

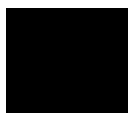
PROGRAMME FOR
HARMONISED AIR TRAFFIC
MANAGEMENT RESEARCH
IN EUROCONTROL



DOC 95-70-09



EUROPEAN ORGANISATION FOR THE SAFETY OF AIR NAVIGATION, EUROCONTROL



PHARE Demonstration 3 PD/3 Facility Specification

PHARE/EEC/PD/3-1.3.2/FAC: 4.2 draft



EUROCONTROL

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- the LVB (Luchtverkeersbeveiliging);
- the DLR (Deutsche Forschungsanstalt für Luft- und Raumfahrt);
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1. SCOPE OF THE DOCUMENT

This document provides an overview of the Demonstration requirements for PD/3 (PHARE Demonstration 3). It is global in content and provides guidance to local sites in the preparation of their facilities.

Local sites shall define their own Facility Specifications to comply as a minimum to the requirements set-up in the present document and to take further account of their simulation facilities and specific PD/3 exercises.

The Local PD/3 Facility specifications shall be made available to the PD/3 and PHARE partners.

2. INTRODUCTION

Today's ATC system is at times unable to handle the demands made upon it. Furthermore, EUROCONTROL traffic growth scenarios, based on a 1995 reference, consider in establishing strategic capacity objectives for EATMS that an increase of 45% might be expected in 2005 and 154% in 2020¹. Restrictions imposed to safeguard the system from overload often lead to delays during peak periods. In less busy areas the required capacity goals can be achieved by the well-proven technology and procedures that represent "best current practice". However, in the busier areas the scope for increasing capacity through existing ATC methods and technology is limited. Although improvements in the existing methods and technologies must be pursued, changes in the technology and processes of ATC must also be envisaged if system capacity and productivity gains are to be secured.

The main limiting factor in the present ATC system is the capacity of the controller. A means must be found by which the system can be improved significantly to meet this predicted demand. This will have to be achieved whilst maintaining or improving system safety.

To evaluate the performance of new concepts taking advantage of enhanced technologies, the PHARE Programme has identified options to be investigated through a series of real time simulations entitled "PHARE Demonstrations".

The term Demonstration is used in the context of PHARE to describe a large scale validation activity, comprising integrated ground system, air system and air-ground datalink facilities. A Demonstration is the last step in a validation process consisting of functional testing, basic evaluation of individual tools and partial validation of subsystems of increasing complexity.

The first two Demonstrations PD/1 and PD/2 concentrate on the air and ground systems available in the 2000 time-scale and address en-route and TMA research issues separately.

PD/1 and PD/2 investigate the provision of automated assistance to both the Planning and Tactical Controllers and the application of data-link for air to ground communication. The provision of automated assistance to the controllers is intended to support them in the resolution of conflicts and in planning the efficient use of the airspace. The introduction of data-link to communicate between the airborne systems and ground environment is expected to remove some of the communication load from the controller, to enable the use of onboard data to improve the precision of the ground system's aircraft model for trajectory and conflict prediction, and in addition a limited exchange of trajectory data.

PD/1 and PD/2 provide a first step in the process of introducing automated tools and data-link facility within an advanced ATC and airborne environment and of obtaining the controllers'

¹ EATMS User Requirement Document, Vol. 1, Ref. EATCHIP Doc.: FCO.ET1.ST04.DEL01 Edition 1.0
September 1995, page 30

reactions. The results of PD/1 and PD/2 provide inputs to following PHARE Demonstration as well as help to refine the techniques used in measurement and analysis of the results.

PD/3 will concentrate on the air and ground systems which could be available in the 2005-2015 time-scale and will address the influence of different controller working methods. It will bring together the en-route and Extended TMA results, extending the work to encompass a series of demonstrations defined in a plural-site environment, where each site's demonstration will be part of a coherent validation plan elaborated in co-operation with the PHARE VAL project.

3. OBJECTIVES

3.1 GENERAL

- Proving and demonstrating the feasibility and merits of a future air-ground integrated air traffic management system in all phases of flight;
- Provide input to the definition of future European Air Traffic Management System concepts.

3.2 SPECIFIC

The two specific objectives of the large scale PHARE demonstration 3 project are to:

- Provide evaluation of a future ATM concept for the time period 2005 - 2015, which supports the introduction of the following functional elements:
 - Multi-Sector Planning
 - Air-Ground integration
 - Traffic Organisation
- Evaluate the transitional introduction of 4D and Data-Link equipped aircraft in this new ATM concept.

The range of operational concepts explored by PD/3 is combining functional elements whilst keeping the man in the loop. This is being done by following a « Human Centred Approach » with the introduction of new tools to support the controllers.

PD/3 will constitute a further step towards the validation of a long-term air-ground integration concept, but will more specifically concentrate on the validation of the medium term systems (2005-2015) where the controller remains a key control element. It can also be stated that PD/3 mainly aims at providing results to support the specification of the European ATM System (EATMS), which will be the first operational system with advanced functionality and is conceived to progressively replace the system operational at the end of EATCHIP Phase III.

PD/3 will be hosted by CENA at Athis-Mons, by EEC at Bretigny and by NLR at Amsterdam, where local demonstrations that aim at evaluating different and complementary sides of the concept will be performed in a co-ordinated way.

PD/3 is also expected to meet the following “operational” and “collaboration” objectives.

The operational objectives concern the demonstration of the feasibility of the PD/3 operational philosophy in accordance with the way the foreseen enhanced CNS technologies or automation capabilities can be used and integrated to support it. They must cover:

- the en-route environment
- the extended TMA (ETMA²) environment
- the integration of the en-route and ETMA concepts
- the use of data link applications through PATN³

²The ETMA environment covers the APP sectors and also the ACC terminal sectors dealing with the descending and climbing traffic to and from the concerned airport. On the other hand "En-route" concerns only the ACC sectors outside the extended TMA and dealing mainly with in-cruise traffic

³The use of PATN in PD/3 will provide an integration test for the ATN concept in a (simulated) ATC application environment

For the En-Route environment, PD/3 is intended to demonstrate the capacity and productivity benefits of the core⁴ PD/3 operational philosophy, i.e. the traffic organisation planning philosophy, including the following and progressive ATC enhancements:

- introduction of advanced assistance tools among which co-operative tools aiming at organising the traffic in a « human-in-the-loop » philosophy;
- introduction of multi-sector planning optimising the way the traffic is organised at a scale larger than the traditional sector;
- introduction of 4D trajectory negotiation and 4D planning in a multi-sector environment (some issues concerning for example the mode of co-operation between air and ground, the role of the aircraft and the pilot in the future ATM concept, or the controller or pilot HMI are covered by this).

In a similar way for the ETMA environment, PD/3 is intended to cover the experimental domains related to the traffic organisation planning philosophy with the following ATC enhancements:

- introduction of advanced tools to help the controller organise the traffic
- introduction of planning functions including the Arrival and Departure Manager tools.
- introduction of 4D trajectory negotiation and planning
- One important aspect of PD/3 concerns the integration of the en-route and ETMA concepts with the demonstration of a planning function supporting the transition between the en-route and TMA flight phases.

The **collaboration objectives** are to:

- demonstrate the capability for a group of ATC research establishments in Europe to join their skills and efforts to specify, design and implement common demonstration environments based upon a standardised architecture and integrating the components developed under other PHARE projects;
- demonstrate the feasibility to elaborate and run large co-ordinated demonstrations taking advantage of the facilities available in the various establishments.

It is expected that PD/3 will provide results in the following areas:

- feasibility of multi-sector planning in association with 4D trajectory negotiation, and hence of the traffic organisation planning philosophy, in en-route and ETMA environments;
- compatibility of the retained controller - automated system integration options with the operational concept;
- compatibility of the pilot - automated system integration options with the operational concept;
- the interface between the various en-route and ETMA modes of operations and planning tools;
- proposed directions and improvement for further experiment and demonstration;
- experience from the co-operation of several European ATM research establishments;
- availability at the PHARE establishments of simulation facilities supporting further research and validation of ATM concepts for EATMS.

⁴The core operational philosophy mainly refers to the research domains retained in PD/3 for the en-route and ETMA environments. It is only a part of what should be a complete ATM operational philosophy. (Ref.: DOC 95-70-02 "PD/3 Demonstration Operational Specification", PHARE/CENA/PD3-1.3.1/OPS;3.1 March 95 - Annex 1)

4. ORGANISATIONS

The PD/3 real-time simulations (plural site at CENA, EEC and NLR) shall comprise two organisations, baseline and advanced, and suitably structured training exercises.

PD/3 baseline exercises shall relate to the PD/1 and PD/2 reference organisations. This shall be a "stripleless" organisation which shall include some basic tools to assist the controller in planning traffic through the sector and also into the approach area.

The advanced operational scenario shall evaluate concepts related to the time period 2005 to 2015 with a traffic mix including 4D equipped aircraft with traffic samples ranging from a 30% to 70% ratio of 4D equipped aircraft.

Advanced concepts to be evaluated include :

- human centred approach for automation;
- multi-sector planning environment;
- traffic organisation and 4D trajectory negotiation.

A detailed description of the Organisations to be tested can be found in the PD/3 Operational Scenario Document - [5] PD/3 Operational Scenarios Document Volume 1 - January 1997 / PD/3 Operational Scenarios Document Volume 2 - February 1997

5. SIMULATION ENVIRONMENT

5.1 SIMULATED AIRSPACE

The airspace to be simulated will comprise parts of Amsterdam TMA, Maastricht upper airspace, Reims ACC, Paris ACC and Roissy Charles de Gaulle TMA, together with TMA and En-route adjacent sectors and multi-sector planning areas.

Due to the extent of the simulated airspace the minimum simulation time should be one and half hours duration.

The airspace is defined in Annex A of Operational Scenarios Document Volume 2.

5.1.1 AIRSPACE DATA

Airspace data shall be that described in the CFMU database as of 21 June 1996 for the reference organisation.

The advanced organisation shall use the reference organisation data as start point but shall evolve in accordance with the PD/3 operational concept to cater for future airspace structures.

Format of the Airspace Data is defined in each Local Facility Specification.

5.1.2 SEPARATION STANDARDS

The separation standards to be used in PD/3 shall be:

AREA	REFERENCE ORGANISATION	ADVANCED ORGANISATION
Multi-sector Areas	Standard level allocation 1000 ft - FL290 and below 2000 ft - above FL290 5 nm radar separation Greater if required by LOA	Standard level allocation 1000 ft - FL290 and below 2000 ft - above FL290 5 nm radar separation Greater if required by LOA
En-route Sector (upper)	Same as above	Same as above
En-route sector (lower)	Standard level allocation 1000 ft - FL290 and below 5 nm radar separation Greater if required by LOA	Standard level allocation 1000 ft - FL290 and below 5 nm radar separation Greater if required by LOA
TMA Approach	Same as above	Same as above
	Standard level allocation 1000 ft - FL290 and below 3 nm radar separation Greater if required by LOA	Standard level allocation 1000 ft - FL290 and below 3 nm radar separation Greater if required by LOA
Departure	Same as above or as defined in airport procedures for SID / runway allocation	Same as above or as defined in airport procedures for SID / runway allocation
Adjacent to be measured	Standard level allocation 1000 ft - FL290 and below 2000 ft - above FL290 5 nm radar separation or 3 minutes at Navigation start Greater if required by LOA	Standard level allocation 1000 ft - FL290 and below 2000 ft - above FL290 5 nm radar separation or 3 minutes at Navigation start Greater if required by LOA

During the Demonstration preparation the PD/3 OTF members may revise these standards. Such a revision should be in writing and included in the local controller instructions.

5.1.3 METEOROLOGICAL CONDITIONS

The meteorological conditions shall be defined in conjunction with the MET project. The MET requirements can be found in the document [7] PD/3 MET Requirements V 4 - January 1997. The UK and French Meteorological offices shall provide met data to PD/3. PD/3 Meteorological requirements are described in Annex B.

5.2 SYSTEM FAILURE

No system failure will be simulated for the PD/3 demonstration.

5.3 TRAFFIC SAMPLES

5.3.1 TRAFFIC VOLUMES

The PD/3 traffic samples at each site shall be based on one morning and one afternoon sample from the CFMU database on 21 June 1996.

The predicted annual traffic growth to be used in the PD/3 demonstrations indicates that by 2005 traffic will multiply by 1.5 on 1995 levels and that demand in 2020 would be multiplied again by 1.5.

To cater for these traffic predictions a series of traffic increments should be used in PD/3 exercises. The table below describes the traffic sample increments to be applied to the base sample.

	June 1996	1.50	1.75	2	2.25
Baseline	✓	✓	✓	✓	
Advanced	✓	✓	✓	✓	✓

It is proposed to perform a minimum block of 14 trial runs to cover a range of traffic volumes and percentages of datalink equipped aircraft. This leaves 4 spare runs at NLR for each set of controllers, 8 spare runs at EEC, and is likely to allow some spare runs at CENA for each set of controllers. It is anticipated that this number of spare runs will mean that there is a high probability that the 14 runs are successfully completed at each site.

The following set of 14 runs are therefore proposed as a minimum:

Traffic (from morning or afternoon)	Traffic from 21 June 96	Traffic +50% (Medium)	Traffic +75% (Intermediate)	Traffic +100% (High)	Traffic +125% (Extra High)
Baseline	✓	✓	✓	✓	
Advanced (no datalink)	✓	✓	✓	✓	
Advanced (30% datalink)		✓			
Advanced (70% datalink)		✓	✓	✓	✓
Advanced (100% datalink)				✓	

Hence:

- a) CENA would perform 2 repetitions for their two sets of controllers, (one morning and one afternoon set separately for two sets of controllers);
- b) EEC would perform 2 repetitions of these 14 runs with their one set of controllers, (one morning sample, one afternoon sample);
- c) NLR would perform 6 repetitions for their 6 sets of controllers (three morning and three afternoon).

Traffic samples should be of 2 hours duration which permits an exercise profile as follows:

- Warm up 10 Minutes (handover and traffic situation familiarisation)
- Measured 60 Minutes (uninterrupted)
- Warm down 10 Minutes (completion of NASA and ISA)
- Exercise extension 40 Minutes (in the event of technical problems)

Traffic Samples requirements and format are defined in each Local Facility Specification.

5.3.2 AIRCRAFT TYPES

It is assumed that all aircraft will be flying IFR and receiving a full ATC service.

No VFR traffic will be simulated.

The following guidelines shall apply to the definition of traffic sample characteristics:

- wake vortex category :

Light aircraft	5 %
Medium aircraft	63 %
Heavy aircraft	32 %

- performance category :

Jet aircraft	90 %
Turboprop aircraft	10 %

5.3.3 AIRCRAFT EQUIPMENT

The simulated aircraft shall be differentiated according to their navigation and communication equipment:

- Class A (4D-Datalink) represents aircraft equipped with P-RNAV, FMS, 4D-navigation and datalink capabilities
- Class B (3D-non Datalink) represents aircraft with a minimum required equipment (at least P-RNAV equipped and communicate exclusively via R/T voice communication).

A transition towards 2015 shall be evaluated using ratios of class A and B representing 70% and 30% of Class B equipped aircraft:

	Baseline	Advanced			
Class A	0%	0%	30%	70%	100%
Class B	100%	100%	70%	30%	0%

5.3.4 TRAFFIC BEHAVIOUR

The traffic behaviour should represent the reality of real traffic i.e. pilot errors, discrepancies between real and planned behaviour.

This will be defined in accordance with the simulated airspace. Scripting shall provide the necessary discrepancies. Additionally, traffic samples should contain representative traffic problems. These should be analysed and understood in advance so that controller interaction on the problems using the PD/3 tools and concepts can be understood.

6. SIMULATION PROGRAMME

6.1 SCHEDULE

A PD/3 simulation schedule shall be defined for each site.

This schedule shall take into account the VAL requirements and specific needs of the air traffic scenario chosen to demonstrate PD/3 at the site concerned.

The schedule should include:

- | | | |
|----|--------------------------|--|
| 1. | integration | External deliveries, platform and air facilities; |
| 2. | testing | System and data (samples and VAL tools); |
| 3. | acceptance | Activities to show the conformity of facility to requirements; |
| 4. | training | Of all participants (trainers, pilots, supervision, software); |
| 5. | pilot phase | First run of the site demonstration (debug, refining, training); |
| 6. | main demonstration phase | Measured exercises, demonstrations, presentations. |

Currently a pilot and main phase are planned. The pilot phase should be seen as a rehearsal for the main demonstration, permitting an in-depth testing and evaluation of each platform, the VAL measurement and analysis and training methods, and permitting fine-tuning.

6.2 EXPERIMENTAL PLAN FOR PILOT AND MAIN PHASE

6.2.1 ORGANISATIONS TO BE TESTED

Two organisations shall be tested:

- Baseline
- Advanced Organisation.

Exercises should be prepared to provide for testing, training and presentation.

A preliminary limited exploration of more direct route structures applied in the PD/3 operational context should be provided as far as possible. These additional exercises shall include:

- the data preparation for advanced routes and RVSM,
- the adaptation of the HMI for the MSP with the GHMI group,

6.2.2 EXPERIMENTAL PLAN

The experimental plan shall be developed in co-operation with VAL and shall define traffic sample requirements, exercise repetition and tool configurations, for both the pilot and main phases.

The VAL guidance to the Experimental Plan is described in VAL documents [18] PD/3 Measurement and Analysis Specification : PHARE/NATS/VAL-4.4.2/WP005;0.3.

The experimental plan should take into consideration the proposed exercise and daily schedules below.

Typical Exercise Schedule:

Time	Activity
15 min	exercise set-up
10 min	briefing on exercise objectives and scenario (parallel with set-up)
10 min	exercise warm up and situation development
60 min	measured period
10 min	warm down and NASA/questionnaire responses
30 min	debriefing (60 min. session in afternoon)

Such a schedule should permit at least three exercises a day with recovery time for late starts e.g. due debriefing extension of technical difficulties.

Daily Schedule:

Time	Ex 1		Ex 2		Ex 3
0845	set-up	1100	briefing	1400	briefing
0900	briefing	1110	exercise	1410	exercise
0910	exercise	1230	debriefing	1530	debriefing
1030	debriefing	1300	lunch	1630	completed

This provides for 15 exercise slots per week. However, to cater for system problems, debriefing overruns and reorganisation it is advisable to provide safety slots. As a result, 12 exercises and 3 safety slots should be scheduled each week.

6.2.3 VISITOR PLAN

Visitors should be restricted during all measured exercises.

However, it is clear that on certain occasions VIPs will have to be admitted to exercise runs. All efforts should be taken to ensure that such visitors are controlled and do not interfere with participating controllers and observers.

In order to cater for general visitors, a visitors programme should be established at each site. These programmes shall be defined and agreed by the PD/3 EG. Appropriate Public Relations documentation shall be produced.

6.3 AIRBORNE PROGRAMME

6.3.1 INTRODUCTION

PD/3 is the cumulation of all the R&D projects within PHARE comprising the development of methods and tools to support both the controller and the pilot in a future air/ground integrated ATM environment. PD/3 has two general objectives:

1. Proving and demonstrating the feasibility of a future air/ground integrated Air Traffic Management system in all phases of flight,
2. Providing input to the definition of the European Air Traffic Management System (EATMS) concept and EATCHIP Phase III.

However, PD/3 will concentrate on two specific objectives:

1. Evaluation of a future ATM concept for the time period 2005-2015, which supports the introduction of Multi Sector Planning, Air/Ground Integration and Traffic Organisation.
2. Evaluation of the transitional introduction of 4D and data link equipped aircraft in this new ATM concept.

The evaluation of this concept requires some large scale demonstrations, which will be performed at the sites of the PHARE partners CENA, EEC and NLR, where each site's demonstration will be part of a coherent validation plan elaborated in co-operation with the PHARE VAL project. The inclusion of flight simulators, real aircraft and pilots is regarded essential to take proper account of the airborne aspects and to improve the realism of the evaluations and demonstrations. The inclusion of live aircraft equipped with real 4D-FMS and data link and experiencing real weather effects will give more realistic results and will thus increase the credibility of the demonstrations enormously.

It is not only ATC authorities and ATC controllers that need to be convinced of the advantages of these new concepts, indeed, it is absolutely essential that the airlines and their pilots, who will be the customers of the future ATM system, are also convinced. Consequently, in order to get airline support for the future ATM system, which will require significant investment by them, PHARE must demonstrate in PD/3 the potential capacity and efficiency gains, plus the benefits of:

- user preferred trajectories
- 4D planning for flexible routing
- data link for air/ground integration with ATC

as well as their impact on the cockpit environment.

The flight trials and demonstrations in PD/1 have already made a major impact on the airline community in these areas. The suggestions and criticisms received have since been incorporated into these programmes for PD/2 and further refined for PD/3. This PD/3 Airborne Programme will demonstrate the total concept to the airlines with their pilots actively participating in the flight trials and AHMI evaluation.

6.3.2 OBJECTIVES OF PD/3 AIRBORNE PROGRAMME

The objectives of the PD/3 Airborne Programme are:

1. To support the overall objectives of PD/3 with the additional specific objective of adding more realism to the evaluations and demonstrations by inclusion of real aircraft and avionics systems, airline pilots, and real weather.
2. To evaluate ('airborne' measured trials) and demonstrate (non-measured trials), using flight simulators as well as real aircraft the following:
 - evaluate the ATM operational concepts from the airline perspective
 - evaluate the human factors aspects in a realistic cockpit environment
 - provide proof of concept(s)
 - demonstrate to the airlines the potential benefits
 - demonstrate to the international aviation community and press.

6.3.3 PD/3 AIRBORNE PROGRAMME

The three airborne projects of PHARE, EFMS, AHMI and PATN, plus the Meteo project will, after initial individual tests, be incorporated into a single coherent evaluation and

demonstration programme using the experimental aircraft of the DLR, DRA and NLR research centres and the MCS flight simulators of EEC and CENA.

The PD/3 Airborne Programme will concentrate on several aspects:

- user preferred trajectories
- 4D-planning and 4D-guidance for a whole flight or parts of a flight
- negotiation of trajectories and constraints via data link
- operating in the PD/3 trials as Class A and/or Class B aircraft
- advanced AHMI
- improving situation awareness
- utilisation of SATCOM in an ATN environment

6.3.4 SCENARIOS

The scenarios (baseline and advanced organisations) described in the OSD document will be applied. However, it is felt that the advanced organisations need to be refined to take full advantage of the capabilities of the developed ground and air systems.

Because the ground element of PD/3 is split across three sites, each focusing on different phases of flight, the following scenarios are envisaged:

- CENA Scenario:

En-Route inter-sector co-ordination in the departure phase (TMA, ACC, en-route)

- EEC Scenario:

En-Route - Multi-Sector Planning (SID exit gate to STAR arrival gate)

- NLR Scenario

En-Route ETMA interaction in the arrival phase (en-route, ACC, TMA)

6.3.5 EVALUATIONS USING FLIGHT SIMULATORS

The advanced airborne HMI will be evaluated by experimental and airline pilots in the MCS flight simulator for a typical flight (tbd) through each of the three scenarios.

6.3.6 EVALUATIONS USING REAL AIRCRAFT

Typical flights (tbd) with real aircraft as Class A and Class B aircraft through each of the three scenarios will be performed employing experimental as well as airline pilots. The efficiency and the benefits of the new concepts will be evaluated.

6.3.7 DEMONSTRATIONS USING REAL AIRCRAFT

Typical flights (tbd) with real aircraft as Class A and Class B aircraft through each of the three scenarios will be performed. The feasibility and merits will be demonstrated to the aviation community.

6.3.8 AIRCRAFT PARTICIPATION

7. TRAINING

Training for PD/3 should cater for the following participants:

1. pilot input operators ;
2. simulation supervision team ;
3. measurement and analysis team; feed sector controllers ;
4. participating controllers ;
5. presentation teams.

A training plan shall be defined separately. This shall take into account the requirements of GHMI, VAL and the specific situation of individual sites. The training plan is the responsibility of GHMI in co-operation with PD/3 Project Leaders.

The GHMI Training effort for PD/3 shall provide common training packages for PD/3 and concept introduction and the initial HMI training. "Hands On" stand-alone training facilities shall be the responsibility of individual sites. However, their content and approach to training shall be co-ordinated with GHMI to assure a harmonised approach.

8. FACILITY REQUIREMENTS

8.1 PREPARATION SYSTEM

8.1.1 GENERAL

A data preparation system is required at each site in order to prepare:

- the simulation static environment;
- the traffic samples for baseline and advanced organisations.

The data used by the three sites should be as consistent as possible in order to assist with the final PD/3 analysis and reporting.

The environment description shall correspond to the European ATC airspace configuration on December 1996. Static data from this period shall be collected by the EEC and provided to partners.

Traffic data shall be collected by the EEC and distributed to the partners. Traffic increments shall be obtained from EUROCONTROL CRCO traffic projections for the construction of augmented traffic samples.

8.1.2 HARDWARE

Hardware necessary to run data preparation facility shall be described in each Local Facility Specification.

8.1.3 SOFTWARE

Software necessary to run data preparation facility shall be described in each Local Facility Specification.

Data preparation requirements include the following:

Data	Requirement
Basic traffic samples for base line and advanced organisations	Should provide realism and consistency in traffic increments between each site

Data	Requirement
Airspace data	Should be identical at each site
Video map data	Should be identical at each site
Meteorological data	Should be identical at each site (provided by UK Met office and Meteo France)
Paper maps	For presentation, documentation and training purposes. Normally sufficient data is available to the controller through the GHMI.
other?	

Shared data shall be provided in a common format: EXCEL spreadsheet.

8.1.4 PERSONNEL

Data preparation shall request the assistance of operational and technical specialists at each site for the preparation tasks and validation of data.

8.2 SIMULATION FACILITY

8.2.1 GENERAL

System failures will not be simulated in PD/3.

8.2.2 GROUND SYSTEM

8.2.2.1 HARDWARE

Hardware shall be described in each Local Facility Specification. However, SUN Workstation hardware has been provided for PATN which is hardware specific.

8.2.2.2 SOFTWARE

The local ground platforms to be used in PD/3 include:

	CENA	NLR	EEC
Ground	DAARWIN	NARSIM	ESCAPE

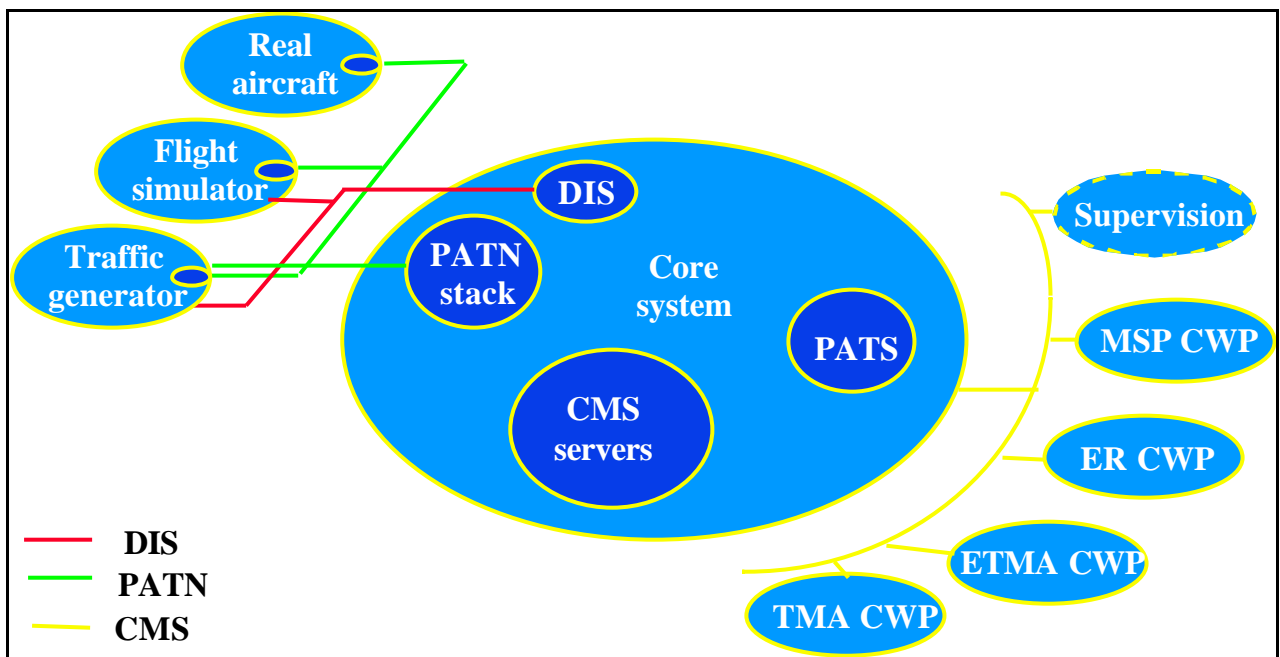
These platforms should provide the capability to integrate the PATs tools and to provide for the provision of functionality such as surveillance, flight plan processing and data distribution, as well as ground/ground and ground/air co-ordination capability.

A brief description of the three ground platforms to be used in PD/3 is provided below:

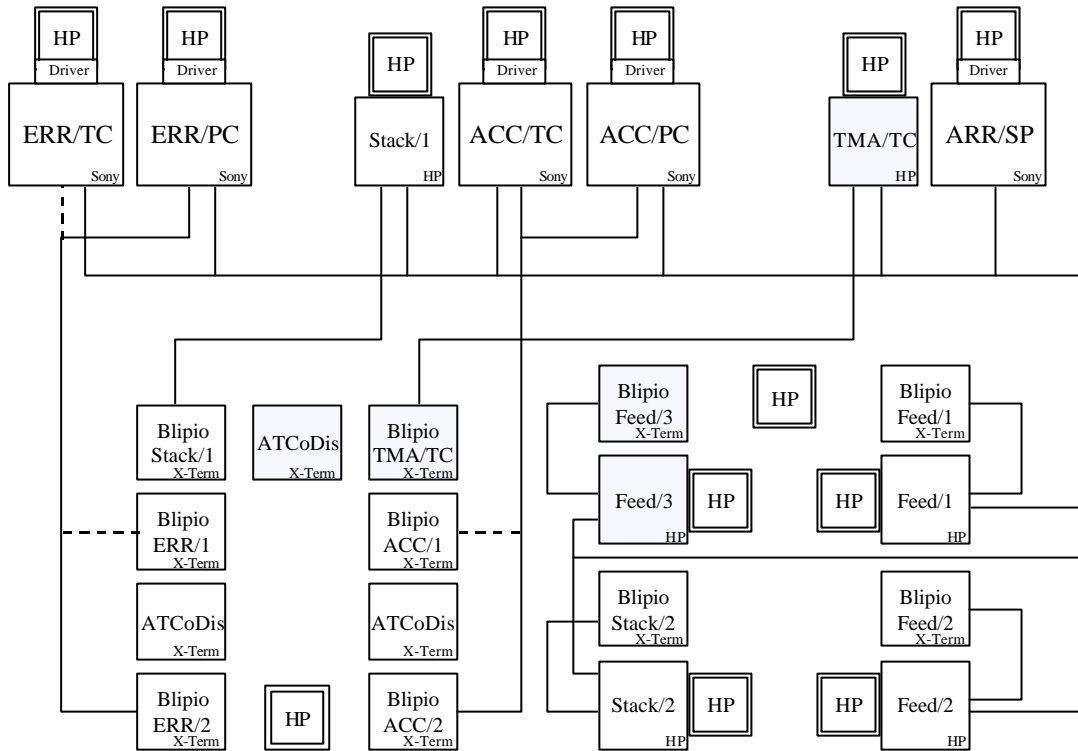
- **DAARWIN (CENA)**

The PD/3 CENA simulation platform is based on the PHARE CMS/PARADISE client/server architecture model. It consists of the following components:






- ◇ the *core system* DAARWIN which gathers the basic servers and clients of an ATC simulator;
- ◇ the *tools* which are supposed to be the PATS. These tools are plugged into the core-system;
- ◇ the *GHMI sub-system* gathers four Control Working Positions (TMA, Extended TMA, En-Route and Multi-Sector Planning) and a Supervision workstation;
- ◇ the *Air-system* composed of :
 - * the MASS air-traffic generator;
 - * the MCS flight simulator;
 - * the real aircraft.
- ◇ the *communication sub-system* (PATN for operational communications, DIS for simulation communications).



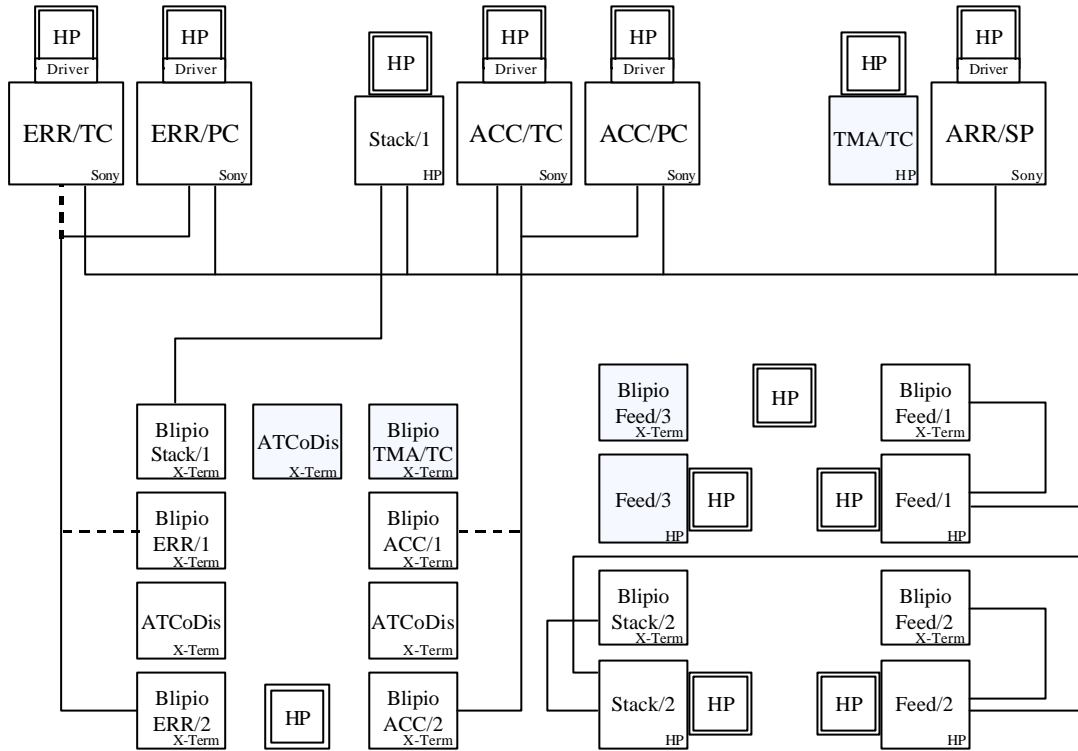
• **NARSIM (NLR)**



Key :

	HP Machine		R/T Channel/Frequency
	Display		Telephone Lines
	Reference Organisation Only		

Reference Organisation R/T Network

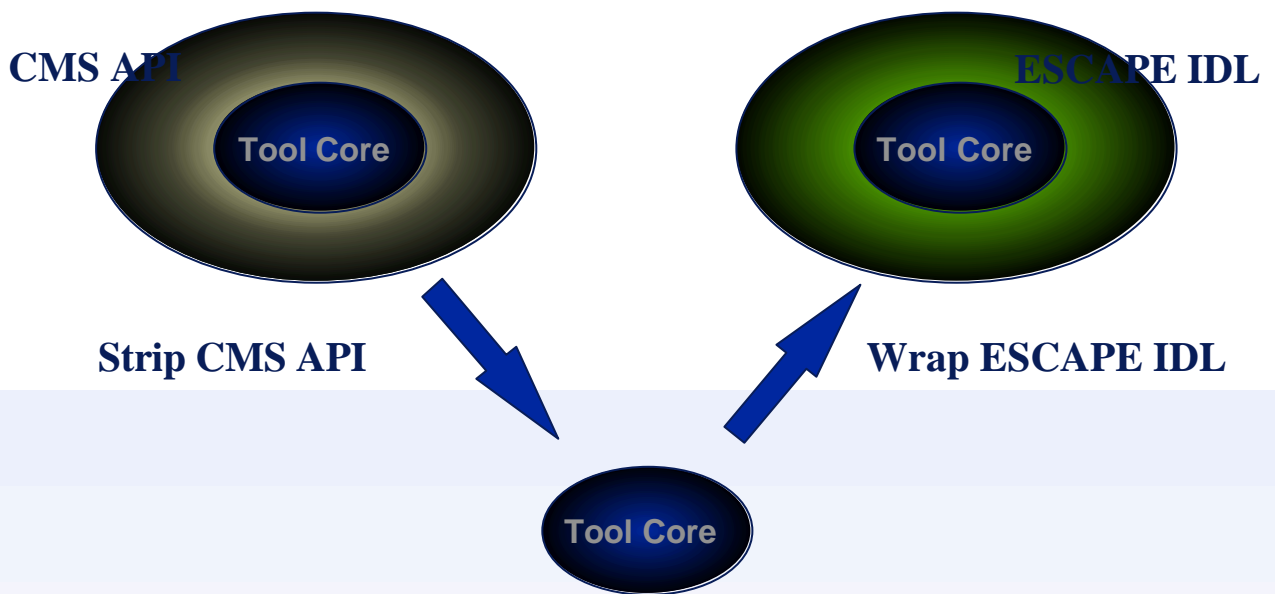
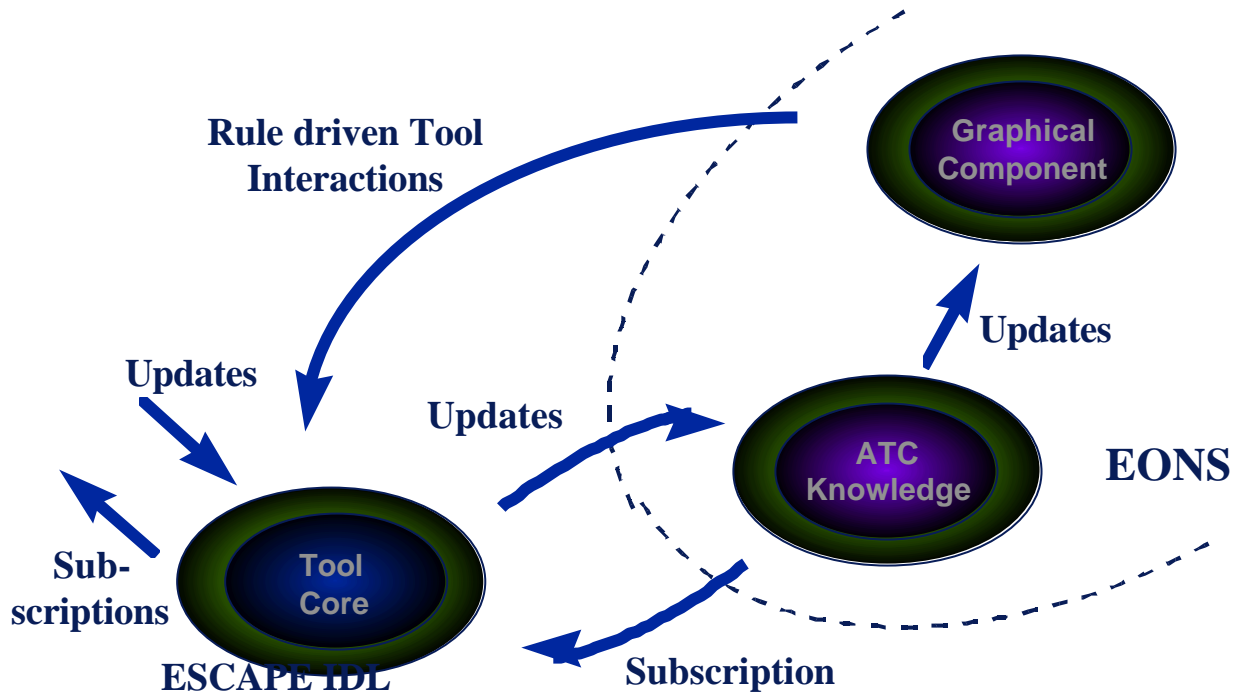


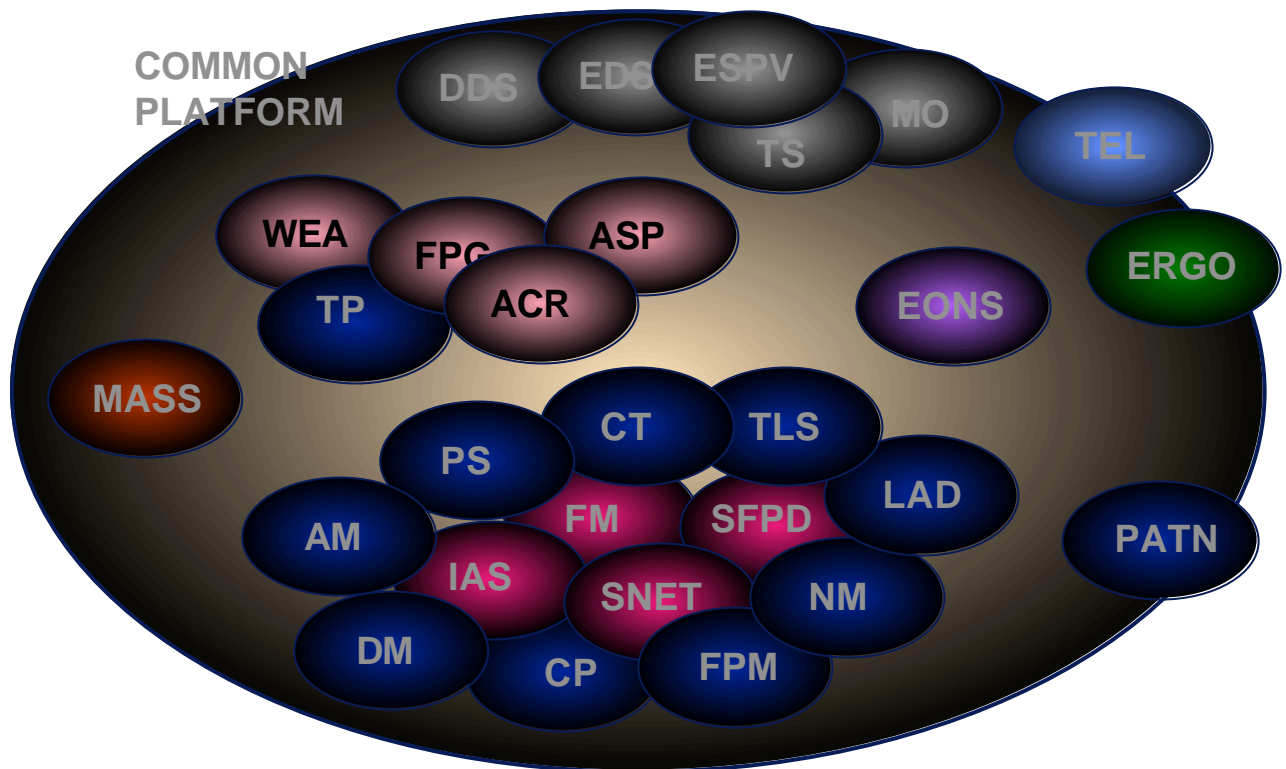
Key :

	HP Machine		R/T Channel/Frequency
	Display		Telephone Lines
	Reference Organisation Only		

Advanced Organisation R/T Network

- **ESCAPE (EEC)**





8.2.2.3 PHARE ADVANCED TOOLS

The following externally supplied tools shall be integrated into each local site simulator for use in the PD/3 advanced organisation:

TP	Trajectory Predictor	DM	Departure Manager
FPM	Flight Path Monitor	CT	Co-operative tools
CP	Conflict Probe	TLS	Traffic Load Smoother MSP
PS	Problem Solver	NM	Negotiation Manager
AM	Arrival Manager		

PD/3 Baseline and Advanced Organisations have different needs, which may require separate configurations and levels of advancement of certain tools.

The integration approach shall depend on the requirements of individual simulators.

Datalink communication procedures will be an integrated part of several tools.

8.2.2.4 CWP - CONTROLLER WORKING POSITIONS

The CWP GHMI shall be designed in order to provide common positions for controllers working in the same sector but with different tasks. "Common" CWP's are required for:

• Multi-Sector Planning		MSP
• En-route	Planning Controller	ER PC
	Tactical Controller	ER TC
• Extended TMA	Arrival Planning Controller	AA PC

Arrival Tactical Controller	AA TC
Initial Approach Controller	INI
Intermediate Approach Controller	ITM
Local Controller	LOC
Arrival Sequence Planner	ARR SP
Departure ACC Planner Controller	DA PC
Departure ACC Tactical Controller	DA TC
Departure Planner Controller	DEP PC
Departure Tactical Controller	DEP TC

- Adjacent (feed) A combination of above.

The operational requirement for PD/3 CWP involves the demonstration of gate to gate capability. The sum total of the 3 sites simulation scenarios should equate to this requirement. As a consequence, the following CWP are identified for the PD/3 demonstrations:

Adjacent positions (feed) should normally be equipped to the same standard as measured positions. The adjacent sector controls aircraft entering and exiting the simulation and assures co-ordination with measured sectors; such a position may represent 3 or 4 sectors. The CWP requirements for PD/3 are defined in:

[5] PD/3 Operational Scenarios Document Volume 1 - January 1997 / PD/3 Operational Scenarios Document Volume 2 - February 1997

The HMI requirements for PD/3 are defined in:

[6] PD/3 Ground Human Machine Interface Specification V2.1 - August 1997

8.2.2.5 PERSONNEL

The following table is a summary of the required CWP:

Controllers Types	CENA	EEC	NLR
En-route Multi Sector Planner (MSP)	1	2	
En-route Planning Controller (ER PC)	1	4	1
En-route Tactical Controller (ER TC)	1	4	1
<i>Total En-route</i>	<i>3</i>	<i>10</i>	<i>2</i>
ACC Planning Controller (ACC PC)	1	3	1
ACC Tactical Controller (ACC TC)	1	3	1
<i>Total En-route</i>	<i>3</i>	<i>10</i>	<i>2</i>
Arrival Sequence Planner (ARR SP)		1	1
Arrival Planning Controller (ARR PC)			
Arrival Tactical Controller (ARR PC)			1
Arrival Sequence Planner (ARR SP)			2
<i>Total Arrival</i>	<i>0</i>	<i>1</i>	<i>4</i>
Departure Planning Controller (DEP PC)	1		
Departure Tactical Controller (DEP TC)	1		
<i>Total Departure</i>	<i>2</i>	<i>0</i>	<i>0</i>
En-route Feeder	3	7	1
ACC Feeder			2
<i>Total Feeder</i>	<i>3</i>	<i>7</i>	<i>3</i>
Total	10	24	11

8.2.2.6 ROOM LAYOUT

Room layouts for demonstrations shall be defined at each site.

8.2.3 AIR FACILITY

8.2.3.1 GENERAL

The air facility requirement for PD/3 includes:

- Air System;
- Flight Simulators;
- Research Aircraft.

The requirement for each site shall be detailed in each Local Facility Specification.

8.2.3.2 AIR SYSTEM CAPABILITY

The air system facilities to be used in PD/3 simulations include:

	CENA	EEC	NLR
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Air System	MASS	MASS	NARSIM
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In addition to the simulation of current day aircraft operations, the following requirements need to be catered for by the air system facilities:

1. to simulate FMS equipped aircraft with 3D and/or 4D navigation capability;
2. to simulate a 4D trajectory calculation algorithm. This may be based on existing EFMS trajectory calculators or on a more simple general purpose trajectory predictor. It is planned that 70% of aircraft will be 4D equipped;
3. to provide datalink message exchange capability;
4. to cater for voice and data link equipped aircraft. Pilot operator HMI should be able to cope with both of these requirements;
5. support the transfer of flying authority between air facilities and flight simulators and/or trials aircraft. PHARE requires Flight simulators and trials aircraft to participate in PD/3. It is probable that Flight Simulators and Research Aircraft will be used for only part of a given flight; hence this requirement;
6. able to handle at least 20 aircraft per pseudo pilot position. However, this is dependent on each site's air facility capability.

The above requirements shall be detailed in the each Local Facility Specification.

8.2.3.3 FLIGHT SIMULATORS

The objective of including flight simulators is to provide more realistic aircraft behaviour than can be achieved using a MASS-type air server and to provide a greater exposure of pilots to PD/3 concepts, PHARE EFMS and airborne HMI.

Such behaviour includes:

- realistic autopilot, FCS and auto-throttle modelling;
- manual control capability;
- realistic airborne HMI environment;
- realistic pilot/system responses.

The Flight simulators proposed for integration in PD/3 are:

- EEC MCS (and possibly TU Berlin);
- CENA MCS.

The operation of flight simulators in PD/3 should be such that they pose no risk to measured exercises. It is a requirement that their use is clearly defined in the simulation experimental plan at the appropriate sites.

It is possible to use a Flight simulator for only a part of an aircraft's flight, enabling experimenters to concentrate on the areas of flight where the Flight simulator provides greatest advantage in realism over the air server. This requires the ability to switch from air system facility and Flight simulator so as to assure continuity of a flight in the simulation.

A typical application for the Flight simulator is approach sequencing and the co-ordination between airborne software and the Arrival Manager.

8.2.3.4 RESEARCH AIRCRAFT

PHARE requires PD/3 to include research aircraft in its demonstrations. It is considered that this will add realism by having (real) pilots participate in experiments whilst permitting an assessment of trajectory predictor accuracy. It also confirms EFMS capability to the ATM public.

Since research aircraft are likely to be influenced by external constraints that could affect measured exercises (actual weather, technical problems and real traffic control intervention), it is recommended that these aircraft only participate in non measured exercises. This means that specific exercises need to be defined for research aircraft participation.

Because the ground element of PD/3 is split across three sites, each focusing on different phases of flight, the following air/ground partners are proposed:

- CENA Site

Scenario: En-Route inter-sector co-ordination in the departure phase (TMA, ACC, en-route)

Aircraft: DRA BAC 1-11 (Class A or Class B)

- EEC Site

Scenario: En-Route - Multi-Sector Planning (SID exit gate to STAR arrival gate)

- NLR Site

Scenario: En-Route ETMA interaction in the arrival phase (en-route, ACC, TMA)

Aircraft: NLR Citation (Class A or Class B)

DLR ATTAS (Class A or Class B)

8.2.3.5 HARDWARE

Hardware requirements for air systems and Flight Simulators shall be defined in each Local Facility Specification.

Research aircraft hardware for EFMS shall be that provided by the PHARE Airborne program.

8.2.3.6 SOFTWARE

Software requirements for air systems and Flight Simulators shall be defined in each Local Facility Specification.

EFMS and AHMI in the air systems and Flight Simulators shall be that provided by the PHARE Airborne program.

8.2.3.7 PERSONNEL

Pseudo pilots, air system and Flight simulator and research aircraft personnel should be provided with training in PD/3 air and ground concepts and facilities.

The number of pseudo pilot, and pilot positions required for Flight simulators and research aircraft shall be defined in the each Local Facility Specification.

8.2.3.8 ROOM LAYOUT

Room layouts for demonstrations shall be defined at each site.

8.2.4 COMMUNICATION FACILITY

8.2.4.1 GENERAL

Voice and data communication facilities are required for PD/3. These are summarised in the communications diagram, and in the table below.

Requirement	Simulated	Real
Pseudo-Pilots	yes	no
Air Server	yes	no
Ground System	yes	yes
Air Traffic Controllers	yes	yes
Flight Simulators	yes	no
Research Aircraft	no	yes

Communication systems should be “realistic”. However, the level of realism must not be such that it frustrates or compromises the success of the simulation.

The communications requirements are:

1. Voice communication between Air and Ground simulation participants, i.e. between pseudo-pilots, flight simulator pilots, research aircraft pilots and controllers. Each pseudo-pilot will require voice links with one sector only. Normally this shall be to the tactical controller, however, it may be that the Planning Controller will also have access to the voice link. This represents the air-ground voice links. It is assumed that there will be no requirement for voice links between pseudo-pilots and multi-sector planners.
2. Simulated data link communications between the pseudo-pilot and flight simulator HMI, and the ground system. Each pseudo-pilot will require data link to one or more tactical controllers, planners and multi-sector planners, representing air-ground data links.
3. Real datalink communications between ground and the research aircraft used in the simulation.

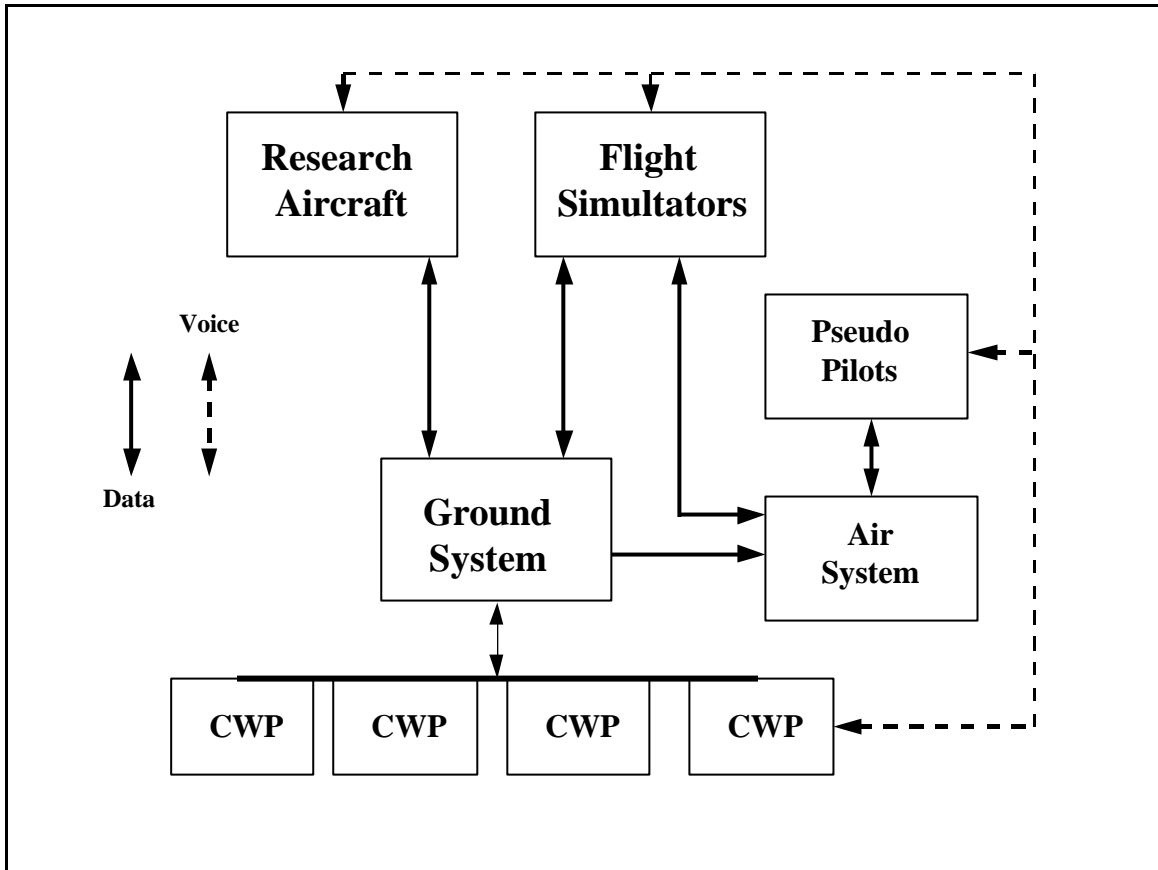


Figure - Voice and Data Communications Diagram

The following CWP will require communications:

En-Route	Extended TMA	
	Arrival	Departure
Multi-Sector Planner (MSP) Planner Controller (ER PC) Tactical Controller (ER TC)	Arrival ACC Planner Controller (AAPC) Arrival ACC Tactical Controller (AATC) Initial Approach Controller (INI) Arrival Sequence Planner (ARRSP)	Departure ACC Planner Controller (DAPC) Departure ACC Tactical Controller (DATC) Departure Planner Controller (DEPPC) Departure Tactical Controller (DEPTC) Local Controller (LOC)

Depending on their role, controllers will need voice and data link with other Air Traffic Controller positions, and with pseudo-pilots, flight simulator and research aircraft crews. This will be defined in each Local Facility Specification.

Aircraft simulators should be integrated in the same manner as air server pilot operators.

Trials aircraft shall be under the control of a "real-world" ATC Centre during the demonstrations and this Centre shall have responsibility for the flight at all times. Nevertheless, the trials aircraft shall require voice and data link communication with the simulation facilities for the periods of "simulated control."

Mode S or SATCOM accessible through PATN is proposed for the integration of research aircraft into the simulation. This may have an effect on demonstrations due to the performance of these systems.

The simulation data communication channels should meet the following performance requirements:

- Minimise worst case delays (so that, for example, the simulation management messages arrive in a timely manner).
- Carry high volumes of data (approximately 50kbits/s are assumed).

8.2.4.2 VOICE COMMUNICATION

The R/T communication channels should replicate “real world ATC.”

Ground voice communications should replicate “real world ATC” with appropriate filtering between R/T and telephone communication. This should provide ground line access between Controller positions appropriate to the planned scenarios.

Detailed telecommunication requirement for linking CWP's shall be specified at each site taking into consideration the Sectorisation and operational concept.

Integration of ground/ground and air/ground voice communications at the CWP should facilitate the controllers' ability to talk to trial aircraft on “live R/T” and pilot operators on simulated R/T at the same time.

It is assumed that:

- the planner and executive controller work as a team (verbal communication) and do not require intra sector communications equipment;
- multi-sector planners may talk to all other multi-sector planners, planners, departure and arrival controllers. It has been assumed that the multi-sector planner to aircraft will be datalink only;
- planners may talk to multi-sector planners, planners, approach and departure controllers at the local and adjacent sectors;
- tactical controller talk to aircraft on one frequency;
- approach and departure controllers talk to aircraft on one frequency;
- approach and departure controllers may talk to departure and approach controllers, to the multi-sector planners and to adjacent sector;
- aircraft talk to only one sector, arrival or departure position.

8.2.4.3 DATA COMMUNICATIONS

Digital data communication requirements have been identified for :

1. ATN experimental or “operational” communications; for ground-air communication between controllers and pilots.
2. Real-time simulation data; for communication of simulation data such as state vectors sent by the air server to the radar simulation.
3. Simulation support communications; for example :
 - Control of the simulation process (start, stop commands).
 - Control of individual flights (start, stop).
 - Monitoring data concerning the overall simulation process.
 - Logging of events and time-periodic data for post-processing.

8.2.4.4 HARDWARE

The following specific hardware requirements have been identified.

Need	Equipment
PATN requires the following	SUN workstations to provide Routers. SUN workstations to provide End Systems. For air-ground communications, Satcom and/or Mode-S equipment.
Voice Switching	Site specific
Air system/Ground system	Site specific

8.2.4.4.1 CWP Equipment

CWP's shall be equipped with the following:

- RTF selection
- Telephone selection
- Headset access
- Footswitch
- Loudspeaker

Each CWP position shall have access to RTF and telephone selection. Communication facilities should have distinct visual indicators showing the states of each RTF channel and each telephone line at that position.

Headset and loudspeakers should have separate volume controls for adjusting levels for:

- live aircraft channel
- simulated RTF
- telephone.

8.2.4.5 SOFTWARE

8.2.4.5.1 Air-Ground Datalink Applications

The following air-ground datalink applications will be required:

- a) Strategic ATC communications Trajectory Negotiation process, including:
 - i) Controller Pilot Data Link Communications (CPDLC) for Frequency Change and Position Reporting (As an alternative to the PR application below.)
 - ii) Down link of Aircraft Parameters (DAP)
Actual aircraft parameters and flight status parameters will be down linked (event driven or periodic) to update and improve the accuracy of the ground database.
 - iii) Position Reporting (PR) to provide aircraft position information.
- b) Context Management (CM)

This application provides the technical means to log-on and log-off the ATN, to exchange identification information and addresses of relevant ground and airborne application processes. May not be required due to the single site application.

8.2.4.5.2 Ground-Ground Datalink Applications

No Ground-Ground Datalink Application is required apart from the Negotiation Manager capability for intersector/inter centre coordination.

8.2.4.5.3 Communications Recording

Communications recording can be separated into two areas:

1. recording of the contents of the communication;
2. recording for statistical analysis concerning the communication activities.

8.2.4.5.3.1 R/T communication recording

Voice recording is required for:

- flight simulators communication channel ;
- live aircraft communication channel ;
- simulated RTF channels ;
- telephone circuits at all operator positions ;
- Direct Voice Liaison (DVL) between operators that occurs when the telephone or R/t are not activated (preferably in the form of a live microphone that is automatically switched off when the operator transmits or receives any transmissions over the communications channels and automatically switched on at the end of such communications).

Separate audio recordings shall be made for each RTF channel and telephone circuit. To permit correlation between recordings, the audio data shall be time-stamped as a coded form of hours, minutes and seconds. The time-stamp shall be synchronised with the same clock used for data logging.

Provision shall be made for continuous recording to cover exercise length plus an appropriate safety period.

8.2.4.5.3.2 Recorded Items

The following parameters shall be logged each time a P/TT switch is operated at any CWP with an RTF channel or live aircraft channel selected for Tx/Rx:

- event identity (i.e. simulated or live RTF);
- identity of "transmitter"
- identity of channel or channels selected for Tx/Rx at "transmitter" position;
- time at which switch operation commenced;
- time at which switch operation ceased (or duration of switch operation).

The following parameters shall be logged each time an attempt is made to establish a telephone call:

- event identity (i.e. telephone call);
- identity of call initiator;
- identity of addressee;
- start time of addressee's incoming call alert.

If the call is answered the following parameters shall also be logged:

- time at which addressee accepted the call;
- time at which the call was disconnected (or duration of the active speech link).

If the call is not answered the time at which the sender abandoned the attempt shall be recorded.

The logging equipment shall contain an internal clock to provide event time data. This clock shall be controllable by the simulation clock (simulation supervisor). Data logging shall only take place with the clock running.

8.2.4.6 PERSONNEL

Communication monitoring and supervision shall request the assistance of technical specialists at each site.

8.2.5 SUPERVISION FACILITY

Monitoring and supervision positions are required for exercise control and shall be local site dependent.

8.3 ANALYSIS SYSTEM

It is important that the data used by the three sites be as consistent as possible to assist with analysis and reporting of exercises.

This will require agreement by PD/3 EG members and the VAL Group. Where appropriate a single preparation of data before delivery to each site.

Data analysis requirements include the following:

Data	Requirement	Single tool
measurement and analysis facilities	should be consistent at each site; should include the VAL requirements as minimum configuration	no
measurement and analysis test data	should be identical at each site	yes

Further detailed requirements for VAL Analysis system are available in the document: [18]
PD/3 Measurement and Analysis Specification : PHARE/NATS/VAL-4.4.2/WP005;0.3.

8.3.1 GROUND FACILITY

8.3.1.1 HARDWARE

8.3.1.1.1 Instantaneous Self Assessment (ISA)

The Instantaneous Self-Assessment (ISA) measurement shall be used during measured exercises.

ISA panel shall be installed on each measured Controller Working Position. This panel shall consist of five numbered buttons. Each of the buttons represents a level of workload.

An off-line recorder file (on a PC) will record controller ISA inputs.

8.3.1.1.2 NASA TLX

PC Based package (EXCEL 5.0) as developed by NATS shall be available in the simulation room.

8.3.1.1.3 Video Recording

S-VHS video recordings, with R/T and direct voice liaison audio signals, should be recorded. The radar screen should fill the majority of the recorded picture. A synchronised timestamp accurate to 0.1 second should also be applied to the recordings.

8.3.1.2 SOFTWARE

8.3.1.2.1 Recording data

Several data require to be recorded during each exercise for measurement and analysis purpose. This data shall be selected according to the low-level objectives.

8.3.1.2.2 Analysis system

Software requirements for analysis system shall be defined in each Local Facility Specification.

8.3.1.2.3 Wilcoxon

Software associated to the Wilcoxon method will be used.

8.3.1.3 PERSONNEL

N.A.

8.3.2 AIR FACILITY

8.3.2.1 HARDWARE

8.3.2.2 SOFTWARE

8.3.2.3 PERSONNEL

8.3.3 COMMUNICATION FACILITY

8.3.3.1 HARDWARE

8.3.3.2 SOFTWARE

8.3.3.3 PERSONNEL

8.3.4 SUPERVISION FACILITY

No requirements related to supervision data analysis.

8.4 TRAINING SYSTEM

The Training shall include:

- Training of the controllers (ground),
- Training of the pilots (air),
- Training of the pseudo-pilots (air),
- Training of the trainers (ground and air)

8.4.1 GROUND FACILITY

The objectives of the PD/3 Ground training shall be:

- 1) Grasping the PD/3 concept
- 2) GHMI-familiarisation
- 3) Learning the procedures (airspace + rules, working methods)
- 4) Tools-familiarisation
- 5) Integration of knowledge and skills
- 6) Skills speeding-up (i.e. building up the required speed of the skills, by varying traffic density and complexity)

The training organisation shall address following parts:

- **Distance Learning (CBT or Paper):**
Concept,
GHMI introduction.
- **Computer Based Training (CBT):**
Concept,
GHMI,
Tools,
Procedures.
- **Standalone PD/3 System (Scenarios):**
Tools,
Procedures,

Integration,
Site and Role specific.

- **Linked PD/3 System (Scenarios):**

Reinforcement,
Practice features,
Speed.

1. Distance Learning

Distance Learning shall train the controller on the PD/3 concept. This preparatory phase shall be valuable and shall permit to reduce the training on site.

The preparatory phase shall consist of general information about PD/3 and an introduction in the PD/3 concept and GHMI.

2. CBT

Computer based training shall contain:

- explanations (e.g. instructions & self-discovery screens),
- graphics,
- animation,
- interactions (e.g. page turning, GHMI),
- trainee monitoring system (e.g. selftests, feedback and adaptive branching).

This part shall contain the common knowledge and skills to be learned and forms the basis for the standalone and linked systems.

There shall also be a branching for role specific GHMI configurations (for each controller the role(s) (s)he will perform in the final demonstration).

The CBT shall address the part-tasks tasks (e.g. how to operate a tool, what is the function of a tool).

The CBT shall be developed using IANS standards.

3. Standalone PD/3 system

Standalone PD/3 system shall reflect the simulation environment based on the PD/3 system, with freeplay activities in different traffic scenarios.

No pseudo-pilots are required.

The ATCO's shall use the system for air traffic control and procedures learning (method of controlling).

4. Linked PD/3 system

The full simulation environment as in the final demonstrations, with pseudo-pilots, headsets, time pressure in different traffic scenarios shall be used for final training.

8.4.1.1 HARDWARE

1. Distance Learning

Distance Learning can be performed on PC computers using CD-ROM facility.

Otherwise some paper instructions can be used.

2. CBT

Computer based training shall be PC based.

3. Standalone PD/3 system

Standalone PD/3 system shall run on the final hardware system used by the PD/3 system.

No link is needed with pseudo-pilots positions.

Number of positions shall be enough to train the number of controllers participating to PD/3 demonstration.

4. Linked PD/3 system

The full simulation environment shall be used for final training.

8.4.1.2 SOFTWARE

1. Distance Learning

Distance Learning can be performed on PC computers using CD-ROM facility.

Otherwise some paper instructions can be used.

2. CBT

CBT software shall be developed with Authorware.

3. Standalone PD/3 system

Standalone PD/3 system shall use the same software than the final PD/3 system.

4. Linked PD/3 system

The full simulation software environment shall be used for final training.

8.4.1.3 PERSONNEL

Trainers shall be trained using Eurocontrol training standards.

1. Distance Learning

Controllers participating to the PD/3 demonstrations will do self training using either the PC based training package or the training paper instructions.

No trainers shall be required.

2. CBT

Controllers participating to the PD/3 demonstrations shall use CBT on standalone, on the site. Trainers shall do assistance.

3. Standalone PD/3 system

Controllers participating to the PD/3 demonstrations shall use Standalone PD/3 system, on the site. Trainers shall do assistance.

4. Linked PD/3 system

Controllers participating to the PD/3 demonstrations shall use the PD/3 system with the full environment including feeders, pseudo-pilots, pilots (MCS, Flight Simulators). Trainers shall do assistance.

8.4.2 AIR FACILITY

The objectives of the PD/3 Air Facility training shall be:

- 1) Grasping the PD/3 concept
- 2) AHMI-familiarisation
- 3) Learning the procedures (airspace + rules, working methods)

- 4) EFMS Familiarisation
- 5) Integration of knowledge and skills

The training organisation shall address following parts:

- **Training of Pilots:**

- Concept,
- AHMI,
- Procedures (airspace + rules, working methods),
- EFMS use,
- MCS of Flight Simulator use,
- Research aircraft parameters and flying procedures.

- **Training of Pseudo-Pilots**

- Concept,
- AHMI,
- Tools (radio, datalink),
- Procedures.

8.4.2.1 HARDWARE

1. Training of Pilots

- **MCS and Flight Simulator Pilots**

- Pilots will be trained on the MCS and Flight Simulators facilities

- **Research Aircraft Pilots**

- Pilots will be trained on the use of the EFMS system on the aircraft

2. Training of Pseudo-pilots

Pseudo-pilots will be trained on the pseudo-pilot positions

8.4.2.2 SOFTWARE

N.A.

8.4.2.3 PERSONNEL

1. Training of Pilots

EFMS team members will train pilots on MCS, Flight simulators and real aircraft.

2. Training of Pseudo-pilots

Local team will train pseudo-pilots on pseudo-pilot positions.

8.4.3 COMMUNICATION FACILITY

Training on communication facility is included in the training of both groundside and airside.

8.4.3.1 HARDWARE

N.A.

8.4.3.2 SOFTWARE

N.A.

8.4.3.3 PERSONNEL

N.A.

8.4.4 SUPERVISION FACILITY

Training on simulation monitoring and supervision shall be local site dependent. Training shall include the monitoring and supervision of both ground side and air side (pseudo-pilots, MCS and Flight Simulators, Research Aircraft).

8.4.4.1 HARDWARE

N.A.

8.4.4.2 SOFTWARE

N.A.

8.4.4.3 PERSONNEL

N.A.

9. CONFIGURATION MANAGEMENT

In addition to locally developed software, PD/3 projects will receive software from the other PHARE projects. A PD/3 configuration management is required.

The EEC where a tool server has been established will provide this service for the PATs. The latest tools deliveries and associated documentation will be recorded at this site and their availability made known to the PD/3 partners.

Local site configuration management should include the following:

- a process to monitor changes in the local platform software, hardware and documentation ;
- a configuration control process to enable cross checks between external deliveries and local site platform capability (this should ensure a record of local software “fixes or patches” that will be used to facilitate the integration of external deliveries to the local site.

A full description of the procedure is available in [17] Contribution to Configuration Management Requirements for PD/3 and provider projects: **PHARE/CENA/PD3-1/WP;1.2**

9.1 REQUIREMENTS TO PROVIDER PROJECTS

Each of the provider projects shall designate a Configuration Manager (CM); the CM shall be the entry point of the project concerning configuration management.

Each of the provider projects shall define adapted procedures for at least:

- software delivery ;
- discrepancy reporting ;
- change proposal.

Discrepancy reporting and change proposal procedure of the provider projects shall be the same procedure as used by PD/3.

9.2 REQUIREMENTS TO PD/3 PROJECT

Each PD/3 partner shall designate a Configuration Manager; the CM shall gather internal information and be the entry point of the local PD/3 project concerning configuration management.

PD/3 project shall designate a Configuration Manager.

9.3 SOFTWARE DELIVERY TO PD/3

Software delivery shall contain software items accompanied by a delivery note.

As a minimum, Delivery Note shall include:

- A functional overview ;
- The software components identification (RCS if acceptable by external projects) ;
- The software generation procedure ;
- The software installation procedure ;
- The test procedure (including expected results) ;
- The required hardware configuration (including compilers information) ;
- The usage constraints, if any ;
- The evolution identification (list of changed files, reference to change request, trouble reports...).

As a minimum, software delivery shall include:

- The sources ;
- The Make files ;
- The binaries (program, data, test data) ;
- The documentation.

Delivered item shall be stored on the PD/3 ftp server with free access for each PD/3 partners. Partners shall be warned of each delivery by mail

9.4 PD/3 DATA BASES

Discrepancy reports and Change Proposal shall be managed in a database.

PD/3 database shall contain information reported by all PD/3 sites.

The form shall be available on the PD/3 WEB server.

Sorting capabilities shall be provided (MS Access Database).

Local databases (at each site) can also be developed and locally maintained.

9.5 DISCREPANCY REPORT IN PD/3

The Discrepancy Reports shall be submitted to the concerned project and to the PD/3 Configuration Manager (PD/3ADM).

The PD/3ADM shall maintain the database and the Discrepancy Report WEB site.

9.6 CHANGE PROPOSAL IN PD/3

The Change Proposal shall be submitted to the concerned project and to the PD/3 Configuration Manager (PD/3ADM).

The PD/3ADM shall maintain the database and the Discrepancy Report WEB site.

10. PUBLIC RELATIONS

10.1 REQUIREMENTS

The PD/3 Executive Group shall define PR requirements.

10.2 VIDEO AND PHOTOGRAPHIC REQUIREMENTS

Publicity photographs shall be required for hand out brochures and reporting on PD/3.

Video recording shall be utilised as a measurement tool. It is likely that a video will be made for controller instruction purposes making it possible to brief controllers without the need to have the system running or to brief controllers whilst a simulation run is in progress.

Video may also be useful for public relations purposes enabling visitors to be briefed without interfering with the simulation.

Video recording of the simulation runs shall form part of the project documentation. The VAL Group shall specify the VAL requirements.

ABBREVIATIONS

4D	Four dimensional
AA PC	Arrival Planning Controller
AA TC	Arrival Tactical Controller
ACC	Area Control Centre
ACM	Aircraft Model
ADEXP	ATS Data Exchange Presentation
AP	Auto Pilot
API	Application Programming Interface
APP	Approach Centre
ARR SP	Arrival Sequence Planner
ATC	Air Traffic Control
ATCO	Air Traffic Controller
ATFM	Air Traffic Flow Management
ATIS	Air Traffic Information System
ATM	Air Traffic Management
ATN	Aeronautical Telecommunication Network
ATS	Air Traffic Services
CAS	Calibrated Air Speed
CPDLC	Controller-Pilot Datalink Communication
CENA	Centre d'Etudes de la Navigation Aérienne
CMS	Common Modular Simulator
CNS	Communication, Navigation and Surveillance
CP	Conflict Probe
DA PC	Departure ACC Planning Controller
DA TC	Departure ACC Tactical Controller
DEP PC	Departure Planning Controller
DEP TC	Departure Tactical Controller
DIS	Distributed Interactive Simulation
DLARD	Datalink Application Requirements Document
DLCRD	Datalink Communications Requirements Document
DME	Distance Measuring Equipment
EATCHIP Programme	European ATC Harmonisation and Integration
EEC	Eurocontrol Experimental Centre
EFMS	Experimental Flight Management System
ER PC	En route Planning Controller
ER TC	En route Tactical Controller
ETMA	Extended TMA
FL	Flight Level
FPM	Flight Path Monitor
GHMI	Ground HMI
HMI	Human Machine Interface
IANAS	Institute of Air Navigation Services
ILS	Instrument Landing System
INI	Initial Approach Controller
IOCP	Internal Operational Clarification Project
ITM	InTerMediate Approach Controller
ISTF	Inter Site Task Force
LAN	Local Area Network
LOC	LOCal controller
MASS	Multi Aircraft Simulator System
MET	METeo project
MSP	Multi-sector Planning Controller
NDB	Non-directional beacon

NLR	National Lucht - en Ruimtevaartlaboratorium
NM	Negotiation Manager
NOTAM	NOTice to AirMen
ODID	Operational Display and Input Devices
OTF	Operational Task Force
PATN	PHARE Aeronautical Telecommunication Network
PATs	PHARE Advanced Tools
PCC	PHARE Co-ordination Committee
PD/1	PHARE Demonstration 1
PD/2	PHARE Demonstration 2
PD/3	PHARE Demonstration 3
PD/3CG	PD/3 Co-ordination Group
PHARE	Programme for Harmonised Air Traffic Research in EUROCONTROL
PC	Planning Controller
PMB	PHARE Management Board
PRT	PD Review Team
PS	Problem Solver
P/T	Press to talk
QoS	Quality of Service
R/T	Radio telephony
Rx	Receive
TMA	Terminal Manoeuvring Area
TC	Tactical Controller
TP	Trajectory Predictor
Tx	Transmit
UIR	Upper Information Region
VAL	VALidation tools project
VOR	VHF Omni-directional Range
WAN	Wide Area Network

REFERENCES

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- [3] PD/3 Operational Scenarios Document. December 1996. Version draft 2. Ref. PHARE/NLR/PD/3-1.1.3.2.2/OSD1;2.0
- [4] E Hoffman, L Malaquin. "XLINK: Connection of Remote Flight Simulators to the EEC Air Systems" SIMU/XLINK_0.4. Revision 0.4 - December 16, 1994
- [5] PD/3 Operational Scenarios Document Volume 1 - January 1997 / PD/3 Operational Scenarios Document Volume 2 - February 1997
- [6] PD/3 Ground Human Machine Interface Specification V2.1 - August 1997
- [7] PD/3 MET Requirements V 4 - January 1997.
- [8] PD/3 Trajectory Predictor : DASR\PD3TP\URD01.
- [9] PD/3 Conflict Probe : PATs/NLR/CP/URD/1.2/97/38.
- [10] PD/3 Co-operative Tools Probe : CENA/NT97-536
- [11] PD/3 Problem Solver : V1.A
- [12] PD/3 Tactical Load Smoother : 1.0
- [13] PD/3 Flight Path Monitor : PATs/NLR/FPM/URD/1.2/97/38
- [14] PD/3 Negotiation Manager : DASR/PD3NM/URD/001
- [15] PD/3 Arrival Manager : Draft 0.1
- [16] PD/3 Departure Manager : Version 1
- [17] Contribution to Configuration Management Requirements for PD/3 and provider projects: PHARE/CENA/PD3-1/WP;1.2
- [18] PD/3 Measurement and Analysis Specification : PHARE/NATS/VAL-4.4.2/WP005;0.3

ANNEX A: ESTIMATED TRAFFIC SAMPLE

The PD/3 Traffic samples are built from the baseline traffic extracted from CFMU data. Following is the PD/3 Traffic Summary for the period 04:00 - 22:00 (21 June 96).

Sector	Number of Aircraft			Flight time
	Entering	Peak	Mean	
AO1	250	7	2.0	3.8
AR1	244	8	2.0	4.1
ARR	837	22	8.1	3.1
BUHWS	822	25	10.1	3.6
BUUCE	262	13	3.1	3.6
BUUWS	554	17	6.0	3.5
COAST	323	14	3.4	3.0
DELTA	614	23	9.7	4.7
E	315	15	3.6	3.3
LUL	1629	40	24.1	4.2
LXNO	1269	40	18.5	3.8
N	146	11	3.3	6.3
NW	140	8	1.3	2.7
SHIP	424	12	1.4	1.6
SOUTH	408	17	5.7	4.4
SW	263	12	3.0	4.0
TBTN	385	13	4.2	3.6
TE	751	25	10.1	4.5
TH	1033	26	11.4	4.6
TP	612	17	5.0	3.2
TS	965	22	9.3	3.4
UNXN	564	18	5.8	3.3
UYUR	494	15	5.3	3.9
XE	448	14	4.2	3.0
Total	5772	241	161	3.8

Detailed traffic samples requirements are described in the each Local Facility Specification.

ANNEX B: PD/3 Meteorological Requirements

1. DATA REQUIREMENTS

1.1 BACKGROUND

The provision of meteorological data is required for the accurate prediction of 4D trajectories by the EFMS and PATS TP. This data will be in the form of a three dimensional grid (latitude, longitude and pressure altitude) for the trials area containing values for air temperature, wind direction and wind speed. QNH for the airports within this area will also be provided. This meteo data will increase the realism of the different operational scenarios tested in PD3. The primary requirement stated is to supply the simulations/demonstrations with a met environment as representative as possible. It has been recognised that PD3 will integrate a met environment but will not conduct specific met experimentation as these are these are to be provided as part of the PHARE Met Project.

1.1 DEFINITIONS

Wind and temperature are provided either from a numerical forecast model (forecast data), from a nowcast model (nowcast data) or from the analysis of the atmosphere (analysed data).

Forecast data: result from the 2 daily runs of a "classical" numerical Met model.

Nowcast data: are real time updates of forecast data generated by the process of mixing forecast data and aircraft observations (aircraft playing the role of sensors of met parameters). The technique used is the same as the one used in the analysis.

It is recommended that the data sampling should be at least one observation within each 4D box. The dimensions of the boxes being:

15 Nm*15 Nm*2000ft*20 minutes for en-route and

7.5 Nm*7.5Nm*1000ft*10 minutes for terminal area.

Measure rates of observations and frequency of observations downlink should ensure that the density of aircraft observations in space and time is sufficient to produce nowcasts with the required accuracy.

It is assumed that the run frequency of the nowcast model will be 20 minutes.

Nowcasting requires a period of time for "listening" to observations before processing can occur. This is called the acquisition phase of data.

Analysed data: the analysis of the atmosphere for time T is performed after a cut off time window centred on time T (currently 3 hours). Analysed data represent the best possible knowledge of the real atmosphere but with at least 3 hours delay. Analysed data are the starting point for operating NWP model. They are computed twice a day for time T=0 and T+12 UTC.

1.3 METEOROLOGICAL DATA NOT CONSIDERED IN PD/3

1.3.1 HUMIDITY

Humidity data is not required by the air servers nor the EFMS in PD/3.

1.3.2 MET MESSAGES

METAR, TAF and SIGMET messages will not be provided for PD/3.

1.3.3 WEATHER RADAR DATA

Weather radar data are not required for PD/3.

1.3.4 PERCEIVED WEATHER DATA

The EFMS will integrate actual meteo data measured in the real aircraft with the forecast data to improve its weather model.

1.4 RETAINED PD/3 MET REQUIREMENTS

The PD/3 simulations will cover the joint FIRs of the Benelux and France (i.e., covering flights from Amsterdam Schiphol airport to Paris Roissy Charles de Gaulle airport, and vice versa. Each ATM simulator participating in the PD/3 simulations will provide its own Meteo Server.

The ATM simulators will not have on-line run-time connections with meteorological offices. All actual, nowcast and forecast weather grids will be supplied in advance of the PD/3 simulations. The MET project will be responsible for the supply, quality and consistency of this data. Up to 3 sets of weather data will be supplied for weather conditions specified below.

The PD/3 simulations will take up to about 1.5 hours. This means that it is sufficient to provide regular sets of weather data, covering 3 hours. They consist of 2 actual weather grids (T0, T0 + 3 hours), up to 10 nowcast weather grids (T0, T0 + 20 minutes, T0 + 40 minutes, etc.) and 4 forecast weather grids (T0, T0 + 1 hour, T0 + 2 hours, etc.).

EFMS-equipped research aircraft taking part in the PD/3 simulations will be supplied with the latest daily forecast data. Nowcast weather grids will not be available for these experiments.

As on-line METARs, TAFs and SIGMETs will NOT be used in the PD/3 simulations, when METARs and TAFs are needed, they will be provided on paper.

1.4.1 MET DATA SAMPLES REQUIREMENTS FOR PD/3 SIMULATOR PLATFORMS

The following co-ordinates shall limit the geographical coverage of the overall area simulated by the three sites:
N46.00.00 > N56.00.00; W005.00.00 > E008.00.00

The introduction of meteo effects in PD/3 will be limited in order to restrict the number of variables in the validation runs. The meteo scenario should not be varied between simulation runs and should present some typical European weather conditions but should not include adverse conditions.

The sets of met data required for PD3 shall include provisions for:

- Wind vectors , Temperature, Pressure Altitude, in grid format;
- QHH (for EHAM and LFPG)
- actual, nowcast and forecast weather grids of 15NM size
- two scenarios:
 - 1 day in summer no major meteo effects (no Cb)
 - spring or autumn

These two samples will allow a further selection to be most representative of the time period of simulated samples.

- no reversal of wind will be required, (but wind velocity and direction change)
- two opposite scenarios for runway configuration (ex CDG W config + CDG E config)
- data shall be provided for periods of 3 hours in order to cover runs of 1h30
- Vertical layers should be provided from SFC to 53000 ft.

1.4.2 MET DATA SAMPLES REQUIREMENTS FOR PHARE EXPERIMENTAL AIRCRAFT IN PD/3

The meteorological forecast to be used by the EFMS equipped aircraft shall be made available in the form of meteorological grids covering the flight trials area, using the same data format to those provided by the UK Met. Office in PD/1 and PD/2. The basic dimensioning used to generate these grids will use spacing of 0.5 degrees of latitude and 1 degree of longitude in order to create grid points approximately 30 nautical miles apart.

Data Formats

The data formats of the forecast met grids will comprise two lines of header information followed by data.

The header information shall include:

Line 1

- Time and Day of the forecast
- Month and Year of the forecast
- Time and Day to which the forecast relates to
- Month and Year to which forecast relates to
- Grid size (number of lat. points x number of log. Points)
- Latitude Origin and increment

Line 2

- number of altitude layers
- altitude of each layer referenced to 1013.25 hPa in feet/100

Blocks formats

LLL PPPP TTTDDDSSS TTTDDDSSS ...

where

LLL is the longitude corresponding to the line of data

PPP is the sea level pressure in (millibars-1000.0)*10.0

for each pressure level

TTT is the temperature in degrees Celsius

DDD is wind direction in degrees (true)

SSS is wind speed in knots

2. MET SERVER SERVICE REQUIREMENTS

It has been seen above that wind components (direction it comes from and speed) and temperature are basic met data. Given that they will be systematically used to compute the predicted trajectory and performed trajectory (by simulated aircraft) these parameters must be computed for every point of space (Lat/Long, FL) and at any time on the basis of data grids. A resolution of 1/4 ϕ (around 15NM) could meet TP requirements. The interface to the meteo system used by the Trajectory Predictor should give its best estimate of the weather at any altitude and position. .

The 4D Meteo server will interpolate the actual weather grids to simulate dynamic weather for the (simulated) aircraft, which is 4D-continuous for all its parameters. The 4D Meteo server will never interpolate the nowcast and forecast weather grids but use the nearest grid point data when necessary.

It is recalled that any details on APIs requirements are not addressed in this document. Functionalities to be met are only listed below.

The met server shall:

- manage loading of the grids with met parameters ;
- manage different sets of data (forecast, nowcast, analysed, nowcast errors) along with time validity ;
- provide computation functions for TP (interpolations, sound speed, volumic mass, delta ISA...) ;
- manage subscriptions, requirements of its clients ;
- manage triggers when new data are available ;
- manage met messages * ;
- manage a function to compute a met route ** (pending) ;
- record any downlink met information from aircraft for later analysis (dedicated to measures oriented towards the aircraft).

* Met messages: It has been agreed that there is no special need for simulated aircraft. So the only information that will be required are those for ATCO information display.

**Met route: This concept is related to the requirement of minimising the accesses to the met server and especially the data flow on the air-ground datalink. The idea is to provide the aircraft with met data (forecast or nowcast) associated to its route.

These met data can be stored aloft by the aircraft and used by the aircraft TP when necessary.

This met route should also be stored on the ground so that uplink of updated met data can be performed when appropriate (according to a threshold to be determined).

The met route should be large enough to avoid numerous accesses to the ground met server each time ATC events lead to trajectory computations or after deviation detection by FPM, but not too large because met updates may concern geographical points far away from the route of the aircraft.

3. POSSIBLE OPERATING MODES OF MET ENVIRONMENT

Several configurations were considered depending on whether there would be a real aircraft or not (cf attachment 1 for more details, the descriptions, the rational as well as the associated comments).

It was decided that only two distinct met environments will support PD3 :

- *one in a context of simulation mode ;*
- *one in a context of live mode.*

3.1 SIMULATION MODE WITHOUT REAL AIRCRAFT

In this case all types of data (forecast, nowcast, analysed) will be supplied by a met office (relevant recorded data) and will be used this way:

- forecast and nowcast data for trajectory prediction (forecast used by ground TP and nowcast used by airborne TP) ;
- analysed data to simulate real atmosphere in which simulated aircraft of the air server are supposed to fly.

There will be no simulated observations and consequently no dynamical nowcast data.

3.2 REAL AIRCRAFT FLYING IN AN AREA DIFFERENT FROM THE ONE USED BY SIMULATED AIRCRAFT (DUE TO REAL ATC CONSTRAINTS).

It is likely that aircraft participating in the demonstration will fly in a reserved area but will be seen as if flying among the other simulated aircraft. There will be a mapping of the real position of the aircraft onto the position it is supposed to be in the simulation.

In this case the only type of met data which will be provided and used is the forecast one. This set of data will be used as pseudo real atmosphere to fly simulated aircraft and for ground and airborne TPs (as well as simulated airborne TPs) to compute the predicted trajectories. The real atmosphere will affect the behaviour of the real aircraft.

The real aircraft will require forecast data for the area it is really flying in

As the position of the aircraft is translated to PD3 area, the air server will use forecast data for the area flown by the real aircraft. Practically this corresponds to a translation in position of the met grids.

4. GLOSSARY

ATIS: Automatic Terminal Information Service

content : Location of the airdrome, validity identification, time of record of the message, expected type of approach, runway in use, significant conditions on runway surface, duration of hold if any, transition FL, useful information for operations (such as modifications of radio/visual aids if any, birds if any, gliders activity if any) wind, RVR, significant weather, cloudiness, temperature, dew point, QNH, QFE, weather significant information in approach area if any, ATIS instructions if any.

METAR: Airdrome observation message (Météo d'Aérodrome)

Fields: Location of the airdrome, time of observation, wind components, visibility, Runway Visual Range, current weather, types of clouds, height of clouds basis, temperature and dew point, QNH recent significant phenomenon.

* ex : snow, rain, fog...

SIGMET: Significant Met Phenomenon message

Content:

- Phenomenon concerned (on subsonic FL): storms, severe turbulence, severe icing, severe hail.
- FIR or UIR concerned.
- forecast evolution in moving and intensity.

TAF: Terminal Area Forecasts

Fields: location of the airdrome, time of forecast, time of validity, wind components, visibility, forecast significant weather, types of clouds, vertical visibility, evolutions and probability associated.

WAFAGE: Winds Analysed and Forecast for Tactical Aircraft Guidance over Europe

ANNEX C: ATN EXPERIMENTAL COMMUNICATION

ATN communication is part of the simulation. The main requirements imposed in order to achieve realism are:

The performance demonstrated on the network should comply with the expected operational performance of a future ATN. If, in operational sense, a compliant network is selected (e.g. PATN), then this will promote realism. At the same time, to accommodate future network performance enhancements, it shall be possible to configure the system to use simulated links that will provide better than current day performances. This will require the capability to simulate air-ground communications via ground-ground means and WAN communications via LANs.

The selected network should be able to work with the expected response performances of a future ATN. Because the simulated traffic density on the ATN is less than under future operational conditions, an additional workload may have to be imposed in order to achieve sufficient realism. Moreover, because most of the Air-Ground datalinks are in fact intra-simulator data transfers, it is required that appropriate simulation of transmission delays is available, at least for Air-Ground communications.

Because pseudo-pilots will not be able to cope with all the required manually performed dialogues, (because of the number of simultaneous controlled flights), it may be required to treat part of the airborne side of the dialogues automatically, simulating manual treatment. This leads to an extra delay modelling requirement, imposed on the network transactions, for simulated pilot responses, which will be put as an additional requirement to the air server.

ATN covers ground-ground communication as well as air-ground communication. Ground-ground datalink communication is concerned with planning and co-ordination. For these exchanges precise timing responses will not be of critical importance except if interactive tools are involved.

Air-ground datalink communication is concerned partly with planning and tactical control. This is time-critical with respect to both the HMI aspects and the requirements of responses for reliable and proper functioning of tools and algorithms. The most time-critical phase of the flight is the approach phase. Applications of optimising approach sequencing are very sensitive to response times as well for automatic tools as for human control functions. These applications will probably only be able to use datalink communication if short message transmission delays are achieved [3].

Considering delays due to transmission and workload congestion, in the strategic phase delays up to about 1 minute may be acceptable, while in the en-route tactical phase delays in the order of 30 seconds may be acceptable, if, at most, datalink is used only as additional communication medium. However, in the approach phase maximum responses of only a few seconds are required.

a) Real-time Simulation Data Communication.

The largest contributor to this communications data class is surveillance information.

Surveillance information must comply with two requirements:

- Surveillance data, after tracking, shall represent a tracked trajectory, that is sufficient realistic to be recognised by the air traffic controller as an (almost) research aircraft.
- Surveillance data, after tracking, shall be realistic enough to allow tools and algorithms to function in a proper way.

Primarily this imposes requirements to the Air Server (see section 6.5) and secondly requirements on data communication.

With respect to data communication capacity, this implies, firstly, that, for the tracking processes, it will be sufficient if new flight status data, e.g. position, speed and heading, are available each 3 to 10 seconds. Secondly, that only surveillance data of flights within coverage of the simulated radar(s), are to be communicated.

The data processing within a real system may allow for extrapolation of time-stamped positions. The surveillance module, simulating radar surveillance and tracking, shall also allow this by providing extrapolation of observed aircraft positions using the time-stamped message data.

Special flights, such as those flown by RFS and MCS, are essentially not different with respect to their contribution to the surveillance information. Provision must be made in the appropriate simulator interfaces for regular reporting of positions using similar formats to the standard air servers.

RFS and MCS will require surveillance information from air servers in support of the visual representation of traffic visible in the direct vicinity of the aircraft (less than 10 NM).

It is possible that this information will be considered essential because it may be judged as replacement for the loss of "third party" information" if tactical control via datalink is used.

Further special processing is required for the research aircraft. Because "real-world" surveillance information will not be available easily and/or not usable, it will be required for this aircraft to determine its position itself (using e.g. the pressure altitude, a GPS receiver or an INS, or using the position and altitude, determined by EFMS), to relay its flight status information to the Ground Station at NLR (by satellite, VHF or SSR mode-S), and for special software to communicate these data afterwards as surveillance data to the Ground Systems. The surveillance information generated in this way will conform the principle of ADS.

Overall, therefore, attention needs to be paid to any significant differences in the delays in communicating positional information to the respective ground systems from each of the platforms providing the air system representation (i.e. air servers, flight simulators and research aircraft).

b) Simulation Support Communications

Simulation control data communications should not normally have a significant impact on the realism of the simulations.

A further exception is the control of flights simulated by flight simulators and research aircraft. If flights are to be properly integrated with the air server traffic it will be important that a flight can be initiated at a precisely defined real and simulated time and place. In addition to the problems of communication delays, this requirement imposes some demands on the efficiency of the start-up procedures of MCS and RFS.

Proper flight start-up procedures will become even more important, if the approach of transferring flight capability between an Air Server and MCS or RFS is required (as well between two Air Servers).

Flight start-up procedures of the research aircraft will be difficult to manage in a realistic and timely way.

Physical Means of Communications

Three classes of digital data communication were identified between the components of the PD/3 demonstration configuration (section):

- Operational ATN communications.
- Real-time simulation data.
- Simulation support communications.

The experimental objectives of PD/3 propose that PATN is used to provide the datalink network for ATN communication [1].

PATN is an implementation of a network. It provides:

- physical means of communication

- routing, error recovery and quality of service software
- application software.

Possible physical means of communication are:

- Satellite (mobile sub-networks)
- SSR mode-S (mobile sub-networks)
- X.25 WAN (fixed ground sub-networks)
- Ethernet (fixed ground sub-networks)

ANNEX D: PSEUDO-PILOT WORKING POSITIONS INPUT ORDERS

Pseudo-pilot positions simulate the activities of pilots in response to voice and computerised messages from the ATC controllers. These responses and activities will result in commands being issued to an associated air server to control the respective aircraft.

One pseudo-pilot will have to control several aircraft, possibly up to twenty in an en-route environment.

All aircraft under the control of a pseudo-pilot will be operating on the same frequency - when an aircraft moves into a new sector, control of it will move to another pseudo-pilot.

The list of commands below is a minimum requirement for PD/3.

List of Commands

Table 1. : Flight entry conditions modification

ORDER	PARAMETER	FUNCTION
Now		Navigation start requested for the flight.
At time	Time	Navigation start requested at specified time.
CFL level	Level	Modify CFL level.
Entry flight level	Level	Modify entry flight level.
New SID	SID	Use specified SID for take off.

Table 2. : Level orders

ORDER	PARAMETER	FUNCTION
Flight Level	Level	Modify altitude to requested level.
Altitude QNH	Altitude QNH	Modify to requested altitude QNH.
Maintain level		Maintain current level.
ROCD	Rate	Modify rate of climb/descent to specified value.

Table 3. : Speed orders

ORDER	PARAMETER	FUNCTION
CAS	CAS	Modify CAS speed to requested value.
Mach	Mach	Modify Mach number to requested value.
Maintain speed		Maintain current CAS or Mach.
Normal speed order		Modify CAS or Mach to normal flight conditions.

Table 4. : Heading orders

ORDER	PARAMETER	FUNCTION
Heading	Angle	Modify heading to specified value.
Left/Right	Angle	Modify heading in the specified direction.
Left/Right	Degrees	Modify heading by specified degrees in the specified direction.
Continue heading		Maintain current heading.
Expedite turn	Angle	Modify heading to specified value with expedite rate of turn.

Table 5. : Flight plan modification

ORDER	PARAMETER	FUNCTION
Resume		Return to original flight plan.
Direct	beacon/point	Navigate to specified beacon or point.
New route	beacons/points and star	Create a new route for the flight through the specified beacons and/or points (optionally) ending with specified STAR.
New STAR	STAR	Use specified STAR for landing.

Table 6. : Other orders

ORDER	PARAMETER	FUNCTION
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Orbit	direction (left/right)	Orbit in a specified direction until further notice.
Hold	beacon/point	Hold at specified beacon or point until further notice.
Leave hold		Leave current hold.
Cancel hold		Cancel future hold.
Offset	direction (left/right) and distance	Offset specified distance in specified direction.
Cancel Offset		Cancel future offset.
Intercept radial	beacon/point inbound/outbound	Intercept specified beacon or point radial towards or away from the beacon or point.
Intercept LOC		Intercept localizer.
Transfer	Frequency/position	Transfer flight to specified frequency or position.
Bearing and distance	beacon/point	Request bearing and distance from beacon or point to flight.
Reach at time	time and order	Execution order ends at specified time.
Reach in minutes	time and order	Execution order ends in specified minutes.
Reach at beacon	beacon/point and order	Execution order ends by reaching specified beacon/point.

Table 7. : Flight equipment modification

ORDER	PARAMETER	FUNCTION
Squawk ident		Squawk ident requested.
Transponder status	on/off	Switch transponder on/off.
SSR code		Modify SSR to specify value.
Mode C status	on/off	Switch Mode C on/off.

Table 8. : Delayed orders

ORDER	PARAMETER	FUNCTION
Start at time	time and order	Execution order begins at specified time.
Start in minutes	minutes and order	Execution order begins in specified minutes.
Start at NM from beacon	distance beacon/point and order	Execution order begins at distance from specified beacon/point.
Start at beacon	beacon/point and order	Execution order begins at specified beacon or point.
Start at radial from beacon	beacon/point and order	Execution order begins at radial from specified beacon or point.
Start at level	level and order	Execution order begins at specified level.