed on users.

[222] See *ANSEP Report, supra* note 197, at 3.11.1.3.

[223] See *ibid.*, at (vii).

The legal panel will deal with various legal aspects such as in States co-operation in cost-recovery.

The works of ANSEP are the most relevant dealing with financing GNSS because of the financial and economics experts sitting on the Panel.

The legal experts, however, examined GNSS financing. Their works have to be mentioned in order to have a global view of ICAO's work on GNSS financing.

The majority of the experts of ICAO LTEP II agreed on that financing and cost-recovery of GNSS have to be effected through user charges.[224]

Concerning the legal entity that would charge the users, the panel repeated the charging methods suggested and analyzed by ANSEP and examined the advantages and disadvantages of two options.[225]

For recall, the first method is the following: the States would levy the charges.

The advantages of this option mentioned by LTEP II would be that the States have the experience in and the organization for collecting charges. Other advantages would be that the States have the power to impose the payment of the charges and that a strong linkage would be established between the current and future charges.

This method has disadvantages, such as the fact that the charges would be centralized and that an ad hoc mechanism would have to be created to distribute the charges to the providers. Another difficulty would be that the user could be charged twice if two providers provided the service in the same area (as GPS and GLONASS do at present).

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[224] LTEP/2-WP/2 Report on the results of the informal survey conducted by WGII at 2.3.3.

[225] LTEP/2 WP/7 at 3.1&3.2.

The second method is that the charges would be levied directly by the providers.

This option has also both advantages and disadvantages.

The advantages of a direct charge would be a simple financial channel, a certain flexibility concerning the amount's adaptation and one single payment by the user to the provider used. The disadvantage of that situation would be mainly provider insufficient experience in financing and provider difficulty in obtaining payment.

Both methods are still being examined by the experts.

If the experts agreed on the fact that the financing and cost-recovery of GNSS have to be done through the user charges, there is, however, no majority concerning the specific forms to charge the users.

Several relevant proposals were mentioned in the Recommendation 14 of LTEP and proposed at the Rio Conference.

Indeed, as already mentioned, GNSS is the central issue of CNS/ATM system.

For that reason, the financing and cost recovery issues examined by LTEP were reported to the Rio Conference in 1998.

On that occasion ICAO made an analysis of the costs and benefits of CNS/ATM[226] for providers and users[227], which is the basic step to determine the financing and cost recovery of a new system.

It was established that the implementation of CNS/ATM would lead to significant benefits to air transport. ICAO calculated that the implementation of CNS/ATM would lead to an amount of US$6 billion per year costs savings to civil aviation.

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226 It has to be recalled that the main component of CNS/ATM is the GNSS.

227 Rio Conference, WW/IMP-WP/7.

The air carriers, users of the new system, will indeed enjoy significant financial benefits by operating more efficiently in using more direct routings and preferred flight profiles, and by saving fuel thanks to a reduction of delays due to an increased airspace capacity. Of course they will have to invest in new equipment.

The costs of the investment in new equipment include "the equipment procurement and installation labor and hardware [but also] […] a share of the certification costs for the new systems, and there may also be costs associated with aircraft down time or out-of-service time required for installation."[228]

The States that provide the system and support its costs will also benefit from the implementation of CNS/ATM system.

Safety will be improved as well as reliability and efficiency.

The developing countries will have the chance "to enhance their infrastructure to handle additional traffic with minimal investment and afford opportunities to modernize inexpensively."[229]

ICAO made three recommendations in the Rio Worldwide CNS/ATM Systems Implementation Conference concerning the financing and cost recovery of GNSS.[230]

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[228] Rio Conference, WW/IMP-WP/20 at 2.3.

[229] *Ibid.*, at 5.3.

[230] Rio Conference, WW/IMP-WP/1,Item 5. These recommendations are based upon the works done by the LTEP/1, LTEP/2 and LTEP/3. Mr. Henaku remark that it was incredible that the LTEP spent so much time on the financing issues which are the task of the ANSEP. See Henaku, *supra* note 13, at 249.
"Recommendation 12: GNSS services should be considered as an international service for public use with guarantees for accessibility, continuity, and quality of the services.
The principle of co-operation and mutual assistance, as enunciated in the Draft Charter on the Rights and Obligations of States relating to GNSS Services, should be applicable, a fortiori, to the cost recovery of GNSS.

It is interesting to note that ICAO insists once more[231] on the application of the principle of co-operation and mutual assistance for cost recovery.

Moreover, ICAO insists on the fact that aviation cannot be the only sector to pay the costs of GNSS.[232] It stresses the fact that the costs have to be spread between the aviation users and the other users of GNSS such as maritime sector, trucking industry, agriculture, and surveyors.[233]

Recommendation 14 contains a list of several methods for financing GNSS.

It includes a yearly subscription charge per using operator or aircraft, license fees, charges per flight, charges per phases of flight, charges based on total passenger-kilometers and ton-kilometers, or regular en-route charges.

Recommendation 13: In the absence of a competitive environment regarding the provision of GNSS services, consideration should be given as to whether mechanisms should be desirable to prevent abuse of monopoly power on the part of GNSS providers.
The administrative mechanisms for GNSS should be at multilateral, regional and national level. The Danish-Icelandic Joint Financing Agreement could be a model but this would not exclude the use of other types of mechanisms, including existing regional arrangements.
[In the Danish-Icelandic Joint Financing Agreement, the air navigations facilities are jointly financed by the contracting States, operated by Denmark and Iceland and the secretary general is responsible for generally administering the arrangements.]
Cost recovery schemes, if any, should ensure the reasonable allocation of costs among civil aviation users themselves and among civil aviation users and other system users.
Recommendation 14: The aviation user charges which may be considered as possible methods for financing of GNSS include the following:

a) Yearly subscription charges per using operator;
b) Yearly subscription charges per using aircraft;
c) Yearly/monthly license fees;
d) Charges per flight;
e) Charges in respect of different phases of flight;
f) Charges based on total passenger-kilometers and tonne-kilometers;
g) Regular en-route charges; or
h) A combination of the above.

The principles recommended in the ANSEP Report and in ICAO Guidelines should in any event be taken into account."

231 This principle was indeed already mentioned in the ANSEP Recommendation No 2 two years earlier.

232 In the Committee FANS II, this idea of sharing the costs was already mentioned in these terms: "Arrangements must ensure reasonable allocation of costs between the user States, aviation and other systems users". FANS II/3-WP/87 Guideline III-6.

233 See Chapter II C. Applications above.

5. Certification of the GNSS

"GNSS, like other air navigation facilities, requires certification by the relevant authorities to ensure that it complies with navigation performance criteria related to civil aviation safety."[234]

Certification can be defined as "an adjudicatory process whereby government makes a determination of eligibility based upon a factual presentation by the applicant."[235]

Before going further, it is essential to recall that certification of GNSS has to be distinguished from the authorization provided for the use of GNSS.

Indeed the certification of GNSS is a technical matter that refers to the conformity, with certain criteria; the authorization to use GNSS is a "policy matter, which is a decision to be made by each State and will be based on its national policy consideration".[236] This section is dealing with the certification of GNSS and not with the authorization of its use.

The Working Group II (WG II) of LTEP deals with the GNSS certification issue.[237]

LTEP put forward eight recommendations which were presented at the Rio Conference in 1998.[238]

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[234] J.Huang, "Development of the Long-Term Legal Framework for the Global navigation Satellite System" (1997) XXII, Part I *Annals of Air and Space Law* 585, at 593.

[235] See M.A. Dombroff, "Certification and Inspection: An Overview of Government Liability" (1981-82) 47 *J.Air L.& Com.* 229, at 231.

[236] LTEP/2-WP/2, at 2.1.3.

[237] The other topics dealt with in WG II were: administration, financing and cost recovery and liability.

These eight recommendations are related to the legal aspects of certification.

Three issues[239] are relevant : the certification authority, the certification procedure and the certification standards.

(i) Certification authority

Certification is performed at the national level. The certification authority is the national governments and they have the responsibility of certification.

In the 29th Session of the Legal Committee in 1994, it was envisaged that the GNSS providers would have to obtain certification from ICAO.[240] This idea was quickly rejected by the first LTEP: the national governments will assure this function.[241]

ICAO will play, however, a limited role in the process of certification: it will serve only as a forum to exchange information and to co-ordinate them.

This information is essential for the user States to know about the reliability of the system.[242]

Recommendation 7 provides that role to ICAO in these terms "[...] additional information [...] should be made available and distributed through ICAO. [...]."

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[238] Rio Conference, WW/IMP-WP/11.

[239] Raised in LTEP/1.

[240] Report of the Rapporteur on the Consideration with Regard to the Global Navigation Satellite System (GNSS) of the Establishment of a Legal Framework, Legal Committee 29th session, Montreal 4-15 July 1994, LC/29-WP/3-1.

[241] LTEP/1 Report on agenda items 5&6 at 5.3.1.

[242] "Access to information is a crucial step in the process of certification. States which do not certify but authorize the use of GNSS also need certain information to satisfy themselves concerning the reliability of the system."
"The user State needs to obtain detailed design and historical data from the owners and operators of the various GNSS components approved for use in its airspace for the purposes of, *inter alia*, accident investigation". LTEP/2-WP/2.

Recommendation 8 identifies the functions of ICAO forum for exchange of information on GNSS certification.

ICAO will play this role through implementation groups and regional planning.

The Recommendation 2 is not really clear exactly what role is assigned to ICAO beyond the adoption of SARPs but it is certain that ICAO has no jurisdiction to validate or to verify GNSS services in accordance with SARPs.

The only task of ICAO related to the certification of the GNSS is, as already mentioned, to provide a forum for information exchanges between the providers and user States.

(ii) Certification standards

Concerning the standards of certification, the experts of the Panel generally agree after debates that certification has to take place in accordance with ICAO standards.

The recommendation 3 confirms that "States providing signals-in-space, or under whose jurisdiction such signals are provided, shall certify the signals-in-space by attesting that it is in conformity with SARPs."

The SARPs will cover, as noted in the Recommendation 1, the system performance criteria of relevant satellite components, signal-in-space, avionics, ground facilities, training and licensing requirements. It will also oversee the system as a whole entity and contain failure mode information to enable States to determine the safety impact on their air traffic service.

For certain authors, if the SARPs are not met, the article 33 of the Chicago Convention will apply[243].

This article provides that:

> Certificates of airworthiness and certificates of competency and licenses issued or rendered valid by the contracting State in which the aircraft is registered, shall be recognized as valid by the other contracting States, provided that the requirements under which such certificates or licenses were issued or rendered valid are equal to or above the minimum standards which may be established from time to time pursuant to this Convention.

In other terms, if the SARPs are not met, the States will have the possibility to decline the recognition of the validity of the certificate.

At least one author, Professor Dr. Milde, rejects any reference to or analogy with Article 33 of the Convention which deals with a completely unrelated issues.

Practically, the States users will wish to ensure that the States providers comply with the SARPs.

Recommendations 4-5 provide that the States providers should also ensure application of ongoing safety management processes and should produce a safety system document.

Practically, it is quite difficult to receive information from GNSS space segment providers regarding the technical specifications and the safety aspects of the system.

On one hand, States users rely on this same system; but, on the other hand, the States providers do not want to reveal the secrets of their system.

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[243] J. Huang, "ICAO Panel of Experts Examining the Many Legal Issues Pertaining to GNSS" (October 1997), ICAO Journal, at 21.

The safety impact assessment system contained in Recommendation 5 allows the provider to operate his system without giving a detailed a priori regulation if a document is published related to the safety of system containing details about the system's safety aspects and ways to prevent any danger.

This allows the operator to keep the secrets of his system and it gives to the concerned regulator and user and institutions the assurance that they are dealing with a serious provider.

This system leads to the understanding that the maintenance and supervision of the level of safety is not in the hands of the regulator but in the hands of the provider.

(iii) Certification procedure

Concerning the certification procedure, the certification is, as mentioned above, performed at the national level. The national authority in charge of the certification will then determine the procedure of certification.

But, if the States agree, it is always possible to perform certification through a regional body. In this case, the procedure of certification will be determined by this regional entity.

6. Liability

It might seem pessimistic to talk about liability.

Indeed to talk about liability means to study actual and potential occurrence of problems such as failure in the system, which causes or could cause damage to person or property. Nevertheless, to examine the legal issues without examining the liability issue would create a gap in the attempt to provide a global view on GNSS.

Liability is one of the most complex and controversial issues in law.

Liability can be defined as " the accountability of a person or entity for damage caused to another person or entity as defined and regulated by a particular set of rules and principles."[244]

The creation of GNSS forces the technical and legal experts of ICAO to address the question as to which liability regime will apply to GNSS.

The liability in GNSS is, unfortunately, still an unresolved issue. There are still many discussions concerning the relevancy of creating a specific liability regime for GNSS, and if so, what type of liability would apply.

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[244] WG1 Paper 3 Definition of the Requirements for A Liability System for GNSS-2, June 28 1999 European Commission at 1.2.

One of the difficulties of the matter is the fact that GNSS involves several categories of law: private, public, air and space.[245]

The contractual relationship between the provider and the user is a relationship in private law: the non-performance of its obligation by the provider may constitute a breach of contract, which will lead to liability.

But the provider, and often the user,[246] are States.

Indeed, the current providers of GPS and GLONASS are the US State and the Russian State and, as soon as States are involved, public law is concerned.

Both Space Law and Air Law can, in a certain way, be concerned by the GNSS.

The authors express different opinions as to the application of one or the other to GNSS.

Concerning Space Law, the Articles VI and VII of the Outer Space Treaty,[247] as well as the Convention on the International Liability for Damage Caused by Space Objects,[248] could apply to GNSS. In the field of Air law, Articles 28 and 37 of the Chicago Convention are related to air navigation aids.

Another difficulty is that any liability regime has always to respect a certain balance between the interests of the parties: the victim has to be adequately and effectively

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[245] A. Kotaite, "ICAO's Role with Respect to the Institutional Arrangements and Legal Framework of Global Navigation Satellite System (GNSS) Planning and Implementation"(1996),*Annals of Air and Space Law*, XXI, Part II, at 202.

[246] Because of the fact that the State that has formally approved the use of GNSS signals provided by another State for air navigation over its territory is called a user State.

[247] Treaty on principles governing the activities of States in the exploration and the use of outer space, including the moon and other celestial bodies, opened for signatures at Moscow, London and Washington, on 27 January 1967

[248] *Convention on the International Liability for Damage Caused by Space Objects* opened for signature at London, Moscow and Washington on 29 March 1972 hereafter called the *Liability Convention*.

compensated but the defendant does not have to feel too much pressure otherwise he could decide not to further offer the service.

It is interesting to mention briefly several options existing in law and which some people might apply to the GNSS liability before examining the need to create a new legal framework in the form of a Convention that would cover the GNSS liability.

(i) The solutions of the existing law.

A) AIR LAW

For some authors, "GNSS will be just another navigation aid, in substance not different from the existing navigational aids (VOR/DME, LORAN-C, OMEGA, INS, etc) for which no special treatment of the liability issues was ever contemplated."[249]

Consequently, the existing air law is largely sufficient to cover the GNSS liability problems: the regime of the Article 28 of the Chicago Convention governing the traditional air navigation services will simply be applied to GNSS: the State is responsible for the navigation services concerned.

If an accident occurs, the investigation will be done by that State. A Court of that State will be competent and a single law applies - the one of the State providing the navigation services.[250]

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[249] See Milde, *supra* note 7, at 323.

[250] The State providing the navigation services is responsible even if the navigation services are delegated to a public or private agency. As well, the State related to the navigation services concerned will be responsible, even if a co-operation with other States exist.

B) SPACE LAW

Some ICAO legal experts[251] submitted the idea of applying the Article II of the 1972 Convention on the international liability for damage caused by space objects.[252]

However, the reference to this convention concerning GNSS seems inadequate.

"Such a reference is prima facie erroneous and irrelevant."[253]

Indeed this Convention concerns the physical damages caused by a space object on the earth or to an aircraft in flight.[254]

The Convention does not cover the economic damage or the economical loss.

The Convention regime does not extend to the damages caused by faulty transmission or reception of a signal generated by space objects.

Moreover, the damages have to be caused by the space objects and, in the case of GNSS, the signals, but not the damages come from the space objects directly. The damages are caused by faulty operations of the signals, not by the physical impact of the satellite.

The liability can indeed never be delegated. " La responsabilité ultime associée a l'engagement consenti par les États en vertu de l'article 28 de la Convention de Chicago, quant à elle, ne peut être déléguée à une tierce personne et demeure dans les mains de l'état déléguant"in Schubert, F., « Réflexions sur la responsabilité dans le cadre du GNSS », La chronique du naviguant, *Revue Navigation* (October, 1997), Vol. 45, Nr. 180, at 418.

[251] LTEP/2, Report on Agenda item 2, at 2.41.

[252] This article provides that "A launching State shall be absolutely liable to pay compensation for damage caused by its space object on the surface of the earth or to aircraft in flight".

[253] See Milde, *supra* note 7, at 323.

[254] Indeed in the Article I of the Convention, the term "damage" is defined as "loss of life, personal injury or other impairment of health; or loss of or damage to property of States or of persons, natural or juridical, or property of international intergovernmental organizations".

C) TELECOMMUNICATIONS LAW

Some LTEP experts raised even the idea to apply the same regime of liability to GNSS as one of telecommunications because of the transmissions of signals in both cases.[255]

In the telecommunications liability regime, the operators generally disclaimed the liability for system failures.

Another expert addressed the suggestion that several types of damages exist: direct and indirect or consequential damages. He noticed that the consequential damage in case of a GNSS signal loss would be dramatic in the field of aviation. It could lead to aircraft accident. To agree to a disclaimer of liability without certain guarantees would be shocking.

The idea to apply the same regime as the telecommunications was therefore rejected.[256]

D) NATIONAL LAW OF THE PROVIDERS

As already mentioned several times, the two providers of GNSS are at present time the US and the Russian Federation.

Both GPS and GLONASS providers apparently rejected the idea of reference to a worldwide liability or responsibility[257] in a legal instrument on the basis that the services they offer as a public utility are offered to an unknown number of users. For this reason,

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[255] LTEP/1 Report on Agenda Item 5&6 at 5.4.3.

[256] LTEP/1 Report on Agenda Item 5&6 at 5.4.4.

[257] The terms "responsibility" and "liability" have to be distinguished: the "responsibility" refers to "the state of being answerable for an obligation" and the "liability" involves "a breach of obligation due to negligence or other fault, which would cause damage to others, compensable usually in terms of money." While it is easy to distinguish the terms theoretically, "in practical terms, those responsible are usually also the ones that were liable". LTEP/1, Report on Agenda Item 3 at 3.32.

the providers have no control on the users and are in no legal relationship with them except in their duty to provide in good faith the signals that they offered in their unilateral statements.

But that does not exclude a possible liability based upon applicable domestic law for negligence.

Indeed, concerning the GPS, actions against the provider, the US, are possible on the basis of the Federal Tort Claim Act.[258]

The US Courts are exclusively competent wherever the damage occurred.

The legal regimes existing for the moment cover all the situations with failures of GNSS signals but some doubts can be mentioned about the satisfaction that the several existing compensation processes give to the victims.

The question was raised: is there a need to create a new legal framework which would cover the GNSS liability?

(ii) The need to create a new legal framework

Several experts and authors are in favor of a new convention which would deal with GNSS liability.

Their opinion is that GNSS differ from conventional air navigation systems and that GNSS raises new questions related to liability.

[258] Which means that the same regime applicable to the ATC will apply to GNSS.

They stress the fact that if an accident occurs because of navigation services, "the organization of GNSS services results in a multiplication of recourses and a risk of less-than-full compensation"[259], which is completely different than for the traditional air navigation services.

In the case of satellite navigation, a few States or entities provide the navigation.

"Each of the actors plays a distinct but interconnected role in the effective provision and use of satellite navigation signals, and is at the same time source of injury to others."[260]

The provider of satellite navigation signal bears, of course, the greatest degree of liability risk from the provision of GNSS.

If an accident occurs, the victims will sue the State providing the air navigation services[261] on the basis of Article 28 of the Chicago Convention because that State authorized GNSS services. The victim will, however, also sue the State or entity responsible for the primary service and the State or group of States responsible for the augmentation services.[262] More than one State liability is concerned, which is a totally new situation.

Such a situation will lead to a multiplicity of courts competent, to a multiplicity of laws applicable to the situation and to the risk of denials of justice or less-than-full

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[259] LTEP/2-WP/5 at 1.

[260] B.D.K. Henaku , "The International Liability of the GNSS Space Segment Provider" (1996), *Annals of Air and Space Law*, Vol. XXI, Part I, at 146.

[261] The victim will bring its action against the State above which the accident occurs or State user, because that State has formally approved the use of the signals coming fromGNSS signals provided by another State for air navigation over its territory. Of course the State user can bring an indirect action against the service provider or other which contributed to the occurrence of the damage.

[262] Even other defendants could be sued, such as the operator of the aircraft using GNSS, GNSS equipment or manufacturer. The number of defendants in a GNSS liability case can be large.

compensation.[263] Moreover, many of the State entities may enjoy immunity from jurisdiction.

If the victims decide to sue all of them, it will take a certain time to get compensation and, moreover, there is always a risk that the defendants will not be found liable.

Some people in favor of a new legal framework use the argument that certain situations, which can occur with GNSS such as a non-fault malfunction[264], are governed neither by the Chicago Convention nor by other existing rules.

A new legal framework that would take the form of a Convention would be, therefore, desirable to offer a uniform liability regime. This regime would provide prompt and effective compensation to the victim.

To develop a new convention will, of course, take time[265] because of the complexity of the matter and also because it takes always time for States to ratify a new convention.

There is still much discussion among ICAO legal experts and authors concerning the type of liability (fault liability, strict liability, limitation or not of liability...), which would be applied to GNSS in the new Convention.

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[263] Indeed, if several judges are in charge of the same case and apply different laws, it seems highly hypothetical that the damage will be completely covered.

[264] Or liability for risk, cases of malfunctions of a service produced by a provider availing itself of sovereign immunity, cases of an enterprise delivering a GNSS service on an autonomous basis. See LTEP/2-WP/5 at 2.

[265] For example, the liability of ATC Agencies was studied by ICAO Legal Committee for more than 20 years.

The majority of them are, however, in favor of a strict liability or no-fault liability regime with limitation of liability.[266]

At the Rio Conference, LTEP presented its work. Three of their recommendations[267] concerned liability.

There was obviously too much discussion about the liability issue in the LTEP and no consensus was reached in order to have a clear regime of liability apply to GNSS.

The recommendations mention, therefore, the need for further studies concerning the liability regime.

Recommendation 9, as well as recommendation 11, stress the fact that certain concepts have to be further considered and discussed, such as; fair, prompt and adequate compensation[268], disclaimer of liability[269], sovereign immunity from jurisdiction[270], physical damage, economic loss and mental injury, joint and several liability[271], recourse action mechanism, channeling of liability[272], creation of an international fund, the two-

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[266] See LTEP/1, Report on Agenda Item 3 at 3.34. This orientation reflects the trend existing in the aviation sector to have a strict liability until a certain amount and a fault liability above the ceiling.

[267] Recommendation 9, 10 and 11 are related to the liability. See Rio Conference, WW/IMP-WP/11, Attachment 3.

[268] Indeed the damages have to be compensated in a just and equitable manner.

[269] It seems that disclaimer of liability, if accepted in the field of satellite telecommunications, is not appropriate for navigation satellites because of the importance of the signals transmitted in terms of safety for the aviation sector.

[270] It seems that this doctrine will not be applied to GNSS to ensure the liability allocation adequalety.

[271] See LTEP/2-WP/2 at 2.2.5.

[272] Or regulatory chain is a concept proposed by EUROCONTROL: a serie of contractual arrangements would be made to provide performance guarantees on one hand and to identify the extend of liability on the other. A Contract would be conclude between the primary signals provider and the augmentation signal provider, between the GNSS service providers and the user States, between the GNSS service providers and the industry.

tier concept, namely strict liability up to a limit to be defined and fault liability above the ceiling without numerical limits.[273] The practical experience in the commercialization of GNSS services as well as the appropriate methods of risk coverage have also to be taken into account.[274]

Recommendation 10 addresses the need to record the signals to solve the problem of evidence.[275] The record of the signals would be useful if the regime of liability chosen is a fault-based liability regime, or in case of a strict liability regime with ceiling for the fault liability above the ceiling.

To conclude with the liability issue, the satellite navigation is perhaps another navigation aid but the characteristics of this new navigation aid differ from the traditional ones because of the use of satellite.

Existing national laws which can reasonably apply at present time are unsatisfactory.

To create a Convention which would rule on the liability issue in GNSS is necessary for the long-term but its preparation should in no case delay the practical implementation of the GNSS.

It is quite impossible to sign a contract with everybody. Eurocontrol suggested that in Europe, a European GNSS agency would sign the contracts on behalf of its members with the signal providers and the system operators.

[273] See LTEP/2-WP/2 at 2.2.4.

[274] In 1997, LTEP stressed also two other important elements to take into account: the non abrogation of the duty of care for provision of GNSS service on the basis that aviation safety is concerned and the certitude that the insurance costs against liability will be properly contained to maintain the economic efficiency of the system.

[275] See LTEP/2-WP/2 at 2.2.6.

It might seem strange to talk about the need to solve issues of liability with respect to GNSS prior to its practical implementation.

It is never too early, however, to prepare strategies in advance which address potential problems.

There is no need to wait for the actual, and often tragic, experience with possible damage to think about a liability regime that would apply.[276]

Any precipitous preparation of a Convention would hardly marshal sufficient political will of States for its wide adoption.

A long-term legal framework concerning GNSS is necessary but this undertaking needs time and careful planning.

Moreover, the liability issue concerning GNSS is perhaps not the only issue a GNSS Convention would have on its agenda.

B. Some legal issues related to the creation of Galileo

Two main legal issues related to the creation of Galileo are interesting for examination: the financing and its organizational framework.

Moreover, it is interesting to explain briefly what the European opinion is about certification and liability related to GNSS.

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[276] *Contra* Milde, *supra* note 7, at 323.

1. Financing

The idea to create a European element in the GNSS is a worthy undertaking, but what would be the use of an idea?

The realization of such an idea requires both technical knowledge and financing.

Determining ways to finance Galileo is a major and difficult task.

The European Commission examined the financing of Galileo in its Communication and created a Task Force on PPP to examine how public and private sectors could collaborate in Galileo's financing in more detail.

Of course, given that Galileo is currently at the definition phase, any element is susceptible to be modified in the future.

The estimated costs and financing plan of Galileo issued by the European Commission will be addressed.

Finally, the positions of some interested actors will be examined.

(i) Estimated costs

The set up of Galileo requires a space segment and a ground infrastructure.

The cost of both elements depends on the satellite constellation. For example, the cost of the satellites located on GEO and IGSO and the launches of these satellites are relatively high compared to the MEO satellites and launches of MEO satellites.

Because some options[277] related to the satellite constellation have to be studied further, the exact cost of Galileo cannot be determined at the present time with high precision. However an estimation of the potential cost of GNSS can nevertheless be done.

ESA together with the industry estimated the cost of a 36 MEO and 9 GEO constellation around 2.2 billion Euros over a 9 year period[278] and the cost of a 21 MEO and 3 GEO constellation around 1.6[279] billion.[280]

The development cost is estimated around 272 million Euros and the launching of two prototypes and the reuse of EGNOS around 449 million.

This leads to an approximate global cost of 2.198 billion Euros.[281]

Recurring costs after 2008 are estimated to reach 155 million Euros[282] annually.

To face these approximate costs, the European Commission developed a financing plan.

(ii) Financing plan

The purpose of the financing plan of the European Commission is to give some options to follow to finance the definition, development, deployment and operation phases of Galileo.

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277 As the potential European co-operation with GLONASS. The co-operation with the Russian Federation would indeed reduce European costs.

278 From 1999 until 2008.

279 1.477 billion Euros exactly. See *EU Communication, supra* note 136, at Annex III b).

280 See *ibid.*, at 14.

281 The CAS, security and safety certification would need moreover a specific budget of around 750 million Euros.

282 For details about costs estimation, see *EU Communication, supra* note 135, at Annex III b).

As previously mentioned, Galileo will have to compete with the American GPS system and the Russian GLONASS system which are offered free of charge.

Moreover, the US are currently leaders in satellite navigation and their long-term objective is to remain in that position.

Europe must consider this objective in the setting up of Galileo.

The fact that GPS is free of charge and that the US has the intention to remain the leader in the field lead to the conclusion that Galileo cannot be exclusively financed by the private sector, user of the services. Moreover, the users will never agree to finance a service that they could receive from another provider free of charge.

Public funding will therefore need to be found to finance Galileo.

The European Commission set out a financing plan examining a three point strategy for Galileo's financing and stressing the participation of both public and private sector.

The three sources of Galileo's financing considered are the following:

- Substantial financing at the European level, through the EU Budget, notably the Transport TEN, and through ESA;
- Establishment of revenue streams, which is likely to require regulatory action; and
- Developing a public/private partnership, to deliver complementary finance and value for money.[283]

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[283] See *ibid.*, at 13.

A) EUROPEAN PUBLIC FUNDING

As previously mentioned, Galileo will be an important element of the Transport Trans-European Network (TEN) and the Common Transport Policy.

The participation of the EU in Galileo's financing is therefore logical.

The European Commission examined several sources of European financing:

It found that 500 million Euros could be allotted to Galileo on the 5.5 billion budget allowed to the TEN.

The second source considers that120 million Euros could be allotted to Galileo on the budget allotted to the 5th Framework Program of the European Union for research, technical development and demonstrative activities.

The Commission's TACIS program could also support the cost of training and conversion of industries from military to civil purposes in the case of co-operation with the Russian Federation.

Finally, ESA could mobilize funds[284] through its institutional mechanisms.[285]

A total of 1.25 billion Euros could already be obtained from the European Union for a total of around 2.95[286] billion Euros of estimated costs.

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[284] The estimation mentioned the amount of around 500 million Euros.

[285] It is interesting to note that the EU would concede some amounts of its existing projects to Galileo but that ESA would have to create a new programme to mobilize funds.

[286] Obtained by the addition of 2.198 billion to the 750 million for CAS, security and safety certification

B) REVENUE STREAMS

Revenue streams will have the advantage of leading to a reduction of public subsidies and will facilitate the PPP.

The European Commission considered three main sources of revenue streams.

The first one is related to the three levels of services that Galileo would provide.

As discussed, Galileo will provide three levels of services and in accordance

with that, the European satellite navigation market can be divided into two main categories combining the three levels of services: the professional market[287] and the mass market[288].

A study of both category markets shows a progressive growth for the future in the number of users of satellite navigation. Indeed many applications are done from satellite navigation and positioning system and their number will continue to increase in the future.

It therefore seems normal to think about charging the users for the services they use to finance the Galileo program. However, not all the users will be charged.

Indeed the level 1 would be the service generally available, provided to the mass market.

It is obvious that no financing could be obtained from level 1 users.

The reason is evident: since GPS and GLONASS signals are being offered free of charge for a few more years, it would be a big mistake for Europe to charge the level 1 users.

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[287] Including notably the aviation, maritime and rail sectors.

[288] Including road transportation, people mobility *etc.*

These users would indeed prefer to use a system free of charge than to pay any charge for another system.

A charge could be considered eventually for level 1 users, if the US and Russian Federation do not renew the offer to provide services free of charges at the deadline of their offer and begin to charge their users. Nevertheless, this situation is hypothetical.

Level 2 and 3 would be CAS. Level 2 is the certifiable service[289] that guarantees availability. Level 3 is the service specific to safety of life and security related services.

Level 2 and 3, contrary to Level 1, could be financing sources for Galileo.

It is considered, at the present time, that the users of level 2 and 3 services would benefit from the technical characteristics of the system, but in return for fees.[290]

The controlled access signal of Level 2, as already mentioned, might be either optional or mandatory.

The Galileo Task Force on PPP addresses the fact that where the use of Galileo signal would be mandated, a "shadow toll model[291]" could be developed.

The public authorities would pay a shadow toll to a private operator.

The shadow toll would be based on the estimation of the system's usage.

The safety of life and security services of Level 3 are normally free of charges and the access to them, not normally controlled.

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[289] It can also be defined as the CAS for commercial application. The users of this service need additional features or combined services than the mass market.

[290] The fact that the use of the level 2 and 3 services might be declared by regulatory decisions mandatory in certain situations could consist also in a certain revenue source. IMO for example requires the ships which are internationally registered to be equipped with GNSS from 2000.

[291] *Galileo Task Force on Public Private Partnership*, Chairman's Report (June 4, 1999), Brussels, at 7 [hereinafter *PPP*].

The possibility to restrict and control the access to such a service and the fact that this service would be charged have to be examined with international organizations[292] for which safety is a priority.

The " shadow toll" mechanism could be applied also to level 3 services.

A second option would be to impose a general levy on signals receivers.[293]

Levies are commonly used all over European States for certain products.[294]

The Galileo receivers would join the list of these products.

The difference with the first option and the benefit of the second option is that all users of the services would be concerned by the levies, the users of Level 1 services included.[295]

The levy could be based on the type of use[296] expected or could be a flat rate imposed on every single receiver.

This levy requires legislation and would be introduced by EU regulatory decisions.[297] It would apply to any receiver sold in the EU as well as imported into the EU.

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[292] Such ICAO and IMO.

[293] Companies such as Matra Marconi, Daimler Chrysler Aerospace and Alcatel particularly examined this option.

[294] Such as video tapes, recording equipment *etc.*

[295] The European Commission estimates that "[If half the new cars registered annually in Europe would be equipped with GNSS] a levy of 20 [Euros] on receivers would lead to receipts of 140-205 million [Euros] annually and could go a considerable way to filling the financing gap for project construction and development." See *EU Communication, supra* note 135, at 17.

[296] As navigational use only or navigational and communication uses combined.

[297] Which will take time to elaborate.

The problem that would have to be faced is the readiness of public authorities to organize collection and distribution of these levies. This option would have to be implemented with administrative overhead.

The European Commission announced a third possibility in the following terms:

"The private sector could generate revenue through wide-ranging applications, facilitated by the integration of communication and positioning, including dedicated navigation-related commercial and high accuracy services and integration of safety-related and security-critical payloads."[298]

The combination of integrated communications function with navigational and positioning function would for sure generate revenue streams from the mass market to finance Galileo.[299]

The concept requires only the integration of a communication payload on Galileo satellites and applies to MEO satellites as well as to IGSO satellites.

C) PUBLIC PRIVATE PARTNERSHIP (PPP)

The idea is that the European program Galileo would be "designed, developed, deployed, operated and maintained as a result of a PPP."[300]

Public and private sectors have to cooperate in Galileo's financing.

The need for public sector intervention in Galileo's financing as well as the need to attract private sector's investments in such a program are obvious.

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[298] See *EU Communication, supra* note 135, at 17.

[299] The company Telespazio elaborated a "business case" about this option and the financial effects of such a combination. See *PPP, supra* note 291, at 9-11.

[300] ICAO GNSSP/3-WP/65 at 3.4.1.

The project Galileo will go through four different phases: the definition phase[301], the development phase[302], the deployment phase[303] and finally the operational phase[304].

The definition phase is planned by the European Commission to be financed primarily by public funds of both EU and ESA.

The development phase would be financed mainly by public funds, EU member States loan guarantees and loans from EIB, commercial banks or similar institutions.[305]

The third phase would be financed by loans or cash flows from public sector, commercial banks and capital market.

The last phase would be financed by the private sector.[306]

One of the objectives and hopes of the European Commission is the partial substitution of public sector financing for private sector financing by the operational phase.

The public sector underwriting Galileo's financing for the first phases would be partly handed over to the private sector's financing for the operational phase.

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[301] Called also design phase in which " the feasibility study is completed, the infrastructure is detailed, the regulatory and commercial environment is defined and the private partners are taken on board." See *PPP supra*, note 291, at 11.

[302] This phase is the phase "in which the infrastructure is developed and validated. Private finance is put in place and the Galileo Infrastructure Promoter, which will be a Special Purpose Vehicle company (SPV) set up." See *ibid.*, at 11.

[303] This phase is the phase "in which the complete system is put in place and the operations worked up." See *ibid.*

[304] This phase can be defined as the phase "in which the services are offered and the system is maintained and developed." See *ibid.*, at 12.

[305] The interests of the loans would be borne by the TEN Budget as it is already done for other European projects such as Malpensa or Oresund.

[306] Through the form of levies on receivers, "shadow tolls" from EU Member States.

The public sector would intervene in the financing of Galileo at the beginning of the program's set up to give a jump start to the program and to give confidence to the private sector to invest. The private sector would hand it over afterwards.

Even if the public sector intervenes more at the beginning of Galileo's project and the private sector at the end, both sectors will be involved in the development of Galileo and in its control.

Such a shared involvement will permit both sectors to reach an equitable repartition of risks[307] and rewards.

Moreover, even if the public sector will intervene mostly at the beginning of the project, the participation of the private sector in Galileo would not be limited to the operational phase. A participation of the private sector is also strongly encouraged in the definition phase as, for example, in the project design.

After the definition phase, both public and private resources would be mixed in a Program Management Board (PMB)[308] which would deal with the next phase, the development phase. Every public and private investor would have a seat in the PMB which would contract out Galileo development to a vehicle company.

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[307] A project like Galileo comprises many risks of several nature: political and institutional risk, market risk, third party liability risk, financial risk, technical risk, certification risks, schedule risk.
The consequence of the occurrence of any of these risks would be a delay in the schedule elaborated for the definition, development, deployment and operation of Galileo which would give rise to an augmentation of cost for the constructor and a loss of incomes for the operator.

[308] PMB tasks would be amongst other things to stimulate the industry to take part in financing, to evaluate and to manage the risks.

Further work has to be done in a few areas: an exacting performance requirement checklist would have to be drawn up, an identification and allocation of the risk defined so the private sector could analyze the balance between the risk and the reward, an identification of revenue streams described with the specific determination of the users agreeing to pay for CAS and the public sector commitment to regulate to secure these revenues.

If the public sector refuses to put the revenue streams in place, the set up of Galileo would be run by a traditional model, such public works contracts, done by a Program Development Office created to fulfill this task and which would be replaced by the vehicle company by the operational phase

D) OTHER SOURCES OF FINANCING

The European Commission foresaw, however, the potential need for further sums[309] and, to face this need, considered other financing vehicles.

It considered the participation of international partners[310] which would cooperate in the Galileo program. It considered, also, the participation of the European Union Member States individually.

The potential involvement of the EIB[311] through long-term loans was also mentioned by the European Commission.

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[309] Between 950 million and 1.7 billion on the basis of the costs estimation described above.

[310] Such as Canada, Japan *etc.*

It is interesting to mention that EIB has so far not been asked to contribute to the funding of the preliminary project phase of Galileo.

EIB participates at present in Galileo as an adviser only but brings considerable experience in Task Force PPP discussions.

Depending on subsequent processes, EIB's participation could remain that of an adviser, but, as the European Commission mentioned it, EIB could also be asked to fund Galileo's infrastructure through loans.

It is certainly early days to have a clear idea about the terms, the loan amounts as well as the security structure. It is at the present time, moreover, pure speculation. What can be Stated firmly is that the EIB lending would not exceed the statutory maximum of 50% of eligible investment cost[312] and the interest rates applicable would be in line with EIB funding cost in the market for the term required.

(iii) Reactions of the airlines, future potential users of the system

The Galileo project gave rise to reactions among the potential future users and charges payers of the system.

European civil aviation is one of the potential users of the European program.

As already mentioned, the civil aviation would be a user of the level 3 services which would not be offered gratis to the users.

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[311] European Investment Bank located in Luxemburg.
If the cooperation between Europe and the Russian Federation takes place, the EBRD (European Bank for Reconstruction and Development) could also intervene.

[312] However presumably net of EC/ESA funding.

It is interesting to examine the reactions of the Association of European Airlines as well as the ones of some European airlines about the European initiative in the field of satellite navigation and its financing.

A) THE ASSOCIATION OF EUROPEAN AIRLINES

AEA is completely opposed to GNSS-1 phase named the EGNOS program for several reasons.[313] It even declared "EGNOS is a wrong investment since it will not provide any tangible operational benefits".[314]

The association stresses the fact that the airlines will not participate in the financing of the EGNOS infrastructure and operation and that this project will have to be completely funded by public resources.

AEA is actually afraid that the European airlines would have to support the costs of EGNOS, which would not provide them any benefits.

Concerning Galileo, AEA is skeptical.

For what is termed the GNSS-2 phase, AEA is not strongly opposed to the Galileo program but would not give a "blank cheque pro-Galileo"[315] either.

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[313] Briefly, AEA reasons are the following. AEA understands very well the institutional reason for Europe to develop an independent system from GPS. However EGNOS would be an overlay system to GPS which does not help to become independent from the US. AEA does not think either that EGNOS is a necessary pre-requisite condition to Galileo. Moreover, the association thinks that the use of GNSS/EGNOS as sole means of navigation is not realistic and that EGNOS will not provide any "tangible operational benefits" to airlines because they are equipped with systems as INS/AIME, Flight Management System (FMS) and double Distance Measurement Equipment (DME).
See V. De Vroey, "GNSS: a European User Point of View", Air Transport World (ATW) Air Navigation Conference, San Francisco (May 19-20, 1999), at 2.2.

[314] See *ibid.*
See also "L'AEA condamne EGNOS", *Air & Cosmos/Aviation Magazine International* (March 20, 1998), Nr.1650, at 35.

[315] See De Vroey, *supra* note 313, at 2.2.

AEA supports further work on Galileo.

The association wishes to see the European public resources fund Galileo.

It voiced however the possibility of giving its support as an user to Galileo, under the condition of the fulfillment by Galileo for users' requirements; namely, increased safety[316], reduced costs[317], increased capacity[318] and reduced delays.

If Galileo meets these requirements, the AEA could consider giving its support to Galileo.

B) SOME EUROPEAN AIRLINES[319]

The opinion of the Association of European Airlines reflects, of course, the opinions of the European airlines which are members of the Association.

It is, however, interesting to mention the reactions of some European airlines individually.

The German airline Lufthansa is ready to contribute as an end-user to the financing of those services supported by Galileo which it would use. The airline would finance Galileo by the users charges but will not invest in the PPP.

Half of Lufthansa's fleet is currently equipped with GPS receivers.[320]

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[316] Safety is the high priority of every airline. Europe faces well the safety issue. Indeed in Europe, the fatal accident rate for the period 1993-1997 is 0.06 per million flights (in comparison with 0.5 per million flights in US and 2.5 per million flight in China).

[317] For the AEA, the inefficiency of the European ATM System costs the airlines a huge amount of money (up to 2.5 billion Euros per year). AEA thinks also that enroute charges would have to be reduced. GNSS would have to meet these objectives to satisfy the AEA.

[318] Punctuality of the airlines is a real problem in Europe (22.8 % of intra-European departures had at least a 15 minutes delay in 1998. AEA hopes GNSS could help in that matter.

[319] This part was written on the basis of E-mails exchanges with people in charge of the topic in the airlines.

If Galileo provides a significantly better service than what GPS offers today, Lufthansa could consider retrofitting their equipment.

A better service for Lufthansa would mean that the airline could reduce its need for traditional navigation facilities.[321]

Lufthansa anticipates improved service concerning Galileo's ground based augmentation services precision approach services down to category III operations. This would reduce ILS ground facilities and could, perhaps, even lead to a decommissioning of all ILS sites.

If Galileo fulfils all these expectations, Lufthansa could consider the use of Galileo as a sole means of navigation, this term being understood as the combination of the satellite navigation system with inertial reference systems[322] (IRS).

The British airline British Airways is not very enthusiastic about Galileo.

For this airline, Galileo seems to be a very expensive project and British Airways would like to see the elaboration of a very strong business case to back it up.

BA is afraid of a monopolistic overcharging which would mean that the aviation sector as well as the other critical safety sectors would have to bear the full costs of Galileo.

The British airline stresses the fact that if Galileo is built for security reasons[323] and can not be justified economically by a strong business case, the governments of the EU member States would have to pay for it.

Austrian Airlines totally supports AEA's opinion.

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[320] Lufthansa plans to equip its all fleet with such receivers except Boeing 737 aircrafts (which would mean that 75 aircrafts only would not be equipped with such a system. The whole fleet of Lufthansa is composed of 300 aircrafts).

[321] Like the decommissioning of Non Directional Beacon (NDB) and VHF Omni-directional Range (VOR).

[322] IRS are useful because they allow autonomous navigation.

[323] Mainly to be independent from the US GPS system.

For this airline if Galileo does not bring the airline any further benefits beyond those of the US GPS and if the airline is asked to pay for that service, Austrian Airlines will not use Galileo unless some European regulations would force the airline to do so.[324]

If it has to pay for Galileo services, Austrian Airlines hopes all Galileo-users will be charge fairly and in a balanced way.

The airline will equip its fleet with Galileo signals receivers only if the same receivers can also be used for other existing satellite systems GPS and GLONASS.[325]

The airline SAS does not support EGNOS because of a lack of benefits the system would provide.

Concerning Galileo, SAS does not think that airlines should have to pay for it.

SAS' view is that the fairest system would be to finance Galileo by tax money.

This solution would involve any user from ships, railway trains to aircrafts.

2. Organizational framework

The European Commission emphasized the need to have appropriate structures to deal with each phase of Galileo.

It stressed also the need to separate regulatory and operational functions and to use the existing structures instead of creating new bodies which would duplicate existing structures.

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324 For example, the Joint Aviation Authorities (JAA) could mandate Galileo-avionics for aircrafts registered in Europe.

325 Indeed there is not enough space in and on an aircraft (avionics and antennas) for a duplication of systems.

Galileo is a developing project. Caution is, therefore, essential.

Any given detail could be modified in the future, depending on future circumstances.

The only firm commitment the European Commission made is the need to provide an appropriate structure for the first phase of Galileo, the definition phase.

The structures needed and used during the other phases have, however, to be prepared as soon as possible.

As previously mentioned, several phases would evolve in the process of establishing Galileo.

It is interesting to examine which structures the European Union plans to set up to interface with the Galileo program.

Briefly, the overall short-term GNSS Coordinating Structure comprises a Vehicle Company, a GNSS Regulatory Co-coordinator and a GNSS Administration.[326]

It is, however, important to note that the strategic decisions would be taken at the European level. The European Commission would be supported by the GNSS High Level Group.[327] Indeed, Galileo is a compromise between many actors and many issues[328]. The

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[326] It has to be mentioned that the proposed short-term solution is planned to evolve in a long-term solution. In the long-term solution, the GNSS Administration would be structured as an intergovernmental organization. It would be opened to participation to non-EU Member States and international organizations such as EU, ESA, Eurocontrol...The European Commission presents the Inmarsat IGO, EUMETSAT as well as a European Community Agency as potential model structures. GNSS High Level group Draft Final report May 1999 at 90. the GNSS Regulatory Coordinator as well as the Vehicle Company would be still present. The form that would take the Vehicle Company would be one of the following possibilities: "a private company or consortium operating a self-financing franchise or concession, a similar arrangement with a partially or fully subsidized franchise or concession, a PPP or operations solely by the public sectors." See *GNSS High Level Group Draft Final Report, supra* note 176, at 91.

[327] The GNSS High Level Group was set up in 1994 (*Council resolution* 94/C 379/02 of 19 December 1994; OJ c 379 of 31 December 1994) and plays the important role to give overall direction of the Galileo programme.

[328] Economic, politic, international, industrial, security issues.

EU institutional structure seems to be the best structure to deal with strategic decisions dealing with so many issues.

(i) Preparatory and implementation phases: the Vehicle Company

A structure has to be created to control the costs as well as to manage common resources offered by contributors[329] to Galileo.

The first structure which would be set up would be a Program Management Board (PMB) pooling public and private financial resources and, therefore, composed of investors such as the European Commission, ESA, the national space centers[330], industries, and ATS providers.

Every investor would have a seat in the PMB.[331]

A Technical Task Force would assist the PMB for questions related to techniques.

Technical experts would compose this task force.[332]

The Board would have the task to set up a new structure called the Vehicle Company[333] through the mechanism of public tender.

The Vehicle Company would be established through a public-private partnership (PPP).

Once the Vehicle Company will be set up, the technical task force will disappear.[334]

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329 Such as EU, ESA.

330 Such as the British National Space Center (BNSC), the French national space center CNES (Centre National d'Etudes Spatiales), the German DLR.
Indeed the national space centers are important investors in Galileo.
The BNSC for example has already invested 7.5 Million Euros in the project.

331 GNSSP/3-WP/65 at 3.4.2.

332 Experts from the European Commission, ESA, National Space Centers, *etc.*

333 Composed of the primary industrial contractors.

The task of this company would be the execution of the Galileo program. The execution would be done in conformance with a contract which would determine the design, the way to build and to operate Galileo. This contract would also deal with delicate and important questions such as public subsidies and revenue streams.

If the estimated costs were overrun, the Vehicle Company would be responsible for the supplementary costs.

The execution of the Galileo program includes many tasks such as service management[335], safety management[336], marketing[337], transition planning and implementation of future GNSS developments, liability and insurance issues[338], definition of the most efficient PPP scheme, Research and Development[339], user liaison[340], training of technical and administrative staff, raising of finance, cost recovery[341], procurement of equipment and services, application of standards,

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[334] If the creation of the vehicle company happens later than foreseen, the task force could benefit from an increase of its status and become a Programme Development Office which would deal with questions planning and development of both space and ground infrastructure, would have to take into account the users requirements and would have to deal with the integration of EGNOS in Galileo programme.
The Office will disappear once the Vehicle Company is set up.

[335] To control that the operation of the sub-systems is coherent and provide an overall level of service.

[336] To insure that Galileo uses best practices to meet adequately the safety requirements.

[337] To promote the use of satellite navigation and to analyze GNSS markets.

[338] It includes definition and acceptance of liability by the Company and amelioration of liability by insurance mechanisms. The passing of liability to sub-systems operators through contracts would also be considered. At short term the contractual chain scheme would be used.

[339] To analyze new applications and technical improvements.

[340] To be sure that the users requirements are taking into account.

[341] This task would be performed with GNSS Administration.

interoperability with other systems, system security, and external relations with other systems operators.[342]

(ii) Operation phase: the GNSS Administration

Two tasks have to be distinguished: the management of Galileo and its operation.

Concerning Galileo's management, a small Galileo Administration structure established by a European Council decision would be set up. It should be based on an evolution of the High Level Group supported by the European Commission.

This permanent administration would be the logical successor of the PMB and would work with the Vehicle Company.

Its tasks are not yet precisely defined , but it would certainly include the development and the application of GNSS policy. It would probably include liaison with organizations dealing with GNSS[343], transition planning, enforcement of performance standards, economic regulations, deal with any claim GNSS-related, encryption for the CAS, establishment of an "international integrity monitoring network"[344], liaison with augmentation services providers, responsibility for peacetime coordination with security organizations[345] and interference problems, as well as respect for nuclear missiles related agreements.

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[342] See *GNSS High Level Group Draft Final Report, supra* note 176, at 60-64.

[343] Like ICAO, IMO, Eurocontrol *etc.*

[344] See *EU Communication, supra* note 135, at 22.

[345] NATO, Interpol for example.

The operation task of Galileo would be done by the Vehicle Company which would deal with economic aspects of Galileo and take into account the developments of new techniques to integrate them in the program to satisfy more adequately the users requirements.

(iii) Regulatory issues: the GNSS Regulatory Co-coordinator

The question arises as to whether if there is any need to create a European GNSS Regulatory Co-coordinator which would be composed of national experts of Member States and observers from other entities.[346]

This Co-coordinator would ensure that Galileo services are provided in respect to legal performance requirements, such as safety for example, and it would, therefore, develop mandatory standards. These standards would be integrated in regulations by the organizations[347] concerned afterwards.

The Co-coordinator would have also the task to monitor the application of the standards by the Vehicle Company.[348]

The development and the definition of the tasks of these structures are complex but the need to have some organizational structures dealing with the GNSS and all related issues is evident.

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[346] Such as agriculture authorities, fisheries authorities *etc.*

[347] Such as ICAO, IMO, Eurocontrol *etc.*

[348] For more details about the GNSS regulatory Co-ordinator, See *GNSS High Level Group Final report, supra* note 176, at 64-66.

3. Certification

The certification issue was addressed by the Working Group 1 which identified the need for certification of Galileo.[349]

This issue concerns the future regulatory structure as well as the future operational structure. Indeed, the future regulatory structure will take care of the certification and the future operational structure will be subject to certification.

Even if details cannot be given yet, the difficulties can be pointed out and general features can be given.

The difficulties identified by the WG are that Galileo, being one single system, comprises of many elements and is used in many sectors.

Moreover, some of the sectors which would use the satellite navigation system Galileo already have a certification system in place, such as aviation sector, which has an elaborate system of certification.[350]

The certification system which would be developed for Galileo will thus have to take into account the several elements to certify, the applications done and the existing certification systems.

Concerning the elements to certify, the WG made a clear distinction between the space segment and the other components of Galileo.

Indeed, the space segment is the only element of Galileo which can be pointed out as a common element across all applications of the system.

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[349] For details see WG1 Paper 2 version 3 "Identification of the Needs for Certification of Different GNSS-2 Components" (28-06-99).

[350] Based on by the Chicago Convention and its Annexes.

Because of the uniqueness of this common element to all applications, the WG1 suggested the "Total System Per Sector" approach to address the certification issue.

However, the common character of the space segment cannot be ignored. It was, therefore, agreed that a "common template" would also be helpful.

The WG concluded that the certification issue would be addressed in a convention.

The question rose as whether to develop a sector-specific convention or a trans-modal convention.

The WG concluded by stating its preference for separate sector-specific conventions dealing with certification and by noting the fact that an European solution could be used as a model for an ultimate global solution.

4. Liability

The liability issue was, and still is, under the examination of the European Commission.[351]

The WG1 was entrusted to deal with requirements related to GNSS activities necessary to address in a liability regime.

It identified several issues to deal with in the creation of a legal framework; such as, the types of liability to choose[352], the character of liability[353], the exceptions to liability[354],

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[351] The Working Group on GNSS Legal and Institutional Issues (WG1) of the High Level Group is in charge of that topic.

[352] Tort or contract liability. Apparently the WG is in favor of a regime would del with both types of liability.

[353] Strict or fault liability. Would the joint and several liability be taken into account? The WG would in favor of a strict liability regime up to a limit and fault liability above.

the definition of "damage"[355], compensation[356] and the creation of an international warranty fund, as well as the procedural aspects[357].

The Working Group stressed the fact that the aviation sector has a well-developed international liability system compared to other sectors, such as the maritime sector.[358]

It was, therefore, decided, with other sectors' approval,[359] to follow the initiatives taken in the aviation sector.

The liability regime which will apply to Galileo will be consequently the international regime created for GNSS by ICAO.

As previously mentioned, ICAO is working on a long-term legal framework which would take the form of an international Convention.

However, the WG1 stressed the need to have a trans-modal liability Convention and not a Convention dealing with the aviation sector only.[360]

The development will take some time, and, until the creation of that Convention, there is a gap to fulfill concerning liability. Europe made the decision to use, as intermediary step, the "contractual chain" mechanism to address any interim liability problem.

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[354] Sovereign immunity from jurisdiction as well as disclaimer of liability has to be discussed.

[355] Economic damages as well as indirect or consequential damages have to be taken into account.

[356] Unlimited or limited.

[357] Such as the jurisdictions. It can be interested to have a look at the Warsaw System in Air Law (with the recent modifications done during the International Conference on Air law at Montreal, 10 to 28 May 1999).

[358] The regime of liability in the maritime sector deals more with private liability claims (under tort) and insurance issues than provides a real international liability regime.

[359] "[...] the 'aviation-first' approach [...] does not seem to face opposition from the other modes and application." WG1 Paper 3, at 7.

[360] WG1 Paper 3, at 8.

Chapter V. The Charter on the Rights and Obligations of States relating to GNSS services

As already mentioned several times, a draft Charter was presented by the Panel in 1998 at the Rio Conference.

The Assembly adopted this draft at its 32nd session under the name "Charter on the Rights and Obligations of States Relating to GNSS Services."[361]

The Charter declares the application of nine principles to the implementation and operation of GNSS.

Further to the principles previously examined[362], the Charter emphasizes that the safety of international civil aviation will be the paramount principle in the provision and use of GNSS (principle 1).[363] The Charter also stresses the essential need for co-operation between States to secure uniformity in the provision and operation of GNSS services as well as the need of co-operation and mutual assistance to facilitate the global planning and the implementation of GNSS (principle 5&7)[364], the regard for other States' interests

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[361] See *Charter, supra* note 8.

[362] Such as universal accessibility without discrimination (principle 2); sovereignty of States (principle 3); continuity, availability, integrity, accuracy and reliability of the services (principle 4); charges (principle 6).

[363] This principle was already embodied in the Preamble of the Chicago Convention in the terms "[...] the undersigned governments having agreed on certain principles and arrangements in order that international civil aviation may be developed in a safe and orderly manner [...]" as well as in the article 44 of the same Convention.

[364] Co-operation and mutual assistance are required and encouraged to achieve the best results without spending too much financial resources and to avoid duplication of efforts and mutual interference. Rio Conference WW/IMP-WP/10, at 2.1.

in the conduct by a State of its GNSS activities (principle 8) and finally the possibility for States to provide jointly GNSS services (principle 9).

The term "Charter" chosen for this Resolution is actually an unfortunate delusion.

Indeed, the term "Charte" refers to the Magna Carta, the most important instrument in our legal system[365] and purports to impart by itself a strong sense.

The Charter on the Rights and Obligations of States Relating to GNSS Services is actually a Resolution of the ICAO Assembly only and has the same force, but no more, as any Resolution adopted by the Assembly.

The choice of the word "Charter" for a simple Resolution removes complete credibility.

Indeed the choice of the term "Charter" would lead to think that the content of the resolution is of overriding legal importance.

In fact, the principles established in the "Charter" are completely derivative.

The "Charter" seems to reflect the opinions of the States at the Rio Conference and to be the result of a compromise between two groups of States present at the Conference; the first one hoping to elaborate a new legal framework in the form of a Convention ruling GNSS and the second opposed to such a Convention and supporting the existing structure.[366]

The States opposed to a new legal framework stress that Article 28 of the Chicago Convention, along with the SARPs, furnishes a responsive legal framework to GNSS.

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[365] Like the Charter of the United Nations signed at San Francisco on June 26, 1945.

[366]The majority of States were in favor. US, Canada, New Zealand and Australia declared the existing structure sufficiently efficient. The Russian Federation and China were neutral.
I. Lagarrigue, "Liability Issue Concerns Global Satellite Users" (September 1, 1998), *Jane's Airport Review*, Vol. 10, Nr. 7, at 31.

Indeed, the Charter is a document containing some rules which satisfy the group of States in favor of a Convention and, at the same time, is only a Resolution which satisfies the States opposed to the elaboration of a real international Convention.

The "Charter" establishes the basis of a legal framework but does not go as far as a Convention.

The "Charter" is, however, a first step and, perhaps the necessary step, to the elaboration of a Convention which would rule GNSS.

As already mentioned, the elaboration of a Convention is essential to deal with GNSS.

The law has to deal with the new types of relationships necessitated by new technology.

However, the creation of such an important Convention does not have to be done in a rush. Ample time for profound reflection is critical.

A Convention is needed, but a few years at the very least would be necessary for a solid legal infrastructure.

As was mentioned earlier, some authors are in favor of the elaboration of a Convention, which would deal with the liability of GNSS.

The Rio Conference stressed the need of a legal framework dealing with CNS/ATM.

These initiatives are certainly laudable.

ICAO, however, seems to conceal or at least overlook the multimodal aspect of satellite navigation.

Except in the matter of financing, ICAO did not focus on the existence of users other than in the aviation sector.

The aviation organization, however, has its own agenda with its own vested interests.

Would it not be more efficient to think about a Convention dealing with satellite navigation and concerning all users of GNSS?

Aviation is only one of the numerous users of the satellite navigation. It might be, therefore, more efficient to develop a global legal framework, accessible all users. The European Commission stressed the multimodal dimension in the establishment of Galileo and is a good example to follow.

The Convention would deal with delicate problems such as liability, certification, financing and cost-recovery and would address the concerns of all users.

The Convention to be adopted would have to be created by the States, meeting in a forum.

ICAO could serve as this forum because it has dealt already with that issue through its legal panels. ICAO, however, seems aviation-biased and does not consider sufficiently the multimodal aspect of GNSS.

Another organization could eventually deal with that task perhaps more efficiently than ICAO. It would be INMARSAT.

The new structure of INMARSAT[367] operating since 1 April 1999, maintains an intergovernmental structure.[368]

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[367] INMARSAT was the first intergovernmental organization to change its status to a UK-registered private company operating under recognized commercial principles and established company law and comprises in future two entities, a public limited company and an intergovernmental structure.

[368] "The IGO will continue to operate through an Assembly of Parties and a small Secretariat, and will monitor and enforce, as necessary, the five basic principles and public service obligations, namely:

- Continued provision of services for the Global Maritime Distress and safety System (GMDSS) set up by IMO;
- Non-discriminatory access to services;
- Service to all geographical areas where there is a need, including rural and remote areas;

This structure could play the role of a forum which would deal with the development of the new Convention.[369]

Some could object that only 84 countries are Member States of the organization.

84 Member States, however, is a solid beginning and it is surely easier to begin with 84 States than to create a new entity.

Moreover, as the developer of the Convention dealing with GNSS in a multimodal perspective, INMARSAT could be the organization in charge of the GNSS for the future.[370]

It could organize meeting once or twice a year, bringing together the States and organizations such as ICAO and the International Maritime Organization[371] to discuss GNSS and to deal possible problems.

The administrative tasks would be carried out by the Secretariat.

- Peaceful purposes;
- Fair competition."

D. Sagar, "Inmarsat goes private", *ECSL News*, Nr.18-19, February 1999, at 3
See also D. Sagar, "Inmarsat and GNSS", unpublished.

[369] Of course it would keep also its primary function which is to provide the maritime distress and safety services.

[370] The High Level Group suggested a long-term solution: the organizational structures created for Galileo would be modified in long-term sructures. As already mentioned the GNSS Administration would be structured as an IGO. One of the potential model structures suggested is the Inmarsat IGO.
See *GNSS High Level group Draft Final Report, supra* note 176, at 90.

[371]Hereinafter IMO.

Conclusion

The evolution of technology permitted the creation of a high sophisticated satellite navigation system.

Three main actors are currently playing a role in satellite navigation: the United States with GPS, the Russian Federation with GLONASS and, recently, Europe with its developing project Galileo.

Better accuracy, reliability, integrity and availability due to this system of satellite navigation are the advantages for the users.

The providers also have many advantages from these services.

GNSS combines interests of all parties.

The Global Navigation Satellite System, however, raises many legal issues.

Some of these issues were already addressed for traditional navigation aids but the specificity of using satellites to navigate requires the search of new solutions specific to the GNSS or at least the adaptation of the existing solutions.

Nothing prevents adopting solutions arising from the existing systems and modifying them to meet the particularities of satellite navigation.

The ideal solution would be the elaboration of a Convention which would deal with legal issues of the satellite navigation.

Some people are in favor of a Convention which would deal with liability only, other talk about a certification Convention.

It could be useful to think about a convention which would deal with all legal issues related to GNSS.

Such issues as liability and certification have to be addressed. An uniform regime has to be developed for the benefit of the users as well as for the providers.

Mounting this Convention is, of course, challenging but the increasing number of applications done with satellite navigation demonstrates the importance of the topic.

In designing the agenda of the Convention, the multimodal aspect of GNSS has to be kept in mind.

Europe is aware of the importance to deal with all types of users with its satellite navigation system Galileo and is attempting not to deal with one single type of user, as does ICAO.

Cooperation between the sectors is essential to obtain a coherent system.

An incoherent system would be more dysfunctional than no system at all.

If the decision to create a legal framework dealing with legal issues of GNSS is actualized, this would be an important achievement.

A future institution dealing with GNSS also would be a good initiative.

GNSS is a new and developing system. All problems cannot be resolved at once.

Time is needed to build a solid foundation.

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