A Framework for Enabling an Integrated and Proactive Decision Making In Airport Systems

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Air transport liberalization has promoted the air traffic growth with a consequential cost reduction to the passengers and air carriers.

The growth is moving the main airports towards the saturation, affecting the performance and quality of the services provided to the passengers.

Analyses foresee that the capacity of the airports, in the management of the aircrafts and passengers, will likely be the bottleneck of the air transport growth.
Two main approaches

- Two complementary ways for improving airport performance:
  - **building new airport infrastructures**, such as runways, taxiways, gates, security checks, …:
    - expensive → many investments
  - **optimizing and better orchestrating the available resources**:
    - enabling **interoperability** and **collaboration** among the airport stakeholders operating both in airside and landside (i.e. Integrated Airport System);
• Novel approaches have to be identified to improve the airport capacity/performance **enabling cooperation/collaboration** among airport stakeholders

• **The challenges:**
  – *Enabling the information interoperability* on top of classic data interoperability among heterogeneous stakeholders operating both in airside and landside
  – **Designing a net-centric orchestration service** capable of optimizing the choices of the stakeholders
What has been done so far

- Interoperability:
  - SWIM (System Wide Information Management) concept has been developing in SESAR JU EU project:
    - Data interoperability;
    - **SWIM-BOX®** a first prototype developed from Selex-Sistemi Integrati supported by SESM;
    - Actually SWIM is currently focused mainly on the “airside”.

“Landside” is completely neglected from the SWIM network
What has been done so far

- **Collaboration:**
  - **A-CDM** (Airport Collaborative Decision Making) is a pool of rules for enabling data collaboration among ATC (Tower), Aircraft, Network Operator (CFMU), Airport operators and Ground Handlers.
  - Data, as EIBT, EOBT, TOBT, TTOT, ..., are shared following a flow for improving the stakeholder awareness.

Each stakeholder takes independently decisions yet relying on received data
**Integrated Totally Airport System (ITAS) has to be pursued**

- ITAS enables:
  - **information** interoperability among airside, landside and ground, not only data one (as SWIM approach)
  - cooperation among the stakeholders in taking decisions by an **orchestration** service capable of forecasting inefficiencies and promptly negotiating suitable countermeasures for the whole airport
The proposed framework

- SES framework is proposed for giving rise to the Integrated Totally Airport System

![SES-BOX Diagram]

- SES relies on a SOA approach in which:
  - **Interoperability service** integrates and enables interoperability among subsystems
  - **Decisions Orchestration service** provides rules and strategies for collaboratively making decisions
  - External Systems (CWP, GMS, and so on) can use the SES framework by **API layer**
• **IS mission:**
  – *It has to ensure the integration of the airport systems*
  – *It has to enable the interoperability among the stakeholders*

• **Ontology approach is implemented in IS:**
  – *Definition of a vocabulary shared among the systems*
  – *Definition of several ontologies, one for each class of system*
**SES-BOX: Interoperability Service (IS)**

- **Data domain** - Local Ontology
- **Data domain** - Local Ontology
- **Data domain** - Local Ontology
- **Data domain** - Local Ontology
- **SWIM Domain**

**Core Layer**
- DOR
- Ontologies DB
- Shared vocabulary
- Pub/Sub Tech
- Authorization Mng.
- Authentication Mng.

**Interoperability Service**
- DMAN
- AMAN
- FDP

**ATC Data Domain**
- SES-BOX Adapter
- SES-BOX Adapter

**WAN/LAN**
- SES-BOX
- SES-BOX
- SES-BOX

**Ground Data Domain**
- SES-BOX Adapter
- GMS: Fuelling
- GMS: Cleaning

**An Adapter for each Legacy systems**
• DSO takes advantage from the IS for gathering useful information from the actual stakeholder’s systems, and tries to forecast the arising of inefficiencies and drawbacks in the airport management in presence of unexpected events.

• Examples of such events are lag in the turnaround processes, delay of flights during a cruise, passenger caught in a long queue at check-in affecting the boarding procedure, break down of security screening, reduction of check-in counters.
• **DSO service** relies on the capacity of each stakeholder's system to be described through its service level agreement (SLA).

• **Forecasting module** hosts an agent-based model of the airport, able to simulate all the processes involved.

• **Forecasting Assessment** allows assessing the performance related to each process simulated by the Forecasting module.

• **Tactical phase** is the module deputed to interact with the system that in the forecasts will face inefficiencies or drawbacks.
Experimental scenario

- The testbed has been built-on to assess the capability of the framework to enable the **interoperability** among systems
- Orchestration decision service is not involved into the scenario, because it’s still under development
- The testbed involves:
  - *Improved weather information systems* (IWIS): is a system in charge of dispatching weather nowcasts and computing a prediction of airport capacity in terms of both arrivals and departures
  - *Departure MANagement* (DMAN): stands for a system able to manage the aerodrome departure flow located in the Tower
**Experimental scenario**

- *Apron Management System* (AMS) is the system capable of transmitting/receiving information regarding the state of the operation performing during the turnaround process.

- *AMS-DCS* stand for a system utilized to manage the passenger’s departure procedures.
• What is the operative scenario flow?

1. IWIS publishes a message on a Topic about the nowcast
2. DMAN has subscribed itself on the same Topic for receiving the IWIS messages
3. DMAN SES-BOX Adapter decodes through the ATC ontology the message and reschedules the take-off for outgoing aircraft
4. DMAN publishes a new message to AMS and to the DCS for each scheduled flights
5. AMS takes advantage from this information
Conclusions

- SES-BOX is the new framework for achieving the Integrated Totally Airport System
- The framework relies on SOA approach and it makes use of hybrid ontology for enabling the interoperability without providing a data standardization
- So far only Interoperability service has been implemented providing good performance
- The ongoing activity will be focused on the development of Decision Orchestration Service and further test of the Interoperability services in other operative scenarios.
Thanks for your attention!