Air Traffic Management (ATM) communications and satellites: An overview of EUROCONTROL's activities

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Abstract. This paper provides an overview of the EUROCONTROL activities and involvement in relation to using satellite communications to support the aviation requirements in the context of the work to define the future aeronautical communications infrastructure. In addition, the paper discusses the key issues that need to be addressed and describes a potential model that could contribute to the greater utilisation of satellite aeronautical communications in the future.

1. Introduction

2007 was a record year for aviation in Europe with over 10 million flights. Between 2006 and 2007, the number of flights grew by 5.3%. Growth was particularly notable in Eastern Europe with several states seeing growth rates near to 20%. According to current forecasts, this trend is set to continue, with the number of flights predicted to grow by 4.2% in Europe in 2008. By 2025, the number of flights in the most demanding growth scenario could reach 19 million a year. According to EUROCONTROL data (Long Term Fore-cast Report, edition 2006), it is estimated that traffic levels in 2025 will be between 170% and 210% of those in 2005.

Safe flying in the busy airspace of the future will require significantly increased volumes of information exchanges, and also reliable and adequate air/ground and air/air transfer mechanisms. Current communications systems will not, however, be able to support the estimated traffic growth using the current operating concept or the future operating concepts which will be developed.

2. Future aeronautical communications

A key enabler for the future growth of the air traffic management (ATM) system is the provision of additional communication capacity meeting strict Quality of Service (QoS) requirements to support the new operating concepts which are expected to be developed to support the anticipated traffic growth.

The aeronautical mobile communication infrastructure must therefore evolve in order to accommodate new functions and provide the capacity and QoS required to support the evolving ATM requirements.

EUROCONTROL is working closely with the other European and international stakeholders to facilitate agreements in relation to the future communications infrastructure. The Future Communications Infrastructure (FCI) will be a key enabler for new ATM services and applications, which will bring operational benefits in terms of capacity, efficiency and safety. The FCI will support both voice and data communication of all types and for all flight phases. In the beginning of the FCI implementation, the emphasis will be on data communication, as the current (analogue) voice infrastructure is expected to be in service for a long period to come.

In Europe the FCI work is being closely coordinated and provided as input to the EUROCONTROL /European Commission Single European Sky ATM Research (SESAR) Programme. SESAR is the European ATM modernisation programme, combining technological, economic and regulatory aspects in order to synchronise the plans and actions of the different stakeholders. SESAR is leading the definition, development and implementation of the required improvements both in the airborne and ground systems in Europe. Currently the Definition Phase is
being completed, which will deliver a European ATM Master Plan covering development activities up to the 2020 timeframe. From 2008 up to 2015 will be the Development Phase of the required new improvements. These new improvements will be implemented in the Implementation Phase from 2013 onwards (with 2020 being the target date to implement the required improvements).

At EUROCONTROL, the Air Ground Communications Focus Group (AGCFG) provides a stakeholder forum to discuss and progress FCI-related work and activities. On the basis of the AGCFG discussions, it is estimated that the likely initial date for FCI implementation is around 2020. This date takes into account the planned ongoing implementations using the existing infrastructure as well as the time for the assessment, selection, decision, standardisation and implementation process for any new infrastructure. In this context, analogue voice (Double Side Band – Amplitude Modulation) will remain the primary means of ATC communications in most regions up to 2020, and will also constitute the back-up for any initial data link services which may be introduced. However, new data services will begin to be introduced in around 2020. These are expected to be volume-intensive (information content) so that voice exchanges will not be able to function as an adequate back-up solution. A data-based back-up option therefore needs to be considered.

The term FCI refers to the communications technology required to support the end-to-end communications requirements of ATM in the 2020+ timeframe. The FCI includes the avionics systems, air/ground (a/g) and air/air (a/a), voice and data links and the essential elements of the ground infrastructure in the context of end-to-end connectivity. The FCI is thus combining several technologies, including the legacy technologies which will still be operational in the future and new components, operating in a transparent way for the user.

Key drivers for the FCI development are that it must:
- support the future ATM communications requirements, as required in all flight phases;
- employ technology in a way that is transparent for the user;
- avoid single points of failure simultaneously affecting the various types of communication;
- enable smooth transition and provide support for legacy systems (backwards compatibility);
- be implementable (in time and space) in a phased manner but be globally applicable;
- include provision(s) for growth in capabilities;
- maximise synergies (telecoms, military) and maximise reuse of available technology;
- be spectrum- and cost/benefit-efficient and efficiently use existing and already planned infrastructure;
- if required, use different technologies for different flight phases and/or functions/applications;

EUROCONTROL, together with other European and international stakeholders, has been assessing the candidate data link technologies which could become part of the FCI supporting the future operational requirements. The investigations show that FCI is likely to be based on a combination of terrestrial and satellite technologies in order to provide the required coverage redundancy and in order to meet the QoS requirements such as availability. Such a scenario for the 2020+ timeframe is depicted in Figure 1.

Figure 1 depicts the current VHF systems (DSB-AM and VHF Digital Link). In addition, it shows some new terrestrial-based systems which will operate in an appropriate band (taking into account the WRC2007 decisions). As illustrated in Figure 1, another important element in future communications is support for air/air communications. Finally, Figure 1 depicts the use of satellite systems for communications with aircraft in some regions at least.

At present, it is INMARSAT and Japan through the MTSAT system which support ATM satellite communications. In addition, work has been completed at ICAO to develop the provisions to allow IRIDIUM to offer ATM satellite communications. However, considering the lifetime of satellite systems, the current ones are likely to have evolved and/or been replaced by newer ones by 2020. INMARSAT for example has launched a new service called SwiftBroadband using a new (4th) generation of satellites. In the case of SwiftBroadband, INMARSAT has not yet decided whether it will offer ATM communications. In any case, even assuming support for ATM communications, the timeframe under consideration for the FCI (2020) will be close to the end of the expected life-span of the current SwiftBroadband service.

Consequently, in the time-frame for the Future Communications Infrastructure (2020), new satellite systems, including the potential evolution of the current ones, need to be envisaged. This is the approach taken in the EUROCONTROL FCI investigations and a “placeholder” for new satellite
systems supporting the AMS(R)S (Aeronautical Mobile Satellite Route Service) has been agreed.

In the FCI investigations, EUROCONTROL has worked very closely with FAA and investigated the terrestrial as well as the satellite options to support in the future requirements. Recognising the unique capabilities of satellite communication systems to provide adequate coverage over large and/or remote geographic areas, the potential was identified for next generation satellite systems particularly those systems customized to meet the needs of aviation. Such systems include commercial as well as government/private solutions. In the European activities, the future satellite systems are also being investigated as a complement of the terrestrial infrastructure to jointly meet the future stringent requirements in the high density continental airspace.

One issue raised was the adverse impact of the proliferation of technologies in the airborne equipment which result in multiple options for equipage. In this context, the availability of a globally applicable standard covering the future requirements was seen as a means to help addressing some of the institutional issues associated with satellites. If such a standard could be adopted by the interested parties, it would support interoperability while minimising airborne equipment requirements. This approach could be a way to address many of the concerns relating to satellite communications, both financial but primarily institutional, such as equipment, ownership, coverage, monopoly service, etc. A successful example of this approach is the INMARSAT AMSS and the Japan MTSAT systems which provide interoperable services using the same standard but through two different satellite constellations and two different satellite service providers (INMARSAT and MTSAT).

Joint (US and European) recommendations to ICAO (delivered to the 1st meeting of the ICAO Aeronautical Communications Panel Working Group T) recognise that satellite communications remain the prime candidate to support oceanic and remote environments and that the considered future satellite systems may also be able to support continental environments complementing terrestrial systems. Therefore it is recommended to monitor and support developments that will lead to globally available ATS satellite communications. The need to update the existing AMS(R)S Standards and Recommended Practices (SARPs) performance requirements to address the future requirements has been identified. Finally in order to support the updated AMS(R)S SARPs, the development of a globally applicable standard for satellite communication systems supporting safety related communications is proposed.

3. Issues

By virtue of their physical location, geostationary as well as other constellations of satellites have the
coverage properties suited to support aircraft communications including ATM communications. However, current satellite communication systems have not been utilised extensively either for ATC/AOC communications or for APC (passenger) communications. The main reason often quoted for the small penetration of satellites in the aviation communications market relates to financial considerations. For the airlines, it is the equipment cost including installation. For the end-user it is the communication cost which limits use, even when the equipment is available. In addition, other issues such as service provision assurances in relation to continuity and reliability of service, liability concerns, ownership, and the operating frequency spectrum are also frequently quoted as areas of concern.

While all issues, as well as their perception, are of importance, addressing the financial concerns of the end-users (in terms of equipment, operation and maintenance costs) is likely to be the starting point for increasing the role which satellite communications can play in the context of future ATM communications.

Various activities have shown the technical capabilities and potential of satellite communications for aviation. It is thus the financial and institutional aspects of satellite communications which need to be further investigated and progressed. The systematic investigation of these issues requires the development of an operating concept which positions satellite communications in the broader picture of overall communications in a future timeframe. Furthermore, in order to better weigh up the uncertainties in relation to future developments from an operational point of view, different scenarios describing different levels of “success” in terms of usage for satellite communications in aviation will need to be considered.

Much of the debate on the use of satellite communications within the aviation community is focusing on the potential options for providing satellite communications for ATM purposes. These options range from considering a system which supports only ATM communications to one which shares the satellite platform to support multiple missions and not just ATM communications.

The “only ATM communications” option, is usually referred to as a dedicated ATM satellite system, and can be implemented by using either a dedicated satellite or a dedicated payload. For these variants, it is the financial considerations which are of key importance. A detailed financial analysis and quantification of the operational benefits and a subsequent comparison with terrestrial-based systems is needed to provide useful information.

At the opposite end of the spectrum is the option of a shared satellite system which supports ATM and other services. There are different variants for shared systems such as sharing with airline communications (AOC), sharing with passenger communications (APC), etc. Such systems are generally seen as financially more appealing than dedicated ones. However, for these options, it is the institutional issues which are emerging as key areas of concern.

4. EUROCONTROL activities

In the context of FCI, EUROCONTROL is cooperating with various partners to further progress deliberations on the use of satellites for ATM communications. This section provides a brief overview of the EUROCONTROL activities on the use of satellite communications.

4.1. NexSAT Steering Group (NexSAT SG)

The NexSAT Steering Group is a EUROCONTROL group which provides a forum for all interested parties in satellite communications for ATM, to discuss ongoing developments, share information, and provide EUROCONTROL with advice on ongoing and planned activities.

The NexSAT SG has played a key role in the development of high-level technology-independent requirements for a new-generation satellite system supporting communications related to safety and regularity of flight. In addition, the group has consolidated contributions to ICAO and provided advice and steering for various projects and activities such as the ESA Satellite Datalink System (SDLS) and the feasibility study into the use of SwiftBroadband for ATM services.

The NexSAT SG usually holds meetings twice a year in which recent developments are outlined and future steps are discussed. The group meetings are linked to the EUROCONTROL AGCFG meetings.

More detailed information about forthcoming NexSAT SG activities as well as about documents and deliverables from past activities is available on the group’s website at www.eurocontrol.int/nexsat.
4.2. ICAO

EUROCONTROL is also supporting ICAO activities in relation to satellite communications. Among these activities, one key task is the availability of the required material, namely SARPs (high-level requirements focusing on system performance) and manuals (supporting technical information specific to individual satellite systems).

Following the development of the so-called Next-Generation Satellite Systems SARPs in 2000 to complement the existing AMSS SARPs material, ICAO has now approved a unified SARPs document: the AMS(R)S SARPs. The scope of the new AMS(R)S SARPs is to cover the current systems (INMARSAT, MTSAT, and Iridium) as well as any new systems which may become available. The AMS(R)S SARPs are complemented by the AMS(R)S Manual, in which the technical details of the satellite systems are provided. For any new system, a dedicated section on the manual will need to be developed to complete the ICAO documentation. Other standard documentation may also need to be developed by other groups such as EUROCAE/RTCA, AEEC, and ETSI.

4.3. Cooperation with the European Space Agency (ESA)

EUROCONTROL and ESA signed an Agreement of Cooperation in 2002 which provides a general framework for mutual cooperation and support covering various activities, in particular in the area of telecommunications.

In this field, ESA and EUROCONTROL have successfully cooperated in jointly preparing material for ICAO ACP and NexSAT SG meetings as well as the ESA SDLS project.

SDLS is an ESA project which investigated the technical feasibility of the concept of a dedicated system (satellite or payload) supporting ATM communications. The SDLS activity culminated in a demonstrator of the SDLS concept showing that a satellite communication system has the potential to support safety-related ATM functions, with performance and services in line with aeronautical requirements. The project carried out a number of tasks such as requirements capture, the related mission analysis, the critical points design analysis e.g. satellite diversity options, waveform and protocol analysis. EUROCONTROL supported the ESA SDLS activities by providing the aviation expertise.

Further cooperation with ESA is planned on new activities. Following a preliminary analysis, covering primarily the financial aspects of using a satellite system, ESA has recently launched a new programme (Iris) for air traffic management via satellites. Iris aims to develop a new ATM dedicated satellite communications standard, to be standardised at ICAO level, the associated avionics baseline and the complementary satellite system in order to provide the additional a/g communication capacity required over Europe, in line with forecast traffic growth. The programme is divided in 3 phases. The first phase (2007 to end 2009) will contribute to the development of a new satellite communication standard and the associated systems. Following approval, the second phase (2009 to 2014) will cover system development and the third phase (2011+) will support in-orbit verification and certification of a preoperational system and provide the technical support for the deployment of the full system. EUROCONTROL is supporting ESA in these activities by providing the aviation expertise.

The ESA activities are separately presented in this special issue.

4.4. Support for EU-funded activities in relation to satellite communications

EUROCONTROL is providing support to the EUROPEAN COMMISSION in steering and reviewing the progress of projects funded by the EC Framework Programmes. In the 6th Framework Programme, “Aeronautics and Space” is one of the 7 key priority thematic areas with an indicative budget of EUR 1 billion. The subsequent 7th Framework Programme (2007-2013) also identifies aeronautics and space in two out of the nine covered themes (Transport (including Aeronautics) and Security and Space), with a proposed indicative total budget of around EUR 10 billion.

EUROCONTROL’s current involvement in relation to satellite communications relates mainly to two projects, ANASTASIA (Airborne New and Advanced Satellite Techniques and Technologies in a System Integrated Approach) and ASPASIA (Aeronautical Surveillance and Planning by Advanced Satellite Implemented Applications). EUROCONTROL provides aviation expertise on these projects.

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3 The NGSS SARPs were developed by the Aeronautical Communications Panel 7th meeting, but in the end were not introduced in the Annex 10 material, as there were financial problems with the considered NGSS system.
5. Conclusions

With the forecast traffic growth and the limitations of the existing communication systems, significant effort has been allocated to investigating the future communication infrastructure for aviation. It is expected that this future infrastructure will include both terrestrial and satellite components to meet aviation requirements.

EUROCONTROL, through its NexSAT Steering Group and the broader international cooperation with ICAO, FAA, etc, is interested in further investigating the technical, institutional and financial aspects of using satellite communications for ATM purposes. The EUROCONTROL investigations include dedicated systems and commercial satellite services.

A promising implementation model requiring further investigation is the development of the appropriate global technical standard for new satellite systems supporting aviation’s expected future requirements. If this standard is adopted and implemented by different entities providing regional and/or global services, then the same avionics will be required to support interoperability between different regions and/or service providers. This model may be useful and contribute to address some of the financial and institutional aspects and lead to a greater utilisation of satellite communications in ATM.