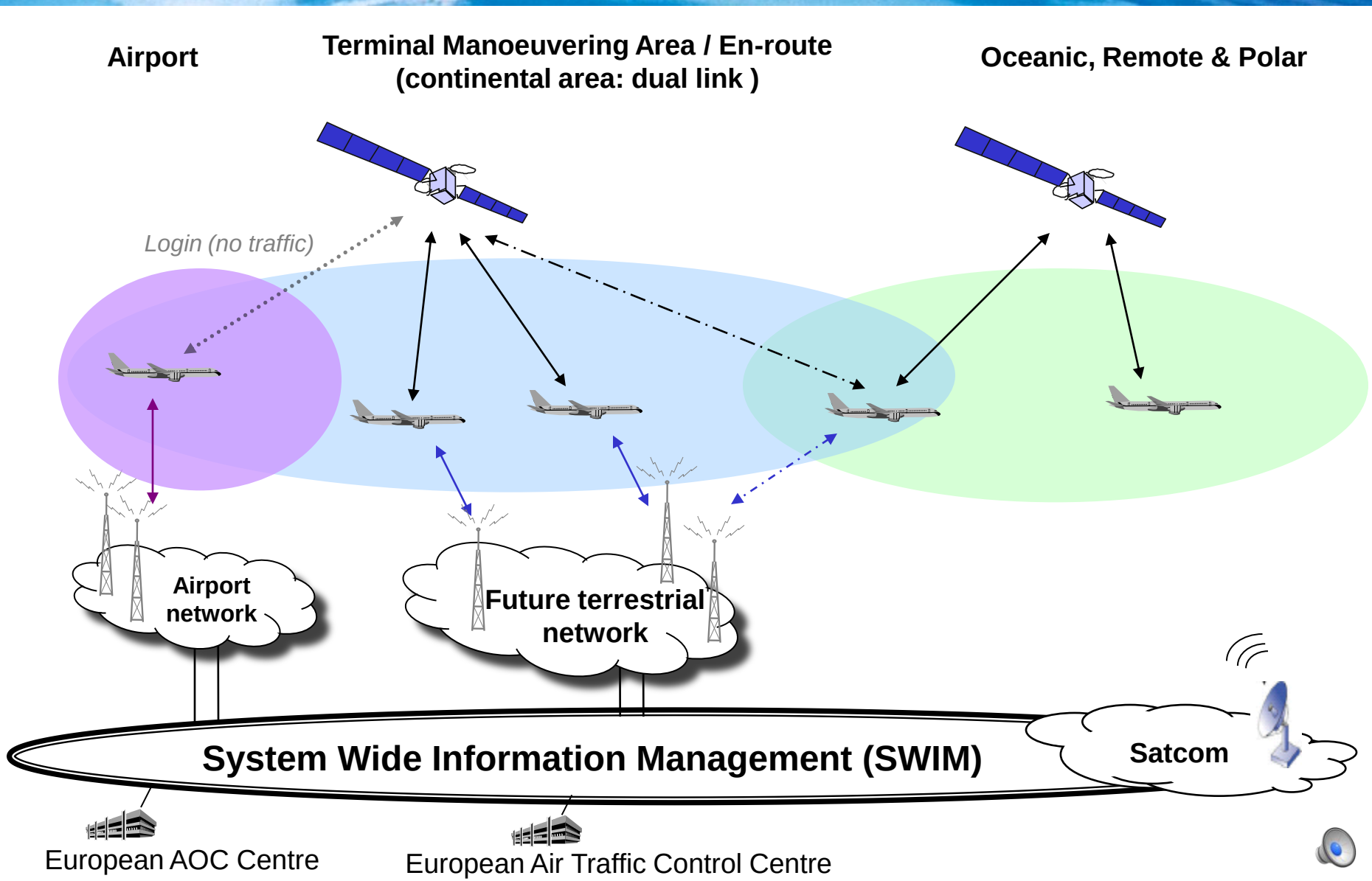

# The ESA Iris Programme: a new satellite communication system for Air Traffic Management

**EIWAC, Tokyo – 12 Nov. 2010**

# ESA Iris Programme: activities status

1. What is the Iris Programme?
2. Requirements and hypotheses
3. Next steps

# Satellite Communications services in SESAR
## Continental airspace + oceanic



# ESA Iris Programme

**Dedicated ESA programme to support SESAR** under the umbrella of ESA's ARTES programme (ARTES 10), named "Iris":

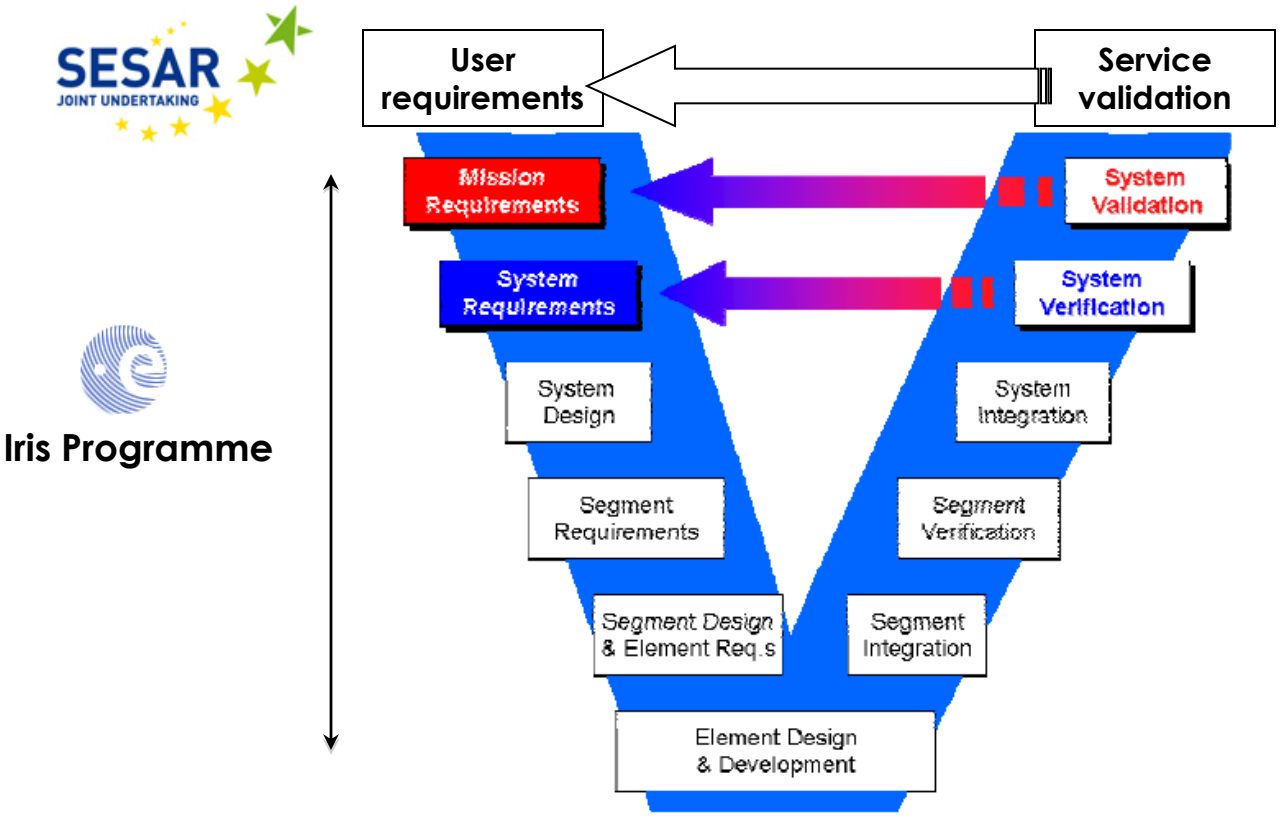
- Commitment of ESA Member States in Sept. 2007
- Definition Phase (Phase 1) completed in Jan. 2009
- Development Phase (Phase 2) approved by ESA Member States in Nov.2008, with funding committed for Phase 2.1 until 2011

Budget of Phase 2.1 is ca. **EUR 40m** (2009 economic conditions)

**12 Participating States**:
Austria, Czech Republic, France, Germany
Ireland, Italy, Norway, Portugal, Luxemburg,
Spain, Switzerland, UK

# Technical interface with SESAR JU

- User requirements are being defined by SESAR JU
- ESA translates them into system requirements, carries out design, development and verification (i.e. under ESA funding)
- SESAR will carry out the service validation end-to-end



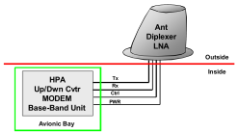
# Iris design activities: 2 approaches considered

## Purpose-built system and open service model

### ANTARES System Design Phase B study

...011010
1001010..
Com. System

Preliminary Design Specifications




Aircraft terminal Preliminary Design

Satellite System

Preliminary Design Specifications

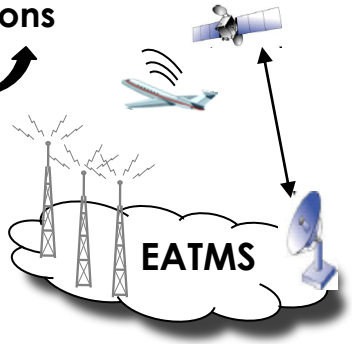
**ICAO Standardisation**
(by SJU/EC)

**Develop Aircraft terminals**
(with industry)

**Satellite system Phase C/D/E1 in Iris Phase 2.2**

### 3 Satellite System Operations studies
### HERMES, OPERA, SIRIO

Interactions




Service provision + Business case model

**3 study teams**

Who operates what?

Who procures what?

Financing scheme?...

**(+) Partnership proposal of each team for Iris Phase 2.2**

## Modified commercial system

### THAUMAS study

...011010
1001010..
SBS Com. System

+

inmarsat

**SwiftBroadband Safety system**

Preliminary Design Specifications

**Use Inmarsat Satellites and SwiftBroadband Safety protocols**
(to be standardised)

# Requirements and hypotheses for the system design

# Requirements and system options

Design of options to face main uncertainties on system-level requirements from SESAR:

1 - Security requirements with regards to the protection of the data transmitted via the satellite system

2 - Security with regard to the transmission of the signal i.e. robustness to intentional and unintentional jamming

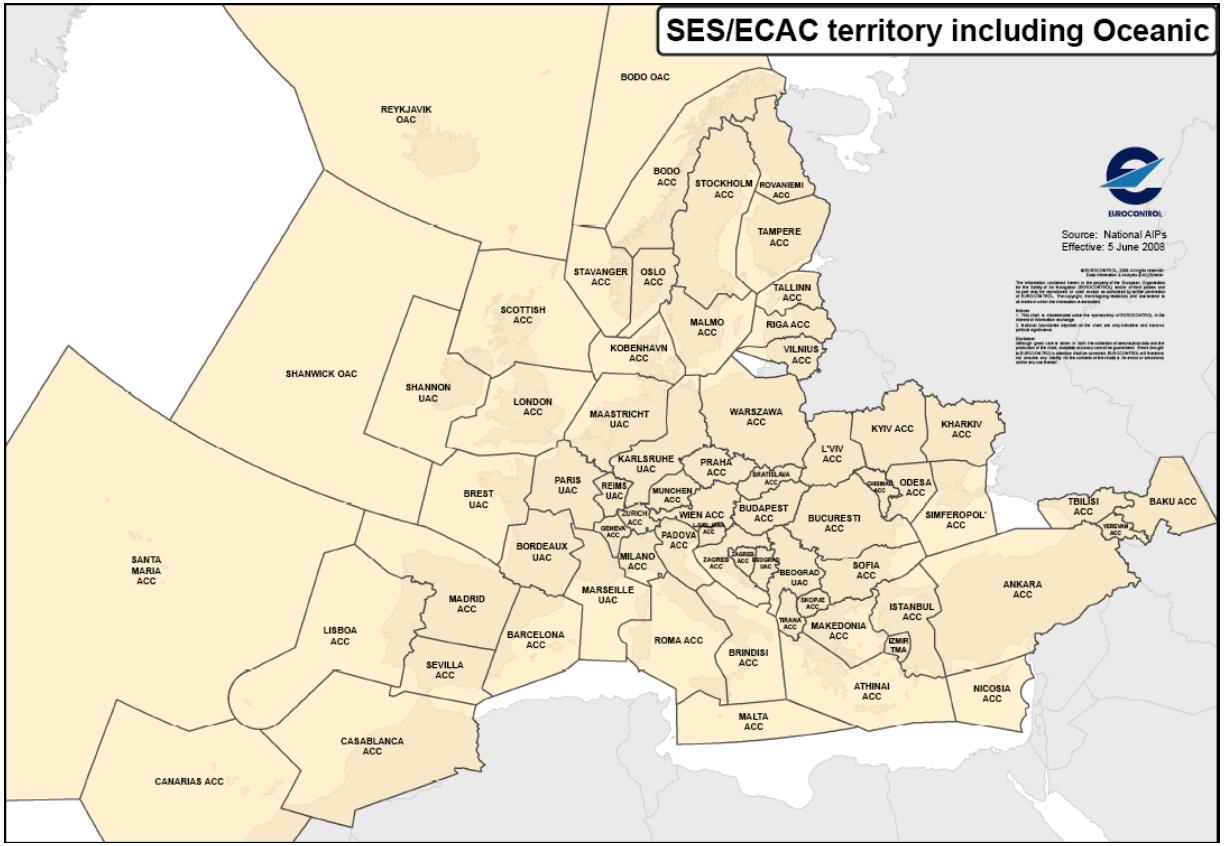
3 - Capacity of the satellite system in terms of amount of user data traffic on forward and return links at peak times of use

4 - Capabilities of the aircraft terminal in terms of power available while still operating without forced-air cooling;

5 - Architecture of the ground segment: several service providers with distribution of elements, or concentration under a single entity

# Service Provision requirements: geographical area

Iris focus on SES/ECAC service area but the communication system is foreseen to become a worldwide standard (ICAO standardisation) so that other world regions could implement compatible systems using the very same terminals on-board aircraft




Possible extensions of coverage considered in Iris studies:

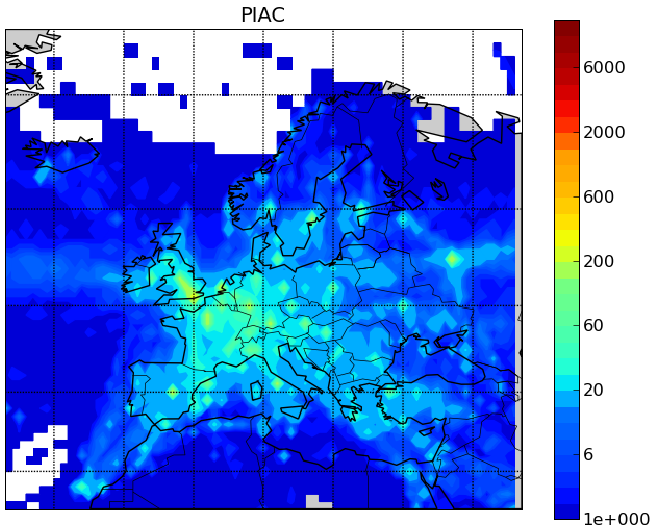
- Visible Earth from GEO orbit

- Northern latitudes areas by agreement with other countries operating HEO satellite systems

# Information throughput requirements: ATS and AOC messages as in COCRv2

## Aircraft fleet

Air Traffic density in 2025
(cf.Eurocontrol Long Term Forecast)

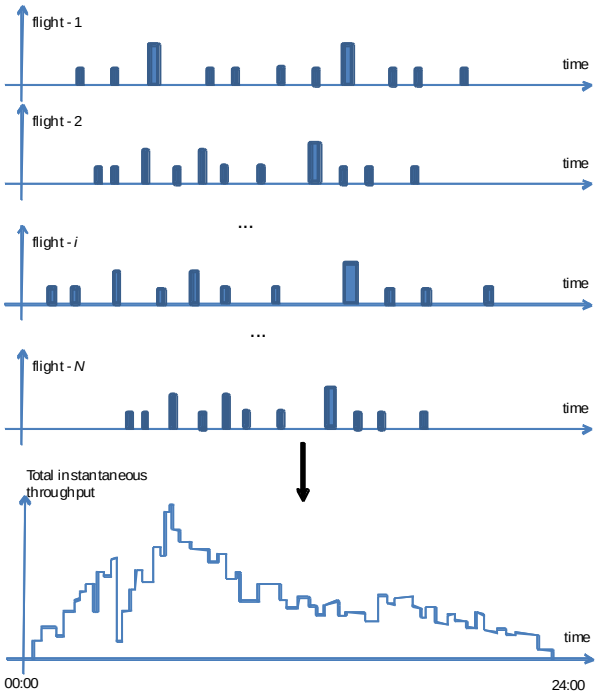



=> **Peak capacity requirements for ECAC**:

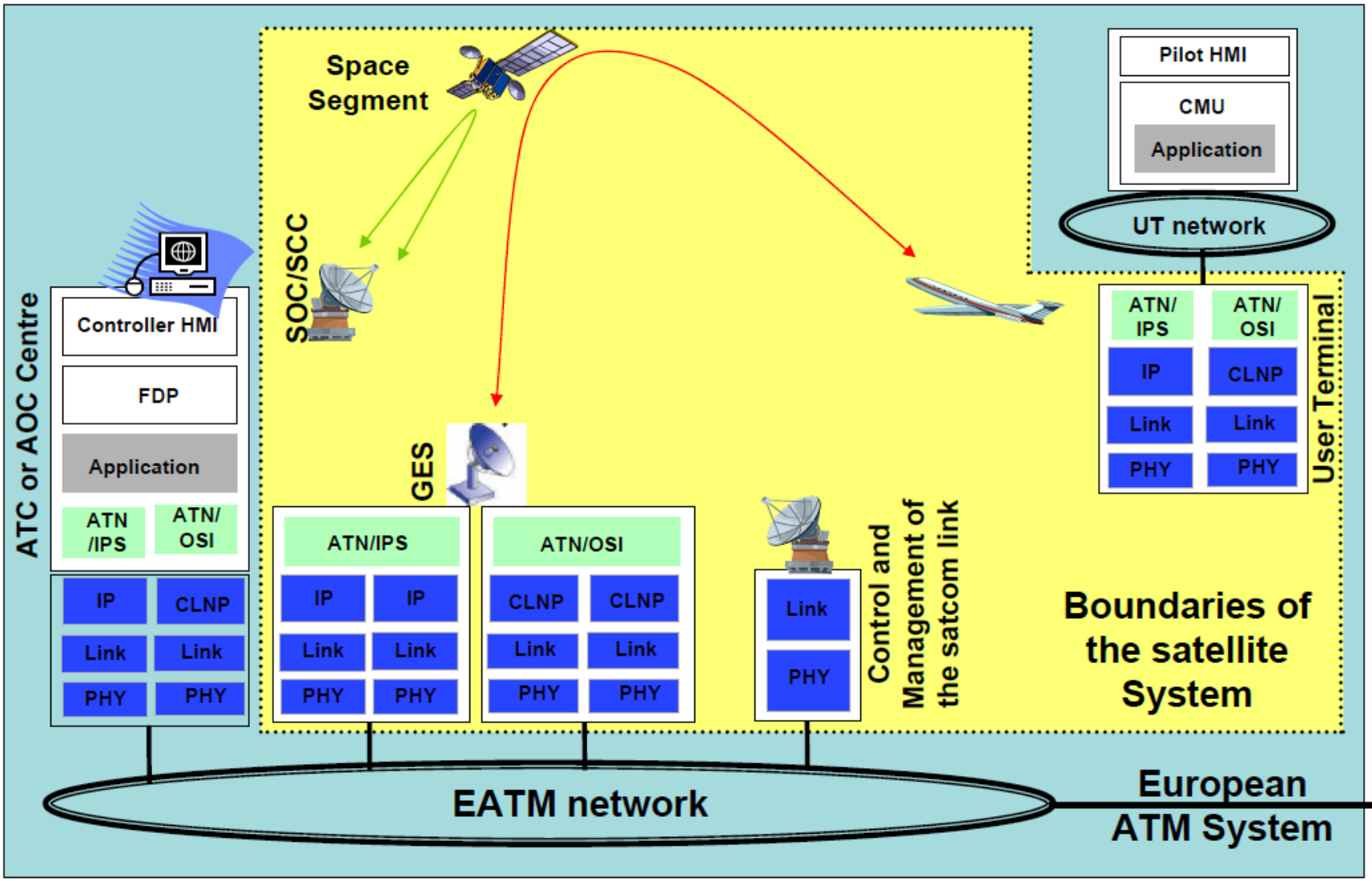
- 4.6 Mbps on the Forward Link
- 0.8 Mbps on the Return Link

## Communication traffic model

Communication pattern (ATS & AOC messages cf. COCR) of all aircraft flying simultaneously is combined to derive the Information throughput



# Boundaries of Communication System Design



- **Detailed design is on-going until end 2010; the following elements have been selected so far:**
  - LDPC code with several block lengths (under definition as well as interleaving strategy) and code rates
  - Linear modulations (min QPSK and 8PSK, might be more); option for variability and adaptivity to be in the CS as option
  - Encapsulation GSE-like with likely use of a CRC
  - TDMA-based access scheme to allow several GES to access the same frame for spectrum and satellite payload amplification
  - Likely no ARQ (TBC as might be needed for some QoS)

**Some decisions are still open and choices may not be based only on technical (performances) results:**

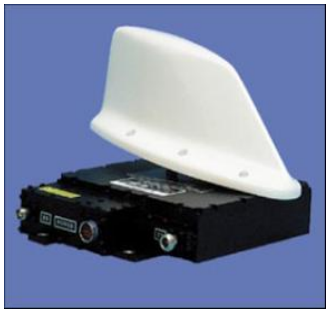
- Encapsulation RGSE-like with likely use of a CRC
- Likely ARQ for most or all traffic (TBC cf random access choices)
- Option for variability and adaptivity of the modulation (TBC)
- Joint modulation and access optimisation is on-going with 2 choices:
  - **MF-TDMA** with advanced constant envelope modulations and eBCH code
  - **A-CDMA** with linear modulations and turbo-code

  *Note: non-binary LDPC could be an attractive alternative on a pure performance basis but there are many doubts on their implementation*

**Detailed design is on-going until end 2010, notably:**

- Definition of the DAMA for accommodating multiple access (on-going)
- Handovers: detection and recommendations to be aircraft initiated except maybe for "bulk handovers" (many aircraft from one GES to another or one satellite to another)
- Compression (OSI and IP): selection of algorithms on-going
- Management plane (on-going)
- Information security: use of CRC from encapsulation but unclear if more is needed? (needs SESAR inputs cf risk analysis)
- Detailed RRM design requires inputs from SESAR on CoS definitions (Inputs expected end September)

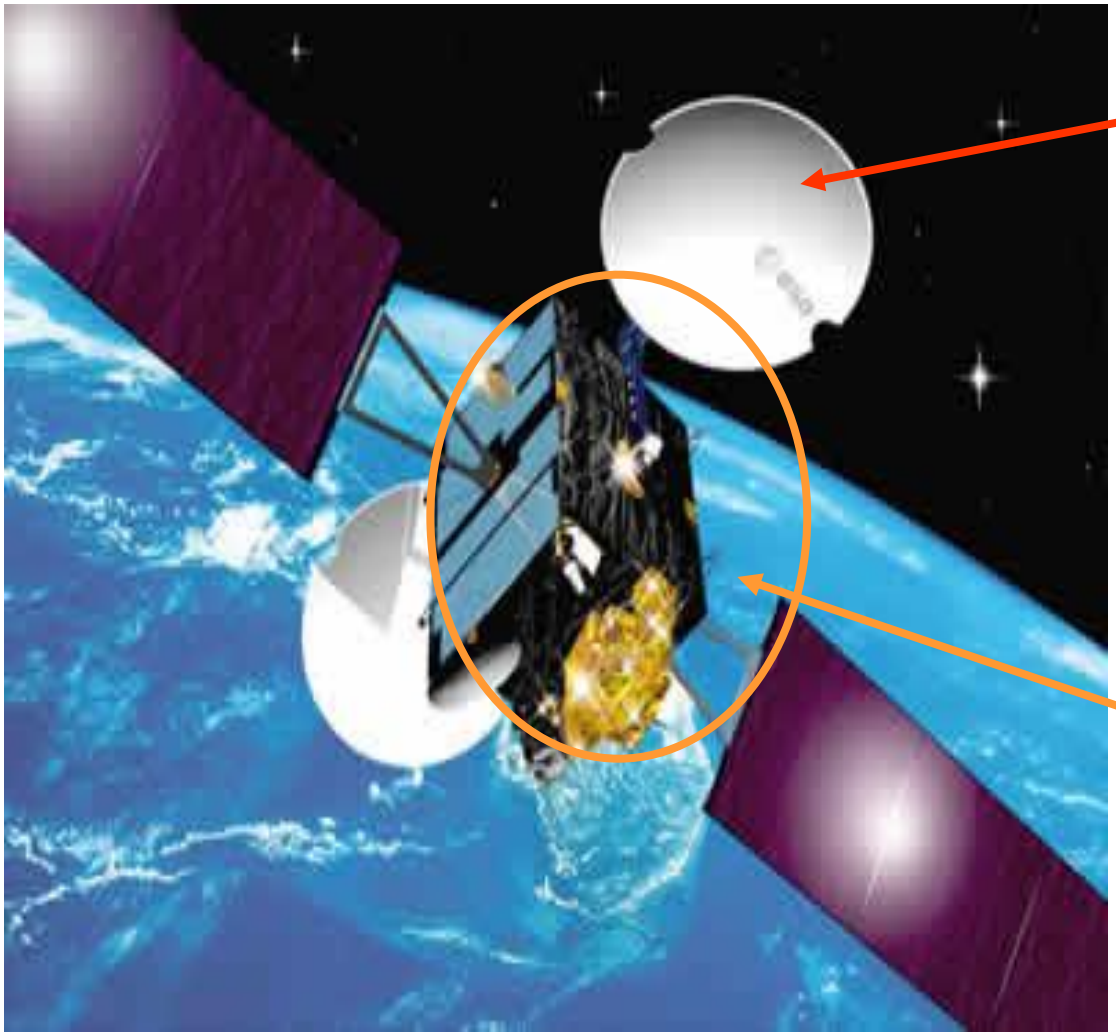
# Requirements for user terminals design



- **Mobile link in L-band**
  - Mature, reliable, proven equipment
  (e.g. no cause of interference)
  - Low cost

- **Key assumptions**
  - Use omni-directional aircraft antennas (suitable for all IFR aircraft)
    - Low power consumption, highly reliable, low drag
  - No forced air cooling required
    - Power likely limited to 40W
  - Co-primary means of communication
    - Software certification probably at level C
  - User terminal developed for airliners but also General Aviation (i.e. business jets, rotorcraft, etc)
    - Probably at least two types of user terminals

# Critical parameters for the system design



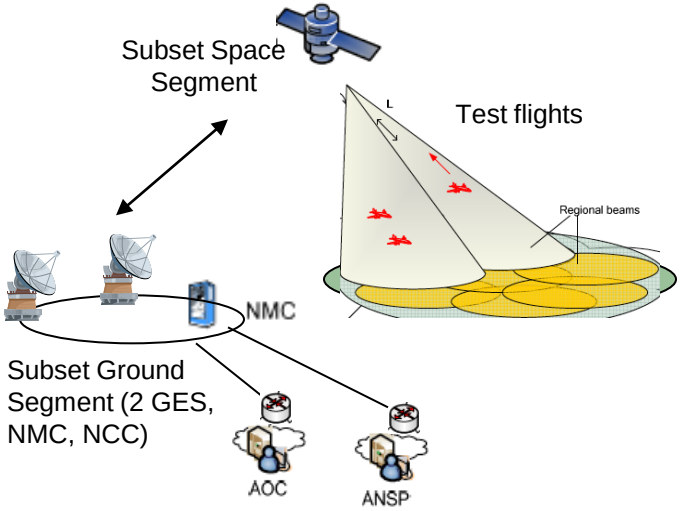
The size of the antenna
for the return link is driven
by the user terminal peak rate

⇓

Linked to application
maximum acceptable delay
In COCRv2

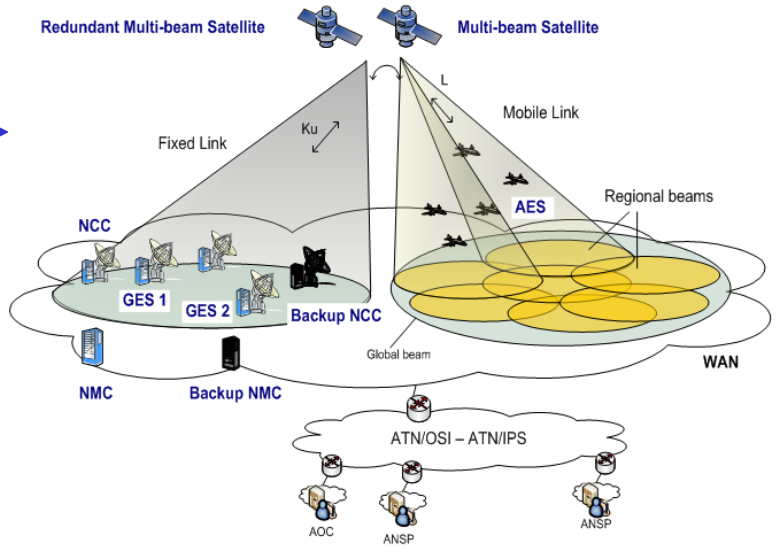
The payload mass+power
is driven by the capacity
on the forward link
i.e. the number of aircraft
communicating
simultaneously

# Infrastructure deployment




**Deployment**

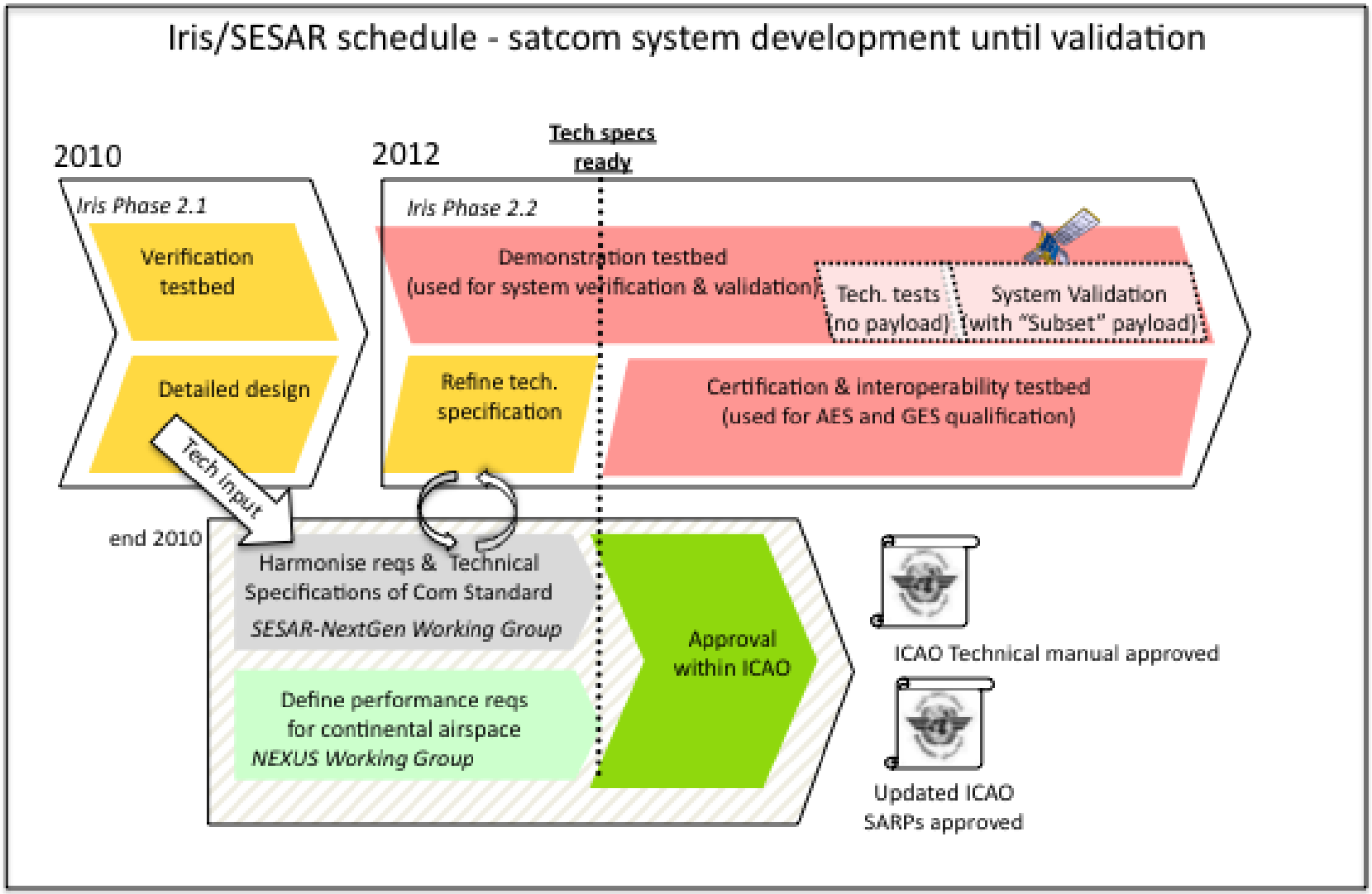
**2015-2020+**




**System validated (2015)** → **Pre-operational phase for Certification** → **Operational System (2020)**

# Next steps

# Standardisation process



# Iris - Contact Points


## ESA Iris Programme

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## ESA Iris System Design Studies

Andrea.Santovincenzo@esa.int (System Engineer)
Catherine.Morlet@esa.int (Communication System)

Documentation of recent public information event is available via
www.telecom.esa.int/iris

# Back-up: industrial teams of Iris Phase 2.1 studies

- **EADS Astrium Satellites**: Prime and coordinator, Critical review of the requirements, SwiftBroadband air interface validation, Validation plan development, Ground segment analysis (satellite operation)
- **Inmarsat**: Critical review of the requirements, SwiftBroadband air interface and protocol adaptation, Validation test bed design, Decentralised ground segment design, Interoperability with ATM networks
- **Airbus**: Critical review of the requirements, AES installation requirements, Interoperability with ATM networks
- **EMS**: Critical review of the requirements, AES design requirements specification
- **SITA**: Critical review of the requirements, Interoperability with ATM networks
- **SINTEF**: Air interface design, propagation modelling
- **DEIMOS**: Critical review of the requirements, Dependability & safety analysis

# ANTARES (1/2)

**Thales Alenia Space Italia:** Prime

Overall System, Space Segment, RAMS, Verification Test Bed, GS external I/F

**Indra:** Communication standard responsible

Waveform, Network Synchronization, Ctrl Plane, Management Plane, Data link

**Thales Avionics UK:** User Terminal Civil Aviation responsible

CA UT elements design, CA UT Proof of Concept, CA UT Prototype development

**Honeywell:** User Terminal General Aviation responsible

GA UT elements design, GA UT Proof of Concept, GA UT Prototype development

**Thales Alenia Space France:** Ground Segment responsible

GS Architecture, GS Design options, GS architecture for pre-op system, GS Verification, GES design, NCC design, NMCdesign

# ANTARES (2/2)

**Airtel:** Support for Network layer, transport layer, external networks

**Aedel:** Contribution to Space Segment operations

**Capgemini Norway:** Support to RAMS Analysis & Safety Case Definition

**Evolving Systems Consulting**: GUI & support to test Results, Satellite Emulator Definition

**Commsonic:** support to GES modem firmware development Modulator/Demodulator

**DLR:** Channel and Traffic model, support for Multiple access scheme (OFDMA), Channel coding and error detection (LDPC), Satellite channel emulator

**Frequentis:** Support to System Baseline Design for ATM aspects, Support for Network layer and Upper layers (Voice), Operational scenarios, GS operations consolidation

**GMV:** Support to GS Emulation (NMC&WAN and Service tool), G/S Emulation

**THLJ:** Support to System Options and preliminary design for Security, Support to System Design for Security Aspects.

**IZT:** Satellite channel emulator physical layer

**Iguassu:** Support to Satellite channel emulator & Test Manager detailed design and development

**Next:** Satellite Emulator Definition and development

**OHB:** Small GEO Platform Accommodation Report

**Space Engineering:** contribution to repeater analyses, Antenna Farm RF/Electrical trade-off & initial design

**Syderal:** support to GES modem firmware development

**Thales Alenia Space España:** Contribution to Space Segment and Satellite Options Definitions, contribution to trade off

**Univ. Salzburg:** Traffic analysis, Traffic Model, End user & AES traffic emulators

**Sintef:** Support for Security

- **Inmarsat Global Limited: Prime**
  - Satellite Operations Impact on System Design
  - Strategic Analysis

- **AENA Internacional**
  - Regulatory
  - Timeline
  - Responsibilities and Liabilities

- **ARINC**
  - Service Model
  - Revenue Model

- **Helios**
  - Business Case
  - Sensitivity Analysis

**SITA**: Prime

Overall Management

Service definition

Regulatory constraints

Financial impact and strategic analysis

**SES-ASTRA**

Definition of operations

Impact of the operations on the system design

Financial impact and strategic analysis

- **TELESPAZIO:** Prime - Satellite Service Provider

  Service model, Business case, Strategic Analysis

- **EGIS AVIA**: ATM Consultancy

  Service Provision Analysis (Interoperability and standardisation), Certification and regulatory issues, Revenue Model

- **HISPASAT:** Satellite Operator

  Engineering analyses, system verification and validation activities

- **NATS:** ANSP consultancy

  Regulatory activities, service certification and validation. Interface to Regulators, Certification Issues.

- **TELESPAZIO France:** Service Model, Business case support