Green Delay Programs

Absorbing ATFM Delay by Flying at Minimum Fuel Speed

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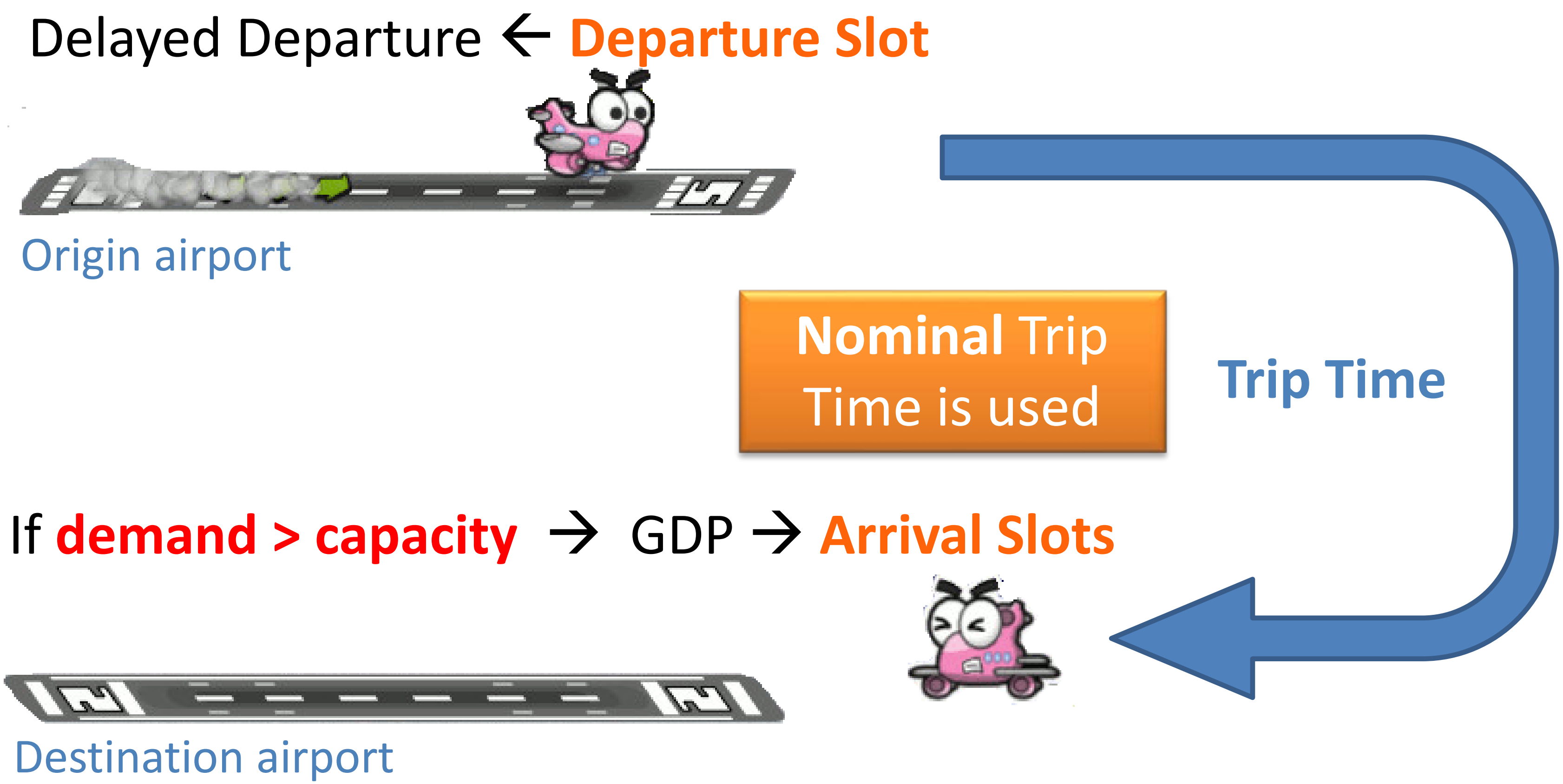
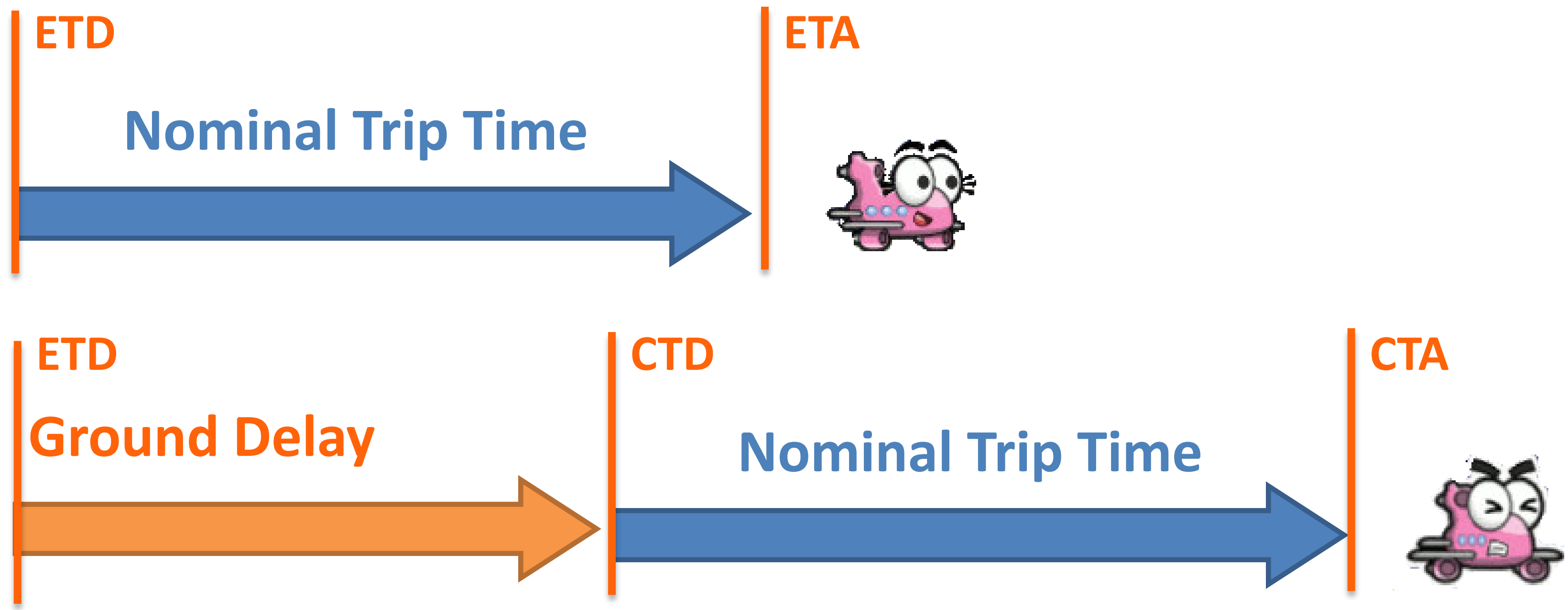
Ground Delay Program (GDP)



Introduction



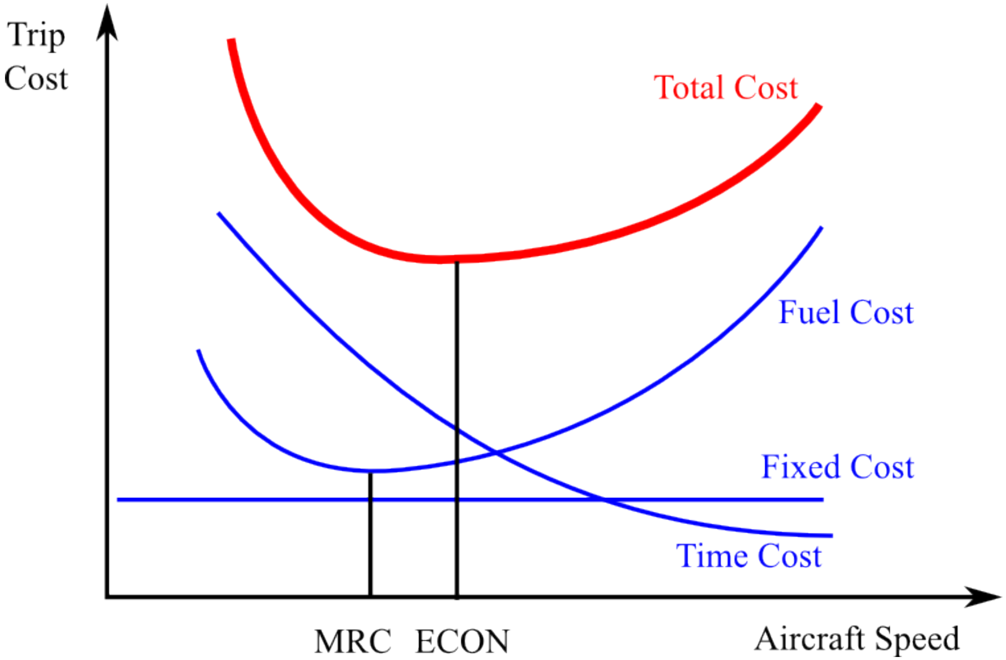
ETD: Estimated Time of Departure
ETA: Estimated Time of Arrival
CTD: Controlled Time of Departure
CTA: Controlled Time of Arrival

Currently, if the flight is delayed on ground aircraft intended cruise **Speed (s) and Flight Level(s)** will be initially the same than for the nominal flight

Introduction

In general,

Nominal Speed > Maximum Range Speed

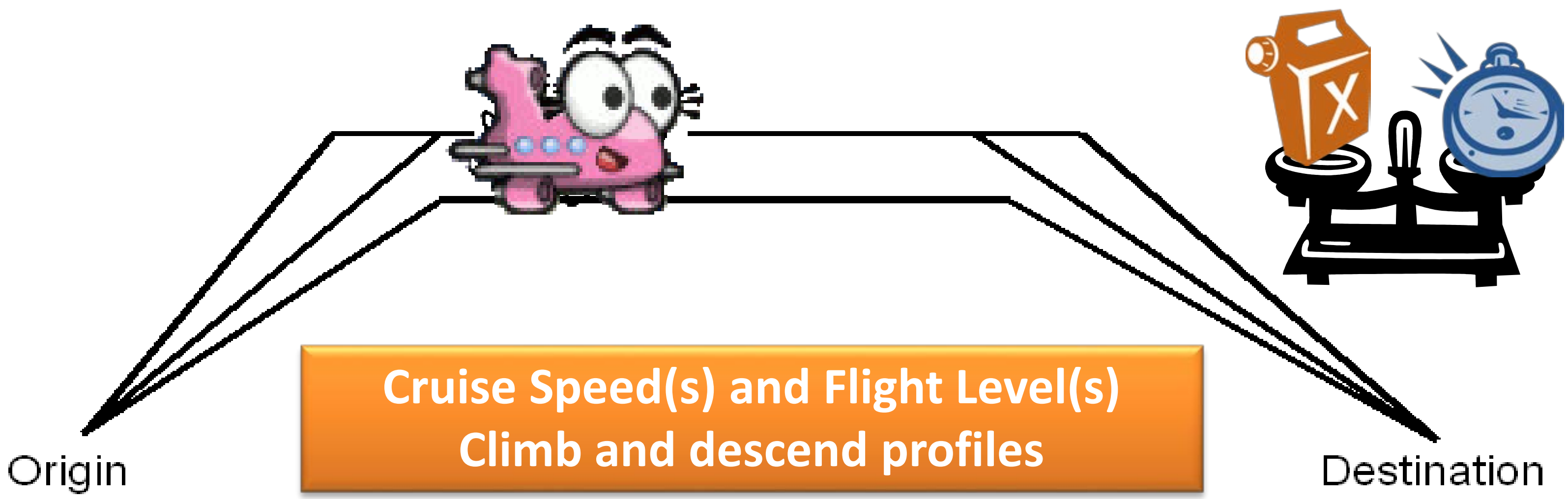


(MRC: Maximum Range Cruise)

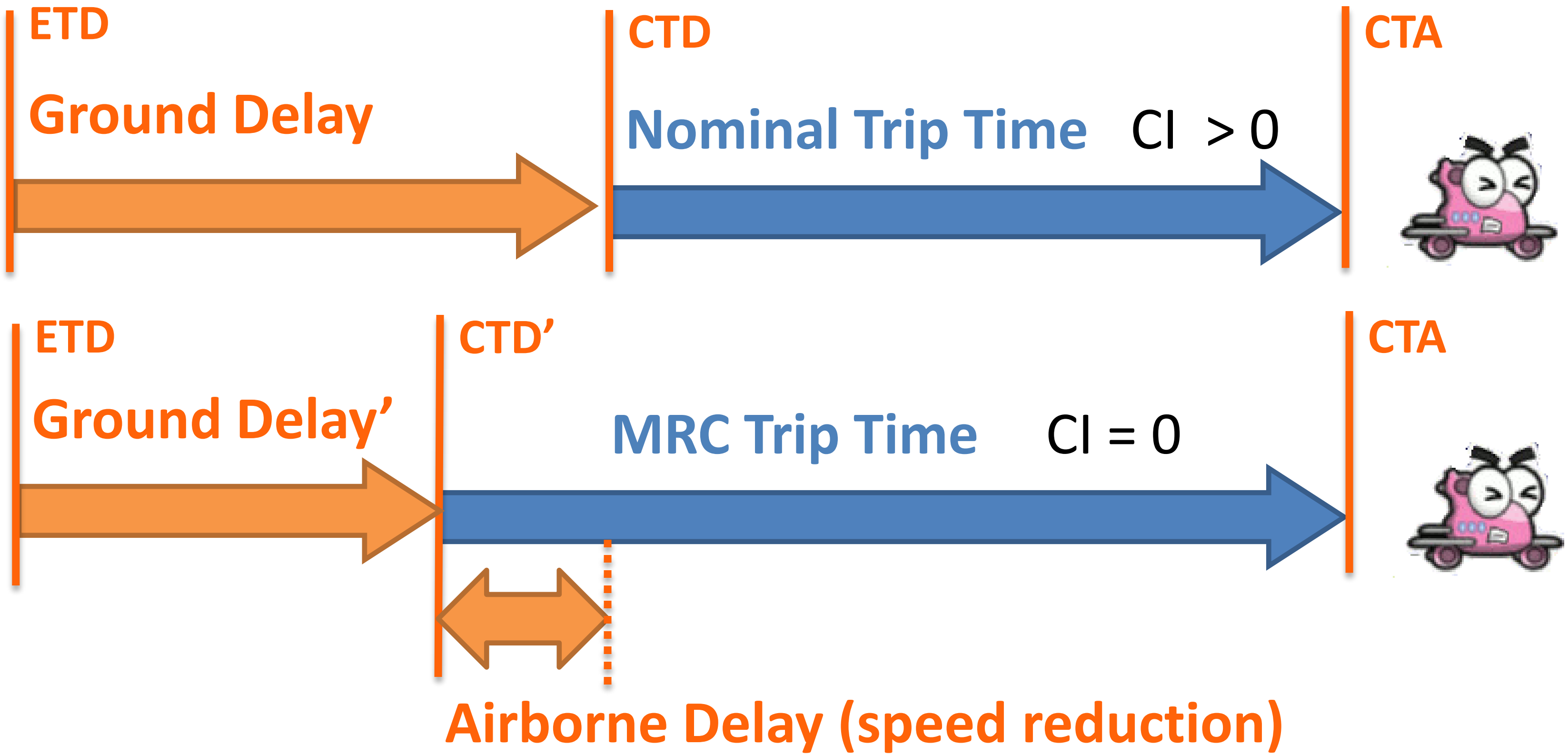
Introduction

Cost Index (CI)

$$CI = \frac{\text{Cost of Time}}{\text{Cost of Fuel}} \quad [\text{Kg/min; lb/hour}]$$



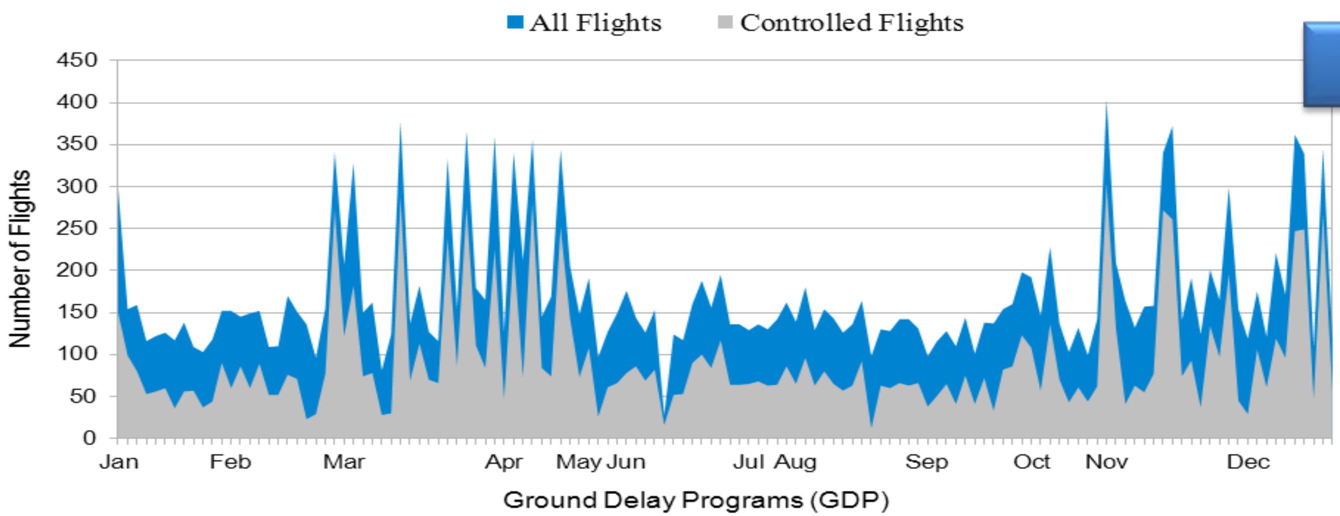
Green Delay Program



Reduce fuel consumption and emissions
Increase the probability to recover time if GDP cancels
Less ground delay at the gate (passenger satisfaction?)

Case study

- San Francisco Iternational Airport (SFO)
- All GDPs in year 2006 were analysed



ETMS data

130 GDPs
22 170 flights
12 076 controlled flights

(ETMS: Enhanced Traffic Management System)

Case study

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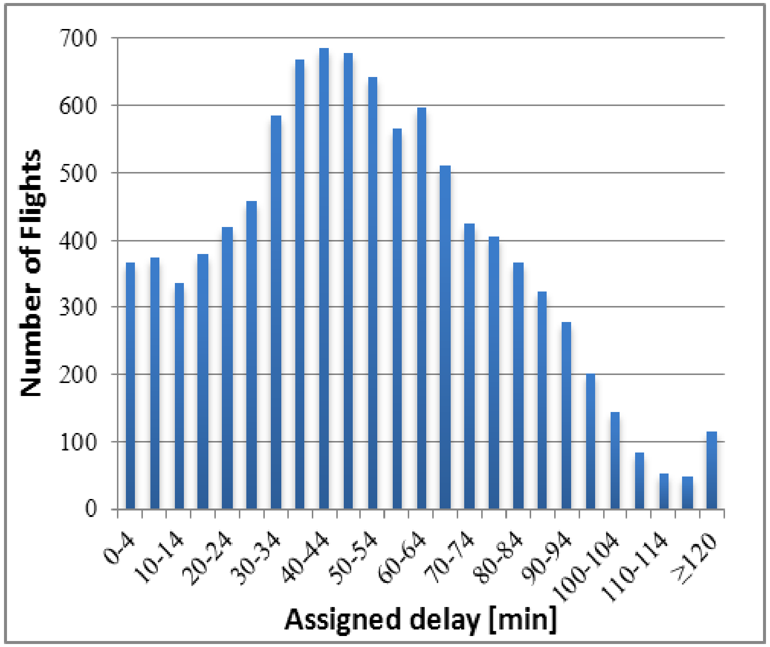
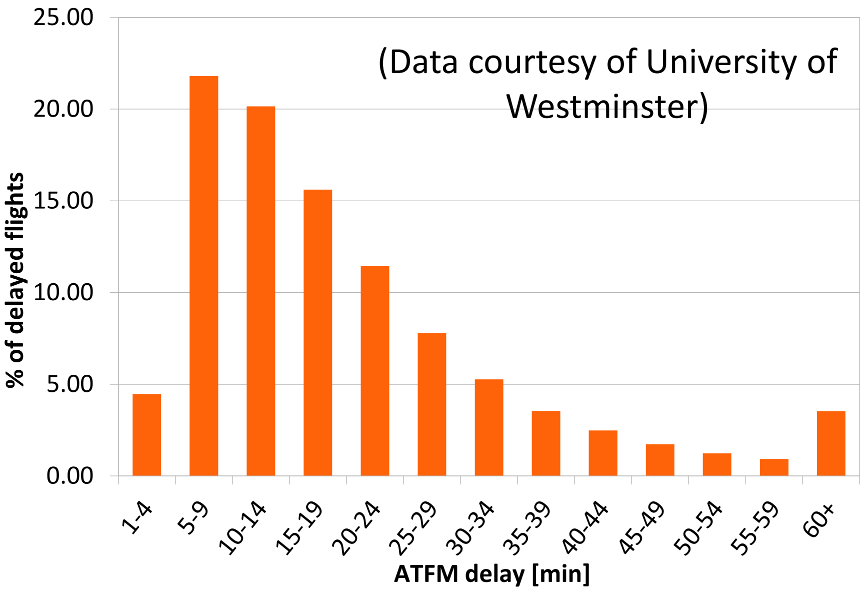




75% delays > 30 minutes

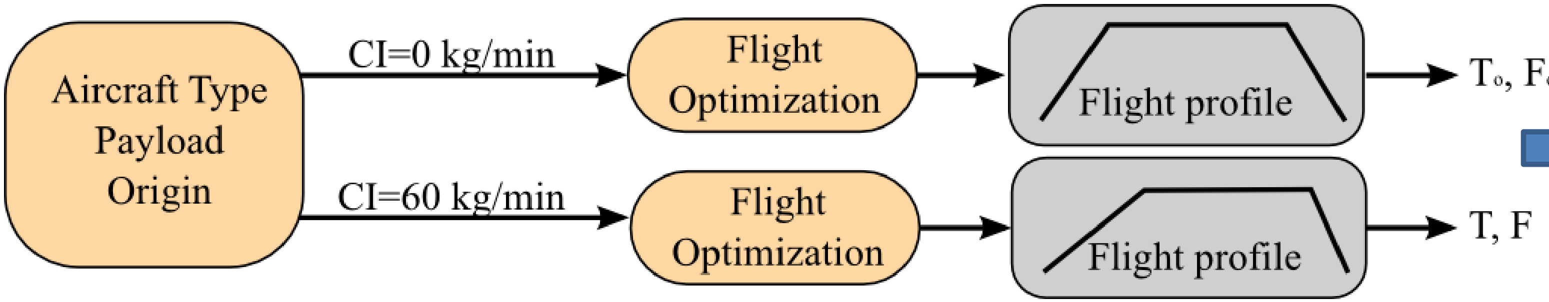
Tipical ATFM delays in Europe

Methodology

Original Ground Delay
Nominal Burnt Fuel

?

Airborne Delay
MRC Burnt Fuel



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(Under constraints)

Airborne Delay = T-To
Saved Fuel = Fo-F

FF: Fuel Flow

To: Nomial Trip Time — T: MRC Trip Time

Fo: Nominal Fuel — F: MRC Fuel

Methodology

ETMS data

Origin, aircraft type, ETD, CTD, **initial** assigned delay

T100 data

Monthly averaged PAX and freight mass → "**Payload Factor**" (PF%)

Airbus performance data

A318, A319, A320, A321, A330, A340

Assumptions

Great Circle Distance and no wind
Maximum two cruise FLs
Nominal Cost Index: 60 kg/min

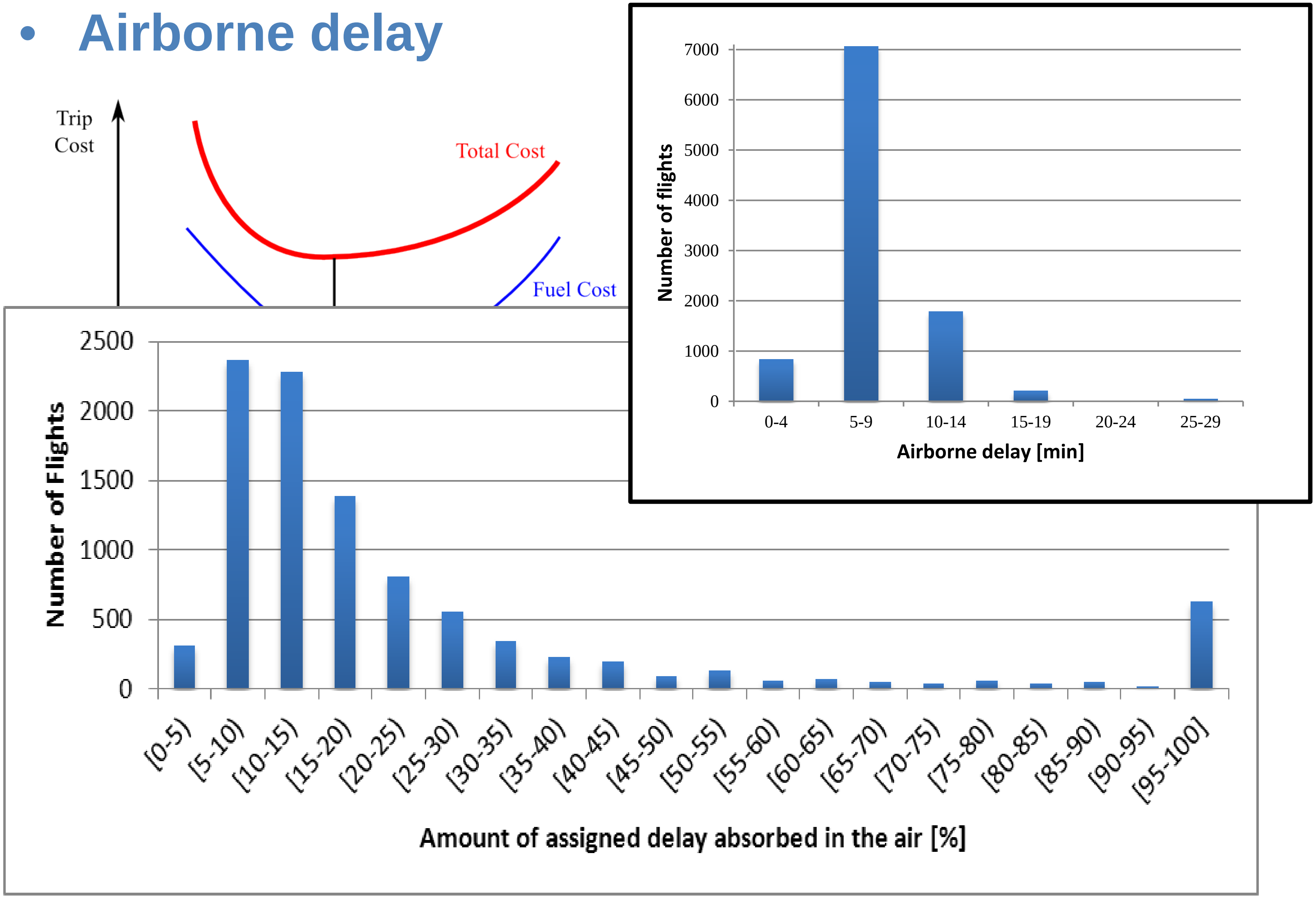
(PAX: passengers)

Methodology

Aircraft family	ETMS aircraft type	# controlled flights	PF (%)
A318	A318, EMB-135, EMB-145, CRJ-200, CRJ-700, CRJ-900	2407	68.58
A319	A319, B727-100, B737-200, B737-300, B737-500, B737-700, DC-9, MD-80, MD-90	2884	66.03
A320	A320, B737-400, B737-800, B737-900	2618	68.73
A321	A321, B757-200, B757-300, B757-700	1533	62.27
A330	A330-200, A330-300, B767-200, B767-300, B767-400, B777-200, B777-300, DC-10	450	63.21
A340	A340-300, A340-600, B747-100, B747-200, B747-400	60	58.31
Not considered	A300, A310, AS65, ASTR, BE40, CL60, CXX, DA90, F2TH, FAXX, GALX, GLF, H25X, HXX, LJXX, MU30, PRM1, R721, SBR1, WW24	1647	--

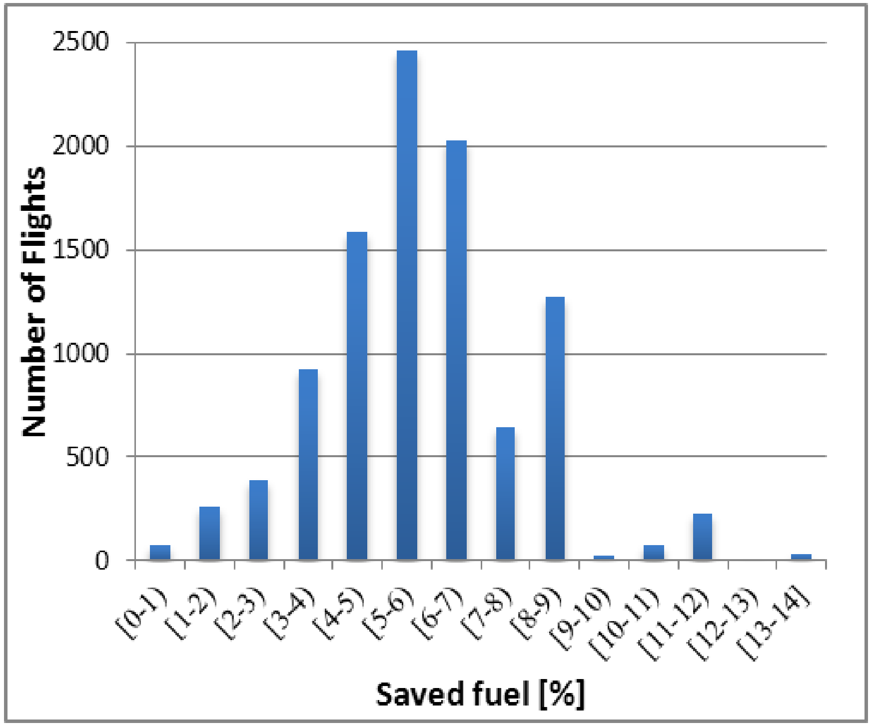
Results

- **Airborne delay**



Results

- **Fuel consumption**



Total Fuel savings

≈ 2000 tons ≈ 4.5% (percentual savings higher for short hauls)

Results

- Current situation: exempted flights (GDP scope)
- GDP may be canceled before its planned end

→ Possibility to **include all flights into the GDP** and apply the speed reduction concept

→ Aircraft will be **closer to the destination** airport **if the GDP cancels**

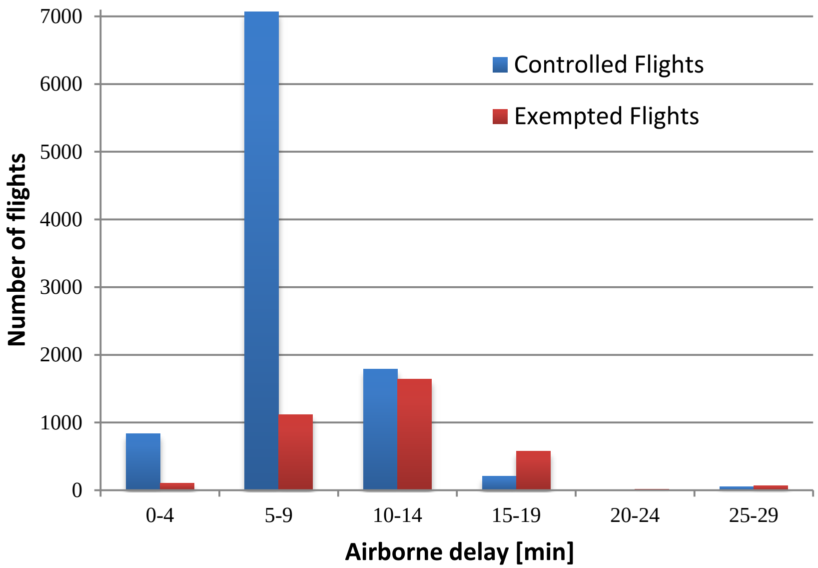
→ **Delay recovery** will be easier for operators

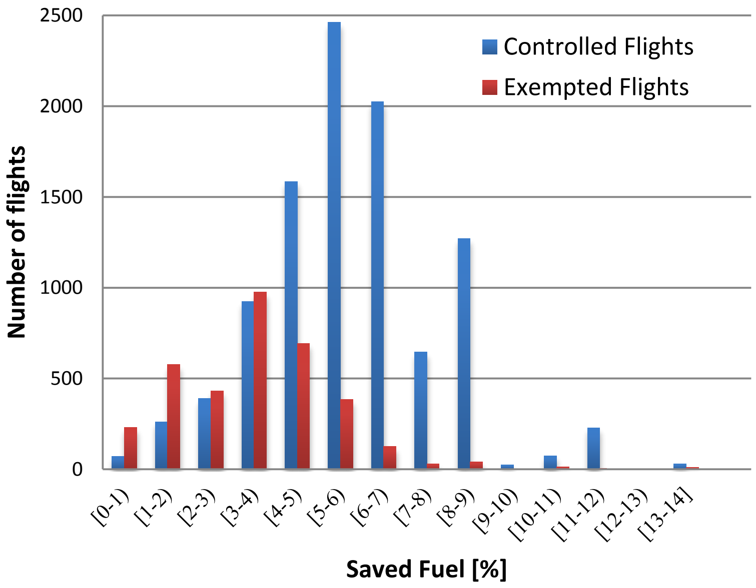
→ Total **delay assignment** will be more **equitable** if all flights are controlled

To be continued…
…as further work.

Results

- **If all non-flying aircraft are controlled at the time the GDP starts**





Conclusions

- Airborne delay by **speed reduction** is proposed
- Aplication to **GDPs** but also to **all ATFM initiatives**
- Amount of airborne delay is very **limited**: the majority of the delay still performed on ground
- Speed reduction as **an additional strategy in the decision making process** when an imbalance between capacity and demand appears
- **Fuel** consumption and **emissions** reduced: interesting results at **aggregate** level.

Future work

- **Consider speed reduction in the overall fleet cost optimization process for a particular operator**
- **Consider wind conditions aloft → increase or reduce the airborne delay.**
- **Analysis of the sensitivity to actual payload values**
- **Consider speeds lower than MCR: reduce fuel savings at the expense of increasing the airborne delay**
- **New delay assignment algorithms by considering speed reduction**

Thank you!

Dankeschön!