1. Highlights and Background

2. SAMARA study
   • Activities Overview
   • Requirements and Drivers
   • Main Outcomes and Key findings
   • Development and Deployment Approach

3. Conclusions

4. Way forward
Overview of the Activities & Background

- **SESAR**: initiative from the aerospace industry
  - Indicates need for a new dual-link system for Air/Ground communications for 2020 with complementary terrestrial-based and satellite-based mobile communication technologies.

- **Iris**: ESA programme dedicated to support SESAR Single European Sky Air Traffic Management Research Programme.

- **SAMARA**: (Satellite communicAtion systeM for Atm seRvice):
  - Phase A: Analysis and definition of the Satellite System Study led by Thales Alenia Space – Italia as Prime Contractor
  - Defines the satellite communication system to fulfil the aviation service requirements.
Need of a Satellite Dedicated System

- **Existing systems providing satellite communications for the ATM services**
  - GEO: INMARSAT, MTSAT
  - LEO: Iridium constellation.
  - providing the ATM services for Oceanic, Remote and Polar (ORP) regions
  - operating in L-band (AMS(R)S)
  - ICAO standard

- **ICAO Future Communication Infrastructure study:**
  - existing aeronautical communication satellites not capable of fulfilling the aeronautical communication requirements because the insufficient throughput per aircraft
  - availability requirements not satisfied

- **A dedicated satellite system is also necessary**
  - to comply with the reliability performance required by the Safety of Life services
  - to provide the ATM service on the ECAC area in the dual link configuration (terrestrial Air/Ground link and satellite link) as indicated in the SESAR programme.
SAMARA mission:
- to provide alternative comms means to carry Air Traffic Communications by satcom system
  - Baseline: full coverage over the ECAC European Area
  - Options: over the whole world and the north polar areas.
- to provide satellite based ATS (Air Traffic Service) and AOC (Airline Operational Communication) services between the airspace users and the ground aeronautical entities (ANSPs and Airline Operation Centers)
- aligned with the SESAR implementation of the Single European Sky target concept.
- answer to the challenging Safety of Life services requirements

SAMARA satellite system and the deployment strategy defined starting from:
- System Requirements Document,
- Protocol definition as provided by both Communication studies
- Target of a low cost new avionic satisfying the availability requirement for the safety of life operations,
- SESAR timeline
Assessment of satellite system user requirements in the context of the SESAR initiative
Trade-offs between different system architecture options
Definition of System Operational Concept
Satellite System Architecture definition
  - definition of preliminary Satellite System Architecture with aeronautical active antennas
  - trade off for Ancillary Payloads
  - refinement with low gain antenna for the airborne equipment
  - basing on communication standard system performances and architecture provided by both communication standard.
Definition “subset system” to allow the system validation and certification during the preoperational phase.
Two options for ATM Payload:
  - Payload with “reduced” capacity to be used for the subset
  - Payload with “full” capacity to be used for operational systems
Certification and liability issues analysis
SAMARA Business Case and Service Model
Analyses of Input Requirements  (1/2)

**COVERAGE REQ.:** Subset Mobile and Fixed Link Requirement Compliance over ECAC Boundary

**Carrier data rates vs spot beams:**
Refined information rates and number of channels based on optimized link budgets and capacity allocation provided by the Agency and based on Communication Studies

**Scenario subset**
- Minimum number of carriers: 22
- Assuming the 3 spot beams originally used in Task 2, the distribution among the beams is 5-12-5,
- 1 carrier per beam of 16 kbps, 1 carrier per beam of 32 kbps and all other carriers of 64 kbps

**Scenario full**
- Minimum number of carriers: 59
- Assuming the 3 spot beams originally used in Task 2, the distribution among the beams is 13-32-14
- 2 carriers per beam of 16kbps, 2 carriers per beam of 32kbps and all other carriers of 64kbps
### Analyses of Input Requirements (2/2)

<table>
<thead>
<tr>
<th></th>
<th>Scenario subset</th>
<th>Scenario full</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>FWD</td>
<td>RTN</td>
</tr>
<tr>
<td><strong>Tot. no of carriers</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>To SB A: 5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>To SB B: 12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>To SB C: 5</td>
<td></td>
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<td></td>
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<tr>
<td><strong>Carrier data rate</strong></td>
<td></td>
<td></td>
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<tr>
<td>3 carrier rate types:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16 kbps</td>
<td></td>
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</tr>
<tr>
<td>32 kbps</td>
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<td>64 kbps</td>
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<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total BW (MHz)</strong></td>
<td>1.94</td>
<td>2.10</td>
</tr>
<tr>
<td><strong>Ant. Polarization</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>U/L: RHCP</td>
<td>D/L: RHCP</td>
</tr>
<tr>
<td></td>
<td>D/L: LV</td>
<td></td>
</tr>
<tr>
<td></td>
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</tr>
<tr>
<td><strong>Min. EIRP (dBW)</strong></td>
<td>41.8</td>
<td>31</td>
</tr>
<tr>
<td><strong>Min G/T (dB/K)</strong></td>
<td>-1.0</td>
<td>-1.0</td>
</tr>
<tr>
<td><strong>C/I (dB)</strong></td>
<td>14 target 18</td>
<td>18 target 20</td>
</tr>
<tr>
<td><strong>Lifetime (Years)</strong></td>
<td>15</td>
<td></td>
</tr>
</tbody>
</table>
User link at L band characterised by:
- multi beams coverage
- high EIRP
- demanding G/T

Low cost approach

Dimensioning and design of L band antenna
- beams generation approach
- reflector dimensions

Payload drivers
- architecture
- consumption, dissipation and mass

Two payload options:
- Payload with reduced capacity
- Payload with full capacity

Small/Medium GEO platforms
A. OHB Luxor for reduced capacity payload
B. Spacebus 4000 B2 for full capacity
Subset Payload:

- Repeater mass: 270 kg
- DC consumption: 3230 W (Psat-4 dB OBO)
- L-Band antenna
  - shaped reflector
  - 4 meters diameter
- OHB Luxor platform.

✓ The proposed design resulted form the trade-off analysis as the most cost effective solution.
Ku-band and TT&C accommodation during GTO-to-GEO transfer

Support structure for reflector during launch

Accommodation in any candidate LV
Full Capacity Payload:
- Repeater mass: 335 kg
- DC consumption: 5841 W (Psat-4 dB OBO)
- L-Band antenna
  - shaped reflector
  - 6 meters diameter
- Target platform: TAS Spacebus 4000 B2 platform.
SAMARA study defines:
- satellite constellation
- ground part of the space system (SCC, SOC and TT&C stations)

Space segment identified option
- composed by at least two geostationary telecommunications satellites as baseline to ensure the ATS/AOC services coverage to the ECAC area.
- GEOs sats operating in hot redundancy
- supporting simultaneously the same coverage area with the same services

Each satellite will provide the following mission services:
- L band Mobile link: Communication links between satellite and aircraft (uplink and downlink)
- Ku band Fixed link: Communication links between satellite and ground stations (uplink and downlink)
- L band Antenna covering ECAC Service area by means of 3 spot beams
- Each satellite providing link for TT&C functions.
Subset Concept & Development Approach

- **Space Segment Samara: Development approach:**
  - dedicated, specially-developed mobile communications payload
  - standard spacecraft bus for which a number of off the shelf products exist
  - Ground Control Segment: integration with terrestrial network & potential interoperability with HEO/LEO constellation control centre for high altitude and polar routes

- **The Iris Subset satellite system:**
  - qualification of the ATM SatCom services
  - system validation in all operational conditions
  - able to ensure qualification of the service
  - certification preparation
  - minimum set of elements required to perform the End to End validation
  - Preoperational service

- **Inherent deployment costs of the GEO Subset:**
  - to be used not only for validation purposes, but
  - will become a first building block of the complete system as an integral part of the operational European ATM System

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**Iris Subset system preliminary definition:**

**Space Segment**
- 1 GEO dedicated satellite (platform and payload with reduced capacity)
- Part of Ground Control Segment
**TIMEFRAME**
- Deployment approach in line with SESAR master plan:
- SESAR master plan:
  - R&D: 2013-2018
  - Implementation: 2016-2020
  - Available for Operations: 2019+

**SAMARA System Deployment Approach**

**First launch** | **2009**
---|---
**now** | **2009**
**2014** | **E2E validation and transition to preoperational phase**
**2015** | **Full Operational System**
**2020** | **Available for Operations: 2019+**
Conclusions

SAMARA main outcomes:
- Definition of a satellite-based communication system specifically designed for the provisioning over the ECAC area of satellite based ATS (Air Traffic Service) and AOC (Airline Operational Communication) Air Traffic Communication services
- Two GEOs satellites
  - operating in hot redundancy
  - supporting simultaneously same coverage area with the same services.
- Two payloads:
  - Subset payload with reduced capacity (pre-operational phase)
  - Full capacity payload for operational phase

Space Segment two steps deployment strategy proposed:
- 1° step
  - Delivering a subset satellite system with reduced payload capacity
  - Able to qualify the services, validate the system and to be used as space segment element for the full operational capability.
- 2° step
  - Delivering a satellite with full capacity payload
  - full operational capability

Deployment strategy in line with SESAR master plan
Way Forward / Main Topics

- Consolidation of the communication traffic (i.e., wxgraph service, multicast vs unicast)
- Consolidation of the link budgets (i.e., waveform optimization)
- Complexity of final technical baseline: L-Band antenna sizing and design (e.g., BFN solution/frequency reuse..), Payload architecture, and related budgets (mass, consumption)
- Schedule and technical coherence and consistency between SESAR and Iris programmes considering the involvement of the Iris stakeholders in the SESAR program
- Reduction of satellite production cost (by analyzing the possibility to produce spare payloads in advance respect to the foreseen launch time)
- Following the design consolidation, to identify and the satellite elements potentially impacting the overall program schedule
- Interoperability with other satellite communication systems existing (INMARSAT, MTSAT) or not (HEO constellation for north and polar routes)
Thanks for your attention!