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Abstract

This document is the final report related to the ATC Full Datalink project, a demonstration project of the SJU that performed a certain number of flight trials, with commercial aircraft, controlled in UK and Italian Airspace, using the 1atalink as primary means of communication for almost all phases of flight. The high level goal of the project was to demonstrate that the 1atalink infrastructure which has to be deployed across the European continental airspace to provide initial CPDLC services to most of the aircraft flying above FL285, as prescribed by the implementing rule 29/2009, could be used also at lower flight levels, and in different flight phases than the en-route phase, to manage the traffic through CPDLC dialogues between controllers and flight crew rather than by voice exchanges.

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This deliverable consists of SJU foreground.

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Executive summary

This document is the final report related to the ATC Full Datalink project, a demonstration project of the SJU that performed a certain number of flight trials, with commercial aircraft, controlled in UK and Italian Airspace, using the datalink as primary means of communication for almost all phases of flight.
The project followed a step-by-step approach, on which an "experimental phase" ensured the readiness for the execution of the flight trials.

Four phases were defined for the experimental campaign execution:

- **Phase 1**: Feasibility Study
- **Phase 2**: Procedure Validation
- **Phase 3**: Impact Assessment
- **Phase 4**: Feedbacks and Conclusions

The aim of the experimental campaign was to assess the feasibility of the subsequent demonstration activities with revenue flights.

During **Phase 1** (September – December 2012), technical capabilities of both ground and airborne systems were verified and AFD operational procedures were designed, based on the standard operational procedures. Two role gaming sessions were conducted in December 2012, during which Controllers and Pilots assessed AFD operational procedures. The complete set of CPDLC messages was identified in a real operational scenario.

Phase 2 (April - July 2013) was devoted to end-to-end datalink validation. ENAV AFD platform was connected with the Airbus test bench and the correctness of CPDLC message exchange was tested.

Phase 3 (September – December 2013) completed the full connection between ENAV AFD platform and Airbus Cockpit Simulator. In particular, two steps were undertaken:

1) Step 1 (Sept 2013): ENAV AFD platform was fully connected with Airbus Cockpit Simulator (ATN connectivity + SVS Surveillance) and a simulated flight was used as ghost of a real flight. The ground system did not provide RTA feature.
2) Step 2 (Oct – Dec 2013): the same configuration of Step 1 was used, plus the update of ENAV AFD platform to allow for RTA feature availability. NATS ATCOs were involved in this activity.

During **Phase 4** (January 2014), feedbacks and conclusions of this experimental plan was collected, with a view to provide both an in-depth procedure scheme and the appropriate level of technical reliability to conduct subsequent activities of the AFD Execution Phase. A complete Safety Assessment was provided, also intended to get NSAs approval on the execution of such flights.

In February 2014, the AFD flight trials campaign started the execution phase both in UK and Italian airspace; ENAV concluded it in April 2014, while NATS in June 2014.

The AFD trials have successfully shown that datalink can be introduced in Italian and UK airspace, integrating ENAV and NATS systems, controllers and operations personnel seamlessly with surrounding flight information regions, ANSPs, and multiple airline carriers and aircraft types. However, based on some observations and findings during the AFD trials combined with recent issues with LINK2000+ implementations in Europe, it would seem prudent to follow up in a number of areas where further investigation could benefit both planned and current deployments. As such, it is suggested to build on the success of AFD by performing continued investigation into key areas. This will help to identify and mitigate potential issues, and to ease the transition to true full datalink operations in Europe.

1 Introduction

1.1 Purpose of the document

This document provides the Demonstration report related to the ATC Full Datalink (AFD) demonstration project.

It describes the results of demonstration exercises and the way they were executed.

1.2 Intended readership

With this demonstration project a legacy technology, datalink over VDL mode 2, was used intensively, testing its usage on a lower airspace as primary means of communication.

At the start of the project in 2012, datalink was not operational in many countries and specific issues on its usage were not well known. Over the last 6 months – even thanks to AFD initial feedbacks on flight trials – some concern was expressed on datalink communications not working as expected owing to several interoperability issues.

Hence, the project, started with the aim of proving this technological enabler capability to support ATCOs on a lower airspace than FL285, gave evidence of technical problems associated to it.

To this regard, the recent EASA datalink report highlights that a technical investigation is further needed in order to achieve a "fine tuning" step that will allow to properly use datalink communications over VDL mode 2. In the next future, the entity in charge of it is expected to use on the content of this report, in terms of anomalies tracked during the AFD flight trials campaign.

This Demonstration Final Report, includes a detailed description of the flight trial campaign, with also a special focus on the feedbacks reported: based on a "final user oriented" campaign, it can be seen as a guideline for technical-operational experts, to analyse and investigate bugs reported, in terms of avionics and ground infrastructure anomalies, as well as a manual for the operators (ATCOs and Pilots), to rise up the level of confidence towards a technology used nowadays mainly for different reasons than Air Traffic Control.

Furthermore, together with other documents already issued (i.e. Link 2000+ other than EASA Reports and regulation EC 29/2009), can be seen as an operational guideline manual for ATM operators, opened for further SESAR development programs for the extended use of datalink.

1.3 Structure of the document

After a description of the project, the context of demonstration activities and the work distribution among partners, the document analyses in depth the approach undertaken for the preparation of flight trials.

Flight trials campaign is then detailed, with evidence of results in terms of HF analysis and logs investigation when problems occurred.

At the end, a summary of communication activities and foreseen next steps are provided, as well.

1.4 Glossary of terms

1.5 Acronyms and Terminology

Term	Definition
ABZ	Aberdeen
ACARS	Aircraft Communication Addressing and Reporting System
ACC	ATC Control Centre
ACL	ATC Clearance Service

ACM	ATC Communication Management
ADS	Automatic Dependant Surveillance
AFD	ATC Full Datalink (this project)
AFN	Aircraft Facility Notification
AFR	Air France
AIP	Aeronautical Information Publication
ALTARR	This is the minimum altitude above which the CPDLC communication can replace R/T communications during the descending phase of the flight
ALTDEP	This is the minimum altitude above which the CPDLC communication can replace R/T communications during the climbing phase of the flight
AMAN	Arrival Manager
AMC	ATC Microphone Check
ANSP	Air Navigation Service Provider
AOA	Plain Old ACARS
AOC	Air Operation Centre
APP	Approach Centre
ARN	Arlanda
ARR	Arrival
ATC	Air traffic Control
ATCO	Air Traffic Controller
ATM	Air Traffic Management
ATN	Aeronautical Telecommunication Network
ATS	ATC Service
ATSU	ATC Service Unit
AVLC	Aviation Very High Frequency Link Control
CDA	Current Data Authority
CMD	Command
COM	Communication
CPDLC	Controller-Pilot Datalink Communications
CPT	Point to be provided as part of variable in some CPDLC instruction/clearances

CRC	Cyclic Redundancy Check
CTA	Controlled Time of Arrival
CTR	Control Zone
CWP	Controller Working Position
DAP	Downlinked Aircraft Parameter
DCDU	Datalink Control and Display Unit
DCT	Stands for Direct Route in between two points or to a given point in a CPDLC request/instruction/clearance
DEP	Departure
DES	Destination
DIR	Direct
DISC	Disconnection
D/L	Datalink
DLS	Datalink Service
DM	Downlink Message
EFB	Electronic Flight Back
EXE	Executive Controller
ETA	Estimated Time of Arrival
EZY	Easy Jet
FANS	Future Air Navigation System
FC	Flight Crew
FCO	Fiumicino
FCOM	Flight Crew Operating Manual
FDP	Flight Data Processing
FIR	Flight Information Region
FLIPCY	Flight Plan Consistency
FMS	Flight Management System
FPL	Flight Plan
FT	Flight Trial

FTS	Fast Time Simulation
GND	Ground
HDG	Heading
HF	Human Factors
HMI	Human Machine Interface
HO	Hands Off
HP	Human Performance
IDRP	Inter Domain Routing Protocol
ILS	Instrument Landing System
LACK	Logical Acknowledgement
KOM	Kick Off Meeting
KPA	Key Performance Area
LAT	Latitude
LDACS	L-band Digital Aeronautical Communication System
MCDU	Multi-Function Control Display Unit
MSG	Message
MWL	Mental Work Load
NAA	National Aviation Authority
NDA	Not Current Data Authority
NOK	Not Ok
NSA	National Supervisory Authority
NSAP	Network Service Access Point
NSEL	Network Selector
OPS	Operations
OSED	Operational Service and Environment Definition
OSI	Open System Interconnection
PECT	**Peer Entity Contact** Table
PENS	Pan European Network System
PLN	Planner (ATCO Role)

PM-CPDLC	Pseudo Message – Controller Pilot Data Link Communication
PMO	Palermo
PSA	ENAV Shadow Mode Unit Centre
R-ATSU	Air Traffic Service Receiving Unit
RSP	Response
RTA	Required Time of Arrival
R/T	Radio/Telephony
RTS	Real Time Simulation
SA	Situational Awareness
SAF	Safety
SAS	Scandinavian Airlines System
SID	Standard Instrument Departure
SOP	Standard Operational Procedures
SSR	Secondary Surveillance Radar
STAR	Standard Arrival Route
SVG	Stavanger
SVS	Shared Virtual Sky
TMA	Terminal Area
TOF	Transfer of Frequency
TP4	Transport Protocol, class 4
TSEL	Transport Selector
UM	Uplink Message
UTC	Coordinated Universal Time
VDL	VDL2 Datalink
VGS	VDL2 Ground Stations
VHF	Very High Frequency
VOBJ	Validation Objective

2 Context of the Demonstrations

2.1 Scope of the demonstration and complementarity with the SESAR Programme

The scope of the demonstration is the usage of datalink as primary means of communications for ATC operations in a normal day of business, conducted on revenue commercial passenger flights operated by EasyJet (EZY), Air France (AFR) and Scandinavian Airlines (SAS) across Italian and UK Airspace during winter and spring 2014.

The selected city pairs for this project are:

SET	Scope	Exercise ID	City Pair	Airline	Fleet	Scenario	Trials
1	Domestic Italian	EXE-02.08-D-001	FCO-PMO PMO-FCO	EZY	A320 family	AFD Upper and TMA, Climb, Cruise and Descend phases and transition to/from Cruise	**22**
2	Domestic U.K.	EXE-02.08-D-002	BRS-EDI EDI-BRS	EZY	A320	AFD Upper, Cruise	**17**
3	Continental	EXE-02.08-D-003	FCO-CDG CDG-FCO	AF	A320 Family	AFD Upper and TMA, Silent Coordination, [RTA Constraint], Cruise, Descend and transition from Cruise	**6**
4	Continental	EXE-02.08-D-004	CDG-MAN MAN-CDG	AF	A320 Family	AFD Upper, Silent Coordination, Cruise	**2**
5	Continental	EXE-02.08-D-005	FCO-BRS BRS-FCO	EZY	A320 family	AFD Upper and TMA, Silent Coordination, Climb, Cruise and transition to Cruise	**12**
6	Continental	EXE-02.08-D-006	FCO-ARN ARN-FCO	SAS	B737-800	AFD Upper and TMA, Silent Coordination, Cruise, Descend and transition from Cruise	**10**
7	Continental	EXE-02.08-D-007	ARN-EDI EDI-ARN OSL-EDI EDI-OSL SVG-ABZ ABZ-SVG	SAS	B737-800	AFD Upper, Silent Coordination, Cruise	**10**

The following picture is a simplified map showing the city pairs flown within AFD exercises. The figures represent the number of legs flown under AFD operations per city pair.

Figure 1- AFD City Pairs Map (The figures represent the number of legs flown per city pair)

The overall objective of the demonstrator is to prove that, with the significant investment performed by Airlines and ANSPs across Europe to comply with the Datalink Implementing Rule, it is possible, with minor adjustments, to extend the number of operations to be conducted by CPDLC rather than by voice, in a bigger volume of Airspace than the one designated by the above mentioned Implementing Rule. AFD resulted in an increased confidence by involved stakeholders that datalink communications can efficiently and safely replace, in most operational conditions, R/T communications, thus moving forward the SESAR target concept where digital communications, including system to system direct data sharing, will replace voice communications, which will be kept solely as a backup for abnormal situations.

The High level Operational Scenario applying for all the Demonstration exercises can be described as a normal business day in continental airspace. The target demonstration flight is conducted, under nominal conditions, in controlled airspace by ATC limiting controllers and pilot interactions to exchanges of information, requests, clearances or instructions performed via datalink. The phases of flight where no voice communication took place, unless non nominal conditions arose, were those as soon the flight crossed ALTDEP during Climb phase and until went below ALTARR during descent. ALTDEP and ALTARR depends on a number of factors and constraints, including message set availability to perform specific departure or arrival operations, end to end communication performances Vs. traffic complexity and density, pilots and controllers workload and radio signal availability. Generally speaking, ENAV identified both values with FL100, while NATS started with FL195 and then, after NSA approval, moved to FL100 as well.

Typically, each exercise run involved a number of expert people for its preparation and conduction, supervision, data registering, data processing and post analysis. On ground, the controllers responsible for the sectors crossed by the flights selected for trials were specifically trained and briefed before and after the trials. The crew on duty on the flights selected for trials were ad hoc trained and briefed.

3 Programme management

3.1 Organisation

The following table represent the composition of the Consortium which has been awarded the ATC Full Datalink Demonstration Project (02.08).

ANSP	Airline	Airframe Manufacturer	Ground ATC Manufacturer	Communication Service Provider
ENAV	EasyJet	Airbus	Selex ES	SITA
NATS	Air France	Boeing		
	SAS (subcontractor)			

ENAV acted as Consortium Coordinator.

The Consortium Members finalised the Consortium Agreement, defining its provisions according to the Terms and Conditions set forth in the Contract Agreement SJU/LC/0194-CTR, signed between ENAV and the SESAR JU, as the result of the Procurement Procedure *SJU/LC/0070-CFP*.

The Figure below represents the work sharing per Consortium Participant.

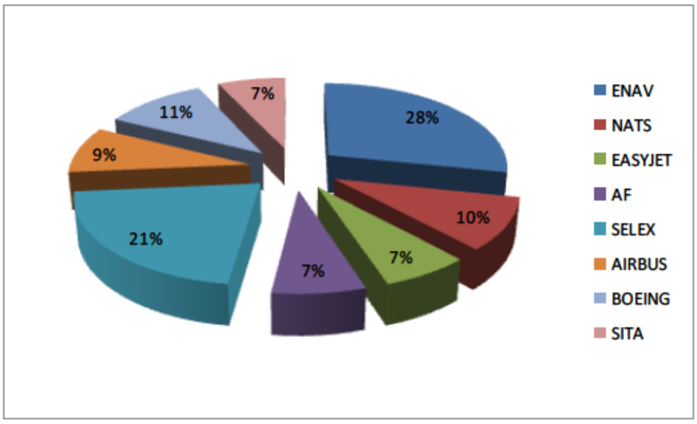


Figure 2 - AFD WBS

The following sections will provide a brief presentation of each Consortium member, its main experiences and contribution to the AFD Project.

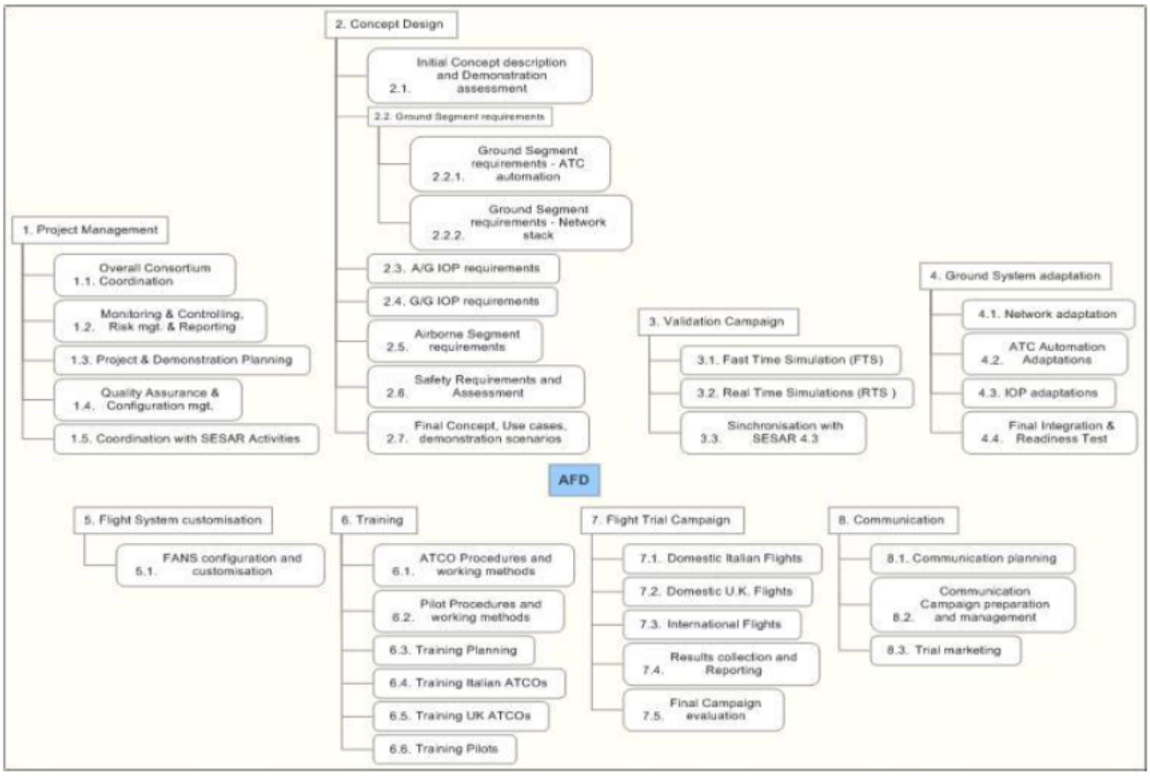
3.1.1 Subcontractor

Along the project lifespan, in compliance with SJU procedures, two subcontracts were activated to complement the available skills with additional specific competences which were needed to successfully complete the project.

- **DeepBlue**, an Italian SME, contributed as ENAV subcontractor along the project activities. Its contribution was mainly due for the Safety assessment and Human factor aspects throughout the various phases of the experimental and demonstration plan.
- **Scandinavian Airlines System Denmark-Norway-Sweden (SAS)**, contributed as ENAV subcontractor to flight trials. Its contribution allowed the project to add Boeing 737 operated opportunity flights, which were not originally available considering that both AF and EZY operated the target fights by A320 family.

3.2 Work Breakdown Structure

The project was organised upon a Work Breakdown Structure which covered all required activities while allowing for clear identification of the competences to be provided by each Consortium partner. The Figure below summarises the highest level of the WBS decompositions into WPs and Tasks.



Each task was led by a single partner, which was overall responsible for the timely conduction of all activities. Each task was participated mainly by a number of partners, depending on the required competences. The full WBS is described in the next table.

WP #	ENAV	NATS	EASYJET	AF	SELEX	AIRBUS	BOEING	SITA
WP 1								
1.1	L	C	C	C	C	C	C	C
1.2	L							
1.3	L	C	C	C	C	C	C	C
1.4	L							
1.5	L	C	C	C	C	C	C	C
WP 2								
2.1	L	C	C	C	C	C	C	C
2.2.1	L	C			C			C
2.2.2	C	C			L			

WP #	ENAV	NATS	EASYJET	AF	SELEX	AIRBUS	BOEING	SITA
2.3					C	L	C	C
2.4			C	C	C	L	C	C
2.5	L	C	C	C	C	C	C	C
2.6	L	C	C	C	C	C	C	C
WP 3								
3.1	C	C	C	C	C	L	C	C
3.2	C	C	C	C	C	L	C	C
WP 4								
4.1					L			C
4.2	C				L			
4.3	C	C	C	C	L	C	C	C
WP 5								
5.1			C	C	C	L	C	C
WP 6								
6.1	L	C				C		
6.2			C	C		L		
6.3	L	C	C	C		C		C
6.4	L							
6.5		L						
6.6			C	L		C		
WP 7								
7.1	C		L					
7.2		C	L					
7.3	C	C	C	L			C	
7.4	L	C	C	C	C	C	C	C
7.5	L	C	C	C	C	C	C	C
WP 8								
8.1	L	C	C	C	C	C	C	C
8.2	L	C	C	C	C	C		C
8.3	L	C	C	C	C	C		C

Table 1 - AFD Project Work Breakdown Structure

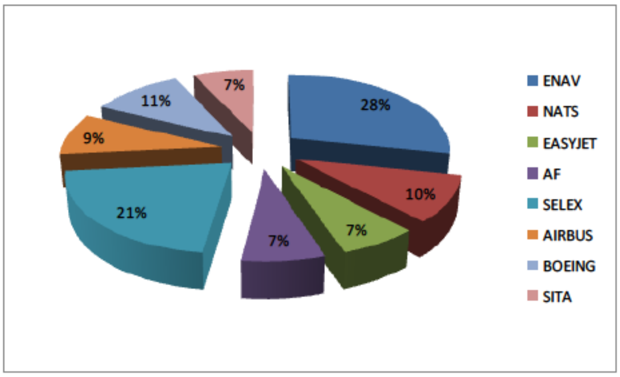


Figure 3 – WP Dimension

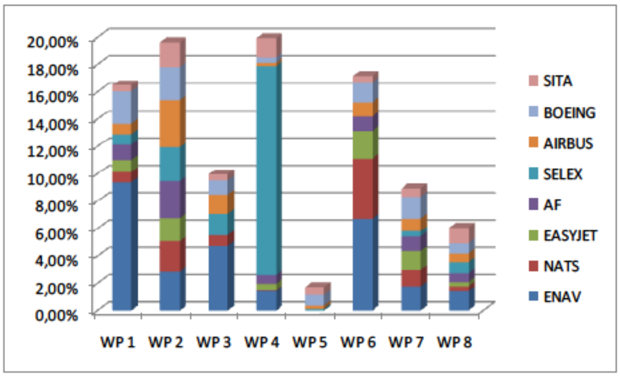


Figure 4 - quote of participation per member per WP

A short description of each WP objectives follows in the next pages:

3.2.1 WP 1: Project Management

To provide all the required management support for the timely and efficient execution of the project, within budget and with the expected level of quality.

3.2.2 WP 2: Concept Design

To precisely scope the demonstration on the basis of the technical and operational evolutions, technical limitations and available workaround, collect the Operational and Safety requirements, refine the Concept of Operations and all the use cases which were managed through the demonstration. A key aspect was availability of workaround to implement immediately proposed new operational concepts on all three segments: avionics, network, hosts systems.

3.2.3 WP 3: Validation Campaign

To support, in a Rapid Application Development approach, the proof of validity of any proposed operational and technical solution along the Conceptual Phase (WP2) and the System adaptation Phase (WP4 and 5). Out of the 2.1 Initial Concept and Demonstration assessment Task, the Validation campaign was designed to get as much as possible outcomes from SESAR V2 and V3 exercises, to avoid duplication and best use of SESAR available/approved validation results. Procedures were validated, prior to flight trials, considering one and then multi-aircrafts by performing both nominal and non nominal scenarios and involving all stakeholders and their related systems.

3.2.4 WP 4: Ground System adaptation

To design and implement any required intervention to the Ground segment, as identified by the OPS/SAF requirements collected in WP2.0. Each implementation was anticipated by a brief CBA, to minimise costs and allow for best utilisation of available Technical Enablers by ad hoc work around, special procedures or working methods, addressing both fidelity to the target SESAR operational concept (under the demonstration conditions), safety and performances.

3.2.5 WP 5: Avionics configuration and customization

To implement any required configuration or programming of the airborne segment, as identified by the OPS/SAF requirements collected in WP2.0.

3.2.6 WP 6: Training

To design procedures and working methods for all active roles in the demonstrator, as described on the basis of the OSED being developed in the Conceptual Phase, and define the training plan to ensure all involved operational resources (ATCOs, Flight Crews) and support were ready to conduct the demonstration flights efficiently.

3.2.7 WP 7: Flight Trial Campaign

To perform the Flight Trial campaign, ensure data collection and results evaluation and assessment.
Flight trials were selected taking into account operating a/c and related equipage, as well as VDL coverage issues.

3.2.8 WP 8: Communication

To ensure an effective communication campaign, showing off results (even intermediate), marketing the progresses and building confidence and buy-in of all stakeholders on the validity of the AFD approach, which finally it is expected to result in an acceleration of IR compliance and exploitation of D/L services beyond its present provision.

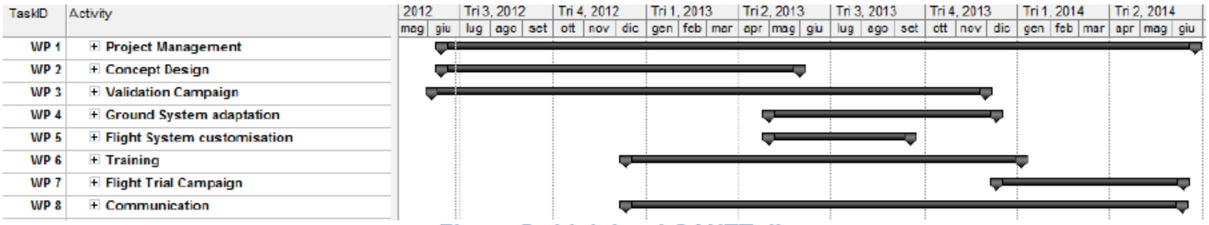


Figure 5 - high level GANTT diagram

The picture above represents the original planning (ref. A1, V00.04.00). The project execution was generally aligned with the original planning. Flight Trial campaign (WP7) was shifted to about 2 months from December 2013 to February 2014.

3.3 Deliverables

The following table lists the contractual deliverables which were due to SESAR JU.

Code	Title	Initial planned date	Due Date
A.1	Refined Project Planning Delivery (V00.01.00)	28/07/2012	28/07/12
A.1	Refined Project Planning Delivery (V00.04.00), to address clarification issues expressed by SJU	N.A.	28/11/2012
B.1	Final Report Delivery	12/06/2014	18/07/14

Table 2 - Main AFD Deliverables

Many documents were produced by the project along its lifespan. This Final Report summarises, along its structure, the main and more relevant results brought by each of them.

On top of the 2 above mentioned contractual deliverables, the project produced a quarterly report per each quarter since its Kick Off. All Quarterly Reports are available in the SJU extranet section dedicated to the project.

Since the KOM, which was held on 13th June 2012 at SJU premises, several face–to- face and WebEx meetings were organized:

Code	Title	Venue	Date
KOM	Kick off Meeting	SJU, Bruxelles	13/12/2012
MS1	Update via WebEx	web	29/08/2012
MS2	Update via WebEx	web	12/09/2012
MS3	First technical meeting	Rome	20-21/09/2012
MS4	First Role Game Meeting	Toulouse	4/12/2012
MS5	Second Role Game Meeting	London	17/12/2012
MS6	Update via WebEx	web	20/12/2012
MS7	Update via WebEx	web	30/01/2013

MS8	Update via WebEx	web	12/03/2013
MS9	Update via WebEx	web	22/04/2013
MS10	Update via WebEx	web	30/05/2013
MS11	Update via WebEx	web	17/07/2013
MS12	Update via WebEx	web	04/09/2013
MS13	SJU Critical Design Review	Rome	20/09/2013
MS14	Demonstration Workshop	Lisbon	27-28/11/2013
MS15	Trial Demo rehearsal	Rome	19/12/2013
MS16	Update via WebEx	web	20/12/2013
MS17	Trial Readiness Meeting	Toulouse	23-24/01/2014
MS18	Update via WebEx	web	28/02/2014
MS19	Update via WebEx	web	28/04/2014
MS20	SJU Critical Design Review	Bruxelles	14/05/2014
MS21	Update via WebEx	web	28/05/2014
MS22	Update via WebEx	web	30/06/2014
MS23	Update via WebEx	web	16/07/2014

Table 3 - List of main Project Meetings

The minutes and presentations or any other documentation which is relevant for each of the listed meetings are available in the SJU extranet section dedicated to the project.

3.4 Risk Management

The following risks were assessed along the execution of the project, as reported in A.1:

- **Lack of capacity**

A lack of capacity happens every day during peak period; the probability of occurrence is set to “medium”. The level of impact is set to “high” since it is always difficult to assess trials during peak period.

- **Drop of capacity**

A drop of capacity barely happens; the probability of occurrence is set to “low”. Since a potential impact would be to postpone trials, the level of impact is set to “high”.

- **Safety issue:**

The probability of occurrence is assessed to “high” since a preliminary safety assessment study is required to know if and under which conditions it is possible to perform trials. The impact has been set to “very high” since no compromise can be found about safety. Thus either solution would have to be found to increase safety or trials would have to be cancelled. The full Safety Assessment was performed as part of the Tasks in WP2 Concept Design.

- **Systems used are not available**

The Implementing Rule is valid from February 2013 for Ground Systems and both ENAV and NATS declared their readiness; both Air France and EasyJet have already equipped aircraft into operation; VDL2 Coverage should be available across the designated routes.

Thus, the probability of occurrence is set to “low”. Since a potential impact would be to postpone trials, the level of impact is set to “high”.

- **Operational procedure not ready**

The probability of occurrence is set to “low” since the project had a long preparatory phase, including Concept Study, validation performed through FTS and RTS, integration into the end-to-end system, training and so forth. As the occurrence of the risk would defer trials to a later date, the level of impact is set to “high”.

- **Experimental conditions not met:**

The probability of occurrence is set to “low” due to the available time planned between beginning of the Project (for WP2 to 6) and the beginning of the trial period (WP7). Should the risk occur, trials could not happen. Thus the risk impact is set to “high”.

Risks Vs. flight trials	Probability of occurrence	Level of Impact	Risk assessment
Lack of the Capacity	Medium (3)	High (4)	12
Drop of the Capacity	Low (2)	High (4)	8
Safety issue	High (4)	Very High (5)	20
Systems used not available	N/A (0)	N/A (0)	0
Operational procedure not ready	Low (2)	High (4)	8
Experimentation conditions are not met	Low (2)	High (4)	8

Table 4 - Preliminary Risk Board

3.4.1 Risks mitigation

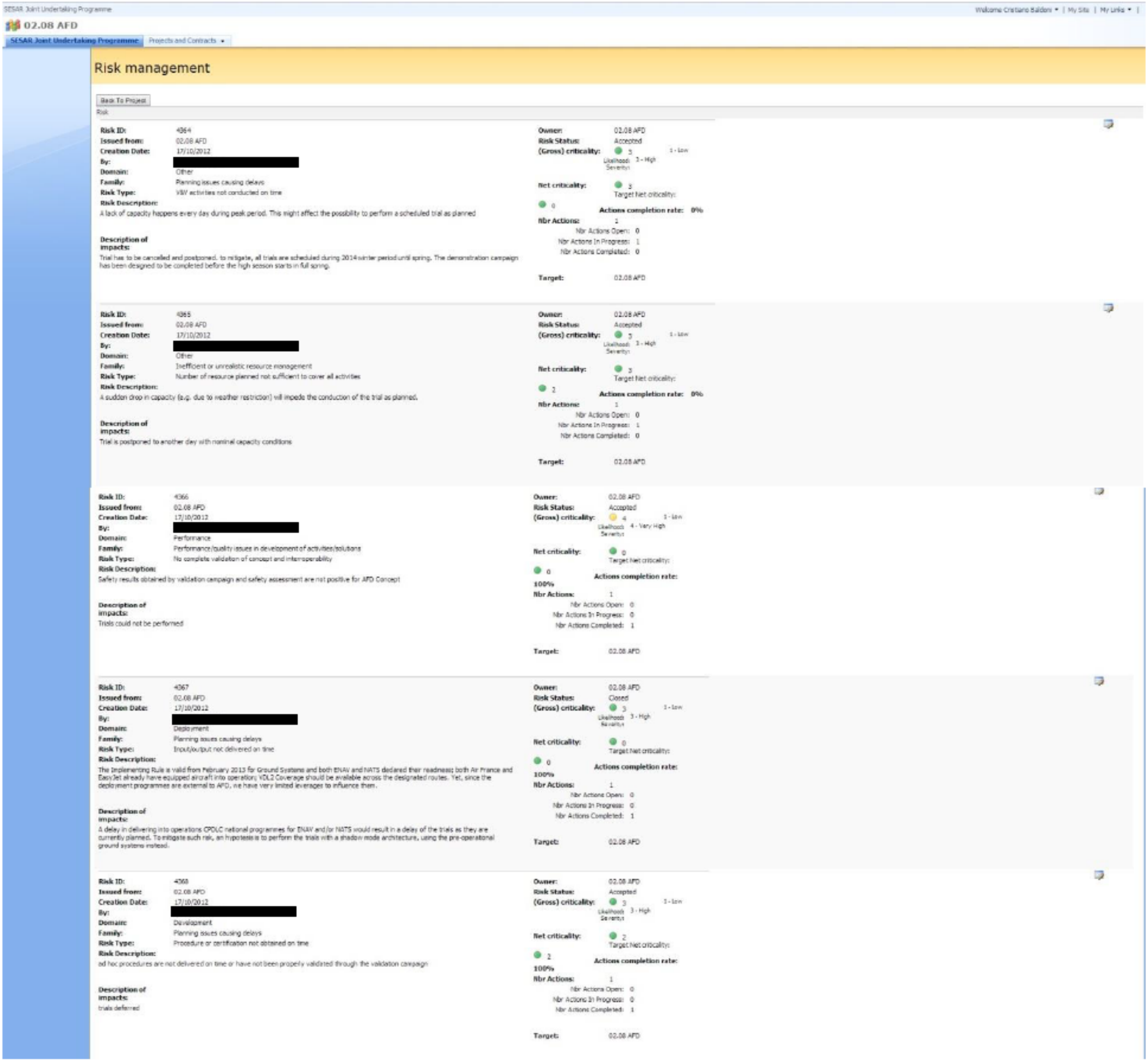
Specific mitigation actions were taken for those risks where the result of the risk assessment was higher than 10.

- **Lack of the Capacity**

It was decided to mitigate such a risk by selecting carefully of the trial candidate flights at a time slot when the demand is lower than the capacity.

- **Safety issue**

In order to mitigate the risk, safety assessment was a pre-requisite of flight trials preparation. Safety assessment was performed by both ANSPs and air carriers. Outcomes of the safety assessment were integrated into the flight trials procedure.



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02.08 AFD

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Risk management

Back To Project

Risk

Risk ID: 4364
Issued from: 02.08 AFD
Creation Date: 17/10/2012
By: [redacted]
Domain: Other
Family: Planning issues causing delays
Risk Type: V&V activities not conducted on time
Risk Description:
A lack of capacity happens every day during peak period. This might affect the possibility to perform a scheduled trial as planned

Description of impacts:
Trial has to be cancelled and postponed. to mitigate, all trials are scheduled during 2014 winter period until spring. The demonstration campaign has been designed to be completed before the high season starts in full spring.

Owner: 02.08 AFD
Risk Status: Accepted
(Gross) criticality: 3 — Likelihood: 1 - Low; Severity: 3 - High
Net criticality: 3
Target Net criticality: 0
Actions completion rate: 0%
Nbr Actions: 1
Nbr Actions Open: 0
Nbr Actions In Progress: 1
Nbr Actions Completed: 0
Target: 02.08 AFD

Risk ID: 4365
Issued from: 02.08 AFD
Creation Date: 17/10/2012
By: [redacted]
Domain: Other
Family: Inefficient or unrealistic resource management
Risk Type: Number of resource planned not sufficient to cover all activities
Risk Description:
A sudden drop in capacity (e.g. due to weather restriction) will impede the conduction of the trial as planned.

Description of impacts:
Trial is postponed to another day with nominal capacity conditions

Owner: 02.08 AFD
Risk Status: Accepted
(Gross) criticality: 3 — Likelihood: 1 - Low; Severity: 3 - High
Net criticality: 3
Target Net criticality: 2
Actions completion rate: 0%
Nbr Actions: 1
Nbr Actions Open: 0
Nbr Actions In Progress: 1
Nbr Actions Completed: 0
Target: 02.08 AFD

Risk ID: 4366
Issued from: 02.08 AFD
Creation Date: 17/10/2012
By: [redacted]
Domain: Performance
Family: Performance/quality issues in development of activities/solutions
Risk Type: No complete validation of concept and interoperability
Risk Description:
Safety results obtained by validation campaign and safety assessment are not positive for AFD Concept

Description of impacts:
Trials could not be performed

Owner: 02.08 AFD
Risk Status: Accepted
(Gross) criticality: 4 — Likelihood: 1 - Low; Severity: 4 - Very High
Net criticality: 0
Target Net criticality: 0
Actions completion rate: 100%
Nbr Actions: 1
Nbr Actions Open: 0
Nbr Actions In Progress: 0
Nbr Actions Completed: 1
Target: 02.08 AFD

Risk ID: 4367
Issued from: 02.08 AFD
Creation Date: 17/10/2012
By: [redacted]
Domain: Deployment
Family: Planning issues causing delays
Risk Type: Input/output not delivered on time
Risk Description:
The Implementing Rule is valid from February 2013 for Ground Systems and both ENAV and NATS declared their readiness; both Air France and EasyJet already have equipped aircraft into operation; VDL2 Coverage should be available across the designated routes. Yet, since the deployment programmes are external to AFD, we have very limited leverages to influence them.

Description of impacts:
A delay in delivering into operations CPDLC national programmes for ENAV and/or NATS would result in a delay of the trials as they are currently planned. To mitigate such risk, an hypotesis is to perform the trials with a shadow mode architecture, using the pre-operational ground systems instead.

Owner: 02.08 AFD
Risk Status: Closed
(Gross) criticality: 3 — Likelihood: 1 - Low; Severity: 3 - High
Net criticality: 0
Target Net criticality: 0
Actions completion rate: 100%
Nbr Actions: 1
Nbr Actions Open: 0
Nbr Actions In Progress: 0
Nbr Actions Completed: 1
Target: 02.08 AFD

Risk ID: 4368
Issued from: 02.08 AFD
Creation Date: 17/10/2012
By: [redacted]
Domain: Development
Family: Planning issues causing delays
Risk Type: Procedure or certification not obtained on time
Risk Description:
ad hoc procedures are not delivered on time or have not been properly validated through the validation campaign

Description of impacts:
trials deferred

Owner: 02.08 AFD
Risk Status: Accepted
(Gross) criticality: 3 — Likelihood: 1 - Low; Severity: 3 - High
Net criticality: 2
Target Net criticality: 2
Actions completion rate: 100%
Nbr Actions: 1
Nbr Actions Open: 0
Nbr Actions In Progress: 0
Nbr Actions Completed: 1
Target: 02.08 AFD

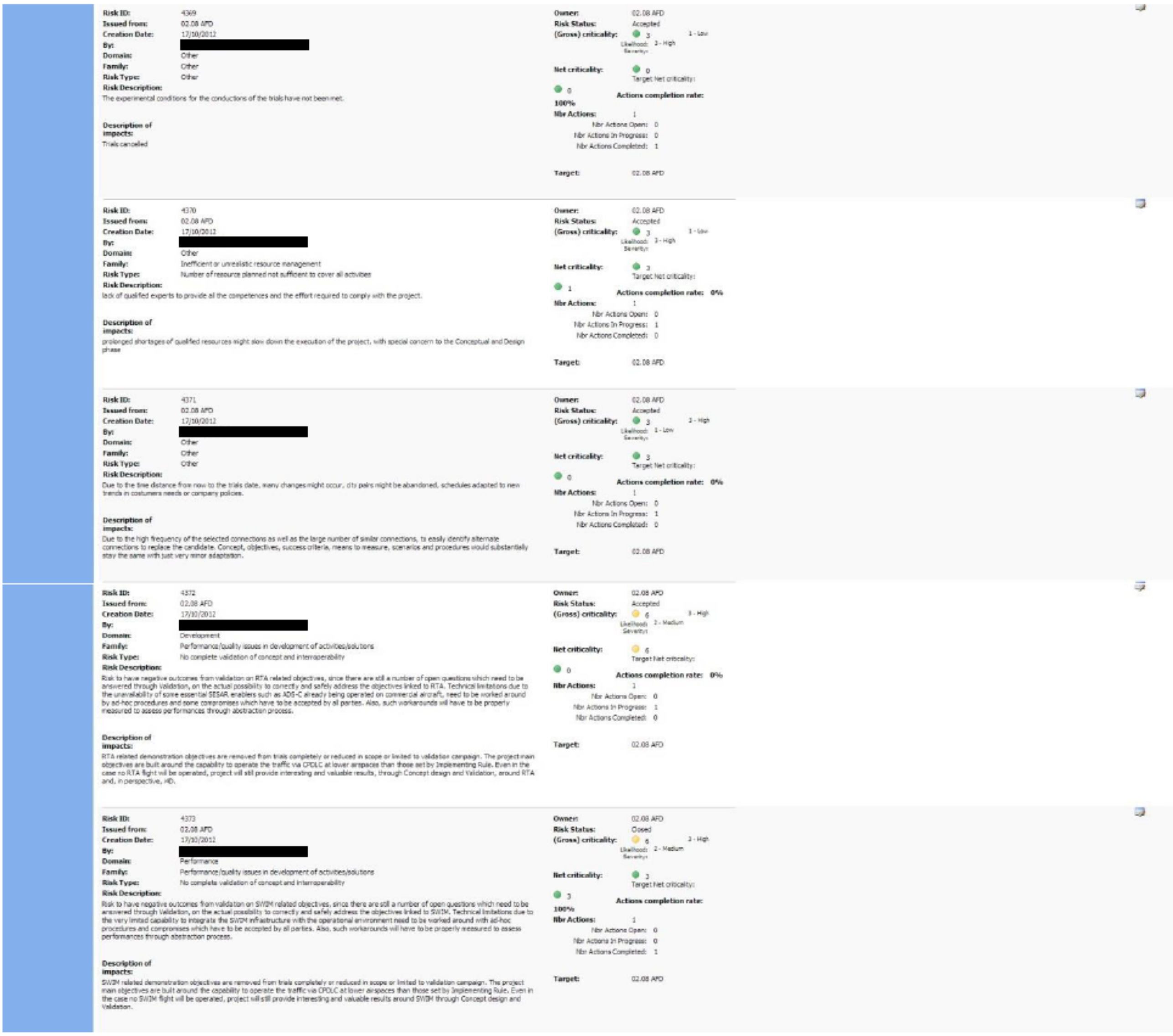


Figure 6 - Extranet Risk Management

3.4.2 Opportunities

At the beginning of the project, an opportunity was anticipated, which was linked with Boeing being part of the Consortium and the expectation to have, along the project, airlines operating B737 which were expected to be equipped with the Boeing Link2000+ Communication Package at the time of the trial. The intention was to explore the possibility to extend the demonstration plan to include them.

The opportunity finally materialised through the inclusion of SAS among the participants (through subcontract with ENAV). SAS currently operates Boeing 737 aircraft which are equipped with VDL2 radio and comply with IR29/2009.

4 Execution of Demonstration Exercises

4.1 Exercises Preparation

The two ANSPs involved in the project, ENAV and NATS, adopted a slightly different approach on the execution of the Flight Trials campaign. This difference is due to the fact that NATS used the system already in operation on their ACCs, while ENAV have preferred to decouple the platform used for such trials from the ops room, mainly because on this way the NSA authorized the usage of datalink on a lower airspace.

The AFD platform used for controlling flights in Italian airspace is located at Rome ACC, in the simulation room. The radar picture of the CWP was aligned with the one used in the ops room (the two FDP were mirrored) and ops controllers were constantly in contact with the AFD controllers. The ALTDEP/ALTARR identified for the campaign in Italy was FL100: all target flights, passing FL100, were controlled totally through datalink, with voice used just, on change of frequencies, for radio check.

NATS ALTDEP/ALTARR was defined to FL195 but, after NSA approval, it became FL100 for the final part of their flight trials campaign.

In order to design common operational procedures, based on similar technological enablers, a step-by-step experimental approach was undertaken, divided in 4 phases, explained in depth here below.

The activities for the execution of the experimental plan can be summarized in four steps:

- **01/09/2012 - 30/04/2013 Feasibility study (PHASE 1):** A feasibility study analysed both technical and operational aspects. Once defined technical limitations, an operational study was conducted to design operational procedures to conduct AFD experiment. To do so, two role gaming sessions were conducted, with all operational actors involved in. Feedbacks were collected and operational procedures readjusted accordingly.

- **01-31/07/2013 Communications test (PHASE 2):** AFD platform, located in Rome ACC, exchanged CPDLC messages with Airbus and Boeing Test Benches using the operational datalink network. The full set of messages identified for the execution of AFD, except for the ones for RTA, was tested;

- **5-10-12/09/2013 Execution of the experimental plan (PHASE 3 step 1):** AFD platform was fully connected with Airbus Cockpit Simulator. A shadow flight was conducted following AFD procedures. No RTA for this flight;

- **28/10/2013 – 19/12/2013 Execution of the experimental plan (PHASE 3 step 2)**: The update of AFD platform, including a new HMI, with an integrated label including both datalink and Mode-S surveillance data features and RTA messages, was completed and several simulated flight were conducted.

- **20/12/2013 – 31/01/2014 Preparation of trials (PHASE 4):** a collection of all outputs resulting from previous phases, representing the evidence that the project was on the right track to tackle AFD Execution Phase.

Each experimental exercise was designed to respond to one or more Experimental Objectives, detailed above.

4.1.1 Phase 1 Exercises

A feasibility study analysed both technical and operational aspects. Once defined technical limitations, an operational study was conducted to design operational procedures to conduct AFD Flight Trials.

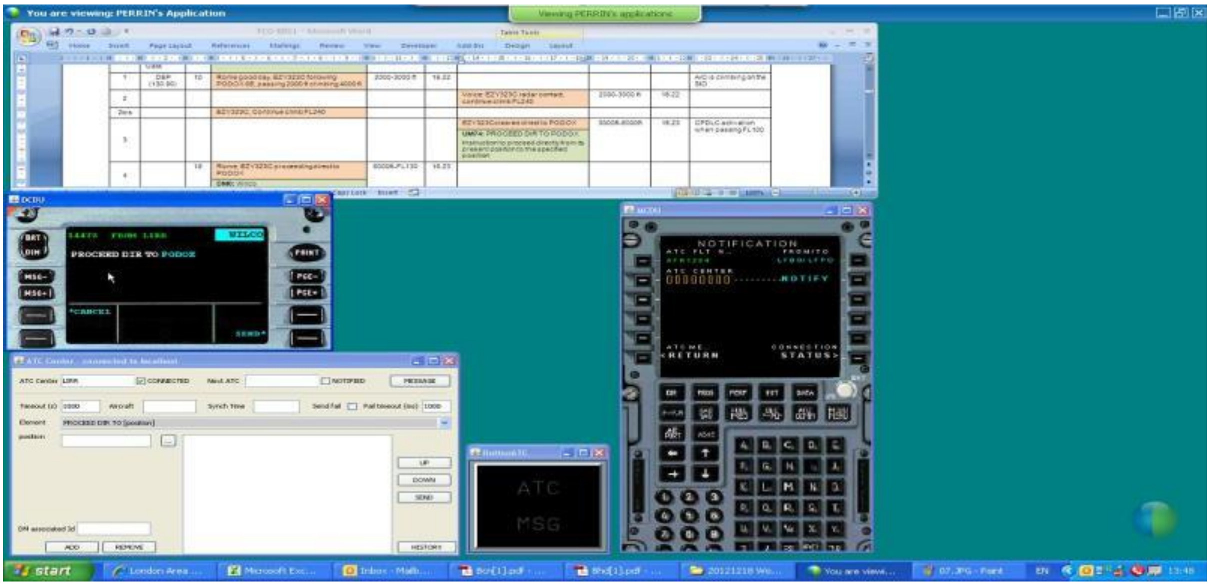
To do so, two role gaming sessions were conducted, with all operational actors involved in. Feedbacks were collected and operational procedures readjusted accordingly.

4.1.1.1 Resources

- ENAV and NATS ATCOs and engineers
- Air France and EasyJet pilots
- Airbus engineers
- Selex-ES engineers

4.1.1.2 Systems

An Airbus mock-up was used, able to replicate both sides of datalink communications, air and ground.



4.1.1.3 Scenario

4.1.1.3.1 Role gaming #1 (FCO-CDG)

4.1.1.3.1.1 Scenario

Normal day of operations. Winter/Spring 2014. Daytime. AFR A320 flight operating between Rome (FCO) and Paris (CDG). Climb and Cruise phases and transition from Climb to Cruise. A/C was accepted by first ACC Sector via Datalink; Flight Plan consistency verification was conducted by CPDLC dialogue with complement of DAP directly available to the R-ATSU. CPDLC operations were maintained till transfer to next FIR (Swiss Upper Airspace). Revert to R/T only for contingency or abnormal conditions. Transfers of responsibility across sectors and across adjacent FIRs were performed silently within Italian Airspace

4.1.1.3.1.2 Procedure

- Call-sign: AFR1205

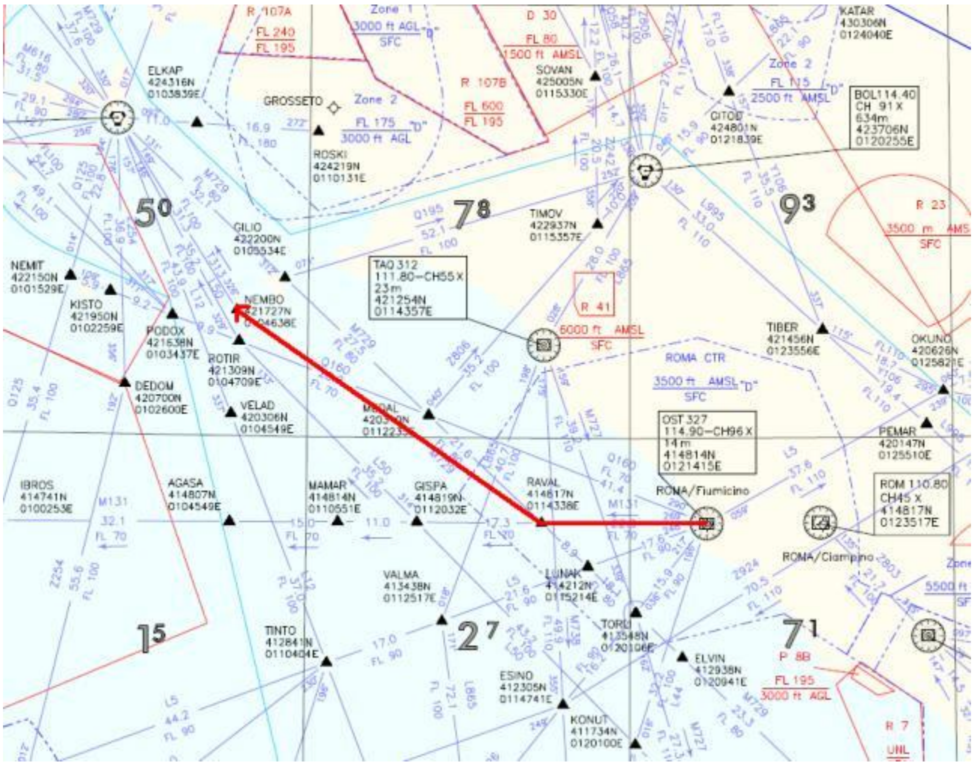
- Route: NEMBO 5A – UT131 – ELB – UM729 – DEVOX – TONDA – AOSTA

- Roles:
    - ATCO EXE/PLN: provided by ENAV
    - Pilot: provided by Air France
    - Game master/note keeper: provided by AIRBUS

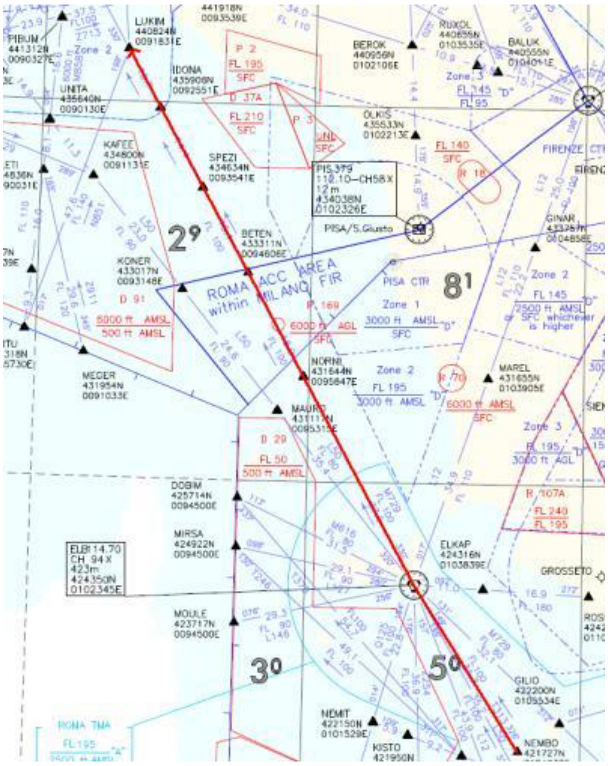
-Sectors involved:

	Point	Sector	Relative Distance between points (NM)	Total distance (NM)
Area of Responsibility DEP	FCO	DEP	0	0
	RAVAL	DEP→NW	22,9	22,9
	NEMBO	NW	58	80,9
Area of Responsibility NW	ELB	NW	31,3	112,2
	NORNI	NW	37,6	149,8
	BETEN	NW→MIU	18,9	168,7
Area of responsibility MIU	SPEZI	MIU	15,4	184,1
	IDONA	MIU	14,4	198,5
	LUKIM	MIU	10,7	209,2
	GEN	MIU	19,7	228,9
	DEVOX	MIU	21,7	250,6
	TONDA	MIU	33,2	283,8
	PIMOT	MIU→SWISS	32,1	315,9
	AOSTA	SWISS	23,6	339,5

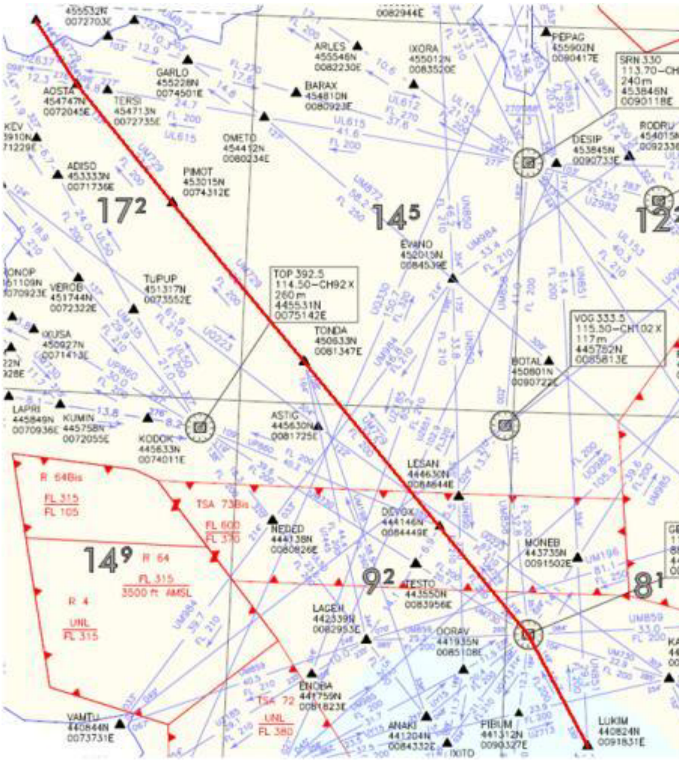
DEP Lower Sector (GND – FL245):



NW Upper Sector (FL245 – FL460):



MIU Upper Sector (FL320 – FL460):



Step	Sector	NM	Pilot voice/CPDLC/CPDLC System generated message	Altitude Band	Time	ATCO voice/CPDLC/CPDLC System generated message	Altitude Band	Time	Note
0	On ground at the Gate	0	Logon[1]	0 ft	10.00				
1	DEP (130.90)	10	Rome good -day, AFR1205 following NEMBO5A, passing 2000 ft climbing 4000 ft	2000-3000 ft	10.22				A/C is climbing on the SID
2						Voice: AFR1205 radar contact, continue climb FL240	2000-3000 ft	10.22	
3						AFR1205 cleared direct to NEMBO **UM74:** PROCEED DIR TO NEMBO Instruction to proceed directly from its present position to the specified position	3000ft-6000ft	10.23	
4		18	Rome, AFR1205 proceeding direct to NEMBO **DM0:** Wilco	6000ft-FL130	10.23				
5		66				AFR1205 contact 124.80 **UM117**: CONTACT LIRR CTR 124.80 Instruction that the ATS unit with the specified ATS unit name is to be contacted on the specified frequency	FL130-FL160	10.31	
6		67	Contact 124.80 AFR1205 **DM0:** Wilco	FL160-FL180	10.31				

[1] After logon message the ground system sends to aircraft the Logon Response.

After Logon Response he ground system sends to aircraft the CPDLC Connection Request and the Aircraft will send the CPDLC Connection Response after this the Aircraft will send to the Ground system the CPDLC Message DM99 (CDA).

The Ground system will send the pre-formatted UM183 (free-text) message with "[ICAOfacilitydesignation] [facilityname] [facilityfunction]".

Step	Sector	NM	Pilot voice/CPDLC/CPDLC System generated message	Altitude Band	Time	ATCO voice/CPDLC/CPDLC System generated message	Altitude Band	Time	Note
7	NW (124.80)	74	Rome buongiorno, AFR1205, passing FL190 climbing to FL240	FL180-FL200	10.32				
8						AFR1205, buongiorno Rome. Radar contact.	FL180-FL190	10.32	
9						AFR1205, continue climb FL300 **UM 20:** CLIMB TO FL300 Instruction that a climb to a specified level is to commence and once reached the specified level is to be maintained	FL190-FL200	10.34	
10		90	Rome, AFR1205 continue climb FL300 **DM0:** Wilco	FL190-FL200	10.34				
11		106	Rome, AFR1205 request direct to TONDA due to weather **DM22:** REQUEST DIR TO TONDA Request to track from the present position direct to the specified position **DM65:** DUE TO WEATHER Used to explain reasons for pilot's message[2]	FL220-FL260	10.37				
12						AFR1205 roger. Standby. **UM1:** STANDBY Indicates that ATC has received the message and will respond.	FL220- FL260	10.37	
13						AFR1205 proceed direct to TONDA	FL220- FL260	10.38	

[2] Pilot will send the concatenate DM22+DM65 messages.

Step	Sector	NM	Pilot voice/CPDLC/CPDLC System generated message	Altitude Band	Time	ATCO voice/CPDLC/CPDLC System generated message	Altitude Band	Time	Note
						UM74: PROCEED DIR TO TONDA Instruction to proceed directly from its present position to the specified position			
14		115	Rome, AFR1205 proceed direct to TONDA **DM0:** Wilco	FL220-FL260	10.38				
15		131	Rome, AFR1205 approaching FL300 , requesting FL360 **DM6:** REQUEST 360 Request to fly to the specified level	FL260-FL280	10.40				
16						AFR1205, Rome climb FL360 **UM20:** CLIMB TO FL 360 Instruction that a climb to a specified level is to commence and once reached the specified level is to be maintained	FL260-280	10.40	
17		139	Rome, AFR1205 climbing FL360 **DM0:** Wilco	FL260-FL300	10.41				
18						AFR1205 contact 132.905 **UM117:** CONTACT LIRR 132.905 Instruction that the ATS unit with the specified ATS unit name is to be contacted on the specified frequency 132.905	FL260- FL300	10.41	
19		143	Contact 132.905, AFR1205 **DM0**: Wilco	FL300-FL320	10.41				
20	MIU (132.905)	151	Rome buongiorno, AFR1205, passing FL320 climbing to FL360 inbound TONDA	FL320-FL360	10.42				
21		155				AFR1205, buongiorno Rome. Radar contact.	FL320-FL360	10.42	

Step	Sector	NM	Pilot voice/CPDLC/CPDLC System generated message	Altitude Band	Time	ATCO voice/CPDLC/CPDLC System generated message	Altitude Band	Time	Note
22		330				AFR1205 contact Geneva 128.155 **UM117:** CONTACT LSGG 128.155 Instruction that the ATS unit with the specified ATS unit name is to be contacted on the specified frequency 128.155	FL360	11.07	Approaching AOSTA
23		334	Contact 128.155 AFR1205 **DM0:** Wilco[3]	FL360	11.03				
Entry into Swiss airspace									

[3] The flight will be CPDLC disconnected.

4.1.1.3.2 Role gaming #1 (CDG-FCO)

4.1.1.3.2.1 Scenario

Cruise and Descend phases and transition from Cruise to descend. A/C was accepted by first ACC Sector via datalink; Flight Plan consistency verification (FLIPCY) was conducted by CPDLC dialogue with complement of DAP directly available to the R-ATSU. CPDLC operations were maintained till ALTARR. Revert to R/T only for contingency or abnormal conditions. Transfers of responsibility across sectors and across adjacent FIRs were performed silently. Through CPDLC supported by Ad-Hoc Procedure, Sequence Manager at Rome ARR selected the best arrival target time at an entrance waypoint (e.g. TIBER) within the flyable A/C ETA min /max in the operating conditions and approved Flight Plan. Selected target time was requested via CPDLC to the Flight Crew to set up capable FMS to consider the corresponding RTA as a soft constraint

4.1.1.3.2.2 Procedure

- Call-sign: AFR1206

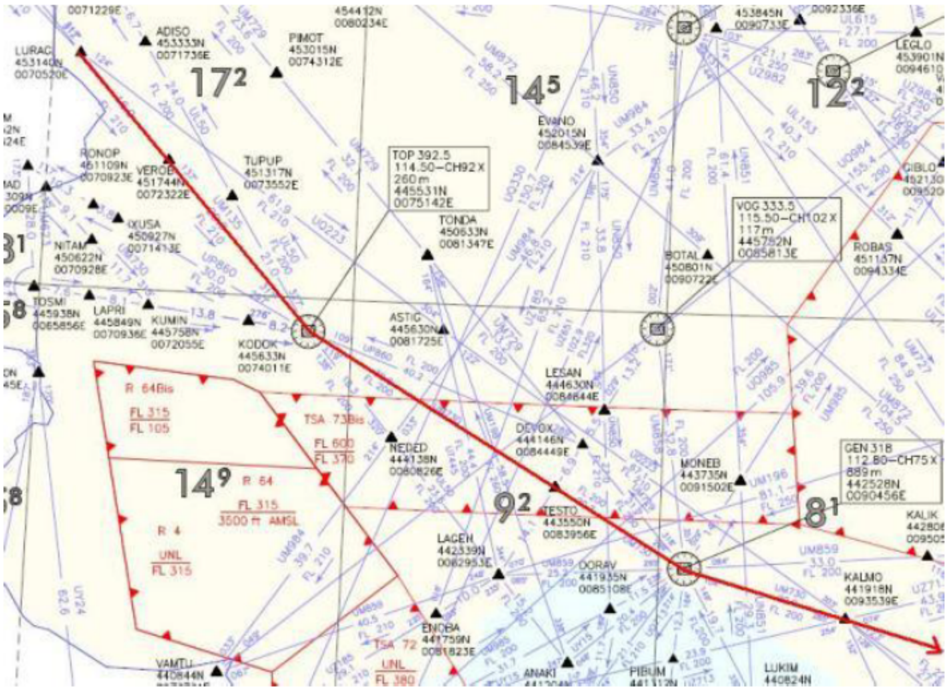
- Route: LURAG-TOP → GEN → BEROK → UQ705 → Link-Route XIBIL4A (XIBIL-RINAD-TAQ) → STAR TAQ1A → RWY16L

- Roles:
    - ATCOs EXE/PLN: provided by ENAV
    - Pilot: provided by Air France
    - Game master/note keeper: provided by AIRBUS

-Sector involved:

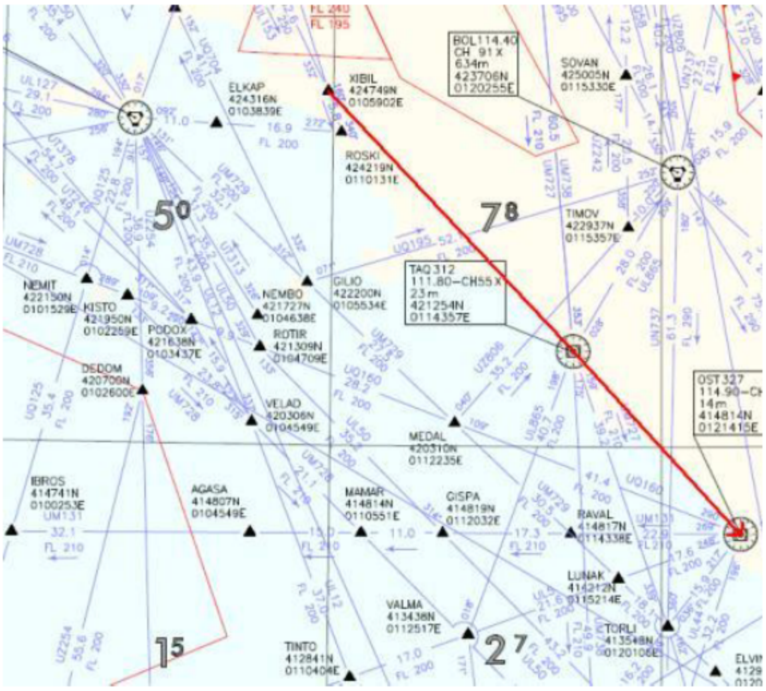
	Point	Sector	Relative distance between points	Total distance
Area of Responsibility MIU	LURAG	MIU	0	0
	VEROB	MIU	18,9	18,9
	TOP	MIU	29,9	48,8
	GEN	MIU	20,7	109,1
	BEROK	MIU→NW	34	166
Area of Responsibility NW	XIBIL	NW	25,5	191,5
	RINAD	NW→ARR	61,1	252,6
Area of Responsibility ARR	TAQ	ARR	48,7	301,3

MIU Upper Sector (FL315 – FL460):



NE Upper Sector (FL245 – FL460):

ARR Lower Sector (GND – FL245):



Step	Sector	NM	Pilot voice/CPDLC/CPDLC System generated message	Altitude Band	Time	ATCO voice/CPDLC/CPDLC System generated message	Altitude Band	Time	Note
0	Marseille ACC		Logon[4]						Before entering Italian Airspace
1	MIU (132,905)	Before the boundary	Rome good-day, AFR1206 inbound LURAG maintaining FL390	FL390	14.10				ETA to TAQ will be sent by A/C via ACARS (telex) to Rome ACC
2		Before the boundary				AFR1206, Rome good-day. Radar contact. Proceed LURAG-TOP UM730 BEROK UQ705 TAQ TAQ1A **UM79:** Instruction to proceed to the specified position via the specified route CLR TO [GOLPO] VIA [LURAG TOP UM730 BEROK UQ705 TAQ TAQ1A]	FL390	14.10	
3		0	Rome, AFR1206 proceeding LURAG-TOP UM730 BEROK UQ705 TAQ TAQ1A **DM0:** Wilco	FL390	14.11				RTA has to be send before the A/C passes TOP
4						**UM51:** CROSS TAQ AT [ETA ± Δt] Instruction to cross the specified point at a requested time		14.12	RTA shall be very close to the ETA communicated by the A/C via its AOC. Δt has to be subject to agreement between the controller and the A/C operator before starting the trial.
5		8	**DM0:** Wilco		14.12				
6						**UM46:** CROSS TAQ AT FL 110 Instruction to cross the specified point at a requested level		14.13	Optional instruction given by the controller if this additional constraint is needed on tactical base considerations

[4] After logon message the ground system sends to aircraft the Logon Response.

After Logon Response the ground system sends to aircraft the CPDLC Connection Request and the Aircraft will send the CPDLC Connection Response, after this, the Aircraft will send to the Ground system the CPDLC Message DM99 (CDA).

The Ground system will send the pre-formatted UM183 (free-text) message with "[ICAOfacilitydesignation] [facilityname] [facilityfunction]".

Step	Sector	NM	Pilot voice/CPDLC/CPDLC System generated message	Altitude Band	Time	ATCO voice/CPDLC/CPDLC System generated message	Altitude Band	Time	Note
7		15	**DM0:** Wilco		14.13				
8		21	Rome, AFR1206 request direct BEROK **DM22:** REQUEST DIRECT TO BEROK Request to track from the present position direct to the specified position. **DM65:** DUE TO WEATHER Used to explain reasons for pilot's message[5]	FL390	14.14				
9		28				AFR1206, Rome. Roger, direct to BEROK. **UM74:** PROCEED DIR TO BEROK Instruction to proceed directly from its present position to the specified position.	FL390	14.15	
10		29	AFR1206 proceeding direct to BEROK **DM0:** Wilco	FL390	14.15				
11		112				AFR1206, Rome. Contact 133.70 **UM117:** CONTACT 133.70 Instruction that the ATS unit with the specified ATS unit name is to be contacted on the specified frequency previously specified next data authority	FL390	14.31	
12		113	Contact 133.70, AFR1206 **DM0:** Wilco	FL390	14.31				
13	NE (133.70)	120	Rome good-day, AFR1206	FL390	14.32				
14		122				AFR1206, buongiorno Roma. Radar contact	FL390	14.33	
15		200				AFR1206, Roma, cleared to TAQ via	FL390	14.44	

[5] Pilot will send the concatenate DM22+DM65 messages.

Step	Sector	NM	Pilot voice/CPDLC/CPDLC System generated message	Altitude Band	Time	ATCO voice/CPDLC/CPDLC System generated message	Altitude Band	Time	Note
						XIBIL 4A **UM79:** CLEARED TO TAQ VIA XIBIL 4A Instruction to proceed to the specified position via the specified route			
16		202	AFR1206 cleared to TAQ via XIBIL 4A **DM0:** Wilco	FL390	14.44				
17		223	Roma, AFR1206 request descent FL110 **DM6:** REQUEST 190 Request to fly to the specified level	FL390	14.47				It is not available at the time to have a message for a general request of descent, as normally is done by airlines without specify a particular FL
18		224				AFR1206, Rome. Unable **UM0:** Unable	FL390	14.47	
19		231				AFR1206, Rome. Descend to FL250 **UM23:** DESCEND TO FL250 Instruction that a descent to a specified level is to commence and once reached the specified level is to be maintained	FL390-FL250	14.48	
20		233	Rome, AFR1206 cleared to descent FL250 **DM0:** Wilco	FL390-FL250	14.48				
21						AFR1206, Rome. Contact 125.50 **UM117:** CONTACT LIRR CTR 125.50 Instruction that the ATS unit with the specified ATS unit name is to be contacted on the specified frequency	FL390-FL250	14.52	
22		250	Contact 125.50, AFR1206 **DM0:** Wilco	FL390-FL250	14.53				

Step	Sector	NM	Pilot voice/CPDLC/CPDLC System generated message	Altitude Band	Time	ATCO voice/CPDLC/CPDLC System generated message	Altitude Band	Time	Note
23	ARR (125.50)	257	Rome good-day, AFR1206. Radio check	FL270-FL250	14.54				
24						AFR1206, Rome. Cleared to TAQ for TAQ 1A **UM79:** PROCEED DIR TO TAQ Instruction to proceed directly from its present position to the specified position	FL270-FL250	14.54	
25		264	Rome, AFR1206 cleared to TAQ 1A **DM0:** Wilco	FL270-FL250	14.55				
26						AFR1206, Rome. Descent to FL110 **UM23:** DESCEND TO FL110 Instruction that a descent to a specified level is to commence and once reached the specified level is to be maintained	FL250	14.57	
27		278	Rome, AFR1206 cleared to descent FL110 **DM0:** Wilco	FL250-FL110	14.57				
28		292	AFR1206, request to maintain 300 Kts **DM18:** REQUEST 300Kts Request to assume the specified speed	FL110	14.59				
29						AFR1206, Rome. Roger, maintain 300 Kts **UM106:** MAINTAIN 300Kts Instruction that the specified speed is to be maintained	FL110	14.59	
30		294	Rome, AFR1206 maintaining 300Kts **DM0:** Wilco	FL110					
31						AFR1206, Rome. Continue descent FL90 **UM23:** DESCEND TO FL90 Instruction that a descent to a specified level is to commence and	FL110	15.00	

Step	Sector	NM	Pilot voice/CPDLC/CPDLC System generated message	Altitude Band	Time	ATCO voice/CPDLC/CPDLC System generated message	Altitude Band	Time	Note
						once reached the specified level is to be maintained			
32		296	Rome, AFR1206 cleared to descent FL90 **DM0:** Wilco	FL110-FL90	15.00				
End of CPDLC use									

4.1.1.3.3 Role gaming #2 (FCO-BRS)

4.1.1.3.3.1 Scenario

Normal day of operations. Winter/Spring 2014. Daytime. EZY A320 flight operating between Rome (FCO) and Bristol (BRS). Climb, Cruise and Descend phases and transition from Cruise to descend. A/C was accepted by first ACC Sector via Datalink; Flight Plan consistency verification was conducted by CPDLC dialogue with complement of DAP directly available to the R-ATSU. CPDLC operations were suspended (in the frame of AFD) when the A/C was leaving the Italian Airspace and resumed when A/C was entering UK Airspace, then maintained till FL195. Revert to R/T only for contingency or abnormal conditions. Transfers of responsibility across sectors and across adjacent FIRs were performed silently.

4.1.1.3.3.2 Procedure

- Call-sign: EZY323C

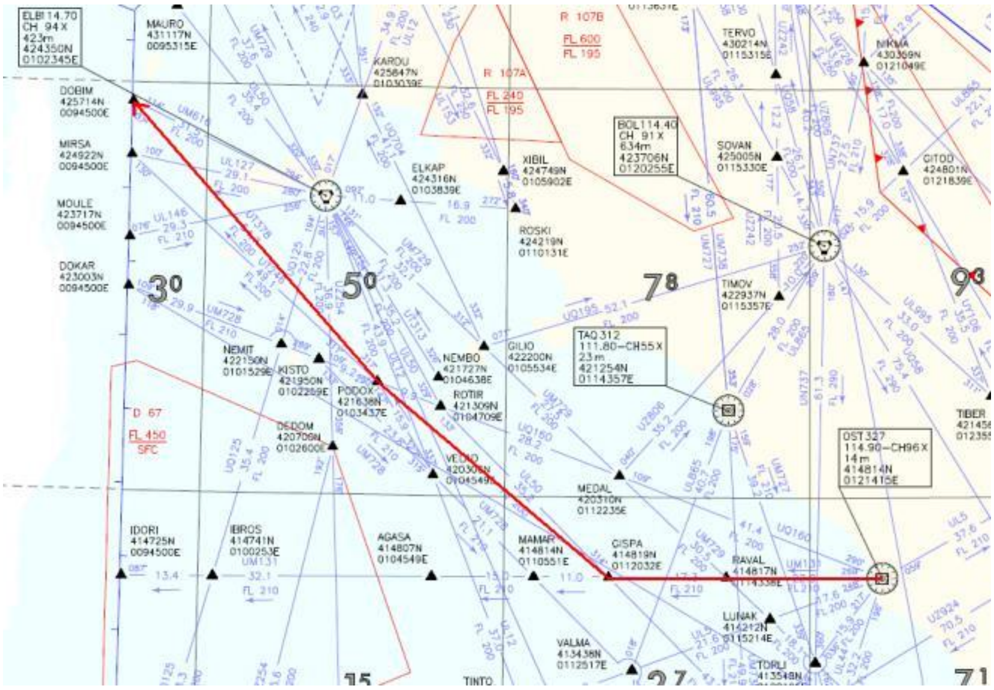
- Route: PODOX 6E – UT378 – DOBIM

- Roles:
    - ATCO EXE/PLN: provided by ENAV
    - Pilot: provided by Easy Jet
    - Game master/note keeper: NATS

-Sectors involved:

	Point	Sector	Relative Distance between points (NM)	Total distance (NM)
Area of Responsibility DEP	FCO GISPA PODOX	DEP DEP→NW NW	0 40 44,5	0 40 88,5
Area of Responsibility NW	DOBIM	NW→MARS	54,7	143,2

DEP Lower Sector (GND – FL245) and NW Upper Sector (FL245 – FL460):



Step	Sector	NM	Pilot voice/CPDLC/CPDLC System generated message	Altitude Band	Time	ATCO voice/CPDLC/CPDLC System generated message	Altitude Band	Time	Note
0	On ground at the Gate	0	Logon[6]	0ft	16.00				
1	DEP (130.90)	10	Rome good day, EZY323C following PODOX 6E, passing 2000 ft climbing 4000 ft	2000-3000 ft	16.22				A/C is climbing on the SID
2						Voice: EZY323C radar contact, continue climb FL240	2000-3000 ft	16.22	
2bis			EZY323C, Continue climb FL240						
3						EZY323Ccleared direct to PODOX **UM74:** PROCEED DIR TO PODOX Instruction to proceed directly from its present position to the specified position	3000ft-FL130	16.23	CPDLC activation when passing FL100
4		18	Rome, EZY323C proceeding direct to PODOX **DM0:** Wilco	FL130-FL160	16.23				
5		66				EZY323C contact 124.80 **UM117**: CONTACT LIRR CTR 124.80 Instruction that the ATS unit with the specified ATS unit name is to be contacted on the specified frequency	FL130-FL160	16.31	
6		67	Contact 124.80 EZY323C **DM0:** Wilco	FL160-FL180	16.31				
7	NW	74	Rome buongiorno, EZY323C, passing	FL180-FL200	16.32				

[6] After logon message the ground system sends to aircraft the Logon Response.

After Logon Response the ground system sends to aircraft the CPDLC Connection Request and the Aircraft will send the CPDLC Connection Response, after this, the Aircraft will send to the Ground system the CPDLC Message DM99 (CDA).

The Ground system will send the pre-formatted UM183 (free-text) message with "[ICAOfacilitydesignation] [facilityname] [facilityfunction]".

Step	Sector	NM	Pilot voice/CPDLC/CPDLC System generated message	Altitude Band	Time	ATCO voice/CPDLC/CPDLC System generated message	Altitude Band	Time	Note
	(124.80)		FL190 climbing to FL240						
8						EZY323C, Rome buongiorno. Radar contact.	FL180-FL190	16.32	
9						EZY323C, continue climb FL300 **UM 20:** CLIMB TO FL300 Instruction that a climb to a specified level is to commence and once reached the specified level is to be maintained	FL190-FL200	16.34	
10		90	Rome, EZY323C continue climb FL300 **DM0:** Wilco	FL190-FL200	16.34				
11		106	Rome, EZY323C request direct to PIGOS due to weather **DM22:** REQUEST DIR TO PIGOS Request to track from the present position direct to the specified position **DM65:** DUE TO WX Used to explain reasons for pilot's message[7]	FL220-FL260	10.36				
12						EZY323C roger. Standby. **UM1:** STANDBY Indicates that ATC has received the message and will respond.	FL220- FL260	10.36	Phone coordination between Rome ACC and Marseille ACC for A/C release
13						EZY323C proceed direct to PIGOS **UM74:** PROCEED DIR TO PIGOS Instruction to proceed directly from its present position to the specified position	FL220- FL260	10.37	
14		115	Rome, EZY323C proceed direct to PIGOS **DM0:** Wilco	FL220-FL260	10.37				
15		131	Rome, EZY323C approaching FL300 , requesting FL360	FL260-FL280	10.39				

[7] Pilot will send the concatenate DM22+DM65 messages.

Step	Sector	NM	Pilot voice/CPDLC/CPDLC System generated message	Altitude Band	Time	ATCO voice/CPDLC/CPDLC System generated message	Altitude Band	Time	Note
			DM6: REQUEST 360 Request to fly to the specified level						
16						EZY323C, Rome climb FL360 **UM20:** CLIMB TO FL 360 Instruction that a climb to a specified level is to commence and once reached the specified level is to be maintained	FL260-280	10.39	
17		139	Rome, EZY323C climbing FL360 **DM0:** Wilco	FL260-FL300	10.40				
18						EZY323C contact Marseille 130.735 **UM117:** CONTACT MARSEILLE Instruction that the ATS unit with the specified ATS unit name is to be contacted on the specified frequency	FL260- FL300	10.43	
19		143	Contact 130.735, EZY323C **DM0:** Wilco[8]	FL300-FL360	10.43				
Entry into French airspac e									

[8] After the Wilco response the flight will be CPDLC disconnected.

4.1.1.3.4 Role gaming #2 (BRS-FCO)

4.1.1.3.4.1 Scenario

Normal day of operations. Winter/Spring 2014. Daytime. EZY A320 flight operating between Bristol (BRS) and Rome (FCO). Climb, Cruise and Descend phases and transition from Cruise to descend. CPDLC operations were initiated above FL195; Flight Plan consistency verification was conducted by CPDLC dialogue with complement of DAP directly available to the R-ATSU. CPDLC operations were suspended (in the frame of AFD) when the A/C is leaving the UK Airspace and resumed when A/C is entering Italian Airspace, then maintained till ALTARR. Revert to R/T only for contingency or abnormal conditions. Transfers of responsibility across sectors and across adjacent FIRs were performed silently.

4.1.1.3.4.2 Procedure

- Call-sign: EZY768P

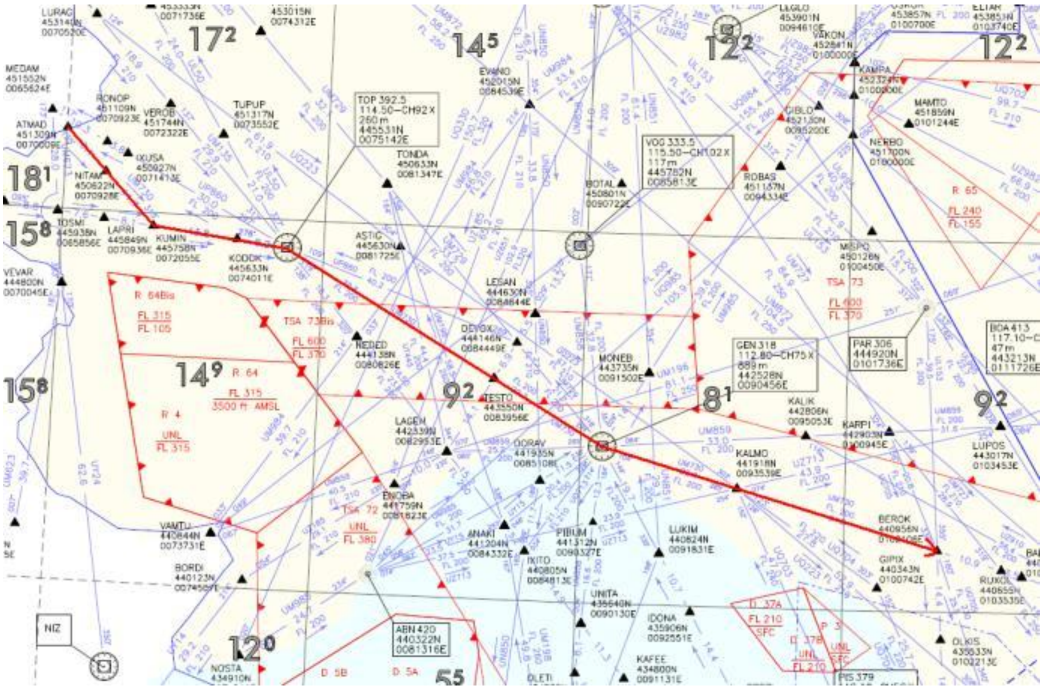
- Route: ATMAD → UM730 BEROK → UQ705 → Link-Route XIBIL4A (XIBIL-RINAD-TAQ) → STAR TAQ1A → RWY16L

- Roles:
    - ATCOs EXE/PLN: provided by ENAV
    - Pilot: provided by Air France
    - Game master/note keeper: NATS

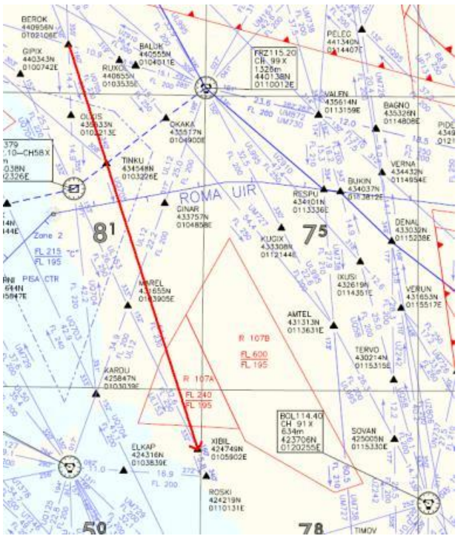
-Sector involved:

	Point	Sector	Relative Distance between points	Total distance
Area of Responsibility MIU	AMTAD	MIU	0	0
	NITAM	MIU	9,1	9,1
	KUMIN	MIU	11,7	20,8
	KODOK	MIU	13,8	34,6
	TOP	MIU	8,2	42,6
	TESTO	MIU	39,6	82,2
	GEN	MIU	20,7	102,9
	KALMO	MIU	22,9	125,8
	BEROK	MIU→NW	34	159,8
Area of Responsibility NW	TINKU	NW	25,5	185,3
	XIBIL	NW→ARR	61,1	246,4
Area of Responsibility ARR	TAQ	ARR	48,7	295,1

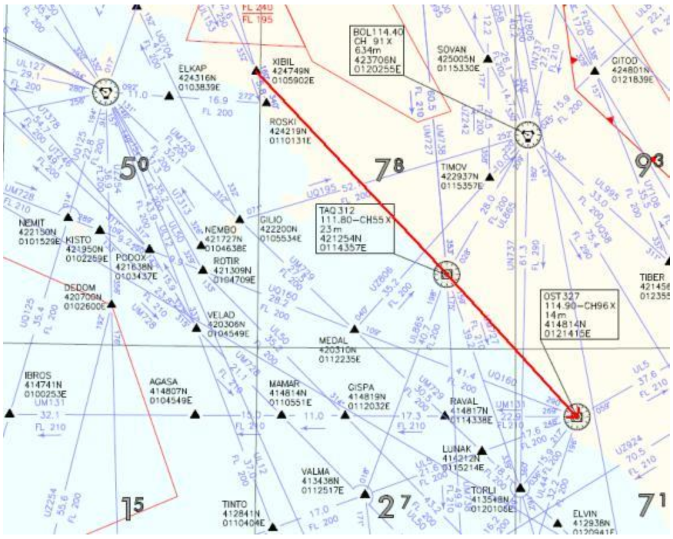
MIU Upper Sector (FL315 – FL460):



NE Upper Sector (FL245 – FL460):



ARR Lower Sector (GND – FL245):



Step	Sector	NM	Pilot voice/CPDLC/CPDLC System generated message	Altitude Band	Time	ATCO voice/CPDLC/CPDLC System generated message	Altitude Band	Time	Note
0	Marseille ACC	0	Logon[9]						Before entering Italian Airspace
1	MIU (132,905)	Before the boundary	Rome good-day, EZY768P inbound ATMAD maintaining FL390	FL390	12.50				
2		Before the boundary				EZY768P, Rome good-day. Radar contact. Proceed GOLPO via ATMAD UM730 BEROK, FPL route **UM79:** Instruction to proceed to the specified position via the specified route CLR TO [GOLPO] VIA [ATMAD UM730 BEROK UQ705 TAQ TAQ1A]]	FL390	12.50	
3		0	Rome, EZY768P proceed GOLPO via ATMAD UM730 BEROK, FPL route **DM0:** Wilco	FL390	12.51				
4		21	Rome, EZY768P request direct BEROK **DM22:** REQUEST DIRECT TO BEROK Request to track from the present position direct to the specified position. **DM65:** DUE TO WEATHER Used to explain reasons for pilot's message[10]	FL390	12.54				
5		28				EZY768P, Rome. Roger, direct to BEROK. **UM74:** PROCEED DIR TO BEROK Instruction to proceed directly from its present position to the specified position.	FL390	12.55	
6		29	EZY768P proceeding direct to BEROK	FL390					

[9] After logon message the ground system sends to aircraft the Logon Response.

After Logon Response the ground system sends to aircraft the CPDLC Connection Request and the Aircraft will send the CPDLC Connection Response, after this, the Aircraft will send to the Ground system the CPDLC Message DM99 (CDA).

The Ground system will send the pre-formatted UM183 (free-text) message with "[ICAOfacilitydesignation] [facilityname] [facilityfunction]".

[10] Pilot will send the concatenate DM22+DM65 messages.

Step	Sector	NM	Pilot voice/CPDLC/CPDLC System generated message	Altitude Band	Time	ATCO voice/CPDLC/CPDLC System generated message	Altitude Band	Time	Note
			DM0: Wilco		12.55				
7		112				EZY768P, Rome. Contact 133.70 **UM117:** CONTACT 133.70 Instruction that the ATS unit with the specified ATS unit name is to be contacted on the specified frequency previously specified next data authority	FL390	13.11	
8		113	Contact 133.70, EZY768P **DM0:** Wilco	FL390	13.11				
9	NE (133.70)	120	Rome good-day, EZY768P	FL390	13.12				
10		122				EZY768P, Roma buongiorno. Radar contact	FL390	13.13	
11		200				EZY768P, Roma, cleared to TAQ via XIBIL 4A **UM79:** CLEARED TO TAQ VIA XIBIL 4A Instruction to proceed to the specified position via the specified route	FL390	13.24	
12		202	EZY768P cleared to TAQ via XIBIL 4A **DM0:** Wilco	FL390	13.24				
13		223	Roma, EZY768P request descent FL110 **DM6:** REQUEST 190 Request to fly to the specified level	FL390	13.27				
14		224				EZY768P, Rome. Unable **UM0:** Unable	FL390	13.27	
15		231				EZY768P, Rome. Descend to FL250 **UM23:** DESCEND TO FL250 Instruction that a descent to a	FL390-FL250	13.28	

Step	Sector	NM	Pilot voice/CPDLC/CPDLC System generated message	Altitude Band	Time	ATCO voice/CPDLC/CPDLC System generated message	Altitude Band	Time	Note
						specified level is to commence and once reached the specified level is to be maintained			
16		233	Rome, EZY768P cleared to descent FL250 **DM0:** Wilco	FL390-FL250	13.28				
17						EZY768P, Rome. Contact 125.50 **UM117:** CONTACT LIRR CTR 125.50 Instruction that the ATS unit with the specified ATS unit name is to be contacted on the specified frequency	FL390-FL250	13.32	
18		250	Contact 125.50, EZY768P **DM0:** Wilco	FL390-FL250	13.33				
19	ARR (125.50)	257	Rome good-day, EZY768P. Radio check	FL270-FL250	13.34				
20						EZY768P, Rome. Cleared to GOLPO via TAQ 1A **UM79:** Instruction to proceed to the specified position via the specified route CLEARED TO GOLPO VIA TAQ1A	FL270-FL250	13.34	
21		264	Rome, EZY768P cleared to GOLPO via TAQ1A **DM0:** Wilco	FL270-FL250	13.35				
22						EZY768P, Rome. Descent to FL110 **UM23:** DESCEND TO FL110 Instruction that a descent to a specified level is to commence and once reached the specified level is to be maintained	FL250	13.37	
23		278	Rome, EZY768P cleared to descent FL110 **DM0:** Wilco	FL250-FL110	13.37				
24		292	EZY768P, request to maintain 300 Kts **DM18:** REQUEST 300Kts	FL110	13.39				

Step	Sector	NM	Pilot voice/CPDLC/CPDLC System generated message	Altitude Band	Time	ATCO voice/CPDLC/CPDLC System generated message	Altitude Band	Time	Note
			Request to assume the specified speed						
25						EZY768P, Rome. Roger, maintain 300 Kts **UM106:** MAINTAIN 300Kts Instruction that the specified speed is to be maintained	FL110	13.39	
26		294	Rome, EZY768P maintaining 300Kts **DM0:** Wilco	FL110					
27						EZY768P, Rome. Continue descent FL90 **UM23:** DESCEND TO FL90 Instruction that a descent to a specified level is to commence and once reached the specified level is to be maintained	FL110	13.40	
28		296	Rome, EZY768P cleared to descent FL90 **DM0:** Wilco	FL110-FL90	13.40				
End of CPDLC use									

4.1.1.4 Experiment planning (duration, preparation)

- First role gaming session: 04/12/2012 – Toulouse (Airbus)
- Second role gaming session: 18/12/2012 – London (NATS)

4.1.2 Phase 2 Exercises

During the exercises, the full set of CPDLC messages, intended to support AFD Operations, were tested in a simulated environment, through real connection means.

4.1.2.1 Resources

- At least one ATCO from ENAV, located in Rome ACC, PSA Room, operating ground CPDLC interface
- At least one CPDLC operator/Pseudo Pilot from Airbus, located in Toulouse Airbus premises, operating airborne CPDLC interface
- At least one CPDLC operator/Pseudo Pilot from Boeing, located in Seattle premises, operating airborne CPDLC interface
- SITA expert, for setup and monitoring ATN communications
- SELEX-ES and ENAV Engineers, for assisting experiment execution, ground side
- Airbus Engineers, for assisting experiment execution, airborne side
- Boeing Engineers, for assisting experiment execution, airborne side

4.1.2.2 Systems

The ENAV LinkIT infrastructure was connected through the existing PENS connection by adding a gateway to reach SITA ATN Backbone Service. This was immediately connected the infrastructure to the Airbus and BOEING Test Benches themselves connected to the local operational VDL radio stations in Toulouse and Seattle respectively.

Once the connection was established, ATN communication could take place between ENAV LinkIT infrastructure and the two simulators. The figure below describes the setup implemented for this phase of the project:

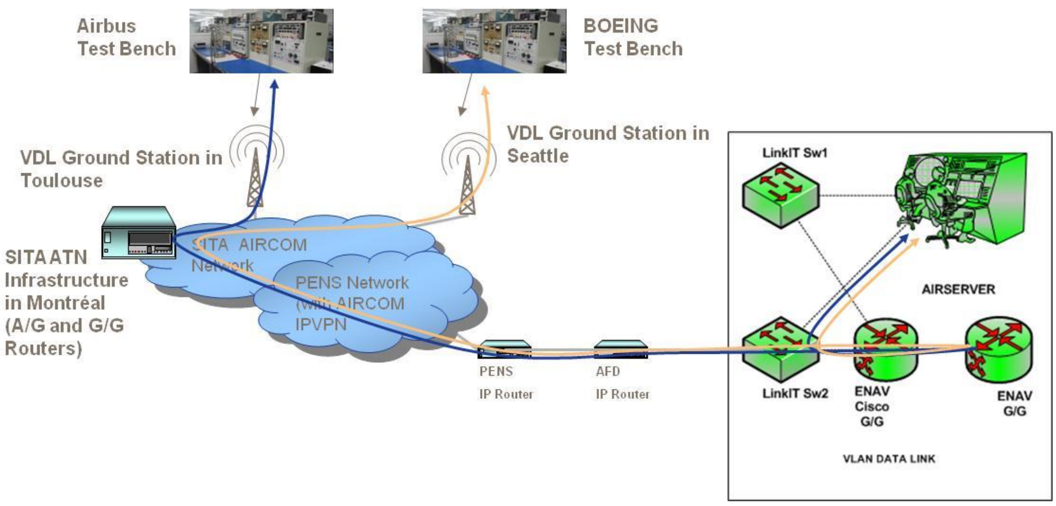


Figure 7 - ATN Connectivity to the Simulators

4.1.2.3 Scenario

4.1.2.3.1 Experiment conditions for execution

ENAV network was connected with PENS network, in order to route datalink messages to/from SITA VDL2 antenna, located in Toulouse and Seattle airports.

The following set of messages was exchanged between AFD platform and Airbus and Boeing Test Benches.

Uplink CPDLC Messages tested from end-to-end:

Msg #	Message Intent	Message Element	Response Attribute	Service	ACL Clearance Dialogues Type
Responses/Acknowledgements					
UM0	Indicates that ATC cannot comply with the request.	UNABLE	N	All	--
UM1	Indicates that ATC has received the message and will respond.	STANDBY	N	All	--
Vertical Clearances					
UM19	Instruction to maintain the specified level.	MAINTAIN [level]	W/U	ACL	Vertical (level)
UM20	Instruction that a climb to a specified level is to commence and once reached the specified level is to be maintained.	CLIMB TO [level]	W/U	ACL	Vertical (level)
UM23	Instruction that a descent to a specified level is to commence and once reached the specified level is to be maintained.	DESCEND TO [level]	W/U	ACL	Vertical (level)
UM171	Instruction to climb at not less than the specified rate.	CLIMB AT [verticalRate] MINIMUM	W/U	ACL	Vertical (level constraint)
UM172	Instruction to climb at not above the specified rate.	CLIMB AT [verticalRate] MAXIMUM	W/U	ACL	Vertical (level constraint)
UM173	Instruction to descend at not less than the specified rate.	DESCEND AT [verticalRate] MINIMUM	W/U	ACL	Vertical (level constraint)
UM174	Instruction to descend at not above the specified rate.	DESCEND AT [verticalRate] MAXIMUM	W/U	ACL	Vertical (level constraint)

Msg #	Message Intent	Message Element	Response Attribute	Service	ACL Clearance Dialogues Type
Route Modifications					
UM74	Instruction to proceed directly from its present position to the specified position.	PROCEED DIRECT TO [position]	W/U	ACL	Route
UM79	Instruction to proceed to the specified position via the specified route.	CLEARED TO [position] VIA [route clearance]	W/U	ACL	Route
UM80	Instruction to proceed via the specified route.	CLEARED [route clearance]	W/U	ACL	Route
Heading Changes (Route Modifications)					
UM94	Instruction to turn left or right as specified on to the specified heading.	TURN [direction] HEADING [degrees]	W/U	ACL	Route
UM96	Instruction to continue to fly on the current heading.	CONTINUE PRESENT HEADING	W/U	ACL	Route
UM190	Instruction to fly on the specified heading.	FLY HEADING [degrees]	W/U	ACL	Route
UM215	Instruction to turn a specified number of degrees left or right.	TURN [direction] [degrees] DEGREES	W/U	ACL	Route
Speed Changes					
UM106	Instruction that the specified speed is to be maintained.	MAINTAIN [speed]	W/U	ACL	Speed
UM108	Instruction that the specified speed or a greater speed is to be maintained.	MAINTAIN [speed] OR GREATER	W/U	ACL	Speed
UM109	Instruction that the specified speed or a lesser speed is to be maintained.	MAINTAIN [speed] OR LESS	W/U	ACL	Speed
UM116	Notification that the aircraft need no longer comply with the previously issued speed restriction.	RESUME NORMAL SPEED	W/U	ACL	Speed
Contact/Monitor/Surveillance Requests					
UM117	Instruction that the ATS unit with the specified ATS unit name is to be contacted on the specified frequency.	CONTACT [unit name] [frequency]	W/U	ACM	--
UM123	Instruction that the specified code (SSR code) is to be selected.	SQUAWK [code]	W/U	ACL	--

Msg #	Message Intent	Message Element	Response Attribute	Service	ACL Clearance Dialogues Type
UM179	Instruction that the 'ident' function on the SSR transponder is to be actuated.	SQUAWK IDENT	W/U	ACL	--
Air Traffic Advisories					
UM157	Notification that a continuous transmission is detected on the specified frequency. Check the microphone button.	CHECK STUCK MICROPHONE [frequency]	N	AMC	--
System Management Messages					
UM159	A system-generated message notifying that the ground system has detected an error.	ERROR [error information]	N	All	--
UM160	Notification to the avionics that the specified data authority is the next data authority. If no data authority is specified, this indicates that any previously specified next data authority is no longer valid.	NEXT DATA AUTHORITY [facility]	N	ACM	--
UM162	Notification that the ground system does not support this message.	SERVICE UNAVAILABLE	N	ACL	--
UM227	Confirmation to the aircraft system that the ground system has received the message to which the logical acknowledgement refers and found it acceptable for display to the responsible person.	LOGICAL ACKNOWLEDGEMENT	N	All	--
Additional Messages					
UM183	Used for additional error information	[free text]	N	All	All

Downlink CPDLC Messages Set to be tested from end-to-end:

Msg #	Message Intent	Message Element	Response Attribute	Service	ACL Clearance Dialogue Type
Responses/Acknowledgements					
DM0	The instruction is understood and will be complied with.	WILCO	N	All	--
DM1	The instruction cannot be complied with.	UNABLE	N	All	--
DM2	Wait for a reply.	STANDBY	N	All	--
Vertical Requests					
DM6	Request to fly at the specified level.	REQUEST [level]	Y	ACL	Vertical
DM9	Request to climb to the specified level.	REQUEST CLIMB TO [level]	Y	ACL	Vertical
DM10	Request to descend to the specified level.	REQUEST DESCENT TO [level]	Y	ACL	Vertical
Route Modification Requests					
DM22	Request to track from the present position direct to the specified position.	REQUEST DIRECT TO [position]	Y	ACL	Route
Speed Request					
DM18	Request to assume the specified speed	REQUEST [speed]	Y	ACL	Speed
Reports					
DM89	The specified ATS unit is being monitored on the specified frequency.	MONITORING [unit name] [frequency]	N	ACM	--
System Management Messages					
DM62	A system-generated message that the avionics has detected an error.	ERROR [error information]	N	All	--
DM63	A system-generated denial to any CPDLC message sent from a ground facility that is not the current data authority.	NOT CURRENT DATA AUTHORITY	N	ACL	--
DM99	A system-generated message to inform a ground facility that it is now the current data authority.	CURRENT DATA AUTHORITY	N	ACM	--

Msg #	Message Intent	Message Element	Response Attribute	Service	ACL Clearance Dialogue Type
DM100	Confirmation to the ground system that the aircraft system has received the message to which the logical acknowledgement refers and found it acceptable for display to the responsible person.	LOGICAL ACKNOWLEDGEMENT	N	All	--
DM107	A system-generated message sent to a ground system that tries to connect to an aircraft when a current data authority has not designated the ground system as the NDA.	NOT AUTHORIZED NEXT DATA AUTHORITY	N	ACM	--
Additional Messages					
DM65	Used to explain reasons for pilot's message.	DUE TO WEATHER	N	All	All
DM66	Used to explain reasons for pilot's message.	DUE TO AIRCRAFT PERFORMANCE	N	ACL	All
DM98	Used for additional error information	[free text]	N	All	All

4.1.2.3.2 Experiment procedure

In order to verify the correct datalink exchange between AFD platform and Airbus/Boeing Test Benches, some test cases were identified. At the end of phase 2, a test report was added to this chapter.

4.1.2.4 End CM-Logon (TEST CASE 001)

4.1.2.4.1 Purpose

The purpose of this test was to check that Ground System correctly interacted with the real aircraft avionic system

4.1.2.4.2 Procedure

Steps	System	Element	Action	Verify	Notes
1	AIRCRAFT	AFN	Aircraft sends CM-Logon Request to the GND	Check the GND receives the CM Logon indication from AIRCRAFT.	
2	GND	AFN	The GND responds with the Positive CM-Logon response to Aircraft	The Aircraft receives an accepted CM-logon confirmation message providing supported applications.	
3	GND			On the GND side verify that Aircraft appears **logged on the CWP** label of the flight	

4.1.2.5 CPDLC Connection : accepted (TEST CASE 002)

4.1.2.5.1 Purpose

The purpose of this test was to check the Ground System correctly handles the CPDLC connection procedure with the real aircraft avionic system.

4.1.2.5.2 Procedure

Steps	System	Element	Action	Verify	Notes
1	GND	CPDLC	GND sends a CPDLC-Start Request to the Aircraft	The Aircraft receives the CPDLC start indication	
2	AIRCRAFT	CPDLC	Aircraft sends to the GND an Accepted CPDLC-start Response	The GND receives from the Aircraft the CPDLC start confirmation.	
3	AIRCRAFT	DM99	Aircraft sends the DM 99 CURRENT DATA AUTHORITY message to the GND	The GND receives the DM 99 CURRENT DATA AUTORITY message from the Aircraft	
4	GND	UM227	GND sends the UM227 LACK to the Aircraft to acknowledge the DM99 CURRENT DATA AUTHORITY	Check the Aircraft receives the UM227 LACK message from the GND	
5				Check that on the GND the Aircraft	

Steps	System	Element	Action	Verify	Notes
				appears as logged and CDA connected.	
6	GND	CPDLC	The GND sends the UM 183 free-text message "CURRENT ATC UNIT <facility designation>,<facility name>,<facility function>"	The Aircraft receives the UM183 message.	
7	AIRCRAFT	CPDLC	The Aircraft send the DM 100 LACK message to acknowledge the UM 183 free-text message	Check the GND receives the DM100 LACK message from the AIRCRAFT.	

4.1.2.6 Dialogue Type Air Initiated (TEST CASE 003)

4.1.2.6.1 Purpose

This test verified the Ground system handle the Air initiate dialogue. It was assumed that the Aircraft was already logged and CPDLC connected to the GND

4.1.2.6.2 Procedure

Steps	System	Element	Action	Verify	Notes
1	AIRCRAFT	DM22	The Aircraft sends the DM 22 Request Direct To [position] to the GND	Check the GND receives DM 22 Request Direct To [position] message from the Aircraft	
2	Gnd	UM227	The GND sends the UM227 LACK to the Aircraft to acknowledge the DM 22 Request Direct To [position] message	Check the Aircraft receives the UM227 LACK message from the GND	
3	Gnd	UM74	The GND sends the UM 74 Proceed Direct to [position] message in response to the DM 22 Request Direct To [position] message.	Check Aircraft receives the UM 74 Proceed Direct to [position] message from the GND	
4	AIRCRAFT	DM100	The Aircraft sends the DM 100 LACK message to acknowledge	Check the GND receives the DM 100 LACK message	

Steps	System	Element	Action	Verify	Notes
			the UM 74 Proceed Direct to [position] message	acknowledging the UM 74 Proceed Direct To [position] message from the Aircraft.	
5	AIRCRAFT	DM2	The Aircraft sends the DM 2 STANDBY message in response to UM74 Proceed Direct To [position] message	Check the GND receives the DM2 STANDBY message in response to the UM74 Proceed Direct To [position] message.	
6	Gnd	UM227	The GND sends the UM227 LACK to the Aircraft to acknowledge the DM2 STANDBY message	Check the Aircraft receives the UM227 LACK message acknowledging the DM 2 STANDBY message.	
7	AIRCRAFT	DM0	The Aircraft sends the DM0 WILCO message in response to UM74 Proceed Direct To [position] message	Check the GND receives the DM0 WILCO message in response to the UM74 Proceed Direct To [position] message.	
8	Gnd	UM227	The GND sends the UM227 LACK to the Aircraft to acknowledge the DM0 WILCO message	Check the Aircraft receives the UM227 LACK message acknowledging the DM0 WILCO message.	

4.1.2.7 Concatenated messages elements, air initiated (TEST CASE 004)

4.1.2.7.1 Purpose

The Purpose of this test was to check that Ground system correctly handles messages, covering concatenated messages element. It was assumed an Aircraft already logged and CPDLC connected to the GND.

4.1.2.7.2 Procedure

Steps	System	Element	Action	Verify	Notes
1	AIRCRAFT	DM6	The Aircraft sends the DM6 Request [level] + DM65 DUE TO WEATHER message	Check the GND receives the DM6 Request [level] + DM65 DUE TO WEATHER message from the Aircraft	

Steps	System	Element	Action	Verify	Notes
2	Gnd	UM227	The GND sends the UM227 LACK to the Aircraft to acknowledge the DM6 Request [level] + DM65 DUE TO WEATHER message	Check the Aircraft receives the UM227 Lack message from the GND acknowledging the DM6 Request [level] + DM65 DUE TO WEATHER	
3	Gnd	UM19 or UM20 or UM23	The GND sends the UM19 MAINTAIN [level] or UM20 CLIMB TO [level] or UM23 DESCEND TO [level] message to the Aircraft	Check the Aircraft receives the UM19 MAINTAIN [level] or UM20 CLIMB TO [level] or UM23 DESCEND TO [level] message.	
4	AIRCRAFT	DM100	The Aircraft sends the DM100 LACK message to acknowledge the UM19 MAINTAIN [level] or UM20 CLIMB TO [level] or UM23 DESCEND TO [level] message	Check the GND receives the DM100 LACK message acknowledging the UM19 MAINTAIN [level] or UM20 CLIMB TO [level] or UM23 DESCEND TO [level] message from the Aircraft.	
5	AIRCRAFT	DM1	The Aircraft sends the DM1 UNABLE message in response to the UM19 MAINTAIN [level] or UM20 CLIMB TO [level] or UM23 DESCEND TO [level] message	Check the GND receives the DM1 Unable message.	
6	Gnd	UM227	The GND sends the UM227 LACK message to acknowledge the DM1 message	Check the Aircraft receives the UM227 Lack message.	

4.1.2.8 Dialogue Type heading controller initiated (TEST CASE 005)

4.1.2.8.1 Purpose

The Purpose of this test was to check that Ground system correctly handles heading type dialogue . It was assumed that the Aircraft was already logged and CPDLC connected to the GND.

4.1.2.8.2 Procedure

Steps	System	Element	Action	Verify	Notes
1	Gnd	UM190	The GND sends the UM190 FLY HEADING [degrees] message to the Aircraft	Check the Aircraft receives the UM190 FLY HEADING [degrees] message.	
2	AIRCRAFT	DM100	The Aircraft sends the DM100 LACK message to acknowledge the UM190 FLY HEADING [degrees] message	Check the GND receives the DM100 LACK message acknowledging the UM190 FLY HEADING [degrees]	
3	AIRCRAFT	DM0	The Aircraft sends the DM0 WILCO message in response to the UM190 FLY HEADING [degrees] message	Check the GND receives the DM0 WILCO message.	
4	Gnd	UM227	The GND sends the UM227 LACK message to acknowledge the DM0 message	Check the Aircraft receives the UM227 Lack message.	

4.1.2.9 Internal Transfer (TEST CASE 006)

4.1.2.9.1 Purpose

The goal of this test was to perform an internal transfer of frequency from T- SECTOR to R –SECTOR. It was assumed an aircraft logged and CPDLC connected to the Ground System.

4.1.2.9.2 Procedure

Steps	System	Element	Action	Verify	Notes
1	Gnd	UM117	The GND (TSECTOR) sends UM117 CONTACT [icaounitname] [frequency] to the Aircraft1 to identify the next sector control.	Check the Aircraft1 receives the transfer instruction message to identifying the next sector for control.	
2	AIRCRAFT	DM100	The Aircraft sends the DM 100 LACK message to acknowledge the UM117 CONTACT [icaounitname] [frequency] message	Check the GND receives the DM 100 LACK message acknowledging the UM117 CONTACT [icaounitname]	

Steps	System	Element	Action	Verify	Notes
				[frequency] message	
3	AIRCRAFT	DM0	The Aircraft sends the DM0 WILCO message in response to the UM117 CONTACT [icaounitname] [frequency] message	Check the GND receives the DM 0 WILCO message.	
4	Gnd	UM227	The GND sends the UM227 LACK message to acknowledge the DM0 WILCO message	Check the Aircraft receives the UM227 Lack message.	

4.1.2.10 Dialogue Type Speed controller initiated (TEST CASE 007)

4.1.2.10.1 Purpose

The Purpose of this test was to check that Ground system correctly handles speed type dialogue. It was assumed that the Aircraft was already logged and CPDLC connected to the GND.

4.1.2.10.2 Procedure

Steps	System	Element	Action	Verify	Notes
1	Gnd	UM106 or UM108 or UM109	The GND sends UM106 MAINTAIN [speed] or UM108 MAINTAIN [speed] OR GREATER or UM109 MAINTAIN [speed] OR LESS message to the Aircraft	Check the Aircraft receives the UM106 MAINTAIN [speed] or UM108 MAINTAIN [speed] OR GREATER or UM109 MAINTAIN [speed] OR LESS message from the GND	
2	Aircraft	DM100	The Aircraft send DM100 LACK to acknowledge the UM106 MAINTAIN [speed] or UM108 MAINTAIN [speed] OR GREATER or UM109 MAINTAIN [speed] OR LESS message	Check the GND receives the DM100 LACK	
3	Aircraft	DM2	The Aircraft sends DM2 STANDBY message in response to the UM106 MAINTAIN [speed] or UM108 MAINTAIN [speed] OR GREATER or UM109 MAINTAIN [speed] OR LESS message	Check the GND receives the DM2 STANDBY message.	
4	Gnd	UM227	The GND sends UM227 LACK	Check the Aircraft receives the	

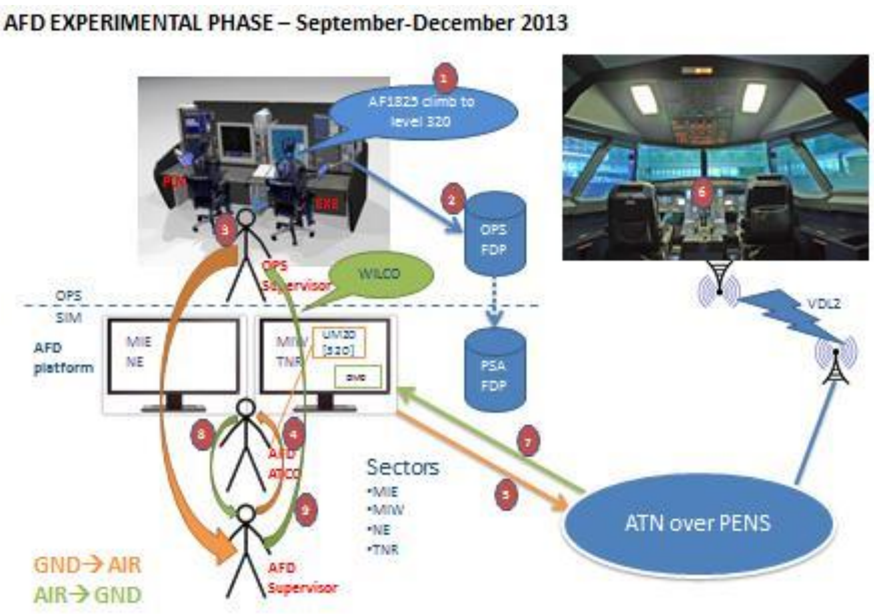
Steps	System	Element	Action	Verify	Notes
			message acknowledging the DM2 STANDBY message.	UM227 LACK message	
5	AIRCRAFT	DM0	The Aircraft sends DM0 WILCO message in response to the UM106 MAINTAIN [speed] or UM108 MAINTAIN [speed] OR GREATER or UM109 MAINTAIN [speed] OR LESS	Check the GND receives the DM0 WILCO message.	
6	Gnd	UM227	The GND sends the UM227 LACK message to acknowledge the DM0 WILCO message	Check the Aircraft receives the UM227 Lack message.	

4.1.2.11 Experiment planning (duration, preparation)

Several test sessions were held to setup properly the AFD platform (a “fine tuning operation”).
On 30th July 2013 the complete set of messages was successfully tested with Airbus Test Bench.
On October 2013 the complete set of messages was successfully tested with Boeing Test Bench.

4.1.3 Phase 3 – Step 1 Exercises

On Phase 3 step 1, both communication and surveillance pillars were tested jointly:



4.1.3.1 Resources

- ENAV ATCOs and engineers
- Air France pilots
- Airbus pilots and engineers
- Selex-ES engineers

4.1.3.2 System

The ENAV LinkIT infrastructure was connected through the existing PENS connection by adding a gateway to reach SITA ATN Backbone Service for Phase 2 already. This was re-used in Phase 3 but limited to the connection with Airbus in Toulouse.

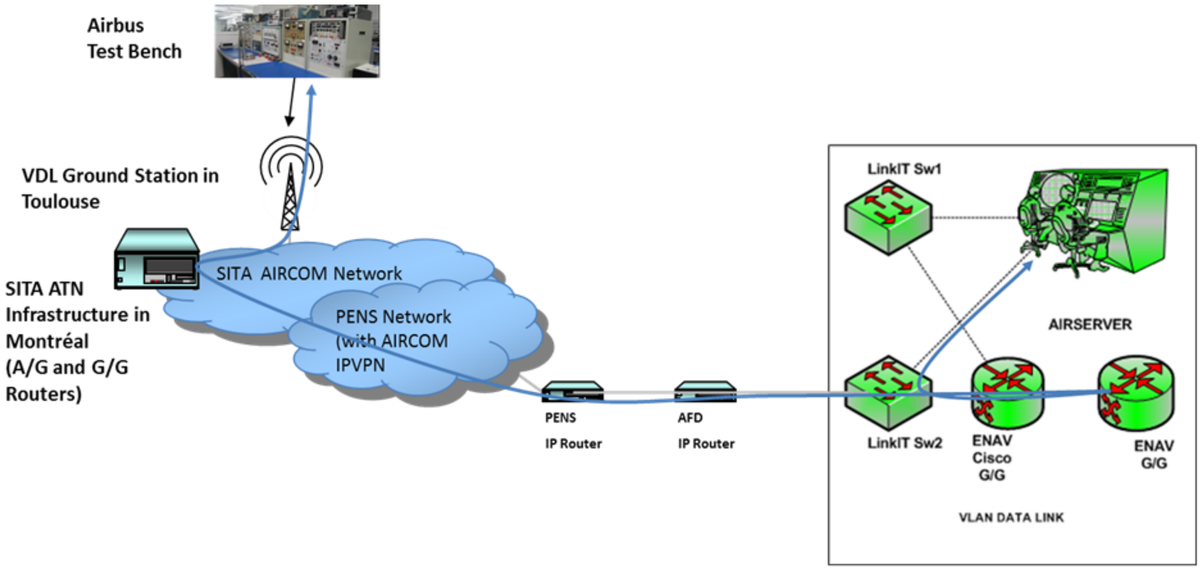


Figure 8 - ATN Connectivity to the Simulators

4.1.3.3 Scenario

(See chapter 3 for more details)

On the three days of tests, two scenarios were used:

CDG-FCO

Route: VEROB -TOP – GEN - BEROK - UQ705

Point	Sector
VEROB	MI3
TOP	MI3
GEN	MI3
BEROK	MI3->MI2->NE2
XIBIL	NE2->TNR
RINAD	TNR
TAQ	TNR->APP
MIKSO	APP
FN	APP->FCO
LIRF5F	FCO

The exercise started at VEROB point, where the flight was supposed to be at FL 370 and 450Kts. Since that point, target flight was controlled with AFD procedures until reaching FL100; voice exchanges were limited to manage the transfer of flight to the next sector (the pilot was presenting himself on the new frequency, receiving the “radar contact” at first call from ATCOs. Voice was exchanged via Shared Virtual Sky).

In order to test the “ATCOs human chain” that connected ENAV ops and simulated rooms, some test flights were conducted in a shadow mode of real traffic, meaning that simulated flight started on

VEROB when a real flight going to FCO was at the same point, and so every instruction to the real flight was replicated on simulated flight.

FCO-CDG

Route: OST - RAVAL – GISPA – PODOX – ELB - UM729

Point	Sector
LIR2F	FCO->APP
OST	APP
RAVAL	APP
GISPA	APP->NW1->NW2
PODOX	NW2->NW3
ELB	NW3
NORNI	NW3
BELEL	NW3->MI3
SPEZI	MI3
IDONA	MI3
LUKIM	MI3
GEN	MI3
TONDA	MI3
PIMOT	MI3

The exercise started at end of SID (about 20NM from OST point), where the flight was supposed to be passing FL100 climbing FL160.
Since that point, target flight was controlled with AFD procedures, having voice usage just on change of sectors (the captain was presenting himself on the new frequency, receiving the "radar contact" from ATCOs), until PIMOT point. On one session, the exercise started on the GND, at FCO airport, controlling via datalink the simulated flight from take-off phase.

In order to test the "ATCO human chain" connecting ENAV ops and simulated rooms, some test flights were conducted in a shadow mode of real traffic, meaning that simulated flight started at end of SID (about 20NM from OST point), when a real flight was at the same point, and so every instruction to the real flight was replicated on the simulated one.

4.1.3.4 Experimental planning (duration, preparation)

The schedule of this phase was the following:

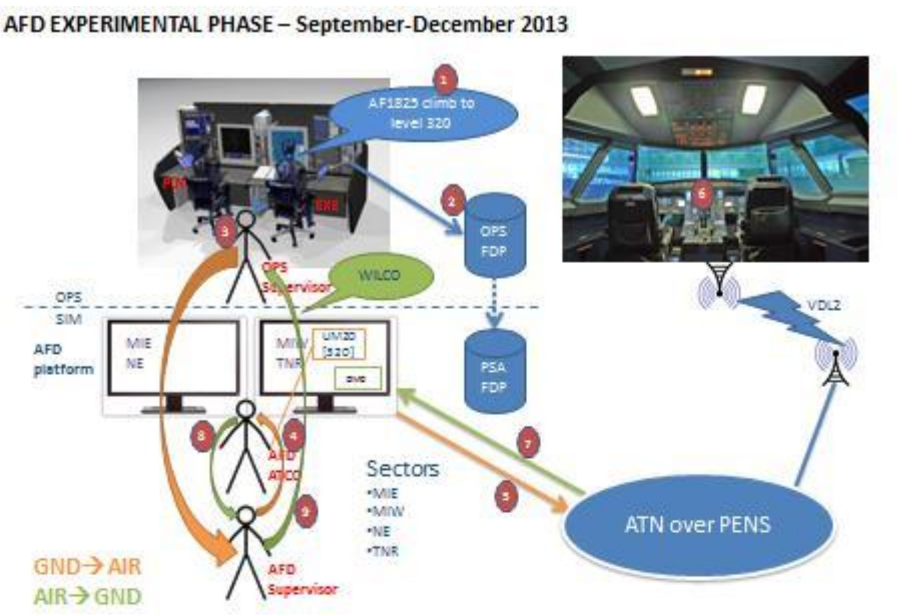
1. **Phase 3 step 1 OPS scenario - dry-run *with Airbus test bench*:**
   - 5th September 2013, 11h30-17h00 UTC
2. **Phase 3 step 1 OPS scenario - dry-run back-up slot *with Airbus integration simulator and Airbus test pilot*:**
   - 10th September 2013, 11h30-17h00 UTC
3. **Phase 3 step 1 execution *with Airbus integration simulator and 1 AFR pilot:***
   - 12th September 2013, 11h30-17h00 UTC

Before that, a SVS validation activity was conducted on 1st August 2013, with positive feedbacks.

The communication leg was tested on Phase 2 with a positive feedback, so just a “fine tuning” operation was needed on the AFD platform, in order to receive flight tracks from SVS wrapper and communicate to this simulated flight, rerouting datalink messages via ATN over PENS and using AudioLan for the voice.

4.1.4 Phase 3 – Step 2 Exercises

On Phase 3 step 2, both communication and surveillance pillars were tested jointly:



4.1.4.1 Resources

- ENAV and NATS ATCOs and engineers
- Air France and Easy Jet pilots
- Airbus engineers
- Selex-ES Engineers
- SITA Engineers

4.1.4.2 System

AFD Platform, new release – Rome ACC

Airbus Integrated Simulator – Toulouse

ATN Ground Connectivity via PENS (operated by SITA)

VDL2 GS, located in Toulouse Airport

4.1.4.3 Scenario

(See chapter 3 for more details)

During the test session, four scenarios were used:

CDG-FCO

Route: VEROB -TOP – GEN - BEROK - UQ705

Point	Sector
VEROB	MI3
TOP	MI3
GEN	MI3
BEROK	MI3->MI2->NE2
XIBIL	NE2->TNR
RINAD	TNR
TAQ	TNR->APP
MIKSO	APP
FN	APP->FCO
LIRF5F	FCO

The exercise started at VEROB point, where the flight was supposed to be at FL 370 and 450Kts. Since that point, target flight was controlled with AFD procedures, having voice usage just on change of sectors (the captain was presenting himself on the new frequency, receiving the “radar contact” from ATCOs), until FL100.

In order to test the “ATCO human chain” connecting ENAV ops and simulated rooms, some test flights were conducted in a shadow mode of real traffic, meaning that simulated flight started on VEROB when a real flight going to FCO was at the same point, and so every instruction to the real flight was replicated on simulated flight.

On some runs, RTA feature was tested, with TAQ as position on which the ETA was provided from FMS. This value was sent from the pilot via SITA telex, then received at Rome ACC and showed to the AFD ATCO who sent the UM51 message accordingly.

FCO-CDG

Route: OST - RAVAL – GISPA – PODOX – ELB - UM729

Point	Sector
LIR2F	FCO->APP
OST	APP
RAVAL	APP
GISPA	APP->NW1->NW2
PODOX	NW2->NW3
ELB	NW3
NORNI	NW3
BELEL	NW3->MI3
SPEZI	MI3
IDONA	MI3
LUKIM	MI3
GEN	MI3
TONDA	MI3
PIMOT	MI3

The exercise started at end of SID (about 20NM from OST point), where the flight was supposed to be at FL100 and 230Kts.
Since that point, target flight was controlled with AFD procedures, having voice usage just on change of sectors (the captain was presenting himself on the new frequency, receiving the “radar contact”

from ATCOs), until PIMOT point. On one session, the exercise started on the GND, at FCO airport, controlling via datalink the simulated flight from take-off phase.

In order to test the "ATCO human chain" connecting ENAV ops and simulated rooms, some test flights were conducted in a shadow mode of real traffic, meaning that simulated flight started on OST when a real flight was at the same point, and so every instruction to the real flight was replicated on the simulated one.

PMO-FCO

Route: LURON UM726 LAT

Point	**Sector**
LICJ	PMO TWR/APP
SASLI	PMO APP
FIZZY	PMO APP-> SU
LURON	SU
DORAS	SU
BEROL	SU->TS
ENSOT	TS
PNZ	TS->US
NEKPI	US
LAT	US->ARR
RATIR	ARR

Flights from Palermo (LICJ) to Fiumicino (LIRF) are normally transferred from Palermo Approach to Rome ACC (SU sector) between the points FIZZY and LURON, climbing to FL160, the SU controller assumed the flight and controlled it with datalink procedures; in the vicinity of BEROL point, the flight was transferred to Rome ACC's TS sector at cruising level; the TS sector provides to descend the a/c on an appropriate flight level in order to reach the correct altitude to join ILS procedures; in the vicinity of PNZ the flight was transferred to Rome ACC US sector, here the flight continued the descend down to FL 100 and, approaching LAT point, the flight was transferred to the arrival sector (ARR).

FCO-PMO

Route: PEPIX UM727 GIANO

Point	**Sector**
LIRF	TWR->DEP
XIBRI	DEP
ELVIN	DEP
PEPIX	DEP->SU
GIANO	SU-> PMO TWR/APP
RONDI	PMO TWR/APP
SALAP	PMO TWR/APP
PRS	PMO TWR/APP

Traffic from LIRF to LICJ, was transferred from DEP sector to SU sector south of PEPIX point climbing to FL 270: it happened after the crossing point with route UM603; SU controller passed en-route clearance and climbing clearance to the aircraft (most used is FL310); approaching GIANO point, the flight was transferred to Palermo Approach, descending to FL 130.

4.1.4.4 Experimental planning (duration, preparation)

The schedule of this phase was the following:

4. **Phase 3 step 2 OPS scenario - dry-run *with Airbus test bench*:**
   - 12th December, 11h30-17h00 UTC
5. **Phase 3 step 1 OPS scenario - dry-run back-up slot *with Airbus integration simulator and Airbus pilot*:**
   - 17th December, 11h30-17h00 UTC
6. **Phase 3 step 1 execution *with Airbus integration simulator and 1 AFR and 1 EZY pilot:***
   - 19th December, 13h00-18h00 UTC

On top of that, a SVS validation activity was conducted on 13th December 2013, with positive feedbacks.

The communication leg was tested on Phase 2 with a positive feedback, so just a “fine tuning” operation was needed on the AFD platform, in order to receive flight track from SVS wrapper and communicate with this simulated flight, rerouting datalink messages via ATN over PENS and using AudioLan for the voice communication.

4.1.5 Phase 4 – Preparation for trials

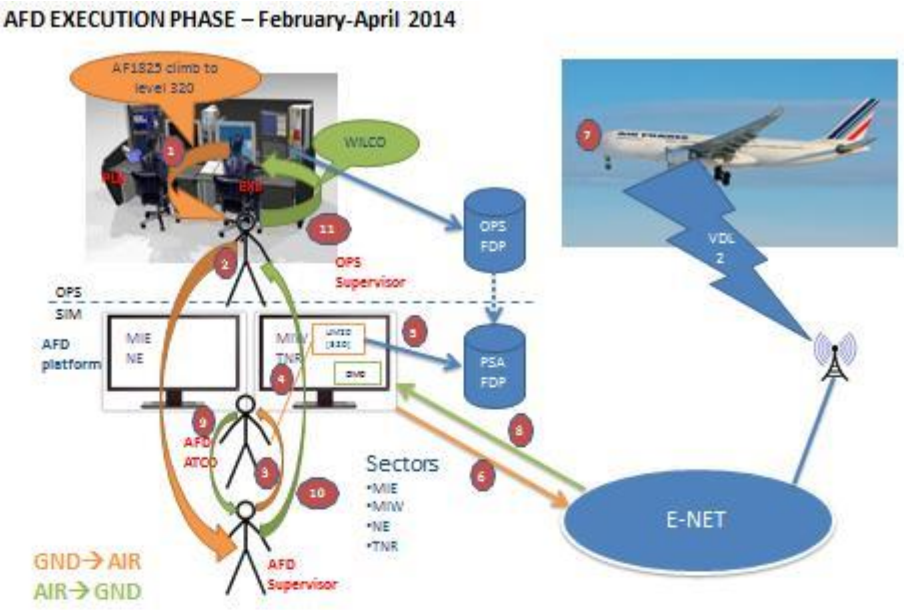
The aim of this phase was a collection of all outputs from previous phases, representing the evidence that the project reached an appropriate maturity level to tackle AFD Execution Phase.

It is based on 3 pillars:

- Operational Procedures
- Safety Assessment
- Human Factor methodology

4.1.5.1 Operational procedures

Operational procedures adopted on Phase 3 were similar to the ones used for the flight trials.



As resumed on the above picture, the actors were four:

- OPS ATCO: he controlled as usual the traffic within his sector of airspace, being trained to not control on voice the AFD target flight;
- OPS Supervisor: a Supervisor, located in the OPS Room communicated and received, via recorded telephone line, all instructions referred to the target flight to the AFD Supervisor, located in ENAV Simulation Room;
- AFD Supervisor: a Supervisor who transferred all communications received from the OPS Supervisor to the AFD ATCO, communicating also to the OPS Supervisor the feedback of DM received from the target airplane. He had a screen representing shadow mode ops traffic, in order to have full situation awareness; plus, the CWP of the AFD platform was totally aligned with the ops room in terms of radar picture of surrounded traffic.
- AFD ATCO: he executed the instructions received from the Ops Room, using datalink feature. He also communicated to AFD Supervisor all DM messages received.

ATCO EXE in the Ops Room communicated to the OPS Supervisor, located behind him, the instructions for the target flight (1) and updated the OPS FDP. The Supervisor repeated the instruction via recorded telephone to the AFD Supervisor (2), who repeated it to the AFD ATCO (3). AFD Supervisor and AFD ATCO were both located on ENAV Simulation room. AFD ATCO sent the instruction via datalink (4). AFD platform updated the Simulation FDP (5). The message moved from the platform through E-NET ground infrastructure (6); it reached the convenient VDL2 GS and finally the message was displayed to the aircraft DCDU (7). The pilot reacted accordingly and another message started from the airplane, reaching VDL2 GS and then, through E-NET, it was showed on the CWP (8). The AFD ATCO was sure that DAP data, coming from Mode-S EH and showed on the integrated label, were coherent with the clearance sent and confirmed the execution of the clearance to the AFD Supervisor (9), who repeated, via recorded telephone, the confirmation to the OPS Supervisor (10). The Ops Supervisor confirmed the instruction to the ATCO EXE (11).

4.2 Exercises Execution

ENAV and NATS executed 2 separate flight trials campaigns for domestic flights, with a common plan for interconnected flights (FCO-BRS and BRS-FCO).

4.2.1 ENAV Flight trials Campaign

Exercise ID	Exercise execution date	Exercise Title	Actual Exercise execution start date	Actual Exercise execution end date
AFD_ENAV_EXE01	12/02/2014	EZY38GP FCO/PMO	19:10	20:20
AFD_ENAV_EXE02	12/02/2014	EZY79FG PMO/FCO	20:55	22:05
AFD_ENAV_EXE03	17/02/2014	EZY38GP FCO/PMO	19:10	20:20
AFD_ENAV_EXE04	19/02/2014	EZY38GP FCO/PMO	19:10	20:20
AFD_ENAV_EXE05	10/03/2014	EZY38GP FCO/PMO	19:10	20:20
AFD_ENAV_EXE06	12/03/2014	EZY98KF BRS/FCO	12:50	16:20
AFD_ENAV_EXE07	12/03/2014	EZY66HP FCO/BRS	16:55	18:45
AFD_ENAV_EXE08	12/03/2014	EZY38GP FCO/PMO	19:10	20:20
AFD_ENAV_EXE09	12/03/2014	EZY79FG PMO/FCO	20:55	22:05
AFD_ENAV_EXE10	17/03/2014	EZY66HP FCO/BRS	16:55	18:45
AFD_ENAV_EXE11	17/03/2014	EZY38GP FCO/PMO	19:10	20:20
AFD_ENAV_EXE12	17/03/2014	EZY79FG PMO/FCO	20:55	22:05
AFD_ENAV_EXE13	19/03/2014	EZY66HP FCO/BRS	16:55	18:45
AFD_ENAV_EXE14	19/03/2014	EZY38GP FCO/PMO	19:10	20:20
AFD_ENAV_EXE15	19/03/2014	EZY79FG PMO/FCO	20:55	22:05
AFD_ENAV_EXE16	24/03/2014	SAS ARN/FCO	11:25	14:35
AFD_ENAV_EXE17	24/03/2014	SAS FCO/ARN	15:20	18:35
AFD_ENAV_EXE18	26/03/2014	EZY98KF BRS/FCO	12:50	16:20

Exercise ID	Exercise execution date	Exercise Title	Actual Exercise execution start date	Actual Exercise execution end date
AFD_ENAV_EXE19	26/03/2014	EZY66HP FCO/BRS	16:55	18:45
AFD_ENAV_EXE20	26/03/2014	EZY38GP FCO/PMO	19:10	20:20
AFD_ENAV_EXE21	26/03/2014	EZY79FG PMO/FCO	20:55	22:05
AFD_ENAV_EXE22	31/03/2014	EZY98KF BRS/FCO	12:10	15:45
AFD_ENAV_EXE23	31/03/2014	EZY66HP FCO/BRS	16.20	18.05
AFD_ENAV_EXE24	31/03/2014	EZY38GP FCO/PMO	19:15	20:25
AFD_ENAV_EXE25	31/03/2014	EZY79FG PMO/FCO	21:00	22:15
AFD_ENAV_EXE26	02/04/2014	SAS ARN/FCO	10:25	13:35
AFD_ENAV_EXE27	02/04/2014	SAS FCO/ARN	14:20	17:30
AFD_ENAV_EXE28	02/04/2014	EZY PMO/FCO	08:55	10:10
AFD_ENAV_EXE29	07/04/2014	SAS ARN/FCO	11:35	14:45
AFD_ENAV_EXE30	07/04/2014	SAS FCO/ARN	15:30	18:40
AFD_ENAV_EXE31	09/04/2014	SAS ARN/FCO		
AFD_ENAV_EXE32	09/04/2014	SAS FCO/ARN	14.20	17.30
AFD_ENAV_EXE33	09/04/2014	AFR CDG/FCO	07:10	09:20
AFD_ENAV_EXE34	09/04/2014	AFR FCO/CDG	10:20	12:30
AFD_ENAV_EXE35	14/04/2014	SAS ARN/FCO	11:35	14:45
AFD_ENAV_EXE36	14/04/2014	SAS FCO/ARN	15:30	18:40
AFD_ENAV_EXE37	14/04/2014	EZY BRS/FCO	12.10	15.45
AFD_ENAV_EXE38	16/04/2014	AFR CDG/FCO	07:10	09:20
AFD_ENAV_EXE39	16/04/2014	AFR FCO/CDG	10:20	12:30
AFD_ENAV_EXE40	16/04/2014	EZY PMO/FCO	08:55	10:10

Exercise ID	Exercise execution date	Exercise Title	Actual Exercise execution start date	Actual Exercise execution end date
AFD_ENAV_EXE41	16/04/2014	EZY BRS/FCO	12.10	15.45

Table 5 - ENAV Exercises execution dates[11]

4.2.2 NATS Flight trials Campaign

Exercise ID	Exercise execution date	Exercise Title	Actual Exercise execution start date	Actual Exercise execution end date
AFD-NATS-EXE01	11/02/2014	EZY82TB BRS/EDI	15:55	17:05
AFD-NATS-EXE02	11/02/2014	EZY72ME EDI/BRS	17:35	18:45
AFD-NATS-EXE03	17/02/2014	EZY82TB BRS/EDI	15:55	17:05
AFD-NATS-EXE04	17/02/2014	EZY72ME EDI/BRS	17:35	18:45
AFD-NATS-EXE05	18/02/2014	EZY82TB BRS/EDI	15:55	17:05
AFD-NATS-EXE06	18/02/2014	EZY72ME EDI/BRS	17:35	18:45
AFD-NATS-EXE07	17/03/2014	EZY98KF BRS/FCO	12:50	16:20
AFD-NATS-EXE08	17/03/2014	EZY66HP FCO/BRS	16:55	18:45
AFD-NATS-EXE09	19/03/2014	EZY82TB BRS/EDI	15:55	17:05
AFD-NATS-EXE10	19/03/2014	EZY72ME EDI/BRS	17:35	18:45
AFD-NATS-EXE11	19/03/2014	EZY98KF BRS/FCO	12:50	16:20
AFD-NATS-EXE12	19/03/2014	EZY66HP FCO/BRS	16:55	18:45
AFD-NATS-EXE13	24/03/2014	EZY82TB BRS/EDI	15:55	17:05
AFD-NATS-EXE14	24/03/2014	EZY72ME EDI/BRS	17:35	18:45
AFD-NATS-EXE15	31/03/2014	EZY39LA	11.10	13.45

[11] Those are just the succeeded flights. The AFD campaign for ENAV counts 50 flight trials. Some of them were cancelled from the list due to technical problem with AFD platform that causes ATCOs voice interventions.

		BRS/FCO		
AFD-NATS-EXE16	31/03/2014	EZY61BD FCO/BRS	16.20	18.05
AFD-NATS-EXE17	10/04/2014	SAS2541 ARN/EDI	08:15	10:30
AFD-NATS-EXE18	10/04/2014	SAS2542 EDI/ARN	11:10	13:20
AFD-NATS-EXE19	10/04/2014	SAS4601 OSL/EDI	09:10	10:50
AFD-NATS-EXE20	10/04/2014	SAS4602 EDI/OSL	11:30	13:10
AFD-NATS-EXE21	10/04/2014	SAS4615 SVG/ABZ	15:15	16:20
AFD-NATS-EXE22	10/04/2014	SAS4616 ABZ/SVG	16:55	17:55
AFD-NATS-EXE23	24/04/2014	SAS2541 ARN/EDI	08:15	10:30
AFD-NATS-EXE24	24/04/2014	SAS2542 EDI/ARN	11:10	13:20
AFD-NATS-EXE25	24/04/2014	SAS4615 SVG/ABZ	15:15	16:20
AFD-NATS-EXE26	24/04/2014	SAS4616 ABZ/SVG	16:55	17:55
AFD-NATS-EXE27	12/05/2014	AF1668 CDG/MAN	05:20	06:50
AFD-NATS-EXE28	12/05/2014	AFR1669 MAN/CDG	07:45	09:15
AFD-NATS-EXE29	11/06/2014	EZY41TD BRS/EDI	16:35	17:50
AFD-NATS-EXE30	11/06/2014	EZY88ND EDI/BRS	18:15	19:30
AFD-NATS-EXE31	17/06/2014	EZY88ND EDI/BRS	18:15	19:30
AFD-NATS-EXE32	18/06/2014	EZY41TD BRS/EDI	16:35	17:50
AFD-NATS-EXE33	18/06/2014	EZY88ND EDI/BRS	18:15	19:30
AFD-NATS-EXE34	27/06/2014	EZY41TD BRS/EDI	16:35	17:50
AFD-NATS-EXE35	27/06/2014	EZY88ND EDI/BRS	18:15	19:30

4.3 Deviations from the planned activities

4.3.1 SWIM

During the requested improvements of the SWIM demonstration scenarios present in Demonstration Handbook, an analysis was performed to investigate the possibility to include an AMAN system in the demonstration activities and in the AFD trials, to show how the flight information exchange through

SWIM could impact the arrival sequence built by an AMAN, and to measure the forecast improvements.

First, an analysis to check if ENAV APP centres could be included in this scenario was performed. Then, an analysis to extend the demonstration scenario to involve also the London APP area was conducted. The main outputs of this analysis are the following:

1) The improvement of demonstration activity in ENAV airspace including an AMAN could have not been performed relying on real APP centres as an AMAN system is not still into operation in ENAV centres. The relevant demonstration would have had a low level of integration with the trials foreseen for AFD activities.

2) The extension of the scenario to UK area would have implied an upgrade and re-configuration of NATS operational environment, not possible in the framework of AFD activities.

3) The availability of datalink systems into operations (namely LinkIT as for Italian area) was assumed as pre-condition before AFD launch, but this was not actually the case. At AFD launch, the LinkIT system required a recovery plan to fill this gap; consequently a lot of effort was redirected to make the pre-operative system be usable for AFD purposes.

As a consequence, the removal of SWIM demonstration objectives, that were anyway relevant to a “second” level objective with respect to the “core” of AFD project, was announced at first CDR meeting. A decision shared among all partners to withdraw “SWIM” related exercises from the list of EXE was finally retained.

4.3.2 Required Time of Arrival (RTA)

RTA was an optional objective of the AFD project.
For the reasons explained hereafter, an Air France -internal safety review concluded that for the AFD flight trials the RTA cannot be effectively used to conduct the flight and maintain an acceptable workload, but no objection was raised to simulate RTA messages exchanges.
Indeed, although RTA usage was not forbidden, RTA function was not used by AFR flight crew on A320 fleet. RTA was used on long haul aircraft with known adverse effects:
- speed can be lower than usual - below max range speed down to max endurance speed;
- speed up to VMO/MMO;
- thrust instability to chase entered RTA;
- fuel consumption is affected and can be inconsistent with computed and boarded fuel.
Additionally, several changes at Air France concerning pilots’ procedures took place in the same time period than AFD flights: new FCOM, EFB entry into service on A320fleet.
Finally, the PM-CPDLC was not still in use at Air France and the AFD flight trials were performed by dedicated and adequately trained flight crew, but with limited experience of CPDLC usage.
The typical scenario was composed with:
- flight crew check the ETA at a given waypoint (TAQ);
- flight crew sent a free text message to the ATC using a predefined telex address ;
- once the aircraft was connected to the ATN network, the ATC sent an RTA request to the aircraft "CROSS TAQ AT hh.mm";
- the flight crew received the request an answered UNABLE.

The RTA test was conducted during the CDG-FCO flight trials.
Typically, the connection of the aircraft to the Italian ATN was initialized around Turin (aircraft had to enter deeply in the Italian airspace in order to be connected to an antenna of the Italian ATN[12]). The late connection during a flight CDG-FCO did not provide with the remaining flight time allowing a significant ETA change to comply with an RTA request.

RTA scenario was played only on the two following flights:

[12] That because the Italian ATN network was not still interconnected with SkyGuide.

<u>09 April AF1204</u>
The ETA free text message was reported to be sent by the flight crew but never received by ENAV. The analysis found no record of an ACARS free text message related to the test on the network. For an unknown reason, the message didn't seem to have reached the ACARS network.
<u>16 April AF1204</u>
RTA message exchange occurred as expected. Even if the trial was not intended to comply with RTA instruction, the pilots reported that RTA transmitted by the ATC was not achievable because the remaining flight time did not allow a sufficient gain to match the instructed RTA.

In order to define the AFD trial scenarios related to RTA exchange, and especially to define an appropriate position of the time metering fix, clarification was needed on the behaviour of current Thales and Honeywell FMS related to the capability to follow a time constraint (in cruise and in descent) in closed loop and in particular when the time constraint is entered near the Top of Descent.

For this purpose, a technical note was issued by Airbus (see Annex B) to explain all the FMS aspects required to understand RTA management of FMS, 2nd generation, on A320 and A30/A340 families of aircraft.
The first part of the note provides a description of FMS behaviour with a focus on the differences between THALES and HONEYWELL.
The second part provides the operational cases derived from the FMS behaviour and the recommendations for the AFD flight trials.

This note also allows airlines and ANSPs – beyond the AFD project – for assessing the potential of current airborne capabilities which can be exploited for time based operations.

5 Exercises Results

5.1 Summary of Exercises Results

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Exercise ID	Demonstration Objective Tittle	Demonstration Objective ID	Success Criterion	Exercise Results	Demonstration Objective Status
ATC Full Datalink	To validate the impact of CPDLC on ATCOs performance	OBJ-0208-016b	Positive feedback about the ATCOs acceptability of the AFD procedure and working methods	Globally the use of AFD communication is perceived beneficial by ATCOs	**OK**
			Perceived MWL is maintain within acceptable level (compare to the current operations) under each condition where AFD operations are applied	Using CPDLC, ATCOs report that the effort request to manage the air/ground communications is slightly higher than in r/t , but within fully acceptable level	**OK**
			Perceived SA is not impaired by the introduction of CPDLC communication	The use of CPDLC may impact critically on PLN controller' s situational awareness. No specific concerns reported referring to the EXE controller' SA	**NOK**
			Positive feedback about the impact of AFD system on coordination	No specific issues reported about coordination, between ATCO and FC ATCO	**OK**

			, collaboration and communication between the flight crew and the controllers	teamwork: Concerns about PLN SA EXE is still responsible of the aircraft with CPDLC: there is the need of standardization of PLN ATCO support to mitigate EXE high workload	
ATC Full Datalink	Flights can effectively be conducted safely via CPDLC below FL285, also during climbing and descending phases, from ALTDEP down to ALTARR	OBJ-0208-011	Based on the Concept design and Experimental campaign, ALTDEP and ALTARR are already defined. More specifically, those values are FL100 for Italy and FL195 for UK. The number of forced revert to R/T operation is zero (unless for Transfer of Frequency (TOF) and/or due to external events)	Acceptable in climb phase as from FL145 and in descent phase down to in between FL195 and FL145.	**OK**
	To validate the impact of CPDLC message on flight efficiency and flight crew prospective	OBJ-0208-014	Positive feedback from Flight Crew	Clarity of message set and easy integration with other pilot tasks seen as main benefits; however additional messages are	**OK**

				needed (e.g. DM REQ HDG).	
	Extended use of CPDLC reduces Pilot workload	OBJ-0208-016	Pilots feel comfortable under each condition where AFD operations are applied. Their workload, when confronted with usual mode of operations, is perceived as less. Quantitative assessment will be elaborated by HF experts during Concept Design and Experimental phases.	Mostly perceived lower or slightly lower workload and some higher but still acceptable workload increase in descent	**OK**
	Closed-loop instructions (i.e. CTA) can be issued in a day by day environment to take advantage of RTA capability of equipped aircraft from airborne prospective.	OBJ-0208-021	The flight will send to the ground an ETA related to a predefined fixed point. The ATCO will react consequently, sending a flyable RTA to the target flight. Flight Crew successfully load it on FMS and the flight reaches the selected metering fix within the FMS	Datalink exchange on ETA succeeded in one out of two cases. The assessment of RTA was out of scope.	**OK**[13]

[13] See §4.3.1 for more details.

			tolerance. On ground the flight is accommodated in the sequence on the basis of the selected RTA		

Table 6 - Summary of Demonstration Exercises Results

5.2 Choice of metrics and indicators

The following table lists the metrics and the indicators along with the associated method or technique used during the human factors assessment referring to Human Performance.

KPA/TA	Objective ID	Success Criterion / Expected Benefit	Supported Metric / Indicator	Method or Technique
Human Performance	OBJ-0208-016b To validate the impact of CPDLC on ATCOs performance	Positive feedback about the ATCOs acceptability of the AFD procedure and working methods	User acceptability Working methods Task sharing	Debriefings Over the shoulder observations Questionnaire
		Perceived MWL is maintained within acceptable level (compared to the current operations) under each condition where AFD operations are applied	Perceived mental workload	Debriefings Over the shoulder observations Questionnaire
		Perceived SA is not impaired by the introduction of CPDLC communication	Perceived situational awareness	Debriefings Over the shoulder observations Questionnaire
		Positive feedback about the impact of AFD system on coordination, collaboration and communication between the flight crew and the	ATCO/FC Teamwork Team Communication load	Debriefings Over the shoulder observations Questionnaire

		controllers		
HP	OBJ-0208-011 Flights can effectively be conducted safely via CPDLC below FL285, also during climbing and descending phases, from ALTDEP down to ALTARR	Based on the Concept design and Experimental campaign, ALTDEP and ALTARR are already defined. More specifically, those values are FL100 for Italy and FL195 for UK. The number of forced revert to R/T operation is zero (unless for Transfer of Frequency (TOF) and/or due to external events)	Perceived impact of CPDLC and related message need Voice reversion: a)Management of voice reversions b) Identified Causes and consequences of voice reversion	Questionnaire Observations Qualitative feedback
	OBJ-0208-014 To validate the impact of CPDLC message on flight efficiency and flight crew prospective	Positive feedback from Flight Crew	Perceived benefits of CPDLC	Questionnaire Observations Qualitative feedback
	OBJ-0208-016 Extended use of CPDLC reduces Pilot workload	Pilots feel comfortable under each condition where AFD operations are applied. Their workload, when confronted with usual mode of operations, is perceived as less. Quantitative assessment will be elaborated by HF experts during Concept Design and Experimental phases.	FL from or down to which CPDLC is perceived acceptable to be used Acceptability of workload change per phase of flight Ease of reversion to radio telephony	Questionnaire Observations Qualitative feedback
	OBJ-0208-021 Closed-loop instructions (i.e. CTA) can be issued in a day by day environment to take advantage of RTA capability of	The flight will send to the ground an ETA related to a predefined fixed point. The ATCO will react consequently, sending a flyable RTA to the target	Acceptability of CPDLC usage for RTA exchange	Qualitative feedback

	equipped aircraft from airborne prospective.	flight. Flight Crew successfully load it on FMS and the flight reaches the selected metering fix within the FMS tolerance. On ground the flight is accommodated in the sequence on the basis of the selected RTA		

Table 7- Summary of metrics and indicators for HP

5.3 Summary of Assumptions

Assumption taken from Demo Plan §4.5:

- The end to end performances of CPDLC services will be in line with the applicable Safety and Performance Requirements expressed by ED-120 [4];

5.3.1 Results per Human Performances

Demonstration results per Human Performances

Exercise	Object Identifier	Success Criterion	Result of the demonstration
ATC Full Datalink – AFD	OBJ-0208-016b To validate the impact of CPDLC on ATCOs performance	Positive feedback about the ATCOs acceptability of the AFD procedure and working methods	Globally the use of CPDLC full datalink communication is perceived beneficial by ATCOs
		Perceived MWL is maintained within acceptable level (compare to the current operations) under each condition where AFD operations are applied	Using CPDLC, ATCOs report that the effort request to manage the air/ground communications is slightly higher than in r/t, but within fully acceptable level
		Perceived SA is not impaired by the introduction of CPDLC communication	The use of CPDLC may impact critically on PLN controller' situation awareness. No specific concerns reported referring to the EXE controller's SA

		Positive feedback about the impact of AFD system on coordination, collaboration and communication between the flight crew and the controllers	No specific issues reported about coordination, between ATCO and FC ATCO teamwork: Concerns about PLN SA EXE is still responsible of the aircraft with CPDLC: there is the need of standardization of PLN ATCO support to mitigate EXE high workload

Table 8 - Result per HP

5.3.2 Impact on Safety and Human Factors

The complete safety assessment of the AFD project is added as ANNEX A

5.3.2.1 ENAV Analysis

Human Performance - Ground side

Human factors qualitative assessment was conducted during the flight trials campaign (see 5.3.3. for details about the methodology applied).

Feedbacks and expectations from controllers were collected through an on line questionnaire and debriefing sessions after each flight trial. The table below reports the ATCOs sample participating in the flight trials campaign and their role during the flight execution.

ATCO ROLE IN THE FLIGHT TRIAL			
AFD Controller (PSA)	AFD Supervisor (PSA)	EXE Controller (OPS)	Total
25	15	11	51

Table 9 ATCO Participants to the HF assessment

A total of 51 questionnaires were collected.

Results collected in the PSA room (from both, controller and supervisor roles) provided a reliable feedback about the AFD system, since participants had the opportunity to interact with the AFD system directly. On the other side, feedback collected from OPS room provided a high level feeling and generally the final output is mainly based on an envisioning process driven by HF experts: this is because the interaction of the OPS ATCO with the datalink communication was very minimal (it consisted in waiting for the communication chain to be completed).

The output collected showed a differentiated impact on several HP issues that are discussed hereafter.

Overall Acceptability of the concept

Generally, the use of CPDLC full datalink communication is perceived as beneficial. Particularly, controllers identified specific operational conditions that can be considered suitable for:

- In en-route phase and in general in en-route sectors, featured by low number of vertical movements (e.g. Route Roma-Palermo) and crossing waypoints
- In nominal condition
- During light traffic hours (for example, during night shifts)
- Limited to “direct and simple” instructions, such as descend/climb or heading.

In these listed cases, controllers expected to experience a positive impact on their mental workload (less communication load, less risk of misunderstandings etc.).

Even if it is well known that in general CPDLC as primary means of communications is not intended to be implemented in case of non-nominal situations, such as bad weather and high traffic conditions, controllers highlighted that in these cases, the revert to R/T communications is mandatory and can be decided by either ATCO or FC.

The figure below shows the perceived workload due to CPDLC operations, compared to normal R/T ones.

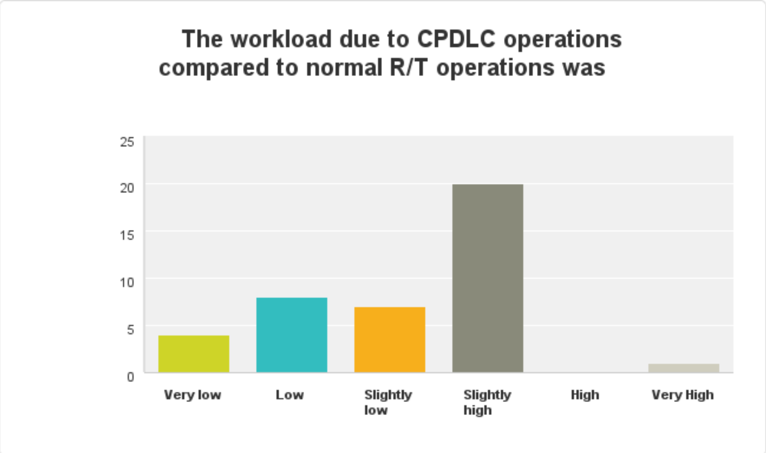


Figure 9 - ATCOs perceived metal workload

ATCOs stated that the level of workload was slightly higher than the current operations. This is likely partially due to the novelty of the system and they agreed that a proper training and familiarization with the concept may further reduce this gap. ATCOs agreed that the test and assessment of the AFD system in a more realistic environment may provide different results.

A future evaluation enclosing a fleet of aircraft managed by AFD system is indeed recommended in order to eventually confirm these impressions.

During debriefings, ATCOs stated that the current AFD implementation can be applied mainly in En-Route phases. In general, they report some concerns in using AFD in the terminal area due to the number of instructions usually exchanged between ATCOs and A/C in this area. ATCOs highlighted that the current operations in terminal area might not be suitable with the current AFD implementation. In TMA there is usually the need for higher speed in message exchange, the need to deliver multi-elements messages (e.g. often within the same instruction is issued FL and speed reduction) and an immediate answer by the A/C (as for R/T communications) is perceived as quite essential.

Level of confidence in the concept

A good level of confidence in the system is a key issue working in complex environment featured by system/technology support. Moreover, a good level of confidence in the system may also have a positive impact on ATCOs, reducing their level of perceived workload.
The figure hereafter shows the results related to evaluation of the level of confidence in using AFD system.

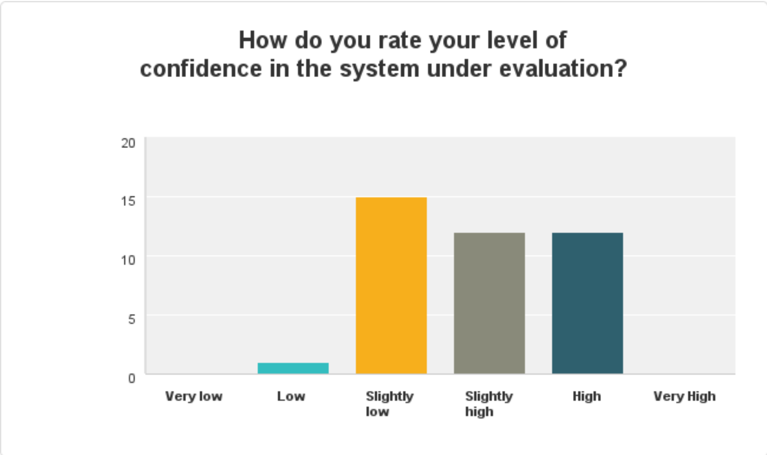


Figure 10 - ATCOs perceived level of confidence in the system

Generally, results showed a positive trend. Some ATCOs reported that the level of confidence is slightly lower compared to the R/T means of communication, but most of them rated their confidence in the system between “slightly high” and “high”.
During debriefings, ATCOs reported that their concerns were mainly due to the following factor:
Risk of decrease of Situational Awareness for the PLN ATCO: due to the “silent coordination” featured by CPDLC, she/he might be not aware of traffic management performed by EXE controller and she/he might have some difficulties in follow the instructions issued by the EXE.
This would lead to an increase of workload and to a decrease of efficiency in performing shared tasks.
Moreover, the massive use of visual attention (particularly form EXE controller’ point of view) can lead to the risk of loss (or decrease) of situational awareness (e.g. focus on the CPDLC windows instead on radar monitoring), especially in case of high traffic load.
Data collected from debriefings seem to suggest that ATCOs’ confidence in using AFD increased during the whole AFD campaign. Controllers agreed that a proper training and the possibility to familiarize with the operational concept itself can further increase their positive confidence rate.

Acceptability of CPDLC below FL 285

The challenge of the AFD project is to implement CPDLC communications below FL 285, with the aim to establish datalink communication also in the terminal area (below FL 195).
ATCOs were requested to provide their feedbacks on that and their answers and suggestions are shown in the pictures hereafter.

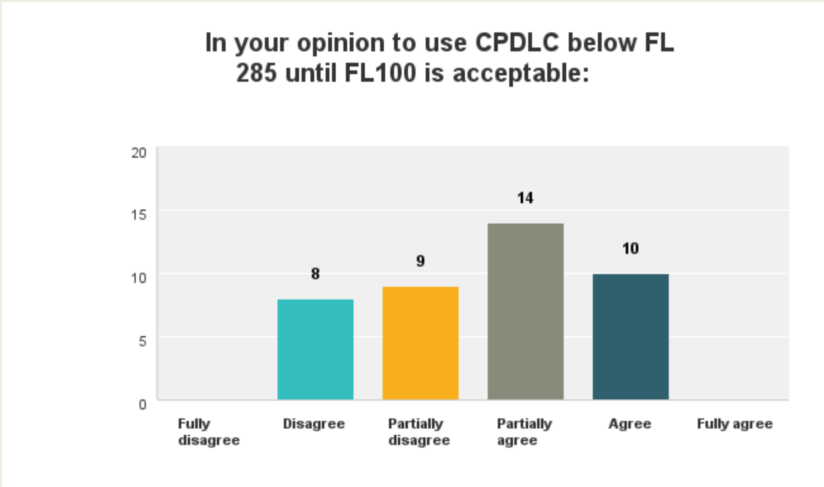


Figure 11 - CPDLC suitability between FL 285 and FL 100

Controllers' feedbacks about the use of CPDLC below FL 285 showed that almost 41% of participants report values around "disagree" and "partially disagree", while the majority - almost 58% of participants - report values around "partially agree" and "agree".

The figure below shows that most controllers, reporting the specific FL where CPDLC could be applied, agreed in setting the minimum acceptable limit around FL300 (values range b/w FL300 and FL280) .

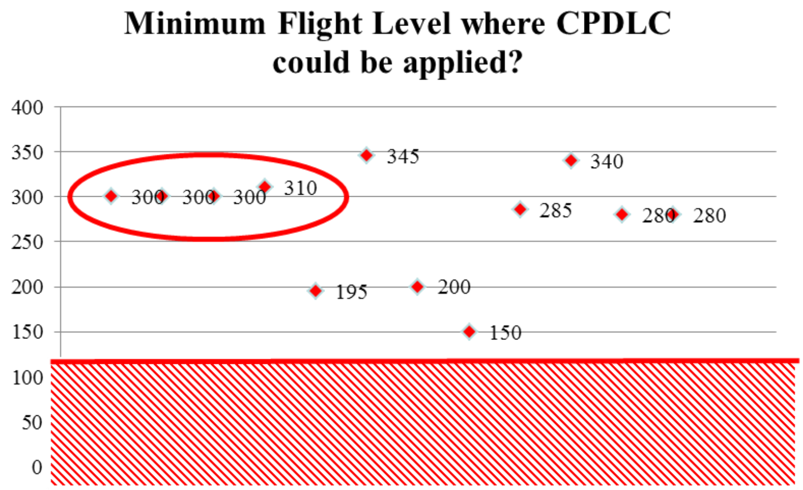


Figure 12 - ATCOs starting CPDLC operations altitude

The FL 300 represents actually the final cruise level and this result seems to be in line with the general controllers' opinion collected during the demonstration activities: considering that some flight trials has been influenced by external factors, such as weather conditions, technical problems on the AFD platform as well as high amount of traffic perceived on the TMA area, we can assume that the difference between data showed on the figure 11 and 12 is due to such external factors, generating a sort of resilience on CPDLC usage.

Controllers agreed that the use of CPDLC communication may be suitable in TMAs only in specific traffic condition: nominal situations, no need of instructions to separate traffics, good weather conditions. ATCOs concerns about the use of datalink communications in the approach phase (both before landing and after take-off) are mainly due to the working methods usually applied in this area featured by frantic flow of instructions, number for restrictions and airspace complexity.

Coordination and communication Air/ Ground

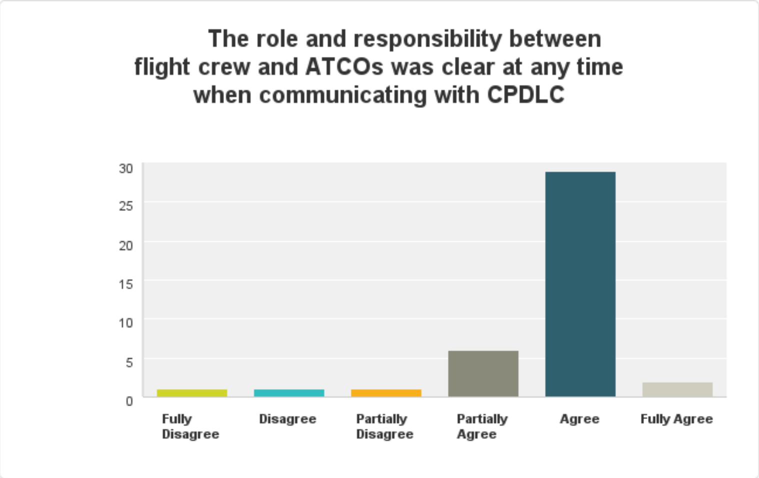


Figure 13 - Role and responsibility between ATCOs and FC

The picture above describes ATCOs' view about the roles and task sharing with the FC, compared to the daily operations (with R/T as primary means of communication).

As explained before, there is not, at the moment, a strict standardisation for the division of roles and responsibilities between EXE and PLN ATCOs, for datalink communications; however, it is recognised that:

- EXE is always responsible for the management of CPDLC operations
- PLN might have the chance (after agreement with the EXE) to interact with the traffic to mitigate EXE's MWL. There is the need to understand how to regulate this, since there might be the chance of overlapping messages.

During debriefings, controllers reported the need to improve the flexibility of CPDLC messages set, without impair the safety of the air/ground communication exchange. An example of this issue is the following.

From ATCO perspective, a pilot request should be always motivated, while the current CPDLC implementation does not allow specifying the rational of a FC request. This aspect might have a negative impact on safety and ATCO's perceived situational awareness.

However, controllers strongly highlighted that a relevant advantage of CPDLC messages is the low risk of misunderstanding during the communication exchange, since the risk of issuing the instruction to the "wrong" aircraft is very low. Moreover, the message itself is less prone to be misunderstood and it is always available on the screen (for both ATCO and FC).

In terms of air/ground communication, ATCOs also highlighted the need to broadcast to a/c relevant messages (e.g. turbulence/bad weather, congested situation, restricted area etc.) as they usually did in R/T mode. A feature to send messages to all aircraft in contact could mitigate this issue.

Another issue identified by controllers that may impact of air/ground communication is the management of message prioritization during high density scenario. ATCOs concern especially refers to situations with high number of aircraft under control that might also clutter the radar screen. Of course, in this case an effective HMI design can strongly mitigate this potential issue.

Finally, it is interesting to highlight that ATCOs reported a differentiated feedback in case of working in mixed mode communication environment (where only a proportion of traffic uses CPDLC communication mode). They stated that receiving mixed mode communication may lead to an increase in workload for the EXE controller, as she/he is requested to invest much more resources and engage visual and aural cognitive channels. On the other hand, instructions issued in mixed mode (namely, ATCO decides to use R/T or CPDLC) did not negatively impact on workload.

Revert to voice from datalink communication mode still represents for controllers the final safety barrier in case of unusual/emergency situations or in case of conditions where the communication via R/T is mandatory (bad weather, high traffic, separation instructions): R/T is still perceived by ATCOs as a way of communication to speed up the operations and the management of event from both airborne and ground side.

Impact of AFD operational aspect on Human Performance

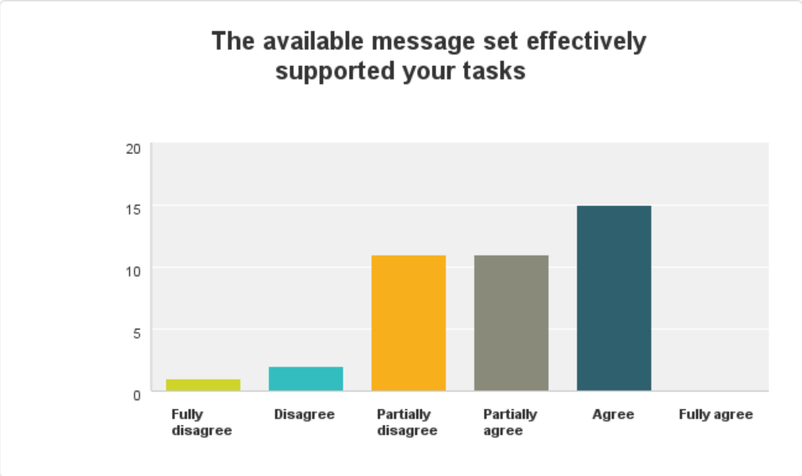


Figure 14 - CPDLC available message set

ATCOs were quite satisfied with the available set of messages. In general, controllers agreed that the use of datalink communication should be limited to “direct and simple” instructions, such as descend/climb or heading. In operational case in which instruction was to be followed by (or requires) a dialogue between ATCO and pilot, they stated that this instruction was to be done by R/T mode. The exchange of messages would require too much time and too much visual attention to the ATCO, increasing the workload and decreasing the level of attention to the other traffic.

Specific suggestions were collected during the debriefing to improve the AFD message set for future updates.

Message set optimization

ATCOs identified some additional items to be added to the message set available for AFD.

It would be useful to add a message to Stop Climb/Descend, since when an aircraft is climbing, for example at FL400, it could be asked to stop the vertical movement at a lower level (for example at FL360); the only way to stop it is to send an instruction of descending to a specific flight level, but the aircraft is still climbing.

The heading instruction should be justified, as it happens for the communications via R/T, adding the reason (e.g. for spacing, for sequencing). A possible way could be to insert a choice window (or a section of it) where the most common reasons are available to be added with a click. This would support also FC situational awareness.

Multi-element messages

In TMA management, ATCOs are used to issue three/four clearances within the same dialogue (particularly in the approach phase). One instruction per time may increase the ATCOs’ workload (and FC’s MWL too), since they have to wait for the reply to each of them. This is one of the main issues highlighted by ATCOs during the demonstration activities, and it represents their major concern in using AFD in approach area. ATCOs, agreed in implementing the multi-element message, but under a strict standardization due to safety reasons.

Preparation time adequacy

As shown in the figure below, ATCOs are generally satisfied with the time required for message preparation.

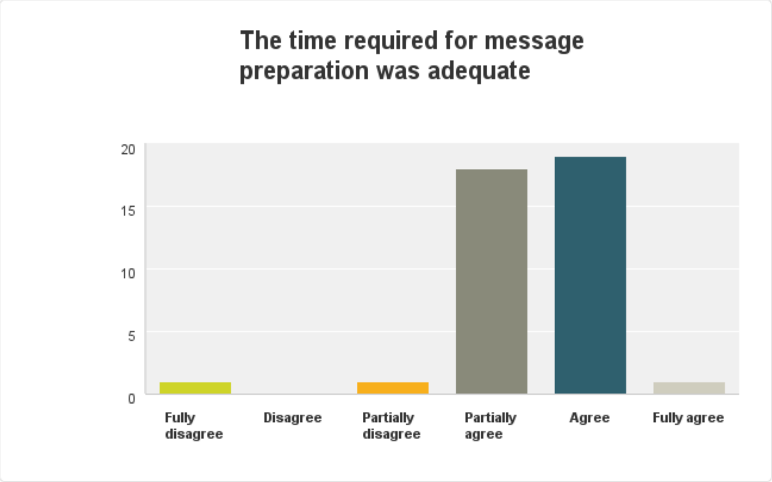


Figure 15 - Time required for messages preparation

Time-out message

The tested setting of time-out feature (2min) was considered not acceptable by ATCOs (lasting too long). However, this is a parameter that can be changed, according to agreements within the ANSP: ATCOs suggested that a time-out should be set at 15/20 seconds, even in en-route phases. This limit should be lower in TMA sectors, where the pace of instruction is much higher.

Acceptability of “unusual” messages

Controllers were requested to report their feeling about specific AFD message, lead to unusual event and situation. “Unusual” messages include the STAND-BY, the reversion to R/T and the time-out.

Results are reported in the following figures.

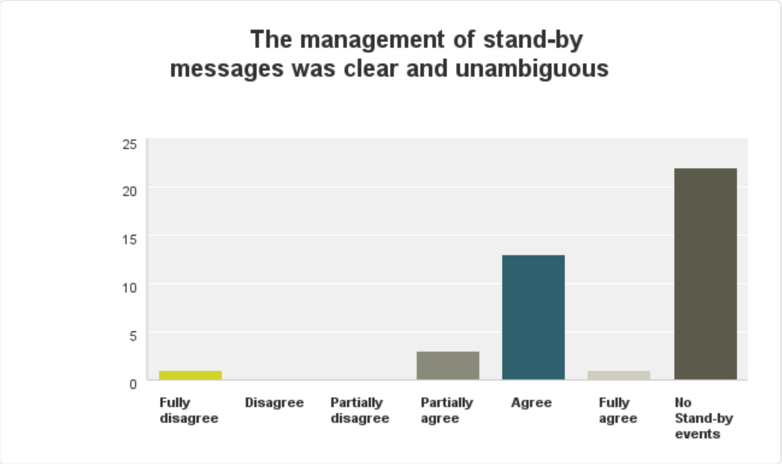


Figure 16 - Management of STAND-BY

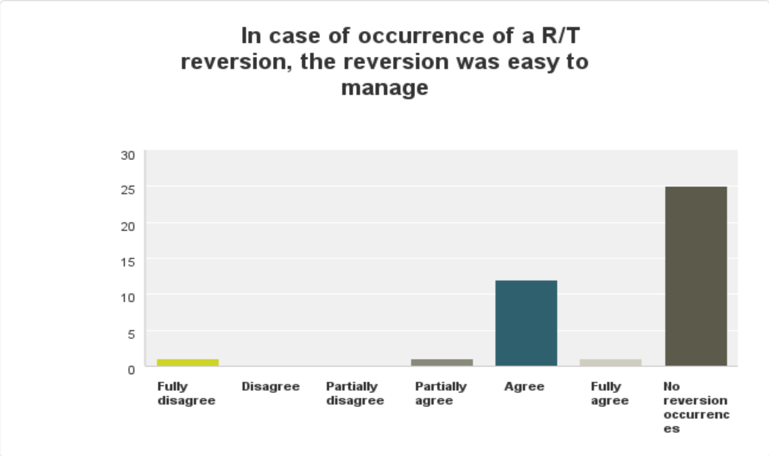


Figure 17 - Management of R/T reversion

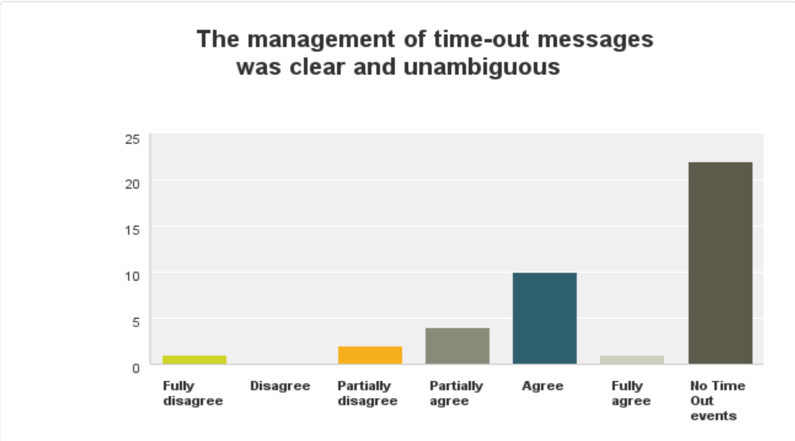


Figure 18 - Management of time-out messages

As shown in the pictures above, most flights trials did not experience such events; however, in some flights ATCOs had these messages and they agreed on the clearness and unambiguity of them.

Optimization of HMI in order to improve the interaction and usability

- **Risk to clutter** the radar screen considering the CPDLC operative windows opened at the same time, especially in high traffic conditions.

CPDLC choice windows

- Choice windows design should be improved. E.g. selected values (speed, Mach, altitude) which appear when the ATCO opens the window, should be the one the aircraft is flying at.
- Heading left or right is not intuitive (sometimes ATCO may have the need to ask for a turn to 270°magnetic southbound, on the left, to delay the aircraft).
- Some windows might be with a black background, to ease the text reading.

5.3.2.2 NATS Analysis

In total 27 Human Factors questionnaires were completed by the Air Traffic Controllers who handled the demonstration flights. The controllers were undertaking tactical, planner or combined roles, and represented the range of sectors through which the demonstration flights transited between FL100 and FL285.

Generally CPDLC was seen as fit for purpose, with low impact on workload and spatial awareness. There were some issues with use resulting in the controller reverting to voice communication, predominantly due to options not available on the system or limitations of the levels in which the trial was operating.

All controllers who offered an opinion were at least neutral to the question of whether they were comfortable using CPDLC between FL195 and FL285, with the majority being positive and the largest number responding “strongly agree” to this question. The equivalent question for the FL100 – FL195 level band is not as conclusive, although the majority did respond either neutrally or positively to this question. This question was present on the questionnaires that went to controllers early on in the demonstrations before safety approval for operations below FL195 had been obtained. A small number of controllers answered this question during this period and these are included in the data. We can only assume that these controllers answered hypothetically to this question.

Frequently controllers did not have the opportunity to use CPDLC for all of the phases. Over 1/2 of the controllers did not use CPDLC during climb and around half during descent.

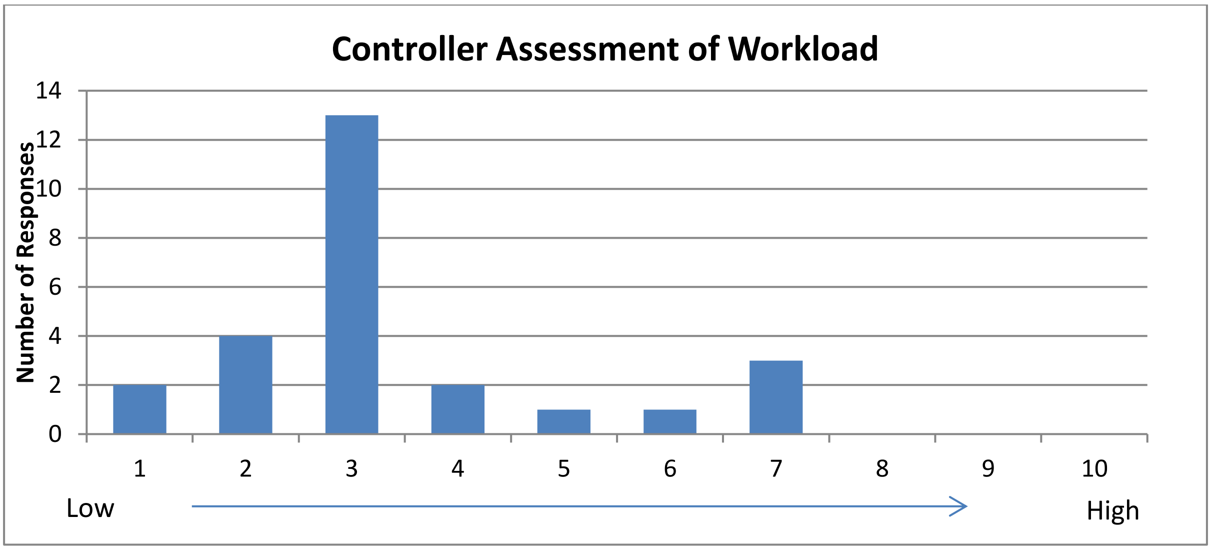
Outcomming was the phase the most controllers used, and also had the highest rating for comfort. “Outcomm” is the NATS terminology for transferring an aircraft to another sector by CPDLC and the associated electronic transfer of control to the new sector within NATS’ systems. When CPDLC was used the majority of controllers found it comfortable with only 2 or 3 feeling uncomfortable.

Is CPDLC fit for purpose?

17 of the 27 controllers felt CPDLC is fit for purpose; 6 disagreed.

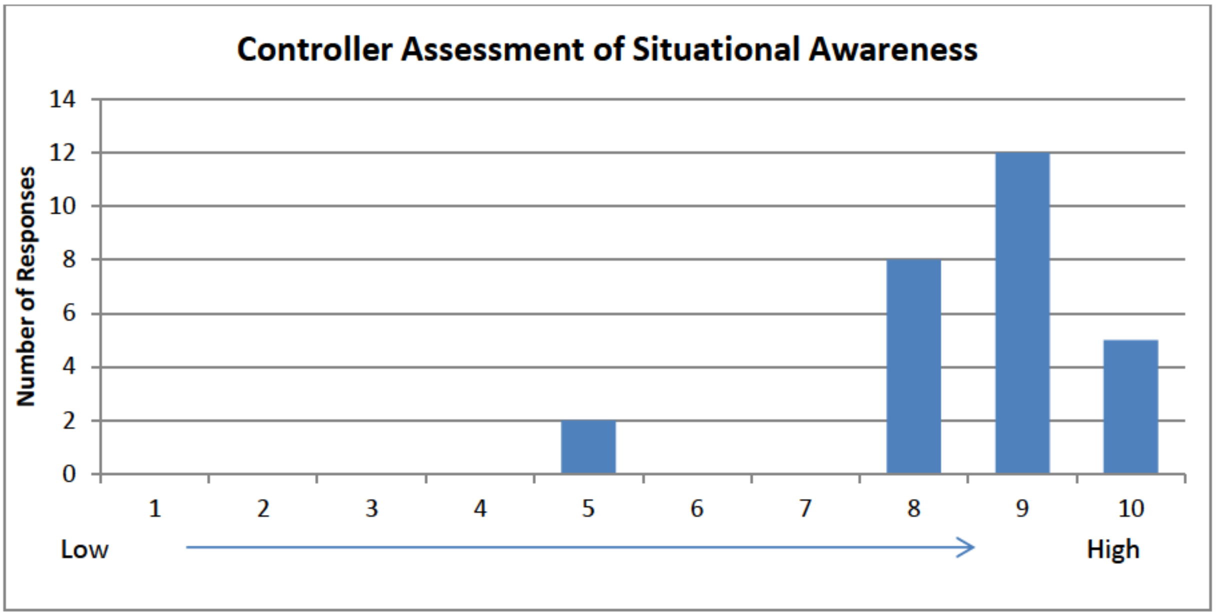
Controller Assessment of Workload

No ATCOs indicated a level of workload that would impact their primary ATM task. More than half indicated they had enough spare capacity for all desirable additional tasks.



Controller Assessment of Situational Awareness

All but 2 controllers reported good, very good or excellent situational awareness. The remaining 2 reported that their situational awareness was reduced, and they were not aware of some of the important information required to perform their task effectively.

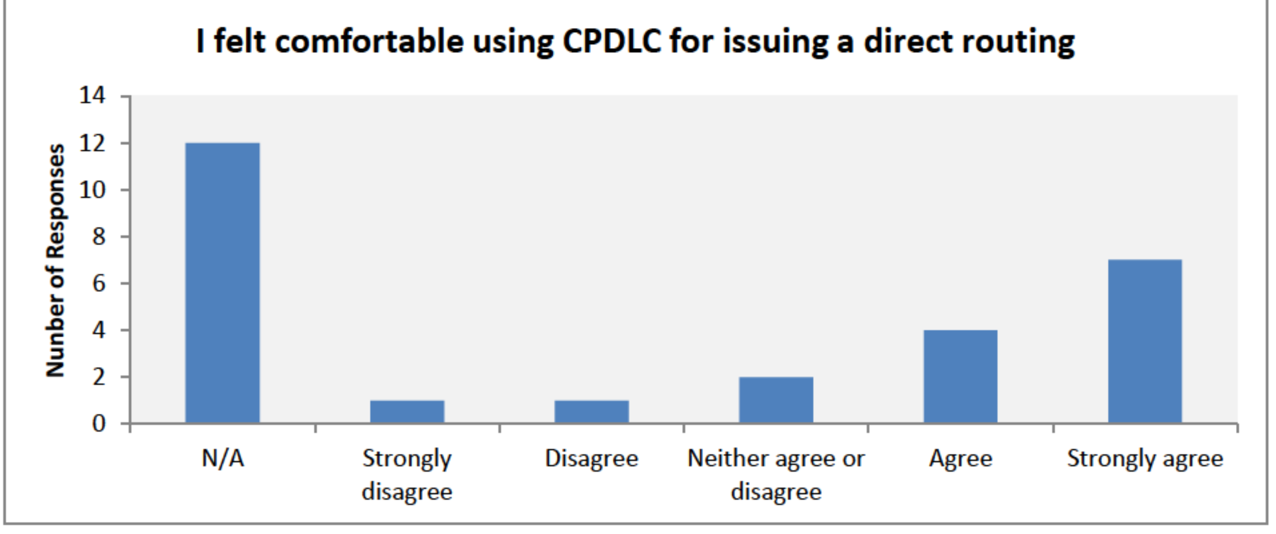


Was it necessary to revert to voice?

2/3 of controllers did not need to revert to voice communications. Of the controllers who reverted to voice, on four occasions the controller did because there was no appropriate CPDLC instruction available for the situation. Of these 2 situations required checks by pilot or controller, and 2 required a configurable option (e.g. frequency) or message which was unavailable. There were 3 occasions where the aircraft was already cleared below the CPDLC minima. There was one case where the controller selected the wrong button so reverted to voice to resolve.

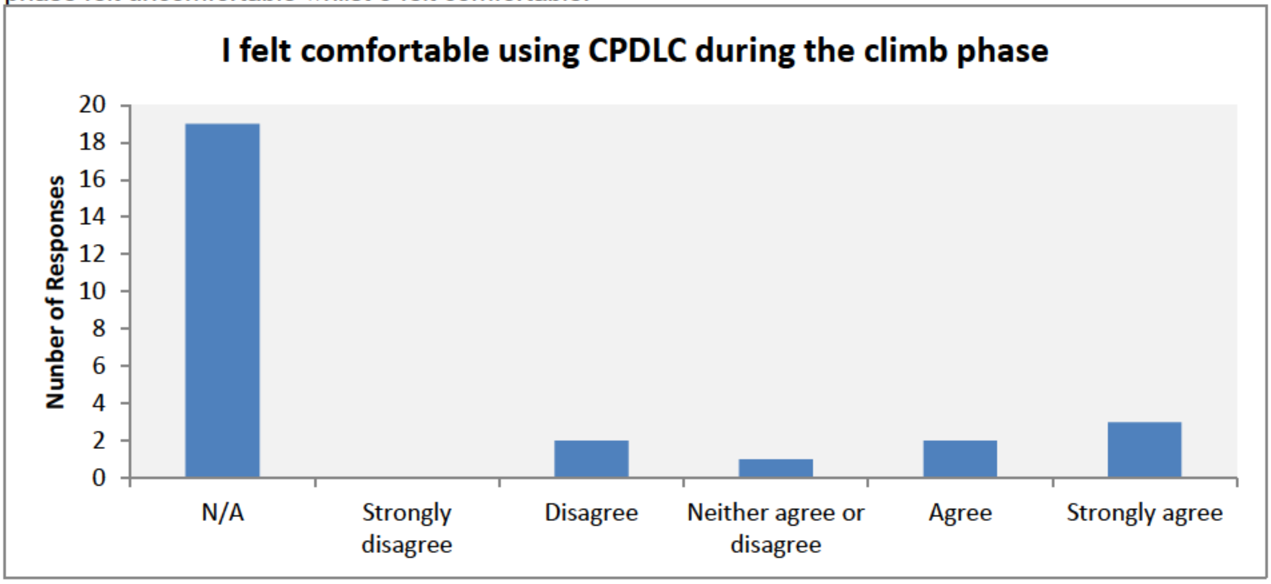
Using CPDLC for a Direct Routing

Nearly half of the controllers had no need to use CPDLC for a direct routing. Of those that used it, 13 agreed it was comfortable, whilst only 2 felt uncomfortable.



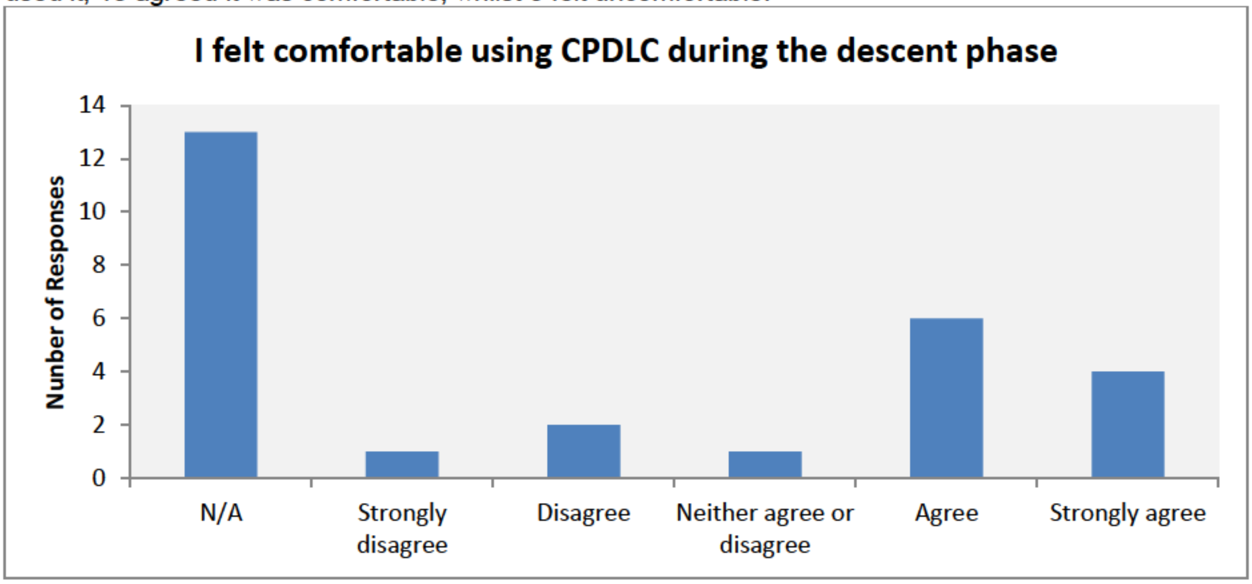
Using CPDLC during Climb

19 out of 27 controllers had no need to use CPDLC during climb. Only 2 controllers who used it in this phase felt uncomfortable whilst 5 felt comfortable.



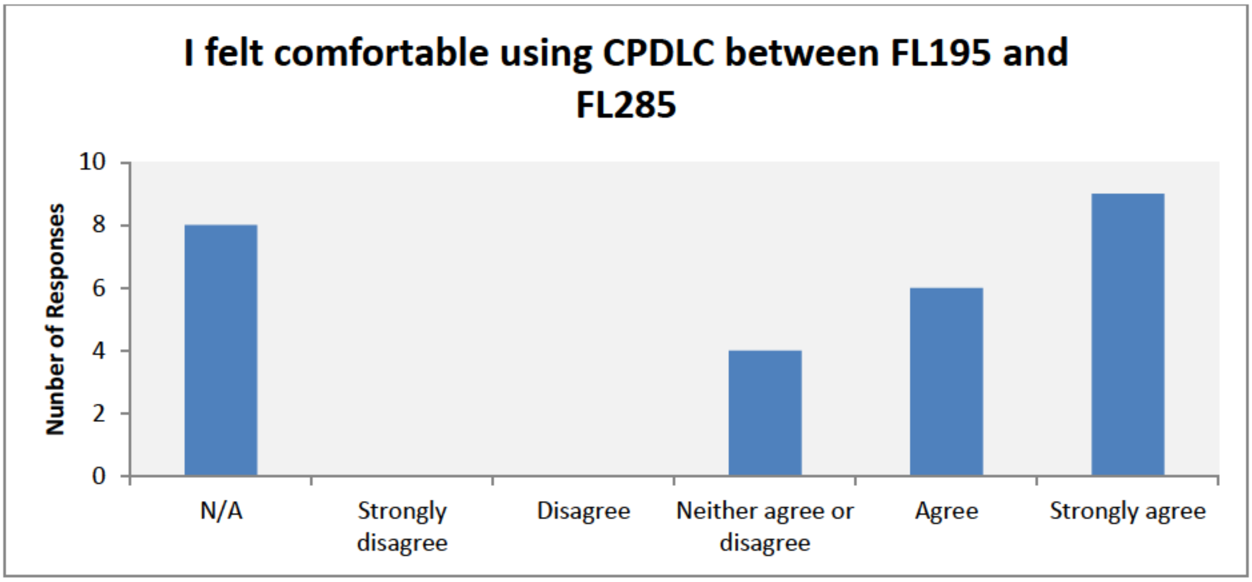
Using CPDLC during Descent

Nearly half of the controllers had no need to use CPDLC during the descent phase. Of those that used it, 10 agreed it was comfortable, whilst 3 felt uncomfortable.



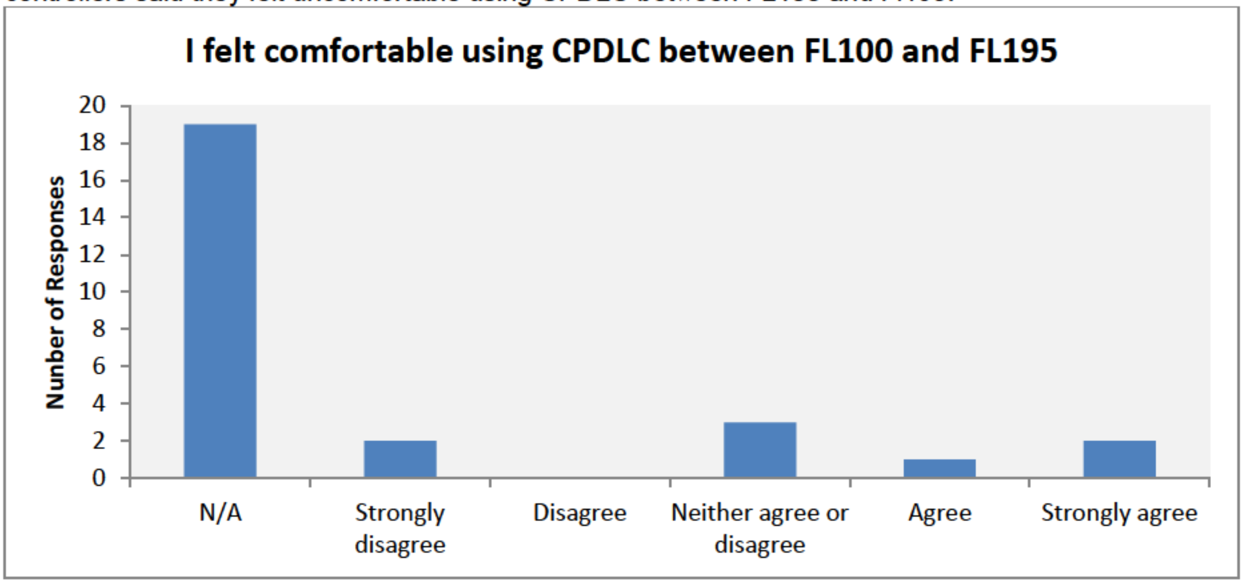
Using CPDLC between FL195-FL285

Of the controllers who used CPDLC between FL195-FL285 none felt it was uncomfortable.



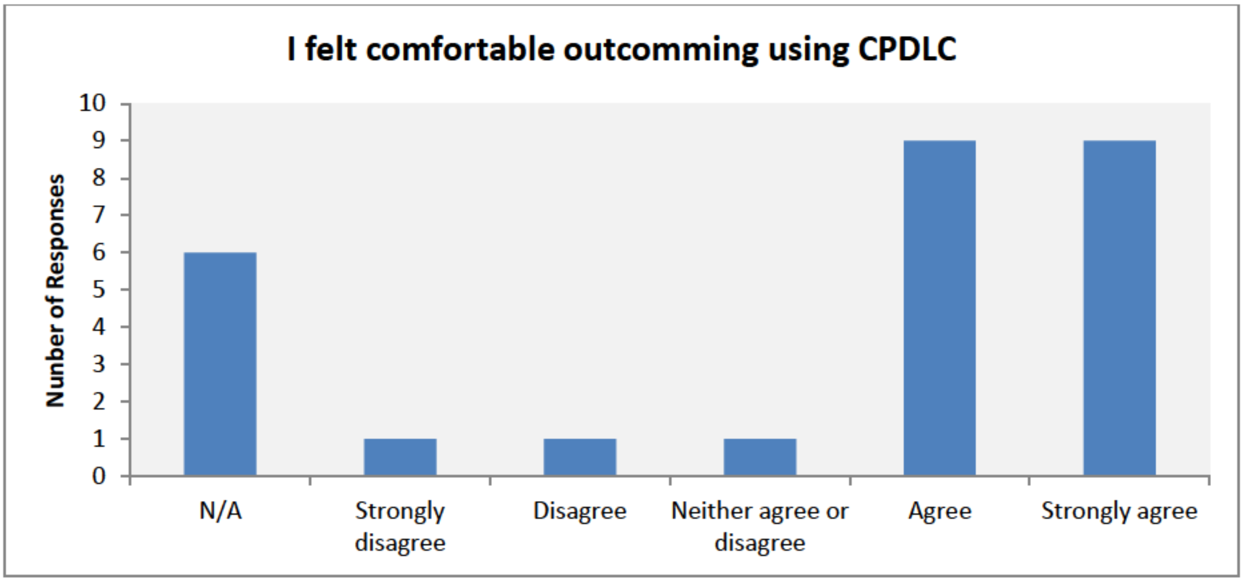
Using CPDLC between FL100-FL195

Only 1/3 of controllers answered this question, as has been mentioned before this is above the number who had safety clearance to operate in this level band. The system logs do not show that CPDLC was used in these levels, so we can only assume that these controllers answered hypothetically. For completeness, these are left in the data set. Of those that answered, only 2 controllers said they felt uncomfortable using CPDLC between FL100 and Fl195.



Using CPDLC for Outcomming

18 of the 27 controllers were comfortable outcomming using CPDLC. 6 controllers did not have the opportunity to use CPDLC for outcomming.



5.3.2.3 AIRSIDE Analysis

As for the ground side, a qualitative assessment was equally conducted for the airside. Feedback from pilots was collected through online or paper questionnaires imported in the survey tool and completed by opinions captured directly by airlines and their observers participating to selected flights.

The gathered evidence relates mainly to the following arguments of the SESAR Human Performance Assessment Process:
Arg. 1.1 Roles and responsibilities of human actors are clear and exhaustive.
Arg. 1.2 Operating methods (procedures) are exhaustive and support human performance.
Arg. 1.3 Human actors can achieve their tasks (in normal & abnormal conditions of the operational environment and degraded modes of operation).

A total of 32 questionnaires (covering 41 flights) were received (12 for EasyJet, 11 for Air France and 9 for SAS), and one observer participated for SAS. It shall be noted that 18 of these questionnaires referred to two legs between city pairs, which potentially could increase the number of questionnaires if they would have been answered separately. Several flights were also conducted by the same pilots, which impacts the distribution of pilot characteristics in the participant sample.
The table below reports the role of the pilots during the flight.

Selection					
	Pilot Flying	Pilot Monitoring	Pilot Flying – Pilot Monitoring	Pilot Monitoring – Pilot Flying	Total
Please select	**25.00%** 8	**37.50%** 12	**18.75%** 6	**18.75%** 6	32

Table 10 - Roles of respondents during flight

In 6 flights each, pilots disposed of either FANS A or FANS B experience, whereas in 5 flights, pilots disposed of both FANS A and B experience. No FANS experience was indicated for 15 flights.

15 participants reported the occurrence of in-flight events, wherefrom 3 where aircraft-related, 7 were weather-related, 8 were ATC-related, and 4 were traffic-related.

<u>**Global acceptability of the concept: below FL285; message need & voice reversion (OBJ-0208-011)**</u>

Acceptability of CPDLC below FL285

<u>Outputs</u>
With regard to the acceptability of CPDLC below FL285, the majority of the pilots perceive the use of CPDLC acceptable, as shown in the figure below. Few pilots do somewhat disagree on CPDLC acceptability for such operational situations, and two pilots disagreed.

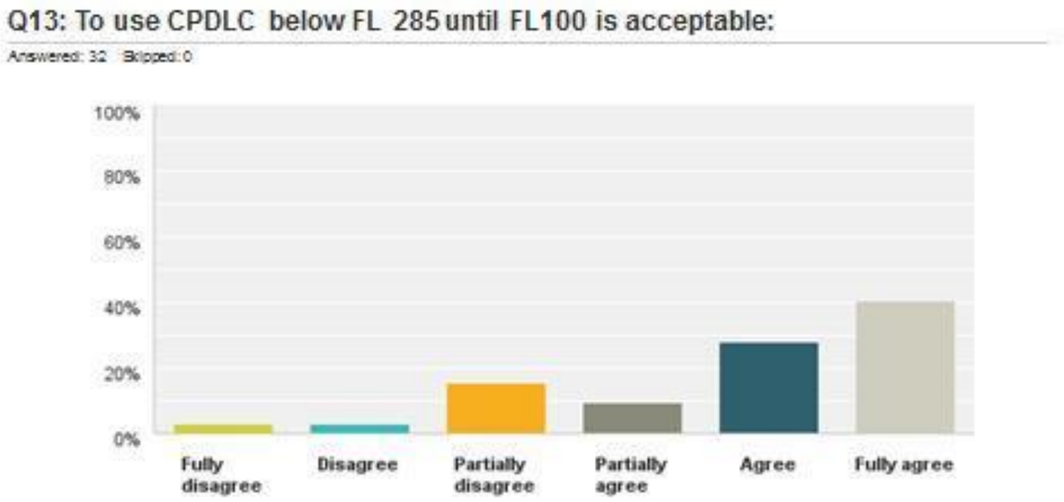


Figure 19 - Acceptability of CPDLC below FL 285

Seven participants specified the flight level (FL) which could be potentially acceptable. Five of them agreed that for the Climb phase CPDLC can be used from FL145 on (one pilot specified that this could be accepted at least at the beginning of the procedure introduction), only two of them agreed for the same level during the descent phase. Three pilots would find CPDLC acceptable for FL195 in descent but only 1 of them in Climb, and 2 for FL245 in descent and 1 in climb.

The major perceived benefit of CPDLC communication below FL285 compared to RT is the clarity of the message set (n=28 out of 32), followed by availability of message set and easy integration with pilot's tasks (n=13 each), ATC responsiveness (n=10), Time available for message management (n=6) and other benefits (n=3).
Some pilots perceived usage of CPDLC as very impressive and indicated CPDLC as a useful tool enhancing efficiency. However, several pilots rose that it was not possible to deploy CPDLC during all flight to the extent desired, because full benefits were not felt exploited. For example, the route FCO-PMO was perceived as a good route for introduction of CPDLC operations as it is a fairly quiet route with regard to ATC communication.

<u>Message need</u>

The following table indicates the messages pilots would use through CPDLC and was indicated for 7 flights. However, this information has to be taken with care because it is not sure if the non-selection occurred on purpose. This point is under investigation at the time of report writing.

Flight profile modification uplink from ATC	vertical (e.g. “request climb to”),	6
	lateral (e.g. “request direct to”)	7
	speed	7
Communication management	contact	7
	monitor	7
	check stuck microphone	7
Surveillance (uplink from ATC)	Squawk	7
	Report/Confirmation Requests Uplink from ATC (e.g. “report present level”)	4
	Negotiation Requests Uplink from ATC (“When can you…?”)	4

Table 11 - Number and type of messages to be used through CPDLC (n=7 out of 32 respondents)

Several respondents raised the need to add a “Heading” to the REQUEST menu. This message is the most commonly used by ATC especially in the UK FIR, and pilots were unable to request headings for weather avoidance for example. Therefore in times of high ATC workload pilots would have to revert to voice which would be adding to the workload.

EasyJet globally reported the observation of a varied use of message sets: Some ANSPs use single elements in multiple messages, which gives a lot of messages to handle. EasyJet would perceive it simpler and less risky if concatenated messages were used. Also, a varied use of the transfer protocol between the London and Scottish FIR compared to other ANSP s was observed.

Some EasyJet pilots found also confusing the terminology with NOTIFICATION / ACTIVE ATC / NEXT / CURRENT in the context of a “LOG-ON”. In addition, pilots would expect a log-off by ATC when instructed to contact a new frequency, which did not occur in a case and required a manual disconnection of CPDLC by the flight crew.

Each time a frequency of a sector is changed, the message “CPDLC in use” was received, which for one pilot leads to too many messages for such phase of the flight. Equally, in one case the adequateness of the DIRECT message was doubted when aircraft received the message “LIRF DCT AOSTA DCT CDG”, since a direct to CDG would be appreciated but was not perceived as very realistic.

Ambiguity was also perceived in a case where a "Cleared to" message appears as "VIA LURON DCT XXX DCT". It was not understood what DCT stood for if part of a truncated message. In this situation, the doubt was further reinforced by a second message "VIA ROM.DCT", which was interpreted as going direct to ROM, which was however inconsistent with the format of the previous message. In contrary, a later received message "PROCEED DIR TO LAT" left no doubt about the type of instruction.

A further unexpected message to a request for a “DCT TO ROM” was the system answer "Rejected with ATC" and then followed by an ERROR MSG "REQUEST ALREADY RECEIVED".

One respondent expressed the need of the free text message on top of “due to weather” and “due to aircraft performance”. One pilot expressed equally that he would like to have the possibility to send a turbulence message, which could eventually occur in form of a free text message. One pilot also explained to prefer uplink messages in CLB/DES, whereas he would prefer voice for pilot requests, as it requires less workload and allows remaining more head-up.

Scandinavian

SAS reported a generally (very) positive feedback and technically the flights worked well. In summary, most pilots saw no/few concerns about using CPDLC down to FL100 as long as it is routine type of messages and clearances. On the Rome Fiumicino (FCO) flights there was very frequent use of CPDLC by ATC. On the flights from Sweden to ABZ (Aberdeen) and EDI (Edinburgh) there was less use of CPDLC. SAS is currently using CPDLC operationally on the 737 fleet with MUAC, NATS, DFS and Skyguide. SAS crews would like ATC to actually use CPDLC more frequently in some sectors after the log on.

Impact of CPDLC on voice reversion

Most of the pilots perceived the voice reversion easy to manage, 3 out of 32 disagreed. It shall be noted that pilots who did not encounter voice reversions addressed this question from a general point of view not due to a specific occurrence. The total number of reversions was not collected.

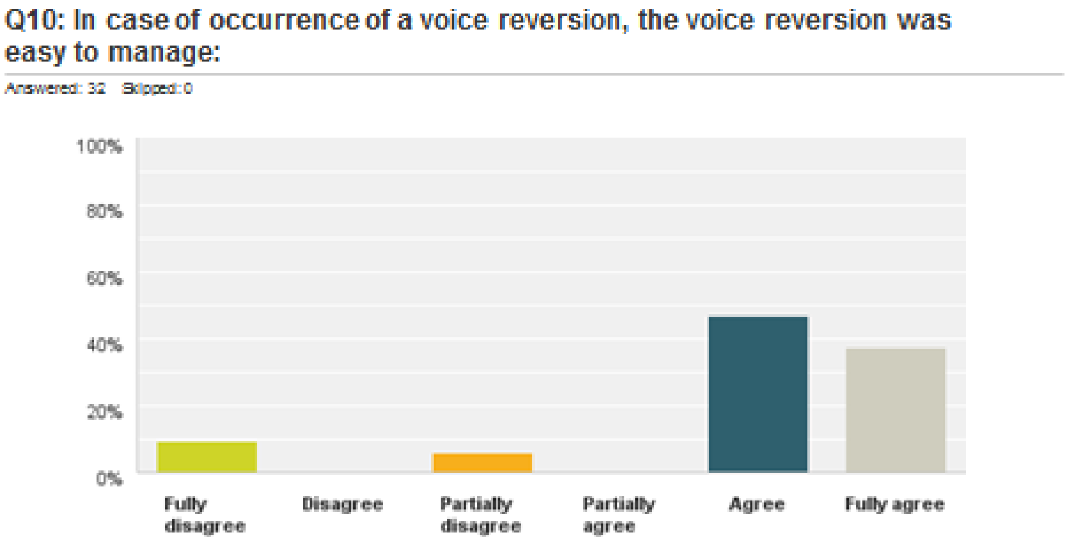


Figure 20 - Easiness of voice reversion management

The easiness of managing voice reversions was mostly perceived for the descent phase (n=16 out of 32), a third of the participants identified this for the cruise phase (n=11), and 15% (n=5) for the climb phase.
As one pilot characterises, the reversion was very simple and ATC was well aware of the situation.

The global number of voice reversions was not systematically collected; the following cases were reported by pilots as leading to voice reversions:

- Answer to a clearance failed and “SEND FAILED” was shown on DCDU (n=1)
- On control request in 2 cases (by voice or by CPDLC) (n=3)
- CPDLC unavailability/connection problems (n=2)
- Request by ATC if CPDLC clearance for climb had not been received (n=2)
- Clarification on descend clearance (n=2) (Answer for Top of descent request was too slow and need to avoid being excessively high on profile; ATC not being able to state for level restriction)

In one case the use of CPDLC was initially planned during climb, however, finally communication occurred through voice as departure was not possible on a SID due to traffic. In one case the reason was not specifically reported by the pilot (n=1).

Analysis & Conclusion

Even though for the majority of pilots the CPDLC find acceptable using CPDLC below FL285, several limitations do impact an efficient CPDLC deployment:

Message set availability

The perception of having less time available for message management can be interpreted as due to the nature of the airspace, which is different with regard to En-Route environment. Availability of message set is only partly perceived as an advantage, which is probably due to the limited set of messages available. The use of additional exchanges with ATC through voice can be avoided in routine situations requiring tactical actions:

- A REQEUEST HEADING would allow asking for a route deviation, for instance due to weather, in a non-time critical situation.
- A REQUEST DESCENT message would allow asking for descent initiation, since the REQUEST level cannot necessarily be accommodated by the ATC.

It is recommended to further study more in detail the need for additional datalink messages in rather tactical operational situations of descent and weather avoidance in order to ensure a benefit of both air and ground.

It is recommended to study the selection of the adequate communication mean (voice or data link) under consideration of message content (e.g. simple Vs. multi-element/conditional) depending on the operational situation in order to allow efficient task management for both air and ground operators.

Pilots suggested the use of some additional preformatted information in order to provide more data on specific weather characteristics such as turbulences during the flight. In addition, pilots would want to inform about the reason for a specific response to facilitate the decision-making of ATC (e.g. UNABLE FL DUE TO AIRCRAFT PERFORMANCE, REQUEST HEADING [HDG] DUE TO WEATHER).
It shall however be noted that the use of free text was not implemented in continental FANS B environment to avoid overloading network with not needed communication. In addition, it may be questioned if there is a real need from ATC to know the reason for a pilot request.

It is recommended to further study more in detail the need by ATC to know the reason for pilot requests in continental airspace.

It is recommended to further study the need to inform operators about the justification of ATC instructions or pilot requests in order to optimise decision-making.

Pilots perceived that the transmission of the message “CPDLC in use” in case of frequency transfers is leading to a lot of message receptions not useful in such a flight phase. This message is not a standardised message and is sent as a free text message by the centre. Its objective is to ensure that the a/c was well received on R/T frequency before sending CPDLC in use, especially since sectors below FL285 do not apply CPDLC today. A general extension of CPDLC to lower flight levels could hence question the need of such a message. It shall be noted that the development of the silent transfer function as conducted in the frame of SESAR project 9.33 is addressing this problem by optimising the transfer process and equally defining procedures.

It is recommended to review the need of sending the message “CPDLC in use” in order to reduce the time needed for message management.

Inconsistent use of messages across ANSPs

Even though the clarity of communication is seen among the major advantages of CPDLC in general, some messages favour misunderstandings.

The usage of clearances containing several DCT within one message leads to difficulty in understanding to what waypoint a DCT refers to. This difficulty may be a consequence of the operational novelty of using CPDLC in general and could be managed by adequate formation. However, an alternative message such as “PROCEED DIR TO” seems to have less potential of misinterpretation.

It is recommended to further study the need for selection of specific clearance types related to DCT issued by ATC in order to facilitate correct understanding of such messages.

Another example of inconsistent message set use between ANSP’s is the use of “STATE PREFERRED LEVEL” as used by NATS, which elicits a different response “MCDU FOR EDIT” that surprises the less familiar pilots. Consequently, EasyJet further suggests that ANSP’s consider the use of the message sets and the roll-out programme (GOLD was reviewing FANS A / B message sets to harmonise both sets) so for an initial period they are non-concatenated (as today) but along the procedure NATS adopted i.e. Notify the ATC unit with no message exchanges then build up to IN-COM / OUT-COM, then finally profile changing messages.

EasyJet raised a difficulty in understanding the terminology and procedures used for transitioning between centres. ATC centres seem to generate differently the transition between CURRENT and NEXT ATC and the meaning of displayed information such as “ACTIVE” ATC compared to a “CURRENT” ATC message is not clear. Harmonised procedures across ANSPs facilitate that pilots do know what to expect.

It is recommended to further study the differences of the transition between data authorities in order to identify their impact on pilot’s understanding and a potential need for harmonisation.

Having two different words ACTIVE versus CURRENT for an equivalent situation resulted in questioning of its meaning. It may be noted that these two terminologies were maintained to ensure consistency across Airbus products.

It is recommended to inform pilots about the purpose of maintaining multiple terminologies on ACTIVE and CURRENT.

As EasyJet summarises, the Human factors issues of managing the CPDLC system will take time, but the lack of a consistent behaviour from the ground stations / controllers (equipped / non-equipped) adds to the confusion / mistrust of the system and the tendency to revert to voice.

Connection availability

The flight trials showed the lack of maturity of the actual FANS-B+ system that is not today robust enough to pretend to be a primary means of communication, particularly in very dynamic phases of flight. To cope with this situation, EasyJet has for example instructed its pilots to notify ATC and revert to voice procedures if confusion / errors occur (disconnecting ATC in the CPDLC menu if required).

It is recommended to ensure the robustness of the system in order to avoid the management of unexpected disconnections.

Impact on flight efficiency and flight crew prospective OBJ-0208-014

As generally reported by EasyJet, pilots did not perceive major concerns for using CPDLC, most crew found the interface quite simple even with the most basic of guidance given before flight. Some reports mentioned the confusion with the loss of connectivity (Provider Aborts).

It was also raised that CPDLC was not included in of Standard Operational Procedures (SOP), even though it is questioned if CPDLC needs a procedure, as it shall be dealt in the same way as with RT to avoid adding complexity. Even though it shall be investigated whether FCOM needs to be updated. Similarly, also for Air France pilots CPDLC usage was not a problem. The use of the DCDU/MCDU is intuitive and message format is clear. Colour codes used allow a good readability. Use of CPDLC makes a cockpit more silent which is a flight safety factor.

Analysis & Conclusion
EasyJet suggests to foresee SOP revisions to formalise the management of CPDLC (subject to NAA requirements).

Impact on Workload
19 out of 32 respondents indicated a reduced level of workload, whereas for the remaining the workload was slightly higher or higher. The following figure shows the distribution of perceived workload due to CPDLC operations.

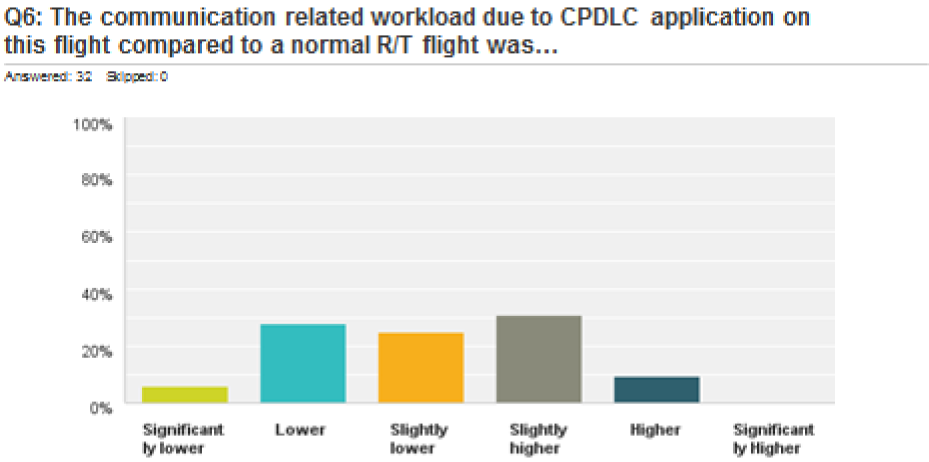


Figure 21 - Perceived workload of CPDLC

Eight out of 13 respondents perceived that the workload increase applies most to the descent whereas four perceive that mostly climb is concerned and for one the cruise phase was mostly related to workload increase. For all of them the workload increase is still acceptable.

Some pilots perceive CPDLC as an excellent system, as it eases the amount of workload and facilitates the management of priorities. In intense traffic environments it keeps the number of R/T messages to a minimum and avoids stepping on other a/c transmitting. Even though, one pilot thought that in case of heavy workload, CPDLC may become too heavy due to the increased number of actions. This also makes aware of the importance of the good timing of complex clearances in order to provide the flight crew with enough time to program the FMS, set nav-aids and brief the approach.
For example, one pilot perceived the NOTIFICATION after start up clearance as increasing workload in a phase already heavy and it was questioned if this could be anticipated with respect to the 15 to 45 minutes.

EasyJet expressed the need to address the loss of the so called “party line” available through R/T in order to avoid unwanted attention to the DCDU. A way to address this loss was having pilot monitoring verbalising the DCDU exchanges for the second pilot.

For EasyJet, the novelty of the application (all Pilot’s in the EZY trials had never used CPDLC before) initially caused some pilots to both focus on the DCDU (non-adherence to task), this reduced with experience. Similarly, an Air France (AF) pilot expressed that “as with all new system, CPDLC is attracting and retain flight crew attention. We need to be attentive to the ONE HEAD UP AT ALL TIME rule, more than with the EFB only,...” Several pilots confirmed the importance of an adequate head-up philosophy. A lot of cross confirmation is required between pilots in operating the system which requires heads down to check and confirm data. If there were to be confusion with the ATC clearance it could result in both pilots being occupied looking at the DCDU which is not advisable at low altitudes. Managing DCDU needs to be practiced.

An AF pilot made aware of a message from Scottish received immediately after take-off which was inappropriate and not relevant. A filter in those phases of flight is necessary.

However, according to several pilots the system shall also be more used in conditions of higher traffic intensity and in situations where weather avoidance is required. As some pilots explained, in case of an avoiding action due to weather, CPDLC may be more difficult to use as contributes to slow down the process.

Analysis & Conclusion
Once a few messages are exchanged the crew become naturally more familiar and competence increases with a reduction to the message response time.

The CPDLC allows a silent cockpit where comprehensive messages are received. However it distracts visual resources from the flight displays and shall not be used intensively when workload increases due to repetitive flight plan alteration, i.e. during climb and descent phases, where it can enter into conflict with the golden rule "one head up at all time".

Air France noticed that typing and sending the message takes more time than grabbing the mike and speak, it is the same for receiving and acknowledging an ATC instruction. Repetitive communications drastically increase the workload in the cockpit.

The loss of a “party-line” (no ATC voice) is another significant concern overcome by the verbalisation of the message to the other Pilot. Once more CPDLC is used (higher equipage rate) the ATC voice channel will be even quieter (except during short term deviations).

> It is recommended to train crews on the integration of the system in crew coordination to ensure that one pilot remains head up at all time.

Air France recommends that communications must be limited to the minimum and limited to non-time critical exchanges. This is already defined in existing Golden Rules. This is also true for communication management messages which are transmitted at each frequency sector change.

RTA usability
09 April AF1204
The ETA free text message was reported to be sent by the flight crew but never received by ENAV. The analysis found no record of an ACARS free text message related to the test on the network. For an unknown reason, the message didn't seem to have reached the ACARS network.
16 April AF1204
RTA message exchange was as expected. Even if it was not the purpose of the trial to follow the RTA instruction, the pilots reported they found the RTA transmitted by the ATC was not achievable because the remaining flight time did not allow a sufficient gain to match the instructed RTA.

Analysis & Conclusion
The evolutions of the existing RTA function are on-going in SESAR 9.01 and 5.6.6 project.

Other
Some further comments addressed some difficulties in filling in the questionnaires and shall be considered for future studies:

- Questionnaire was perceived as being too general in its coverage.
- The question on voice reversion shall be ranked even if not relevant.
- The terms FANS A and B are Airbus-specific terms and shall be generalised (e.g. oceanic – continental).
- It is not possible to rate workload differently in a specific flight phase from the general workload level.

5.3.3 Description of assessment methodology

Human Factors assessment (ground side)

From ground perspective, two classes of measurements - quantitative and qualitative - were applied in an integrated way to investigate the impact on human performance of the introduction of CPDLC as primary means of communication (thus addressing OBJ-0208-016b).

Different methodologies were used, namely over the shoulders observation, debriefing and subjective questionnaire.

The table below reports data types, resulting from each technique and method used for data collection.

TECHNIQUE/METHOD	*DATA TYPE*					
	Qualitative	*Quantitative*	*Objective*	*Subjective*	*Binary*	*Not-binary*
Over-the-shoulder observations	*X*			*X*		*X*
Debriefings	*X*			*X*		*X*
Questionnaire		*X*		*X*		*X*

Table 12 - Data type used during the Campaign

Details about techniques are provided hereafter.

5.3.3.1 Over the shoulder observations

Direct and non-intrusive over-the-shoulder observation was carried out by human factors (HF) team during the trials.

This technique mainly allows addressing topics related to Human Performance. Over-the-shoulder not-intrusive observation has the purpose to provide detailed, complete and reliable information on the way the activity is carried out, especially if further commented and discussed with the observed users. Direct observation enables the collection of a high quantity of data, especially qualitative ones which cannot be collected through other methods. The main advantage of direct observation is the possibility to capture the difference between the normative way of working and the actual one, highlighting the existence and the relevance of common practices of work, personal strategies, standard deviations from official rules, informal rules, e.g. common behaviours neither controllers are aware of.

In the AFD FT direct over-the-shoulder not-intrusive observation was used to collect insights on ATCOs performances, including aspects related to the application of working methods and procedures, satisfaction/frustration, difficulties faced and recovery actions etc.

During the trials, observers sit behind controllers, concentrating on radar displays and taking time-coded notes of anything considered as relevant.

Before starting the observation session, specific observation form was designed to support the HF staff in conducting the observation. This tool is intended to structure the way the observation was carried out, and to steer its focus toward clear and pre-defined objectives.

5.3.3.2 Debriefings

Debriefings were used to address aspects related to the VOBJs under investigation.

During debriefing sessions, ATCOs were provided with different kinds of information and they were required to:

- discuss system performances (accuracy, representation, reliability etc.);
- comment out their activities with the information provided by the new system/procedure;
- make a comparison between activities carried out with or without AFD communications;
- envision the use of information provided by the AFD and the effectiveness of system itself.

5.3.3.3 Questionnaires

Questionnaires allow a wide variety of views to be obtained from the controllers involved in the study who might have different but equally relevant perspectives about the use and the impact of the new system on a robust working environment.

At the end of each FT session , ATCOs were requested to fill a customized questionnaires in order to provide their feedback on aspects mainly related to the assessment of Human Performance.

Two different perspectives were considered in the questionnaire design to allow the identification of potential differences between controllers working in OPS and PSA.

The two questionnaires developed are reported in the appendix C.

Debriefings, over-the-shoulders observations and questionnaires are interconnected techniques. On one hand, this means that data collected through observations and questionnaires was verified and discussed during debriefings and interview. On the other hand, insights from debriefings were used to guide subsequent observations. This combination of techniques reinforces the quality of data collected and contributes to get reliable results.

5.3.4 Results impacting regulation and standardisation initiatives

During AFD Phase 2 execution, AFD platform faced a problem on the CPDLC interconnection with Airbus test bench: connecting via PENS network the AFD platform, located at Rome ACC, with the SITA GS, located in Toulouse, and then via VDL2 reaching Airbus A320 test bench, the platform was not able to establish a connection, while it was working properly with Airbus A350 test bench. A detailed analysis highlighted that:

Field Local System NSEL and TSEL are composed by different parts of the ATN NSAP address:

- LOC (2 octets)
- SYS (6 octets)
- NSEL (1 octets)
- TSEL (1 or 2 octets)

Being TSEL either 10 or 11 can create different interpretations.

Having ground and airborne systems using a different number of octets (10 or 11) poses the concrete risk (more than a risk) of non-communication between ground and airborne systems.

Therefore, it would be useful to address this issue considering that, based on ENAV experience, this could be solved in having the ground system verifying the parameters and adapt itself consequently.

(General statement: too many optional fields complicate the certainty to have a ground platform able to communicate with all models of avionics).

The above aspect was already highlighted to EASA to prevent any "room of interpretation" on the ED110B document.

It is every day more clear the fact that the E.C. mandate 29/2009 is not giving the hooped results, having its applicability create many issues on daily usage.

Having said that, E.C. have indicated EASA as the organization that have to investigate on such malfunctioning; ANSPs in Europe that have already implemented datalink features had an interview with EASA, in order to collect material that could help on problems' identification. A chapter of this study, named "SESAR Validation Exercises", is focused on AFD project. ENAV have explained the project in general, highlighting also the unique technological solution that has been adopted in Italy, where the ANSP is de facto a communication service provider, having the ownership and full control of the GS disseminated along Italy. This means also that ENAV have the possibility to monitor in real time logs on both application and communication layers. As discovered also on AFD project, transport logs are really useful for the understanding of the behavior of avionics, not always predictable. In the EASA report is in fine reported the suggestion to "add some supplementary tasks to AFD in order to implement and check some actions".

5.4 Analysis of Exercises Results

NATS Performance Results

As NATS does not operate its own air/ground network, this limits the opportunities for NATS to gather performance information. However NATS processes its Datalink Server logs to produce time-stamped message flow data. These were used to analyse the AFD flights to produce the following performance analysis. The whole of the NATS AFD exercises performed in February, March and April were used as the population for this analysis. The flights performed in June and July could not be included in the dataset due to the time available, however they would not have added a significant amount of extra data to the set.

Metric type	Description of performance metric	Value
Uplink and Transaction totals	Total number of distinct CPDLC uplinks or downlinks (concatenated up or downlinks are counted as 1)	786
	Total number of uplinks (includes system-level messages e.g. LOGICAL ACKNOWLEDGEMENT)	415
	Total number of downlinks (includes system-level messages e.g. LOGICAL ACKNOWLEDGEMENT)	371
	Total number of transactions initiated from ground	209
	Total number of transactions initiated from the air (as received on ground, includes system-level transactions e.g. CURRENT DATA AUTHORITY)	65

Metric type	Description of performance metric	Value
Message/ Transaction Times	Mean round-trip uplink latency (measured from the sending of an uplink to the receipt of the associated LACK downlink, equivalent to Communication Technical Performance in EUROCAE ED-120)	0.96 seconds
	Worst case round trip uplink latency	9
	Mean Transaction Time	12.97 seconds
	95% Transaction Time – TT(95)	36 seconds
Uplinked message counts by message	PROCEED DIRECT TO xxx	26
	LEVEL xxx	52
	HEADING xxx	17
	ROUTE xxx	3
	STATE PREFERRED LEVEL	5
	CONTACT xxx	40
	STAND BY	3
Uplinked message counts by Datalink Service	ATC Communications Management (ACM)	40
	ATC Clearance (ACL)	96
Downlinked message counts by message	REQUEST DIRECT TO xxx	6
	REQUEST SPEED xxx (not supported on NATS systems, so generated an error)	2
	REQUEST LEVEL xxx	9
Errors	User aborts	13
	Provider aborts	15
	Operational Timer Exceeded (ACL/ACM uplinks)	3

The Message/Transaction Times are particularly interesting, as these performance metrics are mandated in the Datalink Services Implementing Rule (DLS-IR). The round-trip uplink latency is equivalent to the Communication Technical Performance in EUROCAE ED-120, the Safety and Performance Requirements standard for Continental Datalink, which is mandated by the DLS-IR. The mean figure of 0.96 seconds is well within the 16 seconds in the mandate, and the worst case of 9 seconds again is well within this. This was over 162 data points.

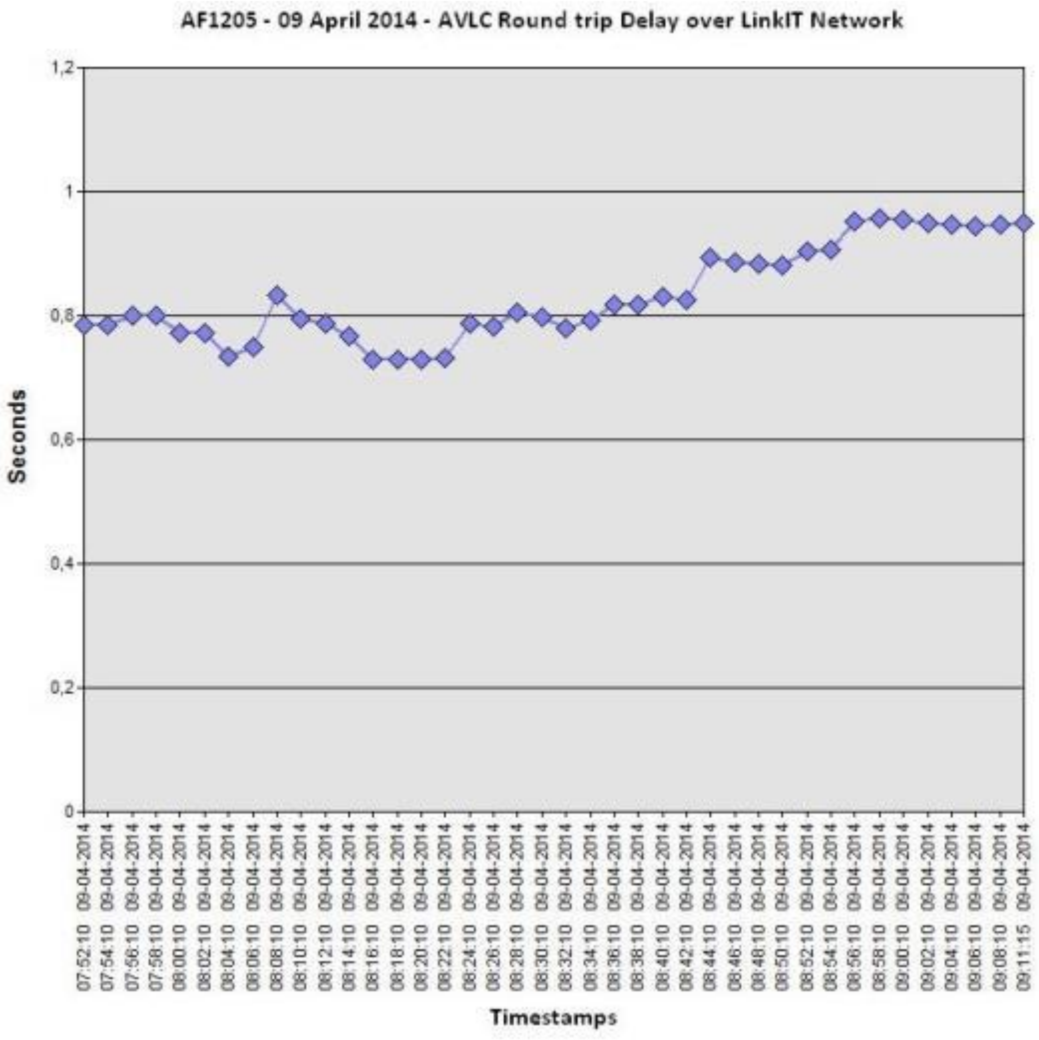
In addition to this, EUROCAE ED-120 mandates a 60 seconds Transaction Time for 95% of controller-initiated transactions - TT (95) - in the ATC Clearance (ACL) and Airborne Communication Management (ACM) services in en route airspace. The NATS system performed much better than this, with a TT (95) of 36 seconds over the 200 data points in the demonstrations.

TT (95) is an important metric, as it captures the pilot thinking and responding time, which becomes more critical in the more tactical airspace at lower flight levels. ED-120 suggests 30 seconds TT(95) performance for the ACL and ACM services in TMA and Arrival/Departure terminal airspace, however it leaves the definition of this to local analysis due to the higher time criticality and tactical nature of low level operations. The NATS TT (95) of 36 seconds is only just outside this suggested TMA performance standard. Since the “responder allocation” (i.e. pilot thinking and responding time) is by far the largest part of this metric, and because a significant number of the flight deck crews taking part in the demonstrations were not fully trained and current with CPDLC, there is hope that in future studies this will reduce to within the ED-120 figure: it is expected that pilot currency will reduce the responder time, although the message latency could increase due to an increase in VDL2 network traffic. This would be an area for careful examination in any future study.

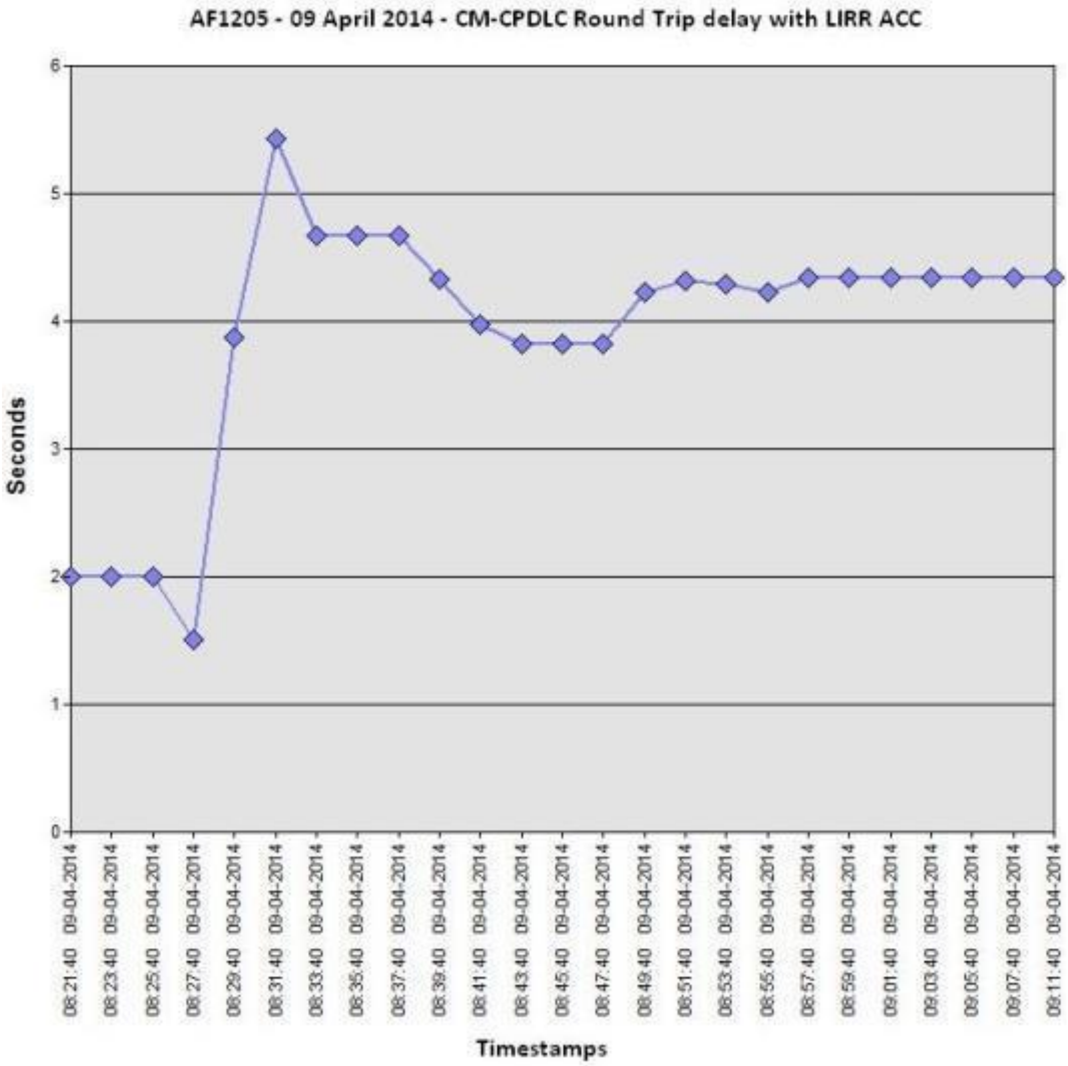
ENAV Performance Results

ENAV has a “Performance Monitoring Tool”, which monitors in real time the performance of its network, including VDL2 link.

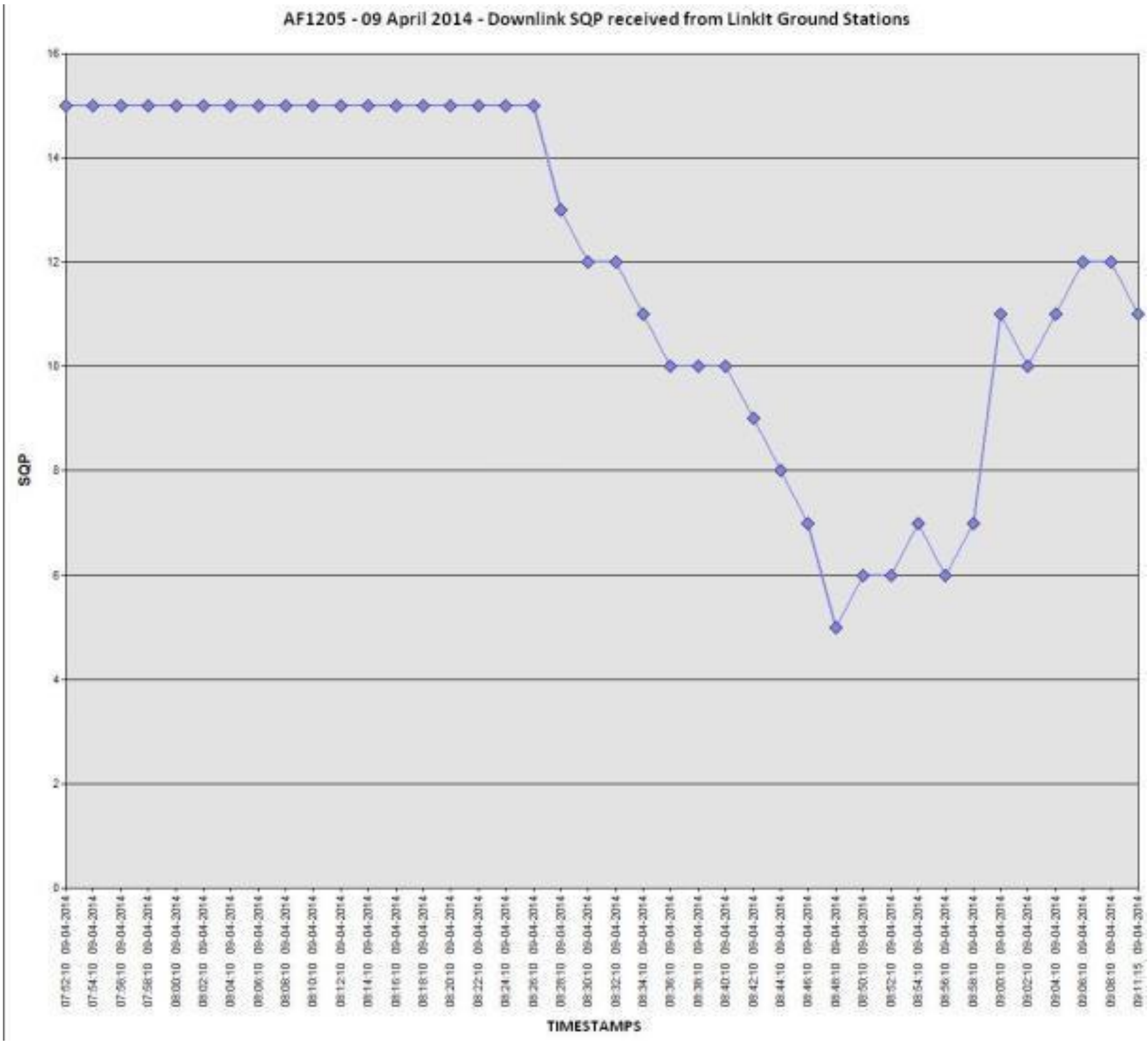
As example, for the flight AFR1202 of the 09/04/2014, the performance monitoring said that round trip delay, calculated at AVLC(Aviation VHF Link Control, communications protocol) level (just Air segment between airborne radio and ground stations) on messages exchanged using FCO2 and LIN2 VDL2 Stations was less than 1 second, as explained on the following diagram.



The round trip delay, calculated at application layer end-to-end (of course it includes AVLC round trip delay; so it measures round trip delay between Air Server and the aircraft) is about 4-5 seconds, as explained on the following diagram.



This performance monitoring tool allows also to monitor the Signal Quality Strength:



We can see that the signal drops during the Hand Over between FCO2 and LIN2 stations.

5.4.1 Unexpected Behaviours/Results

Chapter 5.3.4 already mentioned the issue faced during the experimental campaign, where the TSEL address of 10 or 11 characters can create different interpretations.

At the beginning of flight trials campaign, problems were noticed, during the login phase, with the CRC calculation of certain flights. After an investigation, the problem was on the way the system was doing the conversion of the 24-bit Address, due to Sign Bit (with bytes > 7F, e.g. 3950CE -> CE>7F), that causes incorrect PM-CPDLC pseudo message to be uplinked. With a software patch the issue was solved.

Few abnormal events happened also with some avionics during the flight trials campaign.

On BRS-FCO and FCO-BRS legs, often operated with the same aircraft (ICAO CODE 40612F, avionic -44D) we faced some communication issues: multiple HO and two AVLC disconnections, triggered from the airplane. ENAV collected all communication logs and, with Airbus and EasyJet, a deeper investigation of this anomaly has been realized, in order to better understand the rationale of those multiple HO and especially the motivation of the AVLC disconnections faced on BRS-FCO.

The results said that:

GMT	Event
14:17:30	Connection with 10F63A
14:18:33	VDL Mode 2 DISC due to a VHF3 switch to Voice Mode
14:19:24	Connection with 10F63A, the A/C did not receive the first RSP LE. The CMD LE msg. was sent 3 times
14:19:25	HO with the station to which the ATSU is already connected
14:20:58	Possible DISC due to a VHF3 switch to Voice Mode missing in the .dB traces (only the Q6 label to indicate the transition from Voice to DATA is present in the traces)
14:22:28	Back to Data Mode
14:23:24	6 repetitions of a CMD_HO to 10F63A. Not enough information in the traces to determine why a HO was performed to this station the A/C was connected to prior to the Switch to Voice
14:23:57	Connection with 10F63A (it seems that this station was the only one available for Data Mode 2 at this time)
14:23:57	X25 CR/CC exchanges OK
14:31:11	VDL Mode 2 DISC due to a Switch to Voice Mode
14:31:42	Connection with 10FA4B (that should be the preferred station in the ATSU PECT Table when coming back to DATA Mode)
14:31:43	X25 CR/CC exchanges OK
14:31:45	HO to 10F63A (certainly due to quality reasons)
14:35:25	X25 CR/CC exchanges, 3'40 after the ATSU Handoff (known anomaly described in ATSU DMD 5914)
14:36:16	HO to 10F65A (certainly due to quality reasons)
14:39:57	X25 CR/CC exchanges, 3'40 after the ATSU Handoff (known anomaly described in ATSU DMD 5914)
14:40:05	HO to 10FA9A (certainly due to quality reasons)
14:43:56	X25 CR/CC exchanges, 3'40 after the ATSU Handoff (known anomaly described in ATSU DMD 5914)
14:43:57	HO to 10FA4B (certainly due to quality reasons)
14:47:37	X25 CR/CC exchanges, 3'40 after the ATSU Handoff (known anomaly described in ATSU DMD 5914)
16:11:11	HO to 10FA6A (certainly due to quality reasons)
16:14:51	X25 CR/CC exchanges, 3'40 after the ATSU Handoff (known anomaly described in ATSU DMD 5914)
16:15:02	HO to 10FA4B (certainly due to quality reasons)
16:18:42	X25 CR/CC exchanges, 3'40 after the ATSU Handoff (known anomaly described in ATSU DMD 5914)
16:21:12	HO to 10F66A (certainly due to quality reasons)
16:24:52	X25 CR/CC exchanges, 3'40 after the ATSU Handoff (known anomaly described in ATSU DMD 5914)

DISC sent to the Ground:

It appears that the DISC mentioned was due to temporary switch of the VHF3 in VOICE Mode (certainly due to pilot actions) and thus it is not an anomaly.

2 of these switches with the associated DISC were correctly present in the .database traces, but it is possible that the Ground received another DISC associated to a Switch to Voice Mode that was not present in the traces around 14h21. Indeed, the traces showed a Voice to DATA Switch at 14h22.28, without corresponding DATA to Voice switch indication.

Handoffs:

The Handoffs performed by the ATSU seem to be correct even if there is no indication on the quality received by the Aircraft: it is not sure that these Handoffs respect the thresholds set for this standard.

The ATSU standard that was used for these flights has a quality threshold set to 3 (it means that a Handoff is performed each time the ATSU received more than 5 quality indication messages from the current station equal or below 3 and there is an eligible station in the ATSU PECT Table). It was determined that such a threshold causes lots of unnecessary quality based Handoff, which can explain the multiple HO mentioned. This threshold has been set to 2 on the new ATSU standard.

It seems that all the Handoffs were performed from AOA and ATN capable VGS to AOA and ATN capable VGS.

ATN Availability:

A known anomaly of the ATSU standard used (ATSU DMD5914) caused discontinuities in the X25 (and thus ATN) connectivity. Indeed, after several Handoffs, the ATSU waited for 3'40s before sending the X25 CALL Request downlink to the Ground. During these 3 minutes and 40 seconds, the ATN link is temporarily unavailable. This anomaly is corrected in the new ATSU standard.

For example this issue occurs at 14:31:45, but we have 7 occurrences during the leg.

Unexplained events:

-14:19:25 a Call Request / Call confirm X25

There are traces missing between 14:20:58 and 14:22:28 it is not possible for the ATSU to perform an HO on a station it is already connected to.

There should be a HO in between with another station (most probably another ARINC station not interconnected with ENAV network) for which the traces are not available and then this recorded HO.

-14:22:28

Traces missing as there is a switch voice data in the traces, but no switch data voice previously recorded.

-14:23:24

Handoff to 10F63A reemitted 6 times (the ground station doesn't seem to receive the frame)

LE after 6 HO re-transmissions: no other VDL2 capable station seen by a/c, before switching to mode A ATSU performed a frequency recovery: 10F63A squitter received during frequency recovery.

This is why a LE has been obtained instead of a mod. A connection.

5.5 Confidence in Results of Demonstration Exercises

5.5.1 Quality of Demonstration Exercises Results

Human performance assessment (Ground side)

ENAV Human Factors experts produced a questionnaire based on agreements with NATS and Airbus HF experts, which has been submitted to ATCOs at the end of each flight trial. Results are available in section 6.1.4.1.

The questionnaire was differentiated for ATCOs working in the OPS room or in the PSA room. However, data collected by OPS controllers provide a more reliable feedback as they had the opportunity to directly interact with AFD system. On the other side, feedback collected by PSA controllers provides a more high level feeling about AFD system. Both sample of data has been analysed and discussed during debriefing and results are integrated in the current document.

ATCOs were assisted by HF experts during the questionnaire compiling to enhance the understanding of each question. No quantitative data have been collected.

ATCOs has been involved in debriefing session after each flight trials and for investigate specific aspect they were also required to perform a process of envisioning supported by HF expert.

Human performance assessment (Airborne Side)

Similar as for the ground, pilots completed questionnaires after the participation to flight trials. Due to the characteristics of the operational context the moment of filling questionnaires was directly after each flight leg or after two or several flights, and online or in form of using paper versions transferred into online data. This could potentially impact the perception of the operational situation, as the reference of an assessment could change depending on the moment of assessment. An effect of experience may equally be noted in case the same pilots participated to several flight trials; however, as many pilots reported the system as easy to use, this impact may be neglected. Remark: At the time of writing this report, flight crew feedback of some of the flights was received in form of free text but was not yet available as answers to the questionnaires. When the answers will become available, related graphs will be updated. This shall not cause significant changes of the conclusions and recommendations as the free text feedback was already taken into account.

5.5.2 Significance of Demonstration Exercises Results

Human performance assessment (Ground side)

The significance of HP results of the demonstration activities was affected by the experimental setting, featured by only one aircraft in control of the AFD ATCO. This scenario had an impact on the HP data collected, since the ATCOs feedback was sometime based on envisioning and not to direct experience. However, the qualitative data gathered provide an encouraging input to evaluate the aim of the project, extend the CPDLC as primary means of communication below FL 285 up to FL100.

Human performance assessment (Airborne side)

The significance of outputs in in relation to CPDLC below FL285 was affected by the regular occurrence of datalink disconnections, which could impact the perception of the operational impact of CPDLC, as it was not possible to encounter the variety of all operational conditions. Also, even though the occurrence of in-flight events is reported regarding weather, ATC, traffic, no detailed information is available regarding the characteristics of these situations and how they impact the management of datalink messages, unless they were related to a voice reversion.

5.5.3 Conclusions and recommendations

Human performance assessment (Ground side)

Qualitative HP data collected during AFD flight trials campaign provide interesting results that should further corroborate in future studies. It is recommended, for future flight trial campaigns, to evaluate AFD system in a more realistic environment, increasing number of aircraft AFD equipped and enclosing longer flight legs scenarios. This would lead to a significant increase of reliability of HP evaluation of AFD system.

Human performance assessment (Airborne side)

Stable availability and continuity of the CPDLC service is a sine qua non for its operational acceptability by flight crew. Pilots involved in the AFD trials put the encountered CPDLC service issues by side and concentrated on the observations made when the service was behaving as expected. This allowed collecting valuable feedback which is of relevance for de-risking the CPDLC operational deployment.

Generally, CPDLC is appreciated due to its clarity of message set and easy integration with other pilot tasks. However, additional messages are needed (e.g. REQ HDG – request heading, REQ DES – request descent) to avoid numerous switch between datalink and radiotelephony type of communication in routine situations.

Datalink was perceived as acceptable in climb phase as from FL145 and in descent phase down to in between FL195 and FL145. Workload was generally perceived to be lower or slightly lower except for descent phase of flight, where it was rated somewhat higher but still acceptable.

It is recommended

a) to further study more in detail the need for additional datalink messages in rather tactical operational situations of descent and weather avoidance in order to ensure a benefit of both air and ground.

b) to study the selection of the adequate communication mean (voice or datalink) under consideration of message content (e.g. simple Vs. multi-element/conditional) depending on the operational situation in order to allow efficient task management for both air and ground operators.“

c) to identify options to harmonise data collection in diverse operational environments to ensure that data can be collected in comparable conditions.

d) to more completely assess the use of CPDLC in various traffic and weather conditions.

e) to further study the need to inform operators about the justification of ATC instructions or pilot requests in order to optimise decision-making.

f) to review the need of sending the message "CPDLC in use" in order to reduce the time needed for message management.

g) to further study the need for selection of specific clearance types related to DCT issued by ATC in order to facilitate correct understanding of such messages.

h) to further study the differences of the transition between data authorities in order to identify their impact on pilot's understanding and a potential need for harmonisation.

i) to inform pilots about the purpose of maintaining multiple terminologies on ACTIVE and CURRENT.

j) to train pilots on the integration of the system in crew coordination to ensure that one pilot remains head up at all time.

For the justification of the recommendations, please refer to chapter 5.3.2.3

6 Demonstration Exercises reports

SET	Scope	Exercise ID	City Pair	Airline	Fleet	Scenario	Trials
1	Domestic Italian	EXE-02.08-D-001	FCO-PMO PMO-FCO	EZY	A320 family	AFD Upper and TMA, Climb, Cruise and Descend phases and transition to/from Cruise	**22**
2	Domestic U.K.	EXE-02.08-D-002	BRS-EDI EDI-BRS	EZY	A320	AFD Upper, Cruise	**17**
3	Continental	EXE-02.08-D-003	FCO-CDG CDG-FCO	AF	A320 Family	AFD Upper and TMA, Silent Coordination, [RTA Constraint], Cruise, Descend and transition from Cruise	**6**
4	Continental	EXE-02.08-D-004	CDG-MAN MAN-CDG	AF	A320 Family	AFD Upper, Silent Coordination, Cruise	**2**
5	Continental	EXE-02.08-D-005	FCO-BRS BRS-FCO	EZY	A320 family	AFD Upper and TMA, Silent Coordination, Climb, Cruise and transition to Cruise	**12**
6	Continental	EXE-02.08-D-006	FCO-ARN ARN-FCO	SAS	B737-800	AFD Upper and TMA, Silent Coordination, Cruise, Descend and transition from Cruise	**10**
7	Continental	EXE-02.08-D-007	ARN-EDI EDI-ARN OSL-EDI EDI-OSL SVG-ABZ ABZ-SVG	SAS	B737-800	AFD Upper, Silent Coordination, Cruise	**10**

6.1 Demonstration Campaign - ENAV

6.1.1 Exercise Scope

The scope of this flight trials campaign, conducted in the Italian Airspace, is to demonstrate the feasibility of using datalink communications for almost all phases of flights as primary means of communication.

50 commercial flights, operated by EasyJet, Air France and SAS, were controlled fully in datalink (voiceless, except for radio check) on change of frequency from/down to FL100.

LINK2000+ set of messages was used, as reported on "Exercises Preparation" chapter, plus, for selected Air France flights, 2 new messages (UM46 and UM51) were used, with a view to try to emulate a Controlled Time of Arrival on a specific point (TAQ fix)14.

Human Factor experts composed a questionnaire for ATCOs involved in the campaign, collecting feedbacks and suggestions (see chapter5).

Both application and communications logs were stored, for a post analysis activity related to each flight, that was mainly focussed on analyse the behaviour of different kind of avionics. On the following chapters logs will be listed, with post analysis results coming from significant flights.

6.1.2 Conduct of Demonstration Exercise EXE-02.08-D-001

6.1.2.1 Exercise Preparation

As described on chapter 4.1, an experimental plan has been executed before take on the flight trials campaign.

6.1.2.2 Exercise execution

For this domestic city pair between Rome Fiumicino and Palermo operated by EasyJet, 22 runs were executed, over a period of about 3 months. The complete list of flights for each day can be found on chapter 4.2.1. The list of logs for each file will be added on the SJU extranet.

As an example, the communication log related to the FCO-PMO of the 12/03/2014 is now reported:

Message timestamp	Message UL/DL	Message	Msg Content	Msg IdNumber	Ref. Msg IdNumber	Performance monitoring
17:58:35	downlink	98	LOGON REQUEST CallSign: EZY38GP ICAO Address: 4198367 Departure: LIRF Destination: LICJ	1		
17:58:35	uplink	183	LOGON RESPONSE - ICAO Address: 4198367 - LOGON ACCEPTED	2		
17:59:28	uplink	183	CPDLC START REQUEST SENT	3		
17:59:31	downlink	98	CONNECTION CONFIRM	4	3	3 seconds
17:59:33	downlink	99	CURRENT DATA AUTHORITY	5		
17:59:33	uplink	183	CURRENT ATC UNIT LIRR,ROMA,CENTER	6		
18:23:30	uplink	183	CPDLC IN USE	7		
18:23:51	uplink	20	CLIMB TO 230	8		
18:24:05	downlink	0	WILCO	9	8	14 seconds
18:25:03	uplink	74	PROCEED DIRECT TO GIANO	10		
18:25:13	downlink	0	WILCO	11	10	4 seconds
18:26:17	uplink	20	CLIMB TO 270	12		
18:26:31	downlink	0	WILCO	13	12	14 seconds
18:27:53	uplink	20	CLIMB TO 310	14		
18:28:09	downlink	0	WILCO	15	14	16 seconds
18:29:10	uplink	117	CONTACT LIRR128.800	16		
18:29:20	downlink	6	REQUEST 330	17		

14 See chapter 4.3 and RTA annex

18:29:20	uplink	183	TRANSFER OF CONTROL IN PROGRESS TRY LATER	18	17	0 seconds
18:29:47	downlink	0	WILCO	19	16	37 seconds
18:30:13	uplink	183	CPDLC IN USE	20		
18:30:14	uplink	79	CLEARED TO LICJ VIA XIBRI-DCT-GIANO-DCT	21		
18:30:39	downlink	1	UNABLE	22	21	25 seconds
18:31:04	uplink	74	PROCEED DIRECT TO GIANO	23		
18:31:24	downlink	0	WILCO	24	23	20 seconds
18:31:49	downlink	6	REQUEST 330	25		
18:32:24	uplink	0	UNABLE	26	25	35 seconds
18:35:19	uplink	20	CLIMB TO330	27		
18:35:29	downlink	0	WILCO	28	27	10 seconds
18:37:52	uplink	190	FLY HEADING 165	29		
18:38:04	downlink	0	WILCO	30	29	12 seconds
18:39:25	uplink	79	CLEARED TO LICJ VIA SALAP-DCT	31		
18:39:40	downlink	0	WILCO	32	31	15 seconds
18:40:43	uplink	23	DESCEND TO 250	33		
18:40:54	downlink	0	WILCO	34	33	11 seconds
18:42:51	uplink	23	DESCEND TO 210	35		
18:43:03	downlink	0	WILCO	36	35	14 seconds
18:44:06	uplink	23	DESCEND TO 170	37		
18:44:16	downlink	0	WILCO	38	37	10 seconds
18:47:42	uplink	23	DESCEND TO 110	39		
18:48:01	downlink	0	WILCO	40	39	19 seconds
18:50:43	uplink	117	CONTACT LIRR120.200	41		
18:50:56	downlink	0	WILCO	42	41	13 seconds

Table 13 - Log of datalink exchange related to FCO-PMO of the 12/03/2014

6.1.2.3 Deviation from the planned activities

Due to a FDP anomaly on interfacing with datalink system, sometimes the UM79 CLEARED TO [position] VIA [route clearance] message, sent automatically on each change of sector, was incorrect, having as fix of the VIA one point already flown. Pilots were then aware of it, so that they were replying at the wrong instructions with UNABLE.

6.1.3 Conduct of Demonstration Exercise EXE-02.08-D-003

6.1.3.1 Exercise Preparation

As described on chapter 4.1, an experimental plan has been executed before the flight trials campaign.

6.1.3.2 Exercise execution

For this continental city pair between Rome Fiumicino and Paris CDG operated by Air France, 6 runs were executed, over a period of about 1 month. For this leg, RTA feature has been tried. The complete list of flights for each day can be found on chapter 4.2.1. The list of logs for each file will be added on the SJU extranet.

As an example, the communication log related to the CDG-FCO of the 09/04/2014 is now reported:

Message timestamp	Message UL/DL	Message	Msg Content	Msg IdNumber	Ref. Msg IdNumber	Performance monitoring
06:26:42	downlink	98	LOGON REQUEST CallSign: AFR1204 ICAO Address: 3746536 Departure: LFPG Destination: LIRF	1		
06:26:42	uplink	183	LOGON RESPONSE - ICAO Address: 3746536 - LOGON ACCEPTED	2	1	
06:27:28	uplink	183	CPDLC START REQUEST SENT	3		
06:27:30	Downlink	98	CONNECTION CONFIRM	4	3	2 seconds
06:27:34	downlink	99	CURRENT DATA AUTHORITY	5		
06:27:34	uplink	183	CURRENT ATC UNIT LIRR,ROMA,CENTER	6		
06:27:40	uplink	183	CPDLC IN USE	7		
06:29:11	uplink	74	PROCEED DIRECT TO TINKU	8		
06:29:35	downlink	0	WILCO	9	8	24 seconds
06:33:41	uplink	117	CONTACT LIRR124.200	10		
06:34:03	downlink	0	WILCO	11	10	21 seconds
06:34:35	uplink	183	CPDLC IN USE	12		
06:35:44	uplink	74	PROCEED DIRECT TO XIBIL	13		
06:36:12	downlink	0	WILCO	14	13	18 seconds
06:37:17	uplink	23	DESCEND TO 310	15		
06:37:37	downlink	0	WILCO	16	15	20 seconds
06:39:01	uplink	23	DESCEND TO 270	17		
06:39:27	downlink	0	WILCO	18	17	26 seconds
06:41:45	uplink	51	CROS POSITION TAQ AT 07 : 00 : 00	19		
06:42:16	downlink	1	UNABLE	20	19	31 seconds
06:42:22	uplink	23	DESCEND TO 250	21		
06:42:40	downlink	0	WILCO	22	21	18 seconds
06:43:36	Uplink	23	DESCEND TO 220	23		
06:43:54	downlink	0	WILCO	24	23	18 seconds

06:45:33	uplink	23	DESCEND TO 190	25		
06:45:49	downlink	0	WILCO	26	25	39 seconds
06:46:02	uplink	117	CONTACT LIRR125.500	27		
06:46:27	downlink	0	WILCO	28	27	25 seconds
06:47:08	uplink	183	CPDLC IN USE	29		
06:47:14	uplink	160	NEXT DATA AUTHORITY	30		
06:47:40	uplink	161	DISCONNECTION REQUEST	31		
06:47:42	downlink	100	CONFIRMATION DISCONNECTION	32	31	2 seconds

Table 14 - Log of datalink exchange related to CDG-FCO of the 09/04/2014

6.1.3.3 Deviation from the planned activities

Due to an FDP disease on interfacing with datalink system, sometimes the UM79 CLEARED TO [position] VIA [route clearance] message, sent automatically on each change of sector, was incorrect, having as fix of the VIA one point already flown. Pilots were then aware of it, so that they were replying at the wrong instructions with UNABLE.

6.1.4 Conduct of Demonstration Exercise EXE-02.08-D-005

6.1.4.1 Exercise Preparation

As described on chapter 4.1, an experimental plan has been executed before take on the flight trials campaign.

6.1.4.2 Exercise execution

For this continental city pair between Rome Fiumicino and Bristol operated by EasyJet, 10 runs were executed, over a period of about 2 months. The complete list of flights for each day can be found on chapter 4.2.1. The list of logs for each file will be added as annex of this final report.

As an example, the communication log related to the FCO-BRS of the 12/03/2014 is now reported:

Message timestamp	Message UL/DL	Message	Msg Content	Msg IdNumber	Ref. Msg IdNumber	Performance monitoring
15:46:13	downlink	98	LOGON REQUEST CallSign: EZY66HP ICAO Address: 4219183 Departure: LIRF Destination: EGGD	1		
15:46:13	uplink	183	LOGON RESPONSE - ICAO Address: 4219183 - LOGON ACCEPTED	2		
15:47:08	uplink	183	CPDLC START REQUEST SENT	3		
15:47:10	downlink	98	CONNECTION CONFIRM	4	3	2 seconds
15:47:12	downlink	99	CURRENT DATA AUTHORITY	5		
15:47:12	uplink	183	CURRENT ATC UNIT LIRR,ROMA,CENTER	6		
16:26:30	uplink	183	CPDLC IN USE	7		
16:27:15	uplink	20	CLIMB TO 200	8		
16:27:25	downlink	0	WILCO	9	8	10 seconds
16:28:12	uplink	74	PROCEED DIRECT TO PODOX	10		

16:28:23	downlink	0	WILCO	11	10	11 seconds
16:28:51	Uplink	20	CLIMB TO 240	12		
16:29:02	downlink	0	WILCO	13	12	11 seconds
16:29:41	uplink	117	CONTACT LIRR124.800	14		
16:29:58	downlink	0	WILCO	15	14	17 seconds
16:30:07	uplink	183	CPDLC IN USE	16		
16:30:08	uplink	79	CLEARED TO EGGD VIA RAVAL-DCT-PODOX-ELB-M616-DOBIM-DCT	17		
16:30:53	Downlink	1	UNABLE	18	17	45 seconds
16:31:01	uplink	20	CLIMB TO 300	19		
16:31:13	uplink	0	WILCO	20	19	12 seconds
16:32:08	uplink	74	PROCEED DIRECT TO DOBIM	21		
16:32:24	downlink	0	WILCO	22	21	16 seconds
16:32:39	uplink	20	CLIMB TO 340	23		
16:32:58	downlink	0	WILCO	24	23	19 seconds
16:35:19	uplink	20	CLIMB TO 380	25		
16:35:38	downlink	0	WILCO	26	25	19 seconds
16:41:31	uplink	161	DISCONNECTION REQUEST	27		
16:41:38	downlink	98	DISCONNECTION CONFIRM	28	27	7 seconds

Table 15 - Log of datalink exchange related to FCO-PMO of the 12/03/2014

6.1.4.3 Deviation from the planned activities

Due to a FDP anomaly on interfacing with datalink system, sometimes the UM79 CLEARED TO [position] VIA [route clearance] message, sent automatically on each change of sector, was incorrect, having as fix of the VIA one point already flown. Pilots were then aware of it, so that they were replying at the wrong instructions with UNABLE.

6.1.5 Conduct of Demonstration Exercise EXE-02.08-D-006

6.1.5.1 Exercise Preparation

As described on chapter 4.1, an experimental plan has been executed before take on the flight trials campaign.

6.1.5.2 Exercise execution

For this continental city pair between Rome Fiumicino and Stockholm Arlanda, 10 runs were executed, over a period of about 2 months. The complete list of flights for each day can be found on chapter 4.2.1. The list of logs for each file will be added as annex of this final report.

As an example, the communication log related to the FCO-ARN of the 09/04/2014 is now reported:

Message timestamp	Message UL/DL	Message	Msg Content	Msg IdNumber	Ref. Msg IdNumber	Performance monitoring
12:15:58	downlink	98	LOGON REQUEST CallSign: SAS1842 ICAO Address: 4687504 Departure: LIRF Destination: ESSA	1		
12:15:58	uplink	183	LOGON RESPONSE - ICAO Address: 4687504 - LOGON ACCEPTED	2		
12:16:54	Uplink	183	CPDLC START REQUEST SENT	3		
12:16:56	downlink	98	CONNECTION CONFIRM	4	3	2 seconds
12:16:58	downlink	99	CURRENT DATA AUTHORITY	5		
12:16:58	uplink	183	CURRENT ATC UNIT LIRR,ROMA,CENTER	6		
12:27:52	uplink	183	CPDLC NOT IN USE	7		
12:30:22	uplink	183	CPDLC IN USE	8		
12:30:39	Uplink	20	CLIMB TO 200	9		
12:30:53	downlink	0	WILCO	10	10	14 seconds
12:31:23	uplink	20	CLIMB TO 240	11		
12:31:40	downlink	0	WILCO	12	12	17 seconds
12:32:41	downlink	22	REQUEST DIRECT TO BZO	13		
12:33:02	uplink	0	UNABLE	14	13	21 seconds
12:33:18	uplink	117	CONTACT LIRR124.200	15		
12:33:37	downlink	0	WILCO	16	15	19 seconds
12:33:48	uplink	183	CPDLC IN USE	17		
12:33:49	uplink	79	CLEARED TO ESSA VIA TIMOV-DENAL	18		
12:34:13	downlink	0	WILCO	19	18	24 seconds
12:34:19	uplink	74	PROCEED DIRECT TO DENAL	20		
12:34:31	downlink	0	WILCO	21	20	12 seconds
12:34:44	uplink	20	CLIMB TO 300	22		
12:35:00	downlink	0	WILCO	23	22	16 seconds
12:35:24	uplink	160	NEXT DATA AUTHORITY LIPP	24		
12:36:49	uplink	20	CLIMB TO 380	25		
12:36:59	Downlink	0	WILCO	26	25	10 seconds
12:34:54	downlink	22	REQUEST DIRECT TO VIC	27		
12:35:09	uplink	1	STAND BY	28	27	15 seconds
12:38:58	uplink	0	UNABLE	29	27	
12:39:18	uplink	160	NEXT DATA AUTHORITY	30		
12:39:18	uplink	79	CLEARED TO ESSA VIA DCT-BZO	31		
12:39:43	Downlink	0	WILCO	32	31	25 seconds

Table 16 - Log of datalink exchange related to FCO-ARN of the 09/04/2014

6.1.5.3 Deviation from the planned activities

Due to a FDP anomaly on interfacing with datalink system, sometimes the UM79 CLEARED TO [position] VIA [route clearance] message, sent automatically on each change of sector, was incorrect, having as fix of the VIA one point already flown. Pilots were then aware of it, so that they were replying at the wrong instructions with UNABLE.

6.1.6 Exercise Results

6.1.6.1 Summary of Exercise Results

A complete log file related to each flight trial will be added on SJU extranet; that allow to follow the behaviour of each flight.

6.1.6.1.1 Results per KPA

See chapter 5.3.1.

6.1.6.1.2 Results impacting regulation and standardisation initiatives

See chapter 5.3.4.

6.1.6.1.3 Unexpected Behaviours/Results

See chapter 5.4.1.

6.1.6.1.4 Quality of Demonstration Results

See chapter 5.5.1.

6.1.6.1.5 Significance of Demonstration Results

See chapter 5.5.2.

6.1.7 Conclusions and recommendations

6.1.7.1 Conclusions

AFD Flight Trial campaign demonstrated that CPDLC as primary means of communication can be useful to reduce mental workload of ATCOs, especially in conditions of:

- Low traffic (for example, during night shifts);
- Sectors with a small number of vertical movements and crossing points;
- Good weather conditions.

More in general, CPDLC is to be used with direct and simple messages, and it is not suitable to establish a “dialogue” with the FC, due to the perceived low rapidity of this communication means.

On the other side, ATCOs reported that in case of unusual conditions (bad weather, turbulence, high traffic) R/T is the best way to communicate with the FC.

Thus, ATCOs suggested that CPDLC is not likely to be used in TMA sectors, especially with settings like the time-out, set at 2 minutes, which is too high. In TMA sectors, airlines tend to increase the requests (mainly to save fuel/time), so the number of communications is increasing and this seems to not meet CPDLC philosophy.

En-route sectors are, instead, expected to offer a contribution in terms of reduction of MWL, with the implementation of CPDLC as primary means of communication, respecting the conditions abovementioned. Moreover, CPDLC can represent a backup of R/T mode in areas where the R/T infrastructure does not perform well.

6.1.7.2 Recommendations

REC.1: ATCOs highlighted the need for further training to create the suitable conditions to operate with CPDLC as primary means of communication: this especially refers to ensure confidence with the system to improve ATCOs performances.

REC.2: To further improve the HP evaluation of AFD system a more realistic experimental setting is recommended for future evaluation.
Further experimental studies shall address:

- experimental flight legs with longer duration
- more than one flight connected by CPDLC (at least 5 a/c)
- a/c fleet managed across more complex sectors/scenarios (e.g. MI sectors and higher traffic load)
- increase the number of instructions exchanges between ATCO and FC

6.2 Demonstration Campaign – NATS

6.2.1 Exercise Scope

The scope of this flight trials campaign, conducted in UK Airspace, is to demonstrate the feasibility of using datalink communications for almost all phases of flights as primary means of communication.

6.2.2 Conduct of Demonstration Exercise EXE-02.08-D-002

6.2.2.1 Exercise Preparation

This exercise utilised existing revenue flights between Bristol and Edinburgh operated by Easy Jet whose crew were briefed in advance to use the CPDLC system for communication with ATC. Preparation therefore consisted of:-

- agreement of the flights between airline and NATS
- briefing of crew
- briefing of ATC personnel at Swanwick and Prestwick centres
- distribution of ATC questionnaires

6.2.2.2 Exercise execution

For this domestic city pair, 17 runs were executed, over a period of about 6 months. The complete list of flights for each day can be found on chapter 4.2.2.

6.2.2.3 Deviation from the planned activities

The demonstration plan proposed a minimum of 8 flights be included in this exercise. In total 19 flights have successfully provided input into this exercise.

Despite overachieving the target number of flights there were some unsuccessful flights. The main reasons for unsuccessful flights were initial technical issues with the on-board CPDLC system, aircraft availability, and roistering issues e.g. pilot training flights or ATCO unavailability. There were also some known issues with the CPDLC system at the Prestwick Centre.

It was planned to use Bristol - Newcastle flights for this exercise. During detailed planning it was agreed to change this to Bristol - Edinburgh because it gave more scope to examine low level CPDLC operations over the whole flight profile, since the due to airspace restrictions the minimum CPDLC level in the Newcastle area is FL285, it is FL195 in the Edinburgh area.

6.2.3 Conduct of Demonstration Exercise EXE-02.08-D-004

6.2.3.1 Exercise Preparation

This exercise utilised existing revenue flights between Paris Charles de Gaulle and Manchester operated by Air France whose crew were briefed in advance to use the CPDLC system for communication with ATC. Preparation therefore consisted of:-

- agreement of the flights between airline and NATS
- briefing of crew
- briefing of ATC personnel at Swanwick and Prestwick centres
- distribution of ATC questionnaires

6.2.3.2 Exercise execution

Due to technical difficulties there were only 2 successful runs for this exercise. The complete list of flights for each day can be found on chapter 4.2.2.

6.2.3.3 Deviation from the planned activities

Air France experienced technical difficulties with the on-board CPDLC system which delayed their participation in the trial. The issue could finally easily be solved through an update of the ATSU mask, i.e. the database integrated in the on-board communication avionics, which contains the list of datalink ground stations.

6.2.4 Conduct of Demonstration Exercise EXE-02.08-D-005

6.2.4.1 Exercise Preparation

This exercise utilised existing revenue flights between Bristol and Rome Fiumicino whose crew were briefed in advance to use the CPDLC system for communication with ATC. Preparation therefore consisted of:-

- agreement of the flights between airline and NATS
- briefing of crew
- briefing of ATC personnel at Swanwick and Prestwick centres
- distribution of ATC questionnaires

6.2.4.2 Exercise execution

For this city pair, 6 runs were executed, over a period of about 3 months. The complete list of flights for each day can be found on chapter 4.2.2.

6.2.4.3 Deviation from the planned activities

There were some unsuccessful flights. The main reasons for this were roistering issues and ATCO unavailability as the flights was during a busy period over a shift change.

6.2.5 Conduct of Demonstration Exercise EXE-02.08-D-007

6.2.5.1 Exercise Preparation

This exercise utilised existing continental revenue flights between Scotland (Edinburgh and Aberdeen) and Scandinavia (Arlanda, Oslo and Stavanger) operated by SAS, whose crew were briefed in advance to use the CPDLC system for communication with ATC. Preparation therefore consisted of:-

- agreement of the flights between airline and NATS
- briefing of crew
- briefing of ATC personnel at Swanwick and Prestwick centres
- distribution of ATC questionnaires

6.2.5.2 Exercise execution

For this city pair, 10 runs were executed, over a period of about 1 month. The complete list of flights for each day can be found on chapter 4.2.2.

6.2.5.3 Deviation from the planned activities

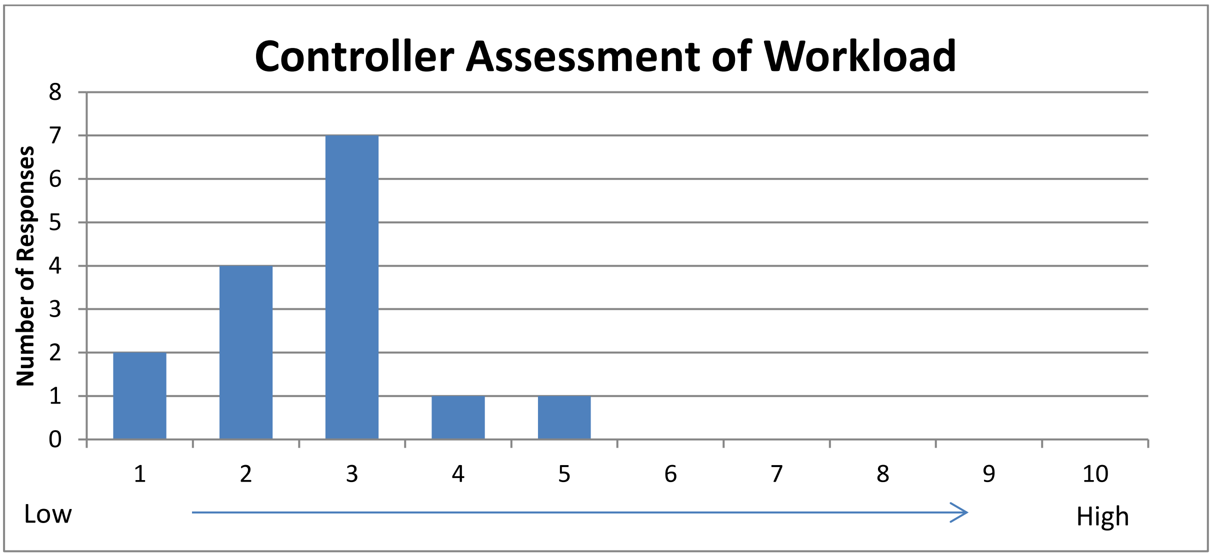
During execution the project was approached by SAS and agreed additional flights between Scandinavian airports and Scottish airports. This instigated this additional demonstration exercise.

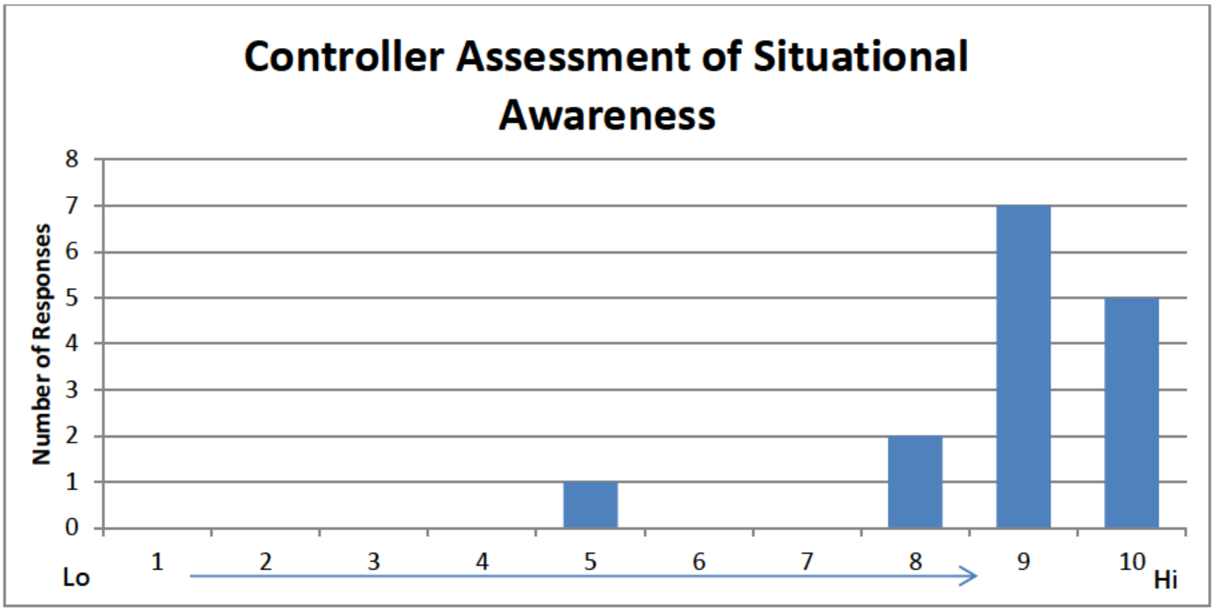
6.2.6 Exercise Results

6.2.6.1.1 EXE.02.08-D-002 Results

6.2.6.1.1.1 Human Factors Analysis

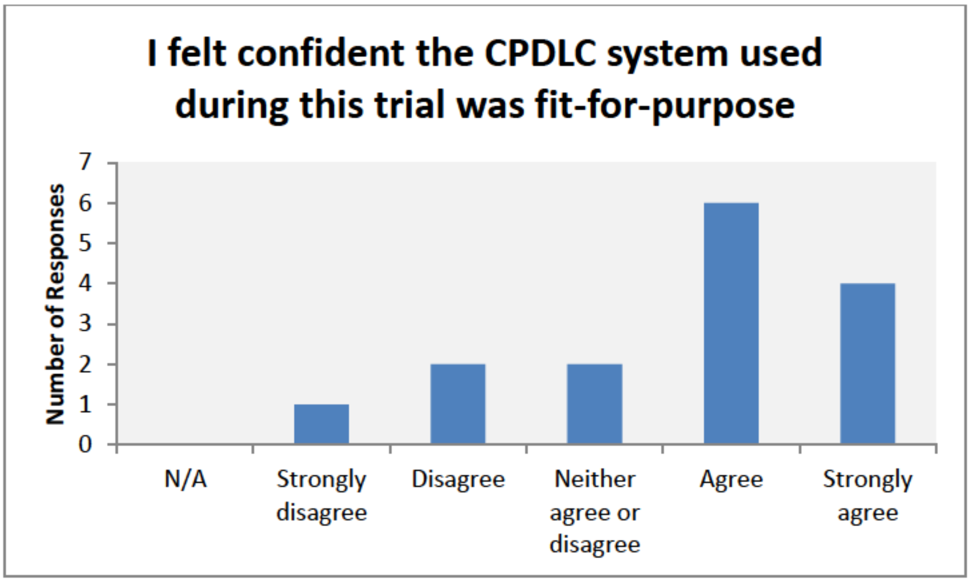
The majority of controllers involved in this exercise felt CPDLC had low impact on their workload and situational awareness.



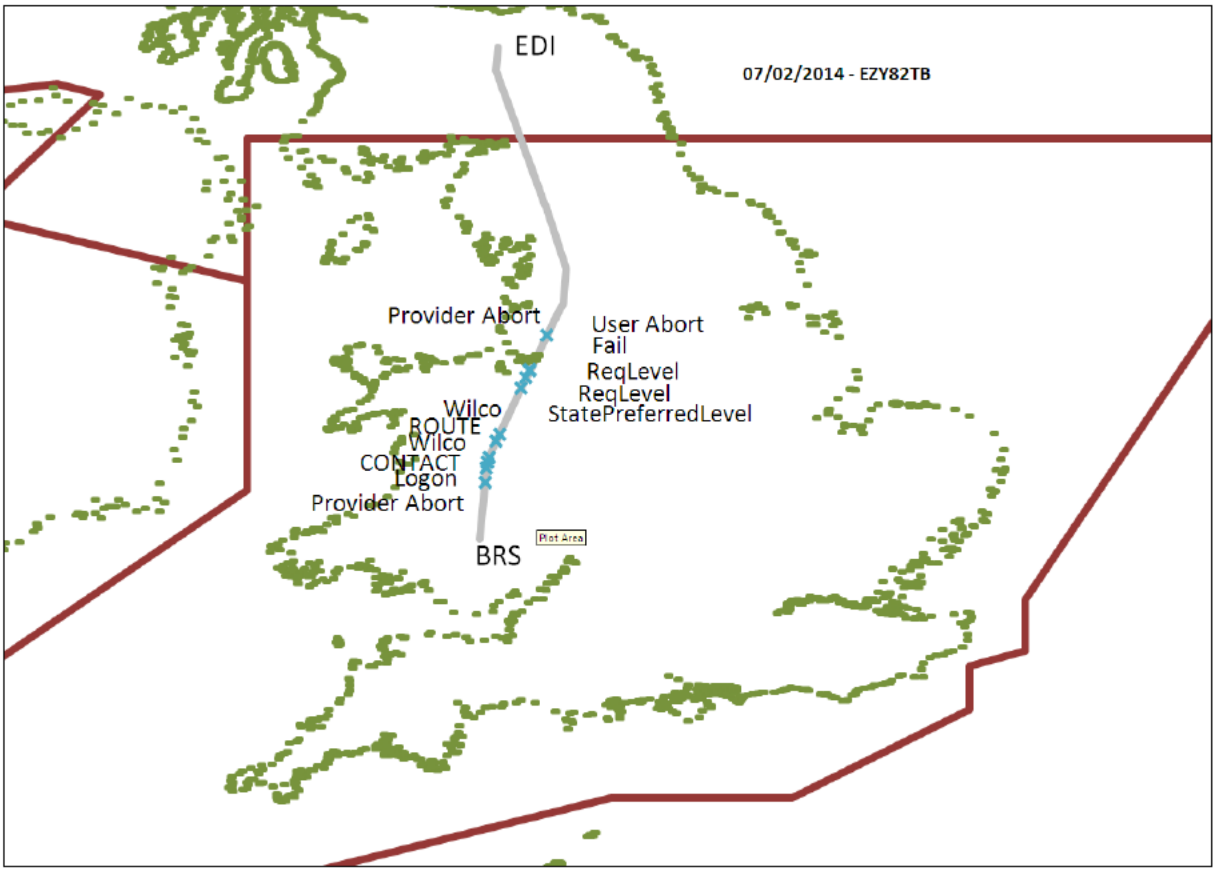


Only 4 out of 14 needed to revert to voice. This was due to a range of reasons: human error, needing re-confirmation, aircraft too low level and frequency not available.

The controllers generally felt very comfortable with CPDLC, with only 2 feeling uncomfortable using it between FL100-FL195 and 1 during descent. 3 felt the CPDLC system was not fit for purpose, but 10 of 14 felt it is fit for purpose.



6.2.6.1.1.2 EZY82TB on 7th February 2014

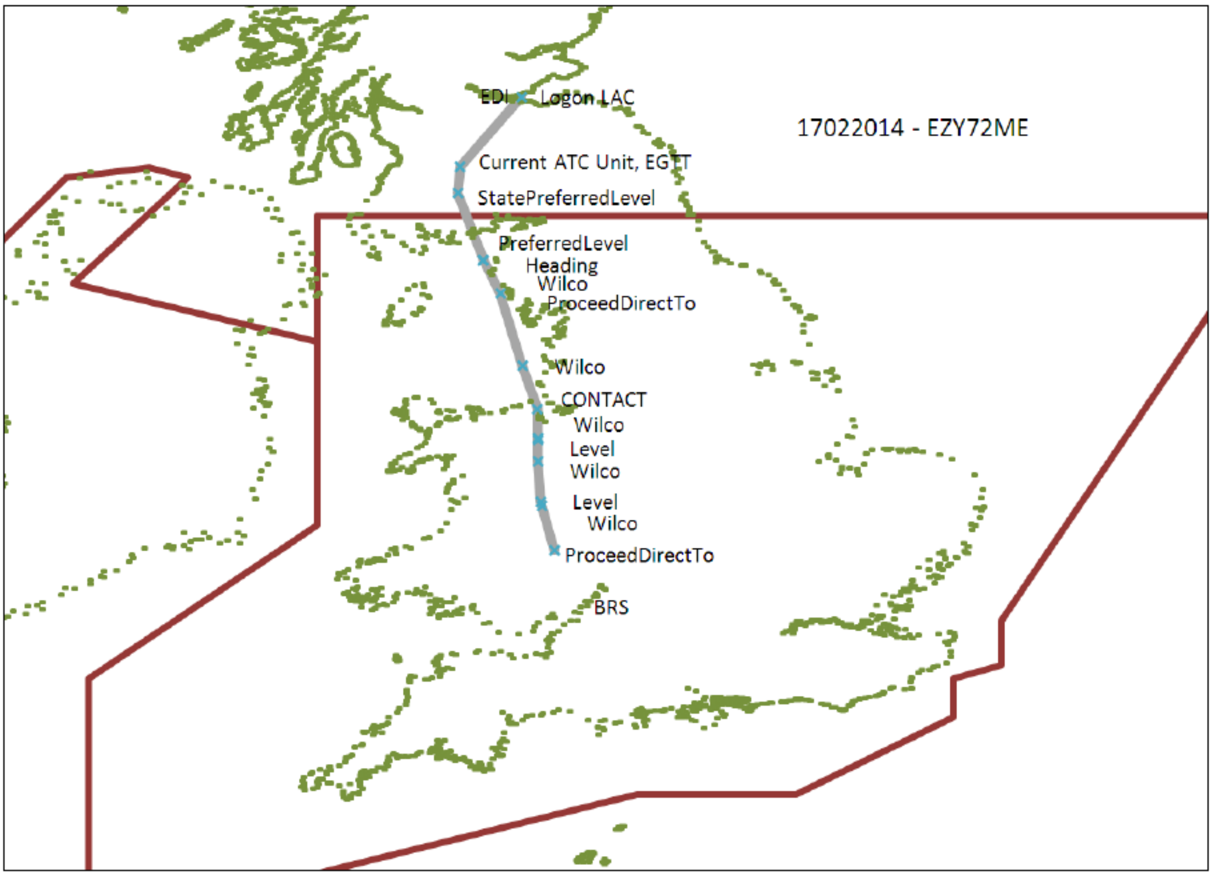


Time	Message Type	Additional Information
16:09:11	Provider Abort	Communication Service Failure
16:10:08	Logon	
16:10:30	CONTACT	[EGTT]
16:10:49	Wilco	
16:11:53	ROUTE	[MARGO][Rest of Route Unchanged][RIBEL][MARGO]
16:12:18	Wilco	
16:15:19	StatePreferredLevel	
16:15:59	ReqLevel	
16:16:26	ReqLevel	
16:16:28	Fail	[Insufficient Resources][Too many level requests - expect only one reply]
16:16:30	User Abort	Duplicate MessageIDs
16:18:47	Provider Abort	Communication Service Failure

EZY82TB incorrectly responded to a STATE PREFERRED LEVEL message with a REQUIRED LEVEL message, which was repeated. This caused the CPDLC link to terminate. The same issue did re-occur on the same route on 24th March, however on other occasions the correct response was given.

This information was shared with EasyJet for future operations.

6.2.6.1.1.3 EXY72ME on 17th February 2014



Time	Message	Additional Information
18:04:27	Logon LAC	
18:04:28	Current ATC Unit, EGTT	
18:15:37	StatePreferredLevel	
18:16:03	PreferredLevel	
18:19:44	Heading	
18:20:01	Wilco	
18:22:56	ProceedDirectTo	[KARNO]
18:23:07	Wilco	
18:28:19	CONTACT	[EGTT]
18:28:29	Wilco	
18:31:03	Level	
18:31:16	Wilco	
18:33:28	Level	
18:33:35	Wilco	
18:35:13	ProceedDirectTo	[AMRAL]
18:35:16	Level	
18:35:20	Wilco	
18:35:34	Wilco	
18:39:03	CONTACT	[EGFF][Next Sector CPDLC not in use until notified]
18:39:18	Wilco	

One flight in this exercise experienced a flight planning issue where the CPDLC equipage was not filed originally, but then updated. However the update was not detected by Swanwick so the aircraft was initially unable to log on. The aircraft did eventually log on once the equipage was updated at Swanwick.

6.2.6.1.2 EXE.02.08-D-004 Results

The 14 flights planned for February/March between Paris CDG and Manchester operated by Air France were unfortunately cancelled due to technical issues with the Air France fleet. Unfortunately London Control was not configured in the ATN operational database in the ATN radios so no aircraft could log on.

Air France and Airbus worked hard to resolve this issue and further flights were planned for May. However these were at an extremely difficult time for NATS, falling in the busiest time of day and over a shift change. It was only possible to complete 2 flights as AFD trial flights: the inward and outward legs on the 12th May.

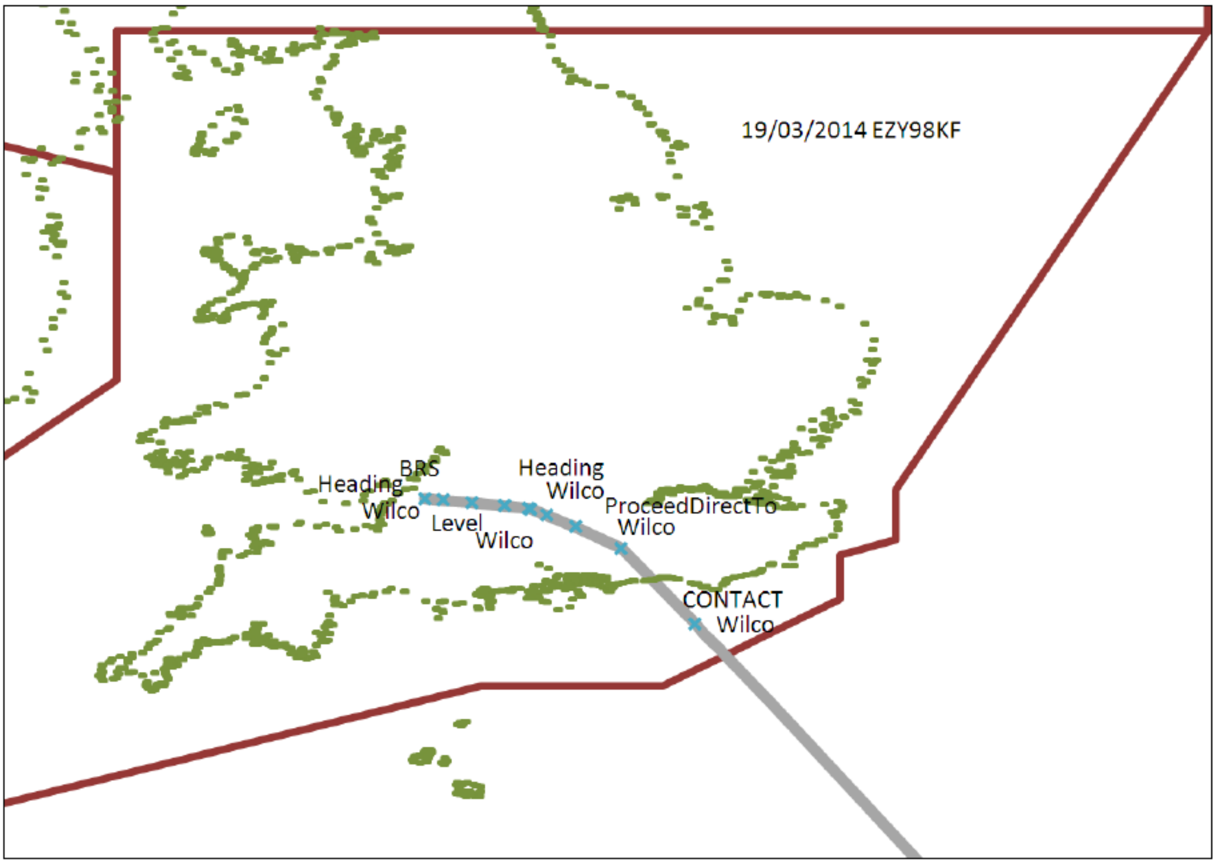
Due to workload, no human factors data was collected for these flights, however they were successful AFD flights on the flight deck with no issues from NATS' perspective, and the CPDLC message logs contained good CPDLC exchanges between the controllers and pilots, so the flights were included in the data set for performance analysis from the airborne side, but were not included in the HF analysis.

6.2.6.1.3 EXE.02.08-D-005 Results

6.2.6.1.3.1 Human Factors Analysis

One questionnaire was returned for flights within this exercise (between Rome Fiumicino and Bristol operated by EasyJet). The controller felt their workload and situational awareness were not impacted adversely by using CPDLC. They did not revert to voice communications, and indicated high confidence in using the system for direct routing and out-coming, but low confidence in using it during climb.

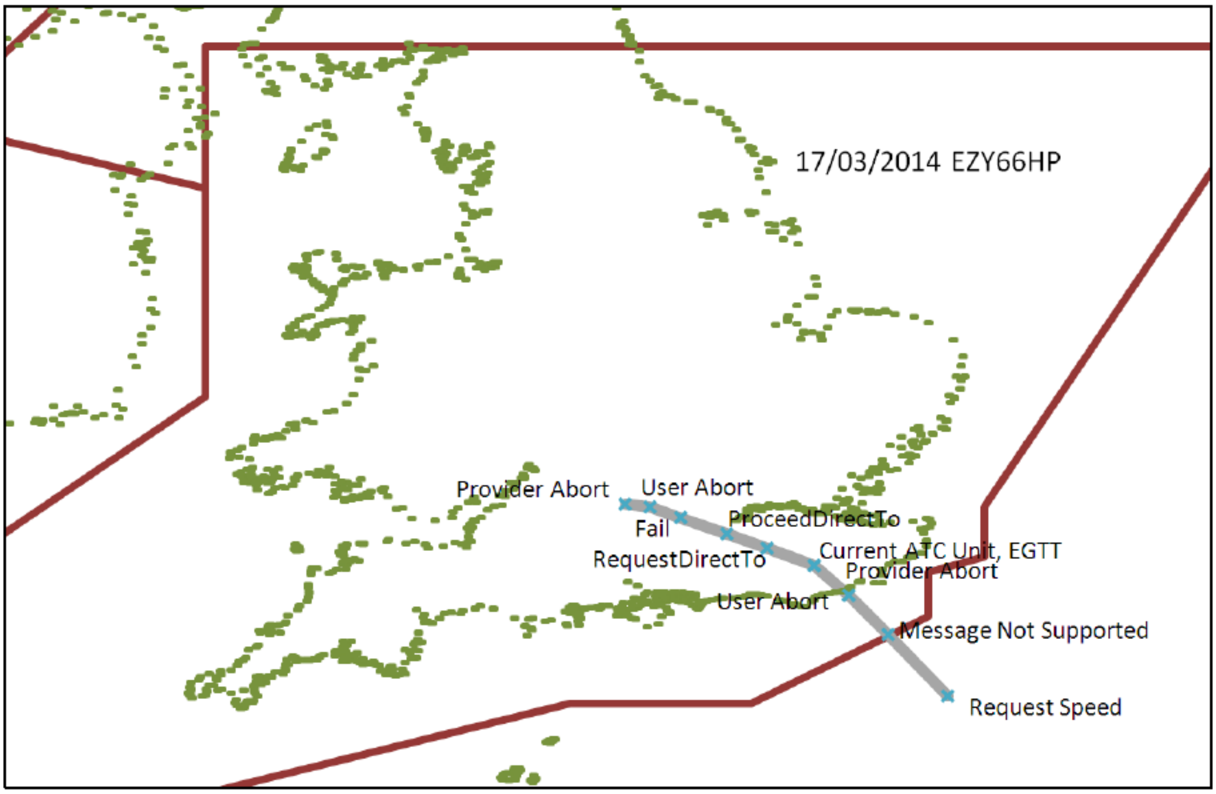
6.2.6.1.3.2 EZY98KF on 19th March 2014



Time	Message	Additional Information
13:05:38	Heading	
13:06:01	Wilco	
13:07:51	Level	
13:08:11	Wilco	
13:10:10	Heading	
13:10:28	Wilco	
13:11:48	ProceedDirectTo	[RESMI]
13:12:05	Wilco	
13:16:06	CONTACT	[LFRR][Next Sector CPDLC not in use until notified]
13:16:42	Wilco	

There were no issues with CPDLC on this flight.

6.2.6.1.3.3 EZY66HP on 17th March 2014

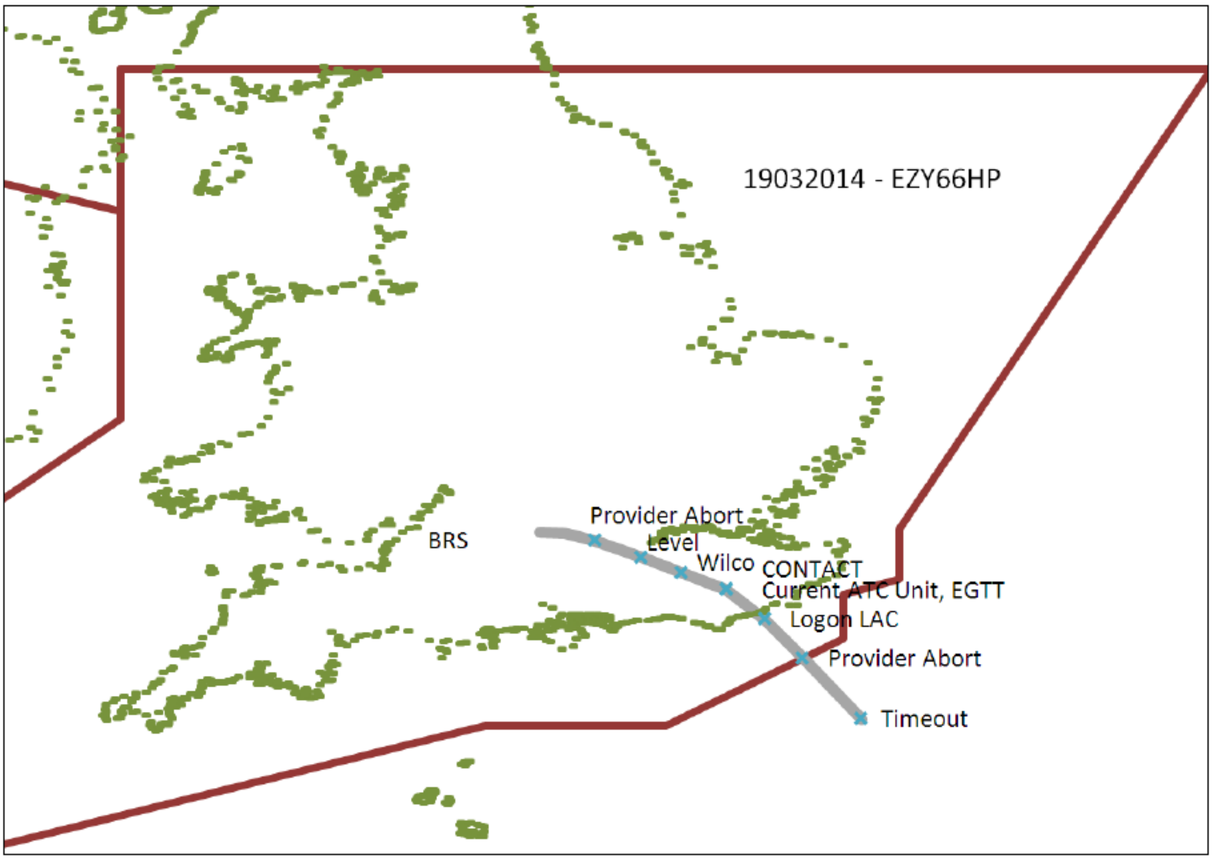


Time	Message	Additional Information
17:57:53	Request Speed	
17:57:55	Message Not Supported	
17:58:03	User Abort	Duplicate MessageIDs
17:59:26	Provider Abort	Communication Service Failure
18:00:02	Current ATC Unit, EGTT	
18:06:24	RequestDirectTo	
18:06:25	ProceedDirectTo	[CPT]
18:06:26	Fail	[Insufficient Resources][Route Request Rejected - Reply to Route Uplink first]
18:06:29	User Abort	Duplicate MessageIDs
18:09:39	Provider Abort	Communication Service Failure
18:09:50	Logon LAC	
18:09:52	Current ATC Unit, EGTT	
18:10:24	RequestDirectTo	
18:11:30	Unable	
18:12:30	Timeout	[Insufficient Resources][Uplink Delayed in network and rejected. Resend or contact by voice]
18:14:45	Heading	
18:15:41	Level	
18:17:41	Timeout	[Insufficient Resources][Uplink Delayed in network and

		rejected. Resend or contact by voice]
18:17:42	Timeout	[Insufficient Resources][Uplink Delayed in network and rejected. Resend or contact by voice]
18:19:29	Level, ProceedDirectTo	[POMAX]
18:19:41	Wilco	
18:20:14	Level	
18:20:24	Wilco	

User aborts were observed where the flight crew repeatedly requested a speed of Mach 0.79, which NATS does not support.

6.2.6.1.3.4 EZY66HP on 19th March 2014



Time	Message	Append
17:45:12	Timeout	[Insufficient Resources][Uplink Delayed in network and rejected. Resend or contact by voice]
17:46:18	Provider Abort	Communication Service Failure
17:46:37	Logon LAC	
17:46:38	Current ATC Unit, EGTT	
17:47:59	CONTACT	[EGTT]
17:48:28	Wilco	

17:56:08	Level	
17:58:32	Provider Abort	Communication Service Failure

This flight experienced a network rejection message followed by a provider abort.

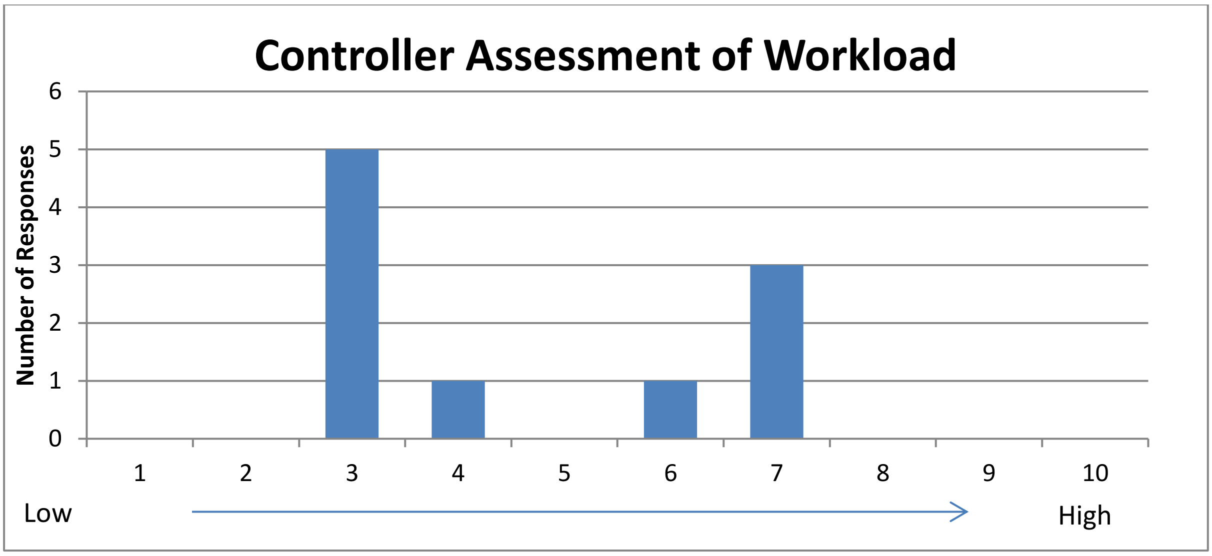
6.2.6.1.4 EXE.02.08-D-007 Results

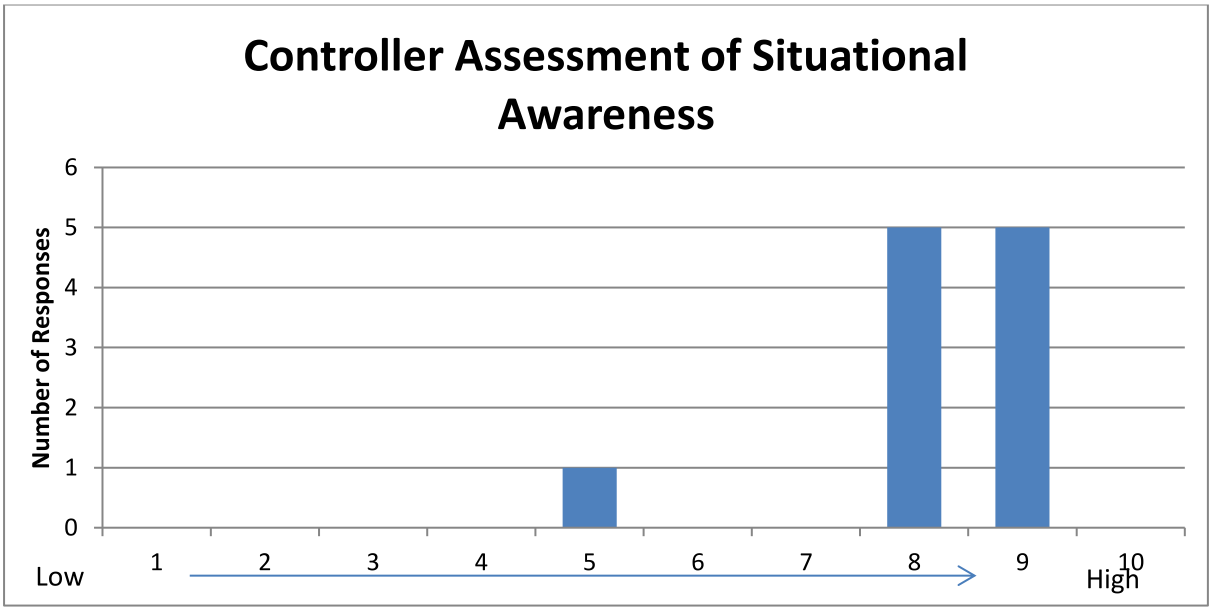
There were no issues identified in the system logs with the use of CPDLC for flights in this exercise (between Scotland and Scandinavia operated by SAS).

6.2.6.1.4.1 Human Factors Analysis

CPDLC was used less by controllers in this exercise that in the preceding exercises. For example it was not used at all below FL195, and by only about half the controllers for direct routings, climbs and descents.

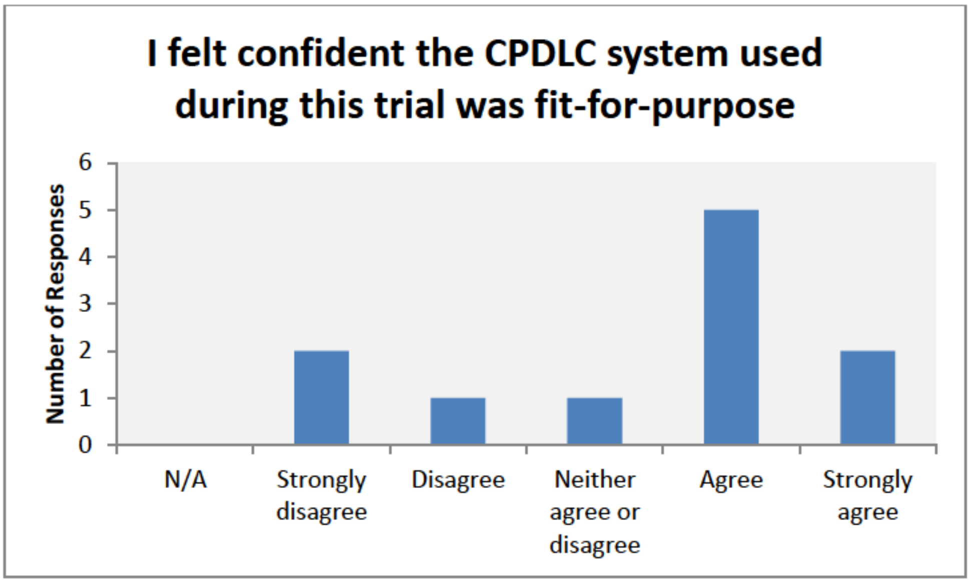
Controllers felt CPDLC did not impact their situational awareness; however some indicated an impact on their workload.





6 out of 10 controllers needed to revert to voice communications for this exercise. This was due to many reasons: no "Descend when ready" message, descending below FL195, pilot using voice communications, and ATM system issues.

Controllers were less positive about the CPDLC system for this exercise than for previous ones. Just over half agreed the system was fit for purpose with 2 strongly disagreeing.



6.2.6.1.5 Results per KPA

6.2.6.1.6 Results impacting regulation and standardisation initiatives

No results impact regulation or standardisation initiatives.

6.2.6.1.7 Unexpected Behaviours/Results

During the trial it was identified that Airbus aircraft which had been incommed prior to attempting CPDLC logon were unable to log on. Instructions were forwarded to the airlines to logon before being incommed where possible, and a software fix was identified.

6.2.6.1.8 Quality of Demonstration Results

The Human Factors analysis is based on questionnaires which as always are subjective. Also there was a very small sample size, particularly for EXE.02.08-D-005 (Rome – Bristol by EasyJet), for which only one questionnaire was returned. This should be borne in mind when interpreting the results.

There are no other issues with the quality of these results.

6.2.6.1.9 Significance of Demonstration Results

These results are not statistically significant due to the small data samples.

The results are operationally significant in that the demonstrations took place in a live operational environment using revenue flights. However again it should be noted that the data sample is small.

6.2.7 Conclusions and recommendations

6.2.7.1 Conclusions

Issues were experienced with familiarity of flight crew with CPDLC and its implementation specific to NATS. If CPDLC use becomes more widespread familiarity will develop but further training may be beneficial.

It was observed that in EXE.02.08-D-007 (between Scotland and Scandinavia operated by SAS) where the controllers were all at Prestwick the CPDLC system was used less and a higher workload impact was perceived. NATS controllers at Swanwick have an ATM system that makes CPDLC relatively simple to operate, and are more familiar with CPDLC during normal operations. It is suggested that the reduced familiarity and system differences have caused this, in addition to the different operational aspects of the flights from Scotland to Scandinavia compared with Bristol-Edinburgh.

The issues with Provider Aborts are well known across Europe, and in addition to this there is a known interoperability issue that affects the Scottish Control CPDLC system that is scheduled to be corrected in a future software release (mentioned in section 6.2.6.1.4.1 above). However, in spite of these the majority of controllers reported positive confidence in the system that the system works well. This is a surprise as the Provider Abort issue remains a concern for datalink experts, although it is worth noting that, while it does see Provider Aborts, NATS does not see them at as high a rate as has been reported in Datalink forums and in the recent EASA report. This could be a significant factor in the NATS controllers' positive confidence levels shown in the demonstrations.

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7 Summary of the Communication Activities

During the reporting period, ENAV AFD communication plan was executed around two high level objectives:

Internal:

- Raise awareness of SESAR Demonstration Activities;
- Inform and show that SESAR is delivering concrete results ready for real life operating conditions; and
- Accelerate acceptance by air traffic controllers of AFD innovative solutions.

- External:
- Promote visibility to general and specific target audience;
- Show the benefits of SESAR solutions in an operational environment to the Aviation Community; and
- Create the conditions to commit Stakeholders, Government, Institutions and Decision Makers.

Internal Communication Plan – Execution and Achievements

In order to ensure awareness of the Project internally ENAV, the following communication initiatives were undertaken during the period July 2012–mid June 2014 to show off AFD progresses and results:

- Intranet (in local language as appropriate)
    - Corporate monthly magazine "**Cleared**" – AFD related articles (e.g. December 2013 Issue / Article on the end of AFD Experimental Phase with datalink tests jointly carried out by AIRBUS and ENAV; June 2014 Issue / Article on the completion of AFD Flight Trials);
    - Corporate Newsletter with online distribution "**e-Cle@red**" – AFD related news (e.g. October 2013 Issue / E-news on the execution of communication and surveillance end-to-end connectivity and performances test at Roma ACC; June 2014 AFD Flight Trials Completion @ Roma ACC);
    - Internal email distribution of AFD related event alerts;
    - AFD Dedicated Section under ENAV International Activities area;
- Periodical Information Meetings / web-conferences (involving ENAV Operations and Technical Directorates as well as International Strategies/SESAR Unit);
- Ad Hoc Training Courses on AFD addressed to ENAV Air Traffic Controllers involved in flight trials (September 2013 - April 2014);
- Periodical Reports to ENAV Top Management.

POSITIVI I TEST AFD DI CIAMPINO SU ATC FULL DATALINK

UTILIZZATI SOLO SCAMBI DI MESSAGGI DATALINK

e-cle@red

Newsletter Gruppo ENAV N.5 - maggio 2014

Conclusa ufficialmente a Roma ACC l'ultima fase del progetto SESAR ATC Full Datalink

Pubblicato a maggio 2014

e-cle@red

Newsletter Gruppo ENAV N.9 - Settembre 2013

WILCO, prove tecniche di trasmissione AFD

Pubblicato a settembre 2013

External Communication Plan – Execution and Achievements

In order to promote visibility of the Project externally ENAV, the following communication actions were regularly implemented through the following channels:

- Internet www.enav.it (in local language and English);
- AFD related articles on technical press;
- AFD Press Releases;
- AFD News on SESAR JU Newsletter (SESAR E-News/May 2014 Issue – ENAV flight trials campaign completion);

- On site information material such as brochures and factsheets distributed by ENAV staff attending international trade events and aeronautical community major occasions;
- Participation in ATC Exhibitions and Aeronautical Events such as ATM CANSO World (February 2013) and ATM CANSO World (March 2014) Congresses.

Additionally, ENAV organised two demo days on the occasion of the completion of AFD Experimental and Demonstration Phases (respectively Demo Day 7 May 2014 and Demo Day 19 December 2013 both held at Roma ACC).

Key ENAV AFD participants were available to support the preparation and participation in SJU yearly internal meetings to allow the Project to be shared with other project managers. Key messages were presented focusing on positive results. ENAV AFD speakers were identified and tailored to the identified target audience. ENAV was present at SESAR JU Demo Workshop in Lisbon on 27-28 November 2013 with its AFD Contribution Manager presentation on session “02.08 ATC Full Datalink”.

Additionally, at the moment of writing this document, ENAV experts are attending the Workshop on the theme “Evolution of Regulation N.29/2009 (Datalink Services) promoted by the European Commission (Brussels 17th June 2014).

ENAV

ATC FULL DATA LINK

ATC Full Datalink

ATC Full Datalink is a SESAR JU Demonstration Project led by ENAV with the participation of AIRBUS, BOEING, Air France, Easy Jet, SITA and SELEX-SI.
During the period 2012-2014 ATC Full Datalink (AFD) intends to demonstrate the possibility to progress toward an operational environment where ATC operations are conducted mainly by digital communications between Controllers and Pilots, reducing drastically information exchanged through voice over the VHF radio frequencies.

The ATC Full Datalink (AFD) Demonstration Project intends to prove that it is possible to exploit the significant investment performed by Airlines and Service Providers across Europe to comply with the EC Implementing Rule on Datalink, to extend the number of operations to be conducted by CPDLC (Controller Pilot Data Link Communication) rather than by voice, even in a larger volume of airspace than the one designated by the aforesaid Implementing Rule.

This would reflect in further increasing the expected benefits, among others additional capacity and increase of safety, related to the introduction of CPDLC services in the continental airspace without additional significant costs.
Both the Validation and the Demonstration Campaign are expected to provide significant information for the next steps of development and exploitation of digital communications for ATC in continental airspace, and for the progressive integration of ground and airborne systems, as it is conceived by the SESAR future Concept of Operations and depicted both by the European ATM Master Plan and by the ICAO Aviation Blocks System Upgrade.

The AFD Project will include 36 revenue flights: the trials will be performed be flights operated by Air France and Easy Jet, using FANS B-equipped A320.

The trials will span along Quarters 1-2 2014, and they will include both short haul domestic flights within Italian and United Kingdom Airspaces and continental flights across the European Core Area, connecting Italian, French and British Cities.

For Further Info:
Cristiana Baldoni

enav.it

IL TEMPO

Italia e Usa, tra collaborazione e competizione

Daily Newspaper “Il Tempo”

SESAR Enews – May 2013

All press releases issued were consistent with the communication guidance provided by the SESAR Joint Undertaking.

A list of AFD Press Releases and Articles is reported hereafter the final report.

ENAV Communication Plan Approach

An effective and dynamic communication is one of the key success factors of all SESAR activities.

ENAV communication activities were jointly conducted by its SESAR Unit (AFD Contribution Manager with the support of ENAV AFD Communication Manager) and ENAV Communications Department.

Further, SESAR JU Communication Cell granted considerable support to boost ENAV AFD visibility through SJU communication initiatives such as Demo Workshops and channels (SJU Newsletters).

ENAV communication efforts ensured that the messages had always been common, related to the SESAR core objectives and been acknowledging SESAR JU's co-financing.

All participant organisations were responsible for the establishment, implementation and follow-up of the agreed dissemination activities - both external and internal.
Task 8.2 Communication Campaign preparation and management, in WP8, implemented most of the actions included in the communication roadmap (regularly "rerouted" to be improved alongside the life of the project and its actual course).

ENAV Communication Plan – Timing 1/2

The initial communication timing schedule was refined during the years 2013-2014 with the aim to reorient it with the actual development of AFD Experimental Phase with special focus on the flight trials campaign.

Being the core of the project the Flight Trial campaign, ENAV dedicated team in WP8 was active for the proper promotion of the AFD project in this phase taking full advantage of participating staff such as air traffic controllers, Human Factor and validation experts who significantly increased the project buy-in under the coordination of ENAV AFD Contribution and Communication Managers.

On the other hand, since it is a very complicated and delicate communication aspect, which needs careful attention, in order to avoid any negative impact on the final outcome of the project, it was decided – jointly with the SESAR JU – to reconsider the opportunity to organise a final workshop according to the evolution of the on-going initiatives at European level with respect to datalink services and the evolution of EC Regulation N.29/2009.

To this respect, it is worth considering that AFD was mentioned in the EASA Report on the investigation of Technical Issues in the implementation of aforesaid Regulation (http://ec.europa.eu/transport/modes/air/single_european_sky/doc/implementing_rules/2014-04-23-easa-datalink-report.pdf).

The report provides a good highlight on the Project and the AFD final report will be definitely linked to it.
Notwithstanding this, due to the timing of the EASA study, AFD was not able to provide it with more consolidated and extensive results, although the demonstration activities somehow contributed to address the EASA recommendations and conclusions toward a precise direction.

In fact, through AFD, it was possible to provide some preliminary answers to the EASA Report recommendations and conclusions and pave the way for the next SESAR activities which will be performed (starting with the VDL2 Capacity study – where most of AFD companies are going to be involved in a way or in a other) to provide the ATM with the appropriate solution for Air Ground System integration.

To this end, it is the intention of ENAV to coordinate its own communication efforts on D/L and eventually hold a dissemination event on the AFD project to keep awareness on datalink services application with selected stakeholders, regardless the expire date of the project eligibility period.

ENAV Communication Plan –Timing 2/2

AFD communication and buy -in was ensured in the following steps across the Project (text in bold):

Phase 1
- June 2012 - Project Kick Off

October 2012 – February 2013
- Operational and technical feasibility study
- Two role gaming sessions

Phase 2
- March – July 2013
- Setup of ATN over PENS communication infrastructure
- Setup of AFD platform
- Communication End-to-End test between AFD platform and Airbus/Boeing Test Bench

Phase 3
- August – December 2013
- Setup of Shared Virtual Sky server/client
- Setup of AFD platform, able to receive flight track from SVS wrapper
- Airbus Simulated flight conducted by real pilots and controlled by ATCOs
- New release of AFD platform, adding RTA capability

Phase 4
- December 2013 – January 2014
- Operational procedures
- Feedbacks and conclusions
- Safety assessment
- Human Factor methodology

EXE

February– May 2014
Execution of AFD Flight Trials

The AFD post-analysis activity is continuing and will be completed by July 2014 when the Project will deliver its final report to the SESAR Joint Undertaking.

Communication Next Steps

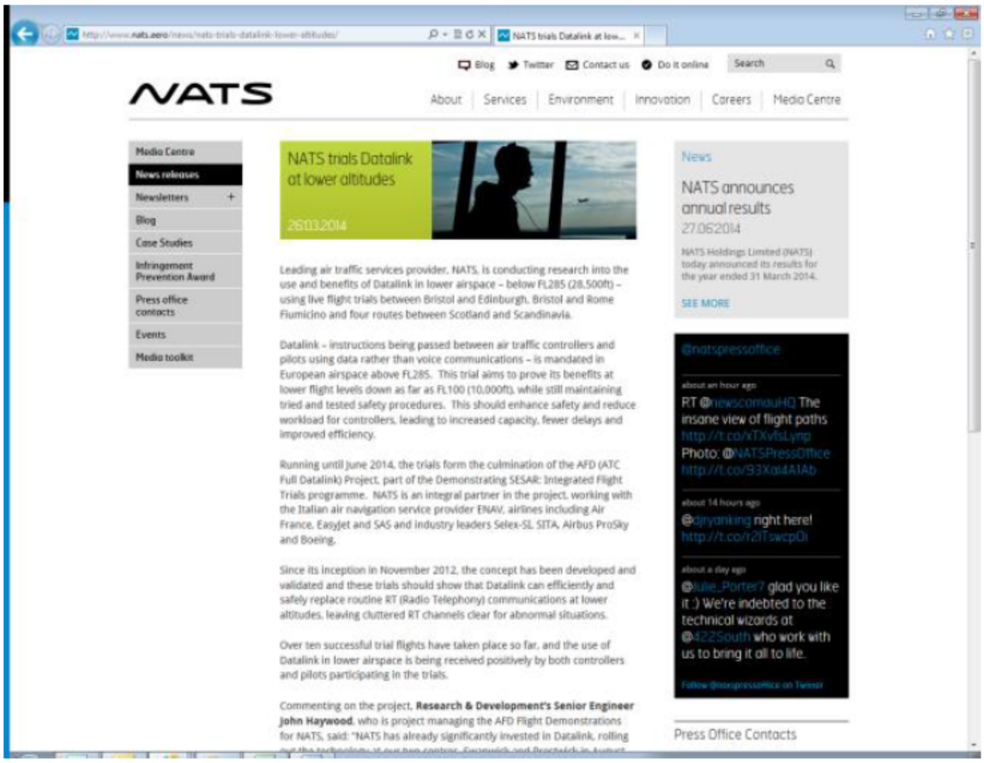
Further to the publication of the AFD final report, ENAV will release a concise final brochure with the description of end results and major achievements, introduced by key messages agreed and shared by all participating partners and SESAR JU. It will be structured as follows:

- Project objectives;
- Members;
- Description of Trials;
- Results (alternatively expected performance gains);
- A view on Implementation.

- The text will be as concise and straight forward as possible and answer the following questions:
    - What was achieved in performance gains?
    - Which lessons were learned in terms of translating the trials into every day procedures?

NATS

NATS worked with its own Corporate Communications department to publicise the AFD project from a NATS perspective. The NATS publicity centred around a press release, published on the NATS media centre web site:-

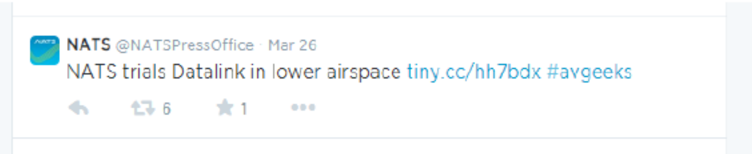


http://www.nats.aero/news/nats-trials-datalink-lower-altitudes/

This press release was taken up by a number of online aviation websites in Europe and the US, including:-

- ADS Advance;
- Airport Technology; and
- Aviation Today.

NATS Corporate Communication further publicised the project via Internet Social Media (Facebook and Twitter), linked back to the press release, which generated a number of likes, shares and re-tweets.



Twitter

Facebook

AIRBUS

After close out of all seven projects to which it contributed in the frame of SESAR Integrated Flight Trials and Demonstration Activities, Airbus intends to issue a press release summarizing the main findings and its motivation to continue to join airlines, ANSPs and airports to exploit in a practical manner new Air Traffic Management concepts for the sake of improved flight efficiency.

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ATM teams from Airbus and EADS to participate in seven SESAR JU Integrated Flight Trials

Paving the way for reduced emissions and optimising airspace capacity throughout the North Atlantic and Continental Europe

8 NOVEMBER 2012 PRESS RELEASE

Airbus and its air traffic management (ATM) subsidiaries – Airbus ProSky, Quovadis and Metron Aviation – together with the EADS division Cassidian, have all been selected to participate in the upcoming SESAR Joint Undertaking (SESAR JU) Integrated Flight Trials. The SESAR JU programme involves a large number of stakeholders in key locations across the North Atlantic and Continental Europe.

The seven integrated flight trials involving these Airbus/EADS teams will commence in early 2013 and conclude by the end of 2014. Together they form part of the SESAR JU's on-going 'Atlantic Interoperability initiative to Reduce Emissions III (AIRE III) SESAR Integrated Flight Trials.' AIRE is the joint European Commission and Federal Aviation Administration (FAA) programme which aims to reduce CO2 emissions and accelerate the uptake of ATM best practices and to capitalise on today's aircraft technology. These integrated flight trials will validate technology and procedures to deliver innovative ATM solutions which will be immediately operational, and allow stakeholders to take direct advantage of the benefits.

http://www.airbus.com/presscentre/pressreleases/press-release-detail/detail/atm-teams-from-airbus-and-eads-to-participate-in-seven-sesar-ju-integrated-flight-trials/

AIR FRANCE

The following article is coming from “Pilotes info”, an internal journal that, 4 times a year, is updating pilots on various ATM subject, such as new technologies. No websites are available to download it, since it is located to an Air France intranet.

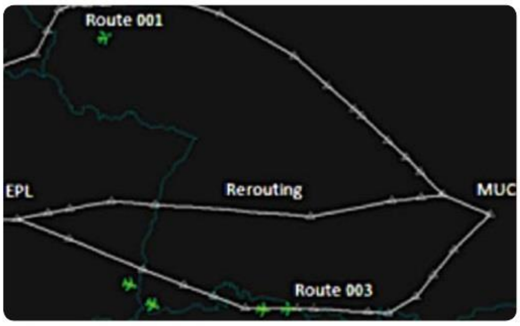
SESAR : améliorer l'efficacité de nos vols

AF participe activement à la modernisation du contrôle aérien en Europe via le programme SESAR. Deux évaluations ont été organisées pour valider des nouvelles procédures qui améliorent l'efficacité de nos vols. Le point avec Hervé Marsal, CDB A320 et Laurent Renou, Responsable Coordination projets ATM/CNS SESAR.

L'optimisation des vols CDG-MUC

Le concept "Flexible Use of Airspace" (FUA) vise à optimiser l'utilisation de l'espace militaire.
Dans ce cadre, les contrôles aériens français (DSNA) et allemand (DFS) ont lancé un projet d'amélioration de la coordination civile-militaire afin de pouvoir proposer aux compagnies aériennes des trajectoires raccourcies pour les vols CDG-MUC quand les espaces militaires sont inutilisés. Le contrôle aérien a proposé à Air France, Lufthansa et Fedex de participer à l'évaluation d'un rerouting "en tactique" permettant de réaliser une économie potentielle de 150 kg par vol.

Cette évaluation a eu lieu du 4 nov. au 20 déc. puis du 1 janv. au 7 fév. Vous trouverez une fiche de la procédure dans les dossiers des vols concernés par cette évaluation ainsi que sous iPN.



En dehors de quelques avions exemptés, toute la flotte Airbus moyen-courrier sera équipée pour février 2015, date butée définie dans la réglementation européenne et imposée à l'ensemble des avions opérant au-dessus du FL285. La formation, quant à elle, vous sera dispensée dans le courant du premier trimestre 2014 afin que vous puissiez utiliser ce service dès Avril 2014.

Côté sol, la réglementation européenne impose à tous les centres de contrôle aérien de l'Europe de l'Ouest d'être équipés depuis février 2013.

Plusieurs compagnies comme KLM et Lufthansa ont fait le choix de commencer à utiliser ce nouveau service dès le printemps 2013. Malheureusement, la montée en charge de l'utilisation de ce nouveau service montre que les solutions sol et bord n'ont pas la fiabilité souhaitée provoquant de nombreuses déconnexions. Les corrections sont en cours de développement mais les délais de certification font que les utilisateurs (pilotes et contrôleurs) seront exposés dans les mois à venir. Ces problèmes peuvent remettre en cause notre position de commencer à utiliser ce service en Avril 2014.

D'ici avril 2014, Air France est engagé dans une campagne de validation du service CPDLC au côté d'EasyJet, Airbus, Boeing, SITA ainsi que les contrôles aériens italien (ENAV) et anglais (NATS). Cette campagne est réalisée dans la cadre du programme SESAR de modernisation du contrôle aérien en Europe. En participant à cette campagne, Air France contribuera à la fiabilisation du service et à son "*utilisabilité*".

SITA

Air traffic management – SITA magazine (*http://www.sita.aero/file/8710/air-traffic-management-highlights-Mar-2013.pdf*)

SESAR JU Integrated Flight Trials projects

SITA has been selected for participation in two SESAR JU Integrated Flight Trials projects as follows:

1. ATC Full Datalink (AFD) will demonstrate how commercial flights can be guided seamlessly through controlled airspace by making extensive use of FANS B+ equipped aircraft. This will allow voiceless Controller-Pilot-Data-Link-Communications (CPDLC) for routine operations such as clearances, hand over and routing instructions. The AFD trials extend the use of CPDLC even below Flight Level 285, which is currently common in some European upper airspace.

The project aims to create an end-to-end operational scenario for the safe handling of a number of continental commercial flights with no voice radio telecommunication between controllers and crew. This will be in nominal conditions along the entire path from first contact with the ACC, to frequency change with the tower on final approach.

The demonstration may prove the viability of introducing time-based operations supported by 'system interoperability with air and ground data sharing' as well as 'i4D+controlled time of arrival' concepts, as described in Step 1 of the SESAR Storyboard.

AFD is led by the Italian Civil Aviation (ENAV) and includes consortium members Airbus, Boeing, UK NATS, EasyJet, Air France, SELEX-SI and SITA.

2. New Bridge is a project designed to sequence air traffic earlier than achieved by current operations. The principle is to extend current airline practices to schedule any aircraft type movements – and to provide extended coordination between airline operation centres and related air traffic control sectors – once movements have departed.

New Bridge will increase flight efficiency by improving sector load management and arrival traffic sequencing through use of the maximum time horizon available for the business trajectory. In particular, New Bridge will consider the exchange of 4D trajectory information for unmanned aerial vehicles (UAV) with a civil air traffic centre.

New Bridge is led by LFV, with consortium members Airbus ProSky, Swedavia, Estonian ANS, SAS, Novair, Estonian Air, Malmö Aviation, Rockwell Collins France, NLR and Egis Avia. Subcontractors include Airbus and the EADS division, Cassidian. SITA is acting as observer.

8 Next Steps

8.1 Conclusions

The AFD trials have shown that pilot and controller confidence is sufficient to support operations at lower flight levels than FL285, but that further analysis is necessary to determine the lower limit of operations. They have also provided valuable additional information for ATN/OSI datalink usage in Europe. As the various stakeholders continue to monitor and prepare for the on-going deployment of LINK2000+ in Europe, there are many factors that seem to indicate follow-on work and further investigation are required. Some of these areas were already touched upon via the EASA "Technical issues in the implementation of Regulation (EC) No 29/2009" report. However, other questions have also arisen given the success of the AFD trials within the context of the larger European LINK2000+ issues. These questions become especially relevant in light of potential advanced datalink services, as these issues should be addressed prior to further implementation.

The AFD trials have also successfully validated the LINK 2000+ concept, within the constraints of known technical issues with the VDL2 technology, integrating ENAV and NATS systems, controllers and operations personnel seamlessly with surrounding flight information regions, ANSPs, and multiple airline carriers and aircraft types. However, based on some observations and findings during the AFD trials combined with recent issues with LINK2000+ implementations in Europe, it would seem prudent to follow up in a number of areas where further investigation could benefit both planned and current deployments. As such, it is suggested to build on the success of AFD by performing continued investigation into key areas. This will help to identify and mitigate potential issues, and to ease the transition to true full datalink operations in Europe.

Some differences in between NATS and ENAV HF results can be noted. Yet, the differences in the collected feedback might be explained with the different level of confidence with CPDLC between NATS controllers and ENAV controllers. More in particular:

- When comparing the NATS results to the ENAV HF results, NATS controllers have a good deal more confidence in CPDLC in general, and significantly have more confidence in operations at lower levels. We believe that this is due to controller familiarity with CPDLC being different at NATS and ENAV, as ENAV is at an earlier stage of their CPDLC rollout and does not yet have CPDLC in normal operation. We see no reasons for the ENAV controller confidence not to improve to more closely resemble the NATS analysis as ENAV controller familiarity increases.
- NATS controller confidence in low level operations (FL195-FL285) was high. Significant contributing factors to this are the fact that NATS is in full operation with its CPDLC system and that NATS already operates CPDLC below FL285, in some parts of the country down to FL195.
- NATS controller confidence in operating down to levels as low as FL100 was sufficient to merit further investigations into the benefits of CPDLC operations down to this level. It should however be noted that operational restrictions meant that the number of exercises that included operations at this level was low.
- UK CPDLC system performance was measured to be close to being sufficient to support TMA and Arrival/Departure operations according to the performance guidelines contained within EUROCAE ED-120. Since the main factor in this performance is the human flight deck element, this performance is most likely to improve with increased flight deck familiarity of CPDLC (although network latency from increased datalink traffic may work against this). It should be noted that, for a number of the exercises, it was the flight crew's first time using CPDLC. It should also be noted that the ED-120 TMA and Arrival/Departure performance standards are guidance only and subject to local analysis.
- Although controllers made no reference to this in the Human Factors analysis, NATS did see as number of unexplained Provider Aborts during the demonstrations. In its operational CPDLC system NATS has experience of the Provider Abort issue, although not with as high an incidence rate as has been reported by ANSPs elsewhere, in the Eurocontrol datalink forums and most recently the EASA Report into Regulation (EC) 29/2009 (the DLS-IR). The NATS AFD team agrees with the EASA Report that, despite this AFD study showing high controller confidence in CPDLC, the incidence of unexplained Provider Aborts that appears to be due to technological and architectural issues with the DLS-IR roll-out is a real concern.

8.2 Recommendations

AFD participants welcome SESAR's consideration and evaluation of technology candidates such as terrestrial LDACS, AeroMax, the Inmarsat Swift Broadband, ATN/Internet Protocol Suite (IPS), and potential future SATCOM technologies to resolve the issues experienced with VDL2. It is this our recommendation that this evaluation goes ahead in the context of seeking a global solution that operates within Radio Frequency spectrum allocated to an appropriate aeronautical safety service.

The airlines participating in the AFD consortium provided significant recommendations stemming from their pilots and experts' feedbacks, among which:

- VHF Data Link Ground Station /avionic investigations are needed in order to identify explained technical issues
- Support the Multi frequency trial to validate if the new VDL plus Airbus ATSU upgrade (permits multi-frequency) could give a contribution to improve reliability to acceptable level
- ATN B2 timeout changes should be investigated more thoroughly to address the controller / Pilot anxiety about the current logical acknowledgement (ACK) timer with B1 up to 2 minutes.
- Procedures among the various airspaces of the European countries must be harmonized to provide the flight crew with seamless procedures all over Europe. For instance, the logon time interval (45' to 15' before take-off or when entering the airspace?), the message set, the altitude used as a floor for CPDLC, and even the designation of the system should be consistent whenever it is possible in the various countries of the European airspace.
- This can be illustrated by the fact that today a pilot reading the information in the AIP and NOTAMS can find the following terms to designate the system:
  - FANS
  - PM-CPDLC
  - CPDLC PM
  - ATN
  - ATN via VDLM2
  - PM CPDLC via VDLM2
  - ATN PM
  - CPDLC ATN VDLM2
- Unless you are an expert of this subject, this requires unnecessary effort to understand.

Generally speaking, some of the areas as highlighted by the AFD trials that should be further investigated include:

- Comments on the TSEL differences that were causing problems (including potentially trying to replicate this condition in Boeing and Airbus ATN laboratories, with support from ENAV and system suppliers). On this point, ENAV submitted to EUROCAE a note to the ED110B document, highlighting some "room of interpretations" on TSEL specifications.
- More in-depth analysis of the EASA report, including discussion of potential follow-on work as recommended by the report. This would likely include some examinations of protocol parameter settings (e.g. TP4 window sizes, IDRP hold timers, etc.) of the AFD setup compared to other parts of Europe.
- Investigating log file correlation and health monitoring requirements. Based on AFD participant experiences, the value of comprehensive logging and monitoring capability became apparent. The ability to be able to investigate specific questions within a short period of time and across different protocol levels (i.e. user, application, transport, RF link, etc.) makes issue tracking quicker and helps to more efficiently identify causes. This is particularly evident when so many service providers, operators and users are involved, and having the end-end picture allows the entire scenario to be viewed instead of discrete pictures. For AFD, ENAV was responsible for setting up the comprehensive logging that was used so effectively. Additionally, some of the stakeholders (e.g. Boeing) have experience in setting up an end-end

health monitoring system for statistics and trouble shooting for services like Tailored Arrivals and FANS-1/A departure clearances in the US. Based on these experiences, potential requirements for future consideration should be outlined in order to provide more meaningful insight into datalink operations. This would include investigating expanding the AFD-type of enhanced logging and monitoring capability to the rest of Europe, combining the experiences gained from AFD with the current different capabilities throughout different communication and air navigation service providers.

-
- Further investigations into user abort events. This would involve analysing the log files of user abort events to gain insight into non-provider abort situations, and correlation into what precipitated their occurrences. The results should be added to guidance material to help pre-empt and minimize the occurrence of unnecessary user aborts.
-
- Investigation into datalink service performance with ATN Vs. datalink service performance with FANS-1/A and AOC messaging within Europe. FANS-1/A is not affected by the VDLM2 issues as is ATN. Defining the reasons would help to potentially further narrow some of the areas that need to be addressed in order to solve the larger VDLM2 issues across Europe (e.g. OSI protocol stack, application layer, etc.). This would be necessary not just for the potential future introduction of new advanced services, but also to ensure the continuing roll-out of LINK2000+ in Europe has fewer problems, and that operators find the services useable and beneficial.
- Investigation of VDLM2 performances, as defined in the new SJU study called “VDL2 Capacity and Performance Analysis”

Further experimental studies shall also attempt to:

- Perform longer experimental flight legs
- Test the system with more than several flights connected by CPDLC
- Test across more complex sectors/scenarios (e.g. MI sectors and higher traffic load)
- Test increasing the number of instructions exchanges between ATCO and FC

Further study of CPDLC operations in the FL100-195 level band should be made. It should include a benefit analysis and a safety and performance analysis that is appropriate for both today’s tactical TMA operations and for future systemised TMA operations.

AFD participants welcome SESAR’s consideration and evaluation of technology candidates such as terrestrial LDACS, AeroMax, the Inmarsat Swift Broadband and potential future SATCOM technologies to resolve the issues experienced with VDL2. The very AFD recommendation is to proceed in the context of seeking a global solution that operates within Radio Frequency spectrum allocated to an appropriate aeronautical safety service.

The aforesaid recommendations should be addressed by subsequent SESAR JU Large Scale Demonstration projects, with a view to follow on the work done in the AFD project to achieve full applicability of datalink as stable means of communications.

9 References

9.1 Applicable Documents

[1] 02.08 A.1 Demonstration plan, V00.04.00, 28/11/2012

[2] EASA: Technical issues in the implementation of Regulation (EC) No 29/2009, V1.1, April 2014

[3] ED-110B Electronic Copy - Interoperability Requirements Standard for Aeronautical Telecommunication Network Baseline 1 (Interop. ATN B1) – December 2007

[4] ED-120 Electronic Copy - Safety and Performance Requirements Standard For Initial Air Traffic DLS In Continental Airspace – May 2004

9.2 Reference Documents

The following documents provide input/guidance/further information/other:

[5] Link 2000+ Programme – ATC Data Link Operational Guidance for Link2000+ Services – March 2010

[6] EC 29/2009 Electronic Copy – EC requirements on data link services for the single European sky – Jan 2009

Appendix A Safety Assessment

Appendix B Required Time of Arrival Management within FMS2

Appendix C Human Factors Questionnaires

-END OF DOCUMENT-