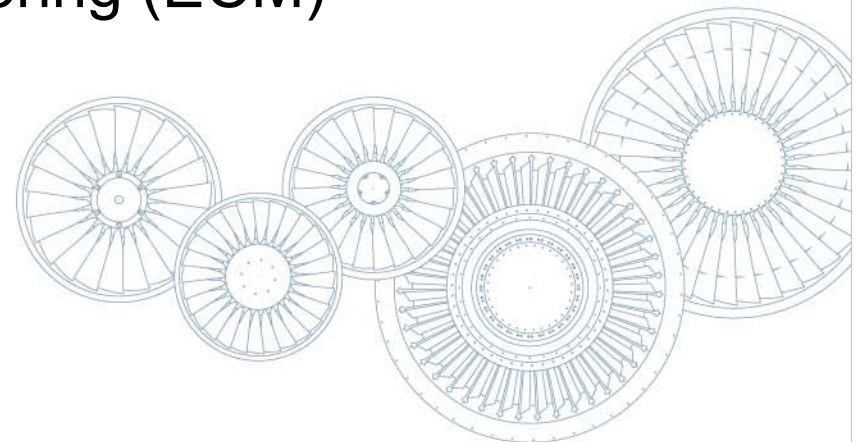


MTU - Engine Condition Monitoring (ECM)

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MTU Maintenance Hannover GmbH

Hannover Messe 2009

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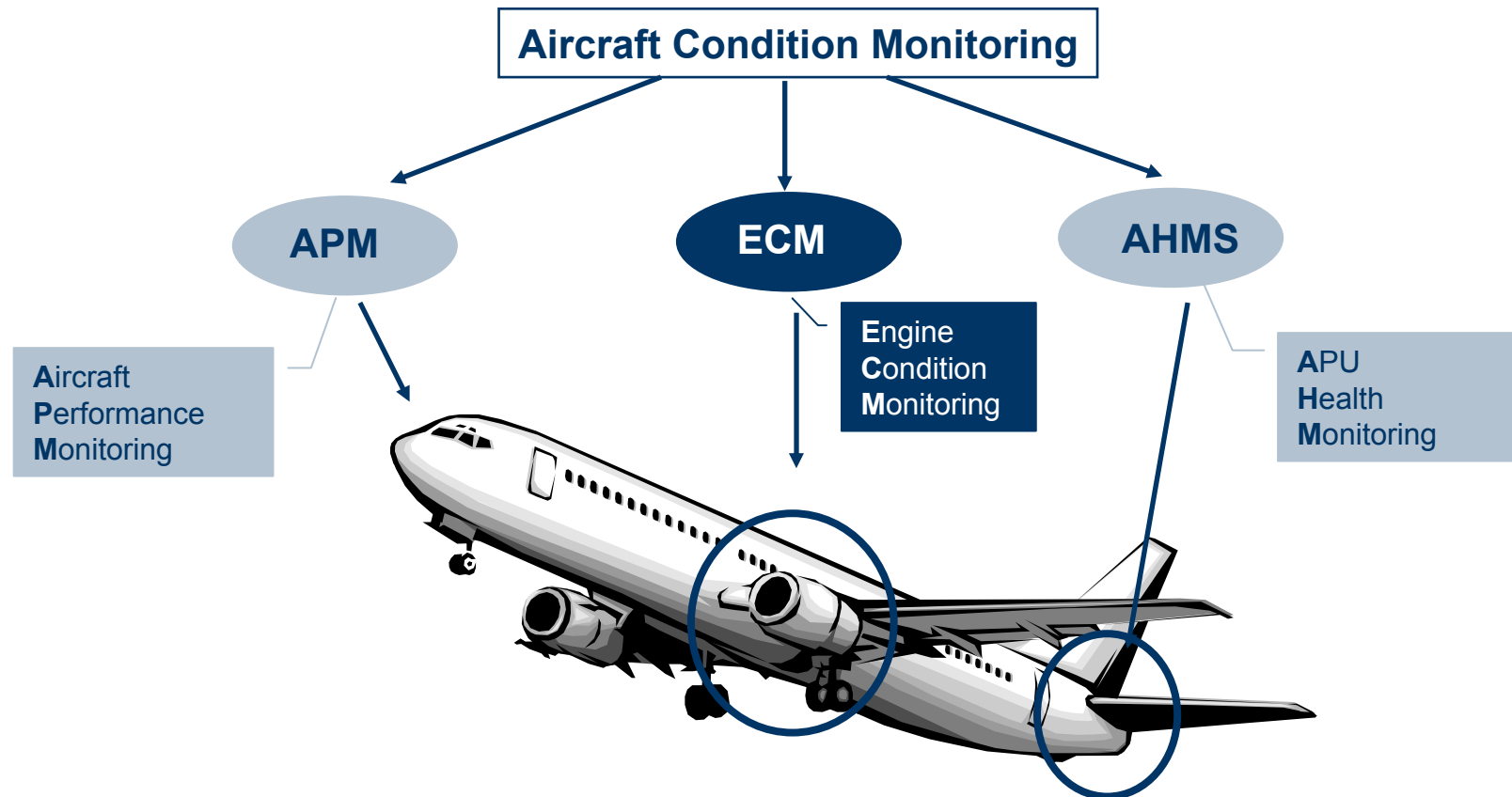
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- Introduction
- ECM @ MTU - MTU^{Plus} Engine Trend Monitoring
- MTU ECM track record
- MTU ECM service levels
- Engine health monitoring
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Aircraft condition monitoring

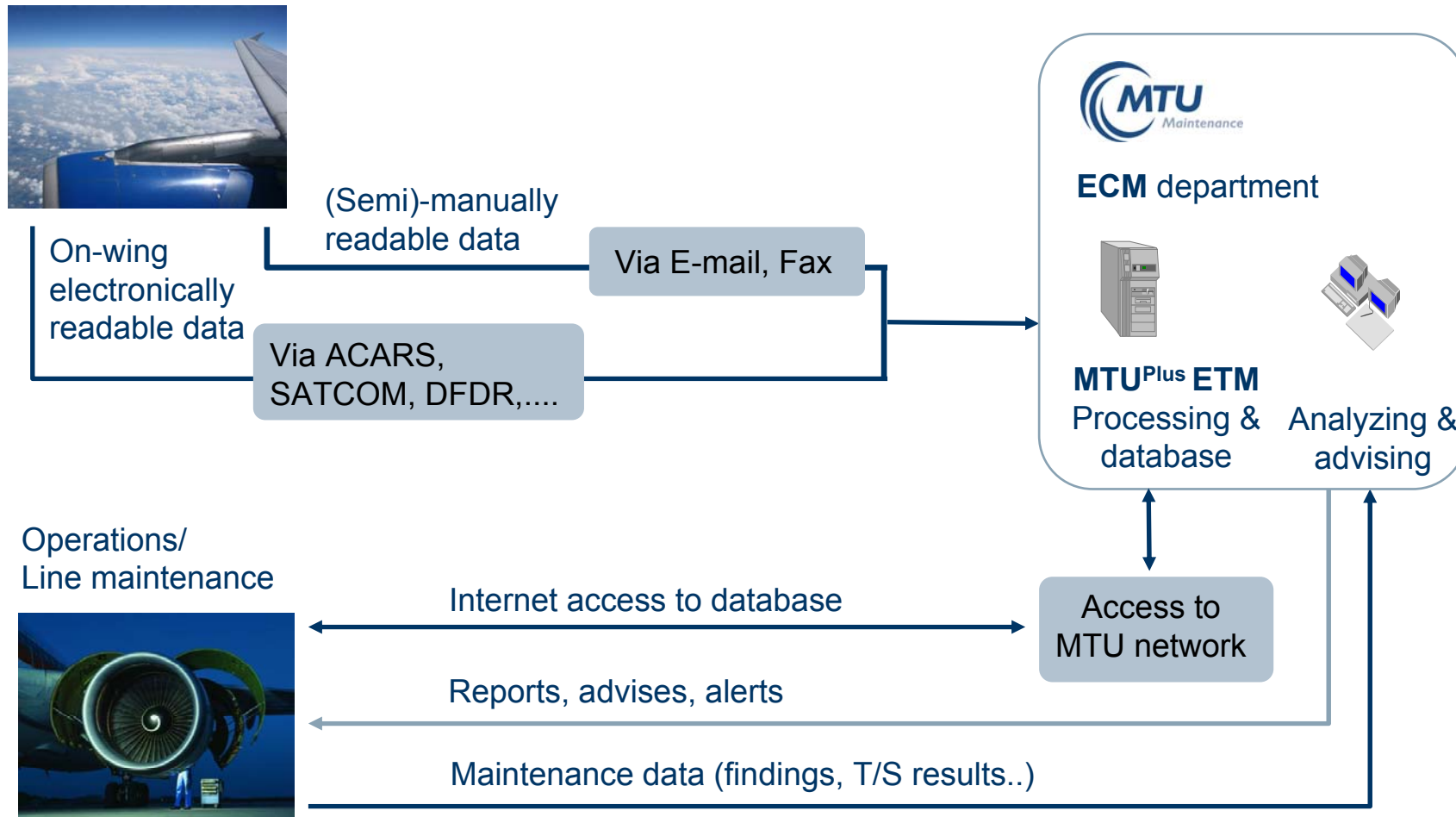


▶ ECM is part of the aircraft condition monitoring system

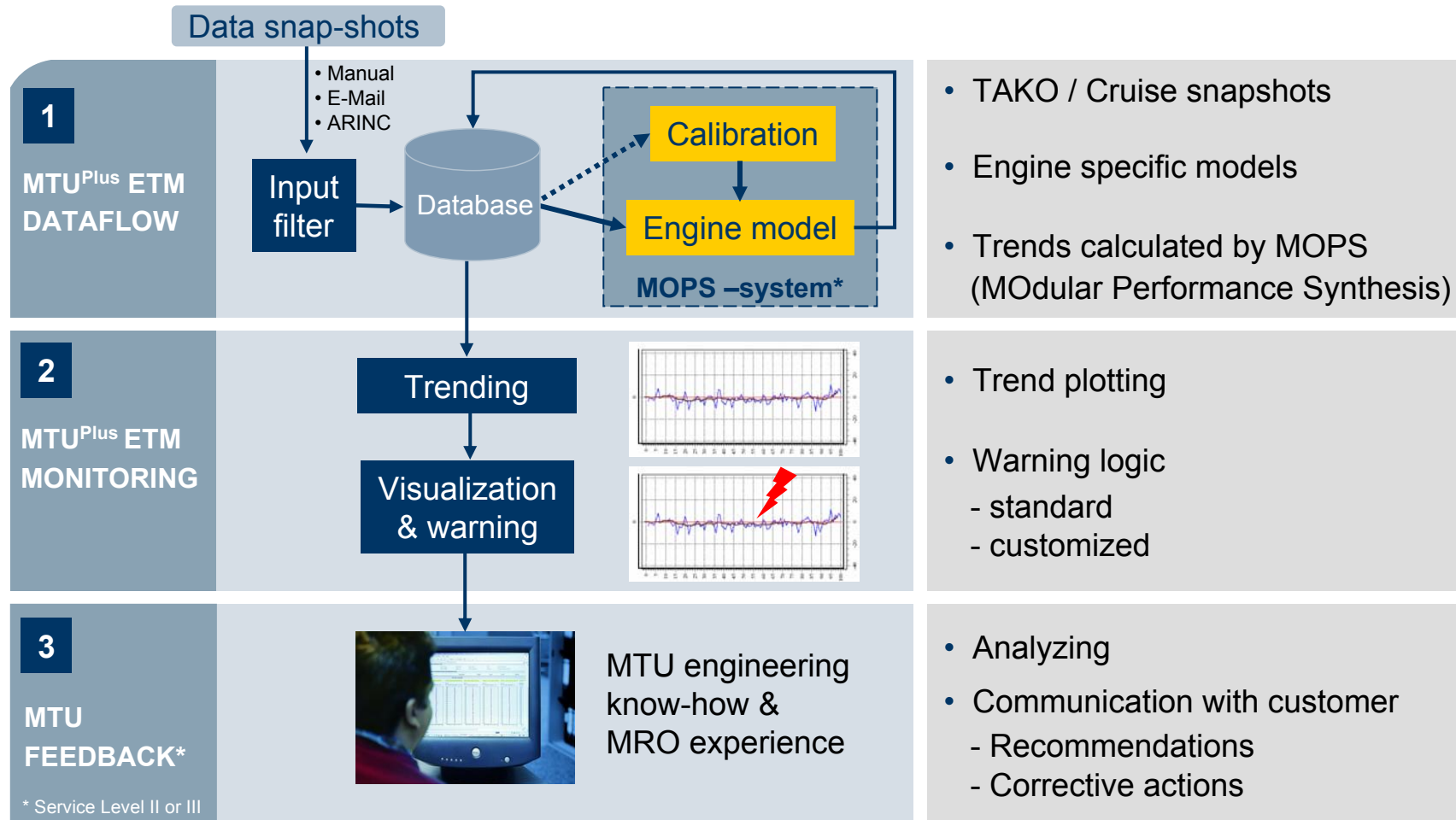
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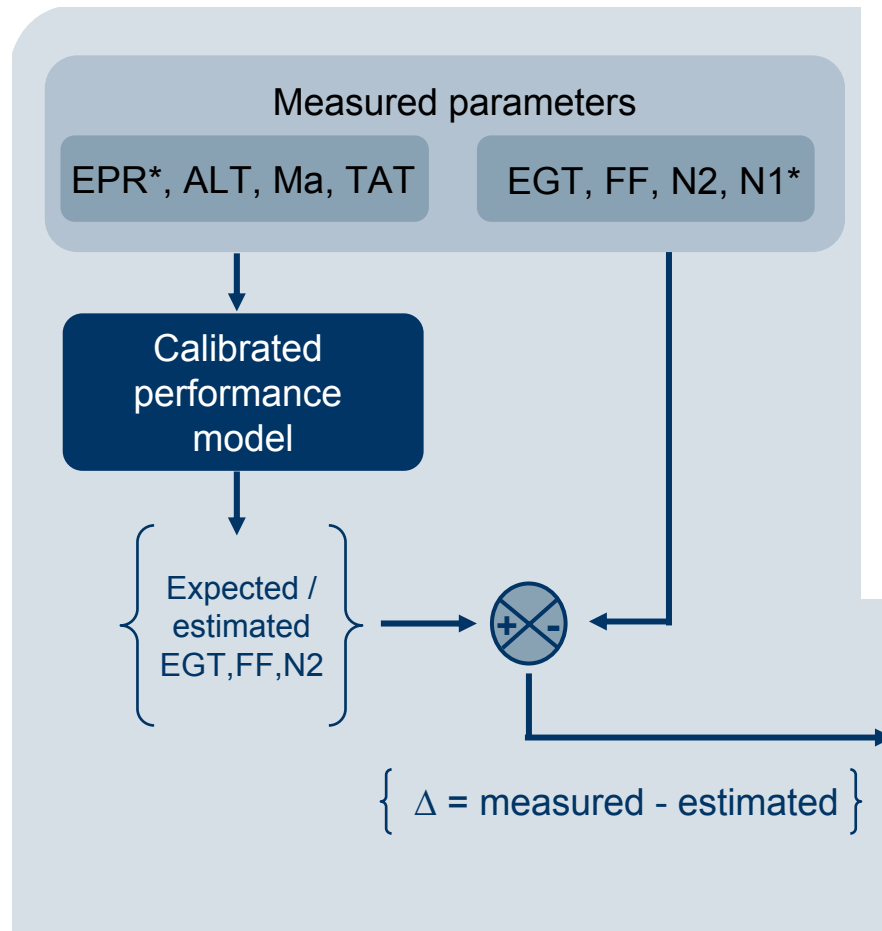
Engine Condition Monitoring (ECM)



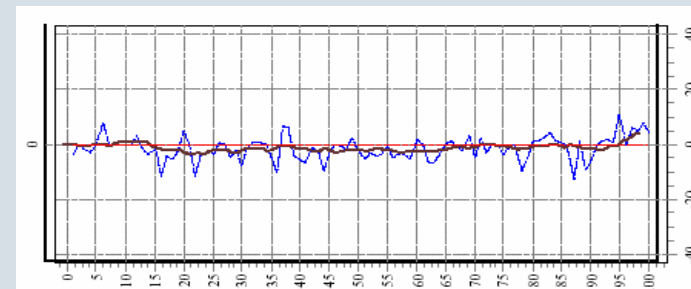
MTU^{Plus} ETM – MTU’s Engine Trend Monitoring tool for ECM



Performance model “MOPS” within MTU^{Plus} ETM



- Engine model specific performance model
- Calibration mode (one-time calibration):
 - „Healthy engine“
 - MOPS calibrated to measured parameters
→ ESN specific performance model
- Trending mode (ongoing):
 - Calibrated MOPS calculates expected parameters
 - Residuals vs. expected and measured parameters plotted



* Depending on engine control principle

ECM – current applications*



CF6-50/80C2



V2500



PW2000



CFM56-7



CF34-10

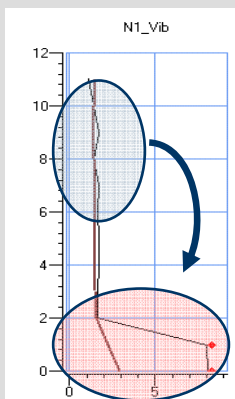
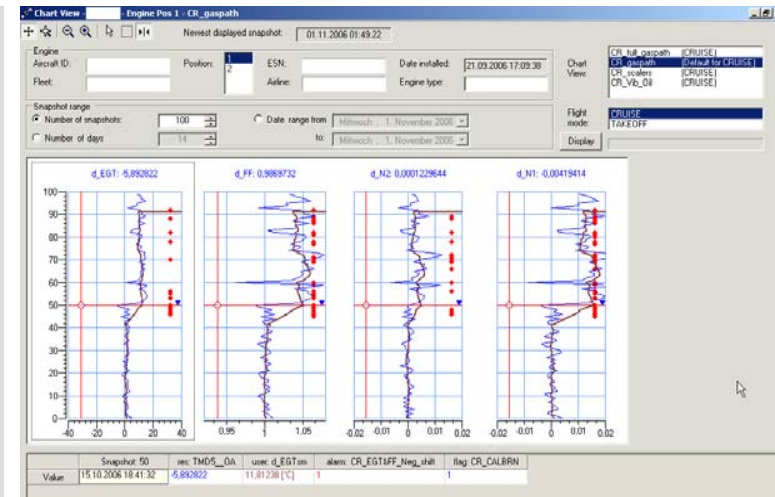
*All other engine types can be supported on request



One single platform for various engine types

MTU^{Plus} ETM – Capabilities & advantages

- Common platform for all engine and aircraft types
- Graphic interface
- Full thermodynamic model
- Monitoring of different operations (TO,climb,cruise)
- ESN related calibration (also “re-calibration”)
- Automated alerts and reports
- Engine performance analysis and management



- Individual alert levels
- Alarm flag indication based on free rules (logical and/or arithmetical calculation)
- Free combination of parameters allows early failure detection
- Free adjustable sensitivity allows „Expert mode“

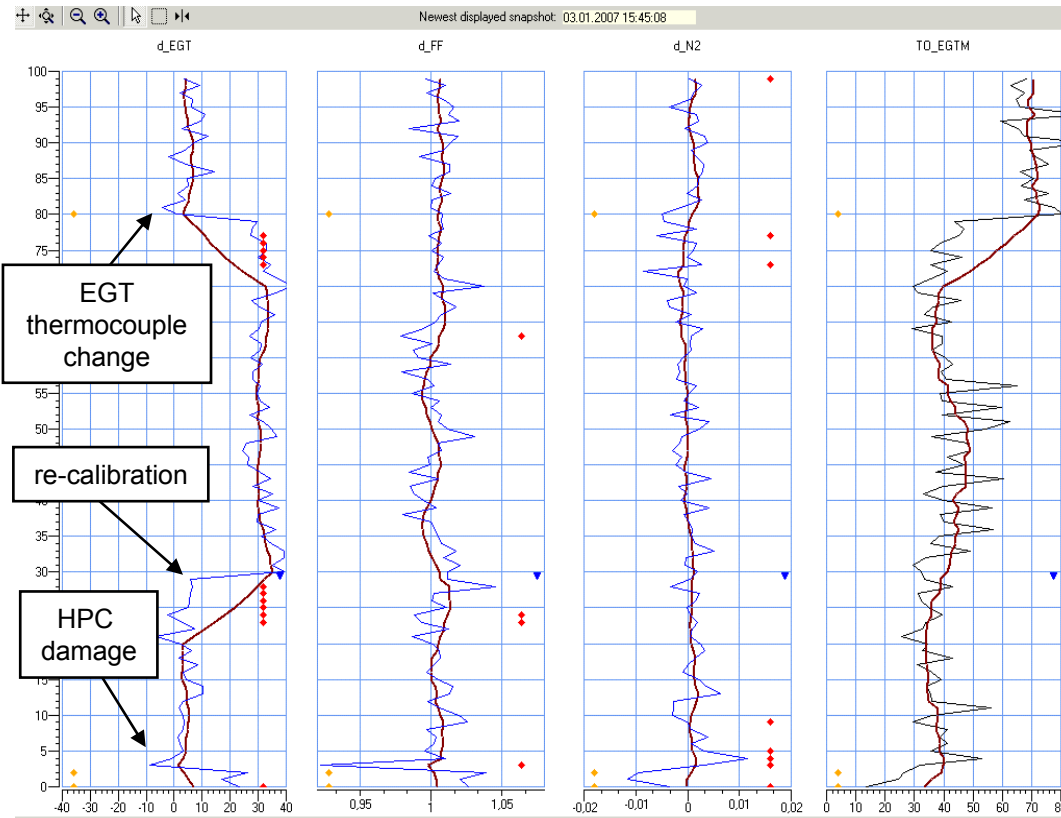
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ECM – Track record (1)



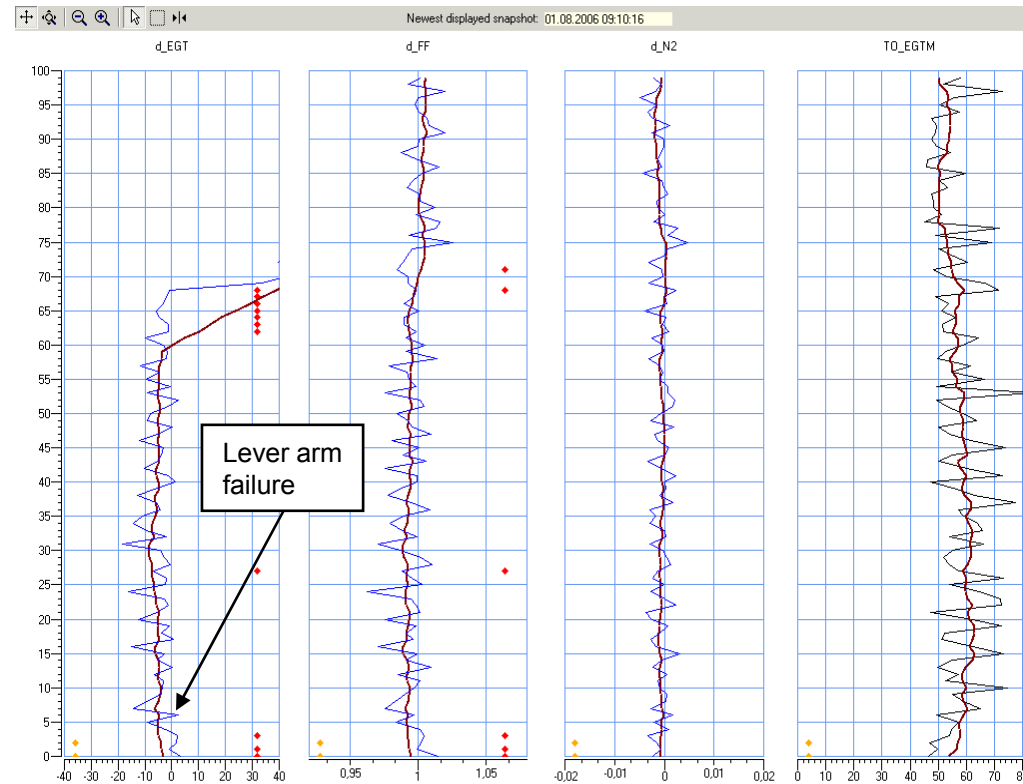
- HPC stg.11 vane liberation
- Engine inspected within one leg after MTU recommendation (A/C relocated)
- BSI confirmed the failure
- Engine was removed and replaced



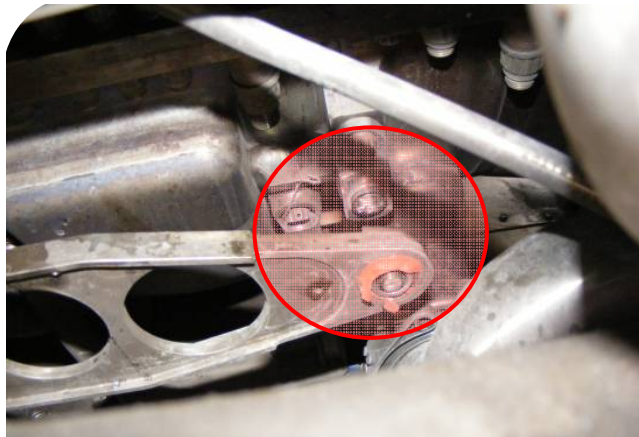
ECM – Track record (2)



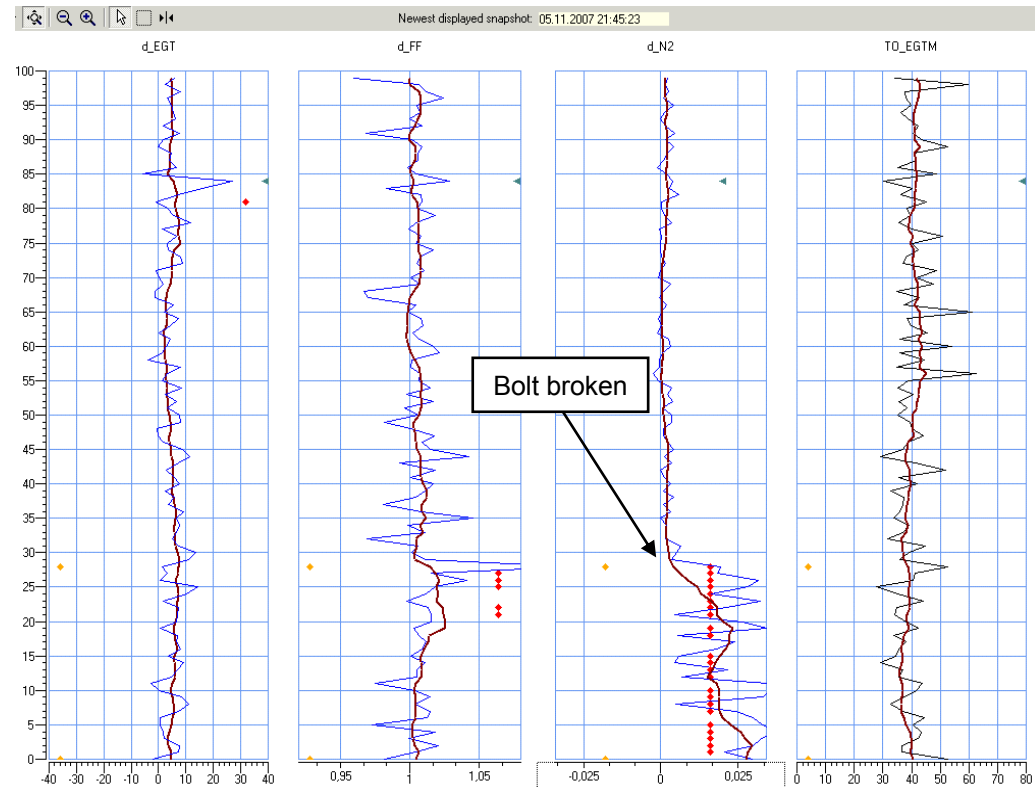
- HPC stage 5 lever arm failure/ liberation
- After visual inspection engine was removed and replaced



ECM – Track record (3)



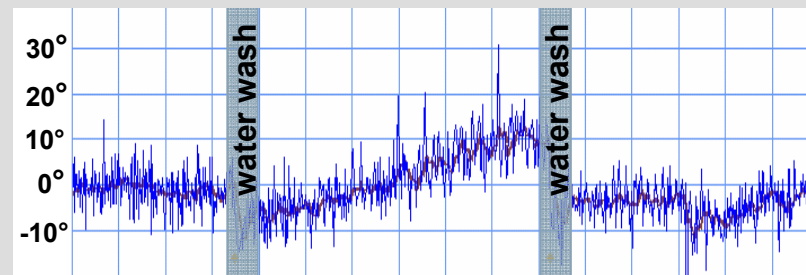
- L/H core VSV master beam aft hinge bolt broken
- Engine visually inspected
- Returned to service after bolt replacement



ECM – Performance management

- Engine performance management tool
- Monitoring of EGT deterioration
- Determination of most effective point for core cleaning based on individual engine performance
- Determination of effective cleaning method (soft / hard)
- Monitoring of performance improvement, re-scheduling if needed
- Extended On-wing time
- Pro-active engine removal planning

Δ EGT (C°)



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ECM - Customer service levels



Service Level I

- Automatic data collection & processing (24 hours / 7 days)
- WEB-based MTU^{Plus} ETM system access, including alerting, trending and diagnostic tools, alarm notification
- Operator performs monitoring and keeps full responsibility



Service Level II

- ECM service provider performs trend monitoring & engineering support incl:
 - Watchlist management
 - Performance reports
 - Fault diagnostic and troubleshooting support
- ECM service provider does the monitoring on behalf of the operator, but the operator keeps full airworthiness responsibility



Service Level III

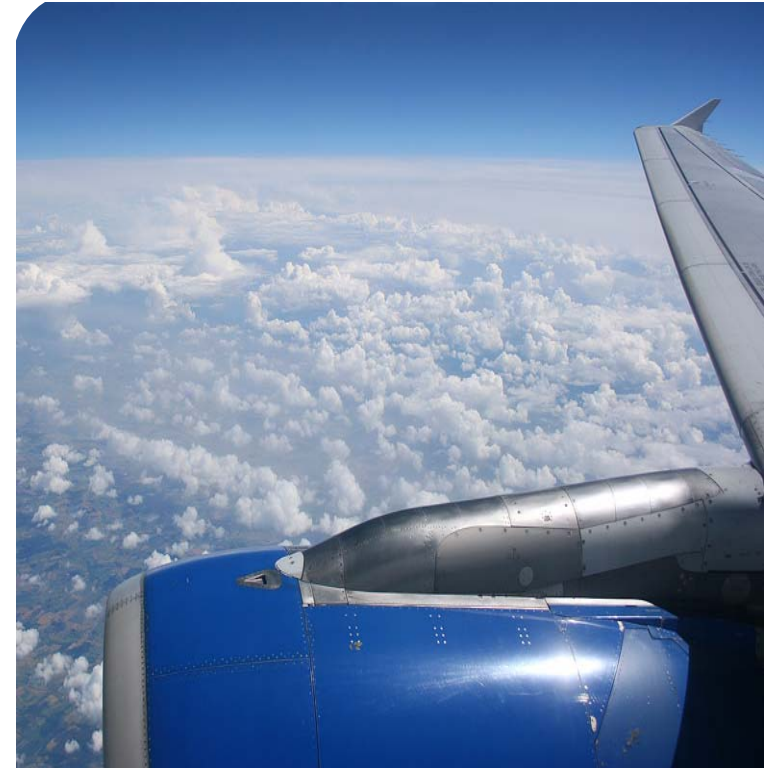
- Service Level I and Service Level II in combination, providing also operator access to the MTU^{Plus} ETM system

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ECM operational benefits

- Gives predictive information about engine abnormal behavior and helps to avoid unexpected failures
- Supports early line maintenance decisions to avoid secondary damages and AOG's
- Supports performance prediction & optimum aircraft operational planning
- Allows better engine removal planning & optimized spare engine management
- Leads to early known damage pattern
- Allows optimized off-wing maintenance planning



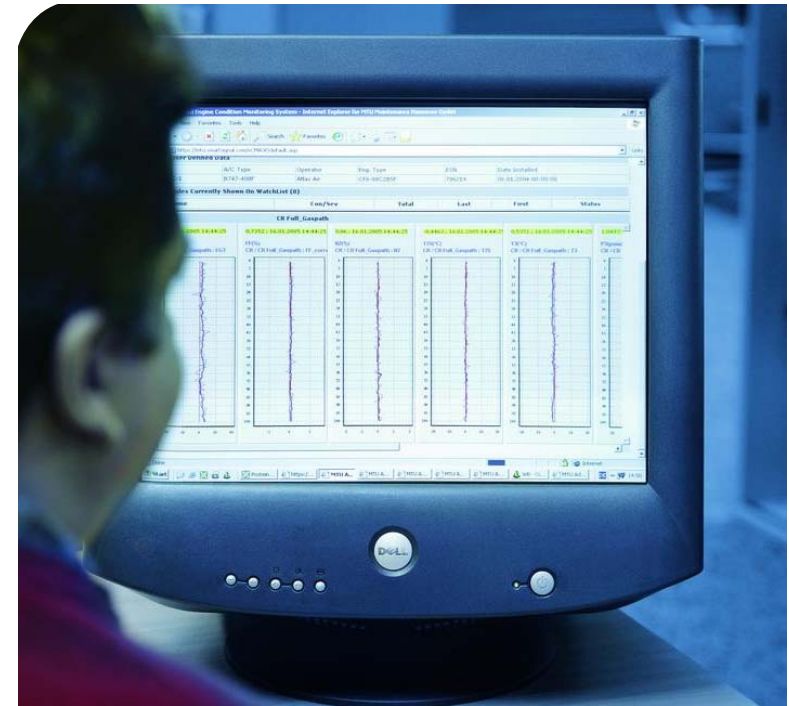
ECM financial benefits

- Optimized usage of engine fleet
- Minimized unscheduled downtime, and optimized on-wing times
- Reduced spare engine level requirements
- Increased fuel efficiency and overall fuel consumption thanks optimized core engine wash timing
- Lower maintenance cost



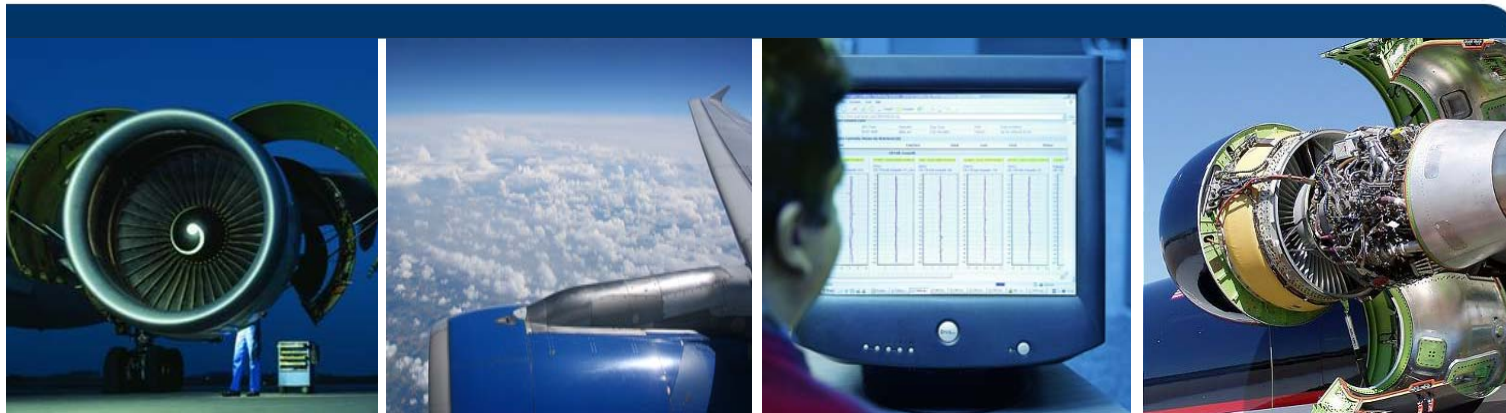
MTU^{Plus} ETM benefits

- One single ECM system - for all engine types
- No additional cost for IT & software
- Complete real-time visibility thanks to a 24/7 web-access via secure customer log-in
- Customized trend analysis based on engine type and history
- Immediate automatic alarm notification when performance trend shifts detected, not when OEM limits are exceeded
- Adjustable “sensitivity” for expert-mode





An MTU Aero Engines Company



Thanks you for your attention!

Special thanks to Ulf Godehardt and Ivo Krastev
for their participation

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