Environmental Issues and application of corresponding Models in the context of Total Airport Management

Florian Piekert (DLR/AT-One)
Holger Feldhaus (DLR/AT-One)

October, 29th 2009
CEAS 2009 – Manchester, UK
Structure

- What is TAM?
- Areas of Influence
- Environmental Models
- Open Issues
Structure

- What is TAM?
  - Areas of Influence
  - Environmental Models
  - Open Issues
Why do we need Total Airport Management?

- It has been identified that currently existing approaches and implementations are not addressing all existing and future problems at the airport.

- There is no real dynamic coordination between airport stakeholders (competition, “don’t care”, hierarchical/ contractual “ignorance”, …).

- The impact of adverse weather conditions is most often not known – “it will impact us, but we have no clue to what extend” (most often true even in good weather situations).

  ➔ The Introduction of Airport-CDM (A-CDM) was believed to address these issues, but…
Inherent problems despite A-CDM

<table>
<thead>
<tr>
<th>Planning</th>
<th>CDM is currently largely limited to the tactical phase. There is a lack of (pro-active) pre-tactical and strategic planning between airport partners.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data Sharing</td>
<td>Despite being a pillar of the EUROCONTROL CDM Implementation Guidelines, real-time data sharing is still limited and therefore pro-activity limited, too.</td>
</tr>
<tr>
<td>Flexibility</td>
<td>Limited flexibility in response to real-time events.</td>
</tr>
<tr>
<td>Shared vision</td>
<td>Still considerable “marketing” required to convince all airport partners of the benefits. Currently, almost no common performance indicators exist.</td>
</tr>
</tbody>
</table>

What can be done, where do we take Airport-CDM from here?
Motivation for Total Airport Management

SESAR (R&D Requirement 1 of D2.2.2): There is a need for

- more dynamic and responsive ways to incorporate the customer’s priorities (i.e. UDPP),
- pro-active instead of re-active planning in predicted bottleneck situations,
- fair and transparent means of handling competing interests at an airport,
- improved predictability of the system „airport“ at and within the network,
- performance measurement with a common set of (key) performance indicators to drive a harmonization process between the different airports‘ performances,
- …
Expectations from Total Airport Management

Expected benefits include:

- more efficient airport operations,
- less operational costs,
- environmental benefits,
- enabling of the system to cope with the future traffic demand.

How can that be achieved?
How does that work out?
From A-CDM to TAM – Expected Benefits

Based on commonly agreed performance indicators, TAM will allow for an assessment and visualization of future airport performance.

Introduction of common databases and systems.

This will allow operators to configure the airport according to agreed “scenarios” most applicable at the time of decision.

Demand and capacity management are organized to meet agreed performance targets for different time horizons. Also able to change the performance objective.

Based on an environment which is designed around the philosophy of information sharing. Past performance used to identify future requirements.

Agreed Performance Measures

Agreed Airport Configuration

Agreed Performance Targets

Improved Predictability

AOP: Joint Plan
From A-CDM to TAM – Generic Requirements

Agreed Performance Measures
Common computer aided (performance) simulations. Common monitoring leading to a more adaptive system.

Agreed Airport Configuration
Representation of information via common displays based on common data sources.

Agreed Performance Targets
Creation, agreement and maintenance of the airport operational plan (AOP) including performance trade-off analysis.

Improved Predictability
Common decision-making for a leading to a common understanding of future system evolutions.
TAM Principles / Levels of decision making

- **strategic**
- **pre-tactical**
- **tactical**
- **ad-hoc**

**situation assessment**

**monitoring and control**

**airport processes**
Scope of TAM
TAM APOC: how does it look like?

ATC Flow Management

Airport Management

Ground Handling

Security Management

Airline Operation Center

ATFCM

Agent

Agent

Agent

Arbitrator

Agent

automated exchange
TAM APOC: Negotiation / Coordination workflow

- Use cases for recurring situations that require coordinated decision making between stakeholders
- Protocols and rules guarantee transparency and fairness
- Support systems (i.e. central powerwall display showing key performance parameters and airport information) to create common situational awareness to all stakeholders
- Automated planning support tools constantly monitor and analyze situational data
- What-If support to analyze and pre-plan future traffic scenarios
TAM APOC: joint Airport mode of operation

Agents decide how the airport shall be operated, i.e.

- punctuality above all else
- more departure than arrival traffic
- throughput over punctuality
- more green operations above all others

...
TAM APOC system architecture

Planning on the performance, traffic flow and event levels, constrained by performance targets

Performance analysis
Compliance monitoring

Exchange of constraints (FUM, tactical times,...)

Airport SWIM (central DB)

TOP

What-If Analysis
Compliance Analysis

stakeholder’s TOP

stakeholder’s TOP

stakeholder’s TOP

stakeholder’s external backoffice systems

tactical planning support tools
TAM APOC Situational Awareness

Situational Awareness created in the APOC between stakeholders includes

- Airport Performance based on i.e. traffic flows and capacity
  - Arrival and Departure rates/throughput
- Punctuality and Delay Situation
- Adherence to Network Performance promises
- Queue Lengths on Taxiways, PAX in Terminal, …
- Stability and Flexibility of Operations

Environmental awareness? What aspects? What exactly?
Structure

- What is TAM?
- Areas of Influence
- Environmental Models
- Open Issues
TAM Areas of Influence

- Turn-Around-Process
- Ground support vehicles
- Uncoordinated de-icing operations without respecting expected taxi times
- Start-Up of Aircraft running engine
- Amount of Holdings (arrival-departure ratio)
- Arrival and Departure routes selection depending on demand
- Ground OPS rostering
TAM Areas of Influence - LTO

Airside
(FWYs, Taxiways, Aprons, Terminals, Landing, etc.)

Airport

Approach

TMA/adjacent sectors

Flights

Surrounding departure airport

most probably no influence exerted by TAM APOC

influence feasible
TAM Areas of Influence - LTO

Flights
- Approach (patterns, holdings, directs, …)
- taxi-in (route, # of stops, waiting times, on-block queues, …)
- taxi-out (pushback delay, departure queues, …)
- Departure (indirect routes, re-routing, …)
TAM Areas of Influence - Ground

Ground Support Vehicles

- Route/Mission optimization
  - PAX bus
  - Baggage trucks
  - Catering
  - other support vehicles…

- Efficiency optimization (coordination)
  - i.e. reducing idle waiting times when waiting for delayed flight
  - …
Structure

➢ What is TAM?
➢ Areas of Influence
➢ Environmental Models
➢ Open Issues
Environmental models

Intention:

- Utilize results from environmental model computation to indicate agents quality of planning with respect to environment (emissions, not noise)
- Modify existing planning algorithms to additionally optimize environmental impacts

Applicable Models (selected from EATRADA inventory)

- Since basically most applicable models are based on LTO, we’ll use LTO directly.

Ground Based support traffic

- No European model yet existing, US models states unclear to us
Environmental models – Data requirements

LTO

- ICAO Aircraft type
- Type of reference engine for each ICAO AC type
- Emission indices
- Times for Take-Off, Climb-Out, Approach, Taxi-in, Taxi-out (from LTO cycle)

Information source can be

- ICAO Engine Exhaust Emissions Data Bank
- LTO Cycle ICAO Annex 16 Volume 2
- Aircraft Engine configuration from AC manufacturers

For APOC pre-tactical planning this information is available for the day of operations!

A modified version of the LTO model will be used for airport and vicinity. Above 3k ft a different model exists, but currently not of interest to us.
Environmental models – Data requirements

Ground Based Support Vehicles

- Type of vehicle
- Average work effort of individual types of vehicles
- Fuel consumption for reference vehicles
- Emission indices for reference vehicles

For APOC pre-tactical planning this information is available for the day of operations!

Information sources can be

- Manufacturer
- A-SMGCS & other surveillance data for work effort / routes / distances
- Fleet Manager/Ground Handler
Structure

- What is TAM?
- Areas of Influence
- Environmental Models
- Conclusion
Conclusion

- Utilization of (modified) LTO model with intend of bringing environmental information into APOC seems feasible
  - Stakeholder decision making variation due to availability of environmental planning data may be assessed

- Supplemental of APU utilization information is believed to be necessary
  - Important for remote stands where no local power supply nor GPU is available

- Creation of a ground support vehicle environmental model is necessary
  - Model needs to be adjusted to each airports’ ground fleet composition
Open Issues with Environmental KPIs

- Currently there is no incentive for stakeholders to adjust their plans in order to optimize the overall environmental impacts (primarily emissions, …)
- Impact of emission trading mandated by EU not yet assessable
- …
Questions?
TAM – Further Sources of Information / Contacts

World Wide Web

- [http://www.tam.aero/](http://www.tam.aero/)
- [http://www.dlr.de/fl/](http://www.dlr.de/fl/)

eMail

DLR, Institute of Flight Guidance
Department of Operations Control
Florian Piekert
TAM Programme Manager
[Florian.Piekert@DLR.DE](mailto:Florian.Piekert@DLR.DE)
Tel +49-531-295-3010

Yves Günther
TAM Operational Concept Lead
[Yves.Guenther@DLR.DE](mailto:Yves.Guenther@DLR.DE)
Tel +49-531-295-2558

Holger Feldhaus
TAM Environmental Issues Evangelist
[Holger.Feldhaus@DLR.DE](mailto:Holger.Feldhaus@DLR.DE)
Tel +49-531-295-2187