IIOT and Big Data at Qantas

19 April 2016

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Qantas the Australian Airline

- Airline founded in 1920 in Australia by an two aviators, an engineer and a farmer-business man!
- Operates 118 aircraft to 37 destinations.
- Around 33,000 employees
- Circa >$1B profit in 2016
- Strong Engineering heritage
- Deeply rooted in the “Aussie Spirit”: Spirit of Australia

QANTAS = Queensland and Northern Territory Aerial Service
There is no “U” in QANTAS!!

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What is IIOT for an airline?

Hardware

Aircraft are producing more and more data:

- A380: Up to 300,000 parameters, from 1Hz to 50Hz.
- 787: > 0.5TB per flight
- Aircraft are becoming hypochondriacs!

Systems (virtual sensors):

- Reservation Systems
- Flight Planning
- Maintenance Systems

And more…

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Data collection and handling

Aircraft Data:

- Flight Safety data (1hz) wirelessly downloaded at gate after each flight.
- Threshold and Air Traffic based data sent in real time
- Large Engineering datasets (>= 1Hz) downloaded via physical or wireless means.

- Operational data:
  - Reservation systems/ Flight Operations data
  - Ground Support equipment
  - System of Maintenance, logbooks etc.

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Data collection and handling

- Mixture of sensor data and unstructured text.
- Data stored on multiple systems
  - Fusion data on ad-hoc basis
  - Data stored on cloud and/or local servers
- Push towards an API marketplace accessing multiple data ponds.

Example I: Aircraft Evaluation

- Qantas is a end point carrier.
  - Our geography is challenging, we are surrounded by the world’s two largest Oceans.
  - Qantas is a world leader on Ultra Long Haul Routes.
- How do we push the frontier even further?
  - We evaluate new aircraft as if they are in real operations with actual constraints using probabilistic models.
  - We simulate over a decade of daily operations.
- Payload increased by up to 95% on long haul over traditional methods.

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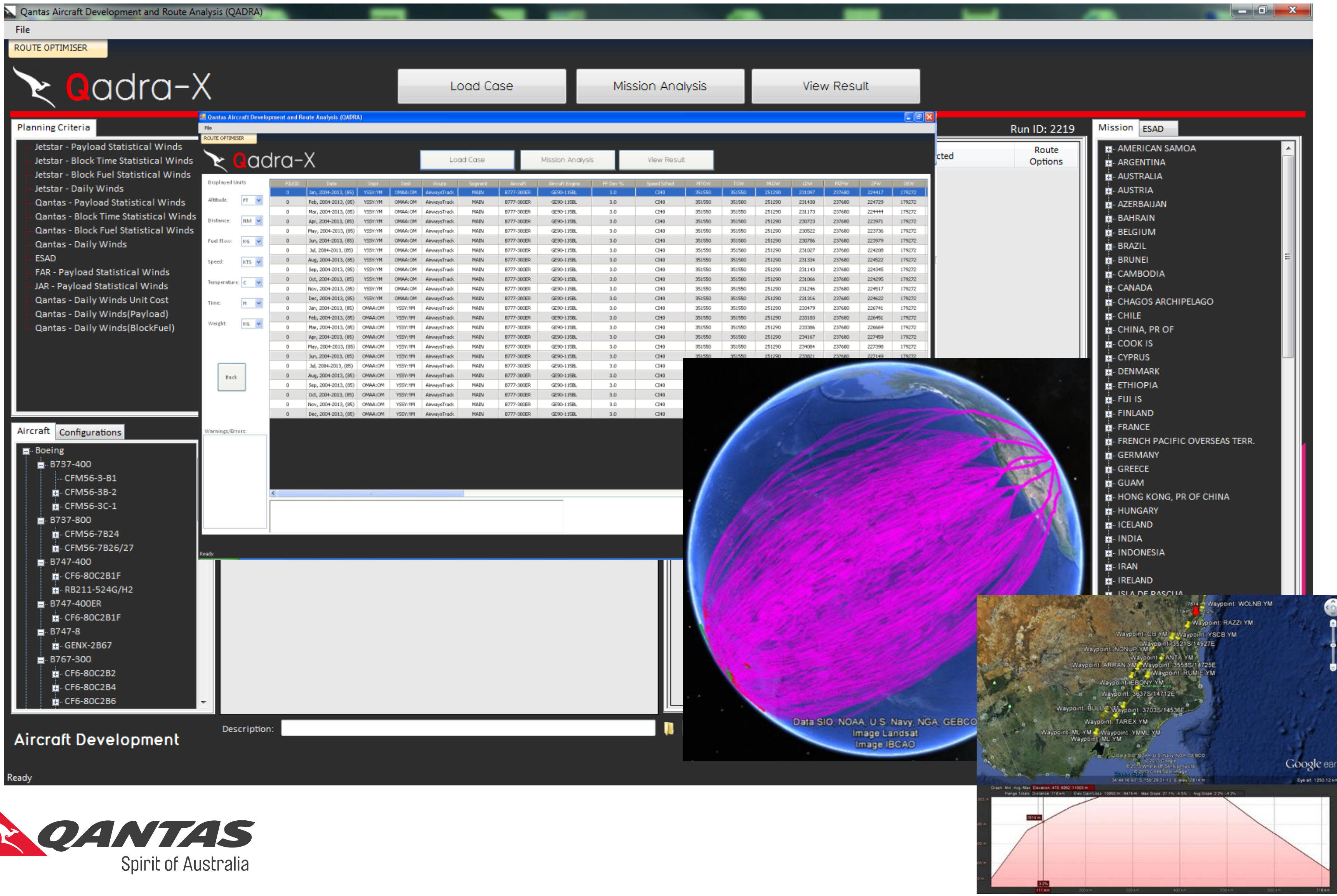
Example I: Aircraft Evaluation



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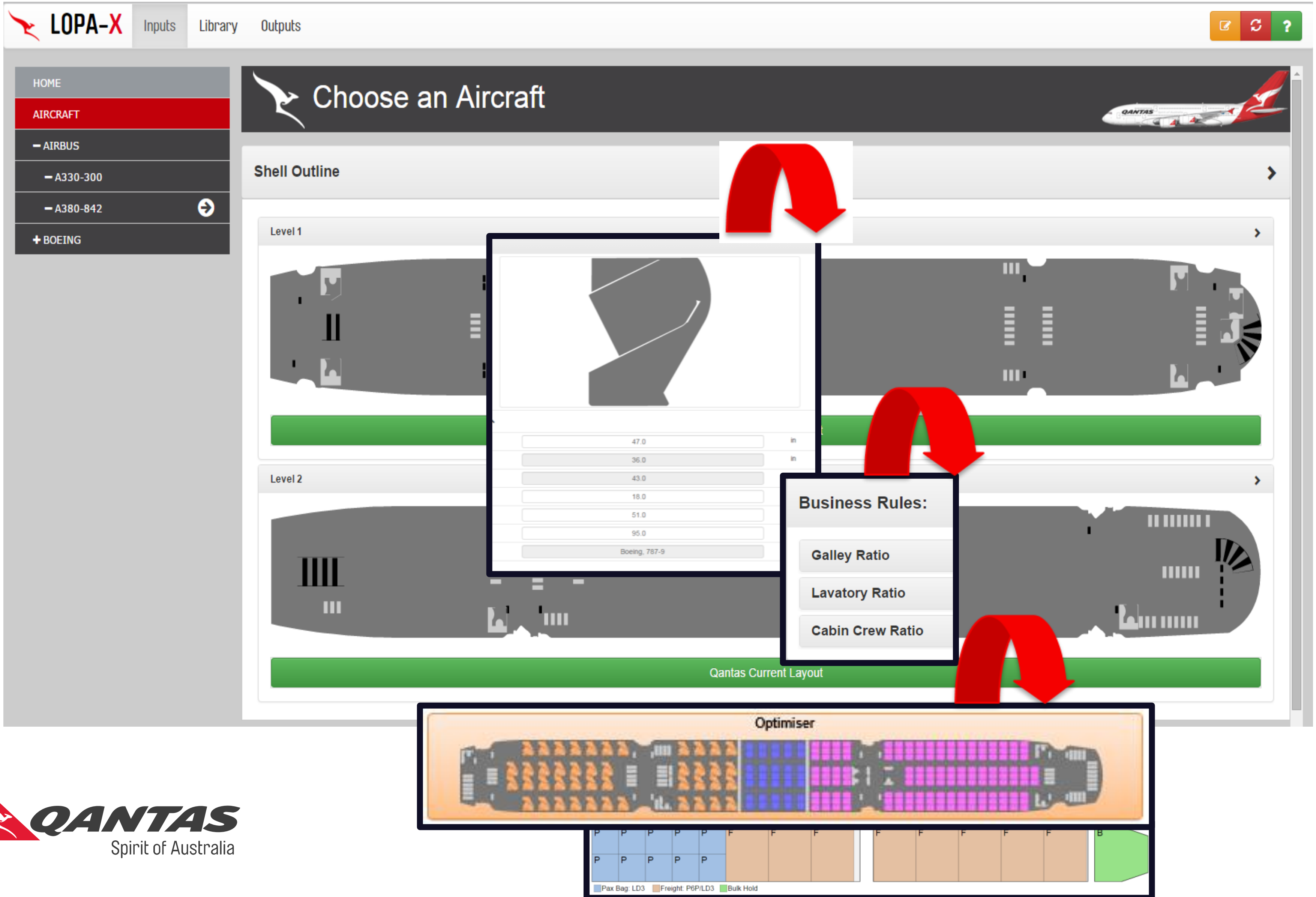
Example II: Total aircraft economics

- Beyond payload capability, how do we completely evaluate aircraft and network economics:
  - Optimize cabin via path search methods
  - Based on a mix of deterministic and machine learning.
  - Makes use of all actual revenue and cost data.
  - Run multiple competitive airline scenarios.
  - Check profit stability against changing economic conditions.

Example II: Total aircraft economics

- Bootstrapped optimizers.
  - Cabin layout
  - Payload
  - Maintenance Costs, including optimizing repair intervals
  - Revenue Modelling
  - Scheduling

Example II: Total aircraft economics



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Example III: Operational Flight Planning

- Aircraft performance decks underpin the ability of an airline to sell seats and evaluate fuel burn.
  - Daily accuracy of these decks are crucial for airline economics.
- However, these decks are *approximate*, and do not truly represent an airframe and it's individual engines.
- Airlines operate in a very narrow band of the flight envelope.
  - Most airlines use a crude single fuel factor offset.
  - Answer: Use the Full Flight Data to create individual aircraft and engine decks.

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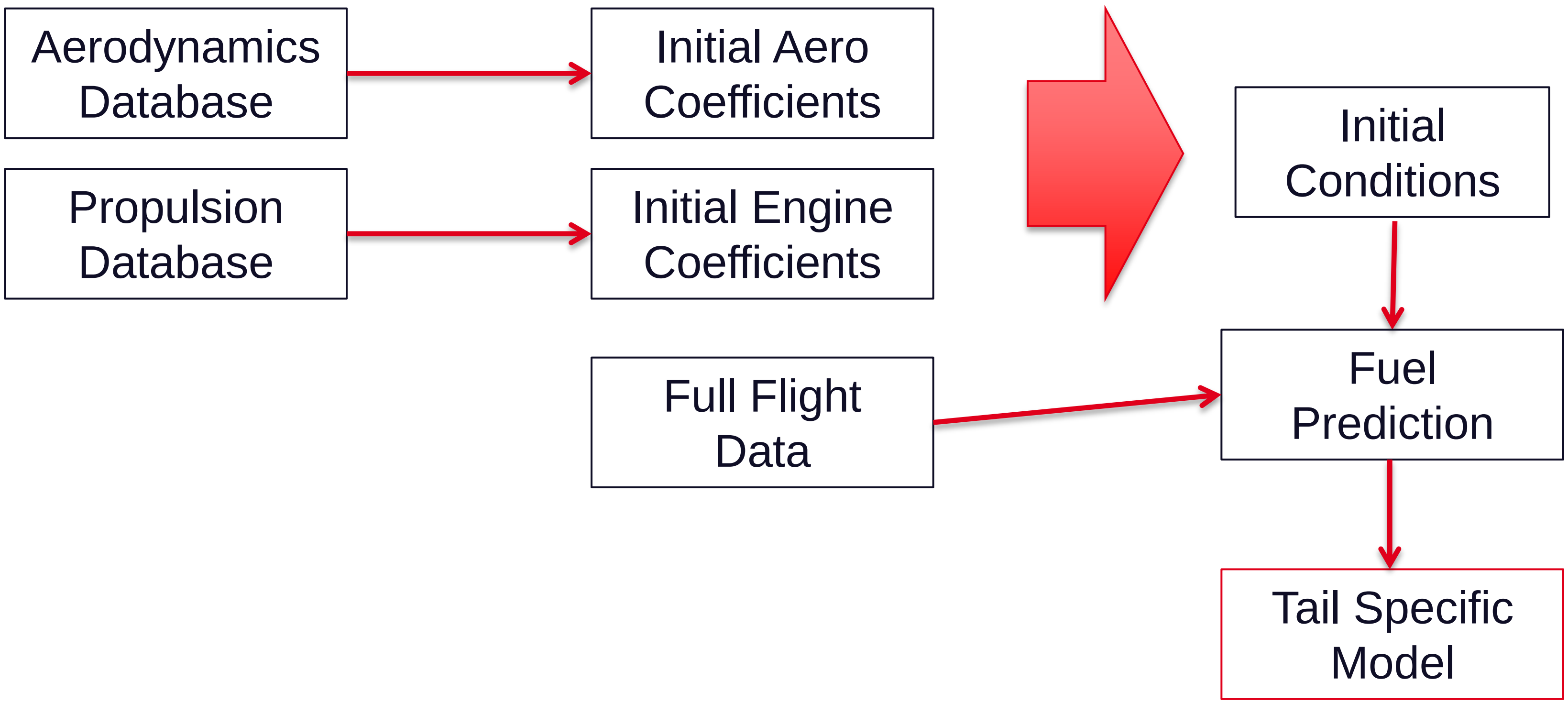
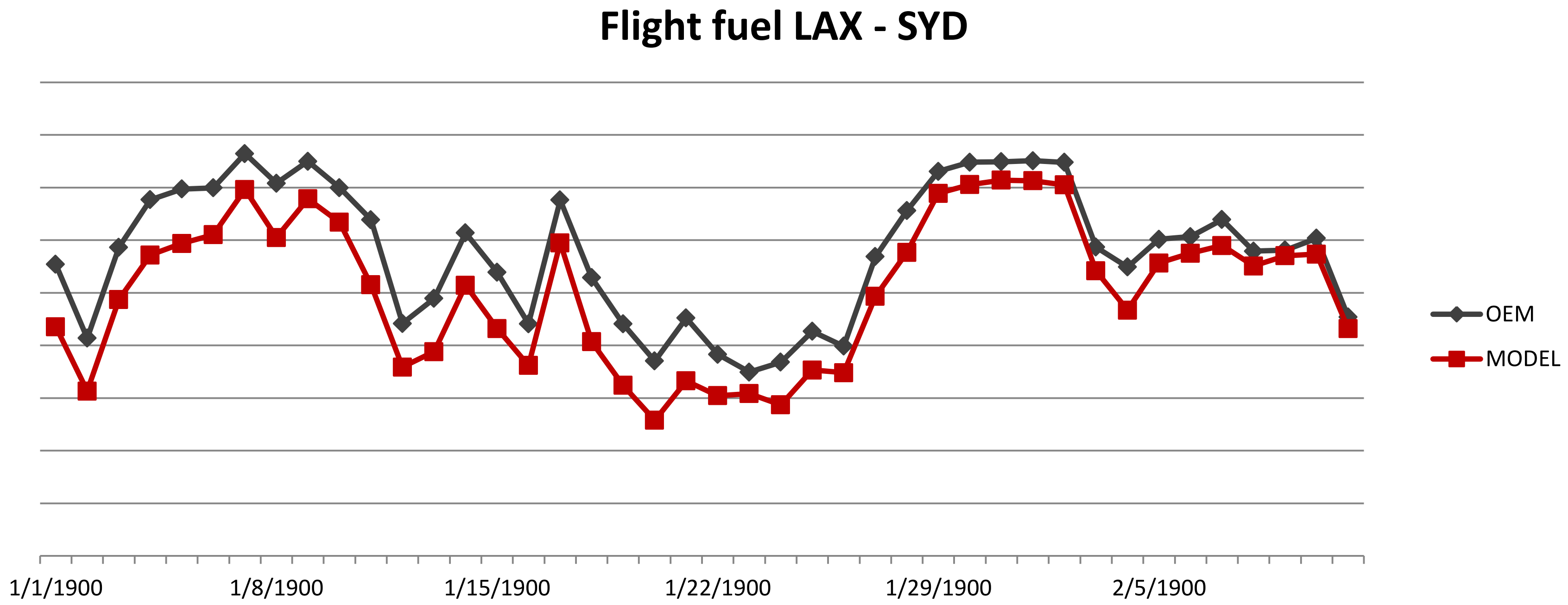
Example III: Operational Flight Planning



Example III: Operational Flight Planning

- Based on a 80% load Factor
- **0.97% reduction in flight fuel**



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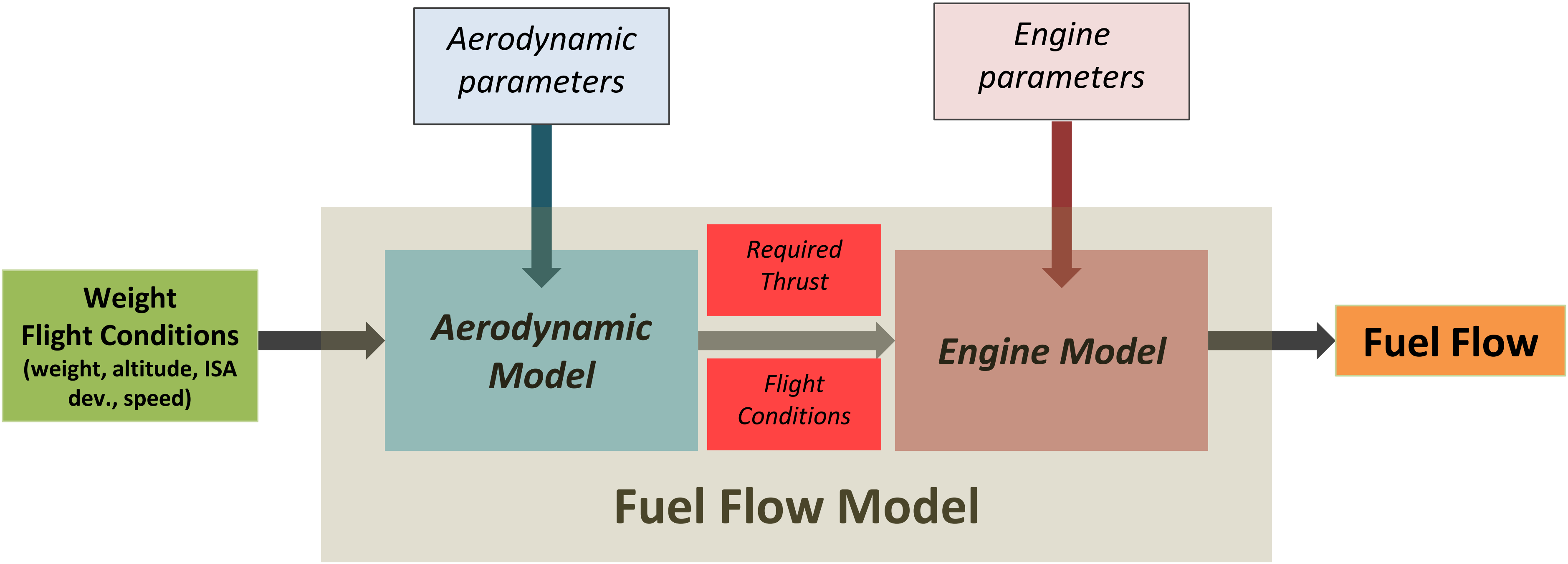
Example IV: Infer engine and airframe performance

- Using either OEM performance decks or actual Full Flight Data to infer
  - A detailed engine model
  - An detailed aerodynamic model



Example IV: Infer engine and airframe performance

- Inference of airframe and engine efficiency on a modular level (Drag, Thrust, Engine efficiencies) is possible thanks to big data and cloud computing.
  - Provides critical insights to Qantas on the effect of OEM design changes on its overall network economics.
  - Enables us to compare airframes and engines.
  - Enables us to combine airframes with engines.
  - *Help to influence aircraft and engine design to meet a network profit target.*

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Example V: Aircraft Fuel Efficiency

- Traditionally, airlines use the Aircraft Performance Monitoring Tools supplied by OEMs.
- *However*
  - Uncertainties in weight (pax, fuel etc)
  - Does not account non standard flight conditions
  - Does not account for hardware changes (ie engine swaps)
- Qantas has created supplemental index called the Fuel efficiency index or FEI that removes all above effects.
- Ability to measure underlying aircraft deterioration.

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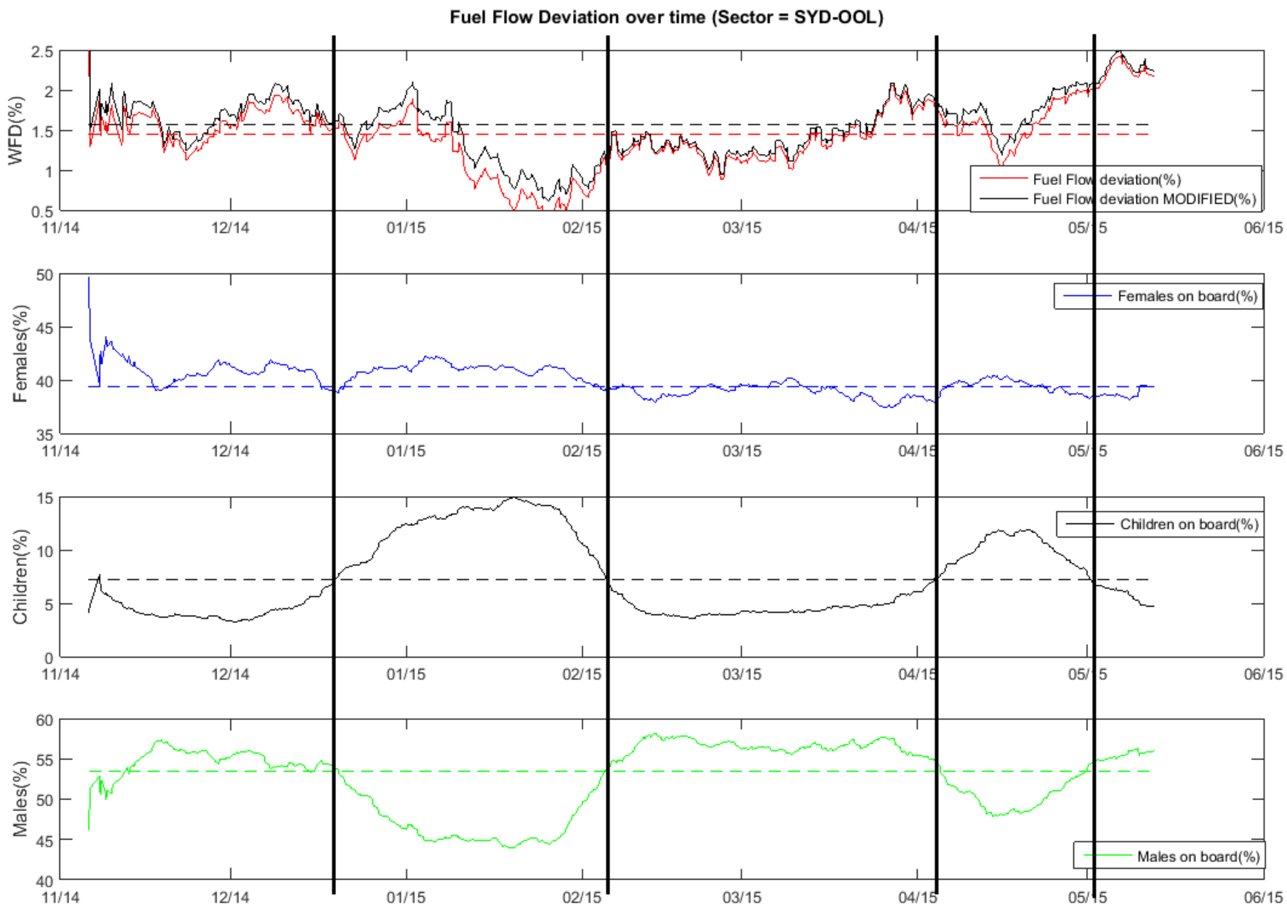
Example VI: Passenger weight estimation



Example VII: Predictive Maintenance

- Problem:
- A380 has in-service faults
  - Aircraft has a large amount of data available
  - Tools provided are not predictive.
  - Can we detect a few cycles ahead these faults?
  - Airline does not have access to onboard logic
- Answer:
  - Use machine learning to detect patterns.
  - Used algorithms detecting hidden relationships between stocks on the stock market!

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Conclusion

- Big data is the new frontier for Qantas.
- Requires fundamental changes in the way Engineers think:
  - Is fuzzy and not deterministic.
- Combination of Business knowledge, formal programming and machine learning *highly* desirable.
- Throwing lots of data at a problem does not help.

Thankyou!

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Questions?

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