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Trajectory Management in a SWIM Environment

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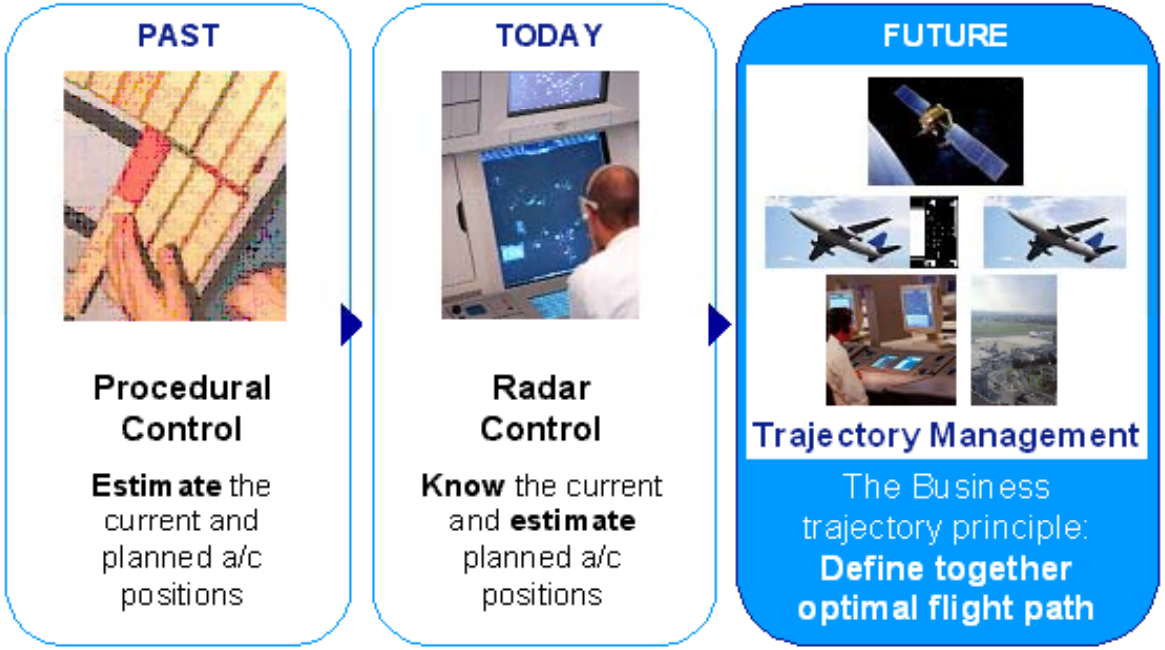
Trajectory Management

- Trajectory Management is core to future ATM concepts
  - Trajectory Based Operations are key to both SESAR and NextGen

SESAR

NEXTGEN
Next Generation Air Transportation System

  - ATM evolution as seen from SESAR :



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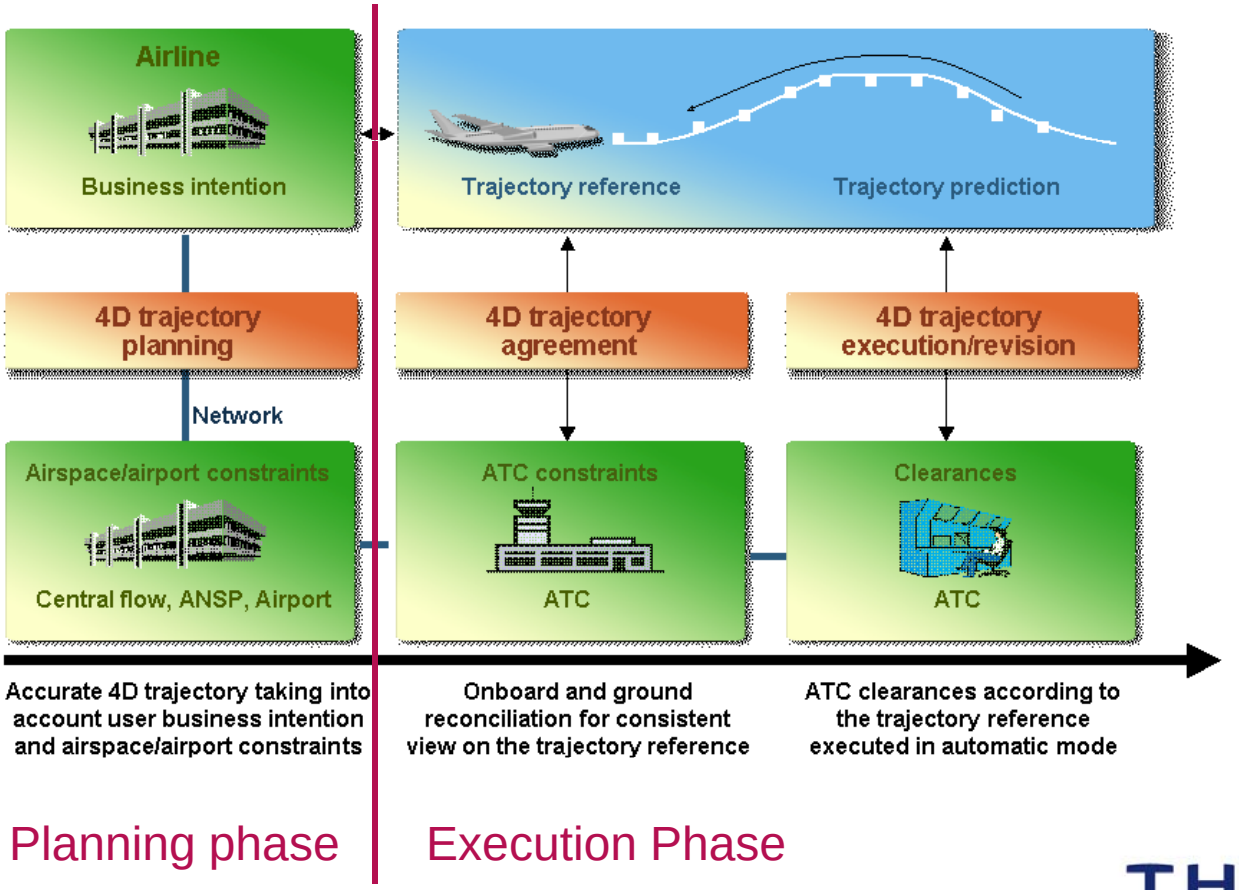
Trajectory Management - Phases

- Trajectory Management concept covers 2 main phases:
  - Planning of flight trajectory before departure
  - Execution of planned trajectory



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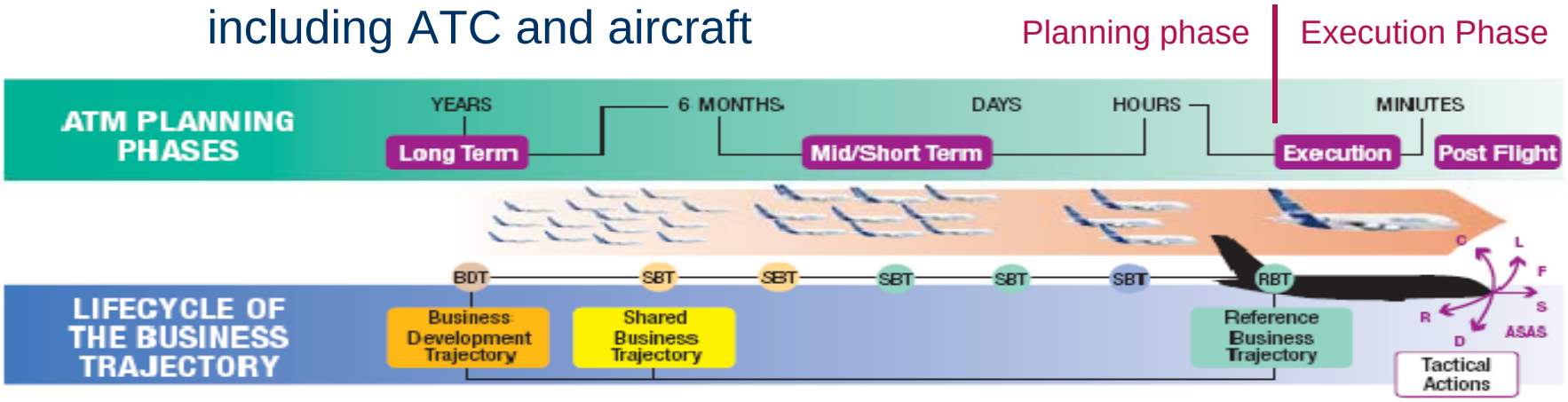
Trajectory Management – Planning Phase

- Planning phase aims at defining the optimal flight trajectory, considering:
  - Flight Operator business objectives (Business Trajectory)
  - Network constraints, arising from all involved stakeholders
    - ATC, Airports, Network Manager…
- Planning phase ends up with the definition of the Reference Business Trajectory
  - Shared and agreed by all stakeholders before departure, including ATC and aircraft



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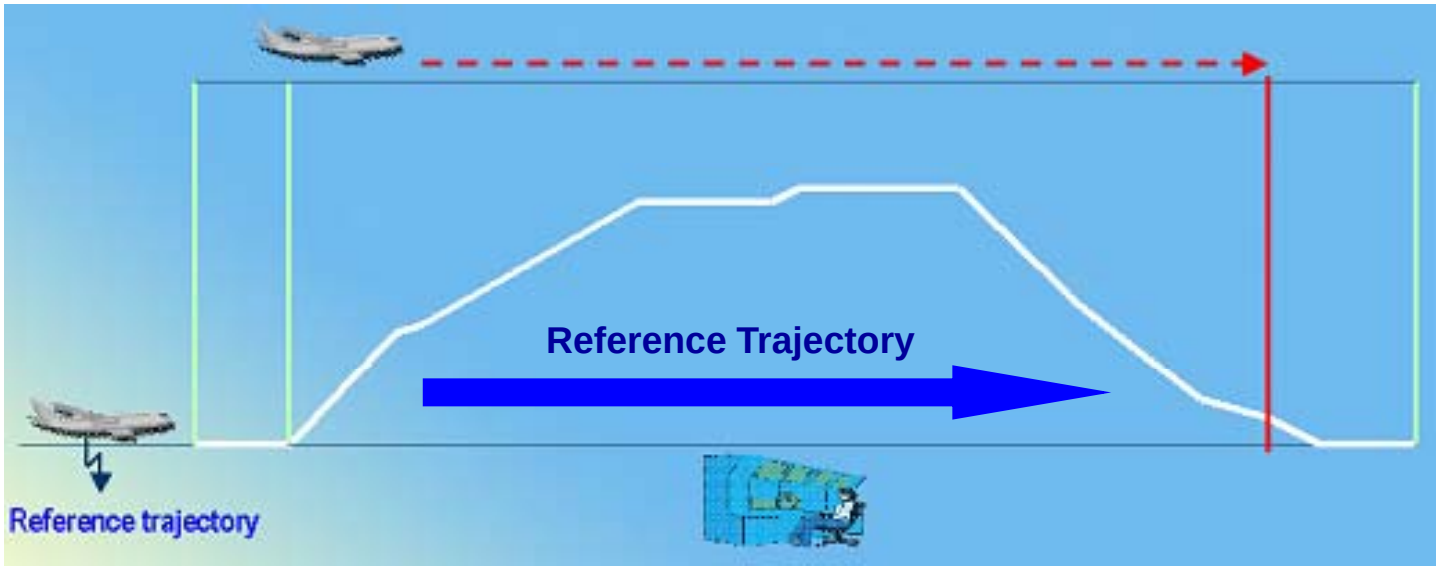
Trajectory Management – Execution Phase

- Execution Phase aims at conducting the flight according to Reference Business Trajectory



- Handling of non-nominal situations results in revisions to the Reference Business Trajectory

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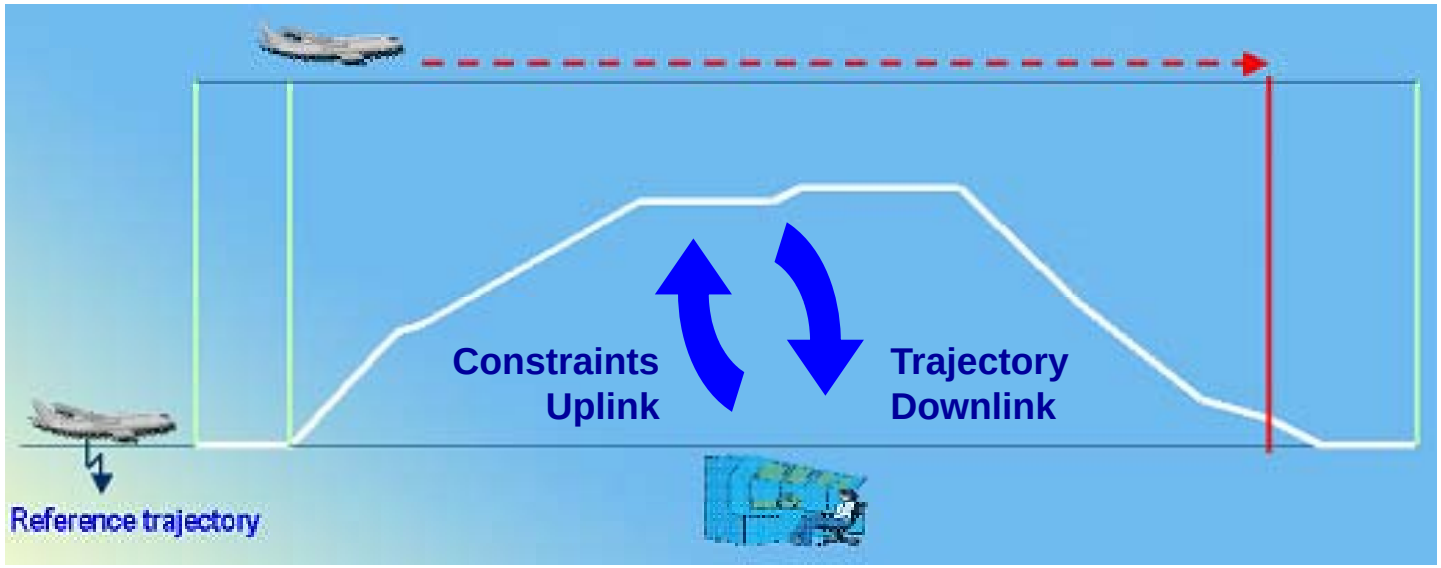
Air-Ground exchanges in support to TM

- During execution phase, aircrew and ground control shall share common awareness of current aircraft situation and predicted evolution
- Air-ground information exchanges are key enabler
  - Downlinking aircraft trajectory prediction
  - Uplinking known ATC constraints



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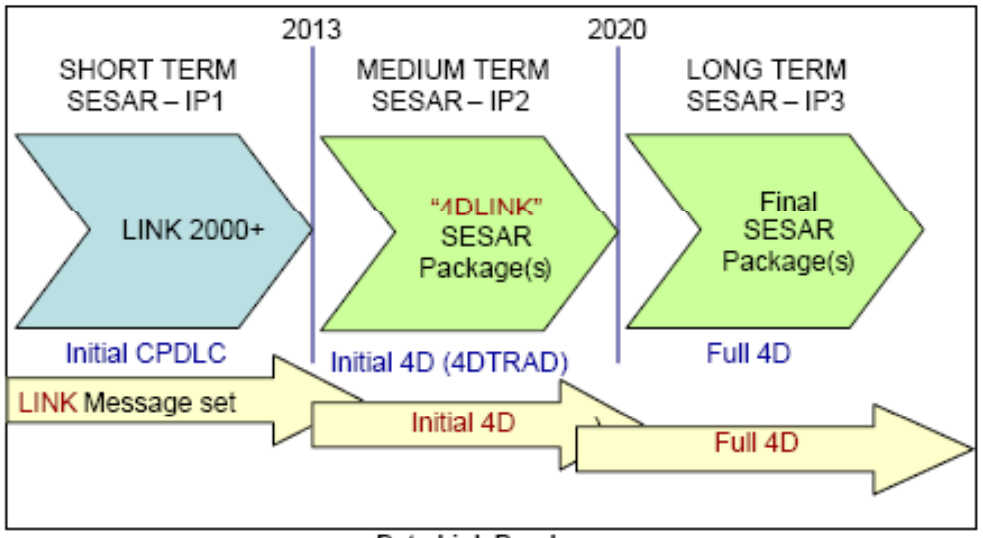
Initial 4D – 4DTRAD

- Trajectory Management will require significant evolution of air-ground exchanges and supporting systems
- An initial step in this evolution is identified as “initial 4D”
  - Operational Concept developed by EUROCONTROL
  - Joint RTCA/EUROCAE Group SC214 / WG78 “Data Link Application SESAR & NEXTGEN” initiated work on the description of initial 4D Trajectory DataLink (4DTRAD) service



Data Link Roadmap

Data Link Roadmap in relation with SESAR

As defined in EUROCONTROL “4DTRAD Concept of Operations”

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R&D activities related to Initial 4D

- Early R&D activities related to I4D jointly initiated by Airbus and Thales
  - Air-ground integrated validation platform developed (cockpit-ATC), supporting technical experimentation of air-ground exchanges
  - 4D Trajectory Downlink, use of CTA (Controlled Time of Arrival)
  - in the scope of EC FP6 Program Episode 3, coordinated by EUROCONTROL
- I4D refinement and validation activities to be continued and developed in SESAR R&D projects
  - With the objective of supporting standardization activities within SC214/WG78

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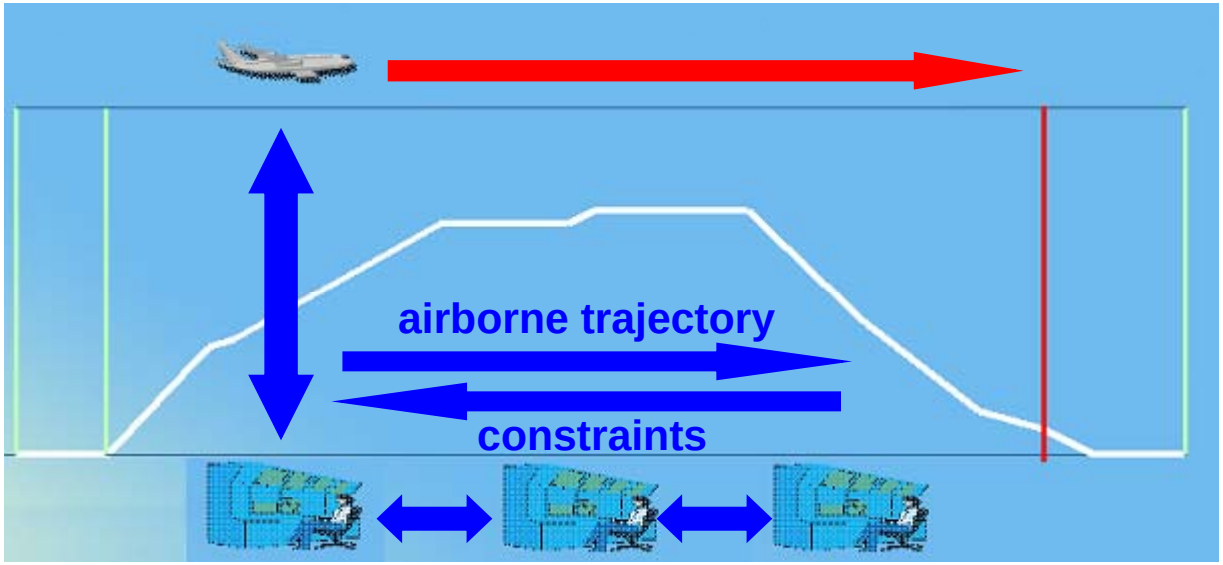
Trajectory Management – Ground-ground IOP

- In most cases, during the execution phase, aircraft will be controlled by several ATSU's
- Trajectory management needs relevant capability in terms of interoperability (IOP) between ground systems
  - Downlinked information available to downstream ATSU's
  - Downstream constraints to be uplinked to the aircraft



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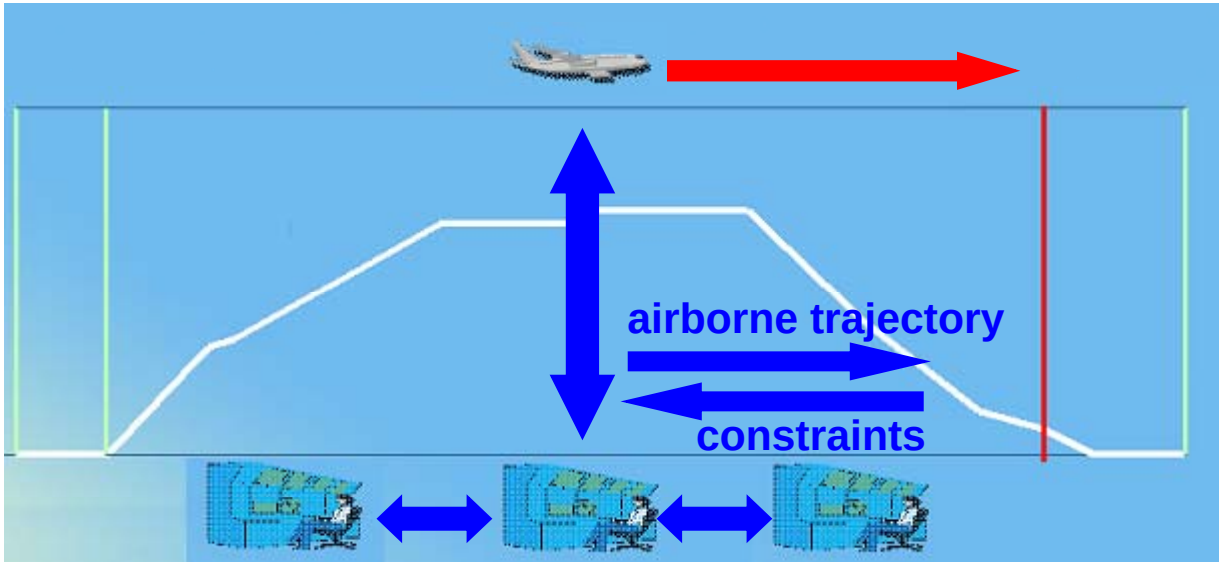

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Trajectory Management – Ground-ground IOP

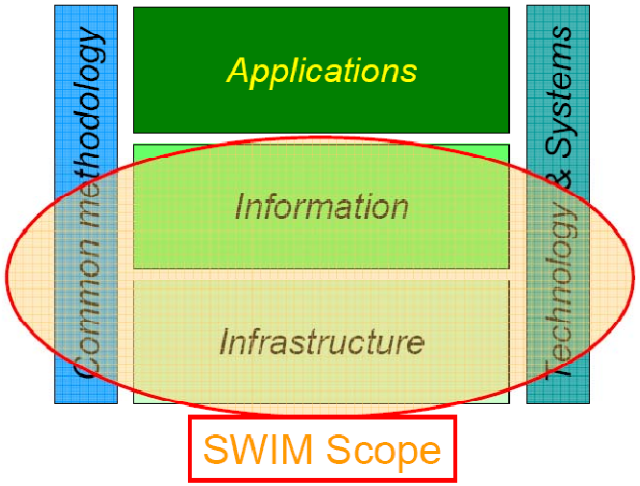
- Trajectory Management requires that ground systems exchange and negotiate 4D information so that consistent end-to-end trajectory view can be elaborated
  - In the scope of Initial 4D, this is limited to 3D trajectory and 3D+time constraints
- This level of interoperability is unlikely to be practically achieved with current data exchanges models and protocols
  - e.g. OLDI
    - EUROCONTROL specification for inter-centre coordination and transfer of flights)
  - Due to
    - data models in use (“route” vs “trajectory”)
    - underlying communication mechanisms and related performances
    - Intrinsic point to point principle

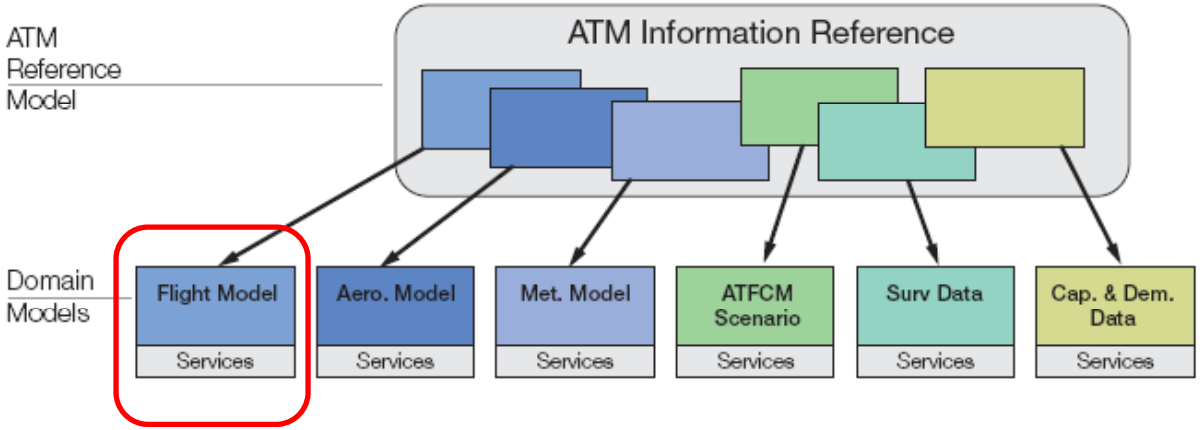
Trajectory Management & Flight Object

- Trajectory Management requires more advanced interoperability between ATC systems
- **Flight Object** is expected to provide this level of interoperability
  - Flight Object is to become the single reference concerning information about a flight, for all systems
    - ATC, Airport, ATFM, …
  - Flight Object specification results from number of initiatives and projects aiming at defining new ATC-ATC IOP model
    - FOIPS, ICOG, …
  - “Specification of Flight Object Interoperability”, EUROCAE document ED133 – Feb 09, produced by WG59

Flight Object in SWIM environment

- SWIM covers both information models and communication infrastructure
- Within SWIM, interoperable ATM information will be defined by a Reference Model
- Flight Object is to become the Flight Information model for SWIM





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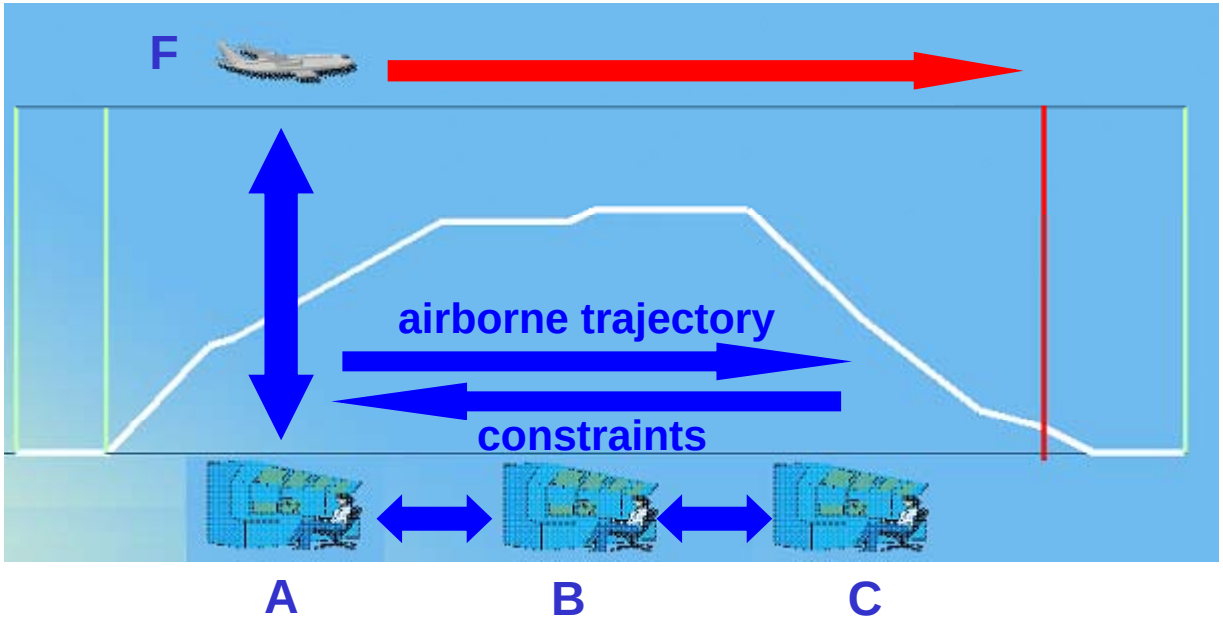
Flight Object Principles (1/2)

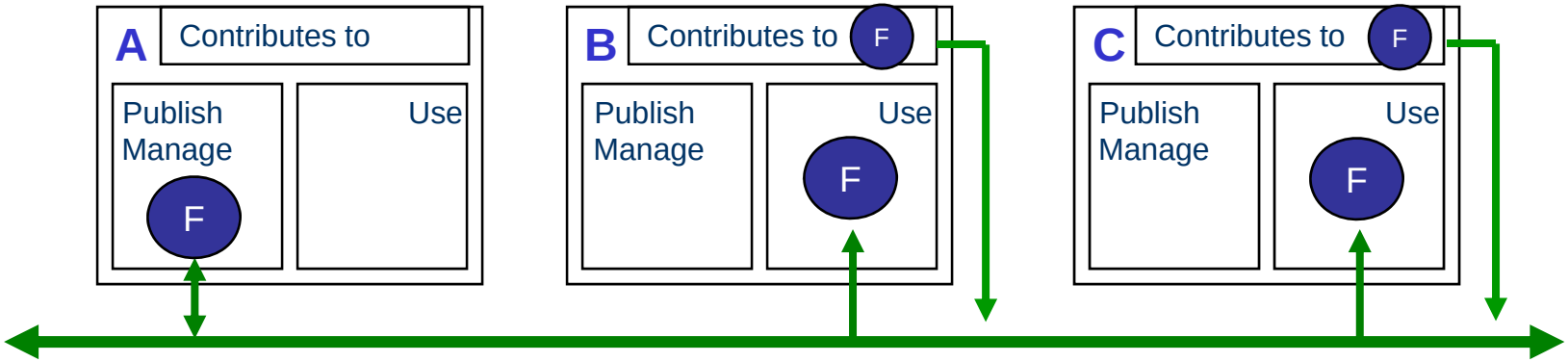
- A unique Flight Object
  - For each flight, at any one time, one system is responsible for the establishment of the related Flight Object
  - Each ATSU concerned by the flight contributes to common view
- IOP roles defined, implementing cooperation patterns
  - Publisher / Manager / User / Contributor
- Flight Object handover management
  - Dynamic allocation of Flight Object responsibility consistent with ATC handover
- Coordination of transfer conditions
  - Fully support coordination of transfer conditions between ATSU's

Flight Object Principles (2/2)

- Implement consistent trajectory management principles across ground systems (ATC-ATC IOP)
  - Flight Script - flight intent expressed in the vertical & horizontal planes with applicable constraints
    - both strategic and tactical & in all dimensions of the flight (route, level, speed, rate of climb/descent, time)
  - 4D trajectory - simulated execution of the script using also weather forecast and aircraft performance model
  - Trajectory management provides shared and consistent view of:
    - The flight script (consolidated with different contributions)
    - The corresponding 4D trajectory with the same accuracy over the IOP area (related to the predicted distance/level)
- Provides adequate ground support to Initial 4D
  - And further air-ground Trajectory Management

Flight Object – Support to Trajectory Management





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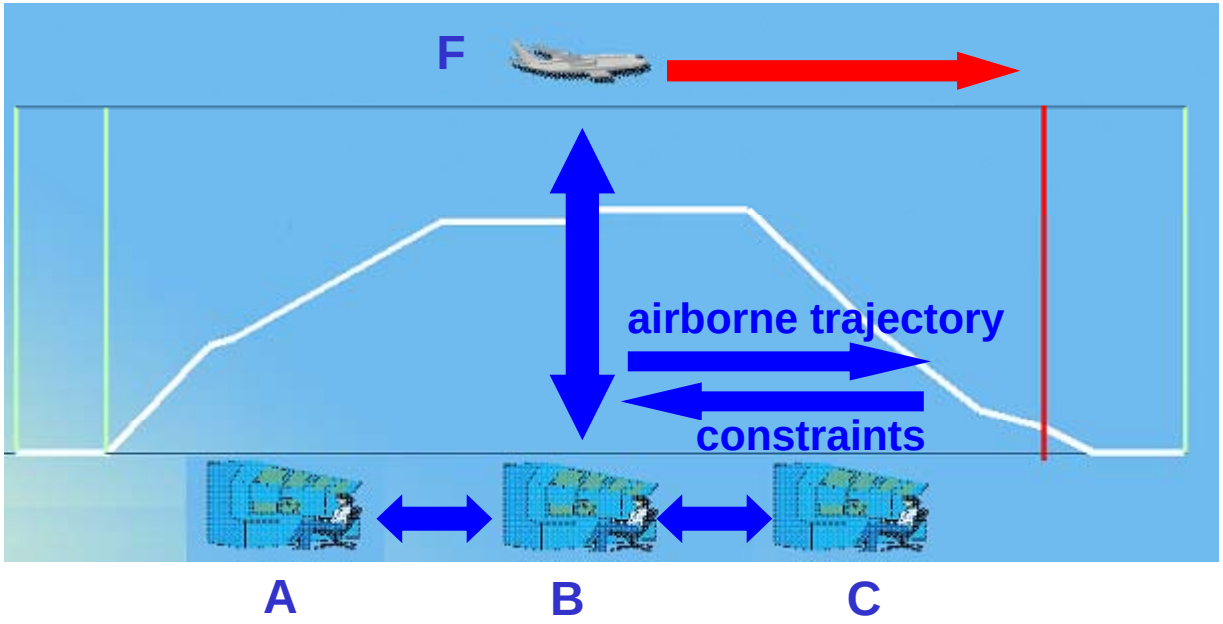
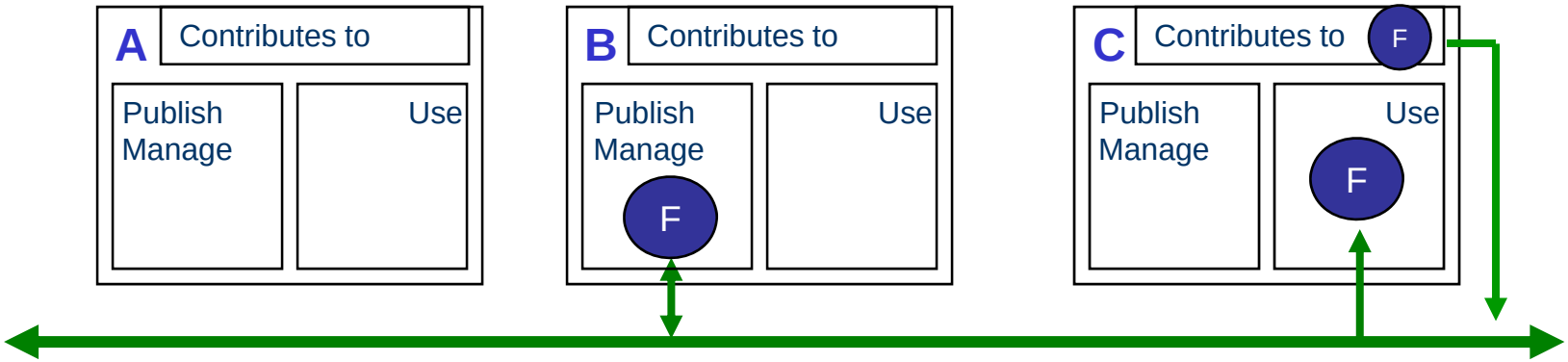
Flight Object – Support to Trajectory Management





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What's next…

- There is a strong need for **coordinated** development of air-ground and ground-ground interoperability, as required for efficiently supporting Trajectory Management
  - Need for validation activities addressing Trajectory Management in a multi-ATSU environment, supported by Flight Object interoperability (data model and information sharing mechanisms)
- Thales will take benefit of its leading role in R&D and standardization activities to foster related activities
  - Chairs EUROCAE WG59 and has active role in joint RTCA/EUROCAE SC214/WG78
  - Will lead R&D activities dedicated to technical implementation of Trajectory Management and SWIM in SESAR

Thank you for your attention

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