POEM
Passenger-Oriented Enhanced Metrics

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Overview

- Background and objectives
- Workplan
- Early results
  - model & data
  - analysis
  - metrics old & new
  - case studies & stakeholders
- Next steps

Background and objectives

Background and objectives

- ICAO endorses performance-based approach; adopted by SESAR and NextGen. Two long-standing, yet still immature issues:
  - metrics quantifying delay propagation
  - embracing passenger-centric metrics

  ] superficial if out of context
- Dominate AO delay costs and therefore strongly influence AO behaviour in the network (strategically and tactically)
- Currently only using single-flight metrics (Europe & US), although flight delay ≠ pax delay (factor of 1.6 – 1.7)
- Pax mobility is an emergent property of air transport system (different stakeholders, different objectives)

Background and objectives

Despite [...] the large share of almost 50% of reactionary delay, there is presently only a limited knowledge of how airline, airport and ATM management decisions affect the propagation of reactionary delay throughout the air transport network.

PRR (2010)

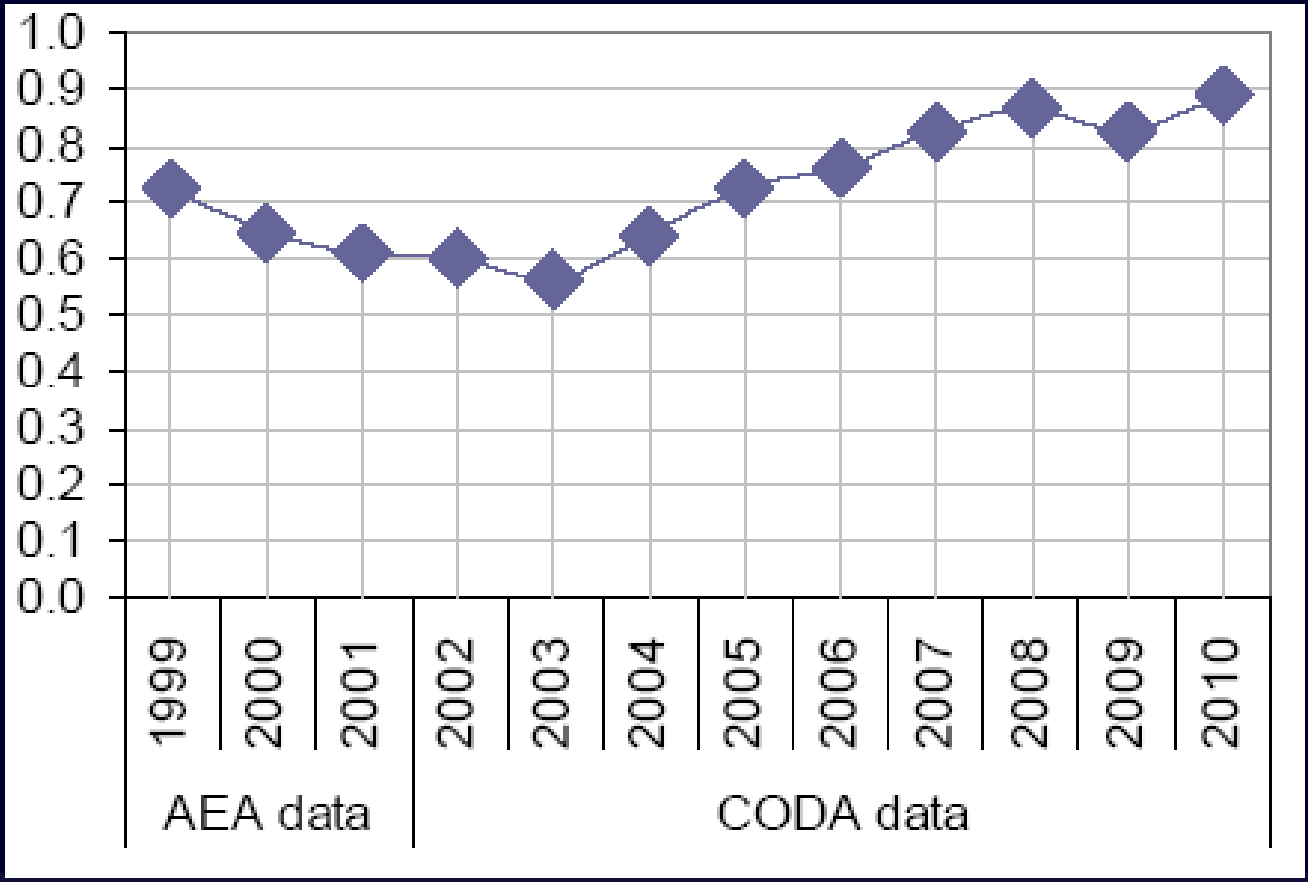
Background and objectives

[…] A better understanding of the contribution of airports, airlines and ANS towards those network effects and possible measured to mitigate those effects would be desirable. […] However such a study is complex as it requires linking the individual legs of aircraft [on a] European scale.

PRR (2010)

Background and objectives

Ratio of reactionary to primary delay,
shows the sensitivity (or robustness) of the network to delay



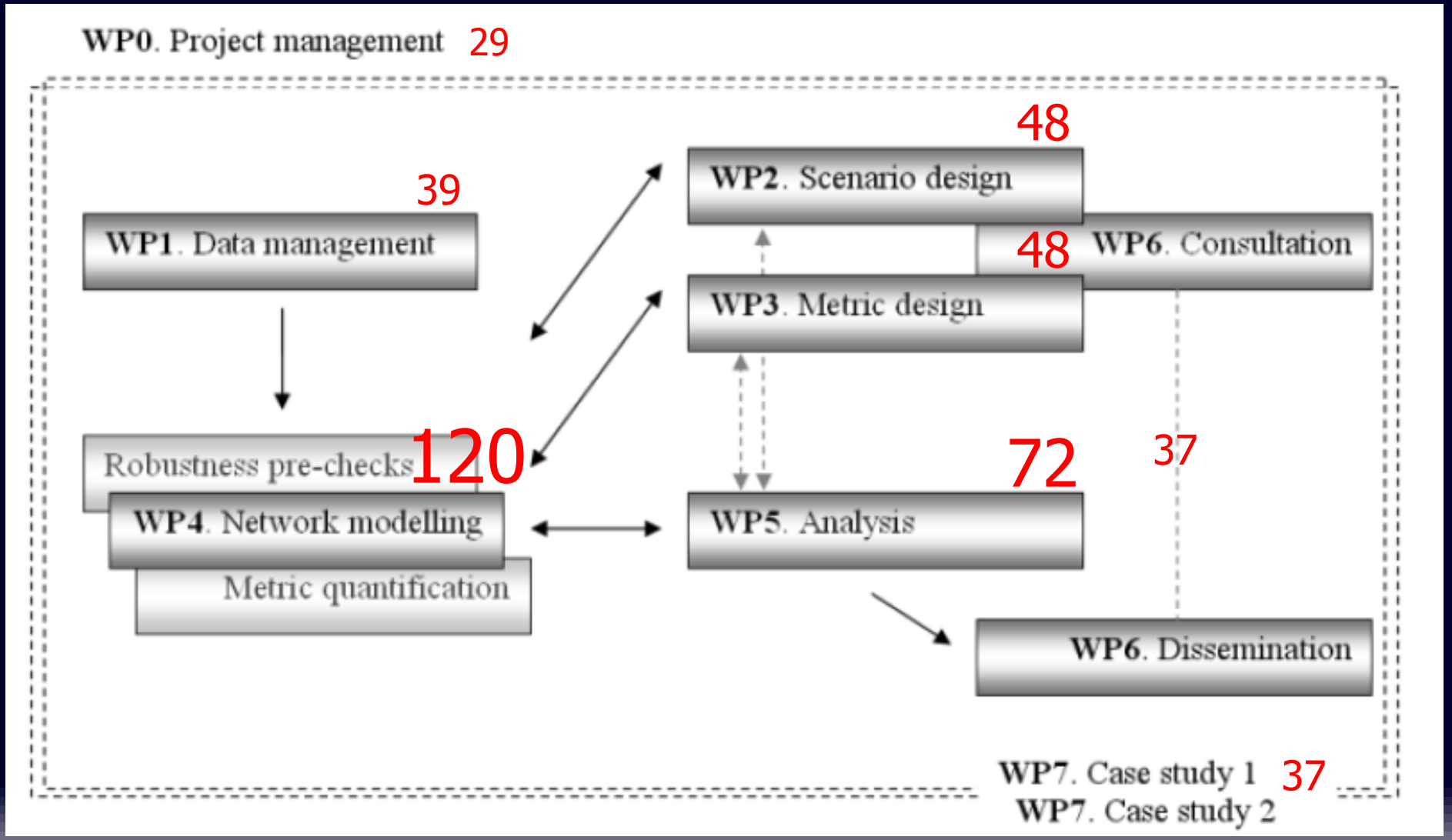
Background and objectives

Commission's new roadmap to a Single European Transport Area for 2050, plans to harmonise (and extend?) pax rights across all modes; specifically cites pax disruption during severe weather (and ash cloud).

> [...] in 2010, it has become evident that Mobility Continuity Plans may be required to preserve the mobility of passengers and goods in a crisis situation. These events also demonstrated the need for the increased resilience of the transport system through scenario development and disaster planning.
>
> EC (2011)

Workplan

Workplan


WP0. Project management 29
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WP2. Scenario design
WP1. Data management
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WP6. Consultation
WP3. Metric design
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Robustness pre-checks
WP4. Network modelling
WP5. Analysis
Metric quantification
WP6. Dissemination
WP7. Case study 1
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WP7. Case study 2

Workplan

Scenarios

It would be worth investigating how ANS could contribute in reducing reactionary delays and whether in the long run the situation could be improved by changing the current ATFM priority rule from 'First planned, first served (FPFS)' into 'First scheduled, first served (FSFS)'.

PRR (2010)

Workplan

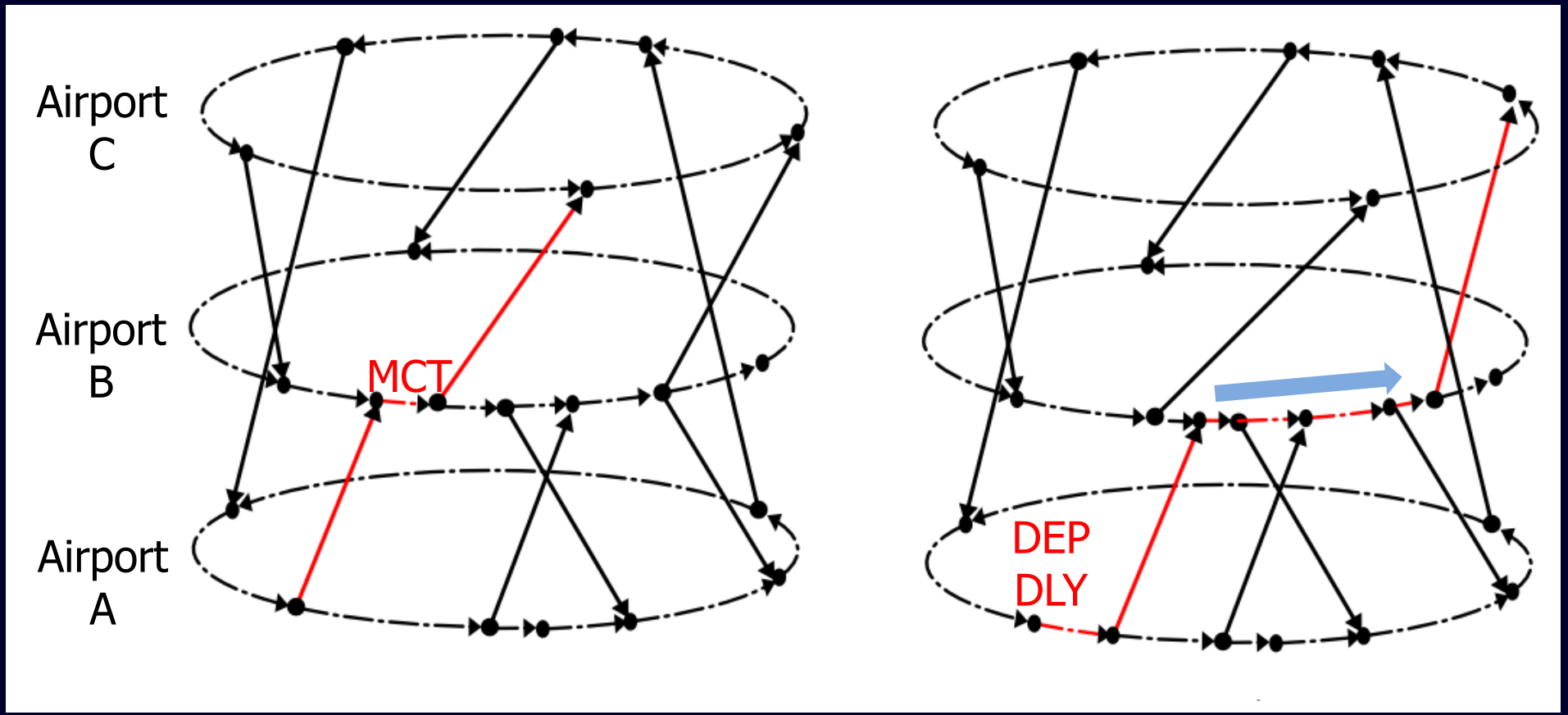
- Rationale for 'early' deliverables
- D1.1 (29JUL11)
  - traffic & pax data spec; model; 1st lit. review (metrics)
- D1.2 (31OCT11)
  - more data samples; missing data imputation
- D4.1 (31OCT11)
  - building the model: high-level structure to MCT
- D5.1 (31OCT11)
  - data analysis, metrics; complementary approach

Early results
- model & data

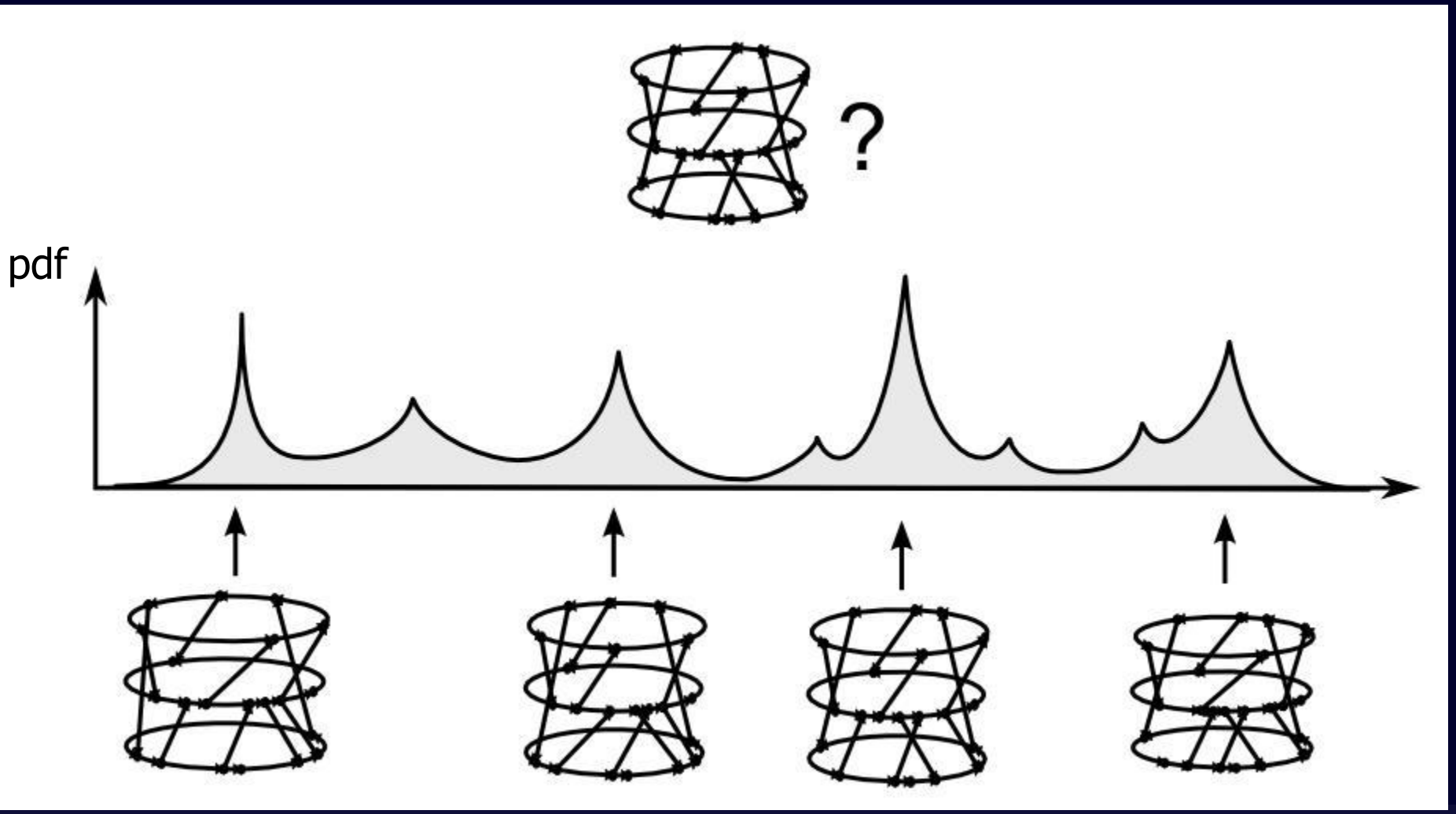
Model and data

- Unique combination of PaxIS and PRISME data
- Testing: 'difficult' airport pair (anonymous, 5 AOs; OAG, CAA, …)
  - imputation of IATA-weighted data: PRISME + load factors (AOs)
- Selection of airports for model (ACI Europe, Eurostat, …)
  - August & September, 2009 & 2010 (busiest holiday & non-holiday)
  - 200 ECAC (97% pax, 93% traffic, 2010)
  - 50 external airports based on pax flows in/out Europe
- PRISME data preferred over DDR, since DDR sample:
  - no scheduled times (last-filed FPL only)
  - no aircraft registrations
  - no ATFM delay codes

Model and data



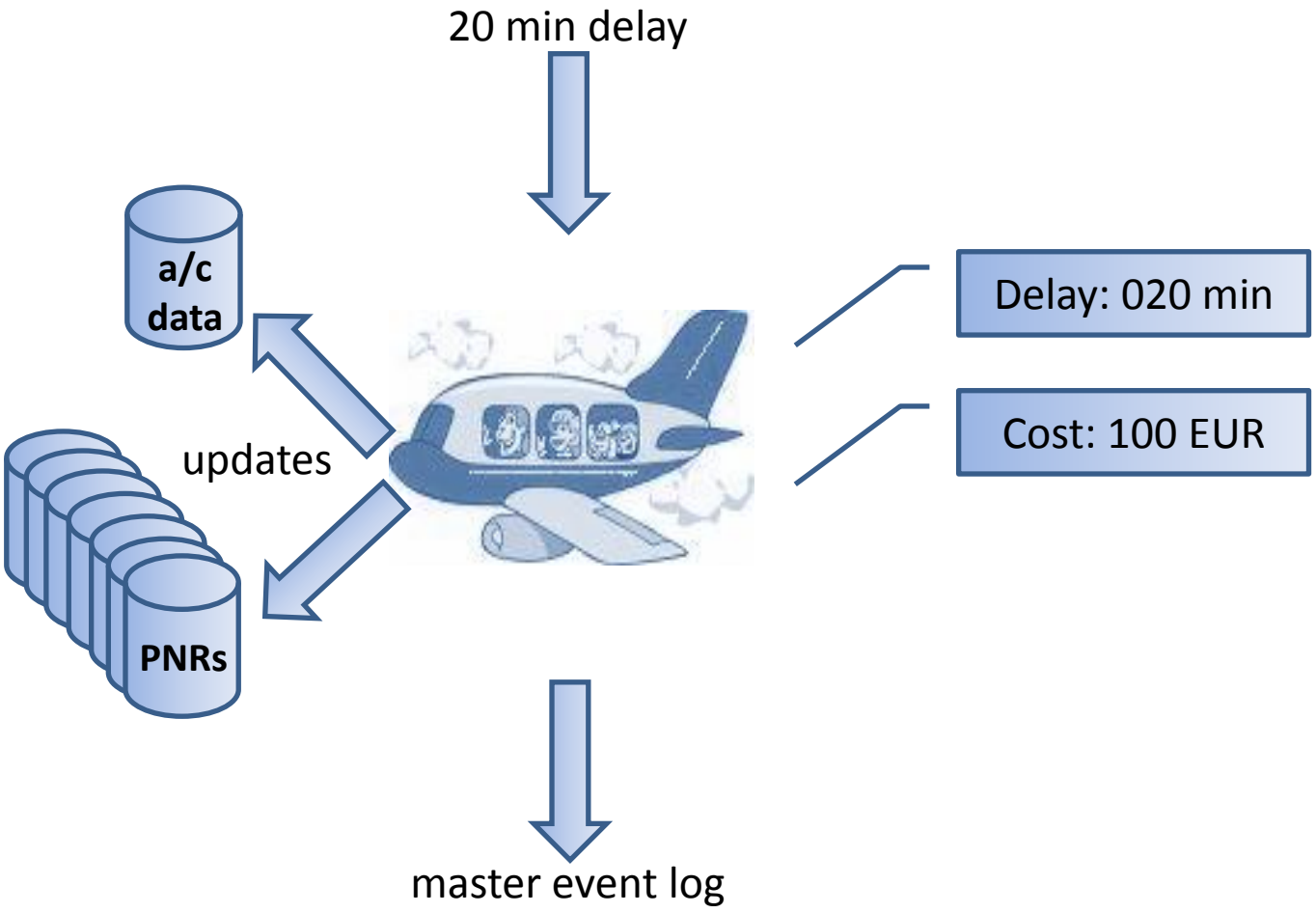
Model and data



Model and data

- Need to consider all possible network outcomes at once
- Emergence of some networks more likely than others
- Each metric will be a RV (an asset of random graph theory)
- *Distribution* of metrics (c.f. central tendency)
- 61 variables & sources identified (PaxIS, PRISME, … etc)
  - non-stochastic / stochastic (parameterisation)
  - Minimum Connecting Times
  - cancellation rules / likelihoods (more later)
  - turnarounds / wait rules / likelihoods
  - exogenous and endogenous delays
- Tracking databases (unaccommodated pax, delays, costs)

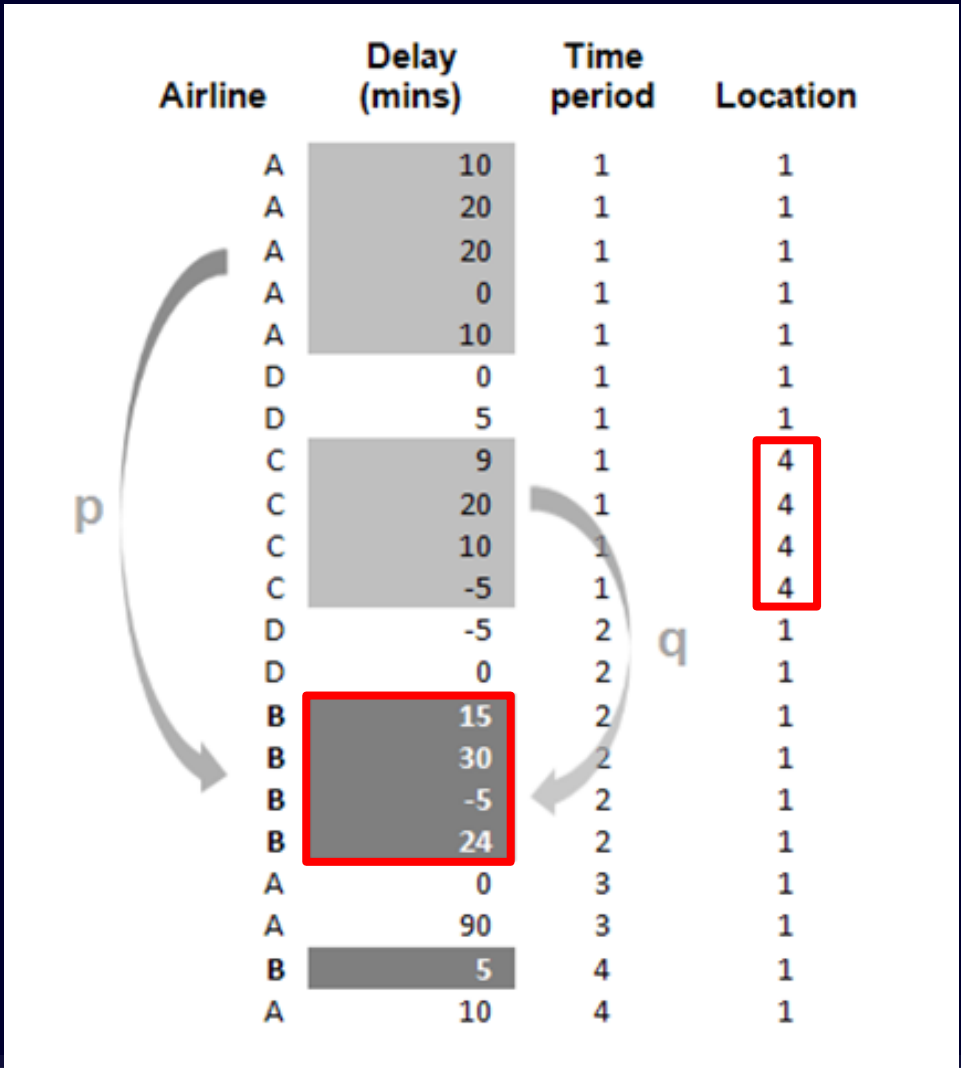

a/c data
PNRs
Delay: 000 mins
Cost: 000 EUR


20 min delay
a/c data
updates
PNRs
Delay: 020 min
Cost: 100 EUR
master event log

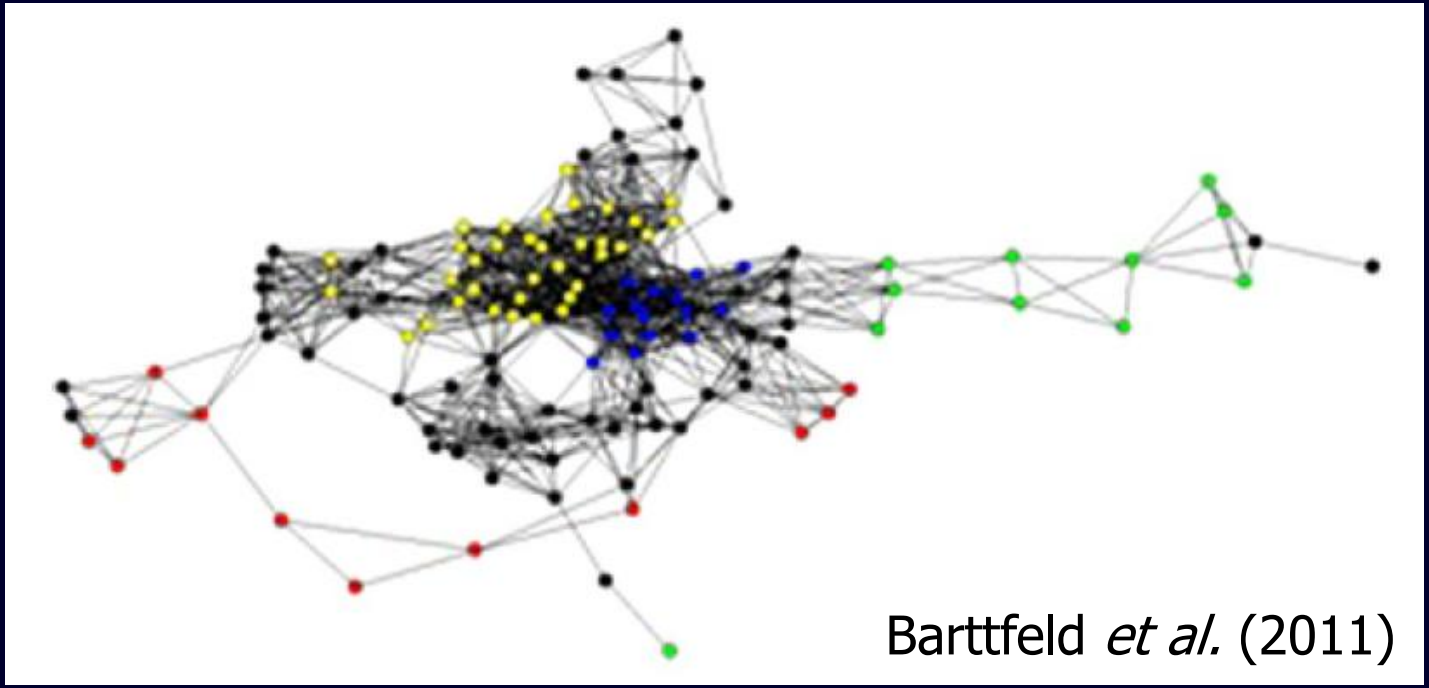

a/c
data
PNRs
Delay: 020 mins
Cost: 100 EUR

Early results
- analysis

Analysis


Airline
Delay (mins)
Time period
Location
p
q
A 10 1 1
A 20 1 1
A 20 1 1
A 0 1 1
A 10 1 1
D 0 1 1
D 5 1 1
C 9 1 4
C 20 1 4
C 10 1 4
C -5 1 4
D -5 2 1
D 0 2 1
B 15 2 1
B 30 2 1
B -5 2 1
B 24 2 1
A 0 3 1
A 90 3 1
B 5 4 1
A 10 4 1

Analysis



- propagation of perturbation
- aircraft and passengers
- consider the whole network (nodes may be synthetic)

Analysis

- Characterisation
  - centralities (degree and betweenness)
  - communities (spatial and conceptual)
  - motifs (functional patterns)
- Analysis
  - synchronisation likelihood
  - Granger causality
  - abnormality graph
  - bivariate association
  - factor analysis (synthetic variables)

  ] non-linearity & collinearity
- To stress: complementary approach, classical & complexity

Early results

- metrics old and new

Metrics old and new

With the data on passenger trip reliability available, a public debate can occur on acceptable performance tolerances. The result would be a service standard equivalent to the 15 minute On-Time Performance standard for flight delays. Since passenger delays are derived from cancelled flights, diverted flights, missed connections and denied boarding, as well as delayed flights, service standards for airline performance in these other areas would be derived.

Sherry *et al.* (2010)

Metrics old and new

- Compare usefulness of new and existing metrics
- Embracing full OD pax centricity (c.f. flight-centric)
- Performance-based insights into, for example:
  - new flight prioritisation concepts
  - passenger-focused flow management
- How (new) metrics behave in context of new operational scenarios modelled, and over multiple scales
- Exploring trade-offs, for example:
  - holding several flights for in-bound delayed flight could improve net pax delay cost (new) but worsen aircraft delay minutes (existing)
  - not between existing KPIs (e.g. predictability c.f. flexibility)

Metrics old and new

CONTRIBUTORY FACTORS FOR US PASSENGER DELAY MINUTES IN 2007

Contributory factor	Total passenger delay minutes in 2007
Flights delayed less than 15 minutes	6%
Flights delayed by 15 minutes or more	48%
Cancelled flights	43%
Diverted flights	3%
Overbooked passengers	< 1%

Calderón-Meza *et al.* (2008)

Metrics old and new

- Node-related (not independent of AOs; swaps, cancellations)
- Arc-related (prioritisation, load factors, airborne recovery)
- Propagation - generators and sinks (especially airport nodes?)
- Ratios, e.g. reactionary/primary delay (*a* robustness measure)
- Severity, depth, branching, magnitude (Cohn *et al.*, 2007)
- Differentiating minutes from cost
- Emergence of new, synthetic metrics

Early results

- case studies & stakeholders

Case studies

- Case study 1 (tbc with Project Officer)
  - Zürich and Berlin Tegel; in collaboration with ZHAW
  - passenger connectivities and delay recovery prioritisations
  - decision-making processes and planning horizons
  - tools used, barriers to improvement, data patterns and MCTs
  - extensive data from Zürich airport authority
  - questionnaires to handling agents and airlines
  - differences between LCC and full-service carrier
  - micro-calibration of data from WP1
- Case study 2
  - several AOs contacted; elaborated following workshop in January
- Will inform scenarios and metrics

Stakeholders

- *Consultation* and dissemination key part of project
- In-depth on-line survey
  - September–October 2011
  - multiple stakeholder groups
  - 157 responses, particularly strong ANSPs (& AOs)
  - useful cross-section of KPA expertise
  - 99 free-responses to question on how use KPAs
- Workshop in London on 10 January 2012
  - http://home.wmin.ac.uk/airspace/workshop_draft.htm
  - will inform scenarios and metrics
  - may help to determine case study 2
  - "There's no such thing as a free lunch!"

Next steps

Next steps

- Data purchase (PaxIS) & full request (PRISME)
- D2.1 (31JAN12)
  - design of the model scenarios
- D3.1 & D3.2 (31JAN12)
  - design of propagation- & pax-oriented metrics
- D6.1 (31JAN12)
  - stakeholder feedback on design
- D7.1 (27APR12)
  - results of case study 1

Thank you