Final Project Report

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Abstract

The aim of this project was to specify, develop and verify a prototype focused on the Runway Demand and Capacity Balancing as part of the Airport Demand and Capacity Balancing concept, with the objective to optimize runway throughput. The project provided the technical requirements needed for developing a system able to obtain the optimal runway configuration for the following hours according to the expected traffic demand by optimising the distribution of arrival and departure flow over all available runways taking into account meteorological inputs and operational rules previously defined by users.

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This deliverable consists of SJU foreground.

Acronyms

Acronym	Definition
A-DCB	Airport Demand and Capacity Balancing
AOP	Airport Operations Plan
APOC	Airport Operations Centre
ATM	Air Traffic Management
ATS	Air Traffic Service
DCB	Demand and Capacity Balancing
DLR	Deutsches Zentrum für Luft-und Raumfahrt
EN	Enabler
EXE	Exercise
FLDT	Forecasted Landing Time
FTOT	Forecasted Take-off Time
HMI	Human Machine Interface
INTEROP	Interoperability Requirements
KPA	Key Performance Area
KPI	Key Performance Indicator
OFA	Operational Focus Area
OI	Operational Improvement
OSED	Operational Service and Environment Description
RMAN	Runway Manager
RWY	Runway
SEAC	SESAR European Airports Consortium
SESAR	Single European Sky ATM Research Programme
SJU	SESAR Joint Undertaking
SPR	Safety and Performance Requirements
SWIM	System Wide Information Management

TRL	Technology Readiness Level
TWR	Tower

1 Project Overview

This project has been focussed on the definition, development and verification of a Runway Manager (RMAN) that provided the optimal runway configuration able to accommodate the expected demand taking into account the available capacity, meteorological inputs and operational rules.

1.1 Project progress and contribution to the Master Plan

The technical project "Runway Management Tools" was focused on the specification, development and verification of a prototype based on the Runway Demand and Capacity Balancing operational concept.

Since the beginning, the objectives of this project were to:

- Provide in advance the optimal runway configuration according to the factors affecting the runway (weather, infrastructure, maintenance…) that will enable to accommodate the expected demand while reducing delays.
- Monitor and manage the configurations proposed identifying any possible imbalance to take corrective actions.
- Calculate the available capacity and provide capacity forecasts for the following hours to optimize runway throughput.
- Assist the Tower Supervisor with decision support tools in managing and optimizing the runway configurations according to the arrival and departure demand during short term and execution phase by using what-if mode.
- Notify any imbalance detected to external systems such as queue distributors (Arrival and Departure Managers) or Airport Operations Plan (AOP), in order to take appropriate actions

To achieve these objectives a stepwise approach in two phases was agreed according to the maturity of the operational concept, the stakeholders involved in the project were assigned to project tasks according to their expertise.

Each phase was composed of a Technical Requirements definition, implementation of an evolutionary prototype developed by each Ground Industry participating in the project (Indra and Finmeccanica), and the Verification Plan and Report covering factory acceptance test activities.

In the initial phase a preliminary set of system requirements were produced according to the initial requirements provided by the operational project. The technical specification included a decomposition of functionalities (DCB Monitoring, DCB Management, DCB Recording and Human Machine Interface) that would form the basis for the prototype development.

This phase resulted in two prototypes, successfully verified, that addressed the first set of validation activities whose objective was mainly to validate the operational concept in isolation.

In the second phase, the system requirements and both prototypes were evolved according to the results and findings from the validation exercises in order to address integrated validations.

A total of 4 validation exercises were supported by 12.02.01 project.

During its lifecycle, the project has contributed to the Enablers (ENs) listed in the following table. These ENs were linked to the Operational Improvement (OI) Step DCB-0309 "Airport Demand Capacity Balancing (A-DCB)".

Code [4]	Name	Project contribution	Maturity at	Maturity at

			project start	project end
AERODROME-ATC-64	Medium-Short Term Runway Management capacity planning support tool	Specification and implementation of the DCB Management functionality, part of the Runway Manager, which calculated and provided the runway configuration that best fits with the expected demand during medium-short term.	TRL3	TRL6
AERODROME-ATC-65	Tactical Runway Management capacity planning support tool	Specification and implementation of the DCB Monitoring functionality, part of the Runway Manager, that monitored the Runway configurations previously calculated that best fits with the demand and proposed any change to the Tower supervisor when an imbalance was detected.	TRL3	TRL6

Through its work on Airport DCB and the SWIM Service RunwayManagementInformation, project 12.02.01 contributed to SESAR Solutions #21 "Airport Operations Plan and AOP-NOP Seamless Integration" and #46 "SWIM Yellow Profile" respectively.

1.2 Project achievements

In order to fulfil the project objectives, the definition and implementation of the Runway Manager was based on searching algorithms able to look for an optimal Runway Configuration along time, based on arrival and departure demand while considering additional external information such as meteorological conditions, operating rules & procedures, constraints and airport preferences.

The main objective during the first phase was the definition and implementation of the core. The calculus of forecasted runway times, Forecasted Landing Time (FLDT) for arrival flights and Forecasted Take-off Time (FTOT) for departure flights, was the baseline to generate and continuously update the optimal runway configuration planning that best coped the expected demand with the existing capacity. Additionally three Key Performance Indicators (KPIs), Shortage, Delay and Punctuality, were calculated and monitored for detecting imbalances; and a what-if mode was implemented allowing the Tower Supervisor to manage and optimize new runway configuration proposals.

In the first set of validations performed by the operational project several improvements were identified such as, stability of selected runway system to prevent switching runways as much as possible, what-if with manual adjustment or capacity and KPI calculations per time period.

During the second phase of the project, the findings from previous phase were solved and the HMI was improved. The DCB management loop between RMAN/AOP and the integration of RMAN in the Airport Performance Monitoring process were implemented and validated by simulating RWY capacity reductions due to weather conditions in different points of time causing imbalances and consequently generating alerts for decision making by the Airport Operator and Tower Supervisor.

Along the project, contributions have been made to the definition, verification and validation of the RunwayManagementInformation service. This service enables to inform interested parties via SWIM such as Network Manager, Airport Operations Centre or En-Route/Approach ATS units about runway information such as Arrival and Departure Capacity and Runway configuration.

1.3 Project Deliverables

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

Reference	Title	Description
D34	P3_Final System Requirements	The Final Technical Specification [[8] gathers the final requirements collected along the project to be used for the implementation of the Runway Management Tool*. The requirements included in the document details the Human Machine Interface, DCB Monitoring, Management and Recording functions that have been derived from the Airport DCB operational concept and updated along the lifecycle of the project in the SESAR Programme.

* Due to the tight schedule at the end of the SESAR Programme it was not possible to include the results obtained from the last V3 validations in the Final Technical Specification.

1.4 Contribution to Standardisation

Along the lifecycle of the project no standardisation activity related to the Runway Management concept has been identified

1.5 Project Conclusion and Recommendations

Different validation exercises performed with the RMAN prototypes highlighted that the tool was foreseen to be located at airports with complex runway layout or with high level of interdependencies between runways, since the efficiency and usefulness for the user was high insofar the number of possible runway combinations increased, although that does not prevent to be adapted to other, less complex, airports.

It has been proven that once the prototype was fully calibrated according to local conditions and airport restrictions, the RMAN was able to monitor the operations during medium, short and execution phases, detecting deviations from planned data and generating alerts when thresholds were crossed. Also the KPIs calculated and shown by RMAN were considered very useful to Tower Supervisors and Airport Operators when taking a decision that is usually based on experience of the Tower Supervisor.

Considering the integration of RMAN into the airport environment, the DCB management loop between RMAN and APOC through the Airport Operations Plan (AOP) was successfully validated so as the integration of RMAN in the Airport Performance Monitoring process. However there is a pending issue about the full integration of information provided by RMAN as a planning tool with other tools such as Arrival and Departure Queue Managers or Surface Manager, this integration is planned to be addressed in SESAR2020.

Another point still pending from a technical point of view is the calculation of the Practical Capacity, the number of aircraft operations during a specified time period corresponding to a tolerable level of average delay, in order to have a more complete tool. Practical capacity could be automatically calculated by RMAN, although it was obtained from files during validations because the procedure proposed by the operational project was not generic and it had dependencies with other tools that were not considered. It was agreed to postpone the calculus to SESAR2020 in order to address the best procedure to do it in a generic way

Additionally the project successfully verified and validated the RunwayManagementInformation service that enables to inform via SWIM about runway information such as Arrival and Departure Capacity and Runway configuration.

As a general conclusion gathered during the iterative validations, RMAN has demonstrated to be a useful tool to assist Tower Supervisors in optimising runway capacity according to demand, reducing the workload and uncertainty of deciding a Runway Configuration based on experience while optimising runway throughput and reducing delays. However this document was delivered before any of the V3 Validation Reports were available and it is not possible to detail and provide quantified data of the results obtained from the validation. For more information it is necessary to check their respective validation reports. The final results from these validations could conclude that some requirements have not reached TRL6 yet. This issue needs to be studied and taken into consideration for further developments.

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

[4] B.01.D84 - Integrated Roadmap DS16 Release Note, 00.01.00, 25/05/2016

[5] 06.05.04.D16 – OFA 05.01.01 Consolidated OSED Edition 3, 00.03.01, 08/04/2015

[6] 06.05.04.D19 – OFA 05.01.01 SPR Edition 2, 00.02.01, 09/07/2015

[7] 06.05.04.D20 – OFA 05.01.01 INTEROP Edition 2 document, 00.02.05, 08/07/2015

[8] 12.02.01.D05 - P2_Technical Specification, 00.01.00, 27/02/2014

[9] 12.02.01.D08 - P2_Indra Prototype Availability Note, 00.01.00, 09/06/2014

[10] 12.02.01.D09 - P2_RMAN Availability note, 00.01.00, 10/10/2014

[11] 12.02.01.D10 - P2_ Indra Verification Plan, 00.01.00, 23/05/2014

[12] 12.02.01.D11 - V2_Selex Verification Plan,00.01.00, 10/10/2014

[13] 12.02.01.D12 - P2_Test Cases Specification, 00.01.00, 26/05/2014

[14] 12.02.01.D13 - P2_Indra Verification Report, 00.01.00, 09/06/2014

[15] 12.02.01.D14 - P2_Selex Verification Report, 00.01.00, 03/11/2014

[16] 12.02.01.D32 - P2_Indra Support to Validation, 00.01.00, 02/09/2014

[17] 12.02.01.D33 - P2_Selex Support to Validation, 00.01.00, 28/10/2014

[18] 12.02.01.D18 - P3_Initital System Requirements, 00.01.00, 02/07/2015

[19] 12.02.01.D21 - P3_Indra Prototype Availability Note, 00.01.00, 02/10/2015

[20] 12.02.01.D22 - P3_Selex Prototype Availability Note, 00.01.00, 21/12/2015

[21] 12.02.01.D23 - P3_Indra Verification Plan, 00.01.00, 23/09/2015

[22] 12.02.01.D24 - P3_Selex Verification Plan, 00.01.00, 01/12/2015

[23] 12.02.01.D25 - P3_Test Cases Specification, 00.01.00, 18/09/2015

[24] 12.02.01.D26 - P3_Indra Verification Report, 00.01.00, 02/10/2015

[25] 12.02.01.D27 - P3_Selex Verification Report, 00.01.00, 13/01/2016

[26] 12.02.01.D34 - P3_Final System Requirements, 00.02.00, 12/04/2016

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