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**'POEM' Outstanding Project Award**

**Cook, A.J.**

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FROM INNOVATION TO SOLUTION

# 'POEM' OUTSTANDING PROJECT AWARD

Dr Andrew Cook (University of Westminster, London)  
& on behalf of Innaxis (Madrid)



founding members



# Overview

- What is POEM about and why did we bother?
- The simulations in a nutshell
- How does complexity science fit in?
- A sample of key results
- Where next?



# What is POEM about and why did we bother?

- Passenger-Oriented Enhanced Metrics
  - putting the passenger at the centre of service delivery
  - exploring new prioritisation strategies using new metrics
- Political motivation re. pax mobility, e.g. Commission:
  - roadmap to a Single European Transport Area for 2050 (2011)
  - ‘Flightpath 2050’, HLG on Aviation Research (2011)
    - ... 4 hour door-to-door target for 90% of passengers
  - on-going reviews to Regulation 261/2004 (2016?)
- Operational motivation
  - pax direct costs often dominate AO cost of delay (& behaviour)
  - even in pure G2G context, passenger delay > flight delay



# The simulations in a nutshell

- Evaluate flight and pax prioritisation strategies
  - currently 3 major scenario types (pax numbers, costs, policies)
- Use new metrics to measure performance trade-offs
  - classical (e.g. pax delay) and complexity (e.g. centralities)
- Investigate delay propagation through network
- First full-scale European simulation with explicit pax
  - captures full AO delay costs (pax, fuel, crew, maint.); 4 types
  - busiest 200 ECAC airports + 50 airports outside Europe
  - unexceptional, busy day in 2010 (17SEP10)
  - detailed decision-making rules (workshops: Reg. 261:



# A look inside one second ...

[...](17-Sep-2010 12:25:00) 47 out of 49 of pax (95.92 pct.) of DLH\_EDDLEGBB02:15877 were ready, flight over 80 pct. occupancy, no more delay added

(17-Sep-2010 12:25:00) Total cost of flight DLH\_EDDLEGBB02:15877 departing at 17-Sep-2010 12:25:00 now estimated at 127.15 euros

(17-Sep-2010 12:25:00) No further pax delay will be introduced, thus flight DLH\_EDDLEGBB02:15877 is now pushback ready, reaccommodating connecting pax

(17-Sep-2010 12:25:00) Pax group DLH1815:37550 of 2 inflex pax coming from DLH\_EDDHEDDL06:12246 to EGBB did not make it to DLH\_EDDLEGBB02:15877 (no more connections afterwards) and need to be reaccommodated

(17-Sep-2010 12:25:00) 2 inflex pax of group DLH1815:37550 of DLH\_EDDHEDDL06:12246 that missed DLH\_EDDLEGBB02:15877 were successfully reaccommodated in DLH\_EDDLEGBB03:23396 same alliance, DLH1815/1:145607 Arrival: 17-Sep-2010 17:50:00 delay: 04:00'00" (airport wait 03:01'51")

(17-Sep-2010 12:25:00) Trying to reaccommodate the 80 pax waiting at EDDL:10 (DUS)

(17-Sep-2010 12:25:00) A total of 2 pax of DLH\_EDDLEGBB02:15877 were left behind and all of them were successfully reaccommodated

(17-Sep-2010 12:25:00) Flight SAS\_ENKBENGM03:15843 loading 67 pax and all of the 67 pax are not coming from a previous flight. There are NO connecting pax

(17-Sep-2010 12:25:00) There are 29 pax groups in SAS\_ENKBENGM03:15843 connecting with another flight afterwards (SAS3310:87574, SAS3311:87575, SAS3312:87576, SAS3313:87577, SAS3314, [...])  
(KSU-OSL)

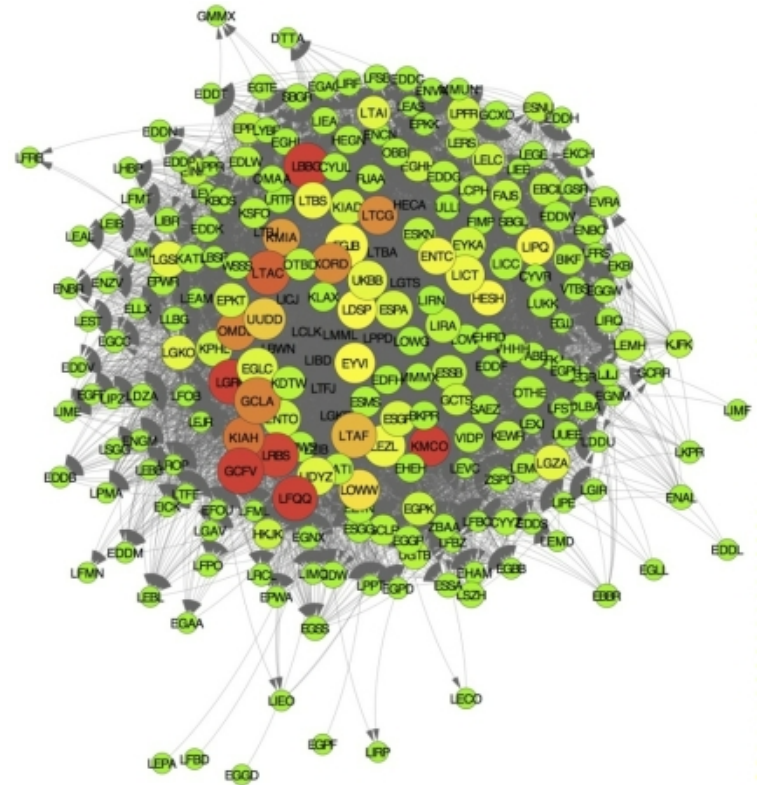
# How does complexity science fit in?

- Not one theory; system of systems – usually a network
  - multiple components, non-linear dynamics: can't predict
  - non-analytical models, e.g. agent-based
  - usually need to take uncertainty into account
- Emergent behaviour, e.g. delay propagation
- ATM = complex socio-technical system
- How can complexity science contribute?
  - user-defined nodes in topological networks
  - existing metrics such as centralities (causality)
  - existing methods such as community detection & percolation
- Complementary approach



# A sample of key results

- Cost-minimising aircraft wait rules (scenario  $A_1$ ):
  - ↓ **€39** avg. cost / flight
  - ↓ **9.8 mins** avg. arr. / dlyd pax
  - ↑ **2%** reactionary (focus)
- All scenarios: no statistically significant changes in current flight-centric metrics
- Persistence of delay
  - hub back-propagation
  - role of smaller airports



- Delay topologies for  $A_1$ :
  - smaller communities
  - more susceptible



# Where next?

- Live model, on-going developments such as:
  - fidelity of various rules (flexible, event-driven; + CO<sub>2</sub>?)
  - 2014 traffic with new costs; GDS integration; D2D context
- Exploring further use of valuable new metrics
  - passenger-centric; in context SES RP3 (2020 – 2024)?
  - increased focus on cost resilience
- Policy evaluation
  - e.g. Regulation 261; ‘exploratory’ policies
- Increased AO-level focus and software integration
  - strategic planning, trending context (e.g. a/c sizes & LFs)





Thank you



# Stand-bys



# Summary of scenarios

Type, level	Designator	Summary description
No-scenario, 0	S <sub>0</sub>	No-scenario baselines: reproducing historical operations
ANSP, 1	N <sub>1</sub>	Prioritisation of inbound flights based on simple passenger numbers
ANSP, 2	N <sub>2</sub>	Inbound flights arriving more than 15 minutes late prioritised based on number of onward flights delayed by inbound connecting passengers
AO, 1	A <sub>1</sub>	Wait times and associated departure slots estimated on cost minimisation basis; longer wait times potentially forced during periods of heavy air traffic flow management (ATFM) delay
AO, 2	A <sub>2</sub>	Departure times <i>and</i> arrival sequences based on delay costs – A <sub>1</sub> is implemented <i>and</i> flights are independently arrival-managed based on delay cost
Policy, 1	P <sub>1</sub>	Passengers reaccommodated based on prioritisation by final arrival delay, instead of by ticket type; preserves interlining hierarchies
Policy, 2	P <sub>2</sub>	As P <sub>1</sub> , now also relaxing all interlining hierarchies

flight-  
centric

new  
metrics

Core metric	Units	N <sub>1</sub> & N <sub>2</sub>	P <sub>1</sub>	P <sub>2</sub>	A <sub>1</sub>
		Inbound prioritisation based on: simple pax numbers, or on onward flights delayed	Passenger reaccommodated based on delay at final destination ...  ... preserving interlining hierarchies	... relaxing interlining hierarchies	Departures times based on <b>cost minimisation</b> (& consideration of ATFM delay)
Flight departure delay	mins / flight	no significant changes in current flight-centric metrics: stresses need for passenger-centric metrics			
Flight arrival delay	mins / flight				
Departure delay of departure-delayed flights	mins / flight				
Arrival delay of arrival-delayed flights	mins / flight				
Pax departure delay	mins / pax			=	+0.4
Pax arrival delay	mins / pax			-0.4	-1.6
Departure delay of departure-delayed pax	mins / pax	no significant changes under simple inbound scenarios driven by passenger numbers, or by numbers of delayed onward flights	revised passenger re-booking rules produce only weak improvements whilst current airline interlining rules are preserved, c.f. →	=	=
Arrival delay of arrival-delayed pax	mins / pax			-2.2	-9.8
Passenger value of time	Euros / pax			-0.2	-0.7
Non-passenger costs	Euros / flight			=	=
Per-flight pax hard cost	Euros / flight			+26	-40
Per-flight pax soft cost	Euros / flight	=	=		
Total flight cost	Euros / flight	+26	-39		
Total flight cost per minute of departure delay	Euros / min	=	-7.8		
Reactionary delay ratio	ratio			49%	51%