ACF: Final Project Report WP-E

Document information	
Project Title	Project Title
Project Number	E.2.38
Project Manager	NLR
Deliverable Name	ACF: Final Project Report
Deliverable ID	D4.3
Edition	00.00.02
Template Version	03.00.00
Task contributors	
NLR, ENAC, GESAC	

Abstract

The final report of the ACF project provides a publishable summary of the results. In addition it lists all deliverables, dissemination activities, eligible costs, deviations, bills and lessons learned.

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Document History

Edition	Date	Status	Author	Justification
00.00.01	14/06/2015	Draft	[redacted]	New Document
00.00.02	23/06/2015	Final	[redacted]	Final version

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This deliverable consists of SJU foreground.

Table of Contents

List of tables

List of figures

No reference list of figures present.

Publishable Summary

For preparing operations at airports, plans are made by each stakeholder to ensure that operations are running smoothly. These plans concern the allocation of personnel and the use of infrastructure and other resources to cater for expected demand. In case of disrupted operations, caused by e.g. bad weather or strikes, it is important to have precise information on the available capacity so that actions can be taken in advance to ensure that aircraft and passengers experience as little as possible from the disruption and that the infrastructure and resources that are still available, will be used in an optimum way.

Airport Capacity Forecast (ACF) concerns the forecasting of available infrastructure and resources, in quantitative terms, based on probabilistic inputs from meteorological forecast and operational information, together with information on planned events, like maintenance and strikes. Forecasting concerns the availability of infrastructure and resources in normal daily operations, for anticipated disruptive events and for the recovery from disruptive events. The envisaged time frame of the forecast is one hour up to two days in the future.

Airport Capacity Forecast deals with infrastructure and resources for all airport activities on airside and landside operations and will be relevant to all airport stakeholders involved in the organisation and planning of passenger and aircraft movements. The project focusses on three use cases:

- runway management
- security passage
- de-icing

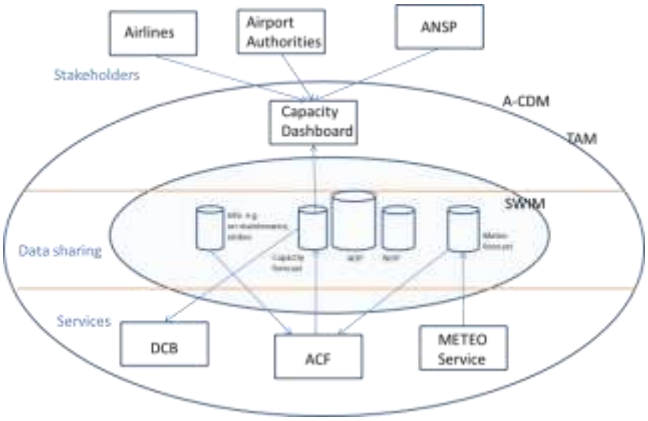
Two workshops have been organised. The first aimed at determining what use cases would be most interesting to investigate in the project and the second aimed at presenting the results and receiving feedback on the design. Both workshops aimed at participation from airport, airlines and ANSPs.

In the first phase of the ACF project, the modelling phase, other airport elements have been considered for capacity forecasting as well: taxiways, gates, ground handling, snow removal, check-in, baggage drop-off, and border control. A generic model of the airport capacity forecasting has been defined, in terms of a capacity tree, where both the relation between all elements as well as the overall architecture have been depicted.

After setting up the general architecture for ACF, each airport element has been further elaborated up to the level of the architecture model. The principle of each airport element is that the forecasting is performed in two steps:

1. Probabilistic information on forecasted events is input to the system to determine the strategy that will be taken in the future operation. A strategy may for example be the number of runways to be used and their operation mode (take-off, landing, mixed mode) or the number of de-icing spots that will be opened.
2. The availability of resources for each process then determines the forecasted capacity. Each forecast is associated with a confidence or probability.

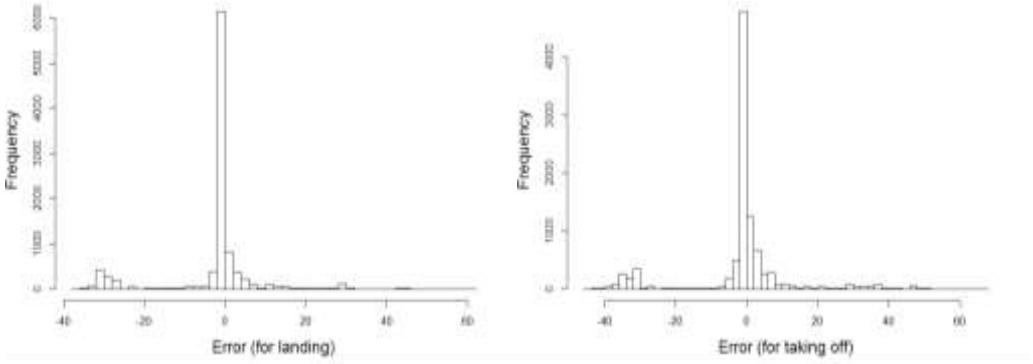
The figure below depicts the architecture of the ACF system. The figure divides the system into a three tier model, where the stakeholders as ANSPs, airlines and airport authorities are shown on top and connected to the system through use of the capacity dashboard. The dashboard in the figure is connected to the *capacity forecast* data sharing element, but will also be connected to the other elements of the Network Operation Plan (NOP) and Airport Operation Plan (AOP). Any forecast information will be made available through a System Wide Information Management (SWIM) layer, to e.g. Demand and Capacity Balancing (DCB). The overall system will be included in the context of novel airport operations such as Airport Collaborative Decision Making (A-CDM) and Total Airport Management (TAM).



The forecasted information for each process is presented at a dashboard. The main requirements for the dashboard were to present all airport elements in a comprehensive overview, to give a look-ahead of 48 hours and to include uncertainty in the presentation.

The results of the *Airport Capacity Forecast* project are twofold: evaluation of the quality of a probabilistic forecast and design of a user interface in the form of a dashboard.

Capacity forecast is evaluated through a large dataset of weather forecasts and runway use, available for Amsterdam Airport Schiphol for the period of 2012 and 2013. The figures below show for the arrival and departure peaks the histograms of errors: 'actual capacity' – 'forecasted capacity' (for each hour in the evaluation period).



The Mean Absolute Percent Error (MAPE), which is the mean of these values (|actual-forecasted| / actual) are observed as follows:

- MAPE (arrival) = 12.88 %
- MAPE (departure) = 15.32 %

This shows that capacity can be forecasted well for runway configurations The use cases for de-icing and security have been evaluated to a lesser extent, as less data was available for the evaluation, but also show some similar figures as for the runway use case.

After the theoretical and mathematical work in the project, a dashboard with indicators has been set up that enable an overview of the airport capacity forecast for all processes. The view shows an overview of the airport as a whole for the upcoming 48 hours. The figure below shows the capacity overview for all airside related processes.

The visualization of the dashboard will largely depend on the environment in which the forecasting will be integrated. In a larger operating environment, such as Total Airport Management (TAM), the forecasting element will become part of the cooperation and planning systems. Methods and presentation will have to connect to that of TAM. In a broader context, the capacity forecast may become part of a larger airport capacity forecast system.

Concluding, the capacity forecast has been proven to be possible with high accuracy. The work described here will be beneficial to airports and airspace users, who will be able to better plan their resources. It will bring automation of airport operations to a higher level and enable further automated planning of the operations. A higher predictability of the operations can be expected as the adherence levels to target times will lead to increased predictability for planning functions in Arrival Management (AMAN), Collaborative Pre-Departure Sequencing (CPDS), DCB and A-CDM.

The proposed dashboard enables display of forecasted information in a comprehensive way, while including information on the confidence in the information. This dashboard is regarded a good basis for a software environment in which capacity forecasting is a common reference to all tools, but also demand forecasting, what-if reasoning and planning tools can be integrated in the same environment. In future steps, more airport processes and more tools will be integrated in the ACF software environment.

1 Introduction

1.1 Purpose of the document

The purpose of this document is to:

- Summarise the technical results and conclusions of the project (Publishable Summary);
- Provide a complete overview of all deliverables;
- Provide a complete overview of all dissemination activities (past and in progress). Where appropriate, provide feedback from presentations. Describe exploitation plans.
- Provide a complete overview of the billing status, eligible costs, planned and actual effort (incl. an explanation of the discrepancies).
- Analyse the lessons learnt at project level.

1.2 Intended readership

This document is intended to be read by SESAR, EC and EUROCONTROL to get an overview of the contents and main results of the ACF project.

1.3 Inputs from other projects

As this document is a summary document, no inputs from other projects are considered.

1.4 Glossary of terms

Capacity

The term capacity in its most general sense refers to the quantitative measure for supply of service of a processing unit to accommodate sustained demand: the maximum throughput or supply of service over a specified period of time under given service conditions.

Operational capacity

The term "operational capacity" refers to the actual capacity that can be reached from use of the infrastructure element or resource. The operational capacity recognises that with adding more infrastructure also increases the overall complexity. Limitations because of operational constraints apply.

Declared Airport Capacity

Declared airport capacity is the capacity per hour used in specifying the number of slots available for schedule coordination purposes. It takes into account airport infrastructure, typical operating conditions, accepted delay and political issues. Declared capacity can vary throughout the day accounting for inbound or outbound peak periods, off peak periods or night time.

2 Technical Project Deliverables

Table 1 provides a list of technical project deliverables, excluding management deliverables such as progress reports, gate report or this final report.

Number	Title	Short Description	Approval status
D1.1	ACF operational concept description	D1.1, *ACF Operational Concept Description*, E.02.38-D1.1-Operational Concept Description, ed. 00.01.01, approved on 18 March 2014	Approved
D2.1	ACF system architecture description	D2.1, *ACF System Archicture Desciption*, E.02.38-D2.1-System Architecture Description, ed. 00.01.00, delivered on 15 May 2014	Approved
D2.2	ACF capacity model descriptions	D2.2, *ACF Capacity Model Descriptions*, E.02.38-D2.2-Capacity Model Descriptions, ed. 00.01.00, delivered on 15 May 2014	Approved
D3.1	ACF demonstrator	Workshop nr. 2 and Final Gate	Open
D3.2	ACF test scenarios and data	Workshop nr. 2 and Final Gate	Open
D3.3	ACF dashboard	Workshop nr. 2 and Final Gate	Open
D4.1	ACF web portal	E.02.38-D4.1 *Web portal*, ed. 00.00.03 (www.acf-project.eu) , delivered on 16 April 2014	Submitted

Table 1 - List of Project Deliverables

3 Dissemination Activities

3.1 Presentations/publications at ATM conferences/journals

The ACF project was present at both SESAR Innovation Days that were organised during the duration of the project:

- Poster at SESAR Innovation Days 2013, Stockholm, 26-28 November 2013.
- Paper at SESAR Innovation Days 2014, Madrid, 25 – 27 November 2014.

SESAR Innovation Days 2013, Stockholm:

The poster that was presented at the SESAR Innovation Days 2013 can be found in appendix A. The poster session was well organised in such that the posters were available in the same room as the conference lunch and welcome drinks. This attracted many visitors, including the SESAR program director at that time.

SESAR Innovation Days 2014, Madrid:

The paper “Airport Capacity Forecast, Short-term Forecasting of Runway Capacity” by H.H. Hesselink (NLR), J.M. Nibourg (NLR), L. d’Estampes (ENAC) and P. Lezaud (ENAC) was presented. The paper has been published as proceeding for the conference and as NLR-TP-2014-538. The paper presented the results of ACF on forecasting runway capacity, which at most airports is the major factor for the overall airport capacity. The possibility to model forecast runway capacity, based on probabilistic inputs, has been investigated with a lead time up to two days.

3.2 Presentations/publications at other conferences/journals

No presentations or publications in other than those mentioned in section 3.1 have been prepared.

3.3 Web presence

A dedicated web site has been set up at www.acf-project.eu.

The project has a group on LinkedIn, called airport capacity forecast. At the moment this report is published, the number of group members is 47 (June 2015).

3.4 Demonstrations

The first project appearance was at a workshop that was organized by ACF: the first end user workshop. This workshop was held on 24 September 2013 in Amsterdam with participants from airports, airlines and industry. The aim was to discuss the first ideas of the project and give direction to further research areas. Most important result: the three use cases have been decided here.

Follow on visits have been made to:

- KLM, Amsterdam/Schiphol, 14 November 2013
- Amsterdam Airport Schiphol, Amsterdam/Schiphol, 21 November 2013
- Finnair, Helsinki/Vantaa, 25 November 2013
- LVNL (Dutch ANSP), Amsterdam/Schiphol 14 October 2014
- Pulkova airport, St. Petersburg, at a management training, 4 December 2014

To discuss the project and to provide mutual information on planning systems and to discuss cooperation, some parties have visited NLR in Amsterdam:

- Scamander, January 2014
- ORTEC, December 2014

The ACF-dashboard was only finished late in the project and was presented at a few occasions:

- ACF Workshop 2, Naples, 23 April 2015, see below
- Visit of INM (Ministry of Infrastructure), Amsterdam, 8 April 2015: Demonstration of the dashboard and possible application to the Dutch government portal for infrastructure data

The most important presentation of the project results was at the second end user workshop, which aimed at demonstration of the dashboard and discussion with end users and industry on open research questions. A discussion with the participating end users was set up to answer questions about applicability.

The project and the dashboard were well accepted by the participants to the second workshop. Good discussions on the contents of the work and the exact way to display information emerged.

3.5 Exploitation plans

Exploitation of the results is expected as follows.

For NLR:

- Encapsulate the software in a larger “toolset” of runway management tools.
- Maintenance of the dashboard to allow further development.
- Further explore the research in capacity management.
- Participation to SESAR Exploratory Research proposals and SESAR Industrial Research (PJ.04, ...).
- Participation to H2020 proposals.
- Presentation of the full results at a scientific conference.
- Maintenance of the web site and the LinkedIn group.

For ENAC:

- Further explore the research in capacity management.
- Participation to SESAR Exploratory Research proposals and to H2020 proposals.
- Use of the capacity management and dashboard software in training material.
- Presentation of the full results at a scientific conference.

For SECAC:

- Installation of the ACF dashboard within the operational environment for security planning.
- Elaboration of the security use case
    - What kind of decisions can be made.
    - What is the effect of decisions (what-if).
- Use of the ACF results in discussions with suppliers for new functionality.

4 Total Eligible Costs

This section is based on the Project Costs Breakdown Forms of the eligible costs incurred by project participants.

Date	Deliverables on Bill	Contribution for Effort	Contribution for Other Costs (specify)	Status
10 April 2014	D0.1, D0.2, D1.1, D4.1, D4.2.1	€ 130,595.30 (incl. VAT)	€ 6,190.64 (travel) (incl. VAT)	Paid
27 November 2014	D0.3, D0.4, D2.1, D2.2	€ 227,886.60 (incl. VAT)	€ 4,143.81 (travel) (incl. VAT)	Paid
	D0.5, D0.6, D0.7, D0.8, D3.1, D3.2, D3.3, D4.2.2, D4.3			Billed or paid
GRAND TOTAL				

Table 2 - Overview of Billing

Company	Planned man-days	Actual man-days	Total Cost	Total Contribution	Reason for Deviation
NLR	370				
GESAC	110				
ENAC	312				
GRAND TOTAL	792				

Table 3 - Overview of Effort and Costs per project participant

5 Project Lessons Learnt

What worked well?
Participation of operational party (GESAC) provides possibility for operational feedback, e.g. at workshops, and thus give the possibility for more contents in the discussion.
The dashboard took some time to develop, but eventually has proven to provide a good presentation of forecasted airport capacity in a comprehensive overview.
At some moments in the project, a more intense communication between partners is necessary, where regular (always the same day + time) telecons after some time prove to be useful.
The workshops provided the possibility for contacts with external parties. Both project workshops have resulted in follow on contacts.
Airport capacity forecasting is possible.
What should be improved?
Further work on a generic airport capacity forecasting model is possible. The generic model that was proposed in the project could be further developed to allow other airport processes to be included as well.
Forecasted capacity information must be combined with information on expected delays to enable better decision making. Possibly what-if reasoning should be included in a full system for airport capacity forecast.
Contacts with other SESAR projects on their contents (e.g. 6.6.2 on de-icing and 12.2.1 on display of KPIs – dashboard) have been limited because of legal issues.
Other SESAR projects could have provided more operational data, it was not easy to get data for the three use cases.
Travel budget was limited for the project. More face to face project meetings would have been good.

Table 4 - Project Lessons Learnt

6 References

[1] Hesselink, H.H., J.M. Nibourg, L. d'Estampes and P. Lezaud, Airport Capacity Forecast, Short-term Forecasting of Runway Capacity, SESAR Innovation Days, Madrid, 25-27 November 2014, and NLR-TP-2014-538.

Appendix A ACF Poster