Use of S5000F for exchanging NH90 maintenance data

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1. Presentation of NH90 program
2. Why to get feedback data from NH90 fleet
3. Proof of Concept for NH90 Maintenance data
4. Return of experience
5. Next steps
Helicopter NH90

• NH90 helicopter is a modern 10 tons helicopter for troop transportation (TTH) or Navy operations (NFH).

• NH90 has a carbon fiber fuselage with two sliding doors and rear ramp, composite rotor blades, modular avionic system integrated in a full glass cockpit, fly-by-wire controls with 4-axis autopilot and advanced mission flight aids, specific mission and role-fitted equipment.

• On-board monitoring and diagnostic system monitors NH90 usage and technical events. After flight this data is downloaded in a ground station. Most of the time this ground station is interfaced with Nation’s Maintenance information system (MIS). This architecture allows an access to a large amount of detailed data about H/C

• Since its design phase in 1992, NH90 serviceability was a primary objective. It was ensured by applying Integrated Logistic Support activities based on specifications : Mil-STD-1388 for Logistic Support Analysis, S1000D for Technical Publication and S2000M for Material Support

• 14 Nations have ordered 535 NH90 helicopters. As of today 365 are in service and totalize more than 180000 flight hours.
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• Within ILS activities, NHIndustries has to collect data about maintenance which is done on NH90 fleet in order to improve NH90 serviceability.

• To organize this data collection, Nhindustries publishes pdf forms (unscheduled maintenance, scheduled maintenance, maintenance man-hours per flight hour and engine maintenance).

• Operators get these forms on ePortal, periodically fill them with data and post them back on ePortal. This information is automatically stored in a NH90 maturity database. This data is used by design office to improve NH90.

But growing number of in-service NH90, lack of integration with National Maintenance Information system is creating a real burden on Customer side (workload to manually fill forms, data inaccuracy, missing data, ...).

Directly collect this data from Nation’s Maintenance Information System (MIS)

... but we’ll have to interface with at least 14 Maintenance Information System!
Agenda

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Feasibility study to answer the question
Is S5000F able to get data from Maintenance information System?

Analyze of 230 information from French Navy MIS (ATAMS) and French Army MIS (Envision RUSADA) gives following results
- around 93% information successfully mapped onto S5000F Issue 1. Information not found in S5000F exists in other ASD specification.
- nearly 70% of mapping rule have a simple (one to one) or medium complexity

In 2017, decision to develop a proof of concept
- with limited scope only data necessary for unscheduled maintenance analysis
- for all French NH90 fleet (MIS ATAMS for Navy H/C and MIS RUSADA for Army H/C)
Process for implementing S5000F

Organization A

Data Exchange specification

Specify

Transform

Information system

Connector

Business data

Data Exchange specification

S5000F Data model

S5000F XML schemas

Guidance Document

Organization B

Connector

Data Exchange
POC - Step 1: Business analysis for Unscheduled Removal

- To identify POC business process for unscheduled removal, we have analyzed the pdf form (see below) which is contractually agreed to exchange data.
Analysis of Unscheduled Removal form (1/5)

Report reference: MML_U_FR_01252_2016-01-18_W03_20160225-105256

FRANCE

Customer reference

First date of the reporting week 18/01/2016 (Monday) Week 03 / 2016

Operator 1° RHC ALAT French Army

Maintainer 1° RHC ALAT French Army

Operating Base Phalsbourg

No unscheduled removals observed during the reporting week

Organization + Envelope data
Analysis of Unscheduled Removal form (2/5)
### Analysis of Unscheduled Removal form (3/5)

#### WEEKLY REPORT ON UNSCHEDULED REMOVALS

**Date of the reporting week:** [Insert date]

**Flight No.:** [Insert flight number]

**Reason for removal:** [Insert reason]

<table>
<thead>
<tr>
<th>Aircraft</th>
<th>Operator</th>
<th>Engine Type</th>
<th>Engine No.</th>
<th>Serial No.</th>
<th>Cause of Removal</th>
</tr>
</thead>
<tbody>
<tr>
<td>[Insert aircraft details]</td>
<td>[Insert operator details]</td>
<td>[Insert engine type details]</td>
<td>[Insert engine number details]</td>
<td>[Insert serial number details]</td>
<td>[Insert cause of removal details]</td>
</tr>
</tbody>
</table>

---

#### HELICOPTER DATA

<table>
<thead>
<tr>
<th>H/C</th>
<th>Roll</th>
<th>TT/SN</th>
<th>T/LSN</th>
</tr>
</thead>
<tbody>
<tr>
<td>[Insert helicopter details]</td>
<td>[Insert roll details]</td>
<td>[Insert TT/SN details]</td>
<td>[Insert T/LSN details]</td>
</tr>
</tbody>
</table>

#### MISSION DATA

<table>
<thead>
<tr>
<th>Mission No.</th>
<th>Mission Type</th>
<th>Mission Phase</th>
<th>Operating Environmental Conditions</th>
<th>Operating Temp. Conditions</th>
<th>Aborted Mission</th>
<th>Delayed 1 Stage 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>1209 / TRIA04</td>
<td>P-MEAN</td>
<td>Maintenance</td>
<td>Sand And/OR Dust-Laden Atmosphere</td>
<td>Between +20°C And +40°C</td>
<td>NO</td>
<td>NO</td>
</tr>
<tr>
<td>1309 / TRIA04</td>
<td>P-MEAN</td>
<td>Maintenance</td>
<td>Sand And/OR Dust-Laden Atmosphere</td>
<td>Between +20°C And +40°C</td>
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</tr>
<tr>
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<td>P-MEAN</td>
<td>Maintenance</td>
<td>Sand And/OR Dust-Laden Atmosphere</td>
<td>Between +20°C And +40°C</td>
<td>NO</td>
<td>NO</td>
</tr>
</tbody>
</table>

*Flight* Mission, Environment, Result
### Analysis of Unscheduled Removal form (4/5)

#### WEEKLY REPORT ON UNSCHEDULED REMOVALS

**Aborted Mission 1:**

<table>
<thead>
<tr>
<th>P/N</th>
<th>S/N</th>
<th>Qty</th>
<th>Item Name</th>
<th>TSN (yr)</th>
<th>TSO (yr)</th>
<th>TSR (yr)</th>
<th>CSN (OPC Ukr)</th>
<th>CSO (OPC Ukr)</th>
<th>CSR (OPC Ukr)</th>
<th>Date of Failure</th>
<th>Failuro Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>65524061201</td>
<td>NA</td>
<td>1</td>
<td>HUB SIDE GUIDE BUSH</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>20/01/2016</td>
<td>Leakage</td>
</tr>
<tr>
<td>A840A10</td>
<td>NA</td>
<td>1</td>
<td>COUPLING HALF; QUICK DISCONNECT</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>19/01/2016</td>
<td>Leakage</td>
</tr>
<tr>
<td>EN4165J14P4</td>
<td>NA</td>
<td>1</td>
<td>BACKSHELL</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>19/01/2016</td>
<td>Broken</td>
</tr>
</tbody>
</table>
### Analysis of Unscheduled Removal form (5/5)

#### WEEKLY REPORT ON UNSCHEDULED REMOVALS

<table>
<thead>
<tr>
<th>Equipment No.</th>
<th>Details</th>
<th>Manufacturer</th>
<th>Condition</th>
<th>Action Taken</th>
<th>SM or UM</th>
<th>SM Type</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>20/01/2016</td>
<td>Leakage</td>
<td>LIABILITY</td>
<td>Replaced - Scrapped</td>
<td>SM</td>
<td>25 FH</td>
<td></td>
<td></td>
</tr>
<tr>
<td>19/01/2016</td>
<td>Leakage</td>
<td>LIABILITY</td>
<td>Replaced - Scrapped</td>
<td>SM</td>
<td>25 FH</td>
<td></td>
<td></td>
</tr>
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<td>Broken</td>
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<td>SM</td>
<td>25 FH</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
POC Step 2: Units of Functionalities, classes and relationships

Messages:
- Parties
- Aircraft
- Flight
- Equipment
- Failure

Interfaces:
- 1 SerializedItem
- 2 Party

UoF:
- Party/Facility/Location
- Organization
- Facility
- Operating base
- UoF Party/Facility/Location
- Location

Classes and relationships:
- ProductVariant
- SerializedProductVariant
- OperationalPeriod
- Mouvement
- MouvementLeg
- MouvementLegDelay
- WorkOrder
- MaintenanceActivity
- PartAction
- LogBookEntry
- HardwarePart
- SerializedHardwarePart
- EquipmentFault
- UoF Equipment
- Failure
- FailureCause
- FailureMode
- OperationalEvent
- Event
- MaintenanceEvent
- UoF Event
- UoF Maintenance Activity
- UoF Event

Relationships:
- Messages between different units and classes
- Interfaces between different functionalities, classes, and relationships
<table>
<thead>
<tr>
<th>PARTIES</th>
<th>Aircraft Aging</th>
<th>Aircraft Flights</th>
<th>Equipment Aging</th>
<th>Equipment Removal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organizations: Maintainer / Operator</td>
<td>- Helicopters and Variants</td>
<td>- Operational Period</td>
<td>- Equipment list</td>
<td>- Unscheduled removal</td>
</tr>
<tr>
<td>People: Maintainer / Operator</td>
<td>- Operating counters</td>
<td>- Flight list</td>
<td>- Log-Book</td>
<td>- Failure description and Failure cause,</td>
</tr>
<tr>
<td>Adresses</td>
<td>« Parties » linked to Helicopter</td>
<td>- Flight data: duration, delay, counters</td>
<td></td>
<td>- Part Action</td>
</tr>
</tbody>
</table>

**POC – Step 3: S5000F messages**

- **Parties:**
  
  - Slow-changing information. Message defined but not implemented in POC.

- **Aircraft:**
  
  - Monthly message giving aircrafts’ aging at end of month

- **Flight:**
  
  - Monthly message with all information about flights done during the month

- **Equipment:**
  
  - Monthly message giving Equipment's aging at end of month

- **Failure:**
  
  - Monthly message with all information about equipment removal done during the month
POC Step 4: Guidance Document

UoF S5000F (UML in EA) limited to aircraft

XML S5000F Aircraft

SQI Data model S5000F Aircraft
• Identification of ‘useful parts’ of S5000F UML model.  
  Definition of XML messages and their associated XML schemas  
  Guidance document with basic « business rules »

• For documenting and implementing this model, we\(^1\) used **Enterprise Architect** (SparxSystems), **ETL** (Open source Talend), **Python** (Open source), **XML Spy** (ALTOVA), **MySQL** (open source) and **Qlik Sense** (Qlik)

• Using this S5000F implementation we\(^2\) exchanged and stored in S5000F database:
  – For French Army NH90, all flights from 2014 to 2018 :
    30 Aircrafts, 16 652 flights , 478 PNR, 2268 SN and 2892 Failure

  – For French Navy NH90, flights done in 2014 :
    20 Aircrafts, 1336 flights , 117 PNR, 565 SN and 253 Failure

\(^1\) Thanks to CIMPA and Cap Gemini project team  
\(^2\) Thanks to French DMAé and DGA
Agenda

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Lesson learned

• S5000F ULM model and S5000F XSD allow to design data exchange compliant with S5000F specification.
  – S5000F data model allows to ensure data persistence.
  – S5000F xsd 1.0 is mandatory to validate S5000F new implementation.

• NHIndustries POC shows that IT workload and elapsed project time are acceptable. Another implementation may precise this workload.

• Similar description (UML schema and XSD) for the others S-series specifications would improve numeric continuity.

• With this use case (Unscheduled Removal), we collect many data that can be used for various goals (other functional domains)

• As S5000F does not define messages, it is convenient to create messages using best practices for instance ‘Aircraft Aging’ allows a periodic synchronization of ‘Aircraft Flight’
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NEXT STEPS ...

- Extend scope of Maintenance feedback to SM, MMH/FH & engine
- Extend to other Nations fleet (not only French Fleet)
- Extend to other activities (LCC, PBH contract, ...)

Here, we are !!!

Formalize Requirements

Lessons learned + Suitability of S5000F for NH90 contractual framework

Proof of concept for Unscheduled Maintenance feedback

Industrialize

In service Activities

Collect Feedback

Control & Improve

Aggregate, compute indicators & Analyse

Maintenance [4]
Supply Support [6]
Life Cycle Cost [7]
Usage - Health [9]
Obsolescence [10]
PBH Contract[13]

...
Thank you for your attention!

Questions?