

Proposal to Standardize Data Exchange for Signal Flow Analysis

Introduction

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 information within and between on-vehicle Electronic Control Units (ECUs). Due to the increasing complexity of automotive software and new regulatory requirements, these use-cases can no longer be supported by manual analysis methods that have been previously utilized.

Automated methods to trace signal flow within a single software module are well established but do not provide all the of functionality required to produce the required results. Areas of difficulty include:

- The signal flow for individual software modules (smallest SW entity) can be computed without great difficulty but an automotive ECU may contain several thousand modules that must be connected to determine the overall use of each signal.
- The software modules within a single ECU will typically be provided by more than one supplier and the vehicle OEM, with formatting and IP concerns hindering the analysis and integration.
- Analysis for emissions compliance from CARB now requires that signal flow be traced for signals derived from physical sensors as well as all signals derived from serial messages.
- Dependency pathways may be substantially modified by calibration data. In many cases, the calibration responsibility is also spread among the parties.
- Utilization of physical Input/Output ports and serial signals may be substantially modified depending on vehicle options and regional specific equipment.
- Requirements for analysis for safety assurance are rapidly evolving but will clearly increase the required fidelity and scope of this type of analysis.
- No common approach exists for either the exchange of required information between parties or for the methodology used.

Recommended Solution

We suggest that HRCS create and lead a team to develop standards, exchange formats, and processes for data exchange to aide in automating the integration of signal flow data. While the method would be extendable to other use cases, we suggest that the team focus their

initial efforts on the data needed to produce the required CARB Functional Signal Dependency Report.

SAE ITC's HRCS Consortium is well positioned to address the challenges identified above. One of HRCS' key goals is to improve communication of complex design and operating information between OEMs, suppliers, integrators and operators. Formalizing the communications required to integrate signal flow data for modules provided by multiple suppliers is natural application of one of HRCS' primary objectives.

The team would be composed of contributors from SAE, OEMs, Suppliers, and (when appropriate) CARB. This would begin with an activity to clarify requirements and then transition to an activity to specify protocols for the exchanged data. These would identify the type of data to be exchanged between parties, including the physical schema for exchange files and the logical schema for encoding the connectivity data (e.g., inputs and outputs of each software module, the functions it supports, the indicators it produces, the effect of calibration variables, etc., and their inter-relationships).

We suggest that this team be assembled in the second quarter of 2022 and with an aim to start their work in the third quarter of 2022.

To assemble the team, we suggest that this document be circulated within the appropriate OBD/OBM Industry Committees and directly to personnel known to have an interest in this area. SAE ITC will identify an intermediate lead for the activity with whom parties can ask for clarifications and register their willingness to contribute.

Near-term Plan

1. Identify and engage stakeholders and key contributors
2. Initiate short-term fact-finding effort with BMW, its collaborators, 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 cover enough functionality to prove out the concept.
 - a. Includes formalizing template structure and shared nomenclature
 - b. Includes user and programmer guides
4. Later stages, not addressed at this time, might cover the full set of OBD requirements and application to other use-cases. It could also include:
 - a. Processes
 - b. Interface definitions
 - c. Exchange formats

Initial Questions for Contributors

1. Are you interested in such a collaboration with HRCS to address the relevant CARB certification requirements?
2. Will you be willing to share an overview of your current projects in this area with members of the team?
3. Would you be willing to dedicate the time required to support the initiative and help to produce the required outputs? It is estimated that members of this team will contribute approximately 4 hours per week for coordination and generation of required outputs. This time will typically be spent in a 1-hour meeting per week plus 3 hours of offline work.

HRCS Overview

SAE ITC's HRCS is a Consortium focused on "Health-Ready Components & Systems". HRCS is a 501(C6) organization meaning that the members of HRCS are *companies*, unlike SAE International which is a 501(C3) where the members are *individuals*. This means that a single corporate membership includes all employees of the company.

SAE International is responsible for its standards groups which are forbidden from serving the interest of specific companies but focus instead on the industry as a whole. In a complementary way, HRCS can develop methods and implementations beyond the relevant standards documents and they can indeed serve the needs of its member companies.

Importantly, HRCS provides a legal umbrella for OEMs, suppliers, and integrators to collaborate on a precompetitive basis and avoid running afoul of anti-trust regulations. It also provides an administrative support function to facilitate the smooth functioning of the consortium. This allows HRCS teams to work at a much greater level of detail and to discuss how the results are aligned with member specific applications.

HRCS (<https://www.sae-itc.com/programs/hrcs>) was created to build on its foundation standard document: SAE JA6268 (https://www.sae.org/standards/content/ja6268_201804/) *Design & Run-Time Information Exchange for Health-Ready Components*.

HRCS is able to provide the right kind of organizational structure to address CARB requirements by having key OEMs, suppliers, and technology partners join the consortium and together share the burdens of developing cost-effective solutions meeting the needs of its member companies while addressing the requirements of CARB. Several existing members have expressed interest in participating in this project. HRCS Membership fees are low to encourage increased membership while covering the necessary administrative and support functions. Membership enables unlimited employee participation from the member organization.

Additional Considerations

Membership in HRCS will be needed for all companies that choose to provide the protections of the 501(C6) organization to the contributors of this initiative. The annual membership fee for each company will be less than \$10,000 per year and will depend on membership level chosen. This is the fee for a corporate membership which covers all contributing employees of the company. This will allow contributors to represent and pursue the interests of their companies and develop the resulting standards to a much greater degree of detail.

All information provided by the members is considered confidential among participants in the project that may be used for the sole purpose of developing these deliverables. It cannot be disclosed or distributed to any third party without written permission of the supplying party and remains property of the respective member organization.

The resulting Standard(s) will be released as SAE HRCS documents with HRCS document numbering and published through the SAE Mobilus website.