Nationaal Lucht- en Ruimtevaartlaboratorium
National Aerospace Laboratory NLR

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OPAL
Optimisation Platform for Airports including Landside

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Summary

This document gives an overview of the project OPAL (Optimisation Platform for Airports including Landside). The project OPAL is a project in the European Commission's Fifth Framework Programme.

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1 Introduction

The ever-increasing growth in air traffic demand shows the vulnerability of the air transport infrastructure: airports are becoming the prime and foremost choking points within the air transport system. Growth in air-traffic demand is not expected to slow down. Despite a recent dip due to the incidents on September 11, 2001, air traffic demand is foreseen to increase by about 4% per year for the next 15 years (cf. [1]). To cope with this growth, airport capacity must increase. However, increased capacity puts additional pressure on maintaining at least the current safety and noise levels. Furthermore, society even forces airports to increase safety and to reduce the burden of their operations on the environment.

To increase airport capacity while maintaining the current safety levels and reducing the burden on the environment, airports may change their infrastructure through the construction of new runways and terminals, and/or they may change airport processes. Such changes are likely to have huge impacts on the overall airport process (i.e., on both the airport airside and landside operations). To study these impacts and to preclude the start of unnecessary (and sometimes irreversible) changes and a waste of scarce resources, the major airport stakeholders (airlines, air traffic service providers, and airport operators) put forward an urgent need for some sort of tool to evaluate the overall airport process. They experienced a lack of insight in the integrated set of airport processes and the individual airport processes. For instance, to increase the airport capacity one might think of increasing the runway capacity, say, by new air traffic control measures. Traditionally, only dedicated airside modelling tools evaluated the effects of those measures on the airside capacity, however, the subsequent increased passenger flows within the terminal or consequences on security measures could not simultaneously be studied. Landside modelling tools, if existent, had no link whatsoever with the airside modelling tools at hand. This precluded a study of the entire airport process, and thus precluded an optimisation of the entire airport’s efficiency.

The European Commission (Directorate General for Transport and Energy) recognised the need for a platform that will allow airport stakeholders to evaluate the efficiency of the entire airport complex. In response to this need, it funded the research project OPAL (Optimisation Platform for Airports including Landside). The major objective of the project OPAL is to provide a generic concept for the development of a decision support system for total airport performance analysis. Within the framework of this project, a user-oriented platform is being developed that allows the integration of airport modelling tools in order to model and to evaluate simultaneously airport airside and airport landside, and their interaction. This platform is called the OPAL platform. It provides the ability to integrate capacity and delay-oriented tools with others, analysing environmental, safety, and cost-benefit impacts of airport operations.

Furthermore, the OPAL platform concept is applied to six major European airports: Amsterdam-Schiphol, Athens International Airport, Frankfurt, Madrid-Barajas, Palma de Mallorca, and Toulouse-Blagnac.

The project OPAL is a project in the Fifth Framework Programme of the European Commission. It started in May 2000 and is planned to end in October 2002. A consortium consisting of 16 partners from 7 countries is carrying out the project activities (cf. [2]).

This paper describes the OPAL platform as developed and built within the project OPAL, and it is organised as follows. Section 2 describes the architecture of the OPAL platform. Section 3 sketches the use of the platform. Section 4 provides the present status and a summary of the project activities to date.

2 OPAL platform

As mentioned in the introduction, the OPAL platform is a decision support facility for total airport performance analysis. It integrates existing airport modelling tools and enables the combined use of these tools in order to assess the overall performance of an airport. Figure 1 illustrates the architecture of the OPAL platform.

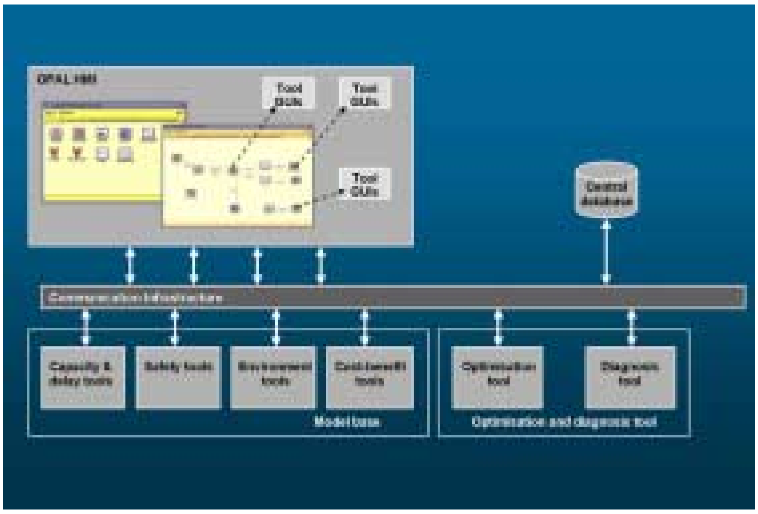

Figure 1: OPAL platform architecture

The OPAL platform comprises five major components: the human-machine interface (HMI), the model base, the database, the optimisation and diagnosis tool, and the scenario manager.

The OPAL HMI is the gateway to the platform and presents the platform as a single virtual computer on the user’s desktop computer. Through the HMI the user gains access to the OPAL platform, and can define a scenario for evaluation and select the airport modelling tools to be used for this evaluation. Moreover, the HMI enables the user to have access to these tools, retaining the tools’ graphical user interfaces, and it presents the results of the evaluation to the user.

The OPAL model base consists of four modules: capacity and delay, safety, environment, and cost-benefit. Figure 2 displays the internal and external relationships and interactions between these modules. Each module may contain a number of stand-alone and state-of-the-art airport modelling tools. For the purpose of the project OPAL, the following simulation and analytical tools are used in the OPAL platform:

- Capacity and delay:
  - MACS (Macro Cargo Simulator)
  - MACAD (MANTEA Airfield Capacity and Delay)

  - PAX/BAX (Passenger/Baggage Flow Model)
  - PowerSim (System Dynamics Passenger Flow Model)
  - SLAM (Simple Landside Aggregate Model)
  - SIMMOD (Airport and Airspace Simulation Model)
  - TAAM (Total Airspace and Airport Modeller)
  - Witness-MODA (Passenger Flow Model);
- Safety:
  - TOPAZ-TAXIR (Traffic Organisation and Perturbation Analyzer)
  - TRIPAC (Third Party Risk Analysis Package for Aircraft Accidents around Airports)
- Environment:
  - INM (Integrated Noise Modeller)
- Cost-Benefit:
  - CBM (Cost-Benefit Model)

Typically, the airport modelling tools may require different hardware platforms and operating systems. Moreover, these tools may be located at geographically different sites (due to, e.g., licence and proprietary issues). Hence, the OPAL platform may operate in a heterogeneous and distributed computer network. The scenario manager (to be addressed later on) has to enable such operations.

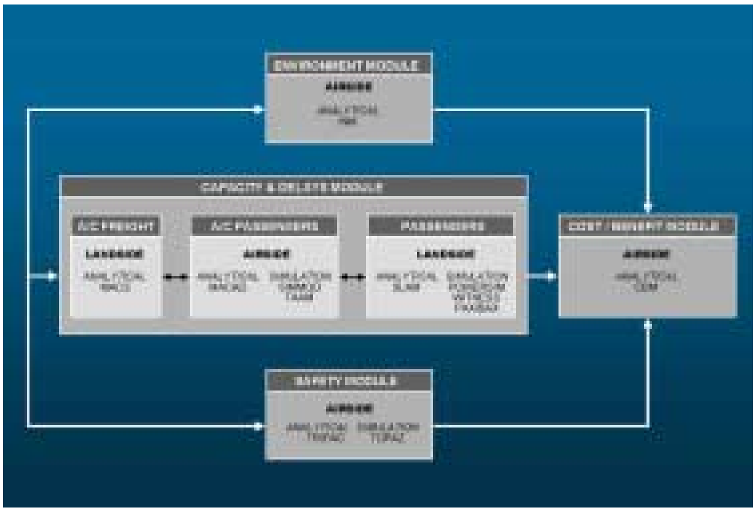

Figure 2: OPAL model base

The OPAL central database constitutes the intermediair between airport modelling tools and is the main integrating component of the OPAL platform. Each airport modelling tool can communicate with this database in order to retrieve (part of the) input data and to store (part of the) output data. In this way, the database is used to exchange data between tools: storing output data of one tool that are used as input data for another tool. As a result, any airport modelling tool can be integrated into the OPAL platform, provided that it can communicate with the OPAL central database. Further, as part of defining a scenario, the database is used to store common data elements.

The OPAL platform contains an optimisation and diagnosis component. This optimisation part enables the user to optimise an airport configuration, given a scenario, the selected airport modelling tools, and an optimisation criterion (e.g., level of service, safety, noise, and cost). Three kinds of optimisation studies can be performed:

- One-parameter: the user selects one parameter (e.g., number of gates, number of check-in counters, and number of security controls in service) and sets the range of variation of this parameter in which the optimum has to be found.
- Two-parameter: similar as the one-parameter, but now with two parameters to be selected.
- Ranking/what-if: seeking the best alternative within a prespecified set of alternative scenarios.

The diagnosis component enables the user to identify the bottlenecks in the overall airport complex.

The OPAL scenario manager activates, monitors and controls the selected airport modelling tools in a simulation. As mentioned before, it has the ability to operate these tools irrespective of the hardware platforms and operating systems as required by the individual tools. Furthermore, it operates in a distributed computer network: the tools may not be located at a single site. The implementation of the OPAL scenario manager is based on the functionality provided by the middleware SPINEware (cf. [3]). Further, in order to support secured communication, the OPAL platform applies the ssh protocol (cf. [4]).

3 Use of OPAL platform

The use of the OPAL platform can be divided into three steps:

- Scenario preparation
- Scenario execution
- Scenario evaluation

The scenario preparation concerns the definition of a scenario and the selection of the airport modelling tools. The OPAL HMI enables the user to define the scenario and to select the airport modelling tools for evaluation (see Figure 3). The scenario is stored in the OPAL central database.

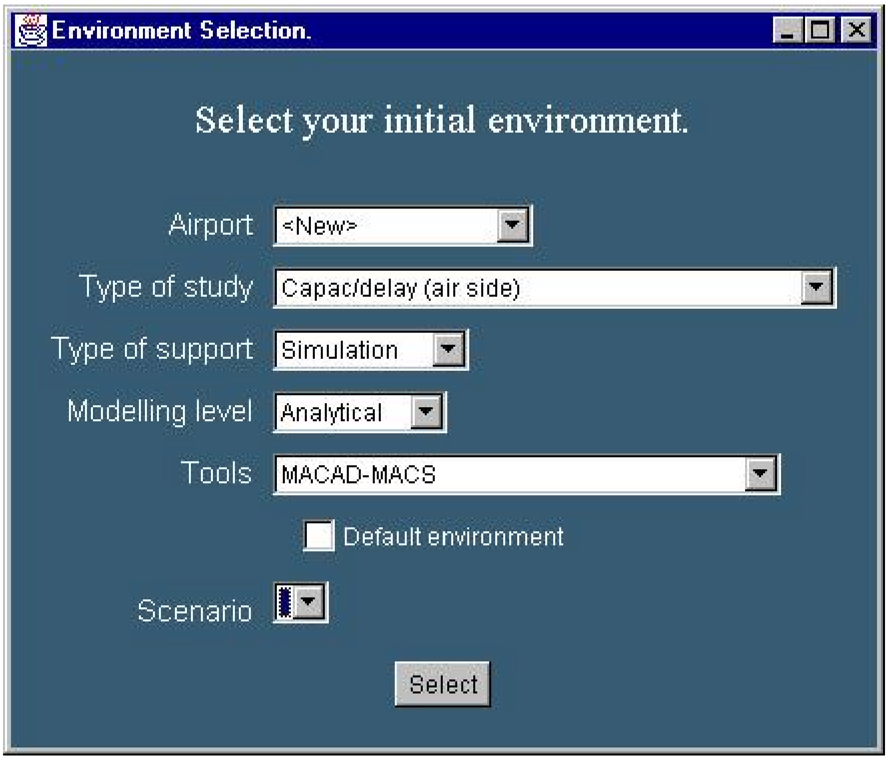

Figure 3: OPAL HMI

Once the scenario preparation is completed, the user can select the workflow associated with the tool combination. A workflow represents a collection of tools and data in an execution sequence. SPINEware provides the workflow functionality, enabling the visualisation of the flow of data, the transfer of data from/to airport modelling tools, the use of filters to select input data for tools, the conditional execution of tools, and the representation of the status of the execution (e.g., invalid output and the successful execution of a tool). Figure 4 depicts a workflow that presents the tool combination TAAM-INM. Before TAAM performs a simulation run, its input files are updated with the information stored in the OPAL central database. After this simulation run, part of the output (in particular the output that is needed for INM) is stored in the OPAL central database. Next, the input files of INM are updated with the data from this database and the INM simulation run is performed. The final step in the workflow is the storage of INM output data in the OPAL central database. During the execution of the workflow, the scenario manager takes care of the communication and activates the tools at the defined location, using the ssh protocol. During the execution of the workflow, the tools' graphical user interfaces can be used.

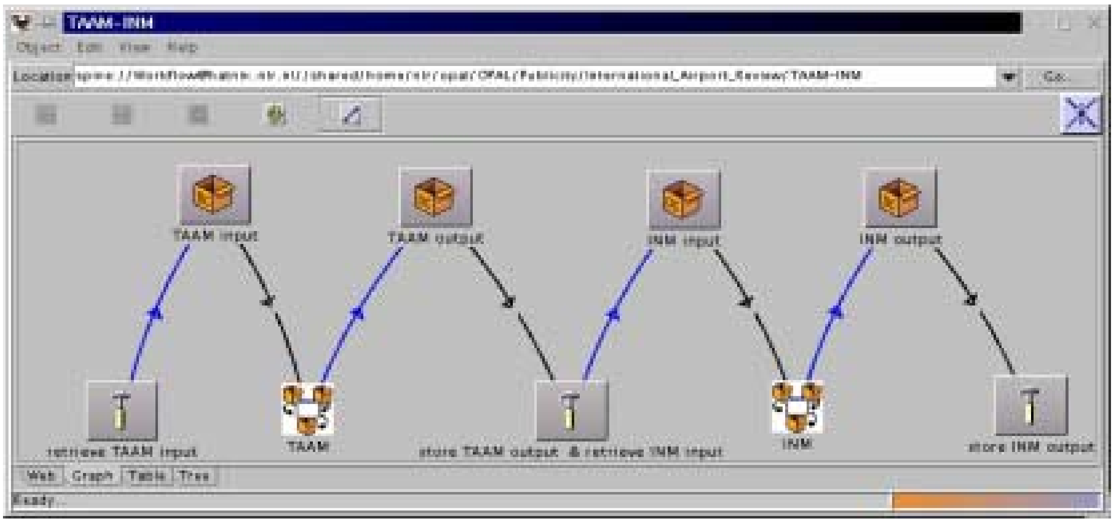

Figure 4: OPAL workflow for TAAM-INM

After the simulation, the user can evaluate the simulation results. To this end, the user can use the graphical user interface associated with the individual airport modelling tools or the diagnosis tool (in case capacity and delay results are involved). In case the user has selected an optimisation simulation, the results of the optimisation are presented by the facilities provided by the optimisation tool.

4 Project status and concluding remarks

The project OPAL is in its final phase: validation and evaluation of the OPAL platform by applying the OPAL concept to 6 major European airports. The OPAL platform operates in a heterogeneous and distributed computer network, using the ssh protocol for secured communication. It enables the use of stand-alone and state-of-the-art (both simulation and analytical) airport modelling tools in combination. Furthermore, the OPAL platform is flexible, open and extendable: access can be arranged from any site and new tools can be integrated from any site, provided that these tools can communicate with the OPAL central database. In addition, the user perceives the OPAL platform as a single, virtual computer.

The project OPAL is a first step towards the design and optimisation of enhancements of an airport system by considering simultaneously the airport airside and landside. The resulted OPAL platform may provide strategic and operational decision-making support to all airport stakeholders such as airport authorities, air traffic service providers, national and international governmental organisations, and consultants. The OPAL platform facilitates the search for solutions to problems experienced by many airports, since it allows the user to perform what-if studies, while searching for improvements or optimal solutions. More specifically, it enables the analysis of changes in either airside or landside with contemporary and future traffic flows scnarios, addressing capcity, delay, level-of-service, environmental, safety, and cost-benefit aspects, and is based on readily available and state-of-the-art simulation and analytical tools.

The OPAL platform is the first version of a decision support facility developed within the concept provided by the project OPAL, and provides a proof of this concept. Future developments could focus on various enhancements of this platform. At present the OPAL database is used for data exchange only. Through modelling all input and output data and their relations independent of the airport modelling tools, a unified and generic component for modelling airports and defining scenarios could be created, ensuring complete data consistency. Further, access to the OPAL platform could be facilitated by enabling web access, implying that a user requires only an internet connection to use the OPAL platform.

Acknowledgement

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