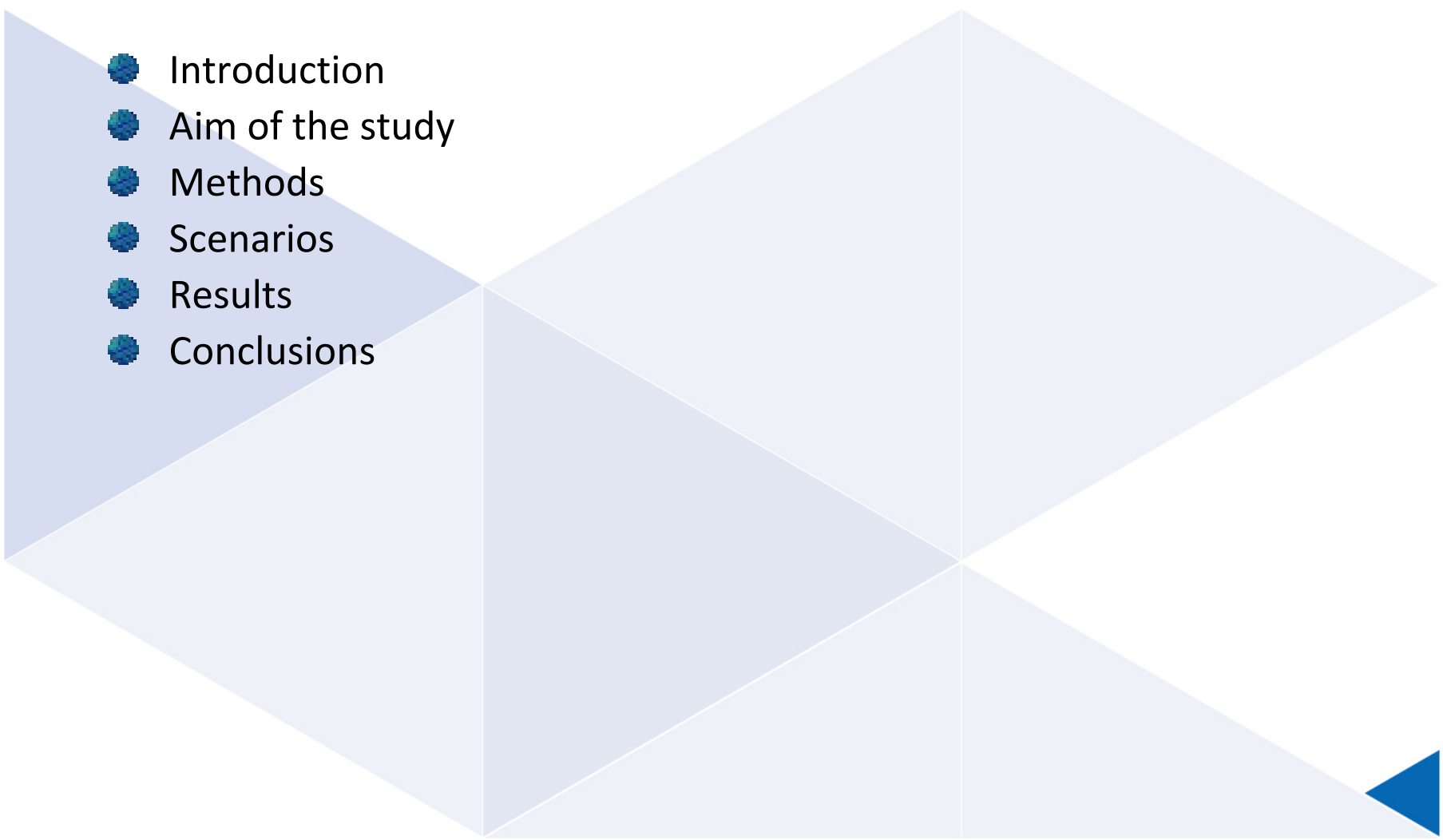


ANALYSING THE DECISION-RULES FOR A GROUND DELAY PROGRAM: MEXICAN AIRPORT NETWORK

MIGUEL MUJICA MOTA, AMSTERDAM U. OF APPLIED SCIENCES
THE NETHERLANDS

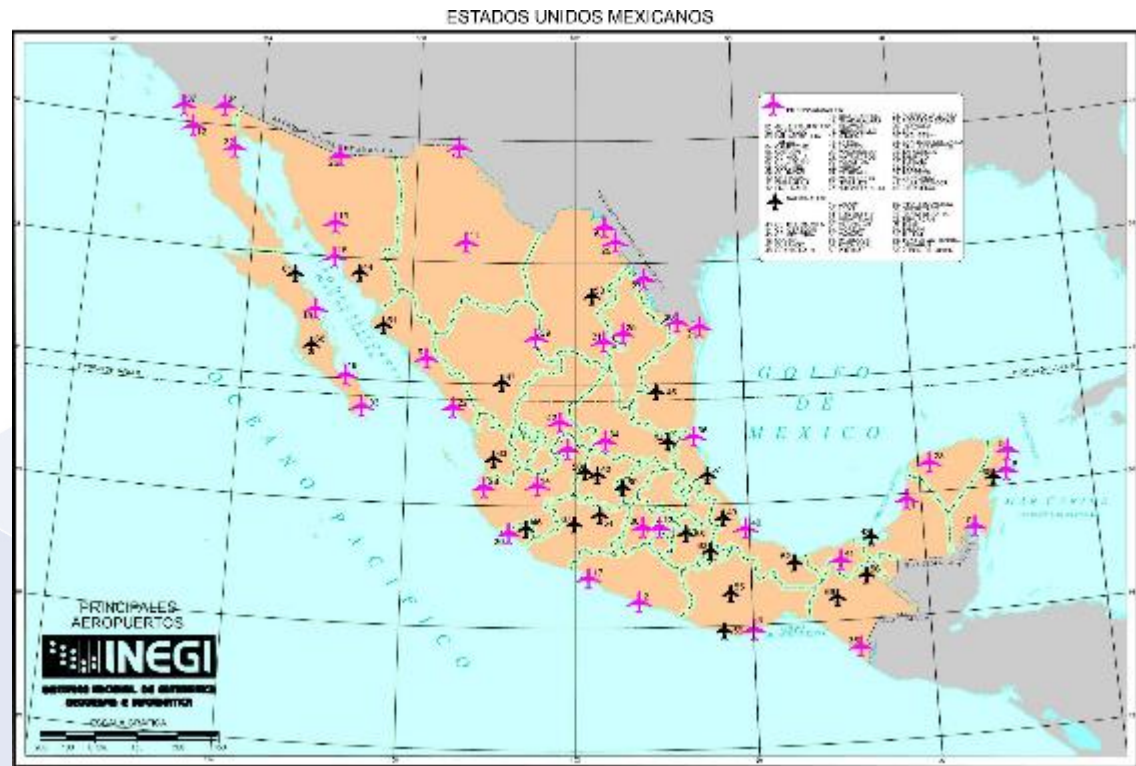
RODRIGO ROMERO, PANAMERICAN UNIVERSITY, MEXICO

OUTLINE

- 
- Introduction
 - Aim of the study
 - Methods
 - Scenarios
 - Results
 - Conclusions

No Open Skies

In 2016 an agreement
between US and
Mexico

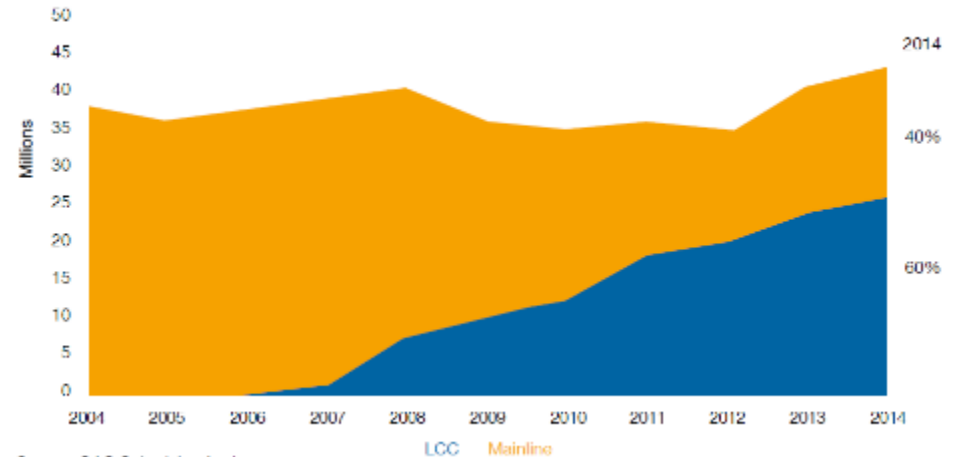


DEMAND GROWTH

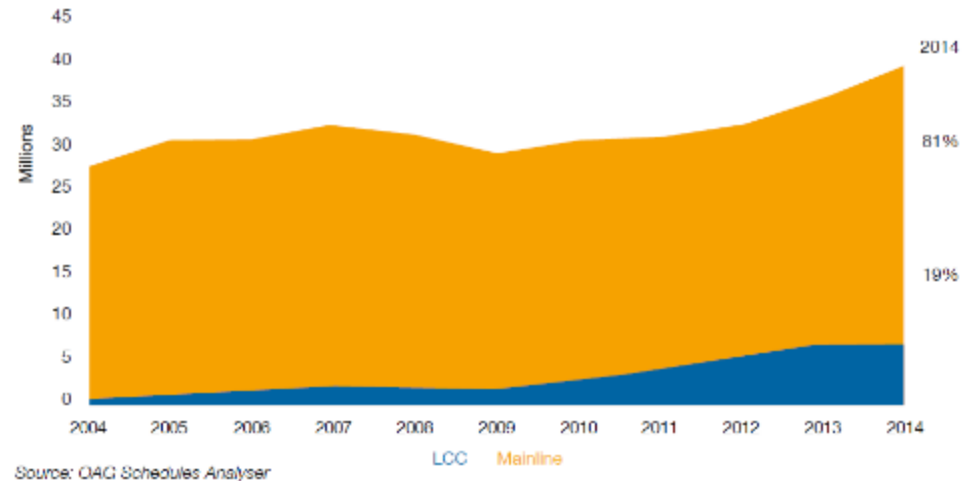
Flag Carrier
Aeromexico

LCCs: Interjet, Volaris,
VivaAerobus

Mexico – Domestic Capacity

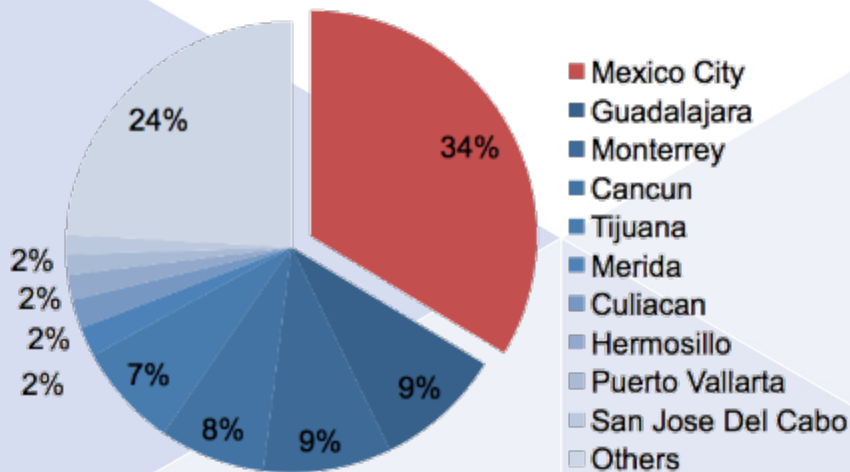


Mexico – International Capacity

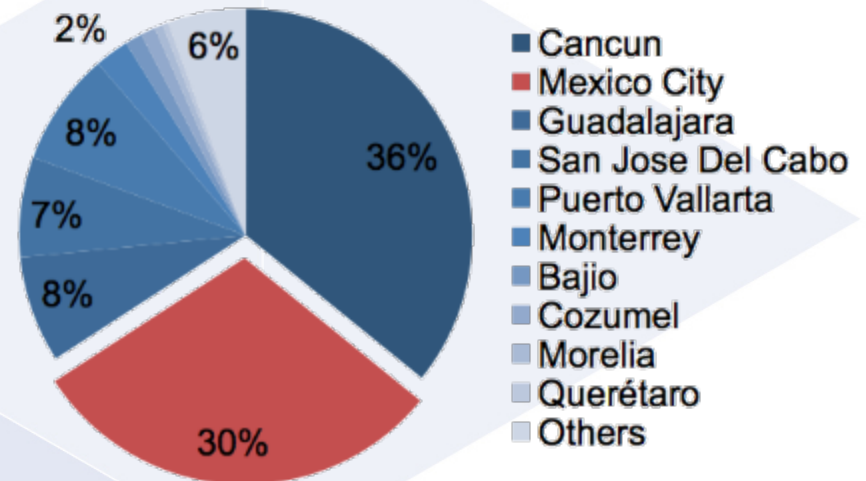


TRAFFIC PERCENTAGES

Air passenger traffic by main airports in Mexico, Jan-May 2017



(a) Domestic



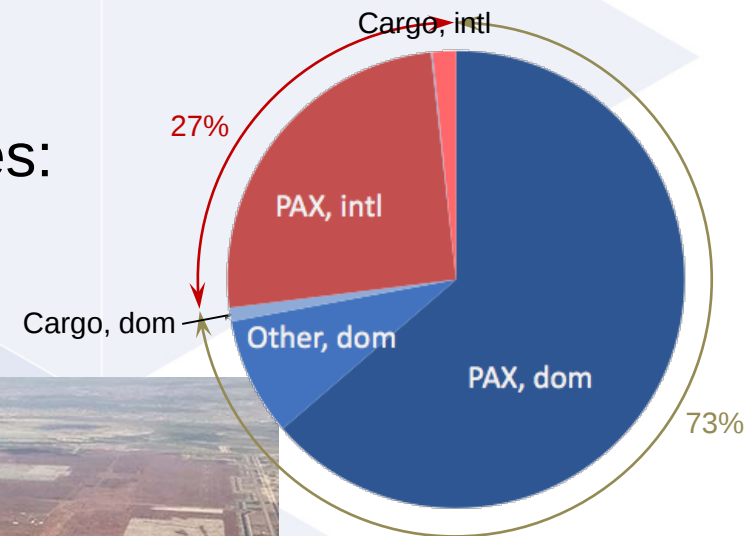
(b) International



CURRENT SITUATION OF MEX

- MEX international airport has limited capacity for growth
 - 2016: almost 450 000 ATM
 - 89% passenger flights
- A new airport is being developed (2020?)
- Traffic flow management initiatives: **ground delay programs**

Domestic	Pax	63.7%
	Cargo	1.0%
	General	8.4%
Internacional	Pax	25.2%
	Cargo	1.6%
	General	0.1%



CURRENT GDP SITUATION

- 40 Arr/hr Hard limitation, 61 ATM/Hr declared capacity
- A GDP is applied when expected 40 Arr/hr.
- A delay of 15 mins is imposed on the Mexican carriers only
- International flights have priority

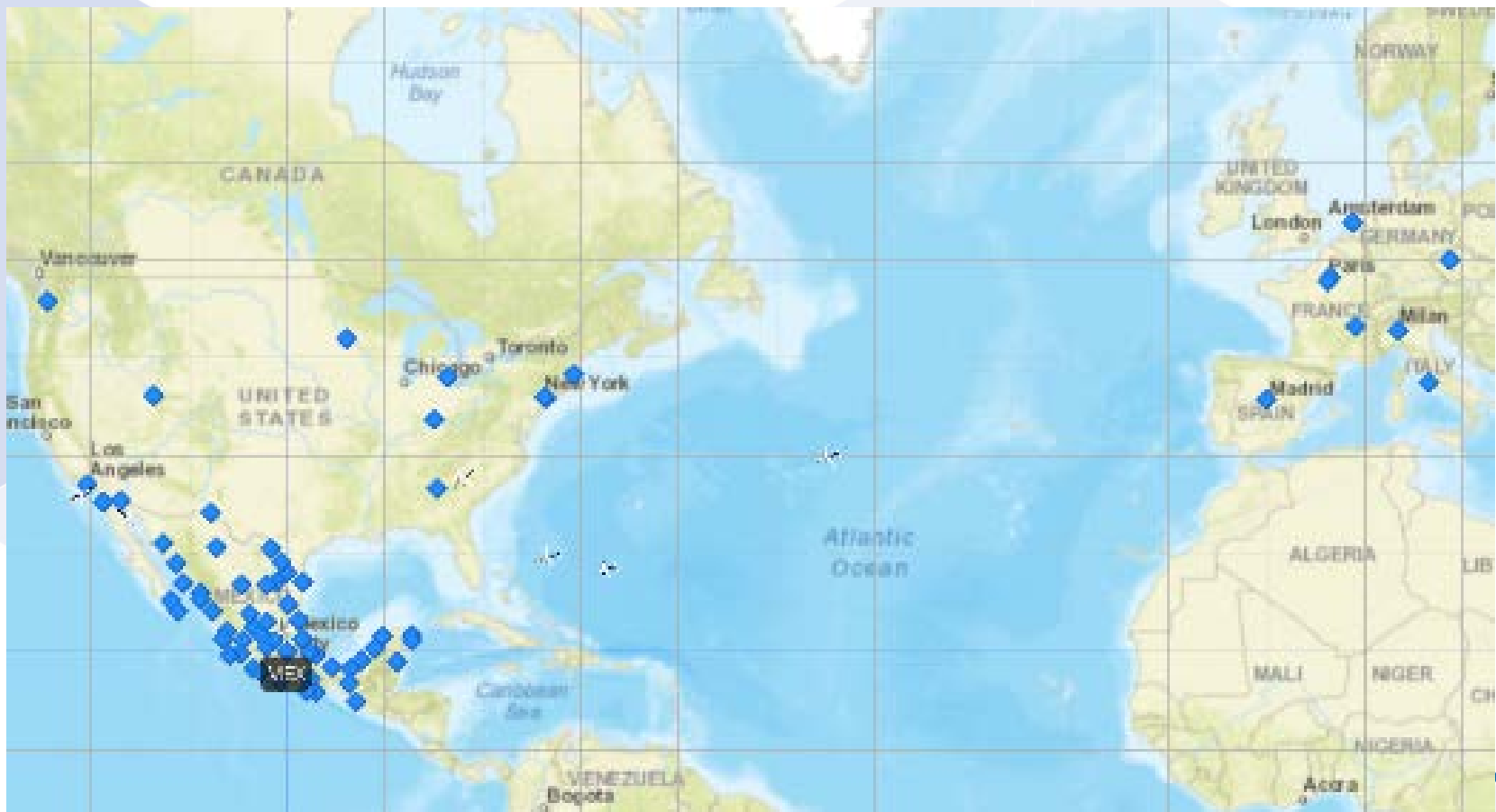


AIM OF THE STUDY

- Simulation-based for assessing the current ground delay program (GDP) in Mexico City.
 - Alternatives for the GDP
 - Better management of the Airport

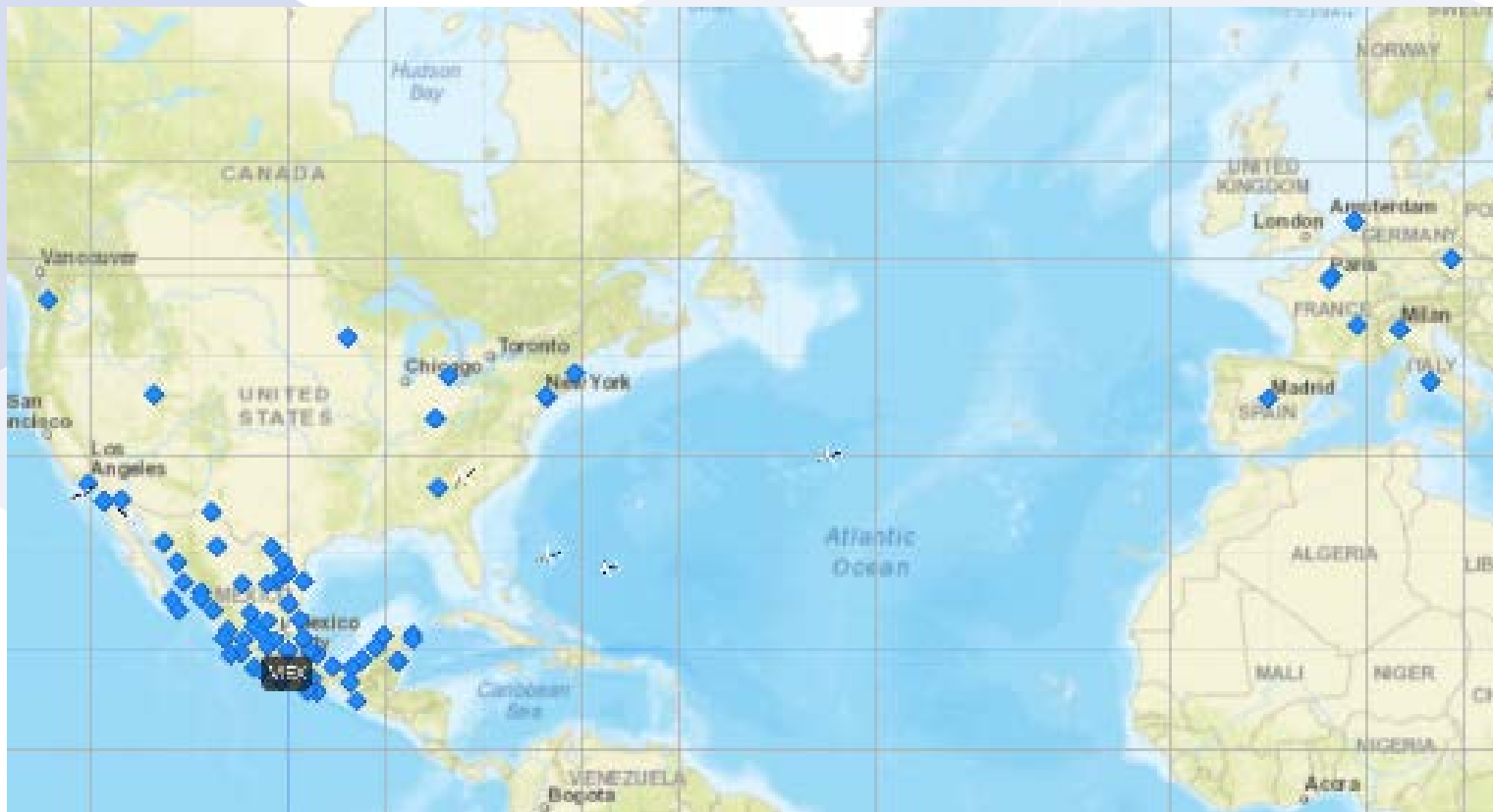
METHODS: MODELING SYSTEM

- GIS & Simulation of Mexican Network
- Stochastic Modelling



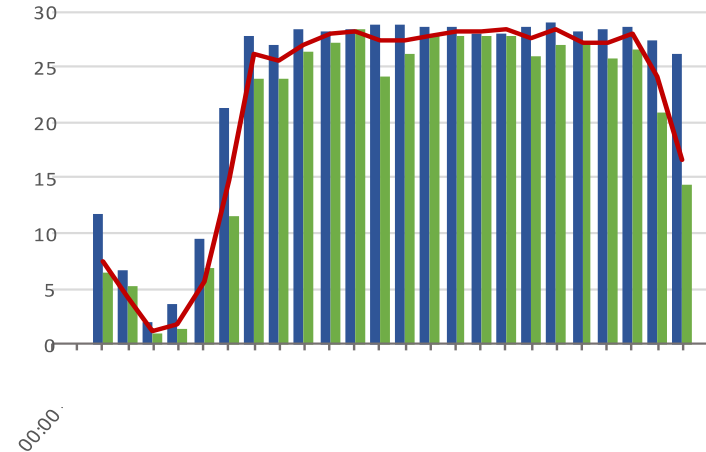
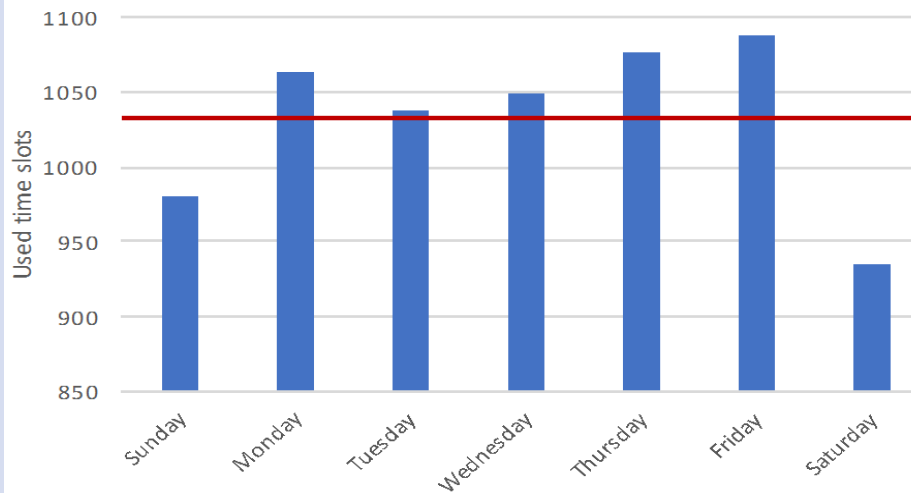
METHODS: MODELING SYSTEM

- MEX: Capacity of 96 Positions, micro ops neglected
- INPUT: Flight Schedule (OAG), origin, flight operator, A/C Type, arrival time, and flight duration



MODEL SET-UP

- Simulation of DEMAND
- Simulation Time: one week of Data, 4000 Flights

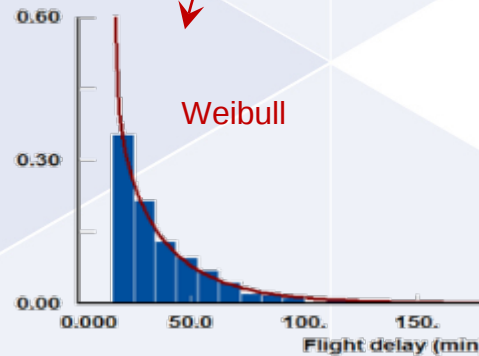
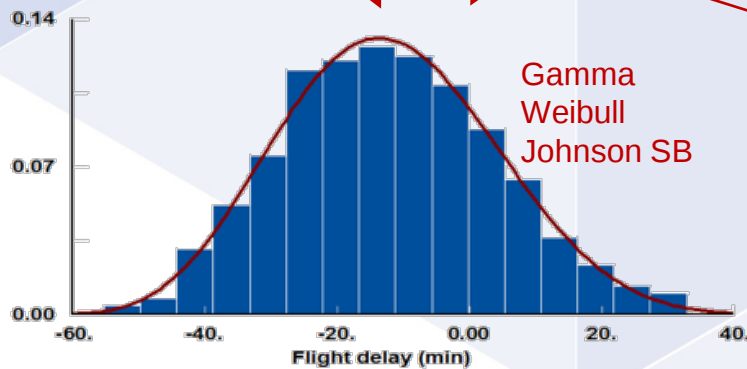
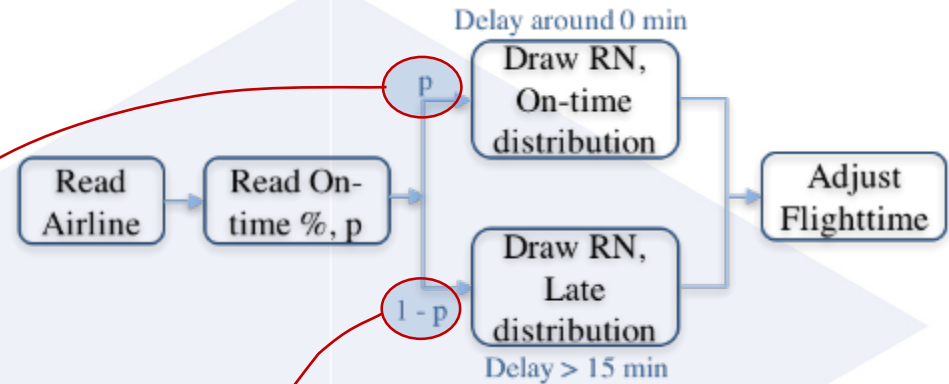
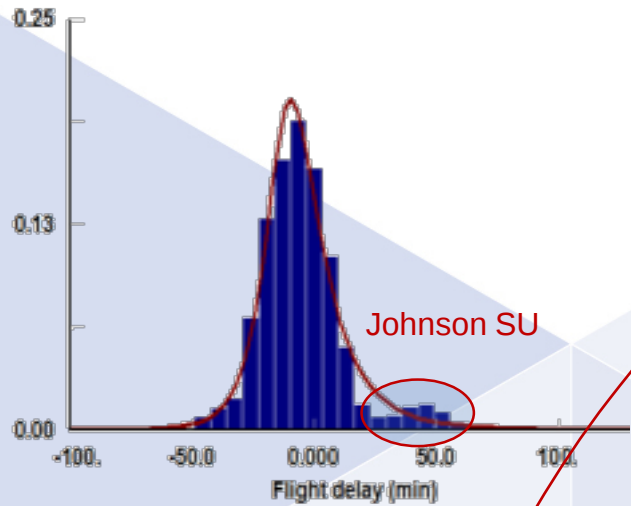


MODEL SET-UP

- 
- A map showing flight routes from various airports in North America to Mexico. Blue dots represent airports, and lines represent flight paths. The map includes labels for Canada, the United States, Mexico, and the Atlantic Ocean. Specific cities like Los Angeles, Toronto, and Mexico City are marked.
- A/C flights between airports in a network of nodes and edges. Length proportional to the flight's travelling time (stochastic)
 - Destination: MEX
 - Origin airports: all direct flights to MEX included
 - 98 departure airports, 26 carriers, 22 equipment codes, 96 contact positions
 - Flight data: OAG (2013) adjusted to 2017 values, public flight information
 - Statistical data: Mexican authorities (AICM, SENEAM, SCT), BTS
 - Variability: Flight time, TAT, Delays, GDP

DELAY DISTRIBUTIONS

6221 flights operated between May 23 and June 10, 2017 were analyzed
(FLIGHT RADAR 24)

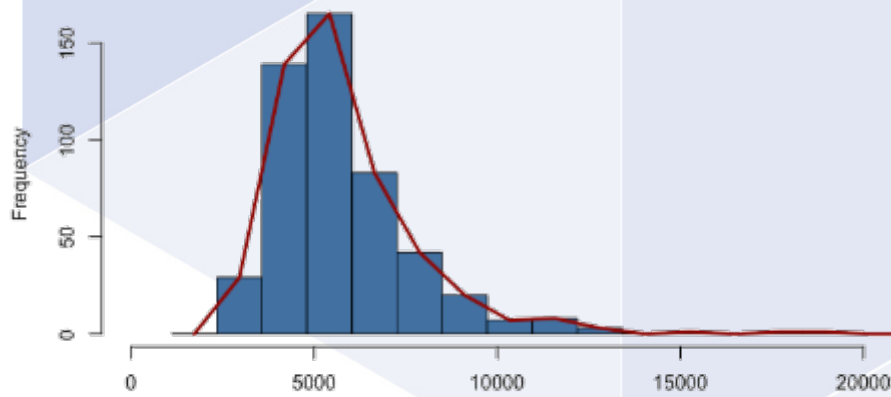


TURNAROUND TIMES

ANALYSIS OF PUBLIC DATA

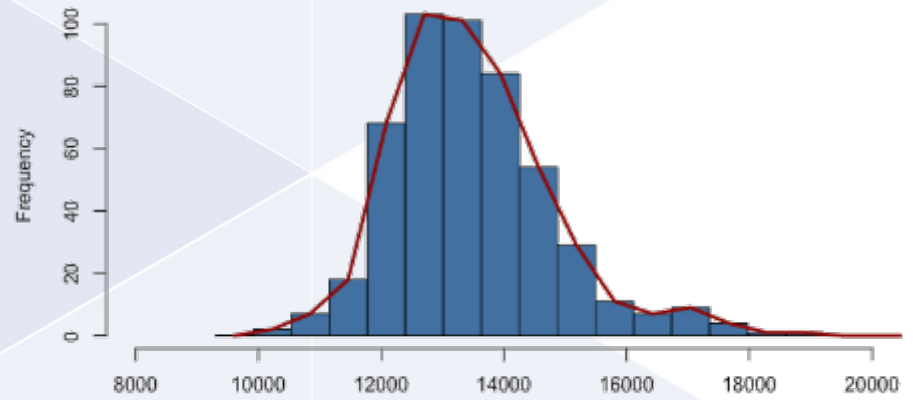
- BY AIRLINE (AEROMEXICO, INTERJET, VOLARIS)
- BY AIRCRAFT TYPE
- BY DESTINATION, BY AIRPORT TYPE, ...

Generic airline, medium aircraft
(0.5 – 2.5 h)



Loglogistic distribution

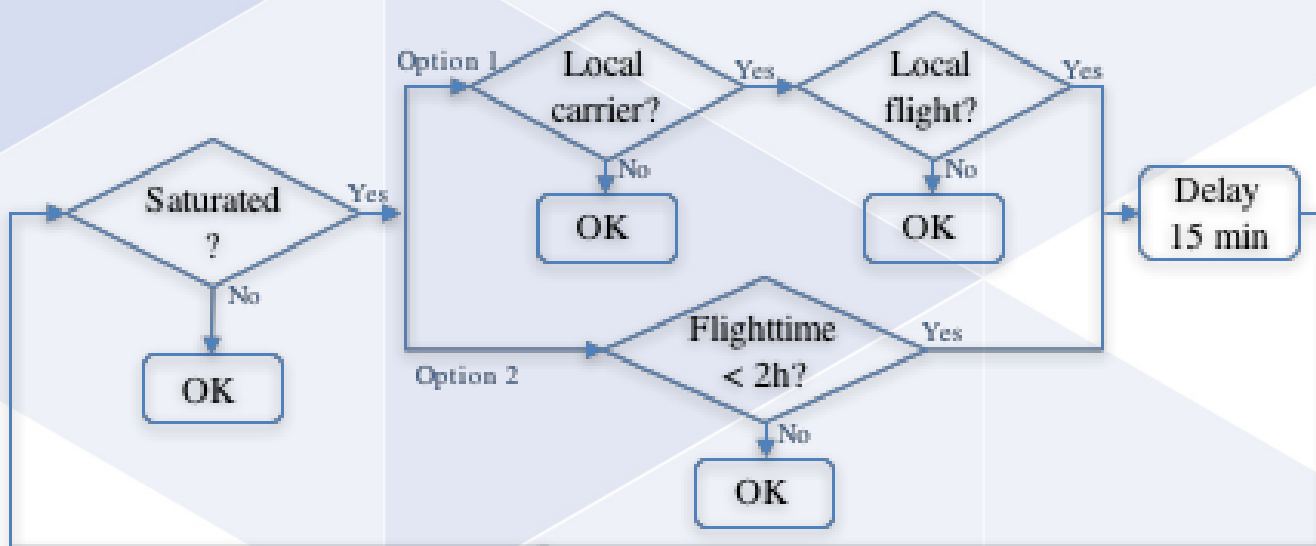
Aeromexico, heavy aircraft
(2.8 – 5.3 h)



Weibull distribution

SCENARIOS

- GDP 1: FLIGHTS DEPARTING FROM MEXICAN AIRPORTS, OPERATED BY MEXICAN AIRLINES (MEX)
- GDP 2: FLIGHTS DEPARTING FROM INTERNATIONAL AIRPORTS, OPERATED BY INTERNATIONAL AIRLINES (INT)
- GDP 3: FLIGHTS WITH AN EXPECTED FLIGHT TIME LESS THAN 2 HOURS (<2H)
- GDP 4: FLIGHTS WITH AN EXPECTED FLIGHT TIME EQUAL OR HIGHER THAN 2 HOURS (>2H)



EXPERIMENTAL DESIGN

Dependency on Limit, RT and Dt:

Domain of ARR/Hr : [25, 30, 35]

Revision of ARR/Hr Rt: [15,30,45,60]

Ground Delay imposed Dt:[5,10,15,20,25,30,35,40,45,50,55,60]

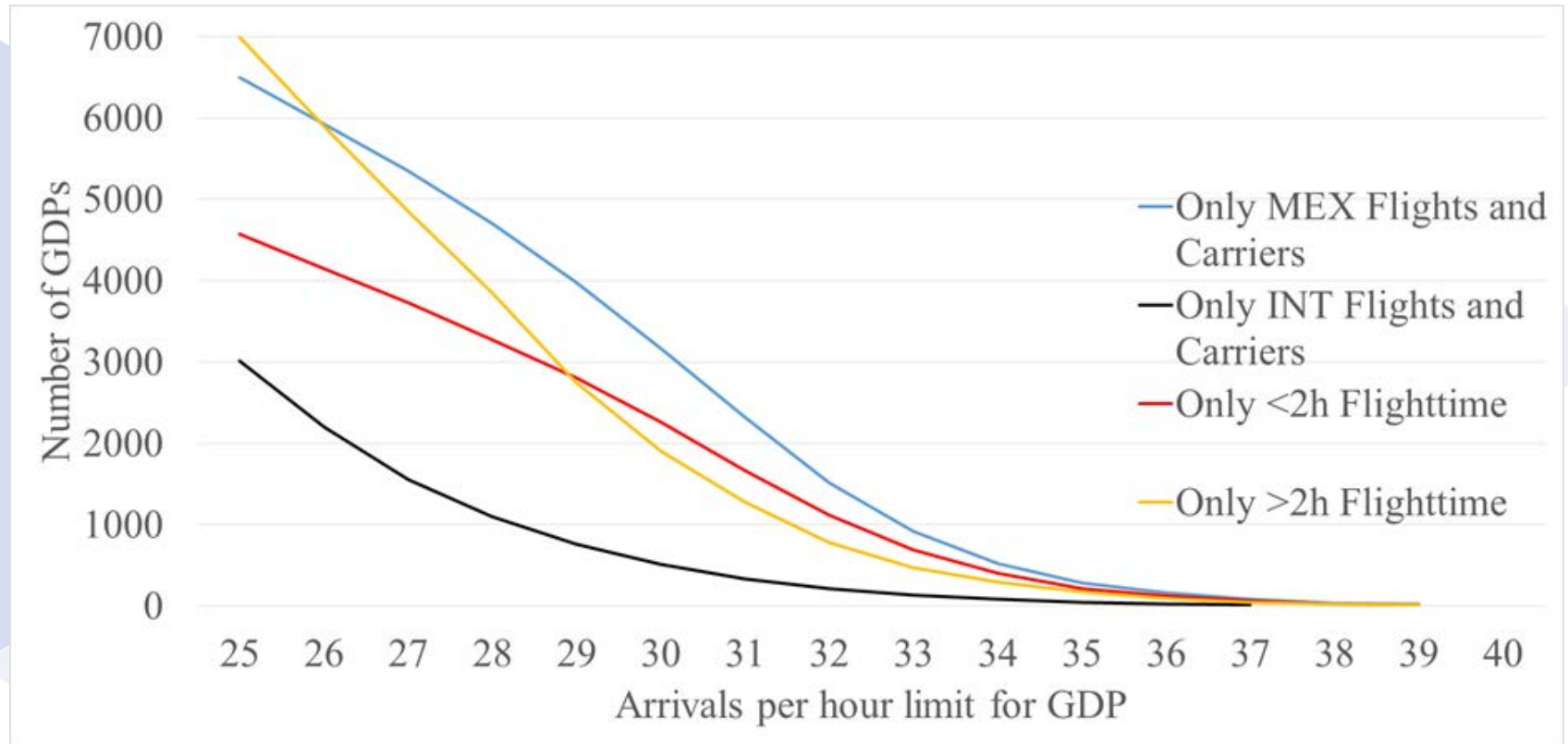
Experiments with 100 replications each.

Warmup period of 8 hrs

RESPONSES:

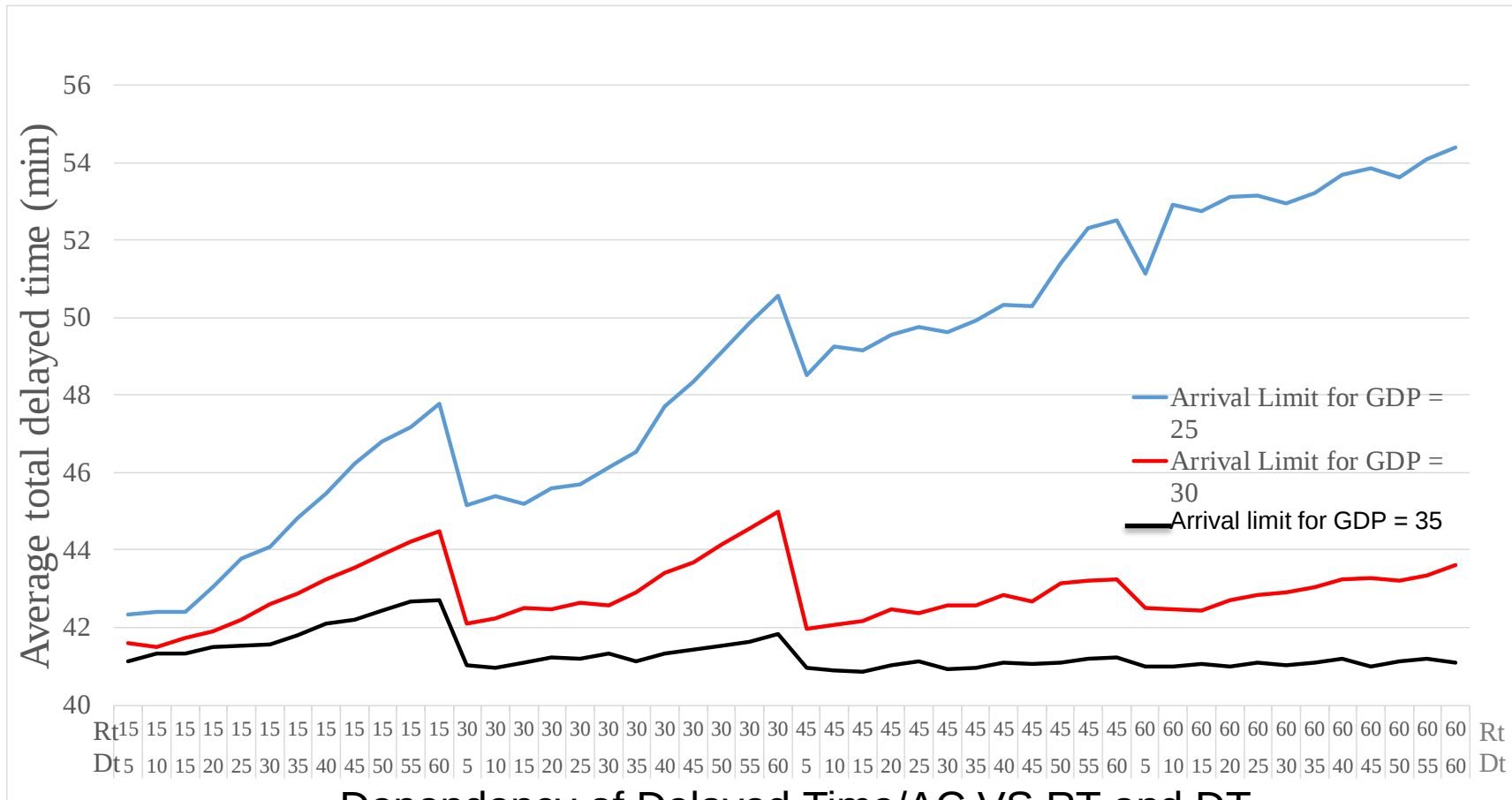
- AVG Delayed Time for Flight
- AVG GDP actions
- Avg number of A/C delayed

GDP ACTIONS DEPENDING ON THE LIMIT



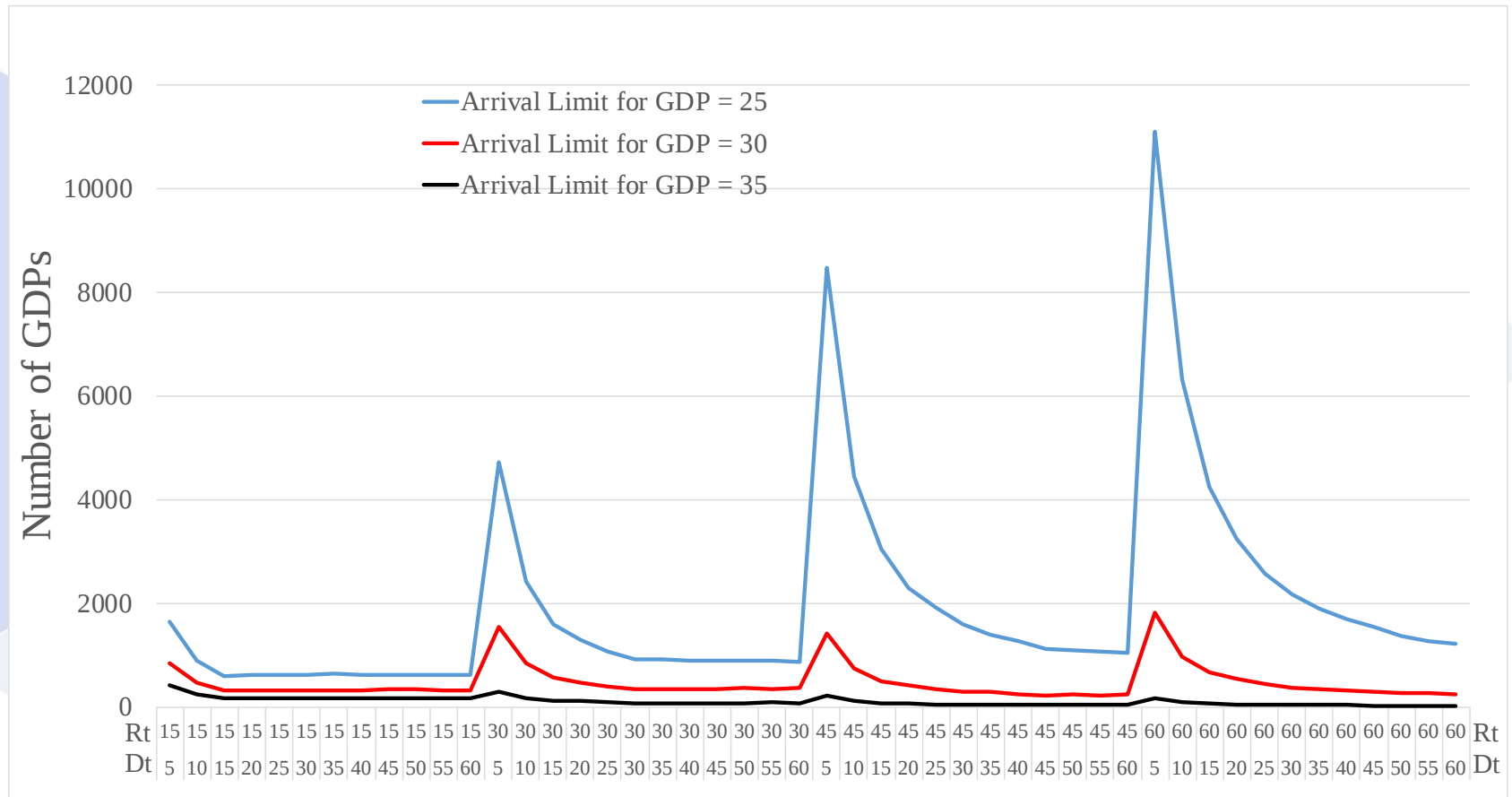
Behavior of GDP actions vs Limit of Arrivals

AVG DELAYED TIME



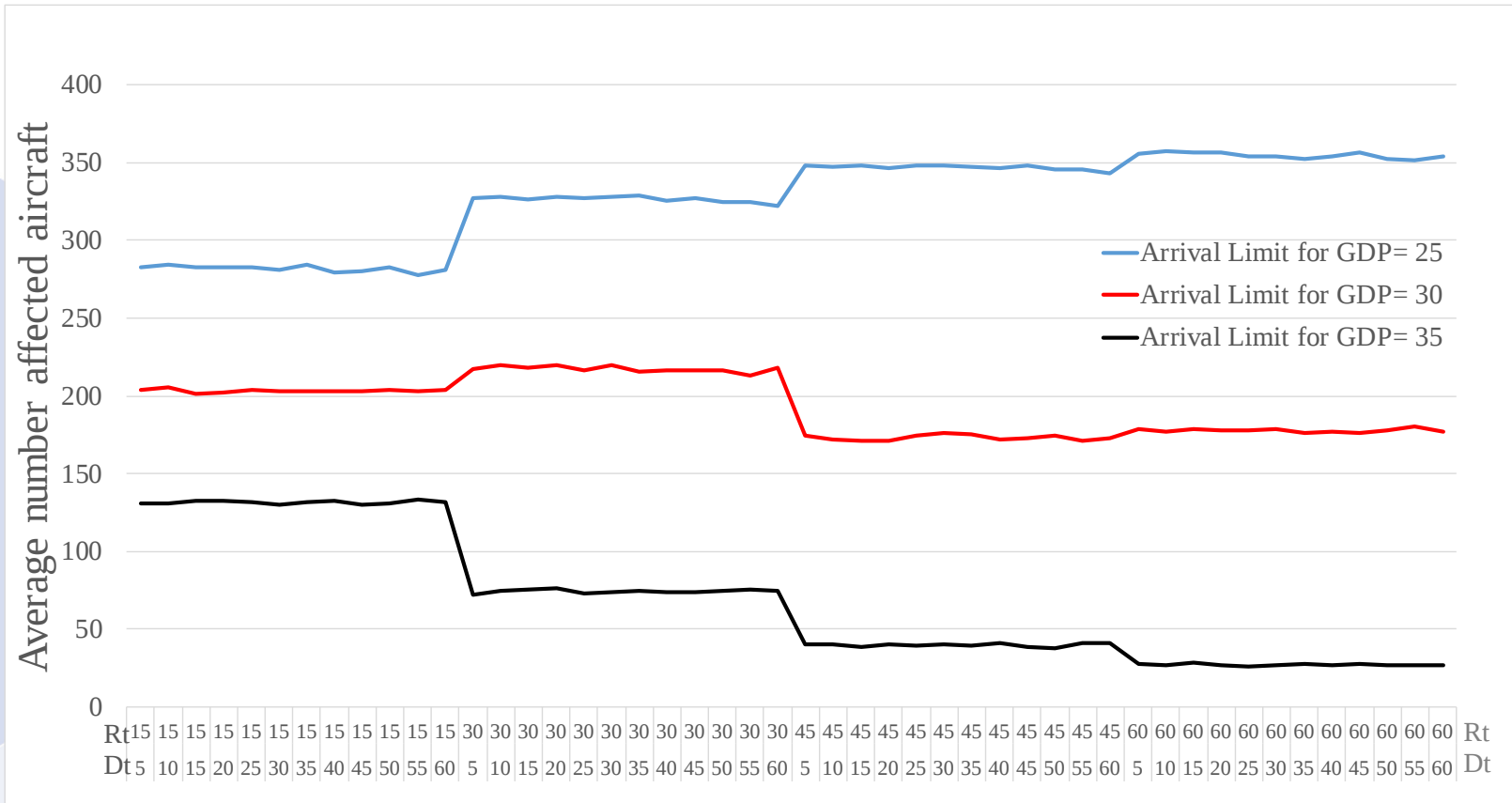
Dependency of Delayed Time/AC VS RT and DT

GDP INSTANCES DEPENDING ON RT AND DT



Dependency on GDP action VS Rt and Dt

AFFECTED AIRCRAFT



Number of aircraft affected by the GDP as a function of limiting arrival capacity

CONCLUSIONS

- We used a stochastic model-based approach for analysing the GDP of Mexico
- We identified that under a restricted scenario, it is better to be more reactive than follow a fixed rule
- The system is more sensitive to the revision frequency than to the amount of delay applied (amount of A/C)
- The GDP action is sensitive to the delay imposed under a fixed revision time (more work for ATC)

LESSONS LEARNED

- The applied rule is not the most efficient one
- Under adverse conditions, it is better to reduce the revision time than increasing the delay time (more work for ATC) but better service to Airlines
- Under a less restricted scenario, it might be better to reduce the frequency (less work for ATC). The AVG A/C affected does not change in AVG.
- A flexible GDP is preferable than the current one

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THANK YOU !

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