Air Transportation and Multimodal, Collaborative Decision Making during Adverse Events

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Introduction
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Flightplan 2050: "90% of travellers within Europe are able to complete their journey, door-to-door within 4 hours. Passengers and freight are able to transfer seamlessly between transport modes to reach the final destination smoothly, predictably and on-time."

Shift towards passenger-centric metrics

Resilience at the airport level: Airport Collaborative Decision Making

Most cited benefits to airlines and passengers:
- better punctuality: average 3 minutes reduction in aircraft taxi time
- fuel savings for airlines: up to 20.8 million euros in 2013
Evidence of the need for and opportunities afforded by Multimodal Collaborative Decision Making
Anecdotal Evidence

- Low storms paralyzing flights in Western Europe (December 2010)
- Volcanic ash clouds grounding a vast portion of European traffic for a week (April 2010)
- Radar failure at Athens Airport (September 2012)
- Hail affecting French airports (April 2012)
- Hurricane Sandy leading to airport closures all over the East Coast of the United States (October 2012)
- Air reservation system outages (Sabre in August 2013, Amadeus in July 2012)
- Bush at San Francisco airport (July 2013)
- Evacuation and two-weeks closure of the Chicago En Route Center (ZAU) (September 2014)
- Flight data system failure at Swanwick air traffic control center (December 2014)

These events were exacerbated by the rigidity and complex nature of transport networks, and a lack of appropriate preparation.

Multimodal passenger routing offer viable alternatives to minimize passenger disruptions.
The need for multimodal CDM

Four types of IROPS impact situations:

- surge, in which extra aircraft and passengers flow into an airport;
- capacity, in which the airport terminal becomes full of passengers or ramp space/gates become full of aircraft;
- after-hours, in which aircraft land and passengers need to deplane at hours when facilities are not functional;
- extended stay, in which passengers and aircraft may be immobilized at the airport for an extended period of time.

Stakeholders, during interviews, acknowledge the need for network level CDM. Example of Winter 2010 snowstorm, with ripple effects from Heathrow to Charles de Gaulle to Toulouse.
More than 15,000 domestic passengers diverted to airports other than SFO. The case of international flight diversions was much worse, with flights from Europe diverted to Seattle.

Cumulative rerouting example for LAX: all passengers are rerouted on remaining seats on maintained flights to Bay Area regardless of their airline.
Passenger side of the situation obtained from Twitter data:
Regarding a SFO-bound UA flight from Seattle diverted to OAK: "United has no support here. They sent a dislocation team, but basically what they keep saying is: "You're dislocated."

"Transportation to San Francisco for passengers diverted to Sacramento depends on the airline. Delta Airlines arranged taxi and shuttle services for passengers to get to San Francisco after their planes were forced to land in Sacramento. US Airways passengers were loaded on to shuttle buses at SMF to be taken to San Francisco. (...) United Airlines did not have a definitive plan in place to help passengers who were diverted to SMF."

Additional staff was brought in to help accommodate the more than 1,000 passengers that were diverted to Sacramento International Airport (..). Officials say they had to bring in extra staff to accommodate all those passengers that were landing at the same time. It was a mad rush as staff scrambled to get everyone to where they needed to go"
Hypothetical Closure of London Heathrow

For passenger journeys between the top 50 airports in Europe by passenger traffic in 2012, 85% have the alternative of a city-city rail connection, 96% have the alternative of city-city road/ferry connections, and all have a feasible ground transport route to another airport.

The number of stranded passengers for whom taking a ground transportation option would be faster than waiting for the next non-cancelled flight depends on how long the anticipated wait is.

Using data on air schedules and air, rail and road journey times from OAG, ETISplus and online journey planners, around 50% of passengers on these routes could arrive at their destination sooner by taking ground transportation if a 10-hour wait time is anticipated. This rises to 70% for a 15-hour wait time.
Hypothetical Closure of London Heathrow

Distribution of passenger delay for a 1-hour, 2-hour and 4-hour airport closure period.

Costs, mean passenger delay at destination airport, and use of alternative modes by length of cancellation period for the hypothetical disruptive events modelled here.
MetaCDM processes and concepts
## MetaCDM Functional Groups

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MetaCDM Milestones

**Pre-Travel**
- M1: Activation of travel connection
- M2: Provision of details on travel connection
- M3: Begin of travel (to booked connection)

**Pre-Boarding**
- M4: Reaching start site of booked travel connection
- M5: Passing of milestone(s) at start site of travel connection
- M6: Boarding of booked travel connection

**End of Transport**
- M7: De-Boarding of booked travel connection
- M8: Passing of milestone(s) at end site of travel connection
- M9: Leaving end site of booked travel connection
MetaCDM milestones chain in case of cancellations

M1: Activation
M2: Preparation
M3: Travel start
M4: Start Site
M5*: Milestones
M6: Boarding

MD: Information on details
RT: MC/MD

MC: Choice between options
RT: MB/MC

MB: Information about options
RT: MA/MB

MA: Information on cancellation

FC: Flight Cancellation

Mx = Milestone x
RT = Reaction Time
Flow A
Flight cancellation information

Flow B
Options list building

Flow C
Final Option choice

Flow D
Practical Details

Flow E (for guided pax only)
Practical Details on D2D ground transport
Conclusion
Conclusion

Strong evidence for the need of multimodal CDM.
Case studies in the US, with the Asiana crash, and in Europe, with London Heathrow closure show that there are significant opportunities for improved passenger reaccommodation.
Multimodal Collaborative Decision Making concept elaborated.

Future work:
- More case reports
- What are the performance limits?
- Validation of the MetaCDM concept.
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