Existing work on CDM, disruption management and improving passengers' experience

Aude Marzuoli

ENAC

Meta CDM

Multimodal, Efficient Transportation in Airports and Collaborative Decision Making

COOPERATION

Introduction

- Vision for Europe in 2050: "90% of travelers 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."

  European Commission [1]
- The objectives of META-CDM are to study the conditions under which Collaborative Decision Making can help the transportation system deal with major disruptive events as they affect civil aviation and facilitate the passenger's journey.

Overview

- Air Transportation Networks
- Delay Propagation and Performance in the Air Transportation System
- Collaborative Decision Making
- Disruptions in Air Traffic and on the Ground
- Multi-modal Transportation
- Shifting the focus towards the Passenger

Air Transportation Network

- Small world Network with scale free distributions of the number of nonstop connections and shortest paths between cities [2]
- Dynamic network, connections appear and disappear [4,5]. Airports in close vicinity tend to have collaborative rather than competing effect on air passenger demand [6]
- Comparison between the networks in Europe/ China /US: which network provides the best service to the passengers? [7]
  - Europe has highest percentage of destinations, but connections take longer than in the US or China. Each country favors connectivity towards its own airports.
  - Better coordination in the US but secondary airports have been marginalized.

Delay Propagation and Performance in the Air Transportation System

- 103 million system delay minutes cost $7.7 billions to scheduled U.S. passenger airlines in 2010. In Europe, reactionary delays add up to half of the delay minutes.
- Metrics have been developed to quantify the propagation of delay in the network: magnitude, severity, depth, depth ratio, stay, crew out, split [10].
- Features of delay propagation:
  - Propagated delays create significantly more impact than the original root delays themselves,
  - A single delay can "snowball" through the entire network,
  - Keeping aircraft and crews together can help to mitigate the impact of disruptions,
  - Delays that occur early in the day can cause greater propagation than delays later in the day.
- Flight cancellations: less than 3% of domestic flights, hard to predict. [12] An analysis of cancellation factors can lead to cancellation prediction, to estimate reduction in flight delays due to cancellations.

Delay Propagation and Performance in the Air Transportation System

- Multi-airport system: a system with a set of airports that serve the air traffic of a metropolitan area.
- Parallel airport system emerging with the low cost airlines, with secondary airports in metropolitan regions [13].
- Metroplex: group of airports with coordinated operations in terms of sharing regional airspace, where some act as reliever airports in case of overshooting of capacity at other airports.
- The quantification of interdependencies between airports can help investigate delay propagation. Main causes of delays: queues and weather.
- Washington-Baltimore, New York and South Florida have huge impacts on the delays in the US. [14] Need for proper regional airport level and airspace planning.

Collaborative Decision Making

- An airport in Europe is considered a CDM airport when A-CDM Information Sharing, Turn-Around Process and Variable Taxi Time Calculation concept elements are applied at the airport.

Collaborative Decision Making

- In the US, the CDM-based ground delay program planning and control appeared in 1998 at SFO and EWR.
- Nowadays, more elaborate CDM-based tools are used for the control and planning of airspace flow programs.
- A key aspect of the CDM effort is its reliance on data analysis and objective critique.
- How should proposed enhancements be evaluated in a CDM environment? Build a sequential evaluation procedure with airline disruption responses [19].
- How can we evaluate the potential of CDM at the network level? Use an Air Traffic Flow Management model with a CDM framework from an airport setting to an airspace context incorporating fairness and airline collaboration [20].

Disruptions in Air Traffic and on the Ground

- The different mechanisms of airline schedule recovery in case of disruption: aircraft swaps, flight cancellations, crew swaps, reserve crews and passenger rebooking.
- Problem usually solved in a sequential manner:
  - infeasibility of the aircraft schedule
  - crewing problems,
  - ground problems
  - the impact on passengers
- A theoretical study of the diffusion of aircraft as dynamic agents in the European air transport network shows a free phase (efficient regime with no airport queues and high diffusivity), and a congested phase (with bottlenecks and poor diffusivity), separated by a jamming transition. This does not depend on the network topology [22].

Disruptions in Air Traffic and on the Ground

- Vaze [25] evaluates the congestion impacts on the NAS stakeholders while explicitly accounting for their interactions and proposes congestion mitigation mechanisms that are beneficial to these different stakeholders:
  - Administrative slot control
  - Congestion pricing
  - Airport slots auction
- At the current level of passenger demand, delays are avoidable to a large extent by controlling the negative effects of competitive airline scheduling practices. The level of congestion in a system of competing airlines is an increasing function of the number of competing airlines, a measure of the gross profit margin and the frequency sensitivity of passenger demand.

Multi-modal Transportation

- The volcanic eruption in 2010 also had knock-on effects on other modes of transportation, because of the rigidity and complexity of transport networks, and the lack of appropriate preparation.
- The partial substitution of some short-haul flights with High Speed Rail transport, either through modal competition or complementarity, is already in place in four European hubs (Frankfurt Main, Paris CDG, Madrid Barajas, Amsterdam Schipol).
- The High Speed Rail substitutive capacity does not act as a barrier to developing air/rail substitutions at the airport. Even very modest substitution of up to 2% air passenger short-haul flights with the equivalent high speed rail services may produce substantive savings, up to about 20% in airline and air passenger delays and up to 17% in related costs.[28]

Multi-modal Transportation

- Zhang [30] develops a framework to reduce passenger disutility due to delay and misconnection, to help airlines reduce operating cost and recover schedule more promptly, and to assist traffic flow managers to utilize and distribute scarce resources more efficiently and equitably.
- When there is a significant capacity shortfall, airlines with hub-and-spoke networks could incorporate ground transport modes into their operations.
- Real-time intermodalism includes the substitution of flights by surface vehicle trips and, when possible, inter-airport ground transport to divert passengers to alternate hubs.
- The current CDM system could be enhanced to realize a regional Ground Delay Program by including regional transport agencies, regional airport authorities, airlines serving regional airports and others.
- Need for collaboration between FAA, airlines, airports, passengers, and consensus on the importance of integrating underutilized regional airports into disruption recovery strategies.

Multi-modal Transportation

- For the passengers, traveling across several modes of transportation to complete their journey can be difficult, especially when it comes to planning travel times.
- To improve the passenger's experience, more and more advanced transport information systems (ATIS) provide services such as route planning, navigation, updates on disruptions, real time information alerts.
- A multi-modal supernetwork encompasses:
  - road, rail, air, water transportation .
  - private (e.g. foot, bike, car) or public modes (e.g. bus, train, tram, metro).
  - the switch between modes occurs only when the transfer is possible. Some links are time independent, others time dependent or stochastic time dependent.
  - travel time and monetary cost need to be computed.[31]

Multi-modal Transportation

- Reliability of the schedule in a multi-modal trip is essential. The traveling time in each mode and the waiting times in between should be balanced to improve passengers' experience.
- Hsu [32] develops a simple model to represent the transfer waiting time for a connecting service at multi-modal stations..
- Transfer waiting times is mostly affected by the capacities and headways of the connecting and feeder services. Transfer waiting time cannot be improved without operational coordination with the feeder service.

Shifting the focus towards the Passenger

- Flight delays do not accurately reflect the delays imposed upon passengers' full multi-modal itinerary. The growing interest to measure ATM performance calls for associated metrics, reflecting the passenger's experience.
- Propagation-centric and passenger-centric performance metrics differ from existing classical metrics, with regard to intelligibility, sensitivity and consistency [33].
- Computing passenger delay using monthly data from a major airline operating a hub-and-spoke network shows that disrupted passengers, whose journey was interrupted by a capacity reduction, are only 3% of the total passengers, but suffer 39% of the total passenger delay [34].

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Shifting the focus towards the Passenger

- The major findings from [35]on 1,030 routes between the 35 busiest airports in the US in 2006 are as follow:
  - High passenger trip delays are disproportionately generated by canceled flights and missed connections.
  - Trend analysis for passenger trip delays from 2000 to 2006 shows the increase in flight operations slowed down and level o in 2006, while enplanements kept increasing, due to a continuous increase in load factor. Passenger performance is very sensitive to changes in flight operations, with an increase in annual total passenger trip delay in 2006, while flight operations barely grew.
  - 17% of routes generate 50% of total passenger trip delays. 9 of the busiest 35 airports generate 50 % of the total passenger trip delays.
  - Congestion flight delay, load factor, flight cancellation time and airline cooperation policy are the most significant factors affecting total passenger trip delay.

Shifting the focus towards the Passenger

- Understanding the passengers' preferences is essential in a period of multi-airports regions' growth and intense competition between airlines, whether legacy airlines or low-cost.
- To model the airport choice of air travelers between 4 airports in Hing-Kong Delta region, and describe scenarios of regional airport competition and airport coordination, Loo includes: average propensity to travel, spatial distribution of air travelers, regional inflows and outflows of passengers, ground transportation infrastructure capacities, number and physical location of airports, ground transportation cost, congestion effect, cross-border cost, airport Level Of Service (LOS) and government's aviation policy. [36,37]
- How do passengers choose an airport over another within the same multi-airport region? Air fare, access time, flight frequency and the number of airlines. The number of airport access modes, access cost, airport shopping area and queue time at check-in counters are not significant.

Shifting the focus towards the Passenger

- Results of DGAC study on 49054 air passengers 2011 in France
- 80 % of passengers only take one flight.
- A passenger needs on average 71 minutes to reach the airport.
- 83% of passengers bought a ticket by itself, not within a full package, on average 52 days before departure.
- 83% had electronic tickets.
- 59% had non refundable tickets, 23% did not know if their ticket was refundable.
- 51% had non exchangeable tickets, 26% did not know.
- Why did some passengers have a connection in France?
  - 63% say there was no direct flight to their destination
  - 19% say it was cheaper this way
  - 9% say because the schedule matched their needs better
  - 9% say someone else booked their ticket.

Shifting the focus towards the Passenger

- 31% of passengers without a connection take public transportation to get to the airport.
- 30% of passengers were dropped off by someone with a car, 18% by a cab.
- Why don't they use public transportation?
  - 23% feel more free with a cab or a car
  - 21% say the public transport schedules did not meet their needs
  - 20% say the public transport options took too long
  - 17% say it was not convenient (heavy luggage)
  - 12% say they had too many changes to make.

Conclusion

- State of the art in research
- Need to develop and integrate landside CDM
- The passenger's role, options, capabilities need to be rethought.
- There is room for improvement.

Questions?

"Questions are guaranteed in life; answers aren't."

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