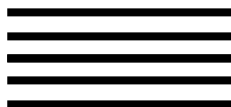
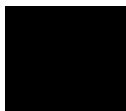


PROGRAMME FOR
HARMONISED AIR TRAFFIC
MANAGEMENT RESEARCH
IN EUROCONTROL



DOC 97-70-08

EUROPEAN ORGANISATION FOR THE SAFETY OF AIR NAVIGATION, EUROCONTROL



PD/3 Operational Scenarios Document

(VOLUME II)

PHARE/NLR/PD3-1.1.3.2.2/OSD2;2.0



EUROCONTROL

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PD/3 Operational Scenarios Document

(VOLUME II)

PHARE/NLR/PD3-1.1.3.2.2/OSD2;2.0

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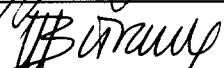
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February 1997	Draft Version 2 for PD/3 Co-ordination Group	Update following an evaluation by PHARE partners
March 1997	Version 2	Include comments from AHMI. Changes in list of acronyms.

PD/3 Operational Scenarios Document

(VOLUME II)

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Forewords

The PD/3 Operational Concept expressed initially in the PD/3 Demonstration Operational Specification (PHARE Document 95-70-02, March 1995) and further adapted in this PD/3 Operational Scenario Document, was largely elaborated under the supervision of Marc Le Guillou, CENA, former Chairman of the PD/3 Operational Task Force, who died on 8 September 1996. He has been a major direct contributor to this document.

Marc Le Guillou was deeply involved in the PHARE programme since 1989 and was a member of the PHARE Co-ordination Committee. He was acting Project Leader for the PHARE Demonstration 3.

TABLE OF CONTENTS - Volume II

1.	SCOPE OF THE DOCUMENT	9
2.	DESCRIPTION OF ATCO'S ROLE AND TASKS	10
2.1	INTRODUCTION.....	10
2.2	BASELINE ORGANISATION.....	11
2.2.1	Introduction to the Organisation.....	11
2.2.2	Controllers' Roles	13
2.2.3	Detailed Tasks Description.....	15
2.3	ADVANCED ORGANISATION	22
2.3.1	Introduction to the organisation.....	22
2.3.2	Controllers roles	22
2.3.3	Multi-Sector Planning Controller - MSP.....	24
2.3.4	En-Route Planning Controller - ER PC	33
2.3.5	En-Route Tactical Controller - ER TC.....	39
2.3.6	Arrival ACC Sector Planning Controller - AA PC.....	44
2.3.7	Arrival ACC Sector Tactical Controller - AA TC.....	50
2.3.8	Departure ACC Sector Planning Controller - DA PC.....	55
2.3.9	Departure ACC Sector Tactical Controller - DA TC.....	59
2.3.10	Arrival Sequence Planning Controller - ARR SP.....	62
2.3.11	Initial Approach Controller - INI.....	67
2.3.12	Intermediate Approach Controller - ITM.....	70
2.3.13	Local Controller - LOC.....	73
2.3.14	Departure Controller - DEP PC	75
2.3.15	Departure Tactical Controller - DEP TC.....	81
3.	DESCRIPTION OF ROLE OF EQUIPPED AIRCRAFT AND PILOT.....	85
3.1	INTRODUCTION.....	85
3.2	TACTICAL AND STRATEGIC CONTROL.....	85
3.2.1	Hybrid control.....	85
3.2.2	Ground prediction	86
3.2.3	Contracts	86
3.3	EFMS EQUIPMENT	87
3.4	COCKPIT EQUIPMENT.....	87
3.4.1	Introduction	87
3.4.2	CDU	87
3.4.3	Navigation interface.....	88
3.5	EFMS START-UP.....	88
3.6	ROUTE SELECTION AND PREDICTION.....	89
3.7	NEGOTIATION CONTROL.....	90
3.8	COMMUNICATIONS.....	91
3.8.1	R/T.....	91
3.8.2	Data-link.....	92
4.	COMMUNICATIONS.....	93
4.1	OVERVIEW	93
4.2	OPERATIONAL DATA-LINK APPLICATIONS REQUIREMENTS	93
4.3	TRAJECTORY NEGOTIATION PROCEDURES	95
4.3.1	Introduction	95
4.3.2	Sequence of events for the air-ground trajectory negotiation dialogues.....	96
4.3.3	Trajectory Negotiation and EFMS.....	100
4.3.4	Trajectory Negotiation and the ATC ground system.....	103
4.3.5	The trajectory negotiation concept and the airborne HMI.....	105
4.3.6	The trajectory negotiation concept and the ground-based HMI.....	106

4.3.7	"Sector contract approval"	106
5.	REQUIRED HMI FACILITIES, FUNCTIONS AND TOOLS	109
5.1	INTRODUCTION.....	109
5.2	REQUIREMENTS FOR THE ADVANCED ORGANISATION.....	110
5.2.1	Required HMI Facilities, functions and tools of the MSP Controller Working Position.....	110
5.2.2	Required HMI Facilities, functions and tools of the ER PC/TC Controller Working Position.....	112
5.2.3	Required HMI Facilities, functions and tools of the ARR SP/ARR TC Controller Working Position.....	116
5.2.4	Required HMI Facilities, functions and tools of the DEP PC/TC Controller Working Position	118
6.	DEFINITIONS AND ABBREVIATIONS.....	121
6.1	DEFINITIONS.....	121
6.2	ABBREVIATIONS	123
7.	REFERENCES	126
8.	ANNEX A: AIRSPACE: SELECTION AND ORGANISATION.....	127
8.1	AIRSPACE ORGANISATION	127
8.2	SIMULATED AIRSPACE.....	127
8.2.1	Summary of Present-days Airspace and Airspace Structure, relevant to PD/3.....	127
8.2.2	Detailed Present-days Airspace Organisation, relevant to PD/3.....	132
8.2.3	Adjacent Airspace	136
8.3	POSSIBLE AIRSPACE SELECTION APPLICABLE TO EACH DEMONSTRATION SITE IN PD/3.....	136
8.3.1	CENA	136
8.3.2	NLR.....	137
8.3.3	EEC	139

1. SCOPE OF THE DOCUMENT

This document, Operational Scenarios Document Volume 2 (OSD Vol.2) complements OSD Volume 1 issued in January 1997. Volume 1 detailed objectives of the PHARE Demonstration programme and supplied an overview of the operational scenario. A general description of the airspace, ATC organisation and roles and tasks was provided to enable the framework of the experiments to be planned.

Volume 2 of the Operational Scenario Document enlarges significantly on Volume 1 in areas such as the Baseline and Advanced Organisations and provides further detail concerning controller tasks, communications, GHMI requirements and the role of equipped aircraft. Although not exhaustive, where the need for operational specification has been identified, the implications have been researched, discussed with other concerned groups and the most suitable operational procedure described. At this level the specification procedure has often needed to be based on theoretical understanding of the principles involved and the technical capability of the ATC tools. It is anticipated that some development and refinement of the concepts will be required to ensure, a completely successful implementation is possible.

The two OSD Volumes combined, form a detailed description of the operational scenario for reference in planning and implementing the final demonstrations of the PHARE Demonstration 3 (PD/3).

This document represents Volume 2 of the second version of the deliverable of the task PD/3-1.1.3.2.2 "Refine the Operational Scenarios". As for OSD Volume 1, the PD/3 Operational Scenarios Document includes results from IOCPs, PD/1 and PD/2, as far as available and takes into account lessons learnt. The OSD combined volumes (OSD Volumes 1 and 2) are issued as the Operational Scenario Document of PD/3, and will contribute to specification of the PD/3 final demonstrations.

2. DESCRIPTION OF ATCO'S ROLE AND TASKS

2.1 INTRODUCTION

This chapter provides a description of the ATCOs Roles and Tasks, defined in the Baseline and Advanced Organisations. The aim of the PD/3 programme, to demonstrate advanced operational concepts, is supported by the assistance of new tools, the introduction of 4D negotiation and 4D planning and the imposition of a high-level planning layer provided by the Multi Sector Planner.

The Baseline Organisation describes a scenario where ATCOs Roles and tasks closely, but not exactly map those available in today's ATC organisations. Some electronic assistance is provided to the controller, however assistance from the main concept tools, 4D Datalink Communication and Multi Sector Planning is withheld.

The Advanced Organisation describes a scenario, based on air-ground integration and with the full complement of assistance tools including Arrival and Departure Management, Problem Filtering and Analysis, 4D Trajectory planning, 4D Trajectory Negotiation and the introduction of Multi Sector Planning. The aims are to better distribute workload, increase capacity and improve flight efficiency.

The specific ATCOs roles to be provided are based on the selected demonstration airspace, between Charles de Gaulle Airport, Paris, France and Schiphol Airport, Amsterdam in the Netherlands, composing part of the core area of Europe targeted by the PD/3 programme. The ATCOs Roles and Tasks are naturally concerned with the sectorisation and predominant traffic type for each sector. They are classified for the Baseline and Advanced Organisation in section 2.2 and 2.3, depending on the service provided to air traffic and the tasks associated with provision of that service. ATCOs roles are defined as either Planning or Controlling. Tasks attributed to each role are then further described with reference to planning, problem solving and traffic analysis, aircraft communication, trajectory negotiation, ground co-ordination, system interaction and the monitoring or surveillance responsibilities.

The following Role and Task descriptions are simple decompositions. They are guidelines to working methods and should be viewed as flexible in the direct mapping of the roles and the manning of the sectors.

2.2 BASELINE ORGANISATION

2.2.1 Introduction to the Organisation

2.2.1.1 Purposes of this scenario and constraints to be met

- Purpose : The Baseline Organisation is a reference close to the today's operational situation derived from the Baseline Organisation of PD/1 and Organisation 1 of PD/2. Its purpose is to enable assessment of the Advanced Organisation by comparing the results obtained from each organisation while the target airspace and traffic samples remain identical in both cases and while the technological environment and the controllers' roles and tasks are different.
- Constraints : In order to minimise development efforts the baseline should operate with facilities adapted from the Advanced Organisation.

2.2.1.2 Guide lines to read the task description

The description of differences with regard to the Advanced Organisation are listed under the heading "differences".

There will be no specific description for roles and tasks of ETMA controllers (AA PC/TC, DA PC/TC), as these roles are integrated in a standard Controller Working Position description in the Baseline Organisation.

2.2.1.3 Main features

The roles and procedures used for the Baseline Organisation will be based on current practices such as those used in the Dutch and the French ATC but with some assistance functions conveyed by the electronic environment such as :

- electronic co-ordination (message in, message out windows),
- entry and exit aids (sector inbound lists, and, possibly, sector exit lists),
- vertical aid window (as a consequence of a basic form of conflict detection),
- trajectory prediction (flight leg display, without input facility),
- conflict probing (in En-route areas),
- arrival sequencing and scheduling (within TMA only).

The computer assistance is strip-less and the air-ground communications are performed via R/T (no air-ground data-link available).

The Planning Controller plays an assistant role to the Tactical Controller, proposing co-ordinations for both entry and exit conditions. The Tactical Controller is responsible for separation, and performs most of the tasks, mainly monitoring, conflict detection and resolution.

2.2.1.4 The operational context

The concepts of Multi Sector planning, Air/Ground integration (including Trajectory Negotiation) and requirements, resulting from the cognitive engineering approach, do not exist in the Baseline Organisation. The impact on the working procedures is as follows (with regard to the Advanced Organisation):

Air/Ground communication:

Communication is performed via R/T only, thus not enabling extra data exchange.

Ground/Ground communication:

The process supporting silent explicit or implicit co-ordination is the same as in the Advanced Organisation, but with no enhancement of the exchanged data with regard to today's situation. This means that the exchanged data is based on flightplan, and not on trajectory information.

Airspace organisation:

The airspace organisation is the same as that described hereafter in the Advanced Organisation chapter, except that standard procedures (SID, STAR, Letters of Agreement) are not put into question by a preliminary planning Process (no MSP, no preferred trajectory submitted during the departure negotiation).

ATC organisation:

The Baseline Organisation is defined to be used as a reference in the measurement of benefits achieved through the Advanced Organisation, in the following airspace :

- TMA (departure and arrival, APP)
- ETMA (ACC)
- En-route (UAC)

The manning of these sectors has to be as close as possible to today's organisation, although some simplification of the final approach (or initial departure) work is admitted, so the resulting set of roles will be the following :

1.	ER PC	En-Route Planning Controller
2.	ER TC	En-Route Tactical Controller
3.	ARR SP	Arrival Sequence Planning Controller (APP)
4.	ARR TC	Initial Approach Controller (APP)
5.	DEP PC	Departure Planning Controller (APP)
6.	DEP TC	Departure Tactical Controller (APP)

The relationship between type of sector, type of airspace and controller roles is shown in the table hereafter :

sector	airspace	short-term planning	tactical control
En-Route	UAC	ER PC	ER TC
ACC (arrival)	ETMA/FIR	ER PC (AA PC)	ER TC (AA TC)
ACC (departure)	ETMA/FIR	ER PC (DA PC)	ER TC (DA TC)
APP (arrival)	TMA	ARR SP	ARR TC (INI + ITM)
APP (departure)	TMA	DEP PC	DEP TC

2.2.2 Controllers' Roles

2.2.2.1 Area of responsibility:

- **En-route control entities (ACC and UAC) :**

- as in the Advanced Organisation, the area of responsibility of each control team is defined by the geographical and vertical limits of the sectors (including delegated airspace in an adjacent sector).
- areas where common co-ordination is required are different:
 - between two UAC sectors : as there is no MSP pre-routing, traffic flows will be more compliant with LoAs (Flight Plans kept as initialised)
 - from an UAC to an ACC sector (arrival flow) : as there is no MSP pre-routing, traffic flows will be more compliant with LoAs
 - from an ACC to an UAC sector (departure flow) : no major difference with the Advanced Org (except no anticipated integration into overflight flows).
 - between ACC and APP :
 - as a fixed airspace structure will be kept, most of the co-ordinations will use the metering fix as a transfer point (along the STAR),
 - as there will be no trajectory negotiation, there will be no agreement between APP and ACC on the aircraft preferred trajectory.
 - along arriving flows, the handling of different flows towards the metering fix will still be the responsibility of ACC controllers, there is no point in asking the ARR SP to try and co-ordinate far in advance.

- **Approach control entities (APP) :**

- along departure flows, from departure gate (before push-back) until the TMA boundary (SID exit point) , which is similar to the Advanced Org.
- along arriving flows , from the arrival metering fix area up to the runway.

2.2.2.2 Planning time and distance horizon:

- **Tactical controllers in all types of airspace** : their area of responsibility is the same as in the Advanced Org.
- **Planning controllers** : as in the Advanced Organisation, the flight information is available 10 minutes before sector entrance for an UAC or an ACC ARR sector and, for an ACC DEP sector, 10 minutes before departure (instead of 30 minutes earlier). In addition to that, because there's no 4D flight and no anticipated planning, this information is not stable enough at this time to enable an active preparation of the sector transit plan. So far as ACC departure sectors are concerned, they will not be informed or consulted about the flight preferred trajectory.

2.2.2.3 HMI facilities, functions and tools

- **General** : no Data Link (meaning no contracted trajectories), no FMS with 4D guidance capabilities, but a simple Trajectory Predictor, limited conflict detection and monitoring. RPVD with trajectory display facilities, (no editing, no what-if facilities), STCA, Sector Inbound Lists, Conflict Risk Display, Message In and Message Out windows for inter-sector co-ordination.
- **En-route** : no Problem Solver, no Co-operative Tools.
- **Departure** : no Departure Manager (only RPVD and departure/in-flight lists)
- **Arrival** : Arrival Manager with a reduced range of functions (TMA sequencing and solving the overflow of the arrival capacity by manual stack control)

2.2.2.4 Roles

- **En-Route PC** :
 - **as in the Advanced Org** : assesses the traffic, starting from 10 minutes before flight entering the sector (anticipation on control problems with the CP/CRD), management of entry conditions in relation to the giving PC. Once a flight is assumed assisting the TC in his monitoring task and co-ordinating the exit conditions with the next receiving PC.
 - **different from the Advanced Org** : does not prepare resolutions for the TC other than co-ordination of entry conditions (**no sector transit plan and limited Planning Authority**). In ACC sectors, does not take time constraints into account (**arrival time constraints not available in ETMA**). Assistance tasks emphasised, preparation tasks limited to the problem detection phase (manual identification of problems to the TC).
- **En-Route TC** :
 - **as in the Advanced Org** : monitors the sector traffic situation, resolves the outstanding problems (conflict situations left pending in the CRD) and copes with unexpected situations. The ER TC has the final authority to issue a clearance.
 - **different from the Advanced Org** : is actually using R/T communications with all the aircraft and performs tactical control without support of any sector transit plan. No specific communication support between PC and TC (**no problem label, no transit plan**).
- **ARR SP** :
 - **as in the Advanced Org** : plans flights within the TMA to cope with the arrival sequence and is responsible for preparing appropriate co-ordinations with ACC over the Metering Fix. Assisting the ARR TC in his tactical handling of the flight.

- **different from the Advanced Org** : limited support to manage a sequence over the Metering Fix, resulting in less anticipated co-ordinations with the giving ACC PC. No transit plan received from the ACC PC. No co-ordination with UAC sectors.
- **ARR TC** :
 - **as in the Advanced Org** : accepts and merges traffic over one or several metering fixes and guides this traffic to final approach. Monitors the sector traffic situation (STCA) and copes with unexpected situations. Has the final authority to issue a clearance.
 - **different from the Advanced Org** : is actually using R/T communications with all the aircraft for guidance.
- **DEP PC** :
 - **as in the Advanced Org** : takes the CFMU departure scheduling into account and prepares the departure sequence. Plans flights within the TMA and co-ordinates the tactical phase with aircraft and DEP TC. After take off, assists the DEP TC with monitoring and co-ordination activities. The PC is responsible for co-ordinating the pre-departure clearance with the Start Up Controller, who will issue it.
 - **different from the Advanced Org** : pre-flight exchanges performed by VHF, no support to manage the departure sequence.
- **DEP TC** :
 - **as in the Advanced Org** : the TC receives control responsibility from LOC after take off and copes with unexpected situations. Has the final authority to issue a tactical clearance.
 - **different from the Advanced Org** : is actually using R/T communications with all the aircraft for guidance.

2.2.3 Detailed Tasks Description

2.2.3.1 En-Route Planning Controller - ER PC

- **Awareness of traffic load and complexity** (no concept of "problem situations"):

The ER PC shall have a synthetic view of the future traffic situation, in order to integrate the traffic and to anticipate actions according to the estimated workload level. He shall have also a view of the potential conflicts within the sector, in order to see when and where the conflicts will appear for defining his strategy of actions.

Differences: no synthetic view of problem situations available: the complexity assessment is based on Sector Inbound Lists

- **Flight integration** (mental planning, but without any input except co-ordination):

- **Validating aircraft sector entry and exit conditions:**

- assess the entry and exit conditions for each aircraft proposed to the sector .
- analyse the flight information so as to fix entry conditions that enable avoidance of unacceptable conflict situations.

Differences : no multi-sector transit plan from a MSP

- **Detecting problem situations through analysis of conflicts and SILs:**

- analyse the flight information so as to detect sector problems. The problem will have to be solved at a later time by a tactical manoeuvre.
- transfer the remaining problems to the TC

Differences : no support to problem management and problem transfer to the TC

- **Preparing sector problem resolution (without clearance system input):**

- preparing flight plan updates, to be used by the TC as a support for tactical control

Differences : no clearance preparation input

- **Co-ordination with Adjacent Sectors:**

- **Implicit and explicit co-ordination on sector entry and exit conditions with controllers of adjacent sectors and areas**

- **Co-ordinating on entering traffic:**

- assess the entry and exit conditions for each aircraft proposed to the sector.
- co-ordinate on the sector entry condition, required for solving conflicts in the giving sector resulting in an adapted sector entry transfer condition. Co-ordination on the sector entry condition can be required as result of a tactical control action in the giving sector. Planning conflicts to be solved in the actual sector, may also require co-ordination.

- **Co-ordinating on exiting traffic:**

- solve a transfer problem and change transfer conditions : implicit co-ordination is possible for default transfer conditions. Explicit co-ordination can be required to solve particular planning problems, exceeding possible default solutions. The ER TC of the giving sector implements the updated transfer conditions.

Differences : no trajectory or contract update, only flight plan input

- **Co-ordination with, and assistance to the ER TC:**

- **Co-ordinating with the ER TC:**

Differences : manual identification of problems to the ER TC and suggesting clearances instead of preparing them.

- **Assisting the ER TC**

- **Monitoring the traffic situation:**

Differences : no sector transit plan to be used as a reference, the ER PC monitors the flights' behaviour as an assistance task to the PC which is to be performed between the assume of the flight and its transfer.

- **Stack control (applicable to ACC only) :** planning aircraft for holding manoeuvre on the stacks, monitoring and control the stacks and co-ordination with APP and other ACC controllers.

2.2.3.2 En-Route Tactical Controller - ER TC

- **Keeping awareness of the traffic situation** : The ER TC shall have an overview of the traffic situation resulting from the integration work prepared by the ER PC, and should have a clear understanding of the flight plans.
- **Conflict Management and Maintaining Separation** : assess flight trajectories and work out resolutions, so as to provide separation between aircraft under his control. Monitor flight plan and clearance compliance, while resolving conflicts by providing tactical intervention. Tactical intervention shall be effected via R/T only.

Differences : no pre-planning made , and no system support providing the identification of conflicting traffic situations already made by the ER PC.

- **Preparing and executing Conflict Resolution Clearances**: solve conflicts by providing tactical intervention. Tactical intervention shall be effected via R/T only. Monitor clearance compliance.

Differences : no pre-planning made by the ER PC. No traffic mix : issued clearances should be achievable by non equipped aircraft; consequently, possible use of open ended clearances.

- **Managing Communication with Aircraft via R/T**: ensure that two way R/T communication is established with all aircraft under his control. Clearances via voice communication should be followed by appropriate flightplan updates. Voice communication is performed by the TC, the actual flightplan updates may be performed also by the PC under the authority of the TC.

Difference : the use of R/T is fundamental, as it is the only means to communicate with aircraft.

- **Co-ordination with adjacent sectors** : accept entering traffic and transfer exiting traffic. The ER TC shall co-ordinate directly with the ER PC or ER TC (as appropriate) of the next receiving sector, if required. Co-ordination is required if complex conflict resolution needs tactical intervention by the ER TC, prior to a transfer to the next sector. The ER TC shall accept each entering flight at or around the sector entry waypoint. The flight is released by the TC of the previous sector. The pilot is supposed to contact the ER TC. If the pilot does not, the TC can try to contact him. The ER TC transfers the flight in the area of common interest, if the required clearances have been supplied to meet the sector transfer condition and if no separation problem is foreseen within the sector. A clearance to change frequency is given via R/T .
- **Co-ordination with the ER PC**: take over part of the work of the TC, while the TC can focus his attention on his primary task of maintaining separation. The TC and PC are working as a team. The first task to be taken over by the PC is the implementation of flightplan updates; the second is monitoring the completion of the clearances issued by the TC.
- **Monitoring Aircraft behaviour and the Actual Traffic Situation** : monitor the actual traffic situation and traffic adherence to flight plans, issued clearances and transfer conditions. ER TC shall be ready to intervene with tactical clearances in the event of unexpected conflict or urgency situations.

The description of the following tasks is specific to the ARR ACC sectors :

- **Arrival Management and Stack control** : deliver aircraft on scheduled time to the Metering Fix and, if required, management of aircraft in the holding stacks.

2.2.3.3 TMA Arrival Planning Controller - ARR SP

- **Re-planning and deconflicting** :

- Re-planning and deconflicting over the APP arrival sector : co-ordinating the planning of all arrival traffic entering the TMA up to touch-down. Arrival traffic, coming from several ACC sectors has to be merged into one or more arrival sequences, depending on the runway configuration in use and depending on the imposed constraints, such as planned departures and interference between different arriving and departing traffic flows. After entrance of the TMA and after passing the Metering Fix, replanning and deconflicting is achieved by supporting the ARR TC.

Difference : limited system support to plan delays over the Metering Fix. No automatic optimisation of the arrival sequence metering.

- **Assuring the re-insertion of Missed Approach Aircraft in the Arrival Sequence:** the ARR SP shall be responsible for the re-insertion of missed approach aircraft into the arrival sequence. He shall co-ordinate with the ARR TC.

- **Co-ordination with adjacent and giving sectors:**

- Co-ordinating on inbound traffic: keeping an overview of the different inbound arrival traffic flows and controlling the optimal metering and spacing of these flows and the optimal merging of these flows into one or more arrival flows on final approach.

Difference : less flexibility to delegate part of the replanning and deconflicting tasks to the ACC and no uplink of constraint to UAC sectors because there is no support to plan delays and transfer conditions over the Metering Fix and no support to propagate them. No en-route descent advisories for en-route arrival traffic. The arrival management process starts at the same time as in the Advanced Organisation, but without explicit co-ordination between en-route sectors and the ARR SP. Thus, the co-ordination process starts significantly closer to the airport but it is achieved by the concerned TC(s) in a way based on current practice (no optimisation through co-ordinating with the ARR SP).

- Co-ordination on holdings in the stack : co-ordinate on the planning of holding aircraft in the inbound stack area, if required. The time of leaving the stack is planned by the ARR SP and tactically, the moment of leaving the stack is determined by the TC responsible for the stack management, co-ordinating with the ARR TC who gives the permission for a transfer of the aircraft on the Metering Fix.
- Co-ordinating on outbound traffic with LOC (Tower Control): co-ordinating with LOC to achieve an optimal use of the landing capacity in a safe, orderly and efficient way.

Differences : no system support to deal with the interactions between arriving and departing flows (no AM/DM interface)

- **Co-ordination with and assistance to the ARR TC** : assist the ARR TC in preparing and implementing the clearances. He shall use the basic AM advisories for resequencing. The feed-back

control process of optimal metering and spacing on final approach continues after passing the Metering Fix. The aircraft is under control of the ARR TC and the ARR SP will assist him in his executive task.

Differences : no planned sequence over the Metering Fix.

- **Monitoring the traffic situation :** monitoring the traffic situation over the full distance of optimal arrival sequencing and monitoring that scheduled runway landing times are enforced. Monitoring the tactical actions in the TMA.
- **Participation in use of the runway capacity :**
 - Participation of assigning the runway configuration in use: co-ordinate with DEP PC and LOC (Tower Control), if the runway configuration is to be changed. And if the configuration is to be changed at which moment and how the transition to the new configuration is achieved. Adapt the planning of arrival traffic accordingly including the STAR assignment.
 - Determination of scheduled landing slot-times: arrival slot-times are based on an initial capacity planning of arrival traffic. These slot-times are particularly critical, if shared use of one or more runways is applicable for departure and arrival traffic. The Estimated Times of Arrival (ETA's) are adapted to meet the **arrival slot times** (less accurate than arrival sequencing).
 - Co-ordinating with the DEP PC and LOC (Tower Control) on use of runway capacity: co-ordinate on arrival planning with DEP PC and LOC (Tower Control), if shared use of the capacity of a runway is applicable.

2.2.3.4 TMA Arrival Tactical Controller - ARR TC

- **Maintaining Separation, solving remaining conflicts while Creating an Arrival Sequence :** maintaining conflict and wake vortex separation between aircraft under his control. Ensuring compliance with AM and creating a runway sequence by merging traffic flows from the arrival gates using, in preference order, first, vertical separation (+ speed) and then path-stretching (+ speed) in order to ensure the correct arrival sequence of traffic on final approach or the appropriate landing aid prior to transfer to the LOC.
- **Managing Communication with Aircraft :** ensuring that two ways R/T communication is established with all aircraft under his control.
- **Co-ordination :**
 - Co-ordinating with the ARR SP as his assistant: transferring part of his preparing tasks and system input handling to the ARR SP, if the workload due to his primary task of maintaining the separation and metering and spacing of arrival traffic, requires this.
 - Co-ordinating the transfer of arrival flows to the LOC: co-ordinating the arrival sequence with the LOC in the event that AM metering requirements have not been complied with.
- **Updating the Ground System :**

Difference : no update of the ground system via a trajectory editing tool.

- **Monitoring Aircraft Trajectories and the Actual Traffic Situation :** monitoring the actual traffic situation and traffic adherence to arrival sequence clearance and final approach spacing for conflict and

wake vortex separation. The ARR TC shall maintain traffic situation awareness and be ready to intervene with tactical clearances in the event of unexpected conflict, urgency situations or runway capacity changes. The closed loop of control and monitoring of air traffic in the approach phase is a highly intensive process of corrective action and of monitoring the effects. Reaction times are short and therefore monitoring and control tasks are almost totally absorbing the capacity of the TC.

2.2.3.5 TMA Departure Planning Controller - DEP PC

- **Departure Sequencing, and pre-departure planning** : working out the departure sequence taking into account the ground and departure runway situation. This planning is based on the ATFM (CFMU) capacity planning. If available, arrival slot times assigned by the AM will be taken into account.

Differences : no DM to give support to the departure sequence definition, resulting in a shorter anticipation for departure planning.

- **Validating and Co-ordinating Aircraft Departure Conditions**: achieving the departure sequence for each aircraft and re-negotiating conditions with LOC in the event that an improved departure sequence can be achieved or that the planned sequence can not be met.
- **Validating and Co-ordinating Aircraft Exit Conditions** : assessing the TMA exit conditions for each departure and re-negotiating conditions in the event that the planned sequence is not achievable. The main concern of replanning shall be to agree on an adapted transfer condition to the next ACC receiving sector and changed merging conditions with en-route traffic in ACC sectors. Once an ETD is available, the DEP PC can start planning or replanning, if required. After take-off, planning can be refined. The DEP PC, and the next receiving ACC PC, can start their deconflicting activities. The result of the planning activities of the DEP PC is to establish a conflict free exit transfer condition of the aircraft from the TMA to the next receiving ACC sector.
- **Co-ordination with, and assistance to the DEP TC** : assist the DEP TC, specifically where it concerns the co-ordination with the Tower (LOC) and the sector transfer condition to the next receiving en-route sector.

Difference : no need to co-ordinate with the next receiving ACC sector PC on any trajectory negotiation.

- **Monitoring the traffic situation** : monitor the pre-departure traffic planning situation, covering the planning of pre-departure activities and maintain initial in-flight traffic situation awareness, enabling support of tactical control. The monitoring of the actual traffic situation concerns the limited period of the initial climb and the transfer of control to the adjacent ACC sector.
- **Runway capacity planning and control** :
 - Participation in the determination of the runway configuration in use
 - Assessment and replanning of scheduled departure slot-times: making sure that a departure slot-time is planned for each departure flight.
 - Co-ordinating with the ARR SP and Tower Control on use of the available runway capacity.

2.2.3.6 TMA Departure Tactical Controller - DEP TC

- **Maintaining Separation** : maintain separation between aircraft under his control and monitoring trajectory compliance and the current traffic situation in order to resolve potential conflicts by providing tactical intervention. Tactical control commands are used to guide the flight to comply with the exit transfer conditions.

Differences : no continuous computed departure sequence, meaning more flexibility provided to the DEP TC.

- **Co-ordination with adjacent sectors** :
 - Accepting entering traffic from Tower Control (LOC)
 - Transferring exiting traffic to the next receiving ACC TCBoth transfer of control are very time critical.

The description of the following tasks is similar to "En-route tactical controller ER TC" :

- **Managing Communication with Aircraft via R/T**
- **Co-ordination with the DEP PC** : this task is more limited than in En-route because the period of tactical control is very short.
- **Updating the Ground System**
- **Monitoring Aircraft Trajectories and the Actual Traffic Situation** : this task is more limited than in En-route because the period of tactical control is very short.

2.3 ADVANCED ORGANISATION

2.3.1 Introduction to the organisation

The aim of the Advanced Organisation of PD/3 is to allow a significant increase of traffic throughput for the period of 2005-2015 in providing re-distribution of workload from tactical controller to both multi-sector planning controller and planning controller.

PD/3 envisages an advanced working environment using ground-ground and ground-air data-link, advanced airborne equipment (EFIS-4D FMS) and advanced tools (PATs) such as arrival and departure managers (AM, DM), trajectory predictor (TP), conflict probe (CP), problem solver and trajectory editor (PS), flight path monitoring (FPM), look-ahead display (LAD) and co-operative tools (CT) including agenda.

The main features of the concept of this Advanced Organisation rely on :

- improved trajectory prediction,
- progressive* air-ground integration,
- progressive* 4D trajectory guidance and control implementation,
- traffic organisation,
- advanced planning.

In defining the advanced organisation roles several main themes have been considered :

- anticipation on the evolving traffic situation,
- use of trajectory accuracy related to time horizon (the further away in time, the less accurate the trajectory),
- reduction in co-ordination and achieved mainly implicitly and via silent communication,
- possible evolution of ATCO's working methods,
- limited ATCO's training period.

2.3.2 Controllers roles

The following controller roles have been identified in the Advanced Organisation :

1. MSP Multi-Sector Planning Controller
2. ER PC En-Route Planning Controller

* Implementation of data link and 4D FMS has been assumed to be progressive during the period 2005-2015. This influenced significantly the design of the concept and controller working methods of the PD/3 advanced organisation.

- 3. ER TC En-Route Tactical Controller
- 4. AA PC Arrival ACC Sector Planning Controller
- 5. AA TC Arrival ACC Sector Tactical Controller
- 6. DA PC Departure ACC Sector Planning Controller
- 7. DA TC Departure ACC Sector Tactical Controller
- 8. ARR SP Arrival Sequence Planning Controller
- 9. INI Initial Approach Controller (APP)
- 10. ITM Intermediate Approach Controller (APP)
- 11. LOC Local Controller (TWR)
- 12. DEP PC Departure Planning Controller (APP)
- 13. DEP TC Departure Tactical Controller (APP)

The table below outlines the relationship between type of sector, type of airspace, type of planning and controller roles.

sector	airspace	medium-term planning	short-term planning	tactical control
En-Route	UAC	MSP	ER PC	ER TC
ACC (arrival)	ETMA/FIR	MSP	AA PC	AA TC
ACC (departure)	ETMA/FIR	MSP	DA PC	DA TC
APP (arrival)	TMA	ARR SP	ARR SP	INI/ITM/LOC
APP (departure)	TMA		DEP PC	LOC/DEP TC

Each role of the above table is described in the following sections.

For each controller the sections describe :

- area of responsibility,
- planning time and distance horizon,
- role,
- tasks.

2.3.3 Multi-Sector Planning Controller - MSP

The availability of data link (ground-ground and ground-air), the improvement of trajectory prediction and the development of advanced tools create the possibility of introducing MSP as a supplementary actor within ATM process.

The MSP functionality is constructed from the following basic concepts :

- It is not the role of the MSP to address and solve all conflicts within the MSP area.
- It is the role of the MSP to anticipate the future traffic situation and ‘initiate solutions’ for the Sector Controllers of the MSP Area.
- The preliminary aim of the ‘initiated solutions’ is to redistribute workload
 - a) from the Sector TC to the Sector PC and MSP
 - b) from overloaded sectors to underloaded sectors.

To reduce or shift workload the MSP may use one or a combination of the actions defined for one or more aircraft.

This balancing of traffic may be effected on flows or individual aircraft as required.

- Solving Complexity may involve the MSP in resolving certain conflicts, however it should not be the task of the MSP to solve conflicts unless complexity is a factor.
- The second function of the MSP is Optimisation, which may be applied to one or more aircraft. The application of Optimisation may also involve the MSP in solving a conflict. Solving complexity problems should always have priority over Optimisation tasks.

To be able to anticipate on difficult traffic sequences and heavy workload periods and in order to prevent undesirable closing times, MSP has to operate on a nearly permanent basis,

- tactical flights distribution between sectors and anticipated treatment of problems will be performed ahead of high activity sectors’ periods,
- flight optimisation will be achieved mainly ahead of low density situations.

2.3.3.1 Area of responsibility

An MSP area covers several sectors and can include En-route (UAC), Extended TMA (ACC) or approach (APP) sectors. The MSP shall organise and plan air traffic in all sectors except within APP sectors.

The construction of MSP areas is mainly determined around traffic flows and association of sectors allowing the possibility to share traffic between sectors.

In the today airspace organisation, selected for PD/3, lateral MSP boundaries slightly differ from sectors’ limits in being extended into giving sectors of other MSP areas. In general, these “buffer areas” enable the MSP both, to amend entry conditions without explicit co-ordination with giving sectors and, to redistribute aircraft to the appropriate sector.

The maximum size of an MSP area is limited by a sufficient and possible trajectory prediction accuracy at a standard subsonic cruise speed.

A maximum level of workload due to expected traffic density and complexity is not to be exceeded.

2.3.3.2 Planning time and distance horizon

The MSP is operating on the traffic situation before short-term planning of PC of the first sector of his area to be entered.

The MSP shall be responsible for planning aircraft through the area between 30 and 10 minutes prior to the entry of the first sector boundary of the area - up to the moment - the planning authority- is transferred to the sector planning controllers (PCs) of his area

Usually, Planning Authority is managed by the system and time based early planning authority can be taken by each PC via manual input.

The MSP is planning airborne traffic and departing traffic after slot-time Departure Manager (DM) assignment.

2.3.3.3 Role

The role of the MSP is to analyse, anticipate on evolving traffic situations and to reorganise them in order to contribute to the increase of capacity and to the flights optimisation of the sectors within the MSP area.

The MSP is acting on departing, en-route (mainly) and arriving traffic in any category of airspace, except in approach areas (APP). The MSP is planning departing traffic only after slot-time allocation.

The MSP elaborates strategies appropriate to the traffic situations and to the sector's configuration.

His strategies are realised under the form of aircraft trajectory modifications allowing an obvious and mainly intuitive understanding of the MSP intentions and actions to the concerned PCs and TCs of the sectors of the area.

2.3.3.4 MSP tasks

The MSP shall be responsible for :

- Assessing and monitoring the predicted traffic situation evolving over the concerned period of time (10 to 30 minutes ahead, if required assessing can be performed between 0 and 40 minutes ahead).
- Optimising trajectories -on a systematic basis unless complexity is increased.
- Balancing traffic flows between sectors when possible and when appropriate.
- Reducing traffic complexity in reorganising predicted difficult traffic sequences.
- Uplinking planned trajectory modifications -to 4D equipped aircraft.
- Performing required co-ordination.
- Updating system.

2.3.3.5 MSP tasks description

2.3.3.5.1 Assessing and monitoring traffic situation

The analysis of traffic complexity and distribution of traffic between sectors (flow rates) is required to judge the traffic situation over a relatively long predicted period (20 minutes) and over a relatively large size (200 NM). This task will be made possible in the use of required traffic simulation and assisting tools (see chapter 5: required HMI facilities, functions and tools).

This assessment will be made available through acquisition of information on:

- sector workload
- traffic density
- nature of flows
- nature of traffic's situations

After assessment, the MSP shall elaborate strategic plans in order to :

- reduce sectors' traffic complexity.
- balance traffic flows between area's sectors
- optimise trajectories

2.3.3.5.2 Trajectory optimisation

The task to optimise trajectories is essential to satisfy airlines economical requirements. Optimisation is devoted mainly to the MSP as far as it can be achieved more efficiently within a wide area than inside a single sector unit.

Incidentally, it is a complementary task which, associated with the others, allows the MSP positions to operate on a nearly permanent basis and which in turn resolves the problem of undesirable closing-times during low density periods.

The MSP is given the tasks :

- to optimise the trajectories on a systematic basis unless complexity is increased, including direct routing and optimum level allocation to satisfy user preferred trajectories.

Note : it is the MSP task, if appropriate, to overrule LOAs according to the analysis of traffic situation. It is expected from the MSP actions to keep to a minimum the trajectory penalties imposed by LOAs. This is assumed to be achievable up to a certain complexity threshold. Beyond this, the action of the MSP will be to focus mainly on reorganising difficult traffic sequences and balancing workload between sectors as appropriate.

- to intensively use the PRNAV aircraft capability with the aim of favouring the elaboration of parallel tracks and direct routes.

MPS optimisation will result in :

- early allocation of RFL or better FL
- direct routes

- combination of better FL (or RFL) with direct routes or OFFSET tracks

2.3.3.5.3 Balancing traffic flows between area's sectors

This task is performed in conjunction with the reduction of traffic complexity (see point 4 below).

The objective of re-balancing flights between sectors is to complement the CFMU and FMP flow rate's allocations based upon hourly sector's capacity.

It is considered that the MSP can operate at shorter term than flow management entities and should be able to smooth sector's traffic peaks in redistributing aircraft from one sector to another when strong unbalance is identified.

Within superposed sectors :

The MSP shall :

- In case of overloaded upper sector :
 - maintain climbing traffic at intermediate altitude (IFL) in the lower sector,
 - anticipate descents from upper sector.
- In case of overloaded lower sector :
 - initiate anticipated climb to aircraft with unsatisfied RFL up to the upper sector,
 - force climb of overflights up to the upper sector according to aircraft performance.

Within (laterally) adjacent sectors, assuming tactical alternative route's structures are made available, the MSP shall :

- re-orientate arriving flights according to destination, providing it ensures specialisation of traffic and balance of sector workload ,
- re-orientate overflights to underloaded sector when possible (if sector mileage is « acceptable »).

¹

2.3.3.5.4 Reducing traffic complexity

This task will be performed for groups of aircraft, the main objective being to reduce the number of actions to be performed later by PCs and TCs, during remaining deconfliction. It is realised in conjunction with « re-balancing » or independently if balancing is not required or not possible. It is applied to complex traffic sequences.

The MSP shall elaborate modifications of transit plans with the aim of partly or totally resolving predicted conflicts and raised difficulties to be beneficial to the PCs and TCs with a simplified traffic situation resulting in reduction of workload (easier analysis) and allowing them increase of room of manoeuvres (easier solution).

The reduction of complexity will be achieved in :

¹ Within successive sectors, no tactical flow balancing will take place due to the sector configuration.

- manoeuvring aircraft positions in preventing trajectories overlaps (mainly when profile problems are identified),
- organising arrival traffic, taking into account predicted arrival delays,
- allocating temporary flight levels to crossing flows.

These tasks are realised in modifying plans by using mainly off-set, re-routing, anticipated descent, intermediate flight levels, and delayed/anticipated climbs.

These actions will result later in contracted trajectories with 4D aircraft (after trajectory negotiation performed by relevant previous PCs) and pre-solutions for 3D aircraft² to be later implemented by TCs.

The MSP shall test modifications before updating the system.

2.3.3.5.5 4D Trajectory Negotiation

The MSP is not responsible for direct negotiation of trajectory modifications with 4D aircraft.

Trajectory Negotiations are performed by PCs of previous sectors (S-1 of S-2) sharing Planning Authority with the MSP or via an automatic time-based direct up-link to the aircraft.

Detailed description of this process is provided in section 4.3: Trajectory Negotiation.

2.3.3.5.6 Co-ordination

All modifications to multi-sector transit shall be transmitted via data-link to internal MSP area's sectors and to adjacent MSP areas or sectors.

As long as modifications are elaborated according to controllers' techniques and obey standard types of actions, co-ordination with internal, external sectors or areas is silent and implicit, else explicit (either silent or verbal).

Co-ordination is made for :

- entering traffic,
- internal traffic,
- exiting traffic.

2.3.3.5.6.1 Co-ordination on entering traffic

Between MSP and giving sector:

² The MSP will replan 3D aircraft in such a way that the TC will easily transmit verbally to the aircraft the MSP modifications. The actions for 3D aircraft will be mainly limited to flight level change, direct-to, and OFFSET tracks. This recommendation is also to be applied by the PC. The expected result is to demonstrate that a more natural way to control 3D aircraft than the pseudo 4D way is reducing workload of the TC and therefore is beneficial to 4D aircraft (lesson learnt from PD/1).

Any standard modifications elaborated by receiving MSP have to be considered by giving sectors as exit constraints requirements and agreed.

If these constraints are not accepted for particular reason by giving PC, counter proposals will be transmitted during the MSP period of planning authority, and at least 10 minutes prior to the aircraft is entering the MSP's area.

This counter proposal shall necessarily be agreed by MSP (short term planning having priority on longer term planning).

If giving PC's refusal is occurring after receiving MSP Planning Authority, co-ordination will be initiated by giving PC or TC to receiving PC or TC of the first sector of the MSP area.

All above co-ordinations are to be made silently through the system.

Any unusual MSP's modifications have to be co-ordinated explicitly by telephone prior to implementation at initiative of receiving MSP.

Between MSPs:

Except for particular cases, co-ordination between MSPs are not required. Only major non standard changes (mainly traffic re-orientation from receiving MSP will be explicitly co-ordinated on initiative of receiving MSP by telephone. Small sectors can create partial overlaps of planning authority between MSPs. In that case the giving MSP has priority on receiving MSP with regards to priority given to shorter term. If co-ordination is necessary it shall be made by telephone on initiative of receiving MSP and then updated into the system.

2.3.3.5.6.2 Co-ordination on internal traffic

Any MSP 's modification has to be made available to PCs and TCs of the area via system in silent mode. MSP's modification shall be clearly highlighted by specific HMI symbology (see: Section 5: "Required HMI facilities, functions and tools") in order to provide sectors and areas with obvious description of MSP's intentions without individual flight explicit co-ordination.

Major traffic sequences' re-organised by MSP will be announced to PCs of the area in explicit mode by telephone at initiative of MSP.

The MSP shall stop planning 10 minutes prior to the aircraft entering the first sector of the MSP area. The system shall automatically transfer planning authority to each PCs of the sectors of the area about 10 minutes prior to the aircraft is entering the concerned sector.

If necessary, a PC may request an early release of planning authority from MSP via system.

2.3.3.5.6.3 Co-ordination on exiting traffic

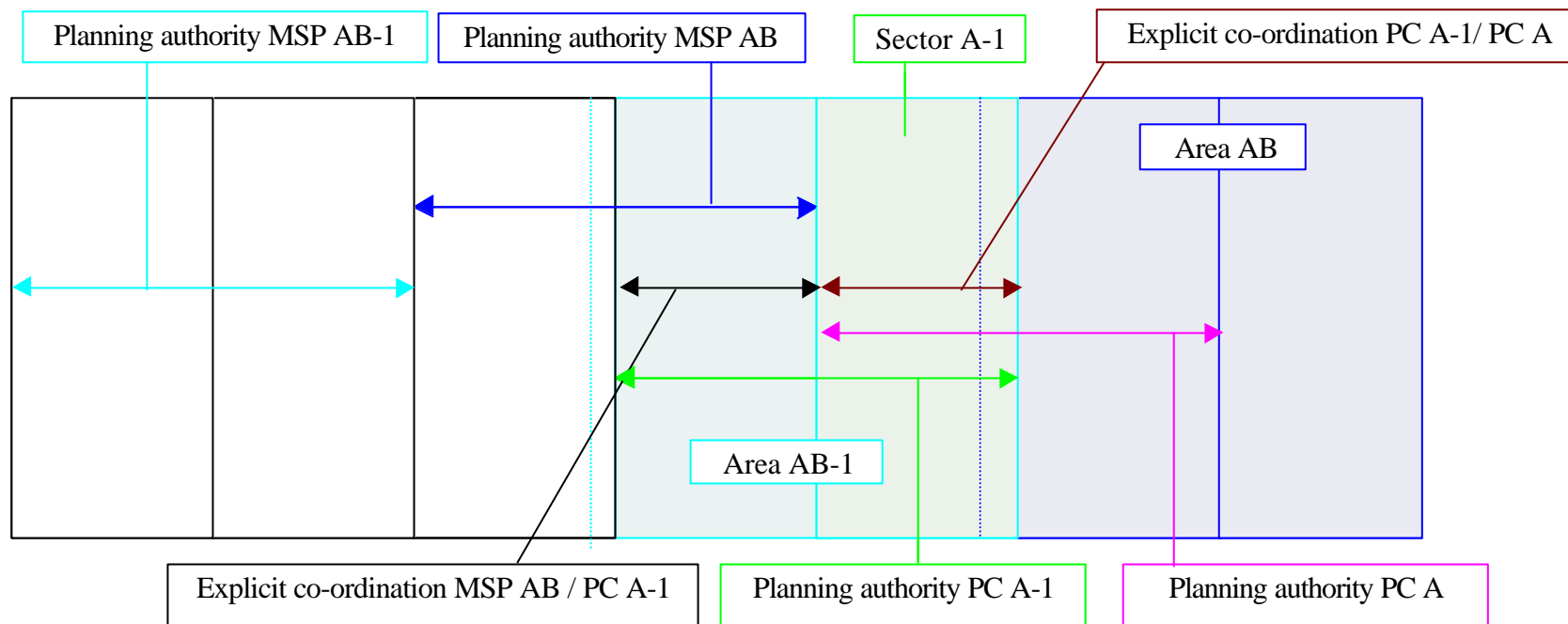
As far as MSP is providing an initial traffic organisation to PCs and TCs of the MSP's area only few co-ordination have to be made with next MSP's areas and next PCs or TCs.

In Order to restrict to minimum, co-ordination on exit traffic, most of MSP's modifications should be standard.

Any standard modification on exiting traffic have to be co-ordinated implicitly in silent mode via system updates.

Only major non standard change (mainly traffic reorientation) from giving MSP have to be explicitly co-ordinated and agreed with receiving MSP by telephone. When partial overlap of planning authority between giving and receiving MSP exists the co-ordination between both controllers will be made as described in above Section 2.3.3.5.6.1(co-ordination on entering traffic, last paragraph).

Figure 2.1 : Planning Authority : overlaps and explicit co-ordination needs



2.3.4 En-Route Planning Controller - ER PC

2.3.4.1 Area of responsibility

The ER PC's area of responsibility shall be defined by the geographical and vertical limits of the sector. The en-route sector is part of a multi-sector planning area.

The area of responsibility may include any delegated airspace in an adjacent sector or airspace where common co-ordination is required.

2.3.4.2 Planning horizon

The ER PC is primarily performing short-term planning starting about 10 minutes before the aircraft entering the sector or after an anticipated transfer of Planning Authority is taken from the MSP.

A secondary role of the ER PC is to provide assistance to the ER TC in his executive controlling role when the flight is assumed. The commitment with a flight ends, when this flight is assumed by the next sector.

2.3.4.3 Role

The planning role of the ER PC is to anticipate the evolving traffic situation in order to ensure efficient organisation of traffic through the sector, in assessing and resolving traffic conflict situations through either the resolution of conflicts, the preparation of conflict free trajectories or the designations of problems to be solved by the tactical controller.

Flights are planned after acquisition of Planning Authority, about 10 minutes before entering the sector. The planning authority is time-based and automatically and silently transferred, by the ground system, initially from the MSP of his area to the first ER PC, and subsequently to following PCs, 10 minutes before entering the concerned sector. An early release of Planning Authority can be taken explicitly from the MSP at the ER PC initiative. The PCs can co-ordinate with all PCs of giving and receiving sectors on flight transfer conditions. The ER PC of the last sector of the area can co-ordinate also with the MSP of the next adjacent area on the transfer condition to this area. Most of this co-ordination is performed implicitly and silently via the system.

After an assume control by the tactical controller of the sector, the role of the PC has become to assist the TC, when required, until a transfer of control to the next sector.

2.3.4.4 ER PC tasks

The ER PC shall use the ground-ground and air-ground data-link facilities for communication purposes. Ground voice channels will be available for late co-ordination only.

The ER PC shall work in close harmony with the ER TC, but specifically, the ER PC shall be responsible for:

- Awareness of traffic load and problem situations.
- Planning over the sector and flight integration:

- Validating aircraft sector entry and exit conditions
- Managing problem situations
- Preparing sector conflict resolution clearances for non-data-link equipped aircraft
- Deconflicting 4D equipped aircraft
- Implicit and explicit co-ordination on sector entry and exit conditions with controllers of adjacent sectors and area's
- Co-ordinating in exceptional cases with the MSP
- Trajectory negotiation with 4D and data-link equipped aircraft
- Co-ordinating with, and assistance to the ER TC and updating the SPL with the updated planned and/or contracted trajectory
- Monitoring the evolving traffic situation over the concerned period of planning and control

Note:

It should be noted that for overflying traffic the ER PC tasks are also applicable to the AA PC and the DA PC, whereas for arrival and departing traffic the AA PC and DA PC tasks are applicable to the ER PC. This section is only dealing with the pure en-route tasks.

2.3.4.5 ER PC task description**2.3.4.5.1 Awareness of traffic load and problem situations**

The ER PC shall have a synthetic view of the future traffic situation, in order to integrate the traffic and to anticipate actions according to the estimated workload level. He shall have also a view of the potential conflicts within the sector, in order to see when and where the conflicts will appear for defining his strategy of actions.

2.3.4.5.2 Planning and integration

- ◆ "Planning over the sector and flight integration":
 - Validating aircraft sector entry and exit conditions
 - Managing problem situations
 - Preparing sector conflict resolution clearances for non-data-link equipped aircraft
 - Deconflicting 4D equipped aircraft

The ER PC shall assess the entry and exit conditions for each aircraft proposed to the sector taking account of the active system trajectory (SPL) including MSP modifications..

The ER PC shall analyse the flight information so as to integrate the flight into the traffic situation without remaining problem. If the problem can be solved in a more efficient manner at a later time by a tactical manoeuvre, decision is made to transfer the problem to the tactical controller (ER TC).

The ER PC shall assess the problem situation and decide on the mode of resolution (on who and how to act). As required he defines conflict resolution clearances for both equipped and non-equipped aircraft.

Conflict resolution clearances shall comprise constraints to be met by the aircraft at particular way-points. These constraints are built graphically via the appropriate GHMI facility.

In order to avoid complex messages being verbally transmitted by ER TC, clearance for non-equipped aircraft should have a lower complexity than those described for equipped aircraft. The actions for 3D aircraft will be mainly limited to flight level change, direct to, and off tracks.

The ER PC makes a planning for different types of flights and flight conditions:

- 4D equipped, with a "contracted" trajectory through the sector.
- 4D equipped, not yet "contracted".
- flights of non-equipped aircraft.

Problems are assessed and conflicts are solved taking into account these different flight conditions and the interaction of different pairs involved in a conflict. Contracted flights, with a high level of confidence of realising accurately their predicted and contracted trajectory, should be preferentially not affected. Nevertheless, the decision and the responsibility of ATC prevail, e.g. safety.

The task of planning and integration has to be completed before the flight is assumed by the Tactical Controller (ER TC).

Afterwards problem management and conflict resolution may still be necessary, but this should occur, if required, in the role of assistant of the ER TC.

2.3.4.5.3 Co-ordination with adjacent sectors

"Implicit and explicit co-ordination is performed on sector entry and exit conditions with controllers of adjacent sectors and areas":

Co-ordinating on entering traffic:

Co-ordination on the sector entry condition can be required as result of a tactical control action in the giving sector. The sector entry condition shall be co-ordinated at the giving sector initiative. The effect will be:

- An adapted sector entry transfer condition.
- Possible loss of a conflict free plan. This condition has to be followed therefore by a replanning action for renewed deconflicting in the sector.
- Possible loss of a 4D "contract". Trajectory re-negotiation is expected after replanning and deconflicting.

A planning conflict in the receiving sector, affecting the entry condition requires co-ordination on entering traffic at the initiative of the receiving ER PC. For this case the required updates will be implemented in the giving sector.

Co-ordinating on exiting traffic:

The ER PC shall co-ordinate on exiting traffic, which may address several objectives:

- solving a planning problem and changing the exit transfer condition
- implicit co-ordination to establish a planned deconflicted trajectory

A planning problem on the transfer condition:

The ER PC can perform a co-ordination process with the planner of the next receiving sector on the transfer condition of the aircraft on the exit boundary. In an early stage of planning, co-ordination can be required with the MSP of the adjacent area, instead of the PC, if the adjacent sector belongs to this adjacent area.

Implicit co-ordination is possible for default transfer conditions. Explicit co-ordination can be required to solve particular planning problems, exceeding possible default solutions. The ER PC of the giving sector implements the updated transfer condition.

Implicit co-ordination to establish a planned deconflicted trajectory:

The ER PC shall co-ordinate on deconflicted planning with adjacent sectors. This co-ordination is always implicit, as long as the transfer condition is not exceeding pre-defined thresholds.

2.3.4.5.4 Co-ordination with the MSP

- ◆ "Co-ordinating in exceptional cases with the MSP":

The ER PC shall co-ordinate with the MSP of his sector almost always implicitly, but sometimes explicitly.

There are two cases for explicit co-ordination:

- The MSP decided to a non-standard solution of a situation and wants to explain (via telephone).
- The ER PC initiates an early transfer of the planning authority.

2.3.4.5.5 4D Trajectory Negotiation

- ◆ "Trajectory negotiation with 4D and data-link equipped aircraft":

The ER PC shall use four options concerning 4D trajectory negotiation:

- negotiation of a trajectory
- a sector contract approval (as assistant on behalf of the TC)
- a formalised clearance (as assistant on behalf of the TC)
- giving the permission to negotiate (as assistant on behalf of the TC)

4D trajectory negotiation is required:

- After modification of the sector transit planned trajectory performed by the ER PC. After a tactical control action, if the 4D contract has been broken or amended, and if it is expected that no new tactical control action is required for the remaining planned trajectory in the actual sector.
- If the 4D equipped aircraft was not yet able to negotiate a 4D contract, and if it is expected that no tactical control action is required for the remaining planned trajectory in the actual sector.
- If the 4D aircraft is requesting a trajectory modification starting within the sector limits and corresponding to the ER PC Planning Authority or on behalf of the ER TC if corresponding to the TC Planning Authority.

The ER PC may up-link a trajectory update up to arrival on the runway. However, he negotiates the trajectory segment relevant to his own sector. There is no co-ordination to be performed with other sectors for the remaining part of the trajectory.

Sector contract approval on behalf of the TC:

The ER PC may approve that part of the 4D contract, which belongs to his sector, on behalf of the TC. Sector contract approval gives part of a contract a status, identical to a list of instructions/clearances. This sector contract approval occurs therefore after implicit or explicit co-ordination with the TC.

A formalised clearance on behalf of the TC:

Instead of trajectory negotiation it is possible to supply a formalised clearance, which is an imposed contract. This formalised clearance is the 4D equivalence of a list of instructions/clearances to non-equipped aircraft. The formalised clearance also requires co-ordination with and approval of the TC.

Permission to negotiate on behalf of the TC:

If not already implicitly supplied, the PC can give a permission to start negotiation to the PC of the next receiving sector on behalf of the TC.

More details about the procedures on trajectory negotiation are given in section 4.3.

2.3.4.5.6 Co-ordination with, and assistance to the ER TC

◆ "Co-ordinating with the ER TC":

The ER PC shall define conflict resolution clearances for non equipped aircraft.

Conflict resolution clearances shall comprise manoeuvres to be met by the aircraft e.g. route, level and speed instructions to be applied or achieved at a time or at particular way-points and which should be of a lower complexity than those described for 4D and data-link equipped aircraft.

Such clearances should be communicated to the ER TC to ensure timely tactical intervention which guarantees the coherence and safety of the conflict resolution.

◆ "Assisting the ER TC and updating the SPL with the updated planned and/or contracted trajectory":

The ER PC shall assist the ER TC when necessary:

- The ER PC can prepare solutions for tactical problems, during the tactical control phase, taking into account the possible restrictions due to 4D trajectory contractual commitments.
- The ER PC can enter the flightplan updates, which are the result of tactical clearances given by the TC via R/T.
- The ER PC can up-link, planned or non-planned, tactical clearances on behalf of the TC, via data-link, and update the flightplans at the same time.

The ER PC can give permission to the ER PC of the next receiving sector to start a 4D trajectory negotiation. However, it is the responsibility of the TC to confirm, that very likely no tactical action is to be performed on a flight any more within the current sector. The permission can be given usually, and by default, implicitly, via silent communication.

2.3.4.5.7 Monitoring the traffic situation

- ◆ "Monitoring the evolving traffic situation over the concerned period of planning and control":

The ER PC shall monitor the development of the traffic situation according to his responsibilities over the applicable time period. The monitoring activities are dualistic. Each flight is monitored for adequate planning for the first planning period (up to assume control) and for assistance to tactical control for the second planning period (after assume control). The PC shall be aware that the progress of each flight is in agreement with the planning.

Points of concern are:

- Deconflicting planning activities on incoming traffic.
- Deconflicting on a tactical level up to the exit transfer condition.
- 4D equipped flights to be monitored for:
 - approval of parts of contracts or required formalised clearances
 - possible deviations from an approved contract or a formalised clearance
 - re-negotiation on new contracts and possible negotiation permission requests of adjacent sectors
- Status of air-ground and ground-ground communication dialogues.

The monitoring activities include the task of highest priority event selection.

2.3.5 En-Route Tactical Controller - ER TC

2.3.5.1 Area of responsibility

The ER TC's area of responsibility shall be the identical to that defined for the corresponding ER PC.

2.3.5.2 Tactical control horizon

The ER TC shall be responsible for tactical control for an aircraft from assume of control until transfer of control to the next sector.

2.3.5.3 Role

The role of the ER TC is to tune and complete the trajectory planning through the sector, to monitor the sector traffic situation, to resolve outstanding problems and to cope with unexpected situations.

That TC is the only one having the final authority to give an aircraft a clearance. He may modify the contract negotiated by the MSP and PC with the pilot.

2.3.5.4 ER TC tasks

The ER TC shall use the R/T for voice communication and data-link, ground-air and ground-ground facilities, for digital communication purposes. Ground voice channels will be available for late or particular co-ordination.

The ER TC shall work in the situation context elaborated by the ER PC, and is responsible for:

- Keeping awareness of problem situations.
- Managing problems and maintaining separation in the controlled sector, taking into account efficiency and 4D planning constraints.
- Preparing and executing conflict resolution clearances for data-link and non data-link aircraft for outstanding conflict situations.
- Managing R/T communications and managing tactical data-link communications with controlled aircraft.
- Trajectory negotiation with 4D equipped aircraft on tactical level.
- Co-ordinating with adjacent sectors:
 - Accepting entering traffic
 - Transferring exiting traffic
- Co-ordinating with the ER PC (assistant to the ER TC).
- Updating the ground system.
- Monitoring the traffic situation in his sector over the concerned period of tactical control.

Note:

It should be noted that for overflying traffic the ER TC tasks are also applicable to the AA TC and the DA TC, whereas for arrival and departing traffic the AA TC and DA TC tasks are applicable to the ER TC. This section is only dealing with the pure en-route tasks.

2.3.5.5 ER TC task description

2.3.5.5.1 Keeping awareness of problem situations

The ER TC shall have an overview of the traffic situation resulting from the planning work carried out by the ER PC, and shall concentrate his activities on solving remaining problem situations.

2.3.5.5.2 Problem management and maintaining separation

- ◆ "Managing problems and maintaining separation in the controlled sector, taking into account efficiency and 4D planning constraints":

The ER TC shall be responsible for problem situation assessment and resolution so as to provide separation between aircraft under his/her control.

The ER TC shall monitor trajectory compliance, while resolving conflicts by providing tactical intervention. Tactical intervention shall be effected via data-link or R/T as appropriate.

Taking control actions, it is the task of the TC to achieve the required separation following priority rules:

- safety:

If required, any tactical control action is appropriate to solve a safety problem. If the safety is not threatened, the preference is to solve a tactical problem by replanning the trajectory. However, temporary open-ended clearances are available options to solve a tactical problem.

- efficiency:

The second objective of problem solving is to maintain an orderly traffic pattern. Solutions for tactical problems should preferably not affect the overall planning, while an individual flightplan is adapted preferably only locally, if possible, not affecting the sector transfer conditions (at least at a 3D level).

- economy:

If possible, tactical problems are solved, taking into account the optimal flight performance strategy of each individual flight with attention to delays and fuel economy (priority on meeting planned times over way-points (ETOs) and on flying the optimal flight profile).

2.3.5.5.3 Preparing and executing conflict resolution clearances

- ◆ "Preparing and executing conflict resolution clearances for data-link and non data-link aircraft for outstanding conflict situations":

The ER TC shall ensure timely tactical intervention which guarantees the coherence and safety of the conflict resolution. Most of tactical interventions should have been prepared by the ER PC during his analysis of the problem situation.

The ER TC shall be responsible for the preparation and execution of conflict resolution clearances for conflict situations which remain following the ER PC's planning and as a response to unexpected situations.

The tactical control actions encompass:

- Changes on 4D planned trajectories for 4D equipped aircraft.

(Any action of adding, moving or removing a 4D way-point is possible. Most changes, implemented by the TC, shall be up-linked as a "formalised clearance").

- Any combination of tactical clearances with closed-end effects on the planning:
- Any combination of tactical clearances with an open-ended character.

(Temporary open-ended clearances are given under urgent conditions. By nature, these conditions require R/T instructions. The R/T instructions has to be followed by a flightplan update, which implies at least disabling part of the planned trajectory. Replanning is required).

The following constraints are to be taken into account, solving tactical problems, if possible, in the listed order of priority:

- to respect 4D contracts
- to honour descent advisories for arrival traffic
- to meet scheduled arrival times and estimates (ETOs) on the sector exit way-points
- to supply tactical control commands with as much respect as possible for the original planning
- and, if feasible, to avoid temporary open-ended clearances

2.3.5.5.4 Managing communication with aircraft via R/T and datalink

- ◆ "Managing R/T communications and managing tactical data-link communications with controlled aircraft":

The ER TC shall ensure that two way R/T communication is established with all aircraft under his/her control. The ER TC shall monitor the status of datalink communication with equipped aircraft.

The ER TC shall be responsible for the choice of communication facility to be used for tactical intervention for equipped aircraft. However, where time permits, the preferred facility shall be data-link.

There is one, and only one, controller, the TC, maintaining voice communication with an aircraft. This exclusiveness is not applicable to data-link communication. The consequence is that tasks applicable to both media are different, taking into account the exclusive character of R/T communication and the shared and distributed communication possibilities of data-link.

Via voice communication any sequence of clearances is allowed, following the Aeronautical Telecommunications, annex 10, Procedures for Air Navigation Services, Rules of the Air and Air Traffic Services (PANS-RAC, doc 4444). Clearances via voice communication should be followed by appropriate flightplan updates. Voice communication is performed by the TC, the actual flightplan updates may be performed also by the PC under responsibility of the TC.

A limited subset of R/T phraseology is available via data-link. When appropriate, the ER TC can delegate the performance of the communication via data-link and the associated flightplan modifications to the ER PC.

If a mix of R/T and data-link instructions is used, and if the meaning of both communications is conflicting, then the R/T communication overrules the significance of the data-link instructions. In exceptional cases the R/T can be used to disregard the data-link submitted clearance instructions.

2.3.5.5.5 Negotiating with 4D and datalink equipped aircraft

- ◆ "Trajectory negotiation with 4D equipped aircraft on tactical level".

The ER TC shall perform the following actions with respect to 4D trajectory negotiation:

- Approval at assuming control of a 4D contracted flight to accept the contracted 4D trajectory segment through the sector as a clearance (so-called "sector contract approval").
- Giving the permission to the PC of the next receiving sector to start 4D trajectory negotiation.
- Giving, if required, a 4D formalised clearance.

The tasks of the ER TC with respect to 4D trajectory negotiation are mainly supervisory and monitoring tasks as long as the ER PC is assumed to have deconflicted most of 4D aircraft.

4D planning and 4D trajectory negotiation activities make sense only, if no tactical control action on a flight is foreseen in the actual sector. If the sector transfer condition can not be met in conformance with the planning, then a new or renewed 4D planning and 4D negotiation activity can be initiated, starting from the sector transfer condition.

It is the task of the TC to support the suitable tactical flight conditions, to give the PC of the next receiving sector the possibility to start the planning and negotiation process for this flight. The permission to start trajectory negotiation is given implicitly, in most cases. Once the permission is given, the TC has accepted the constraining task to give priority to the requirement to realise this flight according to its planning, if feasible.

The task of supervision on 4D planning and 4D negotiation activities is one of the tasks that may be delegated to the ER PC in his role of assistant.

2.3.5.5.6 Co-ordination with adjacent sectors

"Co-ordinating with adjacent sectors":

- Accepting entering traffic
- Transferring exiting traffic

The ER TC shall co-ordinate directly with the ER PC or ER TC (as appropriate) of the next receiving sector, if required. Co-ordination is required, if complex conflict resolution needs tactical intervention of the ER TC, prior to a transfer to the next sector. The transit plan has to be amended.

"Accepting entering traffic":

The ER TC shall accept each entering flight at or around the sector entry way-point after the flight is released by the TC of the previous sector. The pilot is supposed to contact the ER TC. If the pilot does not, the TC can try to contact him.

The ER TC shall verify that after acceptance of a flight, the appropriate communication means are available and that effective contact is established.

- ◆ "Transferring exiting traffic":

The ER TC shall transfer the flight, if the required clearances have been supplied to meet the sector transfer condition and if no separation problem is foreseen within the sector. A clearance to change the frequency can be given via R/T or data-link with a preference for the use of communication via data-link.

2.3.5.5.7 Co-ordination with the ER PC

- ◆ "Co-ordinating with the ER PC (assistant to the ER TC)":

The ER PC shall take over part of the work of the TC, while the TC can focus his attention to his primary task of maintaining separation. The TC and PC are working as a team.

The first task to be taken over by the PC is the implementation of flightplan updates; the second one, if the use of data-link is applicable, to implement data communication instructions, combined with flightplan updates, and monitoring the completion of dialogues via data-link.

2.3.5.5.8 Updating the ground system

- ◆ "Updating the ground system":

The ER TC shall be responsible for updating the ground system via a trajectory editing tool for all tactical clearance instructions and clearance proposals that are passed to aircraft via either R/T or data-link.

The ER TC may request the ER PC to assist him in the system update task.

2.3.5.5.9 Monitoring aircraft trajectories and the actual traffic situation

- ◆ "Monitoring the traffic situation in his sector over the concerned period of tactical control":

The ER TC shall monitor the actual traffic situation and traffic adherence to the multi-sector transit plan.

The ER TC shall maintain traffic situation awareness and be ready to intervene with tactical clearances in the event of unexpected conflict or urgency situations.

2.3.6 Arrival ACC Sector Planning Controller - AA PC

The ACC controller's roles have been identified as being more complex than en-route tasks and therefore justify specific description.

In addition to en-route tasks, ACC tasks include :

- anticipation on inbound traffic sequence management
- majority of vertical evolving traffic treatment
- interface with the TMA approach area

2.3.6.1 Area of responsibility

The AA PC's area of responsibility shall be defined by the geographical and vertical limits of the ETMA ACC arrival sectors. The ACC sector is part of a multi-sector planning area.

The area will include at least one entry point into the TMA, a Metering Fix, including routes to the Metering Fix of the TMA approach zone.

The area may include crossing departure and arrival routes (in the Dutch airspace, sectors are always combined arrival and departure sectors).

2.3.6.2 Planning horizon

The AA PC shall be primarily responsible for planning aircraft through his/her sector from 10 minutes prior to sector entry or after an anticipated transfer of planning authority is taken from the MSP.

As a secondary role, the AA PC assists also the executive controller in his executive controlling role when the flight is assumed. The commitment with a flight ends, if this flight is released, if this flight leaves the sector and if control is transferred to the next sector.

2.3.6.3 Role

The role of the AA PC is to perform the role of a PC in an ETMA/ACC sector. Pure en-route tasks (ER PC, section 2.3.4) are combined with tasks of planning of the descent of arrival traffic in an early stage of arrival management. Also, the interference of arrival traffic with en-route traffic will require special concern with respect to decisions on conflict resolution.

Transit flights through the ACC sector are planned before by the MSP. If required arrival traffic shall be reorganised. The MSP will have reduced the traffic complexity before transferring the planning authority, timely, to the ACC PC.

The ARR SP is controlling arrival sequencing which affects the planning through the ACC sector. Advisories, based on time constraints, are resulting effects, to be taken into account by the AA PC for

planning as well as for his TC assistance activities. Arrival traffic is planned conflict free, but also replanned frequently according to the requirements of arrival management.³

After a transfer of control to the sector, the flight is taken under control by the AA TC, and the role of the PC is to assist the TC, until a transfer of control to the next receiving sector.

Because the AA PC performs en-route planning tasks also, part of his tasks are identical to the corresponding tasks of the ER PC.

2.3.6.4 AA PC tasks

The AA PC shall use the ground-ground and air-ground data-link facilities for communication purposes. Ground voice channels will be available for late co-ordination only.

The AA PC shall work in close harmony with the AA TC but specifically, the AA PC shall be responsible for :

- Awareness of traffic load and problem situations (ER PC task).
- Planning over the sector and flight integration (ER PC task):
 - Validating aircraft sector entry and exit conditions
 - Managing problem situations
 - Preparing sector conflict resolution clearances for non-data-link equipped aircraft
 - Deconflicting 4D equipped aircraft
- Replanning arrival traffic:
 - Validating arrival metering requirements
 - Preparing arrival clearances
- Implicit and explicit co-ordination on sector entry and exit conditions with controllers of adjacent sectors and area's (ER PC task)
- Co-ordinating with the TMA controllers
- Co-ordinating in exceptional cases with the MSP (ER PC task)
- Trajectory negotiation with 4D and data-link equipped aircraft (ER PC task)
- 4D trajectory negotiation on approaching the Metering Fix
- Co-ordinating with, and assistance to the AA TC and updating the SPL with the updated planned and/or contracted trajectory (ER PC task)
- Monitoring the evolving traffic situation over the concerned period of planning and control (ER PC task)

³ In order to significantly reduce the instability effects produced by the frequent replanning, a time window will be used for the constraints at the Metering Fix. The size of the window will be determined during integration before the final demonstration.

- Stack control, planning and preparation of holding manoeuvres

Note:

It should be noted that for arriving traffic the AA PC tasks are also applicable to the ER PC, whereas for en-route traffic the ER PC tasks are applicable to the AA PC. This section is only dealing with the pure arriving tasks, and refers to en-route task descriptions.

Stack control is described here as an ACC task, co-ordinated with the ARR SP. This description is applicable to the Dutch airspace, except that a special stack controller is tasked. In a French TMA, the approach stack is controlled above FL 125 by ACC and below by the TMA approach zone. This requires somewhat different co-ordination and planning activities.⁴

2.3.6.5 AA PC task description**2.3.6.5.1 Awareness of traffic load and problem situations**

See the ER PC, section 2.3.4.5.

2.3.6.5.2 Planning and integration

- ◆ "Planning over the sector and flight integration":
 - Validating aircraft sector entry and exit conditions
 - Managing problem situations
 - Preparing sector conflict resolution clearances for non-data-link equipped aircraft
 - Deconflicting 4D equipped aircraft

See the ER PC, section 2.3.4.5.

- ◆ "Replanning arrival traffic":
 - Validating arrival metering requirements
 - Preparing arrival clearances

The AA PC shall assess the planning of each aircraft through the ACC sector. The planning of arrival traffic imposes specific constraints, because the planning of arrivals on the exit transfer condition, the Metering Fix to the TMA, is linked to the sequencing, metering and spacing optimisation process for landing.

The AA PC shall prepare clearances, based on timing constraints, supplied by the AM. Clearances for 4D aircraft will be negotiated as proposed 4D trajectories, but for non-equipped aircraft, traditional clearances will be prepared, such as route, speed, heading and level clearances.

⁴ It is not envisaged to simulate in PD/3 the CDG approach stack.

The timing constraints due to optimisation of sequencing, metering and spacing are imposed, if the arrivals of aircraft are managed by the ARR SP, assisted by the Arrival Manager (AM), and if appropriate control decisions are made by the ARR SP. There are certain criteria to initiate arrival management by ARR SP and AM:

- The aircraft has reached its requested, assigned and/or negotiated Top-Of-Climb (TOC).
- The aircraft is approaching its Top Of Descent (TOD).
- The distance of TOD to the runway will vary between 120 and 200 NM.
- The aircraft flies within one of the sectors with an agreement to co-ordinate on optimisation of the arrival procedure for that airport.

The part of a flight, controlled for optimal sequencing, can reside within one or more En-route and ETMA sectors, because sizes of sectors cannot be dimensioned for simple and straightforward partitioning of airspace with respect to sequencing. Therefore, an AA PC has to take into account optimal sequencing constraints of an arbitrary number of different flights arriving at several airports. These constraints has to be taken into account if planning conflicts for that flights are to be solved.

Generally, planning conflicts between en-route and arrival traffic are solved in favour of en-route traffic. However, the advisories as result of the optimal sequencing effort of the ARR SP are imposing constraints also. The AA PC is required to solve the planning problems taking into account these imposed constraints. For two reasons arrival traffic constraints are important:

- The arrival flight has a short distance to go, and it is difficult to solve problems in an efficient way with respect to time delays and flight economy.
- The impact of a change of the planning of an arrival flight on the overall traffic situation in the TMA is large, while the impact is insufficient known for an AA PC, knowing only one of several streams of traffic, arriving at the airport.

For efficiently reasons the AA PC will be allowed to modify the en-route aircraft if conflicting with the constraints attached to the arriving aircraft.

As far as a majority of arriving traffic is present in the arriving sectors this reversed priority is considered to be acceptable.

Part of the difficulties of priority assessment with respect to conflict resolution can be avoided by strategic and tactical flow management, which should solve in advance at least conflicts between different flows of arrival traffic, achieved by procedural separation, applying standard arrival procedures (STARs) and complemented by anticipated MSP re-organisation (before AM advisories are delivered).

2.3.6.5.3 Co-ordination with adjacent sectors

- ◆ "Implicit and explicit co-ordination on sector entry and exit conditions with controllers of adjacent sectors and areas":

See the ER PC, section 2.3.4.5.

- ◆ "Co-ordinating with the TMA controllers":

The AA PC shall co-ordinate the planning of arrival traffic and holding procedures on a planning level.

The AA PC shall co-ordinate on a tactical level on request of the AA TC also, if required.

The AA PC co-ordinates for arrival traffic on a planning level with the ARR SP. Continuous co-ordination with the ARR SP is required on the transfer sequence and on the 4D transfer condition on the Metering Fix. (see also footnote 4, section 2.3.6.3 AA PC role)

A special co-ordination activity is co-ordination required to hold an aircraft on a stack. The ARR SP plans the need to hold an aircraft and the estimated time to leave the holding, the AA PC plans the execution of the holding procedure and the assigned flightlevels, the AA TC controls the holding manoeuvre.

During the phase of tactical control, within the sector, controlled by the AA TC, co-ordination is possible with the ARR SP and the INI for leaving the holding, if the aircraft was held, and for a transfer of control on the Metering Fix.

2.3.6.5.4 Co-ordination with the MSP

- ◆ "Co-ordinating in exceptional cases with the MSP":

See the ER PC, section 2.3.4.5.

2.3.6.5.5 4D Trajectory Negotiation

- ◆ "Trajectory negotiation with 4D and data-link equipped aircraft":

See the ER PC, section 2.3.4.5.

- ◆ "4D trajectory negotiation on approaching the Metering Fix":

The AA PC shall follow as much as possible the constraining conditions, imposed by the ARR SP, as result of optimisation of sequencing arrival traffic. If appropriate, he shall plan and up-link a formalised clearance to 4D aircraft, co-ordinating with the AA TC.

The AM advisories will lead to amendments on 4D contracts. The amendments are based on time constraints and are implemented by speed adjustments, path stretching and, in general, by generating an adapted 4D trajectory. This 4D trajectory can be up-linked to the aircraft as a "formalised clearance". In the particular case of a conflict-free arriving trajectory, a single time constraint, resolving the required absorption of delay at the Metering Fix, can be uplinked to the 4D aircraft.

2.3.6.5.6 Co-ordination with, and assistance to the AA TC

- ◆ "Co-ordinating with, and assistance to the AA TC and updating the SPL with the updated planned and/or contracted trajectory":

See the ER PC, section 2.3.4.5.

2.3.6.5.7 Monitoring the traffic situation

- ◆ "Monitoring the evolving traffic situation over the concerned period of planning and control":

See the ER PC, section 2.3.4.5.

The AA PC shall monitor specific points concerning arrival traffic:

- The planning and status of air traffic in a holding stack
- The status of advisories for optimal sequencing, metering and spacing of arrival traffic, relevant to the own sector, and the associated planning of flights. These advisories may be applicable to traffic, arriving at airports in TMAs to be served directly and/or remote TMAs.

2.3.6.5.8 Stack control

- ◆ "Stack control, planning and preparation of holding manoeuvres":

The AA PC shall prepare holdings on request of the ARR SP. These requests are submitted in case of required exception handling due to overload of the available landing capacity.

It is required for traffic, approaching a TMA, that it can be held on a stack. The AA PC of the adjacent ETMA sector, should be able to react on requests to hold an aircraft on the stack, and to monitor the appropriate moment of planning the departure from the holding.

The ARR SP shall indicate via co-ordination if an aircraft has to be planned for a holding manoeuvre. Also an appropriate moment for leaving the stack area shall be determined via co-ordination with the ARR SP and/or the INI. The AA PC shall plan the entry and exit level of a flight in the stack and he shall monitor the overall efficiency in use of available levels of the stack area.

2.3.7 Arrival ACC Sector Tactical Controller - AA TC

2.3.7.1 Area of responsibility

The AA TC's area of responsibility shall be the same as defined for the AA PC. It encompasses the geographical and vertical limits of the ETMA ACC arrival sector.

The area may include shared responsibility with the DA TC, depending on the procedural organisation of arrival and departure traffic. In the Netherlands inbound and outbound traffic is always present in one ACC sector, in France it is separated normally, with some exceptions e.g. for arrival and departure traffic, crossing each other.

2.3.7.2 Tactical control horizon

The AA TC shall be responsible for tactical control for an aircraft from assume control until transfer of control to the next receiving ETMA/En-route sector or to the INI of the TMA approach sector.

2.3.7.3 Role

The role of the AA TC is to tune and complete the trajectory planning through the sector, to monitor the sector traffic situation, to resolve outstanding problems and to cope with unexpected situations.

TC is the only one having the final authority to give an aircraft a clearance. He may modify the contract negotiated by the MSP and PC with the pilot.

Because the AA TC performs also en-route control tasks, part of his tasks are identical to the corresponding tasks of the ER TC.

2.3.7.4 AA TC tasks

The AA TC shall use the R/T for voice communication, and data-link, ground-air and ground-ground, facilities for digital communication purposes. Ground voice channels will be available for late or particular co-ordination.

The AA TC shall work in the situation context elaborated by the AA PC, and is responsible for:

- Keeping awareness of problem situations (see ER TC tasks).
- Managing problems and maintaining separation in the controlled sector, taking into account efficiency and 4D planning constraints (ER TC).
- Preparing and executing conflict resolution clearances for data-link and non data-link aircraft for outstanding conflict situations (ER TC).
- Ensuring compliance with AM requirements at the Metering Fix.
- Managing R/T communications and managing tactical data-link communications with controlled aircraft (ER TC).
- Trajectory negotiation with 4D equipped aircraft on tactical level (ER TC).

- Trajectory negotiation with 4D equipped aircraft for conflict resolution and arrival clearances
- Co-ordinating with adjacent sectors (ER TC):
 - Accepting entering traffic
 - Transferring exiting traffic
- Co-ordinating with the AA PC (assistant to the AA TC) (ER TC).
- Updating the ground system (ER TC).
- Monitoring the traffic situation in his sector over the concerned period of tactical control (ER TC).
- Stack control:
 - maintaining separation
 - maintaining communication
 - performing the planned holding manoeuvres

Note:

It should be noted that for arriving traffic the AA TC tasks are also applicable to the ER TC, whereas for en-route traffic the ER TC tasks are applicable to the AA TC. This section is only dealing with the pure arriving tasks and refers to en-route task descriptions.

Stack control tasks can be delegated to a special tactical controller. To attribute the task of stack control to the ETMA/ACC controller, is a solution which is in conformance with the situation today in the Netherlands. In France, some of the lower levels are controlled by the TMA approach controller (INI).

2.3.7.5 AA TC task description**2.3.7.5.1 Keeping awareness of problem situations**

See the ER TC, section 2.3.5.5.

2.3.7.5.2 Problem management and maintaining separation

- ◆ "Managing problems and maintaining separation in the controlled sector, taking into account efficiency and 4D planning constraints":

See the ER TC, section 2.3.5.5.

The task of maintaining the separation may be expected to be more complicated for arrival ETMA sectors than for En-route sectors due to descending traffic flows and due to arrival constraints.

2.3.7.5.3 Preparing and executing conflict resolution clearances

- ◆ "Preparing and executing conflict resolution clearances for data-link and non data-link aircraft for outstanding conflict situations":

See the ER TC, section 2.3.5.5.

2.3.7.5.4 Arrival management

"Ensuring compliance with AM requirements at the Metering Fix":

The AA TC shall be responsible for ensuring compliance with AM requirements at the Metering Fix.

The AA TC may employ speed, path-stretching or vertical separation in order to ensure the correct sequence of separated air traffic at the Metering Fix. For non-equipped aircraft, direct clearances will be applied, for 4D equipped aircraft a formalised clearance will be up-linked.

Sequencing advisories are to be honoured with a certain priority.

2.3.7.5.5 Managing communication with aircraft via R/T and datalink

"Managing R/T communications and managing tactical data-link communications with controlled aircraft":

See the ER TC, section 2.3.5.5.

2.3.7.5.6 Negotiating with 4D and datalink equipped aircraft

"Trajectory negotiation with 4D equipped aircraft on tactical level":

For En-route traffic see the ER TC, section 2.3.5.5.

The AA TC shall perform the following actions with respect to 4D trajectory negotiation:

- Approval at assume control of a 4D contracted flight to accept the contracted 4D trajectory segment through the sector as a clearance ("sector contract approval").
- Giving the permission to the PC of the next receiving sector to start 4D trajectory negotiation.
- Giving, if required for tactical control reasons, a Formalised Clearance.

"Trajectory negotiation with 4D equipped aircraft for conflict resolution and arrival clearances":

The AA TC shall use 4D capability to guide the aircraft to the Metering Fix according to the exit conditions, prepared by the AA PC and agreed by the ARR SP.

The AA TC can approve a 4D contract through the sector, even if the contracted trajectory is not yet adapted to the corrections provided by the AM.

The AA TC can use 4D formalised clearances in order to control the flight according to the optimised sequencing, metering and spacing process. The AA TC should monitor the adequate separation. In case of conflicting conditions and a required update of the sequencing, he will co-ordinate with the ARR SP.

2.3.7.5.7 Co-ordination with adjacent sectors

"Co-ordinating with adjacent sectors":

- Accepting entering traffic
- Transferring exiting traffic

For En-route traffic see the ER TC, section 2.3.5.5.

The AA TC shall co-ordinate the modifications of transfer conditions with the arrival planner controller (ARR SP) and the tactical controller in the TMA (INI) for a correct and timely transfer of control on the Metering Fix and for co-ordination on holding procedures:

- Co-ordinating on a flexible metering fix time constraint (see AA PC role section 2.3.6.3)

2.3.7.5.8 Co-ordination with the AA PC

- ◆ "Co-ordinating with the AA PC (assistant to the AA TC)":

See the ER TC, section 2.3.5.5.

2.3.7.5.9 Updating the ground system

- ◆ "Updating the ground system":

See the ER TC, section 2.3.5.5.

2.3.7.5.10 Monitoring aircraft trajectories and the actual traffic situation

- ◆ "Monitoring the traffic situation in his sector over the concerned period of tactical control":

For En-route traffic see the ER TC, section 2.3.5.5.

The AA TC shall be able to monitor additional information of the status of the planning of arrival air traffic. The estimated arrival times on the Metering Fix are to be compared with the most recent updates of a planning which is optimised with respect of sequencing, metering and spacing.

2.3.7.5.11 Stack control

- ◆ "Stack control":
 - maintaining separation
 - maintaining communication
 - performing the planned holding manoeuvres

The AA TC shall control holding manoeuvres in the stack area.

If an aircraft is to be held on the stack, the aircraft is planned by the AA PC to leave the stack after co-ordination with the ARR SP. However, the INI shall give the permission to guide the aircraft to the Metering Fix of the TMA and this permission determines the actual moment of leaving the stack. If required, the AA TC should be able to hold the aircraft until this permission is supplied.

Different aircraft are kept on the stack at different levels with sufficient separation. The AA TC shall give descent instructions to each aircraft on higher levels, if a lower level is released by an aircraft leaving the stack area.

If the amount of air traffic guided via the stack is expected to exceed the normal AA TC workload, then it might be required to use a separate TC for stack control.

(Use of the stack area will be considered in the PD/3 demonstrations for exception handling only, and the stack will not be used or in very rare cases only.)

2.3.8 Departure ACC Sector Planning Controller - DA PC

2.3.8.1 Area of responsibility

The DA PC's area of responsibility shall be defined by the geographical and vertical limits of the ETMA ACC departure sectors. Generally, this sector will not be relevant to be included in an MSP area.

The area will be allocated adjacent to the TMA departure zone, where departure traffic will leave the TMA following standard procedures (SIDs).

The area may include, in the French airspace, shared responsibility with the AA PC (arrival) for segments in the ETMA where departure and arrival routes cross. In the Dutch airspace, sectors are always combined arrival and departure sectors.

2.3.8.2 Planning horizon

The DA PC shall be primarily responsible for planning aircraft through his/her sector from 10 minutes prior to sector entry until the aircraft is assumed by the DA TC. Pre-departure flights have to be replanned after take-off for a transit plan through the ETMA.

As a secondary role, the DA PC assists also the executive controller in his executive controlling role when the flight is assumed. The commitment with a flight ends, if this flight is released, if this flight leaves the sector and if control is transferred to the next sector.

2.3.8.3 Role

The role of the DA PC is to perform the role of a PC in an ETMA/ACC sector. Pure en-route tasks (ER PC, section 2.3.4) are combined with tasks of planning departure traffic through the ETMA and planning departure flights to be merged in the en-route traffic flows.

Each departing flight is planned through the ACC sector. After a transfer of control to the sector, the flight is taken under control by the DA TC, and the role of the PC is to assist the TC, until a transfer of control to the next receiving sector.

Because the DA PC performs also en-route planning tasks, part of his tasks are identical to the corresponding tasks of the ER PC.

2.3.8.4 DA PC tasks

The DA PC shall use the ground-ground and air-ground data-link facilities for communication purposes. Ground voice channels will be available for late or particular co-ordination only.

The DA PC shall work in close harmony with the DA TC but specifically, the DA PC shall be responsible for :

- Awareness of traffic load and problem situations (ER PC task).
- Planning over the sector and flight integration (ER PC task):

- Validating aircraft sector entry and exit conditions
- Managing problem situations
- Preparing sector conflict resolution clearances for non-data-link equipped aircraft
- Deconflicting 4D equipped aircraft
- Implicit and explicit co-ordination on sector entry and exit conditions with controllers of adjacent sectors and area's (ER PC task)
- Co-ordinating with the TMA controllers
- Co-ordinating in exceptional cases with the MSP (ER PC task)
- Trajectory negotiation with 4D and data-link equipped aircraft (ER PC task)
- 4D trajectory negotiation for departure traffic
- Co-ordinating with, and assistance to the DA TC and updating the SPL with the updated planned and/or contracted trajectory (ER PC task)
- Monitoring the evolving traffic situation over the concerned period of planning and control (ER PC task)

Note:

It should be noted that for en-route traffic the ER PC tasks are applicable to the DA PC. This section refers to en-route task descriptions.

It should be noticed that in the Netherlands, inbound and outbound traffic is always controlled within one ACC sector. This implies the combination of DA PC and AA PC tasks, performed by one ACC controller.

2.3.8.5 DA PC task description**2.3.8.5.1 Awareness of traffic load and problem situations**

See the ER PC, section 2.3.4.5.

2.3.8.5.2 Planning and integration

- ◆ "Planning over the sector and flight integration":
 - Validating aircraft sector entry and exit conditions
 - Managing problem situations
 - Preparing sector conflict resolution clearances for non-data-link equipped aircraft
 - Deconflicting 4D equipped aircraft

See the ER PC, section 2.3.4.5.

2.3.8.5.3 Co-ordination with adjacent sectors

- ◆ "Implicit and explicit co-ordination on sector entry and exit conditions with controllers of adjacent sectors and areas":

See the ER PC, section 2.3.4.5.

- ◆ "Co-ordinating with the TMA controllers":

The DA PC shall co-ordinate the planning of departure traffic with the DEP PC.

The DA PC shall co-ordinate on a tactical level on request of the DA TC, if required.

The DA PC co-ordinates for departure traffic on a planning level with the DEP PC. The DEP PC is tasked to refine the pre-departure capacity planning to a precise scheduled departure planning. After take-off, the planning can be refined based on the actual departure time. These different planning phases may be a reason for rather frequent co-ordination. The DA PC is tasked to make a planning for departure flights, given the precision of available planning data.

2.3.8.5.4 Co-ordination with the MSP

- ◆ "Co-ordinating in exceptional cases with the MSP":

See the ER PC, section 2.3.4.5.

The MSP is not in a position to make a accurate planning for departures in his own multi-sector planning area before the aircraft is airborne, because the required precision of trajectory prediction data is not available yet. however the MSP will be concerned with the calculated DM departure sequences with the aim of assessing the expected sector workload and global interference between departing and overflying flows.

2.3.8.5.5 4D Trajectory Negotiation

- ◆ "Trajectory negotiation with 4D and data-link equipped aircraft":

See the ER PC, section 2.3.4.5.

- ◆ "4D trajectory negotiation for departure traffic":

The DA PC shall perform 4D trajectory negotiation for 4D equipped aircraft as soon as the planning through his sector is achieved and as soon as the aircraft is in a position to negotiate.

In order to start the 4D trajectory negotiation process, the departing flight has to fulfill the following conditions:

- The flight has to be planned up to the transfer condition of the current DEP sector and the DA PC has obtained Negotiation Authority.
- The flight has to be in a stable condition. After take-off the initial climb phase is not considered as stable and trajectory negotiation is considered to be possible only later during the climb phase or afterwards. This might be the earliest in the ETMA ACC departure sector. If the flight is stable and the predicted 4D trajectory is considered accurate and reliable, then trajectory negotiation can be initiated.
- The aircraft is ready to negotiate. This is assumed to become possible after the take-off phase is finished (possibly between FL50 and FL100).

Due to the short time of flying through the TMA, 4D trajectory negotiation on the trajectory segment in the departure ETMA ACC sector is rather time critical.

2.3.8.5.6 Co-ordination with, and assistance to the DA TC

- ◆ "Co-ordinating with, and assistance to the DA TC and updating the SPL with the updated planned and/or contracted trajectory":

See the ER PC, section 2.3.4.5.

2.3.8.5.7 Monitoring the traffic situation

- ◆ "Monitoring the evolving traffic situation over the concerned period of planning and control":

See the ER PC, section 2.3.4.5.

2.3.9 Departure ACC Sector Tactical Controller - DA TC

2.3.9.1 Area of responsibility

The DA TC's area of responsibility shall be the same as that defined for the DA PC. It encompasses the geographical and vertical limits of the ETMA ACC departure sector.

The area may include shared responsibility with the AA TC, depending on the procedural organisation of arrival and departure traffic. In the Netherlands inbound and outbound traffic is always present in one ACC sector, in France it is separated normally, with some exceptions e.g. for arrival and departure traffic, crossing each other.

2.3.9.2 Tactical control horizon

The DA TC shall be responsible for tactical control for an aircraft from assume control until transfer of control to the next receiving sector.

2.3.9.3 Role

The role of the DA TC is to tune and complete the trajectory planning through the sector, to monitor the sector traffic situation, to resolve outstanding problems and to cope with unexpected situations.

That TC is the only one having the final authority to give an aircraft a clearance. He may modify the contract negotiated by the PC with the pilot.

Because the DA TC performs also en-route control tasks, part of his tasks are identical to the corresponding tasks of the ER TC.

2.3.9.4 DA TC tasks

The DA TC shall use the R/T for voice communication, and data-link, ground-air and ground-ground, facilities for digital communication purposes. Ground voice channels will be available for late or particular co-ordination only.

The DA TC shall work in the situation context elaborated by the ER PC, and is responsible for:

- Keeping awareness of problem situations (ER TC).
- Managing problems and maintaining separation in the controlled sector, taking into account efficiency and 4D planning constraints (ER TC).
- Preparing and executing conflict resolution clearances for data-link and non data-link aircraft for outstanding conflict situations (ER TC).
- Managing R/T communications and managing tactical data-link communications with controlled aircraft (ER TC).
- Trajectory negotiation with 4D equipped aircraft on tactical level (ER TC).
- Co-ordinating with adjacent sectors (ER TC):

- Accepting entering traffic
- Transferring exiting traffic
- Co-ordinating with the DA PC (assistant to the DA TC) (ER TC).
- Updating the ground system (ER TC).
- Monitoring the traffic situation in his sector over the concerned period of tactical control (ER TC).

Note:

It should be noted that for en-route traffic the ER TC tasks are applicable to the DA TC. This section refers to en-route task descriptions.

2.3.9.5 DA TC task description**2.3.9.5.1 Keeping awareness of problem situations**

See the ER TC, section 2.3.5.5.

2.3.9.5.2 Problem management and maintaining separation

- ◆ "Managing problems and maintaining separation in the controlled sector, taking into account efficiency and 4D planning constraints":

See the ER TC, section 2.3.5.5.

The task of maintaining the separation may be expected to be more complicated for departure ETMA sectors than for En-route sectors due to climbing and merging traffic flows and due to departure take-off uncertainties.

2.3.9.5.3 Preparing and executing conflict resolution clearances

- ◆ "Preparing and executing conflict resolution clearances for data-link and non data-link aircraft for outstanding conflict situations":

See the ER TC, section 2.3.5.5.

2.3.9.5.4 Managing communication with aircraft via R/T and datalink

- ◆ "Managing R/T communications and managing tactical data-link communications with controlled aircraft":

See the ER TC, section 2.3.5.5.

2.3.9.5.5 Negotiating with 4D and datalink equipped aircraft

- ◆ "Trajectory negotiation with 4D equipped aircraft on tactical level":

See the ER TC, section 2.3.5.5.

2.3.9.5.6 Co-ordination with adjacent sectors

- ◆ "Co-ordinating with adjacent sectors":
 - Accepting entering traffic
 - Transferring exiting traffic

For En-route traffic see the ER TC, section 2.3.5.5.

The DA TC shall co-ordinate with the departure planner controller (DEP PC) and the tactical controller in the TMA departure zone (DEP TC) for a correct and timely transfer of control to the ETMA departure sector after take-off and initial climb through the TMA departure zone for departure traffic.

2.3.9.5.7 Co-ordination with the DA PC

- ◆ "Co-ordinating with the DA PC (assistant to the DA TC)":

See the ER TC, section 2.3.5.5.

2.3.9.5.8 Updating the ground system

- ◆ "Updating the ground system":

See the ER TC, section 2.3.5.5.

2.3.9.5.9 Monitoring aircraft trajectories and the actual traffic situation

- ◆ "Monitoring the traffic situation in his sector over the concerned period of tactical control":

See the ER TC, section 2.3.5.5.

2.3.10 Arrival Sequence Planning Controller - ARR SP

2.3.10.1 Area of responsibility

The ARR SP is responsible for sequencing of arrival traffic, for planning inside the TMA and for assistance during the phase of tactical control in the TMA.

The ARR SP is responsible for co-ordinating on arrival traffic and merging of the arrival flows, approaching the TMA. The enlarged sequencing area can have a size up to 200 NM from the runway, however, direct control on planning and executive control of flights is implemented via co-ordination only.

2.3.10.2 Planning horizon

The ARR SP initiates work on the planning of a flight from a capacity planning, based on the applicable runway configuration in use. In an early, pre-flight stage, co-ordination with ATFM (the CFMU) is required for management of the capacity planning. In an early, in-flight stage, the arrival capacity planning is based on the traffic organisation effort, performed by MSPs.

The refinement of capacity planning to sequencing, metering and spacing starts when the flight is taken under control of the Arrival manager (AM), roughly about 20 to 30 minutes before the landing, on a distance of 100 to 200 NM from the gate.

The planning task for a flight changes to a task of tactical control assistance. This assistance task starts at the Metering Fix (assistance to the INI) and ends on Final Approach (assistance to the ITM) until a transfer of control to the Local Controller (LOC).

2.3.10.3 Role

The ARR SP has an arrival managing and a co-ordinating role during the ETMA/En-route arrival phase of a flight, before the Metering Fix. He is responsible to adapt the sequencing of flights and the planning of appropriate time constraints on the runway and on the Metering Fix. Via co-ordination he might achieve the required planning in the ETMA/En-route upstream (giving) sectors in agreement with the arrival sequence planning.

The ARR SP shall do the planning of flights within the TMA.

After a transfer of control to the INI, the ARR SP is assisting the tactical controller, first the INI, then the ITM, with their task of tactical control of the flight.

2.3.10.4 ARR SP tasks

The ARR SP shall use the ground-ground and air-ground data-link facilities for communication purposes. Ground voice channels will be available for late communication only.

The ARR SP shall work in close harmony with the INI and ITM during tactical control of a flight, inside the TMA. In En-route airspace and in the ETMA, the ARR SP shall co-ordinate intensively with the PCs of these sectors. The specific tasks of the ARR SP are:

- Replanning over the arrival sector(s) (with support of an AM, up to 30 minutes from the landing)
- Ensuring the re-insertion of Missed Approach Aircraft in the Arrival Sequence
- Co-ordination with adjacent and upstream (giving) sectors:
 - Co-ordinating on inbound traffic
 - Co-ordinating on holdings on the stack
 - Co-ordinating on outbound traffic with LOC (Tower Control)
- Co-ordinating with and assistance to the INI and ITM and preparing clearances
- Monitoring the evolving traffic situation over the concerned period of planning and control
- Participation of assigning the runway configuration in use
- Co-ordinating with the DEP PC and LOC (Tower Control) on use of runway capacity

2.3.10.5 ARR SP task description

2.3.10.5.1 Replanning and sequencing

- ◆ "Replanning and sequencing of arrival traffic":

The ARR SP shall co-ordinate the sequence planning of all arrival traffic of one TMA up to touch-down on the runway. Arrival traffic, approaching from several ACC and En-route sectors has to be merged into one or more arrival sequences, depending on the runway configuration in use and depending on the imposed constraints, such as planned departures and the interference of different arriving and departing traffic flows.

The arrival planning has to be such that optimal sequencing has to be achieved with respect to the use of the available landing capacity. The landing sequence shall be such, that:

- The safety and prescribed separations are maintained.
- The realised arrival times are optimal in two ways:
 - optimal with respect to the average deviation of the scheduled arrival times.
 - optimal with respect to the spread in deviations of scheduled arrival times.
- The arrival procedure is as efficient as possible with respect to flight performance operations.
- The sequencing takes into account optimal sequencing with respect to different weight categories.

The replanning and sequencing task of the ARR SP is most effective far in advance of the landing time to be realised. Therefore, most of the replanning and sequencing task is implemented in the ETMA and En-route sectors via co-ordination with the appropriate AA PC/ER PC or AA TC/ER TC. After entrance of the TMA and after passing the Metering Fix, replanning is achieved by supporting the tactical controllers, INI and ITM.

Sequencing, metering and spacing, and related to this replanning, is a feed-back control process and optimisation will continue from the start of this process up to the moment that the aircraft is cleared to contact the Tower (the LOC controller) on final approach. Although a continuous feed-back control process does not require segmentation of the approaching arrival flight path, segmentation is nevertheless established due to the structure of airspace, dividing the arrival flight path in En-route, ACC and TMA parts. The arrival sequencing is first optimised on the Metering Fixes for different entry points of the TMA, taking into account the constraints for merging the inbound traffic flows; then the sequencing is optimised for deliverance of the aircraft on final approach in one arrival flow for each runway in use.

Taking into account a regularly updated planning of the optimal metering and spacing of the arriving aircraft, replanning should achieve optimal sequencing on final. The means of correcting for optimal arrival scheduling are listed following their preferred priority:

For 4D and data-link equipped aircraft:

- a 4D trajectory, imposed as a formalised clearance

For non-4D-equipped aircraft:

- tactical speed clearances
- tactical heading clearances (vectoring)
- tactical level clearances

◆ "Ensuring the re-insertion of Missed Approach Aircraft in the Arrival Sequence":

The ARR SP shall be responsible for the re-insertion of missed approach aircraft into the arrival sequence. He shall co-ordinate with the INI and ITM.

2.3.10.5.2 Co-ordination with adjacent and upstream (giving) sectors

◆ "Co-ordinating on inbound traffic":

The ARR SP shall keep overview on the different inbound arrival traffic flows and he shall control the optimal metering and spacing of these flows and the optimal merging of these flows into one or more arrival flows on final approach.

The ARR SP shall co-ordinate with the AA PCs and ER PCs of upstream (giving) ETMA and En-route sectors. The sequencing preferences and derived time constraints and descent advisories are the basis for this co-ordination process.

The descent optimisation process starts about 120 to 200 NM out of the gate, or 20 to 30 minutes before touch-down. This implies that co-ordination may be required with several upstream (giving) ETMA and En-route sectors.

The ARR SP is required to be able to survey the overall process of merging the arrival traffic flows; he is not required to take into account the induced planning and tactical control problems. The ARR SP co-ordinates with the AA PC/ER PC or AA TC/ER TC, who are required to be able to solve the short-term planning and tactical problems, but who are not required to be able to survey the sequencing, metering and spacing constraints. The co-ordination process shall lead to a solution of a traffic problem, which will be solved preferentially in favour of the sequencing constraints.

The aim of arrival management is to optimise the use of available runway capacity and to realise optimisation in an efficient way by early, precise and corrective management of the sequencing. Optimisation can be achieved by early planning with support of 4D capability of equipped aircraft, and with support of a ground-based guidance function for non-equipped 3D aircraft. This process of refined planning and control, however, increases the workload in ACC and En-route sectors. Moreover, this process reduces the freedom to solve problems, which is a risk of increased complexity of work, specifically in the En-route sectors.

Therefore, a co-ordination procedure shall be applicable, in which explicit co-ordination between ARR SP, ER PC/TC and AA PC/TC in the ACC sector has been reduced to a minimum, whilst, at the same time, flexibility of control is provided by using early and late arrival times over the Metering Fix. These early and late arrival times are determined by the applicable Fan and/or Trombone possibilities in the TMA, allowing a tolerance of the actual arrival time over the Metering Fix, with a time window to determined.

◆ "Co-ordination on holdings on the stack":

The ARR SP shall co-ordinate on the planning of holding aircraft on the inbound stack area, if required.

Special inbound co-ordination activities are needed for inbound traffic, to be held on a stack. The period of an aircraft, remaining on the stack, is determined by co-ordination between the ARR SP and AA PC. The moment of leaving the stack is planned by the ARR SP and, tactically, the moment of leaving the stack is determined by the AA TC, co-ordinating with the INI, giving the AA TC the permission for a transfer of the aircraft on the Metering Fix.

- ◆ "Co-ordinating on outbound traffic with LOC (Tower Control)":

The ARR SP shall co-ordinate with LOC (Tower Control) to achieve a planned optimal use of the landing capacity in a safe, orderly and efficient way.

The optimised planning supplies air traffic as a flow of traffic, acceptable to be handled by Tower Control. However, any abnormal or changing condition shall lead to a co-ordinating action in order to be able to react appropriately.

Examples of conditions, leading to co-ordinating action, are e.g.:

- Traffic handling problems (e.g. overshoots, obstacles on the runway, a flock of birds).
- Meteo conditions (e.g. changing visual conditions).
- Tactical problems with planned departure traffic, affecting arrival traffic.
- A changing runway configuration, and the transition conditions.

2.3.10.5.3 Co-ordination with and assistance to the INI and ITM

- ◆ "Co-ordinating with and assistance to the INI and ITM and preparing clearances":

The ARR SP shall assist the INI and ITM in preparing and implementing the clearances for data-link and non-data-link equipped aircraft. He shall use the advisories for re-sequencing, metering and spacing for this task.

The feed-back control process of optimal metering and spacing on final approach continues after passing the Metering Fix. The aircraft is under control of the INI and the ITM, and the ARR SP will assist them in their executive task.

2.3.10.5.4 Monitoring the traffic situation

- ◆ "Monitoring the evolving traffic situation over the concerned period of planning and control":

The ARR SP shall monitor the traffic situation over the full distance of optimal arrival sequencing. Also, the regularly updated planning on the Metering Fixes of one TMA, and the planning on the scheduled landing times shall be monitored.

Also, all tactical control activities in the TMA shall be monitored.

2.3.10.5.5 Participation in use of the runway capacity

- ◆ "Participation of assigning the runway configuration in use":

The ARR SP shall co-ordinate with the APP supervisor, with DEP PC and LOC (Tower Control), if the runway configuration is to be changed. And if the configuration is to be changed at which moment, and how, the transition to the new configuration is achieved.

The ARR SP shall adapt the planning of arrival traffic accordingly, while also a transition is required of the use of applicable STARs.

The ARR SP shall be responsible for co-ordination of the runway configuration. This should be a balanced agreement between ARR SP, DEP PC, LOC (Tower Control), airport authority and operating agencies. The runway configuration should take account of arrival and departure traffic flows, meteorological conditions, and noise abatement procedures.

(In PD/3, only a modest use of a possibility to change the used runway configuration is foreseen, while the function of an APP supervisor is emulated.)

◆ "Co-ordinating with the DEP PC and LOC (Tower Control) on use of runway capacity":

The ARR SP shall co-ordinate on arrival planning with DEP PC and LOC (Tower Control), if shared use of the capacity of a runway is applicable.

The planning of departure and arrival traffic has to be planned according to the runway configuration in use. In principle, the planning of departure traffic has to be adapted according to the optimised planning of arrival traffic. However, the arrival sequencing optimisation process has to take into account that the accuracy of the real departures is one of the constraining variables in the optimisation process.

(There is a preferred use of separate runways for departure and arrival traffic in PD/3.)

2.3.11 Initial Approach Controller - INI

2.3.11.1 Area of responsibility

The INI area of responsibility shall extend from the arrival gates, where flights are transferred to the INI arriving on one of the Metering Fixes, to the intermediate approach area.

2.3.11.2 Tactical control horizon

The INI shall be responsible for tactical control for an aircraft from assume control until transfer of control to the ITM.

2.3.11.3 Role

The INI is a TC, operating in the transfer area from ETMA to TMA, controlling arrival traffic, approaching via STARs and passing the Metering Fix.

It is the task of the INI, to accept planned arrival traffic from the ETMA, and to ensure that arrival traffic over several Metering Fixes, will be taken under control and will be guided in such a way, that merging the arrival traffic flows can be accomplished by the ITM on intermediate and final approach.

The tactical control task of the INI is of small duration, and it is possible, traffic permitting, to combine his role with the planning task of the ARR SP, combining planning and the initial phase of tactical control, or with the tactical control task of the ITM, combining the tactical approach control tasks.

2.3.11.4 INI tasks

The INI shall use the R/T for voice communication, and data-link, ground-air and ground-ground, facilities for digital communication purposes. Ground voice channels will be available for late co-ordination only.

The INI shall be responsible for :

- Maintaining separation and contributing to the arrival sequencing.
- Validating and co-ordinating TMA flight entry conditions with AA TCs and/or AA PCs in adjacent ACC sectors, taking into account arrival sequencing constraints.
- Preparing and executing arrival flow and separation instructions for data-link and non data-link aircraft.
- Managing R/T communications and managing tactical data-link communications with controlled aircraft.
- Co-ordinating the transfer of arrival flows to the ITM.
- Co-ordinating with the ARR SP (assistant to the INI).
- Updating the ground system with tactical clearances.
- Monitoring the actual traffic situation within the approach area.

2.3.11.5 INI task description

2.3.11.5.1 Maintaining separation; contributing to the arrival sequence

- ◆ "Maintaining separation and contributing to arrival sequencing":

The INI shall be responsible for maintaining separation between aircraft under his/her control.

The INI shall monitor trajectory compliance and the current traffic situation in order to resolve potential conflicts by providing tactical intervention. Tactical intervention shall be effected via data-link or R/T as appropriate and shall take into account of sequencing and metering constraints.

The INI shall be responsible for ensuring compliance with landing constraints and will create an arrival sequence by merging arrival traffic flows.

The INI may employ speed, path-stretching or vertical separation in order to ensure the correct sequence of separated traffic prior to transfer to the ITM.

2.3.11.5.2 Preparing and executing conflict resolution and arrival clearances

- ◆ "Preparing and executing arrival flow and separation instructions for data-link and non data-link aircraft":

The INI shall be responsible for the preparation and execution of conflict resolution and arrival clearances for situations which arise during the integration of arrival flows into an arrival sequence.

Conflict resolution clearances shall be formulated taking into account the arrival constraints.

- ◆ "Validating and co-ordinating aircraft TMA flight entry conditions with AA TCs and/or AA PCs in adjacent ACC sectors, taking into account arrival sequencing constraints":

The INI shall assess the TMA entry conditions for each aircraft and shall re-negotiate conditions in the event that AM requirements are not met.

The INI shall co-ordinate on separation, if required, or, as a last resort, co-ordinate on a holding procedure, if arrival gate conditions cannot be met or that runway arrival demand is exceeded.

In the event that approach holding is commenced or that arrival capacity is reduced the INI will be responsible for co-ordinating remedial action with concerned arriving traffic controllers in order to reduce arrival rates at the entry gates.

2.3.11.5.3 Managing communication with aircraft via R/T and datalink

- ◆ "Managing R/T communications and managing tactical data-link communications with controlled aircraft":

The INI shall ensure that two way R/T communication is established with all aircraft under his/her control. The INI shall ensure that communication with data-link aircraft is established.

The INI shall be responsible for the choice of communication facility to be used for tactical intervention. However, where time permits, the preferred facility shall be data-link.

2.3.11.5.4 Co-ordination

- ◆ "Co-ordinating the transfer of arrival flows to the ITM":

The INI shall co-ordinate the arrival flow with the ITM in the event that arrival metering constraints are not met.

- ◆ "Co-ordinating with the ARR SP (assistant to the INI)":

The INI shall transfer part of his preparing, implementation and communication tasks to the ARR SP, if the workload due to his primary task of maintaining the separation and metering and spacing of arrival traffic, requires this.

Even if the arrival traffic is managed by the INI during a limited period of time, the frequency and required accuracy of tactical action is very high. This asks for assistance at any possible level, if required.

2.3.11.5.5 Updating the ground system

- ◆ "Updating the ground system with tactical clearances":

The INI shall be responsible for updating the ground system via a trajectory editing tool for all tactical clearance and arrival instructions that are passed to aircraft via either R/T or data-link.

2.3.11.5.6 Monitoring aircraft trajectories and the actual traffic situation

- ◆ "Monitoring the actual traffic situation within the TMA approach area":

The INI shall monitor the actual traffic situation and traffic adherence to arrival sequence clearance and final approach spacing for conflict and wake vortex separation.

The INI shall maintain traffic situation awareness and be ready to intervene with tactical clearances in the event of unexpected conflict, urgency situations or runway capacity changes.

2.3.12 Intermediate Approach Controller - ITM

2.3.12.1 Area of responsibility

The ITM area of responsibility shall extend from the intermediate approach area to the final approach landing facility.

2.3.12.2 Tactical Control Horizon

The ITM shall be responsible for tactical control for an aircraft from assume control until transfer of control to the LOC. The ITM shall be responsible for ensuring aircraft "turn on" to the landing aid or established on final approach.

2.3.12.3 Role

The ITM is a TC, operating in the TMA, guiding arrival traffic to final approach.

The task of the ITM is an intensive tactical control task and this task asks for accurate attention. If more than one runway is used for arrival traffic, this makes it appropriate to control each runway by a separate ITM. (If this can not be accomplished in PD/3, emulation of some control activities may be required in order to be able to perform the demonstrations with the available resources.)

2.3.12.4 ITM tasks

The ITM shall use the R/T for voice communication, and data-link, ground-air and ground-ground, facilities for digital communication purposes. Ground voice channels will be available for late co-ordination only.

The ITM shall be responsible for :

- Maintaining separation in the arrival sequence.
- Responsible for ensuring aircraft "turn on" to the landing aid or final approach.
- Preparing and executing arrival flow and separation instructions for data-link and non data-link aircraft.
- Managing R/T communications and managing tactical data-link communications with controlled aircraft.
- Co-ordinating the transfer of arrival flows to the LOC.
- Co-ordinating with the ARR SP (assistant to the ITM).
- Updating the ground system with tactical clearances.
- Monitoring the actual traffic situation within the approach area.

2.3.12.5 ITM task description

2.3.12.5.1 Maintaining separation

- ◆ "Maintaining separation in the arrival sequence":

The ITM shall be responsible for maintaining conflict and wake vortex separation between aircraft in the arrival sequence

The ITM may employ speed or path-stretching separation in order to ensure the correct arrival sequence of traffic on final approach or the appropriate landing aid prior to transfer to the LOC.

Tactical intervention shall be effected via data-link or R/T as appropriate.

2.3.12.5.2 Preparing and executing conflict resolution and arrival clearances

- ◆ "Responsible for ensuring aircraft "turn on" to the landing aid or final approach":

The ITM shall be responsible for ensuring that an aircraft is turned onto the runway landing aid or final approach before transfer to LOC

- ◆ "Preparing and executing arrival flow and separation instructions for data-link and non data-link aircraft":

The ITM shall be responsible for the preparation and execution of conflict resolution and arrival clearances for situations which arise during the management of arrival flows and turn onto the landing aid or final approach before transfer to LOC

Conflict resolution clearances should be formulated taking into account arrival constraints and wake vortex separation requirements.

The last possibility to change significantly the sequence and/or the metering and spacing during the initial and intermediate approach consists of vectoring manoeuvres. Standardised "fan" and "trombone" vectoring manoeuvres are applicable. Speed adjustments (for 3D aircraft) or time constraints (for 4D aircraft) may also be useful.

The possibilities for metering and spacing during the transition to final approach are limited. Timely transfer of control to LOC (Tower Control) is required.

2.3.12.5.3 Managing communication with aircraft via R/T and datalink

- ◆ "Managing R/T communications and managing tactical data-link communications with controlled aircraft":

See the INI, section 2.3.11.5.

2.3.12.5.4 Co-ordination

- ◆ "Co-ordinating the transfer of arrival flows to the LOC":

- ◆ The ITM shall co-ordinate the arrival sequence with the LOC in the event that AM metering requirements have not been complied with.
- ◆ "Co-ordinating with the ARR SP (assistant to the ITM)":

See the INI, section 2.3.11.5.

2.3.12.5.5 Updating the ground system

- ◆ "Updating the ground system with tactical clearances":

See the INI, section 2.3.11.5.

2.3.12.5.6 Monitoring aircraft trajectories and the actual traffic situation

- ◆ "Monitoring the actual traffic situation within the approach area":

See the INI, section 2.3.11.5.

The closed loop of control and monitoring of air traffic in the approach phase is a highly intensive process of corrective action and of monitoring the effects. Reaction times are short and therefore monitoring and control are almost absorbing the capacity of the ITM.

2.3.13 Local Controller - LOC

2.3.13.1 Area of responsibility

The LOC area of responsibility is restricted to the ground and runway environment of an airport.

2.3.13.2 Planning horizon

For departures, the LOC planning horizon shall include the commencement of departure planning (via co-ordination with DEP PC) until transfer of the airborne flight to DEP TC.

For arrivals, the LOC planning horizon shall extend from transfer of aircraft on the landing aid or final approach until vacating of the runway.

2.3.13.3 Role

The LOC controls departures from the holding point before take-off, until a transfer to DEP TC at about 2000 ft.

The LOC controls arrivals from the transfer by the ITM until vacating of the runway and transfer of control to ground control services.

2.3.13.4 LOC tasks

The LOC shall use the R/T for voice communication.

The LOC shall be responsible for :

- As far as possible, visual control on the separation of controlled flights
- ATC on arrival and departure traffic, via co-ordination
- Maintaining the communication with controlled flights
- Co-ordinating with Ground Control services and with DEP PC, DEP TC, ARR SP and ITM
- Participation of assigning the runway configuration in use

2.3.13.5 LOC task description

2.3.13.5.1 Separation and control

- ◆ "As far as possible, visual control on the separation of controlled flights":
- ◆ "Action on arrival and departure traffic, via co-ordination":

(An emulated process in PD/3, simulated by a feeder position.)

2.3.13.5.2 Communication

- ◆ "Maintaining the communication with controlled flights":

2.3.13.5.3 Co-ordination

- ◆ "Co-ordinating with Ground Control services and with DEP PC, DEP TC, ARR SP and ITM":

(An emulated process in PD/3, simulated by an automated feeder position.)

- ◆ "Participation of assigning the runway configuration in use":

2.3.14 Departure Controller - DEP PC

2.3.14.1 Area of responsibility

The DEP PC's area of responsibility for planning reaches from the gate (planning the push-back) until the boundary of the TMA (the transfer condition).

The DEP PC's area of responsibility for assisting the DEP TC in his tactical control task, shall extend from the runway to the boundary of the TMA departure zone. There is a procedural separation between a departure and an arrival zone in the TMA by using appropriate standard routes (SIDs and STARs) in conformance with the applicable runway configuration in use.

2.3.14.2 Planning horizon

The DEP PC shall be responsible for departure planning, which includes push-back, ground movements and take-off scheduling. Departure scheduling should start with respect to the requirements of the advanced planning concept at least 30 minutes before take-off. Planning shall be completed before take-off.

The planning horizon shall include the transfer condition to the next receiving ETMA sector. The DEP PC shall co-ordinate this planning with the DA PC.

2.3.14.3 Role

Departure scheduling will be determined initially by ATFM, the CFMU, based on capacity planning. The DEP PC shall plan and co-ordinate the tactical phase of departure scheduling.

The DEP PC will continue his task, after take-off, in an assisting role during the initial climb phase of the flight, assisting the DEP TC with deconflicting and co-ordinating activities in the TMA departure zone. This assistance task is terminated if the flight is transferred to the next receiving ETMA sector.

2.3.14.4 DEP PC tasks

The DEP PC shall use the ground-ground and air-ground data-link facilities for communication purposes. Ground voice channels will be available for late co-ordination only.

The DEP PC shall work in close harmony with the DEP TC but specifically, the DEP PC shall be responsible for :

- Pre-departure planning, departure sequencing, and take-off scheduling
- Pre-departure co-ordination on take-off scheduling with Tower Control (LOC)
- Update the departure sequence
- Replanning and deconflicting over the departure zone of the TMA
- Co-ordinating on outbound traffic with the DA PC
- Trajectory negotiation with 4D equipped aircraft

- Co-ordinating with, and assistance to the DEP TC and updating the SPL with the updated planned and/or contracted trajectory
- Monitoring the evolving traffic situation over the concerned period of planning and control
- Participation in the determination of the runway configuration in use
- Assessment and replanning of scheduled departure slot-times
- Co-ordinating with the ARR SP and Tower Control on use of the available runway capacity

2.3.14.5 DEP PC task description

2.3.14.5.1 Departure Sequencing, and pre-departure planning

- ◆ "Pre-departure planning, departure sequencing, and take-off scheduling":

The DEP PC shall be responsible for defining the optimal departure sequence using the DM and taking into account the ground and departure runway situation.

In order to be able to integrate departure traffic into the process of multi-sector planning in the adjacent MSP area, it is required to start the planning of a flight at least half an hour before departure. This planning is based on the ATFM (CFMU) capacity planning

The planning of departures is necessarily an integrated planning of flights from start-up up to the merging into the en-route traffic flow. Before take-off deconflicting is not possible, and medium-term airborne planning is a planning on traffic flow capacity.

The planning is based on the following constraints:

- The departure slot-times, assigned by ATFM (the CFMU), based on a traffic flow capacity planning.
- The planning on arrival traffic, planned by the ARR SP, assisted by the Arrival Manager. This planning shall take into account requirements, derived from assigned departure slot-times, but arrival traffic imposes restrictions also on departure traffic, based on the priority, assigned to arrival traffic. However, the possible interference is dependent on the runway configuration in use.
- Take-off planning: sequencing and scheduling.
- The ground-based planning, which includes the planning of the ground-based activities, such as start-up procedure, apron operations, ground movements.
- A timely request for start-up permission and a pre-departure clearance of the aircraft.

Special conditions are to be taken into account for departure scheduling:

- Separation standards based on the wake vortex categories and, related to this, optimal scheduling with respect to the sequencing of aircraft of different wake vortex categories.
- The actual development of meteo conditions.

The departure planning leads to a planned pre-departure clearance, including a.o.:

- departure time
- departure runway
- SID
- cleared flight level

(The pre-departure clearance, as planned, to be given to the pilot by the Start Up Controller (SUC), will be emulated in the PD/3 demonstrations.)

2.3.14.5.2 Validating and co-ordinating aircraft departure conditions.

- ◆ "Pre-departure co-ordination on take-off scheduling with Tower Control (LOC)":

The DEP PC shall assess the departure conditions for each aircraft and shall re-negotiate conditions with LOC in the event that DM requirements are not met or that an improved departure sequence can be achieved.

Departure scheduling will be co-ordinated with the SUC for start-up approval, with the Ground Control for ground movements and with Tower Control for take-off scheduling. The planning of their activities have to be completed before the actual start-up is initiated and before a pre-departure clearance is submitted.

The following points are essential for proper departure planning:

- The planning, co-ordination, and sequencing and scheduling of take-off clearances is the most crucial element of planning and other pre-departure activities need to be tuned to this planning.
- The take-off scheduling is determined at least half an hour before departure. A timely start-up request by the pilot and the capability to meet the scheduled take-off time by the aircraft is essential.

(In the PD/3 demonstration, this co-ordination will be emulated by pre-scheduled take-off times and pre-determined deviations from the scheduled times.)

- ◆ "Update the departure sequence":

The DEP PC shall update the departure sequence in accordance with ATFM requirements.

The take-off scheduling is based on an available ATFM planning. Ultimately, half an hour before departure, ATFM control on flight planning is transferred to the centre-based ATC planning.

Once an ETD is assigned, the MSP shall be able to take into account this flight for traffic flow management.

(Operational aspects with respect to exception handling, dealing with last minute flights, cancelled and delayed flights are ignored in the context of the PD/3 demonstrations. However, the accumulated effects shall be taken into account by introducing planned delays in the scenarios.)

2.3.14.5.3 Validating and co-ordinating aircraft exit conditions.

- ◆ "Replanning and deconflicting over the departure zone of the TMA":

The DEP PC shall assess the TMA exit conditions for each departure and shall re-negotiate conditions in the event that DM requirements are not met.

The TMA is used for arrival and departure traffic. The required separation is achieved by using standard routes (SIDs and STARs). The standard routes shall supply the lateral separation and, where the standard routes are crossing, separation is achieved vertically by standard flight levels for departure and arrival traffic, included in the SIDs and STARs. So, separation is reached at a procedural level.

Departing flights will use exclusive airspace in the TMA in the initial climb flight phase. Therefore, deconflicting will be required in exceptional cases only. Replanning, however, will be performed continuously due to changed ETD's and the uncertainty of the actual time of departure (ATD) of each departing aircraft. The main concern of replanning shall be to agree on an adapted transfer condition to the ETMA sector and changed merging conditions with en-route traffic in ETMA and En-route sectors.

The uncertainty of the precise moment of take-off depends on the position of the aircraft on the ground, Before push-back, the uncertainty is undetermined. Between push-back and the holding point, the uncertainty is up to 3 minutes. Once the holding point is reached, the uncertainty is within 1 minute.

The precise moment of take-off can be in extreme cases as much as some minutes [Ref. 2]. In future, the uncertainty of the ATD will be required to be limited. A reasonable assumption is that, if sufficient spare time is reserved for up-linking at the holding point before take-off, and if no extreme conditions occur, that it shall be achievable to reach a precision of at least 30 seconds for the planning on the ETD. An Advanced Surface Management Guidance and Control System (A-SMGCS) will be required probably in order to be able to meet the imposed constraints on the precision of ground-based planning. Fulfilling the precision requirement of the ETD is sufficient to be able to perform the multi-sector planning on traffic flows.

Once an ETD is available, the DEP PC can start planning or replanning, if required. After take-off, planning can be refined. The DEP PC and the DA PC can continue or start their deconflicting activities and the MSP of the next adjacent, receiving, MSP area can update his planning.

The result of the planning activities of the DEP PC is to establish a conflict free exit transfer condition of the aircraft from the TMA to the ETMA sector.

◆ "Co-ordinating on outbound traffic with the DA PC":

Departure scheduling shall be co-ordinated with the DA PC. Co-ordination with the DA PC shall lead to deconflicted planning in the adjacent ETMA sector. Successful co-ordination may lead to the start of a trajectory negotiation process with 4D equipped aircraft, if ready.

2.3.14.5.4 Negotiating with 4D equipped datalink aircraft

◆ "Trajectory negotiation with 4D equipped aircraft":

The DEP PC shall perform a 4D trajectory negotiation initialisation process with equipped aircraft, possibly followed by negotiating a 4D contract.

The DEP PC shall allow the DA PC of the adjacent ETMA sector to negotiate a 4D contract with an aircraft, based on the available 4D trajectory.

The basic conditions for starting a trajectory negotiation process, after take-off and with preference before leaving the TMA, are:

- No conflicts and no foreseen tactical activities in the departure zone of the TMA. This may allow the DA PC of the next receiving ETMA sector to start the trajectory negotiation.
- An agreed sector transfer condition and successful planning in this ETMA sector, which makes it feasible to start the negotiation process.
- The aircraft is ready to negotiate.

2.3.14.5.5 Co-ordination with, and assistance to the DEP TC

◆ "Co-ordinating and assistance to the DEP TC and updating the SPL with the updated planned and/or contracted trajectory":

The DEP PC shall assist the DEP TC, specifically where it concerns the co-ordination with the Tower (LOC) and the sector transfer condition to the next receiving ETMA sector, and associated with this, the start of a trajectory negotiation process by the DA PC of this sector.

The DEP TC has a limited executive task. However, there are high constraints on proper timing and fast reactions, given the short period of the initial climb phase.

2.3.14.5.6 Monitoring the traffic situation

- ◆ "Monitoring the evolving traffic situation over the concerned period of planning and control":

The DEP PC shall monitor the pre-departure traffic planning situation, covering the planning of pre-departure activities.

The DEP PC shall maintain initial in-flight traffic situation awareness, enabling support of tactical control.

Monitoring the traffic situation concerns the monitoring of the planning of departures. It is required in order to monitor an acceptable planning, to view different time tables and associated with this, to be able to monitor the acceptable use of capacity for different activities on the ground and in the air. Also, it shall be possible to select an overview of the planning of one or more individual flights.

The monitoring of the actual traffic situation concerns the limited period of the initial climb and the transfer of control to the adjacent ETMA sector.

2.3.14.5.7 Runway capacity planning and control

- ◆ "Participation in the determination of the runway configuration in use":

The DEP PC shall participate in the decision process of a change of the applicable runway configuration. In that case, he shall adapt the configuration settings and the planning of departure flights for which a runway change is applicable.

The runway configuration in use can be changed e.g. due to changing meteo conditions, due to a changing traffic load and due to all kinds of exceptional conditions.

Because the traffic density shall be high during the PD/3 demonstrations, it is foreseen that mostly two runways for landing and one for departure will be applicable for Schiphol, while 2 runways for mixed use of landing and take-off will be available at Charles-de-Gaulle.

(Manipulations with runway configurations are not a high priority topic for PD/3, because PD/3 shall demonstrate in the first place a concept for airborne ATM. Most of the PD/3 demonstrations will be done with straightforward and simple runway configurations.)

- ◆ "Assessment and replanning of scheduled departure slot-times":

The DEP PC shall make sure that a departure slot-time is planned for each departure flight.

The DEP PC shall co-ordinate, if required, with the ARR SP on runway capacity for departures.

The departure slot-times will be the starting point for departure planning and take-off scheduling. These slot-times are determined via co-ordination with ATFM (the CFMU).

The other constraint on departure planning and take-off scheduling, is the actually available runway capacity for departures, which is co-ordinated with ARR SP. The interference with arrival traffic is minimal, when there is one fixed runway allocated exclusively for departures.

Take-off scheduling, replanning and deconflicting shall be based on the assigned departure slot-times.

(The initial planning of departure slot-times will be emulated in PD/3. Emulation may be achieved e.g. by using predetermined values for scheduled departure times in an initial flightplan and deviations from these scheduled times shall be introduced in the scenario.)

- ◆ "Co-ordinating with the ARR SP and Tower Control on use of the available runway capacity":

The DEP PC shall co-ordinate with the ARR SP on the shared use of available runway capacity for arrival and departure traffic.

This co-ordination activity is required when the runway configuration in use is changed or when there is interference between departure and arrival traffic e.g. by shared used of a runway.

(Complexity, due to changing and interfering runway configurations, is not foreseen in PD/3.)

2.3.15 Departure Tactical Controller - DEP TC

2.3.15.1 Area of responsibility

The DEP TC's area of responsibility is restricted to the departure zone of the TMA. The departure zone in the TMA is determined by the applicable SIDs, related to the runways in use, assigned to departure traffic.

2.3.15.2 Planning horizon

The DEP TC shall be responsible for tactical control for an aircraft from assume control until transfer of control to the next receiving ETMA sector.

2.3.15.3 Role

The role of the DEP TC is to monitor the sector traffic situation in order to resolve outstanding or unexpected conflict situations and to ensure the execution of the flight as planned by the DEP PC. After take-off, Tower Control (LOC) shall transfer control to the DEP TC. The DEP TC controls air traffic through the TMA up to the transfer of control to the DA TC of the next receiving ETMA sector.

Departure traffic shall be delivered following a standing agreement to the ETMA sector over agreed way-points on a standard transfer flightlevel, as described by the SIDs, related to each or most of the available runways of an airport.

The TC is the only one having the authority to give an aircraft a clearance in the departure zone of the TMA.

2.3.15.4 DEP TC tasks

The DEP TC shall use the R/T for voice communication, and data-link, ground-air and ground-ground, facilities for digital communication purposes. Ground voice channels will be available for late co-ordination only.

The DEP TC shall work in close harmony with the DEP PC but specifically, the DEP TC shall be responsible for :

- Maintaining separation in the controlled sector, taking into account efficiency and 4D planning constraints.
- Executing conflict resolution clearances planned for non data-link equipped aircraft (ER TC task).
- Preparing and executing conflict resolution clearances for data-link and non data-link aircraft for outstanding conflict situations (ER TC).
- Managing R/T communications and managing tactical data-link communications with controlled aircraft (ER TC).
- Trajectory negotiation with 4D equipped aircraft on tactical level.
- Co-ordinating with adjacent sectors:

- Accepting entering traffic from Tower Control (LOC)
- Transferring exiting traffic to the DA TC
- Co-ordinating with the DEP PC (assistant to the DEP TC) (ER TC).
- Updating the ground system (ER TC).
- Monitoring the traffic situation in his sector over the concerned period of tactical control (ER TC).

The tasks of the DEP TC can be combined with other tasks to be performed in the TMA, because the tasks of tactical control on departure traffic in the TMA are limited. Specifically, the DEP TC can be charged with tactical control on intermediate and final approach of traffic, landing on secondary runways. (This is in conformance with present-days practice.)

2.3.15.5 DEP TC task description

2.3.15.5.1 Maintaining separation

- ◆ "Maintaining separation in the controlled sector, taking into account efficiency and 4D planning constraints":

The DEP TC shall be responsible for maintaining separation between aircraft under his/her control.

The DEP TC shall monitor trajectory compliance and the current traffic situation in order to resolve potential conflicts by providing tactical intervention.

The flight is guided following the applicable SID to its transfer condition. Tactical control commands are used to guide the flight to the transfer condition to the adjacent ETMA sector.

The process of 4D trajectory negotiation is initialised before departure. If applicable, it is possible to give a formalised clearance, giving a tactical instruction with 4D precision. The aircraft shall realise an initial climb, which meets the trajectory planning in the ETMA and En-route sectors as well as possible.

It may be considered to use a standard take-off procedure in which an early take-off is applied for each departing flight. If the aircraft meets its required en-route constraints on an average by an initial climb with less than maximum power climb conditions, it is possible to correct for deviations. Delays can be compensated by climbing at maximum power, and early arrivals on planned way-points can be compensated by using reduced climb performance.

2.3.15.5.2 Execution of planned conflict resolution clearances

- ◆ "Executing conflict resolution clearances planned for non data-link equipped aircraft":

See the ER TC, section 2.3.5.5.

2.3.15.5.3 Preparing and executing conflict resolution clearances

- ◆ "Preparing and executing conflict resolution clearances for data-link and non data-link aircraft for outstanding conflict situations":

See the ER TC, section 2.3.5.5.

2.3.15.5.4 Managing communication with aircraft via R/T and datalink

- ◆ "Managing R/T communications and managing tactical data-link communications with controlled aircraft":

See the ER TC, section 2.3.5.5.

2.3.15.5.5 Negotiating with 4D and datalink equipped aircraft

- ◆ "Trajectory negotiation with 4D equipped aircraft on tactical level":

The DEP TC shall submit a formalised clearance, if this is applicable for tactical intervention.

The DEP TC shall enable and shall permit the DA PC of the next ETMA sector to start 4D trajectory negotiation as fast as possible.

The initial climb phase itself is, due to uncertainties about the actual flight performance, not suitable to start the trajectory negotiation process. The requirements for starting trajectory negotiation are:

- A stable condition of the climb phase of the aircraft.
- A clearance to the transfer condition of the adjacent ETMA departure sector.
- Pilot and DA PC are ready to start the trajectory negotiation process.

2.3.15.5.6 Co-ordination with adjacent sectors

- ◆ "Co-ordinating with adjacent sectors":
 - Accepting entering traffic from Tower Control (LOC)
 - Transferring exiting traffic to the DA TC

A transfer of control from LOC to DEP TC is straight forwards, but very time critical. The same holds for a transfer of control to the DA TC.

2.3.15.5.7 Co-ordination with the DEP PC

- ◆ "Co-ordinating with the DEP PC (assistant to the DEP TC)":

See the ER TC, section 2.3.5.5.

The assistance role of the DEP PC is more modest than for ETMA and En-route planner/tactical controller teams, because the period of tactical control is short and because the traffic complexity in the departure zone of the TMA is limited.

2.3.15.5.8 Updating the ground system

- ◆ "Updating the ground system":

See the ER TC, section 2.3.5.5.

2.3.15.5.9 Monitoring aircraft trajectories and the actual traffic situation

- ◆ "Monitoring the traffic situation in his sector over the concerned period of tactical control":

See the ER TC, section 2.3.5.5.

Monitoring the traffic is for the DEP TC a rather modest task, given the short period of tactical control and the small size of the TMA. There is no other anticipation than on take-off scheduling.

3. DESCRIPTION OF ROLE OF EQUIPPED AIRCRAFT AND PILOT

This chapter is to produce a view of the PD/3 ATM scenario from the point of view of the aircrew.

3.1 INTRODUCTION

This note describes the functions which are expected to be fulfilled by the flight crew involved in a PD/3 ATM environment. It is aimed at crews of real aircraft and of realistic flight simulators. It is not aimed at pseudo-pilots for whom the facilities may be much more variable and simulator specific.

It addresses only those aircraft and flight simulators which are EFMS equipped.

It has been an aim of the EFMS that flight crew should be kept in the loop wherever there are meaningful decisions to be made, and most importantly where those decisions affect the immediate performance of the aircraft.

It has also been an aim that the execution of a flight using the EFMS should be as natural as possible to a pilot used to current operations.

It will always be the case that experienced pilots are involved, so this chapter looks only at the functions which are specifically associated with this style of ATM. In this respect the aircraft is required to operate as a sub-system of the overall ATM environment.

3.2 TACTICAL AND STRATEGIC CONTROL

3.2.1 Hybrid control

The experiments of PD/3 involve a situation where ATC have the option of controlling the aircraft either by strategic or tactical methods.

Strategic control involves the use of data-link to obtain proposed detailed trajectories from an aircraft and to issue either required modifications or specific clearances via data-link.

Tactical control involves the use of R/T and is little changed from the traditional situation. The hybrid approach introduces some problems when transferring from one mode to the other.

Strategic to tactical control is easy - it involves the aircraft responding in real time to R/T commands.

Tactical to strategic control needs attention - it requires a transition:

- from only an outline view by ATC of where the aircraft is and what it is going to do
- to a situation where ATC and aircraft have a shared detailed view of where the aircraft is and what it is going to do. This is discussed in more detail below.

3.2.2 Ground prediction

The use of approximate trajectory predictors by ATC means that they are in a position of being able to offer to the aircrew proposals which are likely to be flyable in most circumstances. This should avoid the need for extended negotiation cycles.

The fact that such ATC proposals can be reasonably ensured to be conflict-free before they are up-linked is the basis for longer term strategic control.

The longer time horizon means that proposals for changes may come from the ground which affect the trajectory only far ahead of the aircraft, perhaps 30 minutes or more in the future. The advantage to the aircraft in this situation is that such changes should ensure that the trajectory which is agreed at the early stage is honoured by the ground and the flight proceeds relatively optimally.

There is no specific explanation of the reasons for change requested via data-link. It may be possible by looking at the proposed constraint list to deduce what is going on.

The overall system relies, as now, to a great extent on a level of trust between air and ground. The aircraft will do its best within reason to meet proposed constraints in return for which ATC will try to ensure as unconstrained a flight as is possible within the overall traffic situation.

3.2.3 Contracts

It is expected that for most of a flight the aircraft will be flown under the control of the EFMS guidance function, with performance being monitored by the aircrew through the navigation interface and CDU.

Such operation is on the basis that the aircrew have a contract with the ground which is based on the down-linked trajectory and an up-linked clearance. There should be little interaction with the ground as long as the aircraft is maintained within the clearance.

Long term monitoring is carried out automatically and the pilot and ground are informed if a likely excursion from the contract is predicted in future.

A clearance for a trajectory will always start from the beginning of that trajectory and will continue to some point along it, possibly but unusually the end. ATC can be expected to extend a limited clearance progressively always well before the aircraft actually reaches the end of the existing clearance.

If ATC (unusually) allow the aircraft to (nearly) fly out of the clearance without providing an extension then the flight becomes tactical and R/T is used. The aircraft in this situation should continue on its last down-linked trajectory until instructed further by ATC.

A required change to the contract, either by aircrew or ground is expected to be handled through the negotiation mechanism:

- Ground request would appear as a new ground constraint list or Formalised Clearance.
- An aircrew request would be formulated initially as a modified constraint list within the cockpit.
- A new prediction would be carried out in either case as for the initial negotiation.

The ground is informed automatically whenever a clearance is activated.

3.3 EFMS EQUIPMENT

EFMS equipped aircraft are those which are fitted with a version of the Experimental Flight Management System produced as part of the PHARE program. The functions performed by this system are defined in EFMS Phase 2 URD [ref. 12].

EFMS provides the following relevant overall functionality:

- Provision of a data-link facility which allows the interchange of complex information between aircraft and ground.
- Access to a navigation database containing definitions of way-points, nav aids, route sectors (of types SID, STAR and En-route) and company routes.
- Selection and editing of company routes and of individual time and altitude constraints at route points. Routes may originate from or be edited by either the pilot or an ATC sub-system on the ground.
- 4D prediction facilities either from the ground or, when airborne, from present position based on selected routes which may contain altitude and time constraints.
- Predicted trajectories may be transmitted to the ground on pilot request.
- Initial flight clearances or extensions may be received from the ground prior to being activated by the aircrew.
- 4D guidance with respect to a previous prediction may be activated on request and the flight performance may be monitored against any existing clearance.

3.4 COCKPIT EQUIPMENT

3.4.1 Introduction

The EFMS cockpit will be equipped with display and control devices as defined by the AHMI project. There is no developed definition of what specific interface devices will be available in experimental environments. This discussion is in terms of the generic interface devices which are expected to be present.

Two general classes of device are supported, a Control and Display Unit - CDU and a Navigation Interface. Either device is in general capable of displaying the same range of data. The CDU also supports the full range of EFMS control and data manipulation possibilities while the typical navigation interface will support a 'most commonly used' subset of these.

3.4.2 CDU

This device mirrors the CDU devices currently used as the main interfaces to flight management systems. The format is different and hard buttons are replaced by buttons generated by software. The general

arrangement of the device, and the way in which pages are built into menu structures should be reasonably recognisable however.

The restriction of the CDU is that it is predominantly a text device.

All of the operations necessary to use the EFMS are available from the device and the performance of the system can be monitored.

Routes and constraints can be selected and modified, preferred operation parameters may be changed.

Input to this device is directly onto the screen via a touch sensitive panel. In this sort of installation the CDU is viewed as the secondary interface to the EFMS, the primary one being that offered by the navigation interface. There are some detailed data display and editing facilities on this device which are not reproduced on the navigation interface.

3.4.3 Navigation interface

The navigation interface is the most innovative interface to the EFMS. The basic displays resemble the conventional EFIS display superficially but present greater functionality than such systems.

The EFMS uses a 4D prediction approach which means that proposed aircraft trajectories may be viewed in terms of altitude and time at any point as well as the conventional lateral display. This information is normally displayed on two selectable formats, a lateral and a vertical display.

Buttons associated with the device allow normal control of the EFMS to be exercised completely from this device without recourse to the CDU (except for some detailed manipulations such as definition of meteo).

'Drag and Drop' facilities are available in addition to facilitate manipulation of routes or constraints graphically.

Input to this interface is via a pointing device, normally some form of tracker-ball with associated selection buttons. It is expected that in normal operation this interface will be the primary means of input to, and of monitoring the performance of, EFMS.

3.5 EFMS START-UP

It is expected that the EFMS will be started at the gate.

The system must be started with the correct data files, including one which has the predicted meteo conditions at way-points which are expected to form part of the route or likely diversions. These operations are carried out at the supervisor terminal rather than from the cockpit.

The system displays UTC time which can be reset manually or can be initialised from a radio clock if available.

A system reset is available to the pilot, but should not normally be used during operation.

3.6 ROUTE SELECTION AND PREDICTION

Initial route selection will be on the basis of a 'company route' stored in the navigation data base. This route will correspond to one which has been previously submitted to the CFMU and has been generally accepted by ATC.

The initial route for flights within Europe is expected to cover the whole flight and will probably consist of a SID, followed by optional en-route segments, followed by a STAR. Long range flights may use an initial route which terminates at a way-point somewhere in climb or cruise at the ATC boundary.

A number of flight parameters are pilot definable:

- Preferred Cruise Flight Level, PCFL, possibly on the basis of an inspection of the meteo conditions predicted for the route.
- Zero Fuel Weight
- Fuel Weight - if not derivable from the aircraft sensors

Generation of a prediction will be carried out either before take-off, when there is a reasonably accurate estimate of take-off time, or at some stage in the climb-out:

- Before take-off an estimated take-off time has to be entered before the prediction.
- After take-off UTC time is used as the starting point.

Trial generations may be carried out as required and time permits to allow selection of the most suitable profile. The last generation at any time results in the 'proposed' trajectory.

The 'goodness' of a prediction is difficult to quantify and in general the decision relies on aircrew experience. The general proposed profile in speed, altitude and time is available for inspection, and a crude cost element in terms of fuel burn and engine cycles is computed.

PCFL is remembered by the EFMS and will always be the target CFL for any generation. It is possible that because of constraints, meteo or just overall flight length that the actual CFL reached in any prediction will be different from the PCFL.

The trajectory predicted may be manipulated indirectly by changing operational parameters such as preferred speeds during different phases of flight, PCFL, etc..

The above operations will normally be controlled from the navigation interface, with use of CDU only to inspect or manipulate details, such as meteo conditions.

The only constraints which are placed on these generations are expected to be any established procedural altitude restrictions associated with the SID and STAR and the estimated take-off time.

This sequence of initial generations and adjustments result in what is the aircrew's preferred profile for the flight. This will form the 'opening bid' in the negotiation with the ground.

3.7 NEGOTIATION CONTROL

The negotiation process inevitably takes some time.

If there is an existing contract then this delay presents few problems. Both ATC and aircraft have a shared view of where the aircraft is going to be at some time in the future, and therefore should be able to converge onto a mutually acceptable solution.

There is a potential problem where the aircraft is under tactical control and is attempting to enter or return to strategic control.

It is essential for a successful outcome in flight that the aircraft is in a situation where it effectively flies the start of the proposed trajectory, both laterally and vertically, even before this has been cleared formally via data-link.

Both the aircrew and ATC must agree in this respect. Otherwise the aircraft may be so far from the proposed trajectory by the time a clearance comes through as to make that clearance useless because the proposed trajectory is now unattainable.

Before take-off the trajectory negotiation process shall be initialised by downlinking the preferred trajectory. This trajectory will be based on the pre-departure clearance specifying the scheduled take-off time, the assigned runway and the SID. The downlinked trajectory will be used in a later stage, possibly after take-off, for the trajectory negotiation process.

The down-link of a proposed trajectory is the only way in which the aircrew is able to request a new, or a change of, contract. This may occur at any time.

It is possible that the down-linked trajectory may be activated before down-link. There will be no formal clearance via data-link at this stage, but since the aircraft is transitioning from tactical control there may be sufficient R/T clearance. This option has the advantage that it provides an immediate and accurate prediction of the aircraft's intentions which is shared with ATC. The down-linked trajectory in this case will be flagged as 'being flown'.

There are three possible ground responses to a down-linked trajectory:

- a Clearance
- a Ground Constraint List
- a Formalised Clearance

A clearance, which will be from the start of the trajectory to some point along it, indicates an acceptance of that part of the proposal. It is expected that the aircrew will accept this (proposed) clearance, and in due course activate both the clearance and the associated (negotiated) trajectory.

A ground constraint list indicates that the ground has problems with the proposed trajectory and is suggesting some extra constraints, and possibly even route changes. The aircrew may inspect the ground list, but it is expected in almost all circumstances that they will request a prediction on the basis of this list, and down-link the new proposed trajectory.

Changes may be needed to the constraint list if the prediction concludes that the revised set of constraints from ATC is unflyable.

A formalised clearance consists of the up-link of both a proposal for the constraint list to be used and a clearance for a flight through the airspace on any trajectory which is compliant with the constraint list. It is expected to be used where ATC wish an expedited response short of an emergency. (The latter would still be handled tactically via R/T) A prediction is performed automatically in this case, and the results are presented to the aircrew.

A trajectory which is compliant with the constraint list means that the aircrew also have clearance to fly this trajectory. Activation by the aircrew is expected immediately and ATC is informed.

Prediction of a non-compliant trajectory would result in a further down-link. It is likely that if the beginning of the trajectory appears acceptable then the aircrew would activate the trajectory in any case and down-link it with the 'being flown' indication.

It is expected that most of this process will be controlled from the navigation interface.

It is important to stress that it is not anticipated that the negotiation process will be lengthy. The norm will be for a down-link of a trajectory, one up-link of extra constraints, a further down-link and an up-link of a (default) clearance.

3.8 COMMUNICATIONS

3.8.1 R/T

R/T facilities remain unchanged and are intended for those cases where it proves impossible for the ground to allow a contract to continue and cannot in the time available define a new one.

Any direct R/T instruction terminates a contract.

An R/T instruction of the form 'Go direct to (way-point) XXXXX and renegotiate' may be used as a re-entry into strategic control. This would be interpreted by the aircrew as edits to a previous constraint list, resulting in negotiation of a new proposed trajectory downlinked as 'being flown'.

The re-entry into strategic control could be the result of an up-link from the ground, always announced as part of an R/T tactical sign-off.

A new clearance may be issued for an existing proposed trajectory if this is still attainable by the aircraft.

A new ground constraint list may be up-linked and the negotiation process carried out as before.

The aircrew (rarely) could request a new contract by preparing and down-linking an unsolicited proposed trajectory during tactical flight.

Sign On, between aircrew and ATC, is expected to be available as now if only to provide reassurance to the aircrew that there is a viable communication channel available.

R/T is not used routinely to request or grant clearances on a sector by sector basis since these should normally be handled via data-link. Reassurance may thus form the major part of the R/T exchanges.

Frequency Change/ Sign Off : It is expected that frequency changes will be passed via data-link, as a result of an ATC stimulus.

There will be no routine R/T sign off from ATC.

It is expected that, in suitably equipped aircraft, this will translate into an information message to the aircrew and an automatic frequency change for the radio on confirmation of this.

A message which will be visible on the navigation interface will request the pilot to change frequency where the automatic option is not available.

3.8.2 Data-link

The data-link is a secure and reliable communication link, within the context of an experimental program.

The operation of the data-link is largely invisible to the aircrew. The link is self checking and there will be an indication on the navigation interface as to whether or not the link is operational. The checking is performed continuously, not only when there are aircrew initiated transfers.

The ground will similarly know if the link is operational.

Any message which is received is guaranteed to be correct.

To a large extent the assumption is always that a message, once sent, has been received and there is thus no requirement to monitor receipt manually or to issue manual acknowledgements.

If the data-link is inoperative then the only available backup is to resort to tactical control via R/T.

4. COMMUNICATIONS

4.1 OVERVIEW

This chapter describes the operational requirements of data-link applications for the Advanced Organisation of the operational concept of PD/3 [Ref. 1]. The chapter starts with an overview of the operational data-link applications, applicable to PD/3, split in a section with applications used for air-ground communication and a section with applications for ground-ground communication.

Finally, a separate section is added to describe extensively the procedural implications of the use of data-link communication for trajectory negotiation (section 4.3).

The (simulated and/or emulated) operational data-link applications are applicable to air-ground as well as ground-ground communications and all phases of flight are concerned:

- pre-departure,
- departure,
- en-route,
- approach.

Operational data-link applications, concerned with ground-movement, guidance and control before departure and after the landing, are considered, but their outputs will be emulated only, as required, e.g. as part of the data preparation of the simulation runs.

4.2 OPERATIONAL DATA-LINK APPLICATIONS REQUIREMENTS

The following air-ground data-link applications will be applicable within the context of the operational scenario of PD/3 [Ref. 1].

- Strategic ATC communications (simulated):

Trajectory Negotiation, based on EFMS URD specifications [Ref. 12], which includes:

- Initialisation of the trajectory negotiation process.
- Negotiation of a "contract", contracting a trajectory.
- Formalised Clearances, specifying a clearance within a sector.
- Sector Contract Approval, making part of a contract within a sector into a clearance.

- Controller Pilot Data Link Communications (CPDLC):

CPDLC is almost not applicable in PD/3, because its functionality is supported already by commands, supported by 4D-TN. The functionality supported by CPDLC is covering:

- tactical control:

This application is not used in PD/3, because its functionality is already supported for equipped aircraft (datalink and 4D equipped) by 4D-TN (Formalised Clearance and Sector Contract Approval).

- frequency change

The frequency change is a tactical control clearance command, supported in PD/3. This clearance is strongly related to Context Management (CM), and the Sector Contract Approval (4D-TN).

- free text (not applicable to PD/3):

The exchange of free text messages could be envisaged for exception handling.

- Down-link of Aircraft Parameters (DAP) (simulated):

Aircraft performance and flight status parameters will be down-linked, event driven as well as periodically, in order to maintain a ground based database of aircraft status data.

These data will enable the ATC ground system to perform its planning and control functions in an improved way.

- Weather Nowcast Services (WNS) (emulated):

This application will cover the pilot and/or airborne system request to up-link Meteo information along the trajectory. The update of the Meteo database with down-linked airborne sensed information is not operated in PD/3. The actual weather experienced by the airborne system, and the nowcast data are provided by realistic, pre-processed meteo data.

- Context Management (CM): (emulated)

This application provides the technical means to log-on and log-off to the ATN, to exchange identification information and addresses of relevant ground and airborne application processes. More specifically, the change of communication context, performed by this application is strongly linked to establishing a frequency change (see CPDLC).

The following ground-ground applications are applicable to PD/3:

- Weather Nowcast Services (WNS): (emulated)

Meteo grid information will be required for processing automatic functions, like trajectory prediction. However, different from the Air, the Ground will require complete information concerning the meteo data in a large volume of air. For efficiency reasons, the Ground will subscribe for a time-driven periodical refreshment of data, or for an automatic update procedure on significant changes within the concerned volume of air, while an aircraft is interested in meteo data along its planned flight profile, along a given set of 4D waypoints.

- Planning Co-ordination (PLCO):

All communicating activities concerning the co-ordination between different sectors and/or MSP areas. Included are passive informative data exchanges following on processing periodically automatic functions and on specific events, as well as information exchanges, which are related to ATCO controlled interactive dialogues. E.g. the status of a flight may change as result of an event-driven signalling process, but also as result of a manually supplied indication, while interactive dialogues may be initiated by an ATCO, if any planning or tactical control activity is required.

Included is also 4-D Trajectory Negotiation:

A special case of planning and co-ordination is the medium-term planning, in which an Air-Ground trajectory negotiation process is involved:

- Co-ordination is required between one or more Sector Planners (PCs) and one or more Multi Sector Planners (MSPs), or
- Co-ordination is required for arrival management between ARR SP/TC, ACC PC/TC and ER PC/TC.

4.3 TRAJECTORY NEGOTIATION PROCEDURES

4.3.1 Introduction

The 4D trajectory negotiation process is an essential part of the operational concept of PD/3. The trajectory negotiation process is controlled by both the airborne and ground ATM systems. It makes available more accurate information on the airborne predicted trajectory, the trajectory generated by the EFMS, and to support consequently more efficient planning and control activities on the ground part of the ATM system. The air-ground exchange through trajectory negotiation leads to a contract between air and ground, providing both with greater confidence within the scope of planning and control, regarding the precision of 4D navigation and guidance, associated with the trajectory data. Therefore, consistent operations are required between the different actors of the air-ground distributed system: EFMS and the Ground System, while these operations are also closely related to the functioning of the airborne HMI, supporting the pilot, and the ground-based HMI, supporting the ATCO.

A crucial point in the trajectory negotiation process is the use of constraint lists and contract tubes. Different modules in different parts of the PD/3 simulation facility, are dealing with constraint lists and tubes, e.g. a TP, a CP, and the NM at the ATC ground system, and the prediction, guidance and negotiation functions of the EFMS. A basic requirement is consistency in functional significance of generation and use of constraints and tubes [ref. 11].

A constraint list is considered to be defined by the result of the application of new, and possibly additional, constraining conditions on the previous flight trajectory, e.g. a complete or incomplete set of windows around a list of 4D way-points. The contract tube is defined by a volume of airspace around the contracted trajectory, described by a list of 4D way-points.

The next section (section 4.3.2) will treat the procedures of the negotiation process and this section will focus on the interference of air ground negotiation and the required planning co-ordination between Planning Controllers (PCs) and Multi-Sector Planners (MSPs). The subsequent sections shall discuss the specific requirements imposed by trajectory negotiation on airborne and ground-based tools and HMI, while the last section deals with the Sector Contract Approval:

- 4.3.2 - Sequence of events for the air-ground trajectory negotiation dialogues.
- 4.3.3 - Trajectory negotiation and EFMS.
- 4.3.4 - Trajectory negotiation and the ATC Ground System.
- 4.3.5 - The trajectory negotiation concept and the airborne HMI.
- 4.3.6 - The trajectory negotiation concept and the ground-based HMI.
- 4.3.7 - The "sector contract approval".

4.3.2 Sequence of events for the air-ground trajectory negotiation dialogues

All dialogues, described in the following sections, are applicable only to 4D FMS and data-link equipped aircraft. The following operational data-link procedures are used in a dependent relationship with trajectory negotiation:

- Air-ground:
 - Down-link Aircraft Parameters (DAP)
 - Controller-pilot communications: frequency change (CPDLC)
 - Context Management change (CM, emulated)
- Ground-ground:
 - Planner Co-ordination (PLCO)

All dialogues are thought to work in such a way that both partners may be able to take the initiative. Either the dialogue starts with a request and the initiating action follows, or the dialogue starts with an initiating action if this is judged as appropriate.

For consistency reasons all dialogues, concerning trajectory negotiation are performed via the TC with the executive control authority on the flight. Although the TC does not need to know this explicitly, and shall not be involved in the dialogue, the messages of the dialogue will pass through his sector. This principle makes it easy to control a consistent dialogue between the ground and the pilot. In cases of tactical control actions each negotiation process can be interrupted easily, while one and only one controller is able to perform the negotiation process with the pilot [see also ref. 13].

All or most of the planning ground co-ordinating actions, related to a trajectory negotiation process, are thought to be performed implicitly and silently, e.g., a planner will perform a planning task at an appropriate time, and this will result in an adapted flightplan. These data is communicated to adjacent sectors/centres

and the result is presented to the applicable controllers. The ATCO will perform the trajectory negotiation process, if appropriate and if he has Negotiation Authority.

4.3.2.1 Departure, trajectory negotiation event sequence

Each series of trajectory negotiation dialogues between an aircraft and the Ground has to be initialised for one flight once by an initialisation dialogue. For an aircraft, departing from an airport within the controlled airspace of the PD/3 demonstrations, this dialogue is performed before departure, if ETD, departing runway and SID are known and confirmed by ATC.

(In PD/3 the pre-departure phase of the flight is emulated and the results of pre-departure dialogues are supplied by appropriate information, stored in the data preparation files.)

- ◆ **Trajectory negotiation initialisation** (of departure traffic):
 - If the pilot does not take the initiative, the DEP PC will send a request to an aircraft to open the trajectory negotiation procedure and to supply 4D planning and aircraft performance information.
 - Usually on own initiative, however possibly in response, the pilot down-links a 4D proposed trajectory, based on the scheduled take-off time (STO). Also, aircraft performance information is down-linked, after the appropriate initialisation of communication (CM and DAP).
 - The DEP PC accepts the trajectory, which includes the transfer flight level proposed to the first ACC sector.

After departure and after a transfer of control to the DEP TC, and if the initially agreed trajectory has to be amended, clearances are to be supplied to reach the new transfer conditions to the departure ACC (ETMA) sector. This can be achieved by a Formalised Clearance or a Sector Contract Approval.

- ◆ **Formalised Clearance:**
 - The pilot may send a request to the DEP TC for a formalised clearance.
 - In response to a request, but usually on his own initiative, the TC with Control Authority may select a 4D trajectory. The constraints are uplinked and a trajectory, meeting the imposed constraints, is downlinked and confirmed as a contracted trajectory with the status of a clearance through the sector.
 - The pilot should accept. If non-compliant, a trajectory shall be downlinked with non-compliance indications. Hereafter, R/T communication may be the best suitable medium for exception handling.

If a clearance has been given, which includes the sector transfer condition, the DEP PC may allow the DA PC of the adjacent receiving departure ACC sector to perform trajectory negotiation. The active clearance will be the starting point of the 4D trajectory to be negotiated, or the already contracted trajectory is retained.

- ◆ **Trajectory negotiation** (ground-ground co-ordination):

- If the DEP PC does not take the initiative, the DA PC may submit a request to the DEP PC to be enabled to start trajectory negotiation (the PC of the next receiving sector has Planning and Negotiation Authority), using constraints, planned by himself, as well as planning constraints, made available by the MSP or the planning controller of the adjacent En-route sector.
- In response to an explicit request, but usually and by default implicitly permitted, the DA PC may start a negotiation. (He has Negotiation Authority.)

4.3.2.2 En-route, trajectory negotiation event sequence

For aircraft, arriving from outside the controlled airspace of the PD/3 demonstration, trajectory negotiation is required to be initialised. This has to be done at such a moment that the MSP is able to perform his planning activities (10 to 20 minutes before passing the sector/area entry way-point). All other flights, departing inside the core area, are initialised for trajectory negotiation before departure.

- ◆ **Trajectory negotiation initialisation** (of traffic, approaching the core area):
 - If the pilot does not take the initiative, and if the ER PC of the first receiving sector does not submit a request, and the MSP has planned the flight and specified constraints, then the ER PC of the first En-route sector is alerted to send a request for trajectory negotiation initialisation. This may be about 20 minutes before entering the first MSP area.
 - If the pilot does not take the initiative and if there is no early planning requirement, then the ER PC sends the request to the pilot to initialise trajectory negotiation, on his own initiative. This may be about 10 minutes before entering the sector.
 - In response to, but usually on his own initiative, the pilot will down-link a 4D proposed trajectory, based on a trajectory prediction, starting from its actual position. Also, aircraft performance information is down-linked, after the appropriate initialisation of communication (CM and DAP).
 - The ER PC accepts the trajectory and confirms the contract, uplinking the tube, or he refuses and the aircraft is under tactical control.

Between 10 minutes before entering the first En-route sector and Assume Control for this sector, so during the time an aircraft is flying in the adjacent giving sector, the ER PC is performing the deconflicting planning task. If this task is completed successfully, he is able to start trajectory negotiation, having also Negotiation Authority.

- ◆ **Trajectory Negotiation:**
 - The pilot may re-negotiate a trajectory and he sends down its updated proposal for a 4D trajectory to the TC with Control Authority of the current controlling sector.
 - If the trajectory is cleared through the sector by a Sector Contract Approval or a Formalised Clearance, then the PC of the adjacent receiving sector, who has Negotiation Authority, will be able to perform the trajectory negotiation process (implicit co-ordination).
 - The PC of the adjacent receiving sector will negotiate a 4D trajectory. This 4D trajectory has to be planned conflict-free through his sector, but can be planned over several sectors within the area and the adjacent receiving MSP area.

If he has a planned 4D trajectory to be negotiated, he may continue, otherwise he is not able to start the trajectory negotiation, and he has to refuse the negotiation request.

If he wants to start trajectory negotiation on his own initiative and there is no implicit permission (exception handling, the aircraft has no approved trajectory through the current sector), he has to ask the TC with Control Authority for the permission to negotiate (explicitly via PLCO).

- The PC of the negotiating sector creates and modifies a 4D constraint list by editing a trajectory to be negotiated, and up-links this list.
- The pilot attempts to fit a trajectory satisfying the imposed constraints and the aircraft's performance characteristics with support of the trajectory prediction function. If this is achieved successfully, the pilot down-links his optimised trajectory, if not, a non-matching trajectory is down-linked with constraint violation indications.
- If a positive reply is received, the PC confirms by up-linking the "contract" tube around the, at this moment, "contracted" trajectory.

If a non-compliant trajectory was received, the PC may up-link a Formalised Clearance as an imposed trajectory.

(If there is non-compliance, and if there is a short-term planning conflict, the best action is to apply a tactical manoeuvre (by the previous sector probably) and to restart trajectory negotiation later on.)

If a "contract" is negotiated and if a PC in a receiving sector has to re-plan the flight and has accomplished this successfully, this controller can take the initiative to negotiate the "contracted" trajectory again. He may use the planned entry condition of his sector as a starting point or may even start at the current position in the previous giving sector. This, however, requires explicit co-ordination.

If a pilot is cleared to contact the next sector and to change the frequency, and the adjacent receiving sector assumes control, an explicit approval of the contracted trajectory is required through this sector. Such a Sector Contract Approval is expected to be a combined action with Assume Control, and it shall mean to take into account the contracted trajectory through the sector as a clearance. So, if there is an existing "contract", then part of this "contract" is approved by the TC, accepting the responsibility for this trajectory through his sector (see also section 4.3.7).

◆ **Sector Contract Approval:**

- The TC with Control Authority approves a contracted 4D trajectory through his sector.
- The pilot acknowledges the approval (implicitly).

If no Sector Contract Approval is received, the pilot may contact the Ground, using R/T.

If an aircraft cannot follow its contracted trajectory, the pilot is expected to initiate a new trajectory negotiation process. If the current situation leads to a conflict before a new contract can be issued a tactical intervention could be required immediately.. This can be achieved by tactical clearances, using R/T, but it can be achieved also by a Formalised Clearance, sufficient to reach the sector transfer condition. Subsequently, a re-negotiation can be started by the PC of the next sector after re-planning.

◆ Formalised Clearance:

- If no clearance is received, the pilot may send a request for a Formalised Clearance.
- In response, but usually on his own initiative, the TC with Control Authority may select a 4D trajectory. The constraints, related to this trajectory, shall be up-linked as Formalised Clearance.
- The aircraft will accept or refuse (downlink a non-compliant trajectory with constraints violations). If refused, R/T communication may be the best suitable medium for exception handling.

If the pilot receives a tactical clearance, then every "contract" is, at least temporarily, invalid. A tactical clearance can be submitted via R/T. Disabling is derived from pilot and controller associated actions, such as a flightplan database update.

As soon as there is no Sector Contract Approval or Formalised Clearance, the aircraft is under tactical control and the aircraft follows its planned and/or contracted trajectory, or performs its flight according to the directives communicated between pilot and tactical controller via R/T.

4.3.2.3 Arrival, trajectory negotiation event sequence

Arrival traffic is subject of an optimal metering and spacing strategy. The AM will determine an optimal arrival sequence and optimal metering and spacing on the Metering Fix, before the aircraft is reaching Top Of Descent (TOD). The AM will give its time constraints (advisories for non-equipped aircraft), applicable to the ETMA and En-route sectors, which precede the TMA entry. Because the optimisation strategy changes from optimisation of individual flight performance to optimisation of the use of runway capacity, the objective of trajectory negotiation also changes at this moment.

If the AM time constraints are accepted by the controller with Control Authority, the ground can up-link a Formalised Clearance, based on an adapted prediction. The aircraft will navigate according to this clearance and the 4D navigation capability of the aircraft will contribute to successful optimisation of the use of the available runway capacity. (Co-ordination, implicit or explicit, is required between the ARR SP, dealing with arrival sequencing, and the controllers with Planning and Control Authority.)

4.3.3 Trajectory Negotiation and EFMS

The concept of trajectory negotiation in PD/3 puts requirements on EFMS.

The following, for the operational requirements of PD/3 essential functions in EFMS, are considered:

- Trajectory prediction
- Trajectory guidance and control
- Meteo data exchange
- Trajectory negotiation in EFMS

◆ Trajectory prediction:

The initial flightplan, before departure, will consist of a list of 4D way-points, based on the initial ETD, which will be updated later on with respect to flight progress. Additionally, there are scheduled time constraints, based on the departure and arrival time. A pre-departure clearance shall provide information about the applicable runway and the SID, while possibly also the STAR and the runway for arrival may be planned and communicated.

Based on this initial flightplan, the trajectory prediction function is expected to be able to prepare a 4D trajectory, which can be down-linked to the ground before departure (initialisation of the trajectory negotiation process). Also the necessary flight performance data can be down-linked on request of the Ground (DAP). Successful trajectory negotiation requires deconflicting (planning and integration) of the trajectory by ATC, although negotiation can occur even if a problem remains. Because deconflicting is nearly impossible before departure due to the uncertainty of the realised moment of take-off, trajectory negotiation will be started by preference after departure.

After departure and the initial climb, trajectory negotiation can be performed. The activity priorities of ATC are to be taken into account. These are listed in the following order:

- execution of tactical operations
- short term planning and merging of the flight into the En-route traffic flow
- strategic operations and trajectory negotiation

During the trajectory negotiation process, a trajectory "contract" is negotiated. The negotiation process can be initiated by the pilot as well as by the ATCO (PC). The trajectory predictor shall be able to construct a trajectory, satisfying, if possible, an up-linked constraint list. If this is impossible, it shall be indicated, where the constraint violations occur.

It is possible that a trajectory is negotiated or re-negotiated during the flight. In this case, the trajectory prediction function shall be able to predict the remaining trajectory, starting from the current position of the aircraft, as far as achievable compliant with a previously up-linked constraint list.

It is possible that the ground will up-link a Formalised Clearance. The pilot may expect that such a clearance is verified by the ground TP and that its associated trajectory is within the aircraft's flight envelope. The trajectory prediction function of the EFMS shall be able to predict a trajectory, in agreement with the Formalised Clearance, and which will indicate, where it violates the clearance. The Formalised Clearance can not be "open-ended" and the trajectory prediction function shall be able to predict the remaining trajectory to fly. The pilot may expect from the Ground that a Formalised Clearance is used to adapt an existing "contract" on a tactical level.

An "open-ended" tactical clearance is possible via R/T. This clearance shall overrule the significance of any 4D "contract". An "open-ended" tactical clearance has to be followed as soon as possible by re-negotiation of the trajectory.

◆ **Trajectory guidance and control:**

The predicted and contracted trajectory is subject to a trajectory monitoring function. This function will verify if the aircraft exceeds the contract tube, associated with its contracted trajectory.

Warnings are expected:

- if the aircraft exceeds or is expected to exceed its contract tube
- if the aircraft is expected to leave its cleared and/or approved part of a “contracted” trajectory.

The guidance function is expected to guide the aircraft along its predicted and contracted trajectory and to correct for indeterministic behaviour, e.g. varying meteo conditions. However, there should be attention for the relationship between capacity, economy and safety. The guidance loop of EFMS and the deviation tolerances are essential variables in this relationship and therefore an acceptable balance between economy, guidance and tolerances should be taken into account.

The economy of flight is determined a.o. by the precision of realising the estimated arrival time (ETA) and by fuel economy. Delay avoidance should get major attention. The guidance process controls the flight to follow a possibly non-optimal trajectory. If acceptable flight economy requirements are exceeded, a more optimal trajectory may be negotiated.

The expected result of varying the deviation tolerances, is a changing frequency of re-negotiations, a change in achieved accuracy of flights and therefore a change in capacity and workload, and a change in the economy of flight performance.

◆ **Meteo data exchange:**

- Meteo nowcast data along the route will be up-linked on request.
- Meteo sensed data will be downlinked on regular time intervals or on predefined altitude increments or decrements.

A meteo grid database on the ground will contain a full set of 4-dimensional nowcast meteo data with a prediction period of about half an hour at most, and will be covering the core area. Required meteo data are: wind direction, wind speed, temperature on different levels, and possibly, humidity, QNH and icing conditions.

If required, the aircraft down-links a request or subscribes for meteo data. The available data in the vicinity of space and time of the predicted trajectory will be up-linked. The aircraft shall use interpolated values of supplied meteo data around the available positions.

The up-linked meteo information is used by the EFMS trajectory prediction function.

◆ **Trajectory negotiation:**

Initially, in the pre-departure state, a route and flight profile is available in the airborne system of the 4D-equipped aircraft, as well as a corresponding flightplan in the ATC ground system. A pre-departure clearance and take-off scheduling becomes available as result of departure planning and is communicated to the aircraft. A 4D trajectory can be generated in the aircraft, based on the scheduled departure times and a pre-departure clearance.

Before departure, the aircraft is required to down-link its planned trajectory and available aircraft performance data. The down-linked data enables the ground to enlarge the precision of ground-based prediction and planning of 4D-equipped aircraft, compared with unequipped aircraft. This will be the basis

for the trajectory negotiation and re-negotiation process. At all times, the pilot and the ATCO can take the initiative to negotiate or re-negotiate a contracted trajectory. It is one of the basic assumptions in PD/3 that 4D-equipped aircraft shall be enabled to perform their flight following their contracted trajectory and that benefits will be provided, associated with early and advanced planning.

The contracted trajectory is a commitment of the pilot for guidance along this trajectory. Because ATC has to accept the responsibility for executive control on the contract, every part of a contracted trajectory through a sector has to be approved by a Sector Contract Approval. Moreover, each ATCO, planner as well as executive, has a commitment to a contract and he shall attempt to keep the contracted trajectory conflict-free planned.

4.3.4 Trajectory Negotiation and the ATC ground system

From the ground-side point of view, the basis for trajectory negotiation is traffic organisation and planning. The planning is possible by using the results of trajectory prediction, by modifying flightplans with support of the PATs until optimised and anticipated conflict resolution is achieved for the concerned flight.

Because negotiated "contracts" exceed one sector, ground-ground co-ordination is required. However, this co-ordination process is simple and always implicit. Planned 4D trajectories are exchanged between sectors and centres, as well as the constraints to be negotiated.

The following discussion, refers to trajectory negotiation regarding:

- Trajectory Prediction (TP)
- The ground side of the air-ground negotiation process (NM)
- The Conflict Probe (CP)
- The Flight Path Monitor (FPM)
- The Co-operative Tools

◆ **Trajectory Prediction (TP):**

A predicted trajectory, generated by the TP, is characterised by a way-point dependent accuracy. The accuracy of the trajectory prediction result is described by the TP error tube.

The most sensitive points of the quality of trajectory prediction are:

- the significance of the prediction result (Is 4D guidance applicable or not?)
- the quality of the aircraft performance data
- the quality of meteo data

Once, there is a "contracted" trajectory, it is less relevant how well the ground TP model predicts, but much more how well the guidance process in the aircraft is performed, and if the current contract is still valid within the near future. Equipped aircraft will be able to follow the "contracted" trajectory with high precision. Unequipped aircraft will be loosely coupled to a ground-determined predicted trajectory. The

TP prediction result and its significance has to be taken into account in the process of planning and deconflicting.

The quality of available aircraft performance data can be improved considerably for equipped aircraft by regular updates of aircraft performance data by down-linking these data, using the DAP air-ground operational data-link application. For non-equipped aircraft only generic and default performance data can be used, as well as data supplied with the flightplan.

The quality of available meteo data can be improved for all aircraft if access to a meteo grid database is applicable. However, the quality or reliability of data stored in this database may be dependent strongly on the data, supplied along the 4D routes of aircraft.

Altogether, this may result in trajectory prediction quality which may vary from point to point and from aircraft to aircraft. It is mandatory therefore to include in different processes, e.g. the CP, FPM, CT, PS and the NM, the use of these prediction uncertainties, stored in the TP error tube.

◆ **The ground side of the air-ground negotiation process (NM):**

A down-linked proposed trajectory is validated with support of the CT and CP. If the proposed trajectory is not conflict-free, the CT, CP and TP are used, together with the PS, to create a trajectory with possibly no remaining problems. This trajectory is optimal with respect to the given constraints and can be close to optimal with respect to flight economy, because appropriate flight performance data will be available and will be used for the trajectory negotiation process.

A constraint list shall be constructed around the predicted trajectory, as determined during the trajectory editing process. This constraint list consists of a complete or incomplete set of windows around 4D way-points.

The constraint list is up-linked. The aircraft will down-link a reply:

- The first option is that the aircraft down-links a trajectory, which satisfies the constraints.
The ATCO accepts this trajectory. A derived contract tube is determined and up-linked, confirming the "contracted" trajectory.
- The second option is that EFMS indicates a problem with one or more constraints, and the pilot down-links a trajectory with constraints violation indications.

A contract tube is determined, based on the down-linked trajectory, if this trajectory is accepted. Otherwise, if necessary, and interactively, an adapted constraint list may be determined, an alternative trajectory is calculated by the ground TP and a contract tube is determined. The contract tube is up-linked, and the trajectory, related to this tube, will be the "contract".

This response is equal to and can be used also to up-link a "formalised" clearance.

Notify that a trajectory is "contracted", while the contract tube defines the manoeuvring space only. This implies that the Ground system will monitor if the performed flight is in agreement with the "contracted" trajectory and its contract tube, and if no new conflicts will be raised.

◆ **The Conflict Probe (CP):**

The (medium-term) CP compares pairs of predicted trajectories. Different PATs are activating the CP and are using its results. If required, the CP activates the TP to generate the required trajectories.

The use of trajectories for conflict detection implies that the CP ignores the significance of contract tubes and anyway, conflicts involving "contracted" flights, are not excluded. However, it is the operational procedure, which prescribes that possible planning conflicts are solved, by preference, in favour of the valid contracts.

All air traffic is monitored on planning conflicts, no matter if equipped, non-equipped, contracted or non-contracted flights are involved. Conflict detection of contracted flights is based on down-linked trajectories, while conflict detection of other flights is based on the results of the ground TP.

It should be notified that use of trajectories calculated with different prediction models may raise inconsistency problems. Only the consequent use of a unique ground-based trajectory prediction tool reduces this risk.

◆ **The Flight Path Monitor (FPM):**

The FPM is processed on all active flightplans (SPL). For 4D equipped aircraft, active flightplans are flightplans, which contain a valid "contract" on a 4D trajectory. For non-equipped aircraft, flightplans are active if the flightplan describes correctly the trajectory, expected to be flown. Even, after an open-ended clearance, a flightplan can be active, if the clearance describes correctly, which trajectory the aircraft is expected to follow. A large deviation, however, will result in a de-activation of the SPL.

The FPM monitors, for all active flightplans, if the aircraft follows its planned or "contracted" trajectory. Different tolerances may be applicable for equipped and non-equipped, contracted and non-contracted flights. These tolerances are system determined, based on default assumptions and possibly also, on the flight phases. At least, a difference is made between En-route and departure and arrival flight phases in the TMA.

◆ **The Co-operative Tools (CT):**

The CT determines the problem situations using all active flightplans (SPL). For the computation of the problem situation and default world representation different tolerances may be applicable for equipped and non-equipped, contracted and non-contracted flights. These tolerances are system determined, based on default assumptions and the segment of the trajectory. At least, a difference is made between En-route and several arrival flight segments in the TMA.

4.3.5 The trajectory negotiation concept and the airborne HMI

During trajectory negotiation, the pilot shall be able to judge a contracted trajectory, alternative trajectories, and essential constraints, while he is able to manipulate the alternatives.

The pilot shall be able to judge a horizontal and vertical view of the optimal, by EFMS preferred, 4D trajectory, and the constraint list, proposed by the Ground. The constraints are to be displayed as far as forcing deviations from preferred solutions. The trajectory will be displayed by default for that part of the trajectory that is subject to negotiation (where constraints are added and or modified).

Interactively, the pilot will be able to select graphically an alternative, by trajectory editing. The violations of the imposed constraints are displayed. The pilot is able to select a trajectory and to down-link this proposal, including indications of constraints violations.

The resulting "contracted" trajectory is displayed, while it should be visible what part of this trajectory is approved by a Sector Contract Approval or cleared by a Formalised Clearance. The contract tube is not essential for the pilot. This tube is subject to the guidance and control function and it is sufficient if violations, if any, are displayed.

A "contract" may be still existing, but disabled for navigational use, if the aircraft is taken under tactical control by ATC, using voice communication. The aircraft is expected to be controlled manually by the pilot, nevertheless the information concerning the contracted trajectory should be retrievable. The disabled "contract" may be used as the starting point of a trajectory re-negotiation.

4.3.6 The trajectory negotiation concept and the ground-based HMI

During trajectory negotiation, the ATCO should be able to judge the planned trajectory (SPL), a trajectory, proposed by the aircraft, alternatives, and the surrounding traffic situation. The TC with Control Authority shall be aware of the status of the planning and negotiation process.

The planning ATCO, which performs the trajectory negotiation, will be able to display a proposed trajectory. It will be verified if this proposed trajectory is conflict-free, and if not, he is able to edit the planned trajectory in order to select a conflict-free trajectory.

Because only a part of the trajectory is within the decisive competence of a planning ATCO, he is able only to contract part of the trajectory conflict-free. However, via implicit or explicit co-ordination he is able to negotiate on constraints outside his sector.

The TC with Control Authority has to be able to monitor a 4D controlled flight. He is required to be able to identify and to see the difference between:

- Part of a trajectory with the status of a Formalised Clearance,
- Part of a trajectory with the status of a Sector Contract Approval,
- a "contracted" trajectory,
- a planned/proposed, but not yet "contracted" trajectory.

Finally, each "contracted" trajectory should be flagged/marked in a way to discern it from non-4D controlled flights.

4.3.7 "Sector contract approval"

The Advanced Organisation of PD/3 supports 4D trajectory negotiation in a mixed air traffic environment, supporting air-ground integration. These features are imposing high requirements on the ATC system in order to enable the controllers to perform their tasks in a consistent and reliable way.

Specifically, the tasks to be performed by the TC have become more complicated than in the present-day situation.

One reason is that his monitoring task is more difficult to perform than before, due to more diversity of levels of equipment, levels of planning and of supporting tools and systems. His primary task with respect to monitoring is to get the proper overview on the traffic situation. And it is questionable if he is able to get the right view at the right time.

Another reason is that more complex and more precise medium-term planning tools have become available, which allows the planners to specify possibly complex and elaborate solutions, but solutions which makes it questionable if the TC is able to perform his operational tasks adequately and to react in a timely manner.

For 4D trajectory negotiation, it was considered necessary to support the TC with a possibility to assess the responsibility accepted for a controlled flight through his sector. Because it appears, that this feature requires clarification, the precise arguments are stated below:

- A negotiated "contract" will be based on a planned trajectory, covering more than one sector. More than 30 minutes planned ahead of the actual position will not be possible, but, if possible, a remaining trajectory up to touch-down will be negotiated.

The planning is used to determine a constraint list, or to impose a Formalised Clearance. A down-linked trajectory, based on a constraint list, can be negotiated and contracted. However, the down-linked trajectory can be assessed to be conflict-free by the negotiating PC in his sector only.

- The negotiated "contract" has to be respected for the trajectory within each sector, unless the changed traffic situation requires re-negotiation.
- The PC of each sector verifies the conflict free planning of a 4D aircraft through the sector. He re-negotiates, if necessary. The time of verification and re-negotiation is between 10 minutes before entry and Assume Control.
- The TC accepts an aircraft by Assume Control. The flight can be 4D, or not-equipped (not-4D and no-data-link). Other possible configurations are possible, but these are outside the scope of PD/3. A 4D equipped aircraft can be contracted or not. He has to be aware of the status of each flight and has to be aware that there is no misunderstanding on the tactical flight conditions.
- The TC can establish communication via R/T. For unequipped aircraft this is mandatory, and the first R/T communication allows the TC to verify that air and ground have a proper understanding of the cleared flight conditions.

For an equipped flight, there shall be an equivalent, but silent, procedure for a frequency change, using datalink. There is no mutual understanding of the conditions of the flight, which can be concluded from this frequency change. If there is a valid 4D contract for the sector, the TC is not required to have monitored if the PC of his sector has negotiated or verified it. The TC can only be aware, if the flight is conflict-free planned through the sector, not how it is planned, and that possibly the trajectory has been contracted. The flight can be Assumed regardless of the conflict-free status.

- The pilot has contact with the ground during the trajectory negotiation process. If the result of the negotiation process is a contracted trajectory, which extends over several sectors, and possibly over more than one centre, the pilot may expect that this contract is active. However, the TC, assuming the flight, puts into effect part of this contract, while “Assume Control” is not explicit about the status of a contract, neither about the contents. Moreover, the pilot is not aware about the ground-based co-ordination, flightplan and trajectory verification, and consistency in the exchange of trajectory information between sectors and between centres.

The negotiating and contracting PC has no authority, neither responsibility for realisation of any part of a contract, and the TC has the authority and the responsibility. The conclusion is that the pilot needs a sign of acceptance of the responsibility of the TC of Control Authority on the trajectory through the sector. If there is no approval, the pilot can not safely fly its trajectory, and he should take appropriate action.

The conclusion is, that linked to the Assume Control action, the TC should approve explicitly the trajectory through the sector, for which he takes the responsibility of control authority and that the TC should make this approval known to the pilot. The approval is given by up-linking a Sector Contract Approval.

5. REQUIRED HMI FACILITIES, FUNCTIONS AND TOOLS

5.1 INTRODUCTION

The basic operational requirements used in the Advanced Organisation of PD/3 are described including HMI facilities, functions and tools. The following section outlines the structure of the description.

The description of the facilities, functions and tools is not exhaustive and is based on the perceived operational needs of the controllers. Only the primary operational requirements of each role are described.

The Baseline functions and facilities shall be derived from a reduced version of that for the Advanced Organisation and are not specifically defined.

The following operational description of the roles of the Advanced Organisation, is derived from roles and tasks descriptions of Section 2.3. The main bullets are described in more detail, with those secondary roles described in a reduced format:

- **The Multi-Sector Planner**, with requirements for:
 - **MSP**
- **The En-route Planning Controller**, with requirements for:
 - **ER PC/TC**
 - AA PC/TC
 - DA PC/TC
- **The Arrival Planning Controller**, with requirements for:
 - **ARR SP**
 - ARR TC (covering the role descriptions of INI and ITM)
- **The Departure Planning Controller**, with requirements for:
 - **DEP PC**
 - DEP TC

The requirements of Tower Control (LOC) are not described, because this position is an emulated one in PD/3.

The description of operational requirements of AHMI (for 4D equipped aircraft) has been covered already in chapter 3, summarising the operational role of equipped aircraft and the implementation of EFMS and AHMI in the cockpit.

5.2 REQUIREMENTS FOR THE ADVANCED ORGANISATION

Following task logic description (TLD) analysis, the operational requirements are derived [ref. 16]. Each section summarises the requirements of roles, which are related with respect to their requirements towards the implemented system.

5.2.1 Required HMI Facilities, functions and tools of the MSP Controller Working Position

The required HMI facilities, functions and tools are specified according to the tasks to be performed. The tasks of the MSP are performed by four main activities:

- **Monitoring and complexity analysing activities:**
 - Monitoring the evolving traffic situation over the concerned period of planning
 - Assessing and resolving traffic complexity and sector flow rates
- **Traffic situation selection and assessment activities:**
 - Assessing and resolving traffic complexity and sector flow rates
 - Anticipation of climbing traffic
 - Assessing and organising arrival traffic flows/sequences until approach management
- **Traffic management activities:**
 - Replanning the multi-sector transit plan, including possible deconflicting
 - Optimising trajectories
 - Balancing sector flow rates
- **Co-ordination and communication activities:**
 - Planned trajectory modification uplink to 4D and data-link equipped aircraft
 - Implicit and, in particular cases, explicit co-ordination activities:
 - a) on entering traffic
 - b) within the actual MSP area
 - c) on exiting traffic

The following requirements of HMI facilities, functions and tools are derived from the identified activities:

- **Monitoring and complexity analysing activities:**
 - The capability to present, on the PVD, a continuously actualised, predicted air traffic situation over a planning period of a maximum of 40 minutes and over an area, covering the MSP area, including, if required, an adjacent buffer area.
 - The capability to present, giving the air traffic planning sectors traffic load over the identified area and time period

- Based on the presentation of sector traffic load, to identify and to show climbing, descending and en-route traffic.
- Based on the presentation of sector traffic load, the capability to relate the actually predicted to the maximum acceptable load.
- Based on the presentation of sector traffic load to present and enable to identify and to select the predicted conflicting traffic .
- The capability to make an analysis of the vertical traffic distribution
- The capability to display geographical location of predicted complex traffic sequences and associated aircraft.
- The capability to represent the predicted flow interaction along time.
- **Traffic situation selection and assessment activities:**
 - Based on air traffic presentation, to identify and select individual flights or a "family of flights", with filters based on time, level, type of flight or associated conflicts.
 - The capability to filter and select flights, based on the presentation of detailed flightplan information.
 - To assess the possibility for successful planning of departure traffic by presentation of a non-airborne/airborne status of departing flights and the ability to be alerted on changes.
 - To assess the arrival flow rates on the Metering Fixes and to present the status of arrival management of a flight.
 - To present the status of the planning authority of the selected flights.
- **Traffic management activities:**
 - The option to replan flights as required to achieve optimising, balancing and decomplexifying.
 - The capability to present the selected flight(s), with their filtered and/or selected environment at that time along the 4D trajectory.
 - The capability to take into account the reliability⁵ of a predicted trajectory.
 - Trajectory editing options, enabling replanning and deconflicting the trajectory.
 - The capability to validate a proposed or edited trajectory.
 - The option to implement a trajectory modification.
 - The capability to translate a solution, selected as a modified trajectory, into a simplified sequence of proposed clearances, in order to support non-equipped flights, via R/T. This sequence should be made available to the TC.
- **Co-ordination and communication activities:**
 - Voice communication co-ordination options with all relevant ATCOs.

⁵ The quality depends on whether the aircraft is airborne or not, and on whether it is datalink equipped or not.

- Datalink communication capability for ground-ground communication with all relevant ATCOs.
- Options for implicit or explicit co-ordination on flight planning.
- The capability to be alerted by a co-ordination request and to perform the co-ordination.
- The capability for the early transfer of the planning authority of a flight, on PC request.

5.2.2 Required HMI Facilities, functions and tools of the ER PC/TC Controller Working Position

The required HMI facilities, functions and tools are specified according to the tasks to be performed. The tasks of the ER PC are performed by five main activities:

- **Monitoring the evolving traffic situation over the concerned period of planning and control:**
 - Monitoring and assessment the evolving traffic situation over the concerned period of planning and control,;
 - Awareness of traffic load and problem situations
- **Traffic problem selection and solving activities:**
 - Replanning and deconflicting over the sector:
 - a) Validating aircraft sector entry and exit conditions
 - b) Managing problem situations
 - c) Preparing sector conflict resolution clearances for non-datalink equipped aircraft
 - d) Deconflicting 4D equipped aircraft
 - Replanning arrival traffic:
 - a) Validating arrival metering requirements
 - b) Preparing arrival clearances
- **Co-ordination and communication activities:**
 - Implicit and explicit co-ordination on sector entry and exit conditions with controllers of adjacent sectors and area's
 - Co-ordination in exceptional cases with the MSP
- **Trajectory negotiation:**
 - Trajectory negotiation with 4D and datalink equipped aircraft.
- **Assistance to the ER TC:**
 - Co-ordination with, and assistance to the ER TC and updating the SPL with the updated planned and/or contracted trajectory

The following requirements of HMI facilities, functions and tools are derived from the identified activities:

- **Monitoring the evolving traffic situation over the concerned period of planning and control:**
 - The capability to present, on the PVD, the continuously actualised, air traffic situation based on surveillance information over the sector and an extended area, providing anticipated display of entering flights.
 - The capability to present, on the PVD, continuously actualised, predicted air traffic situation over a planning period of a maximum of 20 minutes.
 - The capability to present continuously actualised planned traffic data. Partly, this information can be presented in label and/or extended label presentation (PVD), partly in SIL's (Sector Inbound Lists).
 - The capability to present for each flight, on request, representation of its planned trajectory.
 - The capability to present, on request, a dynamically extrapolated filtered traffic situation.
 - The capability to monitor the status of traffic, actually present in the sector:
 - the "assume control" status.
 - awareness of planning stability and activities/results in other sectors.
 - awareness of the status of negotiation and contract of a flight.
 - The capability to present medium-term planning conflicts, short-term conflict alerts and deviations.
 - The capability to present an ordered list of problem situations, conflicts, alerts and deviations, following their, time and urgency permitted, priority.
 - The capability to monitor pending datalink communication.
 - The capability to view for aircraft, for which stable Arrival Management is provided, the relevant AM details such as Metering Fix, Time at the MF, Delay and Level.
- **Traffic problem selection and solving activities:**
 - The capability to present the selected flight(s), with their filtered and/or selected environment.
 - The capability to select one flight for replanning.
 - Trajectory editing, solution, validation and implementation options (similar to see MSP specifications),
 - The capability to present:
 - the system trajectory .
 - the proposed edited 4D trajectory.
 - optionally, a 4D trajectory, an originally earlier planned trajectory.
 - optionally, a 4D trajectory, downlinked by the aircraft as negotiation proposal.
 - The capability to translate a solution, selected as a modified trajectory, into a simplified sequence of proposed clearances, in order to support non-equipped flights, via R/T. This sequence should be made available to the TC.

- The capability to save the planned solution, and to be able to display a trajectory with its predicted, planned and/or contracted status.
- The option to take into account a time constraint advised by an AM, and to validate a conflict free sector plan for arriving aircraft and for non-equipped aircraft. This will result in a displayed advisory.
- **Co-ordination and communication activities:**
 - Voice communication co-ordination options with all relevant controllers.
 - Datalink communication capability for ground-ground communication.
 - Air-ground datalink communication capability, enabling the PC to perform the 4D trajectory negotiation process via the TC with Control Authority for that flight.
 - Options for implicit and explicit co-ordination on flight planning.
 - The option to take early Planning Authority for a flight, explicitly.
 - The option to co-ordinate with an ARR SP on a time constraint advised by the AM, and assessed by the ARR SP, for a particular sequencing solution.
 - The capability to be informed by the TC with Control Authority on the performance of the trajectory negotiation process.
- **Trajectory negotiation:**
 - The capability to perform the trajectory negotiation process with the following options:
 - initialisation of 4D trajectory negotiation
 - 4D trajectory negotiation
 - formalised clearance
 - sector contract approval
- **Assistance to the ER TC:**
 - Visual and audio contact, enabling the PC to work with the TC as a team.
 - The capability to perform each tactical control input, for the applicable sector, as if this input was entered by the TC.
 - The capability to follow each tactical control input of the TC, controlling the sector.
 - The capability to be alerted for each problem, in an identical way as the TC, controlling the sector.

The HMI facility for the ER TC is similar to that for the ER PC except that the following additional HMI Requirements are noted. HMI design should be developed to satisfy the following high level operational needs:

◆ **Required HMI Facilities, tools and functions of the ER TC:**

The ER TC shall be provided with advanced tools and HMI, permitting:

- Maintaining separation in the controlled sector, taking into account efficiency and 4D planning constraints.
- Executing conflict resolution clearances planned for non datalink equipped aircraft.
- Preparing and executing conflict resolution clearances for datalink and non datalink aircraft for outstanding conflict situations.
- Managing R/T communications and managing tactical datalink communications with controlled aircraft.
- Trajectory negotiation with 4D equipped aircraft on tactical level.
- Co-ordinating with adjacent sectors:
 - a) Accepting entering traffic
 - b) Transferring exiting traffic
- Co-ordination with the ER PC as his assistant.
- Updating the ground system.
- Monitoring the traffic situation in his sector over the concerned period of tactical control.

◆ **Required HMI Facilities, functions and tools of the AA PC:**

As it will be necessary for Arrival Management to begin in the En-route and ETMA sectors, AM advisories and advanced tools shall be provided to the ER PC and AA PC to allow them to incorporate AM constraints into their planning activities.

The AA PC shall process AM constraints for one main airport, whilst the ER PC may handle constraints for several airports.

The required HMI facilities, functions and tools are specified according to the tasks to be performed. The following tasks of the AA PC are performed in addition to the tasks, defined for the ER PC:

- Monitoring of the sector traffic planning situation with regard to AM sequence, holding manoeuvres and traffic approaching the MF.
- Monitoring the actual sector traffic situation with regard to AM sequence, holding manoeuvres and traffic approaching the MF.
- Replanning and deconflicting over the arrival sectors (sequencing).
- Stack control, planning and preparation of holding manoeuvres.
- Co-ordinating with other concerned controllers.
- 4D trajectory negotiation on traffic approaching the Metering Fix.
- Co-ordination with to the AA TC and updating the SPL with the updated planned and/or contracted trajectory with regard to planning and execution of holding manoeuvres.
- Providing assistance to the AA TC.

The HMI facility for the AA TC is similar to that for the AA PC except that the following additional HMI Requirements are noted. HMI design should be developed to satisfy the following high level operational needs:

◆ **Required HMI Facilities, functions and tools of the AA TC:**

The AA TC shall be provided with advanced tools, permitting:

- Display of pre-planned traffic sequence
- AM for preparation and modification of the arrival sequence (Time Line)
- Holding Stack facility for controlling holding manoeuvres
- Preparation of conflict resolution clearance for datalink and non-datalink aircraft
- Negotiation and dissemination of trajectories
- Co-ordination
- Monitoring of the sector traffic planning situation
- Monitoring the actual sector traffic situation

5.2.3 Required HMI Facilities, functions and tools of the ARR SP/ARR TC Controller Working Position

The ARR SP shall be provided with advanced tools permitting him to assess and modify AM advisories and to disseminate these to aircraft and sectors. The ARR SP shall be tasked to process AM advisories for proper sequencing of arrival traffic, mainly for one main airport to be serviced.

The ARR SP is for the effectiveness of his work heavily dependent on the AM and on co-ordination facilities:

- AM for preparation and modification of the arrival sequence
- delivery means for arrival sequence trajectories for equipped and non-equipped aircraft
- co-ordination, particularly with ER and ACC and DEP and LOC controllers
- monitoring of the arrival traffic planning situation
- monitoring the actual arrival traffic situation

The HMI facilities, functions and tools are required to support the following tasks of the ARR SP:

- **Monitoring and problem selection activities:**
 - Monitoring of the Arrival Sequence Plan.
 - Monitoring the actual Arrival Sequence.
 - Monitoring the status of Holding requirements.
 - Monitoring the Missed Approach situation.
- **Traffic problem solving activities:**

- Replanning and deconflicting over the arrival sectors (sequencing).
- Determination of Arrival slot times (sequencing).
- Replanning and deconflicting over the arrival sectors following Missed Approach (re-sequencing).
- Runway Configuration assignment.
- **Co-ordination and communication activities:**
 - Co-ordinating with the ER, ACC and DEP controllers on arriving traffic,
 - Co-ordinating with the DEP and LOC controllers specifically on runway capacity and assignment.
- **Assistance to the TMA Controllers:**
 - Assistance to the INI and ITM controllers (ARR TC).
- **Monitoring, planning and sequencing of arrival traffic:**
 - Monitoring the status of planning and control of arriving traffic at the MF.
 - Planning arrival traffic at the MF.
 - Co-ordinating on the MF with concerned controllers.
 - 4D trajectory negotiation, according to AM constraints.
- **Monitoring, planning and control of holding manoeuvres:**
 - Monitoring the status of planning and control of holding manoeuvres.
 - Planning holding manoeuvres.
 - Co-ordination on planning holding manoeuvres.
 - Assistance to the AA TC controlling holding manoeuvres.

◆ **Required HMI facilities, functions and tools of the ARR TC:**

The ARR TC shall be provided with standard TC control functions, similar to those supplied to the ER TC, however in the role associated with the ARR PC certain other facilities are required to permit the following operational duties to be performed.

The ARR TC (INI and ITM) shall be provided with advanced tools permitting :

- Modification of the arrival sequence from the MF as required.
- Preparation of conflict resolution clearance for datalink and non-datalink aircraft
- Co-ordination
- Monitoring of the sector traffic planning situation at and from the MF as required.
- Monitoring the actual sector traffic situation at and from the MF as required.
- Monitoring the aircraft planning deliverance from the holding stack

5.2.4 Required HMI Facilities, functions and tools of the DEP PC/TC Controller Working Position

The flights are taken into account 30 minutes before take off and up to the entering metering fix (TMA). The actual flight time of the aircraft inside the TMA space is about 5 minutes (the exchanges with the aircraft mostly take place before take off, and have to be very limited after take off, co-ordination with En-route ATCOs during the flight phase must be very efficient, and may often result in an anticipated transfer).

The required HMI facilities, functions and tools are discussed according to the tasks to be performed. The tasks of the DEP controllers are performed by four main activities:

- **Pre take-off organisation (performed exclusively by DEP PC):**
 - Supervise planned departure traffic : take off scheduling and TMA traffic planning
 - Manage FPL data of individual aircraft (check parameters received from the aircraft in real time against FPL parameters⁶, act on the time of departure including rescheduling)
- **Flight monitoring and management (performed by DEP TC with DEP PC assistance):**
 - Manage the entering traffic (mostly departure)
 - Monitor assumed flights
 - Manage outbound traffic
- **Co-ordination with surrounding ATCOs (preferably performed by DEP PC):**
 - Surrounding entities : ARR SP, ER PC and MSP of the next area
- **Communicate with aircraft (shared by TC and PC):**
 - Receive and process aircraft preferences, receive aircraft "Ready To Go"
 - Issue ATC intentions and clearances on aircraft calls and when available
 - Perform tactical actions
- **DEP TC/ DEP PC co-ordination**

The following requirements of HMI facilities, functions and tools are derived from the identified activities:

Note : to avoid redundancy, in the detailed description of requirements, co-ordination tasks will not be processed separately, but in the course of other tasks.

⁶ In the real world, this check has to be made by the first ATCO who receives FPL information (LOC), in PD/3 simulation context, the DEP PC is the first "existing" ATCO and will have to perform this task.

Note: As communication facilities are concerned, "VHF" means by voice for both data link and non-datalink aircraft, "VHF or Data-link" means VHF for non-equipped aircraft and datalink for equipped aircraft;

- **To supervise planned departure traffic:**

- Flight Plan data necessary to the sequence computation (estimated time of departure, destination, wake vortex ...) must be made available on the entity 30' minutes before requested departure.
- Prediction data must be made available on the entity as soon as the aircraft is taxiing, to be fed into the TMA planning tool (DM).
- Ability to process flight requirements (vortex separation ...) and environment requirements (runway occupancy, arrival slots, foreseen TMA traffic) to compute a arrival sequence (AM).
- The sequence involving a given aircraft must be known before initial contact with the pilot.
- Ability to take into account changes of the sequence required by the ATCOs.
- Ability to assign a non conflicting departure procedure (at least, up to the exit metering fix).
- Ability to take into account changes of the procedure performed by the ATCOs (through an editing facility).
- Availability of VHF communication (non DL equipped aircraft) or Data Link, as soon as Flight Plan data is available for sequence computation (receive instantaneous aircraft parameters (mass,...) and preferences (estimated time of departure, departure route ...).
- Ability to receive and answer to first pilot contact (VHF or DL).
- Ability to send the initial clearance (time of departure and procedure) to the aircraft (VHF or DL).
- Ability to receive aircraft prediction data for, at least, the part of the trajectory before the exit metering fix (equipped aircraft).
- Ability to receive aircraft Ready To Go.
- Ability to send requests to the ARR SP :
 - to change the runway rates
 - to reschedule the arrival slot of an individual aircraft

- **To manage entering traffic:**

- Availability of prediction (or flight plan) data necessary for the assume of control
- Ability to provide a warning on the assignment of a non standard departure procedure
- Ability to be warned regarding the initial call (VHF or DL)
- Ability to send a clearance modification (VHF or DL)
- Provide a selective list of aircraft to be assumed

- Ability to display entering aircraft trajectories
- Ability to propagate clearance changes to En-route PC (data link)
- Ability for the PC to drag TC attention on aircraft to be assumed
- Ability for the PC to edit and transfer memos linked to problematic aircraft
- **To monitor assumed flights:**
 - Anticipated availability of deviation risks (due to short available time for tactical action)
 - Ability to provide deviation information for individual aircraft and trigger a warning
 - Ability to send corrective action
 - Ability to send tactical clearances (linked with memos or not) (by VHF)
 - Ability to display departing flight positions and trajectories in the TMA
 - Ability to request PC assistance in case of an unforeseen co-ordination need
 - Ability to propagate transfer condition changes in case of a non corrected deviation or tactical action
- **To manage outbound traffic:**
 - Ability to perform a frequency change request (VHF or DL)
 - Ability to perform an anticipated frequency change (VHF or DL)
 - Ability to receive or send an anticipated transfer request (in order to minimise co-ordinations)
 - Ability to detect impact of deviations on exit conditions and provide a warning

6. DEFINITIONS AND ABBREVIATIONS

6.1 DEFINITIONS

Conflict killing	This is a result of actions taken with the aim of de-complexifying a traffic situation, including conflicts. Conflicts are solved indirectly by a more strategic approach than de-conflicting.
Constraint list	Constraining conditions, defined by a complete or incomplete set of windows around a list of 4D waypoints.
Contract	A "contract" shall be defined as the trajectory, negotiated between air and ground, which the aircraft will fly to some point in the future, if possible up to the landing. The "contract" shall be considered on the ground as the active flightplan, describing what the aircraft is flying. This trajectory is giving confidence and accurate flight information. The aircraft stores the "contracted" trajectory in its FMS, and will fly it, 4D compliant, unless an overruling decision of the pilot is required.
Contract tube	The contract tube defines the boundaries of a volume of airspace around the contracted trajectory along which the aircraft is "contracted" to fly. The contract tube is determined during the trajectory negotiation process.
Control Authority	<p>The exclusive authority of executive control on a flight.</p> <p>The TC of the current sector has "Control Authority" and he has also exclusive control on R/T communication with the pilot.</p>
De-complexify traffic	<p>Reduce the complexity of a traffic situation.</p> <p>Many separate factors can combine to affect the complexity. These factors are diverse such as, density, workload, number and type of conflicts, airspace configuration, type of traffic and more. Only some will be modifiable.</p>
De-conflict traffic	Interact with aircraft that will be in conflict to resolve the conflict. This term is used to refer to the more tactical task of solving individual conflicts.
Error tube	Margins around a predicted 4D trajectory (segment), due to flight technical errors, e.g. weather conditions, available performance data and expected guidance accuracy.
Formalised clearance	A 4D trajectory, for which the aircraft is cleared by the ground to fly this trajectory.
Negotiation Authority	The authority to perform a negotiation process with the aircraft.

Negotiation is performed always via the current controlling sector, whilst the PC of the next receiving sector as well as the current controlling sector have Negotiation Authority. Early Negotiation Authority can be provided on request to the PC with Planning Authority of a subsequent sector.

Optimise flight	Interact with an aircraft to provide for a more efficient flight. This may mean allocation of a better flight level, better routing or other parameters. It is possible that an optimisation could be applied to a single aircraft or to a group.
Planning Authority	The exclusive authority of planning on a flight within a certain geographical region, i.e. a sector or an area.
Sector contract approval	The "sector contract approval" shall be defined as a section of the aircraft's trajectory that has been agreed by the TC. This agreement can only extend to the sector boundary, which part of the trajectory belongs to the domain of responsibility of the concerned controller. The sector contract approval will be given at "assume control", before entering the sector.
4D trajectory (segment)	A list of 4D way-points.
4D way-point	A 4 dimensional geographical point defined by latitude, longitude, altitude and time - used to denote a position in space defined relative to the earth and time.

6.2 ABBREVIATIONS

AA PC	Arrival ACC Planner Controller
AA TC	Arrival ACC Tactical Controller
a/c	Aircraft
ACC	Area Control Centre
ACK	Acknowledgement
AHMI	Airborne HMI project
AM	Arrival Manager (PATs)
APP	Approach Centre
ARN	ATS Route Network
ARR SP	ARRival Sequence Planner
ARR TC	ARRival Tactical Controller (INI and ITM)
A-SMGCS	Advanced Surface Management Guidance and Control System
ATC	Air traffic Control
ATCO	Air Traffic Controller
ATD	Actual Time of Departure
ATIS	Airport Terminal Information Service
ATFM	Air traffic Tactical Flow Management
ATM	Air Traffic Management
ATN	Aeronautical Telecommunication Network
ATO	Actual Time Over
ATS	Air Traffic Services
CDU	Control and Display Unit
CDG	Charles-de-Gaulle Airport
CENA	Centre d'Etude de la Navigation Aérienne (France)
CFMU	Central Flow Management Unit
CM	Context Management, a D/L application
CNS	Communication, Navigation and Surveillance
CP	Conflict Probe (PATs)
CPDLC	Controller Pilot Data Link Communications, (an air-ground D/L application)
CT	Co-operative Tools
CTA	Control Area (ACC)
CWP	Controller Working Position
DAP	Downlink Aircraft Parameters, an air-ground D/L application
DA PC	Departure ACC Planner Controller
DA TC	Departure ACC Tactical Controller

DEP PC	DEParture Planner Controller
DEP TC	DEParture Tactical Controller
D/L	Data Link
DM	Departure Manager (PATs)
EATCHIP	European ATC Harmonisation and Integration Programme
EATMS	European Air Traffic Management System
EEC	EUROCONTROL Experimental centre
EFIS	Electronic Flight Instrument System
EFMS	Experimental Flight Management system
ER PC	En-Route Planner Controller
ER TC	En-Route Tactical Controller
ETMA	Extended Terminal Manoeuvring Areas
ETA	Estimated Time of Arrival
ETD	Estimated Time of Departure
ETO	Estimated Time Over
FL	Flight Level
FMS	Flight Management System
FPM	Flight Path Monitoring (PATs)
GHMI	Ground HMI project
HIPS	High Interactive Problem Solver
HMI	Human Machine Interface
IFL	Intermediate Flight Level
INI	INItial approach controller (ARR TC)
ITM	InTerMediate approach controller (ARR TC)
LAD	Look Ahead Display
LoA	Letter of Agreement
LOC	LOcal Controller (Tower)
MF	Metering Fix
MSL	Mean Sea Level
MSP	Multi-Sector Planner
NFL	Entry Flight Level
NLR	Nationaal Lucht- en Ruimtevaartlaboratorium (Netherlands)
NM	Negotiation Manager (PATs)
nms	nautical miles
OPS	Demonstration Operational Specification document
ORG	Operational ORGanisation used as demonstration scenario
OSD	Operational Scenarios Document
OTF	Operational Task Force (PD/3)

PANS-RAC	Procedures for Air Navigation Services, Rules of the Air and Air traffic Services
PATs	PHARE Advanced Tools
PC	Planner Controller
PCFL	Preferred Cruise Flight Level
PD/3	PHARE Demonstration 3
PDC	Pre-Departure Clearance, an air-ground D/L application
PHARE	Program for Harmonised ATM Research in EUROCONTROL
PLCO	PLanning Co-ordination, a ground-ground D/L application
PS	Problem Solver (PATs)
PVD	Plan View Display
QNH	Static air pressure at mean sea level
RETD	Revised Estimated Time of Departure
RFL	Requested Flight Level
RPVD	Radar PVD
R/T	Radio / Telephony
RVSM	Reduced Vertical Separation Minima
SID	Standard Instrument Departure route
SPL	System PAn
STAR	STandard Arrival Route
STO	Scheduled Take-Off time
SUC	Start-Up Controller
TC	Tactical Controller
TMA	Terminal Manoeuvring Area/ Terminal Control Area
TOC	Top Of Climb
TOD	Top Of Descent
TP	Trajectory Predictor (PATs)
TWR	Tower
UAC	Upper Airspace Control
UK	United Kingdom
UTC	Co-ordinated Universal Time
WNS	Weather Nowcast Services, a D/L application
XFL	Exit Flight Level
4D	Four Dimensional
4D TN	4D Trajectory Negotiation, (an air-ground D/L application)

7. REFERENCES

- 1 PD/3 Demonstration Operational Specification, EEC/NLR/CENA, PHARE/CENA/PD/3-1.3.1/OPS;3.1, PHARE DOC 95-70-02, March 1995.
- 2 PD/3 ISTF ATM Data-link - Requirements to d/l applications, DLARD and DLCRD structure, version 1.0, Draft, J.H. Vermeij, NLR, April 1995.
- 3 Detailed Description of Air/Ground Data Link Services, ADSP-WG, Draft, S. Tahmassebi, CENA, May 1995.
- 4 Detailed Description of Pre-Departure Clearance Service, ADSP-WGB, Draft, S. Tahmassebi, CENA, March 1995.
- 5 The Data Link Applications Requirements Document for the Pre-Departure Clearance Application, Draft, J.H. Vermeij, NLR, May 1995.
- 6 Detailed Description of ATIS Service, ADSP-WGB, Draft, S. Tahmassebi, CENA, March 1995.
- 7 Detailed Description of DAP-service (Down-link of Aircraft Parameters), ADSP-WGB, Draft, S. Tahmassebi, CENA, May 1995.
- 8 Data Link Application Requirements, Context Management, Draft, A.R. Schekkerman, NLR, May 1995.
- 9 PD/3 external project: MET
Draft, N. Chrupek-Marque, CENA, May 1995.
- 10 PHARE Demonstration 3, PD/3 Facility Specification, PHARE/EEC/PD/3-1.3.2/FAC;4, P. Latron, R. Graham, November 1996.
- 11 PHARE: Definition and Use of Tubes, PHARE-DOC 96-##-##, version 1.0, I.A.B. Wilson, Bruxelles, March 1996 .
- 12 PHARE: EFMS Phase 2 User Requirements Document for EFMS and EFMS/AHMI Interface, version 2.0, PHARE DOC 96-70-19, June 1996
- 13 I.A.B. Wilson, PHARE: Trajectory Negotiation in a Multi-Sector Environment, Eurocontrol, DED/1 EHQ, Bruxelles, version 0.02, March 1996.
- 14 PHARE, PD/3 Demonstration Project Plan, PHARE/EEC/PD3-1.3.5.2/DPP;3, version 3, M.Bisiaux, Y.Sagnier, Brétigny, June 1996.
- 15 PD/1 Final Report, PHARE/CAA/PD1-x.x/x;0, NATS Ltd, August 1996.
- 16 GHMI Specification for PD3 - Part 1, PD3 Controller Task Logic, EEC/CENA/NLR GHMI Design Team, Version 1.0, PHARE/NLR/GHMI-6.9/WP1;1.0, August 1996.

8. ANNEX A: AIRSPACE: SELECTION AND ORGANISATION

8.1 AIRSPACE ORGANISATION

The PD/3 demonstrations are simulating an airspace from Amsterdam - Schiphol (SPL) to Paris - Charles-de-Gaulle (CDG) where the concerned ATC units are Schiphol APP - Amsterdam ACC - Maastricht UAC - Brussels ACC/UAC - Reims UAC - Paris UAC/ACC - CDG APP. The scenario of the PD/3 Advanced Organisation should be based on the definition of an airspace structure, which takes into account:

- The advanced operational concept: roles and tasks
- The choice to use a traditional airspace structure with centres, sectors, air routes, SIDs, STARs. Also traffic transfer agreements on sector boundaries (LoAs) are taken into account, although for pre-departure flight planning and flow management purposes only.
- The optimal dimensions of sectors and centres, given the advanced concept.

It is essential, demonstrating an advanced concept, to be able to deal with enlarged capacity, efficient use of airspace, and optimal use of tools and procedures.

Unfortunately, it is difficult to create a new airspace structure, while at the same time it is an objective to assess any improvements assumed to be provided by both new tools and new working methods. These considerations result in the use of an airspace structure which is based on the present-day Dutch, Belgian and French airspace structure.

The segmentation of airspace consists of:

- Upper Airspace (en-route sectors), controlled by Upper Airspace Control (UAC).
- ETMA sectors, controlled by ACC.
- TMA, with arrival and departure zones, controlled by APP

The simulations in PD/3 are based on a present-days airspace organisation. Therefore a presentation of a summary of the description of the present-days airspace and structure of the relevant part of Europe (The Netherlands, Belgium and the North of France) is given in Section 8.2.1 of this annex while more detailed description is developed in section 8.2.2. Next in section 8.3 a possible option for airspace selection and the suggested sectorisation applicable to each PD/3 demonstration site is provided.

8.2 SIMULATED AIRSPACE

8.2.1 Summary of Present-days Airspace and Airspace Structure, relevant to PD/3

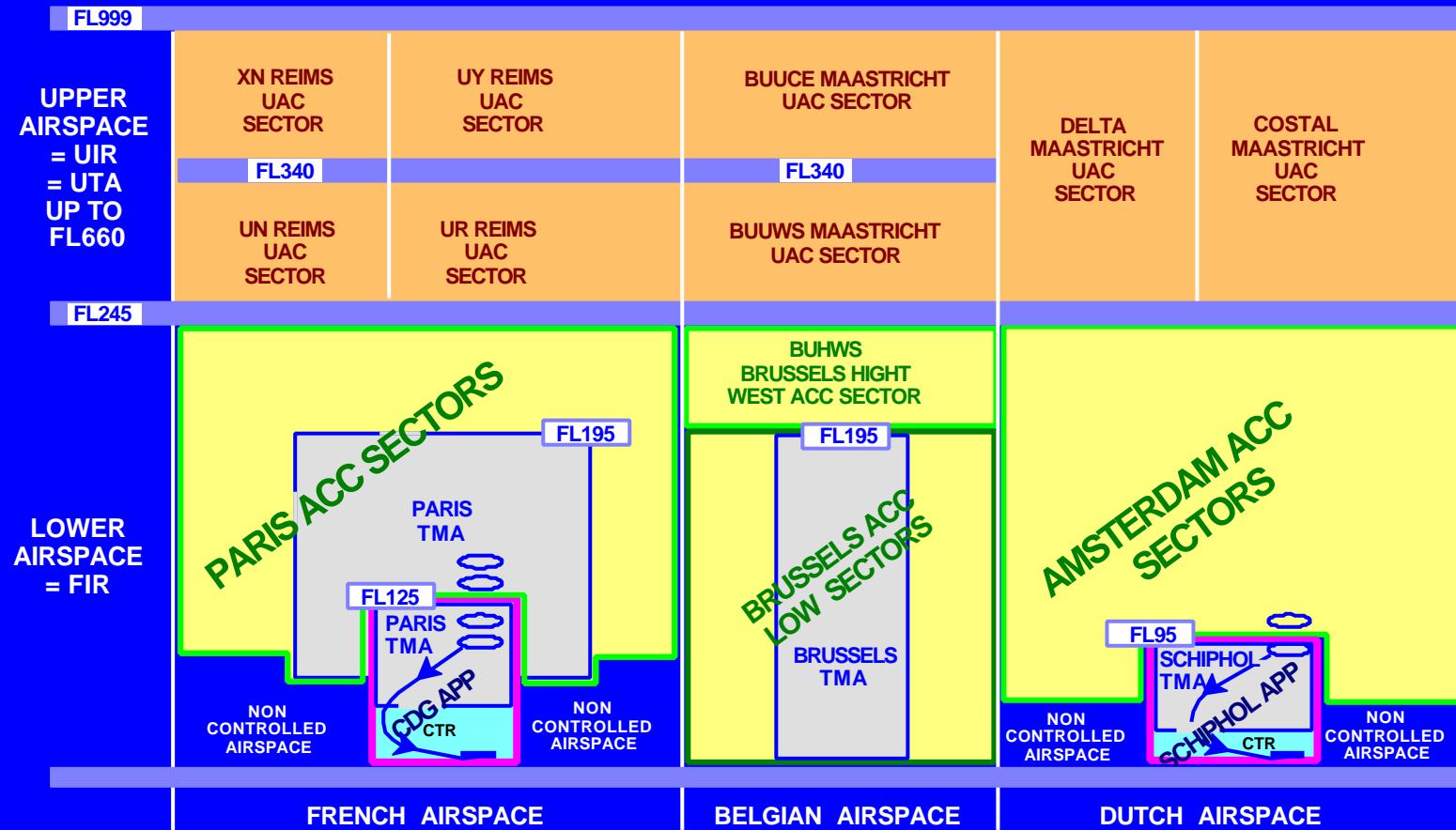
- Regardless simulation constraints, the airspace simulated in PD/3 should encompass the following sectors:

In Amsterdam FIR :	UAC	DELTA and COASTAL sectors
	(2)	(Maastricht FL245 and above)

	ACC	N, NW, SW, S and E Amsterdam
	(5)	(Amsterdam up to FL245)
	APP	Schiphol TMA up to FL95
	(2)	(departure and arrival)
In Belgian FIR :	UAC	BUUCE above FL340
	(2)	BUUWS from FL245 up to FL340 (both Maastricht sectors)
	ACC	BUHWS from FL195 up to
	(1)	FL245 (Brussels sector)
In Paris/Reims FIR	UAC	UY above FL340
	(4)	UR from FL245 up to FL340 XN above FL340 UN from FL245 up to 340 (all Reims sectors)
	ACC	TE up to FL245
	(6)	TB up to FL245 TN up to FL245 TC up to FL245 TS up to FL 265 TH up to FL 245 (all Paris sectors)
	APP	INI up to FL125
	(3)	ITM up to FL125 DEP up to FL145 (all CDG approach sectors)

- A more detailed description of today's airspace structure is given below.

AIRSPACE STRUCTURE AND SERVICES



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EUROCONTROL EXPERIMENTAL CENTRE 

8.2.2 Detailed Present-days Airspace Organisation, relevant to PD/3

A description is given below for parts of:

- the existing Dutch airspace.
- the existing Belgian airspace.
- the existing northern French airspace.
- the to-days sectorisation of airspace, relevant to demonstrations of PD/3.
- adjacent airspace and adjacent countries: UK, Denmark and Germany, as far as, and if this information is relevant to PD/3.

- **Dutch airspace:**

The following centres are active in the Dutch airspace:

- Maastricht UAC, controlling upper airspace:

The Delta and the Coastal sectors are covering the south/middle and north part of the Netherlands, Lower level FL 245, Upper level FL 999.

The activities in these sectors can be identified with the task descriptions for en-route sectors. Although arrival and departure traffic should be separated in a procedural way, using Amsterdam ACC sectors, it can not be excluded that departure and arrival planning procedures for more remote airports, e.g. Paris CDG, interfere, due to the extended working area of an AM and DM in the PD/3 advanced scenario.

- Amsterdam ACC, controlling the ETMA:

The following 5 sectors are covering the Dutch en-route airspace:

- North West
- South West
- South
- East
- North

These sectors are controlling the Amsterdam Control Areas (CTA's) West, South and East from FL 55/65 to FL 195 and upper airspace from FL 195 to FL 245. The sectors meet each other at Spijkerboor (SPY) and airspace partitioning is based on effective control of the air routes, crossing each other at SPY and PAM.

Each sector is controlling a dual carriage route. Therefore, each sector is controlling inbound as well as outbound traffic.

These sectors are including 3 en-route holding stacks for holding inbound traffic:

- River (wp: RIVER)
- Lake (wp: ARTIP)
- Sea (wp: SUGOL)

These stack areas are using holding levels between FL 065 and FL 245.

There is an extra en-route holding area in the east of the Netherlands.

The ACC sectors are controlled by one PC and one TC each, while in quiet hours control of combined sectors is possible. There is one special ATCo in charge of the planning of en-route crossing traffic over SPY and PAM, which can be compared in some way with an MSP of the advanced PD/3 scenario. The holdings, if used, are controlled by a separate stack controller.

The activities in the Amsterdam ACC sectors can be identified with the task descriptions of ETMA controllers with combined approach and departure control tasks. There is an essential interference between -En-route, -Arrival and -Departure traffic.

- Schiphol APP, controlling an approach area:

Only the TMA of Schiphol is considered as relevant for PD/3.

The TMA of Schiphol controls air traffic from 1500 ft MSL up to FL 105. The TMA contains one holding stack area at Spijkerboor.

The following controllers are active in the TMA of Schiphol:

- DCO: a planning and executive controller for departure traffic (DEP PC and DEP TC in PD/3). Also arrivals on secondary runways are controlled by the DCO. Some of the departure planning tasks are performed by the SUC (Star-Up Controller).
- APP VKL: a planning and executive controller for arrival traffic, initial approach (ARR SP and ARR TC in PD/3)
- ARR VKL: executive controller for intermediate and final approach (ARR TC also in PD/3). Depending on the traffic density and the runway configuration in use, several ARR VKL's may be in service.

As a standard procedure, outbound traffic is cleared to FL 060, and separated from inbound traffic, to FL 090 for a transfer to ACC. Inbound traffic is transferred to APP via a clearance to FL 070.

- New Milligen, controlling military airspace:

Different areas in the south, east and north of the Netherlands are under control of New Milligen. These areas are irrelevant for PD/3.

- **Belgian airspace:**

In PD/3 only the en-route part of air traffic is controlled during the simulations, while Belgian approach and departure traffic (e.g. to and from Brussels, Zaventem) is simulated by feeder positions. Therefore, only a global description is given of the following centres, relevant to PD/3:

- Maastricht, controlling upper airspace:

The following sectors are considered:

- The Brussels West sector (West: EBUUWS) (FL 245 to FL 340).
- The Brussels East sector (East: EBULNO) (FL 245 to FL 340).
- The Brussels Upper sector (West+East : EBUUCE) (FL 340 to FL 999).
- The Luxembourg sector (BULUX) (FL 245 to FL 999)
- **Brussels FIR, controlling the ETMA:**
The following sectors are considered:
 - ACC N (up to FL 195)
 - ACC W (up to FL 195)
 - ACC E (up to FL 195)
 - ACC S (up to FL 195)
 - Upper High West (FL 195 to FL 245)
 - Upper High East (FL 195 to FL 245)

- **Northern French airspace:**

The following centres are active in northern French airspace, relevant to PD/3:

- Reims UAC
- Paris UAC/ACC
- Paris APP

Sectors are described in geographical order, as far as relevant to PD/3:

- North-West, En-route and ETMA traffic:
 - XN (FL 340 to FL 999), controlled by Reims UAC
 - UN (FL 245 to FL 340), controlled by Reims UAC
 - TN (up to FL 245), controlled by Paris ACC
 - TB (up to FL 245), controlled by Paris ACC
- North, En-route and ETMA traffic:
 - UY (FL 340 to FL 999), controlled by Reims UAC
 - UR (FL 245 to FL 340), controlled by Reims UAC
 - TE (up to FL 245), controlled by Paris ACC
 - TC (up to FL 245), controlled by Paris ACC
- Around Paris, En-route and ETMA traffic:
 - TS (up to FL 265), controlled by Paris ACC
 - TH (up to FL 245), controlled by Paris
- Paris, approach areas:
 - Paris CDG (up to FL 145), controlled by CDG APP

- Paris Orly (up to FL 145), controlled by Orly APP⁷

For each approach path, there are three holding possibilities, two -En-route and one within the approach area, e.g.:

- Coming from the North-West, approaching CDG:
 - a) Dieppe (DPE), ETMA controlled, FL 70/140 and FL 150/240
 - b) Rouen (ROU), ETMA controlled, FL 70/140
 - c) Merue, FL 50/140, upper layers under control of TP, lower levels under control of CDG APP.
- Coming from the South-West, approaching Orly:
 - d) Chateaudun (CDN), ETMA controlled, FL 70/140 and FL 150/240
 - e) Nojan (NOJAN), ETMA controlled, FL 70/140
 - f) Eper (EPR), FL 60/140, upper layers under control of TW, lower levels under control of Orly APP.
- Coming from the South-East, approaching Orly and CDG:
 - g) Okrix, ETMA controlled, FL 70/140 and FL 150/240
 - h) Melun (MEL), 4000 ft to FL 140, upper layers under control of AO, lower levels under control of Orly APP.
- Coming from the South-East, approaching CDG:
 - i) Okrix, ETMA controlled, FL 200/240
 - j) Troyes (TRO), ETMA controlled, FL 80/140, FL 150/190 and above
 - k) Susin, FL 60/120 and FL 160/180, upper layers under control of AR, lower levels under control of Orly APP.
- Coming from the North-East, approaching Orly and CDG:
 - l) Reims (REM), ETMA controlled, FL 200/240
 - m) Atrix, ETMA controlled, FL 90/140 and FL 150/190
 - n) Boursonne, FL 60/70 and FL 80/140, upper layers under control of TE, lower levels under control of CDG APP.

It is not envisaged to simulate the overall above holding facilities. The CDG - DM interactivity with arriving traffic will be based on a pre-organised traffic sample.

⁷ The Paris-Orly holding possibilities are described in order to indicate partial stack structure commonality between CDG and Orly APP.

8.2.3 Adjacent Airspace

Other ETMA and En-route sectors, feeding the PD/3 simulations, are the neighbouring French, British, Danish and German sectors, feeding the simulations with a mix of inbound, outbound and en-route traffic (see below map PD/3 airspace and sectorisation).

8.3 POSSIBLE AIRSPACE SELECTION APPLICABLE TO EACH DEMONSTRATION SITE IN PD/3

The "ideal" airspace solution should include a number of sectors exceeding the available number of measured and feeding controller working stations.

Therefore this section proposes for each site an airspace selection satisfying the objectives of demonstrations while corresponding to the available equipment at the participating sites and to the minimum requirement of participating controllers . These proposals can be adapted with reports to particular local site constraints.

The equipment are distributed as follows :

Site	Measured Position	Feed Position
CENA	7	2/3
NLR	5	4
EEC	17	7

Definitions

Measured position is assumed to be normally controlled and equipped with all relevant functionality and fed by realistic air-traffic.

Feed position shall be designed and manned to ensure realistic co-ordination and traffic exchange with measured positions. These should require reduced control activity and functionality.

8.3.1 CENA

The main specific measured objectives of this demonstration site are to :

- evaluate the departure phase and integration between TMA, ETMA and En-route airspace;
- demonstrate PATs tools (functionality and interaction), as well as advanced GHMI;
- demonstrate the DM (Departure Manager) functionality;
- evaluate the MSP role in successive sectors with departing and overflight traffic.

The selected sectors and the corresponding controller roles are detailed in the table below :

Measured Position	Sector	Controller Role
2	UN/XN combined, FL245 and above (UAC)	1 ER PC - 1ER TC
2	TN/TB combined, up to FL245 (ETMA-ACC Departure)	1 DA PC - 1 DA TC
2	CDG Departure (TMA - APP Departure)	1 DEP PC - 1 DEP TC
1	UN/XN UR/UY (1) (UAC)	1 MSP

(1) : UR/UY is not measured given the today’s available equipment.

The feed sectors should require 3 feeder positions as follows :

Feeder Position	Sector
1	UR/UY - UF/XF - Maastricht UAC (Brussels West sectors) - Brussels ACC (Brussels West, North and Upper High West)
1	UZ/ZU - London (LYDD and Upper sectors)
1	TE - TC - TS - TH - TP - AR

8.3.2 NLR

The main specific measured objectives of this demonstration site are to :

- assess the ETMA - En-route interface
- demonstrate PATs tools (functionality and interaction), as well as advanced GHMI;
- to demonstrate the AM (Arrival Manager) functionality
- evaluate the ARR SP (Arrival Sequence Planner) role.

The required measured sectors and the corresponding controller roles are detailed below :

Measured Position	Sector	Controller Role
2	South, up to FL245 (Dutch ACC sector) (1) (2) (3)	1 AA PC 1AA TC
2	BUUCE, above FL340 and BUUWS, from FL245 up to FL340, (MADAP UAC sectors) Upper High West from FL195 to	1ER PC 1ER TC

	FL245 (Brussels ACC sector)(4) (all 3 sectors combined)	
1	South	1 ARR SP

- (1) In the Dutch ATC organisation departing and arriving PC and TC functions are combined in each ACC sector.

The feeder positions and the associated emulated sectors are listed below :

Feeder Position	Sector
1	Schiphol APP (TMA including arrival and departure)
1	N - E Amsterdam ACC sectors (up to FL245) combined with the corresponding part of COASTAL and DELTA sectors (above FL245) and the LNO Madap sector (above FL195)
1	NW - SW Amsterdam ACC sectors (up to FL245) combined with the corresponding part of DELTA sectors (above FL245) and the LONDON Clacton/Dover UAC/ACC sectors.
1	N - W - E Brussels ACC sectors (up to FL195) combined with TN - TB - TE Paris ACC sectors (up to FL245) and the XN - UN - UY - UR Reims UAC sectors (above FL245)

Remarks

- 1) Arriving traffic to Schiphol will be generated 220 NM before Amsterdam runways in order to provide relevant data acquisition to the Arrival Manager Tool. This requirement induces the arriving traffic to be initialised from London, Scottish, Copenhagen, Hannover, Rhein and France UIR/FIR.
- 2) This traffic handling will remain unmanned until entering the above listed feeding sectors.
- 3) The best possible realism (including interactive co-ordination) will be given to the ARR SP tasks inside the limits of the measured Maastricht (Brussels West) sectors and Amsterdam ACC South sector. His actions onto the arriving traffic inside the feeding sectors will be automatically implemented by the system (without co-ordination).
It is a minimum requirement for the evaluation of the ARR SP role to simulate all the inbound traffic to Schiphol.
- 4) With regards to the limited number of measured positions, it is proposed to combine all together the MADAP and Brussels sectors covering the Brussels West airspace above FL195 in a single entity in order to simplify the co-ordination process attached to the arriving traffic to Schiphol Airport.

8.3.3 EEC

The main specific measured objectives of the EEC demonstration are to :

- evaluate the en-route phase, in particular the MSP, ER PC and ER TC roles within different types of sectors (superposed sectors, successive sectors);
- demonstrate PATs tools (functionality and interaction), as well as advanced GHMI;
- assess the AM-DM impact on MSP role;
- simulate in a single site an ATC organisation from SID exit gate to STAR arrival gate providing the link and integration between Amsterdam ETMA and Paris ETMA.

The required sectors and the corresponding controllers roles are detailed in the table below :

Measured Position	Sector	Controller Role
2	CDG Departure (TMA - APP departure)	1 DEP PC 1 DEP TC
2	TN/TB, combined up to FL245 (ETMA - ACC Departure)	1 DA PC 1 DA TC
2	UN/XN, combined FL245 and above (UAC)	1 ER PC 1 ER TC
2	UR/UY, combined FL245 and above (UAC)	1 ER PC 1 ER TC
1	UN/XN - UR/UY MSP area 1 (successive sectors)	1 MSP
2	BUUCE, FL340 and above (Maastricht UAC)	1 ER PC 1 ER TC
2	BUUWS, from FL245 (Maastricht) up to FL340 and BUHWS from FL195 (Brussels) up to FL245, both sectors combined	1 ER PC 1 ER TC
1	BUUCE - BUUWS MSP area 2 (superposed sectors)	1 MSP
2	South up to FL245 (Amsterdam ACC sector)	1 AA PC 1 AA TC
1	South	1 ARR SP

The feed sectors should require 7 feeder positions as follows :

	Feeder Position	Sector
Amsterdam	1	Schiphol TMA (ARR and DEP)
	1	SW - NW (ACC sectors) - DELTA (UAC sector)
	1	N - E (ACC sectors) - COASTAL (UAC sector)
Brussels/ Maastricht	1	N - W - Upper High East - Upper High South (ACC sectors) - OLNO - Luxembourg (UAC sectors)
London	1	LYDD - Upper - Clacton - Dover (UAC/ACC sectors)
Paris/Reims	1	TP - TH - TS (UAC/ACC sectors) - UZ/ZU (UAC sectors)
	1	TC - TE - AO - AR (UAC/ACC sectors) - UF/XF (UAC/ACC sectors)