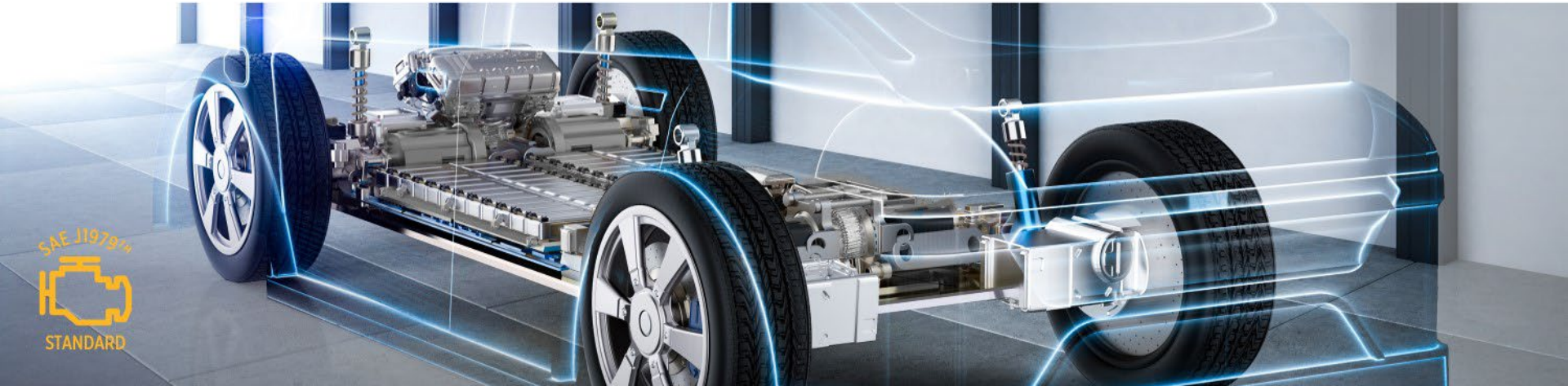




On-Board Diagnostics Symposium-Americas

OBD Signal Flow Analysis Update

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News from the HRCS Consotium

Current members of the HRCS Consortium:



HONDA



SAE International®
On-Board Diagnostics Symposium-Americas

Scope of the OBD working group

There are several use cases related to automotive emissions compliance, safety analysis, system validation, fault isolation and event analysis that require an understanding of the propagation of signals within and between the vehicle's Electronic Control Units (ECUs)

Specifically:

CARB request to all OEMs in 2019 ...

(1) Certification Documentation

(2) The following information shall be submitted as “Part 1” of the certification application. ... The information must include: ...

(2.8) A listing of **all electronic powertrain input and output signals** (including those not monitored by the OBD II system) that identifies which signals are monitored by the OBD II system

The focus of the working group is to develop methods to meet these requirements and to specify standards for portions of the process required for cost effective implementation for all stakeholders.



Signal Flow Analysis Approach - Objectives

Main objective:

- Ensure a sufficient level of diagnostic coverage and certification disclosure

This is achieved by

- Identifying OBD-relevant serial data signals and ECU relationships
- Assigning the signals to the providing and consuming ECUs/devices



Recommended Practice Finally Completed and Published

On 11th of August 2026 the recommended practice (RP) of the HRCS signal flow analysis working group has finally been published:

- Downloads page: <https://www.sae-itc.com/programs/hracs/standards>
- Mobilus pages:
 - <https://saemobilus.sae.org/standards/hracs-prp0001-a-standardized-approach-board-diagnostic-obd-system-signal-classification-dependency-analysis>
 - <https://www.sae.org/standards/hracs-prp0001-a-standardized-approach-board-diagnostic-obd-system-signal-classification-dependency-analysis>



Overview of the Recommended Practice

Table of contents of the RP:

1. Definitions
2. Abbreviations
3. Background
4. OBD Serial Data Signal Flow Analysis Approach
5. Examples for Applying the Signal Flow Analysis Using a Signal Flow Network
6. Establishing a Common Exchange File Format
7. Other Applications for Signal Flow Analysis



Recommended Practice – OBD Serial Data Signal Flow Analysis Approach

Steps for performing an analysis from scratch:

1. OBD Classification of Functions
2. OBD Classification of ECUs and Devices
3. OBD Classification of Signals
4. OBD Received Signal Dependency Analysis
5. OBD Transmitted Signal Dependency Analysis
6. Diagnostic Monitoring Confirmation
7. Certification Documentation Verification



Recommended Practice – OBD Serial Data Signal Flow Analysis Approach - OBD Classification of Functions

Purpose:

Identify and classify the function blocks that are OBD-relevant from a legislated OBD perspective.

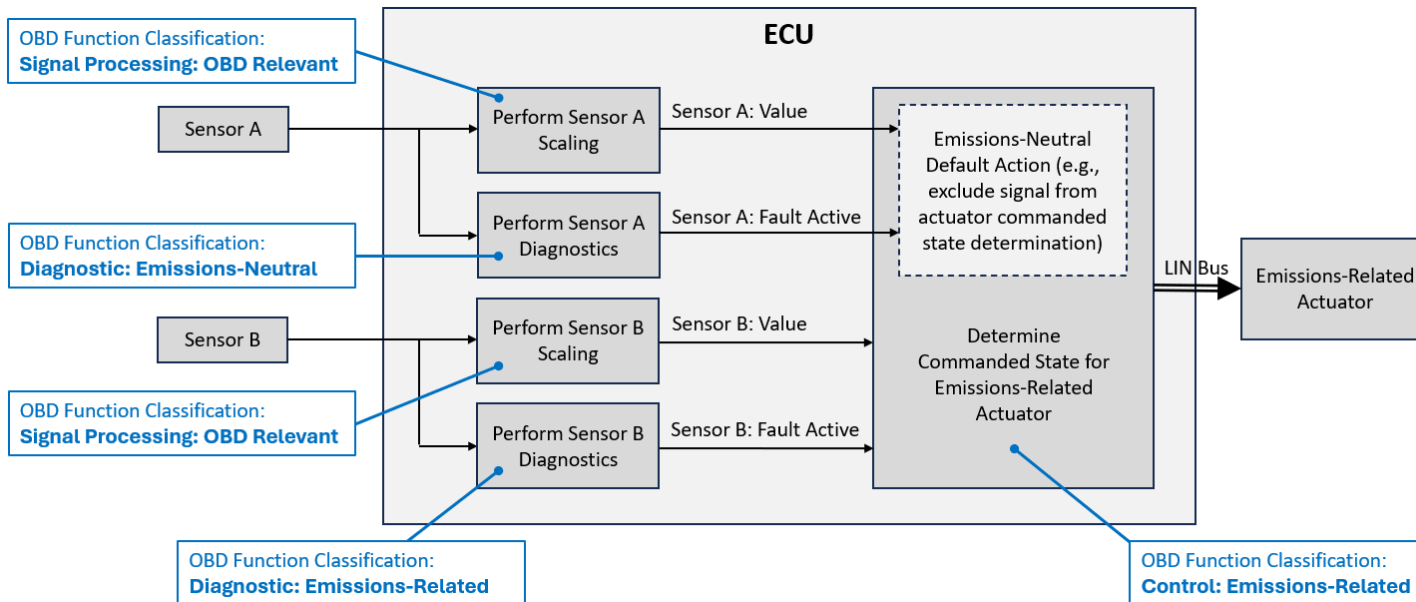
Classifications:

1. Signal Processing: OBD Relevant
2. Signal Processing: Not OBD Relevant
3. Control: Emissions-Related
4. Control: Not Emissions-Related
5. Diagnostic: Emissions-Related
6. Diagnostic: Emissions-Neutral
7. Diagnostic: Not Emissions-Related
8. Other: OBD Relevant
9. Other: Not OBD Relevant



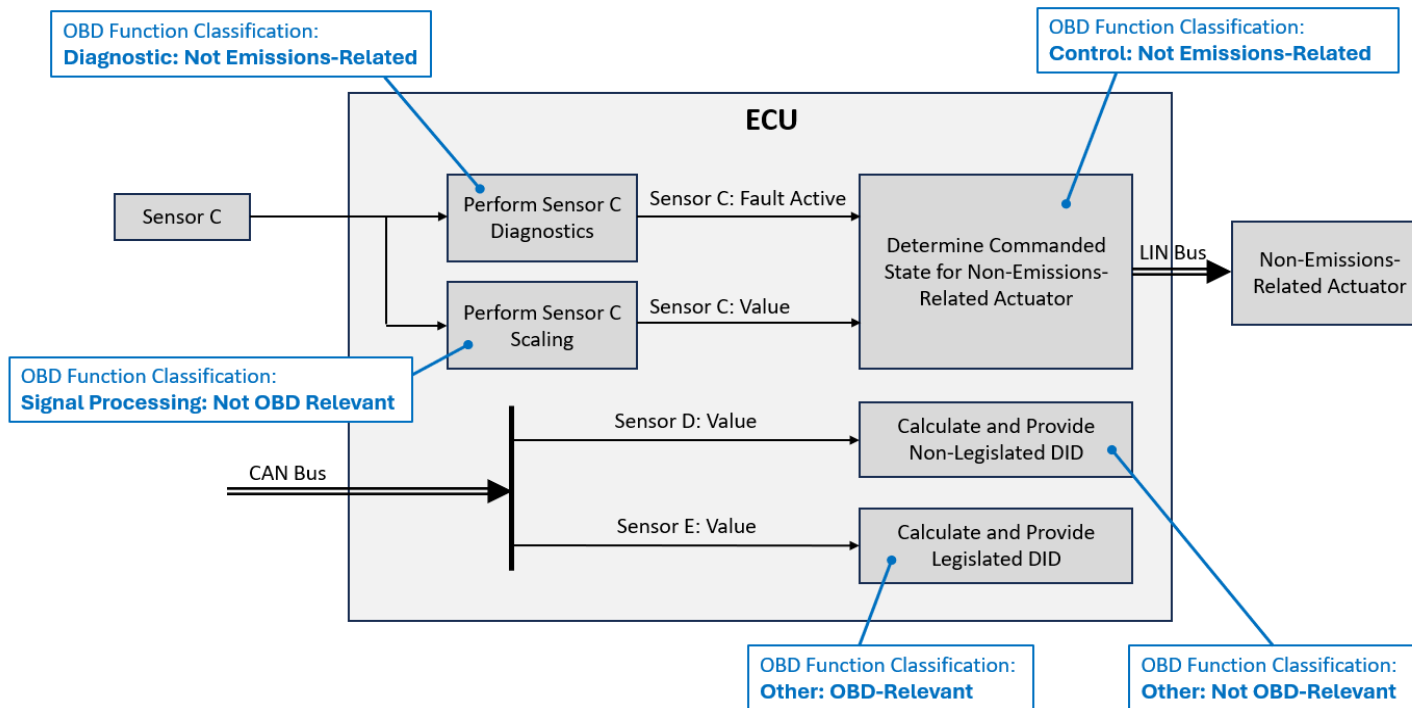
Recommended Practice – OBD Serial Data Signal Flow Analysis Approach - OBD Classification of Functions

Example for function classification within an ECU:



Recommended Practice – OBD Serial Data Signal Flow Analysis Approach - OBD Classification of Functions

Example for function classification within an ECU:



Recommended Practice – OBD Serial Data Signal Flow Analysis Approach - OBD Classification of ECUs and Devices

Purpose:

Classify all ECUs and devices of the vehicle-wide serial data network to enable OBD signal data analysis, OBD system functions (e.g. legislated freeze frame storage), legislated data standardization requirements (e.g. CAL ID/VCN)

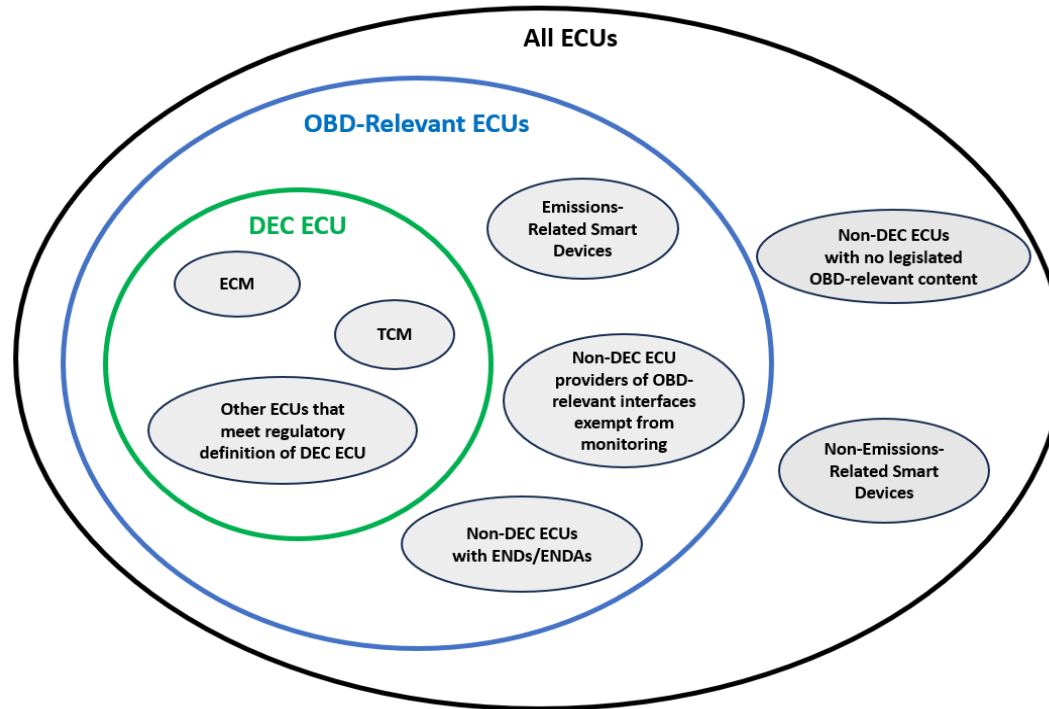
Classifications:

1. OBD-Relevant: Diagnostic or Emission-Critical ECU
2. OBD-Relevant: Emissions-Related Smart Device
3. OBD-Relevant: Emissions-Neutral Diagnostic/Default Action ECU
4. OBD-Relevant: Exempt
5. Non-OBD-Relevant ECU



Recommended Practice – OBD Serial Data Signal Flow Analysis Approach - OBD Classification of ECUs and Devices

ECU classifications:



All ECUs: The superset of all electronic control units on a vehicle

OBD-Relevant ECUs: The set of ECUs that are subject to one or more legislated OBD requirements.

DEC ECU: The set of ECUs that meet the CARB definition of "Diagnostic or emission critical electronic powertrain control unit"

Recommended Practice – OBD Serial Data Signal Flow Analysis Approach - OBD Classification of Signals

Purpose:

Enable system wide serial data signal flow analysis on signal level to determine for OBD-relevance for every signal.

Classifications of received signals:

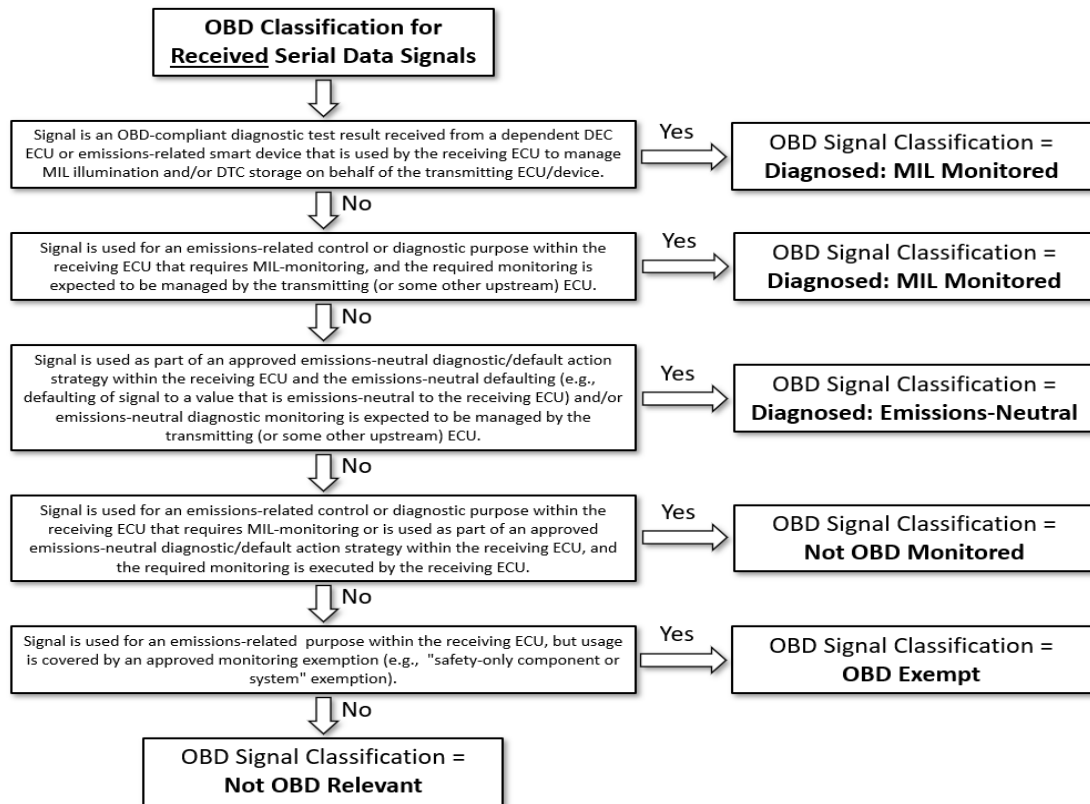
1. Diagnosed: MIL Monitored
2. Diagnosed: Emissions-Neutral
3. OBD Exempt
4. Not OBD Monitored
5. Not OBD Relevant

Classification of transmitted signals:

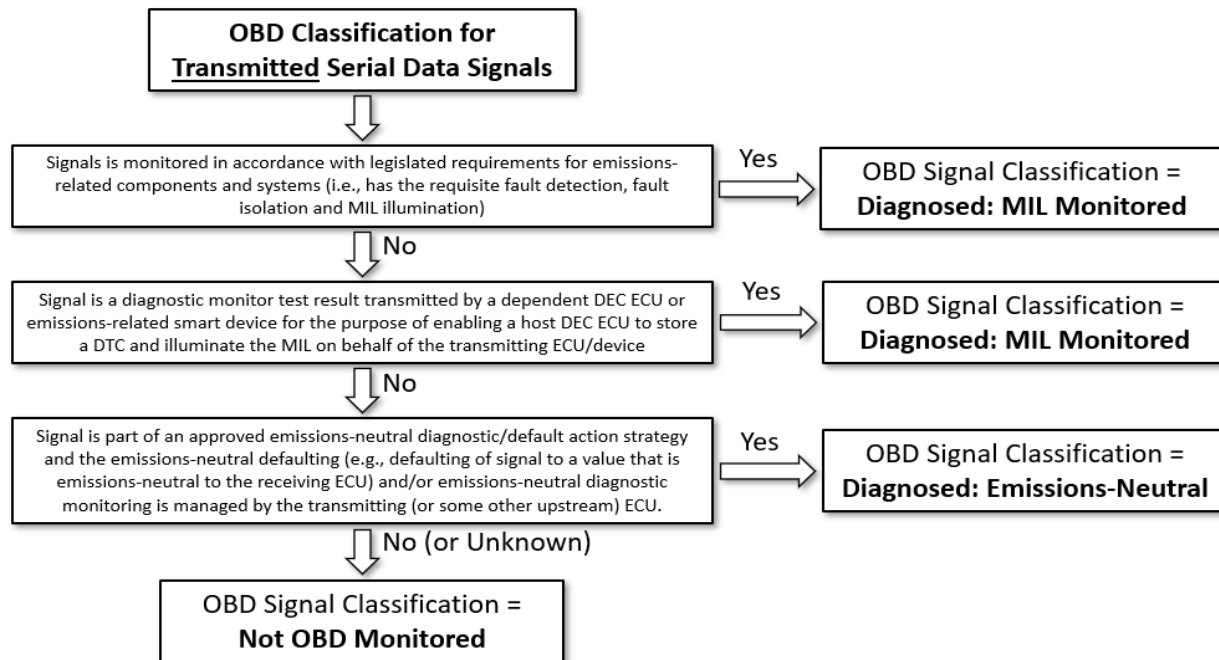
1. Diagnosed: MIL Monitored
2. Diagnosed: Emissions-Neutral
3. Not OBD Monitored



Recommended Practice – OBD Serial Data Signal Flow Analysis Approach - OBD Classification of Signals



Recommended Practice – OBD Serial Data Signal Flow Analysis Approach - OBD Classification of Signals



Recommended Practice – OBD Serial Data Signal Flow Analysis Approach - Received Signal Dependency Analysis

Purpose:

Trace received ECU/device serial data signals to the originating ECU/device and identify all contributing components for the serial data signal.

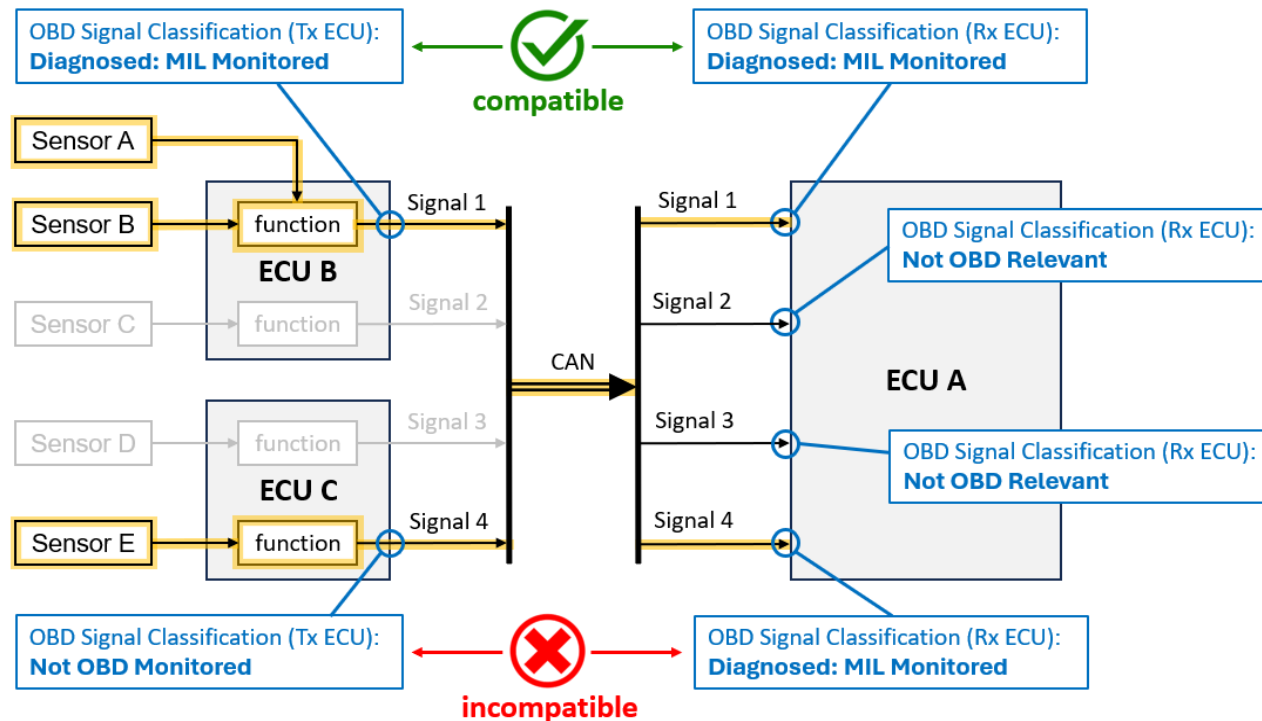
Required steps:

1. Identify all OBD-relevant serial data signals received by the ECU under analysis.
2. For each of the OBD-relevant serial data signals received by the ECU under analysis, evaluate the OBD signal classifications defined during the ECU-level analysis for both the receiving ECU and transmitting ECU for compatibility.
3. For each of the OBD-relevant serial data signals received by the ECU under analysis, identify all components that influence determination of the signal.



Recommended Practice – OBD Serial Data Signal Flow Analysis Approach - Received Signal Dependency Analysis

Example for Received Signal Analysis:



Recommended Practice – Examples for Applying the Signal Flow Analysis

Purpose:

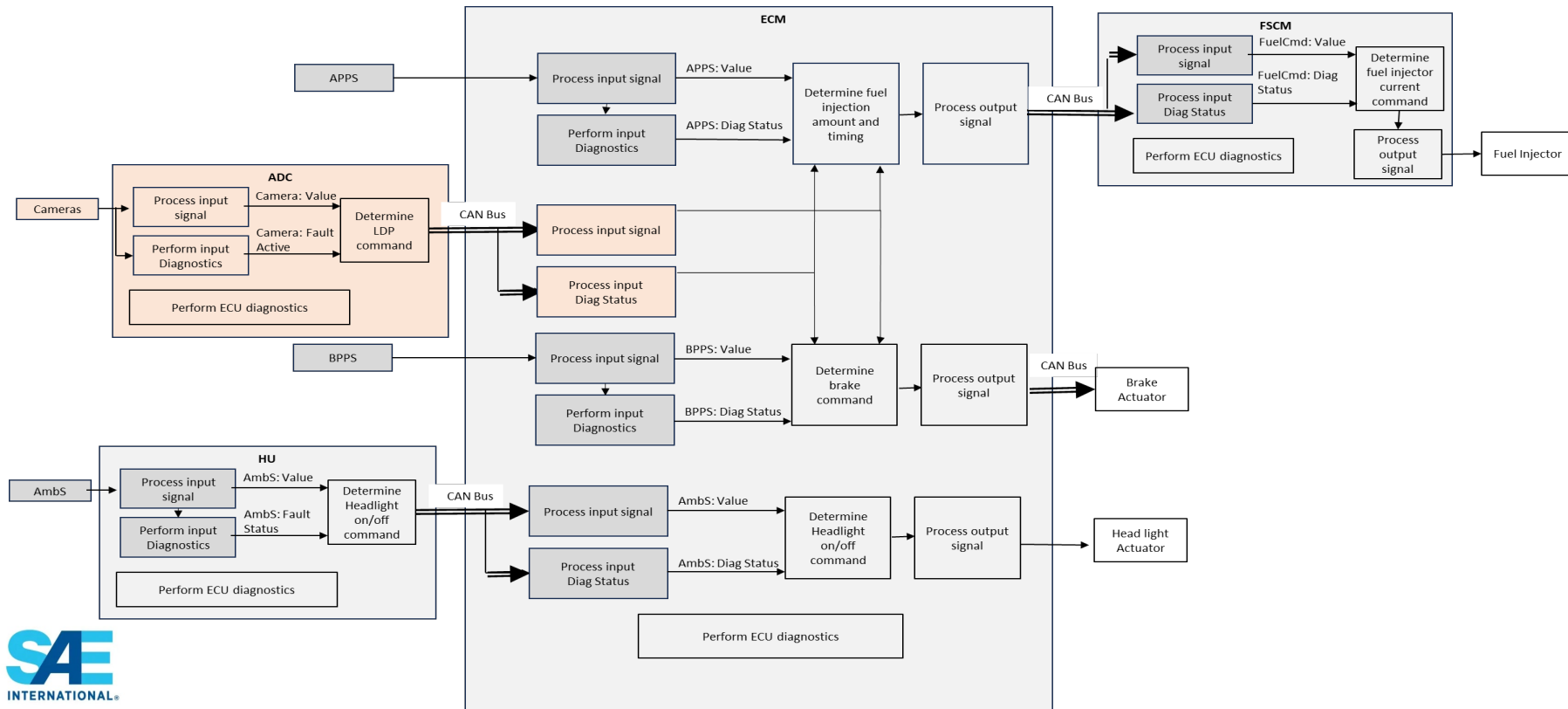
Show examples how to apply the signal flow analysis for some real world use cases.

Six major examples given:

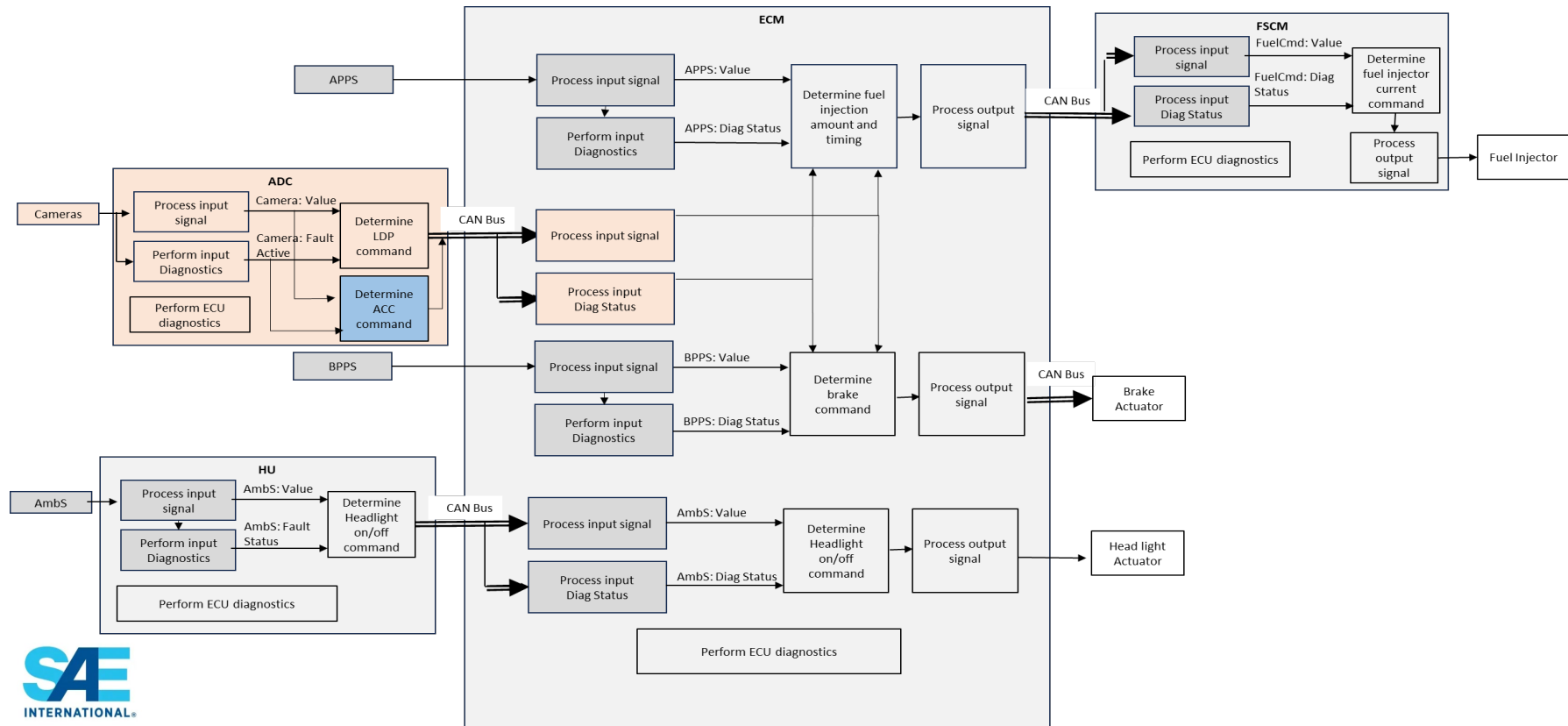
1. Conduct Serial Data Signal Flow Analysis for New or Substantially Redesigned Electrical Architecture
2. New ECU Added to an Existing Electrical Architecture
3. New Function(s) Added to an ECU
4. New or Changed Rx Signals to an ECU
5. New or Changed Tx Signals to an ECU
6. Using the Signal Flow Network for Checking OBD Compliance



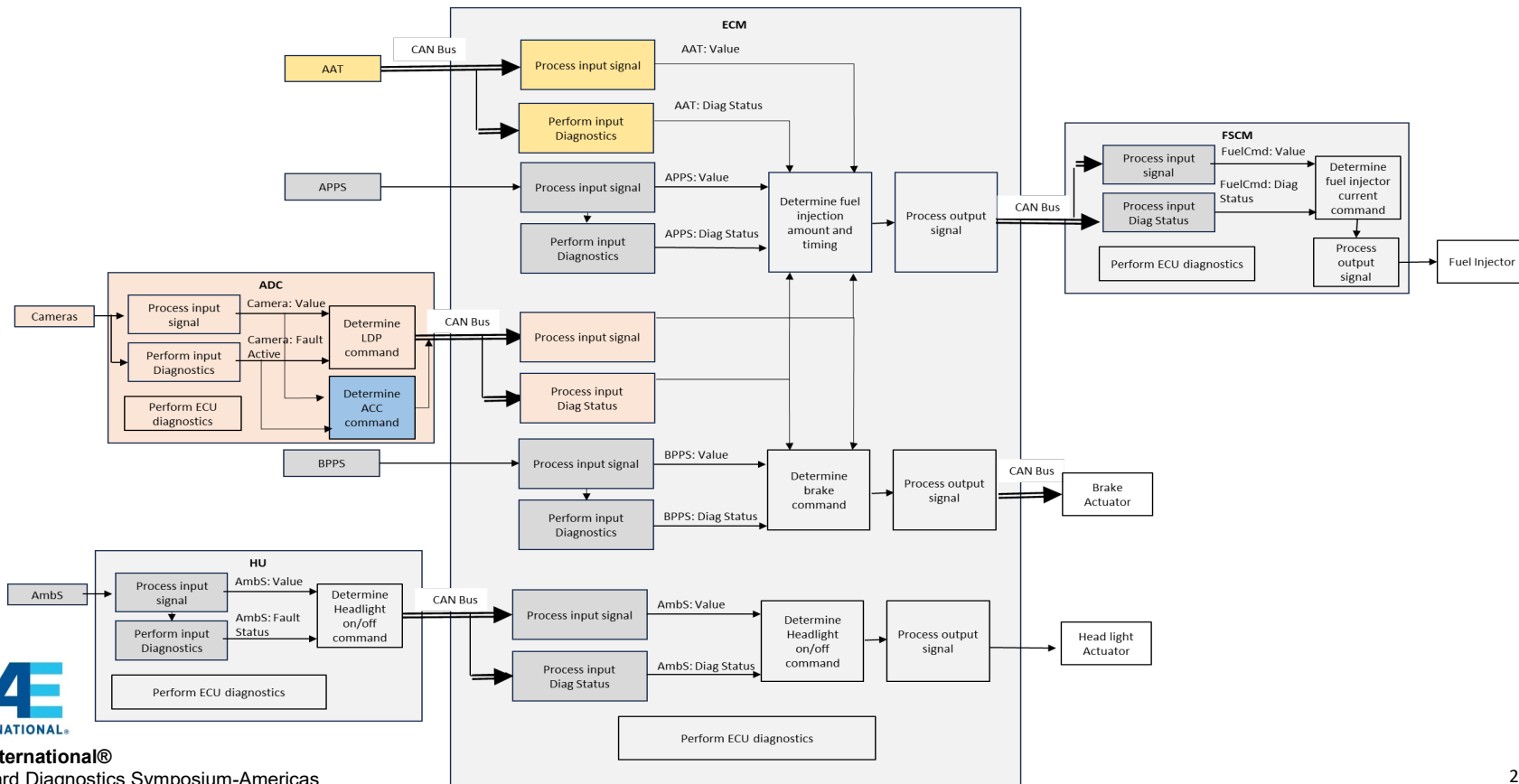
Recommended Practice – Examples for Applying the Signal Flow Analysis – New ECU Added to an Existing Electrical Architecture



Recommended Practice – Examples for Applying the Signal Flow Analysis – New Function(s) Added to an ECU



Recommended Practice – Examples for Applying the Signal Flow Analysis – New or Changed Rx Signals to an ECU



Recommended Practice – Establishing a Common Exchange File Format

Purpose:

Name requirements for and define an actual exchange file format for sharing signal flow analysis results amongst OEM, Tier1 and legal authorities.

Content of the exchange file format:

1. General information about the origin of a file, like author, version information and similar.
2. Architectural information to help relate the single signal flow network stored in a file with others.
3. Graph information describing the dependencies between nodes (e.g. signals or modules) and attributes for nodes and edges (e.g. OBD relevant).



Recommended Practice – Other Applications for Signal Flow Analysis

Purpose:

Introduce other areas where signal flow analysis can be beneficial.

Four additional domains of application identified:

1. Autonomous vehicles
2. Integrated vehicle management
3. Electric vehicles
4. Fixed-base operations



Thanks for your contributions

- Sebastian Rauth (Audi)
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- John Larsen (GM)
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- Yuya Bessho & Soichiro Nishiguchi (Toyota)
- John van Gilder (Van Gilder Engineering)
- Peter Grau & Matthew Chee (SAE)
- Matthias Hampel (Concentrio)



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