SHM in the Airbus Group
SHM within the Evolution of Airframe Structural Design

Metallic structures (riveted, ...)

Composite, primary structures

Composite, secondary structures

Metallic, integral

Advanced alloys & hybrids

Composite, advanced (1st)

Composite, advanced (2nd)

Multifunctional optimized intelligent structures

Structural ‘performance’ increase

1970 → 2030
SHM in the Airbus Group

The intelligently “sentient” aircraft

Goals of Structural Health Monitoring

• Reduce Maintenance Costs
• Increase Aircraft Availability
• Reduce Weight

Non-Destructive Testing (NDT)

Structural Health Monitoring (SHM)

SHM = Onboard NDT of Defects, Damages, Stress, Conditions
Examples for Running SHM Projects in Airbus Group

Tail strike indication system now deployed on the A380
A380 full-scale fatigue test
The A350 used SHM during structure certification and flight testing

The Life-Time Monitoring System (LTMS) is an optional installation on the A400M

Integration of Onboard SHM system as part of the Integrated Vehicle Health Management System

Health and Usage Monitoring Systems (HUMS) in helicopters
Airbus Group Divisions’ Contribution to Support the E2E Value Chain

<table>
<thead>
<tr>
<th>Project: @MOST</th>
<th>Project: NG HUMS</th>
<th>Project: HMM @ Airbus DS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Airbus Total Maintenance Operations Services and Technologies</td>
<td>Airbus Helicopter Next - Generation HUMS</td>
<td>Integrated System Health Management</td>
</tr>
</tbody>
</table>

**Technology Focus**

- Reliable aircraft health status (current and predicted) / including SHM
- Optimized maintenance scenarios from Aircraft and Fleet condition
- Remote Maintenance capability proprietary document.
- Contextualized and dynamic documentation
- Full Aircraft Configuration available “on demand”
- Integrated and Cost-effective end-to-end maintenance operations

- Reliable aircraft health status (current and predicted) / including SHM
- Automated Customer Data Collection
- Customer Data Management
- Usage & health-based Maintenance Management
- Condition based Maintenance (Maintenance Credit)

- Reliable Aircraft Health status (current and predicted) / including SHM
- Data-driven and model-based Diagnostic
- Data-driven and model-based Prognostic
- Condition based Maintenance (Maintenance Credit)
- Open System Architecture for Condition based Maintenance
- Simulation based CBM V&V Framework
SHM in the Airbus Group

Roadmaps for SHM in the Airbus Group Divisions
Critical SHM-related Technologies Currently Elaborated by Airbus Group

Sensor Application
• Surface Application
• Embedded Sensors
• Sensor Network
• Network Management
• Functional Structure

SHM - / HMM Architecture
• On-board Maintenance System
• Off-board Maintenance System
• Mission Management System

Certification
• Probability of Detection
• Reliability of Information

Big Data
• Data organisation and storage
• Data processing: select technologies and frameworks for data processing, visualisation
• Data analytics: correlation, fusion, specific algorithms, …
BIG DATA at Airbus Group
Flight Test Analysis  Flight Operations Support

Maintenance, Diagnosis, Prognosis

Fleet / Constellations Management  Ground Operations

... and probably many others to come.

R&T have to provide innovative solutions to create the expected value out of the data

Cyber Security

Intelligence, Imagery data
## BIG DATA at Airbus Group

We are sitting on a huge amount of data we do not fully leverage

*Example: Aircraft Operation Data*

### Stored & limited use

<table>
<thead>
<tr>
<th></th>
<th>Flight Test</th>
<th>A/C In-Service Data</th>
<th>Take-Off / Year</th>
<th>Total Fleet / year</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Std ACMS</td>
<td>Potentially</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Recordable</td>
<td></td>
<td></td>
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<tr>
<td><strong>A350</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>#Parameters</td>
<td>670 000</td>
<td>4000</td>
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<td>Data Recorded/flight</td>
<td>500 GB</td>
<td>450 MB</td>
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</tr>
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<td></td>
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<td></td>
</tr>
<tr>
<td><strong>A380</strong></td>
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<tr>
<td>#Parameters</td>
<td>320 000</td>
<td>4 000</td>
<td>5.800</td>
<td>2,6 TB</td>
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<td>Data Recorded/flight</td>
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<td>450 MB</td>
<td></td>
<td>1,1 PB</td>
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</tr>
<tr>
<td><strong>Long Range</strong></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>#Parameters</td>
<td>14 000</td>
<td>1 500</td>
<td>84.000</td>
<td>17 TB</td>
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<td>Data Recorded/flight</td>
<td>10 GB</td>
<td>200 MB</td>
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<td>2,5 PB</td>
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</tr>
<tr>
<td><strong>Single Aisle</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>#Parameters</td>
<td>12 000</td>
<td>1 500</td>
<td>744.000</td>
<td>37 TB</td>
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<tr>
<td>Data Recorded/flight</td>
<td>10 GB</td>
<td>50 MB</td>
<td></td>
<td>9 PB</td>
</tr>
</tbody>
</table>

*300 GB produced for the certification process in 2014*

*300 GB produced for the certification process in 2014*

*Not stored & not used*

*11500* in ~30 years (Flight tests)

*450 TB produced for the certification process in 2014*

We are sitting on a huge amount of data we do not fully leverage

Example: Aircraft Operation Data

**Aircraft Operation Data**

- **A350**
  - #Parameters: 670 000
  - Data Recorded/flight: 500 GB
  - Total Fleet / year: N/A

- **A380**
  - #Parameters: 320 000
  - Data Recorded/flight: 250 GB
  - Total Fleet / year: 5.800

- **Long Range**
  - #Parameters: 14 000
  - Data Recorded/flight: 10 GB
  - Total Fleet / year: 84.000

- **Single Aisle**
  - #Parameters: 12 000
  - Data Recorded/flight: 10 GB
  - Total Fleet / year: 744.000

*300 GB produced for the certification process in 2014*

*Not stored & not used*

*11500* in ~30 years (Flight tests)

We are sitting on a huge amount of data we do not fully leverage

Example: Aircraft Operation Data

**Aircraft Operation Data**

- **A350**
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  - Data Recorded/flight: 500 GB
  - Total Fleet / year: N/A

- **A380**
  - #Parameters: 320 000
  - Data Recorded/flight: 250 GB
  - Total Fleet / year: 5.800

- **Long Range**
  - #Parameters: 14 000
  - Data Recorded/flight: 10 GB
  - Total Fleet / year: 84.000

- **Single Aisle**
  - #Parameters: 12 000
  - Data Recorded/flight: 10 GB
  - Total Fleet / year: 744.000

*300 GB produced for the certification process in 2014*

*Not stored & not used*

*11500* in ~30 years (Flight tests)
BIG DATA at Airbus Group

BIG DATA Understanding and Maturity within Airbus Group

Digital and Big Data is a Group priority for 2015

- Internal benefits through new / increased revenue and efficiency gains
- Game changer on the market / Opportunities & Threats to be considered

**Top down**

- CEO: “Group priority for innovation”
- Cross-Industry Benchmark
- Airbus Group Big Data Conference Q4 2015
- Aircraft Connectivity “Object Digitization”

**Bottom-up**

- Flight Tests
- A350 RC
- Aircraft Visibility POC
- R&T studies
- Mono-Domain & fragmented Quicker or nicer

**More & more strategic drive to get business value out of our data as an asset**

**More & more business value demonstrated by doing**

- ECO-Fly POC
- Predict Non-Quality (XQ-Data POC)
- Flight & Ops Data Hub POC
- TTGF POC
- Cross-Domain and federated
- Showing impacts on company essentials
Positioning BIG DATA within the Entire Digitalization Scope

1. Mix the appropriate technological solutions...

2. ...with clear business opportunities or problems...

3. ...and with the right mindset to create tangible business value

- Use digital to improve Products or Customer experience
- Use digital to improve internal Operations
- Use digital to improve Organisation & Culture
The Airbus Group Innovation to Business Center in the Silicon Valley
Silicon Valley is Making In-roads into our Core Market

The Airbus Group Innovation to Business (i2B) Center in the Silicon Valley

Disruption of the current business
- Manufacturing
- Drones
- Launchers
- Satellites

Improvement of the current business
- 3D printed pieces
- In flight entertainment
- Maintenance
- Auto-pilot

Massive investments in key technologies and innovation enablers
- Virtual reality
- New sensors & materials
- Big data
- 3D printing
- Autonomous vehicles & robotics
- Crowdsourcing
- Energy storage
- Artificial intelligence
The Airbus Group Innovation to Business (i2B) Center in the Silicon Valley

The i2B Fosters Innovation to Business for Mothership Airbus Group

1- Scout breakthrough business models and technologies

2- Participate and animate aero start-up eco-system

3- Transfer innovations to Airbus Group (outside-in)

4- Accelerate innovative projects coming from Airbus Group (inside-out)

5- Open center of expertise in Silicon Valley and launch “moonshots” projects

Mothership company in Europe
The Airbus Group Innovation to Business (i2B) Center in the Silicon Valley
The Fully-Electric E-Fan Crossed the Channel on July 10, 2015
Thank you for your attention