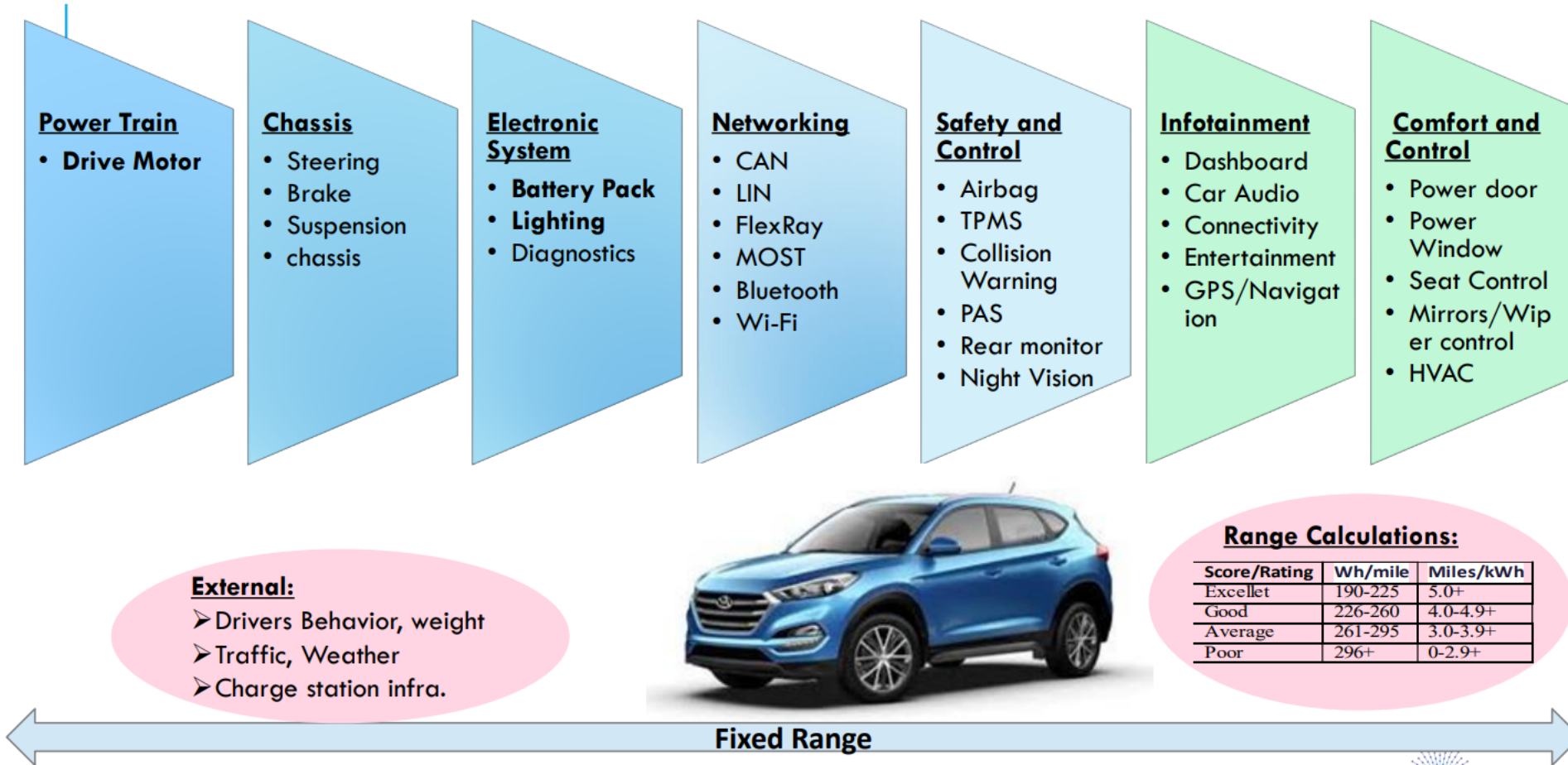digital.auto
Going the extra mile
Whitepaper

Agenda

① Problem Statement

② Target Architecture: SDV + Vehicle APIs

③ #digitalfirst development approach
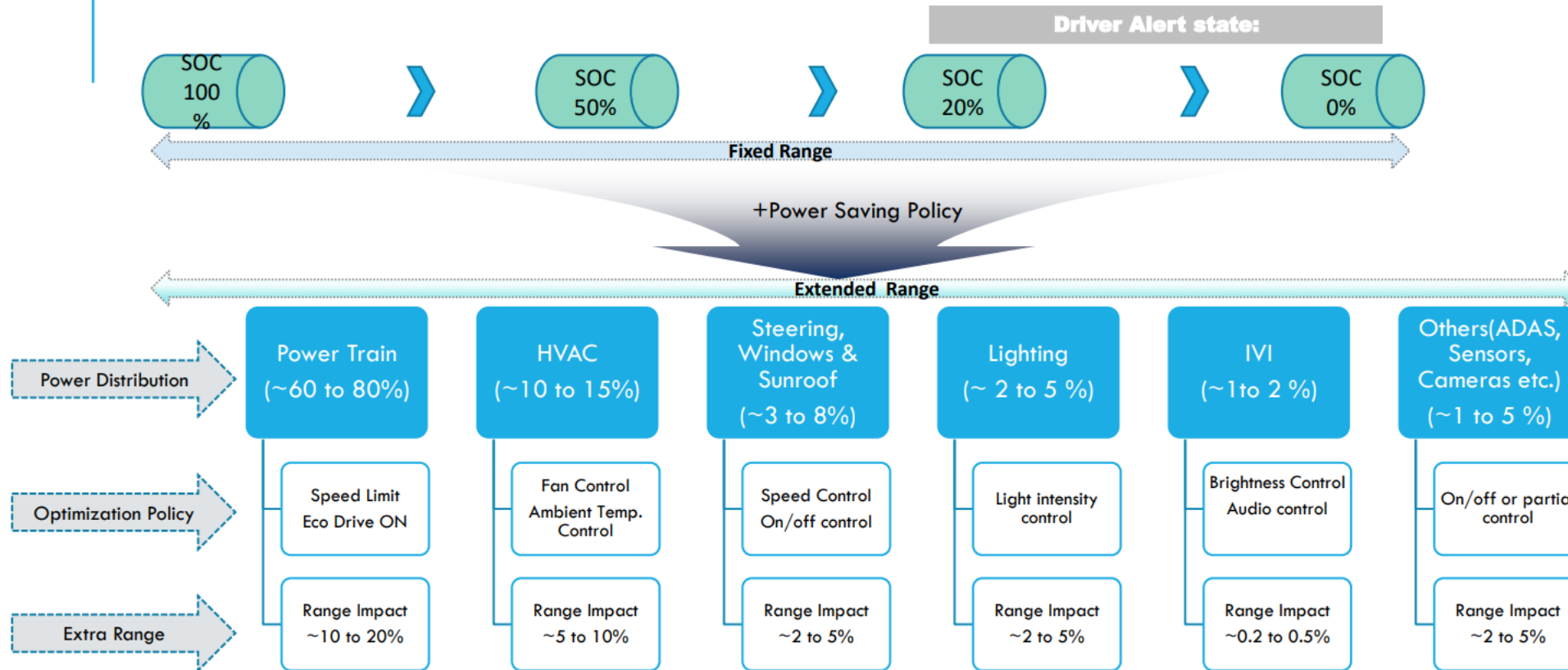
④ Simulation

⑤ Summary

- # Range anxiety
  - EV range anxiety is the fear of running out of power on a journey and not being able to find a charging point.
- # Addressing the issue
  - Mapping the road ahead => Navigation
  - **Going the extra mile** => Focus of this whitepaper
    - Goal: Car should behave like a smart phone => Turn off energy consumers on-demand
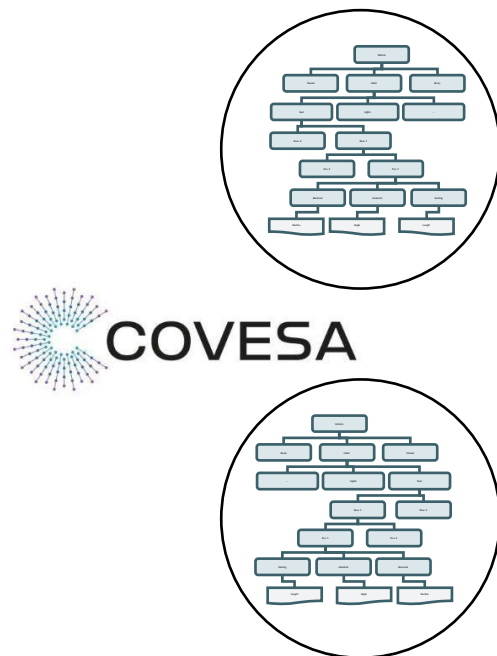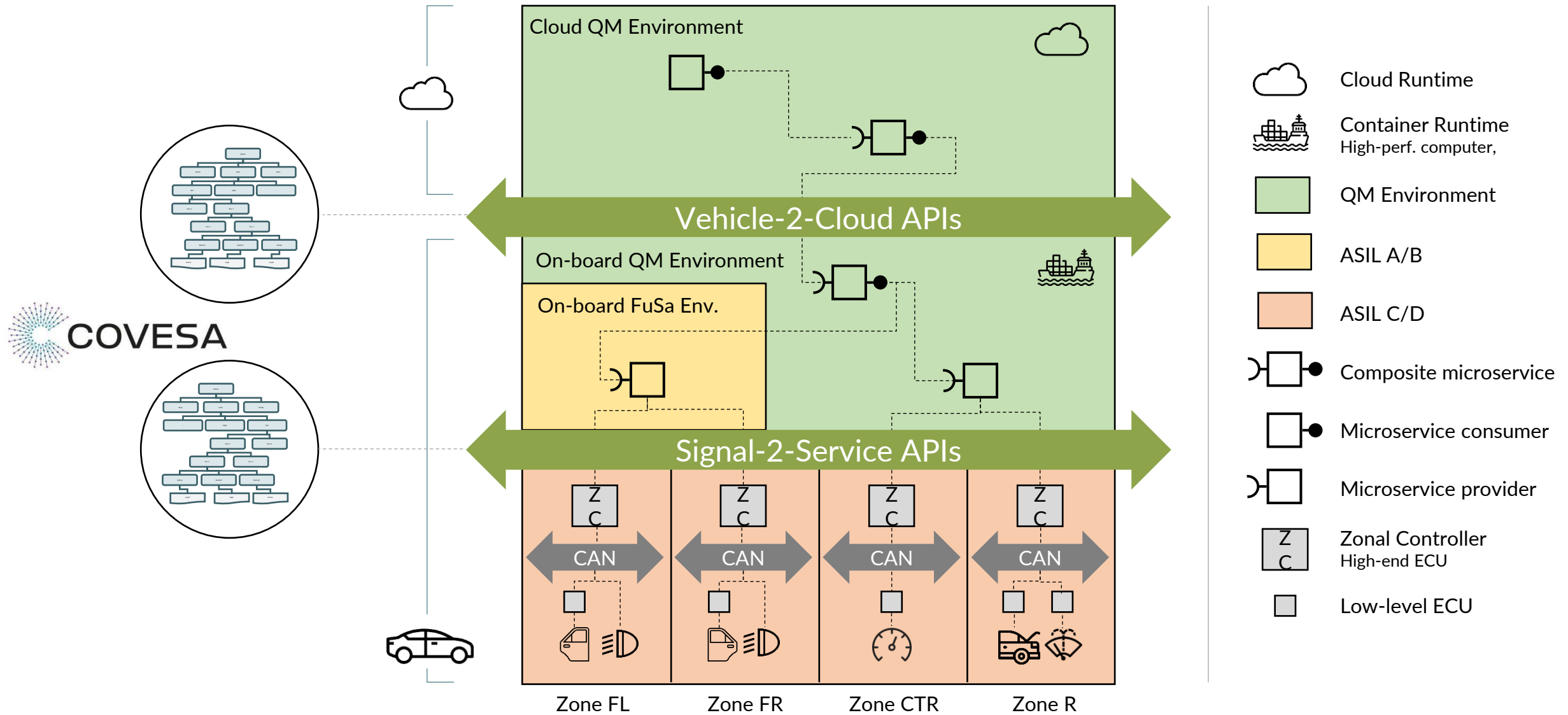
PARAMETERS EFFECTING TRAVEL RANGE

Power Train
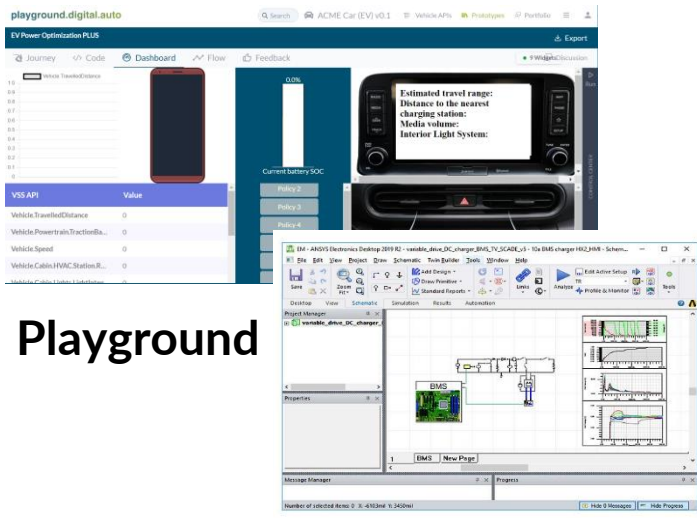- **Drive Motor**

Chassis
- Steering
- Brake
- Suspension
- chassis

Electronic System
- **Battery Pack**
- **Lighting**
- Diagnostics

Networking
- CAN
- LIN
- FlexRay
- MOST
- Bluetooth
- Wi-Fi

Safety and Control
- Airbag
- TPMS
- Collision Warning
- PAS
- Rear monitor
- Night Vision

Infotainment
- Dashboard
- Car Audio
- Connectivity
- Entertainment
- GPS/Navigation

Comfort and Control
- Power door
- Power Window
- Seat Control
- Mirrors/Wiper control
- HVAC

External:
➢ Drivers Behavior, weight
➢ Traffic, Weather
➢ Charge station infra.

Range Calculations:

Score/Rating	Wh/mile	Miles/kWh
Excellet	190-225	5.0+
Good	226-260	4.0-4.9+
Average	261-295	3.0-3.9+
Poor	296+	0-2.9+

Fixed Range

#digitalfirst development approach

| Virtual Prototype | HW PoC / Integration | Production |

Playground

Simulation
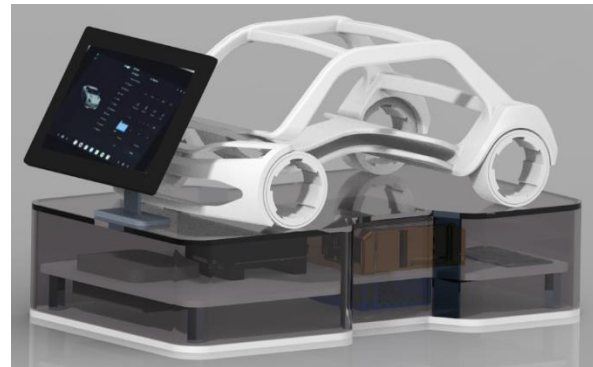
DreamKit

Production Vehicle

#digitalfirst development approach

digital.auto

Virtual Prototype → HW PoC / Integration

Playground

HPC

COVESA VSS

Azure

ZC

ECU

CAN

CAN

ANSYS

DreamKit

HYUNDAI MOBIS

ANSYS
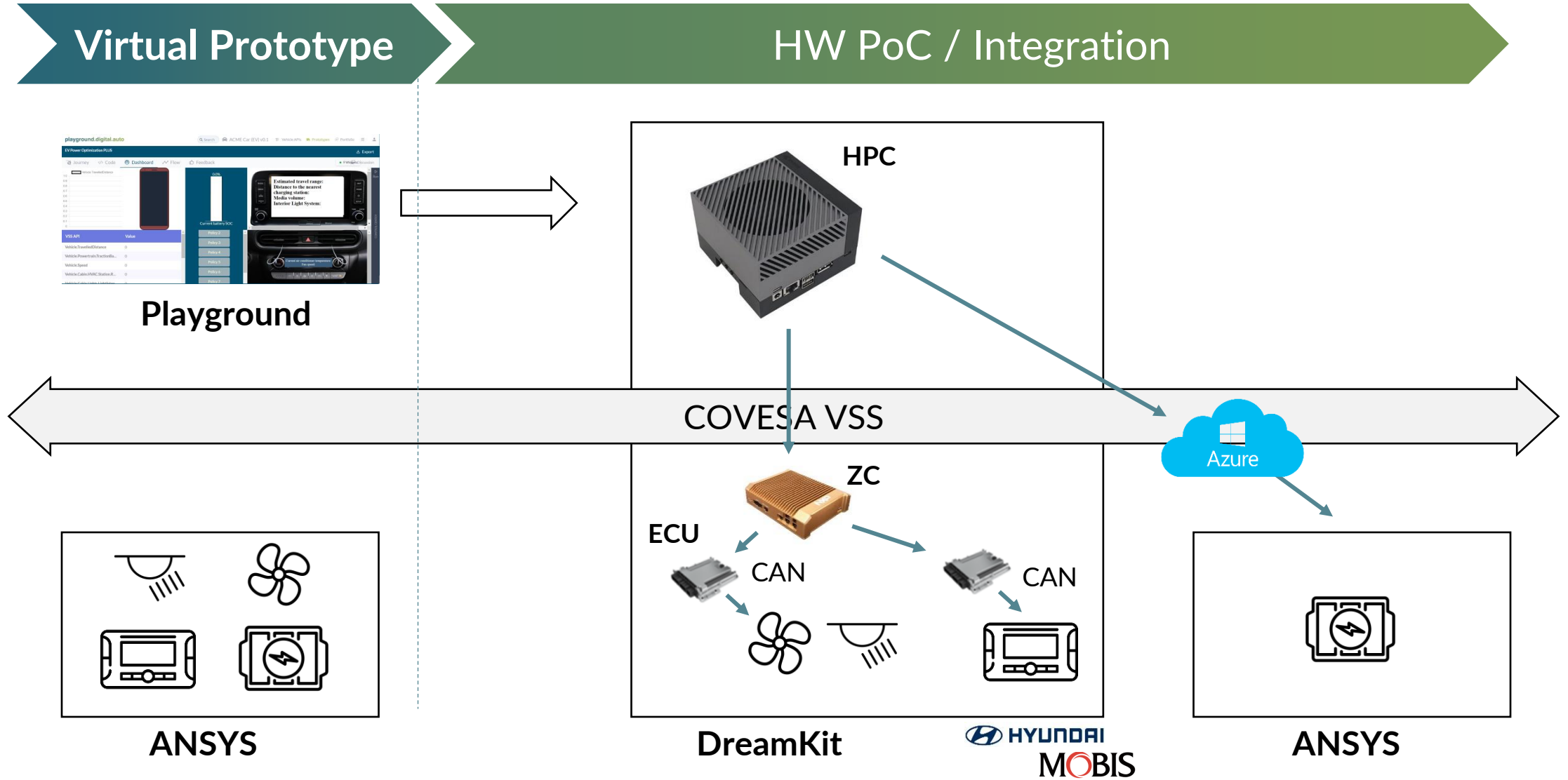
Playground

digital.auto

www.digital.auto

Virtual Validation for EV
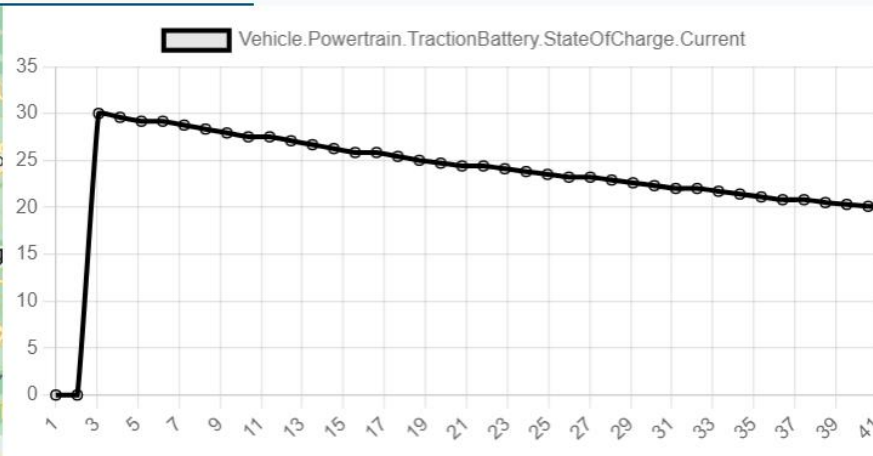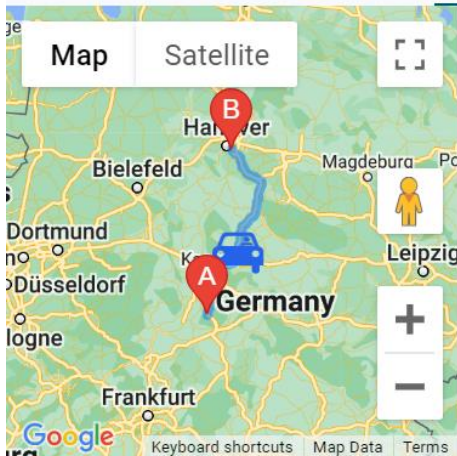
1. Acceleration
2. Range
3. Gradeability
4. Validation
5. ...
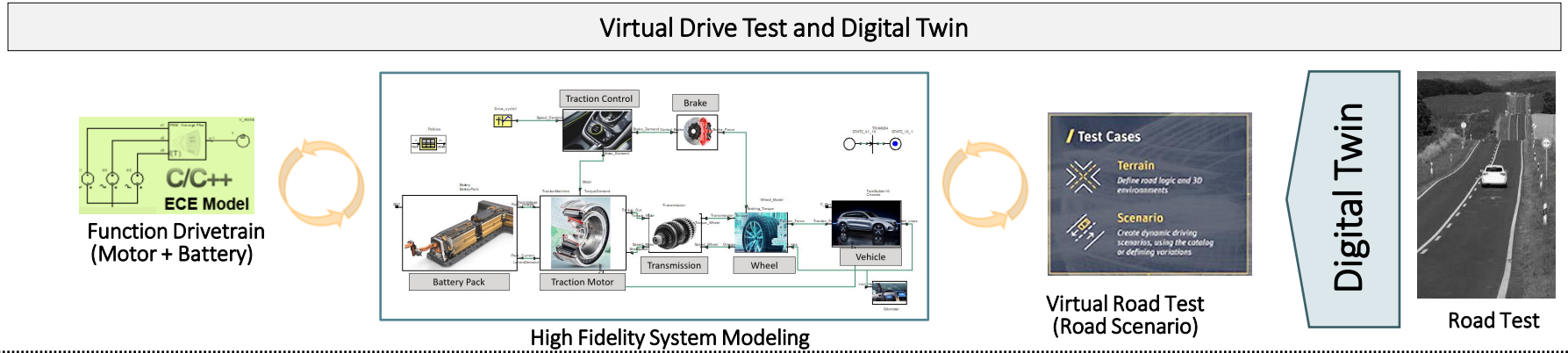
1. Plant model calibration
2. MCU Calibration
3. Software, Safety validation
4. Charge – discharge validation
5. ....
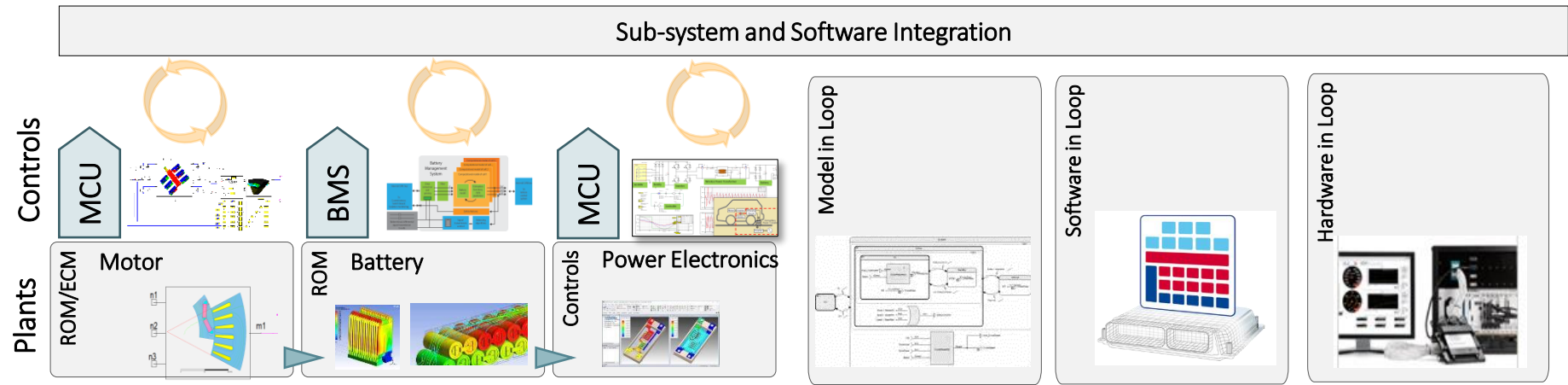
1. Unit Tests
2. Subsystem performance tests
3. Performance characterization
4. Software unit testing
5. ...
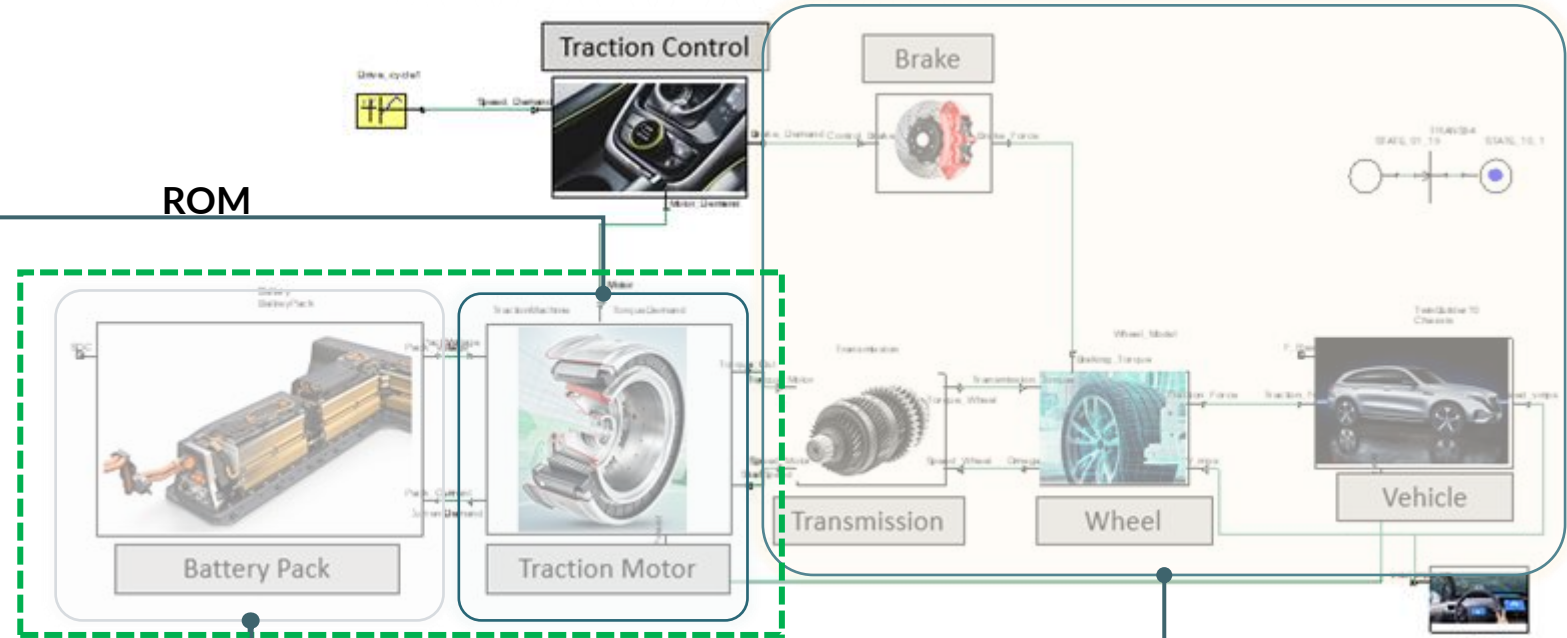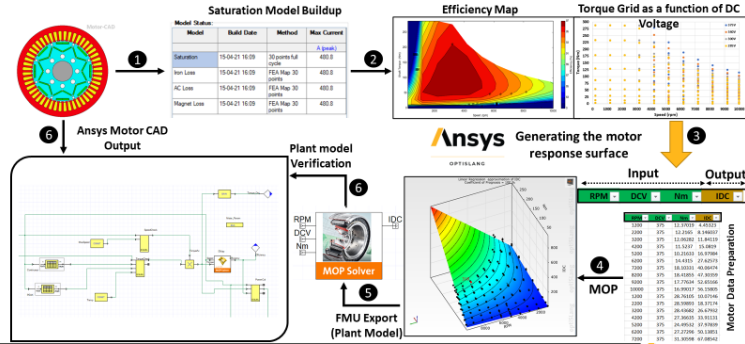
Virtual Drive Test and Digital Twin

C/C++
ECE Model

Function Drivetrain
(Motor + Battery)

Traction Control | Brake

Battery Pack | Traction Motor | Transmission | Wheel | Vehicle

High Fidelity System Modeling

Test Cases
Terrain — Define road logic and 3D environments
Scenario — Create dynamic driving scenarios, using the catalog or defining variations

Virtual Road Test
(Road Scenario)

Digital Twin

Road Test

Stage 3

Sub-system and Software Integration

Controls

MCU | BMS | MCU

ROM/ECM — Motor

ROM — Battery

Controls — Power Electronics

Plants

Model in Loop

Software in Loop

Hardware in Loop

Stage 2

Component Design

Motor | Battery | Software

Physical Testing (Supplier Data)

Motor Bench Test | Battery Test

fmi FUNCTIONAL MOCK-UP INTERFACE

Stage 1

Virtual Validation for EV

Motor ROM generation

ROM

Traction Control

Brake

Battery Pack

Traction Motor

Transmission

Wheel

Vehicle
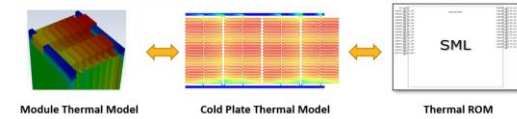
Battery Electrical model
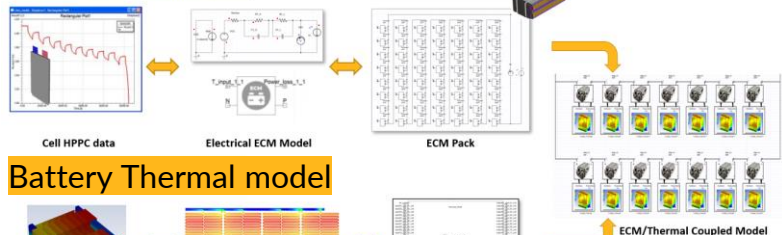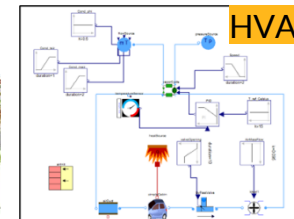
Battery Thermal model

ROM

ROM

Power consumption systems modeled under battery system

- IVI system
- Interior & Exterior Lighting system
- Sunroof & power window system

Cabin model

HVAC

Vehicle dynamic systems

- Transmission
- Brake
- Chassis
- Wheels & suspension

EV Power Optimization - Summary

Goals

- Digitally validate the EV power optimization policies/algorithms to minimize the last mile anxiety.

- Cloud & AIOT platform integration of EV power consumption digital twin vis COVESA VSS APIs to demonstrate the use case.

Solution

- **Physic & Data based High fidelity** EV power consumption system Digital Twin built using Ansys Twin Builder, to validate the power optimization algorithms/policies.

- Digital.auto (AIOT platform) Integration of Ansys digital twin via **COVESA VSS APIs**

- On the fly synchronization with the Digital.auto front end to share the feedback of vehicle parameters like SoC & Range.

Benefits

- **Rapid verification & validation** of the power optimization software algorithms **with digital prototyping** – 200x faster than real time.

- Making the Software define vehicle philosophy a reality with vehicle virtualization via Digital Twins

- **AIOT Platform integration & Cloud deployment** for on-the-fly optimization

Shift left

#digitalfirst

Shift-left quality model

Traditional quality model

640x
NIST (USA): Cost factor of error corrections based on work hours

bn
Lost opportunities due to wrong digital feature set or bad vehicle UX