



# **EHQ TRS T06/11057**

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## **FASTI RTS WP1 D1 Simulation Objectives**

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ABSTRACT	This document is the D1 Simulation Objectives document of the FASTI-RTS related to the TRS T06/11057. It provides the high level and low level validation objectives for the real time simulations related to this contract.

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# 1. Introduction

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## 1.1 Purpose of this document

This document is the contractual deliverable D1 Simulation Objectives, end result of Work Package 1 of the FASTI TRS project.

The WP1 defines FASTI RTS Simulation Objectives in compliance with consolidated Validation methodology and tools. The whole set of Simulation Objectives have been defined in strict collaboration with the EUROCONTROL FASTI team.

In more detail, the deliverable identifies a set of Validation Objectives and defines how FASTI concepts/tools can be evaluated through a co-ordinated and integrated set of validation exercises (Real Time Simulations). The approach, largely based on the European Operational Concept Validation Methodology (E-OCVM), considers as baseline both validation objectives already identified in past and on-going work on similar ATM concepts and procedures (e.g. PROVE, EVP and national projects) and those identified by the EUROCONTROL FASTI Team.

## 1.2 Document structure

- Chapter 1** Introduction, contains the synopsis of the overall document.
- Chapter 2** Background, outlines the methodology used and the context of the experiments by giving an overview of the FASTI Operational Concept / Tools to be validated and of the simulation platforms / tools that will be available to carry out the validation experiments.
- Chapter 3** Validation Goals and Objectives Assumptions, aims at listing Goals and Objectives identified as appropriate for the Real Time Simulations planned in the project. Moreover the section provides some details about the Goals and Objectives themselves and explanations concerning the reason why they were selected as well as a snapshot of the overall Validation Framework. It also contains relevant metrics and indicators.

## 1.3 Acronyms and abbreviations

ACC	Area Control Centre
AMT	Adherence Monitoring Tool
APP	Approach Unit
APW	Area Proximity Warning
ATC	Air Traffic Control
ATCO	Air Traffic Control Officer
ATM	Air Traffic Management
ATSU	Air Traffic Service Unit
CDN	Coordination of Entry Flight Level
CFL	Cleared Flight Level
CM	Configuration Management
CNS	Communication Navigation Surveillance
CWP	Controller Working Position
DST	Dynamic Scanning Tool
E-OCVM	European Operational Concept Validation Methodology
EONS	Eurocontrol Open and Generic ATC Graphics Systems
ESCAPE	Eurocontrol Simulation Capability And Platform for Experimentation
FAB	Functional Airspace Block
FASTI	First ATC Supporting Tools Implementation
FSD	Functional Specification Document
GAT	General Air Traffic
HF	Human Factors
HMI	Human Machine Interface
HST	Horizontal Scanning Tool
IPAS	Integrated data Preparation and Analysis System
KOM	Kick-Off Meeting
MONA	Monitoring Aids
MSP	Multi Sector Planner
MTAPW	Medium Term Area Proximity Warning
MTCDD	Medium Term Conflict Detection
OAT	Operational Air traffic
PEQ	Post Exercise Questionnaire
ROF	Request of Frequency
RTI	Request Tactical Instruction Message
RTS	Real Time Simulation
PSQ	Post Simulation Questionnaire
SAT	Security Air Traffic
SDM	Supplementary Data Message
SICTA	Sistemi Innovativi per il Controllo del Traffico Aereo
SME	Subject Matter Expert
STCA	Short Term Conflict Alert
SYSCO	System Supported Coordination
TIP	Tactical Instruction Proposal Message
WP	Work Package
XFL	Exit Flight Level
ACC	Area Control Centre
AMAN	Arrival Manager
AMT	Adherence Monitoring Tool



APP	Approach Unit
ASAS	Airborne Separation Assurance System
ASMT	Automatic Safety Monitoring Tool
ATC	Air Traffic Control
ATCO	Air Traffic Control Officer
ATM	Air Traffic Management
ATSU	Air Traffic Service Unit
C-ATM	Collaborative Air Traffic Management
CORBA	Common Object Request Broker Architecture
CM	Configuration Management
CNS	Communication Navigation Surveillance
CV	Curriculum Vitae
CWP	Controller Working Position
DGTREN	Directorate General Transport and Energy
DMAN	Departure Manager
DST	Dynamic Scanning Tool
EATMP	European Air Traffic Management Programme
E-OCVM	European Operational Concept Validation Methodology
EONS	Eurocontrol Open and Generic ATC Graphics Systems
ESCAPE	Eurocontrol Simulation Capability And Platform for Experimentation
EVP	European Validation Platform
FAB	Functional Airspace Block
FASTI	First ATC Supporting Tools Implementation
FDP	Flight Data Processor
FSD	Functional Specification Document
FTS	Fast Time Simulation
HMI	Human Machine Interface
HST	Horizontal Scanning Tool
IPAS	Integrated data Preparation and Analysis System
IRS	Interface Requirements Specifications
KOM	Kick-Off Meeting
MFF	Mediterranean Free Flight
MONA	Monitoring Aids
MTCDD	Medium Term Conflict Detection
ORD	Operational Requirement Document
PROVE	European Pre-operational Validation and Experimental Trials Platform
R&D	Research and Development
RTS	Real Time Simulation
SDPS	Surveillance Data Processing System
SICTA	Sistemi Innovativi per il Controllo del Traffico Aereo
SSDD	System/Subsystem Design Document
SSS	System / Subsystem Specification
SYSCO	System Supported Coordination
TEN-T	Trans European Network – Transport
UML	Unified Modeling Language
WP	Work Package

## 1.4 References

- [1] EHQ Task Requirements Sheet No. T06/11057



- [2] FASTI-RTS Technical Proposal
- [3] ISO 9241. Ergonomic requirements for office work with visual display terminals. Parts 10-17
- [4] E-OCVM. European-Operational Concept Validation Methodology
- [5] FASTI - Operational Concept
- [6] FASTI - HF Issues Analysis Workshop Report
- [7] FASTI - OFG Minute (Meeting 1 / Day 2)
- [8] MTCD Trials 2002-2004 Summary of HF Issues

## 2. Background

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This section outlines the methodology used and the context of the experiments by giving an overview of the FASTI Operational Concept / Tools to be validated and of the simulation platforms / tools that are available to carry out the validation experiments.

### 2.1 FASTI Operational Concept

The EUROCONTROL 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.

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.

FASTI Operational Concept, including 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), is described in

[http://www.eurocontrol.int/fasti/gallery/content/public/Library/FASTI\\_OperationalConcept\\_1.pdf](http://www.eurocontrol.int/fasti/gallery/content/public/Library/FASTI_OperationalConcept_1.pdf)

Shortly, 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) revealed to be critical to the performance and use of FASTI tools.

In general, FASTI 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.



## 2.2 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.

## 2.3 Validation Methodology

To fulfil the design/validation objectives of FASTI-RTS, it is necessary to structure the process on a rigorous and scientific approach.

Globally, that supposes to respect precise and explicit steps of the design/validation cycle, which are impossible to pass over. Actually, the risk is high, while using a non-rationalised and incomplete methodology, to produce useless and misleading results. For example, performing real-time simulations with no prior effort put on drawing the unambiguous set of assumptions on which the particular instantiation of the concept is simulated, might mean failing to provide efficient scenario corrections that respect the global philosophy of the concept and integrates the new findings brought by it. Thus, this rigorous process aims at fixing a rigorous Validation framework. It avoids the usual reef, which consists in passing directly from the idea to the simulation, where the demonstrator/simulator regroups the main part of the resources making its development an ultimate target and not a support. When the work on the initial research questioning identification lacks, it is not really probable to obtain relevant and interpretable results. Those one often remains too descriptive and not really exploitable for the future developments. To sum up, detailed assumptions, validation grids and analysis grids are required.

### 2.3.1.1 An E-OCVM based methodology

Firstly, FASTI-RTS uses the European-Operational Concept Validation Methodology (E-OCVM) as a baseline for its validation approach. It has been developed under Eurocontrol and European Commission joint cooperation. It aims at improving the transfer of R&D concepts into safe, efficient and effective ATM systems. It gives guidelines in order to structure the design/validation process according to precise concept lifecycle view. Mainly, it provides elements to plan and structure the validation (the stepped evaluation view) and to integrate experimental information into cases (the case-based view developing safety cases, human factors cases, technical cases, business cases, ...). Several steps sum-up the E-OCVM process:

1. Make explicit the concept and its assumptions (understand the problem(s) and its solution(s))
2. Design an explicit validation strategy
3. Determine the experimental needs
4. Conduct the experimentations
5. Analyse the results
6. Prepare information and its dissemination

Furthermore, E-OCVM develops a maturity model of concept that allows determining the level of validation requirements. The position of FASTI-RTS on this scale is the following:

## ATM Concepts - Levels of Maturity

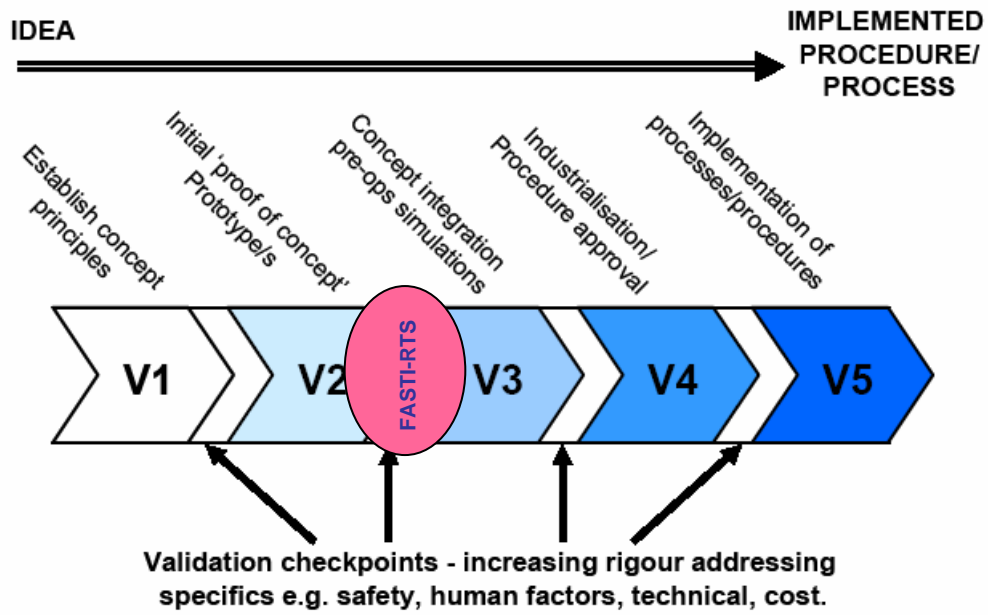


Figure 1 e-OCVM - The action plan 5 concept maturity level

## 2.4 Simulation Platforms

In the following sections the available platforms are presented. These sections are not focused on presenting the adaptations/modifications needed for the Operational Concept validation. These aspects will be discussed in the WP3, Technical Specification and described in the relevant deliverables D3a and D3b.

### 2.4.1 ENAV Simulation Platform

ENAV Simulation environment is based on the ESCAPE (Eurocontrol Simulation Capability And Platform for Experimentation) platform with a HMI representing the actual in operation, thus allowing a representation of experimental scenarios with a high level of fidelity.



ESCAPE platform is composed of two sets of features:

- Data preparation features (off-line simulation facilities) enabling the design of the platform and simulation/scenario/exercise;
- Simulation engines (on-line simulation facilities), the mechanism used to move simulation objects in the scenario according to predefined rules/models.

#### 2.4.1.1 *The off-line data preparation facilities*

##### **IPAS**

The Integrated data Preparation and Analysis System (IPAS) aims to be an integrated system, homogeneous and standard, enabling the data preparation and data analysis of all types of simulations and simulation platforms (simulators).

IPAS is a toolbox supporting the following work process:

- **Data management** that is to create the simulation/exercise/domain environment, to create/delete/copy data set.

- **Data preparation** that is getting data from external sources or inputting data manually into the system, and checking its consistency according to the target simulation and simulator. This includes tabular features to input data, but also graphical feature to display whole or part of the data. It is foreseen to have graphical data input features in the near future.
- **Exercise validation** that is to be able to tune, to validate, to check the exercise according to what we want to simulate, to validate, to evaluate during the simulation. This part of the simulation process is not developed at all in the current version of IPAS. It is important to notice that this step is a fundamental element of exercise preparation. This includes mainly graphical features to analysis, replay exercise data; and also “what if” features to tune and modify automatically data.
- **Exercise pre simulation analysis** including mainly graphical features to analysis, replay exercise data before exercise run; The main component is ART.
- **Exercise post simulation analysis** including mainly graphical features to analysis, replay exercise data after exercise run. The main component is ART.

### **EONS preparation tool**

The Eurocontrol Open and Generic ATC Graphics Systems (EONS) aims to provide a network-connected graphical workstation designed as a configurable ATC Graphical Object Server. One instance of the EONS workstation will be a particular ATC working position: real time CWP, pilot position, supervision console. This generic workstation is a tool to support various evaluations, research and study projects.

The purpose of EONS is to provide a simplified approach to graphical user interface programming for ATC applications.

Changes to the interface should be easy, often involving only the use of an interactive graphical editor or other visual programming tool. EONS won't be developed from scratch, but it is built on an ATC oriented COTS product: ODS Toolbox from BARCO-Orthogon. The use of a Graphical User Interface Builder (GUIB) will also ensure that the requirements for system efficiency, reliability and reusability will be reached, it will also reduce the required amount of work.

### **BADA**

BADA, aircraft database is used to provide the necessary data on aircraft performance and operations models, which are suitable for trajectory calculation and prediction within ATC simulations and on-line applications. The aircraft models are based on a Total-Energy Model (TEM) of aircraft performance and are referred to as the Base of Aircraft Data (BADA). These models specify aircraft performance in terms of thrust, drag and fuel consumption as a function of altitude, weight, speed and temperature.

#### **2.4.1.2 The on-line simulation facilities**

##### **Ground**

The Ground aims to centralise a major part of the flight plan data processing, to provide surveillance processing and advanced ATM features. Ground is based on a Client Server architecture, which shall ease function distribution on the platform and provide flexibility to integrate new components with minimal impact on the existing architecture. OASIS middleware is used in order to hide communication and distribution issues from the components; and also shield the application from specific vendor implementations improving the portability and interoperability issues.

Today, Ground offers:

**For flight plan data processing:**

- **Airspace server (ASP)** aiming to centralise, to keep up to date and to distribute any airspace information to any Ground components. Baseline data is provided by the IPAS system, and updates (area activation, default runway in use ...) are provided by Ground components allowed to do so;
- **Aircraft performances server (ACR)** aiming to centralise and distribute any information dealing with aircraft performances. Today the total energy model (so-called BADA) is used. No online modification is allowed.
- **Flight plan generator (FPG)** aiming to get either prepared flight plan (provided by IPAS), and to manage initial flight plan to be distributed within the ground system
- **Flight plan management (FM)** aiming to generate and manage system flight plans (using initial flight plan information provided by the FPG and trajectory updates provided by the TP). FM also collects the ATC constraints associated with the expanded route and creates the crossing boundary list. It provides the key point list composed of the 4D-profile information to the CWP.
- **Trajectory predictor (TP)** aiming to simulate the progress of the aircraft along the 4D profile according to the initial flight plan, ATC constraints, the aircraft performances and the predicted weather conditions. The 4D profile is updated to integrate controller order and time deviation.
- **Track deviation monitoring (TDM)** aiming to check the conformance monitoring of active flight correlated with a radar track. This consists in the comparison of the predicted 4D profile with the sensors observed actual trajectory. The track deviation is integrated by 4D-profile re-computation.

#### For **surveillance processing**:

- **Independent air surveillance (IAS)** aiming to manage (creation, update and deletion) and distribute radar tracks to any Ground component. This component is connected to the Mass sub-system by means of the DIS Gateway in order to get simulated radar track.
- **DIS gateway** aiming to support the routing of DIS messages to communicate with the Mass system, or any DIS compliant component.

#### For **advanced ATM features**:

- **Safety net** intending to alert the controllers of potentially hazardous air situation in an effective manner and with sufficient warning time for appropriate avoiding action to be taken by the pilot. All safety net features are based on up to date air surveillance information. Algorithm is data driven: i.e. any parameters can be set off line, including inhibition area where safety net will not be whole or part activated. This includes:
- **Short term conflict alert (STCA)** aiming to warn the controller of any situation where couple of radar tracks for which minimum separation distances are violated, or are predicted to be violated in a short look ahead time (usually 2 minutes);
- **Minimum safe altitude warning (MSAW)** aiming to warn the controller of any situation where a radar track is, or is predicted to be in a short look ahead time (usually 2 minutes), in collision with predefined relief (obstacles, ground hazards, runways) and ground description based on French IGN data.
- **Area proximity warning (APW)** aiming to warn the controller of any situation where a radar track is, or is predicted to be in a short look ahead time (usually 2 minutes), flying into a reserved airspace area;
- **Medium term conflict detection features** aiming to warn the controller of prediction of hazardous air situation based on predicted 4D profiles of aircraft. Algorithm is data driven: i.e. any parameters can be set off line, including inhibition area where medium term conflict detection will not be whole or part activated. This includes:

- **Medium term conflict alert (MTCA)** aiming to warn the controller of any situation where couple of aircraft for which in the prediction horizon, minimum separation distances will be violated;
- **Medium term minimum safe altitude warning (MTMSAW)** aiming to warn the controller of any situation where in the prediction horizon, an aircraft will be in collision with predefined relief (obstacles, ground hazards, runways) and ground description based on French IGN data;
- **Medium term area proximity warning (MTAPW)** aiming to warn the controller of any situation where in the prediction horizon, eligible flights trajectories will be flying into a reserved airspace area;
- **Monitoring aids (MONA)** aiming to help the controllers in monitoring all the flight under control in order to detect deviations from the system trajectories. It has been specified to provide the controllers with non-conformance warning and reminders and also to automatically trigger the trajectory recalculation (following longitudinal and speed deviation detection).

### MASS

MASS, for Multi-Aircraft Simplified Simulator, provides an air traffic simulation within the context of large-scale real-time ATC simulators. In particular, it will generate simulated aircraft data (called Aircraft State Vectors) suitable for use in the simulation of surveillance system functions. The air traffic can be generated either automatically or with the help of Pseudo-Pilots controlling simulated aircraft behaviour.

MASS provides an air traffic simulation with a maximum of 1000 Flights within a Simulation Exercise and a maximum of 500 Flights active simultaneously. MASS uses a Total-Energy Model (TEM) and the Base of Aircraft Data (BADA) as a basis for aircraft trajectory calculations.

MASS can simulate the functions of ASAS systems on suitably equipped flights and follow controller traffic delegation orders.

### EONS runtime

Today, EONS runtime offers:

- EONS run time kernel aiming to interpret the interface description and to manage client requests in order to create, modify and destroy graphical presentations of ATC objects; on a given working position. This HMI is designed at the preparation phase using the EONS prep features. EONS runtime is not dedicated to the ESCAPE platform only.
- The Controller Working Position (CWP) which aims to connect the EONS graphical interface for a given controller working position to the rest of the ESCAPE applications;
- CWP communication (CCO) aiming to support the routing of events between the various CWP and the Ground applications.
- The Pseudo piloting Working Position (PWP) aims to connect the EONS graphical interface for a given piloting working position to the MASS applications.

### ERGO

The ERGO component aims to get and analyse in real time the subjective controller workload. It offers feature to get periodical controller input (stress level capture) and features to display results and statistics.

Today ERGO offers:

- ERGO collector which is deployed over each CWP in order to realise the periodical interrogation of the controller;
- ERGO manager who collects all the data provided by all the CWP.
- ERGO HMI which display results and statistics on dedicated display.



### **Supervision (OASIS Tools)**

This component offers technical supervision capabilities over the simulator, by accessing the Oasis infrastructure. This offers graphical HMI driven ways of controlling and monitoring the ESCAPE platform.

This component provides integrated tools to

- Manage sessions (simulations)
- Launch and monitor runs (exercises)

This component is based on a tool set (the Oasis Tools) designed to offer high evolution capability by allowing any users to extend the HMIs to be plugged to a common framework. The development of plugging does not require in-depth knowledge of the Oasis middleware, but only Java/CORBA expertise.

**ENAV platform** is composed of :

- 13 Controller Working Positions, 12 of which equipped with 2k2k displays
- 5 servers hosting the ground and the air part of the simulator and for data management
- 10 pseudo pilot positions
- Audio LAN system (voice over IP technology)
- An exercise supervisor
- A pilot supervisor
- An X-terminal for the ERGO HMI
- An Audio LAN supervisor

## 2.4.2 Skyguide Simulation Platform

The skyguide simulation platform reflects the present system in operation in Skyguide Geneva ACC.

This equipment is also used to validate the operational procedures and to train the ATCOs.

The simulation platform is composed of 12 Controller Working Position which can be easily configured. It is possible to run at the same time up to ten scenarios.

The functionalities that are of particular importance to this simulation project are :

1. The Controller Support Tools (HST, DST, AMT...)
2. The strip less functionalities
3. The inter sector and inter centre coordination

### 2.4.2.1 Architecture diagram of the Skyguide Simulation Platform

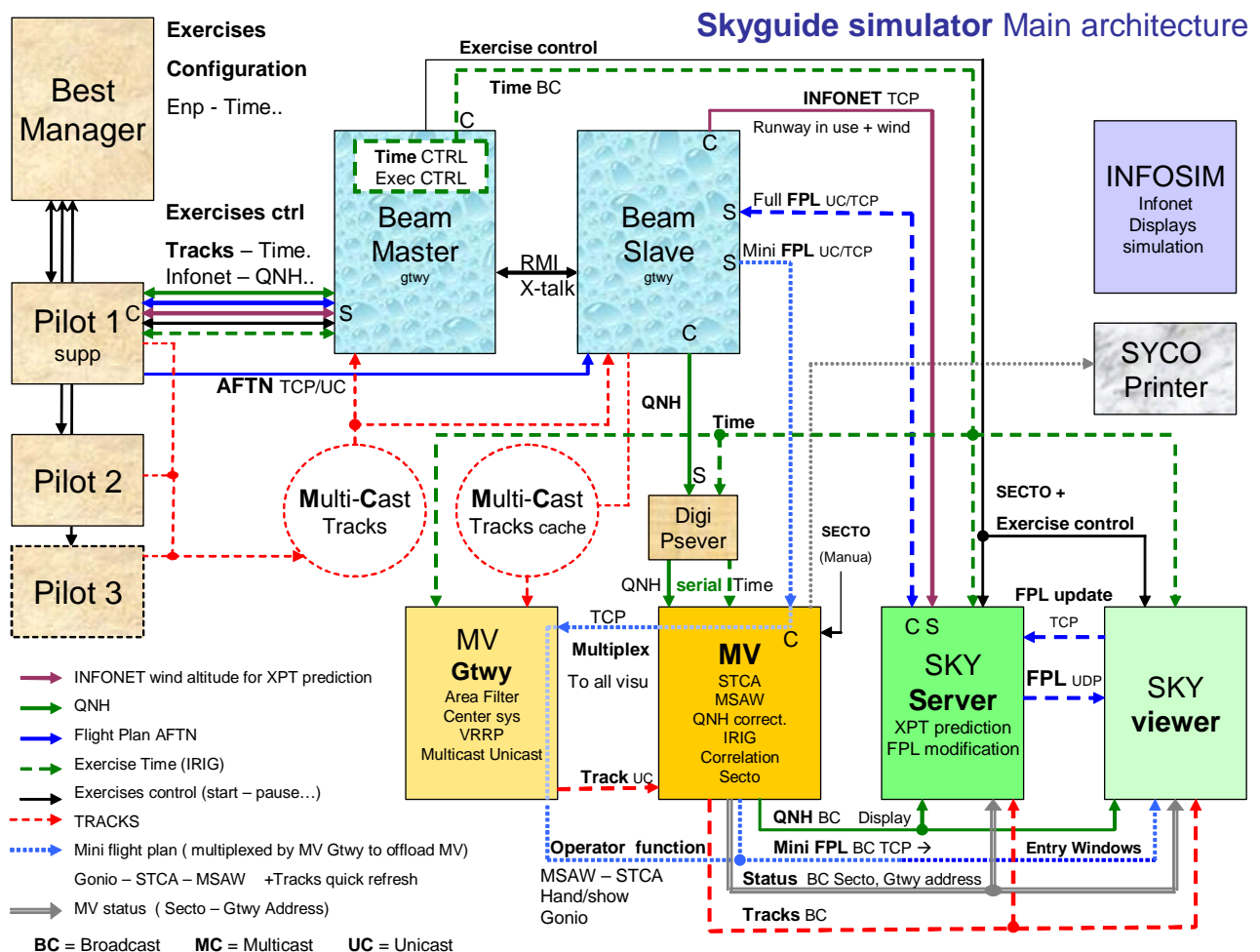


Figure 2-2 Architecture diagram of the Skyguide Simulation Platform

## 2.4.2.2 The Operational Tools

### 2.4.2.2.1 Horizontal Scanning Tool (HST) Conflict

The HST is an automatic conflict detection system operating below a certain separating distance (to be selected on-line, e.g. 10 or 15 NM) and below a certain Time Horizon (e.g. 10 or 15 minutes), for aircrafts crossing the same altitude plan. All flights concerned by HST conflicts are displayed in an HST Window, see Figure below. The Medium Term HST conflicts may be acknowledged individually and they are no more displayed on the Radar picture (however, if such conflicts are still active, they may be displayed on Hook, such as on Figure below). The HST window provides the conflict characteristics such as the CFL, the projected minimum separation distance (MSD) and the time to conflict.

There are several HST conflict filtering parameters: some of them are accessible on-line, others are configurable off-line.

On the radar picture additional information on conflicts are displayed: e.g. aircraft positions at the MSD, the corresponding track vectors and the routes until conflict.

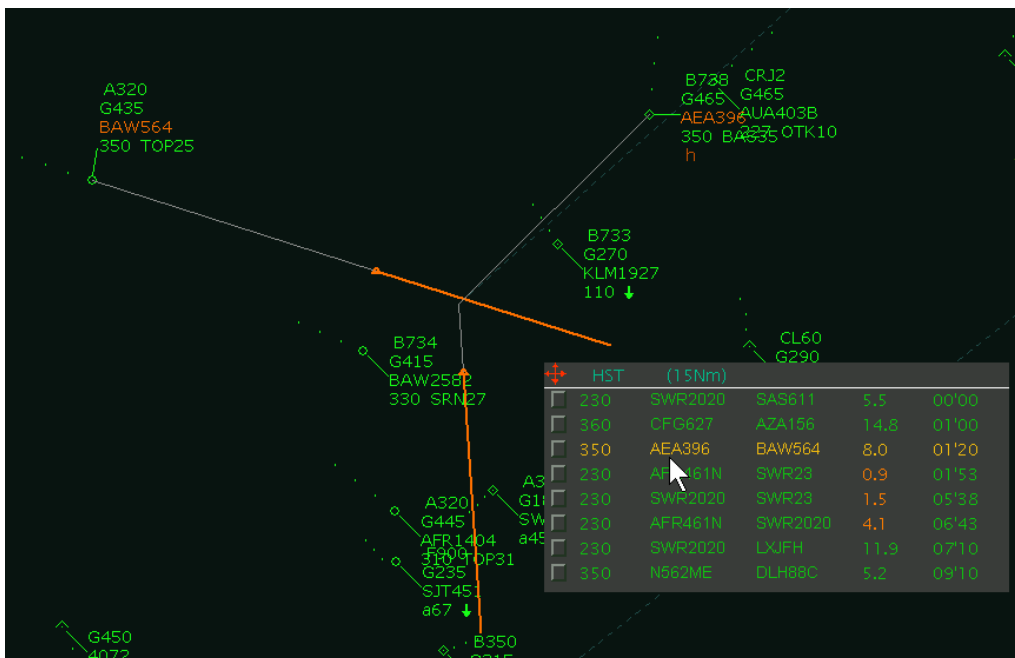


Figure 2-3 Horizontal Scanning Tool (HST) illustration

### 2.4.2.2.2 Dynamic Scanning Tool (DST) Conflict

All clearances given to pilots may be entered through the label in the radar visualization system: e.g. Heading, CFL, Speed, Direct routes or alternatives routes (graphical route modification). For each new clearance for a flight, the system computes eventual Medium Term Conflicts with the other flights. If any, one or several Conflict Alerts are shown on the controller Display. This is the Dynamic Scanning Tool (DST) which completes the permanent HST tool. In case of conflict, the controller has to confirm his input and validate his action. In this case, the system considers the controller input but adds the new DST conflict(s) in the HST window where conflicts are displayed permanently.

As for the HST, there are several DST conflict filtering parameters: accessible on-line or configurable off-line.

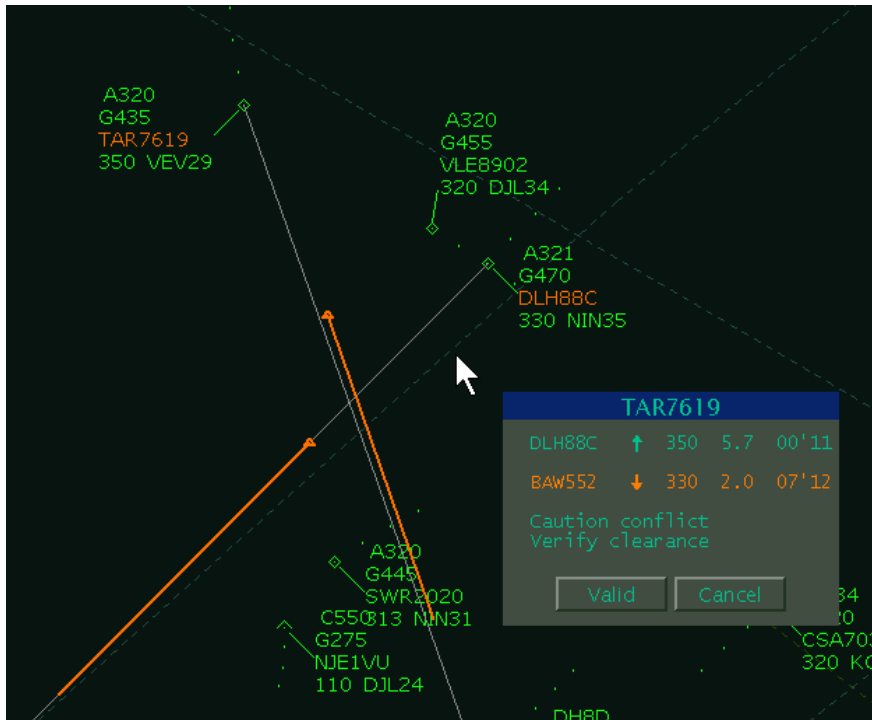


Figure 2-4 Dynamic Scanning Tool (DST) illustration

#### 2.4.2.2.3 Adherence Monitoring Tool (AMT)

All clearances given to pilots are entered through the label in the radar visualization system: e.g. Heading, CFL, Speed, Direct routes or alternatives routes (graphical route modification). The Adherence Monitoring Tool permits to monitor the flight path according to the route entered by the controller. In case of deviation, an alert is displayed on the label.

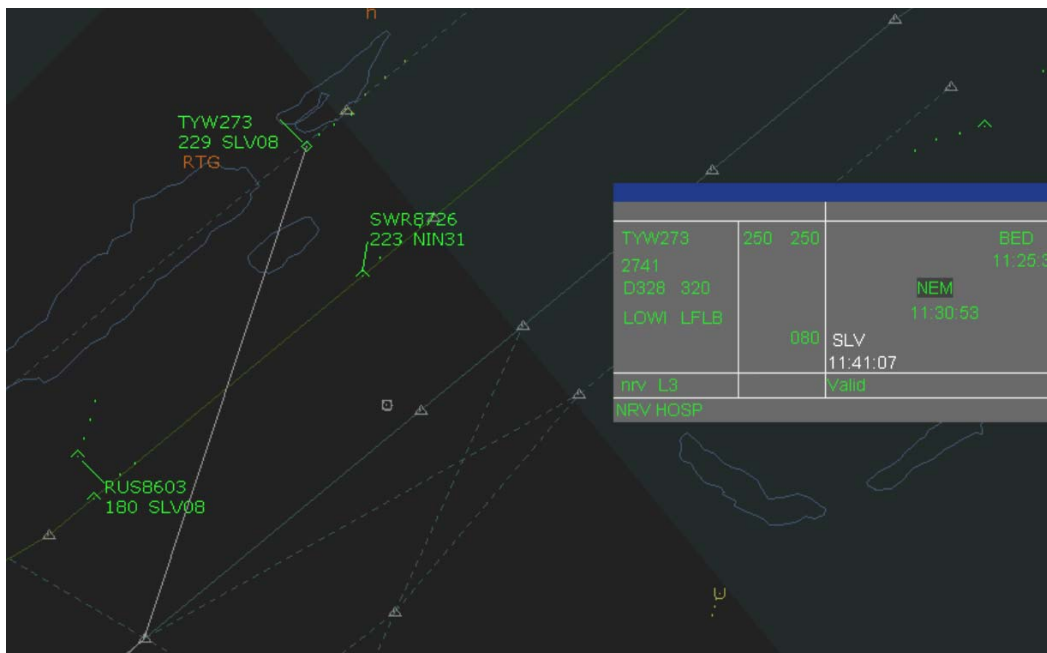


Figure 2-5 Adherence Monitoring Tool (AMT) illustration

#### 2.4.2.2.4 Strip less functionalities

##### 2.4.2.2.4.1 Electronic Co-ordination

The objective is an inter-sector silent coordination from screen to screen : quicker, working time optimization, more explicit than phone, possibility of immediate multi-sector co-ordination, useful for sector altitude layer configuration with evolutionary traffic.

To initiate a coordination the controller has just to input a coordination value (i.e. Suggested Flight Level and corresponding climbing/descending rate, Heading, DCT route or Speed) through a Coordination Window, see Figure below and send it to a receiving sector, usually an adjacent sector who has the flight in contact. The flight is intended to enter the airspace volume of the transferring sector.



Figure 2-6 Silent Coordination Window

The Figures below show the different steps of a silent coordination. Notice that, the receiving sector can reject a proposal or forward it to another sector.

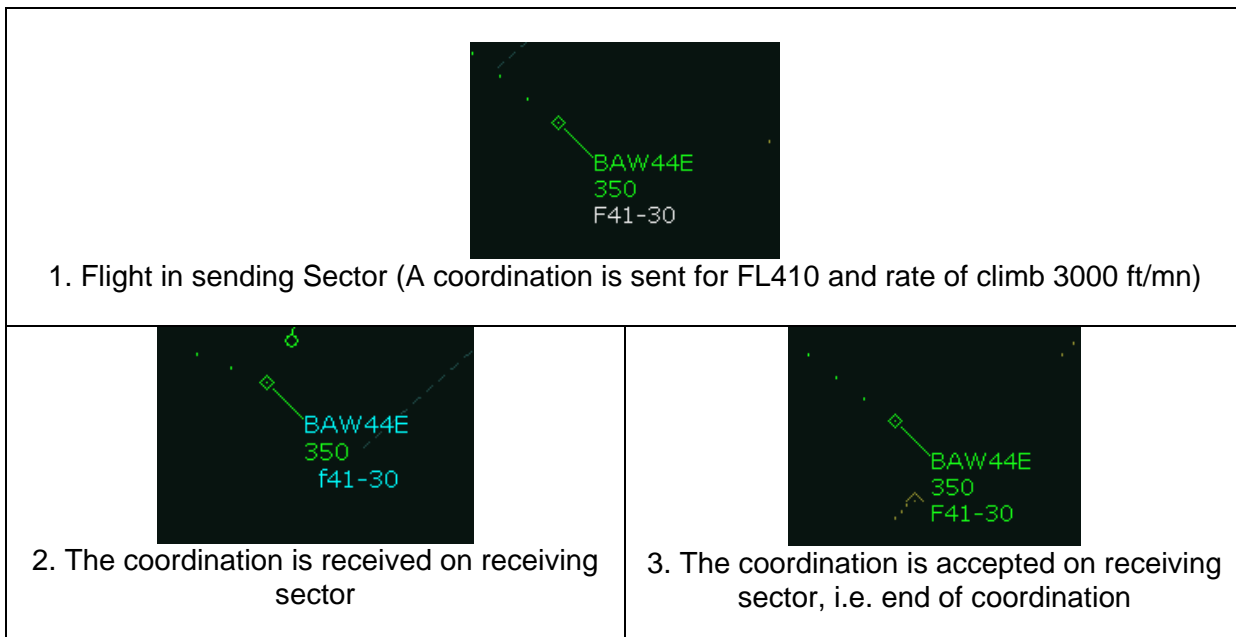


Figure 2-7 Silent Coordination on Flight Level

#### 2.4.2.2.4.2 Strip less Entry window

The Strip less Entry Windows have replaced most of the paper strip features since December 2005 in Geneva ACC. The main functions of a traditional paper strip are accessible via these windows: e.g. acknowledgment of a new flight plan (the flight is displayed in warning colour if not acknowledged below a certain distance from Entry point).

		TOP	SSR	EPT	TO1	EFL	XFL	RFL	Type	XPT	ADEP	ADES
		AFR110U	5773	MAT	-15	220	340		B735	BAW	LIMP	LFP6
■	i	AZA9P3	5740	TOP	-07	240			B763	BAW	LIMC	KIAD
		AZA666	5743	TOP	+00	240	260	300	B763	BAW	LIMC	SVM3
□	i	AZA604	5774	TOP	+09	240			B772	BAW	LIMC	KJFK

Figure 2-8 A Strip less Entry Window at Geneva ACC

At any time the controller may display an electronic strip or an extended flight plan modification Tool to access or modify flight plan data of correlated flights.

SAS1833	290 350	BEN	06:27:47
B746		MFA	06:38:21
B738 470		OTH	06:43:04
ESSA LFL	100		
rv L2	06:43	Sent_ACT_Received_LAM	

Figure 2-9 Electronic Strip (Geneva ACC/APP)

### 3. Validation Goals and Objectives Assumptions

This chapter presents Goals and Objectives of the FASTI Real Time Simulations. For each goal high and low level objectives are listed, along with a traceability matrix where hypotheses and metrics associated to each objective are made explicit.

Figure 3-1 shows the process used to extract the high and low level validation objectives, starting from the FASTI-RTS goals. Even though, the analysis on the metrics and indicators started during WP1, the final identification/selection of them will be reported in the WP2 Simulation Design document (D2) and recording specification in the WP3 Technical Specification document (D3). The decision has been agreed among the partners due to the fact most of the indicators measurements are platform dependent.

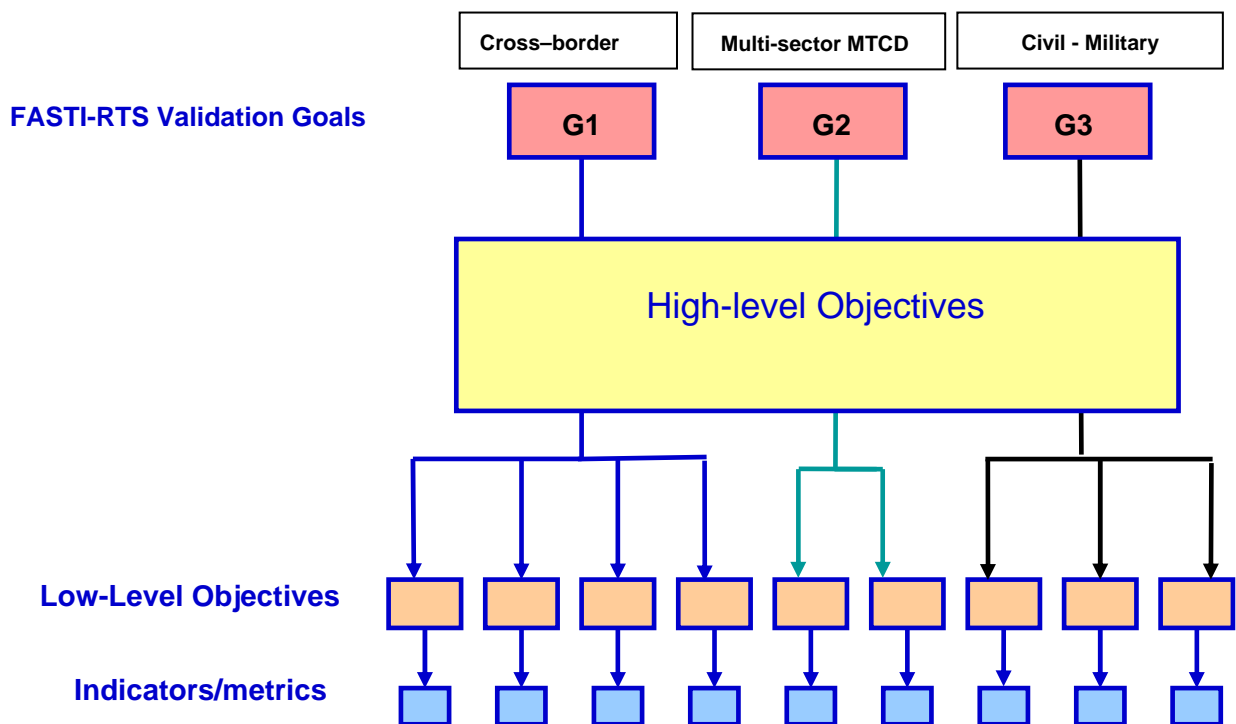


Figure 3-1 FASTI – RTS Validation Goals and Objectives framework

## 3.1 FASTI – RTS Validation Goals

Three fundamental Validation Goals are identified for the FASTI RTSs:

- G1.** Evaluate the use of the FASTI concept/ tools and cross border operations between adjacent ACCs within a FAB;
- G2.** Evaluate the use of FASTI tools within a multi-sector planning concept in the horizontal and vertical planes and identify the required co-ordination processes to support this operation within the same ACC;
- G3.** Evaluate the common use of the FASTI concept/tools in the context of civil/military operations within the same ACC.

As far as Goal 1 is concerned, a FAB is intended as a regional cooperation between different ATSU in which a Technical framework exists that ensures the same degree of technical interoperability between all sectors of the FAB, whether they are situated within one centre or not. As general effect of FAB, controller-controller coordination are expected to be equally easy and effective whether involving sectors of the same ACC or of different ACCs.

The main objective of this assessment is to evaluate the influence of the FASTI tools on “Cross Border” operations between different centres belonging to the same FAB.

Looking at the Goal 2, the “multi sector use of MTCD”, two different approaches have been highlighted.

The first one is related to the investigation of the working methods to apply and focuses on the controllers communication and trajectory(ies) update when the resolution of the conflict impacts on more than one sectors. Typical operational scenarios are:

- Planning controller wants to resolve the conflict changing one of the conflicting trajectories with an impact on the next sector (coordination with next Planning controller needed)
- Planning Controller wants to resolve the conflict happening in its own sector, when flight(s) are currently outside its area of responsibility (i. e. previous sector(s))

The second approach is related to the resolution of the conflict in the context in which the Multi Sector Planner have the role of planning controller for more than one sector, working in team with 2 or more executive controllers.

Goal 3, related to the evaluation of the common use of the FASTI concept/tools in the context of civil/military operations within the same ACC. It focuses on the impact of introducing the FASTI Tools on current civil/military operations.

## 3.2 FASTI – RTS High Level Validation Objectives

The Goals presented in previous paragraph will be evaluated mainly from the Human Factors and Safety perspectives. For each of these two areas of investigation specific issues of interest are identified which are proposed as High Level Validation Objectives. A lighter approach will be applied for the third perspective, Performance, as described hereafter.

### **Safety**

The impact of the introduction of FASTI tools on safety will be evaluated mainly in terms of Situational Awareness. The reason of this choice may be explained as follows.

An increase in safety may be measured in terms of a reduction in safety significant events, and might be achieved through systemizing the conflict detection process.

In more general terms, the display tools might increase the controller's situation awareness and therefore his ability to detect and solve conflicts in a safe way.

Situational awareness is defined as “the continuous a extraction of environmental information, the integration of this information with previous knowledge to form a coherent mental picture, and the use of that picture in directing further perception and anticipating future events” (Dominguez et al., 1994).

In this regard, situational awareness can be considered a mental state consisting of three phases:

1. perception of the situation (perception of important elements in the environment);
2. comprehension of the situation (integration of different pieces of data in order to determinate their relevance);
3. anticipation of future states of the current situation.

Situational Awareness will be investigated only from a Human Factors point of view.

### Human Factors

The EUROCONTROL Human Factors Case was used to identify the HF issues of interest for FASTI RTSs.

At the heart of the Human Factors Case are six Human Factors Issues. These form the basis for each stage of the Human Factors Case, providing a common structure to identify, integrate and assess human factors. The Human Factors Issues are illustrated in Figure 1 in a pie.

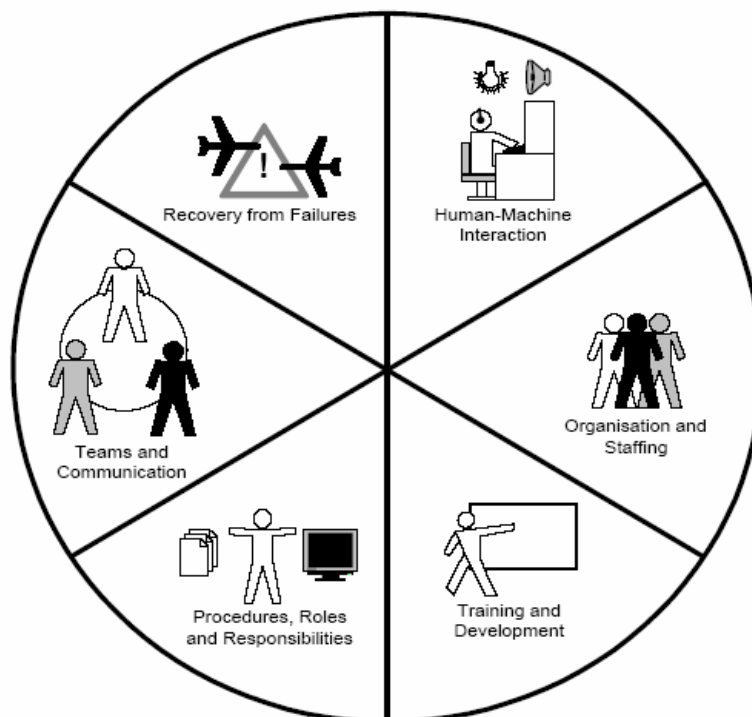


Figure 1: Human Factors Issues

The analysis of these issues and their associated work areas brought to the selection of the following issues to be investigated during ENAV and Skyguide FASTI - RTSs:

- Human Machine Interaction;
- Procedures, Roles and Responsibilities;
- Teams and Communication.

In the next table the description of the main work areas, relating to the above HF issues, is presented.

HF Issues	Work Area	Description
Human Machine Interaction	Input Devices	How information is entered into the system: keyboard, mouse, roller ball, touch screen, microphone.
	Information Requirements	What information is displayed: information content, form and timeliness. Prioritization and categorisation of information.
	HMI usability	The extent to which a system allows an actor to achieve goals (tasks) in an effective, efficient and satisfactory way. Aspects of the system that might ensure or compromise its usability, in terms of feedback, consistency, etc..
Procedures, Roles and Responsibilities	Distribution of Tasks between Human operators	Distribution of tasks between different actors in the system. Changes in the distribution of tasks and in the information different actors are provided with. Impact on workload, team interaction and shared situation awareness.
	Working Method	Description of how the actor performs his/her tasks. Prescribed working methods and individual working practices.
	Trust	The extent to which an actor is willing to act on the basis of information or recommendations provided by the system. Issues related to what is an adequate level of trust (i.e., competent use of the system), ways to achieve them, and possible obstacles.
Teams and Communication	Team interaction	The impact on the team structure (supervision, team formation), team dynamics and relations (e.g. from dual controller to single controller).
	Communication methods	Changes in communication methods – e.g., from verbal communication to computer-mediated communication. Interference between competing sources of information.

Table 1: FASTI-RTSs HF issues description

Though recognised as extremely important for the success of the RTSs, issues concerning *Training and Development* and *Recovery from Failures* are not included in the list of HF issues selected for ENAV and Skyguide RTSs. The reasons are explained below.

The aspects of training and development will not be evaluated during the RTSs, unless as caveats of the results produced. This means that no analysis will be performed concerning the appropriateness or the completeness of the training but, in case of lack in the training impairing the ATCO performances during the RTS, this will be reported as a caveat. In order to prevent problems due to training and development the working areas identified during the workshop as associated to this issue will serve as requirements for the preparation and conduct of the training.

The aspects of recovery from failures will not be evaluated during the RTSs because considered out of the scope of the project.

### Performance

A third perspective is the Performance. The impact of the introduction of FASTI tools on performance will be evaluated mainly in terms of Flight Efficiency. The experience gathered in previous projects revealed that the real-time simulation, as validation technique, is not appropriate for a full flight efficiency assessment. For this reason it was decided to low prioritize the flight efficiency and to take it into account in the quantitative analysis. That means we will be able after the simulation to come up with just some indications on flight efficiency issues.

Interesting metrics about Flight efficiencies are: number of level off (climb/descent) per flight over the Geneva and Roma sectors; number of direct routes application, even inter centre; number of conflicts induced by the more flexible routes.

### 3.3 FASTI – RTS Low Level Validation Objectives

The High Level Validation Objectives are then split into Low Level Objectives to facilitate the design of simulation exercises, the identification of specific hypotheses and the appropriate analysis tools, metrics and indicators.

The following sections present Low Level Validation Objectives identified for each one of the Simulation Goal and relevant item mentioned above.

#### 3.3.1 Low Level Validation Objectives associated to G1 “Cross-border operations”

As anticipated in chapter 1, Goal 1 concerns the cross border operations between adjacent ACC’s operating within a Functional Airspace Block (FAB) and is formulated as follows:

***Evaluate the use of the FASTI concept/ tools and cross border operations between adjacent ACC’s within a FAB***

The following low level objectives are proposed:

G1.1 - Evaluate the operational impact of the introduction of SYSCO messages, namely:

- Counter-proposal for flight level coordination
- Request on frequency (ROF)
- Request Tactical Instruction Message (RTI)
- Tactical Instruction Proposal Message (TIP)
- Supplementary Data Message (SDM)
- Coordination of Entry Flight Level (CDN).

G1.2 - Evaluate the operational impact of the introduction of MONA, namely:

- Altitude deviation (CFL dev / CFL bust / XFL dev)
- Inter-console marker
- Local message (Post-It)
- Coordination reminder (XFL)
- Transfer reminder.

G1.3 - Evaluate the combined effect of MTCD/MONA/SYSCO in cross border operation within a FAB.

The low level validation objectives G1.1 and G2.1 will be evaluate trough the application of different methodologies. The results will be given in relation to FASTI tools, or to one of them, but taking in account the presence of the other FASTI tools at the same time.

Next table presents the traceability between the low level validation objectives associated to G1 and the inherent high level objective, hypotheses, indicators and metrics.

Low Level Objectives		Issues	Work areas	Hypotheses		Metrics/Indicators
G1.1	Evaluate the operational impact of the introduction of SYSCO messages.	Situational awareness	Perception/ comprehension/ anticipation	G1.1.1	The SYSCO messages improve the situational awareness of the operators.	<ul style="list-style-type: none"> <li>Over the shoulders observations.</li> <li>Workload, measured by questionnaire.</li> </ul>
				Human machine Interaction	Input Devices	G1.1.2
		Information Requirements	G1.1.3			HMI presents all the required information to manage (emission/response) SYSCO messages.
			HMI usability		G1.1.4	HMI provides the appropriate feedback subsequent SYSCO message emission.
		G1.1.5			SYSCO HMI is easy to use and coherent with the rest of the system HMI.	<ul style="list-style-type: none"> <li>Over the shoulders observations concerning the interaction with HMI.</li> <li>ATCO acceptability of new proposed objects and relative hierarchical organizations, measured by questionnaire/interview.</li> </ul>
		Procedures, roles and responsibilities	Distribution of Tasks between Human operators	G1.1.6	Distributing of tasks in using SYSCO messages is appropriate and respected.	<ul style="list-style-type: none"> <li>Comparison between workload results relating executive and planner controllers for the same simulation exercise, measured by questionnaire and/or ISA.</li> <li>Task sharing between executive and planner controllers, registered by observation.</li> </ul>

Low Level Objectives	Issues	Work areas	Hypotheses		Metrics/Indicators
		Working Method	G1.1.7	The proposed working methods are appropriate and respected.	<ul style="list-style-type: none"> <li>○ ATCO acceptability of new proposed WMs, measured by questionnaire/interview.</li> <li>○ Respect of working methods through over the shoulders observations.</li> <li>○ Comparison between workload results relating executive and planner controllers for the same simulation exercise, measured by questionnaire/interview and/or ISA.</li> </ul>
		Trust	G1.1.8	ATCOs consider SYSCO messages reliable.	<ul style="list-style-type: none"> <li>○ Number of electronic coordination.</li> <li>○ Time to reply.</li> <li>○ Number of R/T coordination.</li> <li>○ ATCO trust collected by mean of questionnaire/interview.</li> <li>○ Over the shoulder observations.</li> </ul>
		Team interaction	G1.1.9	SYSCO messages support inter sector coordination.	<ul style="list-style-type: none"> <li>○ Number of SYSCO messages.</li> <li>○ Time to reply.</li> <li>○ Number of replies.</li> <li>○ Number and duration of telephone calls, voice communication TC/PC, time to have a reply, number of counter-proposals.</li> <li>○ Workload, measured by questionnaire, interview and/or ISA.</li> </ul>
		Communication methods	G1.1.10	Changes in communication methods associated to the introduction of SYSCO messages supports inter-sector teamwork and communication.	<ul style="list-style-type: none"> <li>○ Questionnaire item.</li> <li>○ Interview item.</li> <li>○ Over the shoulder Observations.</li> <li>○ Workload, measured by questionnaire, interview and/or ISA.</li> </ul>
			G1.1.11	SYSCO messages increase the ATCO coordination capabilities.	<ul style="list-style-type: none"> <li>○ Over the shoulders observations concerning the interaction with HMI.</li> <li>○ Workload, measured by questionnaire/interview and/or ISA.</li> <li>○ ATCO job satisfaction collected by mean of questionnaire/interview.</li> </ul>

Low Level Objectives	Issues	Work areas	Hypotheses		Metrics/Indicators	
G1.2	Evaluate the operational impact of the introduction of MONA	Situational awareness	Perception/ comprehension/ anticipation	G.1.2.1	MONA contributes to improve situational awareness.	<ul style="list-style-type: none"> <li>○ Time between MONA reminder/warning presentation and its presentation.</li> <li>○ Perception of situational awareness improvement, measured by questionnaire/interview.</li> <li>○ ATCO actions following to the presentation of MONA warnings/reminders on HMI, by mean of ATCO observation.</li> </ul>
		Human Machine Interaction	Information Requirements	G.1.2.2	ATCOs appreciate MONA reminders/warnings usefulness and completeness.	ATCO job satisfaction concerning the use of the MONA tool, measured by questionnaire/interview.
	HMI usability		G.1.2.3	MONA HMI is easy to use and coherent with the rest of the system HMI.	ATCO acceptability of new proposed graphical objects, measured by questionnaire/interview.	
			G.1.2.4	MONA triggers an acceptable number of warning.	<ul style="list-style-type: none"> <li>○ Overall acceptability of MONA tool, measured by questionnaire/interview.</li> <li>○ Temporal distribution of warnings.</li> </ul>	
			G.1.2.5	MONA provides useful alert signals.	Comparison of workload between organisation without MONA and the organisation with MONA for each traffic level, measured by questionnaire/interview.	
			G.1.2.6	MONA provides useful alert signals.	Comparison of workload between organisation without MONA and the organisation with MONA for each traffic level, measured by questionnaire/interview.	
	Procedures, roles and responsibilities	Distribution of Tasks between Human operators	G.1.2.7	Distributing of tasks in using MONA is appropriate and respected.	<ul style="list-style-type: none"> <li>○ Comparison between workload results relating executive and planner controllers for the same simulation exercise, measured by questionnaire/interview and/or ISA.</li> <li>○ Task sharing between executive and planner controllers, registered by mean of observation ATCO observation.</li> </ul>	

Low Level Objectives	Issues	Work areas	Hypotheses		Metrics/Indicators
		Working Method	G.1.2.8	The proposed working methods are appropriate and respected.	<ul style="list-style-type: none"> <li>○ ATCO acceptability of new proposed WMs, measured by questionnaire/interview.</li> <li>○ Verification of correctness of working methods through over the shoulders observations.</li> <li>○ Workload, measured by questionnaire, interview and/or ISA.</li> </ul>
		Trust	G.1.2.9	ATCOs consider relevant all the warning provided by MONA.	Reliability of the MONA warnings, measured by questionnaire/interview .
G1.3	Evaluate the combined effect of MTCD/MONA/SYSCO in cross border operation within a FAB	Procedures, roles and responsibilities	Distribution of Tasks between Human operators	G.1.3.1	<ul style="list-style-type: none"> <li>○ Distributing of tasks in using FASTI tools is appropriate and respected.</li> <li>○ Comparison between workload results relating executive and planner controllers for the same simulation exercise, measured by questionnaire and/or ISA.</li> <li>○ Task sharing between executive and planner controllers, registered by observation.</li> </ul>
				G.1.3.2	<ul style="list-style-type: none"> <li>○ FASTI tools allow to empower PLC role.</li> <li>○ Comparison between workload results relating executive and planner controllers for the same simulation exercise, measured by questionnaire and/or ISA.</li> <li>○ Task sharing between executive and planner controllers, registered by observation.</li> <li>○ ATCO acceptability of new proposed WMs.</li> </ul>
				G.1.3.3	<ul style="list-style-type: none"> <li>○ FASTI tools allow to balance team workload.</li> <li>○ Comparison between workload results relating executive and planner controllers for the same simulation exercise, measured by questionnaire and/or ISA.</li> </ul>
			Working Method	G.1.3.4	<ul style="list-style-type: none"> <li>○ The proposed working methods are appropriate and respected.</li> <li>○ ATCO acceptability of new proposed WMs.</li> <li>○ Respect of working methods through over the shoulders observations.</li> <li>○ Comparison of workload (ISA) between organisation baseline and the organisation with FASTI tools.</li> <li>○ Workload, measured by questionnaire, interview and/or ISA.</li> </ul>

Low Level Objectives	Issues	Work areas	Hypotheses		Metrics/Indicators	
		Trust	G.1.3.5	ATCOs consider FASTI tools as reliable and useful.	Reliability of the FASTI tools, measured by questionnaire/interview .	
		Team interaction	G.1.3.6	FASTI tools support inter sector coordination.	<ul style="list-style-type: none"> <li>○ ATCO acceptability measured by questionnaire/interview.</li> <li>○ Workload, measured by questionnaire, interview and/or ISA.</li> </ul>	
		Teams and Communication	Communication methods	G.1.3.7	FASTI tools support intra sector coordination.	<ul style="list-style-type: none"> <li>○ ATCO acceptability measured by questionnaire/interview.</li> <li>○ Workload, measured by questionnaire, interview and/or ISA.</li> </ul>
			Communication methods	G.1.3.8	Changes in communication methods associated to the introduction of FASTI tools supports inter-sector teamwork and communication.	<ul style="list-style-type: none"> <li>○ Questionnaire item.</li> <li>○ Interview item.</li> <li>○ Over the shoulder Observations.</li> <li>○ Workload, measured by questionnaire, interview and/or ISA.</li> </ul>

Table 2: G1 Traceability matrix



### 3.3.2 Low Level Validation Objectives associated to G2 “Multi sector use of MTCD”

As anticipated in chapter 3.1, Goal G2 concerns the multi-sector use of MTCD. In particular it is formulated as follows:

***Determine the multi-sector use of MTCD in the horizontal and vertical planes and identify the required co-ordination processes to support this operation within the same ACC***

The following low level objectives are proposed:

G2.1 - Evaluate the operational impact of the introduction of MTCD, namely:

- Multi-sector use of MTCD (back-forward use)
- Inter-sector use of MTCD (FASTI operational concept).

G2.2 - Evaluate the operational impact of the introduction of MTCD, in multi sector environment (Multi Sector Planner).

The low level validation objectives concerning Goal G2 will be evaluate trough the application of different methodologies. The results will be given in relation to FASTI tools, or to MTCD, but taking in account the presence of the other FASTI tools (MONA/SYSCO) at the same time.

Next table presents the traceability between the low level validation objectives associated to G1 and the inherent high level objective, hypotheses, indicators and metrics.

Low Level Objectives	Issues	Work Areas	Hypotheses	Metrics/Indicators	
G2.1	Evaluate the operational impact of the introduction of MTCD.	Situational awareness	Perception/ comprehension/ anticipation	G.2.1.1 MTCD allows to anticipate the detection of potential conflicts.	<ul style="list-style-type: none"> <li>○ Number of STCA activation.</li> <li>○ Perception of situational awareness improvement, measured by questionnaire/interview.</li> </ul>
		Human machine Interaction	Input Devices	G.2.1.2 The sequence of physical action needed to manage MTCD is easy and coherent with the mouse usage in the rest of the system HMI.	Observation of eventual ATCO errors during the input concerning MTCD, due to differences between input procedures.
	Information Requirements		G.2.1.3 HMI presents all the required information to manage MTCD.	<ul style="list-style-type: none"> <li>○ Observation of conflict resolution.</li> <li>○ Number of operations needed to resolve the detected conflict.</li> <li>○ Time between action, after MTCD information presentation, and resolution of the potential conflict.</li> </ul>	
	HMI usability		G.2.1.4 MTCD HMI is easy to use and coherent with the rest of the system HMI.	ATCO acceptability of new proposed graphical objects and relative hierarchical organizations measured by mean of questionnaire and interview.	
			G.2.1.5 MTCD increases the ATCO capabilities in terms of efficiency and effectiveness.	<ul style="list-style-type: none"> <li>○ Temporal distribution of response time to MTCD: time between message display and removal.</li> <li>○ Workload, measured by questionnaire, interview and/or ISA.</li> </ul>	
			G.2.1.6 MTCD triggers an acceptable number of alarms.	<ul style="list-style-type: none"> <li>○ ATCO acceptability collected by mean of questionnaire.</li> <li>○ Temporal distribution of MTCD information presentation.</li> <li>○ Temporal distribution of ISA high scores.</li> </ul>	
	G.2.1.7 MTCD alert signals support ATCOs.	Time between a MTCD information presentation and eventual operation triggered by it.			

Low Level Objectives	Issues	Work Areas	Hypotheses	Metrics/Indicators		
		Distribution of Tasks between Human operators	G.2.1.8 Distributing of tasks in using MTCD is appropriate and respected.	<ul style="list-style-type: none"> <li>○ Comparison between workload results relating executive and planner controllers for the same simulation exercise, measured by questionnaire/interview and/or ISA.</li> <li>○ Task sharing between executive and planner controllers, registered by mean of observation ATCO observation.</li> <li>○ Questionnaire item.</li> </ul>		
		Procedures, roles and responsibilities	Working Method	G.2.1.9	The proposed working methods are appropriate and respected.	<ul style="list-style-type: none"> <li>○ ATCO acceptability of new proposed WMs measured by mean of questionnaire and interview.</li> <li>○ Respect of working methods through over the shoulders observations.</li> <li>○ Workload, measured by questionnaire, interview and/or ISA.</li> </ul>
			Working Method	G.2.1.10	MTCD allows to empower PLC role.	<ul style="list-style-type: none"> <li>○ Comparison between workload results relating executive and planner controllers for the same simulation exercise, measured by questionnaire and/or ISA.</li> <li>○ Task sharing between executive and planner controllers, registered by observation.</li> <li>○ ATCO acceptability of new proposed WMs.</li> </ul>
			Working Method	G.2.1.11	MTCD allows to balance team workload.	<ul style="list-style-type: none"> <li>○ Comparison between workload results relating executive and planner controllers for the same simulation exercise, measured by questionnaire and/or ISA.</li> </ul>
		Trust	G.2.1.12	ATCOs consider relevant all the alarms provided by MTCD.	ATCO acceptability collected by mean of questionnaire.	
		Teams and Communication	Team interaction	G.2.1.13	MTCD improves intra sector cooperation.	<ul style="list-style-type: none"> <li>○ Comparison between workload results relating executive and planner controllers for the same simulation exercise, measured by questionnaire/interview and/or ISA.</li> <li>○ Usage of responsibility transfer for a conflict between planner and executive, measured by mean of questionnaire and interview and observation.</li> </ul>

Low Level Objectives		Issues	Work Areas	Hypotheses	Metrics/Indicators
				G.2.1.14	<p>MTCD improves inter sector cooperation.</p> <ul style="list-style-type: none"> <li>○ Number of resolution of conflict concerning the downstream sector (multi sector use of MTCD).</li> <li>○ Workload, measured by questionnaire, interview and/or ISA.</li> </ul>
G2.2	Evaluate the operational impact of the introduction of MTCD in multi sector environment	Human machine Interaction	HMI usability	G.2.2.1	<p>MTCD increases the ATCO capabilities in terms of efficiency and effectiveness in a Multi Sector environment.</p> <ul style="list-style-type: none"> <li>○ Temporal distribution of response time to MTCD: time between information display and removal.</li> <li>○ Workload, measured by questionnaire, interview and/or ISA.</li> </ul>
				Procedures, roles and responsibilities	Distribution of Tasks between Human operators
		Working Method	G.2.2.3		
			G.2.2.4	<p>The proposed working methods, in a Multi Sector environment, are appropriate and respected.</p> <ul style="list-style-type: none"> <li>○ ATCO acceptability of new proposed WMs measured by mean of questionnaire and interview.</li> <li>○ Verification of correctness of working methods through over the shoulders observations.</li> <li>○ Workload, measured by questionnaire, interview and/or ISA.</li> </ul>	

Table 3: G2 Traceability matrix



### 3.3.3 Low Level Validation Objectives associated to G3 “Civil-Military”

As anticipated in chapter 1, Goal G3 concerns the impact of FASTI tools on the civil-military operations. In particular it is formulated as follows:

***Evaluate the common use of the FASTI concept/tools in the context of civil/military operations within the same ACC sector***

The following low level objectives are proposed:

G3.1 - Evaluate the operational impact of MTAPW.

G3.2 - Evaluate the operational impact of electronic coordination and activation of military areas and corridors.

G3.3 - Evaluate the operational impact of electronic coordination of Operational Air Traffic (OAT).

G3.4 - Evaluate the operational impact on management of potential conflict between General Air traffic (GAT) and Operational Air Traffic (OAT).

G 3.5 - Evaluate the operational impact on management of Security Air traffic (SAT).

Next table presents the traceability between the low level validation objectives associated to G3 and the inherent high level objective, hypotheses, indicators and metrics.

Low Level Objectives		Issues	Work areas	Hypotheses		Metrics/Indicators
G3.1	Evaluate the operation impact of MTAPW	Situational awareness	Perception/ comprehension/ anticipation	G.3.1.1	MTAPW allows to anticipate the detection of military area infringement.	<ul style="list-style-type: none"> <li>Perception of situational awareness improvement, measured by questionnaire/interview.</li> <li>Number of APW activation.</li> <li>Number of MTAPW activation</li> <li>Number of MTAPW followed by APW activation</li> </ul>
				G.3.1.2	HMI presents all the required information to manage MTAPW.	Over the shoulder observations in order to verify if the information, provided by MTAPW, are sufficient to have the clear understanding of the potential infringement displayed.
		HMI usability	G.3.1.3	MTAPW HMI is easy to use and coherent with the rest of the system HMI.	ATCO acceptability of new proposed graphical objects and relative hierarchical organizations.	
			G.3.1.4	MTAPW triggers an acceptable number of alarms.	<ul style="list-style-type: none"> <li>ATCO acceptability collected by mean of questionnaire.</li> <li>Temporal distribution of MTAPW information presentation.</li> <li>Temporal distribution of ISA high scores.</li> <li>Workload, measured by questionnaire, interview and/or ISA.</li> </ul>	
			G.3.1.5	MTAPW alert signals support ATCOs.	Time between a MTAPW information presentation and eventual operation triggered by it.	

Low Level Objectives		Issues	Work areas	Hypotheses		Metrics/Indicators
		Procedures, roles and responsibilities	Distribution of Tasks between Human operators	G.3.1.6	Distributing of tasks in using MTAPW is appropriate and respected.	<ul style="list-style-type: none"> <li>Questionnaire item.</li> <li>Workload, measured by questionnaire, interview and/or ISA.</li> </ul>
			Working Method	G.3.1.7	The proposed working methods are appropriate and respected.	<ul style="list-style-type: none"> <li>ATCO acceptability of new proposed WMs.</li> <li>Respect of working methods through over the shoulders observations.</li> <li>Workload, measured by questionnaire, interview and/or ISA.</li> </ul>
			Trust	G.3.1.8	ATCOs consider/don't consider relevant all the alarms provided by MTAPW.	<ul style="list-style-type: none"> <li>ATCO acceptability collected by mean of questionnaire.</li> </ul>
G3.2	Evaluate the operation impact of electronic coordination and activation of military areas and corridors	Human machine Interaction	Input Devices	G.3.2.1	The sequence of physical action needed to pre-activate and activate is easy and coherent with the mouse usage in the rest of the system HMI.	Observation of eventual ATCO errors in pre-activation and activation of military areas.
				G.3.2.2	The sequence of physical action needed to manage (emission/response) SYSCO messages is easy and coherent with the mouse usage in the rest of the system HMI.	<ul style="list-style-type: none"> <li>Rate of SYSCO messages, in relation with the total number of SYSCO message, which provide the expected outcome.</li> <li>Observation of eventual ATCO errors during the input concerning SYSCO messages, due to differences between input procedures.</li> </ul>

Low Level Objectives	Issues	Work areas	Hypotheses		Metrics/Indicators
		Information Requirements	G.3.2.3	HMI presents all the required information to manage (emission/response) SYSCO messages, in case of activation of military areas and corridors.	Rate of telephonic coordination, in relation to the total number of coordination, which are performed through R/T instead of the electronic manner allowed by SYSCO messages, measured by mean of questionnaire/interview.
		HMI usability	G.3.2.4	HMI is easy to use and coherent with the rest of the system HMI.	ATCO acceptability of new proposed graphical objects measured by mean of questionnaire/interview. Over the shoulders observations.
	G.3.2.5		HMI provides the appropriate feedback subsequent SYSCO message emission.	Time between SYSCO message presentation and eventual operation triggered by it.	
	G.3.2.6		SYSCO messages increase the ATCO coordination capabilities in terms of efficiency and effectiveness.	<ul style="list-style-type: none"> <li>o Comparison between the time required to perform a coordination through usage of SYSCO messages and the one required to perform a telephonic coordination, measured by mean of questionnaire/interview.</li> <li>o Workload, measured by questionnaire, interview and/or ISA.</li> </ul>	

Low Level Objectives		Issues	Work areas	Hypotheses		Metrics/Indicators
		Procedures, roles and responsibilities	Distribution of Tasks between Human operators	G.3.2.7	Distributing of tasks in using SYSCO messages is appropriate and respected.	<ul style="list-style-type: none"> <li>Comparison between workload results (ISA) relating executive and planner controllers for the same simulation exercise.</li> <li>Observation of task sharing between executive and planner controllers.</li> <li>Workload, measured by questionnaire, interview and/or ISA.</li> </ul>
			Working Method	G.3.2.8	The proposed working methods are appropriate and respected	<ul style="list-style-type: none"> <li>ATCO acceptability of new proposed WMs.</li> <li>Verification of correctness of working methods through over the shoulders observations.</li> <li>Workload, measured by questionnaire, interview and/or ISA.</li> </ul>
	Teams and Communication	Team interaction	G.3.2.9	SYSCO messages support inter sector coordination.	Workload, measured by questionnaire, interview and/or ISA.	
		Communication methods	G.3.2.10	Changes in communication methods associated to the introduction of SYSCO messages supports inter-sector teamwork and communication.	<ul style="list-style-type: none"> <li>Changes in communication workload</li> <li>Number of SYSCO messages</li> <li>Time to reply</li> <li>Number of replies</li> <li>Number and duration of telephone calls, voice communication TC/PC, time to have a reply, number of counter-proposals.</li> <li>Workload, measured by questionnaire, interview and/or ISA.</li> </ul>	

Low Level Objectives		Issues	Work areas	Hypotheses		Metrics/Indicators
G3.3	Evaluate the operation impact of electronic coordination Operational Air Traffic (OAT)	Human machine Interaction	Input Devices	G.3.3.1	The sequence of physical action needed to manage (emission/response) SYSCO messages is easy and coherent with the mouse usage in the rest of the system HMI.	<ul style="list-style-type: none"> <li>Rate of SYSCO messages, in relation with the total number of SYSCO message, which provide the expected outcome.</li> <li>Observation of eventual ATCO errors during the input concerning SYSCO messages, due to differences between input procedures.</li> </ul>
			Information Requirements	G.3.3.2	HMI presents all the required information to manage (emission/response) SYSCO messages.	Rate of telephonic coordination, in relation to the total number of coordination, which are performed through R/T instead of the electronic manner allowed by SYSCO messages.
			HMI usability	G.3.3.3	SYSCO HMI is easy to use and coherent with the rest of the system HMI	ATCO acceptability of new proposed graphical objects and relative hierarchical organizations.
		G.3.3.4		HMI provides the appropriate feedback subsequent SYSCO message emission.	Time between SYSCO message presentation and eventual operation triggered by it.	
		Procedures, roles and responsibilities	Allocation of Functions between Human and Machine	G.3.3.5	SYSCO messages increase the ATCO coordination capabilities in terms of efficiency and effectiveness.	Comparison between the time required to perform a coordination through usage of SYSCO messages and the one required to perform a telephonic coordination, measured by questionnaire/interview.

Low Level Objectives		Issues	Work areas	Hypotheses	Metrics/Indicators
			Distribution of Tasks between Human operators	G.3.3.6 The proposed working methods are appropriate and respected	<ul style="list-style-type: none"> <li>Comparison between workload results relating executive and planner controllers for the same simulation exercise, measured by questionnaire and/or ISA.</li> <li>Task sharing between executive and planner controllers, registered by observation.</li> </ul>
			Working Method	G.3.3.7 ATCOs prefer to coordinate flights with other sectors using SYSCO messages	<ul style="list-style-type: none"> <li>ATCO acceptability of new proposed WMs, measured by questionnaire/interview.</li> <li>Respect of working methods through over the shoulders observations.</li> <li>Comparison between workload results relating executive and planner controllers for the same simulation exercise, measured by questionnaire/interview and/or ISA.</li> </ul>
		Teams and Communication	Team interaction	G.3.3.8 Changes in communication methods associated to the introduction of SYSCO supports inter-sector teamwork and communication.	<ul style="list-style-type: none"> <li>Number of SYSCO messages.</li> <li>Time to reply.</li> <li>Number of replies.</li> <li>Number and duration of telephone calls, voice communication TC/PC, time to have a reply, number of counter-proposals.</li> <li>Workload, measured by questionnaire, interview and/or ISA.</li> </ul>



Low Level Objectives		Issues	Work areas	Hypotheses		Metrics/Indicators
			Communication methods	G.3.3.9	The sequence of physical action needed to manage (emission/response) SYSCO messages is easy and coherent with the mouse usage in the rest of the system HMI.	<ul style="list-style-type: none"><li>○ Questionnaire item.</li><li>○ Interview item.</li><li>○ Over the shoulders Observations.</li><li>○ Workload, measured by questionnaire, interview and/or ISA.</li></ul>

Low level Objectives		Issues	Work areas	Hypotheses		Metrics/Indicators
G3.4	Evaluate the operation impact on management of potential conflict between General Air traffic (GAT) and Operational Air Traffic (OAT)	Situational awareness	Perception/ comprehension/ anticipation	G.3.4.1	MTCD allows to anticipate the detection of potential conflicts between OAT and GAT.	Number of STCA activation.
		Human machine Interaction	Information Requirements	G.3.4.2	HMI presents all the required information to manage MTCD.	Observation of conflict resolution: the controller should resolve it supported by the information provided by MTCD.
				G.3.4.3	MTCD HMI is easy to use and coherent with the rest of the system HMI.	ATCO acceptability of new proposed graphical objects and relative hierarchical organizations.
				G.3.4.4	MTCD triggers an acceptable number of alarms.	<ul style="list-style-type: none"> <li>o ATCO acceptability collected by mean of questionnaire</li> <li>o Temporal distribution of MTCD information presentation.</li> <li>o Temporal distribution of ISA high scores.</li> </ul>
				G.3.4.5	MTCD alert signals support ATCOs.	Time between a MTCD information presentation and eventual operation triggered by it.
		Procedures, roles and responsibilities	Allocation of Functions between Human and Machine	G.3.4.6	MTCD increases the ATCO capabilities in terms of efficiency and effectiveness.	Temporal distribution of response time to MTCD information presentation: time between message display and removal.
			Distribution of Tasks between Human operators	G.3.4.7	Distributing of tasks in using MTCD is appropriate and respected.	<ul style="list-style-type: none"> <li>o Questionnaire item.</li> <li>o Comparison between workload results relating executive and planner controllers for the same simulation exercise, measured by questionnaire/interview and/or ISA.</li> </ul>



Low level Objectives		Issues	Work areas		Hypotheses	Metrics/Indicators
			Working Method	G.3.4.8	The proposed working methods are appropriate and respected.	<ul style="list-style-type: none"> <li>○ ATCO acceptability of new proposed WMs.</li> <li>○ Respect of working methods through over the shoulders observations.</li> </ul>
			Trust	G.3.4.9	ATCOs consider/don't consider relevant all the alarms provided by MTCD.	Questionnaire item "Were all the MTCD alarms relevant?"
		Teams and Communication	Team interaction	G.3.4.10	MTCD supports intra sector coordination.	Number of responsibility transfer for a conflict between planner and executive.
			Communication methods	G.3.4.11	MTCD supports inter sector coordination.	Number of resolution of conflict concerning an adjacent sector (multi sector use of MTCD).
				G.3.4.12	Management of potential conflict between GAT and OAT, with MTCD, doesn't influence negatively communication workload	Number of telephonic coordination between civil sector and military sector.

Low Level Objectives		Issues	Work Areas	Hypotheses		Metrics/Indicators
G3.5	Evaluate the operation impact on management of Security Air traffic (SAT)	Procedures, roles and responsibilities	Distribution of Tasks between Human operators	G.3.5.1	Distributing of tasks is appropriate and respected.	Comparison of workload distribution pattern between PC/TC.
			Working Method	G.3.5.2	The proposed working methods are appropriate and respected.	<ul style="list-style-type: none"> <li>o ATCO acceptability of new proposed WMs.</li> <li>o Respect of working methods through over the shoulders observations.</li> </ul>
		Teams and Communication	Team interaction	G.3.5.3	SYSCO messages support inter sector coordination.	Workload, measured by questionnaire, interview and/or ISA.
			Communication methods	G.3.5.4	Changes in communication methods associated to the introduction of SYSCO messages supports inter-sector teamwork and communication.	Changes in communication workload.
				G.3.5.5	Management of SAT, could have influence on communication workload	Number of telephonic coordination between civil sector and military sector.

Table 4: G3 Traceability matrix