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hybrid event

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Applying a System of Systems Perspective to Hyundai-Kia's Virtual Tire Development

HYUNDAI
MOTOR GROUP

SIEMENS

15-20 July - 2023

www.incose.org/symp2023 #INCOSEIS

Presenter Bio



Shashank Alai

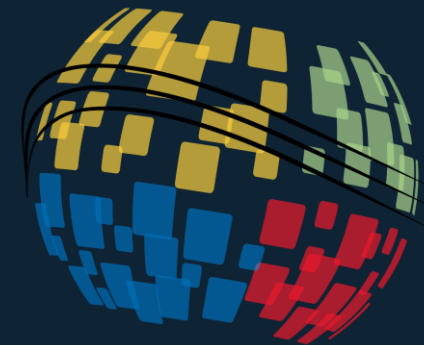
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Outline

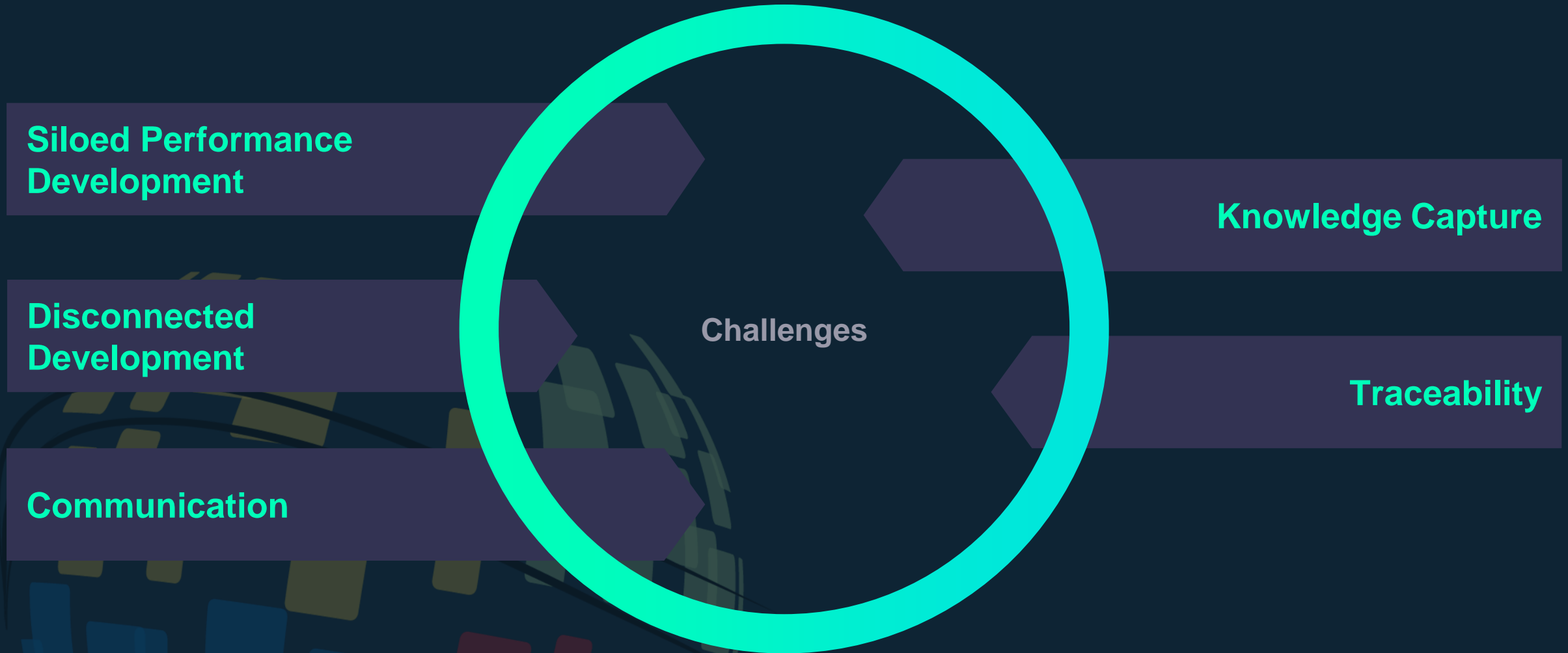
- Background
- SoS Rationale
- Virtual Tire Development Process
- Process Orchestration
- Conclusion & Observations

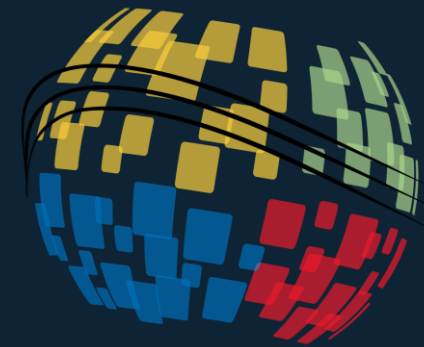


Motivation

Background

Key Motivations for Hyundai

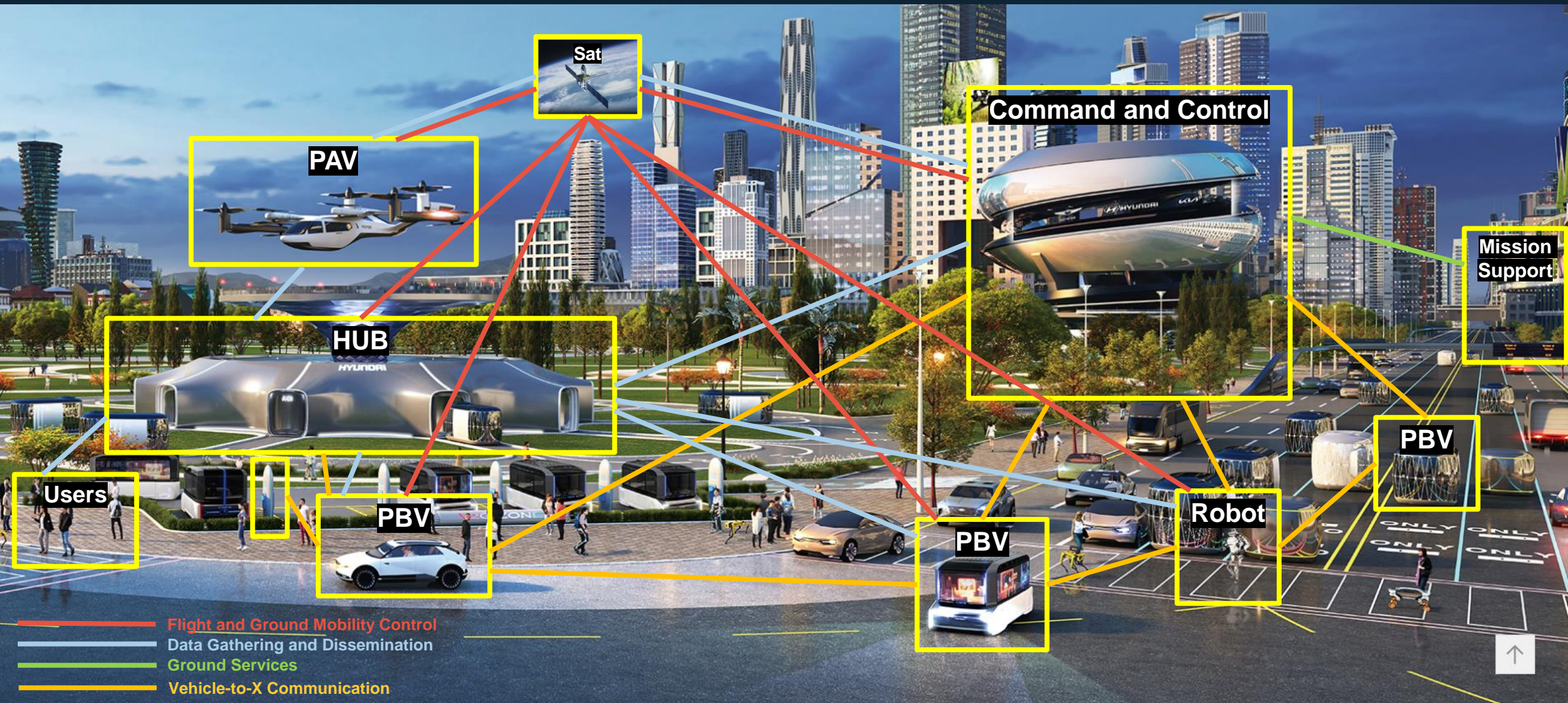




EV Mobility

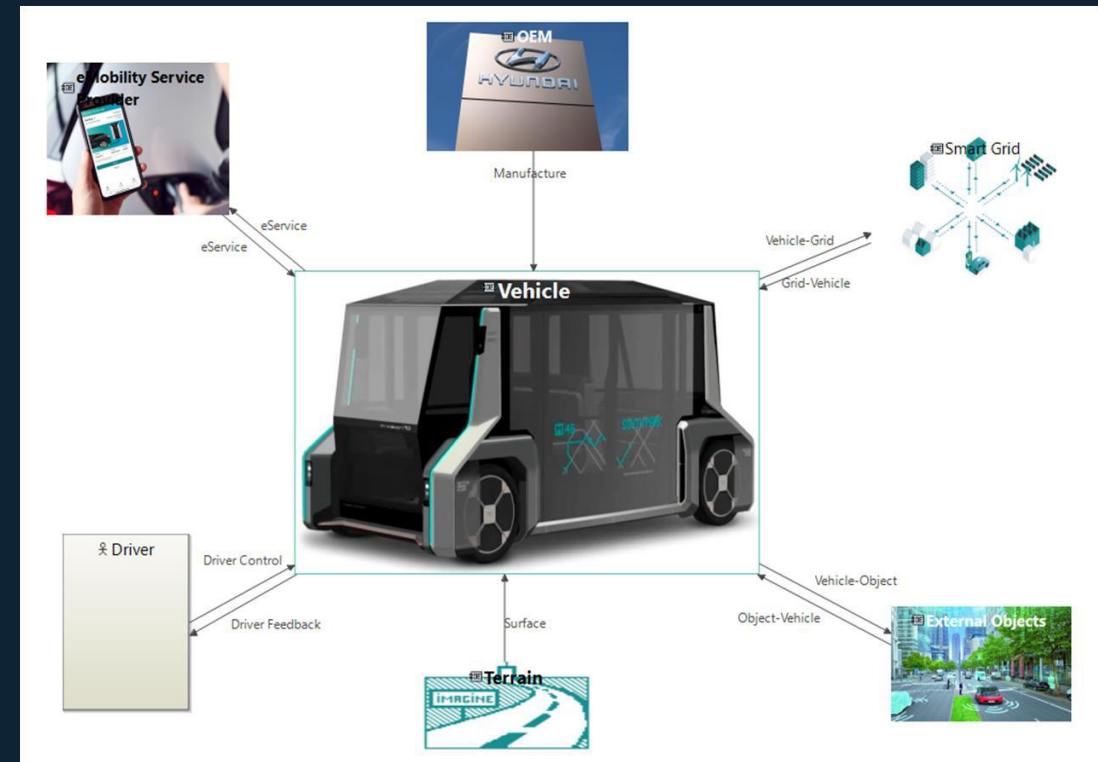
SoS Rationale

The Essence of Future Mobility Lifestyle – Hyundai Motor Group



Narrowing the Case for EV Mobility SoS

1. Operational Independence
2. Managerial Independence
3. Geographical Distribution
4. Evolutionary Development Processes
5. Emergent Behavior



Project Scope

To develop a 'purpose built vehicle' concept architecture that can:

1. Provide a descriptive reference of the SoS context, its constituent vehicle's functions, structure, and interfaces,
2. Enable early vehicle/tire performance verification based on predefined metrics and,
3. Enable system-to-subsystem collaboration with downstream subsystem and component designers/architects through a cross-domain collaboration platform

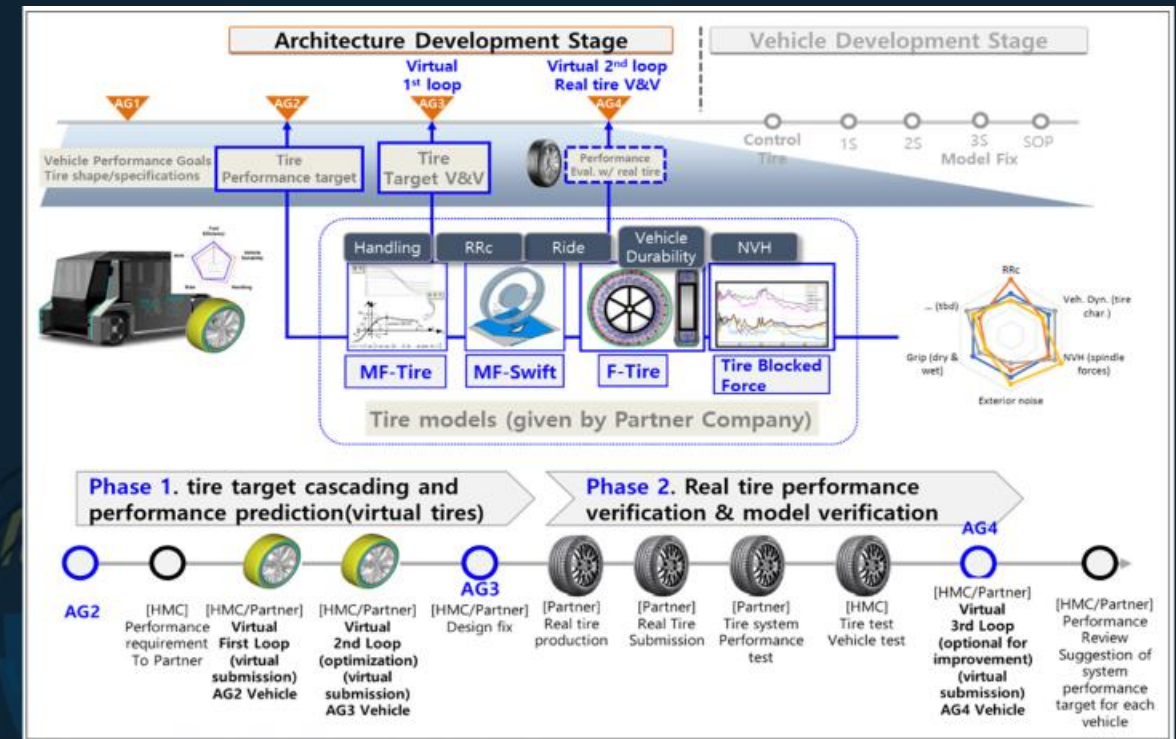


Hyundai-Kia

Virtual Tire Development Process

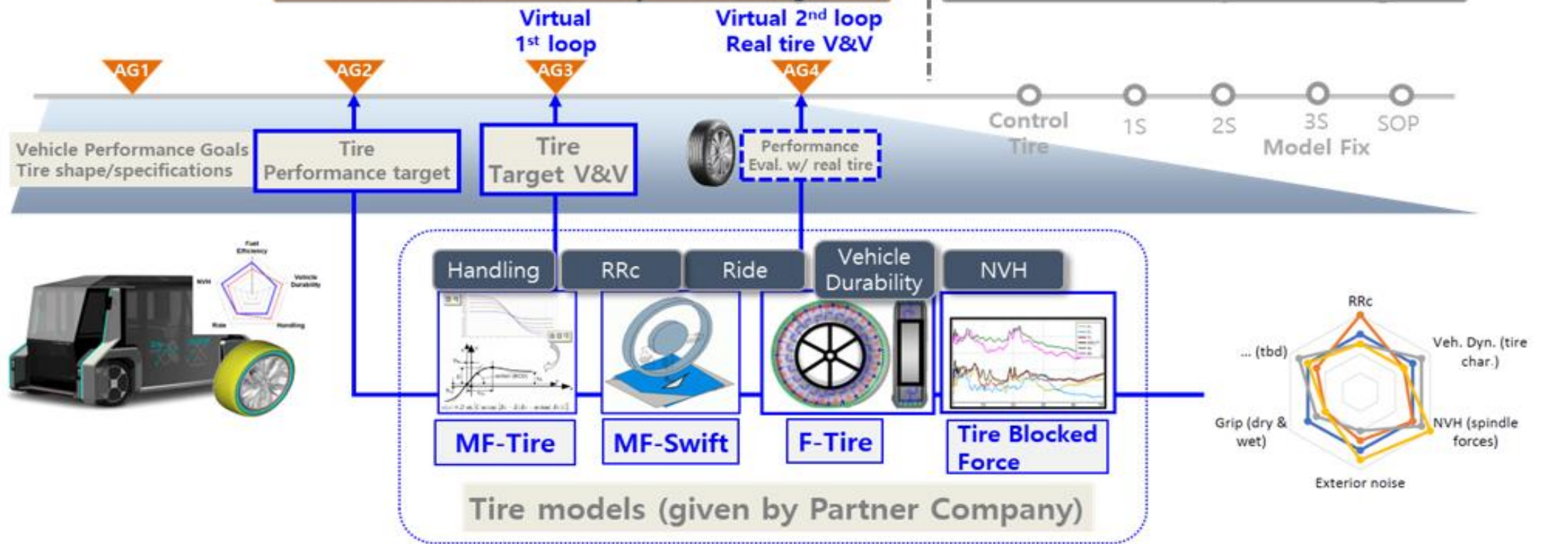
Process

1. Vehicle level performance tradeoffs
2. Vehicle-tire targets cascading
3. Tire level performance tradeoffs



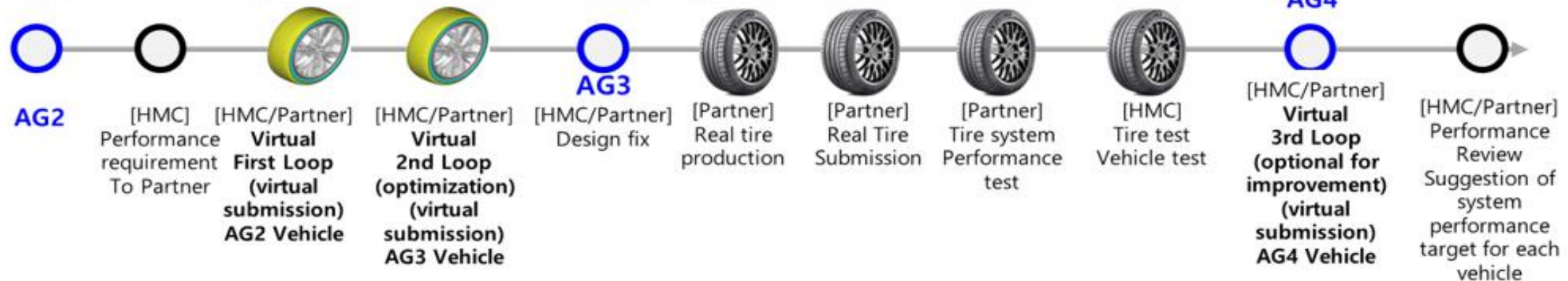
Architecture Development Stage

Vehicle Development Stage



Phase 1. tire target cascading and performance prediction(virtual tires)

Phase 2. Real tire performance verification & model verification



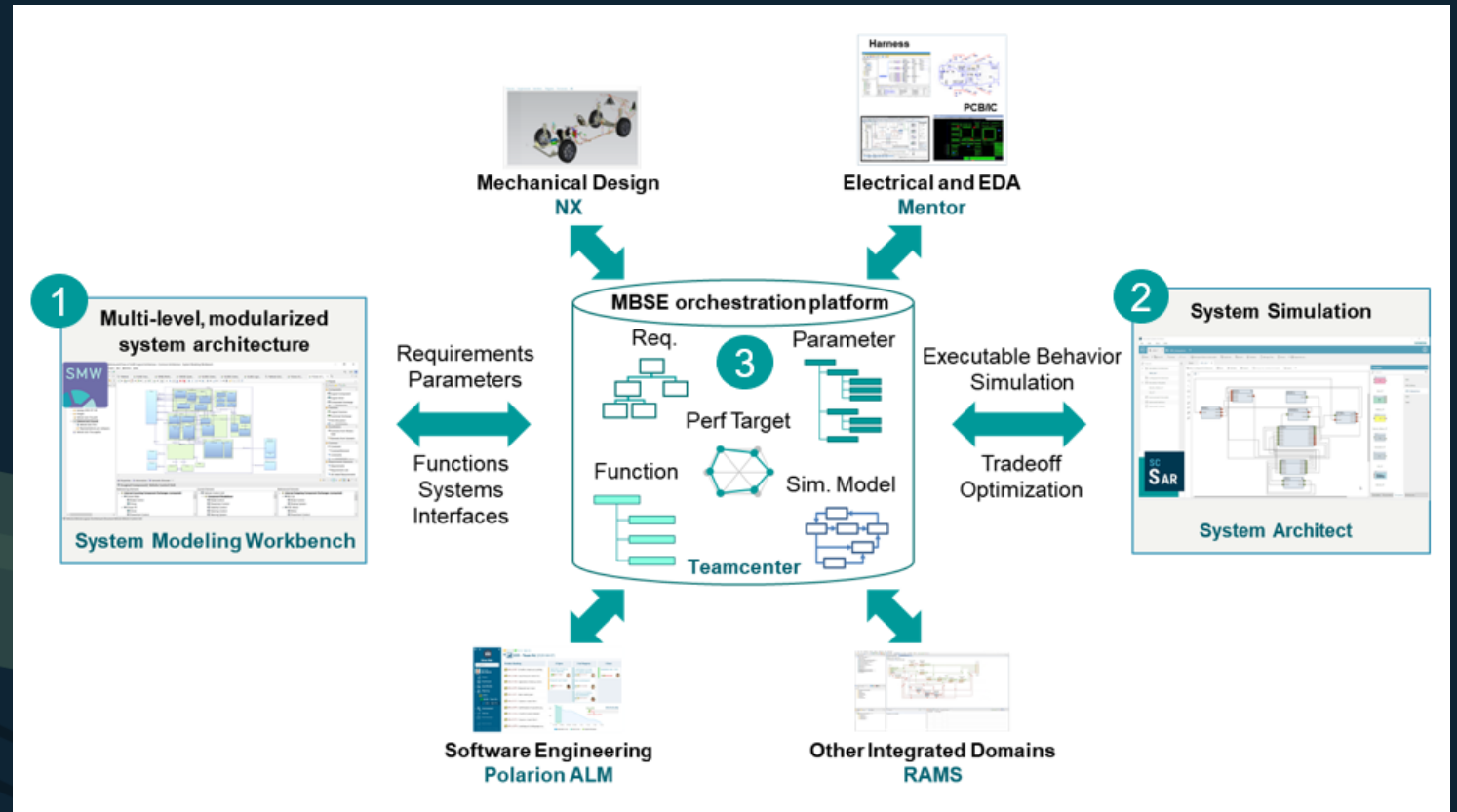


Virtual Tire Development with MBSE

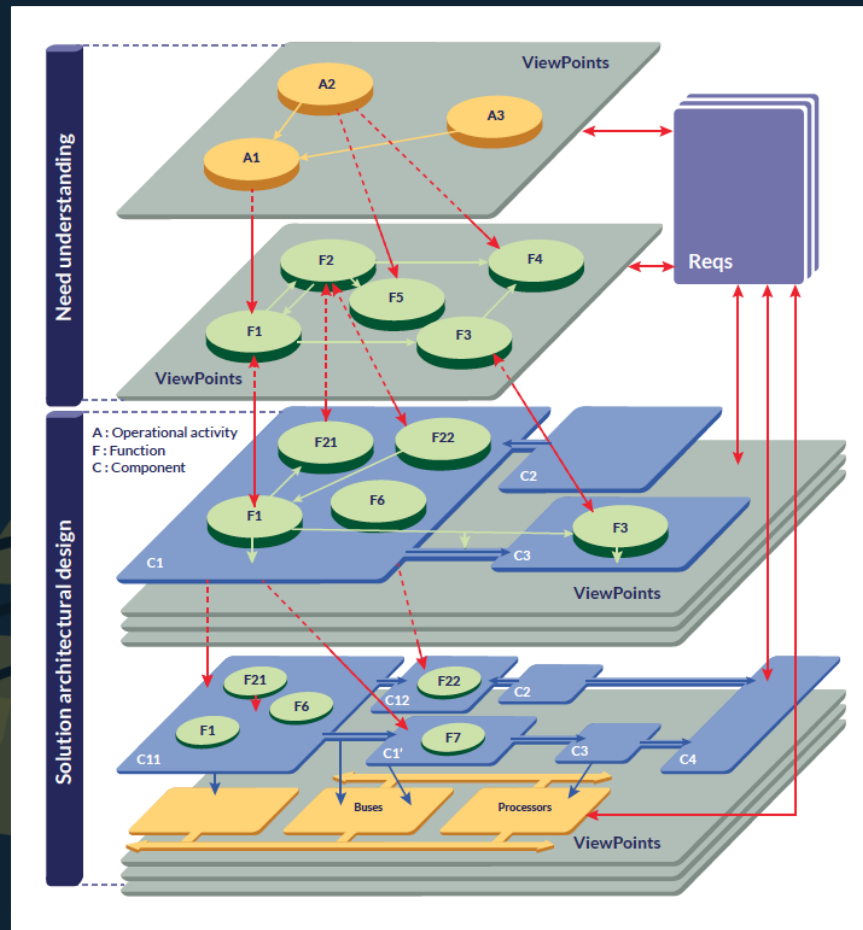
Process Orchestration

Process Elements

1. **System Architecture Modeling:** System Modeling Workbench
2. **System Simulation:** Simcenter System Architect, Amesim
3. **MBSE Orchestration:** Teamcenter



The Arcadia Method



Operational Analysis

What the users of the system need to accomplish

System Analysis

What the system need to accomplish for the users

Logical Architecture

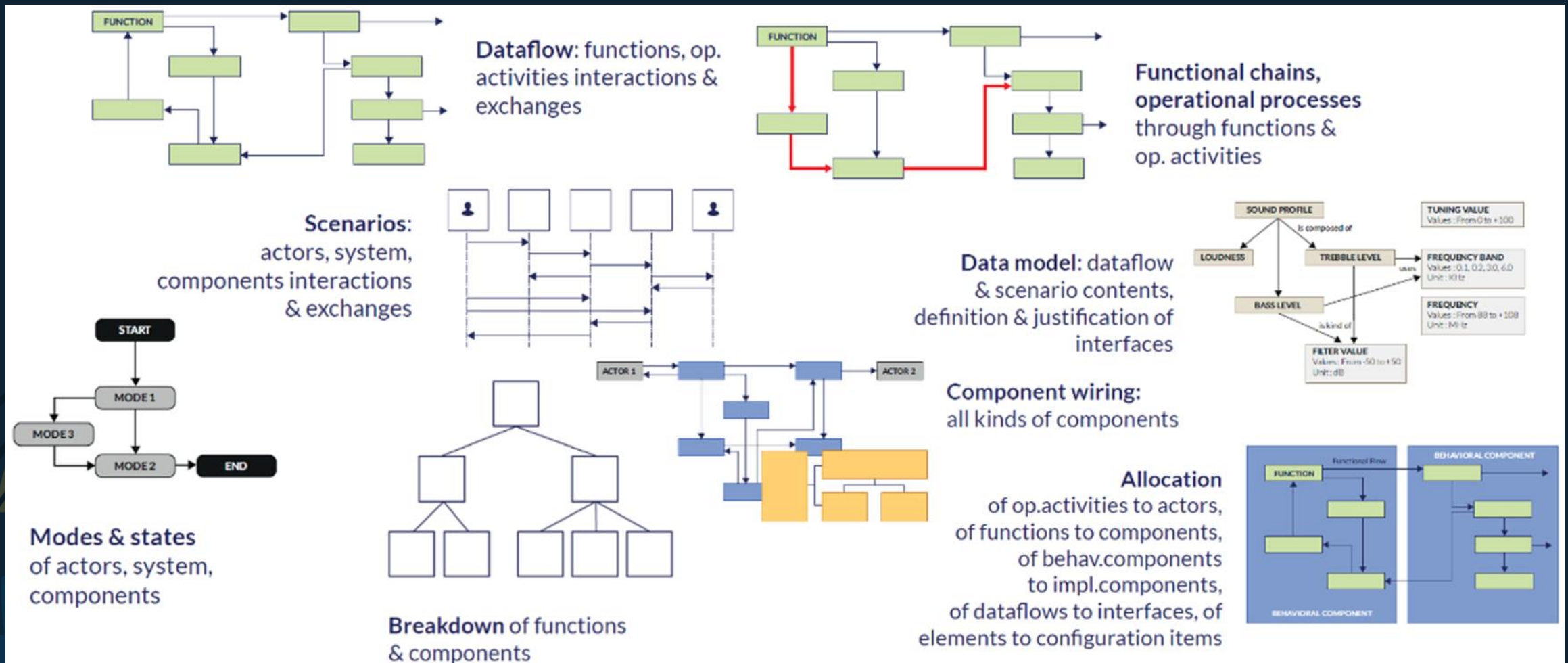
How the system will work to fulfill expectations

Physical Architecture

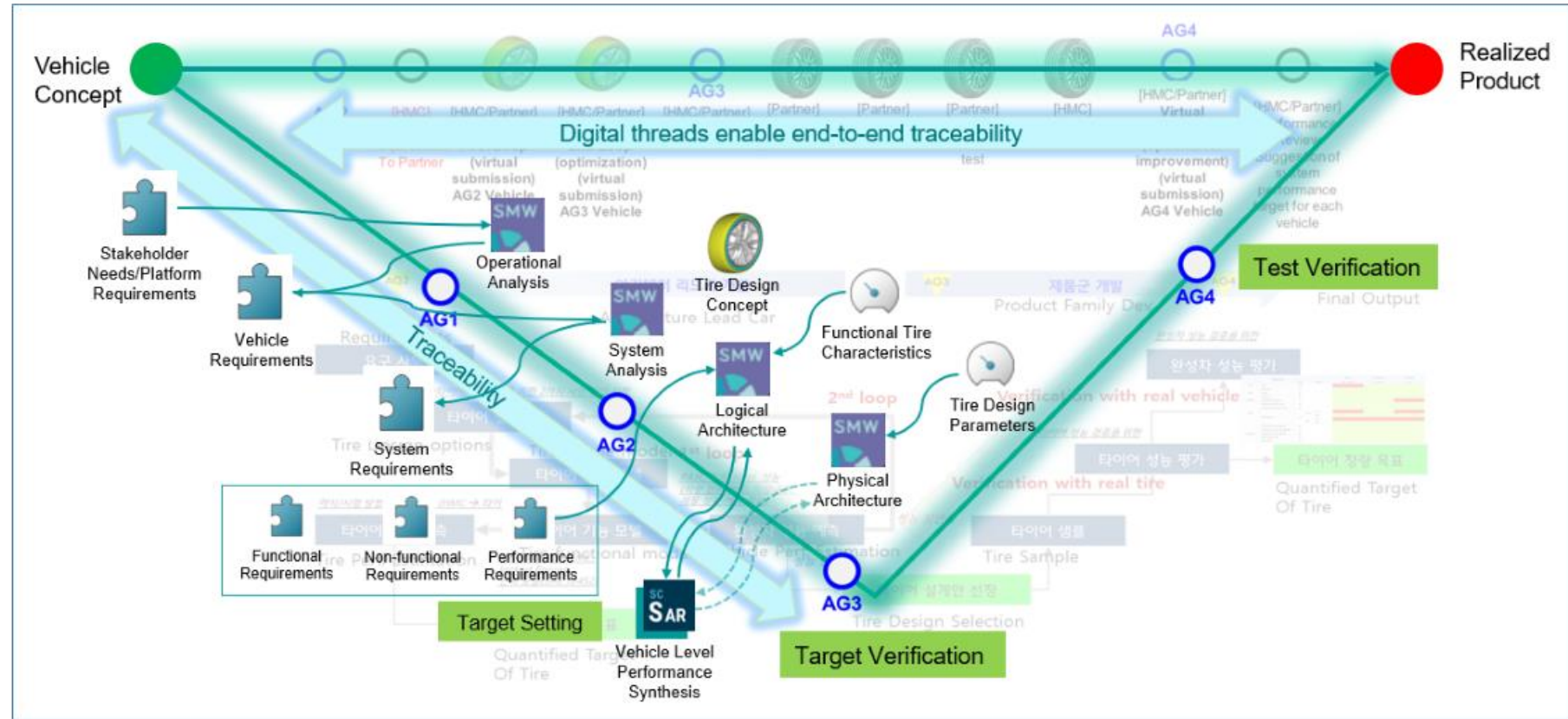
How the system will be developed and built

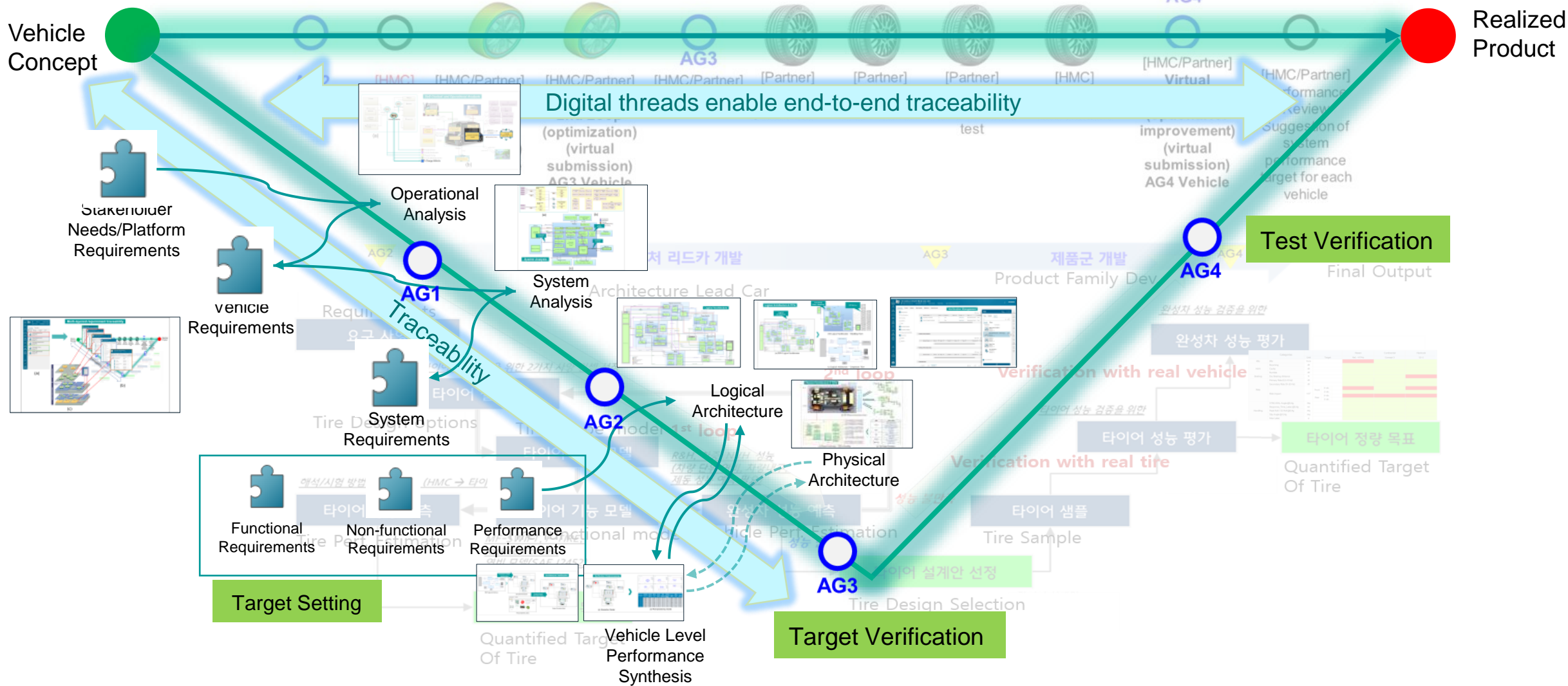
System Modeling Workbench

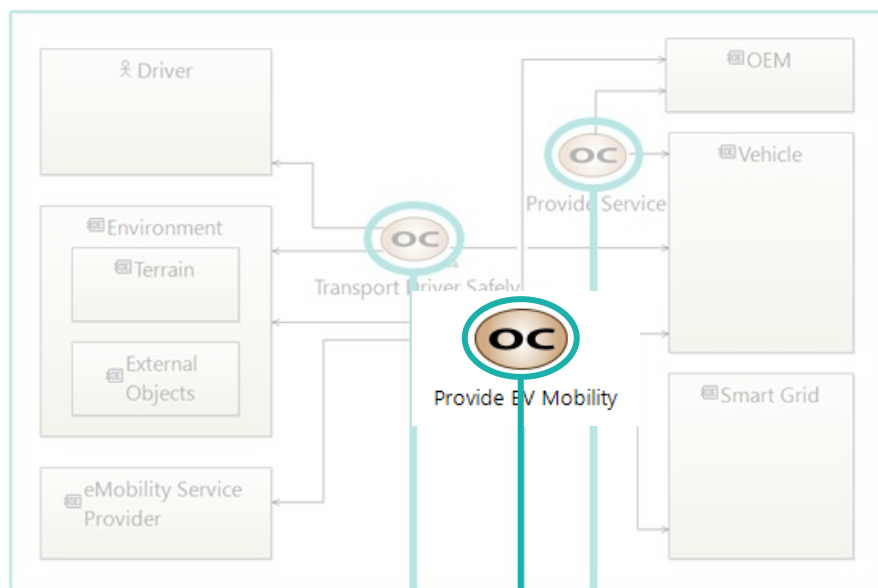
Arcadia Method – Key System Engineering Artifacts



Process

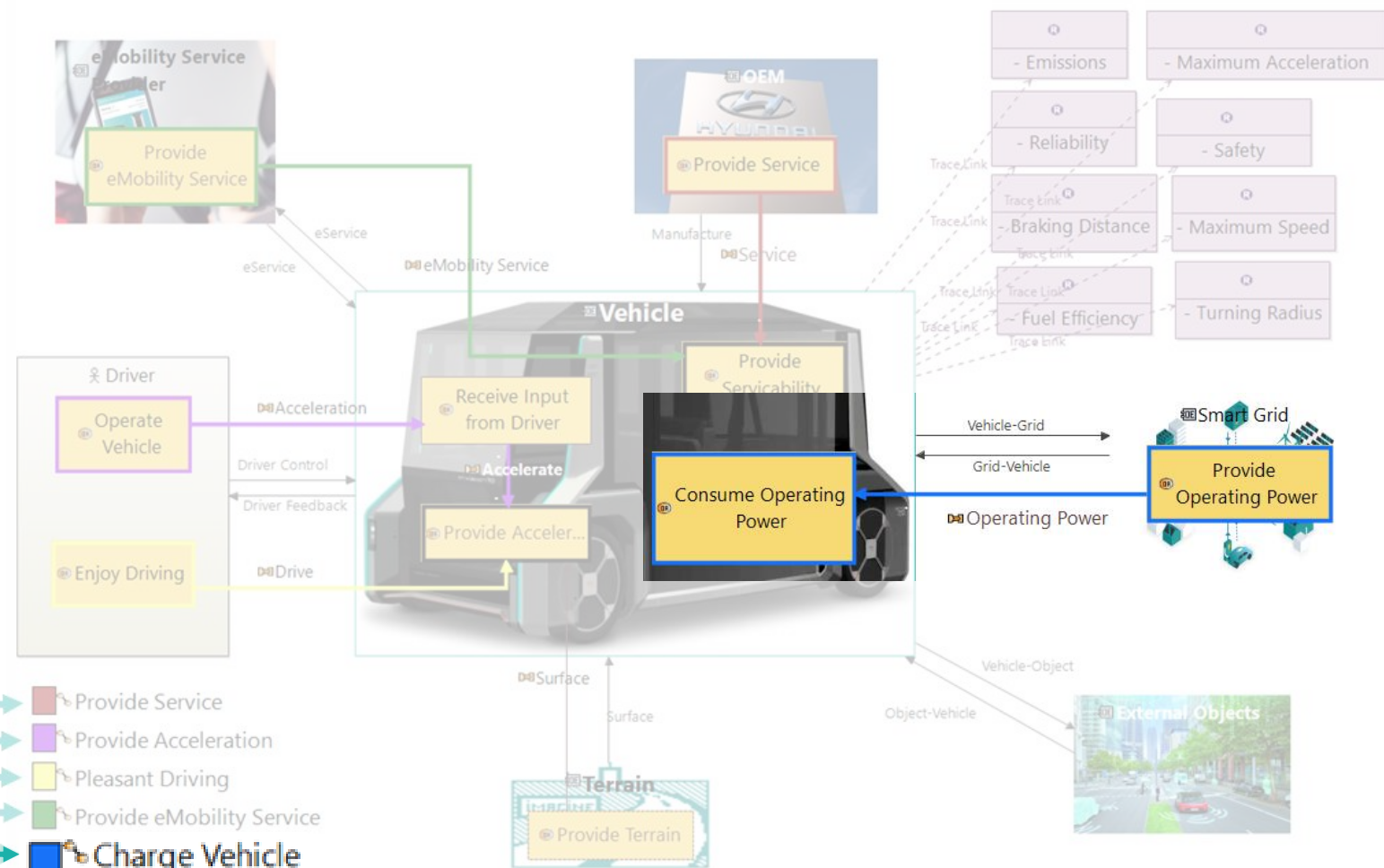




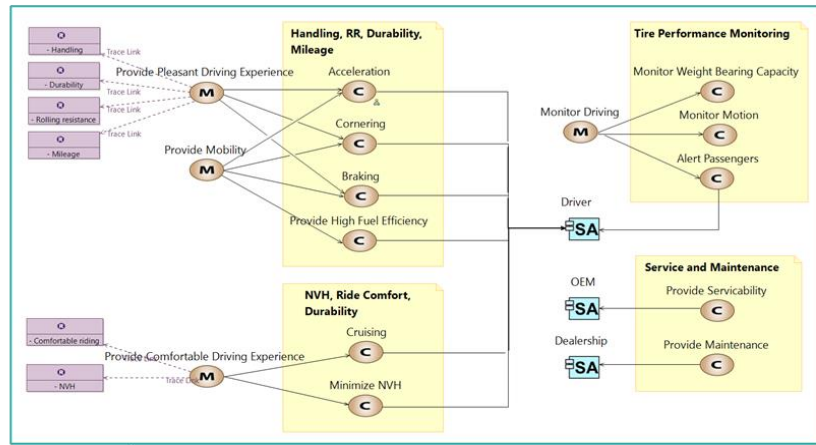


(a)

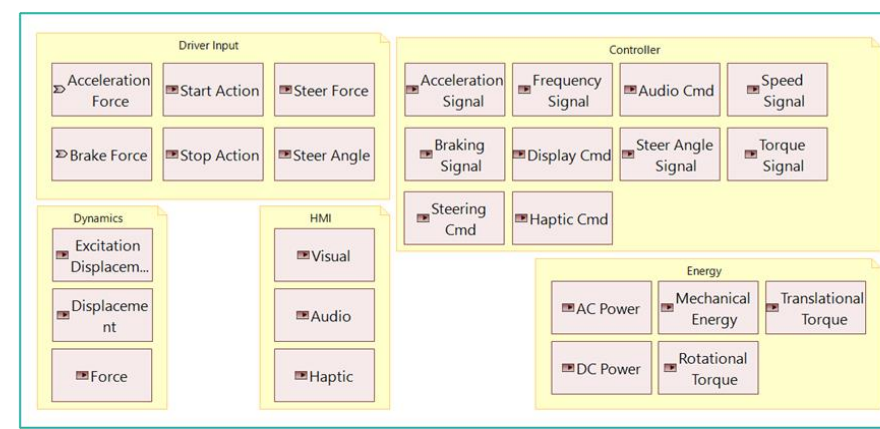
SoS Context and Operational Analysis



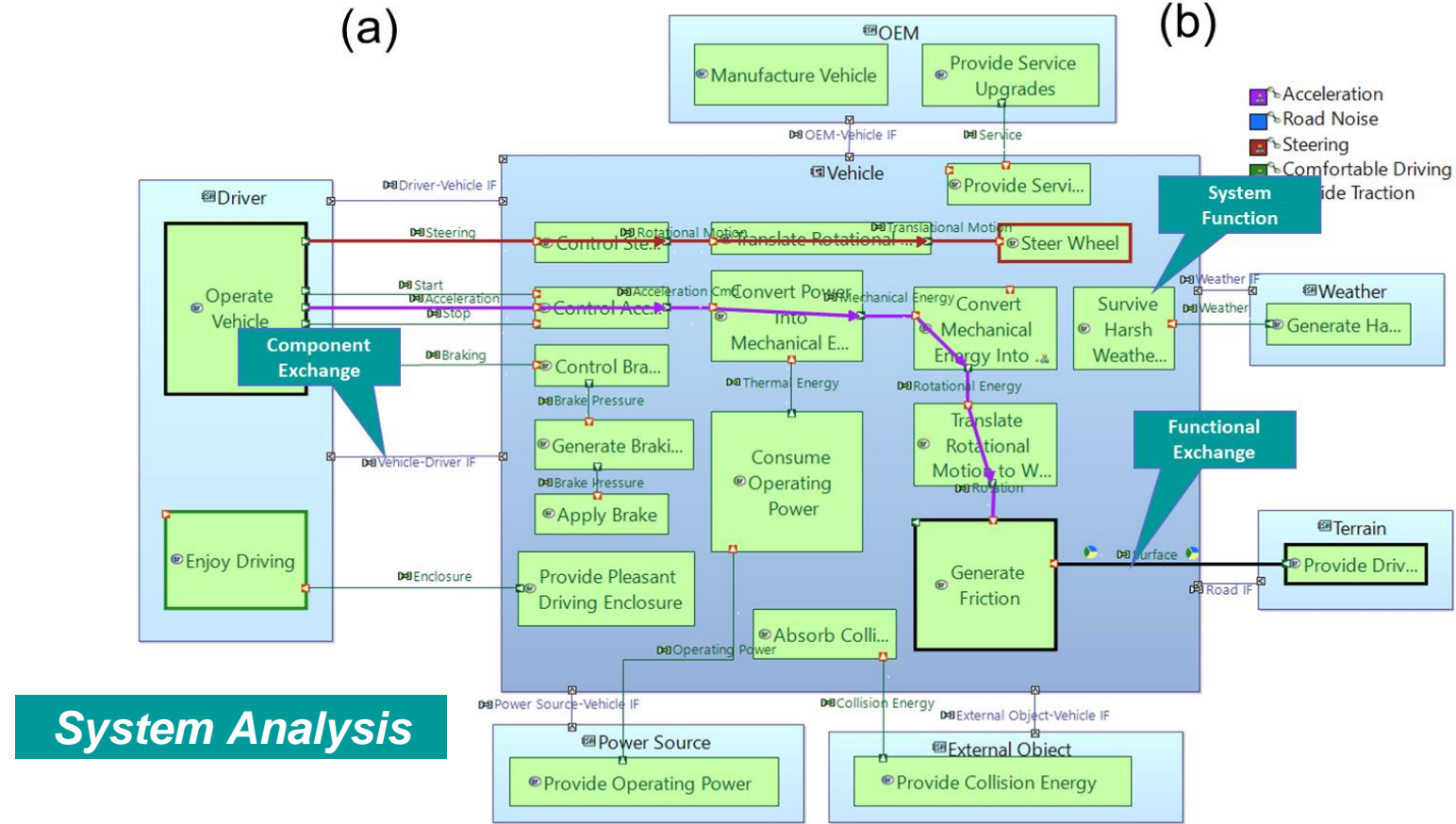
(b)



(a)



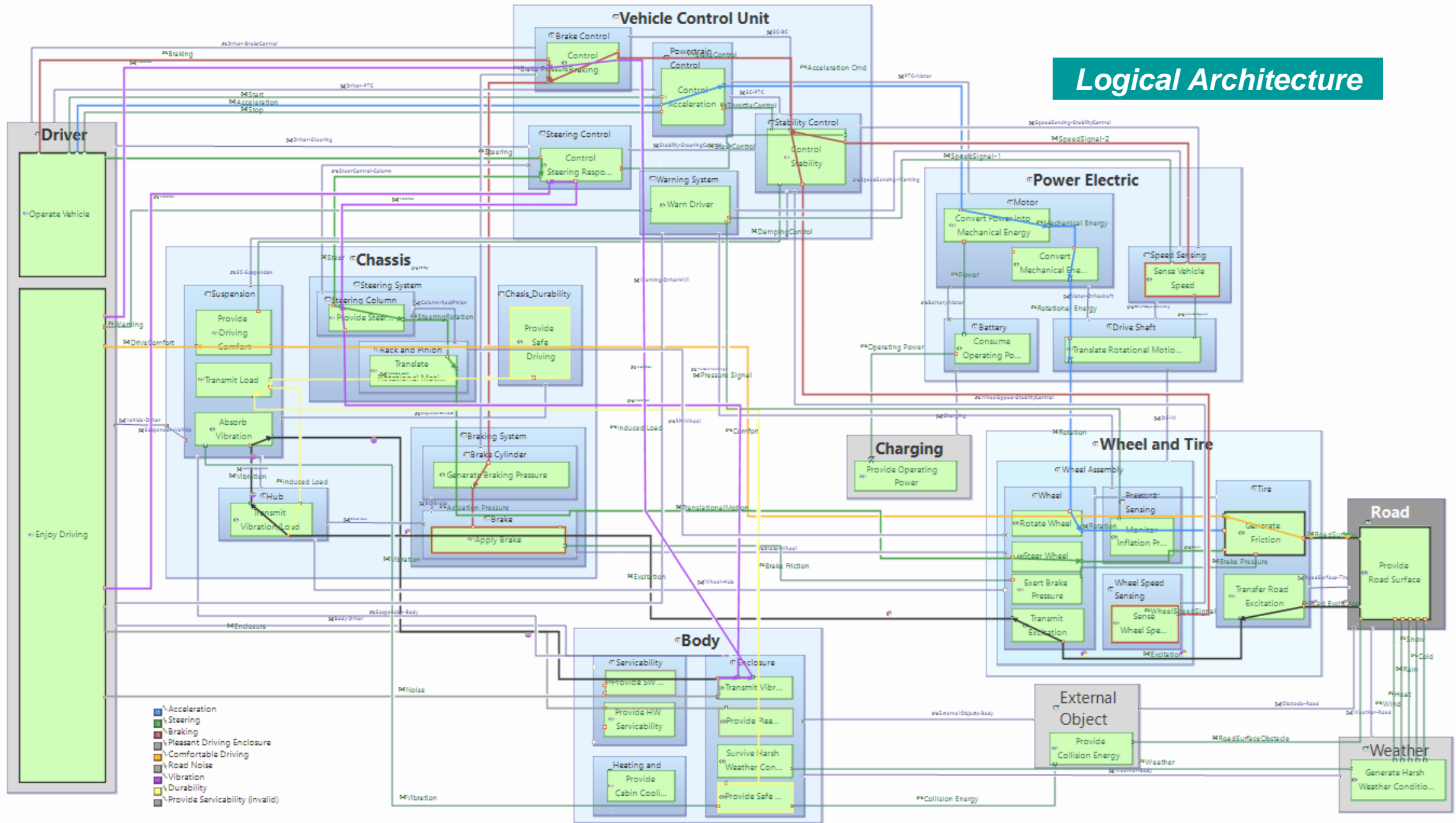
(b)



(c)

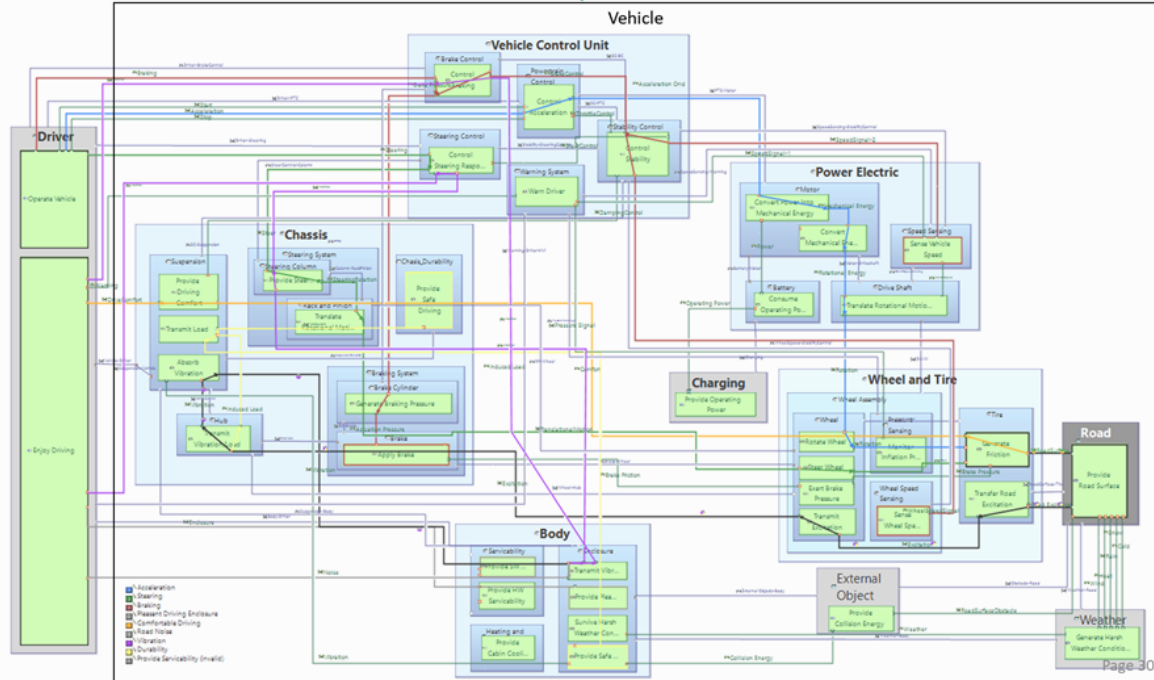
System Analysis

Logical Architecture



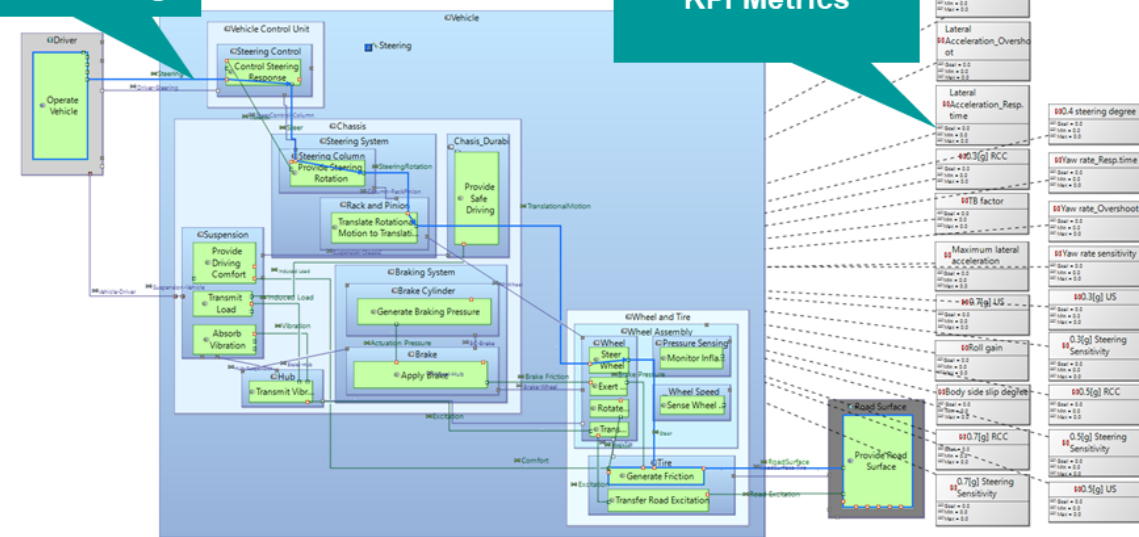
Logical Architecture & FTCs

Logical Architecture

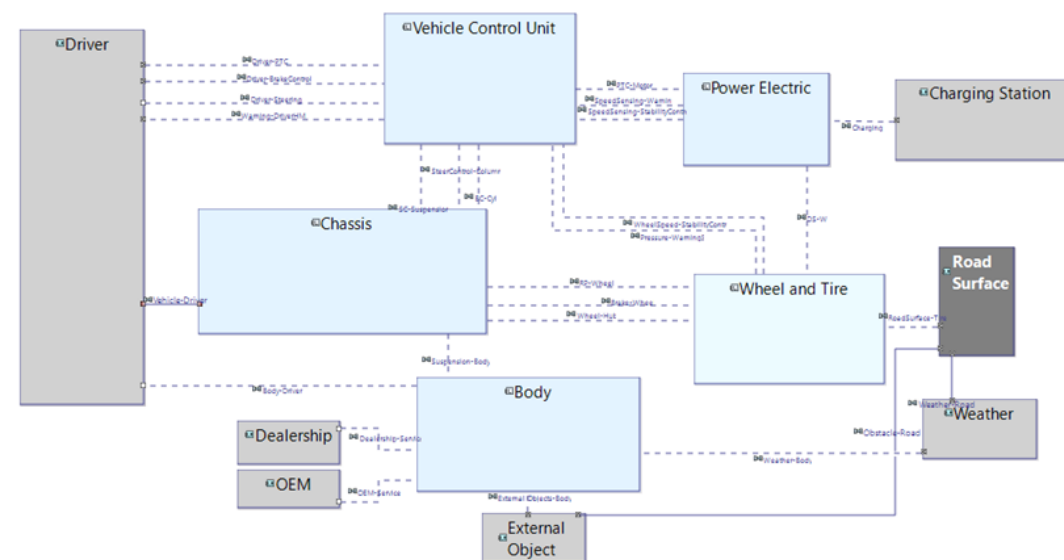


(a) PBV Logical Architecture

Functional Chain 'Handling'



(b) Logical Architecture – Handling View



(c) Logical Architecture – Component View

No previous location

Home

Assistant

Discussions

Folders

Active Folders

Inbox

Changes

Schedules

Schedule Tasks

Alerts

Help

No Active Change

VR-000002/A-완성차 핸들링 성능 검증

Owner: Sam Analyst (sam)

Date Modified: 31-Aug-2022

State: Authoring

Release Status:

Type: Verification Request Revision

SIEMENS

OverviewTrendsHistoryParticipantsRelationsAttachments

Verification Management

Requirements

Test Procedures

Functions

Systems

Parts

Simulation Models

Simulation Analyses

Product and Test EBOMs

Parameters

Others

Reports

Element Name

Revisi...

Target

Result

Owner

Type

Structure

Step Steer Verification

A

True

kmk (kmk)

Requirement Revisi...

False

Virtual Turning Verification

A

True

kmk (kmk)

Requirement Revisi...

False

SIMULATION MODELS

Element Name

Revisi...

Target

Result

Owner

Type

Structure

De

SIMULATION ANALYSES

Element Name

Revisi...

Target

Result

Owner

Type

Structure

De

PARAMETERS

Selection

Select

Hide

Excel

Start

Man

Add

Pin Panel

Close

New

Palette

Search

*

Results

Filters

Keywords:

(5 Results)

Step Steer Analysis

000560

Revision: A

Tire Architecture - Gold Copy

000558

Revision: A

Vehicle

000550

Revision: A

Step Steer

000547

Revision: A

NX_Template

BatchMesh

Revision: A

Copy Parameters

Add

Discuss

Open

Cut

Copy

Paste

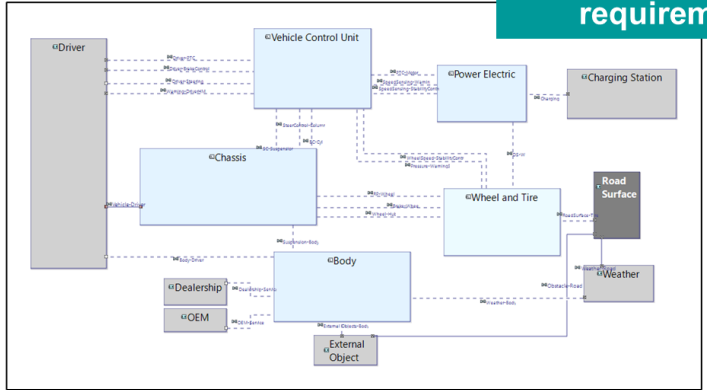
New

Edit

Manage

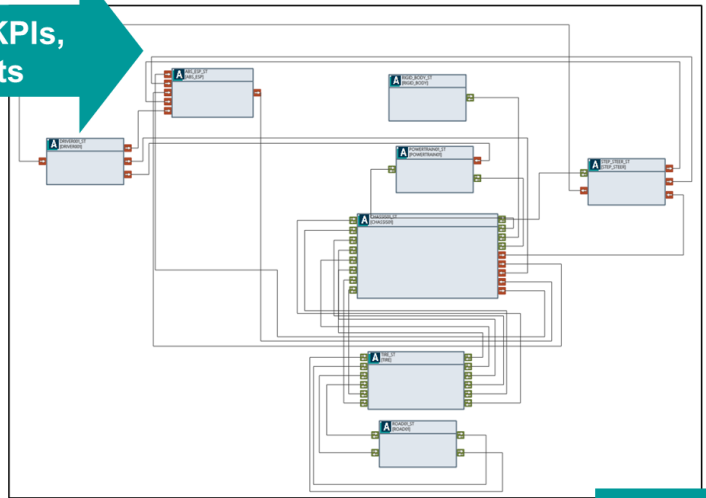
Share

View



SMW Logical Architecture

Architecture, KPIs, requirements



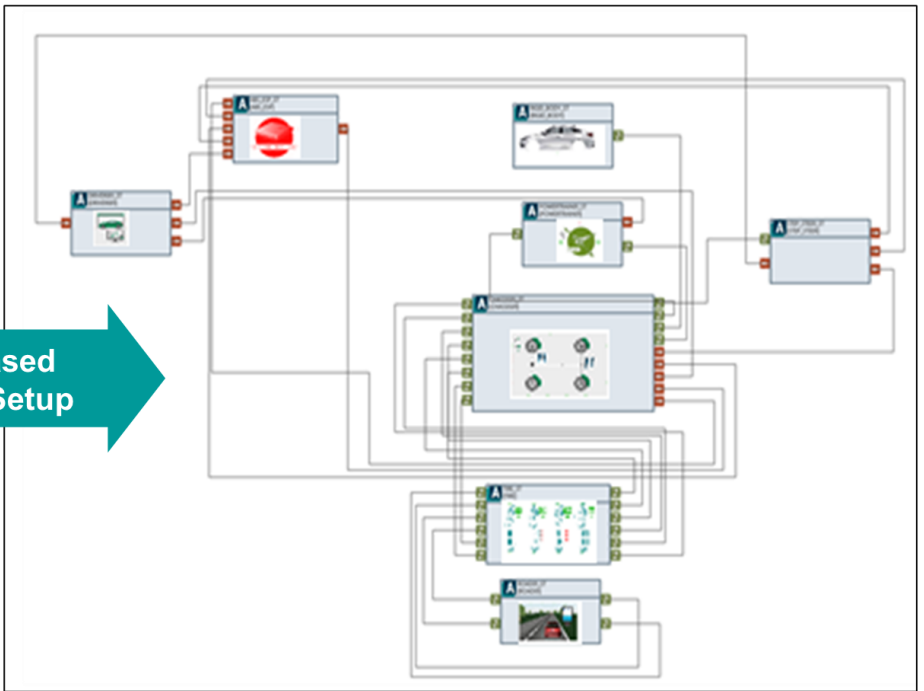
Simulation Architecture

Physics-based Simulation Setup



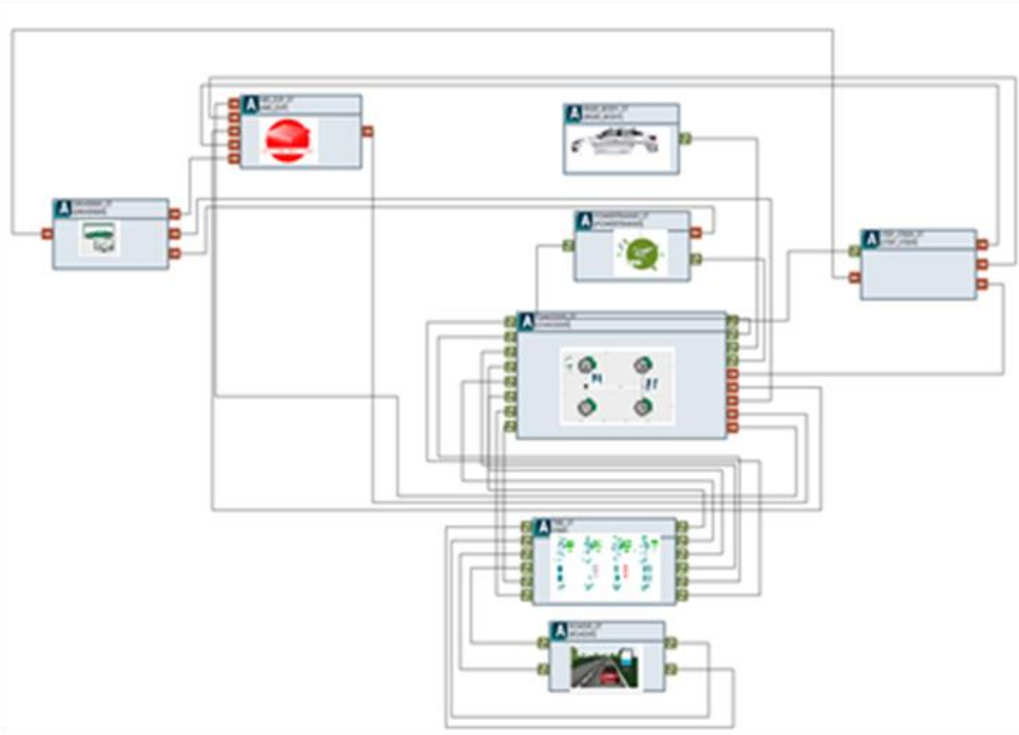
Physical Systems Library

Architecture Verification

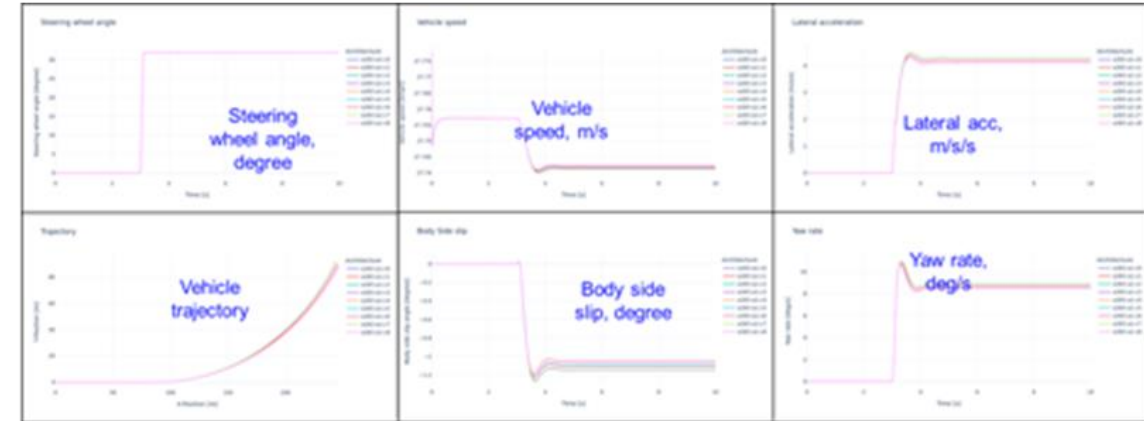


System Simulation Model

Verification Postprocessing



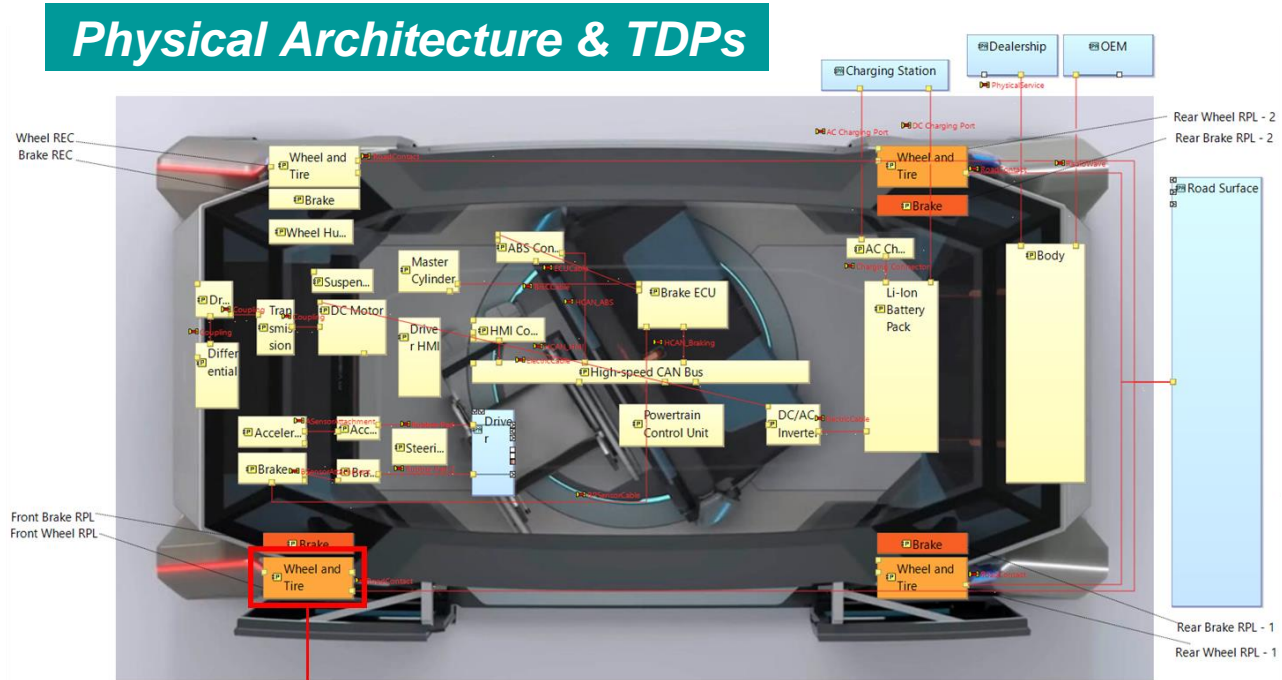
(a) Simulation Model



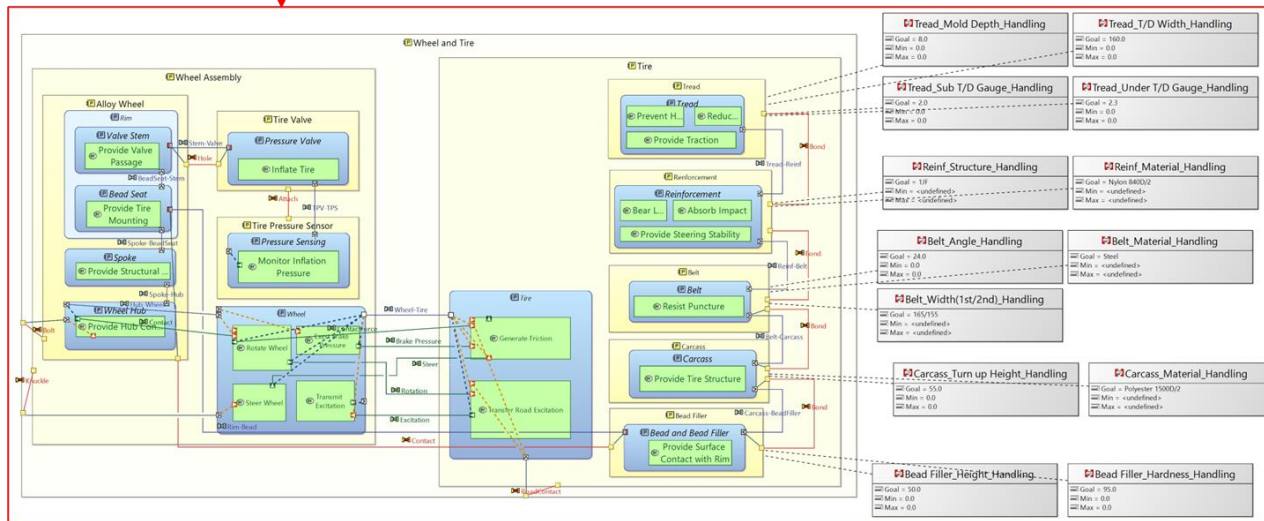
Architecture	Yaw rate overshoot, %	Yaw rate response time, s	Lat acc overshoot, %	Lat acc response time, s	0.4g steering angle, deg	Yaw rate sensitivity, deg/sec/100deg	Roll gain, deg/g	Body Sideslip, deg	TB factor, deg*sec
1	25.44	0.08	4.62	0.19	32	27	0.08	1.05	0.28
2	24.05	0.08	4.51	0.19	32	27	0.07	1.09	0.32
3	23.26	0.08	4.41	0.19	32	28	0.07	1.14	0.34
4	23.23	0.08	4.41	0.19	32	28	0.07	1.14	0.34
5	25.44	0.08	4.62	0.19	32	27	0.08	1.05	0.28
6	24.17	0.08	4.51	0.19	32	27	0.07	1.09	0.32
7	24.19	0.08	4.52	0.19	32	27	0.07	1.1	0.31
8	23.15	0.08	4.41	0.2	32	28	0.07	1.15	0.34
9	25.59	0.08	4.62	0.19	32	26	0.08	1.05	0.28

(a) Post-processing results

Physical Architecture & TDPs



(a) PBV Physical Architecture Views



(b) Physical Architecture – TDP for Handling

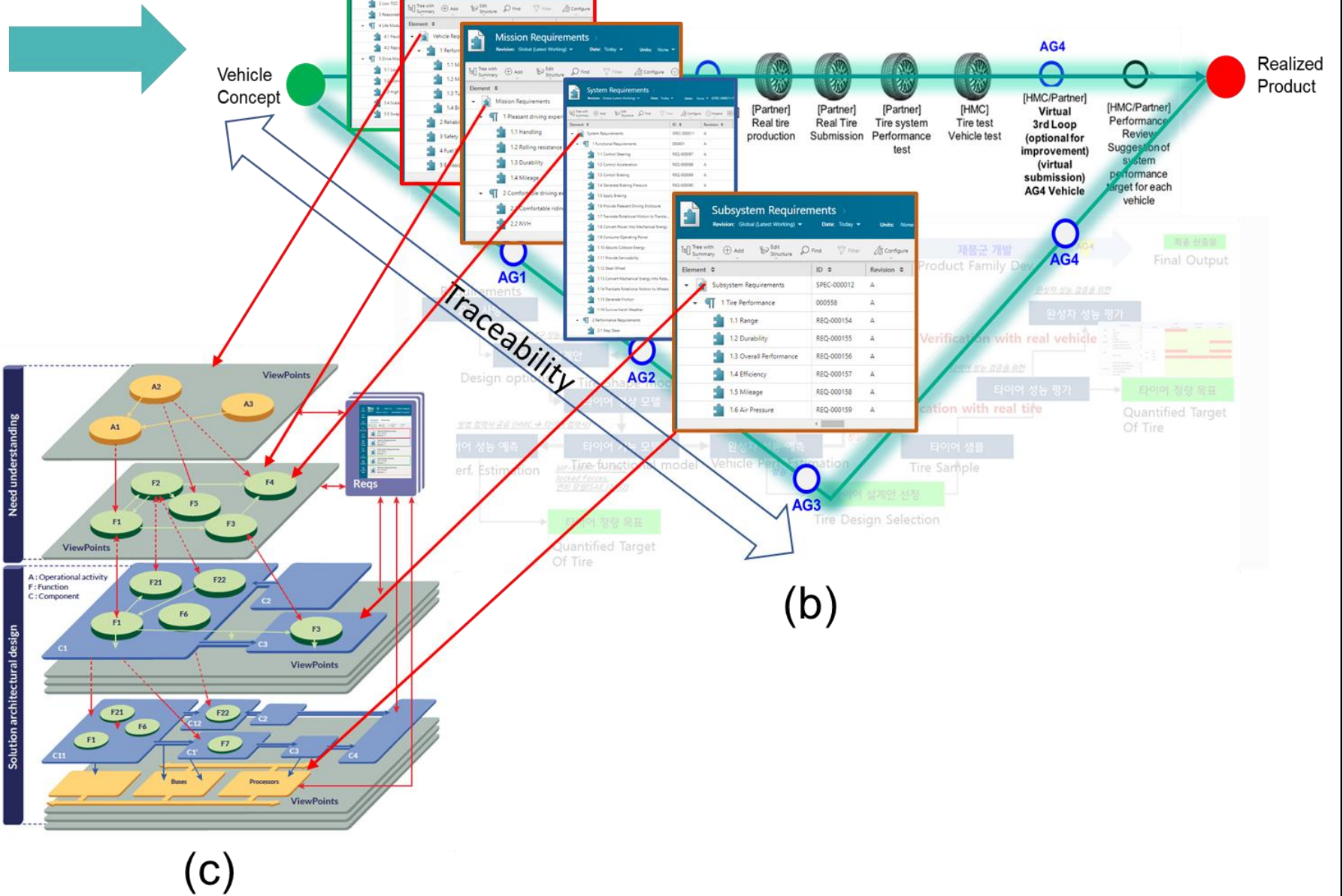
Part	Item (TDP)
Tread	T/D Width (mm)
	Mold Depth (mm)
	Under T/D Gauge (mm)
	Sub T/D Gauge (mm)
Reinf.	Material
	Structure
Belt	Material
	Width (1st/2nd) (mm)
	Angle (deg)
Carcass	Material
	Turn up Height (mm)
Bead Filler	Hardness (Hs)
	Height (mm)

(c) Tire Design Parameters

Multi-layered requirement traceability

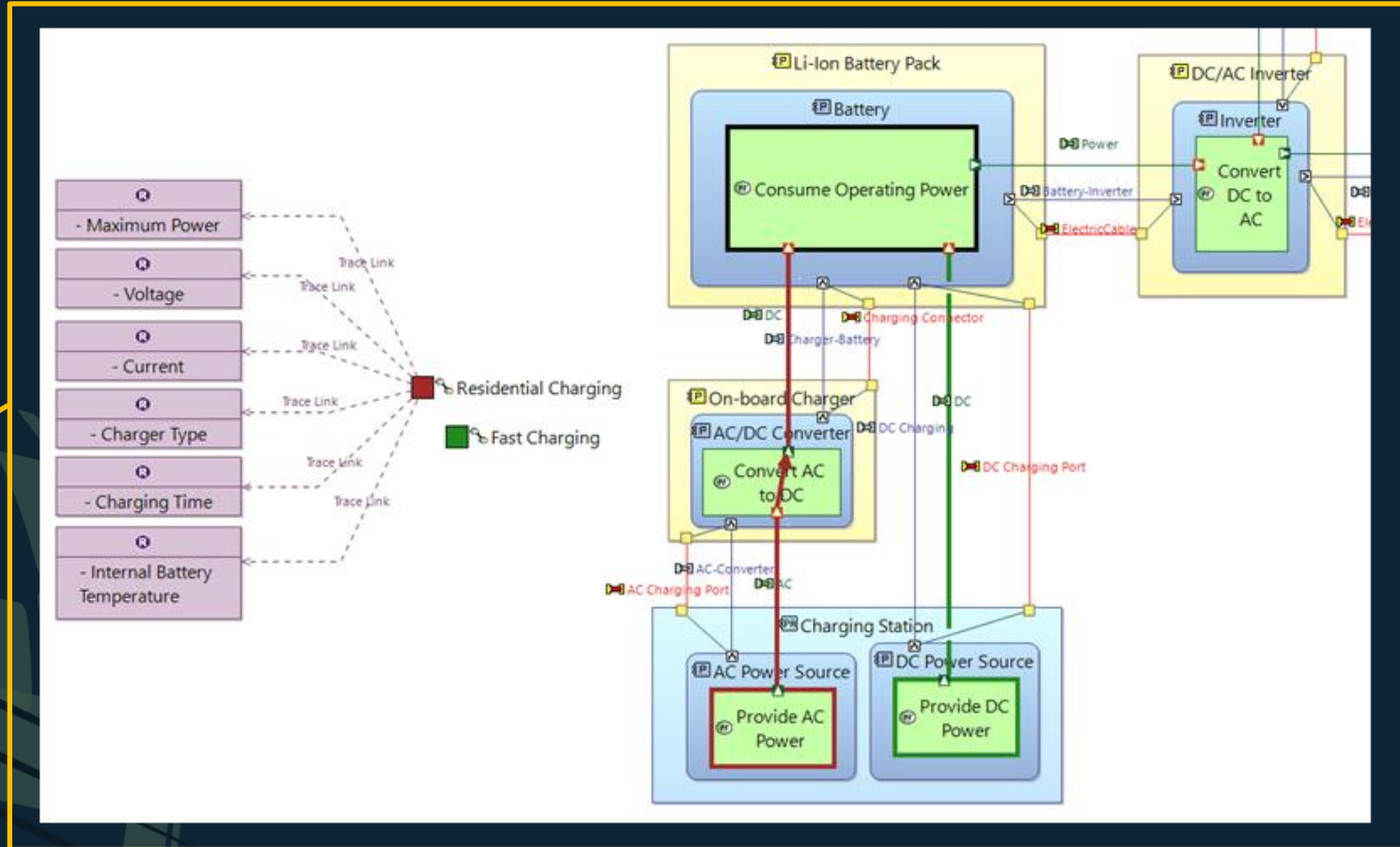
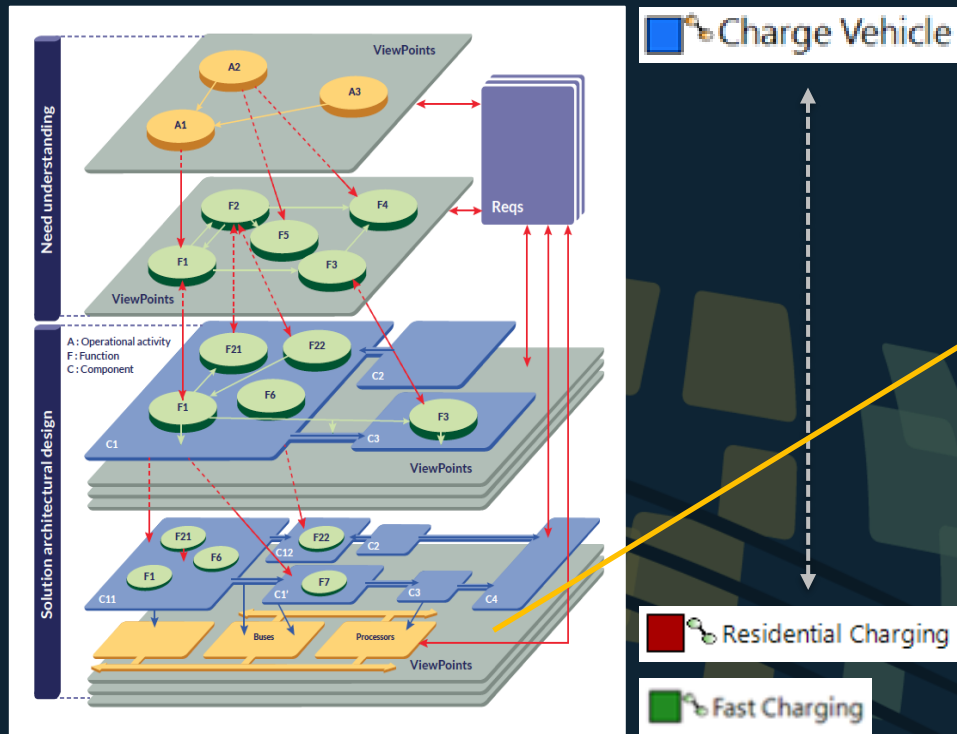


(a)

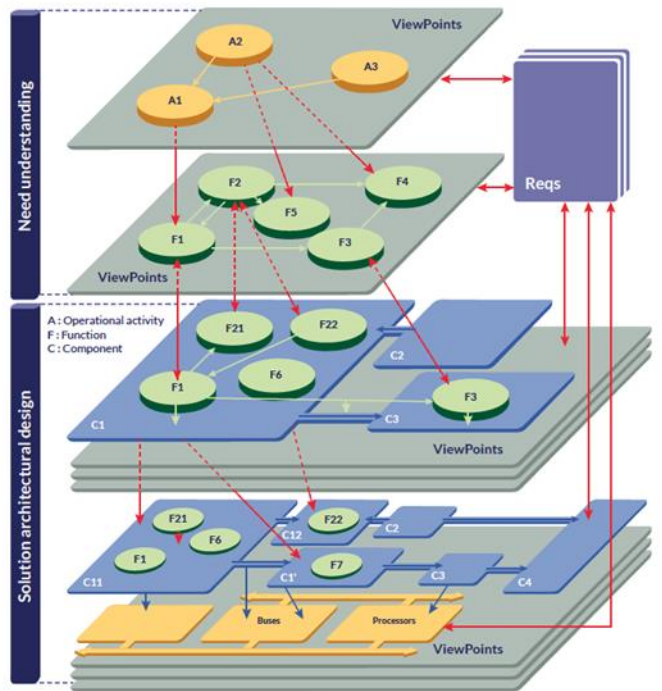


(c)

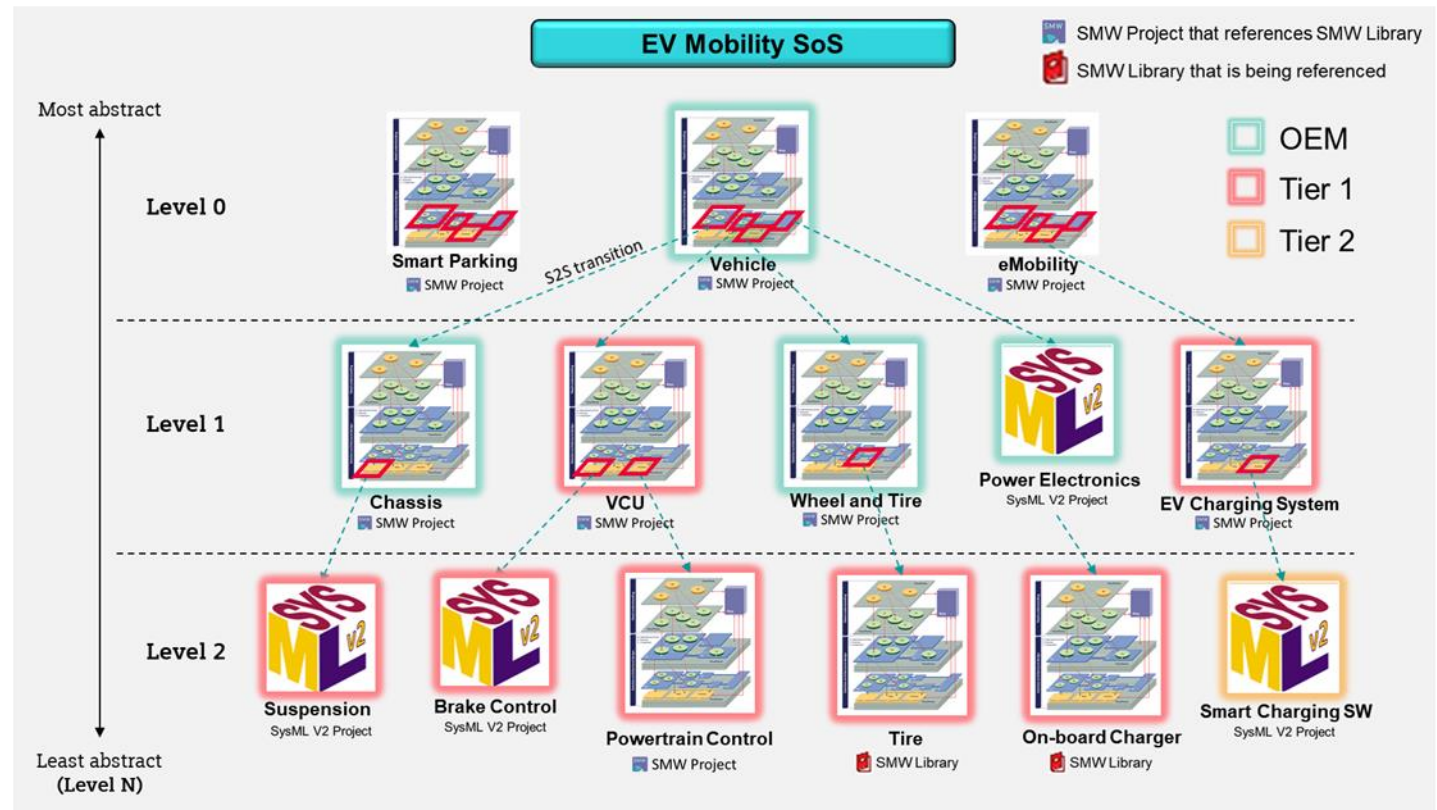
SoS Needs – Physical Architecture Traceability



SoS Modularization Concept



(a) The Arcadia method



(b) EV Mobility SoS organization using SMW and Arcadia



Lessons Learned

Conclusion & Observations

Conclusion



Observations

- Huge potential for model-based approaches beyond Systems
- Increasing need for authoritative sources of truth, especially at early concept stages
- Architecture descriptions crucial for key decision makers across enterprise
- Heterogenous understanding of system architectures – a major challenge
- Need for a PLM backbone to MBSE more evident as more teams adopt MBSE across system development lifecycle

Acknowledgement

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Jason Wickers
Benedetta Iezzi
Fabien Retho

Want to know more?



2021.12.28 Hyundai Motor Group 5min

The Essence of Future Mobility Lifestyle

<https://www.hyundaimotorgroup.com/story/CONT0000000000005028>

Google

hyundai smart mobility

what is hyundai's smart mobility solution?

 **ChatGPT**

Thank you!



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