

Fault-Tolerant Controls using Analytic Redundancy

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Each year, hundreds of lives are lost and millions of dollars worth of equipment are destroyed in accidents that could have been prevented with fault-tolerant control systems

1996 - Birgenair
Boeing 757



1995 - X-31



1996 - Ariane 5



1999 - John F. Kennedy, Jr
Piper Saratoga



1994 - Perseus A



How FTC Works

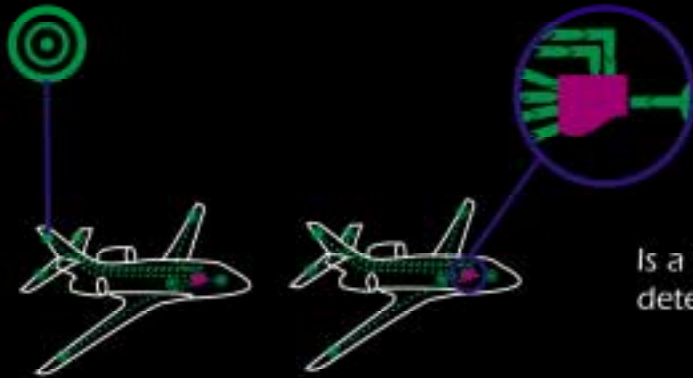
Very Short Execution Time

Sensors continually monitor

- aircraft status
- control inputs

Model-based predictor (simulation-like)

- runs faster than real time
- calculates immediate future with FTC algorithm



Measured state compared with 'predicted'

Is a failure detected?

No



Yes



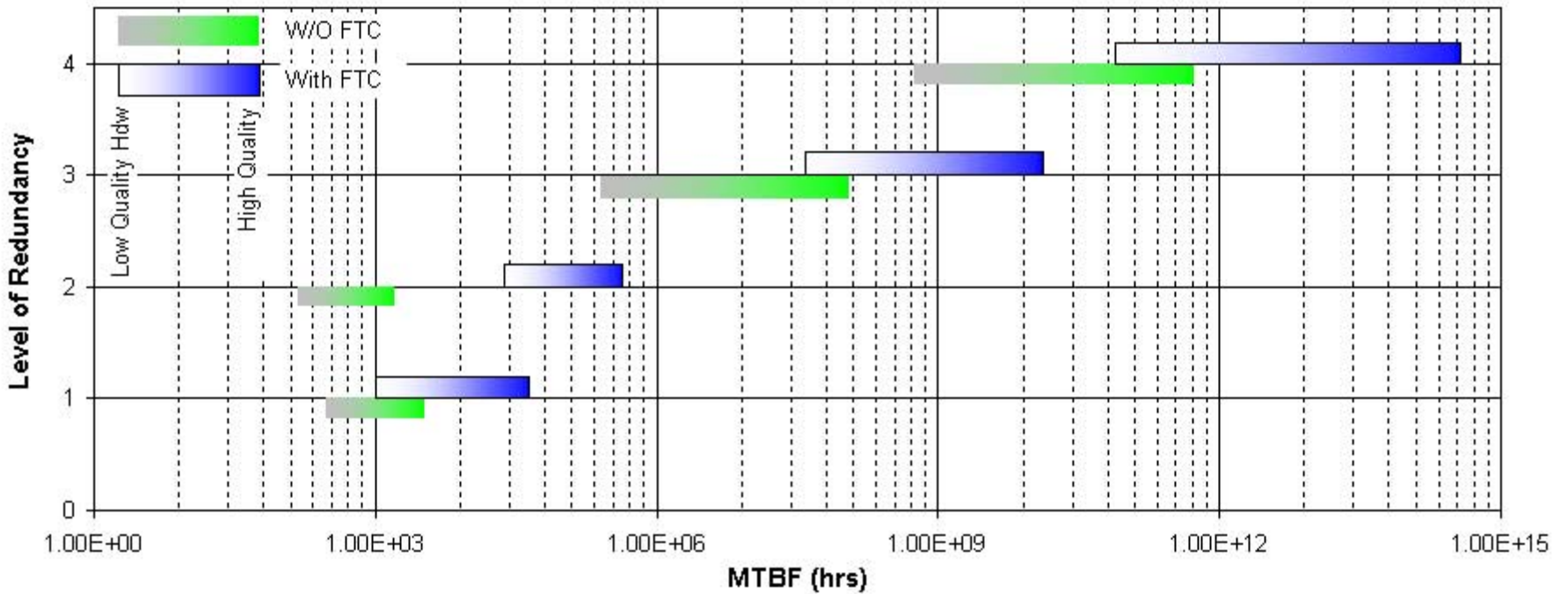
Control system reconfigured

- to cope with failure
- exports redundancy options

Optimized control gains for flight condition

- system performance optimized to "best possible"

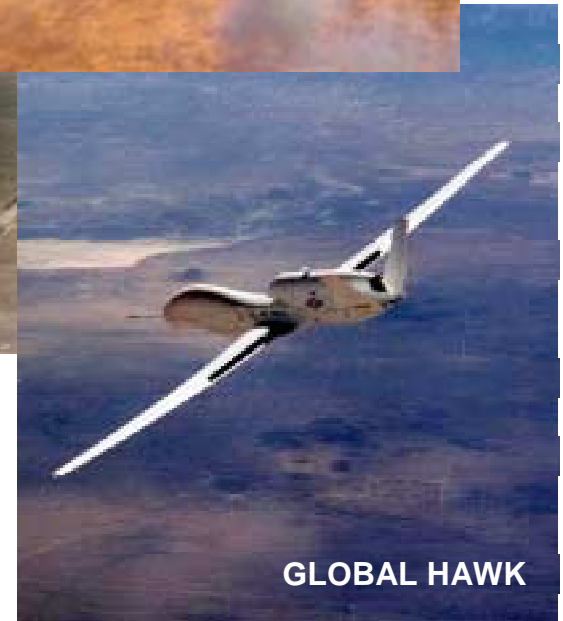
FTC improves reliability of any architecture



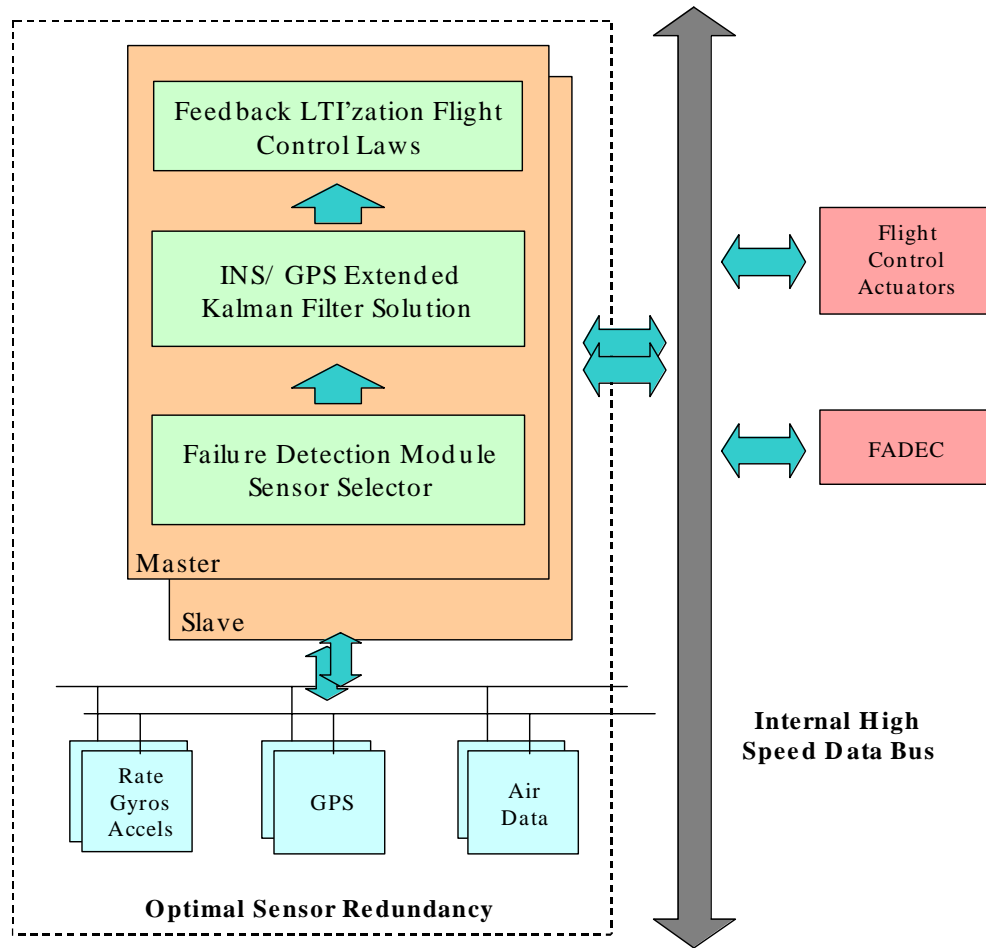
FTC is an enabling technology for...

- Robotic Aircraft
- General Aviation
- Damage Tolerant Aircraft

Robotic Aircraft



Future General Aviation Aircraft



SATS Aircraft concept - takeoff to landing
NASA Langley Research Center 2/3/2000 Image # EL-2000-00602



SATS-Cockpit Concept
NASA Langley Research Center 2/3/2000 Image # EL-2000-00008

Damage Tolerant Aircraft



- “Survivability toolkit” includes speed, altitude, electronics, darkness, stealth, etc
- FTC + ability for real-time parameter I.D. gives an aircraft ability to reconfigure even after physical configuration changes
- Opportunity exists to build an aircraft optimized for damage tolerance