DELIVERABLE

Making change in En-Route Air Traffic control
First ATC Support Tools Implementation (FASTI)

Operational Concept

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Ops Implementation FASTI Programme

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Glossary of terms

Air Traffic Service Unit
A generic term meaning: a) Ground: Air Traffic Control Unit, Flight Information Centre, or Air Traffic Control Service (area control services reporting office. ATSUI refers to both human operators (e.g. controllers) and automated systems (e.g. data processing systems) at an ATSU, unless specifically stated otherwise. b) Aircraft: a concept introduced on-board the Airbus aircraft family, which is in charge of managing the air/ground data link communication, which hosts all air traffic control and flight information applications, which manages the human machine interface and any required integration in air traffic control of flight information user systems on-board the aircraft.

Aircraft Conflict (MTCD)
Two aircraft are involved in an aircraft conflict if the distance between any probable position of one aircraft at a certain time, and any probable position of the other aircraft at that same time, will be less than the required separation criteria.

Airspace Conflict
Airspace conflict refers to special use airspace penetration as defined in the EATM glossary of terms under Conflicts (MTCD).

Area Control Centre
That part of ATC that is concerned with en-route traffic coming from or going to adjacent centres or APP. It is a unit established to provide air traffic control service to controlled flights in control areas under its jurisdiction.

Area of Common Interest (SYSCO)
A volume of airspace as agreed between 2 ATS Units, extending into the adjacent/subjacent Areas of Responsibility, within which airspace structure and related activities may have an impact on air traffic co-ordination procedures.

Area of interest
1. The airspace encompassing the AoR and a defined buffer zone within which airspace status and flight information are of operational interest to the system operators.

2. The Airspace volume for which the ACC requires information such as: entering flights, airspace status, etc. This area includes the AoR and its vicinity.

Conflict
The following conflict definitions apply:

Conflict (MTCD)
Either an aircraft conflict, or a special use airspace penetration, or a descent below lowest usable flight level, or a nominal routes overlap\(^1\).

Conflict (SNET)
An aircraft is in conflict with an object (other aircraft, protected airspace or the ground) when it is, or is predicted to be, within pre-defined separation criteria from that object. The separation criteria do not equate to ATC separation standards and may vary depending on the geometry and location of the conflict.

\(^1\) The type of conflicts described in this document encompass aircraft conflicts and special use airspace penetration conflicts.
Conflict data (MTCD)
Consists of: conflict identification; conflict type, which is either aircraft conflict, or special use airspace penetration, or descent below lowest usable flight level, or nominal routes overlap; conflict severity; either aircraft conflict data, or special use airspace penetration data, or descent below lowest usable flight level data, or nominal routes overlap data.

Conflict severity (MTCD)
Indication of the severity of a conflict (MTCD) on a scale from 1 to 10, based on values of predefined parameters (e.g., time to conflict, minimum distance between trajectories, and geometry of trajectories).

Extended Terminal Manoeuvring Area (ETMA)
In the context of this document the term ETMA (Extended terminal control area) is defined to be the En-route airspace surrounding a TMA which normally contains the en-route network from the top of descent to the initial approach fix. The ETMA sectors are normally under the ACC authority (AGC ODIAC S&M ORD v1.0).

Planning Controller (PC)
The Planning Controller (PC), in the traditional controller team, is that controller responsible for non-radar related tasks.

Planning Controller Role
The planning controller role refers to the responsibility defined for the PC for the purpose of the management of sector traffic entry and exit co-ordination and other tasks delegated by the TC.

Sector
A defined airspace region for which an associated controller (or controllers) has ATC responsibility.

Strategic Planning (Approach)
The use of the term strategic planning in this document is not intended to convey a context related to that of strategic planning by CFMU. Strategic planning (FASTI) refers to that activity whereby the PC, having availability of MTCD and other traffic information, can plan traffic management with a tactical approach/flair for a sector or a number of sectors without the same time critical context as that of tactical control.

SYSCO
The term SYSCO is used as a generic term to indicate the electronic system supported co-ordination process.

Tactical (ATC)
Tactical ATC is a type of operational ATC situation. Tactical ATC situations involve time-critical communications, concerned with the tactical separation of aircraft for immediate safety reasons, or for other reasons of a time-critical and immediate nature.

Tactical Controller Role
The tactical controller role refers to the responsibility defined for the TC for the purpose of co-ordinating and managing traffic in a sector.

Tactical Controller (TC)
The person having final responsibility in co-ordinating traffic in a sector. The radar controller (often simply called the controller) is assisted by a planner (advance planning) and assistant.
The Tactical Controller (TC) or Executive Controller (EXC), in the traditional controller team, is that controller responsible for the tasks associated with traffic co-ordination and management in a sector.

**Terminal Manoeuvring Area**
A volume of airspace of defined dimensions usually established at the confluence of ATS routes in the vicinity of one or more aerodromes.

**Trajectory Edition**
Trajectory edition is an activity whereby the controller can modify the system trajectory for the purpose of FPL/trajectory modification or to perform what-if probing (see what-if probing).

**Trajectory Prediction**
1. Computation of a 4D-trajectory based on an aircraft's planned route and altitudes.

2. The process of calculating a trajectory of an aircraft, based on a current or proposed plan, weather information, aircraft and flight characteristics data, and other variables.

**What-if probing**
What-if probing refers to the action by a controller whereby a trajectory is edited and prior to updating the system this edited trajectory is probed to ascertain if it is conflict free. The ‘probing’ process is a function of MTCD trajectory pair comparison to detect trajectory uncertainty overlap based on the offline predefined parameters set in the system.
## Acronyms and abbreviations

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<th>Description</th>
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<tr>
<td>ABI</td>
<td>Advance Boundary Information (OLDI message)</td>
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<tr>
<td>ACT</td>
<td>Activation Message designator (OLDI)</td>
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<tr>
<td>AMAN</td>
<td>Arrival Manager</td>
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<td>ANSP</td>
<td>Air Navigation Service Provider</td>
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<td>ATC</td>
<td>Air Traffic Control</td>
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<td>ATCO</td>
<td>Air Traffic Controller or Air Traffic Control Officer</td>
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<td>ATM</td>
<td>Air Traffic Management</td>
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<td>ATSU</td>
<td>Air Traffic Service Unit</td>
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<td>BFD</td>
<td>Basic Flight Data message</td>
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<td>CFD</td>
<td>Change to Flight Data message</td>
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<tr>
<td>DGAC</td>
<td>Direction Générale de l’Aviation Civile (France)</td>
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<td>DMAN</td>
<td>Departure Manager</td>
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<td>DSNA</td>
<td>Air Navigation Services Department (DGAC France)</td>
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<tr>
<td>EATCHIP</td>
<td>European Air Traffic Control Harmonisation and Integration Programme (Refer to EATMP)</td>
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<td>EATMP</td>
<td>European Air Traffic Management Programme (Formally EATCHIP)</td>
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<td>ECAC</td>
<td>European Civil Aviation Conference</td>
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<td>ERATO</td>
<td>En-route Air Traffic Organiser</td>
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<td>ETMA</td>
<td>Extended Terminal Movement Area</td>
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<td>FASTI</td>
<td>First ATC Support Tools Implementation</td>
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<tr>
<td>GAT</td>
<td>General Air Traffic</td>
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<td>HCI</td>
<td>Human Computer Interaction</td>
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<td>HMI</td>
<td>Human Machine Interface</td>
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<td>iFACTS</td>
<td>Interim Future Area Control Tools Support</td>
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<td>LoA, LOA</td>
<td>Letter Of Agreement</td>
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<td>MAC</td>
<td>Message for the Abrogation of Co-ordination (OLDI)</td>
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<td>MONA</td>
<td>Monitoring Aids</td>
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<td>MTCD</td>
<td>Medium Term Conflict Detection</td>
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<td>NATS</td>
<td>National Air Traffic Services (UK)</td>
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<tr>
<td>OAT</td>
<td>Operational Air Traffic</td>
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<tr>
<td>OLDI</td>
<td>On-Line Data Interchange</td>
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<td>PC</td>
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<td>REV</td>
<td>Revision Message (OLDI)</td>
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<td>SYSCO</td>
<td>System Supported Co-ordination</td>
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<td>TC</td>
<td>Tactical Controller</td>
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<td>TMA</td>
<td>Terminal Manoeuvring Area</td>
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<td>TP</td>
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1. INTRODUCTION

The need for system support tools for air traffic controllers has never been greater. Concepts devised more than ten years ago under the European Air Traffic Control Harmonisation and Integration Programme (EATCHIP) have still not reached implementation. The development and validation of controller tools across Europe has been fragmented and uncoordinated leading to a diversity in system development and operational philosophies at both ANSP and industry level.

The forecast growth in air traffic, the drive for safety improvements and cost efficiencies, means that the time is now right for a greater focus on the implementation of controller system support to meet the needs of the airspace user. Classical methods of providing operational improvements all have their finite limit.

The First ATC Support Tools Implementation (FASTI) Programme aims at highlighting the need for the co-ordinated implementation and rapid deployment of an initial set of controller support tools. The programme will address short and medium term requirements but will also enable the introduction of further automation in ATC in the longer term. FASTI enables a move towards the EUROCONTROL objectives of ensuring a high quality, safe and cost effective service while matching capacity to airspace user demand.

FASTI objective is to:

Co-ordinate the implementation and deployment of controller system support tools, as required, across ECAC by 2012 in a harmonised way.

To achieve the above objective FASTI aims to:

- Contribute to capacity enhancement, cost efficiency and improved safety;
- Provide implementation support to ANSPs, Regulators and Industry in order to harmonise and expedite the deployment;
- Establish appropriate controller system support and performance levels across the ATM network;
- Act as an enabler for implementation of future automated support to ATC which is currently under development

Traditional ATC working methods, practices and procedures may need to change in order to become compatible with this new system support resulting in requirements for coherent deployment with a change management process to ensure smooth and safe transition to the next generation ATC systems.

This concept outlines the scope of FASTI application, assumptions, dependencies and operational environments as well as descriptions of controller roles and working methods, required for the successful operational implementation of conflict prediction tools (e.g. MTCD) and enablers (e.g. MONA, TP, HMI and SYSCO).

The target audience of this document is operational personnel, airspace and ATM system planners, Human Factors and Safety practitioners and operational focus groups.
2. CONCEPT SCOPE AND OBJECTIVES

The scope of FASTI Programme encompasses the implementation of Medium Term Conflict Detection (MTCD) and enablers Monitoring Aids (MONA) and System Supported Co-ordination (SYSCO). Trajectory Prediction (TP) and Human Machine Interface (HMI) are critical to the performance and use of FASTI tools.

This operational concept scope covers the implementation of FASTI capability at Air Traffic Service Units (ATSU’s) comprising upper, lower en-route and extended TMA operations. This includes ATC sectors where the operational environment may range from low to high traffic density and complexity.

Benefits will vary according to the target environment.

This operational concept will form the basis and permit the elaboration of safety, performance, human factors and operational requirements required for implementation.

2.1 FASTI Tools

The FASTI tools are as follows

**Medium Term Conflict Detection (MTCD)**

Assists the controller in conflict identification and planning tasks by:

- Providing automated early detection of potential conflicts;
- Facilitating identification of flexible routing/conflict free trajectories;
- Identifying aircraft constraining the resolution of a conflict or occupying a flight level requested by another aircraft

**Monitoring Aids (MONA)**

Helps controllers reduce the workload associated with traffic monitoring tasks by:

- Providing warnings if aircraft deviate from a clearance or plan and reminders of instructions to be issued;
- Provides conformance monitoring triggering trajectory re-calculation essential for the MTCD

**System Supported Co-ordination (SYSCO)**

- Permits controllers to conduct screen to screen co-ordination between adjacent ATSU’s /sectors reducing workload associated with co-ordination task;
- Enables controllers to conduct co-ordination dialogue and transfer flights between ATSU’s;
- Facilitates early resolution of conflicts through inter ATSU/sector co-ordination
3. OPERATING PRINCIPLES

The following principles are applicable to the use of FASTI tools.

Principle 1
Implementation of FASTI tools shall be preceded by the development and documentation of future controller roles, responsibilities, and working methods relating to the use of tools and system support.

Principle 2
FASTI promotes a proactive planning approach to air traffic control augmented by controllers task-sharing to provide more conflict-free trajectories for longer time periods.

Principle 3
The ultimate responsibility for conflict detection and resolution will remain with the controller(s).

Principle 4
FASTI Area of Interest is not constrained by adjacent sector boundaries or FIR/ACC area boundaries. Co-operation across boundaries is facilitated by FASTI.

Principle 5
MTCD and enablers such as MONA and SYSCO may co-exist with other Decision Support Tools (e.g. AMAN, DMAN) and work concurrently with them.

Principle 6
Where the crossing of civil sectors by OAT under the control of a military ATSU has been coordinated between the civil and military units/sectors, the OAT traffic should be subject to MTCD provided an updated trajectory for the OAT traffic is available in the system.
4. OPERATIONAL ENVIRONMENT

4.1 Airspace, Sectors and MTCD Horizons

This operational concept scope covers the implementation of FASTI capability at ATSU’s comprising upper, lower en-route and extended TMA sectors. This includes sectors where the operational environment may range from low to high traffic density and complexity. Benefits will vary according to the target environment.

Sector length and geometry (including collapsed sector configurations) vary and consideration should be given to the type of support that MTCD would provide within and beyond sector boundaries.

*MTCD is deemed to be primarily a planning tool* however sector length and TP performance (e.g. Sector transit time greater than 20 minutes or very short sectors) could implicitly highlight a need for new operational procedures and requirements to be defined and addressed.

4.2 Area of Interest between ATSU’s

The use of MTCD and MONA is expected within the Area of Interest (AoI) defined between two ATSU’s or sectors. Each ATSU will need to define and agree on their requirements for conflict detection.

4.3 Civil/Military Environments

FASTI tools support airspace or segregated area conflict detection as well as civil/military co-ordination. Where dual ATC service provision is provided between civil and military ATSU’s in the same airspace each ATSU would be expected to have equivalent capabilities to ensure the safe and expeditious handling of traffic. Where ATC services are integrated then OAT transits and GAT trajectories will be expected to be integrated in one ATC system.

4.4 Conflict Types

The types of conflicts encompassed by MTCD can be considered as tactical in nature. Spatial conflicts are generally defined whereby the distance and/or altitude between aircraft are less than the required minima. This includes multiple aircraft conflicts in any configuration and also airspace conflicts (Intrusion of prohibited/military/segregated airspace). Conflict types include:

- Crossing conflicts
- Converging conflicts
- Opposite direction conflicts
- In trail or catch-up conflicts
- Vertical – climb/descent conflicts
- Airspace conflicts
- Combinations of any of the above conflict types
5. ASSUMPTIONS AND DEPENDENCIES

Tools and system support features supported by intuitive and usable HMI. The availability of the following is thus, assumed:

- An operational MTCD\(^2\);
- Monitoring Aids or similar functions;
- Trajectory Prediction (TP);
- Inter-sector/centre Electronic Co-ordination capability including tactical messaging;
- Intuitive and user-friendly HMI including Trajectory Edition Functionality

Additional assumptions [Ref 1] address the users’ entry into the human-automation relationship with expectations that:

- The system is appropriate for the tasks for which it was designed and that it will remain so

Note: the above descriptions are intentionally generic, which facilitates inclusion of different systems and proposed support tools and additional functions.

The provision of reliable and accurate trajectory prediction is critical to the MTCD process. MONA ensures conformance monitoring and alerts the controller to deviations and also provides reminders of planned actions or tasks.

SYSCO assumes the implementation of ABI, ACT, REV, MAC and for civil/mil BFD and CFD as its baseline.

In the context of the FASTI tool implementation the following co-ordination messages are relevant [Reference OLDI standard 3.0]:

- RAP – Referred Active Proposal;
- ROF – Request On Frequency;
- CDN – Co-ordination Message
- HOP – Hand-Over Proposal;
- SDM – Supplementary Data Message (From transferring unit to accepting unit);
- RLS – Release Message;
- RRV – Referred Revision Proposal Message (Non-standard transfer conditions or referral to standard revision);
- INF – Information Message
- RTI – Request Tactical Instructions Message
- TIP – Tactical Instructions Proposal Message

Note: the OLDI standard is required for the implementation of inter-ATSU electronic co-ordination however within ATSU/ACCs implementations may deviate from the OLDI standard to satisfy local requirements.

\(^2\) The MTCD 'look-ahead' horizon will be up to 20 minutes but this may vary depending on system capability, sector configuration, traffic characteristics, etc
6. CONTROLLER ROLES AND WORKING METHODS

6.1 Controller Teams

Today’s distribution of operational human resources results in sector management by:

- Single person operations
- Planner and Tactical\(^3\) Controller (PC and TC);
- PC and TC and supporting personnel (ATC assistant and/or Co-ordinator)

FASTI provides new opportunities for the utilisation of operational staff as follows (Refer Figure 1):

- Single person operations with enhanced support
- For 2 adjacent sectors two Tactical and One Planner Controller
- New roles for the Tactical and Planner Controllers within the team

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\(^3\) The term Tactical Controller (TC) will be used in this document to identify the role sometimes described as the Executive Controller.

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Figure 1 FASTI and Controller Teams/Roles
6.2 Working Methods

The working methods that are prescribed for the use of FASTI tools take account of task-sharing and/or a task distribution. A technology enabled concept for FASTI promotes a 'paradigm shift' to a 'trajectory-oriented' operational paradigm. Trajectory orientation is a procedural concept that enables en-route controllers to plan and co-ordinate trajectories across sector boundaries while efficiently maintaining separation and conforming to flow-rate constraints [Ref 3].

In general, traditional ATC at sector level is both tactical and reactive with a sector focus. The way forward with FASTI inspires a more proactive approach with a strategic planning philosophy coupled with task distribution and planned/organised task management within the sector and beyond. In contrast with current practices trajectory oriented ATC emphasises on controller actions that work cooperatively across sectors and depend on each other for well planned, nominally conflict-free flow of traffic.

The controller skills and expertise remain as valuable and important as they have been in traditional ATC with requirements for learning, development and training of new skills and expertise.

6.3 Controller Roles

Traditional ATC methods consisted of responsibility allocation within the controller teams, in conjunction with local procedures and practices. Depending on the support that MTCD provides, a more formal definition of the team controller roles, is required and also promotion of the concept that the system is now a team component with a specific role.

Traditional allocation of responsibilities, in many locations, implicitly ensured the PC role was that of support to the TC with limited or no authority in the decision making process for air traffic control. However FASTI as an enabler provides opportunity to allocate specific tasks and/or functions to team members. The team in this context includes the system since the interdependencies between human and machine are important factors. The controller depends on the system for information while the system depends on the controller for updating of flight data, intent information where applicable, trajectory conformance assurance etc. The quality and accuracy of the system output can only be useful if the controller(s) support the system and vice versa.

Note: Various trials and pioneering implementations have shown that MTCD can be deployed in diverse operational environments taking into consideration the diversity in the operational procedures, local constraints and requirements, airspace characteristics as well as traffic density and complexity.

6.3.1 Sector Team operations

Consider the traditional controller team, Planning Controller (PC) and Tactical Controller (TC), with the addition of FASTI.
1. The system detects potential conflicts within a configurable parameter (e.g. 20 minutes), look-ahead time period, based on current trajectory information and the PC is notified.

2. The PC monitoring/scanning process results in detection of the data provided by the system.

3. The PC assimilates the information while assessing the potential conflict and then decides whether to monitor or to act on the information and its content. A 'what-if' tool providing the controller with the ability to create alternative trajectories could be used in the decision making process required for conflict resolution. This should result in the PC providing a resolution by:
   - (4) Ignoring the conflict (i.e. due to foreseen circumstances the conflict will time expire or not occur) or;
   - (5) Resolving it by modifying an entry or exit condition. The PC coordination takes account of LoA conditions or indeed makes proposals outside LoA conditions if circumstances provide this alternative (FASTI flexibility) or;
   - (6) Deciding that the conflict is purely tactical and manageable by the TC and therefore transfers it to the TC (Note: this inter-team co-ordination may be explicit or implicit)
The result of the transfer of the conflict to the TC indicates that the PC considered it likely that some tactical action should be taken by the TC to resolve/monitor a detected conflict. In the process of making this decision the PC will be aware of current and future workload of the TC.

The TC (refer Figure 3) is supported by the system and the PC. The empowerment of the PC results in the TC having more organised workload and earlier notification of conflicts due to the system support and that of the PC. In the processes of information assimilation, assessment and decision making the TC is similarly supported by the system tools and functions.

In figure 3 the sequence is as follows:

1. A detected conflict is displayed to TC. The conflict detection may be system or passed by the PC to the TC for his/her attention.
2. The TC detects the notification of the conflict.
3. The TC assesses the conflict – location, severity time of occurrence and the traffic involved. This process should result in a decision by the TC to address the conflict.
4. The resolution may be immediate or planned for later, depending on factors such as workload at the time and the optimum strategy for resolution, using available system support.

Depending on local implementations, notification of the conflict to the TC may be discretionary, or set dynamically as a parameter by the TC and whichever the case the HMI should support and enable the action.
6.3.2 Single Person Operation (Planning and Tactical Roles Combined)

The possibility of a combined roles operation will be facilitated by FASTI. In this configuration a single person operation is envisaged.

In this scenario the tools are configured as required and the controller is responsible for planning as well as tactical traffic management. On detection of a planning conflict the controller could decide to resolve it by co-ordinating with adjacent ATSU/sectors using SYSCO to modify an entry and/or exit condition or consider the conflict as tactical to be resolved later. The controller is aware of current and future workload and therefore can plan and use the system support as necessary.

Figure 4 Human/Machine – Single person Operations (TC and PC combined)

The controller’s configuration of the display and use of the system as well as a clearly prescribed working method should ensure effective and efficient management of traffic.

In figure 4 the sequence is as follows:
1. A detected conflict is displayed to the controller. The conflict may involve aircraft that are pending sector entry or in-sector.
2. The controller detects the notification of the conflict.
3. The controller assesses the conflict – location, severity time of occurrence and the traffic involved. This process should result in a decision by the controller to address the conflict. Co-ordination of modified entry (and/or exit) conditions (pending aircraft) should result in a resolution of the conflict.
4. The resolution may be immediate or planned for later, depending on factors such as workload at the time and the optimum strategy for resolution, using available system support.

6.3.3 Planning Role supporting n Sector TCs

It is feasible to consider an arrangement whereby a PC could provide support to a number of TCs who operate in different adjacent sectors. In this scenario the PC filters predicted conflicts with a focus on conflict-free trajectories to alleviate or smooth the tactical workload of the TCs. This is not to say that the PC would solve *All* conflicts for the TCs but more to ensure that potentially critical traffic situations and the associated workload are manageable for the TCs, at the *time of occurrence* (e.g. a multiple aircraft conflict reduced to a less complex conflict or even totally resolved).

In this role the planning focus is aimed at:
- Performing planning tasks related to conflict resolution;
- Performing tasks that will reduce the workload of the TC;
- Using the FASTI tools in an effective and efficient manner;
- Monitoring sector workload to ensure that potential workload peaks are smoothed or reduced to comfortable and manageable levels

Sector and ACC capacity management is a function of FMP or a similar role. In this role the PC is subjectively aware of sector limits in terms of density and complexity. This should ensure that actions taken by the PC are coherent with published procedures and also preferences of the sector TC.

MTCD provides information on detected conflicts to the PC for a number of sectors or for a particular area of interest (AoI). The PC can assess the nature, severity, location, time of occurrence and potential impact on a particular sector TC and the probable associated workload. Consideration of all the factors empowers the PC to decide on the best strategy to adopt in dealing with the conflict information. This may result in taking action to:
- resolve conflicts using SYSCO (inter-sector or inter-ACC) or;
- defer resolution by allocation to the subject sector TC or;
- doing nothing due to foreseen circumstances that may alleviate concern or need for action by the PC or the TC

These actions by the PC could be performed at a tactical level of intervention compliant with the scope and remit of the allocated tasks and responsibility encompassed in local or bilateral procedures (e.g. a tactical resolution proposal with SYSCO).

The role of the PC is in effect similar to that described earlier (Refer Figures 2 and 4) in the process of information assimilation and decision making. Another PC role could provide a layer of planning for a number of sectors operated by PC and TC teams.
6.4 Controller Working Methods

Methods of work for controllers vary due to a large number of factors in spite of the end goal being essentially the same for all. Local operational procedures and role definitions, task allocation etc necessarily require particular behaviour however; the skill, knowledge and expertise requirements are similar for the European controller population. Some factors contributing to particular local behaviour encompass segregated or prohibited airspace and their activation periods, sectorisation structure and sector geometry (e.g. vertical v horizontal), traffic profiles and complexity (e.g. predominance of en-route, vertical movement, complex crossing or converging traffic etc) and the ground system technology. Additional considerations relate to constraint management for Arrival/Departure flows, Oceanic entry/exit etc.

FASTI promotes the strategy of defined task distribution between controllers and between controllers and the system. Prescribed working methods facilitate this task distribution as well as the use of tools and interface functions\(^4\) in the performance of these tasks. The core philosophy is to perform ATM/ATC with a strategic approach in the use of FASTI resulting in nominally conflict-free trajectories.

The implementation of FASTI requires an approach, which in essence should be task/tool focused. The addition of new tools encompasses supporting enablers and these must be integrated into the controller task performance and decision making processes.

6.4.1 Task Management

The management of controller and system tasks in the FASTI environment will require a concise identification and clarification process to be employed. This process should incorporate, or be in conjunction with, a change management process thus ensuring a clear understanding of what is to be changed and/or modified. In addition there are important training issues to be defined and addressed and in the overall context these issues are addressed in the FASTI Operations Manual and FASTI Human Factors guidance documentation. This will provide guidance on how change is managed and implemented.

6.4.2 Tasks and Tools

A task/tool focus is required for FASTI implementation. The definition of new working methods is required for FASTI tools whereby the addition of FASTI is achieved in a collaborative manner ensuring task-sharing and task distribution are successful in providing benefit to all stakeholders and actors.

FASTI introduces a new set of tools and enablers, which require prescribed methods of use to be defined for efficient use in achieving the FASTI objectives.

Traditional working methods do not match requirements of FASTI and therefore must be changed while at the same time safety must not be degraded and as a minimum criterion for deployment, current safety levels shall be ensured.

\(^4\) The details of task/tool relationships and the use of the system are beyond the scope of this concept. This level of detail will be addressed in the FASTI Operations Manual – FASTI Concept of Use and Human Factors Guidance Documentation.
6.4.3 Tactical Support Tools

There are situations and environments where the FASTI tools must be tailored for tactical and planning applications. The nature of dynamic traffic evolution, particular airspace design and relevant trajectory characteristics, impact on how the FASTI tools can be implemented. This section addresses the tactical applications of the FASTI tools.

6.4.3.1 Tactical Environments

The environments under consideration are those where traffic evolution and complexity are such that the TC requires dedicated automated support to manage resources while working in a safe, effective and efficient manner. The characteristics of these environments encompass;

- A high percentage of vertical movement;
- A high degree of complexity

6.4.3.2 Tactical ATC with FASTI Tools

The Tactical controller’s resources are devoted to tasks related to:

- Monitoring the evolution of the air situation
- Detecting and managing potential aircraft/aircraft and aircraft/airspace problems
- Communication with pilots
- TC/TC co-ordination and transfer of flights

The FASTI tools support monitoring (MONA) of traffic (trajectories), detection of potential conflicts (MTCD) and facilitate electronic co-ordination with and transfer to, adjacent units. FASTI tools also provide decision support for safety assurance in conflict resolution.

6.4.3.3 Tactical Trajectories

The particular trajectories used for tactical support may be the system trajectory (or planning trajectory), tactical trajectory and/or a state vector trajectory. There is also potential to have tentative trajectories (for probing or what-if). The criteria for use of particular trajectories relates to the time horizon under consideration, the task being supported, the degree of acceptable prediction uncertainty and the applicable operational concept. The sector geometry, route structure and dimensions (transit times) should be taken into consideration to ensure the ‘best fit’ of the FASTI tools for the desired level of tactical support.
7. IMPLEMENTATION ISSUES

The evolution of ATC systems in recent decades has by and large been relatively easy since the "automation" has targeted enhanced HMI display issues. This is not to take a simple view of the technology involved but from the user viewpoint additional functionality has been useful but with minor impact at the front end of ATC. The progression to more complex and supportive automation proposes a challenge in the change management process. Technology has a new role due to the nature and type of support it provides and there are many factors to be considered in the context of implicit and explicit change requirements. Commercial concerns are a reality for all aviation stakeholders and in addition for ATC there are a number of areas of concern to be addressed such as Safety and Human Factors, Cost and Benefit to the controller, Training and Education for the controller and also the business context for ANSPs.

A starting point for FASTI should ensure an understanding of what FASTI will change and what changes should be implemented. There are a number of tools, disciplines and processes that can be employed to facilitate change management for FASTI. The areas that are critical to FASTI encompass:

- Safety considerations;
- Human Factors and training issues;
- System safety and reliability;
- Cost/benefit;
- Implementation convergence and harmonisation

Many Human Factors considerations as well as Safety management issues have to be addressed when the decision to implement FASTI is taken.

7.1 New Practices

The implementation of FASTI may enable the development of improved ATC agreed practices between ATSUs and sectors some examples of which are detailed below:

- Reduction in the use of Flight Level Allocation Systems – use of semi-circular allocation and progression to the tactical use of "all levels";
- Reduce constraints – changes to standing agreements, based on procedural separations, by lifting the need for ATC constraints related to airspace and sector organization;
- Reduce level capping – more tactical allocation of cruising levels due to enhance planning, conflict detection and co-ordination;
- Civil/mil coordination procedures;
- Practices to avoid a controller offering an aircraft to the next sector on a clearance that would cause a conflict in the next sector’s airspace in the vicinity of the sector boundary;
- Changes to co-ordination LOAs – further reductions in longitudinal separation planning minima between ATSUs. Changes to radar handover procedures in order to improve flexibility;
- Migration from the use of heading to track when radar vectoring and hence avoiding the current inconsistency between ground and airborne systems
8. EARLY IMPLEMENTATION CONCEPTS

The early implementation of automated support tools is planned by National Air Traffic Services (NATS), UK and DSNA of the Direction Générale de l'Aviation Civile (DGAC), France. A description of the concepts is provided in Annexe 1.

The NATS concept is based on the interim Future Area Control Support Tools (iFACTS) incorporating TP and MTCD, focused on the tactical view in the near future timeframe and augmentation of the PC/TC team work.

The DSNA concept is based on the En-Route Air Traffic Organiser (ERATO). A cognitive engineering approach is taken, which is aimed at specifying and designing decision aids for En Route Air Traffic Controllers. It will result in a Controller's Electronic Assistant.
REFERENCES

ANNEXE 1

This Annexe contains descriptions of concepts provided by:

1. National Air Traffic Services UK (NATS) – The iFACTS Concept.
A1. DESCRIPTION OF THE NATS iFACTS CONCEPT

The following description of the NATS iFACTS concept was provided by NATS.

Introduction

The iFACTS project is a major initiative being undertaken by NATS in order to introduce advanced tools into LACC. iFACTS is based upon the FACTS project which has been undertaken over the period since 1997 to develop a set of controller assistance tools for en-route application. The intention was that FACTS would enter service as part of the replacement of the initial LACC system.

However, the decision was made in 2001 to pursue the implementation of elements of FACTS as an enhancement to the initial LACC system. This has resulted in iFACTS, which includes the majority of the FACTS tactical functionality, constrained by the existing LACC architecture. FACTS and iFACTS have followed an iterative development process which has included a number of real-time trials.

The fundamental tools that underlie the iFACTS concept are trajectory prediction (TP) flight path monitoring (FPM) and medium term conflict detection (MTCD). These are supported by a number of display (or HMI) tools which the controller will use, either to obtain information or to enter instructions and clearances.

The introduction of medium term conflict detection (MTCD) will contribute to a reduction in controller workload. This function will improve the planning process and will also assist the tactical controller by supporting the routine 'situation monitoring' task. An important pre-requisite of MTCD is the provision of up-to-date trajectories providing details of future aircraft positions. Such trajectories will be produced by the trajectory prediction function.

The main operational goals of iFACTS are:

- Overall reduction in controller workload enabling LACC to meet the capacity demands from 2008 – 2012 (An average capacity increase of 13% across the London FIR)
- Reduction in Safety Significant Events (SSEs) – These are a key performance indicator for NATS
- Cost reduction through re-deployment of operational support staff

Overview of iFACTS Concept

iFACTS modifies the current LACC concept by the introduction of advanced tools to support the problem identification and decision making processes.

iFACTS provides a number of HMI tools that enable controllers to interact with the system, either to obtain information (most notably about interactions between flights) or to make inputs (of control instructions, for example). All iFACTS tools (and pre-existing LACC tools) are available at all workstations, regardless of role.

Broadly speaking, the iFACTS concept is based on the LACC concept, which results in a number of constraints:

- compatibility with the current LACC concept and controller roles and tasks;
• use of the LACC sectorisation;
• use of the current ATC operating procedures for co-ordination, handover, and standing agreements.

The advanced tools enhance the planning process by improving the planner controller’s tactical awareness. This relies on the provision of reliable and accurate interaction information that can be interpreted by the Planner in a meaningful and efficient manner.

The tools modify the tactical process by providing a means of determining and resolving interactions, supporting the monitoring task and enhancing the decision making task.

A key premise of the iFACTS concept is that paper flight strips will not be provided to controllers. The intention is that the system & supporting HMI tools replace the functions of the flight strip. This is an essential step in achieving an effective and efficient tool set, where it is important that the tools are kept up-to-date with the traffic situation and controller interventions. This premise has a significant impact on the nature of the iFACTS HMI tools, and the way in which they are used.

**Tactical Controller**

**Building the ‘Picture’**

Much of what the tactical controller does is done on the basis of the mental model that he holds of the traffic situation.

Currently at LACC, the paper strips provide a complete record of all flights within, or expected by, the sector, including all clearances. Although paper strips support visualisation of the current traffic situation, in a radar-based environment their role has more to do with future intentions than monitoring what is currently happening.

The iFACTS concept relies on the tactical controller’s own judgement in devising solutions to detected problems. The determination of future behaviour, based on observation of past and current behaviour, is still a key part of this. The tools **do not** give conflict resolution advice.

With iFACTS the major sources which assist in the acquisition of the tactical’s mental picture are:

• the radar
• the Separation Monitor;
• the Clearance Window;
• the Level Assessment Display.

The Separation Monitor provides information about ‘problems’ (ie pair-wise interactions) that have yet to be solved, and ones that have been solved. It shows the relationships between flights as they follow their current clearances.

The clearance window enables the controller to input clearances into the system and allows the controller to carry out tasks that were previously done with the paper flight strips.
Whenever a flight is hooked, the Level Assessment Display is populated with the tactical trajectory (showing the current clearance) and interactions in which the subject flight is involved either along its clearance, or at other levels that could be assigned.

Selecting an item in one of the Clearance Window menus causes a Tactical What-If to be performed for that potential change of clearance. The traffic probe is also updated.

**Building the ‘Plan’**

With iFACTS the system must provide a level of support similar to that provided by the PFS display and there are a number of ways in which it does this.

The conflict tools, particularly the Separation Monitor, give information about interactions that need to be resolved. Much of the cocking and marking of PFS done today is to highlight pairs of flights that will require some action to ensure separation. Often the planner will do this when flights are co-ordinated in with a possible conflict that the Tactical controller needs to monitor. As the Separation Monitor shows every interaction that affects the sector, it fulfils much of this role.

Interaction Point-out can also be used (by the planner or tactical) as a reminder that a pair of flights need some attention to ensure separation.

The reminders that are displayed in the Reminder List and are intended to support the tactical planning process. The tactical and planner can insert a reminder for a flight for a number of reasons.

Co-ordination conditions (such as ‘north-side’, ‘released for descent’) also act as reminders of things to be done, or constraints already placed on flights. These are indicated by a border around an NFL or XFL field and can be accessed by a pop-up window.

In current LACC operations, much of the tactical controller’s time is taken up with monitoring the traffic, to make sure that everything is safely separated, and will remain so for the next few minutes at least. This is not always a simple task, and its difficulty is roughly proportional to the number of flights being handled.

The Separation Monitor is the primary iFACTS tool for monitoring separation between flights. The Separation Monitor provides a real-time indication of the separations that will be achieved in the near term (up to fifteen minutes hence). This should provide the tactical controller with sufficient warning that resolution action is required. The Separation Monitor also shows the classification of interactions.

If an interaction with less than required separation comes within 5 minutes of current time, an Interaction Alert is triggered, which invokes an interaction highlight to show the interaction in plan view on the situation displays of the tactical and the planner. This emphasises the urgency of the situation, as there is less than 5 minutes to ensure separation.

The Separation Monitor provides a multi-flight view of the situation insofar as all relevant aircraft are taken into account. If no interactions are shown on the Separation Monitor then any interactions in the sector will be safe.

The iFACTS tools assume that a flight will follow the instructions given to it by the tactical controller, and that the tactical controller will enter all issued clearances into the system. If either of these requirements is not satisfied, then the usefulness of the tools is seriously degraded. However, the system provides a warning if a flight is found to be deviating from the trajectory that the system expects it to follow. Such warnings are
displayed prominently in the TDB and are an indication to the tactical controller that either an input has been omitted, or the flight has deviated from its clearance. iFACTS will create a ‘deviation trajectory’ in such situations, which will provide some measure of protection to the flight, and others that might interact with it. The tactical controller’s first action upon seeing a deviation warning will be to resolve the deviation, either by making the correct input, or by instructing the aircraft to comply with its clearance.

The deviation alerts and deviation trajectory will also give some assistance in emergency situations (e.g. emergency descents), and deviations caused by things like weather avoidance.

**Issuing Clearances**

The Level Assessment Display shows alternative levels that might be given as a clearance to a flight, and these are probed for interactions in the normal way. The Level Assessment Display shows the interactions that will affect the subject flight’s climb or descent from its current level, and those that would occur if the flight were to level off at each achievable flight level. Thus, the Level Assessment Display can be used to determine what is a safe level to give to a flight. In essence, the Level Assessment Display answers the question “what level can I climb or descend this flight to now?”

The Tactical ‘What-if’ function, which can be invoked from any clearance input, allows the tactical controller to check proposed clearances to see what effect they have on the problems that were intended to be resolved, and on the traffic situation generally. The results of the clearance probe are shown in the Level Assessment Display, Interaction Vector and Separation Monitor, and by the traffic probe.

**Achieving Exit Conditions**

The iFACTS HMI and Track Data Blocks provide information about the intentions of each flight and the exit conditions that have been set by the sector’s planner controller. The show route function shows the intended route of the aircraft (as opposed to the currently cleared trajectory displayed by the Interaction Vector, which may be different), and the Level Assessment Display, Task List / Tactical Bay and TDB display the co-ordinated exit flight level which must be achieved by the sector boundary.

**Tactical Data Entry**

Key to the successful use of the iFACTS tools will be the ability to enter control instructions and clearances quickly and accurately into the system, so that the predictive functions accurately reflect what the aircraft have been instructed to do. This must be achieved with the minimum of overhead, so that the associated workload is seen as a benefit rather than a hindrance.

iFACTS relies on knowledge of which aircraft are under the control of which tactical controller. For this reason a transfer of communications concept is incorporated, which allows for the ‘in-comm’ status of a flight to be input by a tactical controller. The callsign menu, called up from the TDB and elsewhere, allows ‘in-comm’ and ‘out-comm’ selections to be made, and the Task List / Tactical Bay include a button field for in-comm and out-comm inputs to be made directly.

For iFACTS purposes eligibility to make tactical inputs is transferred upon out-comm by the offering sector.

iFACTS utilises the ‘hooking’ concept to make a single aircraft the subject of the tools, and for access to its flight data through other windows. One of the main reasons for
hooking is to make the selection of a flight an explicit action, to avoid the accidental selection of the wrong flight, and to ensure a consistent display in all of the tools.

Specific function keys are provided on the LACC keyboard to accomplish common tasks, such as in-comm and out-comm, for the hooked flight. iFACTS also introduces a ‘reminder’ key on the keyboard, which allows the various types of reminder to be inserted in the Reminder List and Task List with a simple key press.

**Planner Controller**

The planner will continue to use the current LACC functionality, MOPS and procedures for co-ordination. The planner *may* be able to utilise the enhanced information available in the iFACTS tactical tool set to improve the assessment of offers.

Agreements, co-ordination conditions and other relevant information between different sectors and/or same sector tactical and planner will be recorded in the iFACTS system. This will be through the co-ordination conditions window in the Level Assessment Display and through use of the sector reminder tool. There will be NO climbing co-ordination functionality introduced into the NERC co-ordination function. However, iFACTS will take account of aircraft climbing or descending across sector boundaries for the purposes of conflict detection.

The planner may be able to make use of the Level Assessment Display to provide support information in the decision making process where an offer may be unacceptable. This will be limited and will involve the planner probing levels, routes, headings and speeds. This will provide an improvement over the current LACC system where a vertical offer is being considered.
A2. DESCRIPTION OF THE DSNA ERATO CONCEPT

The following description of the ERATO concept was provided by DSNA.

Introduction

ERATO is being targeted for both lower and upper sectors in all four of the French regional air navigation centres (CRNA) with the exception of the Paris Center. This represents a spread from medium to high, core-area, levels of traffic density and complexity.

Overview of ERATO Concept

The ERATO concept is controller centred the fundamentals of which being:

- management of the control position by the tactical and planning controllers (respectively “contrôleur radar” & “contrôleur organique), remaining compatible with any additional TC or PC ATC instructor.
- maintaining or enhancing current safety levels.
- keeping the controllers responsible for the traffic management
- increasing controller action capacities by giving them the possibility to smoothen their workload.
- facilitate the cooperation between TC & PC
- increasing cognitive capacities (anticipation & decision process) by decreasing their amount of analysis activity.
- providing a paper strip-less environment.
- facilitate the identification and analysis of potential conflicts, the formulation and implementation of resolution strategies as necessary.

The tools provided by ERATO which are led by those concepts allow both the PC and TC controllers to enhance their activity in the following domains:

- building their mental representation of the situation
- detecting the problems they have to cope with, early on.
- managing efficiently their mental interruption processes (voice and phone calls …)
- preparing coordination with next sector and aircraft exit
- cooperation.

The following tools are used within the ERATO system:

Filter

The purpose of filtering is to assist controller for detecting potential conflicts, by discarding flights that cannot interact and therefore to remove unnecessary information presented when analyzing a flight or potential conflict, thereby reducing the time necessary for the analysis and the possibility of the analysis being interrupted. Three levels of filtering are provided:

- The Basic Filter (Filtrage de Base) shadows the flights that cannot interfere with a selected flight or in a selected potential conflict using assumptions of top of climb and top of descent based on nominal behaviour;
- The Extended Filter (Filtrage Étendu) shadows the flights that cannot interfere with a selected flight without any assumptions on when climb or descent instructions will be issued;
• The What-if Filter (Filtrage Simulé) shadows the flights that cannot interfere with a selected flight if the controller were immediately to clear the flight to a selected level or direct to a selected waypoint.

The filtering algorithms associate with each aircraft a vertical, horizontal and temporal manoeuvring volume around the FDPS route. This volume encompasses the area in which the usual vectoring radar resolutions may take place. These volumes are updated according to the radar positions and the input of controllers' instructions (direct, CFL, TFL). Heading clearance are expected to be of limited duration, normally keeping the aircraft within 8 NM of its original route. Therefore, the system does not expect these clearances to be input, but builds an appropriate buffer either side of the nominal route to cater for possible heading clearances.

When filtering is requested for an aircraft, its volume is compared to the volumes of all the other aircraft. If the volumes of any two aircraft are too close together, each aircraft belongs to the other's filter. In an aircraft's filter, the greyed out aircraft do not interfere with it, and can never disturb any conflict resolution involving this aircraft.

The margins used mean that some of the aircraft kept inside the filter might be considered to be irrelevant by the controller. The aim is not to show them only the aircraft that are considered to be useful, but in fact to eliminate enough unimportant aircraft so that they can evaluate the situation personally in the most efficient way.

Agenda

The agenda constitutes a planning and cooperation tool that assists the controllers in the analysis and monitoring of potential conflicts, providing a time-ordered list of tasks relating to the analysis and resolution of potential conflicts. In order to reduce the necessary effort on the controller in the manipulation of the interface, the system automatically calculates potential conflicts based on the nominal flight plan trajectories, and adds those interactions to the agenda. The controller is also able to add or remove potential conflicts, add and remove flights to/from the existing potential conflicts, merge potential problems and schedule the resolution or re-analysis of the conflict.

Extrapolation

The system assists the controllers (TC and PC) in appreciating the precise nature of the potential conflict.

From either the interaction label in the agenda or from the electronic strip of one of the flights involved, the PC or TC can invoke the filters and extrapolation of the trajectories on the radar display. When invoked from the problem filter (Filtrage Problème), via the agenda, the system extrapolates all significant flights of the interaction; when invoked via the basic filter (Filtrage de Base), via an electronic strip, the system extrapolates the subject flight and all interfering flights.

Extrapolation animates the evolution of the flights selected by the filter according to their trajectories, depicting the uncertainty in the calculation of the future positions.

Monitoring the situation

The margins for manoeuvre used by the filtering algorithms are such that in general the aircraft remain inside the volume that is assigned to them. However, it can happen that an aircraft climbs really slowly, or that radar guidance leads it, voluntarily or otherwise, far from its theoretical trajectory, or that it was forgotten to enter a direct route, or a CFL, etc.

Using the radar information, a monitoring system permanently checks that each aircraft actually is inside the volume used by the algorithms. If an aircraft leaves this volume,
then the machine warns the controllers to let them know that the previous filter has been modified.

Incidentally, this monitoring system makes the system tolerant to input errors.

**Working with ERATO**

ERATO tools are a set of cooperative tools that are used the same manner by both controllers to achieve their specific tasks and common tasks in a cooperative way.

**Flight integration (building mental representation)**

At the moment, with paper strips, PC & TC team picks up a strip from printer, takes notes on it, memorises it, compare it with the others to detect any potential conflict, and place it on the strip board.

With ERATO, by clicking on a pending aircraft, controllers obtain its filter, which highlights some other aircrafts, and leaves all the others greyed out.

In order to analyse this flight, just those highlighted flights have to be considered. From the point of view of the controller who is analysing this situation, some of these aircraft are perhaps in potential conflict, or may perturb the resolution of a conflict involving the flight, or might be irrelevant.

The filtering algorithm cannot analyse the traffic in the controller's place. On the other hand, it guarantees that none of the greyed out flights can interfere in any way at all with this flight. Hence, the machine does not analyse the traffic in the controller's place, but greatly facilitates it by roughly preparing the work.

Furthermore, on an additional 19” screen, the machine displays the electronic strips that correspond to the flights in the filter.

These strips have a format that is very close to the present paper strip. The analysis work is therefore similar to the present one.

The electronic environment also allows the relative positions of the filtered aircraft to be extrapolated into the future. This provides an additional (and efficient) visual aid in analysing the situation.

**How to use the filtering tool (detecting and analysing potential problems)?**

From the TC point of view, the filtering tool is an aid for detection and problems resolution, which acts like a zoom on a particular situation, giving to him all the relevant information he needs to cope with.

From the PC point of view, the filtering tool associated to the agenda facilitates the detection and resolution of conflicts due to entry or exit conditions (the system permits the sector planner to resolve a conflict through amendment of the sector entry or exit conditions).

**What are the relations between the filtering system and the agenda?**

Although the filtering system allows a very quick analysis of the flight, it cannot keep the situations to be monitored in memory, nor have a synthetic view of the situation in order to manage the workload, like the current strip board does. On top of that, presently, keeping the board up to date allows controllers to organise their strips in pertinent packets in order to manage the traffic.
It is in order to answer this need for a global representation of the traffic, shared by both controllers, that the agenda was created. So, added to the normal detection made by the controllers in the flight integration and filtering processes, the system is able to notify them of interactions between flight trajectories in the sector that might require action, in time to plan and implement a resolution if necessary.

Agenda as a traffic manager

The calculation of interactions between aircraft for the agenda is made following the same principle as for filtering, but without taking into account the lateral uncertainty: "If I leave the aircraft on their trajectory, which are the ones I'm going to have to monitor because they might pass too close to each other? The 'margin' I'm going to use depends on the angle of their trajectories."

The system detects interactions in the sector plus a margin prior to entry and post exit. Each interaction is labelled, giving a name that encodes the location of the interaction (common fix on each flight’s route), and the type (climb/descend, crossing, catching, converging, opposite). The different interactions concerning a given aircraft, and which are sufficiently close, are grouped together in the same label of the agenda.

The controller knows from experience where s/he is going to deal with a given problem. The system allows him/her to indicate it, and then it monitors the aircraft passing overhead or abeam this position.

A geographical marker is initially placed roughly by the system in a position where the controller still has plenty of time to begin a normal resolution for the problem. According to his/her needs, the controller can adjust this on the radar image. The agenda then positions each label on a temporal axis, the position of a label represents the time remaining before this place is overflown.

The controllers are able to add or remove flights to an interaction and to retain or suppress the interaction. Once consulted and retained, any modification or termination of the interaction resulting from the amendment of flight data is first proposed to the controller prior to being applied.

An interaction can be proposed for suppression by the system if the flights are on routes that are deemed separated.

Agenda as a cooperation tool

The system facilitates the coordination of conflicts and resolution action between the planner and tactical controllers.

The planning controller has to adapt the preliminary proposal provided by the Agenda to his/her own needs by using a few of the edition functions: creation/deletion of a label, addition/deletion of an aircraft in a label, or repositioning an associated marker.

The tactical and planning controllers at a sector have identical information on their agendas, though the agenda of the planning controller has a longer and adjustable time horizon. At a selectable time before action is required, the potential conflict is transferred automatically to the tactical controller, though it remains also with the planner. The planner can also transfer potential conflicts in advance.

The planner is able to gauge the tactical controller’s workload according to the number of electronic strips and agenda items active, as well as his usage of the frequency and number of strips that are yet to be consulted. The planner can decide when to transfer a potential conflict to the tactical controller, delaying the transfer if necessary in times of high tactical workload, and adjusting the markers properly, the agenda helps him to manage the team time as well as possible and anticipate more effectively the traffic peaks to come.
Situational awareness, planning and conflict resolution

The system assists the controller in the tactical monitoring of the air situation and the maintenance of his mental representation of the situation. The system shall remind the tactical controller of actions that are required to fulfil the sector plan. A geographic marker is roughly created for each potential problem, at the last place where it is safe to engage the resolution of the conflict. Using the filter and extrapolation, the controller is able to adjust the marker to a point in time when he expects really to take action or to reassess the situation. When this time is reached a reminder is generated.

The controller can also use geographical markers to create reminders for events not concerned with problems between two aircraft.

The system assists the tactical controller in deciding the optimum moments to provide climb or descent clearances for flights that have to climb or descend to their exit level. The extended filter (Filtrage Étendu) shows all flights that interact with a subject flight, making no assumptions on when climb or descent instructions will be issued.

The tactical controller can use the a what-if probe (Filtrage Simulé) to show interacting flights were the aircraft to be cleared immediately to the selected level.

The system also assists the tactical controller in responding to a pilot request for an alternative level by indicating the availability of alternative levels for a selected aircraft.

Conclusion

The ERATO tools are not intrusive and only provide proposals to the controller team. The complementarity between the radar image (final support of the resolution), the list of electronic strips (support for memorisation and input), filtering (aid in conflict detection) and the agenda (aid in planning and cooperation) provide an effective MTCD, fully integrated in the controller working method.

ERATO and the Sector Team Operations (Refer FASTI Operational Concept Section 6.3.1)

As described in Section 6.3.1 of the FASTI Operational Concept, ERATO matches and augments the cognitive processing activities of the controller in the tasks of information assimilation, assessment and decision-making and ensures situation awareness. This results in:

- The support provided by ERATO, in the detection of interactions between aircraft, is manipulated by the controller to satisfy the controller’s particular needs;
- The controllers earlier detection and management of situations that require tactical intervention or monitoring and/or co-ordination;
- The controllers deciding what actions are necessary and when they can be executed;
- The controllers efficient and effective management of temporal and cognitive demand on their resources, is adapted by optimum use and benefit of the system support, as the air situation evolves and changes.

Planning and tactical co-ordination activities are also managed effectively by the controllers augmented by support from ERATO.
APPENDIX A: LIST OF CONTRIBUTORS

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<thead>
<tr>
<th>Organisation</th>
<th>OFG Member</th>
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<tbody>
<tr>
<td>DFS</td>
<td>Andreas Krebber.</td>
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<td>DFS</td>
<td>Karl Amend.</td>
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<td>DSNA</td>
<td>Gilles Saulais.</td>
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<td>DSNA</td>
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