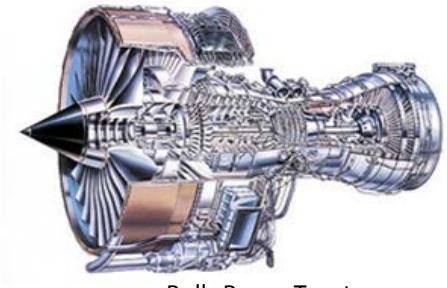
Model Based Testing of Avionics

Dr Stephen Wright

Department of Engineering Design and Mathematics
University of the West of England

steve.wright@uwe.ac.uk

Avionics I have known

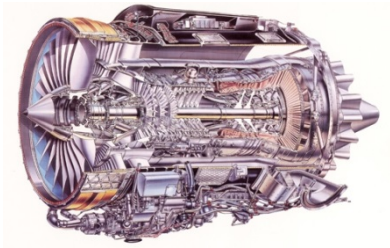


Rolls Royce Trent 700

Airbus A400M

Boeing 767

Airbus A330

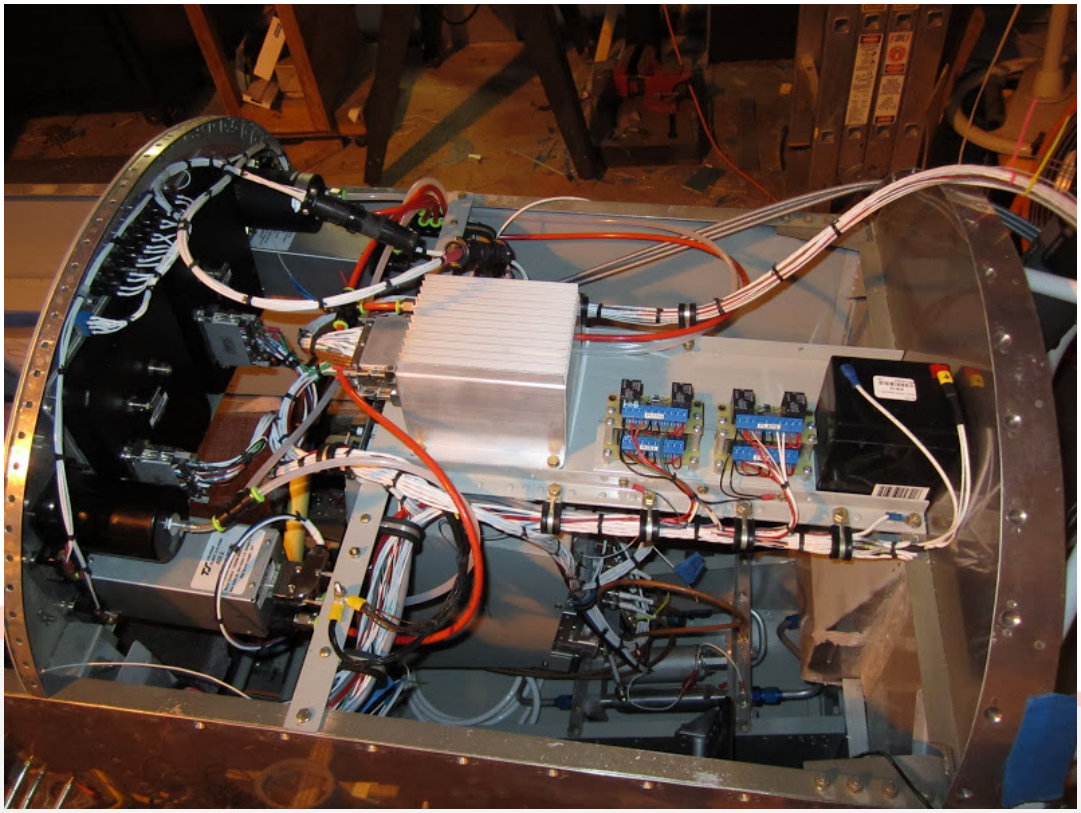


BMW/Rolls Royce BR710

Airbus A380

Avionics = Computer + Other

- Avionics not just a computer – hybrid with other electrical/electronics
  - Hard to differentiate avionics from the aircraft system



How are Avionics Special?

- High cost of failure
- Operate in hostile environments
- High reliability

Reliability

- Availability (does what we want)

- Integrity (doesn't do what we don't want)

Avionics Software Growth

- F-4A (1958) - 1000 lines-of-code

- F/A-18 (1978) – 1 million lines-of-code

- F-22 (1997) - 1.7 million lines-of-code

- F-35 (2006) - 8 million lines-of-code

Auto v Aero

10’s million loc*

10’s million loc*

* Terms and conditions apply

Aircraft Flight Test

- $10k's per flight

Aircraft Flight Test

~10 deaths per decade

Gulfstream G650, 2011

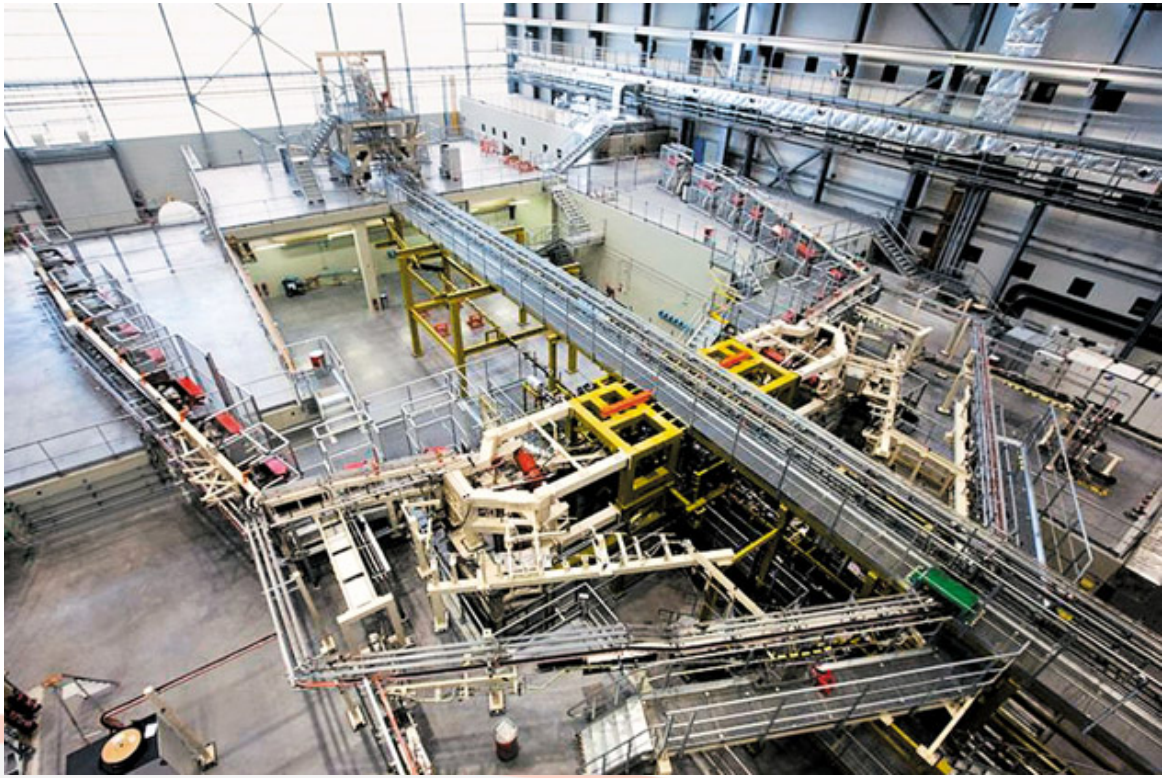
Airbus A400M, 2015

Boeing 767 Production Flight Test

Ground Testing

"*Iron bird*" rigs:

- Avionics
- Hydraulics
- Electricals
- Pneumatic



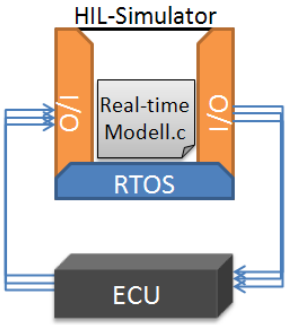
“Lab” Testing

- e.g. Fuel Systems Test, Bristol UK
- Organisation to test and integrate Fuel System & avionics
- Sister department tests Landing Gear

Avionics Testing

Why?

- *Nothing* works first time
- Need lab testing for Flight Test certification



How?

- Simulate all mechanicals in software
- Simulate all interface devices electronically

Avionics evolution: A330-A380

- “Federated”
- 100’s of signals

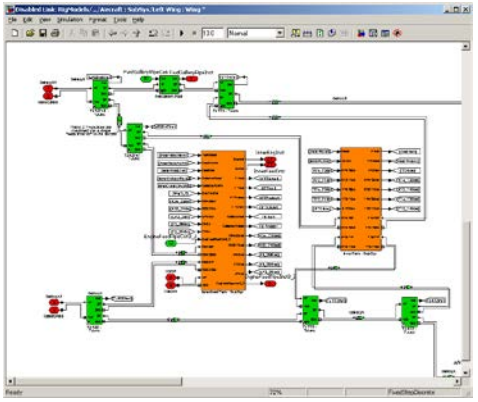
- “Integrated”
- 10,000’s of signals

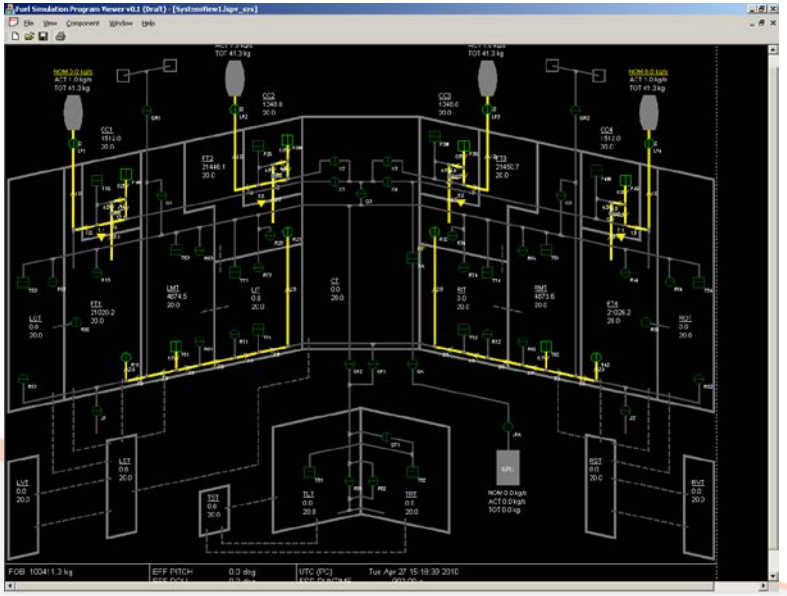
A380 Fuel Avionics SIB

- Interface verification
- 95% of tests for reversionary modes
- SIB functionality expanded with avionics updates

SIB evolution for A380

- Scaling, scaling, scaling
- More sophisticated avionics demanded more accurate models
- State-space explosion demanded more comprehensive models



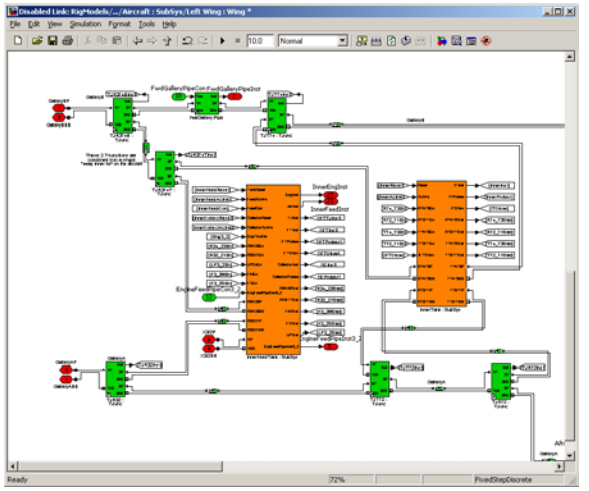


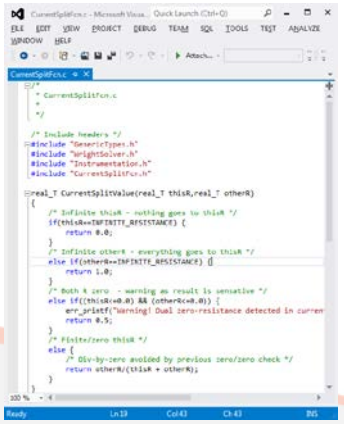
Fuel Avionics Automated Testing

- Scripted or semi-scripted
- In fuel, need to support 1-12 hour test runs
- Automatic logging of results & data

Model Development

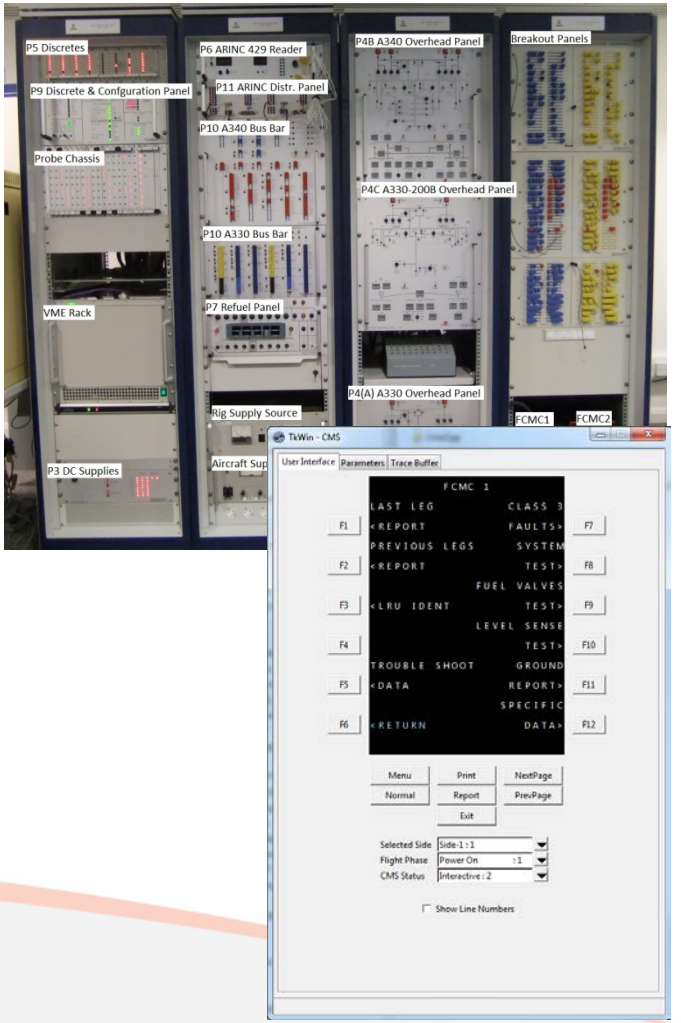
- ***1-250 millisecond*** iteration periods typical
- ***Simulink*** for models
- Use of COTS libraries (e.g. SimPowerSystems) *often replaced with proprietary solutions* (e.g. WrightSolver™)
- C ***S-functions*** for appropriate functions and legacy code
- Auto-generation of ~500,000 loc





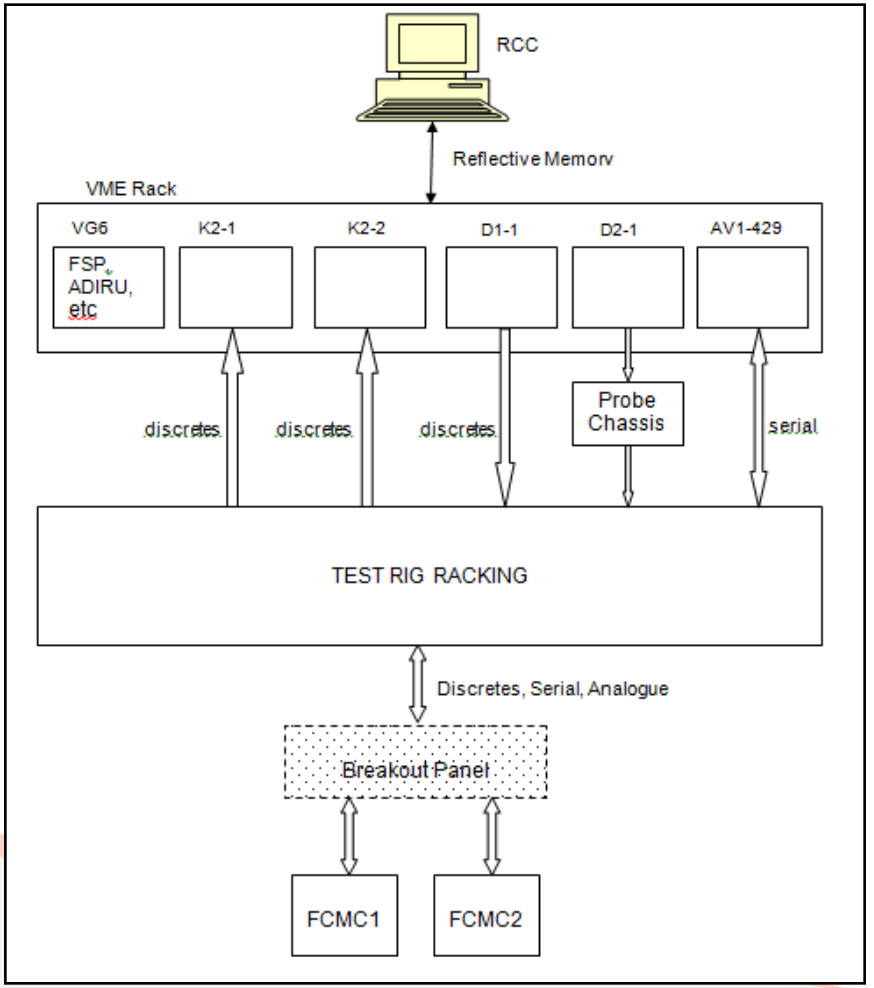
Model Deployment

- ***VxWorks*** for real-time execution
- ***Windows*** for user interfaces
- ***PowerPc/VME*** for model execution and IO
- ***C++*** distributed real-time middleware (*in-house*)
- ***Tcl/Tk*** & ***Java*** for UI development
- ***Tcl*** for test execution
- Much commonality between aircraft rigs (~80%)



SIB Architecture

- Windows user interface
- Distributed real-time middleware (*in-house*)
- VME model execution
- VME IO
- Some proprietary IO (e.g. capacitance emulation)



A380 Avionics Rig Failure

A380 Avionics Rig Failure

Where next?

- Virtualised testing (i.e. iteration or cycle accurate)
- Low cost COTS hardware & software (obsolescence?)
- Formal test construction?

In conclusion

- Avionics test is needed for cost, time, and certification reasons
- Has a need for flexibility and expandability
- The future is more software: IO, virtualisation, automated test...

Questions?