



# ***Signal Flow Analysis for CARB Reporting – Kick Off Meeting June 7, 2022***

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**SAE**  
**ITC**  
*An SAE International Affiliate*

*Collaborative Innovation.  
Trusted Implementation.*

# ***Signal Flow Analysis for CARB Reporting – Kick Off Meeting***

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## Agenda:

- 10 Minutes : Introductions and Overview – Tim Felke
- 20 Minutes: Discussion of Signal Flow Analysis Challenges – Stephan Mauk
- 20 Minutes: Discussion / Q&A - All
- 10 Minutes: Next Steps – All

# INTRODUCTION

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There are several use cases related to automotive emissions compliance, safety analysis, system validation and event data 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 ...

(i) Certification Documentation ....

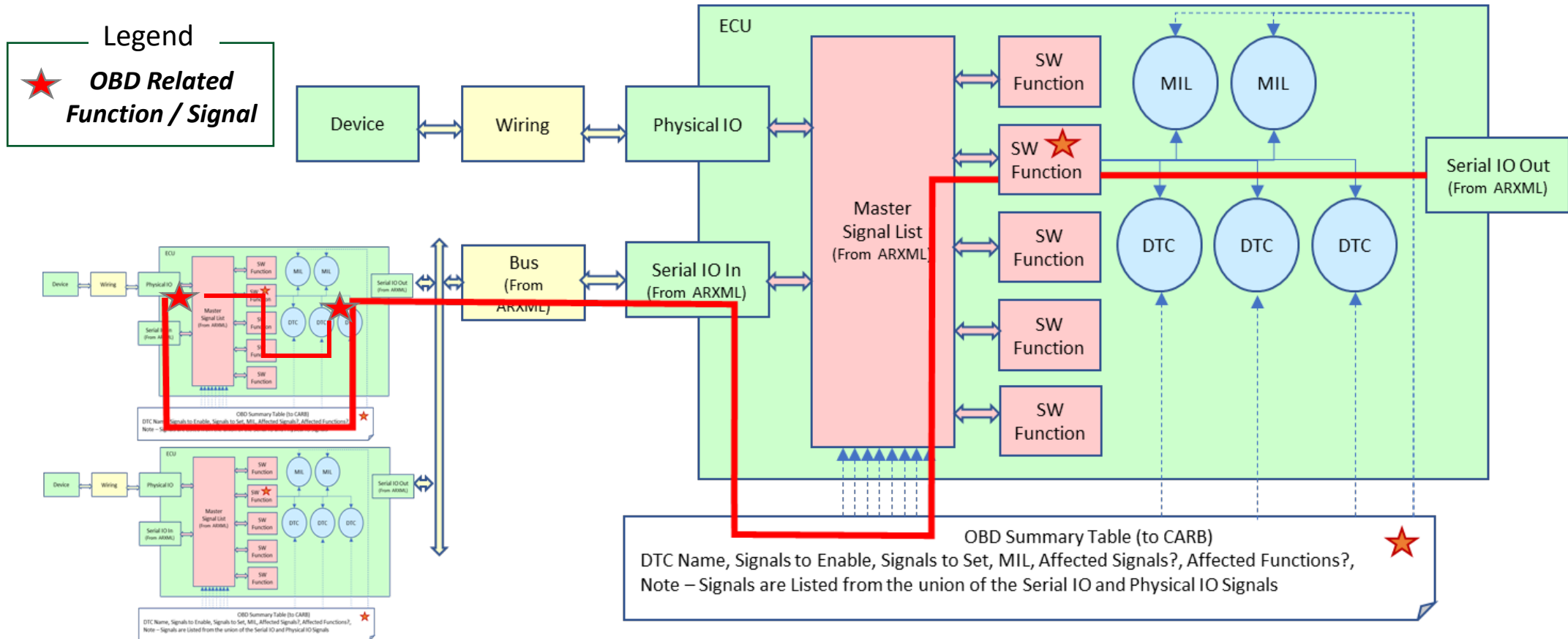
(2) The following information shall be submitted as “Part 1” of the certification application. ...

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

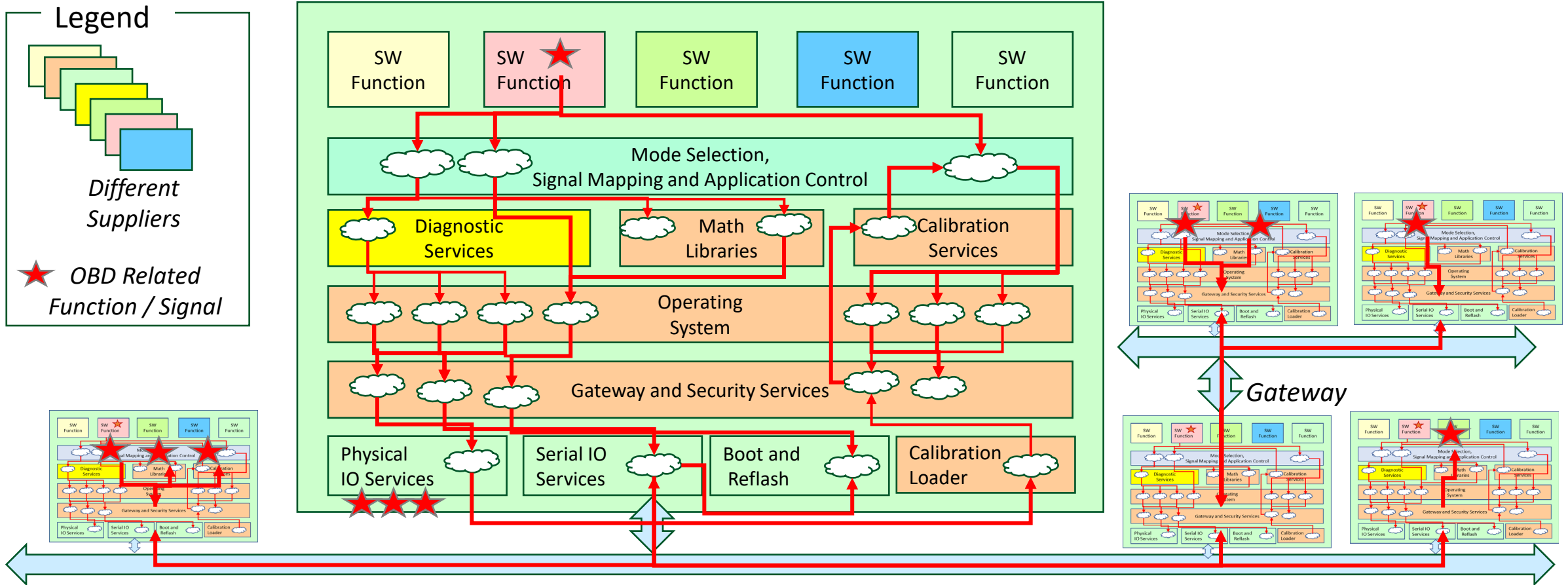
This presentation will discuss the challenges of using signal flow analysis to meet this requirement and a proposal for how these challenges can be overcome.

# TECHNICAL CHALLENGE – SIGNAL TRACING (SIMPLIFIED)



**Intent - Ensure that all signals that enable or control an OBD related signal / function have OBD Documented DTCs and that related malfunctions set the MIL.**

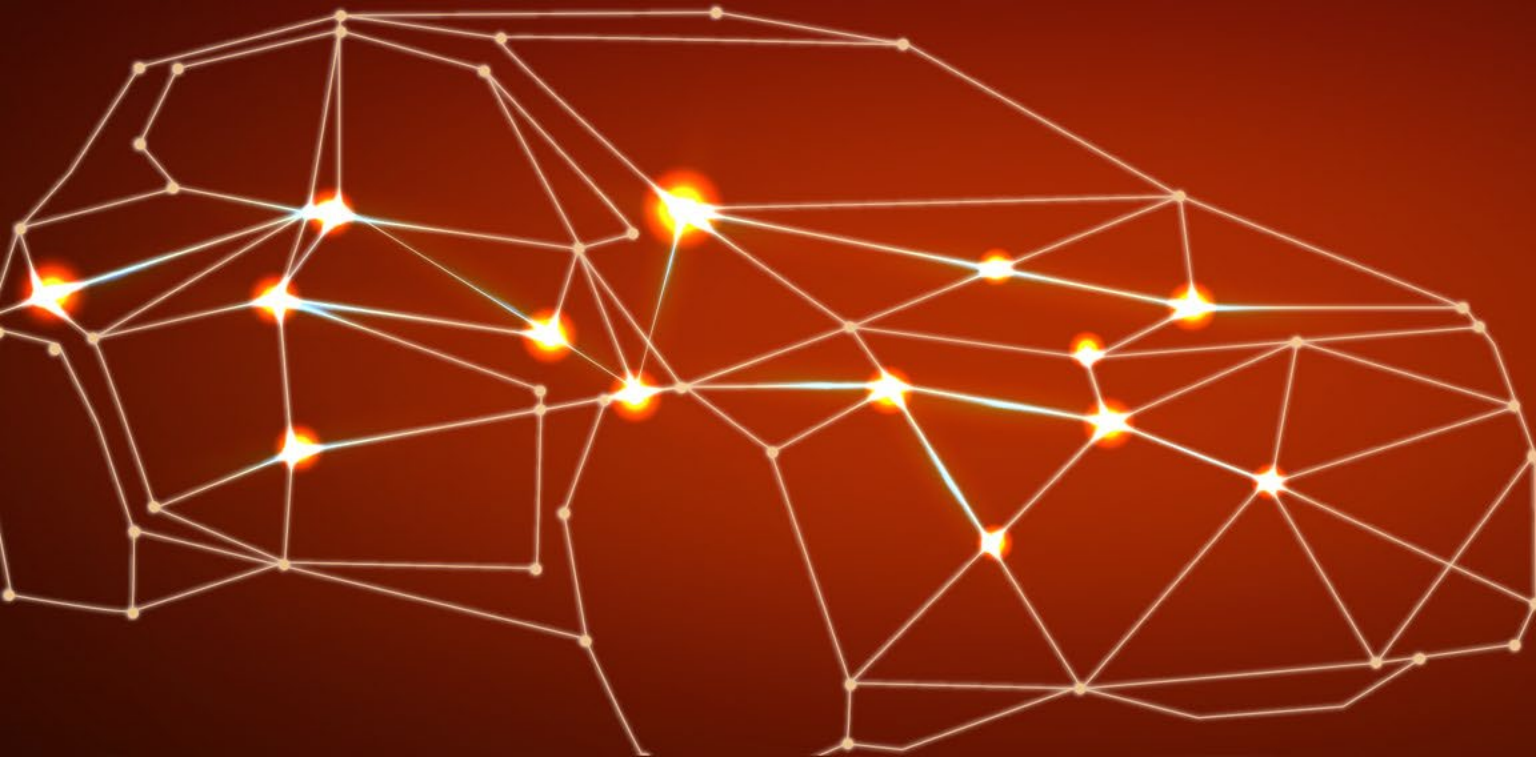
# TECHNICAL CHALLENGE – SIGNAL TRACING THROUGH SW STACK AND GATEWAY MODULES



**Linking signal flow between modules and layers requires a general process model and interface specifications for connectivity through each module.**

# State of the Art Signal Flow Analysis

- General Approach
- Challenges



HRCS Signal Flow Analysis for CARB  
Compliance

06/07/2022 - Introduction Meeting

# INTRODUCTION

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- Living in Munich, Germany
- Family father
- Engineer, TU Munich
- Co-Founder & Co-CEO of Concentrio AG & jember GmbH
- Experience in Automotive, Diagnostics / OBD and **Signal Flow Analysis**

# TOPICS

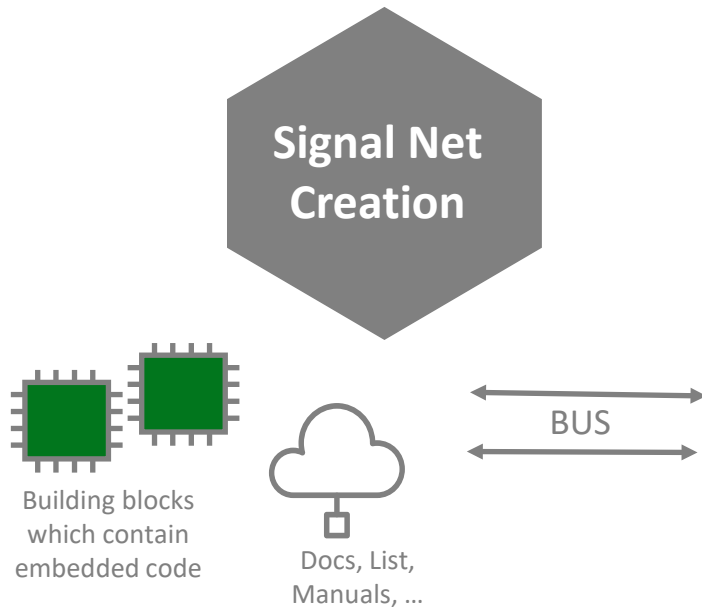
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- ▶ **General Approach & Challenges**
- ▶ **Data Exchange – Focus of this working group**
- ▶ **Call for Action – Possibility to contribute in different stages**
- ▶ **What makes it so difficult - Technical Challenges**
- ▶ **Typical Solution Elements**
- ▶ **Approach / Inputs for a Standardized Exchange Format**



# GENERAL APPROACH

## 1. Create



## 2. Exchange



- Allows standardized exchange between supplier and OEMs
- Encodes all different types of information

## 3. Analyze



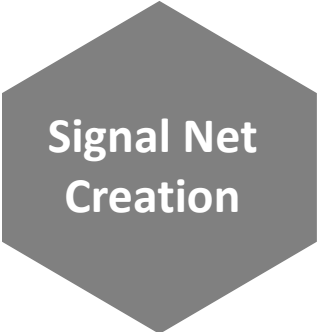
- Integrates data from the source files
- Provides visualization and analysis
- Produces the required outputs

### Use-Cases

- OBD
- R&D
- Testing
- Safety
- Security
- ...

# GENERAL APPROACH & CHALLENGES

## 1. Create



- Different Stakeholders (OEM, Tier, 3<sup>rd</sup> party, ...)
- Different methodologies (manual, tool based, ...)
- Different understanding (content, simplification, naming, annotations, ...)
- ...

→ Leads to different signal net artefacts

## 2. Exchange



- Allows standardized exchange between supplier and OEMs
- Encodes all different types of information

- Not available

## 3. Analyze



- Integrates data from the source files
- Provides visualization and analysis
- Produces the required outputs

- Merge of signal net artefacts
- Cover different Use-Cases (content, granularity, ...)
- Common understanding of external stakeholders (e.g. CARB)
- ...

→ Comparable results need comparable inputs

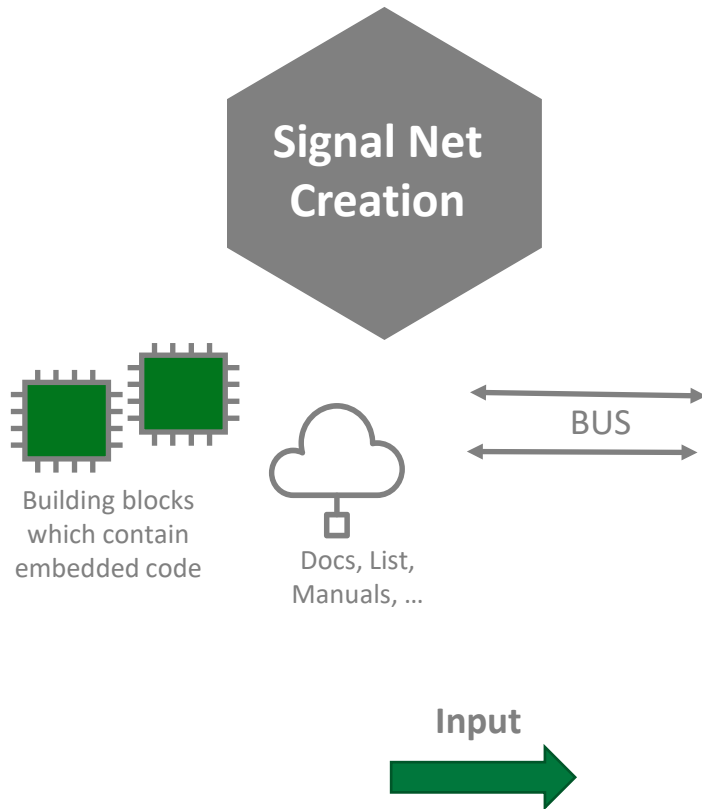
### Use-Cases

- OBD
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- ...

General Challenges

# GENERAL APPROACH & CHALLENGES

## 1. Create



## 2. Exchange



- Allows standardized exchange between supplier and OEMs
- Encodes all different types of information

### KEY Element – Focus of this Working Group

- Definition/creation of common understanding
- Format
- Content
- Granularity
- Naming / annotation
- Merging rules
- ...

## 3. Analyze



- Integrates data from the source files
- Provides visualization and analysis
- Produces the required outputs

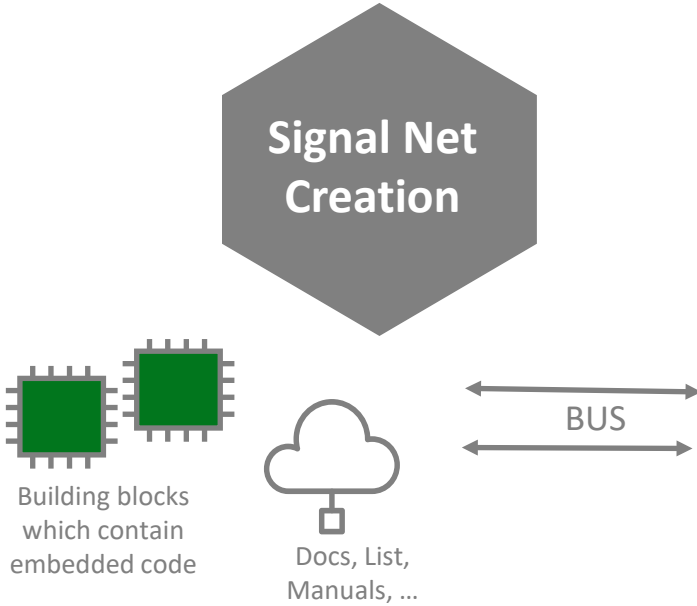
### Use-Cases

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# GENERAL APPROACH & CHALLENGES

## 1. Create



## 2. Exchange



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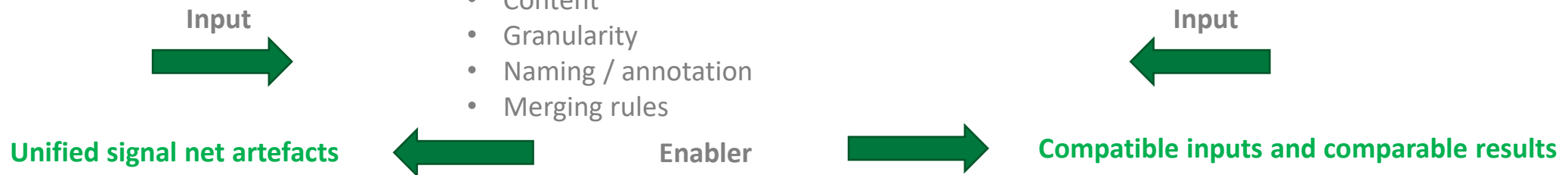
## 3. Analyze



- Integrates data from the source files
- Provides visualization and analysis
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### Use-Cases

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# (TECHNICAL) CHALLENGES WHAT MAKES IT SO DIFFICULT?

## Wide Range of Input Data

- OEM needs to integrate data from many suppliers & departments
- Many languages and bus protocols (CAN, LIN, Ethernet, ...)
- Different AutoSAR implementations
- Many SW layers & interfaces (application SW, basic SW, IO, HW, ...)
- Affects through DTC State Managers, MIL State Managers and overall DTC Reporting and Consolidation Services (DSM)
- Need to consider Calibration Files and System Constants
- How to handle obsolete path / “dead” code
- Existing Know-How needs to be included
- Already agreed “engineering judgements” / agreements

## Definitions / Common understanding

- Definition of OBD relevant, OBD conform, ...
- How to identify which functions and signals are OBD relevant / conform
- Which information shall be included, prioritization, ... (i.e. engineering judgement vs signal net analysis)
- Signal net artefact: content, simplification, naming, annotations, ...

## Complexity

- Static, dynamic, thermal, ... effects
- Location specific and optional functions, or dependent on the conditions of the vehicle
- Need to filter large connection networks to the relevant subsets (size & complexity)
- Requirements from different stakeholder (CARB, Europe, China, RoW, ...)

## Validation

- Automated generated signal flow files can be large and difficult to validate
- Mechanism needed that enables validation on different levels (software, functional, HiL, on vehicle, ...)
- Mechanism to incorporate expert expectations
- Compatibility to use already existing data from i.e.: Functional Safety, Test Plans, OBD Summary Tables, Service Records and Service Procedures, Service Bulletins, ...)
- Solution must produce intermediate results that build confidence in the overall solution

## General

- Solution must protect IP of application SW suppliers, integrators and tool suppliers
- Solution must enable affordable / pragmatic approaches especially for less complex functions / components

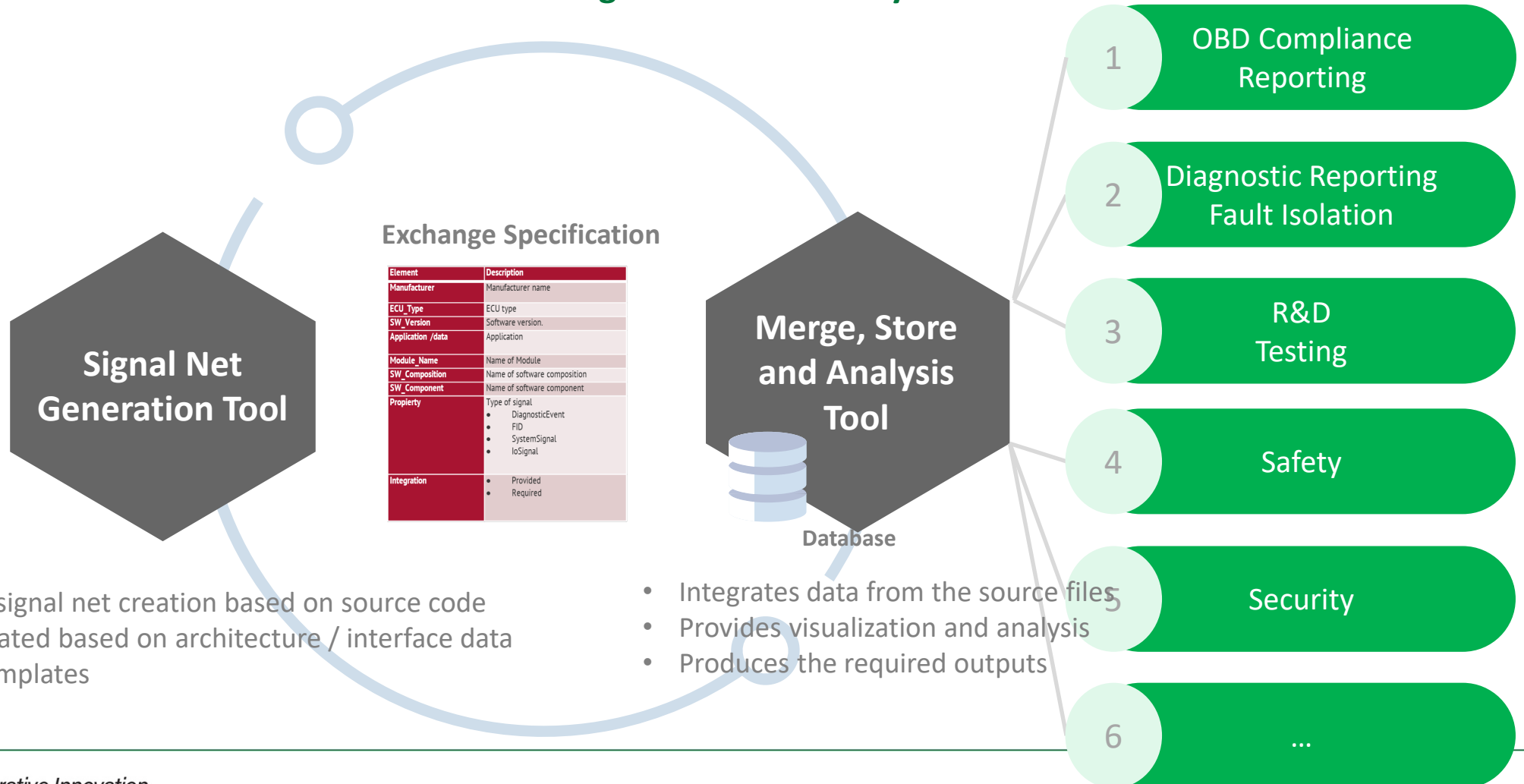
# TYPICAL SOLUTION ELEMENTS

## Overview

### 1. Create

### 2. Exchange

### 3. Analyze



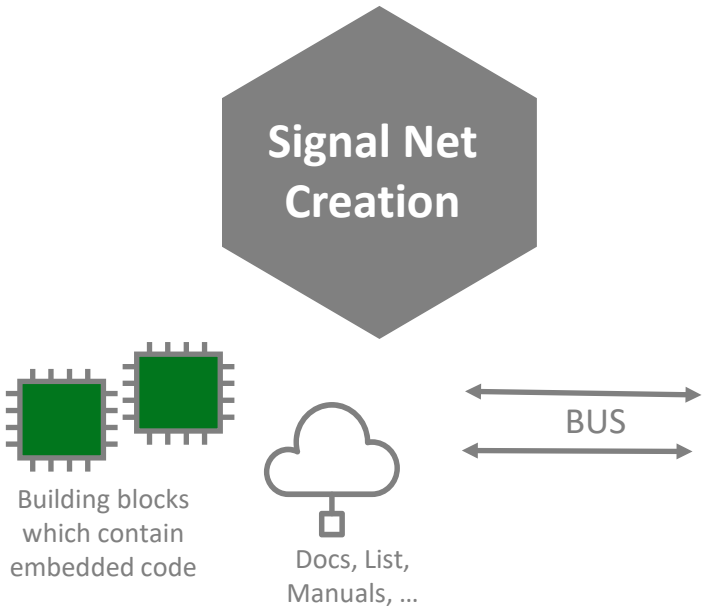
### Examples

- Automated signal net creation based on source code
- Semi automated based on architecture / interface data
- Manual / templates

- Integrates data from the source files
- Provides visualization and analysis
- Produces the required outputs

# INPUTS FOR A STANDARDIZED EXCHANGE FORMAT

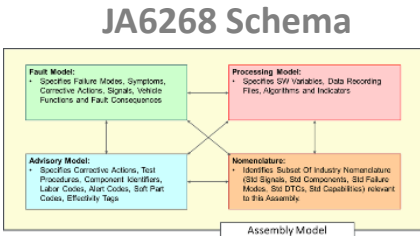
## 1. Create



## 2. Exchange



- Allows standardized exchange between supplier and OEMs
- Encodes all different types of information



AUTOSAR (ARXML),  
DBC, ODX, ...

### GML Specification

Element	Description
Manufacturer	Manufacturer name
ECU_Type	ECU type
SW_Version	Software version.
Application /data	Application
Module_Name	Name of Module
SW_Composition	Name of software composition
SW_Component	Name of software component
Property	Type of signal <ul style="list-style-type: none"> <li>• DiagnosticEvent</li> <li>• FID</li> <li>• SystemSignal</li> <li>• IoSignal</li> </ul>
Integration	<ul style="list-style-type: none"> <li>• Provided</li> <li>• Required</li> </ul>

## 3. Analyze



- Integrates data from the source files
- Provides visualization and analysis
- Produces the required outputs

### Use-Cases

- OBD
- R&D
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- ...

# Discussion / Q&A



# SIGNIFICANT QUESTIONS

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- How do we know which functions / signals need to have OBD compliant monitoring?
- How do we cover requirements to assess impact of detected failures?
- How do we account for dynamic aspects of software signal flow?
- How do we handle affects of calibrations and region specific software?
- How do we ensure all required information for CARB reports are provided?
- Other Questions?

# Near Term Plan

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1. Identify and engage stakeholders and key contributors.
2. Initiate short-term fact-finding effort with team members and CARB to understand and document requirements, timing, and scope.
3. Prepare a detailed project plan to develop and demonstrate the base concept in operation. It would be scoped to only functionality related to OBD
  - Includes formalizing overall process flow and interface specifications
  - Includes user and programmer guides
4. Later stages, not addressed at this time, might cover the additional OBD requirements and application to other use-cases.

To engage in this activity or find out more ...

**Please contact me, Stephan, or other HRCS leadership listed on next page.**

**And/Or – Visit HRCS at <https://www.sae-itc.com/programs/hrcs/presentations>**

# HRCS MEMBERSHIP

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Participation in the OBD Signal Flow Analysis will require HRCS membership

- Full Membership enables participation on this project and all other HRCS projects
  - Voting privileges regarding this project and HRCS operations
- Associate Membership enables participation in this project and other HRCS projects
- Details available on the HRCS webpage: <https://www.sae-itc.com/programs/hrcs>

# Next Steps

# Thank You - Contact Info:

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# HEALTH-READY COMPONENTS AND SYSTEMS

The screenshot shows the SAE ITC website for the Health-Ready Components and Systems (HRCS) Strategy Group. At the top, there are social media icons for Facebook, Twitter, LinkedIn, and YouTube. The SAE ITC logo is prominently displayed, with the tagline "An SAE International Affiliate". Navigation links include "Why SAE ITC", "Resources", "Industry Impact", and "Contact Us". A large blue banner features the text "Health-Ready Components and Systems (HRCS) Strategy Group" over a background of an engine turbine and a circuit board. Below this, a central image shows a person holding a tablet displaying a 3D model of a cyan engine component with a red warning triangle and a yellow box that reads "PROACTIVE ALERT 14 DAYS UNTIL FAILURE". To the right, a blue box titled "Benefits of SAE ITC" lists: Information Center, Administrative & Legal, Strategy & Operations, Marketing & Events, Standards & Data, and Launch Initiative. Below the tablet image is a navigation menu with links for "About", "Members", "News", "Events", "Presentations", "Testimonials", and "Registry". Under the "About" link, there is a section titled "About Health-Ready Components and Systems (HRCS)" with sub-links for "Background" and "Benefits". To the right of the navigation menu is another blue box titled "Programs" which lists "AESQ Aerospace Engine Supplier Quality" and "ASPQP Aerospace Standards and Part Qualification Program", each with a "More Information" link.