

Enabling Condition Based Maintenance for Helicopters

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Falk Hoffmann, Airbus Helicopters Deutschland GmbH

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OUTLOOK

- The Airbus Group
- Airbus Helicopters
  - Recent Highlights & Innovations
  - Condition Based Maintenance for H/C
  - Current & Future Challenges in the field of PHM and SHM

The Airbus Group

AIRBUS

- Globally leading commercial aircraft manufacturer
- Order book coverage >8 years

~~EADS~~ Airbu

n formation to

AIRBUS HELICOPTERS

- Leading helicopter manufacturer
- Accounting for 1/3 of the global helicopter fleet

Recent Highlights & Innovations

- ✓ High Speed & Long Range
- ✓ Blue Pulse Demonstrator
- ✓ Optionally Piloted Vehicle (OPV)

High Speed – Long Range

Idea & Use Cases:

- ✓ Combine the best of helicopter & airplane (vertical take off and high speed)
- ✓ Technology demonstrator based on AS365 Dauphin
- ✓ Reduce acoustic footprint & CO2 emission compared to conventional helicopter
- ✓ Time efficiency for Rescue & Emergency
- ✓ Air Taxi…

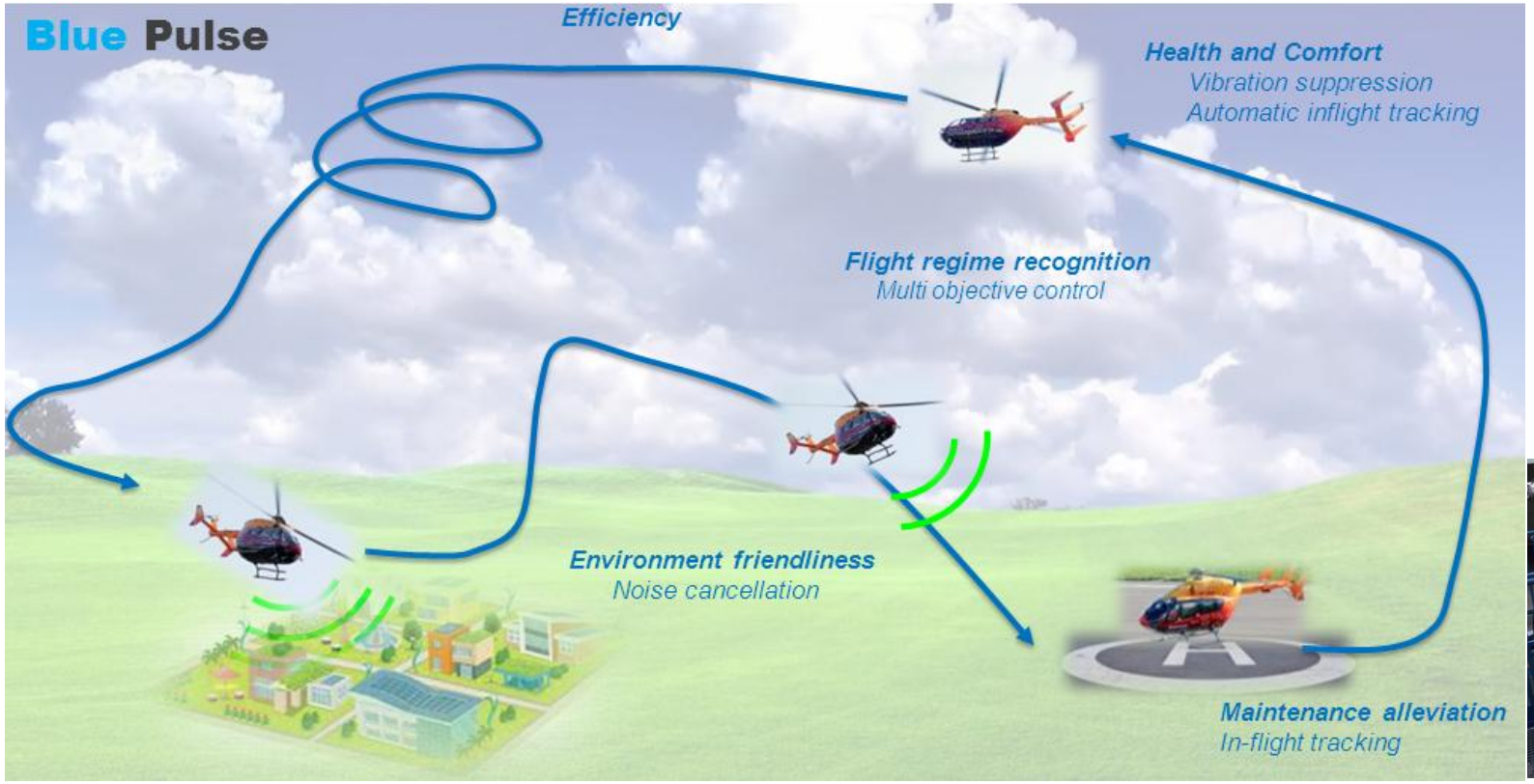
Achievements:

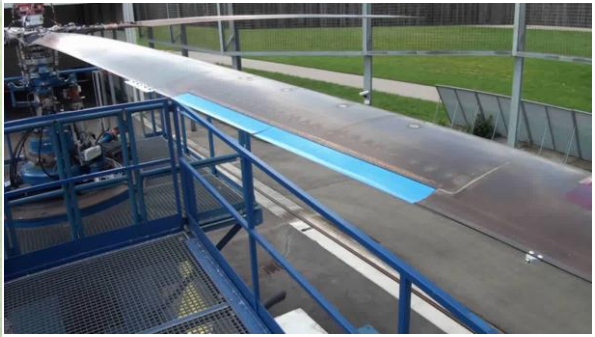
- ✓ Concept demonstration by integration of existing components
- ✓ 2013 speed record: of 255knots in LF

Key messages

Thinking without limits!

Blue Pulse - Innovative rotor system using active flap technology and flight regime recognition





Key messages

Multi-functional, smart active system becomes reality…

Achievements:

- ✓ Vibrations reduced by > 50% in level flight and approach
- ✓ BVI noise reduced by 50% (est. 2-3 EPNdB in approach under certification condition)
- ✓ Active in-flight tracking demonstrated

Optionally Piloted Vehicle (OPV) - Manned and Unmanned Flight

Use Cases:

- ✓Observation and search
- ✓Firefighting/Disaster management in remote areas (e.g. Fukushima)
- ✓Heavy load cargo (e.g. sling load)
- ✓Weapon carrier

Achievements:

- ✓Designed to ensure safety during unmanned test flight close to populated area
- ✓Manual engines start & shut down (by pilot)
- ✓Automatic take off & landing initiated from GCS (Ground Control Station)
- ✓Automatic hover flight with limited speed inputs from GCS
- ✓Automatic and autonomous flight plan execution
- ✓**Autonomous reaction in case of system degradation**
- ✓Flight plan change via GCS
- ✓External load

Key messages

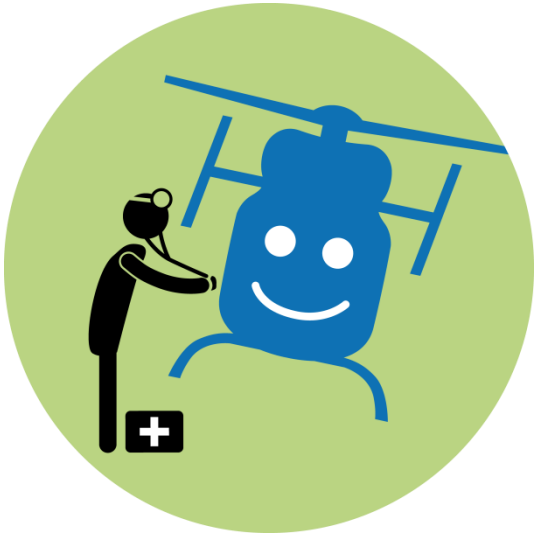
Diagnosis & Prognosis as key enabler for autonomous systems

Condition Based Maintenance (CBM) for Helicopters

- What & Why?
- CBM Development Process
- AH Health Management System
- CBM success factors & challenges

Condition Based Maintenance

→ Maintenance in dependency of the helicopter health:



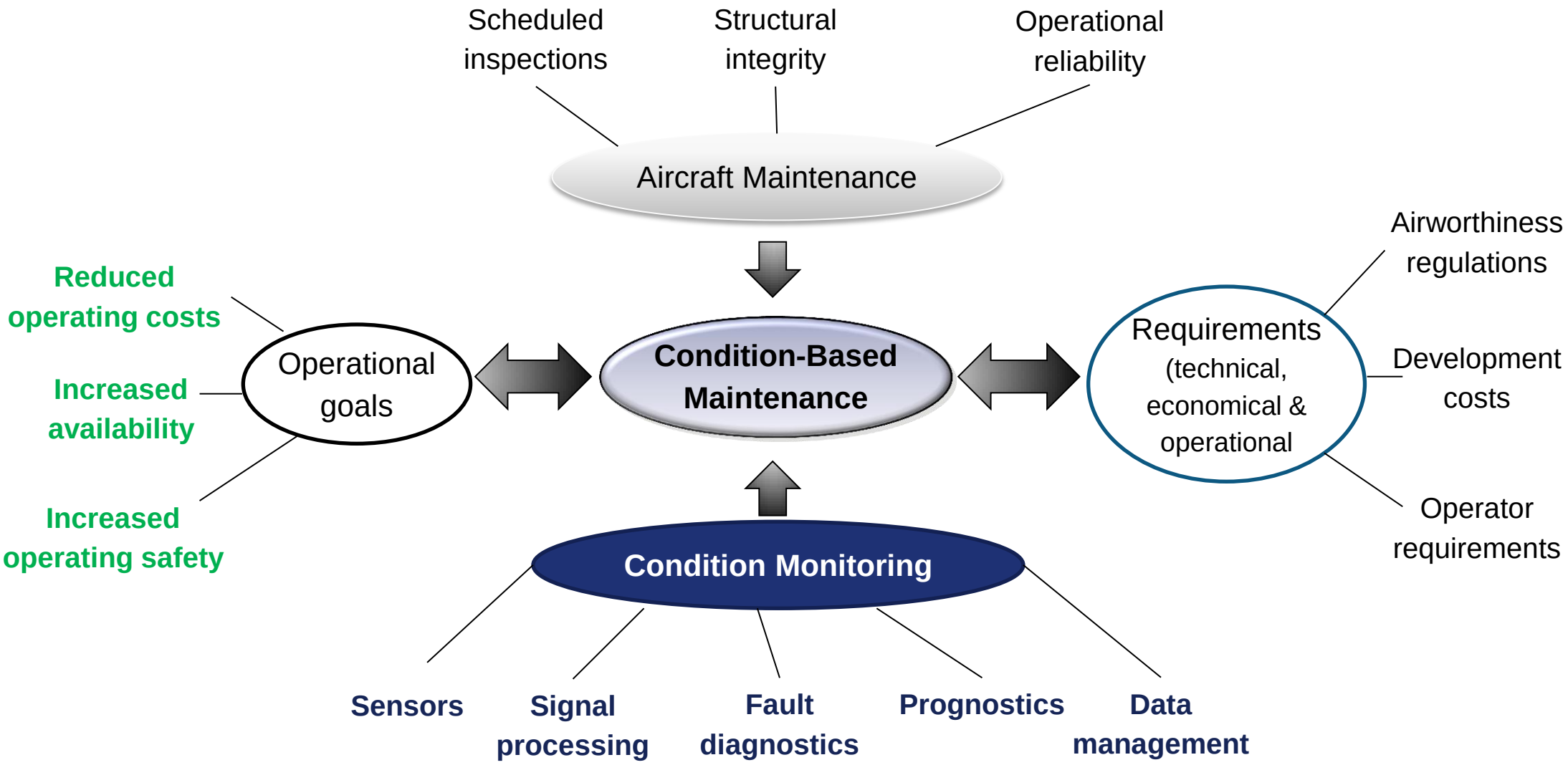
"Healthy" helicopters continue operation

Helicopters with anomalies require maintenance

Objectives:

- Prevention of incidents
- "Maintenance only if necessary"

CBM a Challenge?

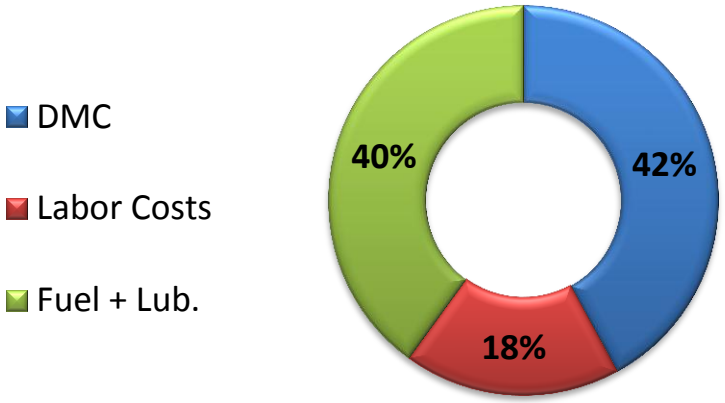


Costs

- **Life Cycle Costs**
  - all costs during the product life cycle

- **Direct Operating Costs (DOC)**

DOC Break Down EC135 P3



- **CBM can reduce Direct Maintenance Costs + Labor Costs**
  - EC135 → Light twin-engine H/C (3t), EMS configuration, ~ 500FH/year
    - After 11 years in-service, DMC reach ~ 50% of H/C sales price
  - EC225 → Heavy h/c (11t), Offshore, ~1000FH/year
    - After ~7 years in service, DMC reach ~ 50% of h/c sales price

Incident Analysis

Original Scenario

- **Severe** TDS bearing damage
- Long drive shaft (consequential) damage
- Cost calculation of ISIRG268
  - **Σ Maintenance Costs*** **~5k€**
- **Safety impact !**
- Worst case grounding time **6 days**
- Worst case grounding costs* **70k€…140k€**
- **Authority investigations**
- Transportation costs **? €**
- **Manufacturer involvement** **? €**

* Labor costs ~ 110€/hour

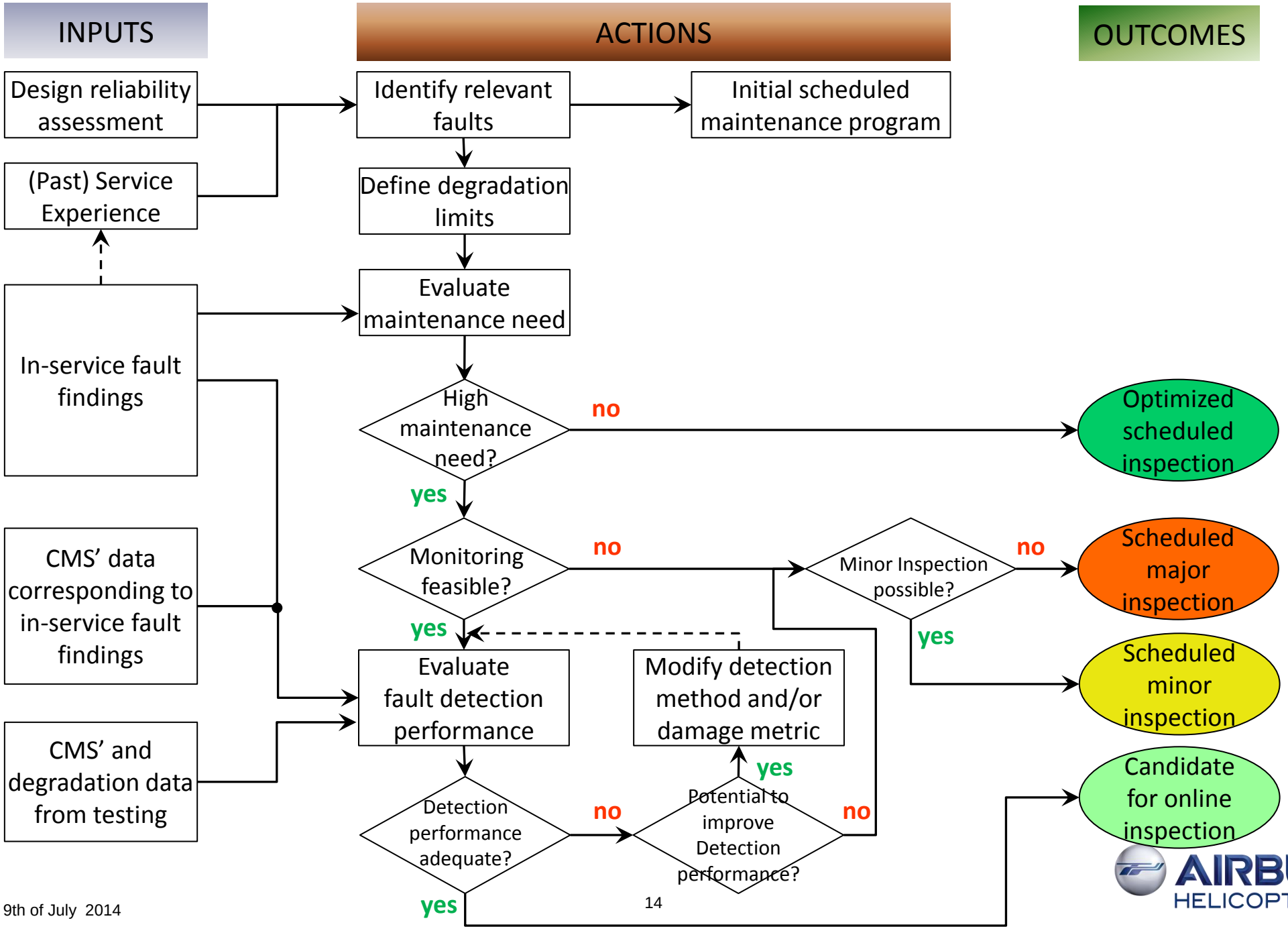
** Grounding costs ~ 3k€/hour

Scenario with HUMS

- TDS bearing damage (early diagnosis of degradation)
- **NO** Long drive shaft damage
- Cost
  - **1500,- €**
- **NO**
- Grou
- Grou **€…12k€**

- **NO Authority investigations**
- **NO** Transportation Costs
- **NO Manufacturer involvement**

Generic CBM Development Process



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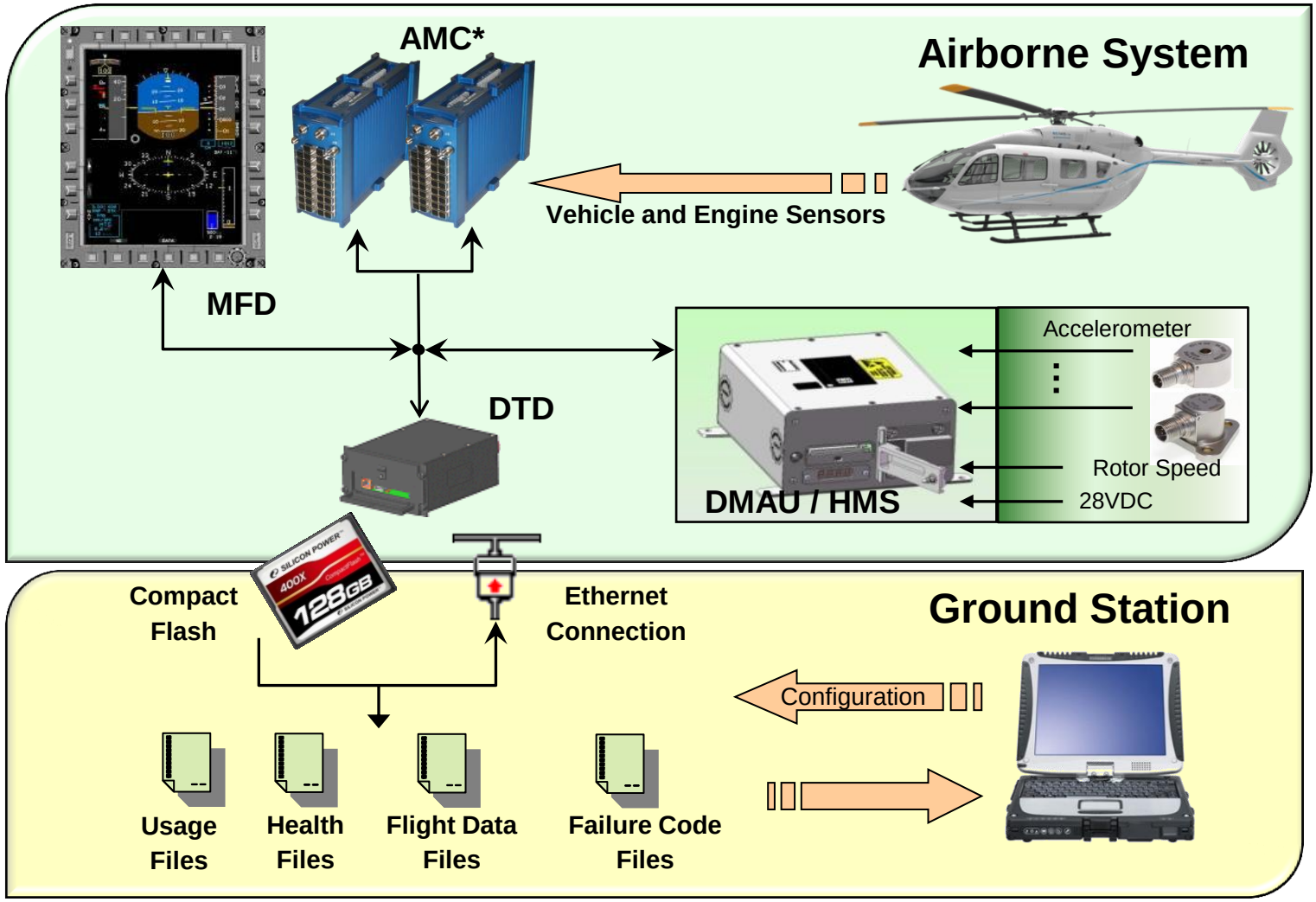
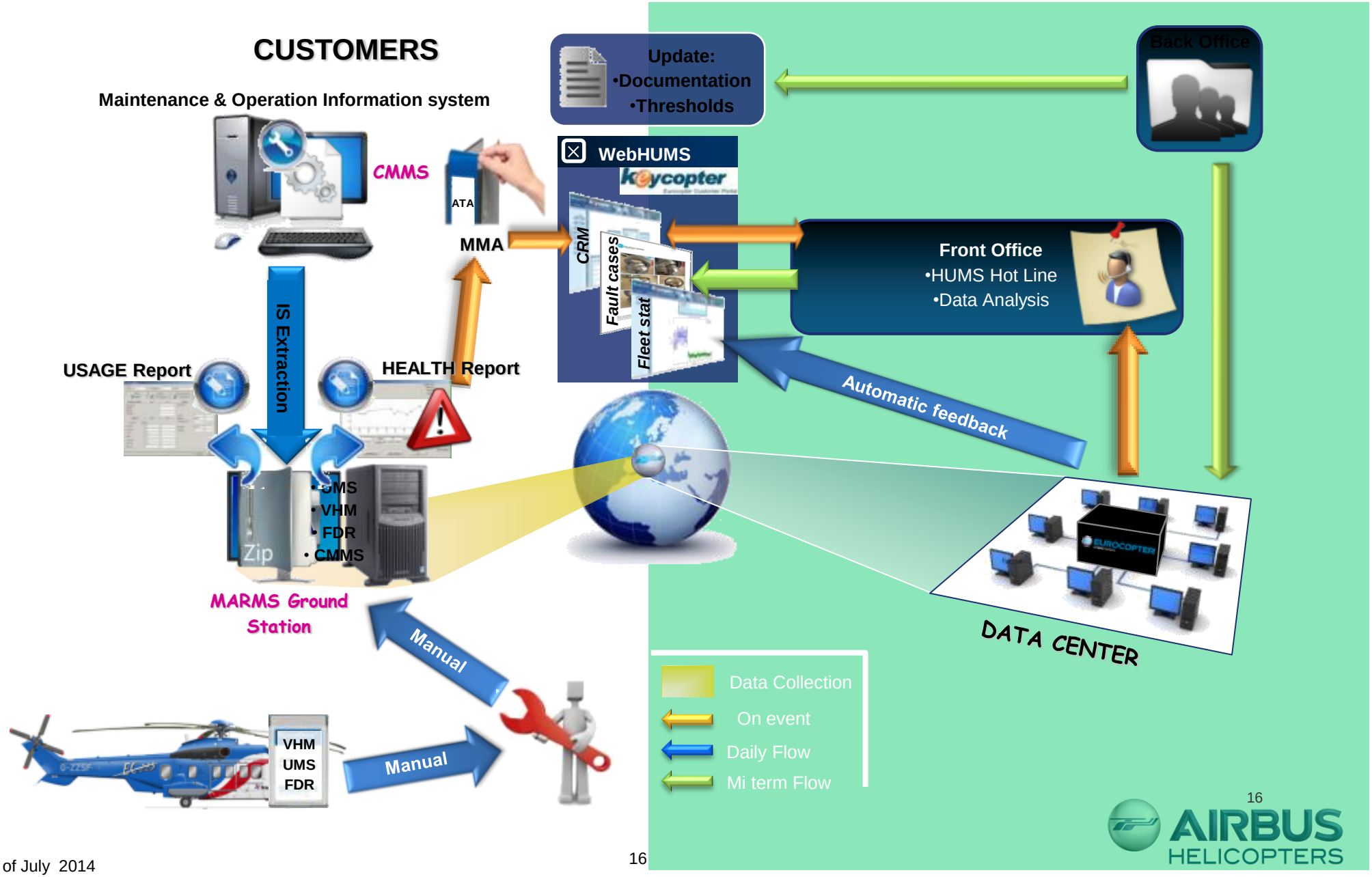
ONBOARD Helicopter Usage, Health & Flight Data Management System



AMC* – Aircraft Management Computer
DTD –Data Transfer Device
DMAU –Dynamic Monitoring Acquisition Unit
MFD –Multi Functional Display
*** Embedded SW for UMS, HFDM & Failure Management**

Ground Helicopter Usage, Health & Flight Data Management System



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CBM Success Factors & Challenges

1. Data Quality
   - Test Data from benches or h/c zero → representativeness…
   - In-service HUMS/HFDM data → SNR, variability…
   - Maintenance Data → fault type, fault severity, pictures, component life…

2. Data Quantity → the more the better

3. HUMS Coverage & Performance

4. Quality of Diagnostic & Prognostics Techniques
   - Degradation modeling, fault type, fault severity, RUL…

5. Part Maintainability and Inspection Methods

Future Trends & Challenges

- CBM certification
- Multi-level data capitalization & data fusion for planning of: mission, resources, maintenance, spare part logistics
- Configuration management
- Secured wireless on ground communication
- Digital sensors and sensor networks
- Integration of robust, energy harvesting sensor technologies in the rotating system
- Mission assurance, sense & respond concepts, real-time decision making

Thank You for Your Attention