Final Project Report

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Abstract

P10.04.01 was focused on Conflict Management function within the En-Route, Terminal Manoeuvring Area (TMA) and Free Route environments.

The project defined system requirements derived from operational requirements and provided verified prototypes to support operational validations addressing the Separation Management concept.

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Rational for rejection

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00.00.02	29/08/2016	Final Draft	Indra	Draft update: comments from internal project partners have been implemented
00.01.00	05/09/2016	Final Version	Indra	Approved version
00.02.00	24/10/2016	Final Version	Indra	Version update after SJU assessment, operational and technical related projects review.

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This deliverable consists of SJU foreground.

Acronyms

Acronym	Definition
ACC	Area Control Centre
APP	Approach
ATC	Air Traffic Control
ATCO	Air Traffic Controller
ATM	Air Traffic Management
CD&R	Conflict Detection & Resolution
CTO	Control Time Over
DRA	Direct Routing Airspace
EAP	Extended ATC Planner
EGLL	Heathrow Airport
EN	Enabler
EPP	Extended Projected Profile
ER	En-Route
FIR	Flight Information Region
FRA	Free Routing Airspace
HMI	Human-Machine Interface
iTEC	interoperability Through European Collaboration
iFACTS	interim Future Area Controls Tools Support
IOP	Interoperability Protocol
LACC	London Area Control Centre
MTCD	Medium Term Conflict Detection
OI	Operational Improvement
OSED	Operational Service and Environment Definition
PC	Planning Controller
SESAR	Single European Sky ATM Research Programme

SJU	SESAR Joint Undertaking (Agency of the European Commission
SPR	Safety and Performance Requirements
TC	Tactical Controller
TCT	Tactical Controller Tool
TMA	Terminal Manoeuvring Area
TRACT	TRajectory Adjustment through Constraint of Time
UIR	Upper flight Information Region

1 Project Overview

The main P10.04.01 objectives were:

- Improve the Conflict Detection and Resolution Tools (CD&R Tools) specifications based on the new operational concepts,
- Provide verified prototypes for these tools supporting the validation of the new operational concepts and the performance targets specified by the operational projects.

The three services under definition were:

- Conflict Detection and Resolution Aid to Planning Controller (CD&R Aid to PC)
  - To support the individual and multi-sector Planning Controller,
  - To detect encounters between pairs of aircraft and between aircraft and airspace, considering trajectory uncertainty volumes and typically 20-30min time horizon,
  - To provide the Planning Controller with resolution aid tools.
- Conflict Detection and Resolution Aid to Tactical Controller (CD&R Aid to TC)
  - To support the Tactical Controller,
  - To detect encounters between pairs of aircraft and between aircraft and airspace, considering trajectory uncertainty volumes and a short time horizon (typically 5-10 min),
  - To provide the Tactical Controller with resolution aid tools.
- Conflict TRajectory Adjustment through Constraint of Time (TRACT)
  - To identify and resolve encounters without active Air Traffic Controller (ATCO) involvement, supported by trajectory prediction.

These new services offer ATCOs reliable predictions regarding the traffic situation in the near future in order to help to detect and also to resolve some of the detected encounters.

1.1 Project progress and contribution to the Master Plan

Focusing on CD&R Tools, the project was structured in three different phases using the same pattern in all of them.

Every phase started analysing the operational documentation in order to derive the operational requirements into technical requirements (functional and non-functional). The project analysed the operational requirements to identify:

- Improvement to existing functionalities, and
- New algorithms and performances.

Human Machine Interfaces (HMI) requirements related to CD&R tools were defined and included in the 10.04.01 technical specification.

To assure compliance and coverage of the operational requirements, traceability from technical requirements to the operational requirements defined in the Operational Service and Environment Definition (OSED) and Safety and Performance Requirements (SPR) documents, was maintained.

Based on the technical specification and the requested capabilities to support the validation exercises (from the validation plans), prototypes were developed and verified. The verification process determines that technical functionalities implemented in the prototypes met the technical requirements.

After the successful verification, the prototypes were accepted and were ready to be integrated in the validation platforms to support the operational validation. During operational validation, technical support was essential to integrate the prototype into the validation platform and tune it to correctly support the validation objectives used for the validation. After the validation exercise was finished and conclusions were ready, an update of the technical requirements was done.

During the first phase, the project compiled the CD&R baseline requirements set. Using the new operational Separation Management concept defined in SESAR, these technical requirements were updated focusing to improve the tools supporting Tactical and Planning Controllers to detect encounters and solve them in En-Route environments. Verified prototypes were developed to support different validation exercises:

- CD&R Aid to TC integrated in a validation platform based on iTEC (interoperability Through European Collaboration) was validated in Lower Airspace in Germany. The main validation objective was to assess the impact of CD&R aid to TC on:
    - En-route capacity;
    - Operability;
    - Human performance;
    - Safety;
    - Flight efficiency
    - Environmental impact.
- CD&R Aid to PC integrated in a validation platform based on iTEC (iFACTS, interim Future Area Controls Tools Support, version was integrated to support Tactical Controller) was validated in South-West Upper London airspace (UIR/IFR) including interface with the London TMA with Heathrow Airport (EGLL) holds. The main validation objective was to demonstrate the benefits for the CD&R aid to PC on:
    - En-route capacity;
    - Operational Acceptability;
    - Human performance;
    - Safety;
    - Flight efficiency.

In the second phase, the project was focused to refine CD&R technical requirements based on the refined operational Separation Management concept for En-Route environment. New prototypes were developed and verified to support different validation exercises:

- CD&R Aid to PC integrated in a validation platform based on iTEC (iFACTS version was integrated to support Tactical Controller) was validated in South-West London Area Control Centre (LACC) airspace including interface with the London TMA.

  The main validation objective was to demonstrate the benefits for the CD&R aid to PC on:
    - En-route capacity;
    - Operational Acceptability;
    - Human performance;
    - Safety;
    - Flight efficiency.

  The sectors used were each simulated in a collapsed configuration (one PC and one TC for each sector) resulting in four measured positions being simulated.
- CD&R Aid to PC integrated in a Coflight-based validation platform was validated in French and Italian airspaces.

The main validation objective was to assess part of Free Route (Direct Routing Airspace, DRA, and Free Routing Airspace, FRA) concept supported by the Conflict Detection and Resolution services to PC and TC. Also Precision Conformance Monitoring Service, “Extended ATC Planner” (EAP) concept for decomplexification measures and Interoperability Protocol (IOP) were validated in this validation exercise.

During the third phase, the Separation Management concept for TMA was included. Technical requirements were analysed and updated. Prototypes were developed and verified to be integrated in the validation platforms supporting the concept validation:

- CD&R Aid to PC was evaluated in a validation platform based on iTEC at the same time that conformance monitoring and what-if function. The Real Time Simulation was run on a Spanish scenario, En-route with TMA interface and TMA with Approach (APP) interface. The scenario had multiple and close-by airports

  The whole separation management concept was addressed, nevertheless it was focused on how the planner role can use the new tools and procedures for managing vertical constraints that typically contribute to the biggest decrease in flight efficiency.

In addition the CD&R Aid to PC was integrated in a validation platform based on iTEC to evaluate the Collaborative Control concept in TMA. The Real Time Simulation was run on a Spanish scenario, En-route with TMA interface and TMA with APP interface. Enhanced CD&R tools offer the opportunity to investigate the utilization of operational staff, including new roles for the Tactical and Planning Controllers within the team, to provide improvements in cost effectiveness, fuel efficiency and predictability due to better aircraft profiles.

Finally the technical requirements were revisited and updated to include the conclusions on the CD&R Tools for En-Route, TMA and Free Route environments.

With the system requirements and the prototypes developed the project contributed to increase the level of maturity of the following Enablers included in DataSet15 [4]:

Code	Name	Project contribution	Maturity at project start	Maturity at project end
ER ATC 157 (1)	ATC System Support for Medium-Term Conflict Detection and Resolution in En-route Airspace	Related to the Operational Improvement (OI) CM-02XX (2) focused on CD&R Aid to TC service in the En-Route environment. Technical requirements to detail the Enhanced CD&R Tools supporting TC detecting encounters between pairs of aircrafts, solving them and managing separation in the En-Route environment, were defined. A set of those requirements were implemented in prototypes, verified and integrated in different validation platforms. V3 validation was	TRL2	TRL6

(1) After solution #27 final scope and review, this enabler will be split in two parts: one to address the Tactical Controller Tool, TCT, considered as TC aid, ER ATC 157 will be keep and one to address the Medium Term Conflict Detection, MTCD considered as PC aid, ER ATC XXX name under definition. Due to time constraints, these new OIs will not belong to DS16 and will be published later, after the project closure.
(2) After solution #27 final scope and review, this OI will be split in two parts: one to address the TCT, temporary named CM-02XX and one to address the MTCD, temporary named CM-02YY. Due to time constraints, these new OIs will not belong to DS16 and will be published later, after the project closure.

		supported.		
ER ATC XXX (3)		Related to the OI CM-02YY (4) focused on CD&R Aid to PC service in the En-Route environment. Technical requirements to detail the enhanced CD&R Tools supporting PC detecting encounters between pairs of aircrafts, solving them and managing separation in the En-Route environment, were defined. A set of those requirements was implemented in prototypes, verified and integrated in different validation platforms. V2 validation activities were supported.	TRL2	TRL4
ER ATC 162	Ground ER ATC system is able to assign CTO to flights for early conflict resolution	Related to the OI CM-0403-A "Early Conflict resolution through CTO allocation in STEP1", focused on TRACT service. Technical requirements to detail TRACT service in the En-Route environment were defined.	TRL2	TRL3
APP ATC 155	ATC System Support to Medium-Term Conflict Detection and Resolution in the TMA	Related to the OI CM-0206 "Conflict Detection and Resolution in the TMA using trajectory data", focused on CD&R Aid to PC and TC services in the TMA environment. Technical requirements to detail the Enhanced CD&R Tools supporting TC and PC detecting encounters between pairs of aircrafts, solving them and managing separation in TMA environment, were defined. A set of those requirements were implemented in prototypes, verified and integrated in different validation platforms. Validation activities were supported and partial V2 maturity was achieved.	TRL2	TRL4

Project P10.04.01 developing the above Enablers (ENs) contributed to the following SESAR Solutions:

(3) After solution #27 final scope and review, this enabler will be split in two parts: one to address the TCT (TC aid), name will be kept as ER ATC 157 and one to address the MTCD (PC aid), name under definition ER ATC XXX. Due to time constraints, these new OIs will not belong to DS16 and will be published later, after the project closure.
(4) After solution #27 final scope and review, this OI will be split in two parts: one to address the TCT (TC aid), temporary named CM-02XX and one to address the MTCD (PC aid), temporary named CM-02YY. Due to time constraints, these new OIs will not belong to DS16 and will be published later, after the project closure.

- SESAR Solution #32: Free Route through the use of Direct Routing for flights both in cruise and vertically evolving for cross ACC borders and in high & very high complexity environments.
- SESAR Solution #33: Free Route through Free Routing for Flights both in cruise and vertically evolving within low to medium complexity environments.
- SESAR Solution #27: Enhanced Tactical Conflict Detection & Resolution (CD&R) services and conformance monitoring tools for En-Route (5).
- Solution #10-01C Collaborative Control
- Solution #10-02A: Improved Performance in the Provision of Separation

1.2 Project achievements

The main project achievements were focused on the technical requirements and prototype developments.

The project was working following an iterative process to produce a complete Technical Specification. This Technical Specification addressed following services:

- CD&R Aid to PC
- CD&R Aid to TC
- TRACT

supporting En-Route, TMA and Free Route environments.

The maturity achieved for these services and environments was not always the same:

- Conflict Detection and Resolution Aid to support Tactical Controller
    - En-Route: V3 level was successfully demonstrated allowing entering industrialisation (V4) as a next step.

      Prototype developed in 10.04.01 was correctly integrated in the validation platform to support the Real Time Simulation conducted in a realistic environment with traffic scenarios based on real traffic data.

      The validation results showed the operational benefits of the tools: workload decreased, situation awareness increased, safety improved. Acceptability, trust and reliability of the tools were on a satisfactory high level.

      In addition, it was considered these tools provided benefit to the Planning Controller from the display of potential conflicts and possible solution options. PCs could support their respective TCs efficiently, especially in peak situations.

      Solution #27 "Enhanced Tactical Conflict Detection & Resolution (CD&R) services and conformance monitoring tools for En-Route" was correctly supported.
- Conflict Detection and Resolution Aid to support Planning Controller:
    - En-Route and Free Route: V2 maturity was achieved.

      Different prototypes were developed in 10.04.01. These prototypes were integrated in the related validation platforms to support several Real Time Simulations.

      The validation results showed that tools supporting PCs provided the ATCOs an improvement compared to current operation, but the technical solution implemented

(5) At the time of the writing, solution #27 final title, as specified here, was not yet officially published. The action is however launched at SJU level.

in the tools requires additional work to be accepted by ATCOS, decrease workload, increased situation awareness and improve safety.

- TMA: partial V2 maturity was achieved.

  Prototype developed in 10.04.01 was correctly integrated in the validation platform to support the conducted Real Time Simulation.

  The validation results showed that tools supporting PCs provided the ATCOs an improvement compared to current operation in any TMA single or multi airport under MD/MC environment. HC/HD environment needs further developments.

- TRACT: V2 maturity was achieved. The new CD&R service designed to reduce number of conflicts was compatible with ATCOs work and it may be interesting to keep a decomplexification loop in the whole Air Traffic Control (ATC) process.

1.3 Project Deliverables

The following table presents the relevant deliverables that have been produced by the project.

Reference	Title	Description
D78	Conflict Detection and Resolution Tools System Requirements Refinement- R5	This document is the Enhanced Tools for Conflict Detection and Resolution Final Technical Specification in SESAR1. This document is an incremental update from the previous technical specification baseline performed in P10.04.01. It includes system requirements mainly for: - Conflict Detection and Resolution Aid to Planning Controller (CD&R Aid for PC) - Conflict Detection and Resolution Aid to Tactical Controller (CD&R Aid to TC) - TRajectory Adjustment through Constraint of Time (TRACT) derived from the related operational requirements developed in P4.7.2 (Separation Management in En-Route environment) and 5.7.2 (Separation Management in TMA environment). Also Free Route environment has been considered.

1.4 Contribution to Standardisation

No standardisation activities were performed within the scope of the project. Nevertheless the material produced (i.e. the technical specification) can be used as technical input to support any.

1.5 Project Conclusion and Recommendations

The project results are focused on CD&R Tools supporting the Separation Management Concept for En-Route, TMA and Free Route environments.

The project, as a technical project, developed system requirements and prototypes taking into account operational needs to support the delivery of the expected benefits defined in the ATM Master Plan.

For the En-Route environment it was proved, that Advanced CD&R Tools supporting Tactical Controller provided high operational benefits and improved teamwork. In addition, these tools focused on Tactical Controller provided a benefit for Planning Controller supporting the respective Tactical Controller in a more efficient way. It is concluded that tools developed in project 10.4.1 Phase1 supporting Tactical Controller could be implemented into an operational ATM system.

For the En-Route, TMA and Free Route environment it was proved, that Advanced CD&R Tools supporting Planning Controller provide operational benefits but need to be refined. The operational concept is considered mature but implementation requires additional work.

It is recommended to continue the investigation, definition, implementation and analysis activities focused on CD&R Tools to support the Separation Management concept for Tactical and Planning Controllers, in different team organisations for En-Route, TMA and Free Route environments. These investigations have to be focused to explore the reduction of undesired conflict to be displayed to the controller. Improvements have to be focused to correctly define the display, priorities and conflicts types. Also, improvements in trajectory prediction, using Extended Projected Profile (EPP) and wind data, are essential to achieve this objective.

2 References

[1] SESAR Programme Management Plan, Edition 03.00.01

[2] European ATM Master Plan

[3] Multilateral Framework Agreement ("MFA") signed between the SJU, EUROCONTROL and its 15 selected members on August 11, 2009, amended on 14 June 2010, 19 October 2010 and 2 July 2012

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