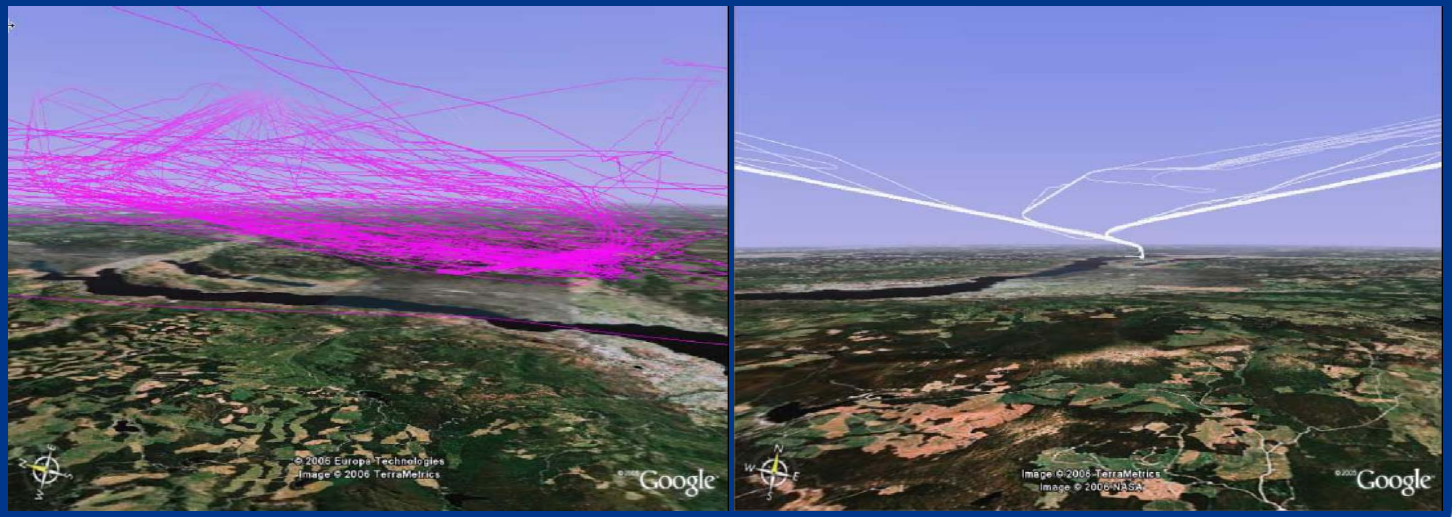
SESSION 6A
SESAR TECHNOLOGY



Peter Hotham

Chief of Technology & Innovation

founding members

EUROPEAN COMMISSION

EUROCONTROL

SESAR Technology
6A-1

4D-Trajectory Management

Aerodays – 31 March 2011

MEMBER OF SESAR JOINT UNDERTAKING

Presented by
Patrick LELIEVRE / Head of ATM Programme Operation & SESAR Contribution Manager - Airbus

AIRBUS

SESAR Concept of Operations – the keys

- Performance Partnership
- Sharing of information system wide - SWIM (interconnecting AOC, ATC, Met Office, etc.)
- Collaborative planning reflected in rolling Network Operations Plan
- Extensive use of 4-D Trajectories
- Automation support to the Human centred system
- Efficient separation modes
- Integrated Air- and ground systems
- Integration of Airport operations

4D-Trajectory-based concept : Planning

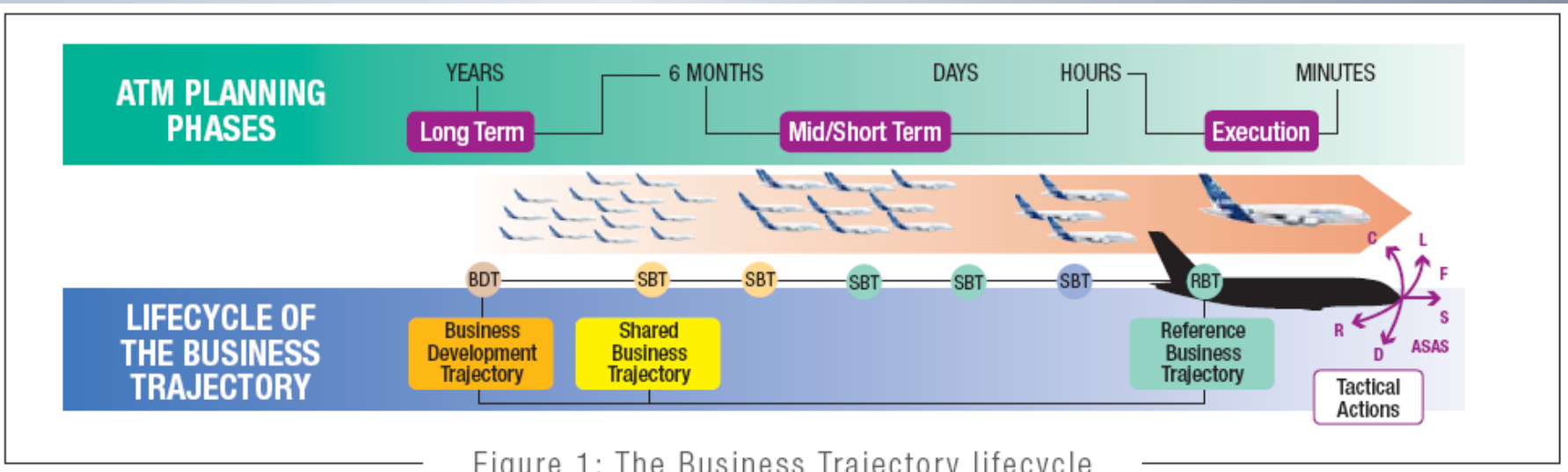
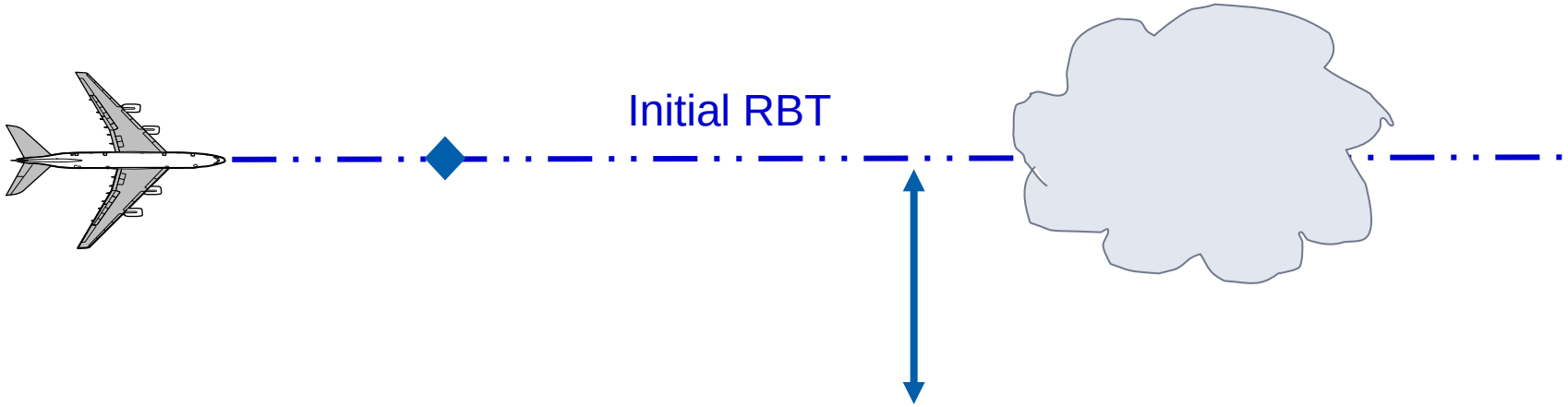


Figure 1: The Business Trajectory lifecycle

- **Before flight,** a Shared Business Trajectory (SBT) is progressively elaborated using pseudo-FMS tools in Airlines Operating Centres through collaborative planning
- **Before push back,** the SBT is refined with latest data (MET, ATC constraints) using onboard FMS and becomes the Reference Business Trajectory (RBT)
  - RBT is the **user preferred trajectory integrating ATC constraints**
  - RBT is the trajectory users agree to fly and ANSP agree to facilitate
  - RBT contains time estimates, some becoming target or controlled times
  - RBT is a gate to gate trajectory including surface operations

4D-Trajectory-based concept : Execution

- **2 Trajectories used onboard**
  - The Reference Trajectory (RBT) is the agreed reference between Air and Ground
  - The "Predicted Trajectory" (PT) is what the aircraft is predicted to fly (managed mode), it is continually computed by FMS and corresponds to updated prediction from current position back to RBT
- **After Push-back, during the execution phase:**
  - RBT is revised by ATC and flight crew only when constraints are to be changed due to separation of traffic or weather hazards
  - RBT is automatically updated when PT deviates more than pre-defined thresholds (new predicted trajectory is shared with ATC and becomes the new RBT)



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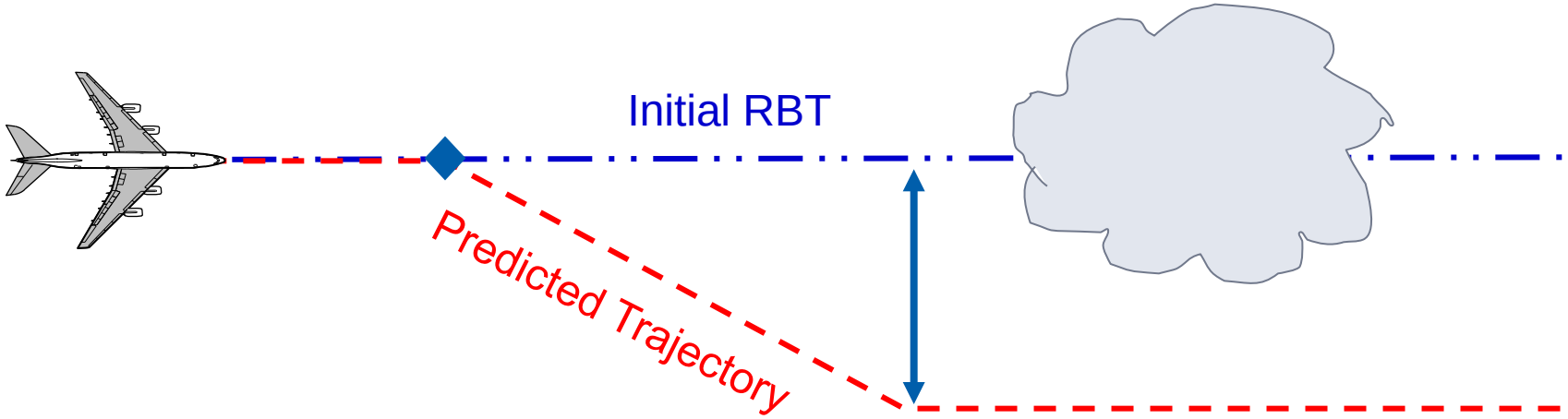

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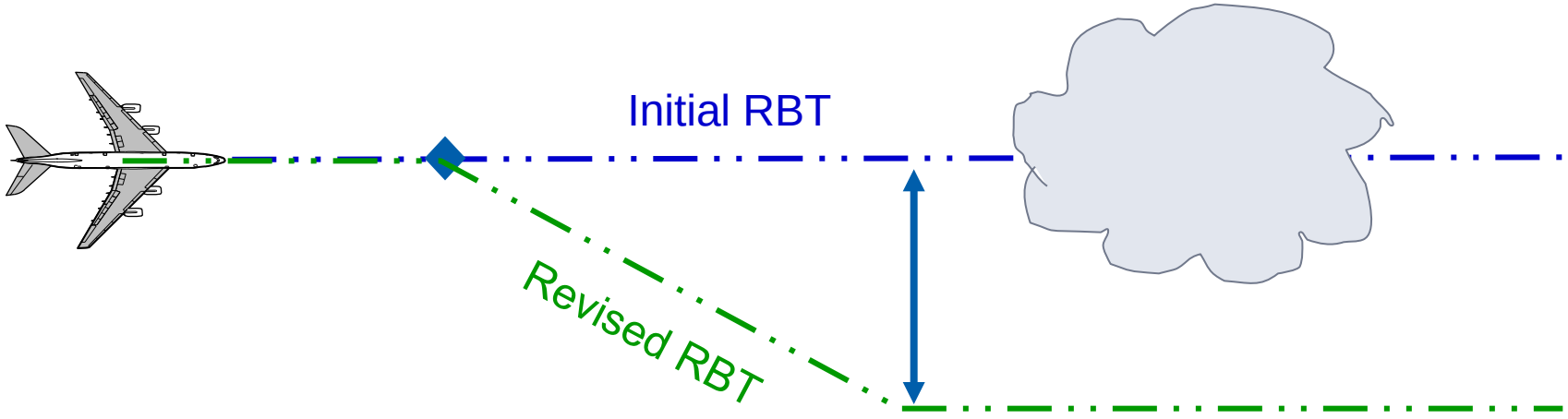


4D-Trajectory-based Concept : Benefits

Main **Benefits** of the Business Trajectory approach:

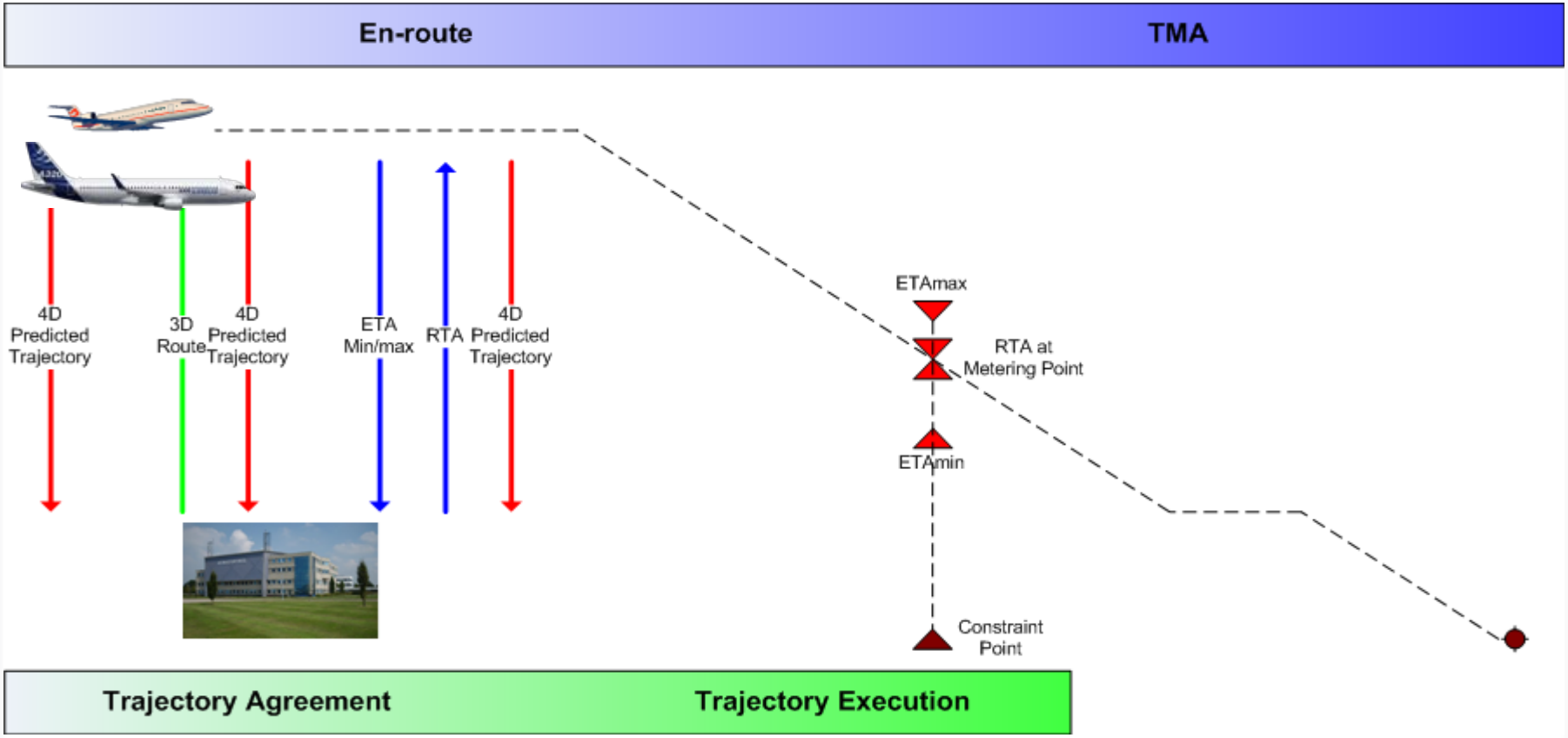
- Get as close as possible to the **user-preferred trajectory** (shortest distance / optimized profile between two points)
- Have a common and **shared representation of the flight** information between the aircraft and the ground
- Make the **best use of technologies and procedures** (FMS, Airlines Operating Centres, weather prediction…)

Initial 4D vs. Full 4D

- "Full 4D trajectory management " Concept of Operations was initially targeted for implementation starting between 2017 and 2019 (but would be probably implemented even later)
  - Strong impact on Airborne and Ground systems as well as on procedures
- A mid-term Concept of Operations, named 'Initial 4D' has been defined
  - taking maximum **benefits** of slightly improved airborne solutions
  - preparing the implementation of "Full 4D trajectory management " Concept of Operations
- Initial 4D operations consist in giving a time constraint at merging point to each aircraft converging to this point, in order to sequence the traffic.
  - Typical merging point could be Initial Approach Fix points, in the vicinity of congested airports (CTA given before Top of Descent)
  - Impact on airborne systems : light avionics upgrade (COM and NAV) with limited cost
  - Impact on airborne systems : Arrival Manager (AMAN) and DL COM capabilities

What is I-4D?

- Share and synchronise airborne and ground trajectory.
- “Flying to Time constraints” to optimize sequences as defined by ATC.



I-4D Validation Campaign in 2011

I-4D Validation Campaign in 2011

- Simulations using MUAC and NORACON ATC in simulation mode connected with Airbus Cockpit simulator.
- Simulations with i4D aircraft model in ATC Simulators.
- Live trials with AIRBUS A320 Test Aircraft.
- All exercises using the real Data Link chain/systems and networks in shadow mode.
- Simulations in three iterations, planned for 2011, 2012 and 2013.

Thank you
for your attention

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AN EADS COMPANY

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SESAR – the Human in the Loop

….but the human is still in command…

Theodor Zeh/FREQUENTIS
sWP Mgr. 10.10. and 12.5.

SESAR Objectives (excerpt)

- → - SESAR ATM Concept - D3:
  - **Humans** (with appropriate skills and competences and duly authorised) will constitute the **core** of the future European ATM System's operations. However, to accommodate both the expected traffic increase and the reference performance framework an **advanced** level of **automation** will be required.
- → Triplicate Traffic Load
- → at cost of 50%

sums up in a productivity of x6

Simple Solution

- Define a “Mass Production Process”
- Divide it into Value Adding Roles
- Develop optimised Human/Machine teams for each Role

That can sum up to factor 6 in productivity.

Solution – a new view at ATM

- New Mops and Conops
  - Workflow, integrating ground and in air (4D–Trajectory, Paradigm Shift)
  - new "production process"
- "mass production processes" can be applied
  - “mass production of safe airmiles”
  - acc. Zero Defect Mass Production Process in automotive industry.
- Seamless integration of all players – Ground and Air.
- new roles - adding value upon each other

The Human Machine Symbiosis (ground view)

- Humans and Machines are to be seen in Symbiosis.
- Holistic view on the Working Position (iCWP); "single point of contact" between Machine and Humans.
- Roles are interconnected according the "production workflow“ – including all airspace users
- Human/Machine teams (the symbiosis) will be optimised for each role.
  - Pilot/GlassCockpit in air
  - Controller/iCWP on ground

Machines shall be optimised at each role to support their humans
=> adaptable workspace is a must!

HF/Usability/HP/iCWP – the big picture

WPE – ZeFMaP
zero failure maximum at productivity process

16.5.3 – Effective Information Presentation

5.9 – Use Cases for ACC&TMA iCWP

16.6.5 – Human Performance Support and Coordination

16.4.4 – Social and Cultural Factors of Change

4.2&5.2 – detailed operational description

6.9.2– Use Cases for remote&virtual TWR

6.9.2– Use Cases for TWR&Airport iCWP

10.10.2 – ACC&TMA iCWP HF Design

10.10.3 – ACC&TMA iCWP Prototyping

12.5.5 - TWR iCWP Usability and Human Factors Engineering

12.5.7 - Performance Based Monitoring and Decision Support within the HMI of the iCWP

12.5.4 – TWR iCWP Design, Specification Prototyping

Validation of Use Cases

- Three validation cycles per release are foreseen:
  - V1 – within the operational thread
  - V2 – between operational thread and HMI design (industrial thread)
  - V3 – including an industrial prototype, closing the loop to the original use cases.

Connection of the roles => SWIM

- Mimicking mass production
  - value adding production process is defined
  - durable means of production are defined
- The conveyer belt is missing – we can call it

SWIM

Thank you!


COMMUNICATION
AND INFORMATION
SOLUTIONS FOR
A SAFER WORLD

SESAR Technology
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SWIM

The ATM Interoperability Infrastructure

Richard Houdebert

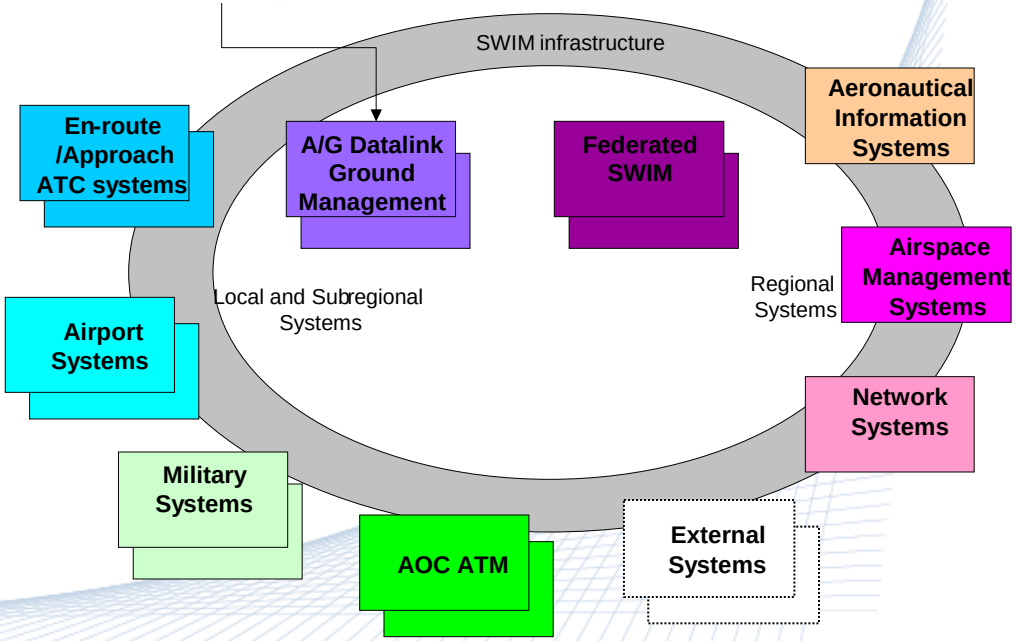
SESAR WP14 Co-Leader

SWIM infrastructure role in the ATM context

- SWIM addresses both G/G and A/G

- Integrates the aircraft
- Regional systems
- Sub-regional/local systems

- SWIM infrastructure will support the transition of ATM systems to the Service Oriented Approach (SOA)



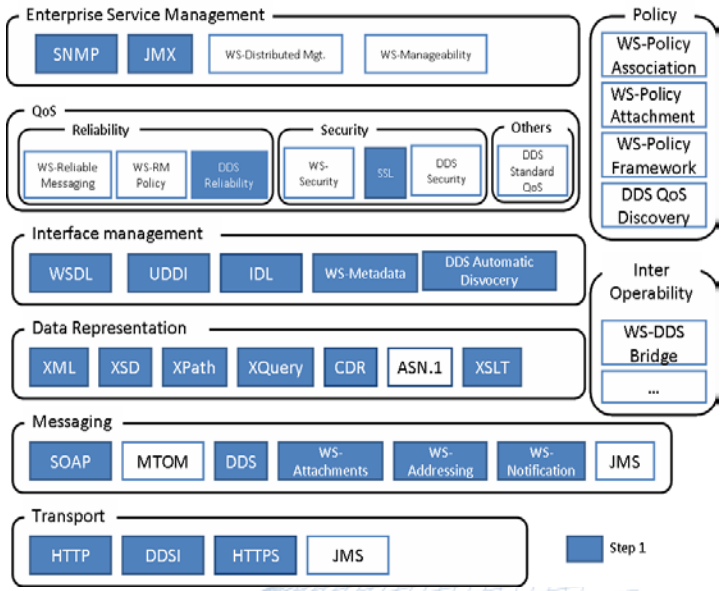
- Safety requirements imply high levels of availability, continuity, integrity

- Information security addressed; increased security needed due to increased information access through SWIM

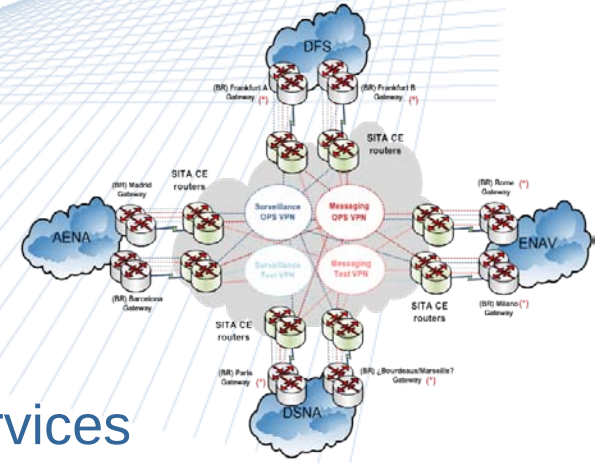
What is the SWIM infrastructure ?

1. Standard SOA technologies

2. Associated SOA products
   - Enterprise Service bus, Security solutions, supervision products, Data distribution solutions (DDS), etc …



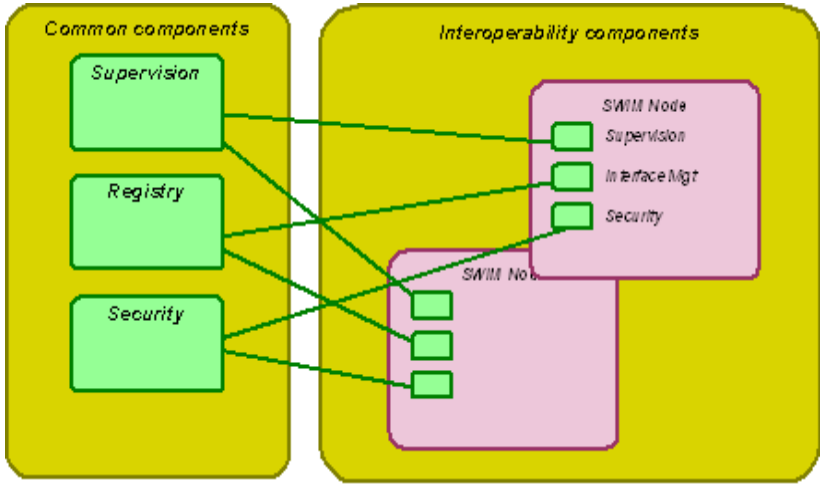
3. Developed software to complement and interconnect products



Relying on IP-based communication network services

SWIM infrastructure - Technical capabilities

SWIM Federated capabilities

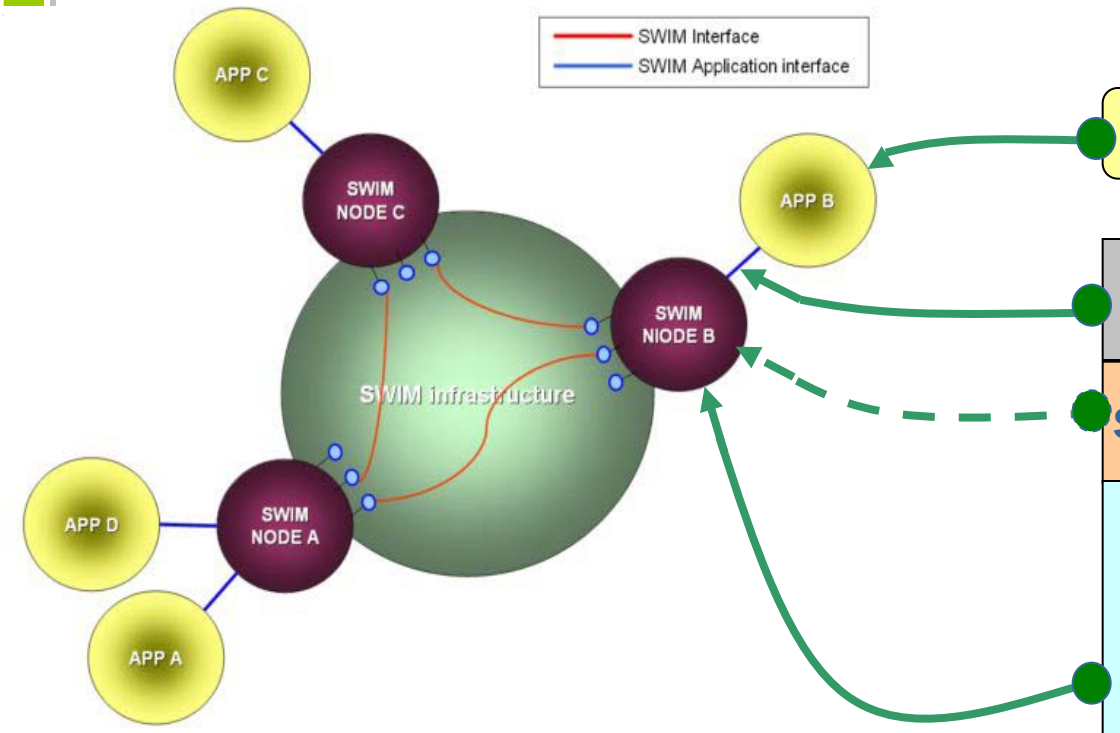


SWIM local capabilities

Interconnectivity creates new and more stringent requirements for the federation :

1. Administration (Supervision, registry, recording, security, etc …)
2. Performances (Availability, QoS, Load balancing, integrity, etc …)

SWIM infrastructure - Technical local capabilities



System B

SWIM Technical Access Sublayer

SWIM Tech. Added value Sublayer

- Security
- Supervision
- Interface Management
- High Availability
- Messaging
- Recording

SWIM access capabilities are implemented as per dedicated/local requirements to access SWIM for certain actors (allow different transition paths for different systems)

The need for and content of the Added Value Sublayer is still subject for research and validation

THALES

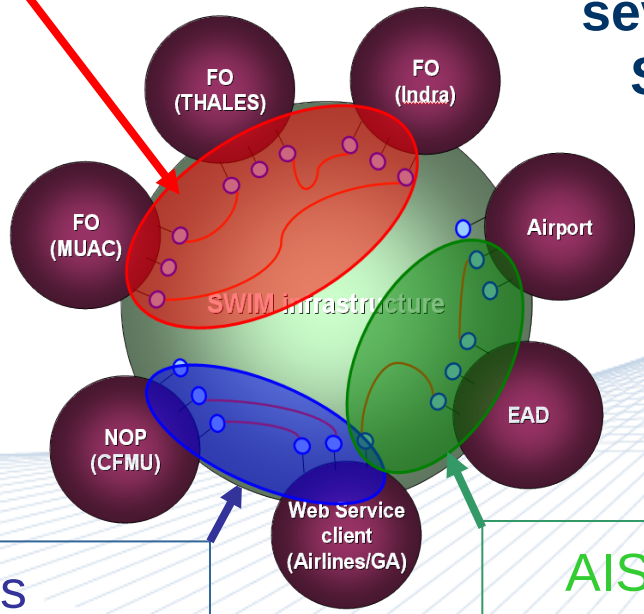
SESAR Step1 - SWIM Profiles selected

Flight Object
Web services & Data distribution
(Follow-up of Flight Object studies)

One solution will not necessarily fit all

The SWIM infrastructure can be composed of several technologies for SWIM users families

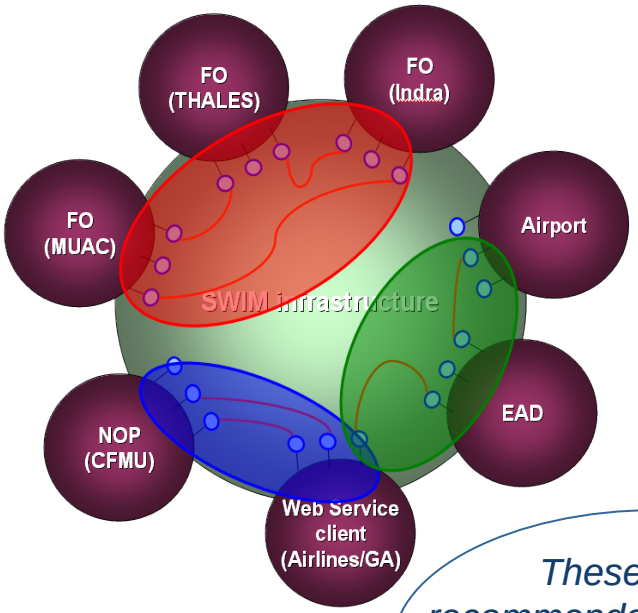
SWIM Step1 concentrates on Ground-Ground SWIM profiles



ATFM Web Services
(Integration with CFMU NOP Portal already in operation)

AIS Web Services
(Integration with EAD services already in operation)

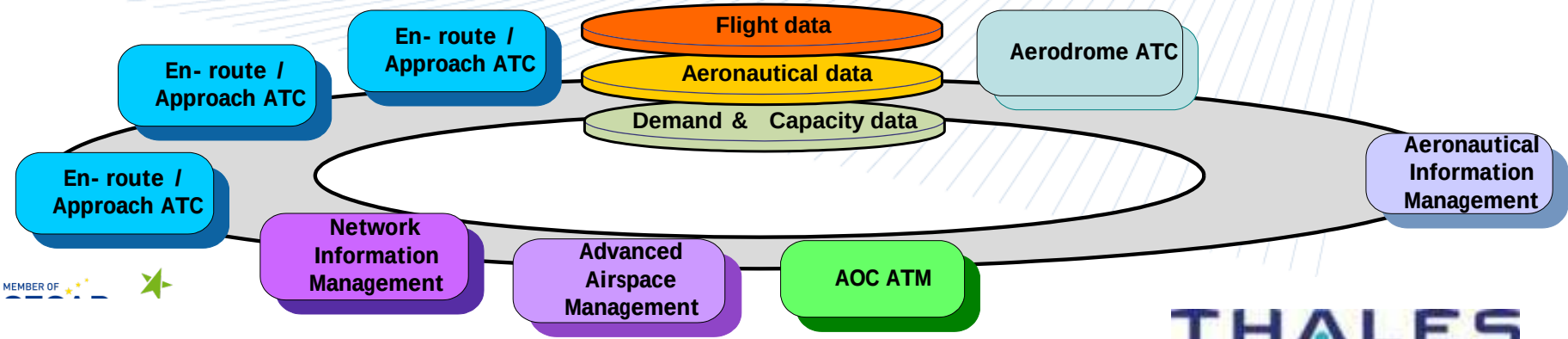
SESAR Step1 - SWIM infrastructure - Outlook



- Specification & Design completed
- Technologies and **Products** selected
- Developments achieved
- Verification test campaign initiated

- *Apache / ServiceMix*
- *Oracle / GlassFish*
- *Progress Software / Fuse & Actional*
- *Prismtech & RTI / DDS products*

These are not recommended products but selected today to verify the SWIM requirements



SESAR Steps 2 & 3 - SWIM infrastructure - Outlook

SWIM will progressively deliver more services to an increased set of actors

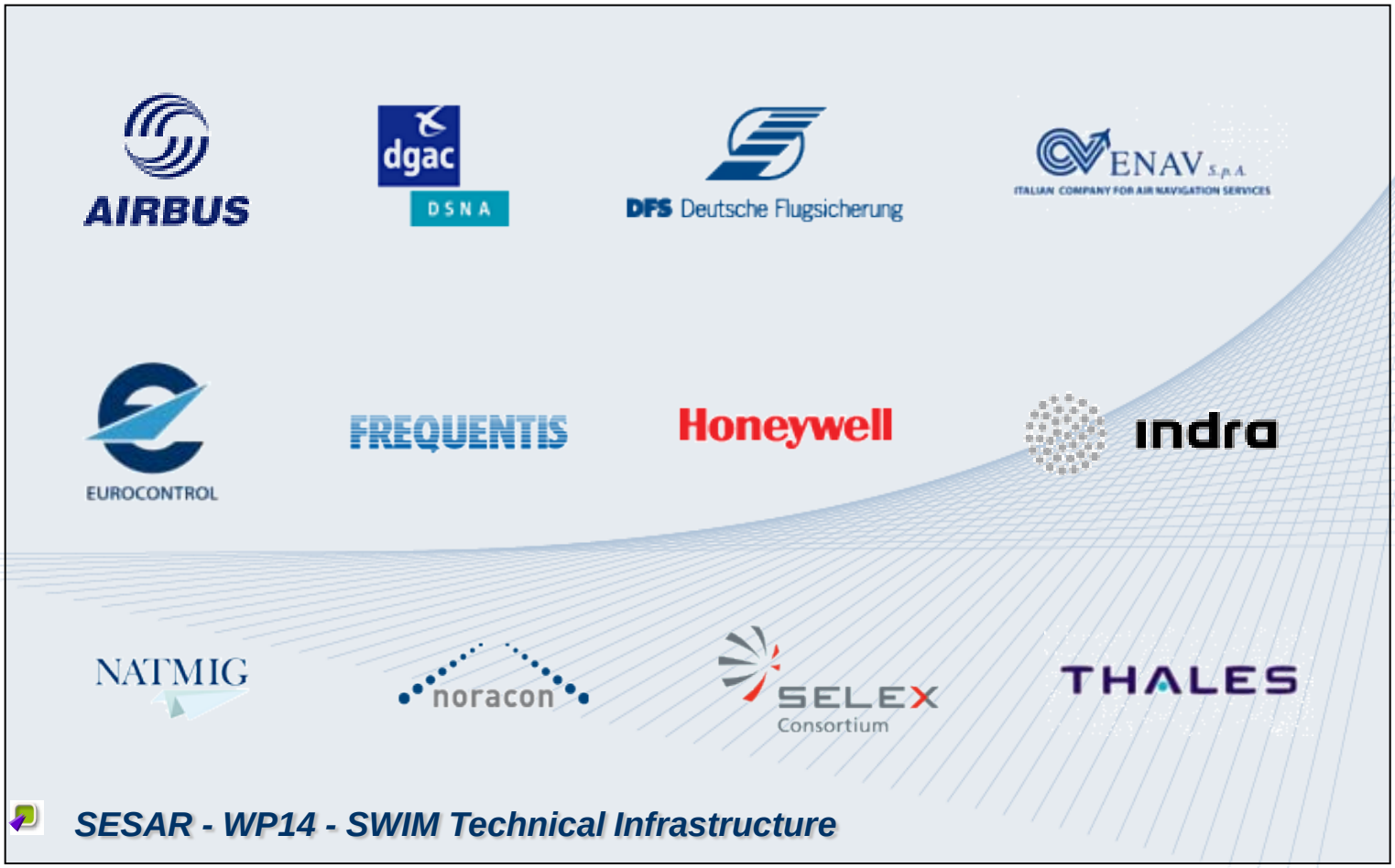
Airspace Users
Are contributing to the
SWIM projects

ATFCM scenario data
Surveillance data
Meteo data
Flight data
Aeronautical data
Demand & Capacity data

En- route / Approach ATC
En- route / Approach ATC
En- route / Approach ATC
Aerodrome ATC
Aerodrome ATC
Aeronautical Information Management
Military
Meteo Offices
AOC ATM
Advanced Airspace Management
Network Information Management

Regular demonstrations will take place (Starting this year !)

Questions ?


AIRBUS
dgac
DSNA
DFS Deutsche Flugsicherung
ENAV S.p.A.
ITALIAN COMPANY FOR AIR NAVIGATION SERVICES
EUROCONTROL
FREQUENTIS
Honeywell
indra
NATMIG
noracon
SELEX
Consortium
THALES
SESAR - WP14 - SWIM Technical Infrastructure

SESAR Technology
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SESAR Optimisation of Communication Technologies

Angeloluca BARBA - SELEX Communications

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SESAR : The ATM Evolution

3x
More flights in the EU skies

10x
Improved safety factor

10%
environmental impact reduction per flight

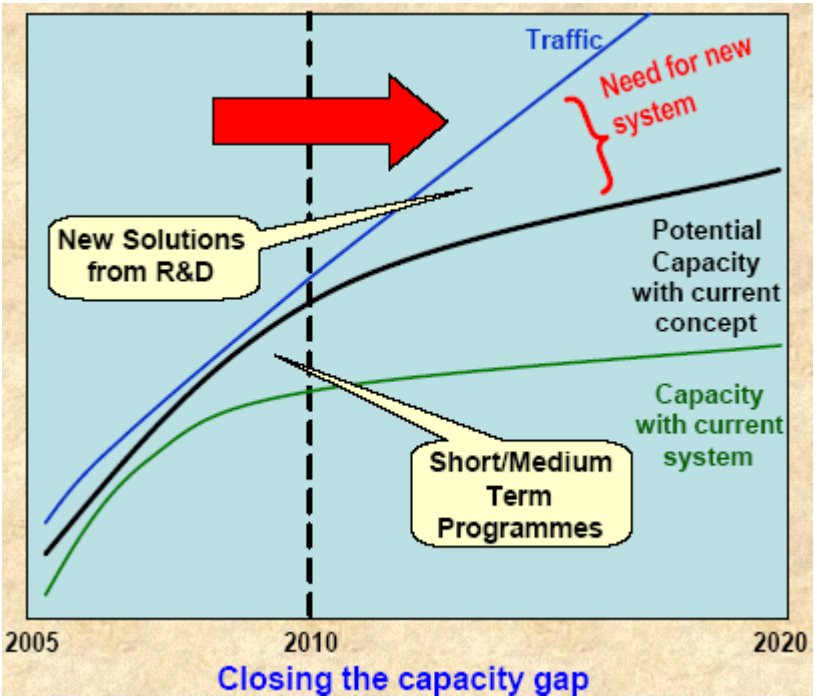
50%
ATM costs cut

(Official EU objectives for 2025)

SESAR Development Phase (2009-16) : 2.1 BEuro(33% EC, 33% ECTL, 33% Ind.)
SESAR Deployment Phase (2013-25) : 25 BEuro(?)

Enabling ATM : Resulting systems/services

Source: Expectations of SESAR, Bernard Miaillier, D1 Forum



- **Covering all the ATM Services:**
  - ATS/ATC
  - AOC (airline operations)
- **Implementable/used worldwide**
  - ICAO framework
  - EUROCAE/RTCA
- **Supporting all airspace users**
  - Mainline, Regional, Business, General Aviation
  - Military *OAT not in the SESAR remit*
  - Unmanned *C&C, ATM relay, payload, sense & avoid not in SESAR remit*

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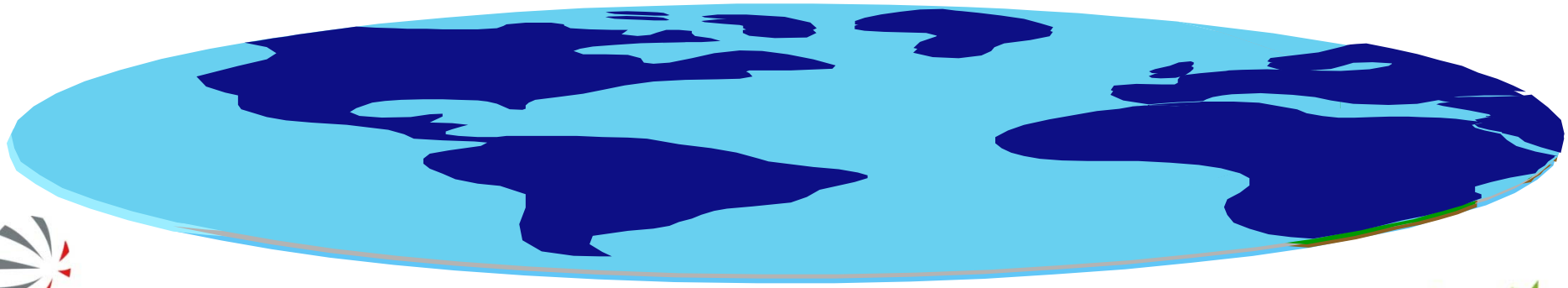
15.2.4 : The Multilink Concept

The future communication infrastructure

- Existing Systems : VHF/VDL2
- Airport surface: C band
- General terrestrial: L Band
- Satellite: Oceanic + Continental



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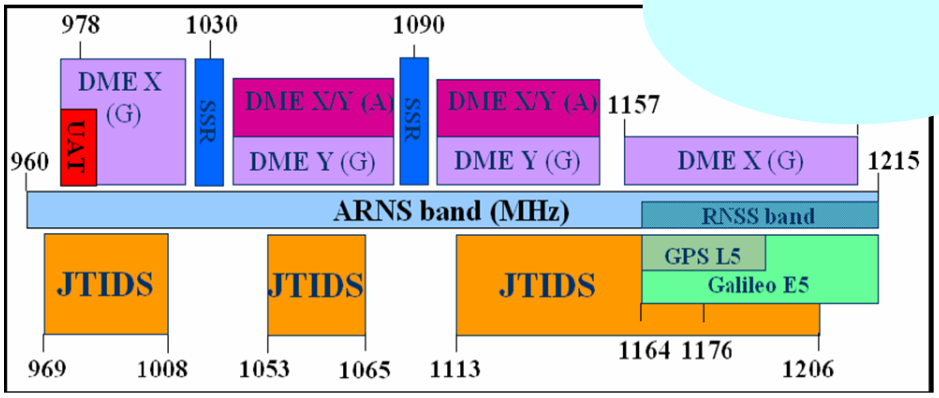
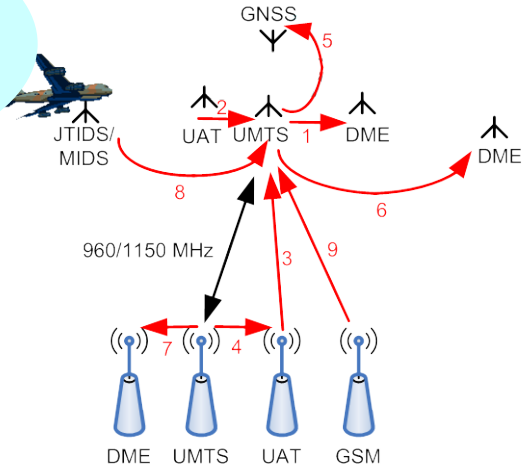
15.2.4 : LDACS – A/G Communications System

Actually
LDACS-1 is favoured

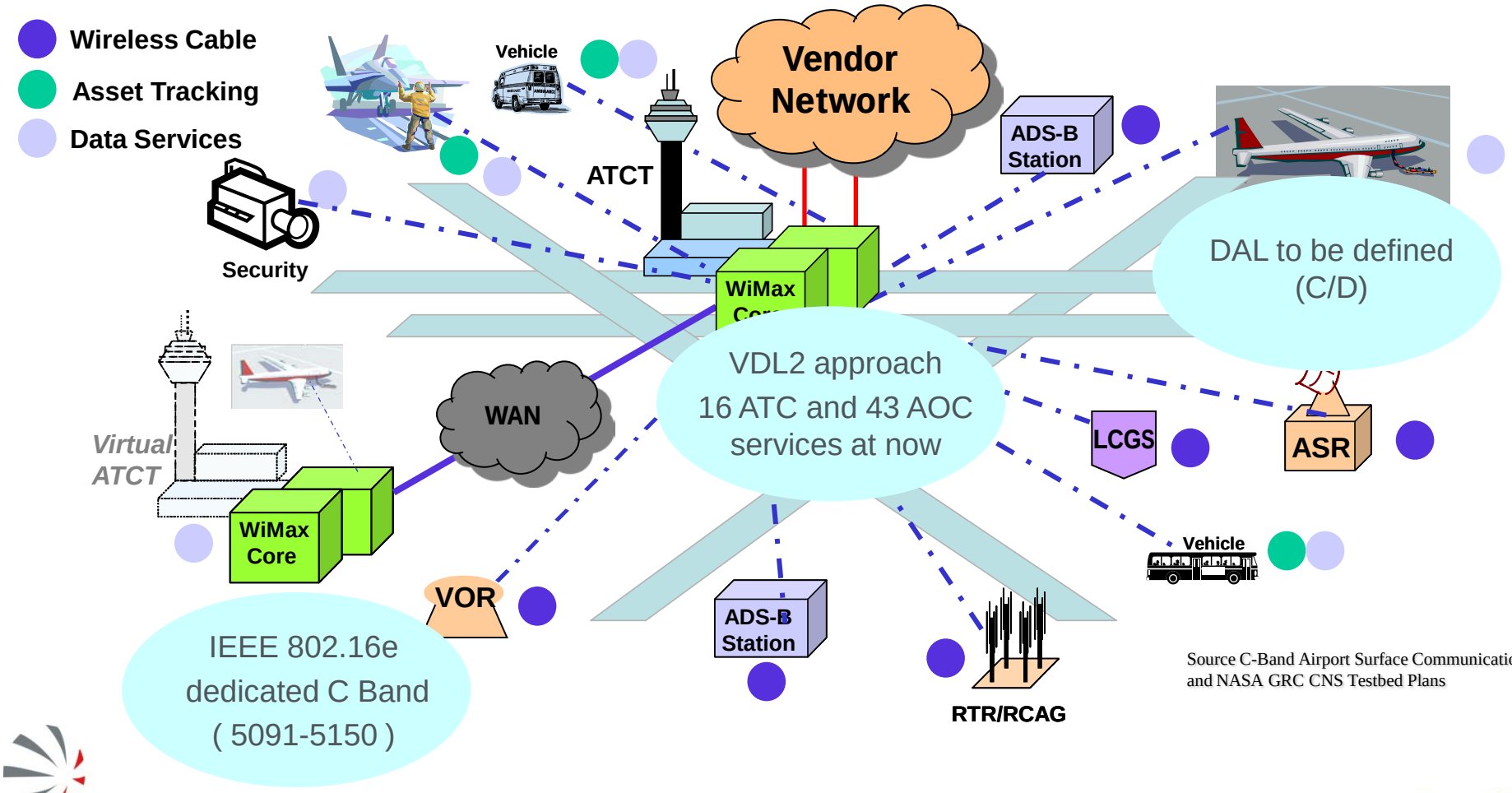
Options	Access Sch	tion	Origins
L-DACS 1	**FDD**	**OFDM**	**B-AMC, P34**
L-DACS 2	*TDD*	*CPFSK/GMSK*	*LDL, AMACS*

Crowdy Bandwidth





9.16/15.2.7: Airport Surface Communications



Source C-Band Airport Surface Communications and NASA GRC CNS Testbed Plans

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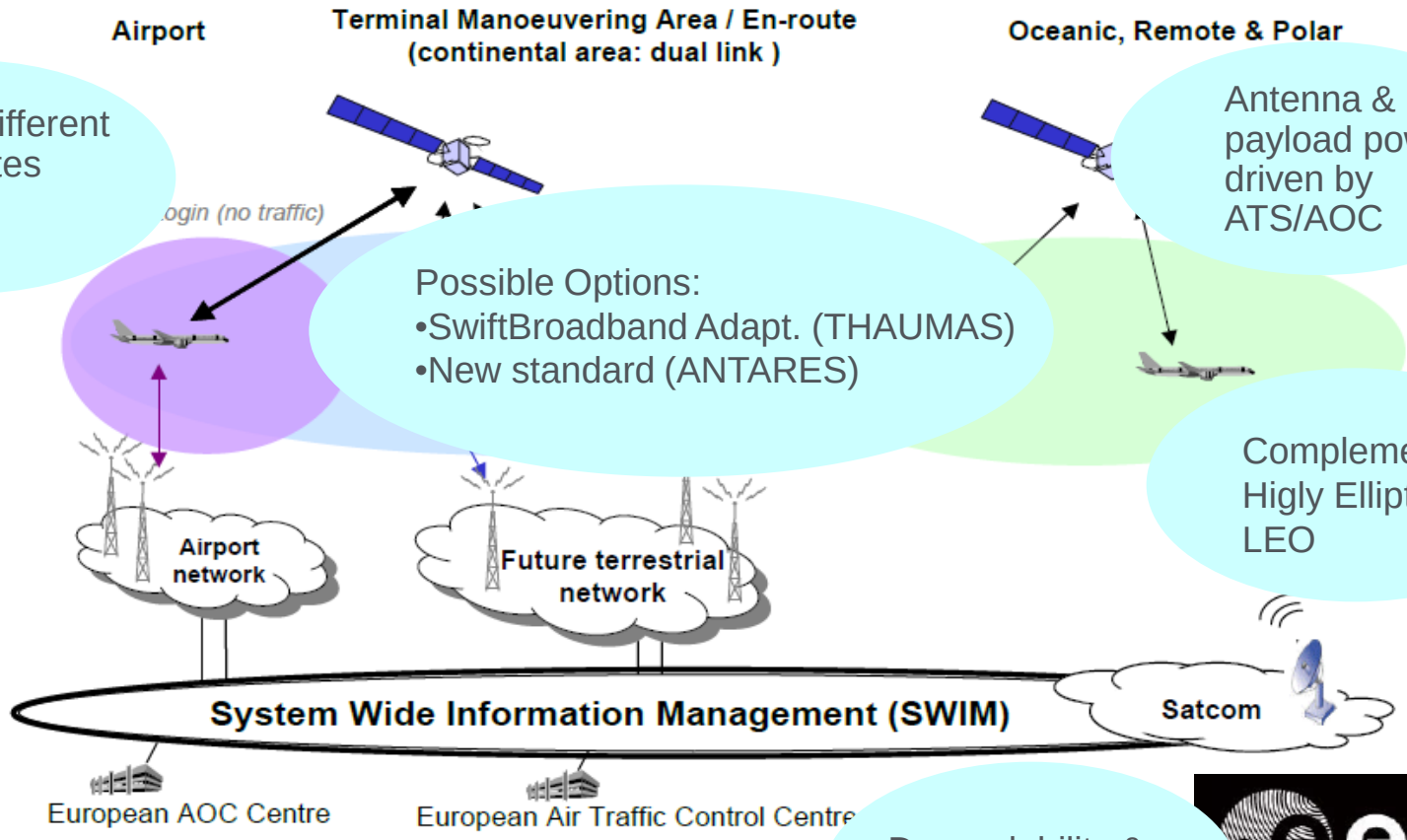
15.2.6 : SAT in collaboration with ESA IRIS



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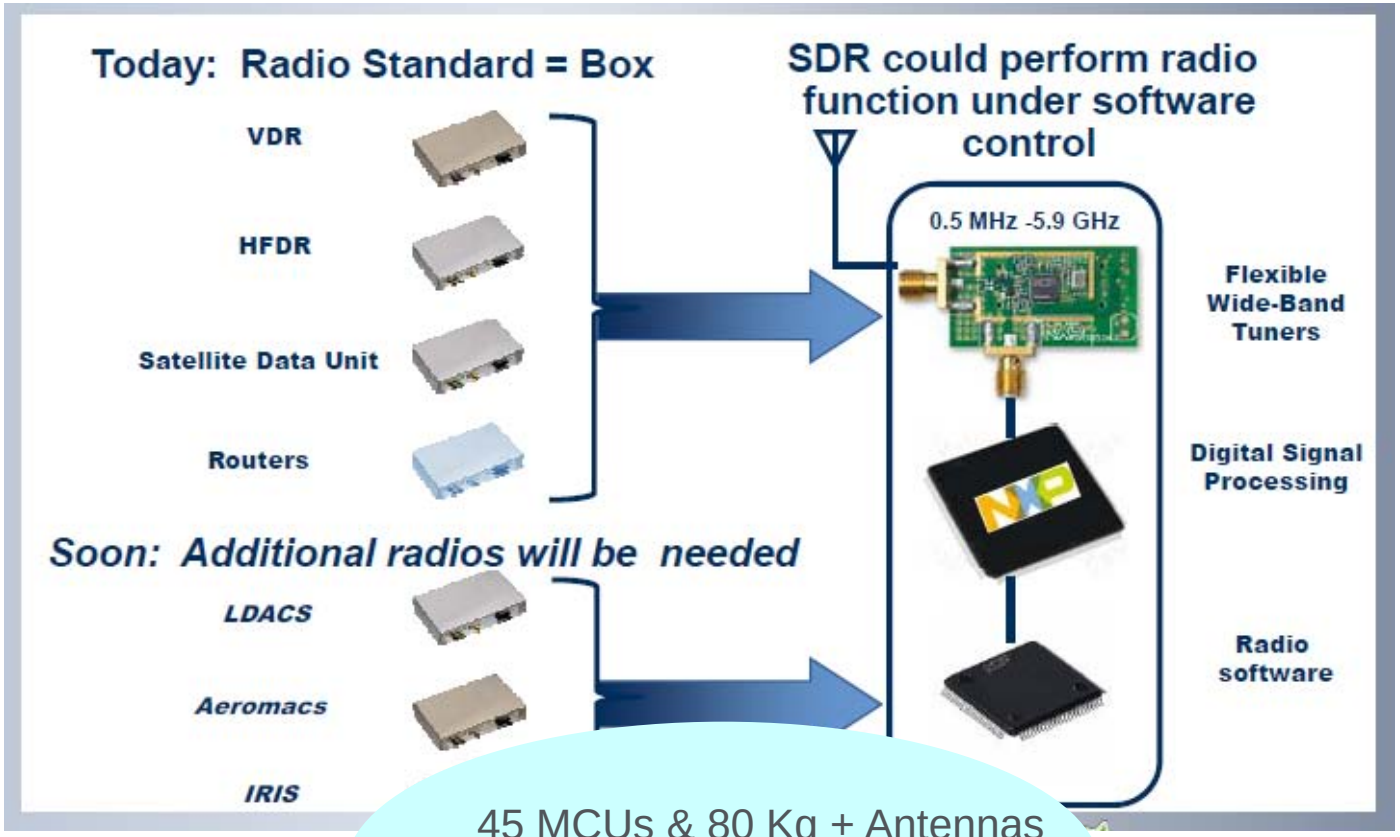
9.44 : The Avionic Federator



45 MCUs & 80 Kg + Antennas
(Without the new systems!)

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9.3/9.20/15.2.8 : The military dimension

9.3

Interoperability of Business and Mission Trajectory

Link 16 exploitation to support SESAR

Link 16

9.20

MIL

15.2.8

Civil-military interoperability, through a ground gateway

Key area for a fully integrated European Sky

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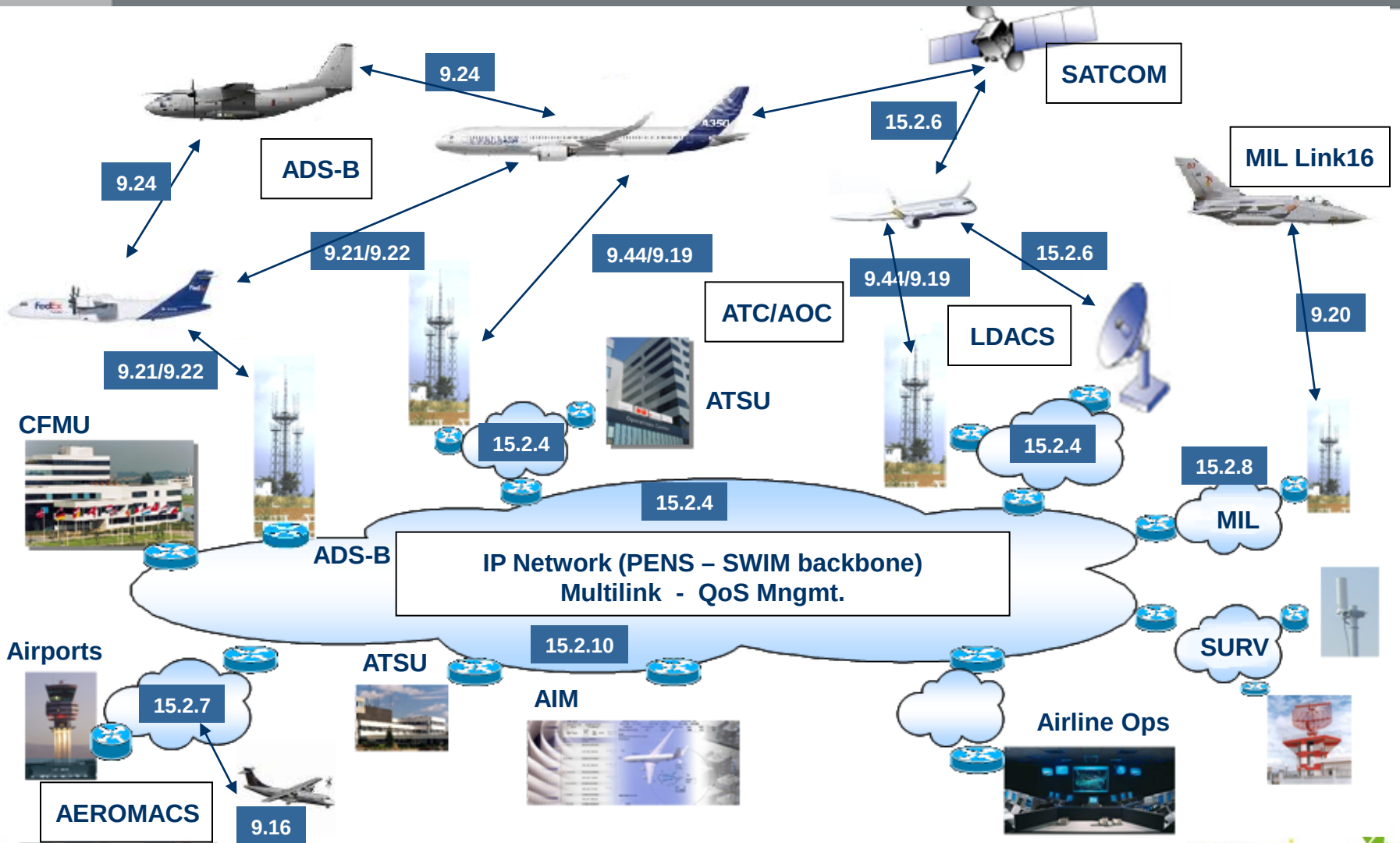

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End of presentation

Questions ?

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QUESTIONS & ANSWERS
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