THE WAY AHEAD

Indra's Contributions to Automation and SWIM in the SESAR JU

indra

Mexico City, 21 April 2014

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02 I4D (4D-TRAD): Findings in MUAC

03 Current Discussions and Next Steps

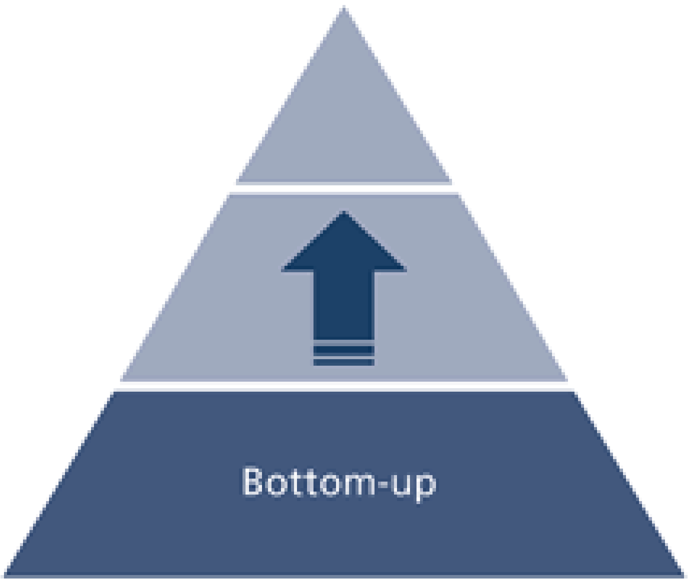
CURRENT SITUATION OF ATC INFRASTRUCTURE

- There are currently several **problems affecting ATC**:
  - ✓ Communications are point-to-point
  - ✓ Private and dedicated interfaces are deployed
  - ✓ Different visions of the same flight
  - ✓ Isolated planning is affecting a flight through its whole life time

CURRENT SITUATION OF ATC INFRASTRUCTURE

- So far, **different types of air traffic-related info have evolved differently**, based on sub-system and/or service-specific requirements.

- As a result of this **bottom-up approach**, today's ATM information systems are insufficiently integrated, resulting in organisational and institutional barriers which prevent timely use of relevant information.



CONSEQUENCES

- ATCOs have to deal with **additional tactical commands** which increase their workload and that of pilots.
- Flight routes are not optimal and holdings are necessary.
- Higher fuel consumption
- **Non-coordinated tactical actions** produce an **impact** in the network that is **not easily assessed**.

THE IOP-G CONCEPT

- The main objective of the **I**nter**OP**erability **G**round (**IOP-G**) concept is to allow a set of heterogeneous systems to maintain a consistent view of the flight data, and to allow them to coordinate changes to that flight data even between systems that are not yet operationally responsible for the flight.

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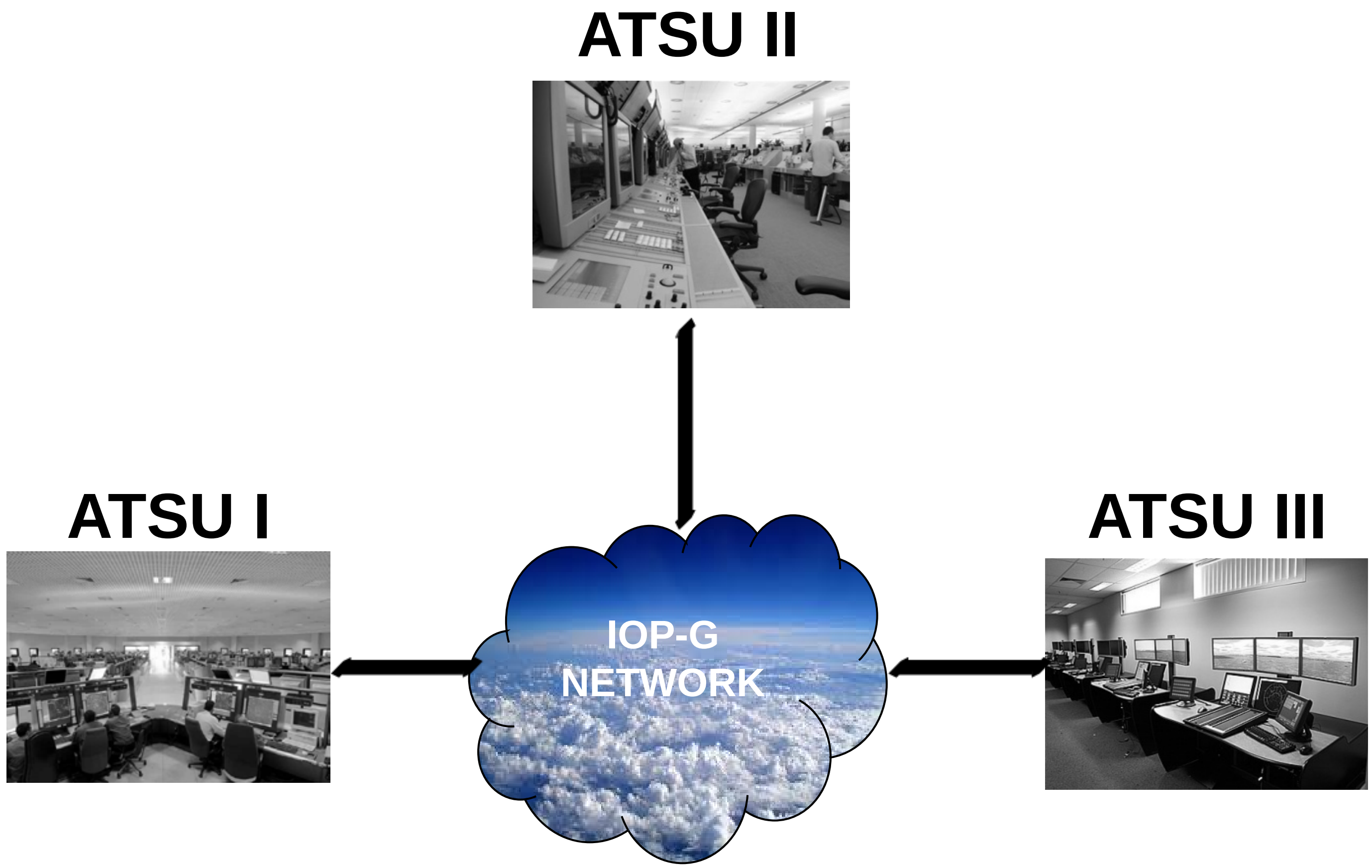
THE IOP-G CONCEPT



THE IOP-G CONCEPT

- In a few words, **IOP-G** can be summarized as a means to:

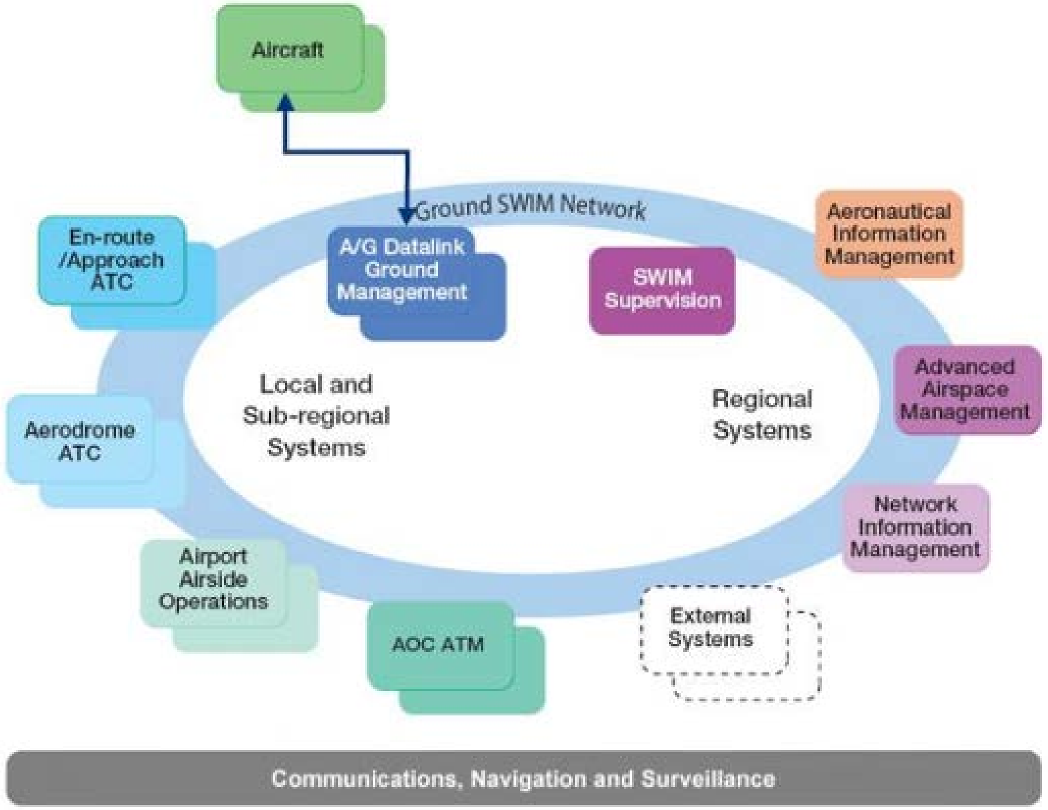
  ✓ Have a **common view** of a flight across the set of heterogeneous systems which will be interested in the flight during its lifetime.

  ✓ Have a **technical means** to support a collaborative approach for building the shared flight vision. That is, system actions over a flight are instantly distributed and even agreed among different systems.

- However, IOP-G will not be possible without an **infrastructure.**

SWIM AS AN ENABLER OF THE IOP-G CONCEPT

- The **System Wide Information Management** (**SWIM**) concept enables **IOP-G**.



THE SWIM CONCEPT

- **SWIM** is an informational infrastructure which will connect all ATM stakeholders and customers facilities.
- The aim of this new SWIM infrastructure is to allow **seamless information interchange for improved decision-making** and the capability of finding the most appropriate source of information while catering for the information security requirements.
- Through SWIM all air traffic partners will contemporaneously have **the same and for their own business needs the appropriate and relevant operational picture**.

SESAR PROJECT 10.2.5

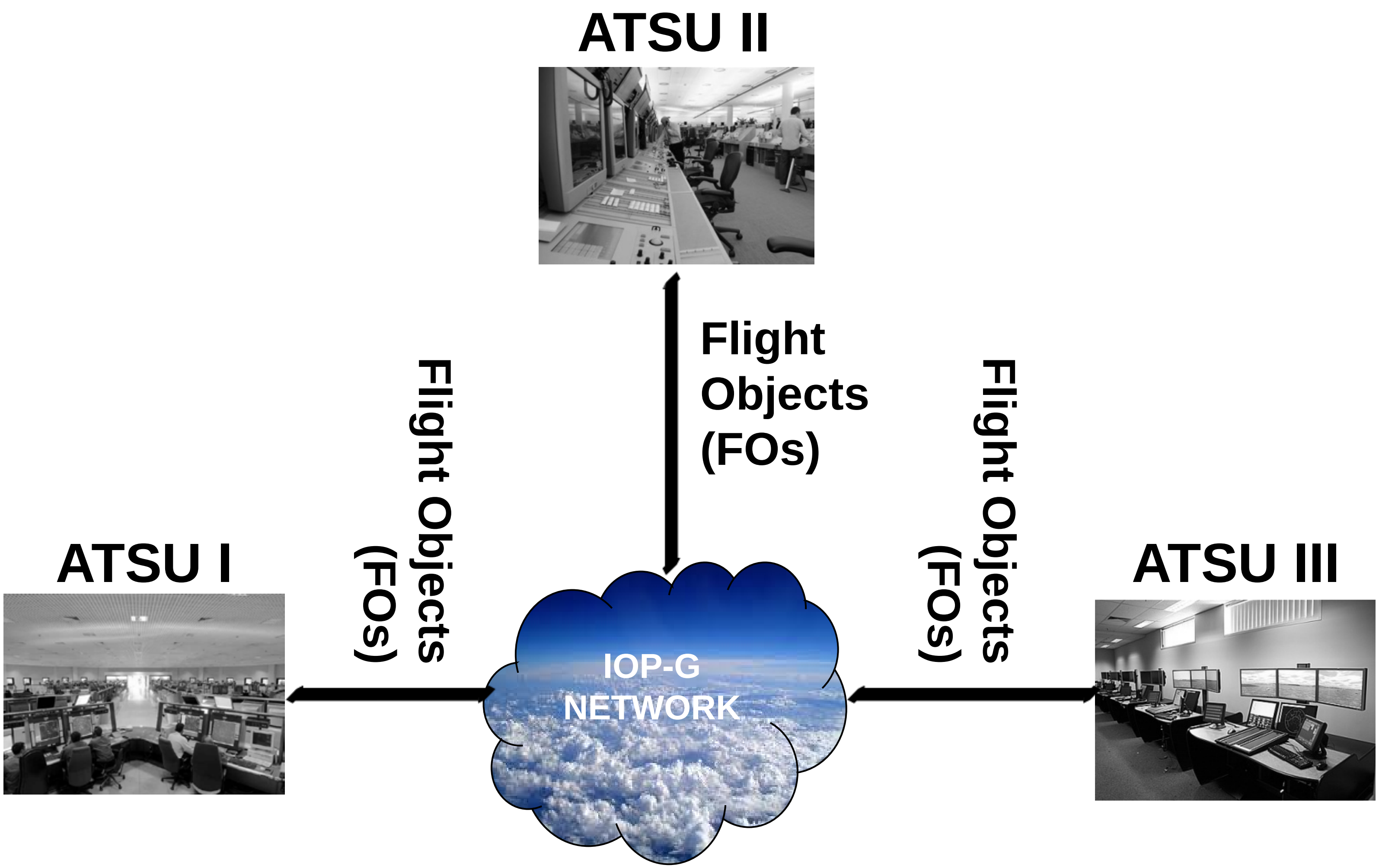
- Official name: **10.02.05 Flight Object IOP System Requirement & Validation**.

- Led by Indra

- One of its main final goals is to establish the mechanism that allows to share flight information and have a trajectory that is **shared and handled in a seamless way by all the interoperable ATSUs and collaboratively built by them**.

- The **Flight Object (FO)**!

THE FLIGHT OBJECT (FO) WITHIN THE IOP-G NETWORK

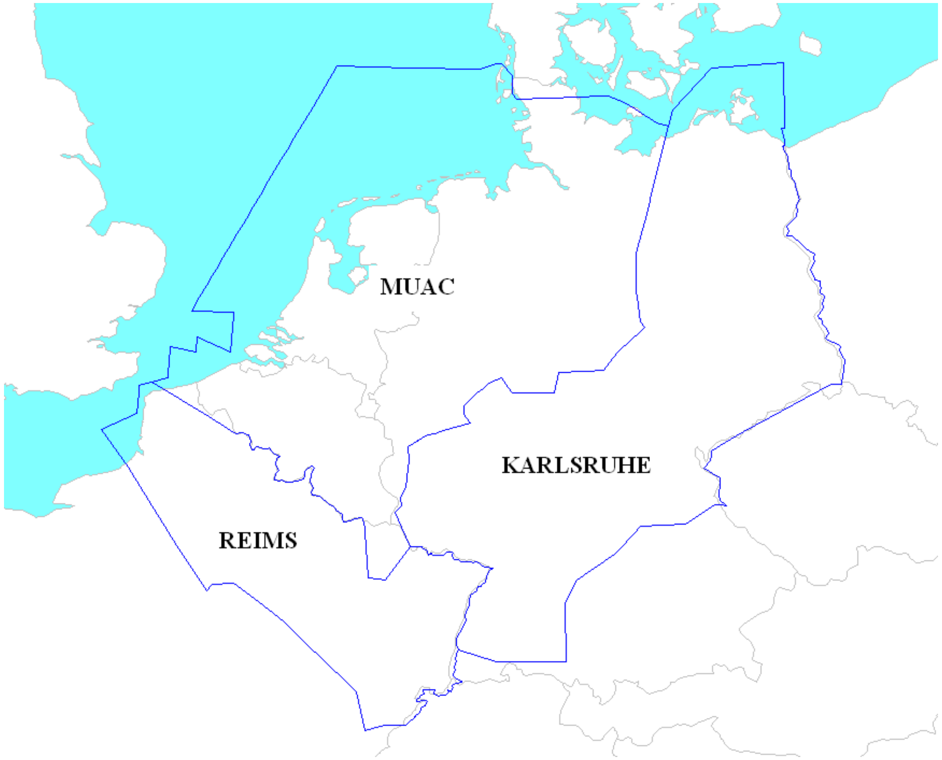


HOW THE FLIGHT OBJECT (FO) WAS DEVELOPED

- The Flight Object was defined as a mean to share consistent **detailed** flight data information between different stakeholders.
- A group of six ANSPs and three industrial partners worked together in order to develop an ATC-ATC IOP concept based on the FO. **Eurocae ED-133 was developed**.
- The features described in ED-133 will be implemented and validated system-wide in steps. Step 1 dealt with the new features providing backwards compatibility with the systems currently in place.

OUR TEST BENCH

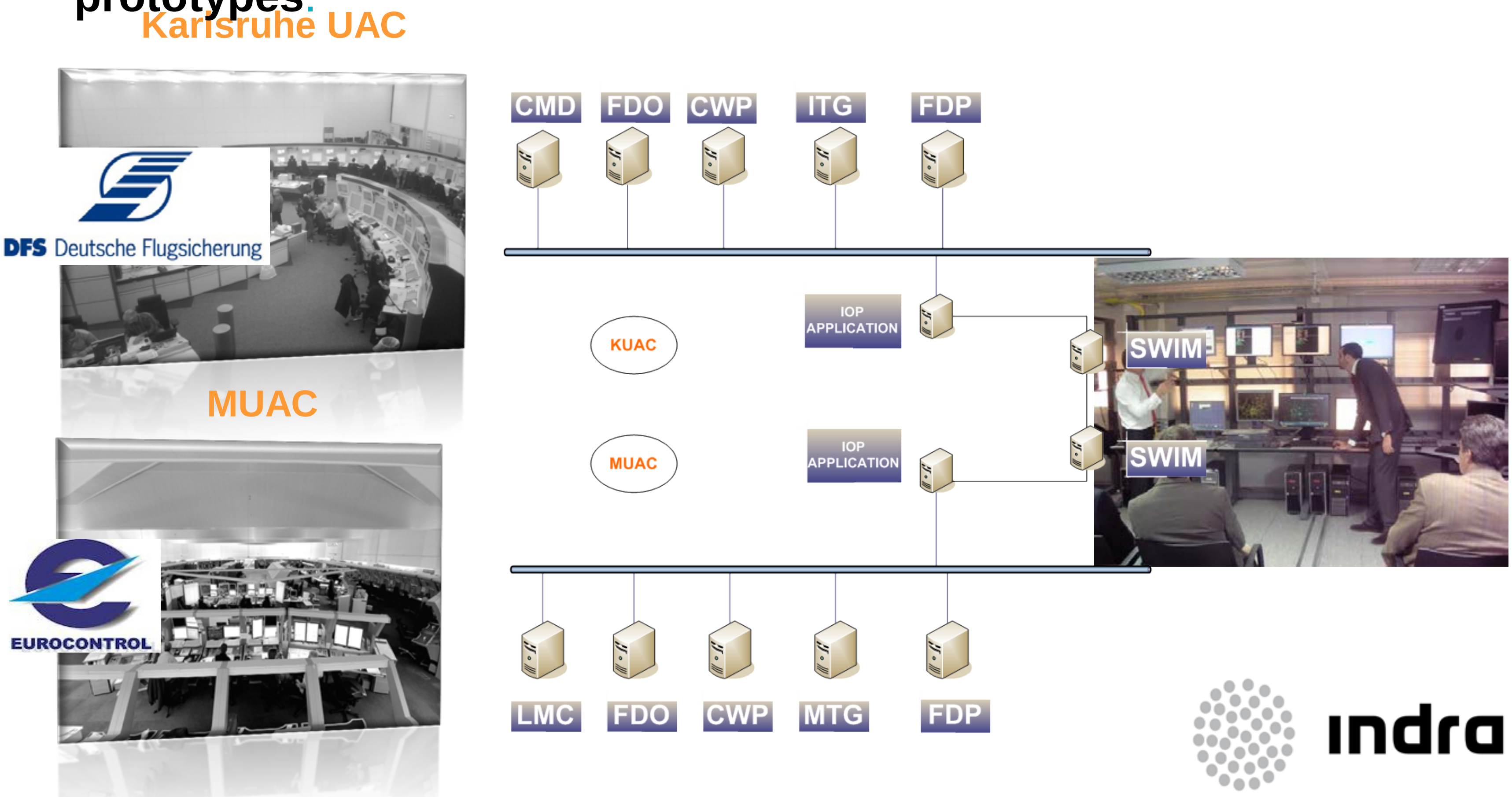
The validation triangle



- Maastrich Upper Area Control Center (MUAC) – Indra's FDPS-based system
- Reims Area Control Center - COFLIGHT-based system (Thales)
- Karlsruhe Upper Area Control Center - iTEC-based system (Indra)

THE FIRST IOP-G DEMO

- The first demo of the IOP-G concept (exchange of Flight Objects through a FOS) was carried out between MUAC and Karlsruhe in November 2011. It served as validation for our initial **ATC-ATC IOP and SWIM prototypes**.

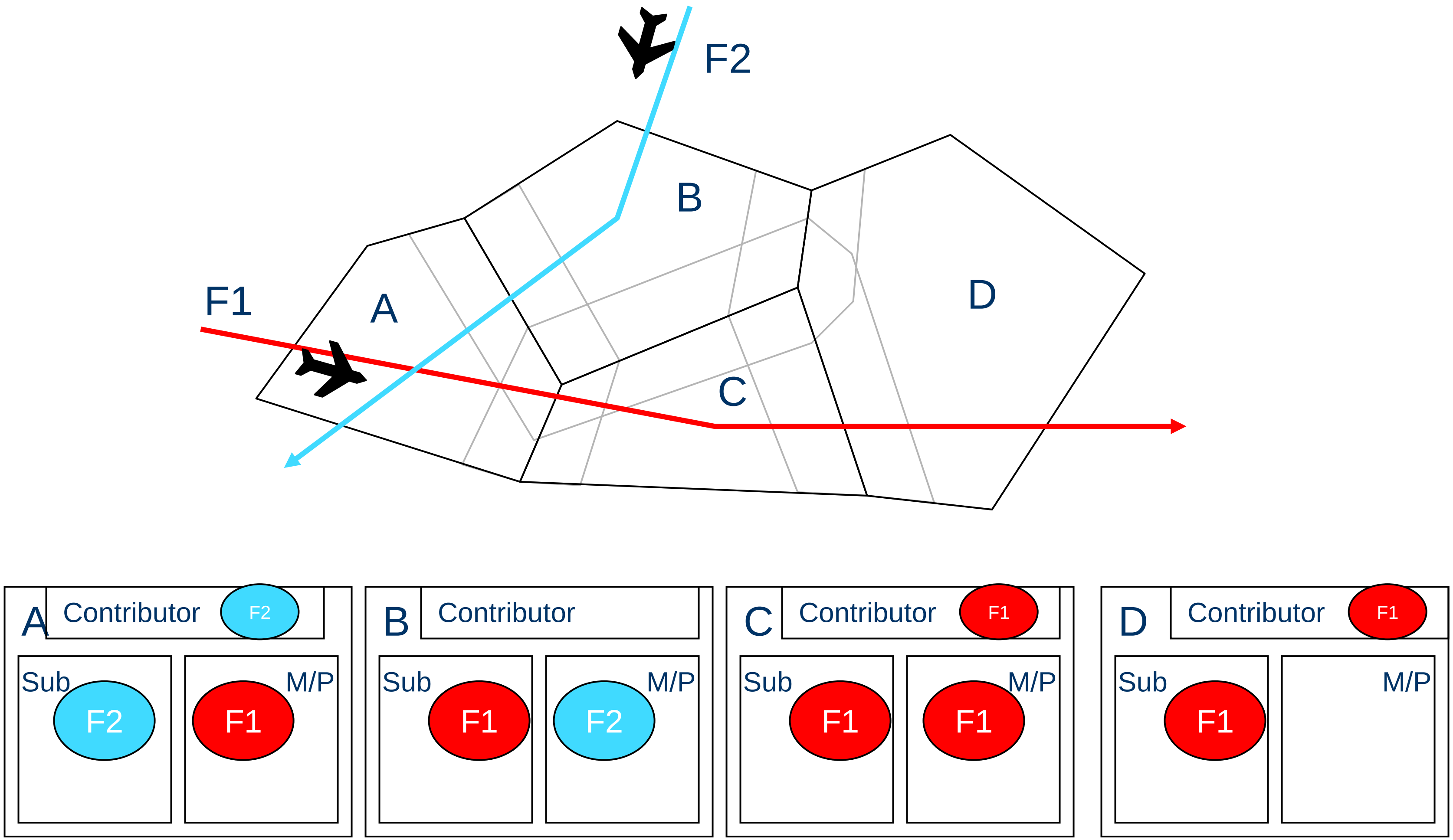


HOW THE WHOLE THING WORKS

- Every ATSU acts within its **Area of Responsibility** (AoR) but 'is interested' in a larger area, its **Area of Interest** (AoI).

- Every ATSU can thus act in **one of three different roles** with respect to a flight at a particular time:
  - ✓ A unique ATSU behaves as **Manager/Publisher** of the FO. This role is transferred between consecutive ATSUs as the flight progresses.
  - ✓ A set of systems behave as **Contributors**. They receive FO updates and are allowed to request changes to it by interacting with the Manager ATSU.
  - ✓ A set of systems behave as **Users**. They receive FO updates for internal purposes but are not allowed to request changes to it.

HOW THE WHOLE THING WORKS: THE IOP-G CONCEPT



MAIN GOALS

- **Improvement of safety.** By a resilient provision of consistent information across the system.
- **Seamlessness.** Users should have the same view of the FO and its associated environment regardless of which system is responsible for the flight and any changes in that responsibility.
- **Robustness.** Firstly, each FDPS must be able to operate independently. Furthermore, in the event of an FDPS failure, the other FDPSs on the network must take over the management of the FOs previously managed by the failed system, and once the failed system is available again, the other FDPSs must support a fast recovery of the flight data to that system.

OUR GOALS FOR 2014 IN IOP-G

- This year's validations, with regard to IOP-G, will allow Indra to:
  - ✓ Keep on showing the feasibility of the IOP-G concept, and demonstrating that it does not imply an operational regression for current procedures.
  - ✓ Set up the basis and technical means for the future RBT collaborative processes to come.
  - ✓ Demonstrate that current systems in operation can be upgraded to support the concept.
  - ✓ Exploit the benefits of this early phase of the IOP concept.

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03 Current Discussions and Next Steps

INDRA WITHIN I4D (4D-TRAD)

- Indra has been involved in the **current operational CPDLC baseline system in MUAC** since its deployment in 2003 and in all its trials since 1997.
- Indra is actively participating in the **definition of the 4D-TRAD Concept of Operations**, which will become the baseline for i4D SESAR ATM Master Plan.
- Indra is also actively involved in **EUROCAE WG78 / WG85**, in charge of the definitions of the new standards for Datalink and 4D Navigation.

INDRA WITHIN I4D (4D-TRAD)

- Indra has been **working with AIRBUS since early 2010 to define the air-ground interface to be used in SESAR**.

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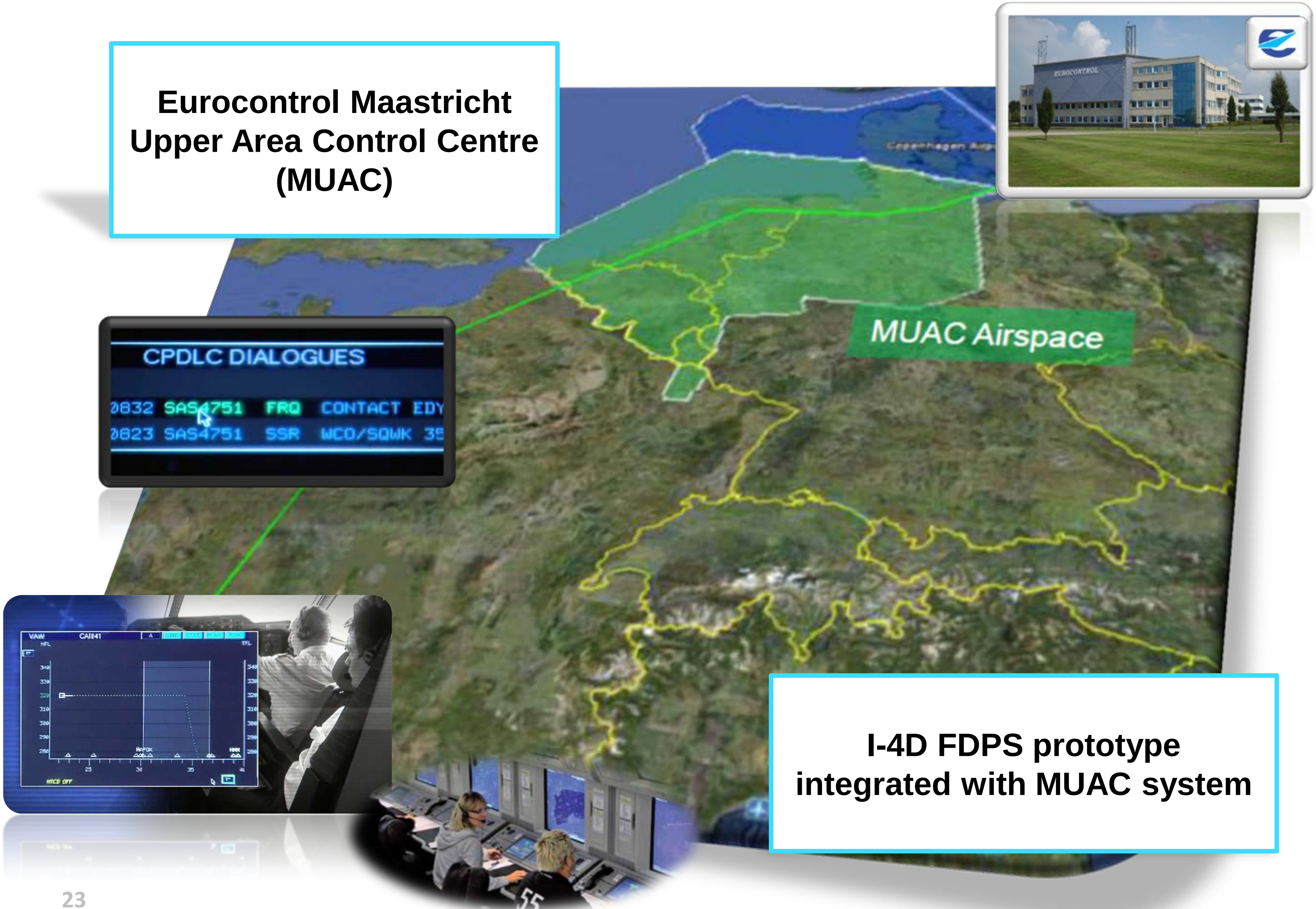
OUR TEST BENCH FOR I4D



INDRA'S ENHANCEMENTS TO MUAC FDPS TO ACHIEVE I4D REQUIREMENTS

- Indra, as a ATM Ground System supplier, has an **FDPS Trajectory Based System with Air Ground Data-Link (AGDL) capabilities already implemented and in operation** at Maastricht Upper Area Control (MUAC) center.

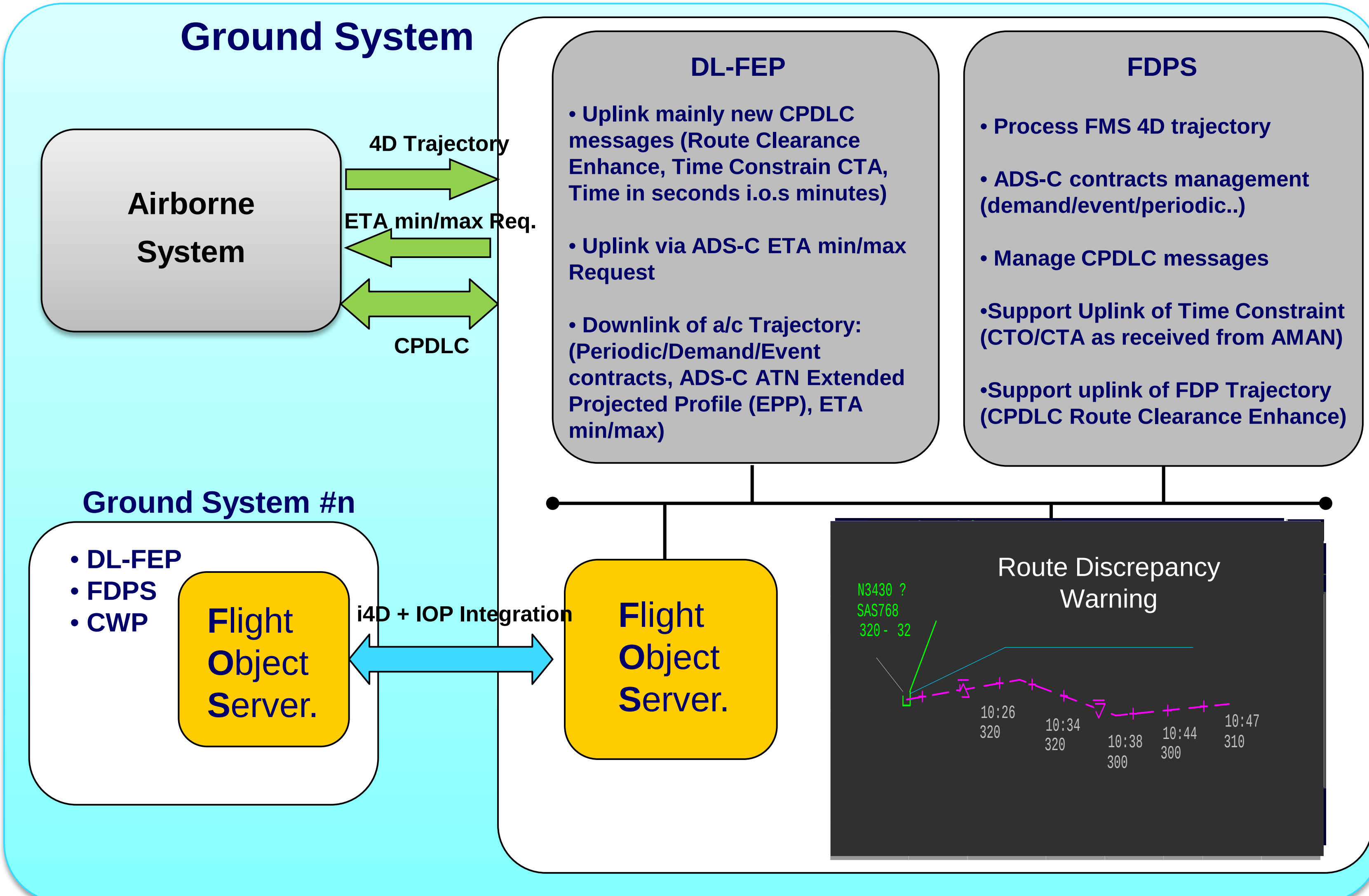
INDRA'S ENHANCEMENTS TO MUAC FDPS TO ACHIEVE I4D REQUIREMENTS

- Indra contributes to the I-4D MUAC IBP by providing an enhanced FDPS SW to support the new I-4D + CTA operational concept in its two aspects:
  - **SESAR Core Functions.** Production of the new ADS-C engine and updating the current CPDLC application and its associated services to comply with EUROCAE WG78/SC214 Advance ATS Data-link applications over ATN.
  - **MUAC-Specific Functions.** Adaptation of current FDPS interfaces with the Data Link Communication Front-End (DL-FEP) and with the CWP to support the new I-4D functionality.

INDRA’S ENHANCEMENTS TO MUAC FDPS TO ACHIEVE I4D REQUIREMENTS

- Specifically, Indra’s enhancements to MUAC FDPS allow to:
  - Process the 4D Trajectory from the FMS
  - Manage ADS-C Contracts (demand / event / periodic)
  - Manage the new I-4D CPDLC v2 messages.
  - Request ETA min/max via ADS-C
  - Support uplink of Time Constraints (CTO / CTA as received from TMS or AMAN)
  - Support uplink of FDP Trajectory (CPDLC Route Clearance Enhance)
  - Support ground-ground co-ordination for the forwarding of log-on parameters.

INDRA'S ENHANCEMENTS TO MUAC FDPS TO ACHIEVE I4D REQUIREMENTS

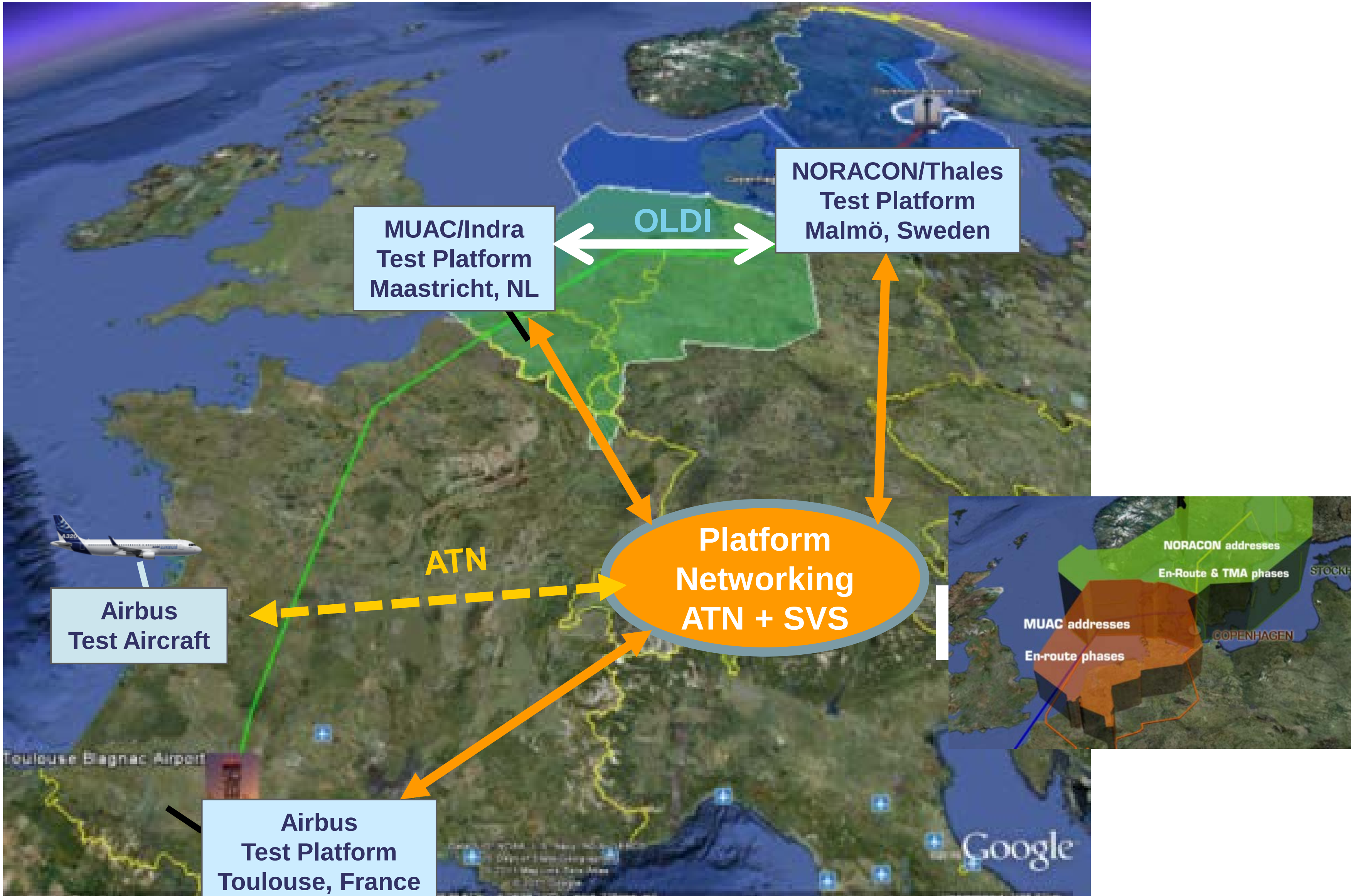


VALIDATIONS UNTIL MARCH 2014

- MUAC i4D validations from 2011 up till mid 2014
  - ✓ 3 Steps evolving functionality and complexity;
  - ✓ 35 days of Real Time Simulations with 6 controllers each day;
  - ✓ 2 Flight Trials with AIRBUS' test aircraft and handover to NORACON.
- Live traffic recordings adapted to be representative of future operations:
  - ✓ Up to 80% CPDLC equipped;
  - ✓ Free Route Airspace Maastricht routes;
  - ✓ When needed constraints applied on IAF;
  - ✓ Several levels of i4D equipage rising to 80%.
  - ✓ TMA CTAs provided electronically via OLDI AMA.

THE WAY AHEAD

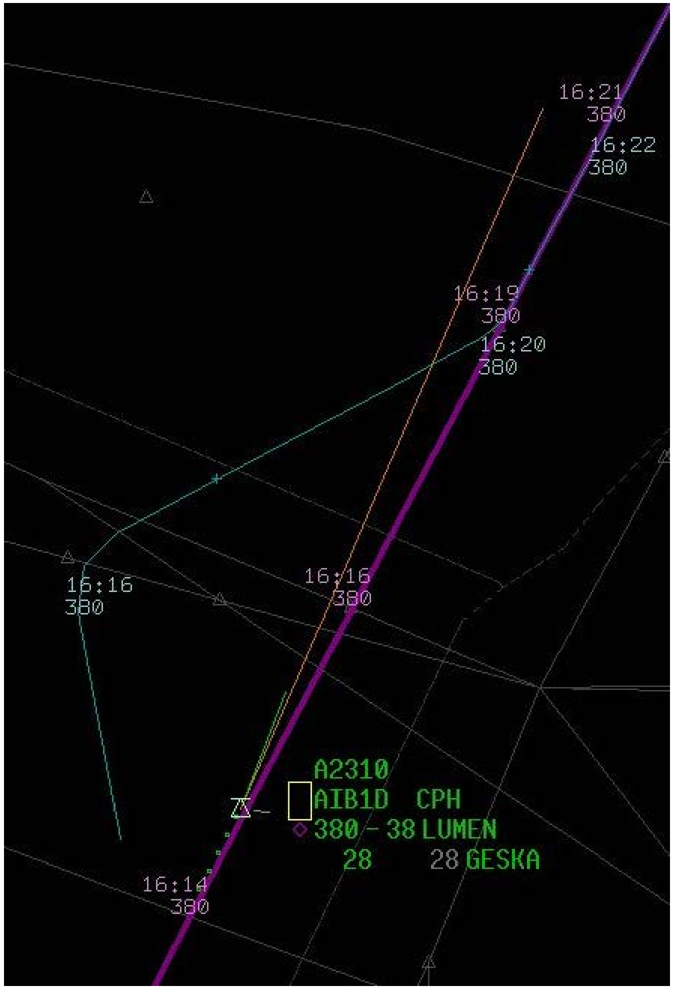
INDRA + THALES + AIRBUS TEST BENCH FOR I4D



KEY FINDINGS IN MUAC

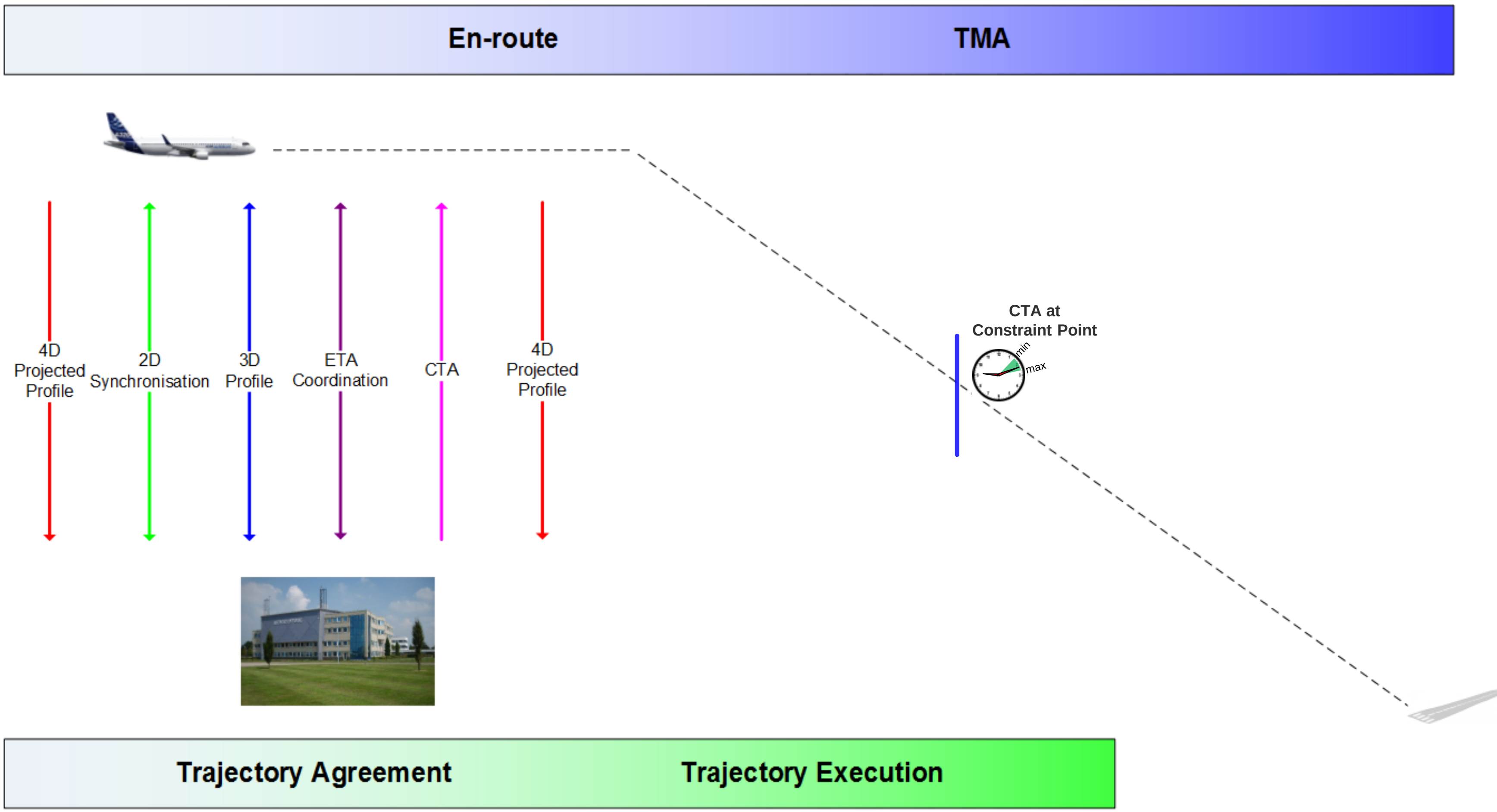
- EPP data beneficial
  - ✓ Large safety gains when indicating possible discrepancy between airborne trajectory prediction (FMS) and ground-based Flight Plan (FPL).
- The use of time constraints resulted in:
  - ✓ Local en-route workload increase -- impact reduced with increased number of equipped flights.
  - ✓ Increase in the use of vertical separation because of uncertainty in longitudinal separation -- changes to LoAs to allow handovers at multiple flight levels.
- Overall network and flight efficiency expected to be improved when using i4D.

KEY FINDINGS IN MUAC



- Confidence in use of RTA increased during validations due to familiarity.
- HMI is important/essential to enable quick and simple interaction with CPDLC and ADS-C.
- Mixed equipment increases complexity.
- Five i4D airports were emulated, which did not appear to add complexity.

OVERVIEW OF THE I4D CONCEPT



BENEFITS OF THE I4D APPROACH

- Sharing and synchronising of air and ground trajectories
  - ✓ Improved predictability
  - ✓ Better consistency of Air and Ground Trajectories
  - ✓ Enhanced automation between air and ground
  - ✓ Enhanced Conflict Detection and Resolution

- Time constraints
  - ✓ More strategic management of arrival flows, less tactical interventions
  - ✓ Improved flight efficiency through optimised speed and descent profiles

- i4D uses existing Datalink technology **just adding a few ADS-C and CPDLC messages**.

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PUTTING IT ALL TOGETHER – CURRENT DISCUSSIONS

- ✓ Aircraft downloads EPP
- ✓ Flight Object contains EPP data without processing
- ✓ Flight Object is distributed to the downstream

PUTTING IT ALL TOGETHER – CURRENT DISCUSSIONS

- ✓ Aircraft downloads EPP
- ✓ EPP data is processed by Trajectory Predictor (TP)
- ✓ Flight Object contains TP-enhanced EPP
- ✓ Flight Object is distributed to the downstream

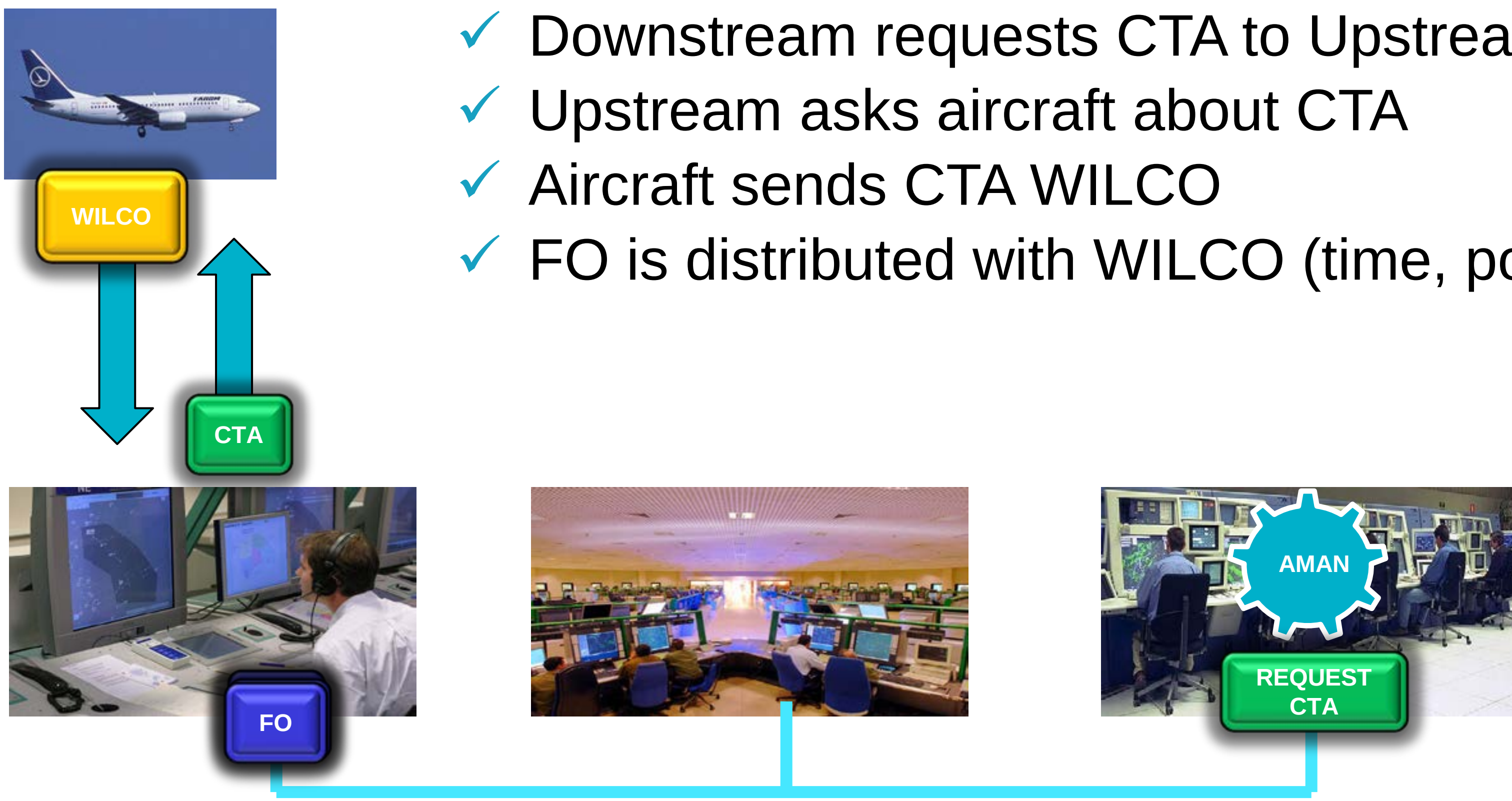
PUTTING IT ALL TOGETHER – CURRENT DISCUSSIONS

- ✓ Aircraft downloads EPP
- ✓ EPP data is processed by TP
- ✓ Flight Object contains TP-enhanced EPP
- ✓ Flight Object contents EPP data
- ✓ Flight Object is distributed to the downstream

PUTTING IT ALL TOGETHER – CURRENT DISCUSSIONS

CTA Distribution

- ✓ Downstream (AMAN) calculates a CTA
- ✓ Downstream requests CTA to Upstream
- ✓ Upstream asks aircraft about CTA
- ✓ Aircraft sends CTA WILCO
- ✓ FO is distributed with WILCO (time, point)



NEXT STEPS IN 2014-15

- Joint exercise with TMAs:
  - ✓ To enable an overall benefit assessment;
  - ✓ To assess the concept using ground-ground interoperability via SWIM (Flight Object) and an AMAN system;
  - ✓ LVNL will start participating in trials in 2015.
- i4D will be part of the SESAR-2 Very Large scale Demonstrations (VLD).
- Refinement of ground tools (HMI and other things)
- Use EPP data to further refine existing ground tools:
  - ✓ Trajectory Prediction (TP);
  - ✓ Medium Term Conflict Detection (MTCD);
  - ✓ Ground calculated Vertical Profile and Sector Sequences;
  - ✓ Feeding Flow and Complexity Management.
  - ✓ (There's also an EPP Task Force for this.)

Thank you!

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THE WAY AHEAD

A 7-MINUTE MOVIE

- Selected portions of a simulated flight cruising through Maastricht UAC then descending to CPH
- Recorded during rehearsal sessions to prepare the i4D flight trial planned on 19th March
- Illustrates:
  - Exchange of 4D trajectory
  - Use of CTA to sequence arrival traffic
- 3 screens each showing a particular angle of i4D operations: