

[EN-014] The ESA Iris Programme – a new satellite communication system for Air Traffic Management ATM

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Abstract: The Iris Programme of the European Space Agency aims at designing, developing and validating a new satellite communication system for air-ground safety communications within the framework of the Single European Sky ATM Research (SESAR) Programme. This new satellite communication system for ATM, together with a new terrestrial-based datalink system to be developed in L-Band (LDACS), constitutes a dual link to be used in high-density continental airspace by 2020. The satellite communication system shall be able to support ATS and AOC datalink applications, notably for future 4D-trajectory management, with the required performance level for use in high-density continental airspace. To implement this vision, international coordination activities are foreseen, notably technical coordination to facilitate standardisation of specifications of the new communication protocols within the ICAO future aeronautical communication system activities. The Paper presents the status of technical design activities of the Iris Programme and the roadmap foreseen for international coordination activities.

Keywords: CNS, datalink, satellite communication, satcom, ESA, SESAR

1. BACKGROUND: SATELLITE COMMUNICATIONS IN SESAR

In order to accommodate future air traffic growth and tackle the problems of fragmented European Airspace, the SESAR (Single European Sky ATM Research) Joint Undertaking was launched to oversee the technological research and deployment activities required to integrate European ATC systems and accommodate future Air Traffic needs in Europe.

The SESAR Definition Phase ultimately concluded that there is a necessity to evolve to datalink based technology for aeronautical air/ground communication by 2020; this has driven the requirement for a multi-link solution to guarantee the necessary availability for aeronautical safety communication, especially over dense traffic areas. The ATM Master Plan, which has been endorsed by the EU Transport Council, therefore includes Research and Development for new Air/Ground datalink technologies. It is widely shared among stakeholders that use of this satellite link in dense continental airspace requires new performance standards, which calls for a new ATM-

dedicated Satellite Communication standard and the supporting satellite capacity.

For continental airspace, a dual link is expected to include both a terrestrial (LDACS) and a satellite-based component. The satellite component is being defined within the ESA Iris Programme in close cooperation with the SESAR Joint Undertaking (SJU).

The main objectives of the Iris Programme are:

- To develop a new satellite-based Air-Ground communication system for Air Traffic Management and to validate the end-to-end performance of a new satellite-based Air-Ground communication standard for Air Traffic Management
- Subject to agreement with the SESAR JU/European Commission and a future Operating Entity, to develop a subset of the system for validation of this new satellite-based Air-Ground

communication system for Air Traffic Management.

The Iris Programme is financed by ESA Member States, and closely coordinated with SESAR JU under the aegis of the agreement between ESA and the European Union

Because aviation operates on a global basis, any new ATM solution must be supported and coordinated on a worldwide basis. The global interoperable satellite communication system infrastructure, which will be deployed over time in the various world regions and procured by different organisations, will be made up of different modules. Europe will only deploy a regional infrastructure that will focus on ECAC and ensure seamless transition from high traffic density areas to oceanic and remote areas. However the key will be to guarantee that a unique communication standard is available for all regions, so that the new aircraft avionic terminals are interoperable and communications can occur seamlessly and transparently when aircraft travel from one regional system to the next. This requires standardisation and coordination with the international stakeholders. In this perspective, activities at ICAO level will be triggered by SESAR, leading to standardisation of a new satellite communication standard suitable for use in high-density continental airspace.

As the system is intended to become a primary means of communications for ATM by a vast majority of aircraft categories after 2020, cost is one of the main design factors. The system developed within the Iris Programme will allow for low cost user terminals with low-drag aircraft antenna, low operational costs, and minimising the cost of installing or retrofitting equipment is also taken into account in the system design. The service model shall ensure low cost of use for ANSPs and airspace users.

The satellite-based system is envisaged to be part of, interface with, and be fully interoperable with the other elements of the new telecommunication infrastructure of the European ATM System (EATMS), notably the other communication links based on terrestrial networks.

The satellite communication system shall be able to support ATS and AOC datalink applications, notably for future 4D-trajectory management, with the required performance level for use in high-density continental airspace. Reference applications are defined in the Communications Operating Concept and Requirements for the Future Radio System version 2.0 (COCRv2) document [1]. The satellite link will also be used in oceanic and remote airspace to support voice communications when

needed. The European regional system must be designed and specified according to the SESAR requirements and ready for deployment during the 2014-2020 timeframe, with the aim to start operations in 2020.

The focus of the Iris programme is the design of the communication system (i.e. communication protocols optimised for air-ground data exchanges), of the European satellite system infrastructure (i.e. space segment, ground segment and user terminals), and their validation by an end-to-end system as close as possible to the system to be deployed operationally.

The design and validation activities will be performed in full coordination and cooperation with the SESAR JU as the Design Authority for the future European ATM System.

2. PROGRAMME OVERVIEW

The Iris programme has been structured to match the SESAR's programme schedule and milestones, and is in line with the calendar of development and deployment of the EATMS infrastructure.

From a technical perspective, ESA's role covers the design of the new communication system, the design and development of the satellite system, as well as the procurement and deployment of the infrastructure required for the system validation.

From an institutional perspective, ESA is supporting SESAR JU and the European Commission in facilitating the definition of the service model by carrying out preparatory activities with satellite operators and satellite service providers, and analysing options for the business case. ESA is also facilitating the definition of the safety case, by involving the Safety Regulator (i.e. the European Aviation Safety Agency inter alia) in a supervisory role from inception of the technical design.

The Iris programme has been structured into the following three phases:

Phase 1 related to assessing feasibility of the concept, and provided design options for both the Communication Standard and the satellite system architecture. It was carried out in parallel to SESAR Definition Phase. Phase 1 has been completed in 2009.

Phase 2 (subdivided in two sub-phases: Phase 2.1 in 2009-2011 and Phase 2.2 in 2012-2015) - relates to design and

development of the new Satellite Communication standard, design and development of the Satellite System, integration and test in pre-operational conditions, and system validation. The actual validation of the end-to-end system requires implementing an end-to-end system as close as possible to the system to be deployed operationally. Phase 2 corresponds to the SESAR Development Phase.

Phase 2.1 considers two approaches for the system design: either developing a new system specifically built for purpose, or adapting the existing Inmarsat SwiftBroadband system. The main driver behind this dual approach is the assumption that adapting an existing system might be more economical than designing a new one, but it is still unknown whether technical adaptations could be designed, what the cost of their implementation would be, and whether considerations of an economical and political nature would make it an attractive solution for aviation stakeholders worldwide. While these issues are being studied with Inmarsat, an ambitious design activity to develop an entirely new system is carried out by a team gathering telecommunication industry, satellite manufacturers and aircraft avionics manufacturers. These two approaches are in any case complementary, as, should a purpose-built system be required, the satellite infrastructure would focus on European airspace only (i.e. where performance requirements are the most demanding), while Inmarsat's worldwide coverage could ensure further service coverage.

A decision by ESA Member States is forecast in 2012 to give the go-ahead for the Phase 2.2 and complete the Iris Development Phase.

Phase 3 is to be launched in 2014. ESA's role at this point will only be to provide technical support to the system owner for the time during which the system owner will procure, deploy and start operation of the complete infrastructure of the new satellite-based Air/Ground datalink for the EATMS.

3. Iris PROGRAMME ACTIVITIES

Within Iris Phase 1, several industrial studies were carried out, involving a large number of companies out of the telecommunication, aeronautical and space industries [2]. They addressed the technical feasibility of the system. In addition, an Expert Group composed of aviation experts analysed the processes for standardisation, certification

and preparation of the safety case, and provided recommendations [3].

The studies results have provided confidence on the feasibility of designing and developing a satellite communication system answering the needs identified by SESAR. ESA gathered the main results of those feasibility studies into a technical report [4], which highlighted several areas where specific design effort is required in the next Phase of the Iris Programme. ESA Iris Programme Phase 1 results have been presented during the Air Ground Communications Focus Group (AGCFG/5) and NexSAT Steering Group (NexSAT/10) meetings at EUROCONTROL on 24-25 March, 2009, Brussels [5]. Final reports of all studies, as well as the final report from the Iris Expert Group, are freely available from ESA upon request.

The development phase of the Iris Programme has started in 2009, with system design activities foreseen to last until early 2012.

Following a request from the European Commission, ESA did split activities between those relative to design of the communication as well as the satellite system, and activities relative to operation/service provision. Phase 2.1 activities include a system design study for a purpose-built system (called ANTARES [6]), three competitive studies preparing potential operators and service providers for future service provision (HERMES [7], OPERA [8] and SIRIO [9] studies running in parallel) and an analysis of the feasibility of adapting Inmarsat's SwiftBroadband system for provision of a safety service (THAUMAS [10] study). Other smaller activities focus on detailed technical analyses, understanding aircraft manufacturers requirements and facilitate the preparation of the safety case.

Technical activities in the ANTARES and THAUMAS design studies revolve around three aspects:

- (1) design, develop and validate communication protocols for a new communication standard, purpose-built to support the use of ATS and AOC applications defined in COCRv2 [1], both in continental and oceanic airspace;
- (2) design the satellite system infrastructure required for provision of the safety communication service, including low-cost Aeronautical Earth Stations (AES) and a satellite system infrastructure able to provide services for the Single European Sky/ECAC airspace;
- (3) support the worldwide effort to define aviation long-term requirements for satellite spectrum in the

AMS(R)S band, in preparation of the ITU World Radio Conference 2012.

Based on user requirements established by SESAR JU, ESA is responsible for the capture, management, and downward flow of requirements for the design activities. ESA will then be responsible for the verification of the system developed, while SESAR JU will be responsible for the validation of the service.

The Iris Programme interacts with the SESAR Programme via its project P15.2.6, which is dedicated to satellite communication. It interacts closely with the project P15.2.4, which defines the multiple data links that will be in operation in European airspace.

Some requirements are well-known, but some can only be consolidated after an iterative process between users and system designers has taken place: depending on the evaluation of the impact of a given performance figure in terms of complexity and cost of the operational system, users might in some instance adjust these targets to lower the system cost. In a first step, the ANTARES and THAUMAS design studies have analysed the impact of the performance requirements defined at application level in the COCRv2 document. The studies design several possible system options and carry out a sensitivity analysis on technical criteria. The purpose of this trade-off exercise is to determine which requirements are driving the overall system design (user terminal, space segment, ground segment and communication protocols) and which requirements contribute most to the system cost and complexity. This information will be provided to SESAR JU project P15.2.4 to facilitate the refinement of user requirements for air-ground communications and allow aviation to take informed decisions when consolidating requirements.

Verification testbeds will be produced by early 2012, whose purpose is to validate the performance of the communication protocols designed and support standardisation activities. The verification testbed will model the satellite communication system, and will be integrated with other elements of the communication system developed by SESAR JU in order to validate performances end-to-end. The verification testbed will be also a mean of support of the standardisation activity since it will provide a tool that demonstrates the performances expected in all operational conditions foreseen. This verification testbed will be composed of simulators and emulators, including hardware equipments performing end-to-end communication exchanges.

Three Satellite Operation studies are underway for the definition of the satellite system operations aspects and for analysis of a service provision scheme and the associated business case. The SIRIO, the OPERA and the HERMES studies are carried out in parallel and each study team performs the very same tasks. The teams are composed of aeronautical communication service providers, satellite services providers, satellite operators, air navigation service providers and consultancy companies. They will define operation and service provision requirements, including:

- Technical and regulatory issues of service provision
- Definition of options for the roles of entities involved in service provision
- Definition of the validation activities required to validate the safety communication service, leading to the definition of the technical infrastructure required for initial validation
- Development of a business case, including a cost/benefit analysis of service provision, and a revenue scheme for operation.
- Proposals for financing schemes for the deployment of the validation infrastructure and the eventual operational system.

Technical design activities of the communication protocols will result in the provision of technical specifications by end 2011. These technical specifications will be the basis for standardisation activities to be undertaken by SESAR JU. The specifications of the communication protocols will be made openly available by ESA for implementation in any world region by any interested party, and they will be proposed for standardisation among ICAO Aeronautical Mobile Satellite Services (AMSS).

Activities of design of the satellite system infrastructure and of user terminals are foreseen to result in the definition of the system to a level allowing ESA to issue a tender in 2012 for provision of the first elements of the system infrastructure required for validation.

4. OPEN REQUIREMENTS AT SYSTEM LEVEL

Consolidation of requirements is to be carried out in cooperation with SESAR JU, and the design of options has been started in view of refinement of some requirements.

In order to propose a design robust and resilient to requirements, the major uncertainties on system-level requirements have been summarised as follows in the

ANTARES study:

- 1 - Security requirements with regards to the protection of the data transmitted via the satellite system, i.e. integrity, authentication, encryption, non-repudiation, access control of all communication and signaling necessary within the satellite communication system;
- 2 - Security with regard to the transmission of the signal i.e. robustness to intentional and unintentional jamming of any given link of the satellite communication system;
- 3 - Capacity of the satellite system in terms of amount of user data traffic on forward and return links to be transmitted at peak times of use;
- 4 - Capabilities of the aircraft terminal in terms of power available while still fulfilling the constraint of operation without forced-air cooling;
- 5 - Architecture of the ground segment, considering either the possibility to have several service providers and distribution of several ground segment elements and communication stations per service provider, or concentration of ownership of all elements under a single entity in a single location.

The study is analysing the consequences of each option to produce evidence of their impact in terms of spectrum requirements, complexity and cost of the satellite system infrastructure, cost of user terminals, etc. and SESAR JU Projects (notably Project 15.2.4) shall consolidate technical performance requirements during 2011.

Concerning availability requirements, a derivation of performance figures from safety considerations needs to be performed in cooperation with EASA, and the apportionment methodology among the system elements needs to be defined and iterated with the design work.

The communication traffic profile needs to be consolidated in cooperation with airspace users. As an example, use of the broadcast/multicast capability of the satellite could help lowering the overall capacity requirement. Operational scenarios for voice use and characterisation of the use of the satellite link in the framework of the dual-link system needs also to be consolidated by SESAR JU Project 15.2.4. Other operational constraints, in particular for AOC, have to be collected from airspace users.

A major element to dimension the system is the maximum overall data traffic of all aircraft flying simultaneously at any given time within the service coverage of the satellite

system. This data traffic determines the bandwidth/spectrum required by the system and a map of its geographical repartition is required to optimise the satellite beam sizing and the potential frequency re-use scheme. The Iris Programme is focusing on European airspace, where the highest density of air traffic is currently confined within a small geographical area (i.e. including the area London-Paris-Frankfurt-Amsterdam).

As detailed in [11], the peak volume of information traffic (i.e. traffic at network layer including upper layers overhead) for all aircraft flying in ECAC and its surrounding oceanic area in 2030 (i.e. time when data applications will have replaced voice applications) has been estimated at:

- 4.6 Mbps on the Forward Link
- 0.8 Mbps on the Return Link

Uncertainty on the growth of air traffic results in a range of estimates, and the fact that some applications can either be offered either the way COCRv2 describes them, or in a more efficient manner using the broadcast capabilities of the satellite adds possible options. The figures above are high estimates, that assume that each aircraft flying under Instrument Flight Rules is equipped and makes use of the satellite system for ATS and AOC applications defined in COCRv2. Given the constraints on frequency allocation for the communication link between the satellite and aircraft terminals in L-band, spectral efficiency shall be optimised in the overall system design. However, the amount of data to be exchanged overall is extremely low in comparison to what telecommunication systems can offer today and these requirements are sufficiently modest to be accommodated within the existing ITU AMS(R)S allocation of twice 10MHz in L-Band. Overall, technical challenges originate from the fact that this data is generated by a large number of end users at unpredictable times, that messages are infrequent and very short, and that their timely delivery and their integrity is critical. This is a very different set of characteristics than what most communication systems have been designed to deliver (notably internet access or telephony for passenger communications), and this requires developing very specific communication protocols.

5. DESIGN FEATURES OF THE COMMUNICATION SYSTEM

Design of the satellite system infrastructure required for provision of the safety communication service is a significant part of the design studies. However, most of the technical challenges of the Iris Programme revolve around

designing appropriate communication protocols, purpose-built to support the performance of ATS and AOC applications defined in COCRv2 [1], both in continental and oceanic airspace.

Although the SESAR Programme and the Iris Programme are focusing on European needs, aviation operates on a global basis and a new satellite communication system should be such that it could be implemented by several regional systems. The aim of the design for the communication system is the definition of a set of protocols to be approved by ICAO so that it becomes a worldwide standard. Having an ICAO standard would enable the use of a single equipment installed on-board aircraft, to be used in a fully interoperable manner with every regional satellite system infrastructure wherever it flies. As complementary satellite systems might be developed besides Geostationary ones, this communication standard shall include the possibility to be used over various satellite orbits, notably Highly Elliptical Orbit constellations that would cover polar areas.

While the THAUMAS study builds on Inmarsat's Swiftbroadband communication system with some adaptations of the air interface, the ANTARES study is designing a new communication system entirely built around COCRv2 requirements. The ANTARES design is based on systematic technology trade-off and selection of technical solutions providing the best compromise in terms of performance and cost-efficiency. The communication standard addresses the physical layer, the link layer, the interface with the network layer and all the control and management planes.

At physical layer the selection is to be made among the various modulation and coding schemes suitable for the transportation of messages of variable lengths and for which high quality of transmission is expected (in time and in terms of absence of errors). The selection of the modulation and coding needs to take into account the characterization of the aeronautical mobile channel which presents different fading events, especially fading caused by multipath. Since most applications generate very short bursts on the return link (even considering the overheads), their transmission time may be well shorter than the fading correlation time. Any retransmission of a message because of a fading event will impact the delay performances of the system.

In the ANTARES study, linear modulations coupled with an iterative code have been favoured for the forward link, enabling low packet-error rate values for low signal-to-

noise ratios, without any error floor. On the return link, the choice is more open since different packet-error-rates may be envisaged depending on the access scheme technique; linear modulation with an iterative code is one of the possibility but a simpler code coupled with a constant envelope modulation (binary or M-ary) may be used as well. Constant envelope modulations to operate the HPA at saturation can be an asset for getting the highest power out of the User Terminal. The effective duty cycle of the User Terminal is a key factor for the use of the HPA. Its reduction to 10-20% by defining the framing/link layer/physical layer design for accessing the resources would reduce heating of the terminal. These elements require careful analyses and detailed trade-offs are currently on-going.

At the link layer level, the trade-off mainly focuses on how to share the satellite resources among all users considering the constraints brought by the time delay requirements as well as robustness to interferences. On the forward link, the choice is to be made between an independent allocation of resources to each Ground Earth Station and the possibility of have several GES accessing the same pool of resources at the same time. The second option provides room for improving the bandwidth efficiency but comes at the price of a mechanism of coordination of access between the GES. On the return link, two main trade-offs have to be considered in the ANTARES study: (1) the possibility to have no, partial or full traffic to be transmitted in a random-access (RA) mode; (2) the choice to operate in time-division multiple access (TDMA) or code-division multiple access (CDMA). The efficiency of the random access scheme may be improved using recently developed techniques that would enable lowering the level of retransmissions far below conventional techniques such as S-ALOHA. The random access efficiency impacts the system performance in terms of delay; besides, the sizing of the random access slots or channels also impacts the total bandwidth needed. These analyses are currently on-going.

At the interface with the network layer, the important element is the definition of a convergence layer in order to best shape the messages to the radio link capabilities and characteristics. This convergence may certainly include some header compression technique(s); most likely a dedicated header compression algorithm will be specified for ATN/OSI applications and for ATN/IPS. The convergence layer will certainly include elements for the encapsulation of the messages onto the link layer; methods base on either GSE (Generic Stream Encapsulation) or ULE (Unidirectional Lightweight Encapsulation) are favoured and precise configuration is under definition in

the ANTARES study. Efficiencies approximating 95% are expecting to be achieved on both forward and return links. Some security mechanisms for the link layer may rely on the encapsulation method, e.g. by use of a CRC (Cyclic redundancy check); in that case, some security features will be included in the definition of the convergence layer. Moreover the security technique may show incompatibilities with the header compression technique proposed so that both have to be studied together in order to take a final design choice.

The control and management plane of the communication system are two important elements though not always strictly linked to the definition of protocols. In order to ensure interoperability and use of several regional systems thanks to the same aircraft equipment, it is important to consider control and management as part of the communication standard. It includes all the definition of logon to the network, handover procedures and technical procedures for implementing redundancy techniques. It includes also some elements of the radio resource management for the forward and return link. The handovers are one of the important elements considering that any given aircraft may fly along one flight through different satellite spot beams, or be communicating with different GES or even move from one regional coverage to another using a different satellite. The process of handover needs to be time-efficient and to limit the extra signaling over the satellite link to the minimum. To this end, mechanisms driven by the mobile entity, i.e. the aircraft, are favoured. The fine details of the set of mechanisms will be consolidated once the access scheme will reach a more mature stage.

The possibility to have several service providers for satellite communications imposes the need to design the system with the capability to fragment the resources among several ground earth stations. In addition, each service provider may decide to install their own ground earth station(s) anywhere within the service coverage area. Considering the current high fragmentation of the European ATM provision with small geographical sectors and the evolution towards implementing Functional Airspace Blocks (FAB) within European airspace, it has been assumed that a similar model could be applied for service provision, with an independent service provider with one ground earth station per FAB and a terrestrial infrastructure between the FABs to convey the communication traffic. Therefore the number of ground earth stations could be at least 8, without considering the needs for redundancy because of the safety criticality of the system.

As a consequence of the uncertainty on the number of ground segment elements providing the communication service, both the ANTARES and THAUMAS studies are required to ensure flexibility and scalability in sharing the resources, either among different commercial entities or among physical entities of a same commercial entity. A communication means is also required to exchange network signalling between different ground segment elements. Two options have been considered and need to be further analysed: (1) use of a terrestrial backbone (e.g. the future EATMS defined by SESAR could be used) or (2) a Satellite communication link in either L-Band, C-Band, Ku-Band or Ka-band.

Design of aircraft user terminals (Aeronautical Earth Stations) is focusing on ensuring low cost, mass and volume of the satellite data unit, with low-drag aircraft antenna with an omni-directional antenna pattern. A key design driver is the necessity to ensure safe operation of the terminal without requiring forced-air cooling, which has lead to consider specific modulation techniques and High-Power Amplifier technology. The location of antenna on the aircraft fuselage and the location of indoor unit(s) on-board different aircraft types is being assessed. The purpose is both to minimise the cost of installing or retrofitting equipment and to ensure continuous availability of the communication link even when the aircraft is banking. Packaging of the terminal and interconnection with the other elements of the cockpit avionics is also being defined.

The space segment design is mostly a consequence of the reliability, availability and safety analyses. The payload design is mostly constrained by capacity requirements originating from the number of simultaneous users and the transmission rate from user terminals towards the satellite. In this sense, the design and sizing of the satellite payload will be a consequence of the design of other elements of the system, and can only be consolidated once all open requirements at system level have been refined.

6. NEXT STEPS

The ANTARES, THAUMAS, OPERA, HERMES and SIRIO studies are on-going, with public dissemination of information foreseen to take place as soon as technical design activities have documented the analyses performed. The specifications of the communication protocols will be made openly available by ESA, with the aim to be proposed for standardisation among ICAO Aeronautical Mobile Satellite Services (AMSS).

ESA has planned to consolidate requirements for the satellite communication system in agreement with SESAR JU and the aviation community during a System Requirements Review end 2010. By early 2011, it is foreseen that SESAR JU will have refined users requirements, notably within SJU Projects P15.2.4 and P15.2.6, in order to allow most technical trade-off to be closed and detailed design activities of the system baseline to proceed. ESA studies will then start to produce verification testbeds and design a system baseline. Technical design activities of the communication protocols will result in the provision of technical specifications by end 2011. These technical specifications will be the basis for standardisation activities to be undertaken by SESAR JU. The verification testbed will model the satellite communication system, and will be integrated with other elements of the communication system developed by SESAR JU in order to validate performances end-to-end. Activities of design of the satellite system infrastructure and of user terminals are foreseen to result in the definition of the system to a level allowing ESA to issue a tender end 2011 for provision of the first elements of the system infrastructure required for validation with Iris Phase 2.2.

As the use of satellite communications as primary means in continental airspace would require an update of ICAO SARPS, worldwide coordination will be required in two areas:

1 - technical coordination to facilitate standardisation of specifications of the new communication protocols within the ICAO future aeronautical communication system activities

2 - coordination of the service provision concept to harmonise deployment of a global satellite communication solution for aviation relying on regional satellite system infrastructure deployed by regional entities

It is foreseen that a Technical Manual gathering the system specifications will be standardised at ICAO. In this respect, bilateral SESAR-NextGen discussions on standardisation are foreseen, under the aegis of the European Commission and the Federal Aviation Administration. It is expected that the requirements and technical specifications of the communication system will be discussed within this framework, in view of preparing submissions to ICAO once inputs are sufficiently mature.

Regarding update of the Required Communication

Performance within the ICAO SARPS for use of satcom datalink as primary means on communication in continental airspace, consultation of all interested stakeholders is foreseen to take place under the NEXUS subgroup coordinated by EUROCONTROL [12]. The first task for this group will be to prepare proposals to update the SARPs with more stringent performance requirements. The first meeting of the group is foreseen during the last week of October 2010.

Coordination of the service provision in various world regions will depend on the model adopted for service provision and of associated stakeholders in each world region. Several business models allowing interoperability for end users while maintaining independence and competition of service providers are being studied in HERMES, OPERA and SIRIO. Technical design activities are carried out with the perspective to enable distribution of system elements among different entities, allow decoupling of the system ownership from its operation, and provision of an open service model where several manufacturers and equipment providers could exploit the technical design produced and made available by ESA. However, the definition of the service model and the selection of the stakeholders involved in deployment of the European operational system are issues being considered by SESAR Joint Undertaking and the European Commission, and which go beyond ESA's involvement. Ultimately, although each world region would be able to procure and operate an independent satellite system infrastructure, use of the common communication standard will allow full interoperability from the perspective of airspace users.

7. CONCLUSIONS

ESA's role in the Iris Programme is to design a satellite system for Air Traffic Management communications that will fulfil the requirements of the SESAR Programme. Several technical design studies are underway, and will result in a favoured system design by end 2011. ESA shall then ensure that the elements required for validating the service will be procured, and prepare the case for full system deployment with SESAR and the European Commission by facilitating the definition of service provision schemes with potential operators and service providers.

To implement this vision, international coordination activities are required to facilitate standardisation of specifications of the new communication protocols within the ICAO future aeronautical communication system activities. Interested parties are cordially invited to contact

the European Space Agency and the NEXUS subgroup coordinated by EUROCONTROL for further information.

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