Iris Operations Studies SIRIO–Study for the Satellite Air Ground Interface with Reliable and Interoperable Operations

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Abstract. SIRIO is one of the three Operations Studies included in the framework of the ESA Iris Programme, which aims to design and develop a new Satellite Communication system for Air Traffic Management. SIRIO focus is on the definition of a Service Model and Business Model for the provision of ATS and AOC communication services via satellite. The definition activity is based on the analysis of the ATM service value chain, and takes into account also the impact of the regulatory framework. Revenue Model was designed and together with associated CAPEX and OPEX estimates based on the Reference system architecture coming from the Manufacturer Study constitutes the basis for a Business Case Analysis. Positive Preliminary results coming from the business case and based on different Public/private Partnerships financing schemes are shown.

Keywords: Iris, SIRIO, Satellite Communication System, Air Traffic Management, Service Model.

1 Introduction

SIRIO is one of the three Operations Studies included in the framework of the ESA Iris Programme: the study is lead by Telespazio in collaboration with Hispasat, NATS, EGIS AVIA and Telespazio France.

The objective of the Iris Programme is to design and develop a new Satellite Communication system for Air Traffic Management: such a system consists of a new communication standard and a satellite system infrastructure. The Programme is divided into three Phases:

- Phase I was completed in 2009 and it defined satellite link feasibility and requirements, including top level design options for the new Satellite Communication System;
- Phase II focus on technical activities such as the design and development of the new Satellite Communication standard, and Satellite System ,together with. Service related activities which include the definition of the business case and investigation of future services provision schemes. Phase II.1 (2009-2012) includes detailed definition of all system elements. Three main activities are :

G. Giambene and C. Sacchi (Eds.): PSATS 2011, LNICST 71, pp. 74–83, 2011.

- (1) the design of a dedicated Satellite Communication System (ANTARES phase B study) by Manufacturing Industry,
- (2) three parallel studies (including SIRIO) of the satellite system operations performed by service providers/operators,
- (3) a study of the feasibility of adapting Inmarsat's Swift Broadband system.
  Phase II.2 (2012-2016) which would deal with the development of the system and the procurement of the subset for validation and complete the Iris Phase II in full alignment with the SESAR Development Phase.

- Phase III foresees ESA technical support to SESAR Service Validation and System Certification activities.

2 SIRIO

SIRIO and the other Operations studies are included in Iris Phase II.1; several activities are currently in progress; and in the following sections, what is available today as preliminary results of the study is presented.

The name SIRIO contains all the main elements of the study: it investigates the use of Satellite for the provision of air-ground communication, with the eye of a Satellite Service Provider and Operator, with the aim to satisfy requisites of reliability and interoperability.

The industrial team was organized in order to cover all areas of activity with the necessary expertise: Telespazio act as coordinator with the intention to characterise the study with a clear operational service view and user/market driven approach in collaboration with Hispasat, which has been involved as Satellite Owner and Satellite Operator; NATS is an Air Navigation Service Provider and therefore brings specific expertise on certification and technical service validation, while EGIS AVIA provides experience on standardisation, certification of aviation communication systems. and Telespazio France.

The SIRIO study is focused on the following objectives which are detailed in dedicated sections:

1. Service model definition: includes the definition of several options for service provision scenarios, taking into consideration also the impact of the regulatory framework
2. Service funding / cost-recovery mechanisms analysis: includes activities related to the identification of a revenue model based on the service model, and which will lead to the definition of the business case.
3. Business Model and Financing schemes identification: this activity includes the proposition options for financing deployment of the Iris "Subset", and of the full operational system architecture,
4. Deployment scenario/timeline investigation: this activity contains all issues concerning timeline of system deployment and certification steps; this means to propose a deployment strategy to reach full operational capability by 2020; and to determine which activities are required for the validation of the service .

2.1 Service Model Definition

The value chain for the provision of satellite-based communication services for aviation is composed by several main stakeholders ranging from the Satellite Owner to the Airlines and Air Navigation Service Provider (ANSP) which are the final users of the services.

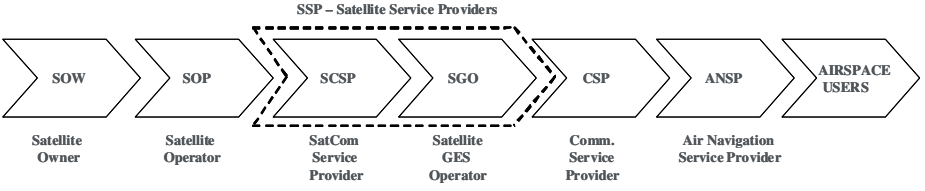

Fig. 1. Satellite-based Communication - Value Chain

The stakeholders identified in the figure above are:

- The Satellite System Owner (SOW) owns the space segment.
- The Satellite Operator (SOP) is in charge of operating the space segment
- Satellite Communication Service Providers (SCSP) are in charge of marketing the satellite capacity.
- The Satellite GES Operator (SGO) is in charge of the provision and operation of Satellite Ground Earth Stations' and Terrestrial Circuits to provide satellite access via terrestrial links
- The Satellite Service Provider (SSP) covers both SCSP and SGO roles, and is in charge of providing the satellite-based communication service to the Communication Service Provider (CSP).
- Communications Services Providers (CSP) is the entity who bundles communication services and represents a single interface for procurement of telecommunication services for ANSPs and Airspace Users.
- Air Navigation Service Providers (ANSPs) and Airspace Users (Airlines) are the end users of the service.

The Service Model definition activity is based on the detailed analysis of the value chain. Starting from the ATM service value chain, different grouping of value-chain roles have been studied, identifying actors and roles to be performed to deliver the service to the end users.

For the Service Model definition a set of topics has been taken into account and a balanced mix of the following key issues seems to be the preconditions to have a viable Service Provision Model:

- Adoption of an ATM-dedicated satellite-based communication standard, widely recognised by Airline companies, airspace users and ANSPs'.
- Focus on the end users needs to make sure that such a service is suitable for aviation safety communications in terms of safety, operations, costs and technical requirements (e.g. coverage, capacity, service interoperability)

- Profitability and bankability: A satisfactory profitability should be guaranteed for the private shareholders, especially in a PPP approach with investments of the private sector
- Market competition: Avoid a monopolistic framework that would have a negative impact on service provision; indeed, the Service should not contain any feature which would restrict competition among operators in the future.

The service model scenarios analyzed in the study, were defined taking into consideration that service provision set up will not limit the number of Ground Earth Stations, but allow incremental deployment of Space and Ground Segment sub-elements, and a competitive framework will be guaranteed through the presence of multiple CSP and/or SSPs.

Next figure shows the service model baseline.

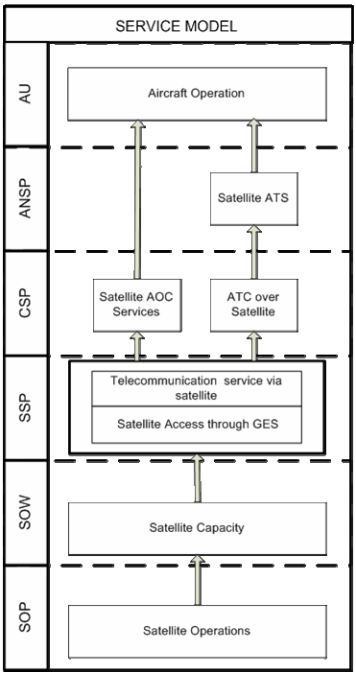

Fig. 2. Service Model for ATS and AOC services provision

It has to be noted that as far as commercial satellite systems are considered, the roles of the Satellite System Owner (SOW) and Satellite Operator (SOP) are usually performed by a single entity. In other types of programmes, where the development of a satellite system is funded (or co-funded) by National Space Agencies for scientific mission purposes, or by Governments for military purposes, the SOW and the SOP can be different. In the framework of the Iris programme, the two roles are considered to be separated because this is what usually happens when the development of a

satellite system is funded (or co-funded) by National Space Agencies for scientific mission purposes, or by Governments for military purposes.

It is also assumed that the Satellite Communications Service Provider (SCSP) and the GES Operator (SGO) are performed by a single entity: the Satellite Service Provider (SSP):

Several Scenarios can been investigated starting from the service model presented, depending on different combinations of the following options:

- the satellite system architecture adopted (centralized, decentralized)
- grouping of entities (i.e. if the CSP and the SSP can be grouped together into a single role)
- who is the entity (or entities) which owns and operates the Ground Earth Stations (SSP,ANSP)

It is also essential to consider not only satellite communication but also future A/G Mobil Data-Link communications.

The A/G Mobil Data-Link terrestrial communication infrastructure for ATS services provision could be either owned/operated by ANSP or by any CSP. This rationale applies to the AOC service provision by CSP.

In the design of the service model, also the impact of the regulatory framework and liabilities issues has been considered to define the responsibilities and liabilities of entities involved in the Service Model and also of entities contributing to set-up the provision of the SATCOM services.

Actually, in order to comply with the safety requirements,, at least one actor in the value chain must be certified. according to SES legislation .The certified Service Provider will have to obtain a certificate from EASA, which will state its compliance with the applicable requirements and implementing rules.

Possible scenarios taken into account are single certified Pan-European Service Provider or Multiple certified Service Providers separately for Satcom, Air/Ground com and Air/Air com, as shown in the following table.

Table 1. Certification Models

Certification Model 1		
Entity:	Certified for:	Certification includes:
ANSP	ATS	
CSP	Bundled AMS services Bundled AFS services	Data Link Service SATCOM service
SSP	N/A	
PENSP	PENS services	
Certification Model 2		
Entity:	Certified for:	Certification includes:
ANSP	ATS	
CSP	Bundled AMS services Bundled AFS services	Data Link Service
SSP	SATCOM service	SATCOM service
PENSP	PENS services	

2.2 Service Funding and Cost-Recovery Mechanisms

In order to develop investment profiles for each entity in value chain and to identify associated financial support to develop, procure and operate full system starting from the definition/identification of the ATS/AOC revenue flow, a cost assessment and related sensitivity analysis has to be performed. In particular:

- Conduct a revenue model that take into account the Service Model for AOC and ATS services via satellite, considering that ATS and AOC will have different revenue flows within the entities of the provision chain
- Develop a cost model that takes into account Capital costs (from Phase B studies) and Operating costs (determined by Operator Study) all phased with the implementation timeline
- Conduct a Sensitivity Analysis on main revenue and cost risks, considering in addition that infrastructure cost recovery will be based on revenues from ATS as for AOC revenues will depend on the market penetration levels

In SIRIO the revenue model was conducted taking into account that service for ATS communications shall be provided with an auditable and established subscription and/or communication charges that reflect the cost of service provision to the ATM user. The following assumptions have been applied:

- Mandatory carriage year start: extrapolating the "Implementing Rule on Data Link Services" that can be considered assuming similar obligations (and exemptions)
- Traffic model; starting from the traffic forecast in terms of IFR flight movements for the EUROCONTROL Statistical Reference Area (ESRA) two extrapolation has been carried out (1. until 2016, using the three growth scenarios from the Medium-Term Forecast IFR Flight Movements 2010-2016; 2 until 2030, using the three growth scenarios from the Long-Term Forecast IFR Flight Movements 2008-2030)
- SATCOM equipment ramp-up, based on the assumption that there will be a mandate to equip the aircraft with the new SATCOM system and the start of full operation of the new SATCOM system will be in 2020.

Different charging schemes and related revenue models apply to ATS and AOC, since AOC charge and the associated revenues for the operator are market-driven and therefore the revenue model is designed following a market approach, which includes presence of competition among operators. Moreover, the CSP can sell directly to the end users.

Instead for ATS the ANSP is mandatorily present in the ATS provision value chain since Air Traffic Services are regulated; the revenue model in this case has been designed with the goal to guarantee to the service provider a minimum profitability of its investment.

2.3 Business Case and Financing Schemes

The reference system architecture considered is given by ANTARES and is the basis for a preliminary estimate of the CAPEX and OPEX, which together with the revenue model, allows for the business case analysis.

The Space Segment architecture considered consists of 2 geostationary satellites and 1 spare., while two options for the Ground Segment architecture are considered, one is representative of centralized GS architecture with a single SSP and the other one for a distributed GS architecture, which foresees the presence of 3 SSPs.

For each architecture two different funding scenarios have been investigated: the two scenarios differ in the sharing of CAPEX between public and private actors.

Each scenario considers both AOC and ATS flow. The AOC revenues have been designed following a market approach: from the revenues estimated in the revenue model . Instead the ATS revenues flow has been designed with the goal to guarantee a minimum profitability of the investment (calculated in terms of combination of economic parameters, such as IRR, NPV and pay back period).

In both scenarios, public investments are considered to cover at least the following elements:

- 1st CAPEX outflow
- Non recurring ground segment elements.

Preliminary results of analysis which is still in progress, shows the cash flow trend of the Service Provider, in the scenario characterized by a Centralized Architecture and the larger public financing scenario between the two considered.

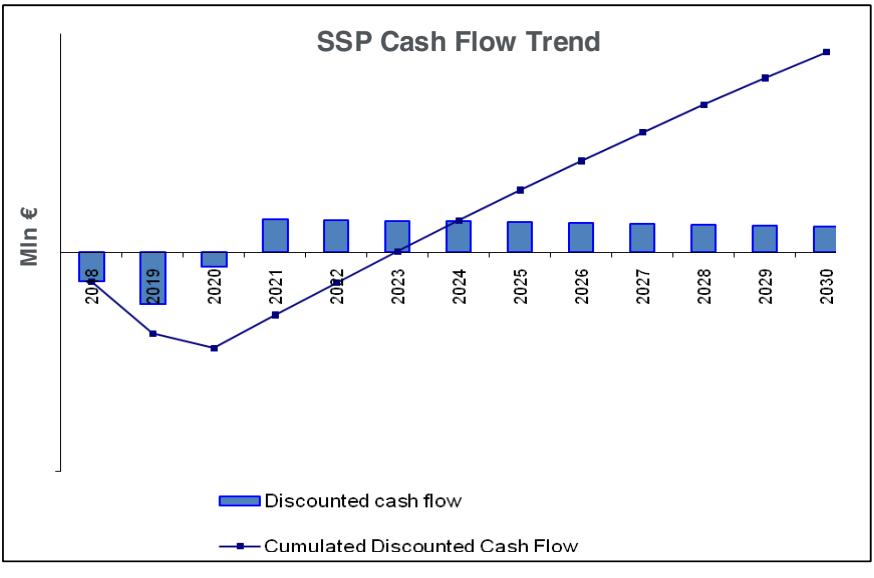

Fig. 3. Business Model Preliminary output- SSP Cash Flow Trend

The outcome of the business case is to determine the ATS charge per flight, in order to get the optimum value which allows by one side for a sustainable business case for the private investors and by the other side a low price for the end users. Current analysis give positive outcomes in terms of payback period for the Service Provider investing in the system and in terms of a fair price for the end users.

The financial viability of the business case relies on guaranteed revenue from ANSPs and airspace users for the service provider, coming from the use of the satellite communication link for ATS, as mentioned in the previous section dedicated to cost-recovery mechanisms and on additional revenues given by the AOC services provision.

The infrastructure required for validation of the pre-operational system is included in the financing scheme and all non-recurring elements of both Ground and Space Segments will be funded by ESA. At the same time, additional elements required to complete the operational infrastructure would be financed through other means/by other entities. At this stage, the business is perceived as quite risky in terms of cost-recovery period by the private sector to allow for a full private investment. However, having the guarantee of an Implementing Rule to be issued would assure a certain level of revenues to be collected by the provision of ATS and would improve the associated business case.

Therefore as already mentioned above, several financial schemes are currently under investigation,. in order to bridge the gap between the technical validation stage and the operational service when a private investor could recover its initial investment.

A possible scheme for sharing the investment and the associated risks, is to include both private and public entities, into what is called as PPP.

Public Private Partnerships (PPP) rely on a series of performance and payment arrangements, which are intended to give a private consortia appropriate incentives to deliver good service to the envisaged final customers. Moreover, the partnership with a qualified private partner can limit public risks while helping to ensure that quality services can be provided quickly and efficiently.

Therefore a PPP-structure can be considered as an attractive way of financing transport infrastructure. Nevertheless, a PPP can only work if certain pre-conditions are met, such as clear commitment and vision from all the involved actors. Moreover, the "project" must be attractive in a competitive market and it must be "bankable," meaning that it must look attractive to bankers and other providers of financing.

Among the different ways to develop and implement a PPP, the attractiveness of providing operational service depends on the following key drivers:

- Pre-requisites for each entity in the value chain
- Clear definition of Roles & Responsibilities in Service Provision
- Certainty / Clarity around risk analysis and allocation
- Efficient Risk Analysis and Allocation
- Financial Analysis: business case and in particular the sensitivity analyses highlighting cut-off conditions

2.4 Timeline for the System Development and Operations

All the aforementioned activities should be synchronised with the following timeline, where regulatory and standardisation activities, Service Provision and Business Model key aspects.

Moreover, the Service development and deployment shall be in accordance with the SESAR Master Plan which aims to have the operational system ready by 2020; key milestones are:

- 2012 ESA member states funding decision for starting Iris Phase II.2
- 2012-2016: Development and deployment of the subset, which is the pre-operational system for verification and validation activities
- 2015/2016 First satellite launch
- 2016 start of system validation activities.; the Satellite Communication System will be validated using the Pre-operational System; the subset will become the first building block of the operational ATM System and all assets funded by ESA will be transferred to the System Owner
- 2016-2010 deployment of the operational system (redundant payload) and certification of the Service Provider
- 2020 start of operations

For the Business Model and Financing activities, end of 2010 / beginning of 2011 is the milestone when the decision on the financial model (i.e.: Public or PPP) and the assets to be financed (i.e.: Iris subset...) has to be taken.

Subsequently, in case of a private investment (e.g.: to cover the satellite platform and launch procurement), a consultation process should be launched in order to look for interested parties and the financial risk for the private investors should be timely mitigated by means of:

- Confidence on the revenues
- Confidence on the timeline to start recovering the investment
- Technological risks

For what concerns regulatory issues, a significant advance on standardisation should be achieved in the next two years aligned with the Communication System Critical Design Review (end of 2012). The development of Implementing Rules and Acceptable Means of Compliance by EASA to be applied for the development and verification of pan European CNS/ATM systems is required even before the System Critical Design Review. i.e. not later than mid- 2012.

3 Conclusions

All the activities detailed in the paper were the preconditions to conduct a reliable business case analysis. What is highlighted in the study is that having a guaranteed return is a pre-requisite for industry to invest.

The expected market to be derived from AOC services as it is currently estimated by SIRIO study is not big enough, and therefore cost-recovery schemes need to assume significant revenues from ATS communications, which materialises if there is a requirement for airspace users to use the satellite communication service.

In any case, with a financing scheme which foresees a large public investment it has been possible to have an acceptable return of the investment in terms also of payback period for the private investors, and to determine a fair price for the end users of the communication services (i.e. ANSPs and Airlines).

This positive results encourage for a deeper analysis, once more a final decision on the system architecture will be taken, allowing for a refinement of the system costs and associated business case and PPP scheme.

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