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Legacy Meets Future: SOA Migration and Signal-to-Service Integration for Automotive HPCs

Jyotsana Singh [1] Piyush Burangi [1] Rital Surana [1] Arshiya Shaikh [1] Uzeena Mhaskar [1]
Pravinjoelraj Victorsam [2] Masato Ugaki [2]

1)FEV Smart Mobility Centre
Baner, Pune, 411045, India
(E-mail: singh_jy@fev.com, burangi@fev.com, surana@fev.com, shaikh_ar@fev.com, mhaskar_u@fev.com)
2)FEV Japan Co., Ltd.
1008 Burex Kojimachi, 3-5-2 Kojimachi, Chiyoda, Tokyo, 102-0083, Japan
(E-Mail: victorsam@fev.com, ugaki@fev.com)

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SOA Migration and Signal-to-Service Integration for Automotive HPCs presents a unified modernization framework enabling coexistence between legacy signal-based ECUs and emerging service-oriented HPC platforms within next-generation Software-Defined Vehicles (SDVs). As OEMs transition from distributed, hardware-centric E/E architectures to centralized and zonal compute domains, the industry faces challenges integrating tightly coupled CAN/LIN-based systems with flexible, service-oriented frameworks such as AUTOSAR Adaptive. The whitepaper addresses these challenges by combining structured SOA migration workflows with a scalable Signal-to-Service (S2S) translation mechanism, ensuring real-time behaviour, functional safety alignment, and future software extensibility.

A technical case study demonstrates two complementary modernization directions: migrating ADAS functions Traffic Sign Recognition (TSR) and Adaptive Cruise Control (ACC) to Adaptive AUTOSAR, and translating legacy body-domain CAN signals such as Child Lock and Light Control Module (LCM) functions into Ethernet-based service interfaces. TSR is transformed from a Python perception module into a DDS-enabled Adaptive application, while ACC's model-based logic is converted into optimized C++ suitable for HPC environments. In parallel, a bidirectional S2S translation pipeline running on an NXP Gold Box gateway maps legacy CAN frames to structured service payloads, consumed by both HPC applications on NVIDIA Orin Jetson and a virtualized IVI cluster on QEMU. The combined setup validates end-to-end interoperability where perception, control, and body-domain functions operate cohesively within a service-oriented architecture.

Results confirm seamless integration across ADAS, cockpit, and body functions without modifying validated legacy ECUs, establishing a hybrid SDV-aligned environment that supports incremental migration, mixed-criticality execution, early virtualization-based validation, and reuse of proven algorithms. The unified workflow provides reusable templates, decision matrices for SOA applicability, consistent data semantics across domains, and a practical approach for exposing CAN-based features as discoverable services.

The whitepaper also outlines project offerings that support SDV transformation platform software engineering, CAN-to-Ethernet translation, SOA migration assets, solution accelerators, and customizable workflows enabling OEMs to avoid fragmented gateway solutions while accelerating the shift toward scalable, software-defined platforms.

Looking ahead, the roadmap emphasizes OTA-enabled lifecycle management, increasing adoption of modular open-source components, strengthened safety and cybersecurity frameworks, unified gateway architectures, and the growing role of Generative AI in accelerating design, abstraction, and validation. These hybrid architectures will progressively evolve into fully service-oriented SDV ecosystems, leveraging centralized compute nodes, Ethernet backbones, and cloud-integrated toolchains to achieve continuous improvement and domain-wide coordination.

In conclusion, the proposed modernization strategy provides a practical, scalable migration path from legacy signal-based systems to unified SDV architectures. By combining structured SOA transformation with real-time S2S translation, the framework supports reuse of legacy functionality, minimizes disruptive redesign, and establishes a foundation for production-grade service-oriented automotive platforms.

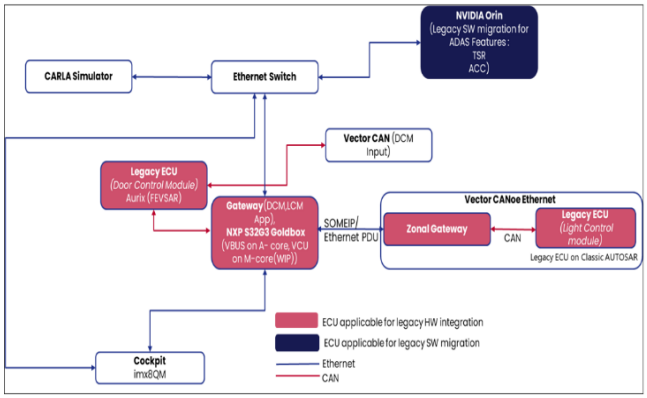

Fig.1 Legacy-to-SOA Migration Demonstration Setup for Automotive HPC with Signal-to-Service Integration