Monday, March 2

On-Board Diagnostics Symposium, Day One Program

Session Code: OBDE1

Room TBD

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<th>Time</th>
<th>Paper No.</th>
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<tr>
<td>9:45 a.m.</td>
<td>ORAL ONLY</td>
<td>Announcements</td>
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<td>Bernard Challen, Shoreham Services</td>
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<td>10:00 a.m.</td>
<td>ORAL ONLY</td>
<td>Symposium Opening Address</td>
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<td>Andrew Smart, SAE International</td>
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<td>10:30 a.m.</td>
<td>ORAL ONLY</td>
<td>Keynote Address: OBD in Highly Cross-Linked Vehicle-Systems</td>
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<td>All current OBD legislation worldwide are based on either European or US legislation. Emission limits for combustion engines are the basis for the OBD regulations. New technologies, like electrification, bring other components such as air conditioning systems, brake systems, electric motor and HV-battery directly or indirectly into OBD focus in the US. The influence on the network topology has increased because the number of the electric control units cross-linked under OBD criteria has also increased, especially as only a limited number of legally allowed diagnostics addresses are available. This leads to network topologies that have to be considered and evaluated critically under the premise of OBD-communication, particularly with specific timing requirements. Thus the OBD-requirements become a direct criterion for the network topology of electric control units and sensors/actuators in modern vehicles. New bus systems for sensors and actuators (e.g. LIN, SENT) must be considered also with respect to OBD requirements. In addition to the increased number of the ECUs in the OBD-Network, functions and diagnostics of one ECU have direct influence on functions and diagnostics in other ECUs within the OBD network. Therefore signals, that are provided in the OBD network must be evaluated under OBD requirements and must be flagged for OBD relevance in the bus system. Future OBD-communication concepts adapted to this increasing complexity must have buy-in with the legislators and be fully standardized.</td>
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<td>Volker Lantzsch, Volkswagen AG</td>
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<td>11:15 a.m.</td>
<td>ORAL ONLY</td>
<td>Worldwide OBD</td>
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<td>David H. Ferris, General Motors Co.</td>
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<td>11:45 a.m.</td>
<td>ORAL ONLY</td>
<td>Electrification Update</td>
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<td>In the new upcoming California Light Duty OBD regulation, CARB is focusing on hybrid componentry. This presentation provides a template for items of consideration when certifying a comprehensive battery pack functional diagnostic.</td>
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<td>Andrew Zettel, General Motors Co.</td>
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<td>12:15 p.m.</td>
<td>ORAL ONLY</td>
<td>Exhibitor Introductions</td>
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<td>Darlene C. Waychoff, SAE International</td>
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12:30 p.m.  ORAL ONLY  Monday Networking Lunch with Exhibits

1:30 p.m.  ORAL ONLY  Ford Experiences
Paul A. Baltusis, Ford Motor Co.

2:00 p.m.  ORAL ONLY  Toyota Experiences
Morton M. Smith, Toyota

2:30 p.m.  ORAL ONLY  VW Experiences
Robert Gruszczynski, Volkswagen of America

3:00 p.m.  BREAK

3:30 p.m.  ORAL ONLY  Challenges in Designing Global Diesel OBD Systems
This presentation is about the challenges encountered to transform an EOBD capable Engine Control System for a diesel engine into an OBDII capable one.

Complexity of OBDII legislation is not only related to the need of a larger number of diagnostic monitors. In some cases, it demands a different conceptual approach.

During the presentation, a high level comparison of the two legislations will be provided, resulting in significantly different interpretations, even when similar requirements are present in both regulations. Moreover, some examples of OBDII specific features that may appear conceptually controversial from a European mindset will be presented.

In conclusion, this "adaptation" will no more appear as a simple addition of functionalities. It may require instead some significant changes in the existing diagnostic concepts and, eventually, a "change of mind" of the development team as well as the creation of an adequate organizational supporting structure.

Francesco Siano, General Motors Powertrain Europe Srl
Virtual Exhaust System for Analyzing the Robustness of OBD Functionalities

The statutory requirements on OBD are becoming ever tougher. At the same time, OBD functions are growing in scope and complexity. Fault patterns are interlinked, making functions increasingly susceptible to incorrect diagnosis. Today, organizing a comprehensive analysis of functionalities in all relevant driving situations with various faulty components is a mammoth undertaking. Added to this is the uncertainty of not being able to estimate which component tolerances are amplified when they occur together, and therefore possibly leading to unfamiliar faults.

IAV has combined simulation tools that provide the capability of completely simulating exhaust gas aftertreatment components downstream a defined point in the exhaust system. Within this environment it is possible to apply tolerances to all components. Simulation input is provided using the measurement technology of a roller dynamometer to measure the individual species of the exhaust gas. OBD functions are integrated which access all functionalities within the simulated environment and can also actively intervene (e.g. increase AdBlue dosing).

A passenger car underfloor SCR with dosing control software and dosage adaptation serves as an example. The surrounding sensors (AFM, NOx1, NOx2 and temperature), actuators (dosing valve) and media (AdBlue) can be provided with componentspecific tolerances or faults which are varied in the appropriate way. An analysis tool is used for completing a series of simulations to produce a statistical distribution of defined output variables (e.g. cumulative NOx mass downstream of the SCR over a test cycle / variable for evaluating OBD functions).

The integrated OBD functions are assessed for the way in which they deal with the tolerances of the functional components. Also investigated is the reliability with which OBD functions identify the fault in components. The aim is to configure OBD functions robustly enough to remain unaffected by component tolerances and, at the same time, respond sensitively to a faulty component.

As far as the work process is concerned, the virtual exhaust system makes algorithms far quicker to develop. The ability to draw comparisons with the software used to date makes it possible to quickly implement and test changes in the software structure as well as to completely substitute or omit functions (OBD, adaptation, dosing software).

Tools that can be used by calibrators (e.g. MiLDesk as a tool for calibrating with INCA) are integrated in the process for optimizing the calibration of OBD functions.

Marco Moser, IAV GmbH
JLR MAF Sensor Rationality Monitoring

Introduction: Two examples will be presented of the work needed to comply with the OBD II regulation’s comprehensive component monitoring requirements.

Input Component Example: Rationality Monitoring of Mass Air Flow Sensors:

In common with a number of manufacturers, for higher output engines JLR has found it necessary to have two separate air intakes, each with its own mass air flow (MAF) sensor. On JLR’s vee-configuration engines, the two separate intakes converge to a single throttle. CARB’s OBD II regulation requires that input components be monitored for values that are neither inappropriately high nor inappropriately low, and the diagnostic for this compared each MAF sensor reading with half of the modelled engine airflow.

This worked well on the initial passenger car applications, but on JLR’s SUVs it must be possible to fit raised air intakes to improve the vehicle’s wading performance. Due to the distance between each intake entry point, a crosswind can create a flow imbalance across the two intakes, causing a false failure of the MAF sensor monitor.

Characterisation of the problem showed that a simple adjustment of the monitor entry conditions would mean blocking out a significant low speed and load area of engine operation, with no guarantee that there wasn’t a customer driving condition somewhere that would still lead to a false failure. Discussing this approach with CARB did not go well, as the MAF is viewed as a key input component.

A number of solutions were then proposed and discussed internally, with the goal of no hardware changes, no changes to the existing sensors and acceptance from CARB. This was achieved by developing a software algorithm that could identify a flow imbalance, but still allow the detection of a biased MAF.

Output Component Example: Functional Monitoring of Camshaft Profile Switching:

An engine control module (ECM) operated oil control solenoid on each cylinder head of JLR’s V8 engine is used to switch the intake camshafts from a low lift to a high lift profile. For OBD II compliance, the diagnostic system must detect a malfunction when a correct functional response does not occur.

Monitoring at the normal switching point was not possible, instead an intrusive diagnostic was developed that inferred that a change in engine airflow due to the profile switch had occurred by monitoring the Lambda control system.

Martin Haggett, Jaguar Land Rover

CARB Light-Duty

Thomas Montes, California Air Resources Board
Tuesday, March 3

On-Board Diagnostics Symposium, Day Two Program

Session Code: OBDE2
Room TBD

Session Time: ALL DAY

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<td>8:00 a.m.</td>
<td>ORAL ONLY</td>
<td>Morning Announcements</td>
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<td>Bernard Challen, Shoreham Services</td>
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<td>8:15 a.m.</td>
<td>ORAL ONLY</td>
<td>OBD Standards Update</td>
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<td>Paul A. Baltusis, Ford Motor Co.; Robert Gruszczynski, Volkswagen of America</td>
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<td>9:00 a.m.</td>
<td>ORAL ONLY</td>
<td>J1939-84 HDOBD Testing</td>
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<td>Mark Zachos, DG Technologies</td>
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<td>9:45 a.m.</td>
<td>ORAL ONLY</td>
<td>Diagnostic Approaches for SCR Feedgas Monitoring</td>
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|            |               | California’s LEV III emission regulation leads to ongoing tightening of emission limitations and creates a challenging framework for diesel vehicles. To ensure compliance with future emission limits an optimized combination of advanced internal engine measures and new highly efficient aftertreatment systems must be considered. At the same time, legal requirements towards on-board diagnostic systems (OBD) of diesel vehicles continue to increase as well. Tighter emission limits will reduce the margin between worst performing acceptable part and best performing unacceptable part indicating that even more complex monitoring functionalities are needed to ensure robust and reliable malfunction detection. Especially, the requirements for monitoring of aftertreatment components are strongly tied to their respective conversion efficiencies and demand a holistic view of the aftertreatment system.
|            |               | Beginning MY2015, diagnosing a drop in feedgas quality that impacts SCR performance is becoming an OBD compliance need for the US market. For future applications with tighter emission limits, it may become critical to assess the impact of the oxidation catalyst on SCR efficiency and if necessary diagnose the deterioration of its feedgas generation ability. Consequently, development of monitoring concepts that clearly attribute a feedgas decrease to a malfunction of the oxidation catalyst is needed.
|            |               | FEV Group in cooperation with VKA RWTH Aachen University will present its experiences on the measurable impact of NO2 on SCR conversion capability and propose potential OBD strategies for feedgas monitoring with regard to regulation compliance, optimally using existing sensor concepts. |
| 10:15 a.m. | ORAL ONLY     | Exhibitor Introductions                            |
|            |               | Darlene C. Waychoff, SAE International             |
| 10:30 a.m. | BREAK         |                                                    |
11:00 a.m.  ORAL ONLY  Breakout Sessions

Four dynamic and informative Breakout Sessions will be offered:
</p>
Communication Standards, moderated by Paul Baltusis and Bob Gruszczynski
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Electrification, moderated by Andrew Zettel
</p>
Diesel Misfire Monitoring for NAFTA, moderated by Jeff Potts
</p>
Diesel Aftertreatment, moderated by John Van Gilder

12:30 p.m.  ORAL ONLY  Tuesday Networking Lunch with Exhibits

1:30 p.m.  ORAL ONLY  Break Out Session Summaries with Q&A

Paul A. Baltusis, Ford Motor Co.; John Van Gilder, General Motors Co.; Robert Gruszczynski, Volkswagen of America; Andrew Zettel, General Motors Co.; Jeffrey Potts, Cummins Inc.

2:30 p.m.  ORAL ONLY  Bosch OBD Development for Future OBD II Requirements

LEV III emission standards and CARB's upcoming OBD II review set the framework for development activities in the next years. We will highlight technical challenges from the point of view of a system supplier. One field of activity will be the intake air subsystem. Based on a study on LEV III OBD requirements, we will present approaches to enhance diagnostic functions to meet future requirements.

Richard Holberg, Robert Bosch GmbH

3:00 p.m.  ORAL ONLY  Misfire Diagnosis by Torque Estimation

The purpose of this presentation is to present an alternative algorithm for misfire detection based on pattern recognition technique such as static feed forward artificial multilayer neural networks system which is widely used in the classification and virtual sensing applications. The engine torque signal provided by each cylinder is really useful for several monitoring to meet the future stringent OBD regulations in particular the requirements regarding the misfire monitoring. The logic is decomposed in two neural network, the first one is learned to identify a relationship between an engine torque and crank tooth acceleration. The second neural network is trained to discriminate between a normal pattern and all possible misfire patterns. By this, we can achieve a good misfire detection almost on full speed/load range and in turn respect the further US regulation requirements.

Farah Hindi, Noureddine EL HOR, Delphi Diesel Systems
3:30 p.m.  ORAL ONLY  Development of a Generic DPF OBD Algorithm Using Soot Sensor Technology

The impending Euro 6 Light-Duty (LD) and Euro VI Heavy-Duty (HD) On-Board Diagnostics (OBD) Threshold Limits (OTL) for Particulate Matter (PM) are a major challenge for vehicle manufacturers. This report presents the investigations into developing an OBD monitor for Diesel Particulate Filter (DPF) performance using a Soot Sensor located downstream of a DPF. Soot Sensor Technology has been undergoing extensive development over the past years and is now reaching a Technology Readiness Level (TRL) such that Soot Sensors are in production, initially on LD applications, and are approaching maturity with many OEMs. A summary of the sensor types will be given along with an overview of the basic requirements for the monitor. The design of a monitor that is able to successfully identify Soot levels that are above the OTL for different sensors and applicable to both LD and HD Test Cycles will be presented. Conclusions will summarise the initial results and discuss the next steps.

Sandra Michele Hounsham, Ricardo

4:00 p.m.  BREAK

4:30 p.m.  ORAL ONLY  A Disk Drive in my ECU? Robust OBD Data Storage in Real Time: A Flexible Flash Filesystem Solution

OBD-compliant ECUs must store an increasing collection of non-volatile data including DTCs, freeze frames and snapshots, performance ratio counters and serial numbers. Application 'learning' or accumulator values add to this. Traditionally this data would be allocated a fixed layout in EEPROM or flash, writing one of two copies at key-off time. But this is inflexible even when updating the same software, and is almost useless for rapid-prototyping ECUs like our OpenECU where different users have completely different storage needs. And drivers who cut the battery instead of of turning the ignition key make key-off time storage alone unreliable.

Here we detail a radically different approach. Two blocks of flash are formatted and used as a versioning filesystem, containing different files for different purposes. Read, write, delete, and format operations are supported. Flash wear is minimised. Files can be written while the application continues to execute in real time. The boot loader can use file-stored PIDs and the security algorithm left by the application, even if the code has been erased. Multiple file revisions, checksums and hardware ECC all contribute to robustness.

Charles E. Wartnaby, Pi Innovo

5:00 p.m.  ORAL ONLY  CARB Heavy Duty Presentation

Thomas Montes, California Air Resources Board
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<td>9:00 a.m.</td>
<td>ORAL ONLY</td>
<td><strong>Cummins Experiences</strong></td>
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<td>This presentation will focus on OBD regulation differences specific to the Worldwide Heavy Duty Diesel market. Areas to be discussed include status on Korea releasing their OBD regulations, Beijing V and Special Beijing V requirements, and an update on where Japan stands with their OBD and inducement requirements. Euro VI regulation status and any potential changes will also be addressed. 2nd adopting countries plans for moving to Euro VI will be discussed along with how that could impact product plans. Finally the management of products across that world that have to meet Euro V, Euro VI, and US HD OBD will be discussed.</td>
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<td>Jeffrey Potts, Cummins Inc.</td>
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<td>9:45 a.m.</td>
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<td><strong>Challenges for the Application of OBD Dongles in Road Vehicles</strong></td>
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<td>The utilization of aftermarket OBD dongles in public road passenger and transport vehicles involves opportunities for innovative telematics and fleet management services, but also creates risks regarding safe and secure vehicle operation. This leads to a discussion on the future application range of the vehicle OBD interface. The presentation addresses the question of possible risks when applying OBD dongles into road vehicles and outlines possible impacts in terms of road safety in the case of malfunctions. It also recommends to establish a standardized validation process for OBD dongles that are available on the vehicle aftermarket.</td>
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<td>Tobias Olschewski, TUV NORD Mobilitat GmbH &amp; Co. KG</td>
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The heavy-duty commercial engine market is dominated by diesel-fueled engines. However, with a lower price and an abundant domestic supply nowadays in the U.S., some fuels, such as compressed natural gas (CNG), are driving the market toward alternatives to the conventional diesel engine. With this price advantage, the market is growing quickly for both dedicated and dual-fuel natural gas engines. Dual- and bi-fuel heavy-duty engines benefit from the ability to retrofit on existing platforms and an ability to avoid dependence on an alternative fuel that may not yet have achieved a sufficient infrastructure. For these reasons, dual- and bi-fuel heavy-duty engine offerings are expected to see continued growth in the commercial engine market.

As more stringent OBD requirements for these engines are phased in over the next few years, with requirement for full OBD compliance in 2018 in the U.S., manufacturers must understand the impact these regulations will have on their base engine OBD strategies and calibration. This overview includes a summary of the current and upcoming OBD regulation requirements and focuses on the impact they may have on dual- and bi-fuel engines. These requirements will likely lead to an inability for retrofit companies to achieve OBD compliance without OE support.

The vast majority of dual- or bi-fuel systems on the market today are retrofit kits applied to Outside-Useful-Life (OUL) engines, which have the least certification requirements. With a significant amount of integrated strategy to support current HD OBD requirements for conventional HD engines, the retrofitter may not be able to apply a secondary controller for alternative fuel concepts without disrupting the OBD functionality.

If implementing a dual- or bi-fuel approach to an existing platform, OE manufacturers will also need to address impact of this new fueling and combustion system on their OBD monitors. Potential impacts may include the functionality and accuracy of monitors applied to the air, fuel, EGR and aftertreatment systems. For example, a diesel engine converted to dual- or bi-fuel operation can no longer use lambda as feedback for EGR control without modification, leading to a need for base engine and OBD strategy adjustment. In many cases, a parallel or switching approach with separate OBD strategy/calibration may be required.

An additional concern for alternative fueled engines utilizing natural gas is the emission of methane (CH4). While there are currently no OBD requirements in place for Green House Gas (GHG) emissions, it is likely that additional monitors will be required to ensure compliance with future regulations. As CH4 is considered to be a GHG with greater impact than carbon dioxide, any future regulations could greatly influence the OBD systems for those engines whose fuels have potential for excessive CH4 emissions. The known challenges of short circuiting air/fuel mixture with the currently common intake fumigation approach and poor conversion of CH4 with conventional catalyst formulations are potential impediments for success of some alternative fueled engines if OBD monitoring is required for GHG constituents in the future. Based on these concerns, it is critical that industry understands the impact new OBD regulations may have on current and future alternative fuel approaches and its ability to provide the market with powertrain alternatives that make use of currently abundant and lower cost fuels.
10:45 a.m.  BREAK

11:15 a.m.  ORAL ONLY  US and EU HD-OBD Type Approval Processes: Like Football and Soccer?

Euro VI and US13 OBD requirements are build on the same principles, but the way from design to certificate is significantly different. In this presentation an overview of the written procedures, commonality and differences and experiences with EU and US OBD type approval authorities are shared.

John Degraaf, DAF Trucks NV

11:45 a.m.  ORAL ONLY  Advanced SCR and DPF Efficiency Monitors for Commercial Vehicles Using Stochastic Methods

The introduction of the EURO VI C and EPA MY16+ emission regulations for commercial vehicles has brought an increase in the complexity of exhaust gas aftertreatment systems and its On-Board Diagnostics (OBD). IAV has developed algorithms meeting the challenges for SCR efficiency monitoring and DPF efficiency monitoring. The SCR efficiency monitoring algorithm is based on a stochastic filter which removes the outliers in the data depending on stochastic moments like mean-value and standard deviation of a Gaussian distribution. Secondly, an algorithm for DPF efficiency monitoring without the necessity of a particulate matter sensor based on an extended Kalman filter is presented. Both methods were validated on a heavy duty engine with focus on selected certification cycles.

Rifet Muminovic, IAV GmbH

12:15 p.m.  ORAL ONLY  Historical OBD Collaboration Panel/General Discussion with Q&A

Paul A. Baltusis, Ford Motor Co.

1:15 p.m.  ORAL ONLY  Networking Lunch