INTEGRATED VEHICLE HEALTH MANAGEMENT – BENEFITS AND CHALLENGES

AMC Big Data Symposium

April 23, 2018
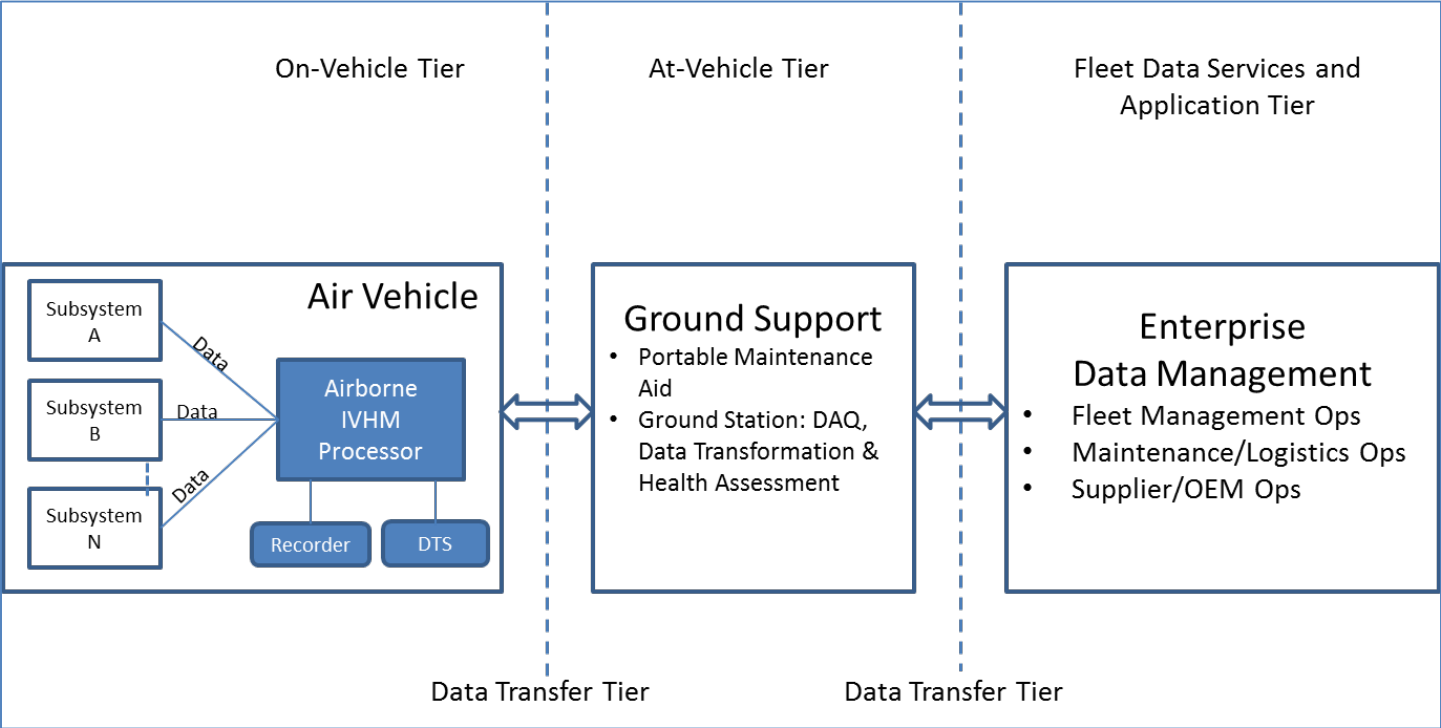
Monitoring: Data for data's sake?

Management: Closed Loop   Data → Decisions
- *"Without the why, the how doesn't matter"*

Integrated Vehicle Health Management

"The unified capability of a system of systems to assess the current or future state of the member system health and integrate that picture of system health within a framework of available resources and demand."

What Does IVHM Look Like? Sample Architecture

On-Vehicle Tier

At-Vehicle Tier

Fleet Data Services and Application Tier

Air Vehicle

Subsystem A

Subsystem B

Subsystem N

Data

Data

Data

Airborne IVHM Processor

Recorder

DTS

Ground Support
- Portable Maintenance Aid
- Ground Station: DAQ, Data Transformation & Health Assessment

Enterprise Data Management
- Fleet Management Ops
- Maintenance/Logistics Ops
- Supplier/OEM Ops

Data Transfer Tier

Data Transfer Tier

Source: SAE JA6268™

SAE Standards Efforts

- **SAE HM-1 Committee created to develop standards to aid in IVHM adoption, development**
- **Multiple Documents released; many more in work**
  - Overview
  - Work Flow (figure)
- **Recent Effort – JA6268™ Health-Ready Components**
  - Released April 2018

Health-Ready Components Standard (JA6268™)

Source: SAE JA6268™
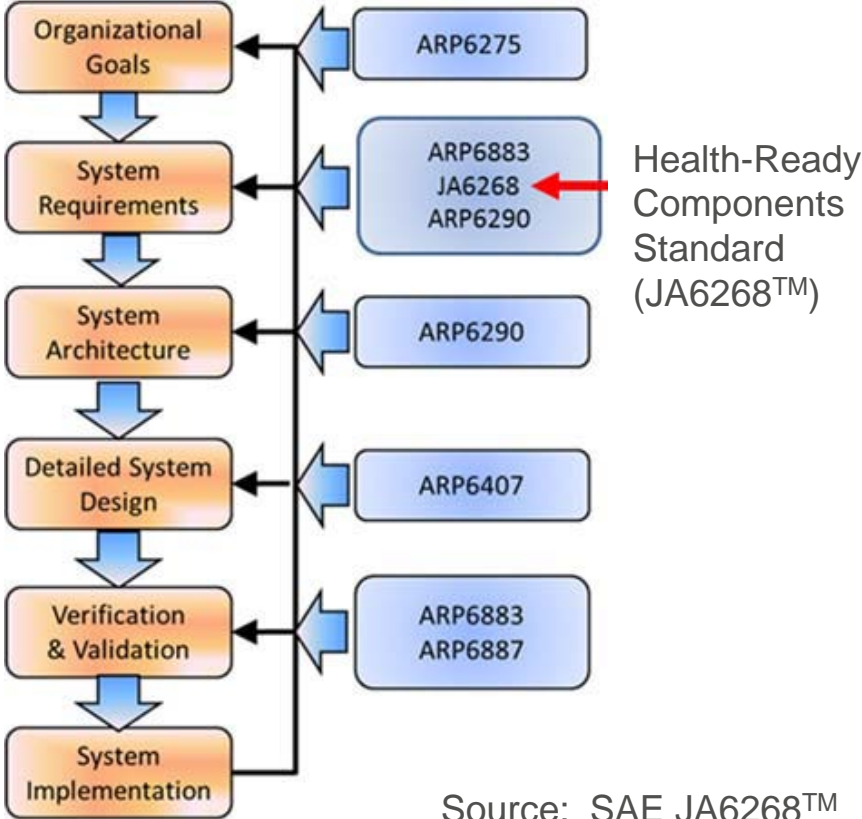
SAE IVHM Capability Levels (JA6268™)

- **Sets interaction expectations between OEM and system suppliers**

- **Goal: moving from manual repair, diagnosis to analytics-based diagnosis, predictions**

Source: SAE JA6268™

SAE Level	Vehicle Health Capability	Narrative Description	Participation in Repair Actions	Key Data Resources	Availability of Logged &/or Real-Time Data	Use of Supporting Models	IVHM System Characteristics
Manual Diagnosis & Repair Process performed by Technician							
0	Limited On-Vehicle Warning Indicators	Service actions for scheduled maintenance or when Operator notices problems or is alerted by indicator lights or simple gages.	**Operator/Driver & Service Tech**	On-Vehicle Measurements & Observation	N/A	Paper-based Manuals	Only Manual Diagnostic Tools & No Condition-Based Services
1	Enhanced Diagnostics Using Scan Tools	Service techs gain added diagnostic insight using automated scanners to extract vehicle operating parameters & diagnostic codes.	Operator/Driver & Service Tech	**On-Vehicle & Service Bay/ Depot Tools**	Logged Diagnostic Codes & Parameters available to Service Tech	Paper-based Manuals	On-Board Diagnostics Available
2	Telematics Providing Real-Time Data	Service techs gain real-time vehicle data via remote monitoring of vehicle to more completely capture issues.	Operator/Driver, Service Tech & Remote Support Center Advisor	On-Vehicle, Service Bay / Depot & Cloud Data	**Telematic Data Available to Service Tech with Diagnostics Info**	Paper-based Manuals	On-Board & Remote Data Available
Diagnosis & Repair Augmented by Prognosis & Predictive Analytics							
3	Component Level Proactive Alerts	Operator and service techs are provided with component health status (R/Y/G) before problem occurs . Limited condition-based maintenance.	Operator/Driver, Service Tech & Cloud-Based Services	On-Vehicle, Service Bay & Cloud Data	Telematic Data Available to Service Tech with Diagnostics Info	**Addition of Component-Level Health Models**	Component-Level Health Predictions
4	Integrated Vehicle Health Mgmt.	Operator and service techs are provided with system or vehicle level health indicators before problems occur with remaining useful life estimated. Condition-based maintenance.	Operator/Driver, Service Tech & Cloud-Based Services	On-Vehicle, Service Bay & Cloud Data	Telematic Data Available to Service Tech with Diagnostics Info	Addition of Vehicle-Level Health Models	**Vehicle-Level Health Management**
5	Self-Adaptive Health Mgmt.	Self-adaptive control and optimization to extend vehicle operation and enhance safety in presence of potential or actual failures.	Operator/Driver, Service Tech & Cloud-Based Services	On-Vehicle, Service Bay & Cloud Data	Telematic Data Available to Service Tech with Diagnostics Info	Addition of Vehicle-Level Health Models	**IVHM Capability Integrated into Vehicle Controls**

BELL IVHM IMPLEMENTATION EXPERIENCE

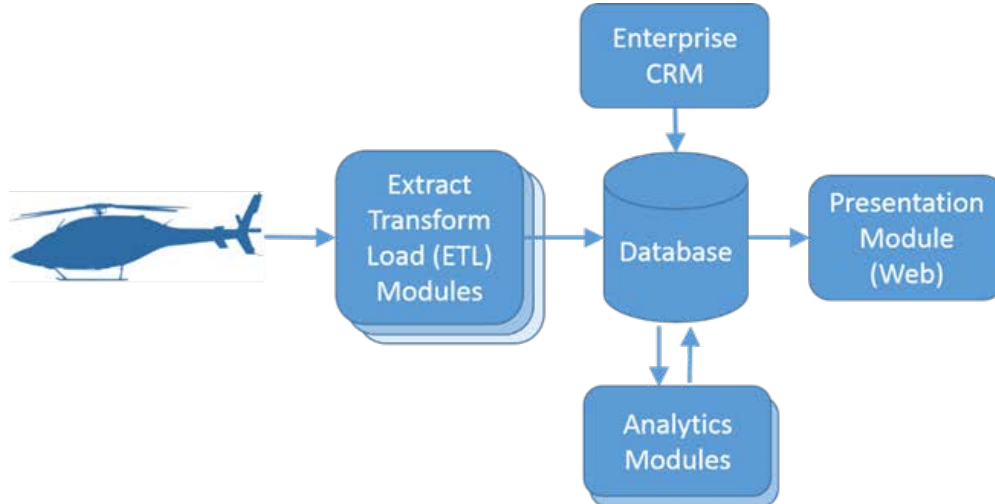# Bell MissionLink® Implementation

What were the "why's" that drove our approach?

- **Local Maintenance**
  - "Tell me what's wrong, and tell me how to fix it"
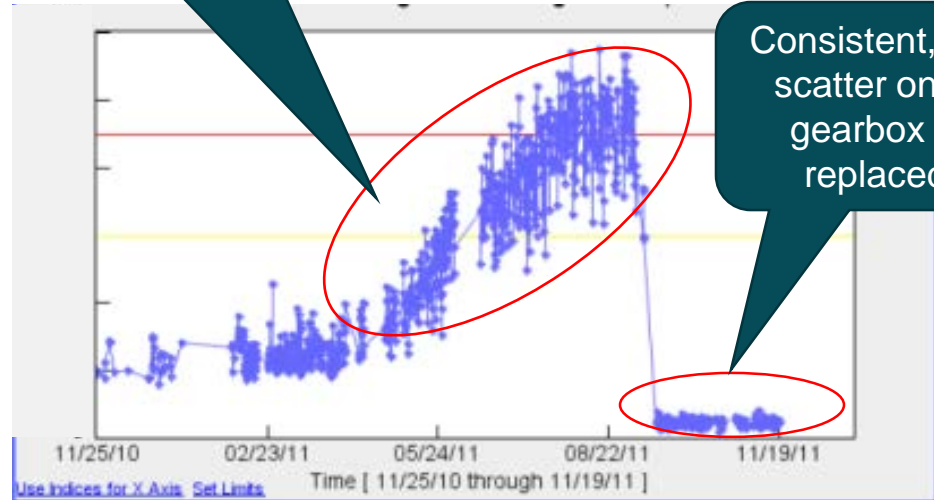
- **OEM Support**
  - Support troubleshooting

MissionLink Architecture

Integration Points

- **Enterprise Information Systems (CRM)**
- **Existing Customer Portal**
- **Electronic Tech Pubs**

Finding Anomalies in Vibration Data

- **Thresholds**
  - based on fleet characterization
- **Automated trend detection**

Clear change in trend, scatter during fault progression

Consistent, low scatter once gearbox is replaced

Time period = 1 year

<u>Benefits</u>

- **All data in one place**
- **Easy ad-hoc queries**
- **Customer responsiveness - able to update as needed**

<u>Challenges</u>

- **Cultural/Organizational**
- **Business case**
- **Data quality**
- **Data Transmission**

Lessons

- **"Implement early, implement often"**
  - Can't do everything at once; early value breeds continued investment
- **The more people learn about your data, the more requests you will get**