A MODULAR FRAMEWORK FOR DASHBOARD INTEGRATION IN SOFTWARE-DEFINED VEHICLES USING SERVICE-ORIENTED ARCHITECTURE

Master's Student: Gustavo Viana Leite Scheidt

Advisors: Max Mauro Dias Santos & Evandro Leonardo Teixeira

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Federal Technological University of Paraná– Ponta Grossa
Ponta Grossa, Paraná, Brazil

gustavoscheidt@alunos.utfpr.edu.br

Summary

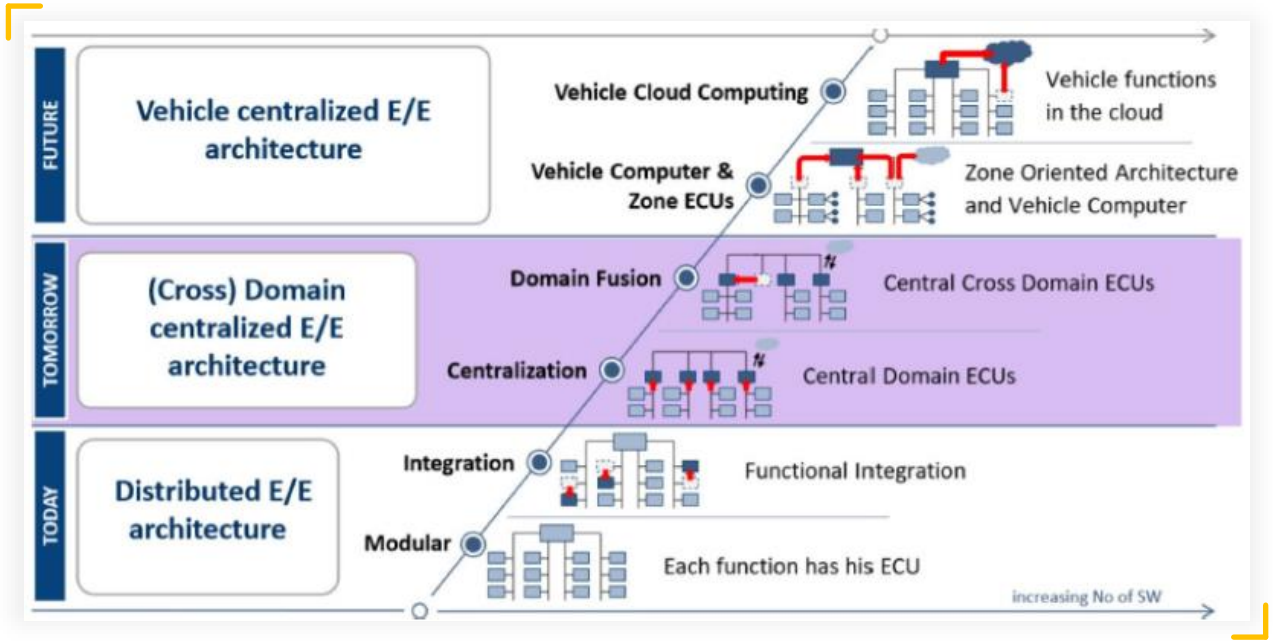
Motivation

Industry shift:

- Automotive industry moving towards SDVs due to the need for flexibility and adaptability in vehicle functionalities.
- Increasing complexity of vehicle features (i.e., ADAS, infotainment and real-time diagnostics).

Industry gap:

- Traditional architectures struggle with scalability and integration of new features.
- Use of multiple modules that could be combined
- Real-time data processing challenges due to the increasing complexity, safety and data processing requirements.
- Limited data availability regarding development frameworks and processes



Motivation

Why SOA-based Dashboard?

- SOA provides a modular, flexible, and scalable framework.
- Easily integrates various components, reducing development time and increasing flexibility for future upgrades.
- Facilitates real-time data processing, critical for modern vehicles with complex systems.

Industry Trends:

- Growing demand for connected and autonomous driving technologies.
- Major role of dashboards to support these emerging trends.

Problem Statement

The Problem:

- Existing automotive dashboard systems are not designed to easily integrate new features.
- Issues with scalability, integration, and real-time performance hinder the development of next-gen dashboards.
- The challenge: How can we create a flexible, scalable, and future-proof framework for dashboard integration?

Research Objectives:

- Provide a structured theoretical foundation for understanding the potential of a modular SOA
- Develop a modular framework using SOA to overcome the integration and scalability challenges in traditional dashboard systems.
- Enable real-time data processing and seamless integration of new services (e.g., navigation, ADAS, infotainment).
- Ensure compliance with key automotive industry standards (ISO 26262, ISO/SAE 21434) to enhance safety and security.
- Future-proof the dashboard design to accommodate emerging technologies like AI, autonomous driving, and machine learning.

Case Studies - BMW iDrive System

BMW iDrive System:

- Implementation of SOA: The BMW iDrive system leverages SOA principles to integrate various services.
- Architecture: Layered architecture with a clear separation between the user interface, service logic, and data management .
- Benefits: The iDrive system is highly modular, scalable, and allows for easy integration of new features through OTA updates .

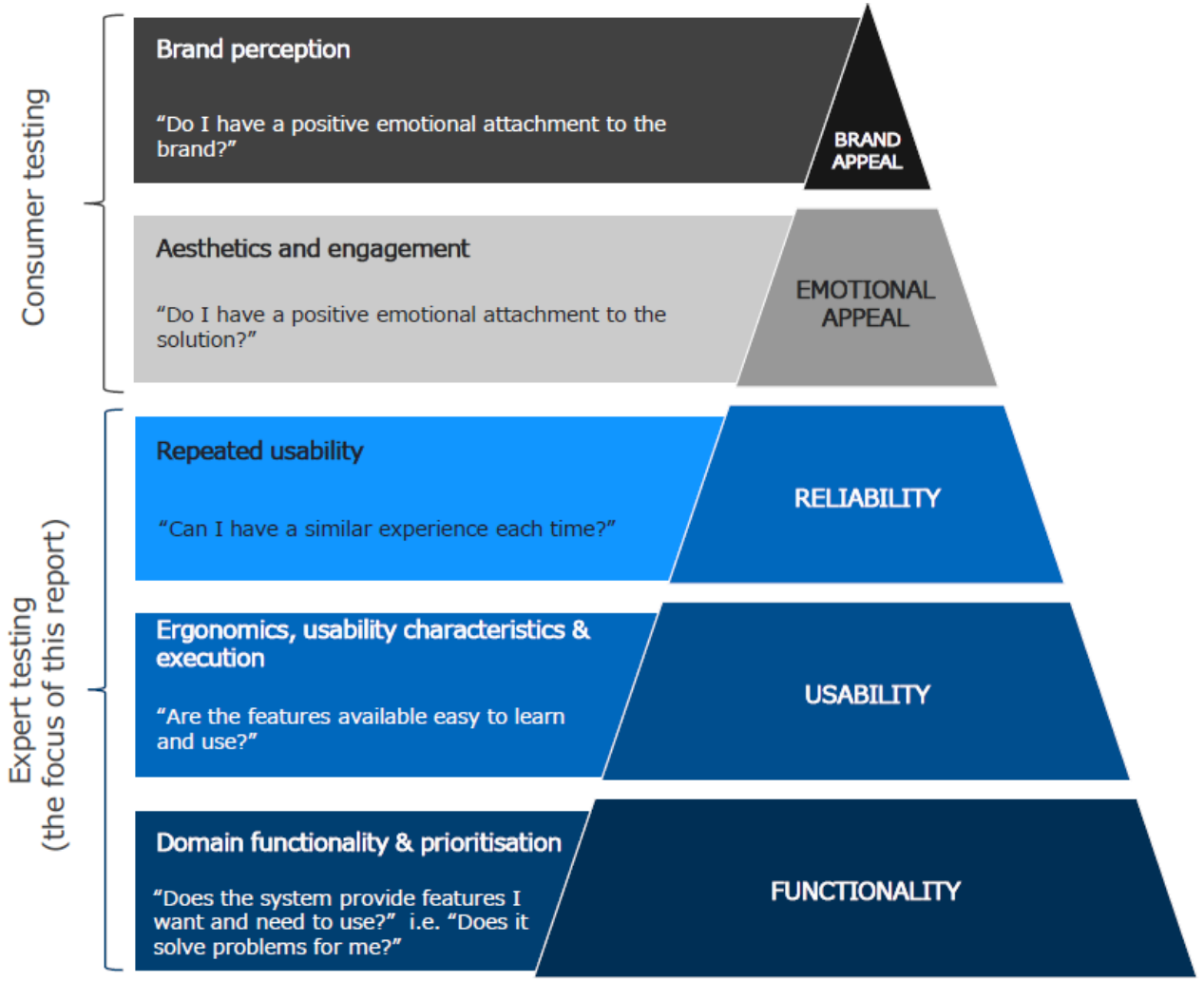
Case Studies - Evaluation & Benchmarking Industry Reports

Key Metrics Checked

- Features and Functionality
- Usability
- Reliability and Stability
- Performance
- Perceived Quality

Tests Performed

- Objective Tests
- Subjective Tests
- Task-Based Evaluations
- Freeform Testing Dynamic Testing
- Misuse/Failure Testing



Foundation - Conceptual Framework Design

Systematic Literature Review

Review Protocol

Systematic review methodology

Research Strategy

- Research questions
- Search strings

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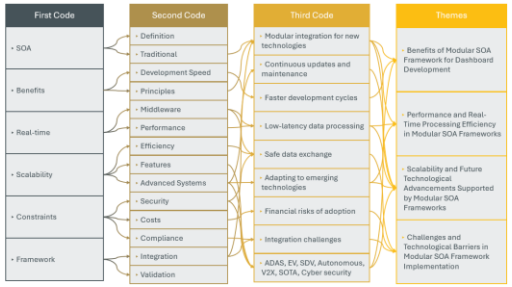

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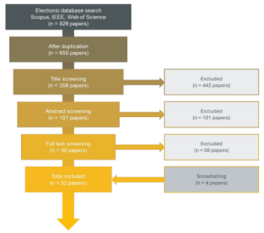

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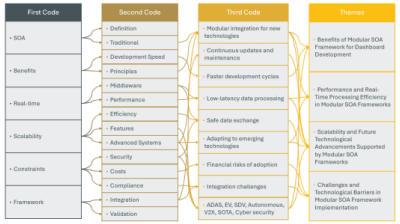

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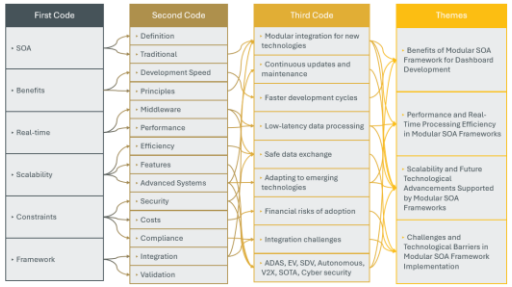

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Thematic Analysis and Findings

Theme 1

Scalability and Future Technological Advancements Supported by Modular SOA Frameworks

Theme 2

Performance and Real-Time Processing Efficiency in Modular SOA Frameworks

Theme 3

Benefits of Modular SOA Framework for Dashboard Development

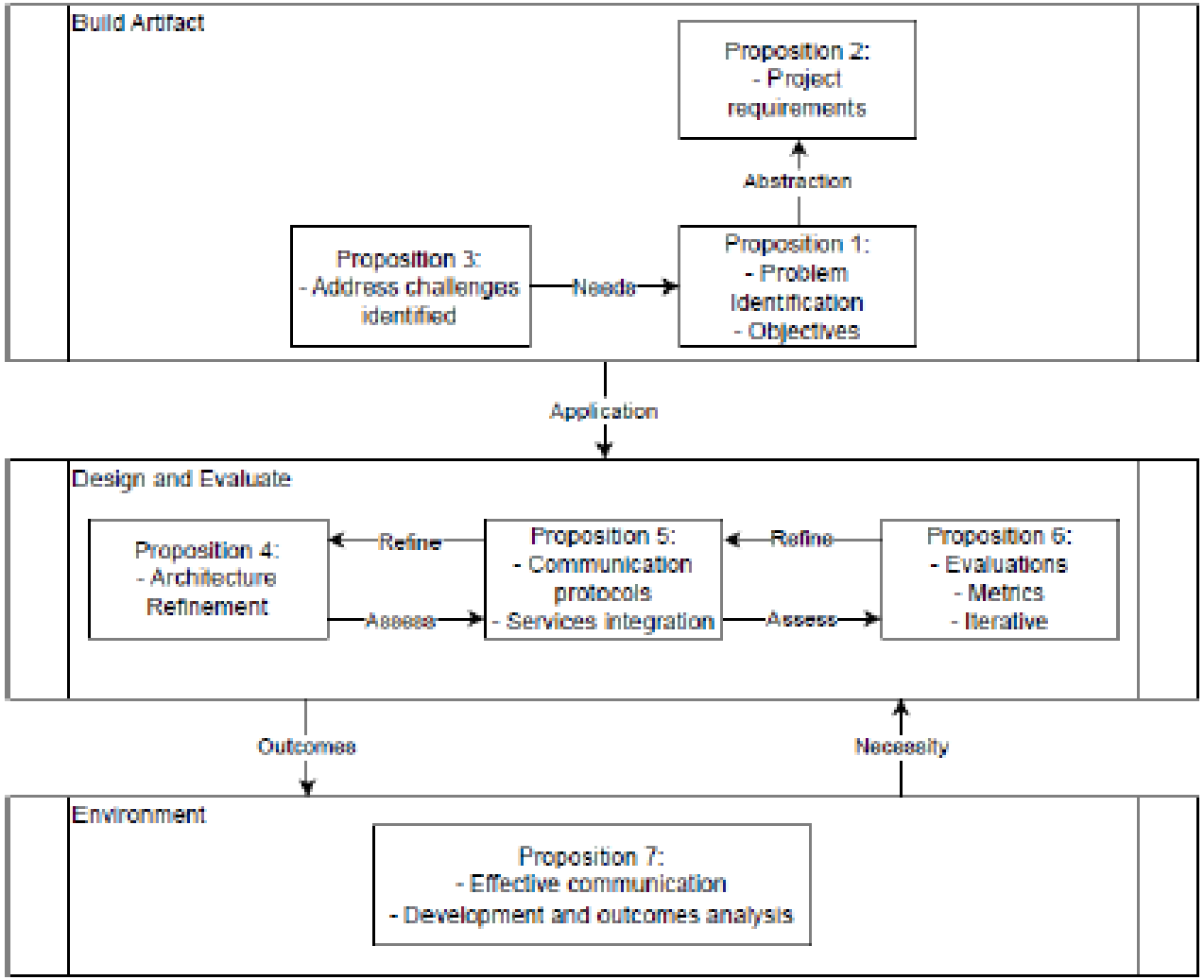
Theme 4

Challenges and Technological Barriers in Modular SOA Framework Implementation

Foundation - Conceptual Framework Design

Design Science Research Framework and Propositions

- DSR Conceptual Framework Process
  - Proposition 1: Identify objectives and challenges to develop project scope and requirements.
  - Proposition 2: Define services to ensure modularity, scalability, and seamless integration.
  - Proposition 3: Establish clear objectives for secure and compliant development.
  - Proposition 4: Refine architecture for adaptability and future advancements.
  - Proposition 5: Perform testing and integration to optimize findings and improve performance.
  - Proposition 6: Validate framework through evaluations, compliance, and stakeholder feedback.



Solution - SOA-Based Framework Guidelines

A **step-by-step** guide to building a scalable and modular architecture for dashboard integration.

- **Define Project Scope and Requirements**
- Define System Services
- Implement Security and Compliance
- Implement Data Management
- Design the Architecture
- Integrate Services
- Deployment and Maintenance
- Develop the User Interface

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Solution – Key Technologies

1. Real-Time Data Processing and Sensor Communication

- CAN
- LIN
- Ethernet
- SOME/IP

2. Data Storage and Management

- SQLite
- InfluxDB
- NoSQL Databases

3. Middleware and Base Software

- AUTOSAR Adaptive Platform
- VSOME/IP

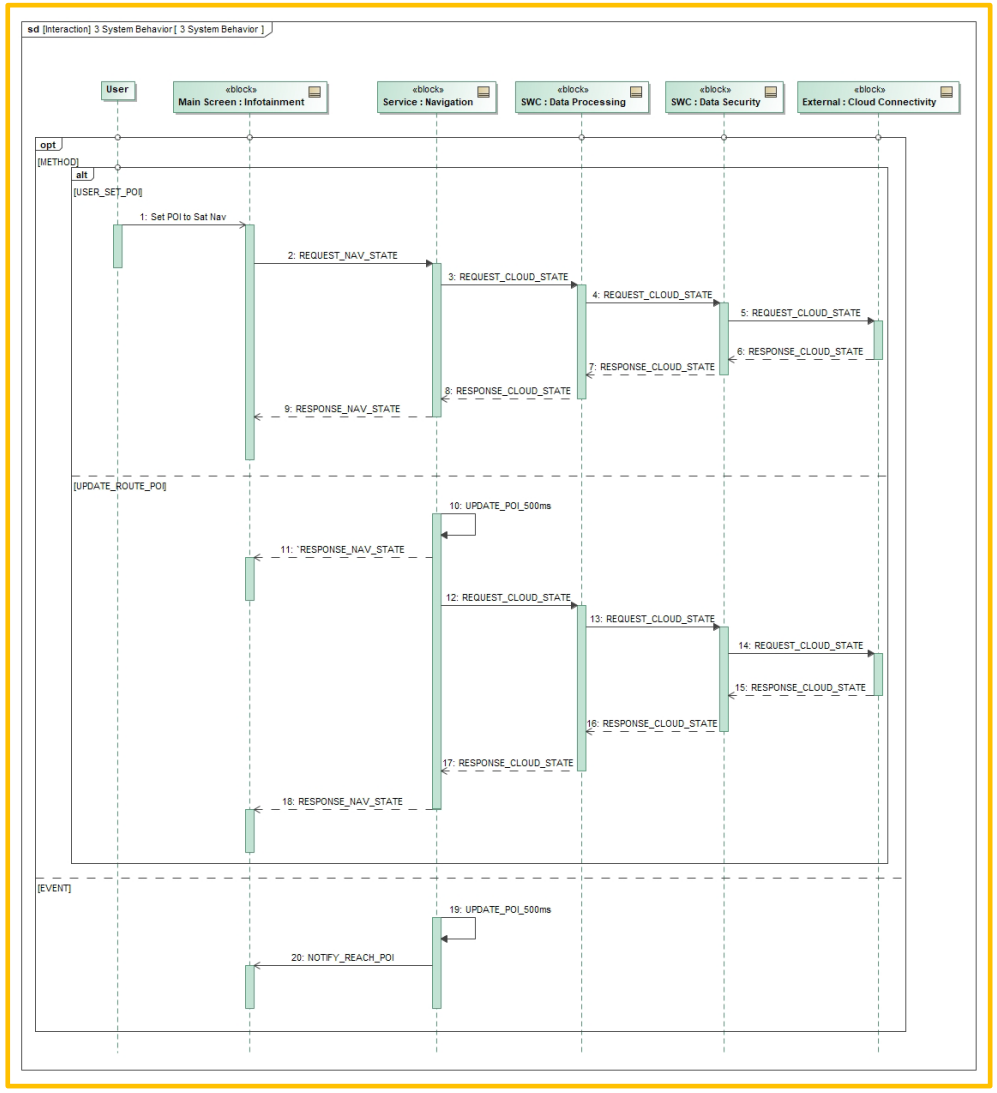
4. Simulation and Development Tools

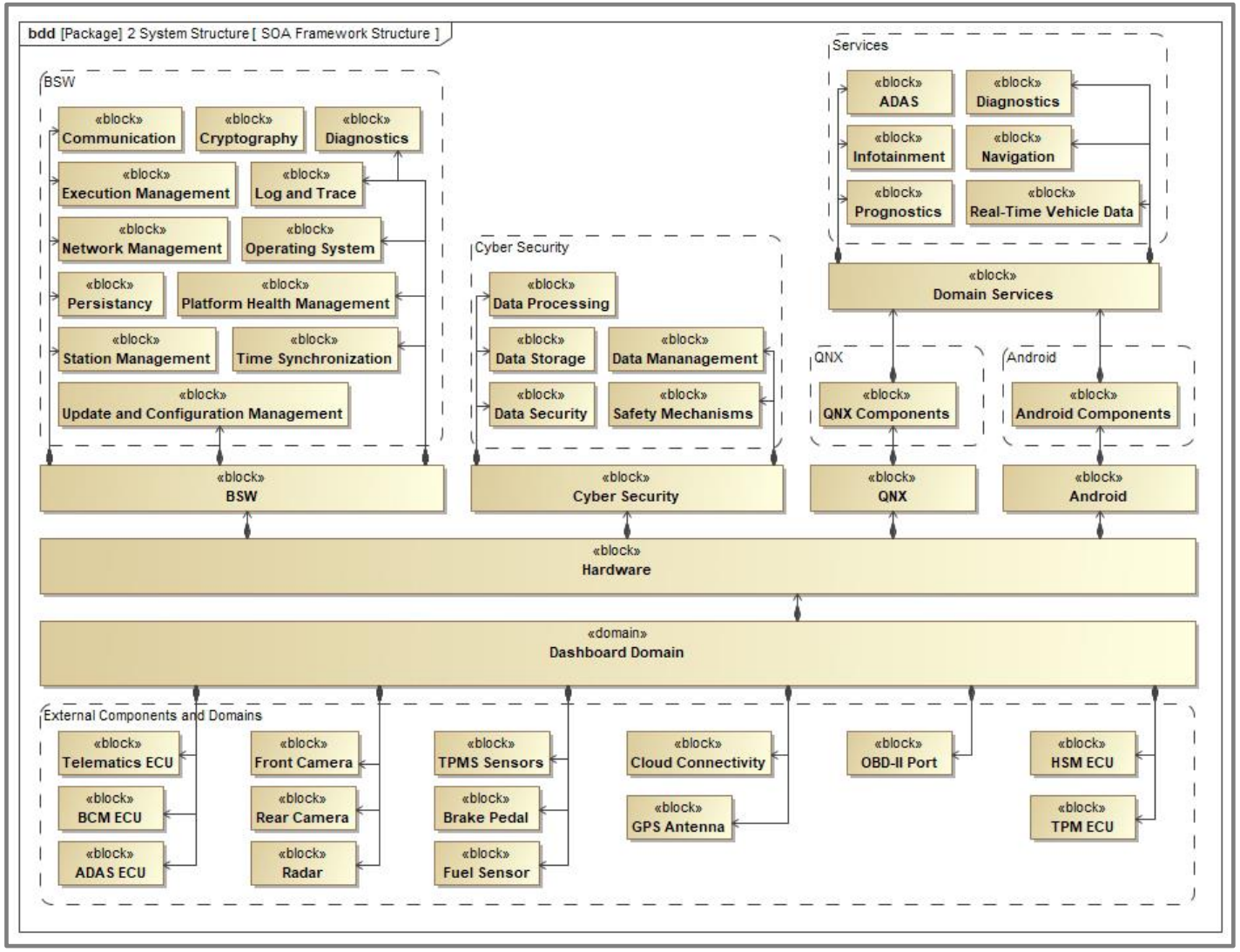
- MATLAB/Simulink
- Software-in-the-Loop (SIL)
- Hardware-in-the-Loop (HIL)

5. Cybersecurity and Data Security

- AES-256
- TLS (Transport Layer Security)
- RBAC (Role-Based Access Control)
- Trusted Platform Modules (TPM)

Solution – Framework Overview

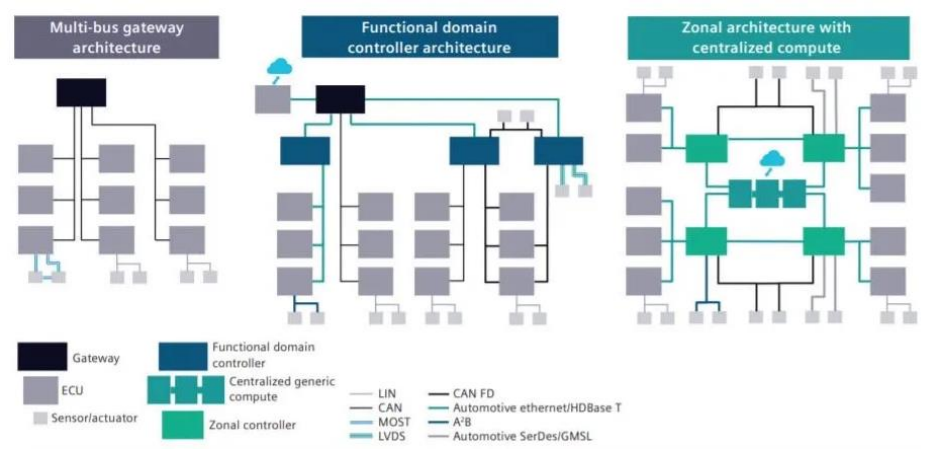




Architectures Comparison

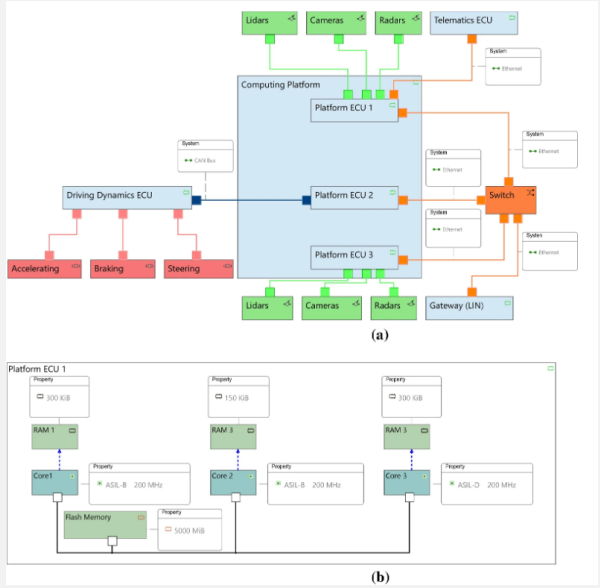
Traditional Dashboards:

- Monolithic design, hard to scale, complex to update or add new features.
- Services are tightly coupled, making integration of new systems (like ADAS) costly and time-consuming.



SOA-Based Dashboards:

- Modular design enables scalability and flexibility.
- Easier integration of new technologies such as ADAS and infotainment.
- Services are decoupled, allowing updates or new integrations without affecting existing systems.



Next Steps – Future Implementation

Collaboration:

- Continue to collaborate with automotive professionals and group partners to further develop and refine the SOA framework for diverse vehicle models and advanced technologies

Implementation of SOA Framework:

- Practical implementation of the SOA framework developed, focusing on modularity, real-time data handling, and service integration.

Simulation:

- Run simulations of the SOA framework in a controlled environment to validate system behavior, real-time data processing, and service independence.

Prototyping:

- Develop a prototype of the SOA-based dashboard for initial testing on hardware platforms before vehicle integration.

“ The automotive industry is at a pivotal juncture, with SDVs enabling smoother interaction between a vehicle’s internal systems and the outside world. ”

Arm Newsroom

QUESTIONS?

THANK YOU

Gustavo Viana Leite Scheidt