POEM
Passenger-Oriented Enhanced Metrics

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Overview

- Background and objectives
- Importance of passenger context
- Progress so far
  - model & scenarios
  - data & cleaning
  - metrics
  - recent results
- Conclusions

Background and objectives

Background and objectives

- Building an integrated simulation model for flights and passengers, which will:
  - include a range of new performance metrics we have designed: passenger-centric and propagation-centric
  - operate under a range of flight prioritisation scenarios
- Two key analytical objectives – under these scenarios:
  - to explore trade-offs between various metric types
  - to characterise propagation of delay through network

] related tasks

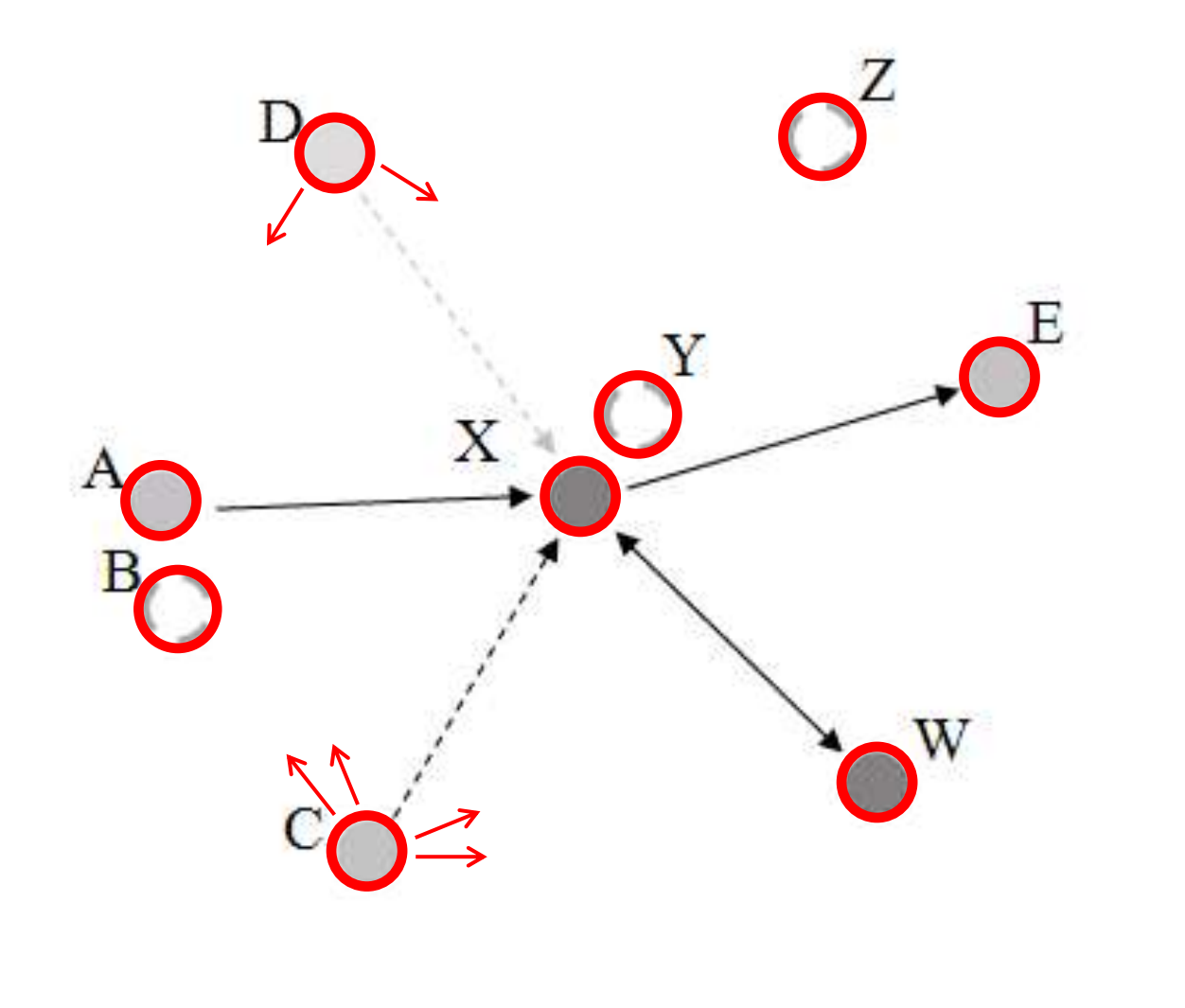
- Design and data front-loaded
- Stakeholder consultation: workshops and case studies

Importance of passenger context

Importance of passenger context

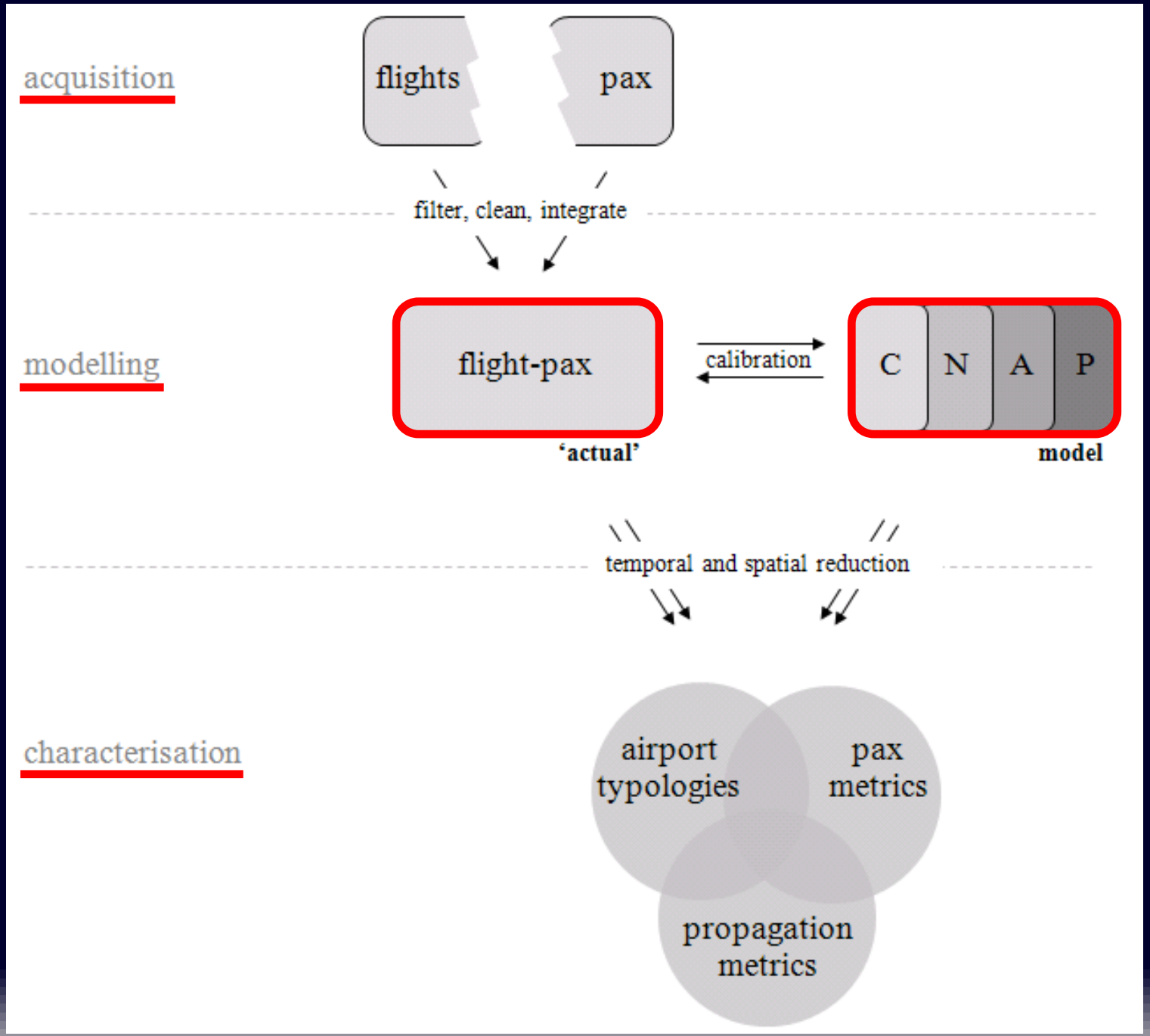
- Policy-driven motivation
  - ultimate performance delivery to the passenger
  - Commission's new roadmap (2011) to a Single European Transport Area for 2050: pax mobility & network resilience
  - extension of passenger rights (e.g. review of Regulation 261)
  - ACARE Strategic Research & Innovation Agenda (Sep. 2012)
- More compelling still: the technical imperative
  - dominate AO delay costs and therefore strongly influence AO behaviour in the network (strategically and tactically)
  - currently only using flight-centric metrics (Europe & US), although flight delay ≠ pax delay (factor of 1.6 – 1.7)
  - from the context of fully understanding network behaviour …

Importance of passenger context



Progress so far

- model & scenarios


acquisition
flights
pax
filter, clean, integrate
modelling
flight-pax
calibration
C
N
A
P
'actual'
model
temporal and spatial reduction
characterisation
airport typologies
pax metrics
propagation metrics

Type, and level	Designator	Summary description
Common, 0	C_0	Level '0' - common baseline, reproduces historical operations
ANSP, 1	N_1	Prioritisation of inbound flights, based on simple passenger numbers
ANSP, 2	N_2	Inbound flights arriving more than 15 minutes late are prioritised based on the number of onward flights delayed by inbound connecting passengers
AO, 1	A_1	Departure slots allocated based on delay costs – if ATFM delays are not severe, implement wait rules for premium passengers, long-haul passengers and minimum passenger load
AO, 2	A_2	Departure slots *and* arrival sequences based on delay costs – A_1 is implemented *and* flights are (independently) arrival-managed based on delay cost
Policy, 1	P_1	Passengers are reaccommodated based on prioritisation by arrival delay, instead of by ticket type, but preserving interlining hierarchies
Policy, 2	P_2	Passengers are reaccommodated based on prioritisation by arrival delay, regardless of ticket type, and also relaxing all interlining hierarchies

Progress so far

- data & cleaning

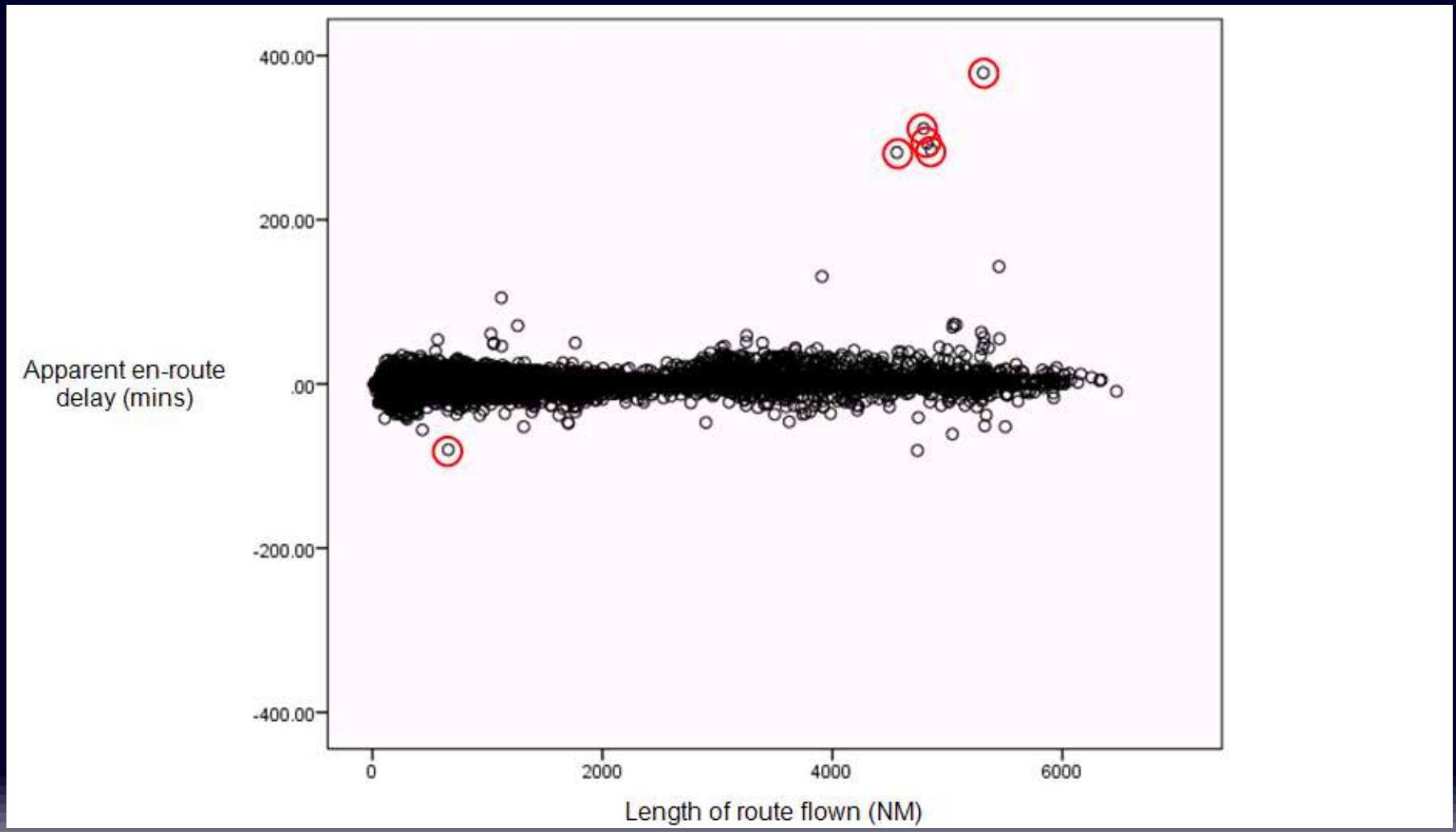
Data and cleaning

- Unique combination of PaxIS and PRISME data
- Two stages of testing pax allocation
  - early: 'difficult' airport pair (anonymous, 5 AOs; OAG, CAA, …)
  - recently: 460 000 pax & connections for 500 routes (17SEP10)
  - assign 4 AO types; use a/c configurations and load factors (rules)
- Airports in final model (ACI Europe, Eurostat, …)
  - August & September, 2009 & 2010 (busiest holiday & non-holiday)
  - 200 ECAC airports (97% pax, 93% traffic, 2010)
  - 50 external airports based on pax flows in/out Europe
- Selection of days
  - Tuesdays and Fridays, excluding high strike/ATFM & bad weather
  - bad weather day as reserve

Data and cleaning

- Logic checks
  - exclude by operator / aircraft type:
    cargo, helicopters, military, air taxi operators, corporate, private
  - resolve discrepancies:
    aircraft type (about 10%), WTCs, registrations (sequences)
  - circular flights (slot-retaining, maintenance, training)
- Range checks
  - outliers and variances (e.g. delays by phase of flight)
  - ratios (e.g. filed over actual route lengths, durations and speeds)
  - absolute speeds (some a/c & route sensitivity)
- Removal (11%) c.f. 'demotion' (80); 17SEP10 final = 26 170

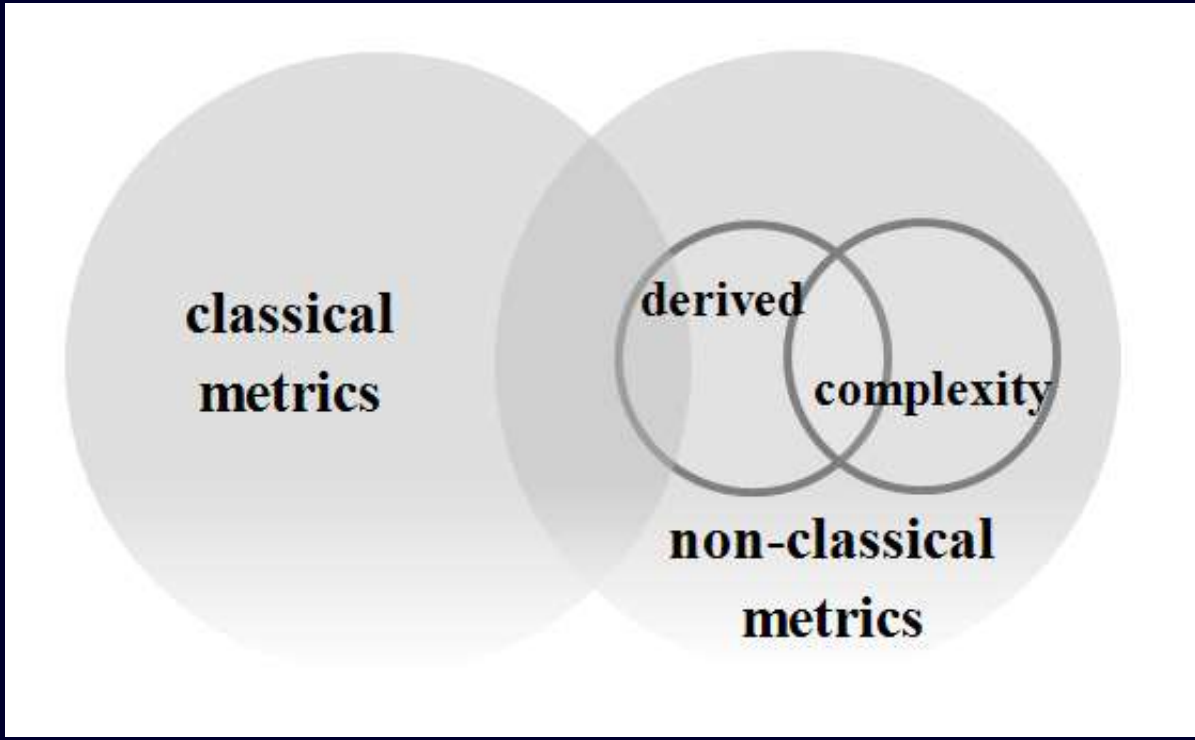
Data and cleaning



Progress so far

- metrics

Metrics


classical
metrics
derived
complexity
non-classical
metrics

Metric family	Type	Primarily drives delay or propagation metrics	Remarks
delayed departures	count	d	-
delayed arrivals	count	d	-
departure delay	duration(s)	d	to specifically include % above certain thresholds
arrival delay	duration(s)	d	to specifically include % above certain thresholds
cancelled flights	count	p	-
extra flight time	duration(s)	d	-
extra gate time	duration(s)	p	analogue of the pax 'missed connections' metric
reactionary minutes	duration(s)	p	reactionary delay mins caused by primary delay
back-propagation	ratio	p	ratio of reactionary delay from an airport that later propagates back to the same airport
reactionary depth†	count	p	number of disrupted flights in the longest path in the propagation tree*
reactionary disruptions†	count	p	number of disrupted flights*
reactionary depth / disruptions	ratio of nodes/flights	p	-
reactionary / primary delay ratio†	ratio of durations	p	value is 0.85 for whole European network (2010)

* Excluding the causal flight.

† These metrics may be expected to be lower at hub airports than for other stations.

Progress so far

- recent results

Recent results

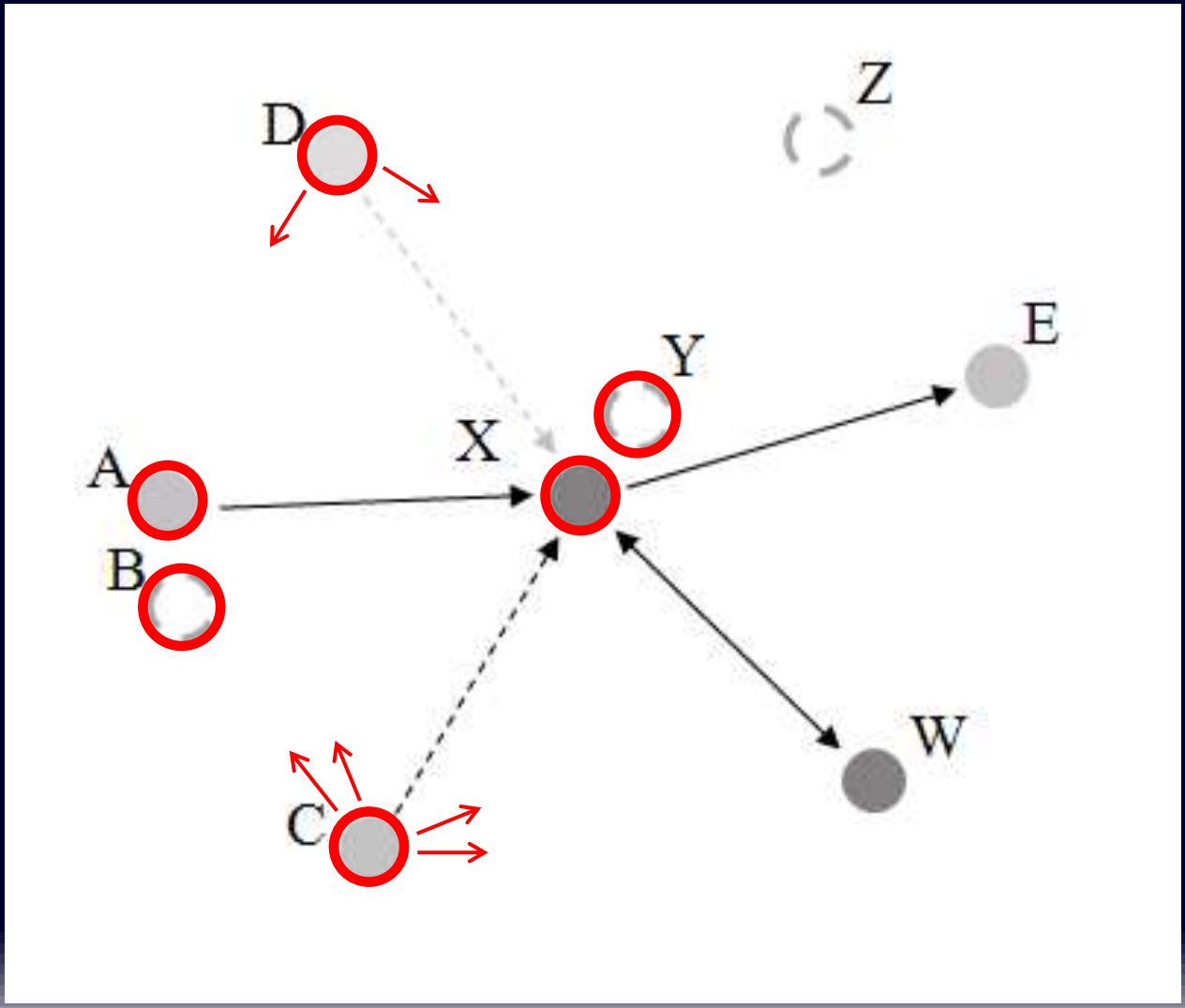
- First run of model – 200 baselines, 87 million cells
- Delay matrix, M_d, characterisation of delay propagation:

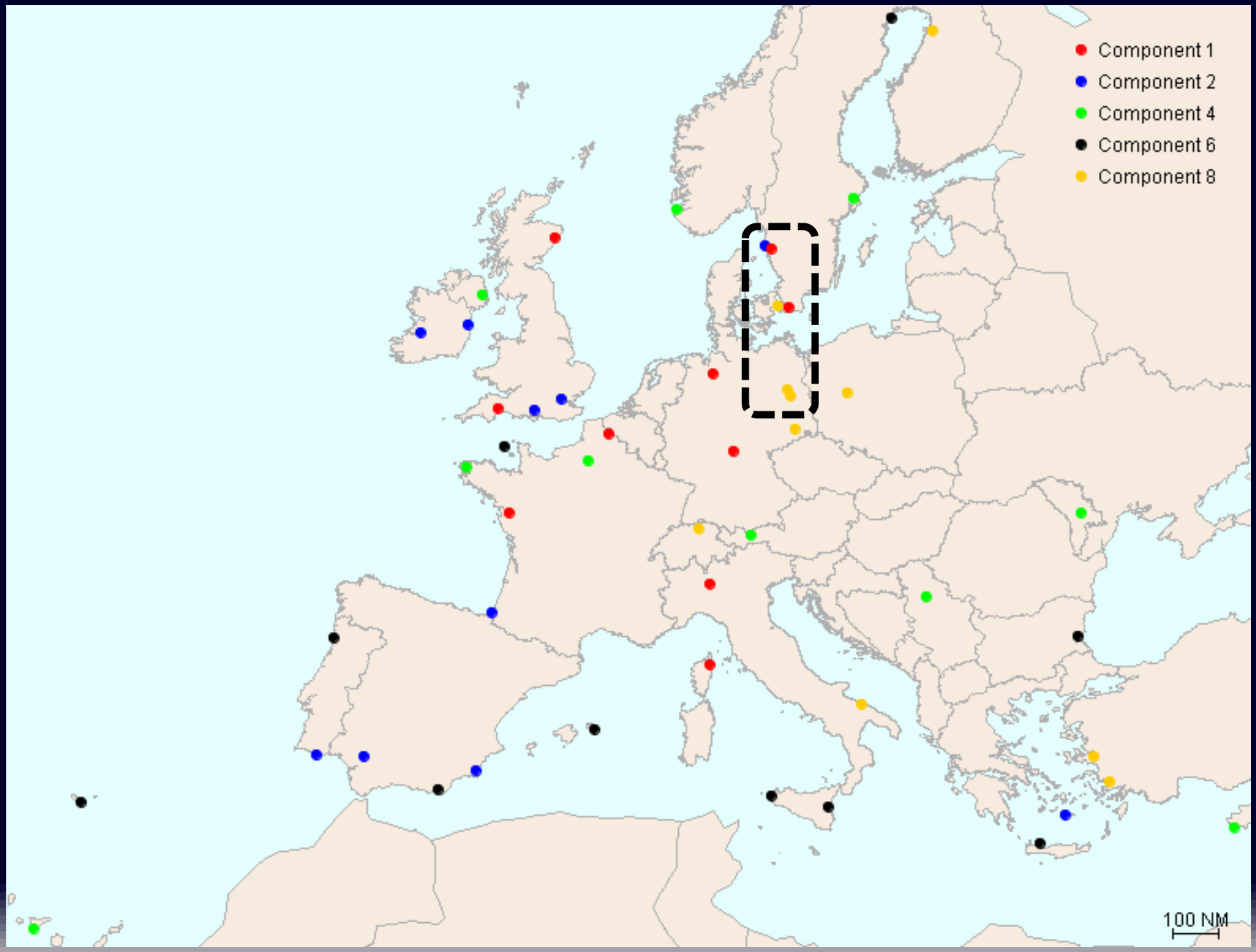
  Factor analysis
  - PCA, eigenvalues > 1, oblique (promax) rotation
  - 5 components gave good differentiation

  Percolation approach & centralities
  - link density, degree assortativity, clustering coefficient, efficiency
  - quite widely distributed backbone, many isolated nodes

- Compared with 'classical' – degree of subjectivity
- Association rather than causality (Granger causality)
- $w_d C_d - w_f C_f = C''$

Recent results




Component 1
Component 2
Component 4
Component 6
Component 8
100 NM

Conclusions

Conclusions

- Early results of analyses
  - comparative & complementary approach; further depth; causality
- Secondary & tertiary effects in network behaviour
- Building a simulation model (partly) using PRISME data
  - extensive cleaning and calibration
  - by individual phase of flight
  - taxi-out unreliable; taxi-in missing; IOBT c.f. schedule
  - distribution of metrics important
- Full prioritisation scenario trade-offs in May 2013
  - for now, we seem to have more questions than we started with!

Thank you