Optimode.net
Intermodal airport management with passenger trajectories
Besuch Nds. Landwirtschaftskammer
Braunschweig, 05.04.2016
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DLR German Aerospace Center

Research Areas

• Aeronautics
• Space Research and Technology
• **Transport**
• Energy
• Defence and Security
• Space Administration
• Project Management Agency
Challenges in Transport

• Achieving sustainable mobility with balance between
  • economy
  • society
  • ecology

by
• ensuring the mobility of people and goods
• protecting the environment and resources
• improving safety
# Portfolio of Transport

## Transport Research Area
Mobility, environment, safety, economy

<table>
<thead>
<tr>
<th>Terrestrial vehicles</th>
<th>Traffic management</th>
<th>Transport systems</th>
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</thead>
<tbody>
<tr>
<td>• Road vehicles</td>
<td>• Road traffic management</td>
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<tr>
<td>• Rail vehicles</td>
<td>• Rail traffic management</td>
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<td>• Airport management</td>
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<td>• Sea traffic management</td>
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<td>• Traffic management for major events and disasters</td>
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<td>• Transport development and the environment</td>
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Institut für Flughafenwesen und Luftverkehr
Leitung: Prof. Dr. J. Reichmuth

Flughafenwesen und Luftverkehr

Leitungsgruppe

Abteilung Luftverkehrsforschung
Gruppe Luftverkehrs-entwicklung
Gruppe Luftverkehrsökonomie

Abteilung Flughafenforschung
Gruppe Flughafensimulation
Gruppe Flughafenmanagement
Flughafenforschung
Problem Warteschlangen

\[
\text{Warteraum} \quad \lambda \quad \mu \quad c
\]

Ankunftsstrom \( \lambda \)
Bedienrate \( \mu \)
Anzahl der Bediener \( c \)

Quelle: Fraport AG

Quelle: DLR
Flughafenforschung
Problem Warteschlangen

→ Mittlere Verweilzeit (Wartezeit + Bediendauer) in Abhängigkeit der Auslastung einer Bedienstelle

\[ \bar{V} \text{ Verweilzeit pro Nachfrager} \]

\[ \text{Auslastung} = \frac{\text{Nachfrager}}{\text{Kapazität}} \]

\[ \mathbb{E}(N) \approx \frac{\rho}{1-\rho} \times \sqrt{\rho^{2n}} \times \left( \frac{c_1^2 + c_2^2}{2} \right) + \rho \times c \]

\[ \mathbb{E}[V] = \frac{\mathbb{E}[N]}{\lambda} \]

Auslastung = Nachfrager / Kapazität
Flughafenforschung
1. Verändern des Betriebspunktes

Ø Wartezeit pro Nachfrager

\[ W(K_1) \quad W(K_2) \]

Bedienungen pro Stunde

K1 \quad K2

Sättigungskapazität
Flughafenforschung
2. Ausbau

\[ W(K_1) = W(K_2) W(K_1) \]

Ø Wartezeit pro Nachfrager

Bedienungen pro Stunde

K1

alte Sättigungskapazität

neue Sättigungskapazität

Bedienungen pro Stunde
Flughafenforschung
3. Reduktion der stochastischen Einflüsse

Ø Wartezeit pro Nachfrager

\[ W(K_1) = W(K_2)W(K_1) \]

Sättigungskapazität

Bedienungen pro Stunde

K1

K2
Intermodal airport management with passenger trajectories

- Project Optimode + Optimode.net
- Collaborative Decision Making CDM
- Multimodal Control Centre MCC
- Key Performance Indicators driven management
- Door-to Door (D2D) - oriented operational re-scheduling
Intermodal airport management
State of the Art: A-CDM
Source: Eurocontrol
Intermodal airport management
State of the Art, next step: TAM
Source: Eurocontrol, DLR

- Total Airport Management
  (Performance based Airport Management)
Intermodal airport management as part of ITS (Intelligent transportation system)

- Customer-centric approach
- Passenger information
- Stakeholder information
- Passenger’s preferences and choices
- Infrastructure and schedules adoption
- Airport fully embedded in main catchment area
- Link between service provider, infrastructure provider, and customer
- Digitalized reality
Intermodal airport management
Use case example 1

• LATE COMMUTING PASSENGERS
Intermodal airport management
Use case example 2

- GATE CHANGE
  - Revenue optimised gate re-assignment
  - Arriving / departing passengers (separated shopping experience/offers)
  - Estimated willingness to buy, depending on availability, dwell time, and of course on the ability to pay – optimisation task!
Intermodal airport management
Passenger trajectory

- Scheduled, calculated, estimated, and actual tasks
- Standardisation is the key to reduce development efforts to include additional partners and stakeholders

<table>
<thead>
<tr>
<th>Task station (point in time &amp; event)</th>
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<tbody>
<tr>
<td>OPAT</td>
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Intermodal airport management
Performance measurement

• Current KPI + D2D oriented KPI, e.g.:
  • Boarding score
  • Walkthrough time
  • Availability of shops and services (distance / buffer time)
Intermodal airport management
Customized information broadcasting

• Optimode.app
Intermodal airport management
Collaborative decision making (I)

- Pax_radar, full view
- Innovative human-machine-interface
- Situational awareness
- Passenger status
  - Check-In
  - Security
  - Boarding
Intermodal airport management
Collaborative decision making (II)

- Pax_radar, detail one flight event

Forecast feature: *When is boarding completed?*

Gate-Change feature

Tooltip feature

Check-In

Security

Boarding

Callsign: DE5958, AGP | FRAN
Aircraft: A320 (-200)
Airline: CONDOR
Gate: Gate-A17 (Gate-A17)
Pax: 130 (105/121/45)
Transfer Pax: 0/0
SOBT: 08:10 EOBT: 08:10

<table>
<thead>
<tr>
<th>Event</th>
<th>Time</th>
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<tbody>
<tr>
<td>5:30</td>
<td>7:29</td>
</tr>
<tr>
<td>5:37</td>
<td>7:43</td>
</tr>
<tr>
<td>7:40</td>
<td>7:43</td>
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</tbody>
</table>

- all 121/130 Pax
- Check In: 105 Pax
- Security: 121 Pax
- Boarding: 45 Pax

Time to Off-Block: 26 min
Forecast BS: 100% Last Pax: 07:05:21
Intermodal airport management
Collaborative decision making
(III)

Gate as partition of circle

Radius =
time to departure (logarithm)
Intermodal airport management
Collaborative decision making
(IV)

- Passenger Trajectory Tool PETRA
  - single flight view

Passenger status (nowcast + forecast hybrid)

- Pax already boarded to plane
- Pax with good connectivity
- Pax arriving at gate close to OBT
- Pax arriving the gate after OBT

Pax per flight

50 100 150 ...

05.04.2016
Intermodal airport management
Collaborative decision making

(V)

- Passenger Trajectory Tool PETRA
  all flights view

1st flight

common problem identification support

Pax already boarded to plane
Pax with good connectivity
Pax arriving at gate close to OBT
Pax arriving the gate after OBT

last flight

Pax per flight

DLR.de • Chart 25
05.04.2016

> Besuch Nds. Landwirtschaftskammer > E. Grunewald • Optimode.net_NdsLandwirtschaftskammer_20160405.pptx >
Optimode addresses performance-based intermodal airport management as a modular toolsuite.
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