History of Mobile Satellite Communications

(Part II)

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Abstract: Communication satellites provide the bridges for a number of new, specialized markets in commercial and private telecommunications and make ties between nations. In the course of more than 40 years they have obtained Fixed Satellite Communications (FSC). Soon after Mobile Satellite Communications (MSC), Navigation and Determination came to serve navy, ground and air forces worldwide and for of economic reasons, they also provided commercial MSC. For 35 years, MSC was used, particularly because ocean-going vessels have become dependent for their commercial and safety communications on Mobile Satellite Services (MSS). Although, aircraft and land vehicles started before ships, due to many unsuccessful experiments and projects they have had to follow the evident lead of Inmarsat maritime MSC service and engineering. The modified ship's Mobile Earth Stations (MES) are today implemented on land (road or railway) vehicles and aircraft for all civil and military applications, including remote or rural locations and industrial onshore and offshore installations. The GPS, GLONASS and other new Global Navigation Satellite Systems (GNSS) provide precise positioning data for vessels, aircraft and land vehicles. Because of the need for enhanced services, these systems will be augmented with satellite Communications, Navigation and Surveillance (CNS) facilities.

Key Words: FSC, MSC, MSS, MES, GPS, GLONASS, Galileo, GNSS,CNS, Intelsat, Inmarsat, Intersputnik, ESA, Eutelsat, Marisat, Marecs, Prodat, GMSS, GMSC, MMSC, LMSC, AMSC, GMPSC, SCADA

1. Establishment of Communications Organizations and Operators

Government and intergovernmental satellite communications organizations and operators are established soon after first successful experiments in MSC and divided into international for providing almost global service, regional for covering few countries or entire continents and domestic, for local service only.
The Global Mobile Satellite Communications (GMSC) system operators are the only entity responsible for the operation of the GMSC space and ground network configurations providing global, regional or domestic coverage. However, the GMSC service providers are any entity commissioned by system operators to provide GMSC services to the public within a region or country and which may require an authorization to do so under the applicable legislation of the country concerned.

1.1. International Satellite Communications Organizations

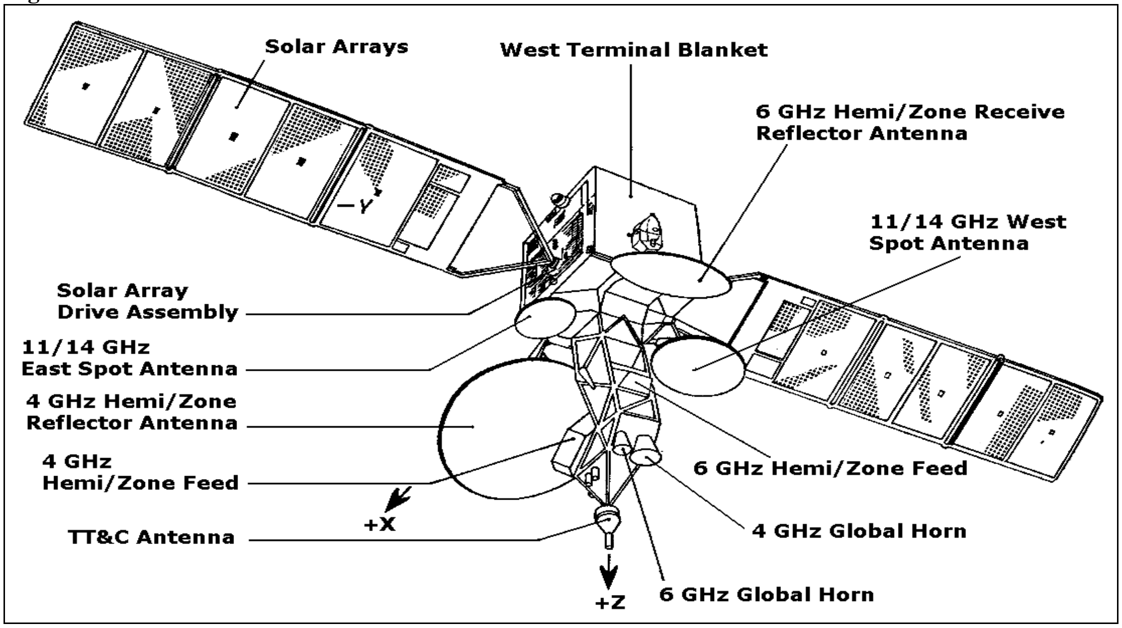
International satellite communications organizations and operators are Intelsat, Inmarsat, Intersputnik, Eutelsat, ESA and other global, multinational or intergovernmental operators serving outside domestic and regional boundaries interfaced to the Terrestrial Telecommunications Networks (TTN).

1.1.1. Intelsat

The FSS were the first to develop and there was rapid recognition that these new global possibilities necessitated the creation of some kind of international organization. Thus, this led to the creation of the Intelsat international organization based in Washington. On 20 August 1964, 11 countries signed a charter agreement creating the Intelsat, the first open worldwide satellite communications network and appointed the Comsat Corporation as its first manager. However, Comsat placed a contract for a GEO and the Intelsat fixed system started to offer transatlantic satellite services in 1965 after the successful deployment of Intelsat I (formerly Early Bird), the world's first GEO spacecraft. Today, more than a fifth generation of Intelsat birds provides international and domestic satellite communication service on behalf of over 112 member nations. Since 1973, Intelsat has operated with an organizational structure that has only four tiers: the Assembly of Parties, the Meeting of Signatories, the Board of Governors and the Executive Organ.
During the 1990s, users were served by the following satellite constellations: Intelsat K and the Intelsat V to VIII series of spacecraft. The first Intelsat VIII was launched in 1996 on board an Ariane 4 booster. Moreover, the first satellite in the Intelsat IX series, Intelsat 901, was scheduled to be launched in 2000 to the

60°E GEO location. The next series of Intelsat GEO spacecraft 902, 903 and 904 were scheduled in the period between 2000 and 2002.

Figure 1. Intelsat V MCS



Courtesy of Book: "Telekomunikacije Satelitima" by R. Galic

The Intelsat provided as well as MSS using payloads carried by its GEO spacecraft Intelsat V MCS series: A (F5), B (G6), C (F7) and D (F8). The Inmarsat organization leased capacity on Intelsat V MCS flights F5 through F8 for MMSS, shown in **Figure 1.** These four satellites used portions of the L-band (from 0.5 to 1.7 GHz) and C-band assigned for such purposes by the ITU. The Intelsat V MCS A (F5) was launched on 28 September 1982 over IOR in orbital location at 63°E; The Intelsat V MCS B (F6) was launched on 19 May 1983 over AOR in orbital location at 18.5˚W. The Intelsat V MCS C (F7) was launched on 19 October 1983 as a spare spacecraft over IOR in orbital location at 66˚E and the Intelsat MCS V D (F8) spacecraft was launched on 3 March 1984 over POR in orbital location at 53˚E longitude and at the end of 1985 was relocated to the assignment of 179/180˚. Thus, MCS uses radio frequencies in the top C-band transponder and an additional L-band spectrum to link CES with ships as part of the Inmarsat network. Because of the additional power requirements by the MCS packages on Intelsat V F5 – F8 satellites, the Ku-band operations on these four spacecraft must be limited or curtailed when they are activated for Inmarsat use. However, when the L-band signal amplifier is operating in the high power mode, the 11 GHz Ku-band capacity of these spacecraft is switched off. These satellites after many years of service are deployed and not used by the Inmarsat system any more.

1.1.2. Inmarsat

The Inmarsat organization is the only international and nonmilitary MSC provider in the world. The Inmarsat MSC network provides Tel/Tlx/Fax; slow, medium and high-speed data; image; video; videoconferencing; videophone; new mobile MPDS and ISDN; LAN and IP service; and in the framework of the GMDSS system, developed by Intrnational Maritime Organization (IMO), enables distress and safety service for maritime, land and aeronautical MES, including government, rural, military and offshore infrastructures.

In the early 1970s the IMO, then known as the Intergovernmental Maritime Consultative Organization (IMCO), began to consider the possibility of using MSS to improve maritime communications, not least for safety purposes. Towards the end of 1973, IMCO convened a conference to decide on the principle of establishing an international maritime safety system and to conclude the necessary agreements. The work of this conference culminated in September 1976 in the adoption of what became the Inmarsat Convention and its complementary Operating Agreement, requiring always acts exclusively for peaceful purposes. Inmarsat was established on 16 July 1979 by the major maritime nations to finance this project, which is to investigate using satellites to form links with vessels and offshore oilrigs at sea. Inmarsat also owes much of its success to the foresight and commitment of the IMO, which played a crucial role in its creation.

On 1 February 1982, Inmarsat officially took control of satellites previously operated by three Marisat spacecraft (series F1, F2 and F3), a joint venture among nations begun in the early 1970s through the efforts of the Comsat General.

Inmarsat has since expanded its space segment by leasing additional capacity from Intelsat and ESA, Intelsat V MCS series of four spacecraft and two Marecs spacecraft (B and B2A), respectively. However, today an additional Inmarsat second, third and forthcoming fourth generation of GEO, Inmarsat-2, Inmarsat-3 and Inmarsat-4 spacecraft, respectively, are being exploited. Thus, the Inmarsat is patterned after the Intelsat system and almost all countries comprise the Inmarsat Assembly as members, each country casting one vote. The Assembly meets once every two years to formulate general policy, long-term strategy and objectives, and each government selects a representative Signatory to the Inmarsat

Operating Agreement from the public or private sector. The Assembly has also primarily to establish financial, technical and operational standards. The Inmarsat Council, similar to a corporate board of directors, meets three times a year to implement all policy decisions of the Assembly. The Director General of Inmarsat oversees the day-to-day management of the organization, with an executive staff headquartered in London.

Inmarsat is financed in two ways: signatories must pay fees based on their use of the network, or can purchase investment shares in Inmarsat that reduce the user fees in proportion to the investment and signatories earn a return of 14% per annum on their investment in Inmarsat. During 1987, the largest numbers of investment shares were held by the USA, UK, Norway and Japan.

1.1.3. Intersputnik

The Russian Federation, that is to say, the former USSR, is not a member of Intelsat. Instead, in 1971 it created a similar multinational organization named Intersputnik, which provides FSS for its 14 member states and a number of other associated countries. This system uses the various families of Soviet communications satellites, such as Molniya, Raduga and Gorizont, using GEO, HEO and PEO satellite coverage.

The Russian satellite system conceivable can beam radio broadcasting, TV programs, voice and data traffic to almost any location on Earth, and only Intelsat can supply more global FSS links than Intersputnik. This Organization is an open international intergovernmental that any sovereign state can join. The fundamental structure of Intersputnik was determined by the Cooperative Agreement on the Establishment of the Organization. A representative for each member nation serves on the Board of the Members, which is the main governing body of Intersputnik organization. Besides, this Board selects a Director General to chair the Intersputnik Directorate based in Moscow.

The Organization also provides three MSS for all three applications, using payloads carried by its GEO spacecraft Gorizont (Horizon), Raduga (Rainbow) and Morya (Seamen):

1. The Volna (Wave) Network – The Volna MSC system served to connect maritime and aeronautical MES terminals via space segment constellation to LES and ground-based telecommunication facilities for former USSR ships and aircraft. This MSS consists in communications payloads carried by the spacecraft Gorizont and Raduga. The Volna Network provided radio and TV service for mobile stations on UHF frequency bands between 335–399/240–328 MHz. On the other hand, the Volna Network provided service uplink/downlink on L-band between 1636–1644/1535–1542 MHz for MMSS and also on L-band 1645–1660/1543/158 MHz for AMSS applications, while feeder link used 6/3 GHz uplink/downlink bands for both MSS applications.

2. The Morya Network – In 1989 the former Soviet Union expanded its MMSS with the Morya MSC Network, using existing Soviet satellites series Morya for carrying the MSC payload. Namely, the Morya Network provided MMSS on two 2.5 MHz wide frequency uplink/downlink bands centered on 1637.25/1535.75 MHz (service link) and 6084.0/3758.3 MHz (feeder link).

3. The Gals Network – Piggybacked on the former Soviet Union's Raduga spacecraft, named Gals (Tack), a special telecommunications payload was serving as satellite links for the former USSR (today Russia) military forces. Thus, this Network will operate using the X-band spectrum for up linking (7.9 to 8.4 GHz) and down linking (7.25 to 7.75 GHz), for defense maritime, land and aeronautical applications.

1.1.4. ESA

The idea of creating an independent space organization in Europe goes back to the early 1960s when six European countries: Belgium, France, Germany, Italy, the Netherlands and the UK, associated with Australia, to develop and build a heavy launcher called Europa. In 1975, a Convention was endorsed at the political intergovernmental level to set up the European Space Agency (ESA). Finally, the Convention entered into force on 31 October 1980. Since then the founding ESA members have been joined by 4 new members from Europe, while some other European countries have expressed their interest to join ESA.

In addition, the Cooperation agreements have also been signed to allow Canada to participate in certain ESA programs and to sit on the ESA Council. This makes the dreams of Europe's space scientists come true, by creating and operating new scientific spacecraft for the ESA.
The project management interacts with the aerospace and instruments industry in the 15 member states and oversees the construction, launch and operation of the spacecraft. There is close liaison with ESA's European Space Operations Centre (ESOC) in Darmstadt, Germany, with Arianespace and other cooperative agencies providing launchers and with the GES needed for communication with the spacecraft.
The ESA Research and Scientific Support Department was restructured in 2000/2001 into Divisions. In such a way, each Division is the home of the project scientists for the study, projects development and operation of the missions, serves the space scientists of Europe, under the supervision of the Science Program Committee, on which all member states are represented. Any scientist or group within the member states can propose a space science mission. Before a final selection, some rival proposals are selected for detailed study of their scientific, technological and budgetary implications. Under a science communications initiative, ESA is intensifying its efforts to keep the press, public and schoolteachers well informed about the science program and the progress of its various missions. Apart from construction, launch and operation of the spacecraft, ESA has developed Artemis MSS, derived from former Prodat MSS for all three applications. At present ESA members are developing GSNS named Galileo and satellite augmentation systems EGNOS for maritime, land and aeronautical satellite CNS.

1.1.5. Eutelsat

The European Telecommunications Satellite (Eutelsat) Organization was provisionally founded in 1977 by representatives of 17 members of the European Conference of PTT and telecommunication Administrations, with headquarters based in Paris. Its major mandate was to establish and run the European satellite communications system as a regional operator but because it is currently offering global FSS service on an international basis, it can be classified into the group of global and international satellite organizations.
The constitution and financing of Eutelsat are modeled on those of Intelsat. Although it did not formally come into existence until 1984, Eutelsat started work in 1977 with ESA on the exploitation of the Orbital Test Satellite (OTS) experimental communication birds and on the design of the operational European Communications Satellite (ECS) series.
The latter were in due course taken over and operated by Eutelsat, which is now procuring its second generation of satellites. At this point, Eutelsat passed from an interim organizational structure to definitive operational status on 1 September 1985 and all shares were divided at that time among about 25 member state nations. During the early stages of planning, Eutelsat designers thought their spacecraft primarily would carry voice and high-speed data service. Although Eutelsat was set up to handle long distance traffic, a significant part of its revenue now comes from the relaying of satellite TV programs for distribution through the TTN or into the cable system. Throughout its 25 years experience, Eutelsat has placed innovation at the centre of its development. The Company has distinguished itself, notably by being the first in Europe to distribute satellite TV and pioneering the use of the Digital Video Broadcasting (DVB) standard for the transmission of digital TV channels and data.
Eutelsat is one of the world's leading operators of multipurpose satellite infrastructures. It provides capacity on 23 satellites that offer a broad portfolio of services, which include direct TV and radio broadcasting for the consumer public, professional video broadcasts, corporate networks, Internet services and MSC systems. Therefore, Eutelsat is providing regional MSS for all three applications with the current Emsat MSC system for maritime and land applications and the EutelTRACS system for mobile tracking and messaging. The latter system is developed by technical cooperation with the US Qualcomm to establish communication network and equipment infrastructures.

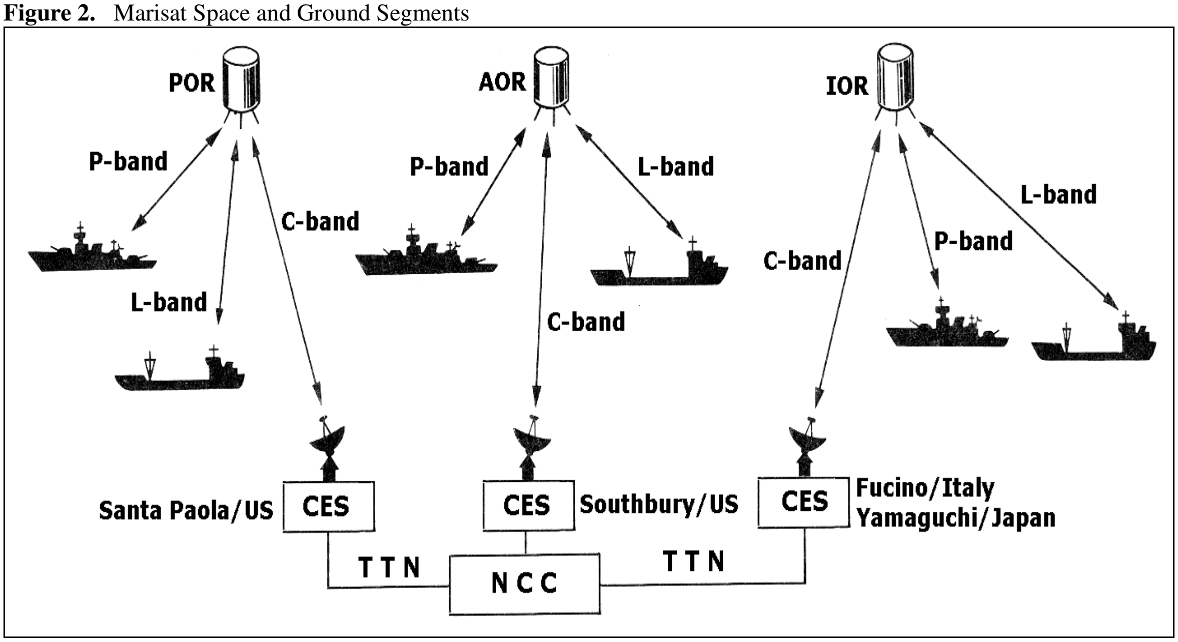
1.2. Former International MSS Operators

Former international global and regional MSS organizations and operators were Marisat developed by the US-based Comsat Gebneral, the Marecs company for MSS formed by European nations and Prodat was a project of ESA.

1.2.1. Marisat MSS

The World's first maritime MSC system as a new application of the GEO system was unveiled in 1976 with only three satellites and ocean networks that are providing Maritime MSC (MMSC) services in the Atlantic, Pacific and Indian Oceans. The Hughes Aircraft Company, known today as Boeing Satellite Systems Inc, under contract to Comsat General Corp, built three multifrequency communications spacecraft called Marisat (Maritime Satellite), for the space segment of the world's first MMSC operator.

Figure 2. Marisat Space and Ground Segments



Courtesy of Book: "Sputnikovaya Svyaz na More" by L. I. Novik, I. D. Morozov and V. I. Solobev

The Comsat General was developed a Marisat system for MSS at first for only maritime applications. In 1971, frequency bands around 1.6 GHz were allocated for satellite communications connections with ships and aircraft.

The Marisat satellites were designed initially for US Navy vessels and they had a UHF transponder on board in a band from 240 to 400 MHz. Because there was sufficient margin for additional payload, L and C-band transponders were installed on the Marisat satellite to provide commercial MSC traffic for maritime applications. These satellites had a dual role at that time: to provide space segment facilities that were leased to the US Navy for military communications with naval ships and it also enabled the use of transponders for Comsat General itself to operate MSS for traffic with merchant ships, virtually worldwide.

All three Marisat satellites were launched with the same type of USA rocket "McDonnell Douglas 2914 Delta" during 1976, on 19 February, 9 June and 14 October, for the needs of the company Comsat General. Marisat F1, F2 and F3 satellites were placed in GEO position planes at 15^{o}W, 72.5^{o}E and 176.5^{o}E longitude, respectively.

All satellites have been leased from Comsat, in effect; Marisat F1 spacecraft served as an in-orbit spare for the Marecs A spacecraft in the Marisat AOR region at a position 15˚W. Then this satellite was leased as a spare in Inmarsat AORE region and removed to 106˚W. Marisat F2 spacecraft served as a spare in IOR region at a position 73˚E and lately, for the Inmarsat space segment.

The Marisat F3 spacecraft served at a position 176.5˚E in the POR region, and afterwards reprogrammed as a spare for the Marecs B2 satellite. This satellite was finally relocated as in-orbit spare to 182.5˚E. The service at that time was welcomed by merchant shipping and by 1982 around one thousand vessels were equipped to use the Marisat system. All three Marisat satellites also served as an emergency backup, one in each of the three ocean regions: AOR, IOR and POR. Accordingly, after many years, these satellites are no longer in exploitation either by the Comsat or Inmarsat systems.

The Navy fleet used P-band frequencies (Tx = 248–260 MHz/Rx = 1300–312 MHz) for the MMSS link, while the merchant-shipping element of the Marisat payload used the newly allocated L-band frequencies (Tx = 1537–1541 MHz/Rx = 1638.5–1642.5 MHz) for its MMSS links and C-band (Tx = 6174.5–6424 MHz/Rx= 3945.5–4199 MHz) for feeder links.

Fixed CES for mobile service were located at Santa Paola for POR, at Southbury for AOR and at Fucino and Yamaguchi for IOR, see **Figure 2.** The system provided access to the satellites, linking ships at sea through the PSTN with the TTN subscribers ashore for Tel, Tlx, Fax, data and HSD transmissions. The Marisat system was controlled by Network Control Centre (NCC) located at Washington. Satellite Tracking, Telemetry and Command (TT&C) are also conducted over C-band frequencies.

However, the governments of many other countries were not quite content for control of MSC with their ships to rest with a foreign commercial corporation. Owing to this problem, in 1976 under the aegis of IMCO an agreement was drawn up for the establishment of an Inmarsat organization, initially for maritime service only, and later for land and aeronautical applications.

1.2.2. Marecs MSS

The ESA organization's Maritime European Communications Satellite (ECS) or Marecs project covered the study, development, launch and in-orbit operations of communication spacecraft to be integrated in a global MMSC. Development began in 1973 with funding from Belgium, France, Italy, UK, Spain and Germany, then later joined by the Netherlands, Norway and Sweden. In effect, the program started at first as the experimental Maritime Orbital Test Satellite (Marots) but was subsequently changed to an operational system resulting in a name change, satellite redesign and delayed development.

The Marecs satellite was part of the GMSC system configured to provide high quality full duplex, reliable real-time voice, Fax, Tlx and data services between SES and CES with automatic connection to the TTN. The Marecs satellites operated by ESA were members of Inmarsat first generation MMSC network. The Marecs-1 B2A spacecraft was successfully launched via an Ariane rocket from Kourou, French Guiana on 9 November 1984 at AOR region location 26°W. It was later relocated to the assignment of AORW at 55.5°W as an operational satellite of the Inmarsat network. The next Marecs A satellite was successfully launched via an Ariane rocket from Kourou, French Guiana on 20 December, 1981 on a POR assignment at a position of 177.5°E and was later relocated to POR at 178.5°E, as a spare satellite leased by Inmarsat.

The Marecs satellite consists in two modules: a service module, which is a derivative of the ECS bus and a payload module. The spacecraft has a design life of 7 years, a 3-axis altitude control and TT&C that uses VHF spectrum during transfer orbit and C-band through the communications subsystems on station. Thus, the payload is capable of operating without continuous ground control and it consists in a C to L-band forward transponder and an L to C-band return transponder, incorporating SAR channels. The Marecs spacecraft was based on the British Aerospace ECS 3-axis stabilized platform, with two sun-tracking solar arrays providing 955 W (BOL) with 2 NiCd batteries for eclipse power supply. Payload had three repeaters: shore-to-ship with 5 MHz bandwidth, ship-to-shore with 6 MHz bandwidth and shore-to-shore with 0.5 MHz bandwidth. These provide 35 two-way voice channels plus search and rescue capabilities. Hence, one 2 m diameter L-Band antenna and 2 horns (one transmit, one receive) for 4/6 GHz channels provide almost 1/3 of Earth coverage.

1.2.3. Prodat MSS

The ESA organization promoted a special Prosat program, which included propagation measurements of the aeronautical channels. The second phase of the Prosat MSS project primarily consisted in the design, development and prolonged demonstration of a two-way low rate data system. The latter service is referred to as Promar, while the low cost digital data only MSC service included in the configuration is known as Prodat, to be available for maritime, land and aeronautical mobile operations, on 1.6 GHz band to the satellite, which in turn relays the signals to ground using a 6 GHz carrier.

The Prodat program conducted successful field trials with low data terminals using the Marecs satellite. In parallel, two L-band MSC payloads are being procured by ESA to promote European MSS: the European Mobile System (EMS) payload on the Italsat 1-F2 satellite and the L-band Land Mobile (LLM) payload on the Artemis satellite. The EMS allows voice and data communications with a capacity of 300 channels. The available capacities are partially being used to demonstrate and evaluate the emerging MSC system. The European MSS operational phase started with the EMS payload in orbit during 1996 and is continuing with the LLM payload, which was planned to be launched in 1997.

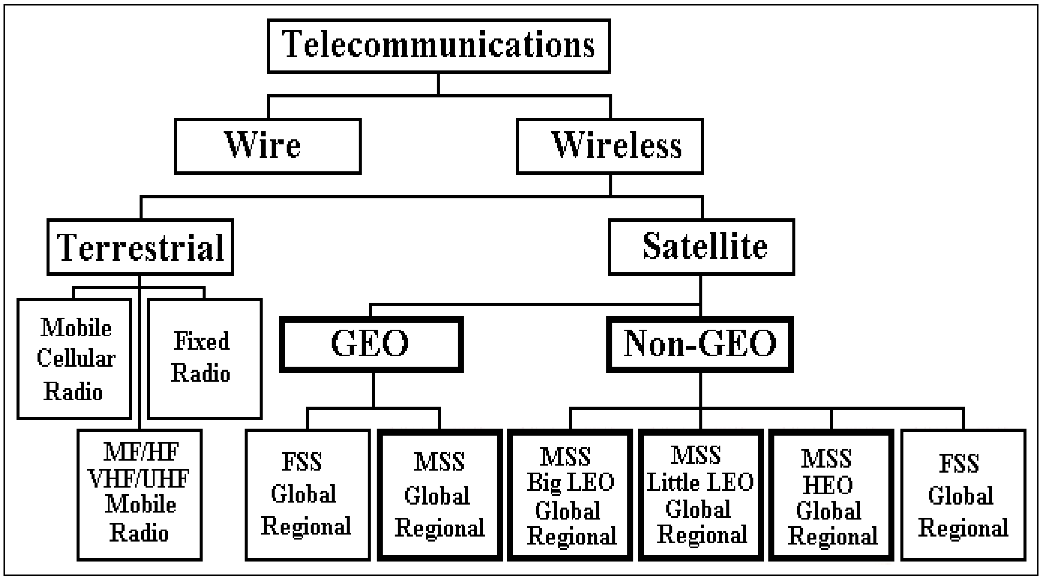
The Prodat MSS was operated through ESA ground stations and Inmarsat communications satellites and provided a low speed, low power and narrow bandwidth service between the terrestrial Public Data Network (PDN) and a population of maritime, land and aeronautical mobile terminals.

2. Development of Modern Global Mobile Satellite Systems (GMSS)

Once the principles of radio were understood, mobile radiocommunications have been a matter of steadily developing and perfecting the radio technologies, extending accessibility and the possibility of radio networks, enhancing range, extending coverage and reliability, reducing the size, cost and power consumption of radio devices and improving efficiency. With further MSC innovations an age long barrier was eliminated between vessels and shore, vehicles and dispatch centres, aircraft and airports and thus, facilities were created to provide mobile offices in ships, land vehicles and aircraft and to communicate with

Land Earth Stations (LES) independently of space, place and time. Therefore, the world is going to reduce communications barriers and move people across borders for business, social, safety, economic, technical and prosperity purposes. In facct, the new mobile satellite industry must ensure that mobile communications and navigation services will be responsive to these extraordinary changes and globalization trends.

Table 1. GMSC Position within the Telecommunication Structure



Courtesy of Book: “GMPCS Reference Book” by ITU

The MSC systems and technology also offer other benefits and perspectives. In many developing countries telephone density is still at a low level in urban and non-urban areas, because the cost of upgrading such facilities through wireless or Terestrial Telecommunicaion Network (TTN) means is prohibitive for much of the world areas. Remote, rural and mobile service sectors in many regions are outside the reach of communications facilities, so the new MSS technology, with its instant ubiquitous coverage, may provide cost-effective solutions for developing countries.

2.1. Global Mobile Satellite Communications (GMSC)

The GMSC are developed by using GEO or Non-GEO satellite systems, which refers to all communications solutions that provide global MSC service directly to end users from a satellite segment, ground satellite network and TTN landline and/or radio infrastructures. The term GMSC means not only global coverage but also includes local or regional MSS solutions as an integral part of the worldwide telecommunications village. Namely, some of the regional or local MSS can be afterwards integrated to establish a Global MSC network. **Table 1.** Gives an overview of telecommunication systems showing the respective satellite fit.

The GMSC solution is a modern mobile communication structure systems, which began providing communication links to vessels initially in the 1970s and later to aircraft and all kinds of land vehicles. It must be noted that GMSC providing global and regional coverage represents a new technology era in which wire terrestrial and wireless cellular voice, image, video and data systems are combined with MSC applications to provide communication services available anytime and anywhere. Additionally, new satellite technologies, such as GMPSC and Very Small Aperture Terminals (VSAT), have also allowed global personal and commercial mobility. In fact, some of the new GEO or Non-GEO GMPSC systems have entered the field of MSC solutions, which for the past 20 years has been occupied predominately by Intergovernmental Satellite Organizations. In recent years, a growing number of private entities have been prepared to develop and invest in satellite technology, such as Iridium, Globalstar, Teledesic, Ellipso, Orbcomm, Leo One, etc.

At the same time, satellite technology continues to advance; so satellite mobile terminals have become smaller, better and cheaper. Some GMSC systems now being developed are the initiative of the private sector or consortiums. This implies that there should be changes in policy, particularly in countries that do not foresee sufficient private participation in the telecommunication sectors to allow these systems to thrive and to realize their potential.

As mentioned, GMSC systems can provide global or regional coverage. This capability has raised questions about national sovereignty, integrity and security of a country covered by a particular GMSC network.

Generally speaking, communication networks in the concerned country must always comply with national regulations that govern integrity and assistance to law enforcement and security agencies. These typically have requirements for national routing, location determination, call monitoring and legal interception. Therefore, seven categories of players in the GMSC community can be identified:

1. National Regulatory Authorities – The international community has to recognize the sovereign right of each country to adopt its telecommunication regulations and that the authority acts in the name of and on behalf of a certain state. It is the responsibility of the National Regulatory Authorities, according to their national laws, regulations and policies, to grant the appropriate authorization to allow GMSC services in a country.

2. GMSC System Operators – These are the owners or operators of the space segment, who have assumed all the financial, technical and commercial risks of developing a GMSC system applications and seek the harmonization of procedures governing the provision of GMSC services to avoid a proliferation of administrative impediments liable to constrain the development of the market.

3. GMSC Gateway/LES Operators – Gateways are LES links between the space segment and TTN, from which, as main sources, GMSC terminal traffic is drawn. The LES in some cases, depending on the business structure of the GMSC system, can be considered as a part of the space segment and can be managed by the GMSC satellite network operator.

4. PSTN Operators – The traditional PSTN operators provide most telecommunication services and networks, both wired and wireless, in a certain country. Furthermore, they are indispensable business partners and responsible for interconnection with terrestrial landline telecommunication networks.

5. Local and/or Regional Service Providers – Local service providers are responsible for the local or regional provision of GMSC services, distributing GMSC terminals and billing GMSC customers. Otherwise, GMSC system or Gateway operators could also be local or regional service providers.

6. GMSC Terminal Manufacturers – These are companies that manufacture MSC and semi-fixed terminals for mobiles, including GEO and Non-GEO satellite networks.

7. GMSC Terminal Users – These are the customers whom all the other players are called upon to serve. They should receive good quality service at the best possible price, within the strict confines of the laws and regulations of the host countries.

2.2. Global Navigation Satellite Systems (GNSS)

The first generation GNSS, as defined by the experts of the International Civil Aviaton Organization (ICAO) GNSS panel, plans for some system augmentations in addition to the basic GPS and GLONASS satellite constellations in order to achieve the level of performance suitable for augmented civil aviation applications in oceanic flight and also for enhanced maritime routing applications worldwide, especially in narrow passages, coastal navigation and approaching ports.

The GPS network is a satellite-based all-weather, full jam resistant, continuous operation radio navigation system, which utilizes precise range measurements from the GPS satellites to determine exact position and time anywhere in the world. This system provides military, civil and commercial maritime, land and aeronautical users with highly accurate worldwide three-dimensional, common-grid, position/location data, as well as velocity and precision timing to accuracies that have not previously been easily attainable. The GPS service is based on the concept of triangulation from known points similar to the technique of “resection” used with a map and compass, except that it is done with radio signals transmitted by satellites. The GPS receiver must determine when a signal is sent from selected GPS satellites and the time it is received. Nothing except a GPS receiver is needed to use the system, which does not transmit any signals; therefore they are not electronically detectable. Because they only receive RF satellite signals, there is no limit to the number of simultaneous GPS users.

The Russian Federation (former Soviet Union) provides the GLONASS service from space for accurate determination of position, velocity and time for mobile or fixed users worldwide and in all-weather conditions anywhere. Therefore, three-dimensional position and velocity determinations are based upon the measurement of transit time and Doppler Shift of RF signals transmitted by GLONASS satellites.

The GNSS consists in many players with similar GMSC systems and three major segments:

1) The Space Segment has 24 satellites (21 functioning satellites and 3 on-orbit spares) and is controlled by a proprietary satellite operator or service provider.

2) The Control Segment is operated by Master Control and Monitor Stations.

3) The User Segment is represented by the military/civil authorities for maritime, land and aeronautical users located worldwide. This segment offers Standard Positioning Service (SPS) and Precise Positioning Service

(PPS), available to all users around the world. Access to the SPS does not require approval by a certain service provider but PPS is only available to authorized users via the service provider administration.
The European Union is developing first civilian GNSS known as Galileo, who has to be operational in several years to come, but they have some slight difficulties. The Chinese government is also developing their own GNSS constellation for military and civilian service known as COMPASS (Beidou).

3. GMSC Applications

The present GMSC systems are in use for maritime, land and aeronautical applications. Recently, several Personal mobile multipurpose applications using GEO and Non-GEO satellites have been developed and introduced. The lately developed regional networks using stratospheric aircraft and airships will be introduced as very low satellite systems.

3.1. Maritime Mobile Satellite Communications (MMSC)

The commercial MMSC systems are designated for very large and medium ocean-going vessels, passenger cruisers, small coastal and river ships, fishing boats, pleasure yachts and rescue boats. These systems are also available for navy vessels, offshore rigs and platforms, including any kind of off/onshore infrastructures. The MMSC system is a successor to the Conventional Maritime Radiocommunications system, which for almost a century was very successful on the commercial and distress scene at sea. In fact, the biggest MSS operator for MMSC is Inmarsat, while other global, regional or local GEO or Non-GEO systems providing MMSC are Iridium, Globalstar, Optus, Emsat, Thuraya, MSAT, AMSC, N-Star, Orbcomm, Leo One and others who have introduced their own MMSS.

3.1.1. Maritime Transportation Augmentation System (MTAS)

The development of the MTAS was to identify the possible solutions for enhancement of DCS MF/HF/VHF radio and satellite communication, navigation, surveillance and safety systems including transport security and control of vessels and freight at sea, on lakes and rivers and the security of passengers on board cruisers and hovercrafts. These enhancements include many applications for the better management and operation of vessels and they are needed more than ever because of world merchant fleet expansion. Just the top 20 world ships registers have about 40,000 units under their national flags.
Above all, the biggest problem today is that merchant ships and their crews are targets of the types of crime traditionally associated with the maritime industries, such as piracy, robbery and recently, a target for terrorist attacks. Thus, IMO and flag states will have a vital role in developing International Ship and Port Security (ISPS). The best way to implement ISPS is to design a Port Control System by special code augmentation satellite tracking, monitoring and surveillance of all vehicle circulation in and out of the port area. The establishment of MTAS will meet most of these requirements and will complement the services already provided by marine radio beacons.

3.1.2. Service for MMSC Users

The first-class two-way MMSC will be essential for mariners to contact and constantly exchange information between vessels, owners, agents, shippers, port authorities, families and friends, or to deal with emergencies, distress and rescue situations at sea. Navy ships can use these facilities for fleet defense, tactical, emergency and information purposes. Therefore, shippers will be nearer to their fleet units, using not only commercial MSC but also reliable distress and intership communications and will also have important 24-hour Maritime Safety Information (MSI), such as Weather (WX) and Navigation Warning (NX).

3.2. Land Mobile Satellite Communications (LMSC)

The development of LMSC application for vehicles first started with the unsuccessful Canadian MUSAT regional program in 1970. The earliest experiment was carried out in the USA, where it was realized that the cellular system could not economically provide coverage of vast rural areas, as could MSC. After the cellular system was allocated the spectrum of 810–960 MHz, the ITU WARC-97 allocated sections of this band to the LMSS in Regions 2 and 3 only. This allocation stimulated much research in North America with the initiation of Canadian MSAT and NASA/JPL MSAT-X projects. The MSAT LMSS would be operated by TMI (Telesat Mobile Inc.), a joint venture between Telesat, Canadian Pacific and C Itoh.

In the meantime, the US-based Marisat network was developed and the next ESA Prosat program, which started in 1982 with the initial phase, involved a number of propagation experiments via the Marecs AOR spacecraft. Furthermore, the American Mobile Satellite Consortium (AMSC) in the USA and TMI in Canada, were both inaugurated in 1988 and started to collaborate on a low-bit rate messages MSC system in 1991, in the same way as Inmarsat-C, by leasing Marisat and Inmarsat transponders. The first AMSC and MSAT spacecraft were launched in 1995 and 1996, respectively.
Both are establishing the interim use of Inmarsat-C for LMSS. However, this is perhaps one of the major reasons why Inmarsat has decided to reconfigure AOR into two regions, AORE and AORW, in order to improve coverage of the North American land mass.
In Europe, a less ambitious scheme has been initiated such as the unsuccessful Swedish Trucksat project. The geographic nature of Europe is very attractive for LMSS because of the predominant high mountain localities and many small countries, which is not at all convenient for cellular roaming. Therefore, the ESA has been considering, together with Eutelsat, the possibility of including an L-band transponder on the Eutelsat II spacecraft to provide a space segment for a new MSC solution known as the European Land Mobile Satellite System (ELMSS). The discussions about this project were unsuccessful and ESA is now considering the use of Italsat as a host satellite.
In addition, Australia has become a new domestic MSS provider via the Australian MSC operator Optus (former Aussat), who decided to include an L-band transponder on their second generation B1-series spacecraft and to allow the provision of LMSS service in rural areas. They introduced the new MSS Optus in 1992, compatible with both AMSC and MSAT systems, launched for the commercial Australian market in 1994 and providing as well as the AMSC service. Similarly, Japan commenced with MSS implementation within the large Experimental Mobile Satellite System (EMSS) program funded by the Japanese Ministry of Post and Telecommunications. In effect, this project has included the launch of the ETS V satellite, the development, experiments and trial of various speech and data-only LMSC terminals.
Inmarsat also started in 1988 with LMSC service, proposing its second standard Inmarsat-C two-way data only system. This standard was initially developed for ships but was later adapted for land and air services. For such reasons, several trials were carried out by ESA throughout Europe to establish its performances. After some time, the MOBSAT Group carried out comparative trials of Inmarsat-C and the ESA Prodat and concluded in early 1989 that while Prodat provides a higher throughput under realistic operating conditions, the Inmarsat-C was preferable due to its more flexible network configuration and practical abilities. Soon after, Inmarsat proposed a low-cost MSC telephone system, known as Inmarsat-M, compatible with the service proposed by AMSC, MSAT and Optus. The next standard suitable for LMSC is Inmarsat mini-M, designed to exploit the spot-beam power of the new Inmarsat-3 satellites, as the smallest, lightest and most cost-effective MSC unit ever made.
All systems discussed above have been developed to use L-band frequency spectrum via the ITU WARK MOB-97. The new initiative Qualcomm OmniTRACS system has been developed to use the secondary LMSC location at Ku-band (11/14 GH). This US-based project started in 1986 and trials were carried out two years later. The OmniTRACS system has also been trialed in Europe, using Eutelsat I-F1 spacecraft during the summer of 1989. However, soon after, Eutelsat announced the intention to launch their own service known as EutelTRACS, based on the OmniTRACS CDMA system.

3.2.1. Land Transportation Augmentation System (LTAS)

The LTAS has been set up to identify the possible applications for global radio and satellite communication, navigation, tracking and determination; safety systems; transport security and control of all vehicles and freight on roads and railways, including the security of passengers in buses and trains. Namely, these enhancements will comprehend the local and regional road and railway transportation, including a drastically density of vehicles on the roads and railways, which in the future will need some regulation and control using augmentation satellite communication, positioning and tracking solutions. Therefore, this potential benefit will assist vehicle tracking and control to cope with increased traffic and to improve the safety and control of track lines and signaling.

3.2.2. Service for LMSC Users

On a worldwide scale, millions of medium to large trucks, buses, cars, trains and other types of land vehicles lack any form of in-cab communications with their dispatch bases, owners, agents, families and friends, or the capability to deal with emergencies such as damage to cargo, engine breakdowns, collisions and rescue situations on the roads. Now transport companies can locate their vehicle fleet and stay in touch with them, no matter where and when they roam. In the same spirit, bus and railway companies can always be in contact with their rolling stock and coach and train personnel and passengers will have the possibility to make private phone calls. The best LMSC solutions on board road and railway vehicles will be utilization of MSC service by two-way low-rate data and message facilities in combination with voice only services such as Inmarsat-C and Inmarsat mini-M standards, respectively. Besides, there are similar solutions like Iridium, Globalstar, Optus, AMSC, MSAT, OmniTRACS and other systems also suited for Army ground forces.

3.3. Aeronautical Mobile Satellite Communications (AMSC)

Commercial AMSS is being implemented for aircraft and helicopters, though the different service varies widely depending upon the group or aircraft concerned. The general aviation communities with large aircraft flying worldwide are potential users of AMSS, while light airplanes flying short routes are not now considered to be potential users of MSS for economic reasons. The Army air forces are also potential users of AMSC terminals.

3.3.1. Development of AMSC

The MUSAT system was the first LMSS in the VHF 200–400 MHz band, developed by Canadian specialists and started in 1970, also providing AMSC experiments, mainly for military applications, using the ATS-6 spacecraft. This program was changed to the new MSAT for all three applications in 1980 because the 800 MHz band was allocated to MSS by the WARC-79. The next program was designed by Japanese experts to develop an AMSC and MMSC and started with exploitation in 1975. The ESA started with the Prosat system in 1982 to contribute to the Inmarsat system. The ICAO embarked on a study into the Future Air-Navigation System (FANS) and new concept of ADSS using the MSC system in 1985. The ADSS was developed and finally accepted as the future prime means of aircraft surveillance and control over oceanic and remote regions.

The Oasis study carried out and completed a research project in 1982 by Stanford Research Laboratories, which confirmed the benefits of MSS in terms of improving ATC in ocean areas and recommended that “satellites of opportunity” be considered as a way of easing the financial burden of introducing such a system. Thus, the Inmarsat organization noted this recommendation and commissioned the Oasis study to investigate the applicability of the Inmarsat system to the AMSS. This study was started by Racal-Decca and confirmed that a 200 b/s data service could be provided to aircraft using 0 dBi antennas and the existing Inmarsat space constellation, which was considered for ATC and AOC, including the provision of data service to passengers. The Oasis study was practically validated by Racal at the 1984 Farnborough International Air Show using aircraft-to-ground data links via Inmarsat AOR satellite and BT Goonhilly GES. Following the successful events at this air show, the Skyphone consortium was formed by Racal, BT and British Airways (BA) to design and develop a system capable of supporting preoperational trials of a public telephony service for passengers on a few BA long-haul airplanes.

A similar experiment was performed by Comsat Labs, in conjunction with Mitre, Collins and Ball Aerospace, in 1985. Simultaneously, ESA was working on the Prosat program that at first included propagation measurements of the aeronautical channels. Furthermore, in the second phase the ESA program will be renamed Prodat in consideration of the design and prolonged demonstration of the two-way low rate data transmission system for all GMSC applications.

The USA-based program, developed by the ARINC organization, commenced in 1985. This project proposed the AvSat system to provide integrated voice and data AMSS between air and ground services throughout the world. AvSat developed a system in 1986 based on six satellites with the advanced TDMA scheme. However, this program collapsed because of the excessive costs of deploying a six-satellite constellation, leaving Inmarsat as the only provider of L-band links, so in 1986 Inmarsat confirmed its intention to set up a versatile AMSS and invitations were issued to tender for the development of the avionics.

The world’s first aeronautical telephone call from a commercial jetliner over transoceanic flight routes was successfully carried out from a Japan Air Lines (JAL) aircraft Boeing 747 in October 1987 using the Inmarsat space and ground satellite segments. Otherwise, this experiment was jointly carried out by KDD, JAL and CRL of the Ministry of Post and Telecommunications in Japan. It was based on ETS-5/EMSS research and development program of CRL, which was reorganized from AMES in 1984. The other significant AMSS voice trials were conducted by the Inmarsat, BT, BA and Racal Decca companies and conducted a Skyphone service in May 1988, using a fully avionics-compliant package located in the bay of BA Boeing 747 aircraft, not in the passenger cabin.

The AMSS L-band frequencies, which had been exclusively allocated for ATC and ACC, were opened to APC at WARC-87. With these trends, L-band became the most suitable spectrum for integrated GMSC, which provide worldwide service to ships, land vehicles and aircraft. Since 1990 Inmarsat has carried out a program of AMSC tests, demonstrations and trials and later started to lead an AMSC service. Accordingly, large airways companies worldwide can now use Inmarsat for reliable corporate, social and safety AMSC service.

The Inmarsat system is not ideal for AMSC, in particular because some scheduled flights are using lines far over the North Pole, beyond the coverage of GEO.

Meanwhile, this problem can be solved similarly to MMSC, by using integrated Radio and Satellite Mobile Communications under GMDSS and establishing a Global Aeronautical Distress and Safety System (GADSS). On the other hand, by using a combination of GEO and PEO or HEO constellations, the coverage problem for both polar zones will be solved.

3.3.2. Present Status of Aeronautical Communications

Business or corporate airlines have for several decades used HF communication for long-range voice and Tlx communications during intercontinental flights. For short distances, nearby airports during approach or departures, all aircraft have used the well-known VHF/UHF radio. Data communications are since recently also in use, primarily for flight plan and worldwide weather (WX) reporting in a form similar to the VHF/UHF Airborne Flight Information Service (AFIS) system. Apart from data service for the aircraft cockpit and cabin crew, cabin voice solutions and passenger telephony have also been developed. On the other hand, some airlines servicing major transcontinental routes have provided free telephone services to passengers as marketing ploys, whereas others want the service to generate additional revenue.

The airline data service requirements are divided into two main areas: AAC-AOC (Airline Administrative and Airline Operational Control) and ATC services. Efficient operation of modern aircraft requires that automatic engine airframe health monitoring and control is available wherever the aircraft is flying. Worldwide access to remote databases while in flight is required for optimum flight profile planning. Therefore, the ARINC (Aeronautical Radio Inc.) program named ARINC Communication and Reporting System (ACARS) and the SITA (Societé Internationale de Télécomommunications Aeronautique) system known as AIRCOM still provide these facilities via VHF radio, although they have started to use AMSC to make these services available worldwide and more effectively.

The success of Inmarsat MMSC and LMSC systems together with the rapid growth of VHF air-to-ground radiocommunications has encouraged the development of the AMSC system. Avionics companies have the best solution to organize MSC links and within their own fleets and also to enable reliable voice, Fax, video, image, data and Internet service for their passengers, crewmembers and corporate purposes. At present, Inmarsat is the only global operator providing the AMSC service, while other GEO and Non-GEO operators also provide AMSC, such as Globalstar, Iridium, Optus, AMSC and MSAT.

As with Inmarsat's MMSC system, the AMSC service is provided to users via the Inmarsat signatories, who are predominantly national PTT or Telecommunications organizations. In the meantime, several competing service provider agreements have been announced with: US-based Arinc, Japanese Avicom, Satellite Aircom consortium of France Telecom, SITA, Teleglobe Canada and Telstra Australia, Skyphone consortium of BT, Singapore's SingTel and Telenor and the multinational Skyways Alliance led by Comsat.

3.3.3. Aeronautical Transportation Augmentation System (ATAS)

The ATAS has been set up to identify the possible applications for global radio and satellite communication, navigation, surveillance and safety systems including security and control of aircraft, freight and passengers and SAR service in accordance with ICAO regulations and recommendations. The world's commercial airline fleet is expected to double in the next 20 years, which will result in crowded routes, leading to fuel wastage and delays, which could cost millions of dollars annually. In this sense, the new augmentation system for aeronautical satellite CNS/ATM is designed to assist navigation both en-route as well as during landing and in airports. In fact, the potential benefits will assist ATC to cope with increased air traffic as well as improving safety and reducing the infrastructure needed on the ground.

When planning aircraft routes and landing schedules at busy airports, it is essential to ensure that aircraft are always a safe distance from each other. The trouble is that it is not always possible to know where the planes are. Thus, it is necessary to leave a very large safety margin but when it is possible to know precisely where the planes are, it will be easy to reduce the margins safely and increase the numbers of planes in each corridor. At any rate, the new WAAS, EGNOS, MTSAT and forthcoming Galileo GNSS will provide a guaranteed service with sufficient accuracy to allow airlines and pilots to know their current position and safety margins reliably and precisely enough to make substantial efficiency savings. The GNSS can also help pilots to land planes safely, especially in poor weather and dense fog, in which only with DGPS or the augmented satellite CNS system is reliable. Unfortunately, small airports are unlikely to invest in this system but they can use local augmented system or when Galileo becomes operational, the need for a differential antenna will reduce costs. Galileo's guaranteed service and use of dual frequencies will increase accuracy and reliability to such an extent that planes will be able to use its navigational signals for guidance with their on-board technology alone.

3.3.4. Service for AMSC Users

New aeronautical services will provide mile-high opportunities to bring AMSC to general aviation planes, commercial airlines, helicopters, their crewmembers and passengers. They can use air-to-ground AMSC facilities to optimize commercial and safety communications, fuel, maintenance and revenue demands. All the communication features found in the office are made available in the airborne environment, with direct dialing and continuous global coverage. The AMSC service provides passengers, pilots and crew to communicate critical business decisions or social, private and confidential cockpit and seat phone calls.

The airborne equipment enables direct dial phone calls, data and messaging services, HSD, Internet, E-mail, E-commerce, videoconferencing, databases and Aeronautical Information Services (AIS), such as news highlights, WX reports and stock market information. The GMSC system benefits long, medium and short haul airline customers by facilitating accurate positional information for better aircraft utilization and more productivity, good air traffic management and they are very important for increasing airline revenues. In this way, except for Crew and Passenger Service, Aircraft Operation Management, ATC and HSD/ISDN services through the Swift64 Inmarsat system integrated with GNSS solutions, will offer two very important services:

1. Aircraft Security Control – All planes can be provided with the service of Aeronautical Safety Information (ASI) via satellites, such as Turbulence Warnings, Weather (WX) and Ace Reports to assure safe flights. Anti hijacking actions are important for the safety of lives and property on board aircraft, as hijacking is usually violent, causing injury or death among crew and passengers or the loss of valuable cargo. All airports have security control of passengers on all gates but it will also be important to find out how the AMSC system can provide automatic surveillance and monitoring of aircraft and cargo before departure.

2. Remote Troubleshooting System (RTS) – For almost one year, Dassault Aviation has been using the Inmarsat-ISDN solution for a new remote analysis and technical assistance system called Telemaque. It enables the technical support specialists at Dassault Aviation to carry out all diagnoses or repair operations in real time with customer sites located anywhere in the world. Using an audio and video system connected to an Inmarsat-ISDN transmitting (Tx) antenna, the aircraft sends images in real time to the technical support team at Dassault, enabling them to identify the fault precisely. Besides, secure software for application sharing and file transfer enables the two teams to connect up and work on the same documents, such as databases and plans of the aircraft located at the Dassault office. Dassault Aviation started with Global Telemaque Service (GTS) to all its customers in 2001, which offered video camera, a digital camera, an Inmarsat antenna, a PC, an earpiece and remote maintenance software.

3.4. Global Mobile Personal Satellite Communications (GMPSC)

At the beginning of the 1990s, several private US firms proposed new concepts for MSC known as GMPSC, using a group of LEO or MEO spacecraft. Typical systems were Iridium, Globalstar and Odyssey. In 1991, Inmarsat also proposed the new Project 21, named Inmarsat-P, which would provide GMSC for personal applications using Non-GEO systems. After feasibility studies, Project 21 is now going to use the ICO, which is the same as MEO and belongs to ICO Global Communications. With regard to this, in 1992, WARC-92 responded to these activities and allocated the L-band (1626.5 to 631.5 MHz) and S-band (2483.5 to 2500 MHz) for MMS using LEO or MEO satellites.

Those people living and working far from the reach of cellular wireless networks, for example, roaming construction engineers, exploration workers, medical staff, journalists, rangers, farmers, fishing boat or yacht crew members and small planes or helicopters, can also have access to the GMSC network. Namely, every customer can choose to use satellite and/or a convenient cellular network when they are in urban roaming areas, because mobile phones will be dual-mode and triple-mode handsets. Therefore, it is possible to produce dual-mode satellite/GSM handheld phones (the waterproof boat kit solution is optional) and triple-mode satellite/cellular models for D-AMPS/AMPS or for CDMA/AMPS systems.

The GMPSC handsets are lightweight, easy to carry, simple to use and, similarly to current mobile phones, are able to provide a GMSC service with both satellite and cellular network access. These phones can offer voice, Fax, data, SMS and voice mail. The dimensions of unit are about 54 x 26 x 145 mm and about 240 g in weight. The graphic display is with fixed icons and keypad consists in 6 menu-driven soft keys. This unit can support European Community, East European, Chinese, English and other languages. The delivery features include voice, data and Fax messaging in both satellite and cellular modes. The handset has manual or automatic satellite/GSM mode selection, using a small extending antenna.

The special, rugged GMPSC equipment with external antenna can be fitted on board ships, land vehicles or aircraft similar to the ship borne, vehicle borne and airborne Inmarsat solutions. Otherwise, similar equipment is designed for use in Rural and Remote (R&R) environments as well.

Three billion people living in remote villages and households have no access to a cellular or landline network using semi-fixed installations but providing this telephone service to remote rural areas is often very slow, complex and quite an expensive project. The GMPSC system can extend the existing telephone utilization to any location in the world, with more products and solutions and with much cheaper equipment and usage charges providing the following services:

1. Rural Villages and Remote Communities – The GMPSC model of rural payphone will offer the ability to communicate with any location in the world using voice facilities and emergency numbers for access to medical, firefighting or security services. The terminal will be similar to a typical city payphone operated by phone cards, ruggedly constructed to withstand vandalism, simple to use and able to indicate the amount of money remaining on the card and will be powered using mains network supply or solar panels and batteries. Additional services include remote fault diagnosis, local support to ensure rapid repair and high availability. This payphone can be used in remote suburban and village environments, in desert and forest areas, on cruise ships, on board aircraft, sea platforms and oilrigs. Otherwise, they are easy and cost-effective to install and operate, using prepaid chip cards. Local authorities can use payphones for emergency calls, using a special access card.

2. Phones for Remote Households – The GMPSC model of an indoor phone offers every remote household connection to TTN via a standard phone set connected to an interface box and external outdoor antenna mounted on the roof. This box can be linked to standard Tel/Fax or ISDN/Internet lines, using mains power, 12V battery or solar cell energy.

3. Remote Business Sites – The GMPSC system is giving an advantage to every business based in suburban and R&R areas, providing in the developing and developed world the following services:

a). Basic GMPSC remote service is suitable for companies requiring voice, Fax, LSD and SMS facilities via a compact system, which includes a small interface box and a compact rod antenna. The system will utilize existing TTN devices easily attached to a company's Tel, Fax or PC and is ideal for remote post offices, credit card companies, administrative authorities, small private companies and companies requiring telemetry and SCADA.

b). Advanced remote service is specified for companies requiring full telecommunication services such as voice, Fax, HSD and efficient data transmissions and SMS facilities, using a GMPSC interface box and an A4-sized antenna. The interface box can easily be fixed to Tel, PABX, Fax or PC, while outdoor antenna can be mounted onto an appropriate on-site building. This GMPSC service is ideal for geological, mining, agriculture, manufacturing, construction, energy and gas exploration companies, local government administration and other organizations requiring high volumes of computer data service.

c). Portable GMPSC remote service has been determined for the early stage of exploration and survey work, or for journalists using a portable laptop-sized terminal, which can easily be connected to a telephone handset or PC configuration. This service is ideal for the immediate transmission of data from a remote site to a headquarters or research location, for transmitting urgent copies of visual images or photos and for any customer requiring advanced telecommunications with easy installation in remote locations.

4. SCADA (Supervisory Control and Data Acquisition) – The Inmarsat D+, C, GAN, OmniTRACS or Orbcomm and other SCADA (M2M) equipment or systems may be used in the point-to-multipoint broadcast of Automatic Remote Monitoring and Messaging Data (ARMMD), which installations are fitted with automatic sensors that regularly report back to a control centre via satellite. With its greatly reduced power consumption and by being remotely controlled, this device is a very effective way of remotely collecting basic environmental and industrial data via messages of up to 2000 bits, together with one of four alert signals, which may be sent as a single message. Therefore, the setting up of theses M2M systems and devices are all remote industrial and manufacturing installations, oil and gas pipeline pumping stations, offshore platforms, meteorological observatories, water treatment and energy stations, maritime lighthouses and buoys signaling and other remote systems to run unattended is fairly easy. Keeping this equipment working efficiently, gathering management data and guarding against remote catastrophic failure, all without overspending on expensive technical labor and travel is a tougher challenge.

5. Government Services – The GMPSC system network will also provide possibilities to organizations involved in fast-moving emergencies and interventions such as disaster relief agencies and SAR organizations, military and international peace-keeping forces, police squads, medical teams and civil authorities. This service offers assured communications by PC data, voice, Fax, SMS and encrypted messages. For personal use it will offer dual mode functions portable handsets for both satellite and cellular connection. On the other hand, for group use the system will offer mobile handset terminals for fitting to ships, vehicles, aircraft and temporary accommodation at camps or bases. Therefore, Inmarsat, Iridium, Globalstar and other current GMSC systems have developed both common and special military mobile and portable satellite tactical and defense communications equipment.

4. Conclusion

The latest developments in GNSS fields a
re Communication Navigation and Surveillance (CNS) systems for Augmented GPS and LONASS signals, such as already operational the US Wide Area Augmentation System (WAAS), the Japanese MTSAT Satellite-based Augmentation System (MSAS) and the European Geostationary Navigation Overlay Service (EGNOS).

In the meantime, were projected and are under development other four SAS: the Russian System of Differential Correction and Monitoring (SDCM), the Chinese Satellite Navigation Augmentation System (SNAS), Indian GPS/GLONASS and GEOS Augmented Navigation (GAGAN), and soon IS Marine Radio will propose to ICAO own project known as African Satellite Augmentation System (ASAS), as an African Project for Africa and Middle East.

In additional, several very interesting projects are developing in Europe, Japan and the USA for new mobile and fixed multimedia Stratospheric Communication Platforms (SCP) systems powered by fuel or the Sun's energy and manned or unmanned aircraft or airships equipped with transponders and antenna systems at an altitude of about 20–25 km. At the end of this race a new mobile satellite revolution is coming, whereby anyone can carry a personal handheld telephone using simultaneously satellite or cellular/dual systems at sea, in the car, in the air, on the street, in rural areas, in the desert, that is to say everywhere and in all positions. These integrated systems will soon be implemented, with new stratospheric platform wireless systems using aircraft or airships. The final target of this race is to do Space more friendly to mankind and eventually to discover our new home.

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