phmsociety

Panel Discussion on:

Automotive PHM & Emerging Standards

3-Oct-2017, 1:15-3:00 PM EDT
St. Petersburg, FL

Chair: Steven W. Holland, GM

Today's Diverse Panelists

- Automotive Suppliers:
  - Andre Kleyner (Delphi)
  - Klaus Sekot (Bosch)
- Automotive OEM:
  - Yilu Zhang (General Motors)
- International Standards:
  - Luis Hernandez (Global Strategic Solutions)

Panel Abstract

- PHM technology has entered production use in the automotive domain and is expected to become increasingly important for:
  - Advanced Diagnostics &
  - True Prognostics
- The scope of this panel includes the opportunities and barriers to the growth of PHM for commercial automotive and fleet applications
- This panel is highly qualified to address the critical role suppliers will need to play in collaboration with the OEMs/Integrators to maximize the value to themselves but more importantly to the end customer
- Effective supplier engagement will depend upon emerging standards to reduce proliferation and to manage costs

Panel Format

- Purpose & scope of today's panel
- Brief introduction of panelists with their own statements:
  - Relevant background & interests (limited to 5-7 minutes each)

➔ Audience questions & discussion

  - This is the important part
  - I will try to keep things moving so all have an opportunity to ask questions

Need for Collaboration

- Given the emergence & growing importance of PHM systems across a variety of industries, how can OEMs and Suppliers best collaborate to:
  - Speed introduction of PHM functionality for maximum customer/user benefit
  - Maximize system coverage, scalability & accuracy
  - Avoid inefficiencies & wasteful duplication of effort
  - Clarify coordination & communication needs
  - Ensure that data is used as agreed by stakeholders and is secure
  - Respect privacy & regulations relative to operator performance tracking

Steve Holland

- Currently, Research Fellow, Vehicle Health Management at GM Global R&D
- 40+ years of experience at GM in R&D and Manufacturing Eng/Robotics
- Previously R&D Director in Mfging: application of PHM to improve GM plant throughput (4 yrs)
- Currently Chief Technologist: applying PHM technologies to GM vehicles (11 yrs)
- Bachelors/EE from Kettering & Masters/CS from Stanford
- PHM Board of Directors & Member of PHM International Scientific Committee
- SAE Member: HM-1 IVHM Standards & IVHM Steering Committee
- Professional Engineer & IEEE Fellow

steven.w.holland@gm.com

SAE Standards Work

AEROSPACE & AUTOMOTIVE RECOMMENDED PRACTICE	JA6268	REV. 1C
	Issued July 24, 2017 Draft Revised N/A Reaffirmed N/A Stabilized N/A Cancelled N/A Superseding N/A	
Design & Run-Time Information Exchange for Health-Ready Components		

RATIONALE

This Aerospace & Automotive Recommended Practice was created to help reduce existing barriers to the successful implementation of Integrated Vehicle Health Management (IVHM) technology into the aerospace and automotive sectors by introducing health-ready components. The principal motivation for health-ready components is to facilitate enhanced IVHM functionality in supplier-provided components that meet the needs of end users and government regulators in a cost-effective manner. Underlying this motivation is the assumption that market forces will drive the need to achieve IVHM's benefits, which will in turn drive new requirements that suppliers must ultimately meet. This recommended practice has two primary objectives: (1) to encourage the introduction of a much greater degree of IVHM functionality in future vehicles at a much lower cost, and (2) to address legitimate intellectual property concerns by providing recommended IVHM design-time data specification and exchange alternatives in an effort to help unlock the potential of IVHM.

IVHM Capability Levels for Aerospace/Automotive

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 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**

http://www.sae.org/servlets/works/committeeResources.do?resourceID=570618

SAE INTERNATIONAL

Integrated Vehicle Health Management

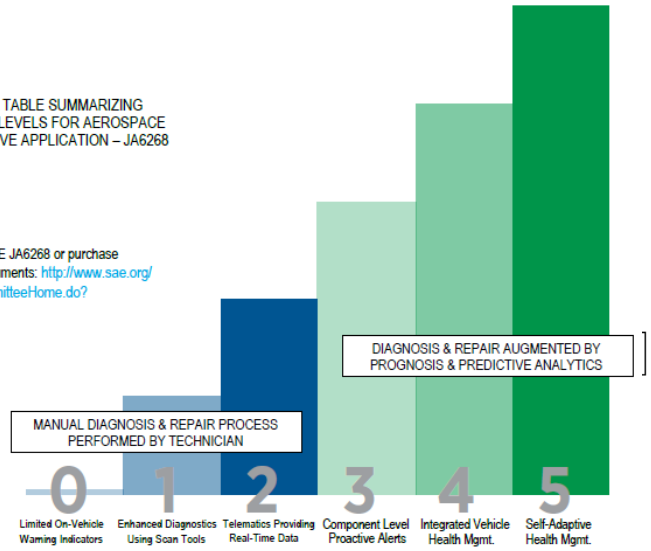
IVHM CAPABILITY LEVELS ARE DEFINED IN FORTHCOMING SAE INTERNATIONAL STANDARD JA6268

With the goal of providing common terminology for Integrated Vehicle Health Management Systems, SAE International's forthcoming standard JA6268: "Design & Online Information Exchange Standard for Health-Ready Components," includes a harmonized classification system and supporting definitions that:

- Identify six levels of IVHM system capability from essentially "no automation" to "self-adaptive health management".
- Base definitions and levels on functional aspects of technology.
- Describe categorical distinctions for a step-wise progression through the levels.
- Are consistent with current industry practice and future directions.
- Eliminate confusion and are useful across numerous disciplines (engineering, legal, media, and public discourse).
- Educate a wider community by clarifying for each level what role maintenance technicians have in performing vehicle repairs.

OVER FOR A TABLE SUMMARIZING CAPABILITY LEVELS FOR AEROSPACE & AUTOMOTIVE APPLICATION – JA6268

Learn more about SAE JA6268 or purchase related standard documents: http://www.sae.org/servlets/works/committeeHome.do?comtID=TEAHM1



SUMMARY OF SAE INTERNATIONAL'S CAPABILITY LEVELS FOR AEROSPACE & AUTOMOTIVE APPLICATIONS

Expected publication in April 2017, SAE International's JA6268 was created to help reduce existing barriers to the successful implementation of Integrated Vehicle Health Management (IVHM) technology into the aerospace and automotive sectors. It is motivated by the need to facilitate the introduction of enhanced IVHM functionality relating to supplier-provided components to better meet the needs of end users and government regulators in a cost effective manner.

The report's six capability levels for IVHM span from no automation to self adaptive health managment. A key distinction is between level 2 & 3, where prognostics and predictive analytics are brought to bear to significantly enhance the capabilities of the system.

These levels are descriptive rather than normative and technical rather than legal. They imply no particular order of market introduction. Elements indicate minimum rather than maximum system capabilities for each level. A particular system may have multiple IVHM features such that it could operate at different capability levels depending upon the feature(s) that are engaged.

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
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5	Self-Adaptive Health Mgmt.	Self-adaptive control 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

Key definitions relating to JA6268 include (among others):

Diagnosis is the process of determining the root cause of a problem once a failure has occurred …that is, what part replacement(s) or repair action is necessary to fix the problem

Prognosis is the process process of predicting the onset of a potential failure mode BEFORE the failure has occurred …while the component is still operating within specs & with sufficient advance notice to avoid the problem

Integrated Vehicle Health Management refers to 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 (as defined by SAE's IVHM Steering Committee.)

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Introducing Today's Panel

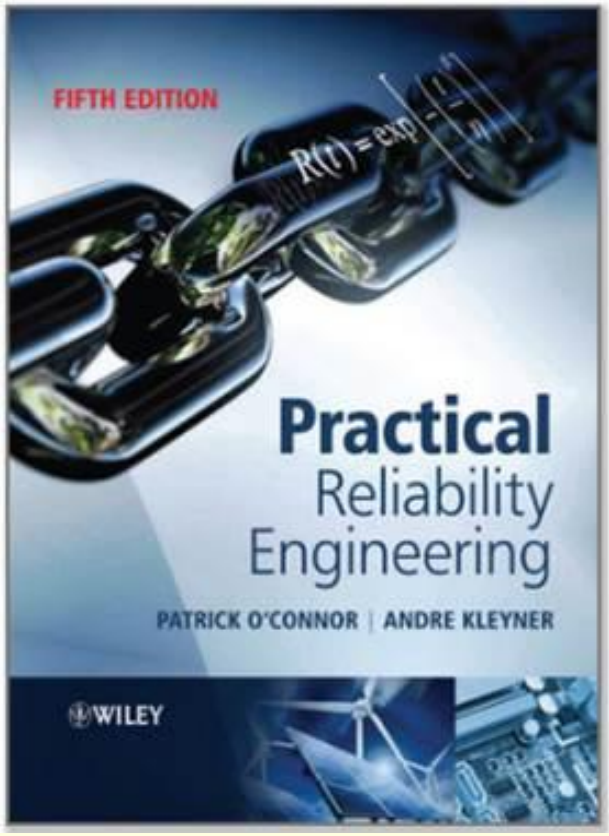
Chair:

- Steve Holland, General Motors

Panelists:

- Andre Kleyner (Delphi)
- Klaus Sekot (Bosch)
- Luis Hernandez (Global Strategic Solutions)
- Yilu Zhang (General Motors)

Andre Kleyner, PhD, Certified Reliability Engineer
Global Reliability Engineering Leader, Delphi Electronics & Safety (Aptiv)



- Experience 30+ years: Reliability Engineering, Harsh Environments, Accelerated Testing; Warranty data analysis and forecasting, Reliability data analysis, statistics and Monte Carlo simulation; Vehicle occupant safety systems design.

- Editor for the Wiley Series in Quality & Reliability Engineering John Wiley & Sons, UK

WILEY

40 professional publications including three books on the topics of reliability, statistics, warranty management, and lifecycle cost analysis. Including an engineering college textbook **Practical Reliability Engineering, Ed. 5**

Automotive Electronics Challenges and Prognostics?

- Increasing reliability requirements (15 years mission life and increasing)
- Self-driving cars – new expectations on system reliability and more importantly, safety
- Functional Safety standard – ISO 26262 (13 parts document) covering various aspects of design, safety and reliability
- Long validation testing programs (3-5 months) need to be shortened. Repeat validation testing.
- Limited ability to accelerate the key reliability tests

Interests and Objectives

Interests: Explore the applications of prognostics in the Automotive Industry.

Objective: Introduce a new application of prognostics in the automotive reliability testing and generate interest in this application in the PHM community. Why? Because it presents interesting and challenging problems and the industry will gladly spend money to get the solutions.

Klaus Sekot

- Director at Bosch Corporate Quality Management responsible for field monitoring and field data
- Previously Corporate Quality Key Account for Daimler, BMW and VW
- 10+ years experience in automotive product development
- Leading plant quality and development business excellent at Bosch plant in Clayton, Victoria (AUS)
- Engineering degree of Heilbronn University - Germany

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phmsociety

QUALITY 4.0
CONNECTED LIFE CYCLE MANAGEMENT

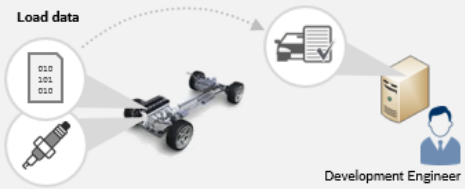
CONNECTED LIFE CYCLE MANAGEMENT
Vision

All products fulfil the requirements of real use

Continuous product control in real use

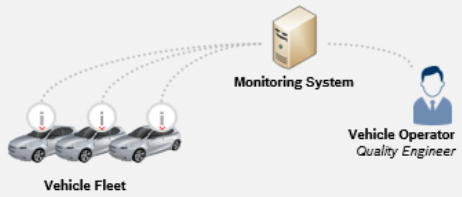
CONNECTED LIFE CYCLE MANAGEMENT
Value add areas and their benefits

SPECIFICATION & VALIDATION



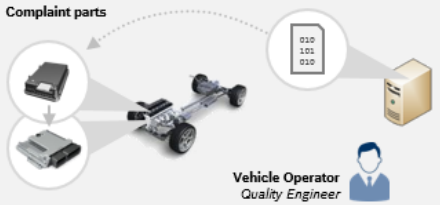
- Product **specification** and **validation** based on data out of vehicle **in use**
- Reduced **costs** by avoided **over-designs**
- Early **detection** of **deviation** between specification and real use
- **Field Load Data Model**

MONITORING & EARLY WARNING



- **Monitoring** of **known failures** in real time and **confirmation** of their counter **measures**
- **Monitoring** of components **health state**
- **Detection** of **unknown** emerging **issues**

COMPLAINT & RISK MANAGEMENT



- **Classification** of **root cause** (e.g. NTF)
- **Complaint parts handling** from dealership to parts investigation point
- **Focused** analysis of **relevant failures**
- Support **decisions** about field campaigns **by data**

Customer benefits: Cost reduction / quality improvement by avoided over and under-design

Increased vehicle availability and reduced costs for field campaigns

BOSCH

Luis Hernandez

- Managing Director, Global Strategic Solutions LLC
- 30 years experience in diagnostic equipment systems engineering
- 10+ years experience in IVHM/PHM systems applied research
- Leading company's contribution to SAE HM-1 standards development efforts
- Electrical engineering degree from Wayne State University

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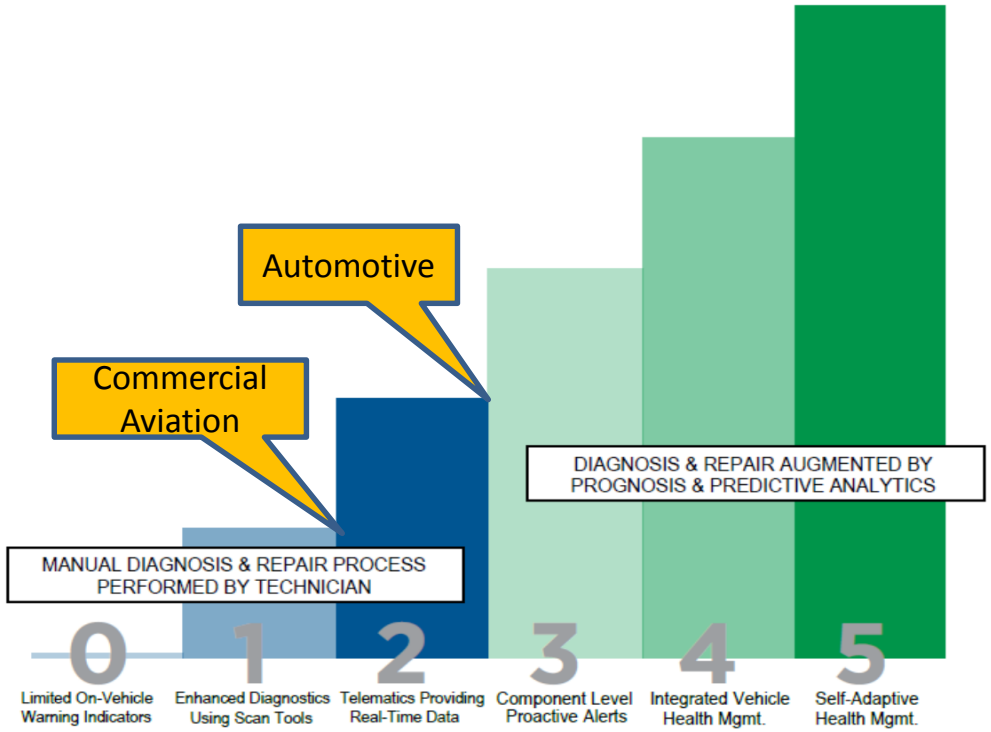
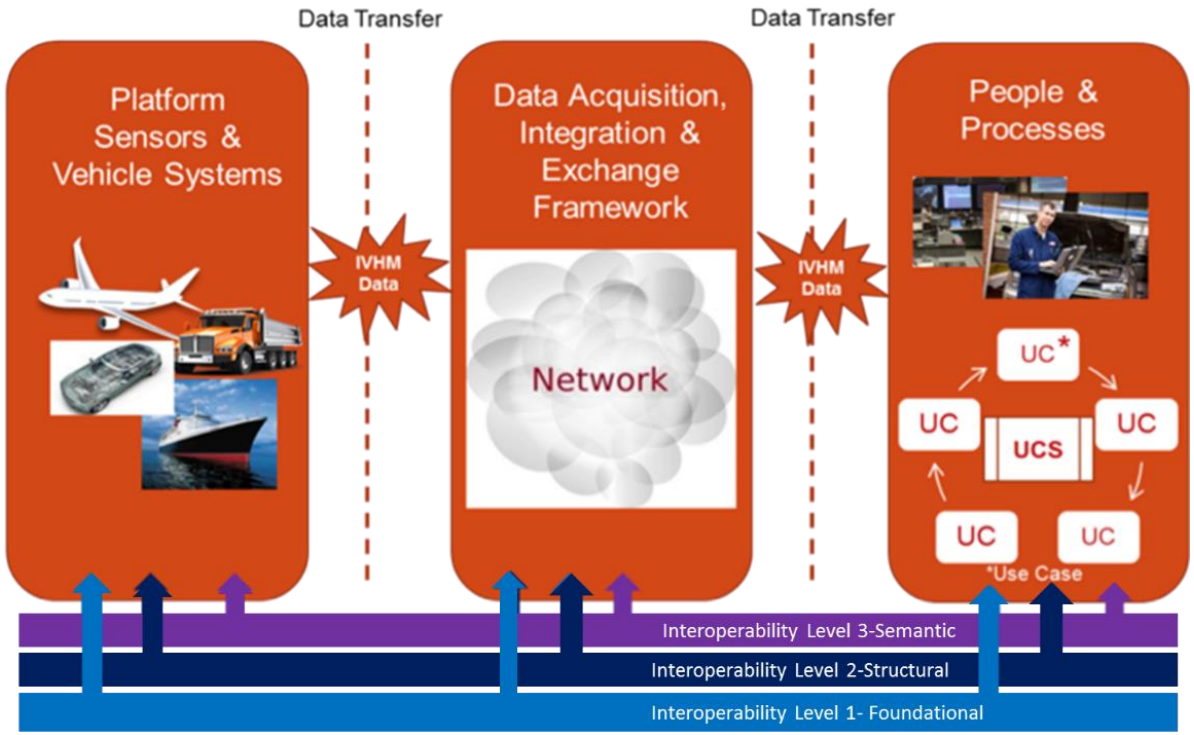
Why Standards?

- Avoid proliferation (OEM) specific technology solutions
- Address data ownership issues
- Enable application of health state data close to operations
- Enable interoperability between solutions
- Stimulate development of advanced technology solutions
- Accelerate time-to market

Where are we after 15+ Years?



Standards Enable the Data Supply Chain



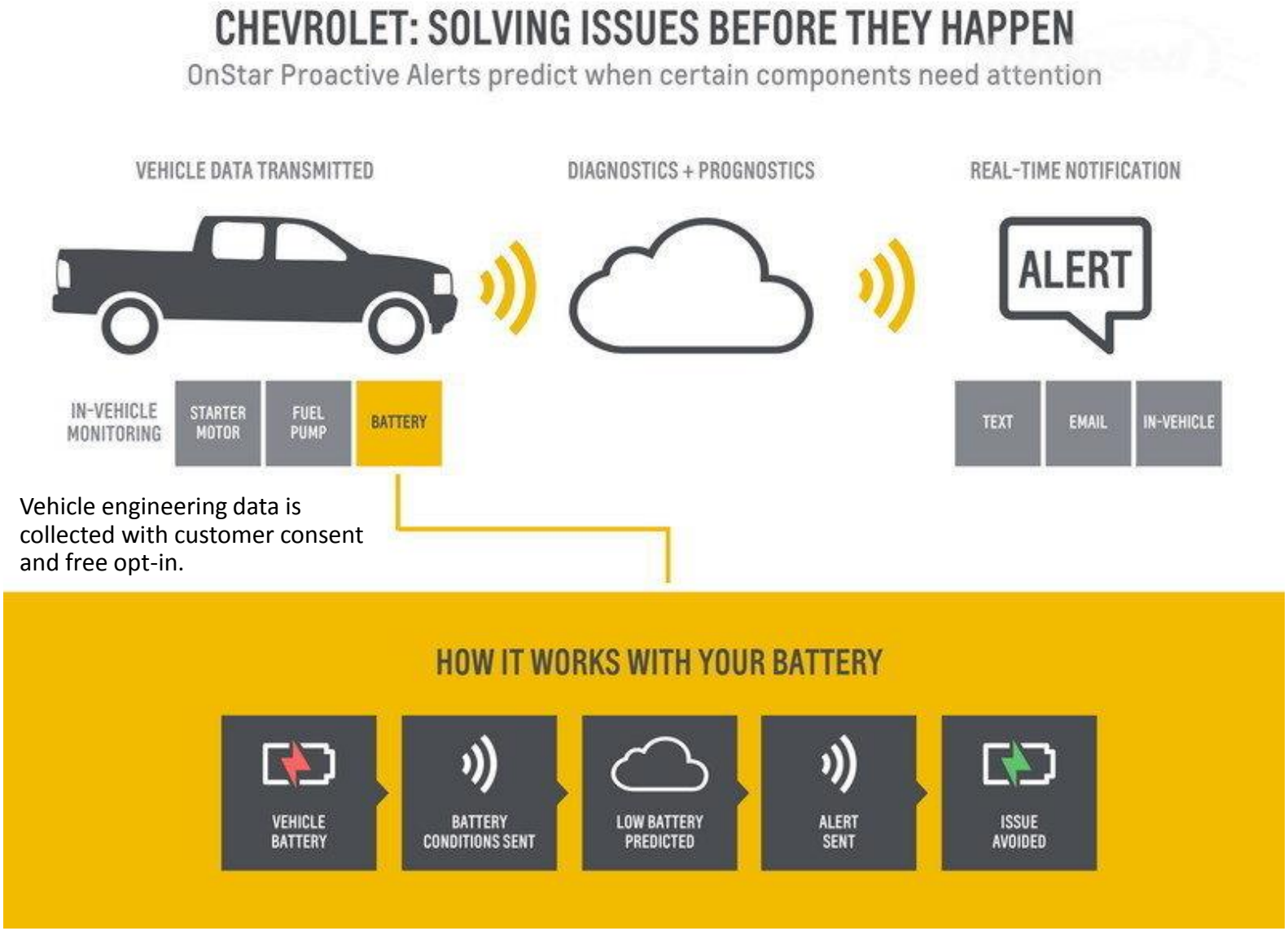
- Integrated data supply chain
- Efficient data acquisition, integration and exchange with enterprise applications
- Data collected across operations and vehicle maintenance activities in standard format
- Preservation of data source context (Values, Meta Data)
- OEM dependence & data ownership resolution
- Efficient processing, correlation, and analysis of data across a fleet

Yilu Zhang

- Technical Fellow and Group Manager of Vehicle Health Management, Vehicle Systems Research Lab at General Motors Global R&D
- Three-time recipient of GM “Boss” Kettering Award, the most prestigious technology award in GM to recognize “stretch thinkers and drivers of innovation”
- Awarded 29 patents, and published 59 papers
- PhD in Computer Science from Michigan State University, MS and BS in Control from Zhejiang University, China
- IEEE Senior Member

Yilu.Zhang@GM.com

- Everything wears out over time
- Customer's life is disrupted, when his/her vehicle needs repair unexpectedly
- The solution - Vehicle Health Management (VHM)
  - Alert before failure happens
  - Transform an emergency repair to planned maintenance
  - Enhance ownership experience - a delight to customers
- Introducing OnStar™ Proactive Alerts - a new customer care service launched in 2015


CHEVROLET: SOLVING ISSUES BEFORE THEY HAPPEN
OnStar Proactive Alerts predict when certain components need attention
VEHICLE DATA TRANSMITTED
DIAGNOSTICS + PROGNOSTICS
REAL-TIME NOTIFICATION
ALERT
IN-VEHICLE MONITORING
STARTER MOTOR
FUEL PUMP
BATTERY
TEXT
EMAIL
IN-VEHICLE
Vehicle engineering data is collected with customer consent and free opt-in.
HOW IT WORKS WITH YOUR BATTERY
VEHICLE BATTERY
BATTERY CONDITIONS SENT
LOW BATTERY PREDICTED
ALERT SENT
ISSUE AVOIDED

Beyond Prognostics – VHM impacts automotive value chain


Supplier


Vehicle development


Manufacturing


Sales


Ownership


Service

Selected Thought Starter Questions

1. What are the challenges of large scale PHM deployment?
2. What are the best practices for OEM/Supplier collaboration?
3. How can we avoid duplication of effort between OEMs and Suppliers?
4. Importance of Health-Ready Components?
5. What strategies will help us avoid IP issues & concerns?
6. How to get component & system designers to consider the Prognosis Paradigm and build in the hooks?
7. Do fleets need something different than private vehicle owners?
8. How can international standards promote the application of PHM?
9. Has your management “bought in?” What arguments were effective?
10. What fundamental research would you like to see from the academia?