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PHASE 3
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COM - ATN - EOLIA Project
Experiment 3B: A/G DATALINK
Final Report

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EUROCONTROL Experimental Centre
B.P.15
F - 91222 Brétigny-sur-Orge CEDEX
FRANCE
Telephone : +33 (0)1 69 88 75 00</td></tr>
<tr><td colspan="3">Sponsor:
EATCHIP Development Directorate</td><td colspan="4">Sponsor (Contract Authority) Name/Location:
EUROCONTROL Agency
Rue de la Fusée, 96
B -1130 BRUXELLES
Telephone : +32 2 729 9011</td></tr>
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<tr><td>Author
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Abstract:

This report describes an experiment to evaluate the impact of Datalink Communication on the controller. Traffic samples representing 3 proportions of datalink-equipped aircraft and 3 levels of traffic load were used. The experiment was conducted on simulations of the civil airspace of Paris ACC, Reims ACC and Maastricht UAC.

The concept was well received. There was a general feeling amongst the participants that datalink was of benefit to the controller. Problems were identified when the proportion of non-equipped aircraft is high. Some general issues about responsibility and task delegation between Planner and Executive were raised.

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ABBREVIATIONS

Abbreviation	De-Code
ACC	Area Control Centre
ACL	ATC Clearances Datalink Service
ACM	ATC Communications Management Datalink Service
ADS	Automatic Dependent Surveillance, ATN Application
AFL	Actual Flight Level
ATC	Air Traffic Control
ATM	Air Traffic Management
ATN	Aeronautical Telecommunications Network
ATS	Air Traffic System
CAP	Controller Access Parameters
CFL	Cleared Flight Level
CM	Context Management, ATN Application
CPDLC	Controller-Pilot Datalink Communications, ATN Application
CWP	Controller Working Position
DAP	Downlink of Aircraft Parameters
DLIC	Datalink Initiation Capability
EATCHIP	European ATC Harmonisation and Implementation Programme
ECAC	European Civil Aviation Conference
EEC	Eurocontrol Experimental Centre
EOLIA	European pre-Operational data Link Applications Project
FL	Flight Level
HMI	Human Machine Interface
ISA	Instantaneous Self Assessment
NASA	National Aerospace and Space Administration (USA)
NM	Nautical Miles
ODID	Operational Display and Input Development
OLDI	On-Line Data Interchange
(R)PVD	(Radar) Plan View Display
R/T	Radio Telephony
SIL	Sector Inbound List
SYSCO	System Supported Co-ordination
TCAS	Traffic Alert and Collision Avoidance System
TLX	Task Load index (Workload Assessment Method)
XPT	Sector Exit Point

Summary

This experiment representing one of a sequence of studies in the EATCHIP III ATM Operational Concept Evaluation and Demonstration programme, was performed in collaboration with the European pre-Operational data Link Applications Project (EOLIA) at the EEC.

The aim of the experiment was to perform an initial evaluation and demonstration of subsets of the A/G Datalink operational requirements which form part of the EATCHIP III ATM Operational Concept. At the same time the EOLIA project aimed to show the feasibility of the integration of ATN and its related services into the real time simulator facility.

Three components of Air/Ground datalink were simulated:

- Controller-Pilot Datalink Communications (CPDLC)
- Automated Downlink of Aircraft Parameters (ADAP)
  (The experiment only evaluated functionality similar to the Controller Access Parameters (CAP) service defined by ODIAC. The remainder of this document, however, refers to this as DAP)
- Datalink Initiation Capability (DLIC)

The operational requirements for the datalink services have been defined by the Eurocontrol Operational Development of integrated Air/Ground Data Communications and surveillance (ODIAC) Sub-group, based on the ICAO Manual of ATS data link applications (Doc. 9694/AN955) and can be found in [Ref.6]

CPDLC and CAP were selected because of the level of maturity from a standards point of view, their introduction in operations is justified as it represents a logical initial step from an operational implementation perspective; these applications are an entry into the data link operations and culture keeping with similar procedures.

The variables of interest concerned the proportion of aircraft that were datalink-equipped, the volume of traffic and the division of tasks between executive and planning controllers. Additionally, the study was used to obtain feedback on the effectiveness of the proposed HMI.

The experiment was conducted in simulated airspace representing parts of Paris ACC, Reims ACC and Maastricht UAC. It was conducted over a three week period, with the first week reserved for hands-on training. Ten civil controllers from seven European states participated in the experiment. Six control positions and three feed positions were simulated.

Measures were made to provide indicators of controller workload, airspace safety, level of service and HMI utilisation. Recordings were made from the simulator data (Air, CWP and Telecom), questionnaires, Instantaneous Self-Assessment (ISA) and NASA Task Load Index (NASA TLX) workload measurement.

The experiment showed that:

1. CPDLC is considered by the controllers to be a viable communications method for strategic and partly for tactical ATC.
2. The use of CPDLC and DAP has the potential to reduce controller workload.
3. Integration of the ATN and its related datalink services is feasible.

It was also identified that:

1. The use of CPDLC raises some issues about the division of tasks between executive and planning controllers.
2. The full benefits of datalink communications can only be obtained when the system is sufficiently reliable and the traffic contains a large percentage of appropriately equipped aircraft.
3. Some benefits, such as those associated with the availability of DAP, are however evident even with relative small percentages of equipage.

Areas for further experimental work were identified as a result of this initial “Hands on” experiment.

1. Introduction

1.1 Context

Experiment 3B formed part of the third phase of the EATCHIP III ATM Operational Concept Evaluation and Demonstration Programme. The experiment, conducted at the EEC from the 4th to the 20th May 1999, focused on the evaluation and demonstration of the use of Air-Ground Data Communications in ATM. The simulation was a joint activity by the EOLIA Project and EATCHIP.

Controller Pilot Data Link Communications (CPDLC) was implemented to provide the communication of controller instructions and clearances to the pilot, the pilot requests to Area Control Centres and all the associated acknowledgements and error messages..

All CPDLC equipped aircraft in the simulation were also transmitting downlinked aircraft parameters (DAP) which were available to the controller for these flights.

The functions simulated were those evaluated in Phase 2 [Ref.3],[Ref.2]and some of 3A (MONA and SYSCO [Ref.4]) to provide a realistic basis for the CPDLC. The MTCD function was not simulated because from the feedback received after the previous experiments it was considered that the version available was not sufficiently refined (see controller comments in Experiment 3A report [Ref.4]). Civil/Military crossing functionality was made available, but for the sake of simplicity it was later decided not to operate military traffic during the exercises.

1.2 The International Development

CPDLC and ADS (ADAP in this case) form the first applications of the ICAO FANS CNS/ATM concept whereby the introduction of global communications, navigation and surveillance systems based on the ATN will provide users with the tools required to enhance ATS on an harmonised world wide basis.

One of the starting points in Europe for the development of CPDLC and DAP was a fast time simulation indicating that routine radiotelephony communications account for about half of total sector workload and can be as high as 60 to 70 % of executive controller workload. Thus it is necessary to find means of reducing this amount which in fact constitutes the main limiting factor of sector capacity. CPDLC is expected to be a solution to this limit by partly automating routine communications using data link. In addition to the capacity gains, other benefits of air/ground data link are expected as follows:

- reduction in voice channel load,
- backup to voice (2 channels are available),
- reduction in misunderstandings,
- multicast communications (e.g. for “stuck mike”, uplink to all aircraft),
- capability to access information from the avionics,
- no need to hand-copy,
- further automation (e.g. deferred clearances, route loading into the FMS),
- more surveillance possibilities (Ground plus Air),
- extension of the common reference for pilots and controllers.

The issues to be resolved, for which this experiment provides some answers, are:

- Human Factors,
- Situational Awareness,
- Pilots/Controllers Cross-check and task distribution,
- HMI and Input systems,
- Head-down Time,
- System reliability and Transmission Times,
- New Working Procedures,
- Legal aspects for responsibilities,
- Quality of service,
- Global Standards.

Later on, after gaining operational experience it will be possible to introduce more automation but controllers and pilots must learn to use datalink progressively. There are still many human factors and technical issues to be considered. The ultimate aim is to achieve a system where the best of voice and the best of data will be used to optimise productivity of ATM.

The operational use of these applications (CPDLC and ADS) has started in the South Pacific area and is on trial in Europe core area (MAASTRICHT UAC) with the PETAL Trials.

1.3 Experimental Approach

The series of EATCHIP experiments have been designed with a common philosophy to optimise the exploitation of the results obtained. This approach can be qualified as an “Incremental Evaluation and Development Approach”. Its main characteristics, which constitute the principal differences compared with real time simulation are:

- the small scale of the study and in particular the fact that the study is *‘just detailed enough*’ to provide initial answers to the questions posed and give an indication for further progression,

- a high degree of continuity between successive studies, e.g. airspace etc. is changed only for specific reasons concerned with the operational and technical issues being examined,

- a high degree of dependency between the studies. The purposes and objectives of each study are open to reflect the results and experiences of the previous studies,

- that, in order to yield reliable results, sources of variance are kept to a minimum in the course of the studies.

- only a small number of clear and direct questions are examined in each study. In consequence, the number of variables is kept to a minimum.

2. Experimental Objectives

2.1 Aims

The aim of the experiment was to evaluate and demonstrate parts of the A/G Datalink operational requirements which form part of the EATCHIP III ATM Operational Concept. At the same time the EOLIA project aimed to show the feasibility of the integration of ATN and its related services into the real time simulator facility.

2.2 Operational Objectives

1. To measure the effect of CPDLC operations on controller workload.
2. To measure the effect of CPDLC operations on the Level of Service provided to airspace users.
3. To assess the effect of CPDLC operations on the participating controllers perception of safety.
4. To measure the effect of the availability of DAP data on controller workload.
5. To obtain feedback from the participating controllers on the effectiveness of the error messages presented to them.
6. To obtain feedback from the participating controllers on the acceptability of the CPDLC end-to-end delay.
7. Determine whether the use of datalink should be associated with a redistribution of tasks amongst the sector team.

2.3 System Objectives

1. To integrate the ATN prototypes Trials ATN router, Trials Transport Server and Trials End System (TAR/TTS/TES).
2. To integrate the ODIAC/EOLIA datalink services ATC Communications Management (ACM), ATC Clearances (ACL), Downlinked Aircraft Parameters (DAP) and Datalink Initiation Capability (DLIC).

3. Description of Experiment

3.1 Operational Context

3.1.1 Simulated Airspace

The simulation area included adapted sectors from Reims, Paris and Maastricht ACCs. It was divided into Measured sectors and Feed sectors (see map in Annex A).

The Measured sectors were:

- Sector YR: FL245 to Unlimited
- Sector Luxembourg (LUX): FL245 to Unlimited
- Sector Paris (PARIS): Surface to FL245

Each measured sector had 2 Controller Working Positions (CWP):
the Executive position(EC) and the Planning position (PC).

The Feed sectors were :

- Sector MARR
- Sector SEST
- Sector PARNO

Detailed description of static data, video data, simulations room layout, telecommunications requirements and ATC constraints can be found in the Experiment 3A Conduct and Environmental Definition [Ref.5].

3.1.2 Traffic Samples

Four traffic samples representing different levels of traffic volume were used in the simulation:

- Training (Low): 86 flights per exercise
- Morning (Medium): 103 flights per exercise
- Afternoon (High): 127 flights per exercise
- Busy (V.High) 140 flights per exercise

The low and medium traffic samples were used during the training period. The medium, high and very high traffic samples were used during the evaluation weeks.

To prevent the controllers from learning the behaviour of the traffic samples, the start times of the aircraft in each sample were modified to generate three variants of each traffic level. This was done by applying a randomly generated delay of between +3 and –9 minutes to each navstart time. {N(3,4) distribution}.

To minimise the number of samples that needed to be generated, the 3 navstart variants coincided with the 3 levels of datalinked equipped aircraft. So TRAM4 (40% equipped aircraft) was based on the same set of flights as TRAM0 (no equipped aircraft) but with modified navstart times.

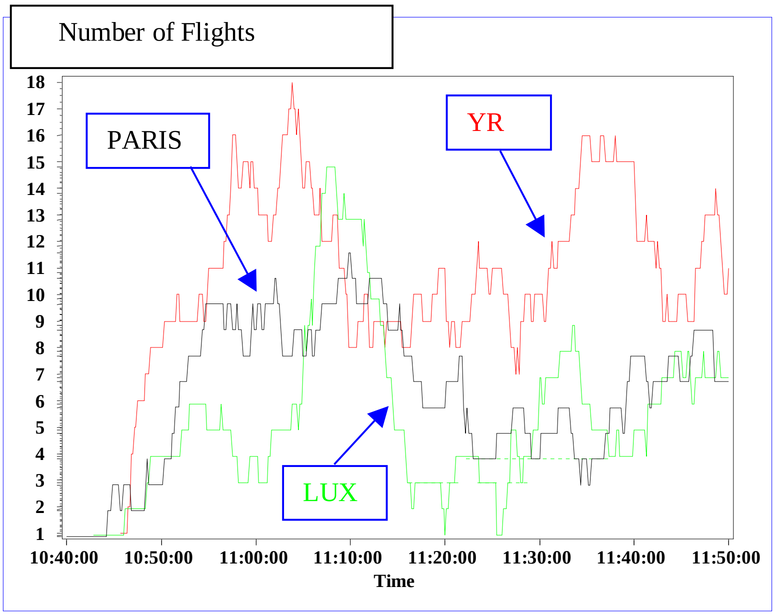

Figure 1: Sector Loading of VB Traffic Samples

There were 12 traffic samples in total, namely: TRAM00, TRAM40, TRAM90, TRPM01, TRPM41, TRPM91, TRPM02, TRPM42, TRPM92, TRVB02, TRVB42, TRVB92. Where AM ="Medium" , PM ="High" , VB ="Very High" and 0,4,9 indicate 0%, 40% and 95% datalink equipped aircraft. The final number indicates the navstart variant.

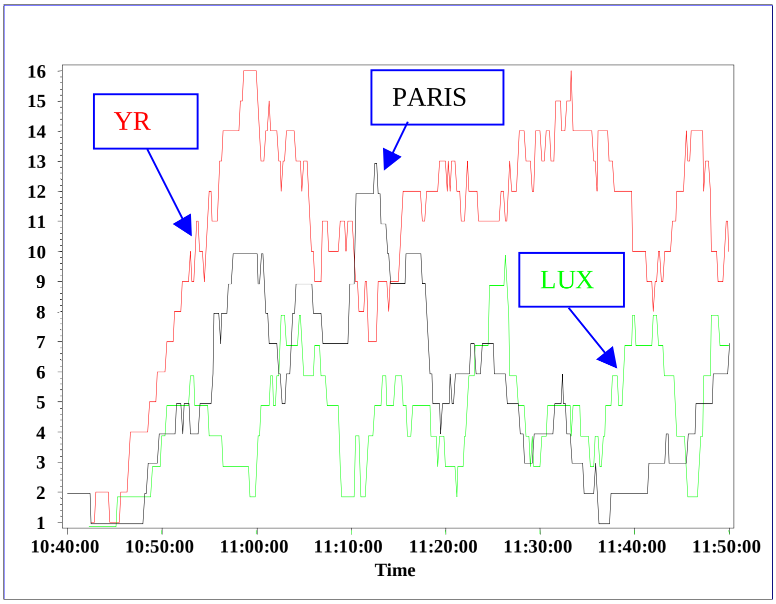

Figure 2: Sector Loading of High Traffic Samples

The table below presents for each traffic sample the flow rates (average number of aircraft per hour) in each measured sector.

Table 1 : Traffic Sample Flow Rates

	Flow rate				
	Declared	Low	Medium	High	V.High
YR	**37**	**51**	**56**	**61**	**68**
LUX	**37**	**33**	**39**	**46**	**53**
Paris	**30**	**27**	**35**	**38**	**48**

It should be noted that the very high flow rates are indeed significantly above declared capacity.

3.1.3 Participating Controllers

A sample of 10 controllers from a variety of ACCs participated in the experiment: AustroControl, CRNA, DFS, LFV, LRI, ROMATSA and UK-NERC were represented, only the controller from CRNA had a rating on one of the simulated sectors.

The controllers were all male, aged between 23 and 51 years old, and had between 1 and 28 years of operational experience. Six of them had previous experience of working with a stripless system.

The average age was 37 years old. The average level of experience was 13 years since qualification.

The controllers were assigned to one of three teams. Each team being responsible for one measured sector (two positions) and one feed sector (one position). During the experiment the members of each team rotated through these three positions in a controlled manner. The groups were:

- Sector YR (+feed SEST) : 4 controllers
- Sector LU (+feed MARR): 3 controllers
- Sector PA (+feed PARNO) : 3 controllers

Controller profile information is presented with the questionnaire results {see Annex C}.

3.1.4 ATC Working Procedures

For the **Measured** sectors, the ATC working procedures used during the simulation were based on those used today in the respective sectors, and were in accordance with current Letters of Agreement. Controllers were provided with detailed procedures prior to the evaluation.

The control actions of the **Feed** sectors were kept to a minimum. They had to respond to co-ordination requests, to update the data, and to instruct pilots according to the co-ordination requests.

It was anticipated that some procedures would be adapted to allow for the introduction of air/ground datalink application and to optimise the benefits achieved from this. However in practise this was not the case (see 5.3.7).

3.2 System Description

The ESCAPE real time simulator comprises two parts. The air system and the ground system with the ESCAPE air and ground systems communicating via the ATN (or an ATN emulation called ATN-Lite, see below).

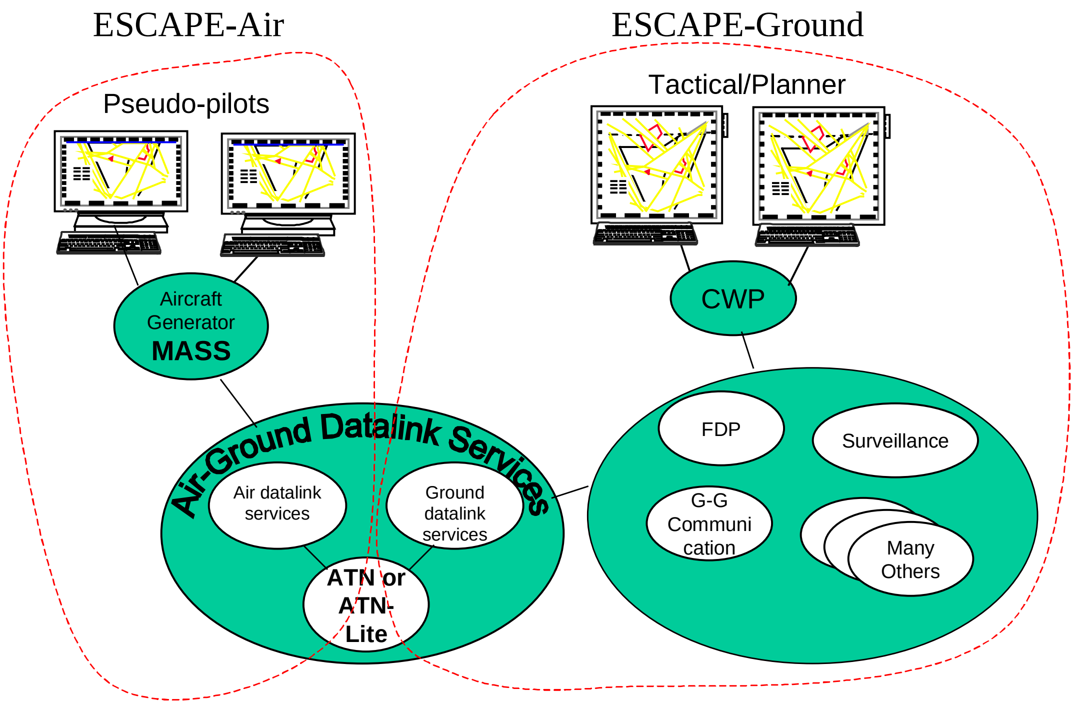

Figure 3: Functional Overview of ESCAPE Simulator

The ESCAPE ground system is comprised of the Controller Working Position (CWP), and "the rest of ESCAPE ground", which includes components like the flight data processing, ground-ground co-ordination, surveillance, etc. It also includes the ground part of the datalink services and the interface to the ATN.

The ESCAPE air system is comprised of the pseudo-pilot positions for the aircraft generator (MASS), and the air part of the datalink services and the interface to the ATN.

In addition to the above, EOLIA specifications have introduced a dispatcher or control component between the ATN CPDLC application and the datalink services ACL and ACM (and others), the CPDLC-CC (CC = Control Component). Similarly, an ADS-CC component has been defined for the ground sub-system to control the flow between the various ADS based services defined by the EOLIA consortium. N.B. Of these ADS based services only APR, now termed CAP, is currently present.

ESCAPE uses CORBA middle-ware for almost all communications between its components. Each datalink service is implemented as a CORBA client and service. Generally, the services in the EOLIA specifications have been defined on a per-aircraft basis. As real time simulators treat more than one aircraft, they have been adapted to this requirement. The air-ground datalink chain is shown in the next figure.

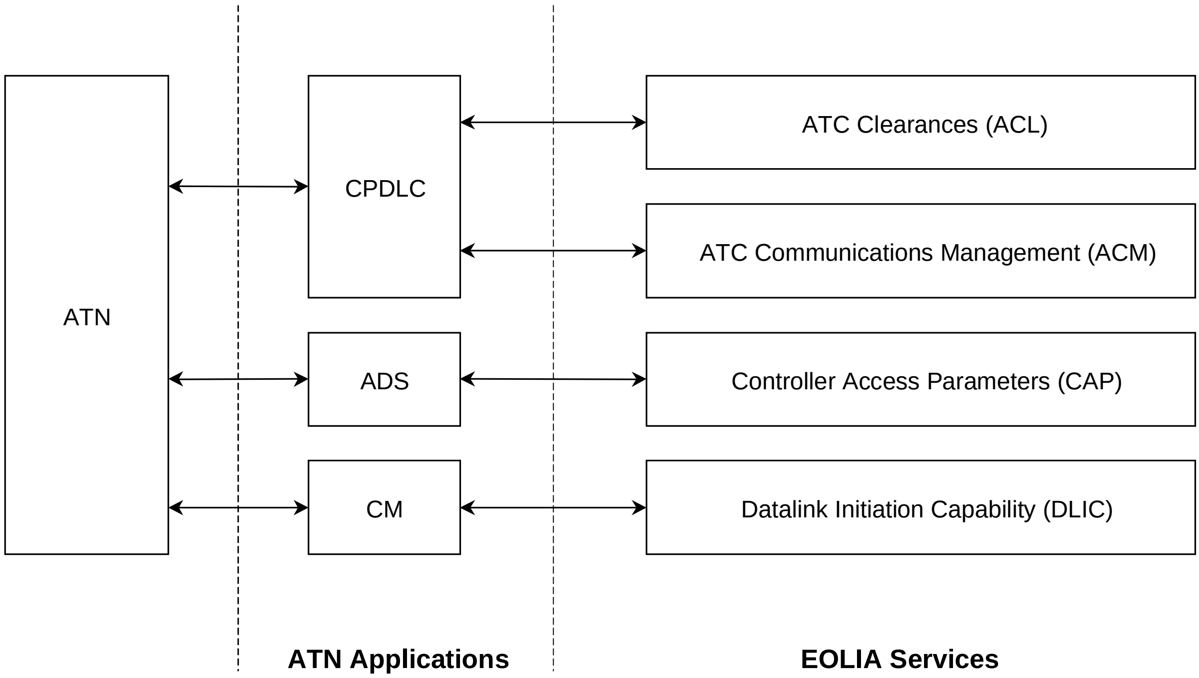

Figure 4: Overview of ATN Applications and EOLIA Services

As far as the air and ground sub-systems of ESCAPE are concerned they communicate with each other via the ATN.

However, the actual ATN communication between the air and ground sub-systems is carried out in one of two ways. These are the real ATN, using the SARPs compliant ATN components Trials ATN Router/Trials Transport Server or TAR/TTS and the Trials End System TES.

The current design of the TES API causes an architectural difficulty, as it has been designed to be used by only one (1) aircraft (or ground system) at a time. Because of this design limitation of the end systems, there are as many ATI Interface processes as there are simulated aircraft (or ground systems) needed.

This results in a limitation of approximately 20 aircraft, and 4 ground systems, that can be simulated over the real ATN at a time. Real time simulations, however typically consist of many more aircraft, and therefore the simulator has to support more datalink equipped aircraft and ground centres. To overcome this difficulty, a “simulated” ATN was created above the real ATN. This is called the ATN-Lite component.

By using the ATN-Lite component there are no restrictions concerning the number of datalink equipped aircraft or ground centres. The ATN-ESCAPE-Gateway dispatches between real ATN and ATN-Lite aircraft in a transparent way, based on a configuration file.

One added advantage is that the ATN-Lite component also contains a transmission delay model, which is configurable to emulate the behaviour of various networks and sub-networks.

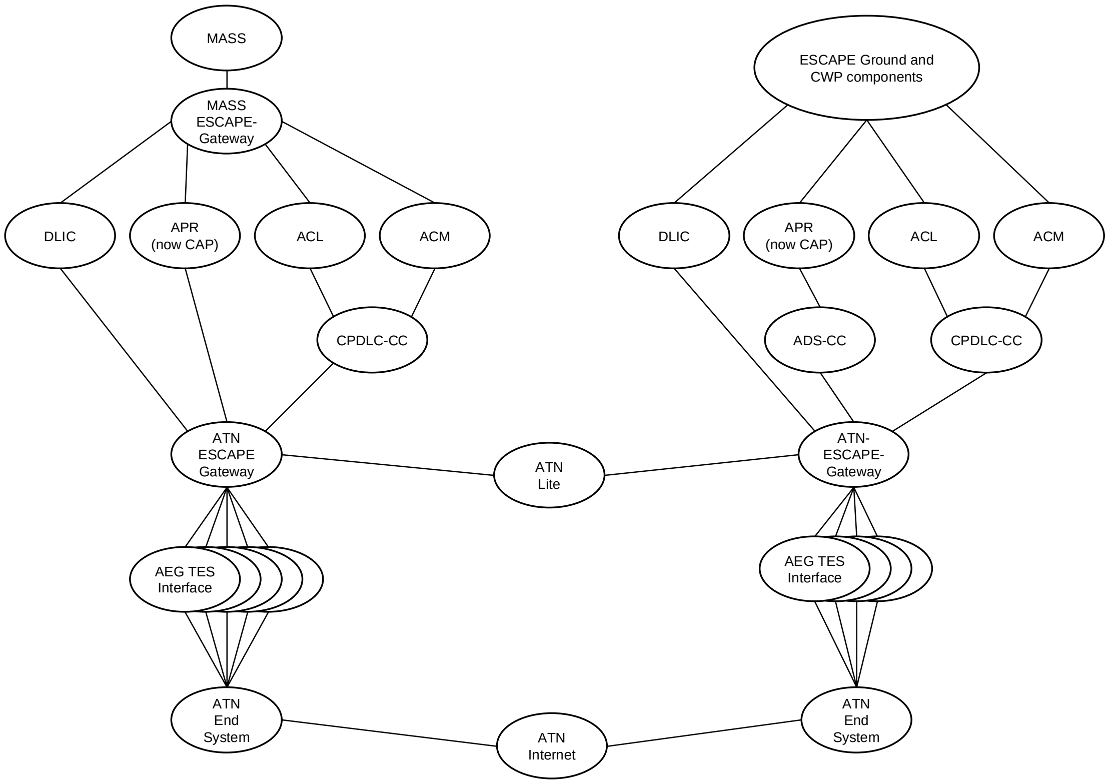

Figure 5: EOLIA Process Components.

3.2.1 Delay Models

A transmission delay model was added to emulate the transmission delays of the communication chain. This delay is comprised of two components, the ATN router delay and the sub-network delay. The ATN router delay is relatively low, i.e. estimated 0.5 seconds for an average end-to-end connection. The sub-network delay is much higher, and the quality of service of sub-networks largely differs.

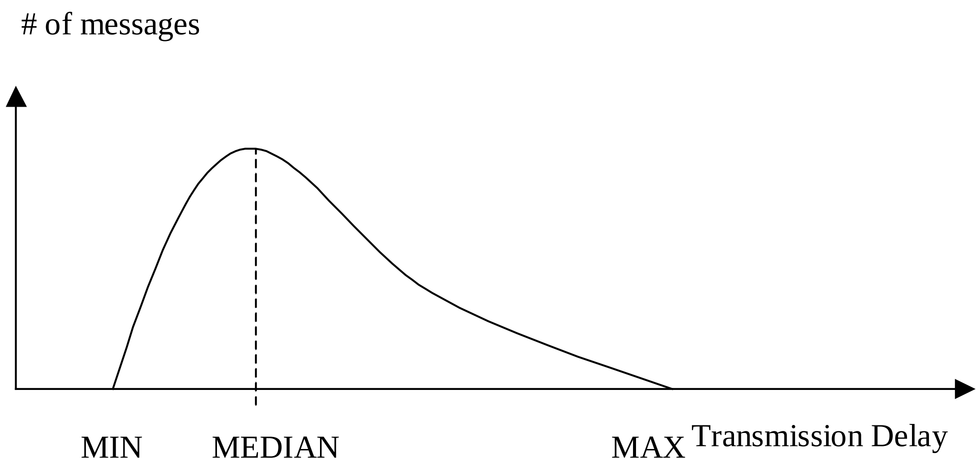

Figure 6: Transmission Delay Model

The transmission delay is treated in the ATN-Lite component. Each datalink message is delayed applying a delay model, which corresponds to a Poisson distribution. This model reflects our current measures of sub-networks like satellite communication and VHF Data Link, where only the parameters of MIN, MAX and MEDIAN differ.

For this simulation values have been chosen which are believed to become typical for VDL Mode 2: MIN = 2sec, MEDIAN = 5sec, MAX = 16sec. That means that 50% of the messages are delayed between 2 and 5 seconds, and 50% between 5 and 16 seconds. There are no delays less than 2 or greater than 16 seconds.

3.2.2 Emulated Pseudo Pilot Behaviour

The pseudo pilot position and the aircraft generator MASS respond automatically to incoming D/L clearances of the controller, without human interaction. As long as the aircraft is able to execute the transmitted clearance, a WILCO is sent. However, if the aircraft performance does not allow a positive answer, then an UNABLE is sent. The system can further be configured for STANDBY messages, i.e. the pilot answers first with the STANDBY, then waits, and then sends the response message. The pilot response time can also be configured. It is emulated by a static distribution between 5, 10 and 15 seconds, plus a parameter to no-response messages.

The parameters for this simulation have been set to:

STANDBY-RATE: 1% and 25%, STANDBY-TIME: 20 sec.

NO-PILOT_RESPONSE-RATE: 1%

STATIC-PILOT_RESPONSE-TIMES: 5, 10, 15 sec.

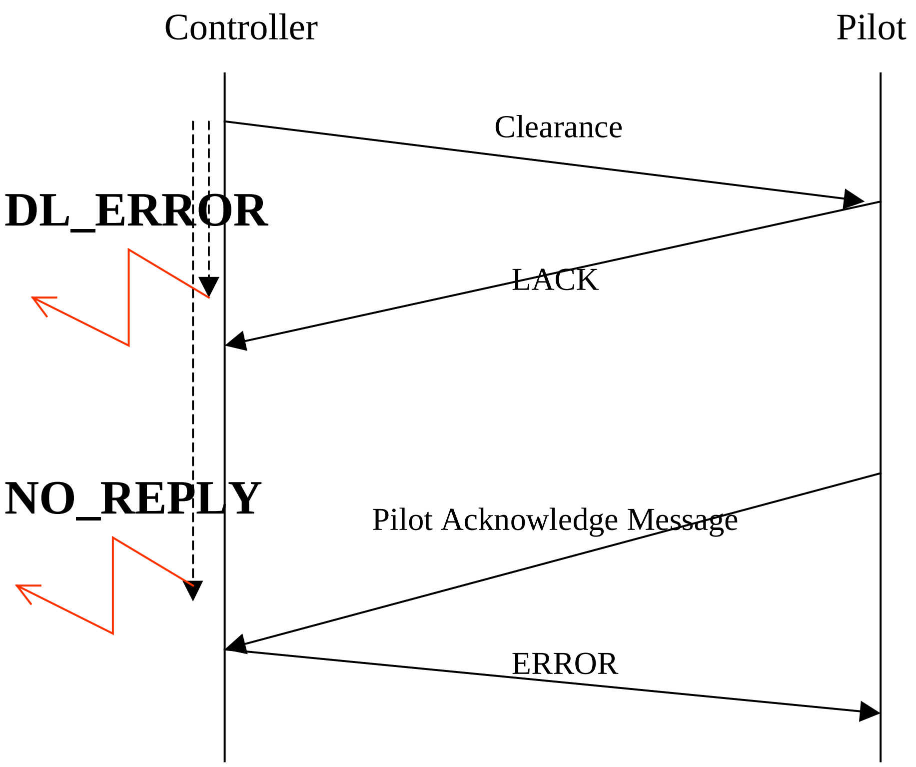

Figure 7: DL_ERROR and NO_REPLY

3.2.3 Error Models

Two types of errors are shown to the controller, which are both generated by timeouts.

NO_REPLY. This error is generated when there is no operational response before a timeout occurs, where the value for the timeout was set to 30 seconds for the experiment.

DL_ERROR. This error occurs when there is no LACK message in response to a clearance within a given time, where the timeout was set to 15 seconds for the experiment.

3.3 Control Facilities

3.3.1 Floor Plan

The floor plan of the simulation platform was the same as that used in the previous experiment [Ref.5].

Seven pseudo-pilots manned the piloting positions within the main pilot room.

3.3.2 Controller Working Position Components

Each CWP consisted of:

- 28” (20” square) colour display, providing a multi-window working environment;
- 3 button mouse;
- individual telecom panels with push-to-talk facility, providing link with all the other sectors;
- radio system with headset and foot switch for communication with pseudo-pilots.

Each measured position was further equipped with an ISA input panel used by the controller for periodic input of subjective workload assessment.

3.3.3 HMI Design Philosophy

The philosophy applied during the design phase of the HMI for Datalink closely follows the principles for the general EATCHIP HMI, i.e. a mouse-controlled interface where the Radar Label only shows the information necessary. A consistent symbology (a frame around the concerned value/parameter) was used. The actual interface for input of CPDLC clearances was identical to the interface for non-Datalink Aircraft. The feedback from the participants confirmed the validity of this design approach.

The baseline interface used in this experiment was the EATCHIP HMI, developed over the series of trials from results of ODID_IV and PD1 (the detailed specification is provided in [Ref.1]).

Its major components included:

- the Radar Plan View Display (RPVD) of the airspace and of the traffic situation;
- the aircraft tracks with Radar Labels presenting flight plan information. The information displayed and the colour of the Radar Label were dependent upon the aircraft planning state;
- the Extended Radar Label providing additional flight plan data, not available within the Radar Label;
- the Radar Toolbox containing a set of tools which allowed the controller to change the display characteristics of the Radar PVD;
- the Preferences Tool enabling the controller to save and re-load a preferred display configuration (only partly implemented in this experiment);
- the Sector Inbound Lists (SILs) displaying advanced information for aircraft planned to enter the controlled sector;
- the Message IN and the Message OUT windows providing in-coming and out-going co-ordination messages exchanged with neighbouring sectors;
- the Dynamic Flight Leg providing display of the selected flight's currently planned path within the Radar PVD, updated after route changes;
- support for basic OLDI/SYSCO;
- Short-term Conflict Alert

Information was updated by system events and by controller inputs via the mouse.

The system DID NOT provide:

- conflict prediction,
- trajectory editing.

3.3.4 Software Components

The baseline interface and the civil/military airspace crossing functions were implemented on the EONS Generic Working Position developed at the EEC. This was interfaced with the ESCAPE simulator, composed of three sub-systems: Air, Ground, and Supervision.

3.4 Experimental conditions

3.4.1 Controlled Variables

The experiment comprised three experimental factors, or independent variables, so-called since their existence and potential values are chosen by the experimenter. Each factor may take several values or levels e.g. the factor %D/L Equipage has the levels 0%, 40% and 95%. The purpose of the experiment is to measure the effect of changing the level of each factor on a set of dependent variables. The dependent variables for this experiment are described in section 5.

The factors are summarised in the table below:

Experimental variable	Description	Number of levels
Task Division Configuration	The assignment of the two measured controllers to the role of PC or TC	2
% CPDLC-equipped aircraft	The % of the total traffic volume possessing a CPDLC capability	3
Traffic volume	The hourly demand for ATC services in sector YR	3

Table 2: Experimental Variables

3.4.2 Task Division Configuration

The experiment was designed to allow the participants to agree on a task division configuration to be applied for the final week. The idea was that the controllers should work with a standard task division during the first week while developing a new configuration based on the experiences with the concept.

A standard task division configuration was provided to the controllers during the training period. Unfortunately, as described in section 5.3.7, no alternative configuration could be agreed by the participants during the experiment. However this did not prevent some participants from experimenting with different task divisions.

3.4.3 %D/L -equipped aircraft

The percentage of datalink equipped aircraft has three levels,

- **0%**: there are no datalink equipped aircraft. This configuration was strictly equivalent to the one used during experiment 3A with all functions except MTCD (ORG1 of 3A).
- **40%**: 40% of aircraft were datalink equipped.
- **95%:** 95% of aircraft were datalink equipped.

Controllers and pilots were asked to use CPDLC as the primary means of communication whenever it was felt appropriate. If CPDLC was unavailable, or the controller was uncomfortable with its use for a particular task, then voice communication should always be used.

3.4.4 Traffic Volume

Traffic samples for the measured exercises represented 3 levels of traffic volume. These are described in section 3.1.2

4. Conduct of the Experiment

4.1 Training

Training was conducted at the EEC from 4th to 7th May 1999. It comprised:

- Classroom lessons
- Knowledge testing
- On job training - using the system (from day one)

Training notes for both Controllers and Pilots were provided for the training period.

On-the-job training comprised three training sessions of 45 minutes each. The training traffic samples were used.

No seating plan for the training sessions was used. Controllers were allocated to positions such that each controller participated at least once in each of the three organisations, on each position of his allocated sector plus the associated feed sector. The same sector teams as for the evaluation were used.

4.2 Exercise Schedule

The planned daily schedule was:

- 09:00 to 10:15 First exercise
- 10:15 to 10:45 Break
- 10:45 to 12:00 Second exercise
- 12:00 to 13:00 Lunch
- 13:00 to 14:15 Third exercise
- 14:15 to 14:45 Break
- 14:45 to 16:00 Fourth exercise
- 16:00 to 17:00 Daily Debriefing

Seven exercises were lost due to technical problems and time constraints. Fourteen exercises were run successfully during the first period and eleven more during the second period . The seating plan was designed to allow for a small number of lost exercises and with some minor modification the balance of the experimental design was maintained.(See the seating plan of the experimental sessions in Annex C).

The duration of the measured exercises ranged from 75 to 85 minutes. The traffic sample was built with a slow traffic build-up during the first 15 minutes of the exercise; these were not taken in account in the data analysis. This is represented on the examples of traffic load distribution for Low, Medium and High traffic samples, shown in Figure 1 and Figure 2.

4.3 Data Collection and Measurement

4.3.1 Data Collection

For each of the measured exercises, a set of data was collected. The data collection covered the following sources:

- System recordings,
- NASA Task Load Index (TLX)
- Instantaneous Self Assessment (ISA) workload evaluation,
- Debriefings and questionnaires.

<u>System Recordings</u>

The data recorded automatically by the system comprised:

- State vector data for each active aircraft every 5 seconds
- all datalink messages exchanged between pilots and measured positions (number, nature and duration),
- R/T between-sector and controller/pilot communications (number and duration),
- controller inputs to the system and system responses (interaction object, nature, and duration).

NASA TLX workload evaluation

NASA TLX ratings were used to measure the controllers' overall perceived workload. First, prior to the experiment, each measured controller established weightings for 6 factors (Mental demand, Physical demand, Temporal demand, Own performance, Effort, Frustration) contributing to their workload in general. Then, at the end of each exercise, each measured controller assessed his subjective workload on these factors.

ISA workload evaluation

ISA was used to measure the controllers' instantaneous perceived workload. Measured controllers were prompted every 2 minutes by the ISA system, (red flashing light during 30 seconds on the ISA panel), to input their current workload rating on a scale ranging from 1 to 5 (1: Under-utilised, 2: Relaxed, 3: Comfortable, 4: High, 5: Excessive). Input was effected by pushing the appropriate button on the ISA panel.

Questionnaires

A questionnaire was distributed to the controllers at the end of the first week of measured exercises. The aim of this questionnaire was to acquire feedback on the controllers' first impressions of working with the concept. The questions were mostly open questions to encourage the respondents to write free text replies.

A general questionnaire was presented to each participant at the end of the evaluation period (see Annex D). The aim of this questionnaire was to obtain feedback on the concept of CPDLC from a point of view of workload, safety and level of service. The questions were all closed requiring the controllers to choose from several possible answers. The results of both these questionnaires are presented in Annex D and are discussed at appropriate points throughout section 5

4.3.2 Technical Problems

Some exercises were lost during the experiment due to technical problems. In some exercises the datalink server crashed even though the other simulator components continued to function correctly. These exercises were allowed to continue as they provided the controllers with the experience of having to fall back from a datalink environment to an environment exclusively controlled via R/T..

HMI response times slow up to 6s under heavy traffic loads.

Full details of the simulators performance during the experiment are given in E3B Technical report ([Ref.9]).

5. Analysis of Results

5.1 Planned Analyses

The analyses are based on two sources of data. The first concerns the subjective feedback i.e. the comments made in questionnaires and debriefings. This type of data is useful not only as a direct indication of the controllers' perception of the concepts but also as an indicator of how representative the simulated exercises were. The problem with this type of data is that is not easily associated with the precise conditions of an experiment. This feed back is supplemented by observations from development staff.

The second source is the recorded data which covers several different systems: air, telecommunications, pseudo-pilots and CWP as well as the TLX questionnaire results. For analysis purposes the recorded data have the advantage that they can be associated with a particular set of experimental conditions .e.g. organisation, traffic sample, control position. Thus these data can be used to compare results recorded under different conditions.

The subjective feedback serves two purposes. Firstly, it provides valuable direct feedback to experts, developers and implementation planners. Secondly, the subjective feedback is used to indicate the participants' perception of the experiment and therefore the quality of the recorded data. The data recordings are used to undertake the pre-planned comparisons defined for this experiment.

5.2 Analysis of Questionnaires & Debriefings

5.2.1 Simulation Environment

It is useful to place the subjective feedback of the participants into context by first considering their overall impressions of the experiment. Clearly if they were unhappy with the structure of the exercises or felt that the lack of realism was too significant then this would draw into question all the findings of this experiment. However it can be concluded from the comments made at the final debriefing and those written on the questionnaires that in general the controllers were happy with the conduct of the experiment.

Specifically, 9 out of 10 felt that they were adequately trained before the measured exercises. The same number also felt that the feed sectors were suitably simulated. Seven out of ten said that the traffic samples were realistic, though some commented that the situation was perhaps too idealised to be real. Some also commented that the number of downlinked requests, especially requests for level changes, from the pilots was unrealistically high.

Several controllers were frustrated at having to work on the same sector for two weeks. This was not in keeping with their normal roster and in some cases caused the controllers to become bored.

The main complaint about the working environment provided for the controllers was the level of noise caused by the building work (the EEC was undergoing a complete refurbishment during this period). There were also comments about the temperature of the operations room and the height of the CWP, which caused neck-ache for some participants. Overall though, 6 out 10 agreed that the working environment was acceptable.

Visitors to the simulation were introduced in groups during two sessions. None of the participants felt that the presence of visitors was a distraction but 5 again mentioned the building work as a factor affecting their concentration.

All participants felt that the ISA prompt was prominent enough and only one out of ten thought that ISA distracted them from their work.

Thus, apart from some irritation caused by the building work, we are able to assume that the participants were provided with a system which allowed them to work in a reasonably normal fashion.

5.2.2 A/G Datalink: General

Participants were unanimous in the opinion that the concept of A/G Datalink operations was easy to understand. The majority (8/10) also felt that the associated procedures were easy to work with and easy to learn. Both of these statements constitute a very important finding of this experiment as they indicate the feasibility of the concept and associated procedures which was the primary aim of the experiment. On the question of whether datalink would change the way that controllers work, seven considered that it would. The main difference noted was the removal of the need to wait for a pilot to read back the instruction.

Opinion was not unanimous on whether the introduction of datalink necessitates a change in task distribution. Half of the controllers felt that datalink should be associated with a change in task distribution within the sector team. Only half agreed that datalink made them think differently about tasks.

Seven out of ten agreed that datalink removed the need for routine communications tasks and eight out of ten thought that subtle voice information would be lost. Several commented that the amount of R/T transmissions on a sector frequency provides an invaluable indicator to aircrew of how busy the controller is. This phenomenon, known as “the loss of the party-line effect”, has been the subject of much discussion amongst experts involved in the development of datalink and the importance of maintaining the situational awareness of the aircrew is widely recognised.

5.2.3 Workload and Situational Awareness

Although six participants reported being confused by the mix of datalink and non-datalink traffic, only two out of ten felt under more stress when dealing with datalink traffic. However eight of them agreed that handling the mixture was more demanding than controlling purely non-equipped traffic. The reasons given for these results were lack of familiarity with the new way of working and the additional task of deciding how best to communicate with the datalink equipped traffic.

The amount of failures and No_Reply pilot messages associated with an unrealistic number of pilot requests had a serious effect on the workload and created confusion when it arose; controllers reported that the error rate was unacceptably high for real operations; in cases where the system worked well, controllers did not appear confused and were able to handle data link communications even for tactical clearances, which was not expected before the experiment.

All said that they had a good picture of the datalink traffic in their sector but two commented that this was also true for the non-datalink traffic. Only four out of ten felt that the datalink helped them to better predict aircraft movements and only two of ten thought that datalink would make the job boring. Some commented that with CPDLC there was a longer delay, between issuing an instruction and seeing the response, than there would be with r/t.

There were several suggestions on the question of whether the use of datalink necessitates new tasks or the re-definition of existing tasks, these are summarised in the table below:

Additional Tasks	Number of Mentions
None except in case of error	5
Identifying datalink flights	1
Monitoring state of link	3
Reading DAPs	1
Scanning for DAPs	2
Monitor for response to instruction	2
Choose communication method	1

Table 3 : New tasks necessitated by CPDLC

Note that half the controllers did not consider that there were any additional tasks unless some sort of error occurred.

5.2.4 Level of Service

Opinion was evenly divided on the question of whether datalink enables the controller to provide a higher level of service. It was pointed out that some actions take longer via CPDLC and that it is necessary to allow for longer pilot response times. Similarly divided opinions were found regarding the amount of traffic and whether tasks could be performed more effectively. The general view seemed to be that CPDLC would allow more aircraft to be handled, but only if the system has a high reliability. If not the increased workload associated with an eventual datalink error, might cancel out the expected gain in capacity.

Seven out of ten agreed that the use of datalink enabled them to prioritise their messages in a better way. This was explained in terms of the additional confidence they felt in the data presented.

5.2.5 Safety

In general the participants felt more confident with the data which they were presented with. They were comfortable with the knowledge that each instruction would be executed by the intended aircraft and with the intended result. However they felt that there were too many No_Reply situations for them to feel completely confident. Consequently only 5 out of ten agreed with the statement that datalink made them feel more confident and safe.

Four out of ten were unable to decide whether the absence of human voice decreased the level of safety. The other six controllers were evenly split on this question. Several comments were made to the effect that the pilots could learn a lot from being able to hear the controller's voice. Unless the pilots have some other means of seeing the amount of traffic around them then it was felt that voice was an essential indicator.

Six of the controllers believed that datalink reduced the potential for human error. Others felt that although this was not the case in this simulation, datalink did have the potential to reduce error. In addition seven out of ten felt that datalink reduced the impact of errors made. Two disagreed pointing out that it is sometimes difficult to recover from a wrong input because of the dual communications channels.

Finally, there was no support for the statement that the consequences of human error were greater for datalinked than for non-datalinked aircraft. However a small majority (6/10) thought that the type of human error would be slightly different for datalink flights. The most obvious error noted was in mixed traffic where it was easy to forget to use the r/t for a non-datalink flight.

In debriefings the main safety advantage was identified as the reduced possibility of readback errors and other misunderstandings. Perceived safety risks were associated with the mixed traffic sample (datalink and non-datalink). It was also commented that there were dangers associated with failing to revert to voice in the event of any difficulties.

5.2.6 HMI

A large majority (9/10) of participants found the methods and messages used for data input were easy to learn. The only negative comment concerned the fact that the messages were presented in a separate window which could be a distraction. There was unanimous agreement that the HMI concept (callsign framing etc.) was easy to understand. Everyone also agreed with the statement that it was easy to distinguish between datalink and non-datalink flights.

Four out of ten agreed that it was confusing to have both G/G and A/G messages in the same window, although this was felt to be simply a question of familiarity.

A slight majority (6/10) thought that they could do without the information in the message windows, using just the label instead. Others felt that the message window was essential to see the detail of a downlinked request.

In debriefings many comments were offered about the general EATCHIP HMI: only those relating to datalink are described here. Most participants were concerned that they did not always notice the NO_REPLY warning. It was suggested that some sort of audio warning should also be used. This problem was particularly sensed if it coincided with an STCA. The STCA warning is displayed on the same line as the NO_REPLY, making the datalink warning completely unnoticeable.

Overall the HMI was appreciated by the controllers. Most felt that the few problems noted could be resolved with more training. Although all controllers agreed that the HMI clearly distinguished between datalink and non-datalink flights this did not occasionally prevent controllers from forgetting to use r/t for non-datalink, or vice-versa. This is once again a very important indicator of the necessity for proper training.

5.2.7 Downlink of Airborne Parameters

The availability of DAPs were considered useful by eight of the ten controllers. Seven controllers felt that the availability of DAPs would to a greater or lesser extent reduce the number of R/T transmissions.

5.2.8 Error Messages

Overall the error messages were found to be easily understood. This was further stressed by the fact that although there were far more error messages than planned, the majority of controllers found that the messages clearly showed what had gone wrong and where.

Only half the controllers considered that the number of errors generated would be acceptable in an operational ATC system. However, the majority of these errors were the result of the unexpected outages of the datalink server, a situation not likely to occur with the planned levels of redundancy of planned implementations.

5.2.9 CPDLC

In response to questions whether the response times for CIC and ACM messages were acceptable, there was an even split amongst the participants. Comments were made that the poor response time caused an increased use of r/t and consequent increase in workload. The general view was that the delays were just acceptable but that the response would need to be much faster in a real system.

It is clear that the chosen 15s end to end transfer delay was not realistic, in particular as technology available today would provide better performance. The poor response times added to the error rates and failures had a negative impact on the measured results and perception of the system.

5.3 Analysis of Objectives

The measured results can not be used in absolute terms as valid data for capacity and safety gains and should not be used for any CBA or other productivity analysis of datalink applications for the following reasons:

(a) The simulation was an experiment for initial evaluation and demonstration of a number of tools, including the HMI for which an extraction of specific data link items has been performed. The results only apply to the specific conditions of this particular experiment.

(b) There was an unexpectedly high amount of failures, errors and No_Reply messages as well as a slow response time from the system. These greatly detract from the validity of certain measurements. Which should thus be treated with caution within the context of an initial experiment.

The following constraints applied:

- Only one controller was qualified for one of the simulated sectors;
- Controllers were unfamiliar with the concept of data link, (however they easily adapted to it and the associated procedures);
- Controllers had only had three 45 minute sessions of on the job training prior to the exercises;
- Some of the controllers were not familiar with the HMI prior to this exercise;
- Some controllers adapted easier than others and were able to make full use of the potential of data link; some of the controllers could not detach themselves from their current practices and were not open for example to try sharing communications between executive and planner.

- The measurements applied to all sessions including those with many errors and slow response.

The controllers were positive about the use of data link although the measurements seem to indicate no clear trend in gains.

The very high traffic flow was indeed very high (up to 68 aircraft per hour in a sector) and controllers were still able to perform their tasks safely.

It is evident from the recorded data that the results of this experiment are different for each of the three measured sectors. In some cases this is simply a difference in the magnitude of an effect, in others the sense of the effect changes altogether. For this reason the results presented here are classified by sector.

5.3.1 Objective One - Workload

To measure the effect of CPDLC operations on controller workload.

The perception of the participating controllers was that CPDLC did lead to a reduction of their workload, provided the system was performing correctly, but that there was a definite increase in workload when this was not the case..

Through the debriefings and questionnaire responses the controllers identified the following as reasons why CPDLC would decrease their workload:

1. Faster than using r/t
2. No wait for confirmation
3. Allows task sharing
4. No need to repeat (say again or confirmations)
5. No interruptions
6. Allows ‘batch’ processing (send several messages simultaneously)

It was also noted that these advantages could only be fully achieved if datalink was used for non time-critical communications only. The controllers further identified the following as circumstances under which all expected benefits from CPDLC might not be achieved:

1. Datalink (No_Reply) Error
2. Mixed datalink and non-datalink traffic
3. Poor system performance
4. Too many UNABLE responses
5. Use in TMA Sectors
6. Misuse for time-critical instructions

The first two items in this list were considered as very important. It was clear that the participants were frustrated by the occurrence of NO_REPLY error messages. They felt that this effectively doubled their workload because they had to restart the communication again.

It is not possible to observe this relation between datalink errors and workload from any of the recorded data. This is not too surprising as we would expect the controllers to consider many factors, not just datalink errors, when evaluating their own workload. Plots of NASA tlx against either the absolute number of datalink errors or the proportion of errors all show poor correlation.

From Figure 8 it can be seen that in four exercises the proportion of datalink exchanges ending in error exceeded 25% without any measurable impact on perceived workload. However it is clear from the controllers' comments that there is an impact on their level of frustration. Although "Frustration" is a factor in the NASA Tlx calculation, it would appear that controllers do not typically consider this as a component of workload, particularly in a simulation environment. For future studies this should be addressed more fully in briefing sessions.

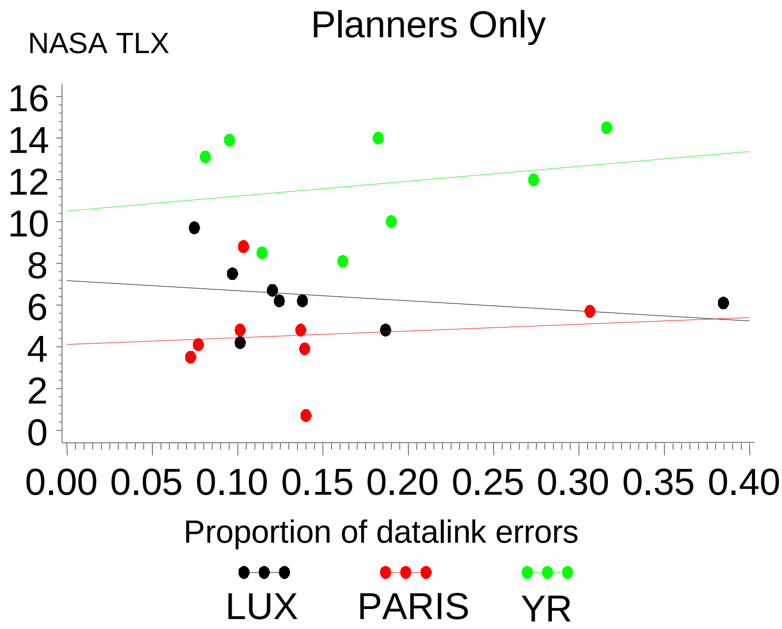

Figure 8 : Workload against Errors

It is a natural tendency that the participants in a simulation use subjective workload measures on a relative basis. That is, they will normally compare the workload of a given exercise with what has gone before. This means that the results are unduly influenced by unplanned differences between the exercises. In the case of this experiment the higher-than-planned error-rate almost certainly impeded the controllers ability to compare exercise runs.

Over all exercises, the average proportion of errors is just under 15% and, from the subjective feedback, this seems to be about the maximum acceptable level. Again it should be noted that the intention had been to simulate an error-rate of 1%.

All the participants reported that the mixed traffic samples (40% datalink equipped) were the most difficult because they had to operate two communications systems in parallel. In YR the 40% samples always produced the highest workload, in LUX this is only the case with the busiest traffic level. It can also be seen that the level of workload is lower in PARIS.

Another influence on the subjective workload could have originated from the fact that the %datalink equipped was changed every exercise. This may have exacerbated the learning difficulties particularly with the 40% sample.

An objective indicator of workload is usually taken from the percentage of r/t usage. Clearly for a datalink situation this would be expected to decrease with increasing percentage of equipped aircraft. This relation is shown in Figure 9 where it can be seen that the gradient does indeed decrease with increasing datalink availability.

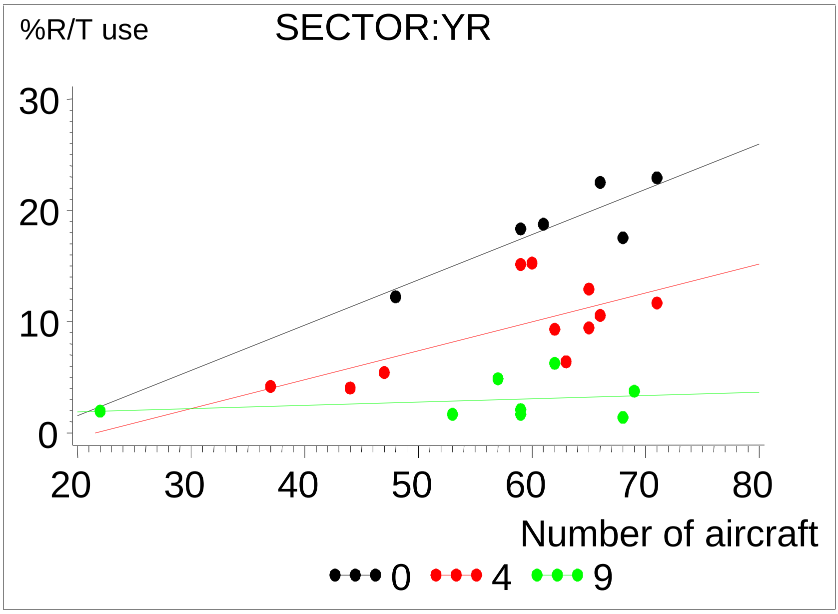

Figure 9 : r/t load against traffic

In fact the gradient for the 95% sample is very close to zero. It is noteworthy that the correlation is less strong for the 40% sample than for the other two. This is as expected, as the availability of a second communications channel causes the relationship to be no longer linear. The fact that the 40% gradient is approximately half way between the 0% and 95% gradients indicates that the average r/t time per non-datalink aircraft is the same for all three %D/L Equipage levels.

Similar results are observed from the ISA recordings although overall the ISA results are difficult to interpret. In PARIS, and to a lesser extent LUX, the predominant response was 'Low' or 'Very Low'. Even in YR, which appeared to demand a lot of controller activity, there are relatively few instances of 'High' or 'Very High' ISA responses. It is possible that there was a tendency among the participants to attribute some workload to their own lack of familiarity with the airspace, which they did not reflect in their ISA response.

5.3.2 Objective Two – Level of Service

To measure the effect of CPDLC operations on the Level of Service provided to airspace users.

It appears from the subjective feedback that the controllers were not easily able to relate their activities in the simulation to the concept of 'level of service'. Several commented that certain unrealistic features in the traffic samples, plus the fact that they were not completely familiar with the airspace, made this difficult. However there was agreement that although they did not give expediency the priority they would normally, this occurred for all organisations and all traffic levels so that a comparison was still possible.

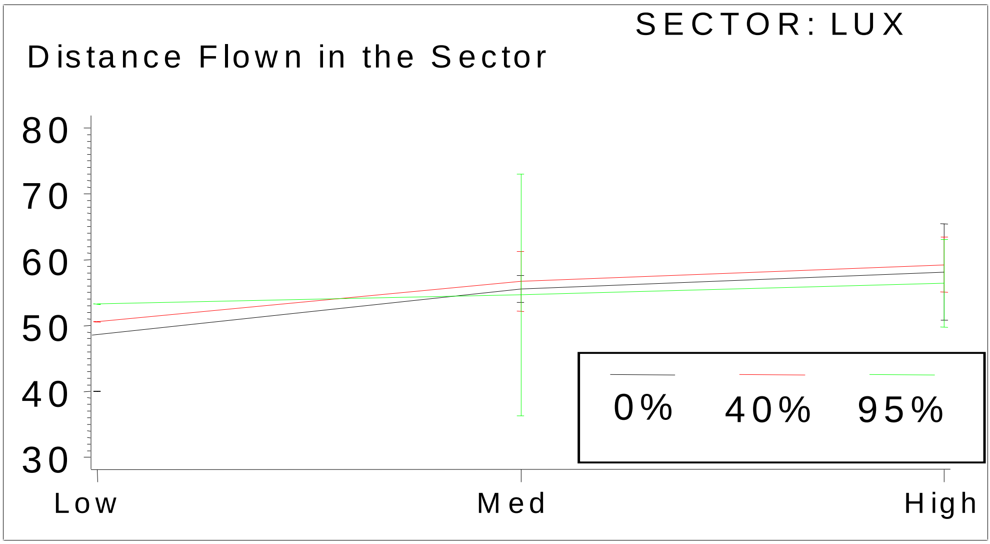

Figure 10 : Distance flown in sector LUX

Taking two possible indicators of "service" as (a) the percentage of flight time spent at RFL and (b) the distance flown in the sector it is possible to compare results from the different organisations.

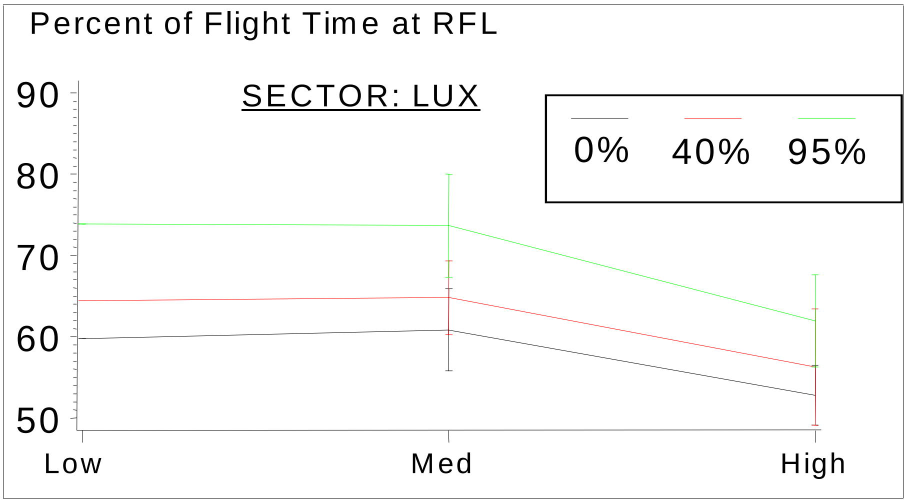

Figure 11 : Percent of flight time at RFL in sector LUX

In Figure 10 it can be seen that there was virtually no effect due to organisation or traffic sample on the distance flown in the sector. The sector shown in the figure is LUX but the same was seen in the other two sectors as well. Sectors YR and PARIS also showed no difference for the percent of RFL flight time.

In sector LUX the percent of time at RFL (Figure 11)is persistently higher for the 95% samples than the 40%, which are in turn higher than the 0%. In each case the value is lower for the VB samples than for the other two.

5.3.3 Objective Three - Safety

To assess the effect of CPDLC operations on the participating controllers perception of safety.

This objective was to capture the controllers' perception of safety rather than to undertake a rigorous analysis of the safety of a datalink based system. The aim was to identify those aspects of the use of datalink which may introduce elements of risk.

Through questionnaires and discussions the controllers described a few areas that should be considered in further developments.

There was no significant difference in the number of STCA triggered between the three organisations. It would be difficult to draw too many conclusions from safety data collected in a simulation environment. It is only natural that the participants would take the system alerts less seriously than they would in real traffic. In addition it must be remembered that the controllers were operating in airspace that was still new to them. It is possible that they lacked certain 'automatic' reactions which they would have had in their normal working environment.

Some specific instances were described during the debriefings of dangerous situations that had arisen during the exercises. The cause was invariably one of two types:

1. Failure to revert immediately to voice communications in the event of problems, or

2. Attempt to use CPDLC communications for a time critical instruction.

Although the controllers had been trained and instructed to avoid these two types of events, this gives an indication of the amount of training necessary prior to actual implementation.

The only other safety issue raised by the participants concerned the implications of planning controllers performing certain tactical inputs. This is discussed further in section 5.3.7.

5.3.4 Objective Four - DAPs

To measure the effect of the availability of DAP data on controller workload.

It is clear from their comments that the controllers appreciated the availability of DAPs. Unfortunately there is no way of quantifying the saving in r/t time which can be accredited to the use of DAPs because there is also a clear reduction in r/t usage associated with the use of CPDLC. However, seven of the ten participants stated that the availability of DAPs reduced the number of r/t transmissions.

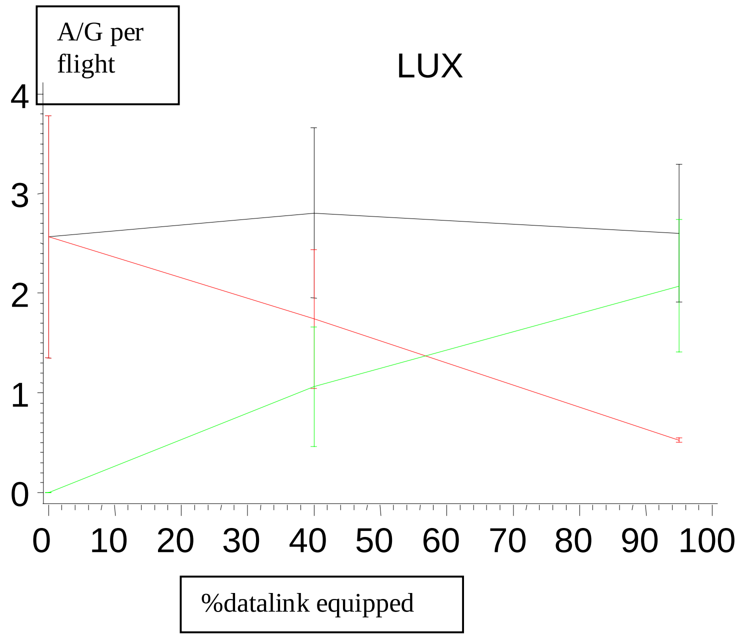

Figure 12: A/G Communications per flight – sector LUX

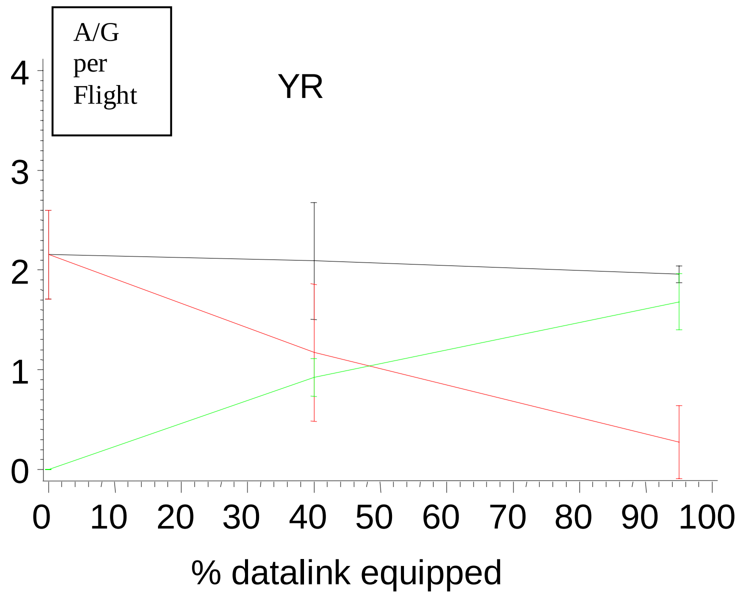

Figure 13: A/G Communications per flight - sector YR

It might be expected that the availability of DAPs would lead to a reduction in the total number of A/G communications (r/t communications plus datalink communications).

In Figure 13 it can be seen that there was a small decrease in sector YR when DAPs were available. However, similar decreases were not found for the other sectors.

In all sectors the increase in the number of datalink exchanges was approximately linear whereas the associated decrease in r/t use was not as large as expected. This is probably due to the number of communications which had to be completed by r/t because of errors. The results for LUX are shown in Figure 12.

In debriefings the controllers identified the case of a mixed traffic sample (40%) as an area where there were problems associated with the use of DAPs, as with all the datalink services simulated. The DAP information was useful to the controllers but they found it easy to forget that, for the mixed sample, not all flights were downlinking information. Once again, it can be assumed that the relatively steep learning curve associated with the simulation progress influenced the perceived importance of this observation.

When available, the DAPs were indeed used and found to be useful. It is likely that they caused a reduction in the r/t workload of the controller as well as an increase in the quality of the information available.

5.3.5 Objective Five – Error Messages

<u>To obtain feedback from the participating controllers on the effectiveness of the error messages presented to them.</u>

From the questionnaires and debriefings it is apparent that the controllers were able to interpret the error messages without any problems. Whenever they saw an error message it was clear to them what had happened. The only concern expressed was that they did not always notice the error message. The appearance of the message itself was not always enough to attract the controllers attention. If Line0 was already being used for an STCA warning then the datalink error was not even visible at all.

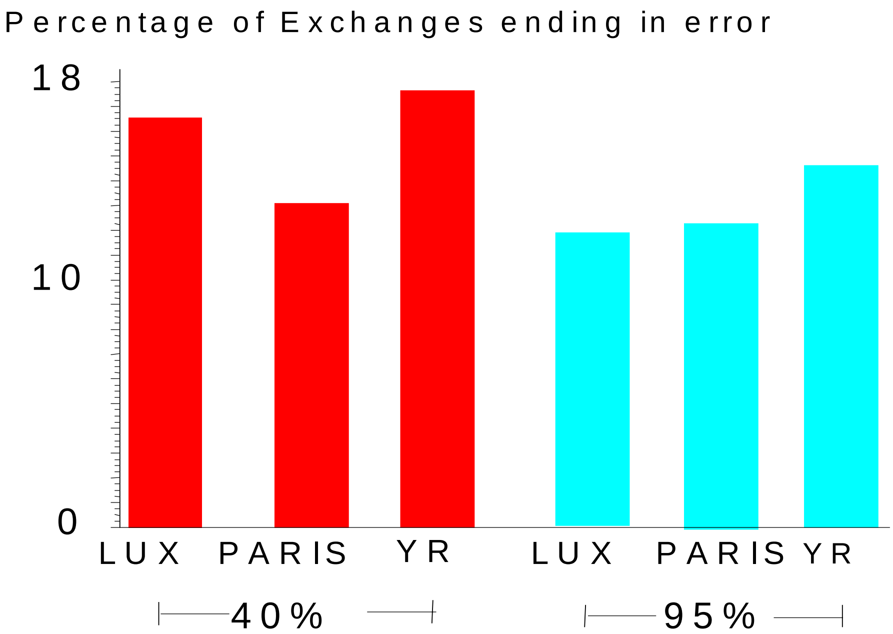

Figure 14 : Error proportion by Org.

The participants suggested that some sort of audio signal should accompany the error message and that Line0 should be arranged to make messages visible at the same time as an STCA.

Though there were more errors in the 95% samples the actual proportion of exchanges resulting in error was fairly constant. For LUX and YR there was perhaps a slight increase for the 40% samples. This was perhaps due to the increased number of input errors made by the controllers caused by confusing datalink and non-datalink flights.

The total number of errors is comprised of three types:

1. A small percentage of randomly generated errors were deliberately included.
2. Errors caused by time-outs due to the load on the system (this includes NO-REPLY because of D/L-server breakdowns)
3. Controller generated errors

The total percentage of errors is presented in Figure 14.

Many comments were received concerning the number of exchanges ending in error. Opinion was evenly divided as to whether the level of failures was acceptable. It would appear from these comments that a level of around 15% should be considered as the maximum tolerable, however the operational system will be designed such that errors will be in the order of 1% (as was expected from this experiment).

5.3.6 Objective Six - Delay

To obtain feedback from the participating controllers on the acceptability of the CPDLC end-to-end delay.

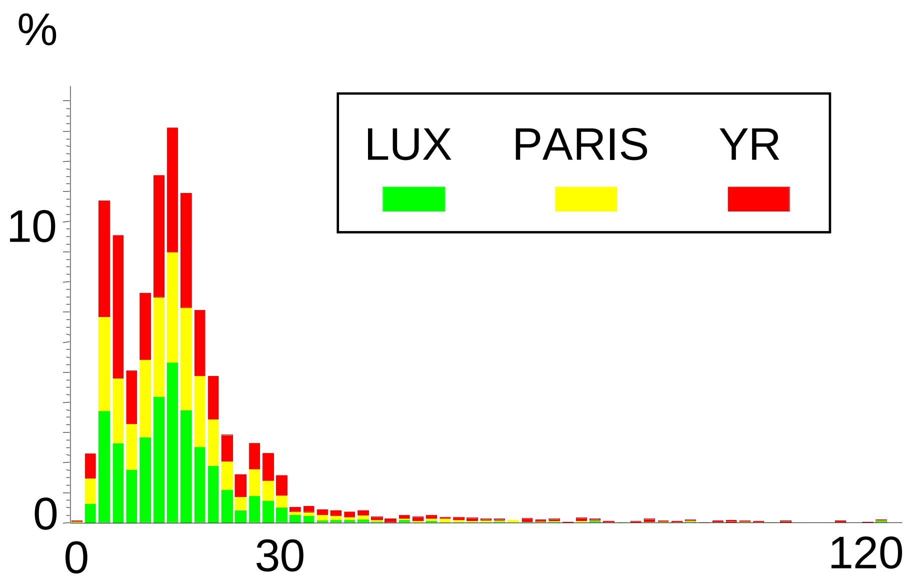

Figure 15 : Distribution of durations

From the questionnaire responses it can be seen that the delays witnessed were considered to be just acceptable.

Figure 15 shows the spread of the durations of datalinked exchanges found during the simulated exercise.

It can be seen that the great majority fall within the range of 0 to 30 seconds. The larger delays were those involving STANDBY responses and represent less than 1% of the total (see Figure 16).

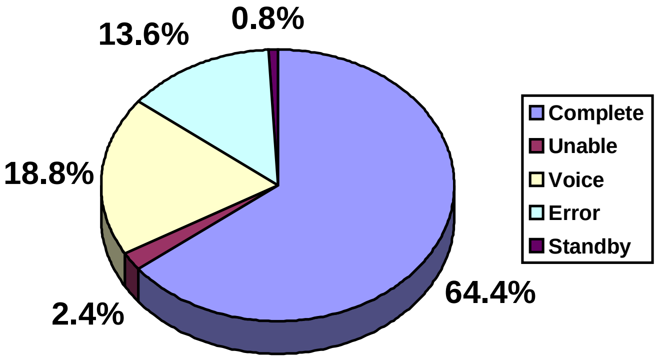

Figure 16 : Outcomes of datalink exchanges

The response times were consistent across all sectors and all traffic levels. The outcomes of the exchanges were also constant over the different sectors and traffic levels. Figure 17 shows the spread of exchange durations less than 30 seconds and broken down by outcome. It can be seen that there are two definite peaks in the distribution. A first sharp peak at 4 to 5 seconds is composed almost exclusively of successful datalink exchanges.

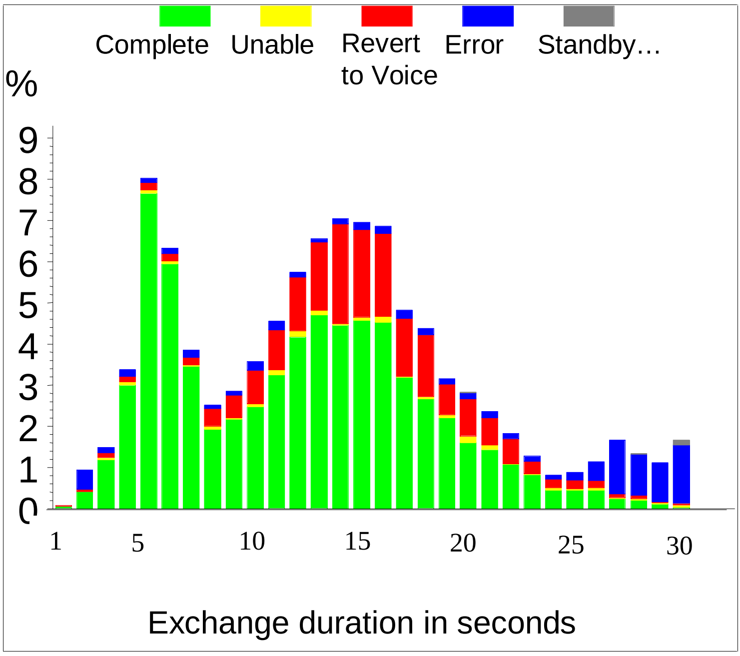

Figure 17 : Duration by Outcome

A second blunter peak occurs around about 13 seconds and contains a higher proportion of exchanges which were completed using voice. However even here the majority of exchanges are still completed using datalink.

Unsuccessful exchanges are spread throughout the histogram but there is a concentration of these types toward 30 seconds. The very small number of UNABLE responses are evenly distributed over time.

To investigate the reason for these two peaks the same histogram is shown in Figure 18 broken down by instruction type. Now it can be seen that the first peak is due to the monitoring exchanges associated with TRANSFER/ASSUME. Nearly all instruction of this type were completed within 5 seconds. There is then a small and decreasing number of instances between 6 and 18 seconds plus a final grouping around 30 seconds, presumably representing exchanges ending in error.

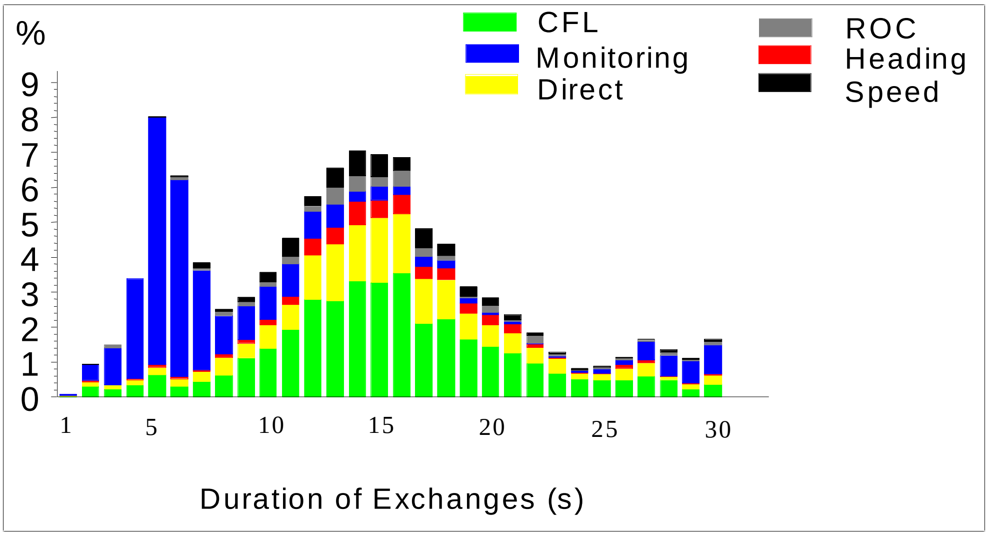

Figure 18 : Exchange Durations by Instruction Type

The second peak is associated with control actions, predominantly CFL instructions but there are also a reasonable number of Direct Route and Heading instructions. The relatively small number of Speed and Rate of Change instructions are evenly spread between 5 and 20 seconds.

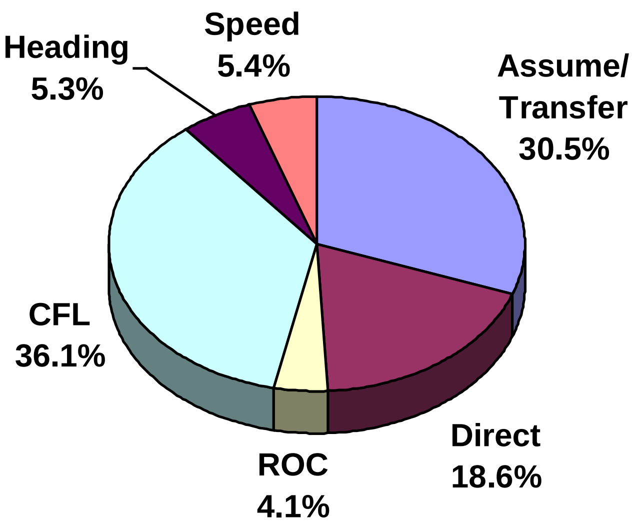

Figure 19 : Use of datalink by Instruction type

The most common usage of datalink was for ASSUME/TRANSFER and CFL instructions. It can be seen in Figure 19 that these two types plus Direct Routes account for 85% of usage. This confirms that in general the participants adhered to the policy of only using CPDLC for non time-critical instructions.

5.3.7 Objective Seven – Task Division

Determine whether the use of datalink should be associated with a redistribution of tasks amongst the sector team.

The findings of the experiment are inconclusive for this objective. Some participants readily tried out new ways of partitioning the work between planner and executive. Others found these changes very uncomfortable. If datalink necessitates a change in task distribution then it is clear that such changes will require more discussion.

The difficulties were associated with the reluctance of some executives to delegate ASSUME and TRANSFER tasks to the planners. Although some were willing to do this on a case-by-case basis they felt it would be impossible to systematically hand over such tasks. One participant was not even willing to go this far as he felt it would too easily lead to confusion within the sector team.

Most controllers felt that the executive had to control the timing of all TRANSFER actions because only he could judge when he would no longer need control of the flight. Certain flights, particularly in YR, were however felt to be sufficiently simple that the planner could confidently send them away. Delegation of the ASSUME task was more generally accepted although some executives said that they needed to “feel” the presence of each new flight by performing the ASSUME themselves.

The table below shows the various responses to the question “As an Executive which tasks would you feel happy delegating to your Planner?”:

Task to Delegate	Number of Replies
None	3
ASSUME	6
TRANSFER	5
Some Level Clearances	1
Some Speed Restrictions	2
Retry after datalink error	2

Table 4 : Delegable tasks

At the final debriefing there was general agreement that the planner could safely be delegated the task of resending instructions which had produced a NO_REPLY message.

The subject of task distribution could not be addressed further in this experiment because there was a feeling that the planners were working in a slightly artificial way. Because of the absence of a MTCD the planners were not able to plan the traffic as they would have liked. During the very busy periods in YR the planner was often operating as a second executive.

6. Conclusions and Recommendations

6.1 Operational Hypotheses

The following operational hypotheses were made before the experiment:

1. Datalink will be considered safe and operationally acceptable assuming the planned transmission delays are achieved.

2. When using CPDLC, it is expected that a reduction in R/T load will be observed, thus increasing Controllers working capacity which can be devoted to other tasks.

3. When DAPs are made available to the Controller, it is expected that a significant reduction in R/T load will be observed, thus increasing Controllers working capacity which can then be devoted to other tasks.

4. It is expected that an improved level of service will be provided to all aircraft as a result of the potential reduction in controller workload.

5. The reflex action for the Controller should be immediate “revert-to-voice” to clarify any non-normal situations.

6. It is expected that the Controller will be content with simple error messages.

7. Negative reaction is expected to long delays, positive reaction is expected to short delays.

8. It is expected that the planner could conduct some of the routine communications currently undertaken by the executive.

9. Hypotheses 1,5,6 and 7 have been seen to be correct. Hypotheses 2,3 and 8 are probably correct but only under certain circumstances, the benefit achieved being linked to the percentage of equipped aircraft operating in the concerned airspace. Hypothesis 4 could not be tested in this experiment.

6.2 Summary of Findings related to the Objectives

Of the 7 objectives set for this experiment all but 2 have been at least partially met. It has been seen that CPDLC has the potential to reduce controller workload but this requires adequate system performance combined with an efficient HMI. The workload reduction is closely linked to the ratio of equipped aircraft..

It has been found that except for some minor issues the controllers did not feel that the use of CPDLC would have a negative impact on safety. This must be related to actual operations whereby many ATS incidents are due to R/T misunderstandings, in particular the growing number of level busts incidents which is becoming a major safety issue in the core area.

Both the error messages and the end-to-end delay were found to be acceptable, although any benefits in workload reduction were quickly cancelled if the error rate was high.

There was general acceptance that the use of datalink would open up possibilities for task redistribution within the sector team. However there was no clear agreement as to whether this redistribution of tasks was required, and one participant was concerned that its effect would disturb the current working methodology between executive and planning controllers.

The integration of ATN, its applications and datalink services was found to be feasible. In parallel to the experiment, a demonstrator of the air- and ground- parts of the simulator communicating over ATN and the INMARSAT satellite sub-network has been set up. Some useful feedback has been acquired by the EOLIA consortium about the ATN standardisation.

The experiment did not succeed in measuring the relationship between CPDLC usage and the level of service provided to the airspace users. This was in part due to the lack of familiarity of the controllers with the airspace they were working. It must also be considered as an effect of working in a simulated rather than a real environment.

Similarly the experiment did not provide clear evidence of the impact of the availability of DAPs on controller workload. However it was observed that the DAPs were considered useful by the controllers.

6.3 Discussion of Findings

Although the experiment as such did not meet all the planned objectives, there is consensus amongst the developers involved in the preparation and conduct of the experiment, that many important lessons have been learned as a result of the experiment. It was apparent that when the system worked as planned and observing the most proficient controllers they were making a very powerful use of the data link function.

As has been described earlier, it can be assumed that the amount of benefits gained from the introduction of datalink services depends on the percentage of equipped aircraft. It is not clear whether the problems encountered by the participants when working the mixed traffic sample are really representative of what would be seen in actual implementation. In fact the operational system will perform much better than in this experiment. It must be recognised that in such a short period of time the controllers cannot be expected to fully adapt to using an asynchronous mode of communications when they are used to working on a one-to-one dialogue basis. The possibility of communicating at their own pace that data link can provide requires experience and adaptation.

Given that the transition period from 0% to almost full equipage will happen over a time-span of many years, one can safely assume that the resulting slow introduction will negate most, if not all, of the problems described earlier.

As a result of the planned datalink outages and the unforeseen datalink server outages, the controllers were at times faced with a large number of error messages. In the case of a server outage it took a few minutes for the participants to what had happened, but once this had happened there was generally no major problems in reverting to full voice-only operations.

The importance of an efficient HMI has been always been considered a key enabler when new technology and procedures are introduced in ATC. This view has definitely been confirmed by the feedback from the participants in the experiment.

One final important observation concerns the differences between the participants in the way they accepted and adapted to the new concepts and technology presented to them. This was very much as expected since the participants constituted a fair representation of the average controller population. This will have to be taken into account when planning the syllabus for the controller training.

6.4 General Conclusions

Datalink was well received by the participating controllers. It was apparent from their comments and enthusiasm that they recognised the potential for workload reductions and/or safety improvements.

It was also noticeable that the use of datalink opens up the possibility for more efficient task sharing between executive and planning controllers. Although this change will require careful consideration it is improbable that such potential will not be exploited as familiarity with the system increases.

A transition period will be necessary. Controller familiarity is a key factor in achieving the full benefits offered by datalink. It is a fact that controllers will have to learn to operate with a mix of datalink-equipped and non-datalink flights during the early stages of implementation. At this stage it is not possible to determine to what extent the problems reported with the 40% samples were due to the relatively steep learning curve encountered when jumping directly from 0% to 40%. It can be assumed that the actual deployment of datalink services, both on the ground and in the air, will take place at a much slower rate, with a much less steep learning curve as a result.

In summary then it can be concluded that the use of CPDLC is a viable concept to which controllers adapted easily, which will very probably produce reductions in controller workload. However before this can be realised more consideration needs to be given to how the new facility should be used. Specifically, the question of how responsibilities and priorities are allocated within the sector according to the message and intervention type, needs to be addressed.

6.5 Recommendations

As a result of the findings and failures of this experiment the following recommendations are made:

That a full scale real time simulation be conducted specifically dedicated to data link applications, in order to effectively evaluate expected benefits, constraints and human factor issues building on the experience gained from this experiment. The simulation should be performed by controllers familiar with the system, the airspace and the concepts being presented with sufficient training prior to the measured exercises so as to remove any learning effects on using the system.

1. -That further experiments and research be conducted to investigate the relationship between controller workload and %D/L equipage. It is important to identify the percentage of equipped aircraft required in order for datalink to be beneficial to the controller. There are obvious implications here for any transition period, during which the percentage of equipped aircraft could be below 95%. Given the important influence of this factor on the level of benefits obtained from datalink, special attention must be given to the transition period.

2. -That the discussion of the possible redistribution of tasks be opened to a wider audience. Although no consensus was found in this experiment there was local agreement within certain sector teams which might suggest that there would be support for a well-considered redistribution.

3. -That one or more propositions for task division be drafted and tested in future

experiments. In order to test properly it will be necessary that the planner is able to work in a realistic way. This will probably require that an acceptable MTCD be included. It may well be the case that the optimal task division configuration is dependent on the %D/L-equipage. Such configurations need to be developed from sector-team models and tested experimentally.

4. -That Line0 of the radar label be modified to allow for datalink and safety net information to be visible simultaneously.

5. -That more work be performed to identify clearly the benefits of making DAP information available to the controller. This may justify a single-sector experiment using DAP equipped aircraft but without the use of CPDLC. By comparing samples with different percentages of flights transmitting DAP information, the impact of DAP on R/T load and perceived workload could be more clearly investigated.

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Traduction en langue française du Résumé, de l'Introduction, des Objectifs, des Conclusions et Recommandations

1. Résumé

Cette expérimentation représentant une partie d'une série d'études dans le programme de concept opérationnel d'évaluation et de démonstration EATCHIP III ATM a été conduite en collaboration avec le projet pré – opérationnel européen d'applications datalink EOLIA (European pre-Operational dataLink Applications Project) au CEE.

Les objectifs de l'expérimentation étaient de démontrer la faisabilité de l'intégration d'un réseau de télécommunications aériennes ATN dans le simulateur en temps réel et ensuite d'évaluer l'impact de la disponibilité d'un datalink air/ sol sur le travail des contrôleurs.

Trois composantes du datalink Air / Sol ont été simulées :

- Communications contrôleur – Pilote par Datalink (CPDLC Controller-Pilot Datalink Communications)
- Récupération automatique de Paramètres avions par liaison descendante (ADAP Automated Downlinked Aircraft Parameters)
  La simulation a évalué uniquement la fonctionnalité similaire au Service CAP définie par ODIAC. La suite du document y fait cependant référence en tant que DAP.
- Capacité de déclenchement de Datalink (DLIC Datalink Initiation Capability)

Les besoins opérationnels pour les services de datalink ont été définis par le groupe de développement Opérationnel de communications Initiales Air/sol (ODIAC).

Les variables d'intérêt concernaient la proportion d'avions qui étaient équipés de datalink, le volume de trafic et la division des taches entre le contrôleur et son assistant. Egalement, l'étude a été utilisée pour obtenir des réactions sur l'efficacité de l'interface homme machine proposée.

L'expérimentation a été menée dans l'espace aérien simulé représentant des parties des centres de contrôle de Paris, Reims et Maastricht. Elle a été réalisée sur une période de trois semaines, avec la première semaine réservée à un entraînement pratique.

Dix contrôleurs civils de sept états européens ont participés à cette expérience.

Six positions de contrôle et trois positions d'alimentation ont été simulées.

Des mesures ont été faites pour fournir des indicateurs de charge de travail, de niveau de sécurité de l'espace aérien , du niveau de service et de l'utilisation de l'interface homme / machine. Des enregistrements ont été réalisés depuis les données du simulateur (Air, position de contrôle, et télécommunications), depuis des questionnaires, et depuis les systèmes de mesures de charge de travail ISA (Instantaneous Self Assessment) et NASA TLX (NASA Task Load Index).

L'expérimentation a montré que :

1. La communication entre pilote et contrôleur par datalink (CPDLC) est considérée

comme une méthode de communication viable pour le contrôle tactique de la circulation aérienne .

2. L'utilisation de la communication entre pilote et contrôleur par datalink (CPDLC) ainsi que les paramètres avions par liaison descendante (DAP)ont un potentiel pour réduire la charge de travail du contrôleur.
3. L'intégration du réseau de télécommunication aérien (ATN) et de ses services concernant le datalink est réalisable.

Il a également été montré que :

L'utilisation de la communication entre pilote et contrôleur par datalink (CPDLC) soulève des questions clefs sur la division des taches entre les rôles de planification et d'exécution.

Le bénéfice total des communications par datalink est seulement réalisable quand le système est suffisamment fiable et que le trafic contient un large pourcentage d'avions proprement équipés.

Quelques avantages associés à la disponibilité des paramètres avions par liaison descendante (DAP) sont tout de même évidents même avec un relativement faible pourcentage d'avions équipés.

2. Introduction

2.1 Contexte

L'expérimentation 3B faisait partie de la troisième phase du programme de concept opérationnel d'évaluation et de démonstration EATCHIP III ATM. L'expérience, réalisée au Centre Expérimental Eurocontrol du 4 au 20 mai 1999, s'est concentrée sur l'évaluation et la démonstration de l'utilisation de communications Air – Sol dans la gestion du trafic aérien. La simulation a été une activité commune au projet EOLIA et à EATCHIP.

La communication contrôleur – pilote par datalink (CPDLC) a été introduite pour fournir les communications des requêtes du pilote aux centres de contrôle et les instructions du contrôleur au pilote.

Tous les avions équipés CPDLC dans la simulation ont également transmis des paramètres par liaison descendante (DAP) qui étaient disponibles pour le contrôleur pour ces avions.

Les fonctions simulées furent celles évaluées dans la phase 2, et quelques unes de la 3 A (MONA et SYSCO) pour fournir une base réaliste pour le CPDLC. La fonction MTCD n'a pas été simulée car suite aux réactions reçues après les expériences précédentes il a été considéré que la version disponible n'était pas suffisamment affinée (voir les commentaires des contrôleurs dans le rapport de l'expérimentation 3A).
La fonctionnalité croisée Civile /Militaire était disponible, mais dans un souci de simplicité il a été ensuite décidé de ne pas opérer de trafic militaire durant les exercices.

2.2 Approche Expérimentale

Les séries d'expérimentations EATCHIP ont été réalisées avec une philosophie commune pour optimiser l'exploitation des résultats obtenus. Cette approche peut être qualifiée d' "Approche Incrémentielle d'Evaluation et de Développement" . Ses principales caractéristiques, qui constituent également ses principales différences avec les simulations temps réel, sont :

- la petite échelle de l'étude, et en particulier le fait qu'elle est "juste assez détaillée" pour apporter des réponses aux questions posées,
- une grande continuité entre les études successives ; par exemple on ne changera d'espace aérien que pour des raisons spécifiques concernant les questions opérationnelles ou techniques à explorer,
- une dépendance élevée entre les études. L'objet et les objectifs expérimentaux de chaque étude peuvent refléter les résultats et les leçons tirées des études précédentes,
- pour obtenir des résultats fiables, les sources de variabilité sont réduites au minimum au cours de l'étude,
- seulement un petit nombre de questions claires et directes sont examinées au cours de chaque étude. En conséquence de quoi le nombre de variables est restreint au minimum.

3. Objectifs Expérimentaux

3.1 Buts

Le but de cette expérimentation était d'évaluer et de démontrer ces aspects des besoins opérationnels du datalink Air / sol faisant partie du concept opérationnel EATCHIP III ATM.

Dans un même temps le projet EOLIA devait montrer la possibilité d'intégration du réseau de télécommunication aérien ATN et de ses services attachés dans les facilités de simulation en temps réel.

3.2 Objectifs Opérationnels

1. Mesurer l'effet de la mise en fonction du CPDLC sur la charge de travail du contrôleur.
2. Mesurer l'effet de la mise en œuvre du CPDLC sur le niveau de service fournit aux utilisateurs de l'espace aérien .
3. Evaluer l'effet de la mise en fonction du CPDLC sur la perception de sécurité des contrôleurs participants.
4. Mesurer l'effet de la disponibilité de données DAP sur la charge de travail du contrôleur.
5. Obtenir des réactions des contrôleurs participants sur l'efficacité des messages d'erreur qui leurs sont présentés.
6. Obtenir des réactions des contrôleurs participants sur l'acceptabilité du délai de bouclage du CPDLC.

7. Déterminer si l'utilisation du datalink doit être associé à une redistribution des tâches au sein de l'équipe d'un secteur.

3.3 Objectifs pour le système

1. Intégrer les prototypes ATN :essais de routeur ATN, essais de serveurs de transport, et essais système final (TAR/TTS/TES)
2. Intégrer les services datalink ODIAC/EOLIA gestion des communications ATC autorisations ATC (ACL), paramètres avion (DAP) et capacité de mise en œuvre du datalink (DLIC)

4. Conclusions et Recommandations

4.1 Hypothèses opérationnelles

Les hypothèses suivantes ont été établies avant la simulation:

Le datalink sera considéré comme sûr et opérationnellement acceptable avec le respect des délais de transmission planifiés.

En utilisant le CPDLC, il est prévu qu'une réduction de la charge de la radiotéléphonie sera observée, augmentant ainsi la capacité de travail des contrôleurs qui pourra être vouée à d'autres taches.

Quand les données DAP sont mises à la disposition du contrôleur, on s'attend à observer une réduction de la charge de la radiotéléphonie, augmentant ainsi la capacité de travail des contrôleurs qui pourra être vouée à d'autres taches.

Il est attendu qu'un niveau amélioré de service sera délivré à tous les avions comme résultat de la potentielle réduction de la charge de travail contrôleur.

L'action réflexe pour le contrôleur sera d' immédiatement revenir à la communication vocale pour clarifier la moindre situation non standard.

Il est attendu que le contrôleur soit satisfait avec des messages d'erreur simples.

Une réaction négative est attendue à des délais longs, une positive à des délais courts.

Il est prévu que le contrôleur assistant puisse conduire certaines communications routinières actuellement effectuées par l'exécutif.

Les hypothèses 1, 5, 6 et 7 se sont avérées être correctes. Hypothèses 2, 3 et 8 sont probablement correctes mais seulement en certaines circonstances, le gain obtenu étant lié au pourcentage d'avions équipés opérant dans l'espace aérien concerné. L'hypothèse 4 n'a pas pu être testée dans cette simulation.

4.2 Résumé des constatations en relation avec les objectifs

Des 7 objectifs fixés pour cette expérimentation tous, sauf 2, ont été au moins partiellement atteints. Il a été identifié que CPDLC a l potentiel pour réduire la charge de travail du contrôleur mais cela demande des performances système adéquate combinées à une interface homme machine efficace.
La réduction de charge de travail est étroitement liée au taux d'avions équipés.

Il a été mis à jour qu'à l'exception de considérations mineures les contrôleurs n'ont pas sentis que l'utilisation du CPDLC aurait un impact négatif sur la sécurité.

Que ce soit les messages d'erreur ou le délai de bouclage tous deux ont été jugés acceptables, cependant le moindre bénéfice dans la charge de travail était rapidement annulé si le taux d'erreur devenait grand.

Il y a eu une acceptation générale quant au fait que l'utilisation du datalink devrait ouvrir des possibilités de redistributions de tâches dans l'équipe d'un secteur. Néanmoins il n'a pas été clairement établi si cette redistribution des tâches était nécessaire, et un participant a émis des réserves que ses effets puissent perturber l'actuelle méthode de travail contrôleur- assistant.

L'intégration de l'ATN, ses applications et les services de datalink ont été ressentis comme viables. En parallèle à la simulation, un démonstrateur des parties air et sol du simulateur communiquant à travers le réseau ATN et un sous réseau de satellite INMARSAT a été mis sur pied. Des rétroactions intéressantes ont été récoltées par le consortium EOLIA et par l'équipe chargée de la standardisation de l'ATN.

L'expérimentation n'a pas permis de mesurer la relation entre l'utilisation du CPDLC et le niveau de service délivré aux utilisateurs de l'espace aérien. Ceci en partie à cause du manque de familiarité des contrôleurs avec l'espace aérien dans lequel ils travaillaient. Il doit aussi être pris en considération le fait de travailler dans une simulation et non dans un environnement réel.

De même l'expérimentation n'a pas pu prouver de manière évidente l'impact de la disponibilité de données DAP sur la charge de travail du contrôleur. Néanmoins il a été observé que les données DAP étaient considérées comme utiles pas les contrôleurs.

4.3 Débats sur les conclusions

Même si l'expérimentation en tant que telle n'a pas atteint tous les objectifs planifiés, il y a un consensus entre les développeurs engagés dans la préparation et ceux de l'exécution de la simulation ; de nombreuses et importantes leçons ont pu être tirées de cette expérience.

Comme cela a été décrit plus tôt, on peut supposer que la quantité des avantages apportés par l'introduction des services datalink dépend du pourcentage d'avions équipés. Il n'est pas clair si le problème rencontré par les participants quand ils travaillaient avec l'échantillon de trafic mélangé est réellement représentatif de ce qui sera vu dans l'implémentation actuelle.

Etant donné que la période de transition de 0% à un équipement presque total va avoir lieu sur une échelle de temps de plusieurs années, on peut sans risque considérer que la lente mise en service qui va s'en suivre va annihiler la plupart, voire tous les problèmes décrits plus tôt.

Résultant de dysfonctionnements planifiés du datalink et d'imprévisibles mal fonctions du serveur de datalink, les contrôleurs ont été à certains moments confrontés à un grand nombre de messages d'erreurs.

Dans le cas de mauvais fonctionnement du serveur il a fallu quelques minutes aux participants pour réaliser ce qui s'était passé, mais une fois qu'ils avaient appréhendé la situation il n'y avait généralement pas de problèmes majeurs à revenir à des opérations uniquement vocales.

L'importance d'une interface homme - machine a toujours été considérée comme un facteur clef de réussite quand de nouvelles technologies et procédures sont introduites en ATC. Cette vue a définitivement été confirmée par les remarques des participants durant la simulation.

Une dernière remarque importante concerne les différences entre les participants quant à la manières d'accepter et de s'adapter aux concepts nouveaux et à la technologie qui leur est présentée. Ceci était bien sûr attendu puisque les participants formaient une bonne représentation de la population des contrôleurs aériens. Ceci devra être pris en compte lors de la planification des programmes pour l'entraînement des contrôleurs aériens.

4.4 Conclusions Générales

Le datalink a été bien reçu par les contrôleurs participants. Il était apparent à partir de leurs commentaires et de leur enthousiasme qu'ils voyaient le potentiel de réduction de charge de travail et/ou l'amélioration de la sécurité.

Il était aussi visible que l'utilisation du datalink laisse la porte ouverte à un partage des tâches plus efficace entre le contrôleur exécutif et son assistant. Cependant ce changement va demander une attention toute particulière. Il est improbable qu'un tel potentiel ne soit pas exploité au fur et à mesure que la familiarisation avec le système augmentera.

Une période de transition sera nécessaire. La familiarisation des contrôleurs est un facteur clef pour tirer parti des pleins bénéfices offerts par le datalink C'est un fait que les contrôleurs auront à apprendre à opérer avec un mélange d'avion équipés datalink et non – datalink pendant les premières étapes de l'implémentation.

A ce stade il n'est pas possible de déterminer jusqu'à quel point les problèmes rapportés avec l'échantillon de trafic 40% étaient causés par le saut brutal de 0 à 40 %. On peut supposer que le déploiement actuel des services de datalink, que ce soit au sol ou dans les airs, aura lieu à une vitesse beaucoup plus lente, donc avec un changement beaucoup moins radical.

En résumé donc, on peut dire que l'utilisation du CPDLC est un concept viable qui très probablement entraînera des réductions de charge de travail contrôleur. Cependant avant que cela puisse être réalisé plus de considération doit être apportée à la façon d'utiliser ces nouvelles facilités.

Plus spécifiquement, la question portant sur comment les responsabilités et les priorités sont réparties au sein du secteur selon le type de message et d'intervention, doit être posée.

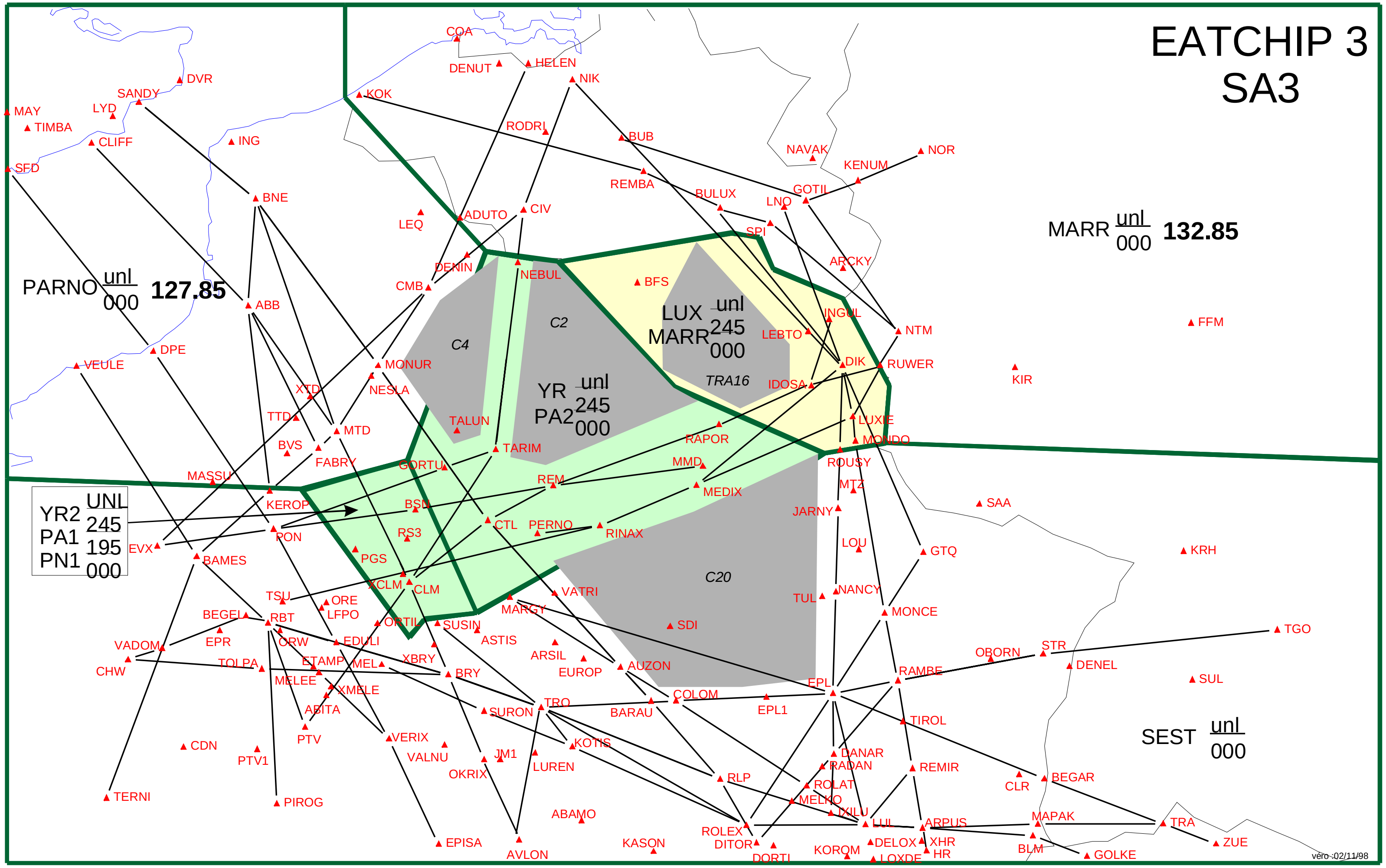
4.5 Recommandations

Faisant suites aux découvertes et aux échecs de cette expérience les recommandations suivantes sont faites:

1. De prochaines recherches et expérimentations doivent être menées pour examiner la relation entre la charge de travail contrôleur et les pourcentages d'équipages avec datalink. Il est important d'identifier le pourcentage d'avions équipés nécessaires pour que le datalink soit bénéfique au contrôleur. Il y a ici des implications évidentes pour une période de transition, durant laquelle le pourcentage d'avion équipés peut être au dessous de 95 %.étant donné l'importance majeure de ce facteur sur le degré de gain obtenu grâce au datalink, une attention spéciale doit être apportée a cette période de transition.
2. La discussion sur la possible redistribution des tâches doit être ouverte à une audience plus large. Même si aucun consensus n'a été trouvé pendant cette simulation, il y a eu un accord local entre certaines équipes sur les secteurs qui devrait présager qu'une redistribution bien pensée devrait trouver des appuis.
3. Une ou plusieurs propositions de divisions de tâches doivent être définies et testées dans des simulations futures. Pour un test convenable, il sera nécessaire que le contrôleur organique soit capable de travailler d'une manière réaliste. Cela demandera probablement qu'un MTCD acceptable soit incorporé. Il se peut bien que la configuration de division optimale des tâches soit dépendantes du pourcentage des avions équipés datalink. De telles configurations doivent être développées à partir de modèles d'équipe de secteur et testés expérimentalement.
4. La ligne 0 de l'étiquette radar doit être modifiée afin de permettre aux informations datalink et filet de sauvegarde d'être visible simultanément.
5. Un travail plus approfondi doit être mené afin d'identifier clairement l'utilité des informations D.A.P. Cela peut nécessiter une simulation sur un secteur utilisant les avions équipés D.A.P mais sans l'utilisation du CPDLC. En comparant des échantillons avec différents pourcentages d'avions transmettant des informations DAP , l'impact de DAP sur la charge de la radiotéléphonie et la charge de travail perçue pourrait être examiné.

Annex A

Annex A. Sector Map



YR (245/unl) : **135.50** (Reims Control)
PARIS (000/245) : **129.35** (Paris Control)

LUX (245/unl) : **133.35**(Maastricht Control)
MARR (000/245) : **132.85**(Maastricht Control)

MAZT (all sectors) (000/unl) : 262.70

Annex B

Annex B. Controller Profiles

	1	2	3	4	5	6	7	8	9	10
1.1 What is your age ?	47	23	32	51	32	33	49	45	31	31
1.2 How many years have you been a qualified controller ?	24	1	5	28	1	10	27	20	6	6
1.3 Have you previously worked with a strip-less system ?	Yes	No	Yes	Yes	Yes	No	Yes	No	No	Yes
7.4 Please rank the 3 types of DAP's according to their usefulness : Indicated airspeed Magnetic heading Vertical rate	2 1 3	1 2 3	1 3 2	2 3 1	2 3 1	2 1 3	1 2 3	1 2 3	1 3 2	1 3 2

Annex C

Annex C :Seating Plan

	Day 5: 10/5/99				Day 6:				Day 7:				Day 8:			
Traffic	AM01	AM41	PM41	PM01	AM91	PM91	PM01	PM41	PM42	PM02	PM91	PM92	VB02	VB42	VB92	PM41
Org.	0	1	1	0	2	2	0	1	1	0	2	2	0	1	2	1
Exer.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Sector																
YR/R	Hy	Hy	Hy	C	C	C	H	H	H	S	S	S	H	H	C	C
YR/P	H	H	H	S	S	S	Hy	Hy	Hy	C	C	C	Hy	S	S	S
LU/R	B	B	B	O	O	O	B	B	B	L	L	O	O	O	B	B
LU/P	O	O	O	L	L	L	O	L	O	B	B	B	L	L	O	O
PA/R	P	P	P	R	R	R	G	G	G	P	P	P	R	R	G	G
PA/P	G	G	G	P	P	P	R	R	R	G	G	G	P	P	R	R
SEST/F	S	C	S	H	Hy	H	C	S	C	Hy	H	Hy	S	C	Hy	H
MARR/F	L	L	L	Hy	B	B	L	C	L	O	O	H	B	B	L	L
PARNO/F	R	R	R	G	G	G	P	P	P	R	R	R	G	G	P	P

	Day 9: 17/5/99				Day 10:				Day 11:				Day 12:			
Traffic	AM91	PM01	PM41	PM91	VB42	VB02	PM42	VB92	VB02	VB42	VB92	VB02	VB02	PM42	VB92	VB02
Org.	2	0	1	2	1	0	2	2	0	1	2	0	0	1	2	1
Exer.	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
Sector																
YR/R	S	S	S	Hy	S	H	S	S	Hy	Hy	Hy	C	R	B	L	C
YR/P	Hy	C	C	H	H	C	C	Hy	H	H	H	S	O	G	P	Hy
LU/R	O	O	O	B	B	B	L	L	L	O	O	O	S	P	C	B
LU/P	L	L	L	O	O	O	B	B	B	L	L	L	H	R	G	L
PA/R	R	R	R	G	G	G	P	P	P	R	R	G	Hy	H	O	R
PA/P	P	P	P	R	R	R	G	G	G	P	P	P	C	S	B	P
SEST/F	H	Hy	H	S	C	S	Hy	H	S	S	S	Hy	G	Hy	S	G
MARR/F	B	B	B	L	L	L	O	O	O	B	B	B	L	C	H	O
PARNO/F	G	G	G	P	P	P	R	R	R	G	G	S	B	O	R	S

Annex D

Annex D : Questionnaire Results

End of Week 2 Questionnaire

Number of each response is given in parentheses after each question

Was it clear to you which flights under your control were datalinked?

Always	Sometimes	Rarely	Never
(8)	(2)	(0)	(0)

Did you ever confuse a datalinked flight with a non-datalinked flight or vice versa?

Often	Sometimes	Rarely	Never
(1)	(3)	(5)	(1)

Was it clear to you in what state a datalinked aircraft was ?

Always	Sometimes	Rarely	Never
(9)	(1)	(0)	(0)

Each box contains the comments of one participant.

<u>What additional tasks do you perform when controlling a datalink flight as compared to a non-datalinked flight?</u>

Please describe…

> EC : I have to scan the monitor more often. I mean I have to be careful with DL a/c because of DL ERROR or NO REPLAY or a/c unable to comply the given instruction ! Or an a/c sends a request message, BUT if in the future if these will be possible to divide the tasks between the EC and PC perhaps these won't be big problems.
>
> PC ; EC : They should increase their "look a head time" by response time or by any DLINK ERRORS;

> Usually none. With a little training you get use to do the inputs for non datalink a/c while you're talking, so it's the same thing for equipped ones.

> Sometimes checks the ADAP, and use that information as a reference when controlling R/T traffic.

All inputs given to the pilots must be watched closely :

whether pilot received the message
whether pilot is complying to the clearance
whether he is unable to comply to the clearance

I have the feeling that it needs more time as compared to the normal R/T

Need to monitor when datalinked aircraft has acknowledged input. When "NO REPLY" there are additional tasks such as using voice and then updating the system.

The simple answer no. More detailed is also no. You don't have to do nothing special, only the way of transmitting clearances differs.

Monitoring the state of the link between pilot & controller.

I have to decide whether it is better to use RT or not.
I have to do my <u>work</u> more <u>in advance</u> than in case of using "only" RT.
I would never work as close as I'd use to work using RT in real live traffic.
I have to <u>take into account</u> that I could get an "UNABLE MSG" after <u>one minute</u> or even more. That means that I must plan with a period of <u>uncertainty</u>. 80" could be lost and there could be a problem then, which would never have been a problem using RT and getting the response early enough. Using RT I'll get a positive or negative answer earlier than when using CPDLC.

IN HANDLING THE A/C THERE'S VIRTUALLY NO ADDITIONAL TASK. IT'S JUST A MATTER OF DIFFERENTLY ASSIGN MY INSTRUCTIONS TO THE A/C.
ONLY IF THINGS GO WRONG (e.g. DL ERROR, NO REPLY) I HAVER TOTHINK ABOUT HOW TO GIVE MY INSTRUCTIONS TO THE A/C.
IN A MIXED ENVIRONMENT I HAVE THE ADDITIONAL TASK OF DECIDING /RECOGNISING WHICH ONE IS DATALINKED AND WHICH ISN'T.

Are there any instructions which you think it is definitely not appropriate to transmit by datalink?
Please describe…

The criticised functions must be implemented but in a more sophisticated form !!!

① Vertical Rate of Change : if I have to make level separation by rate of climb/descent restriction (I mean for arriving departing traffic) I would need a possibility to indicate to pilots the correct restriction – I mean climb to FL XXX maintain 2000 FT/min or more or less.

② This is the problem with the assigned speed too more or less or exactly buttons ? are missing.

Not in particular but it is really necessary to transmit all tactical (immediate) clearances via RT instead of datalink.

NO

---

pilot is requesting to deviate from the course due to CBs
specifying holdings, other than the published ones
specifying fuel dumping areas
descend or climb in VMC, pilots maintain own separation, less than standard IFR
military procedures [refuelling]
inbound clearance

Avoiding actions and anything else that needs imminent attention e.g. late descents/climbs

---

I cannot ask correctly because I don’t know the 350 instructions. All we use in this simulation are appropriate.

Avoiding Actions.

When you expect a very quick response you have to use R/T.

E.g. : 1) climb to FL370
2) climb at a rate of 1000ft per minute minimum. WHY ?
The pilot receives 370 → he’s happy → starts climb. The aircraft has left 330 for higher at the time the second MSG arrives in the cockpit. The pilot realises that he is only able to keep 600 ft/min. => Revert to voice => MORE WORK

ANY INSTRUCTIONS WHERE YOU NEED INSTANT REPLY OF THE A/C

**<u>As an executive controller, would you be comfortable delegating certain tactical tasks, concerning a datalinked flight, to your planner?
Please describe which tasks or why not…</u>**

If the EC is very busy :
- ASSUMING ; TRANSFERING of A/C but the PC should be obliged to inform his/her EC about it.

- in case of DL ERROR or NO REPLY messages PC should initiate another -a second- message by using Dlink. Thereafter if DL ERROR or NO REPLY messages appear again, PC should give an immediate warning to EC for using mic !

- PC should scan the message in window and in case of getting a request from a <u>DL A/C</u> (is under controlled by EC) for example for a higher level just PC should check the situation, should co-ordinate with other sector then PC should inform his EC for giving DL message.

Not at all. In fact I do not agree also with the concept of “message in/out windows” managed by the planner. I think it’s better that those windows should be managed by both – the planner for the “pending” traffic, - the exec for the already assumed traffic. The planner cannot accept (i.e. new XFL) new transfer dates for assumed traffic – perhaps the exec would not be able to perform them.

Yes. Assume, transfer. Some clearance, speed instructions.

I tried to delegate the following tasks to the planner :

planner assumes the a/c in any case (advice to the executive, when planner isn’t sure that executive realised the a/c)
planner transferred a/c when necessary and executive focussed his attention to other things
planner descending inbound traffic to FL250 or below, when executive is very busy and descending a/c will not get in conflict to other traffic

YES Quite happy to let planner assume datalinked aircraft but not non-datalinked a/c. I do not want planner to transfer either datalinked or non-datalinked aircraft. As executive there may be a reason for wanting a certain a/c on frequency e.g. an aircraft may be in conflict tactically with another aircraft coming from an adjacent sector.

Until a certain sector traffic load you can do everything alone, without help of PLC.

→ Transfer if I forgot or I'm busy.
→ Some speed regulations for flights just entering my sector.

Generally no, I don't think so. Depending on the structure of the airspace I can delegate some tactical tests like assuming and transferring a/c and respond to the "No reply" and "Datalink error" messages by making a second attempt to establish the datalink.

Why not ? ASSUME and TRANSFER. But even these actions only after telling the EC. Otherwise EC could lose the traffic picture.
ASSUME helps the EC (done by the PC) if an aircraft calls in many miles prior sector boundary, so that EC has not the "work" to change his RANGE.

NO !!!! THERE SHOULDN'T BE ANY MIX OF RESPONSABILITY ON THE SECTOR REGARDING A/C ON THE FRQ

In what circumstances do you believe that the use of datalink could decrease your workload?
Please describe…

If the task sharing is appropriate between EC and PC in a medium or minimum traffic level almost always.
If it would be possible to find a solution for reducing the response time : DL would be more useful in rushing hours too, or if the controllers would get accustomed to the big response time, would perhaps in any traffic levels DL decrease our workload.

- But the DL doesn't change the main basic theory of the control, , I mean the conflict search, planning and EC main tasks.

- DL decreases the misunderstandings which are sometimes unavoidable in a very high level traffic !

I think it will go all right in an Enroute sector without to many tactical (immediately) clearances to be given.

Yes.
You can issue new clearances without having to wait for confirmation.
You will not be interrupted by A/C calling in when you are talking to another A/C.
There will be no say again or confirm.
You can issue more clearance than compared to R/T. I believe you will be more relaxed when it's lesser R/T calls to answer and you will have more time to control the traffic and that will decrease the workload.

An agreement with the planner has to be made to share the workload, in any other cases I have the feeling that Datalink increases executive workload, specially when half of the traffic is data-linked, the other half isn't.

I often get confused e.g. level change is necessary, input has done to the system and I forgot to tell the pilot that he has to change FL, because I didn't realise that a/c isn't datalinked. But I believe : training will help.

Can't think of any at the moment. It is that the way of working is different but that does not necessarily mean an increase or decrease in workload. Everything in level flight and datalinked may be slightly less workload. A mix is a definite increase in workload – there is a need to constantly remember which a/c in datalinked versus. these who are not.

In the first place the reduction in R/T load which effects the controller working capacity and comfort. In second place the controller has more time/capacity to deal with other tasks.

In all circumstances .
With DL it's not necessary to wait for the answer of a pilot. You can make a lot of inputs and later you just have to load if the pilot have read back.

Statement : Datalink decrease the workload ! It's obvious for me !

For routine clearances it is very easy to use CPDLC instead of RT. CPDLC decreases frequency load.

NONE
IT JUST REDUCES THE AMOUNT OF SPEECH

<u>In what circumstances do you believe that the use of datalink could increase your workload</u>?

- if the traffic level is very high if the EC is very busy and there are a lot of potential conflicts which demand intermediate actions and intermediate dialogue between EC and Pilots.

- in case of DL ERRORS, NO replay, or unable messages.

In a lower sector and in approach – in sectors where clearances are given frequently for the same aircraft – in sectors where you have to "work" very much on one aircraft.

When you use it in time critical situations and when you got DL error or no reply, but I believe that is to misuse the system.

Due to the fact, that I need more training applying Datalink, I can only say for the moment :

I have the feeling that Datalink is increasing the workload in general (except in the exercise, in which nearly all a/c are data-linked)

Use of mixed types i.e. non datalinked & datalinked. If datalinked, and there one problem e.g. NO REPLY, failure of datalink, then you must use voice and then update the system – this doubles workload on any one a/c. Not immediately recognising that an input to the system on a non-datalinked a/c also needs voice input & vice versa.

I don't believe that the use of datalink could increase the workload.

If the system wasn't good enough.

When the link isn't reliable. If the datalink errors are more than, let's say, 20% my workload is increased.

As soon as I have to feed the system because of any error ; CPDLC increases workload. ALSO after UNABLE. Would I have used RT, I won't have lost many minutes, because in such cases I have to start from the beginning (Ask pilot if able, clear aircraft) if anything within a label becomes yellow, you tend to focus system problems and serve the system.

IN A MIXED ENVIRONMENT, WHERE YOU HAVE LINKED AND NON-LINKED A/C.
IN BAD WEATHER CONDITIONS (DEVIATIONS DUE TO TS AND CLOUDS)

In what circumstances might the use of datalink effect the safety of your airspace?

Maybe when you have a mix of DL and R/T and you input a clearance but forget to transmit the clearance to A/C;

As experienced last week :
vertical rates of climb/descent are executed not correctly (not in any case, but often)
assigned headings differ sometimes from the flown ones (sometimes 5° or even more)
in any cases, realising a conflict very late, I would prefer R/T, to solve the problem quickly

The transition period of mixed traffic is potentially dangerous due to not inputting the correct parameter and there being no warning of incorrect inputs. Too easy to transfer a/c without a confirm that this is your intent.

If datalink works properly, it won't effect the question of safety negatively.

"When you have any doubts, reverse to voice" resolve any problems. Using datalink increase the safety because the controller have more time to think and the misunderstanding errors are very rarely or missing.

No misunderstanding.
Only the aircraft, which is expected to change frequency will change it. Today you have now and then the problem that 2 aircraft change the frequency together, whilst only one was requested to do so.

THERE MIGHT BE A REDUCTION IN READBACK FAILURES/MISUNDERSTANDINGS

And finally, please note any observations you have made this week concerning datalink that you do not feel are covered by the questions above

I would appreciate, prefer to get voice acknowledgement from Pilots after they are getting the instructions by DLINK => we could avoid :

① big response time

② problems of unable to comply messages, which is a big problem if EC wants to solve a potential conflict by the given DL message in busy hours.

③ the problems of the late recognition of a radio failure. We have to be sure that the normal radio-set is working properly.

I believe it is very important to have short response times and a minimum of DL errors to trust the system and make it possible to be used in time critical situations.

Vertically change : I am only able to input a minimum rate of change but to apply vertical separation I need to have the possibility to advice a/c : descent/climb 2500 ft or more
“ 2500 ft exactly
“ 2500 ft or less
Speed : same as mentioned above
Heading : to solve separation problem I like to advice a/c not to fly a specified heading, I prefer turns to the left or right by a certain amount
Sometimes I would like to clear the pilot to descend on his own discretion to a specific Flight level, to reach this level at a specific point. For the time being I have no possibility to clear the a/c via Data-link in this manner.

When it gets busy the system slows down to the extent you are unable to input quickly. Leads to frustration, distraction and overall control of sector is down graded. In this situation workload is increased by needing to use R/T to compensate for the system deficiencies.
Some of the parameters used have definite potential but the need to have a much more robust simulation to be able to educate controllers is a primary need. They would not trust it as it is but I believe they could be persuaded if they have a warm feeling about it.
Need MTCD, or equivalent, desperately. It is not easy to spot all conflicts at conflict points all the time – something to replace the PPS function of old.

Maybe it’s not quite clear reading my previous answers that I’m satisfied with datalink as whole. It’s the one of the best development in recent years which aims to help controllers.

I think it’s necessary to be more advised in case of NO REPLY (with a “sound”) When you are advised you have a STCA or a AIRSPACE, would it be possible to erase this alarm on the screen.

I have the feeling that it is easier to handle either 01 or 91 examples than 41 samples.

End of Week 3 Questionnaire

	strongly disagree	disagree	slightly disagree	neutral	slighly agree	agree	strongly agree	comment
2.1 The Concept of operations for A/G Datalink is difficult to understand.	1	9						
2.2 The A/G Datalink procedures were easy to work with.			2			8		As soon as there are problems (e.g. DL ERROR, NO REPLY) it takes some time to sort it out.
2.3 It is easy to learn to work with A/G Datalink.			1			8	1	The system is slow to react to inputs and there are certain safeguards that need to be in place to "undo" inputs.
2.4 The A/G Datalink will not fundamentally change the way that controllers work.			3			7		It allows you to give orders to different A/C without having to wait for their read-back.
2.5 A/G Datalink enables a re-distribution of tasks within the team.	1		3		3	2		The PLC should only execute TRANSFER and after notification (PLC : "I assume the Flt…") do ASSUME as well, but he should assign clearances. Not really a redistribution. The task as a whole is different and therefore the distribution of
2.6 Using A/G Datalink makes you think differently about the tasks.		2	2	1	2	2	1	The task is always the same : to make separation between a/c.
2.7 The A/G Datalink takes away routine communication tasks.		1	1	1	3	4		If it works. Only as long as aircraft (pilots) do what you want them to do and are able to execute the clearances given by ATC. But only when it works. Any fault increases workload dramatically.
2.8 A/G Datalink makes you miss the subtle information obtained from voice.			3		1	3	2	It depends on the situation. Not during this experiment. I need the pilot to understand when I'm busy.
3.1 You did not feel more tense than usual when handling A/G Datalink traffic.		1	1		2	4	2	Only when you had a lot of errors or No reply.
3.2 Controlling a mixture of A/G Datalink and non-A/G Datalink flights is more demanding than controlling pure non-A/G Datalink flights.		1	1		3	4	1	It's a matter of training.
3.3 Handling a mixture of A/G Datalink and non-A/G Datalink flights is confusing.		5	1	1	1	2		You have to think a little bit more about the way you instruct aircraft to do something. E.g. : is there enough time to use CPDLC ? Am I going to use RT ?
	strongly disagree	disagree	slightly disagree	neutral	slighly agree	agree	strongly agree	comment

3.4 You had a good picture of the traffic in your sector using A/G Datalink.				2	1	4	3	I had even a good pic. of non-equipped aircraft. The advantage using A/G DL is the last line in the selected label (H, M, K, R).
3.5 A/G Datalink enabled you to better predict aircraft movements and pilot compliance.	2	3		1	3	1		Using CPDLC you have much more time in between the clearance sent to the aircraft and the result than when using RT. The system is not robust enough to trust it.
3.6 A/G Datalink makes the job boring.	3	3	1	1	1	1		
4.1 A/G Datalink enabled you to handle more traffic.	1	3		1	3	2		It causes even more work as soon as you have to revert to voice for a few aircraft. In such cases it would be better to use RT from the beginning.
4.2 A/G Datalink enabled you to provide the airspace users a better level of service.	2	2		1	3	2		It is faster to clear a flight direct to a fix after passing by a military active area using RT, than it is using CPDLC. Using CPDLC you have to take into account a time period of uncertainty. That's the reason for starting descent earlier.
4.3 A/G Datalink enabled you to execute tasks more effectively.		4			2	4		
4.4 A/G Datalink enabled you to prioritise your messages differently.		2		1	3	2	2	I think that's the most important thing (also with the fact that no confusion is possible with le FL etc…).
5.1 Working with A/G Datalink makes you feel more confident and safe.		3		2	2	3		No misunderstanding. Only one aircraft, which is expected to execute a clearance, will proceed according the instructions given (freq. change, level change). Too many "NO REPLY" to make me feel confident. Do not trust the system
5.2 The absence of the human voice does not decrease the level of safety.	1		2	4	1	1	1	It is good to hear uncertainty. Pilots can recognize that the ATCO is under pressure. Pilots hear others and will not state stupid requests. As long as pilots have not the possibility to see the traffic around them its good to hear the human voice.
	strongly disagree	disagree	slightly disagree	neutral	slighly agree	agree	strongly agree	comment

5.3 The introduction of A/G Datalink will not increase the impact of human error.		1	1	1	2	4	1	You have to fall back to RT to cancel a certain clearance immediately. If you do a wrong input there is no way to send a disregard msg. fast enough that the pilot is not going to execute the previous clearance received.
5.4 A/G Datalink reduced the potential for human error.	1	2		1	2	4		During this simulation I think there was more potential for ERROR, but it does have prospects to be developed and maybe decrease human error. I don't believe we are near this stage at the moment.
5.5 The consequences of control errors on A/G Datalink equipped aircraft were more serious than the consequences of control errors on non-A/G Datalink equipped aircraft.		3	2	4			1	There is no difference. Error is error. It requires a lot of extra work to reverse an error on this system. Voice communication is always there but the system needs a lot of work to keep correct.
5.6 The types of human error associated with A/G Datalink equipped aircraft were not different than those associated with non-A/G Datalink equipped aircraft.	1		3	1	3	2		With a mixed datalinked and non-datalinked, the inputs are very similar but the consequences of forgetting to use voice on non-datalinked a/c is potentially very dangerous. The displayed info may reflect your mind but not reality.
6.1 The methods used for data entry were easy to learn.			1		2	5	2	Some entries were long, complicated and could be confusing. Some are very simple. Frustration and distraction result in loss of "The Picture".
6.2 The messages used for data entry were not easy to learn.		7	2		1			Only problem in that message is in a separate window, distracting you from the problems at hand.
6.3 The general concept of A/G Datalink HMI (framing of call sign, numbers) was easy to understand.					2	7	1	
	strongly disagree	disagree	slightly disagree	neutral	slighly agree	agree	strongly agree	comment
6.4 In a mixed traffic environment it was easy to distinguish between equipped and non-equipped aircraft.					3	7		Only as long as the label is not selected. But having distinguished the fact, the brain tends to forget which are which, particularly non-datalinked, when entering data. Forgetting to use voice for non-datalinked is a pr

	strongly disagree	disagree	slightly disagree	neutral	slighly agree	agree	strongly agree	comment
6.5 It was confusing to have G/G communication (SYSCO) and A/G communication in the "Message In"/"Message Out" windows.		3	2	1	4			Education is the answer. I feel more comfortable now after 3 weeks getting used to this but to the extent that I feel totally comfortable.
6.6 Using only labels it would be possible to follow system/pilot, responses/ requests without the "Message In" and "Message Out" windows.		3		1	2	4		In the label I can see only that the pilot requested something but I have to see the message in window for details.
7.1 The availability of Downlink Access Parameters (DAP's) was generally useful.		1	1			5	3	I don't feel happy when a datalinked a/c is transferred and the DAPs disappear. I think "do the still apply or have they been charged by next sector ?". There had been wrong indications (e.g. rate of climb, speed).
7.2 DAP's were useful in the monitoring of pilot compliance with instructions.				2		6	2	It would be useful if it works as it should work. In a mixed traffic sample, must remember to differentiate info available from datalinked and non-datalinked. It is easy to confuse the info from both types as meaning the same
7.3 The availability of DAP's did not reduce the number of R/T transmissions.		6	1	1	1	1		Specially VRC was, for me, useful on deciding whether to climb at a particular time or not.
8.1 The error messages make it obvious what went wrong.		1	1		2	6		TOO MANY OF THEM TO BE REAL !
8.2 The error messages make it easy to distinguish between datalink errors and the absence of pilot response.		2	1		1	6		
8.3 The number of datalink errors was unacceptable.		1	2	2	2	1	2	It depends on whether the system was working or not. You would not have a system accepted in this state by any authority responsible for ATC.
9.1 The update rate on DAP's did not pose a problem.		1	2	1		5	1	TOO SLOW !
	strongly disagree	disagree	slightly disagree	neutral	slighly agree	agree	strongly agree	comment
9.2 The response times for Clearances and Information Communications (CIC) was not a problem.	1	4			2	2	1	It's too long for tactical use. TOO SLOW ! Increases the need to use voice to supplement and consequently an increase in overall workload
9.3 The response times for ATC Communication Management (ACM) was not a problem.		4		1	2	3		You could live with the response times but it should be faster. Working properly, this may have a future.

10.1 There was enough training to get familiar with the airspace and the route structure.				2	1	7		4 days to forget your current thinking and operate what is effectively 2 different system was only just adequate. I haven't been here during training.
10.2 There was enough training to get familiar with the new DAP functions being examined.				1	1	8		Haven't been here during training.
10.3 There was enough training on the HMI, its rules and its mechanisms.				1	2	6	1	A lot of the training/learning still going on during first week of measured runs. Haven't been here during training.
10.4 The traffic samples were realistic.		2		1	2	5		Not enough requests. It seems to be an ideal atmosphere. No deviations. Need MTCD to help now there are no strips. I don't know, because I haven't worked yet in Paris airspace.
10.5 The feed sectors were suitably simulated.				1	2	6	1	
10.6 The work environment (seating, lighting) was comfortable.	1	1	2		1	5		It was a little bit in the OPS-room. Too much noise ! Desk too high, therefore displays (SONY's) too high. Easy to miss traffic at top of display and also gives neck-ache from the necessary working position
10.7 Responding to the ISA was disturbing/distracting.		7		1	1		1	For me this is the next of many times I have used it. It is automatic for me.
10.8 The ISA prompt was noticeable enough.					1	8	1	
10.9 There were distractions/disturbances from other activities (e.g. visitors) in the test room.		5			5			Visitors, no problem. The building work and associated noise was excessive.