

ATN Baseline 2 and 4D Developments

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ATN B2

SOME TECHNICAL INFORMATION

ATN B2: CPDLC and ADS-C



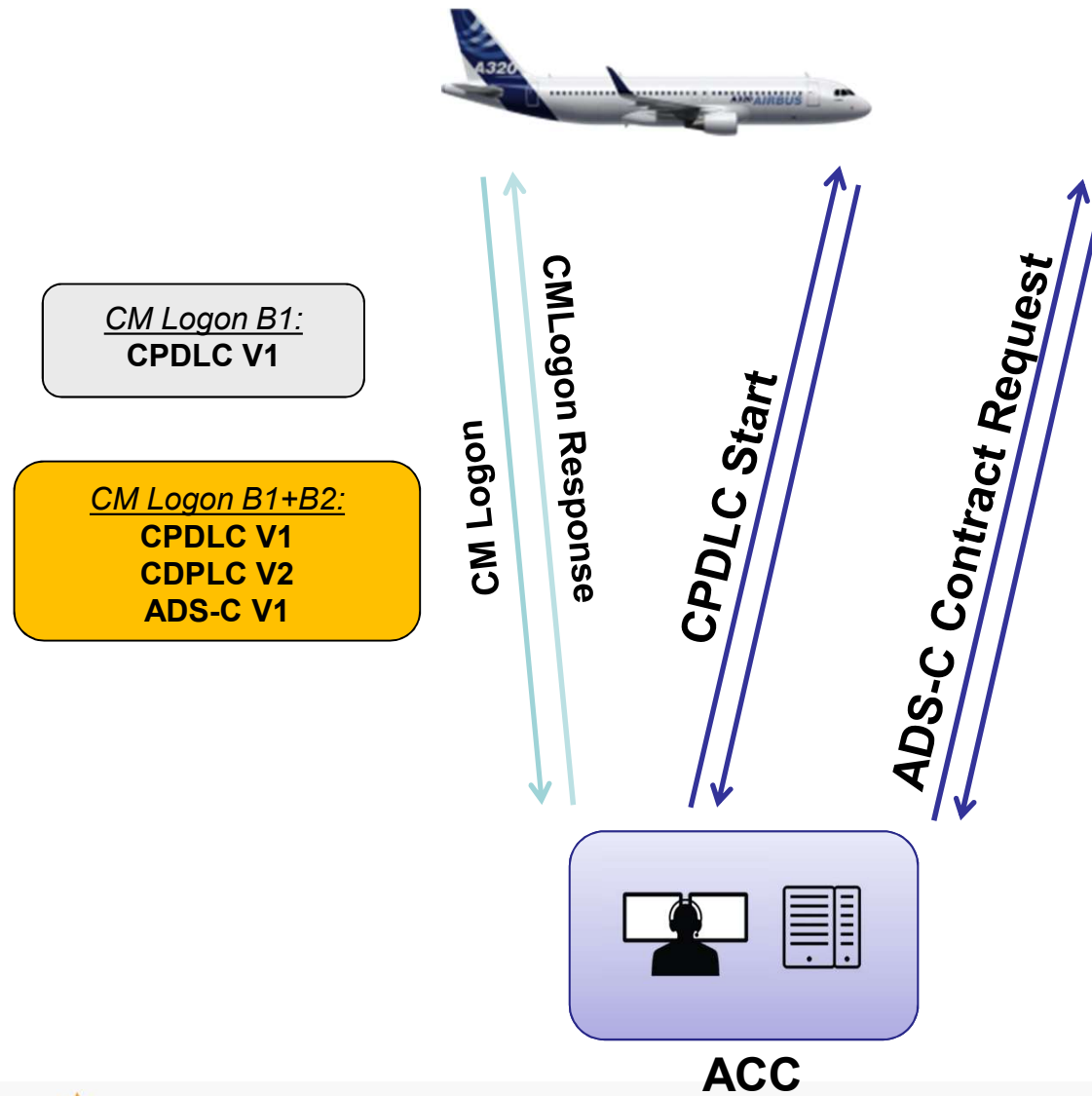
ATN Baseline 2 – Rev A (March 2016)

- Defined in EUROCAE,
 - ED229A: Interop requirements
 - ED228A: Safety and Performance Requirements
 - ED230A: Interop requirements FANS 1/A – ATN B2
 - ED231A: Interop requirements ATN B1 – ATN B2
- Updates of following ATN applications to support the services
 - Context Management (CM) – none.
 - Controller-Pilot Data Link Communication **V2** (CPDLC): new messages defined.
 - **Automatic Dependent Surveillance – Contract (ADS-C) V1.**
- Relies on the same ATN stack

ATN Baseline 2 : CM Logon for B2 A/C



2019



ATN B2: CPDLC and ADS-C



ATN Baseline 2 [some impact on En-Route services]:

■ **CPDLC V2**

- Enhancement of ACM, AMC, ACL (becomes CRD and IER)
 - extension of the CPDLC message sets
 - Support new 4DTRAD
 - Accuracy of time in seconds
 - Improvement in the Clearance management
- Backwards-compatible with CPDLC V1,
- Technically no major modification,
- Change in CPDLC Start request

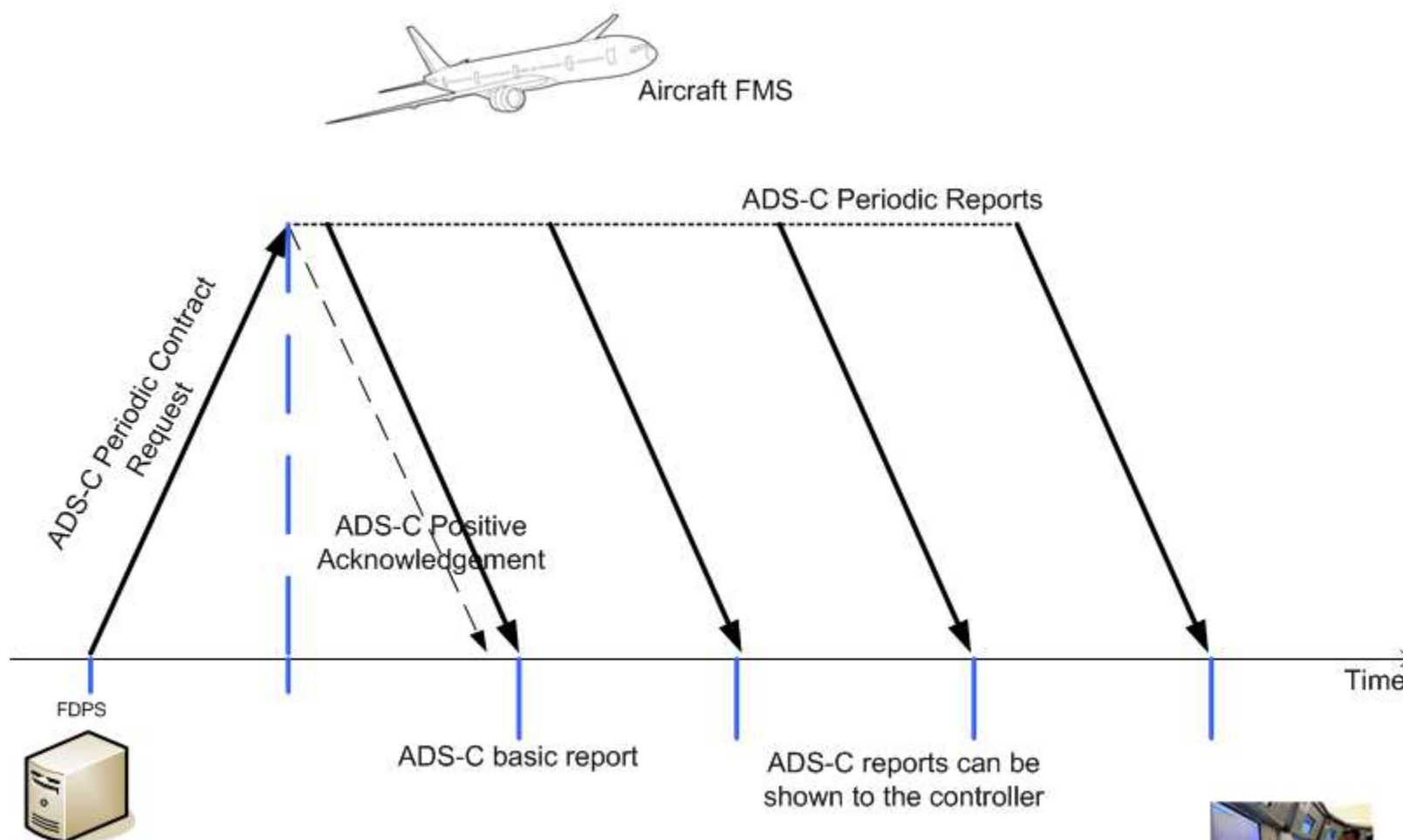
ATN B2: CPDLC and ADS-C



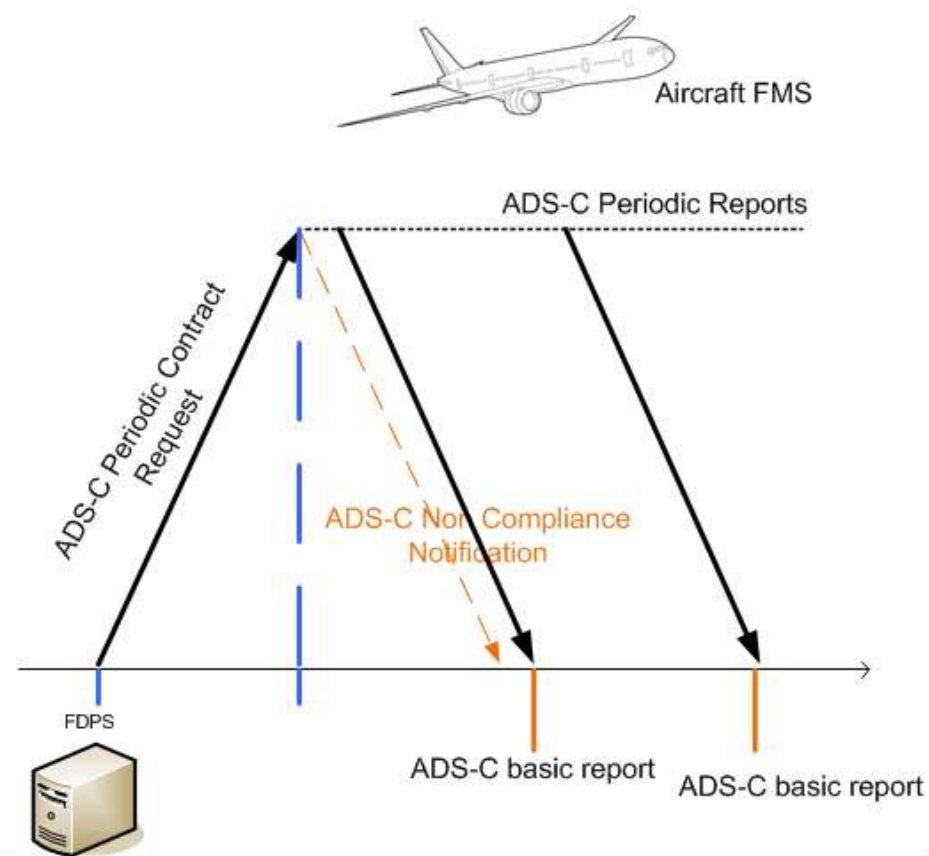
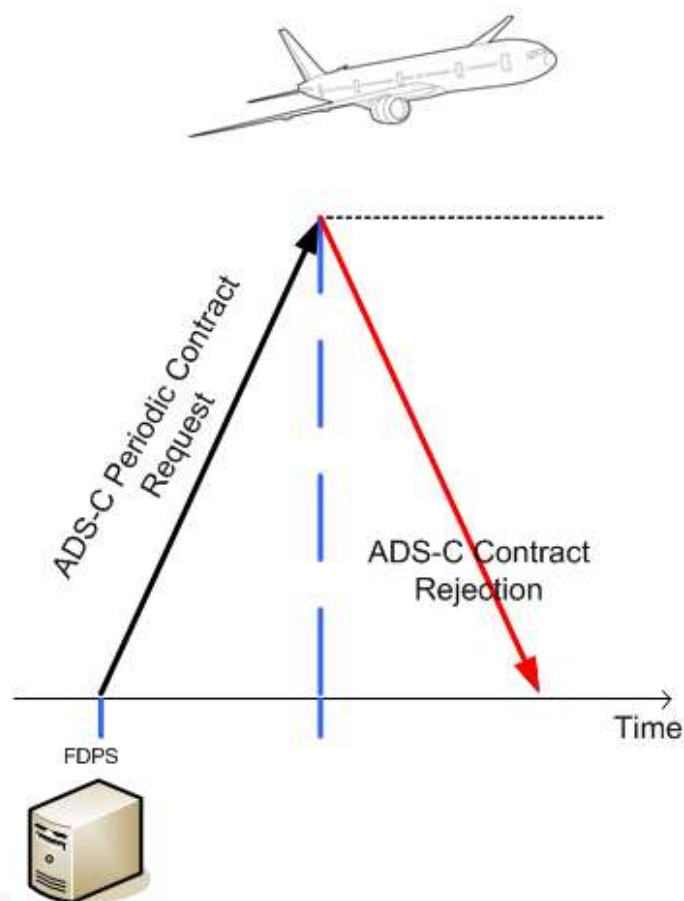
ATN Baseline 2 : ADS-C V1

- 3 types of contracts established by a ground system
 - ADS-C **Demand** contracts: one-time report
 - ADS-C **Periodic** contracts: regular reports
 - ADS-C **Event** contract: reports sent when going above thresholds
- Content-wise:
 - Reporting rates [Periodic] or thresholds [Event]
 - Blocks of data can be requested by the ground system, e.g.
 - Estimated Time of Arrival over one point
 - Extended Project Profile: 4D-route from the FMS.
 - Gross Mass
 - Number of Way Points / time interval for a 4D-route
 - Etc.
 - Up to 4 ADS-C connections at one any time

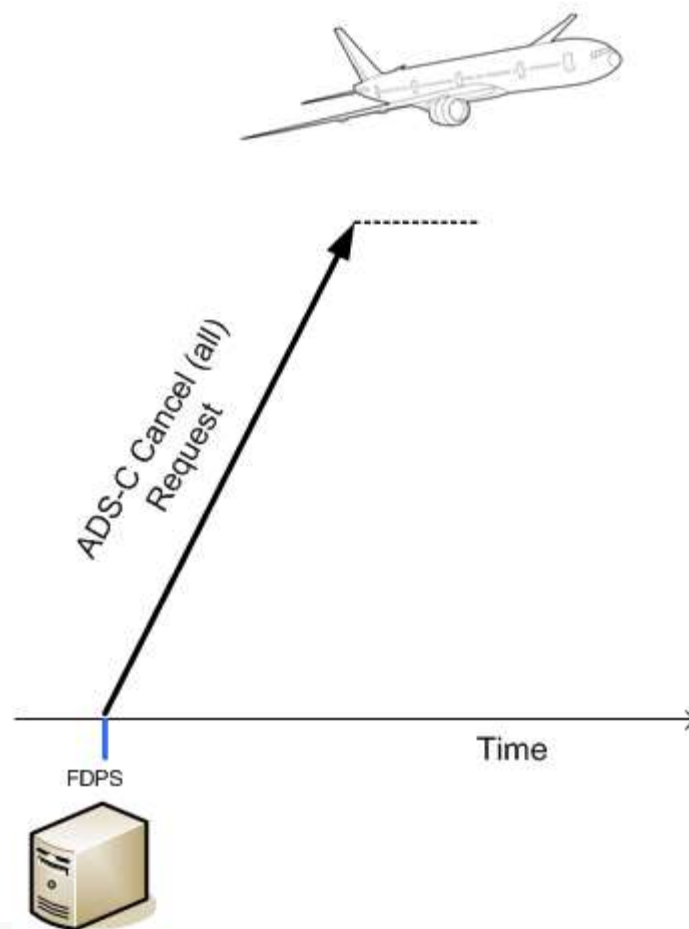
ADS-C: from FDPS to FMS



ADS-C: Unsupported request / Partial support



ADS-C Contract cancellation



AIRBUS equipment



DIGITS-AU Avionics Upgrade



9

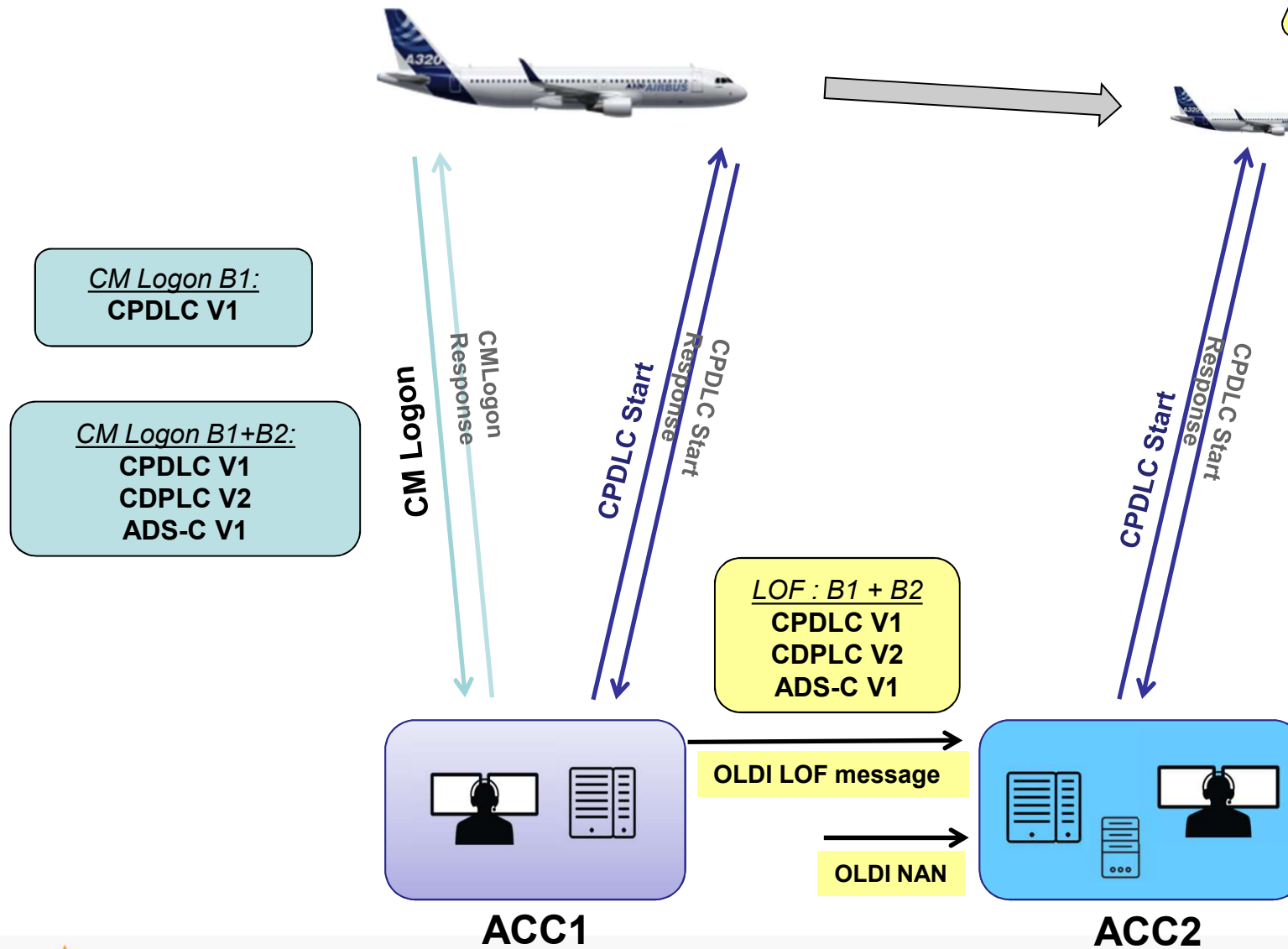
DIGITS PJ31 WORKSHOP, 14 DEC 2017

AIRBUS

ATN Baseline 2 : CM Logon for B2 A/C



2019



ATN Baseline 2: Challenges

- How should ACC1 react?

CM Logon B1+B2:
CPDLC V1
CDPLC V2
ADS-C V1



CM Logon Response:
CPDLC V1



CM Logon Response:
CPDLC V2
ADS-C V1

- Content of the LOF message



LOF : B1 + B2
CPDLC V1
CDPLC V2
ADS-C V1

The LOF for ATN B1 + B2 is not supported by OLDI V4.2.

ATN Baseline 2: current observations

- All ACC1 should react on receipt of CM Logon ATN B1 + B2?

CM Logon B1+B2:
CPDLC V1
CDPLC V2
ADS-C V1



CM Logon Response:
CPDLC V1

- Content of the LOF message (as observed today).



LOF
CPDLC V1
ADS-C V1

- Requirements for all Ground systems (datalink ATN B1) on receipt of the CM Logon ATN B1 + B2:



CM Logon Response:
CPDLC V1



LOF
CPDLC V1

ATN Baseline 2: current observations

- All ACC1 should receive receipt of the CM Logon ATN B1 + B2?

CM Logon B1+B2:
CPDLC V1
CDPLC V2
ADS-C V1

→

CM Logon Response:
CPDLC V1

→

LOF
CPDLC V1
ADS-C V1
- Content of the LOF message (as observed today).

→

CM Logon Response:
CPDLC V1

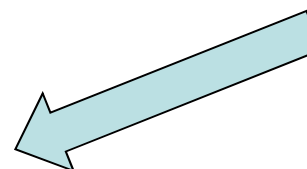
→

LOF
CPDLC V1
- Requirements for all Ground systems (datalink ATN B1) on receipt of the CM Logon ATN

Proposed NEW LOF MESSAGE supporting ATN B2

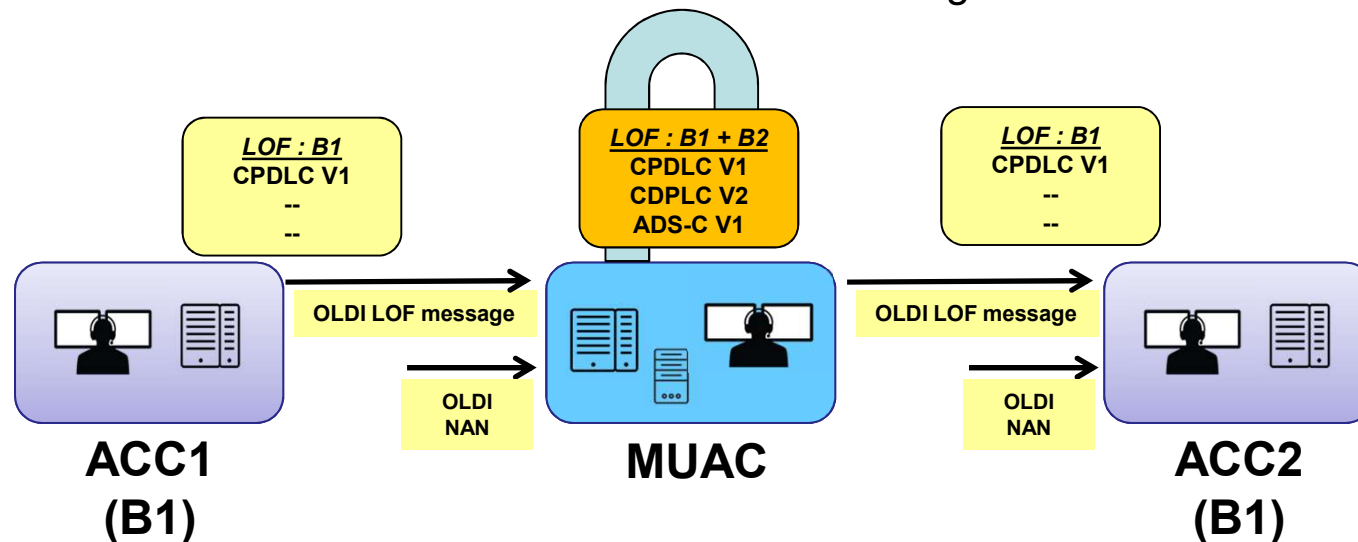
-TITLE LOF
 -REFDATA
 -SENDER -FAC LWSS
 -RECVR -FAC LBSR
 -SEQNUM 047
 -ARCID WZZ178
 -ADEP LIRF
 -ADES LTBA
 -AF ATN
 -ARCADDR ABC123
 -ATNLOGON
 -CMLTSP 8183657500A49CD7000100004747313301111
 -ADSQVLTSP
 -AGAPPQUALIFIER 0
 -AGAPPVERSION 00
 -CPCQVLTSP
 - AGAPPQUALIFIER 22
 -AGAPPVERSION 01
 -CPDLCADDRESS 8183657500A49CD700010000474731330AAAA
 -ATIQV
 -AGAPPQUALIFIER 3
 -AGAPPVERSION 00
 -ATNLOGONB2
 -ADSQVLTSP
 -AGAPPQUALIFIER 0
 -AGAPPVERSION 01
 -ADSADDRESS 8183657500A49CD7000100004747313301111
 -CPCQVLTSP
 - AGAPPQUALIFIER 22
 -AGAPPVERSION 02
 -CPDLCADDRESS 8183657500A49CD700010000474731330AAAA

Optional field
ATN LOGON
B2



OLDI – LOF for ATN B1+B2: Impact on MUAC neighbours

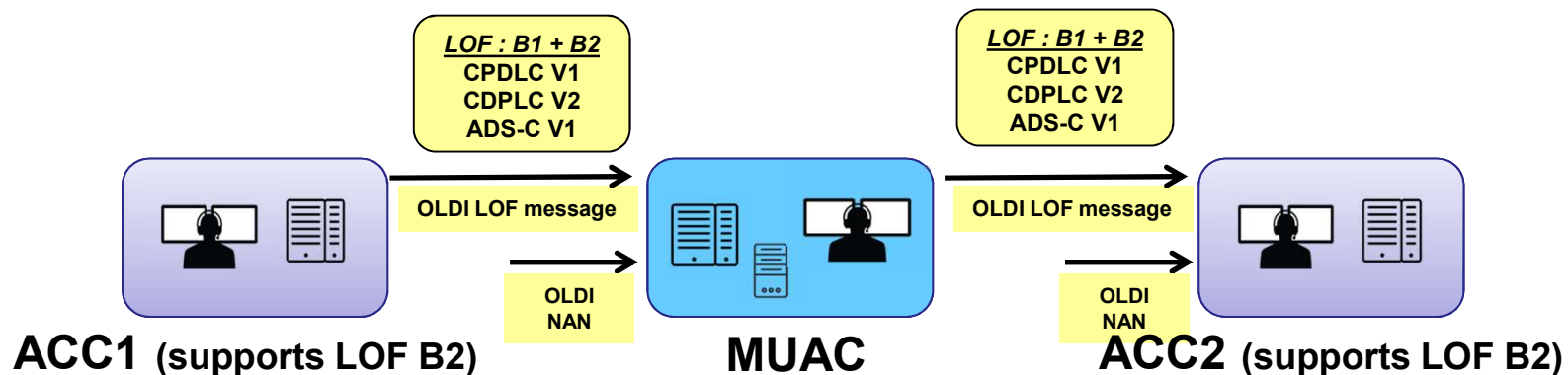
- **NONE** (if not yet supporting LOF B2)
 - INCOMING LOF: only ATN B1
 - MUAC has implemented a feature to convert LOF B1 into LOF B1+B2 (Based on static list of known aircrafts)
 - OUTGOING LOF: only ATN B1
 - MUAC will continue to emit LOF B1 messages



OLDI – LOF for ATN B1+B2: Impact on MUAC neighbours



- If supporting LOF B2 (*Even if the ACC only uses ATN B1*)
 - INCOMING LOF:
 - LOF contains B1 + B2
 - OUTGOING LOF:
 - LOF contains B1 +B2
 - All changes are tested / coordinated



ATN Baseline 2

CONTEXT AND OBJECTIVES

ATN B2: How it all started



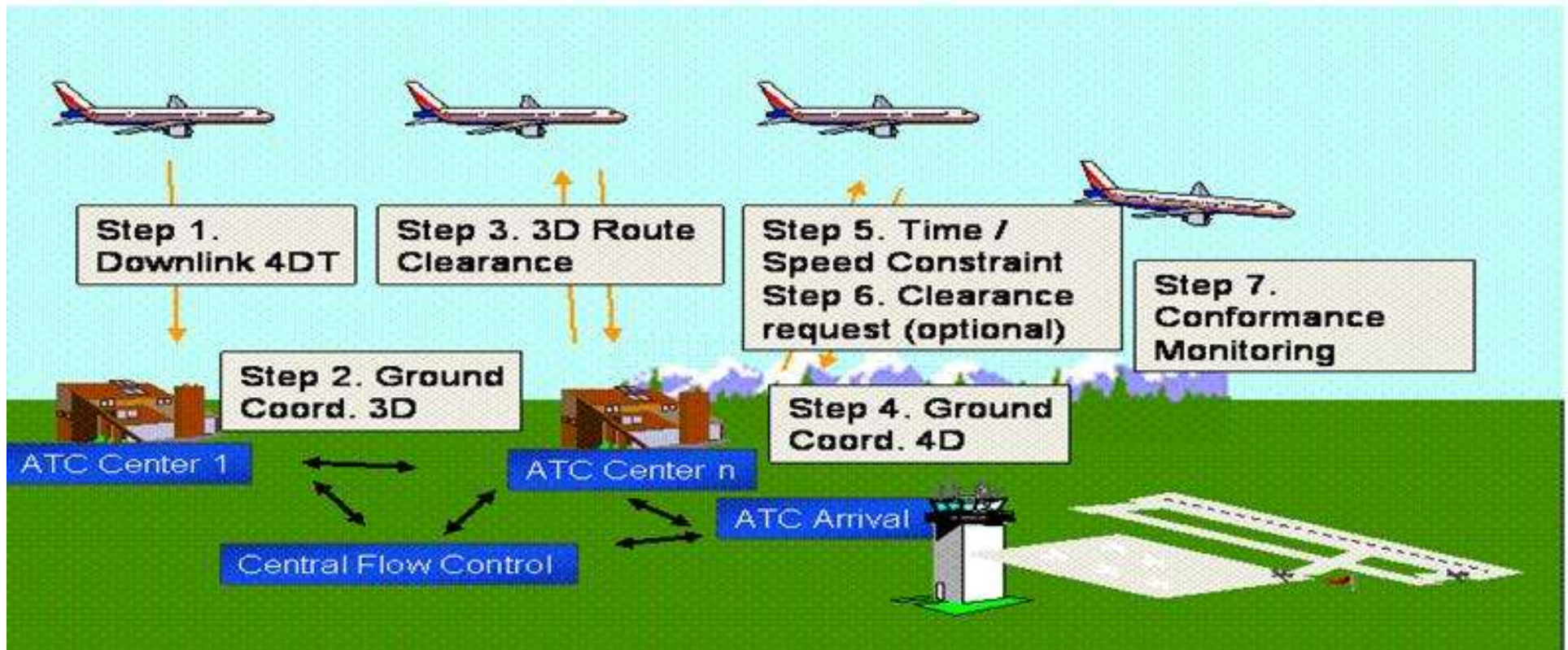
- Need for Global / Converging Datalink Standards,
 - supporting all types of airspaces (En Route, Terminal, Airport)
 - in different environments (Oceanic, Continental)
 - Align technologies
- Pre-SESAR it all started with the 4DTRAD Concept, with a follow up in the European ATM Master Plan as:
 - “Moving from Airspace to 4D Trajectory Management”
 - Trajectory management and Business & Mission Trajectories (BMT)
 - System Wide Information Management (SWIM)
 - Interoperability Ground-Ground → AF#5
 - Interoperability Air-Ground → “parts of i4D” → AF#6
(linked to SESAR Solution#06; Controlled Time of Arrival - CTA)

[A very short introduction movie](#)



4DTRAD (Full Scope)

4D → Latitude, Longitude, Altitude + Time



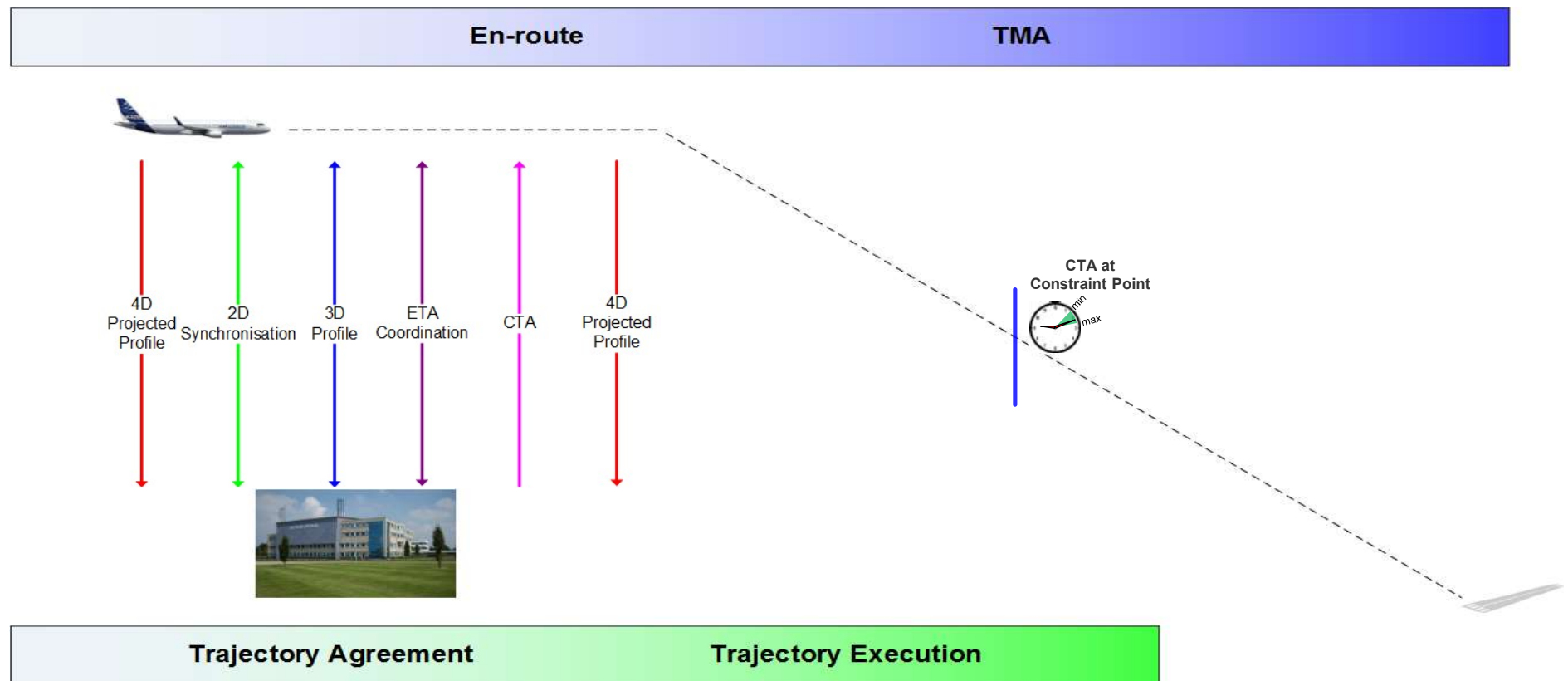
ATN B2, 4D : Some Operational Drivers

- **4D TRAD: 4D trajectory exchanges** via Datalink;
- Enhancement of Current Datalink Services
- **Monitoring** 2D/3D routes as used by FDPS (ATC) and FMS (Aircraft);
- **Periodic, Demand or Event-Based** distribution of EPP (ADS-C)
- **Aircraft flying to a single Time Constraint** (RTA), upgraded navigation performance of the a/c;
- **Support of “extended AMAN”** by uplink of Time Constraint.
- Decrease workload (automation) for Pilot / Controller.
E.g. autoload

What is i4D (initial 4D)

A first step towards 4D Trajectory Datalink (4D-TRAD):

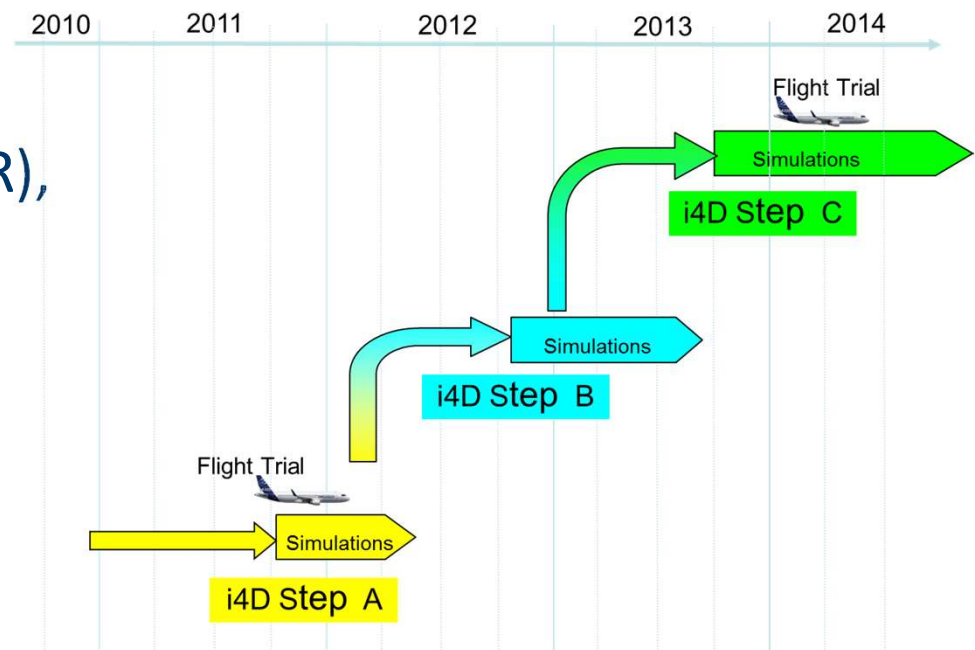
1. Sharing and synchronising airborne and ground trajectory.
2. Flying to a single time constraint.



The history of AF#6: i4D in SESAR1



- i4D was one of the first projects starting up in SESAR1 with a number of validations in three steps in the period 2011 till end 2015.
- i4D evolved into a project with as main partners:
AIRBUS,
EUROCONTROL MUAC,
NORACON (LFV & NAVIAIR),
THALES,
INDRA.



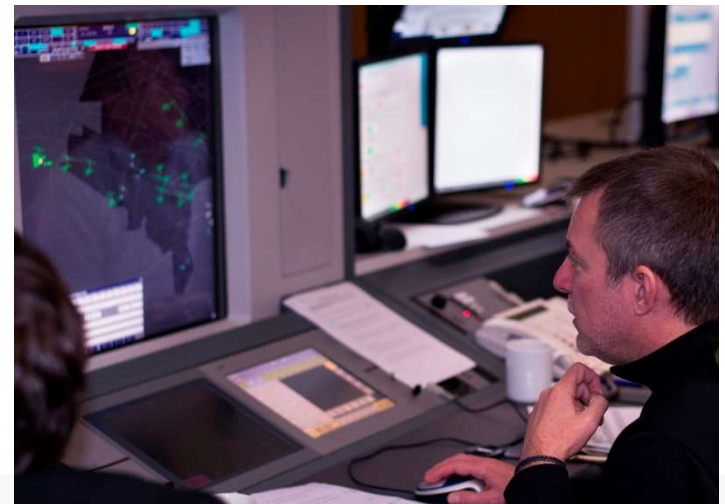
Initial display on the CWP window

VAR	AIB1D	AIRBUS-INDUSTRIE	FDM	COORD	CPDLC	EPP	MSG	RTE	X
		A320 /M N0464 LFBO EKCH	ECL380	PIBUL 1703 280					119.550
		AIB1D	F000	H064 IAS278 M0.81					GS0467 ↓16
POINTS	FL	ETA	SPEED	FL	RTA	SPEED			
LAMOX	030	17:22:32	IAS155						
CI22L	030	17:22:53	IAS142						
FI22L	016	17:24:44	IAS140						
EKCH2	001	17:26:57	IAS133	001					
AGE: 16:52			REFRESH	CUR/PRED GS: N0455 /			UPLINK		

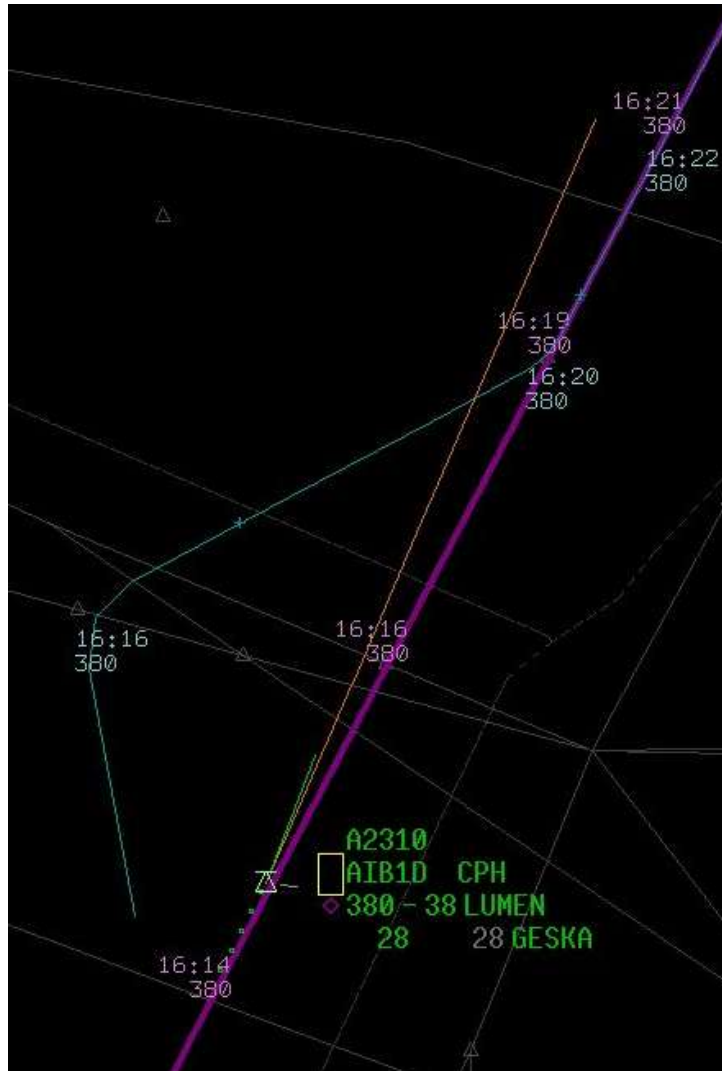
Maastricht UAC i4D Findings in SESAR1



- **EPP (Extended Projected Profile) data** beneficial.
 - Large safety gain 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.
 - Reduction in situational awareness due to unknown speed variations.
 - Increase in the use of vertical separation because of uncertainty in longitudinal separation.
- Use of limited vectors and level changes does not dramatically impact the flying to the RTA.
- Overall network & flight efficiency expected to be improved when using i4D.



i4D SESAR1 Validation: Main Outcome



- The flying to time is not yet mature enough to be part of PCP.
- The enhanced Data Link with the downlink of the airborne trajectory is ready to be part of PCP.

i4D SESAR1 Validation: Main Outcome



Link to the 2014 Flight trial
movie (7min19)

<https://www.youtube.com/watch?v=CI8y9QL6K3Y>

SESAR1: Technical Validations

THE PROJECTS

SESAR1 Live Trials - PEGASE



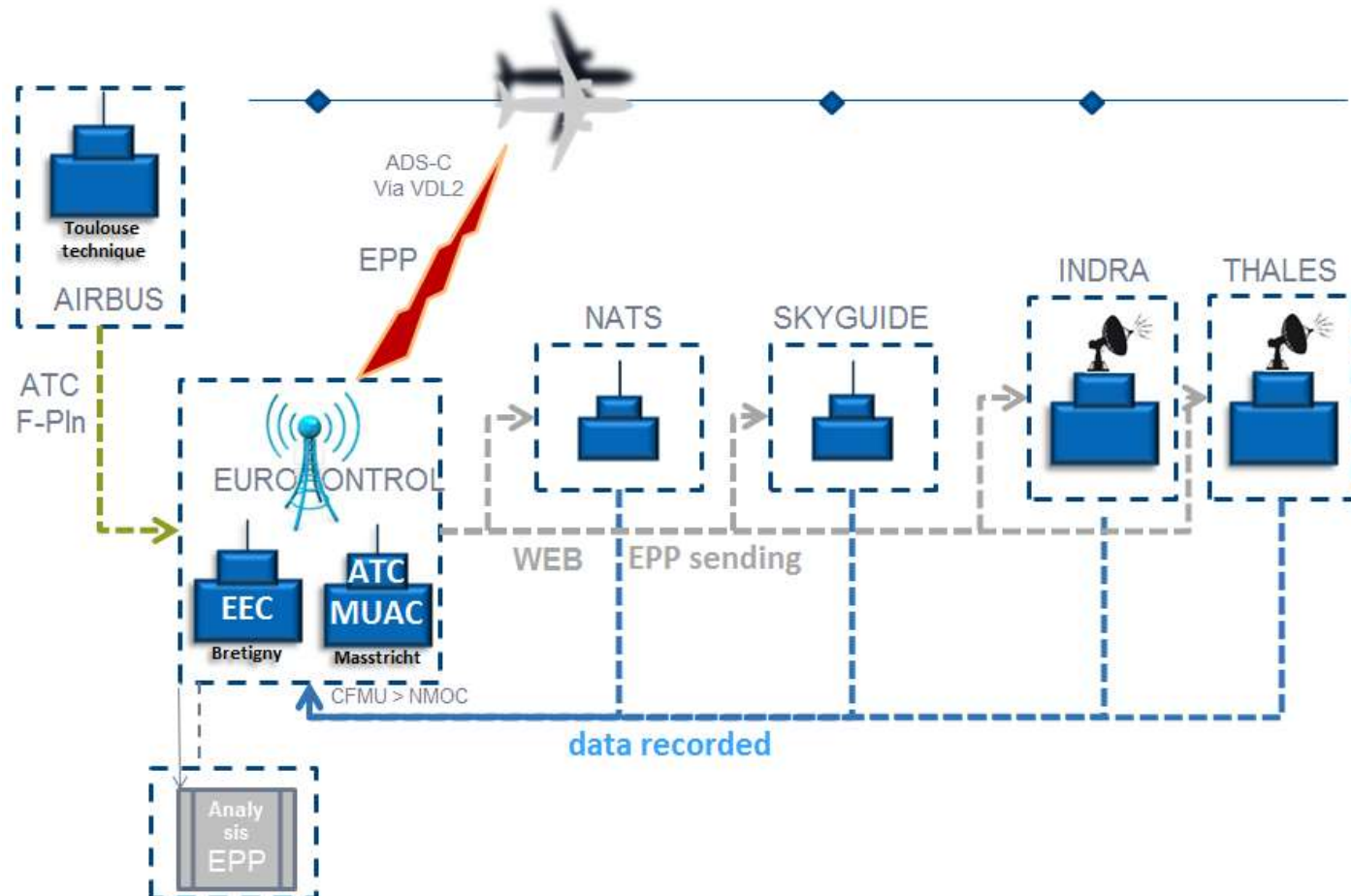
- Providing Effective Ground & Air data Sharing via EPP
- One of the conclusions of SESAR validations was that more live data is needed to analyse and feed operational improvements.
 - SESAR1 / Large Scale SESAR Demonstrations (LSSD) PEGASE:
 - ±60 “A320 AIRBUS flights” in period mid 2015-mid 2016.
 - 3 different routes Hamburg to Toulouse.
 - ADS-C only, no control via new CPDLC.
 - ADS-C Connections via EUROCONTROL Maastricht and Bretigny.
 - Bretigny distributed EPP via “working draft service” of Yellow SWIM.





PEGASE project: collection of ADS-C data during 59 AIRBUS ferry flights

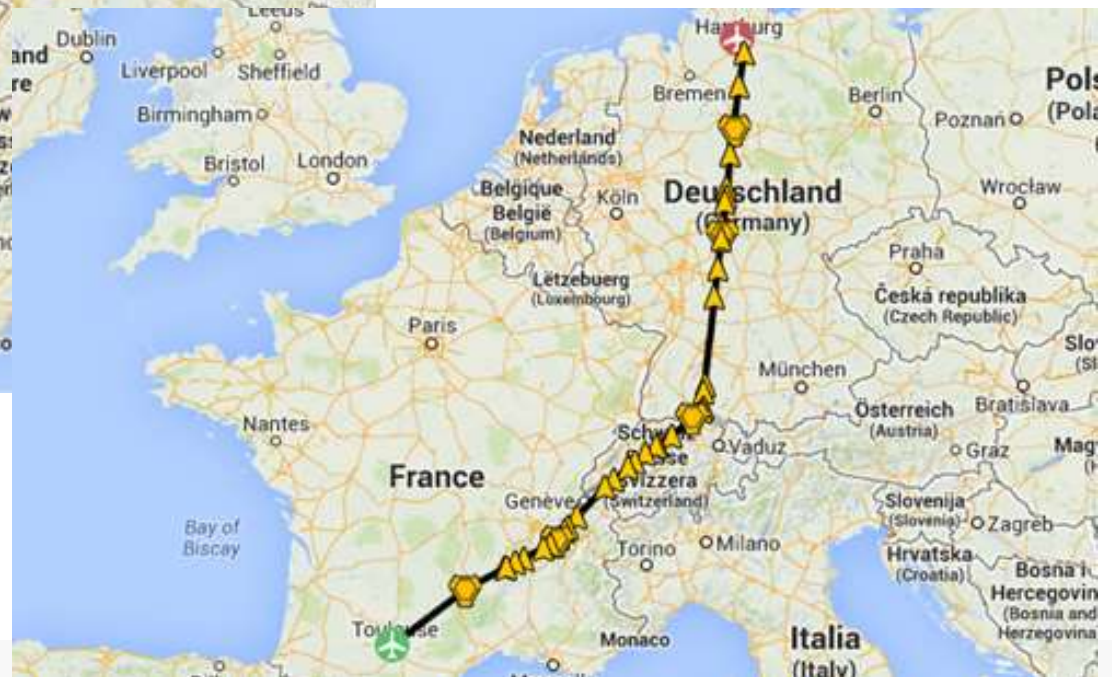
2014-2016



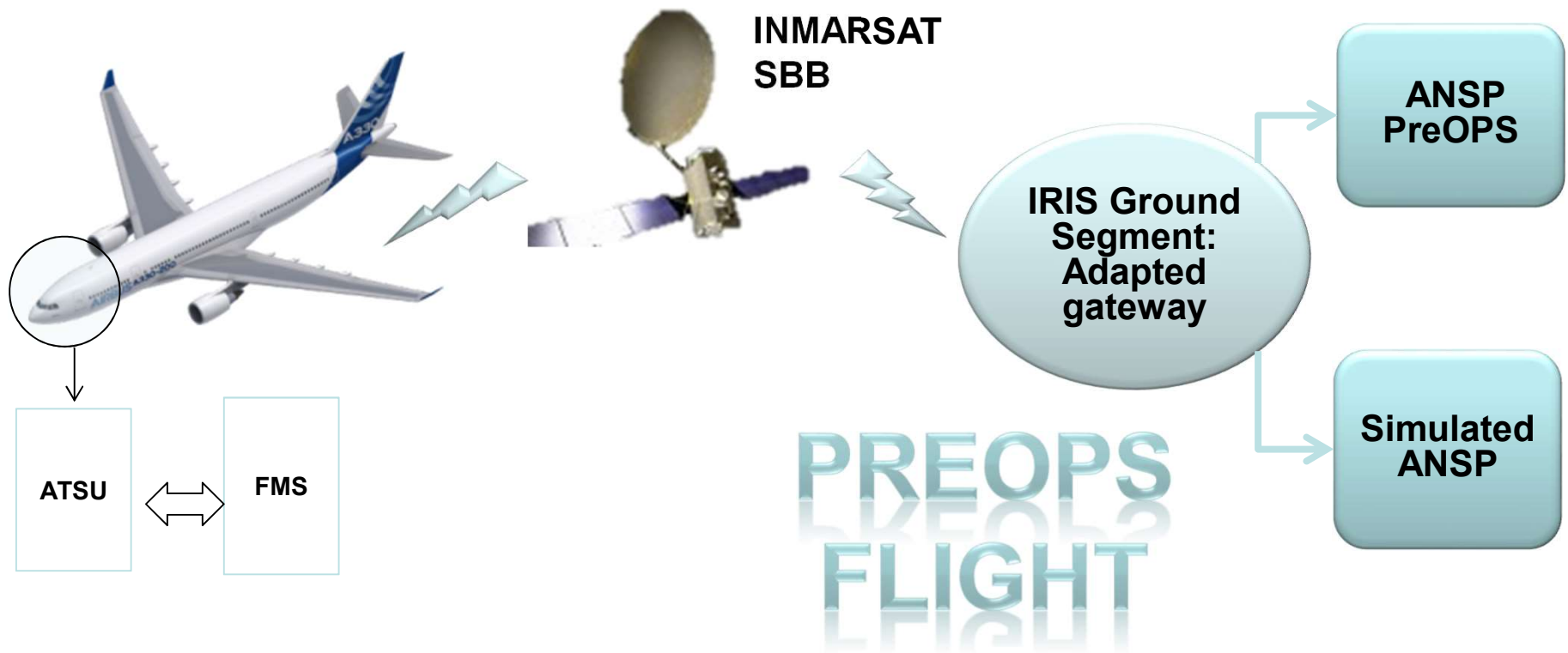
Live Trials - PEGASE



Examples of possible routes



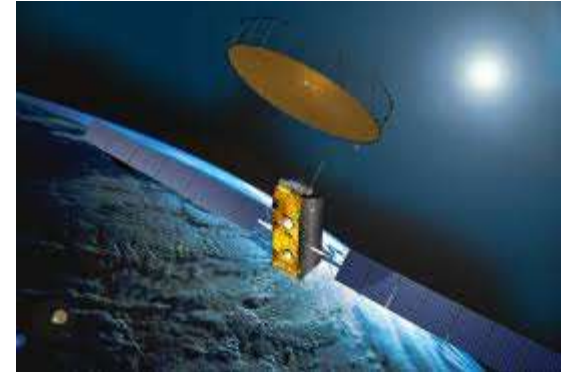
- ATN B2 Datalink over SATCOM → SATCOM using SBB network



SESAR1 SatCom Trials



- Satellite Communication for Data Link
- What is available to complement the VDL Mode 2 radio frequency medium?
 - SESAR1 Project 15.2.5
 - Preparatory testing with Airbus test benches and INMARSAT over 2015 and early 2016



- **Flight Trial on Feb 23rd 2016.**
- **Promising results, but still “just” at prototype level.**
- **Testing will continue under SESAR2020 PJ14 and via a new extra VLD called EAGLES.**

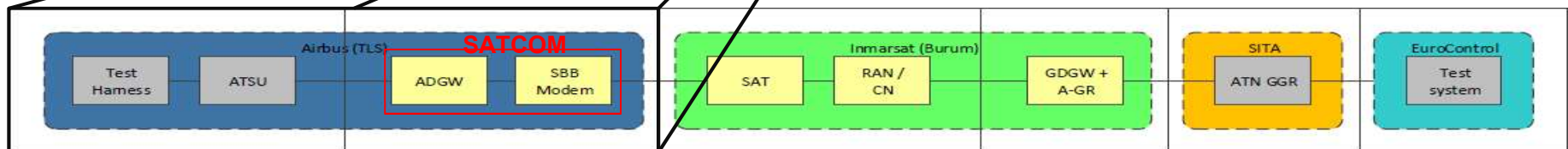


SATCOM Flight Tests outcomes

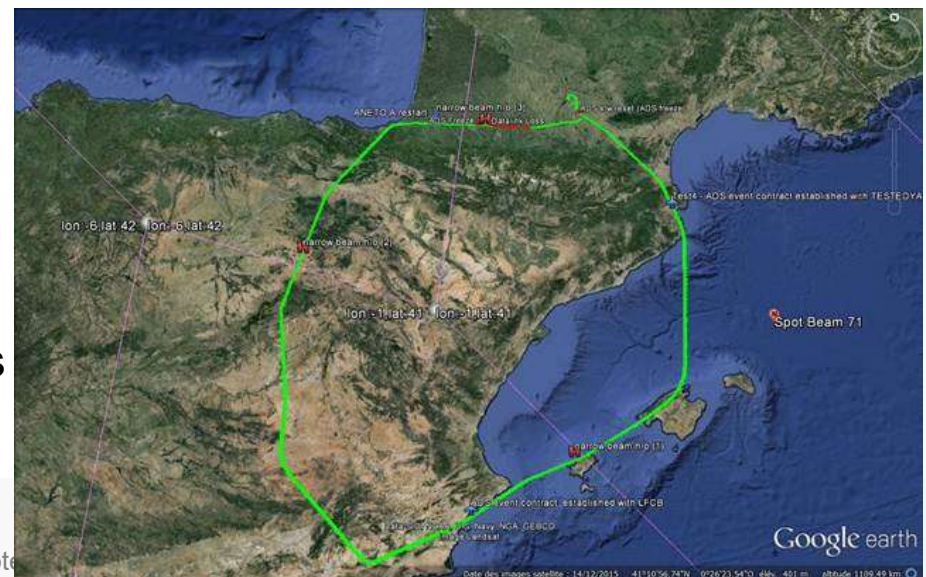


Flight Duration : 2h40

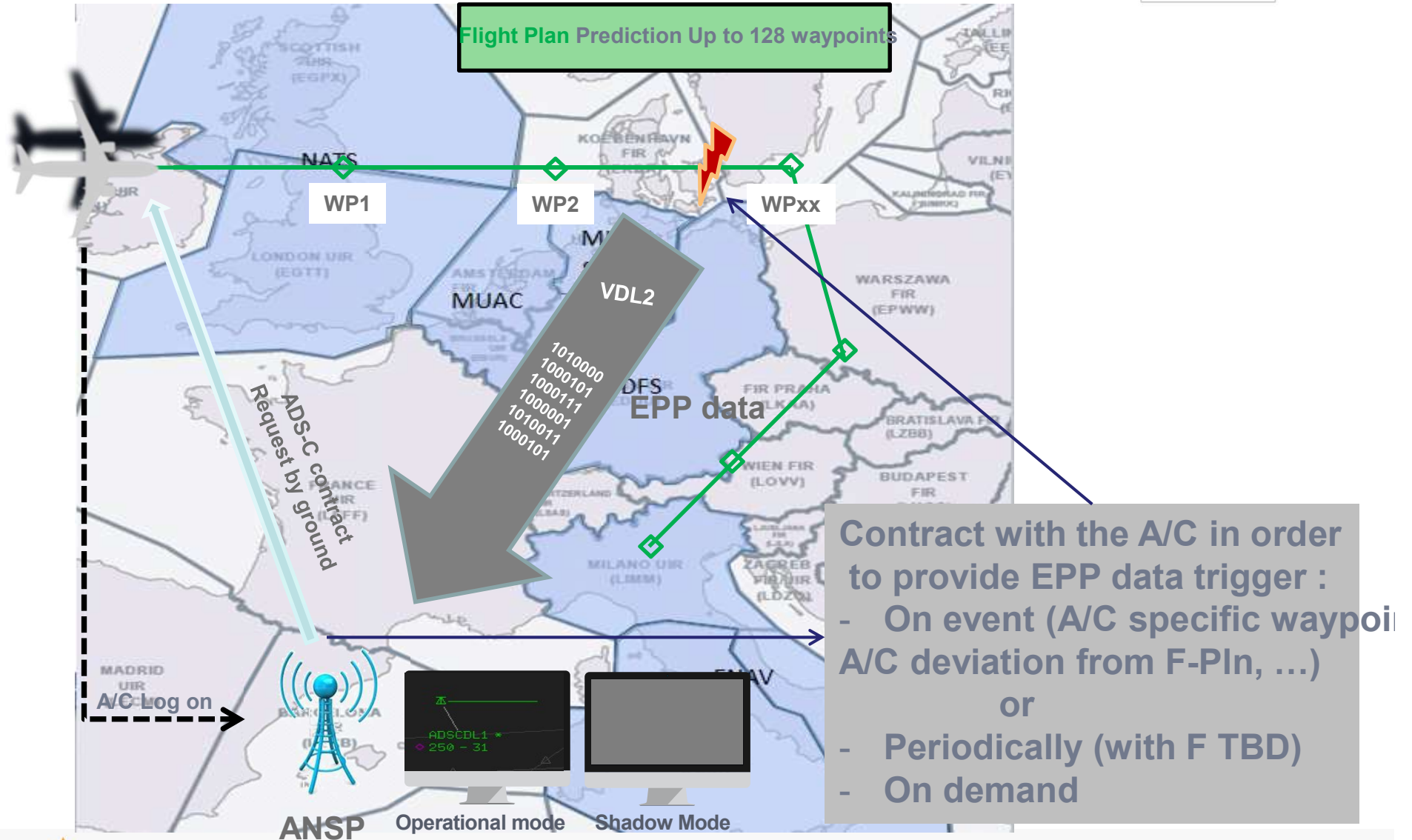
- 2 hours ADS-C over two ATC centres
- 2 h ADS-C on event : EPP report every 20s triggered
- Various CPDLC exchanges



- Spot beam handover completely transparent for the Aircraft
- No Provider Abort
- Performance: 5-7 seconds for ADS-C downlink and less than 2 seconds for CPDLC downlink



PJ31 DIGITS: EPP Project Description



SESAR2020 PJ31

ATN-B2 (ADS-C) PRE- OPERATIONAL TRIALS

ADS-C at MUAC

a SESAR2020 Very Large scale Demonstration (VLD)



- **DIGITS - Demonstration of Air Traffic Management Improvements Generated by Initial Trajectory Sharing** (SESAR2020 PJ31)
- Main airborne enabler: **FANS C** avionics for **ATN B2**
 - Airbus A320 family as initial target
 - Airbus A330 family to follow shortly after



The Ground Partners

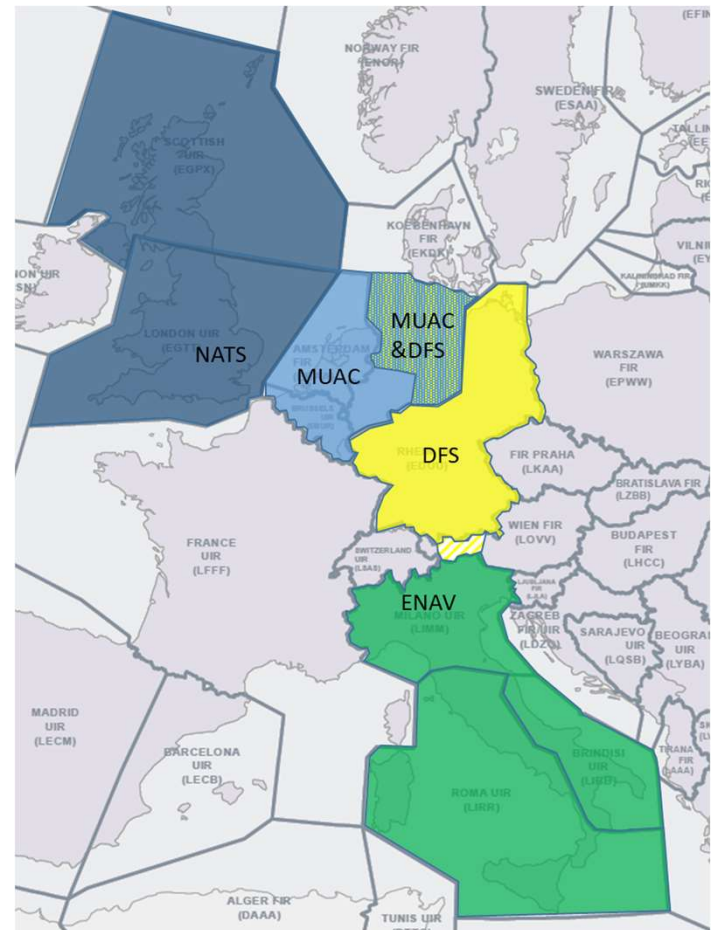
- MUAC targets a Pre-Operational implementation.
- DFS, NATS, ENAV and ECTRL Bretigny (EEC) will build shadow mode / test systems.
- Industrial partners: INDRA, THALES ATM and AIRTEL



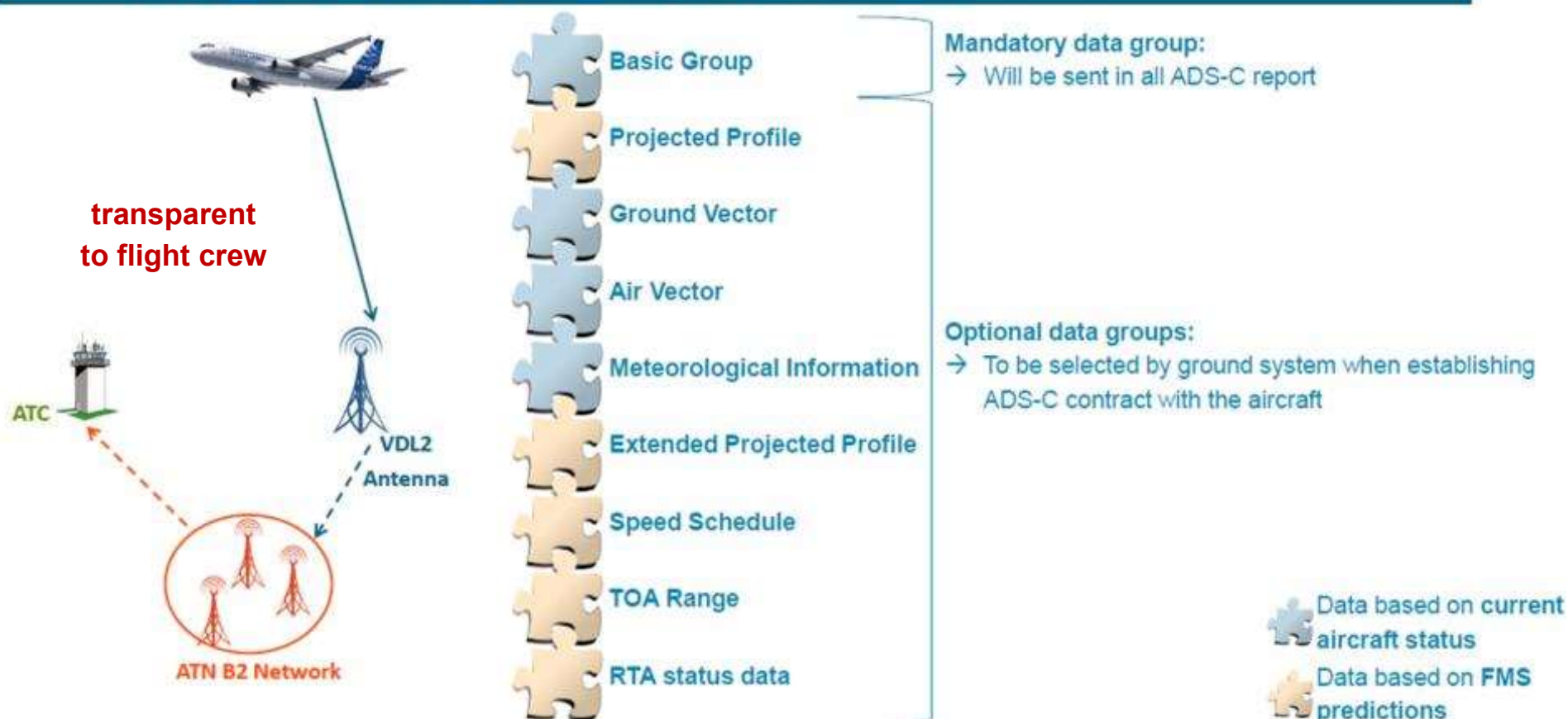
indra

AIRTEL^{ATN}

THALES



Automatic Dependent Surveillance – Contract (ADS-C) ATN B2 – ADS-C Downlink report – Content

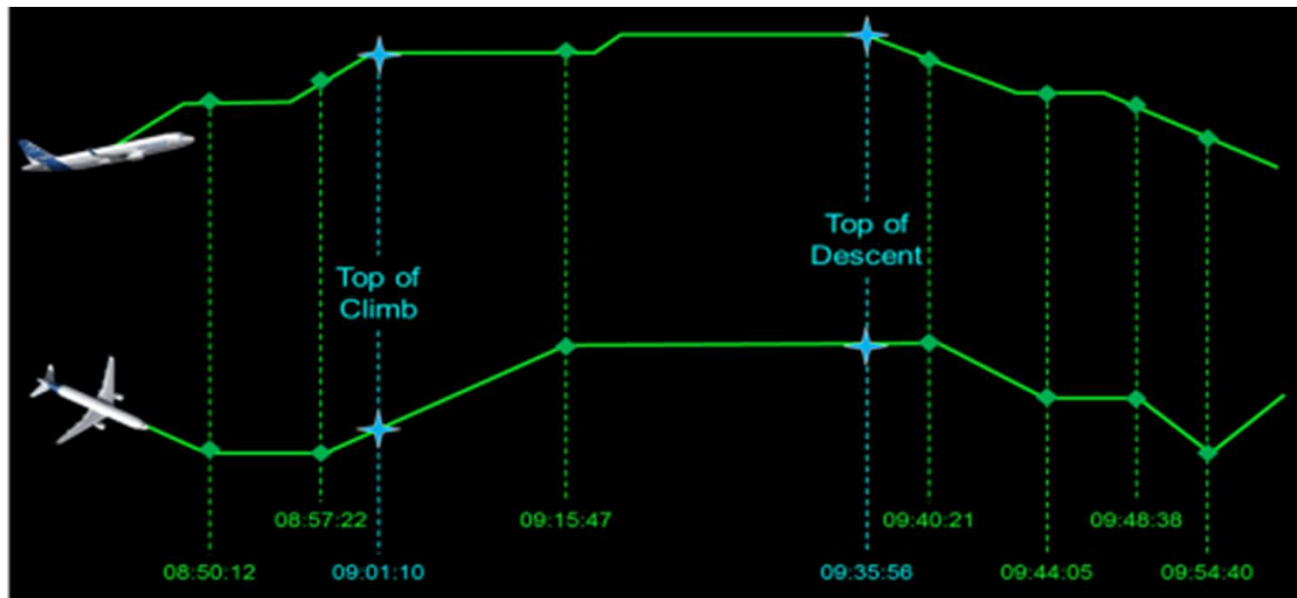


ADS-C Content and Standards



**4D
Trajectory
predicted by
the Flight
Management
System**

Vertical
Horizontal
Time



ADS-C EPP is part of the ATN B2 set of standards published in March-2016

Safety & Perf. Req. Std. for Baseline 2 ATS Data Com: RTCA DO-350A / EUROCAE ED-228A
Interoperability Req. Std. for Baseline 2 ATS Data Com: RTCA DO-351A / EUROCAE ED-229A
Interoperability FANS 1/A Accommodation: RTCA DO-352A / EUROCAE ED-230A
Interoperability ATN B1 Accommodation: RTCA DO-353A / EUROCAE ED-231A



The Formal Driver



28.6.2014

EN

Official Journal of the European Union

L 190/19

COMMISSION IMPLEMENTING REGULATION (EU) No 716/2014

of 27 June 2014

on the establishment of the Pilot Common Project supporting the implementation of the European Air Traffic Management Master Plan

PCP ATM Functionality #6 Initial Trajectory Information Sharing (i4D)

- improved use of target times and trajectory information
- including where available the use of on-board 4D trajectory data by the ground ATC system and Network Manager System
- implying fewer tactical interventions and improved de-confliction situation.



The Airspace Users involved: the Pioneering Airlines

	AFR	BAW	EZY	IBE	NVR	TCX	WZZ	100
Forward-Fit		9	25	6			18	58
Retro-Fit	25	1			2	14		42



Objectives of DIGITS (1/2)



DFS Deutsche Flugsicherung

NATS



Collection of ADS-C data:

- from revenue flights / “normal” commercial flights
- operated by different Airspace Users
- in a variety of operational conditions
- in shadow or test mode (DFS, ENAV, NATS, ECTRL EEC) and pre-operational (MUAC)

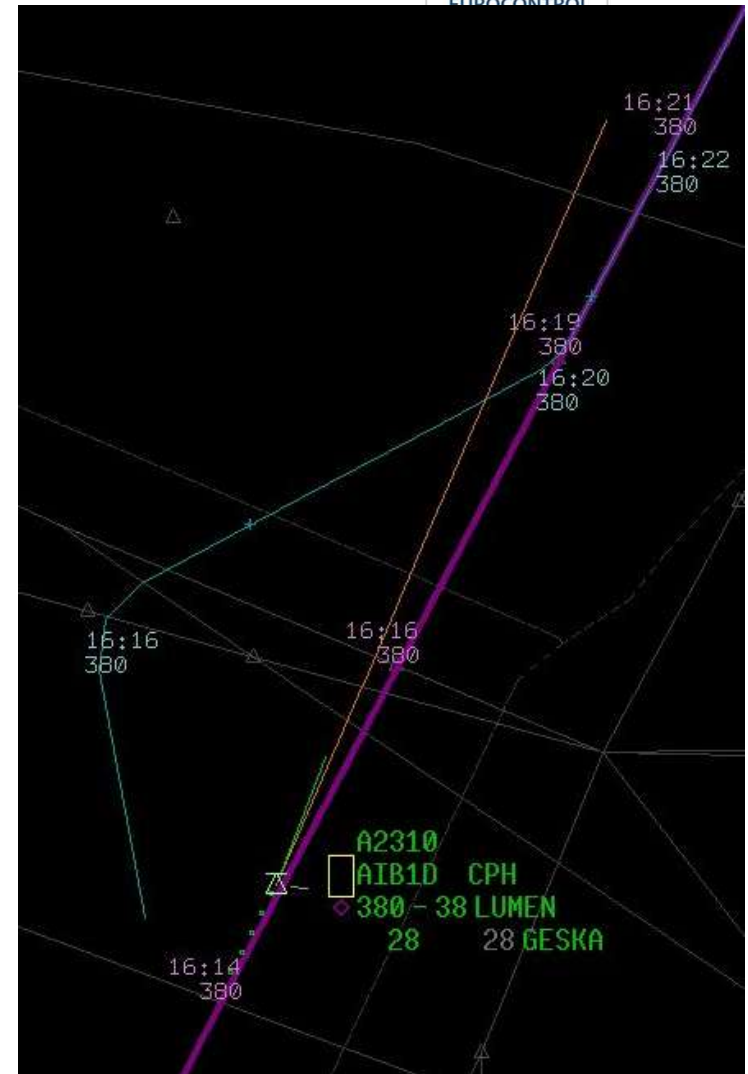
Objectives:

- understand the impact of operating practices on the downlinked data
- fine tune the requirements for integration of EPP in ground system
- assess benefit potentials

Objectives of DIGITS (2/2)

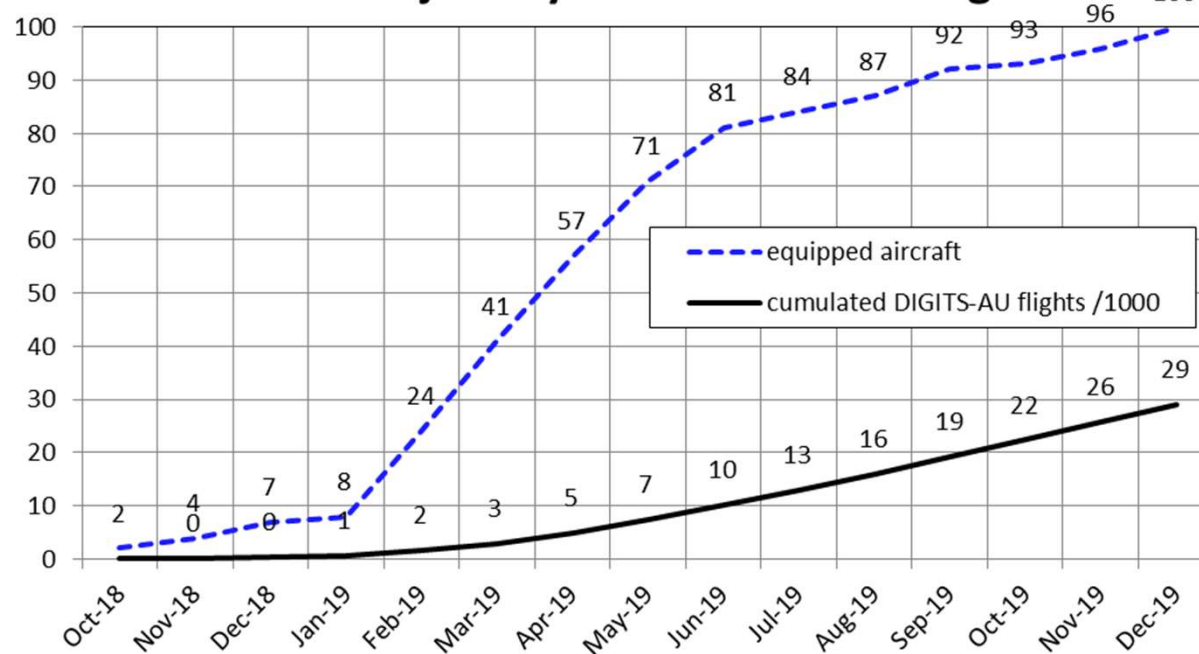
First trial implementations:

- Display the downlinked trajectory
- Generate an automated alert when air and ground are not synchronised (discrepancy indicator)
- Trial enhancements of the Trajectory Prediction by using a first set of downlinked parameters



Number of “useful” flights expected

Airborne Deployment of Initial Trajectory Information Sharing



Assumptions

flights per day per a/c	4.0
DIGITS rate	30%
DIGITS flights per day per a/c	1.2
flying days per month	29
DIGITS flights per month per a/c	34

DIGITS Summary

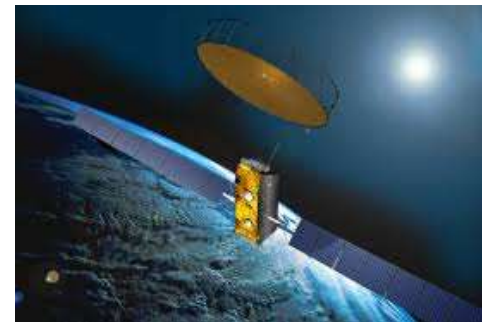


- **DIGITS will pioneer ATN-B2 operations through ADS-C / Extended Projected Profile application**
- **Airspace User part of the project was kicked-off on 3rd May 2018 with the participation of 7 airlines: Air France, British Airways, EasyJet, Iberia, Novair, Thomas Cook and Wizz Air**
- **Demonstration flights will start by end 2018 reaching 100 aircraft by end 2019**
- **Benefit potential will be assessed with participating ANSPs Maastricht UAC, ENAV (Italy), DFS (Germany) and NATS (UK) as well as EUROCONTROL EEC**
- **SESAR ADS-C/EPP Task Force propagates ADS-C/EPP applications across various SESAR solutions**

Maastricht UAC's View



- **MUAC sees an immediate benefit for safety and every aircraft being equipped counts.**
- **MUAC strongly believes in the future of Trajectory Based Operations (TBO), closing the loop air-ground via ADS-C and the ATN-B2 CPDLC message set is one of the main pillars and technically ready**
- **MUAC envisages a long list of opportunities to improve the operational use and tools, but in a gradual /step-by-step manner.**
- **MUAC supports with their ATN-B2 system Data Link via Satellite trials (IRIS IOC with INMARSAT)**



Airlines joining the PJ31 ADS-C deployment



Coordinator



Airspace Users

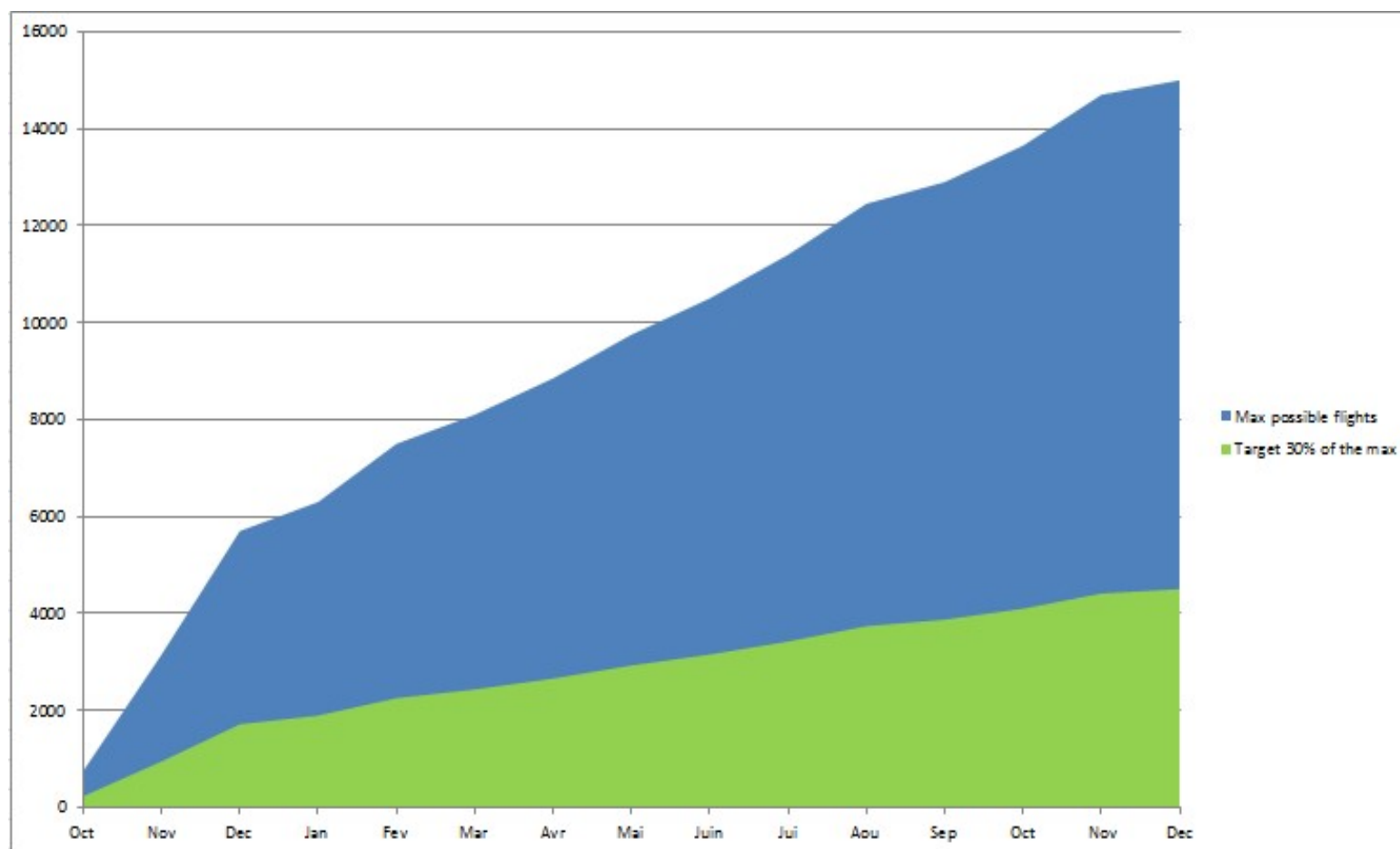


Industry

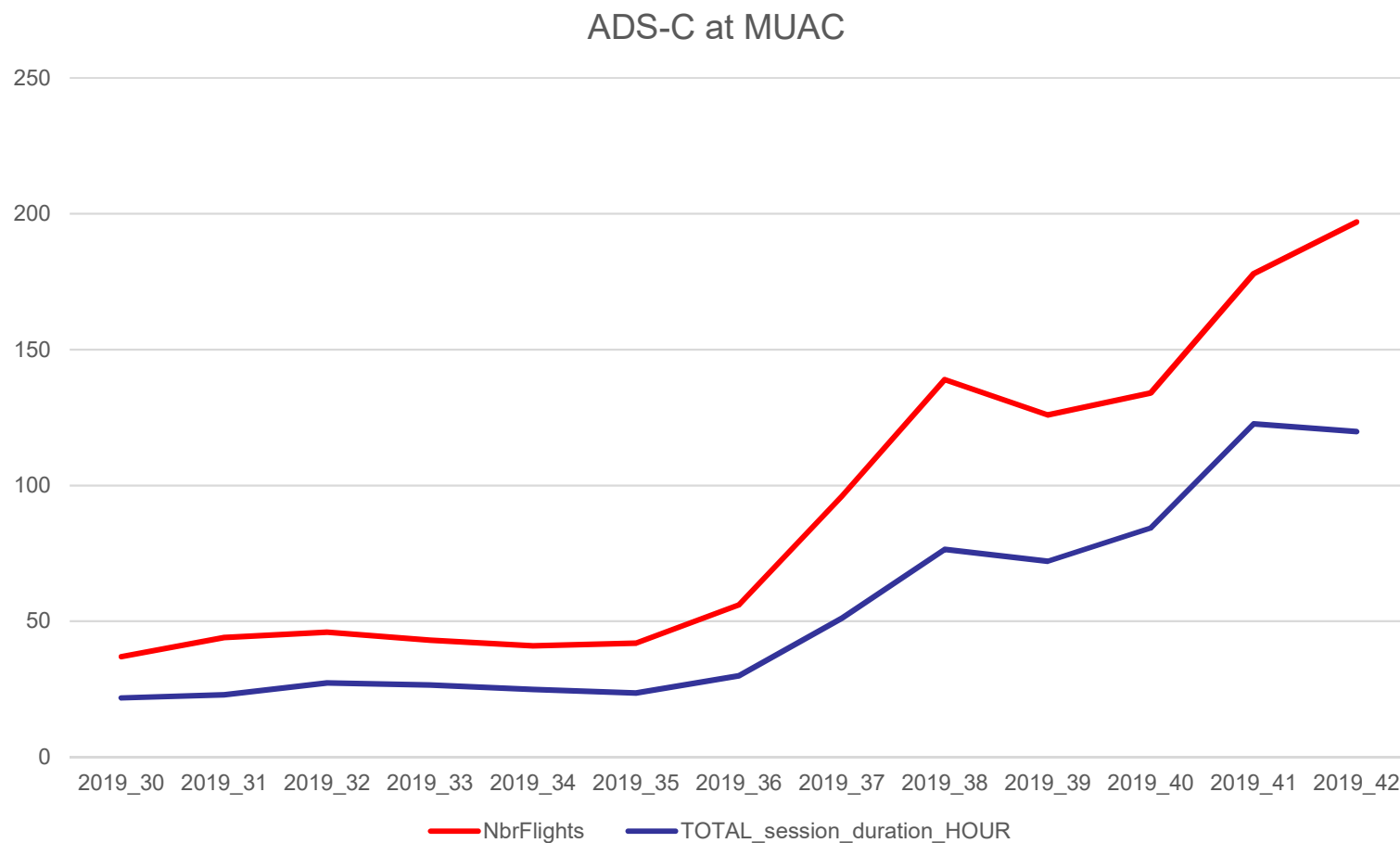


Number of aircraft				
Airline	FMS	fwd-fit	re tro-fit	TBD
NVR	Honeywell		2	
DLH	Thales	18		
SWR	Thales	2		
EZY	Honeywell	25		
IBE	Thales	6		
AFR	Thales		23	
BAW	Thales	9	1	
TCG	Thales		4	
TBD				10
Total		60	30	10
			100	

Estimate of ADS-C revenue flights per month in MUAC airspace (Oct 2018 - Dec 2019)



ADS-C operation at MUAC



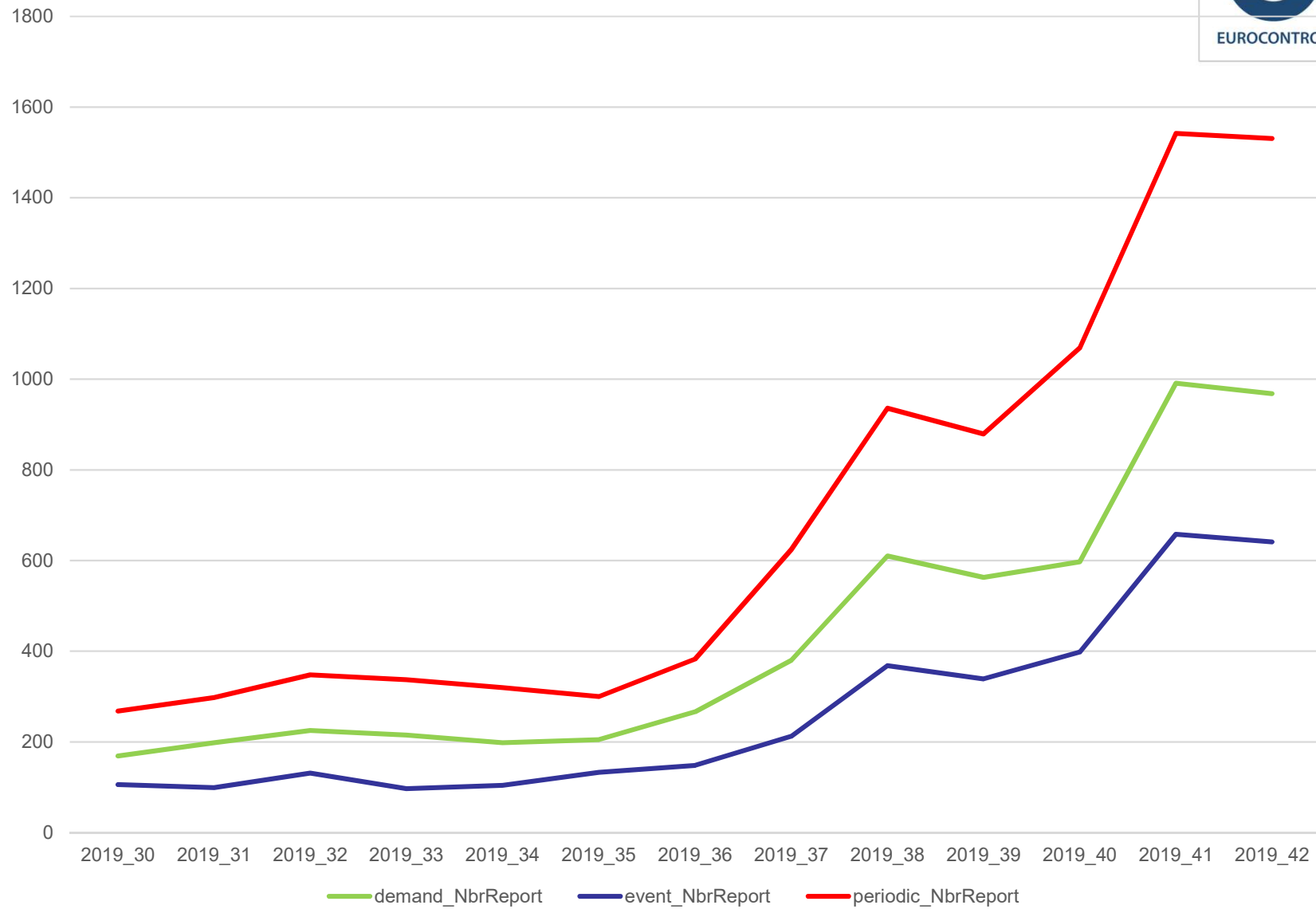
Average number of reports per ADS-C session:

15

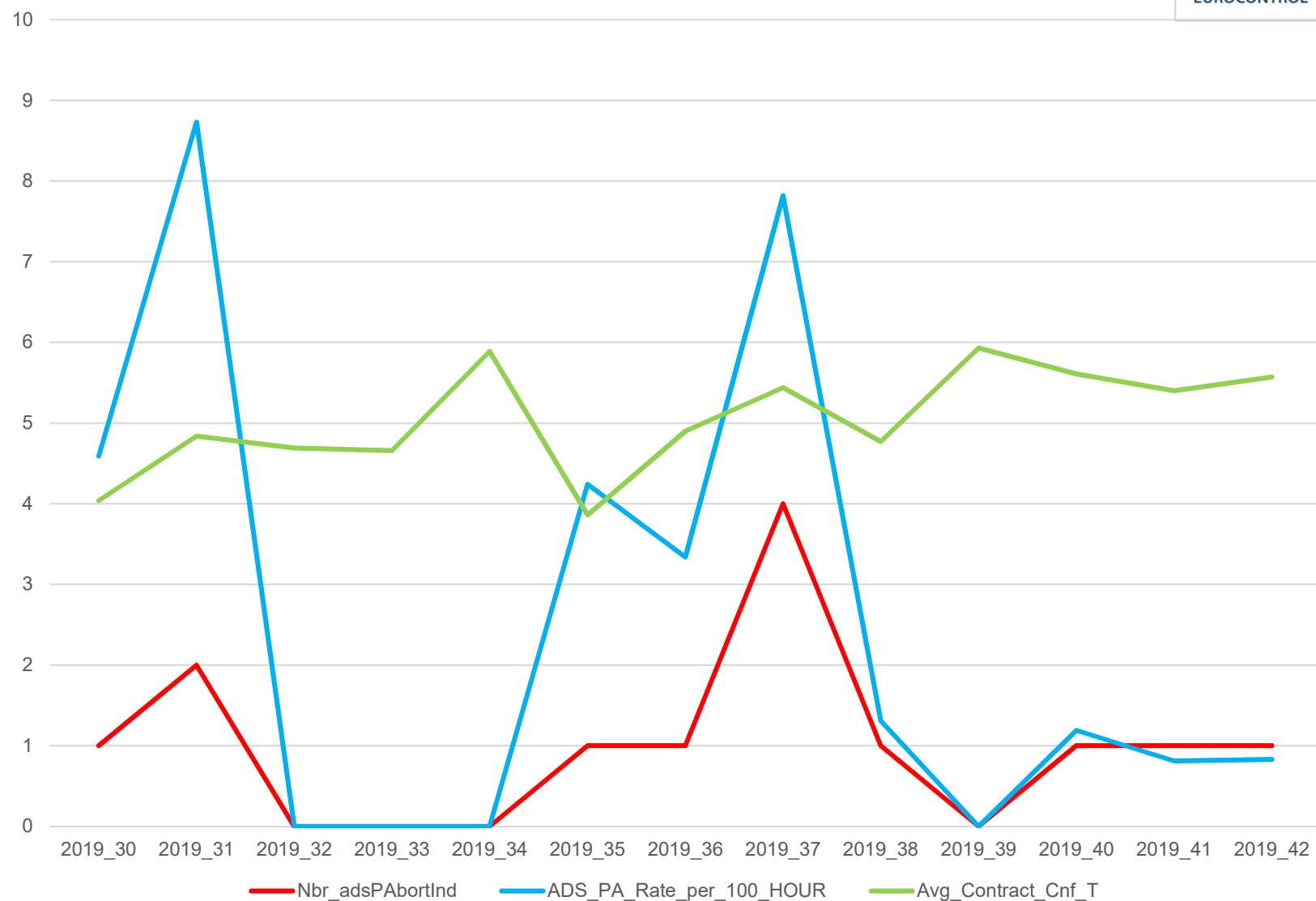
Average Contract duration :

40 min

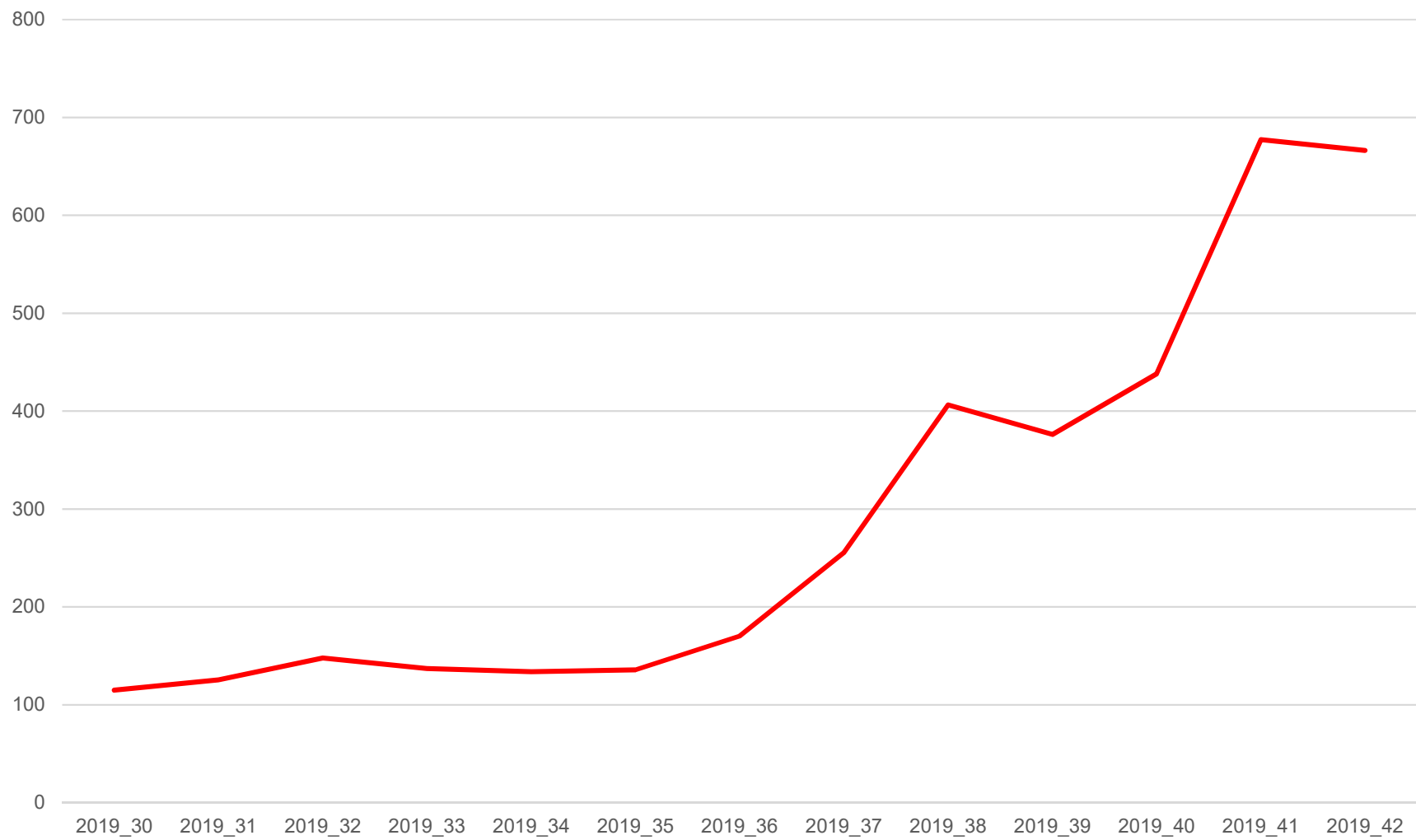
Number of reports per week



ADS Performance – and response time (sec)



ADS-C payload (kB - week)





Thank You