Predictive Maintenance in Defense and Smart Manufacturing

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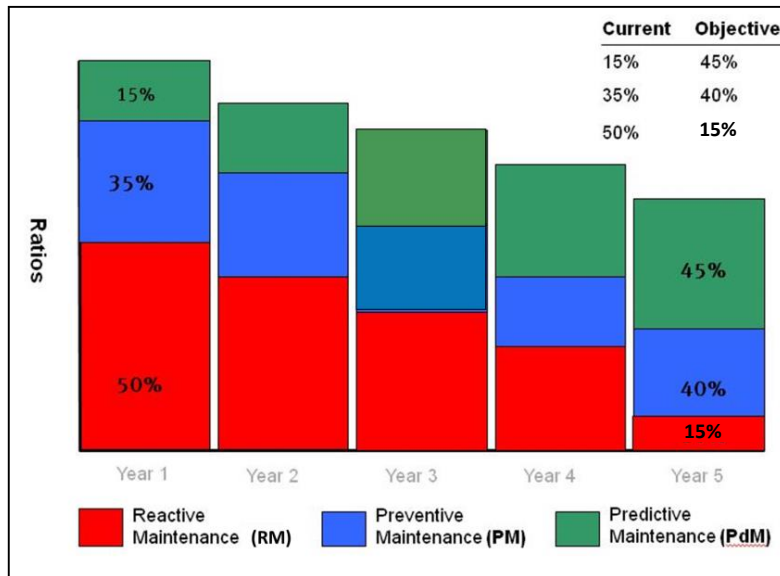October 29–31, 2019 | Novi, MI

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Outline

➢Transforming the Maintenance Practice

➢The Motivation

➢System Health Management Perspective

➢A Common Architecture Framework

➢Path to Self-Adaptive Health Management

➢Lessons Learned

➢Challenges

Transforming the Maintenance Practice

The Goal-*deliver higher asset availability, mission effectiveness and lower maintenance costs.*

The Objective- *change the ratio of the current maintenance mix over time.*

DDTs should increase over time

DDT: Data Directed Task

Why Predictive Maintenance?

Improve Safety!

Reduce Cost!

Reduce Downtime!

Improve Availability!

Improve fleet management!

Improve customer experience!

Improve product quality !

Improve product yield!

Autonomous Systems are here to stay!

System Health Management Perspective

The immune system protects the body against disease or other potentially damaging foreign bodies.

A self-adaptive health management system provides autonomous, self-adaptive control to extend vehicle operation in the presence of system degradation.

"Created System"

"Engineered System"

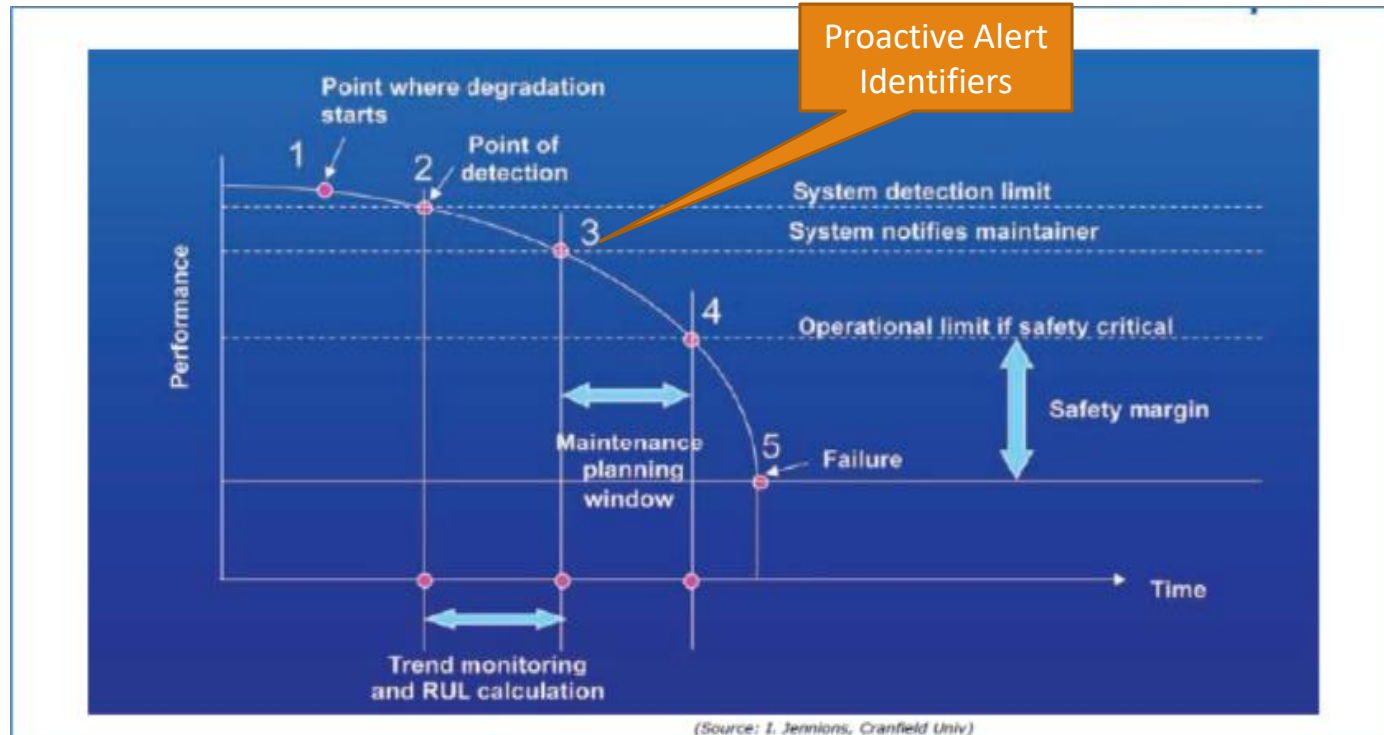**Inherent Self-protection mechanisms**

- System degrades with age or exposure to damaging environment.
- System's inherent sensing mechanisms monitor system health.
- System's self-healing is supplemented with changes in system operation & maintenance.
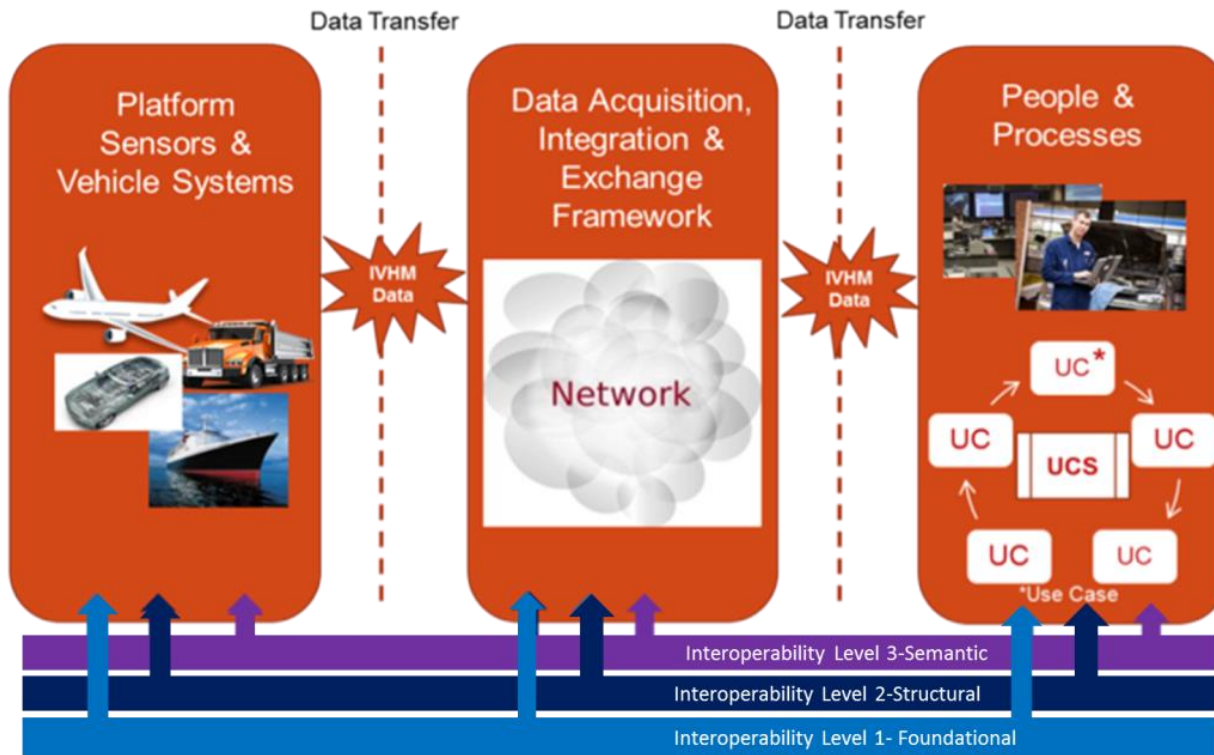
System Health Management Principles

(Source: I. Jennions, Cranfield Univ)
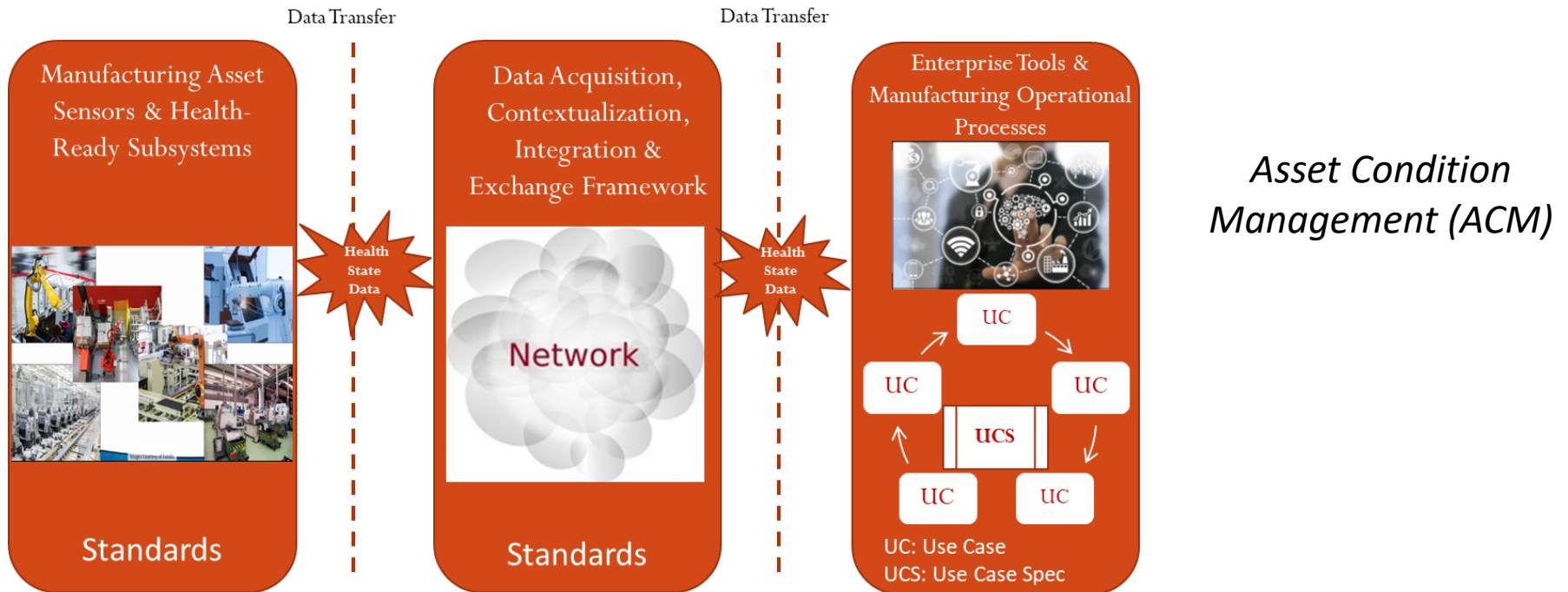
System Architecture Framework

Integrated Vehicle Health Management (IVHM)

- Aviation
- Automotive
- Defense

IVHM is the unified capability of a system of systems to assess current or future state of member system health and integrate that picture of system health within a framework of available resources and operational demand. (SAE ARP6803)

Smart Manufacturing Application

Data Transfer

Data Transfer

Manufacturing Asset Sensors & Health-Ready Subsystems

Data Acquisition, Contextualization, Integration & Exchange Framework

Enterprise Tools & Manufacturing Operational Processes

Health State Data

Health State Data

Network

Standards

Standards

UC

UC

UC

UCS

UC

UC

UC: Use Case
UCS: Use Case Spec

*Asset Condition Management (ACM)*

*"**ACM** can be defined as the unified capability of a manufacturing system (i.e., the asset) to assess its current and future state of health and integrate that knowledge of the system state of health with enterprise applications to meet production operations demand."*

System Operational Processes
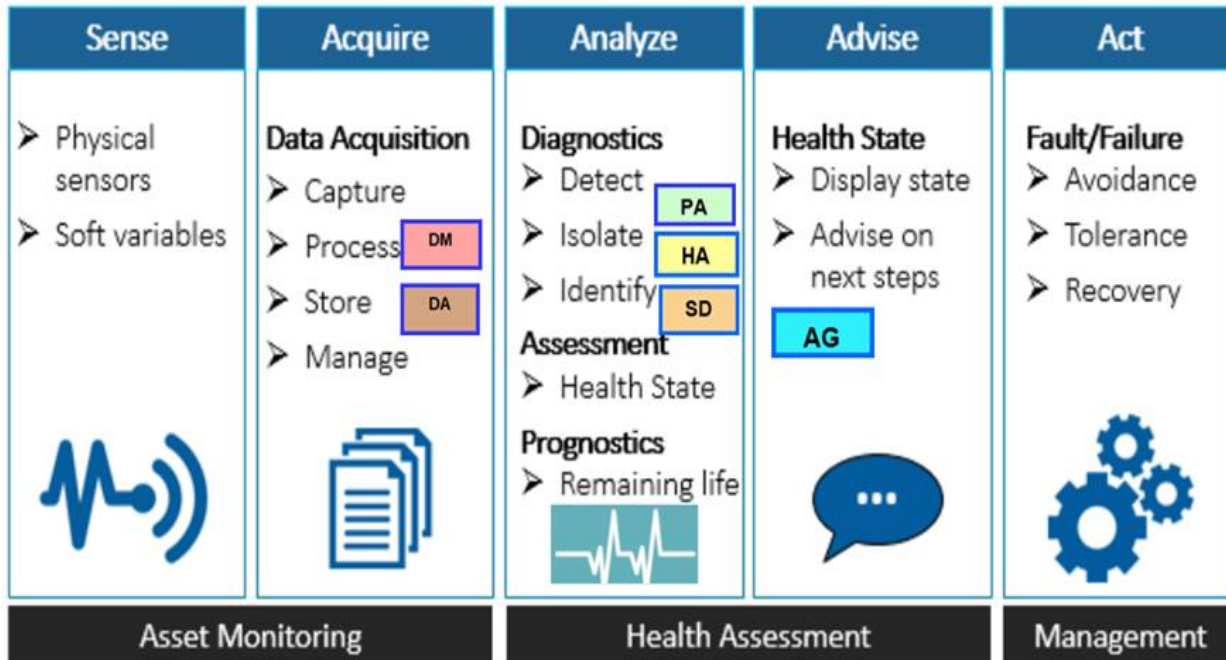
DA: Data Acquisition DM: Datta Manipulation SD: State Detection HA: Health Assessment
PA: Prognostic Assessment AG: Advisory Generation (**Reference Model** based on ISO 13374)

Path to Self-adaptive Health Management
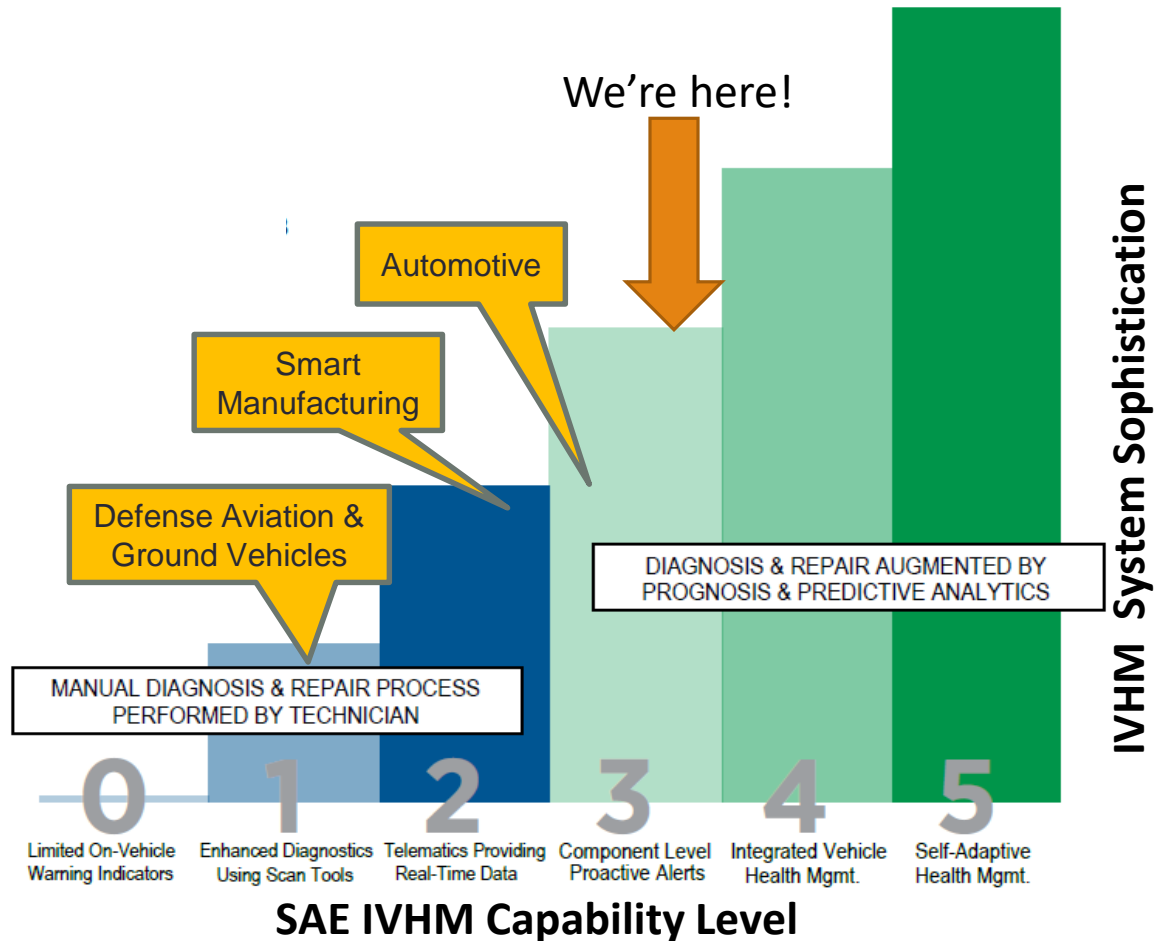
What we have learned to date...

➢ **CBM/Predictive Maintenance** requires a systematic maturity model of Capability Levels **(SAE JA6268**)...there is no silver bullet!

➢ **Use of Standards** (ARINC, OBD) has enabled IVHM in commercial aviation & automotive industries.

➢ **"Health-Ready Components"** and **Standards** are Key to unlocking the potential of IVHM in any domain.

➢ **System solutions** should be based on operational use cases; asset maintenance, fleet management, manufacturing operations planning, etc.

➢ **Infrastructure investments** without having a consistent collection, transformation, exchange and quality of asset data deliver limited value to stakeholders.

➢ **Consistent collection of the "right data"** and derivation of the right asset health indicators are essential to predictive analytics.

Challenges

Data Ownership:

◦ Equipment OEM dependence & data ownership issues.

◦ Maintenance and Logistics organizations limit access to their data.

◦ "Perceived value" and "classification" of raw asset data and maintenance information limit rapid dissemination across the enterprise.

Data Connectivity:

◦ Non-integrated data supply chain.

◦ At/off-platform test and maintenance information is still captured into paper records or within isolated databases.

◦ Maintenance and logistics information systems may limit the ability of users to extract relevant data in a form that can be communicated to other enterprise systems.

Data Quality:

◦ Inconsistent/non-continuous data collection

◦ Dissimilar preservation of data source context (Values, Meta Data)

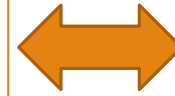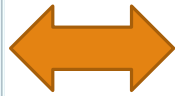◦ The data collected across operations and maintenance activities is in numerous non-standard formats.

Data Standards Needed

➢ **Standards needed for data collection, transformation and exchange.**

Health-Ready Assets

Predictive Analytics

➢ Data Connectivity
➢ Data Ownership
➢ Data Quality
➢ Data Interoperability

Thank you!

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