CES - EV POWER OPTIMIZATION

Guidelines/Attributes to increase travel range for fixed battery

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COVESA Wiki Link for EV Power Optimization Project:
https://wiki.covesa.global/display/WIK4/EV+Optimization+-+Increase+Travel+Range+for+Fixed+Battery

REDUCING LAST MILE ANXIETY OF EV DRIVERS
EV POWER OPTIMIZATION

Ensuring that the Battery is managed properly throughout the Drive Cycle is a key issue faced by all EV drivers. State Of Charge (SOC) is an indication of the remaining charge present in the battery. Under a power demand, ability of battery to supply required power can be estimated based on the SOC state information. With known battery states and the power supply capability, the maximum distance covered by the car can be estimated.

Through EV Power Optimization, we can identify power optimization scenarios for different Automotive Systems in an Electric Vehicle to achieve the following Objectives:

1. Overall Runtime Optimization of Electric Vehicle to achieve Effective Range Extension

2. Achieving Extra Mile during critical SOC stage to accomplish the following:

    - Increasing Range
    - Avoiding Last Mile Anxiety
    - Appliance of backup data in crisis situations like running out of battery

Date: 05th January 2023
Place: Bellagio Hotel and Resort, 3600 S Las Vegas Blvd
Las Vegas, NV 89109
Time: 6 PM to 9 PM
QR Code to access COVESA Wiki Page:

AGENDA/OBJECTIVE

Why?

- Need to understand the importance of Power optimization during critical SOC stage
- Backup the travel range effecting parameters data on cloud

Where?

- Appliance of backup data in crisis situations like running out of battery
  - ✓ **Goal** - To minimize/**avoid last mile anxiety**
- Support OEMs to analyze and derive power efficient algorithms
  - ✓ **Goal** – **Better battery management** by run time optimization

What?

- Seek Collaboration from the industry players

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

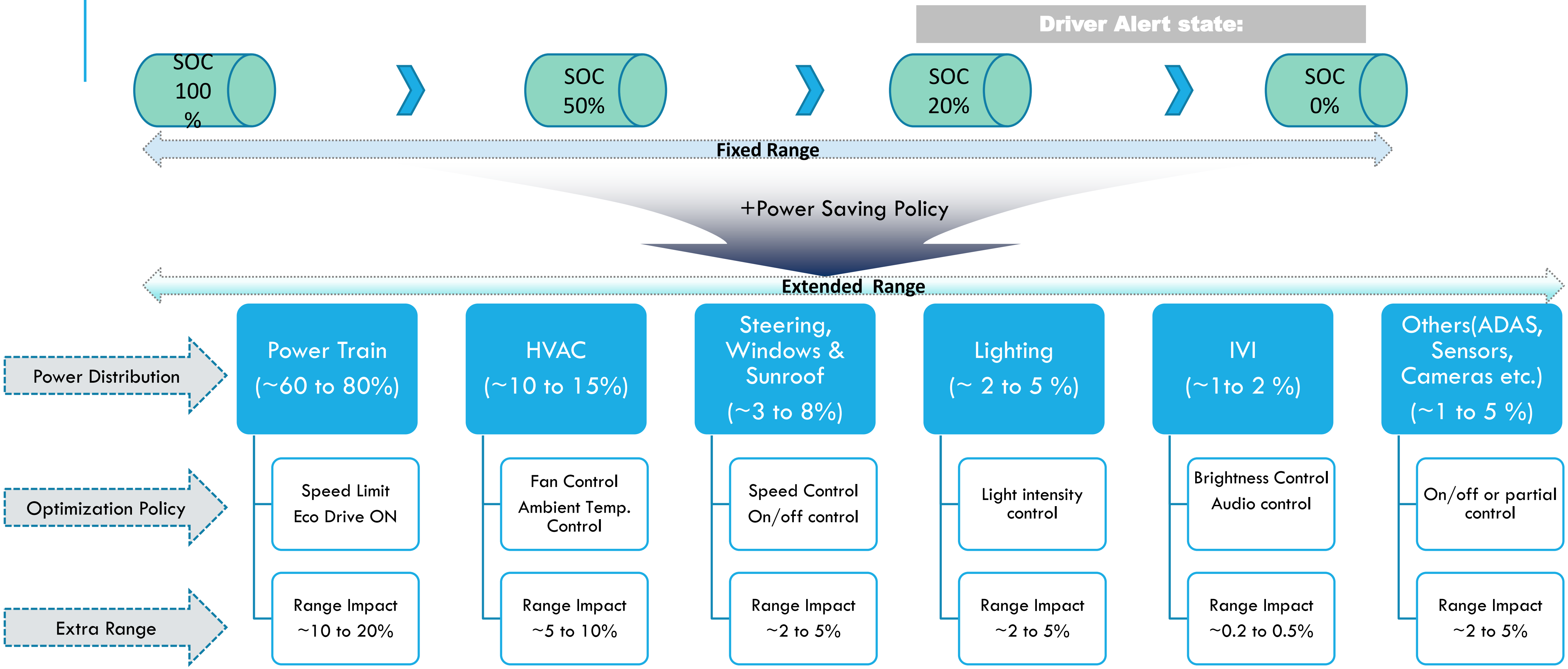
External:
- ➢ Drivers Behavior, weight
- ➢ Traffic, Weather
- ➢ Charge station infra.

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+

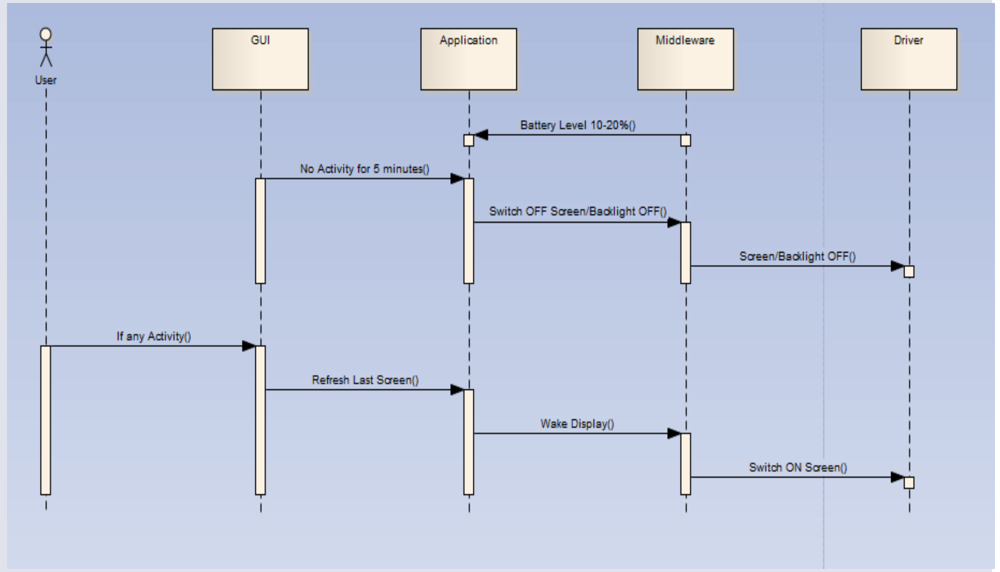
Fixed Range

PRACTICAL USE-CASES



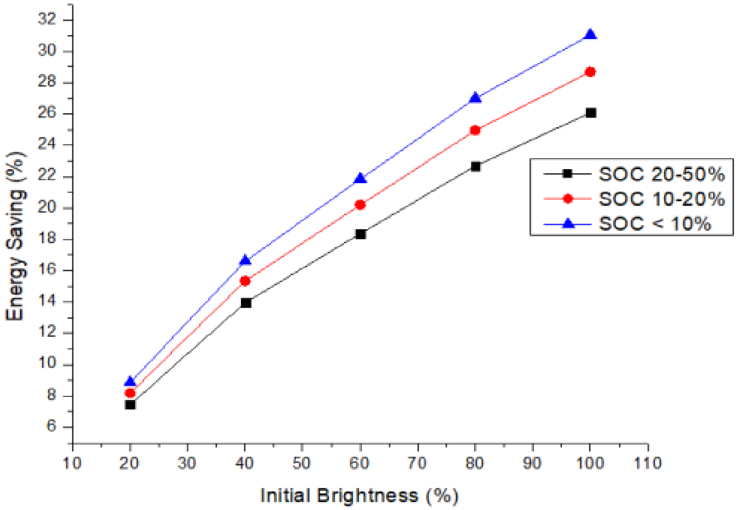
PRACTICAL/SIMULATION RESULTS

IVI USE CASES : POC RESULT - DISPLAY(8” TFT) POWER OPTIMIZATION

<table>
<tr><th>Module Name</th><th colspan="7">Display</th></tr>
<tr><td>Description/Objective</td><td colspan="7">Display Turn off for Energy Conservation.</td></tr>
<tr><td rowspan="3">Pre-condition</td><td colspan="2">ACC OFF</td><td rowspan="2">ACC ON</td><td rowspan="2">IGN ON</td><td colspan="3">Start</td></tr>
<tr><td>Sleep</td><td>ACC ON Timeout</td><td>Stationary</td><td>Moving</td><td>ISG</td></tr>
<tr><td>X</td><td>X</td><td>O</td><td>O/X</td><td>O</td><td>O</td><td>X</td></tr>
<tr><td>SOC Level</td><td colspan="7">20 – 50 %</td></tr>
<tr><td>Optimization Rules</td><td colspan="7">1) Display goes to screensaver for more than 5 minutes and backlight off for 10 minutes of inactivity.</td></tr>
<tr><td>Optimization Sequence Diagram</td><td colspan="7">
</td></tr>
<tr><td>User Impact</td><td colspan="7">Screen will not show anything unless activated or navigation is going on.</td></tr>
<tr><td>Special Conditions</td><td colspan="7">Option will be given to driver to choose whether they want these harsh methods for battery saving.</td></tr>
<tr><td>POC Results</td><td colspan="7">10 - 25%</td></tr>
</table>

DISPLAY MODULE

Initial Brightness (%)	$E_{initial}$ (Wh)	E_{final} (Wh)	E_{saving} (%)
100	18.830	13.917	26.088
80	17.772	13.741	22.684
60	16.590	13.544	18.359
40	15.535	13.368	13.947
20	14.202	13.146	7.439



<u>Observation</u>: At high display brightness, if optimization is applied to minimize brightness, then maximum power savings achieved

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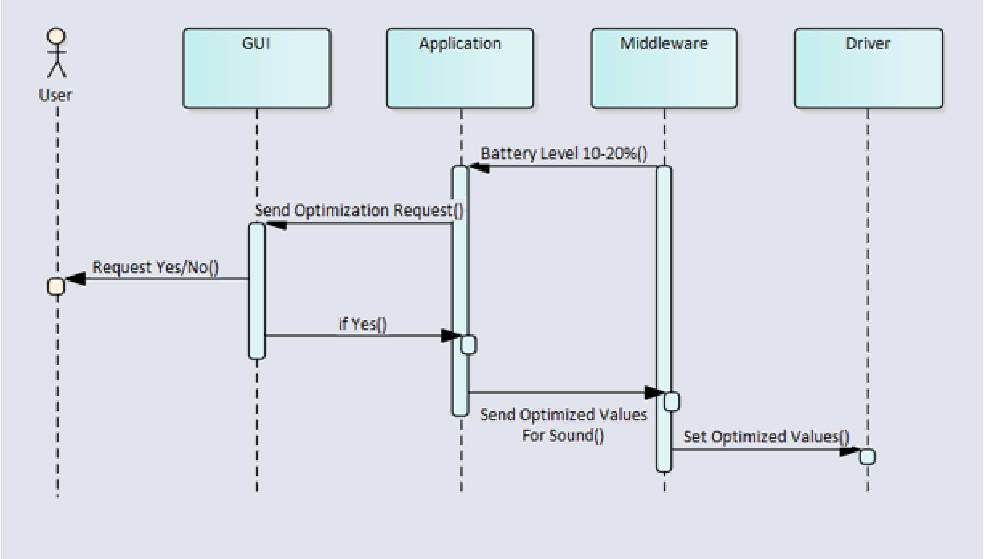
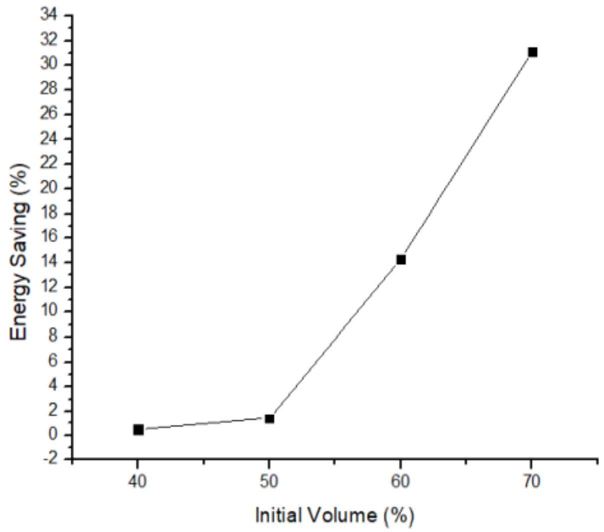
IVI USE CASES :POC RESULT-SOUND LEVEL POWER OPTIMIZATION

	Sound
Description/Objective	**Sound System optimization for Energy Conservation.**
Pre-condition	(see table below)
Optimization Rules	1) Premium Sound option will be made unavailable. 2) Position will be fixed to the last set setting/optimum values. 3) Sound Tuning will be made to the optimum value. 4) Subsystem volume will be fixed to last set values/optimum values. 5) Noise Cancelation will be switched off.
Optimization Sequence Diagram	
User Impact	Sound Quality of Output sound might be affected.
Special Conditions	Option will be given to driver to choose whether they want these harsh methods for battery saving.
POC Results	10 – 30 %

Pre-condition:

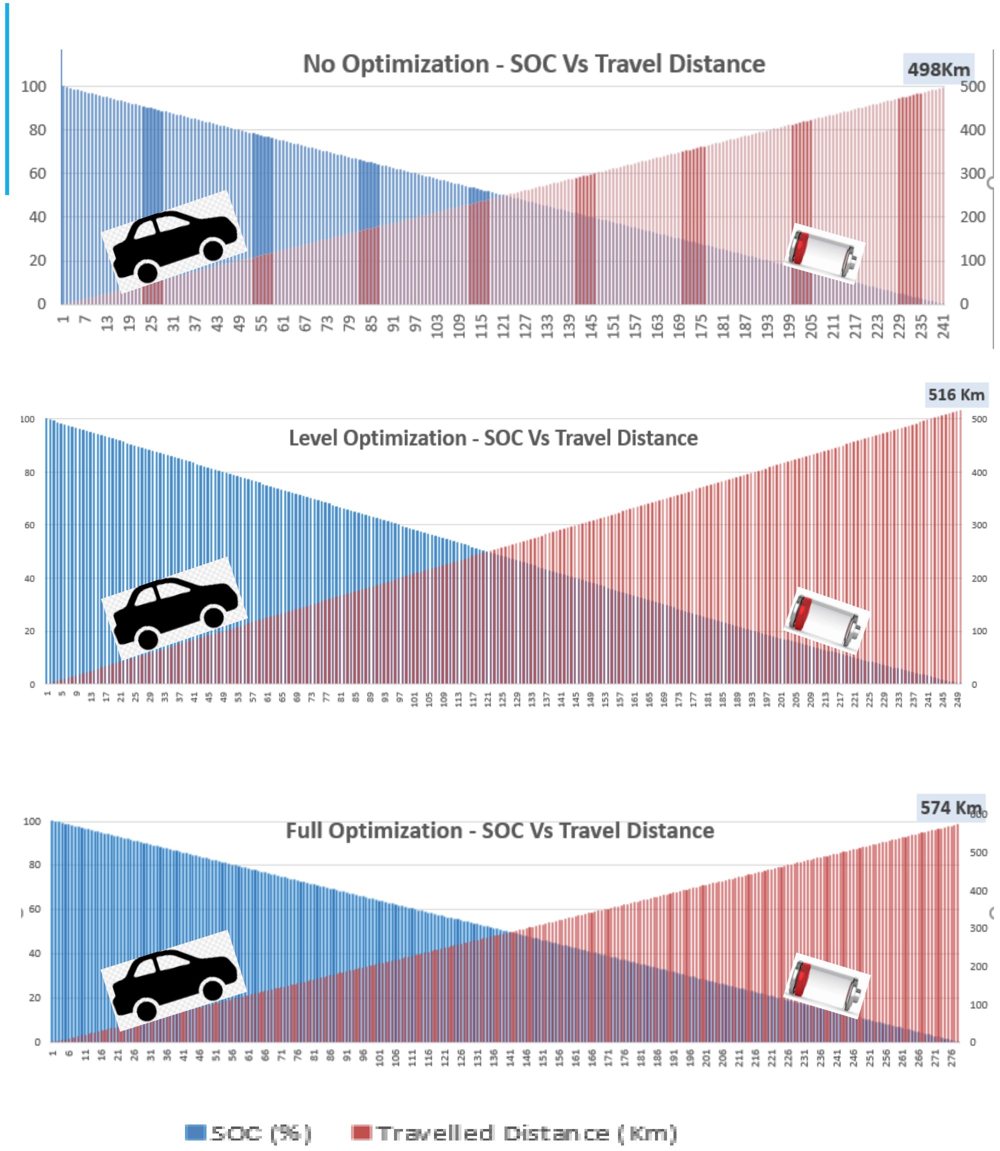
ACC OFF		ACC ON	IGN ON	Start		
Sleep	ACC ON (Timeout)			Stationary	Moving	ISG
X	X	O	O/X	O	O	X

Initial Volume (%)	$E_{initial}$ (Wh)	E_{final} (Wh)	E_{saving} (%)
70	22.252	15.33	31.107
60	17.885	15.33	14.286
50	15.553	15.33	1.433
40	15.406	15.33	0.493



<u>Observation</u>: At high volume, if optimization is applied to minimize volume, then maximum power savings achieved

SIMULATION RESULTS OF OPTIMIZATION POLICIES



Vehicle Model Considered	Kia EV 6
Maximum Range	310 Miles/498 Km
Battery Size/Capacity	77.4 Kwh
Energy Consumed (Wh/mi)	288 Wh/mi
Optimization policy	**No Optimization**

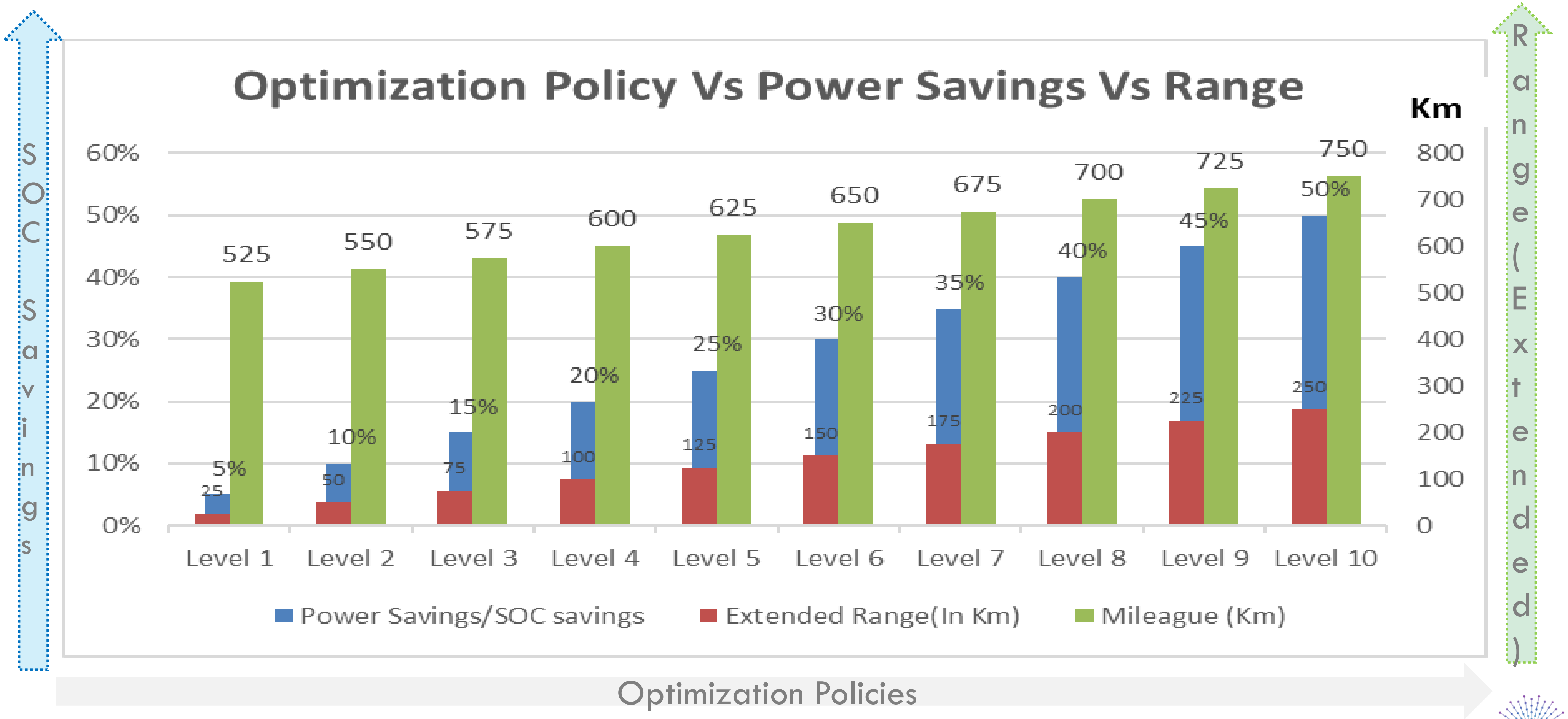
Optimization policy	**Level/Partial Optimization** • **Level 1 Optimization (at 25% SOC):** - 10% Power Savings in Powertrain System • **Level 2 Optimization (at 20% SOC):** - 10% Power Savings in Powertrain System, - 30% Power Savings in HVAC System, - 50% Power Savings in Lighting System, • **Level 3 Optimization (at 10% SOC):** - 10% Power Savings in Powertrain System, - 30% Power Savings in HVAC System, - 50% Power Savings in Lighting System, - ~36% Power Savings in IVI System (as per IVI POC result)
SOC savings	**3%**
Power Savings	**1.46 Kwh**
Extended Range	**18.68 km**

Optimization policy	**Full Optimization (at 100 % SOC to 0%)** - 10% Power Savings in Powertrain System, - 30% Power Savings in HVAC System, - 50% Power Savings in Lighting System, - ~36% Power Savings in IVI System (as per IVI POC result)
SOC savings	**13.54%**
Power Savings	**6.52 kWh**
Extended Range	**76.78 Kms**

OPTIMIZATION POLICIES VS POWER SAVINGS

Vehicle Model Considered	Kia EV 6
Maximum Range	**310 Miles/~500 Km**
Battery Size/Capacity	77.4 Kwh
Energy Consumed (Wh/mi)	288 Wh/mi
Optimization policy	**Level 1/……………Level 10**

***Graphical Representation is based on Theoretical Data**



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EV POWER OPTIMIZATION IN VSS

Integration of EV Power optimization signals in VSS

VSS IN BRIEF - HTTPS://WIKI.COVESA.GLOBAL/DISPLAY/WIK4/VSS+-+VEHICLE+SIGNAL+SPECIFICATION

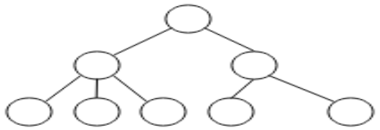
What is VSS

Vehicle Signal Specification

- Domain taxonomy/Catalogue for vehicle signals.

Domain Taxonomy

The three major components a domain taxonomy consists of in this context are described below, namely Rule Set, Data Definition and Tools and Serialization. A domain taxonomy shall be a self-descriptive tree and only the leaves shall be attributes, signals or equivalent.



1 Rule Set

The Rule Set defines how to syntactically describe the Data Definition.

The Rule Set is the ground for human and machine understanding.

2 Data Definition

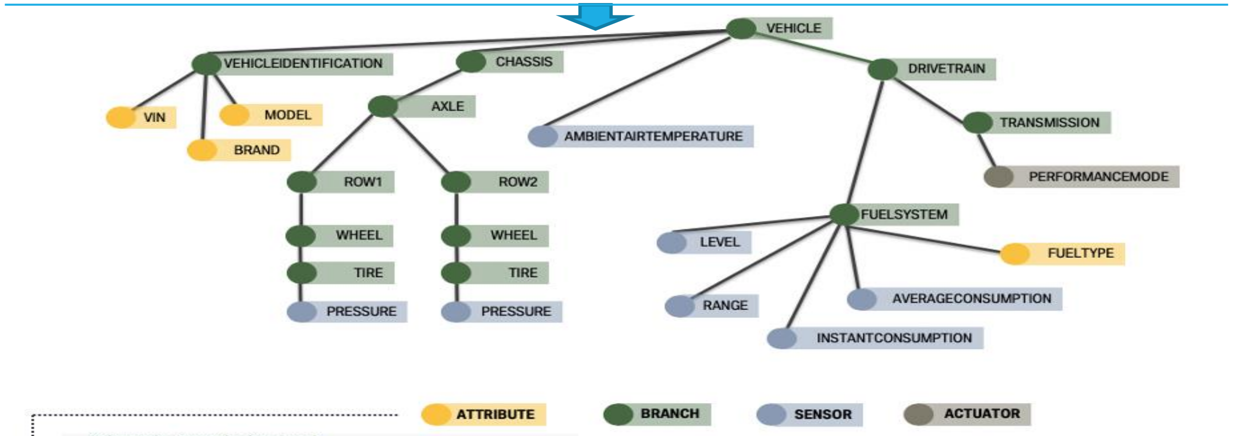
The data definition describes the domain as a simple graph. As a goal, it maps features and behaviors of the domain onto a tree structure with child-parent relationship.

It's the released content of the domain taxonomy.

3 Tools and Serialization

Tools work on the specifcation to generate the serialization as basis for further usage. This could be json, franca or even a graphql schema, etc.

The tools create the serialization as interface to the developer for further usage.




```
- Drivetrain.Transmission.Speed:
  type: sensor
  datatype: uint16
  unit: km/h
  min: 0
  max: 300
  description: The vehicle speed, as measured by the drivetrain.
```

Rule Set

- Parent node – Vehicle model
- Branches - Vehicle main sub systems
- Modules - Subsystem components
- Signals – In the form of sensor, Actuators and meta data(**new**)

```
Vehicle.Cabin.Door.Row1.Left.IsLocked
Vehicle.Cabin.Door.Row1.Left.Window.Position

Vehicle.Cabin.Door.Row2.Left.IsLocked
Vehicle.Cabin.Door.Row2.Left.Window.Position
```

Data Definition

- Define data model of each module in terms of signals
- Categorize the signal based input and out forms
- Identify data types for each signal
- Define the acceptable range of signals

Tools to Develop & Serialize

- Define interfaces for each signal
- Implement and push to(using GitHub) local branch for review(by VSS team during weekly meet)
- Make pull request to integrate with main branch code

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VSS THROUGH PLAYGROUND - HTTPS://DIGITALAUTO.NETLIFY.APP/MODEL

VSS List View

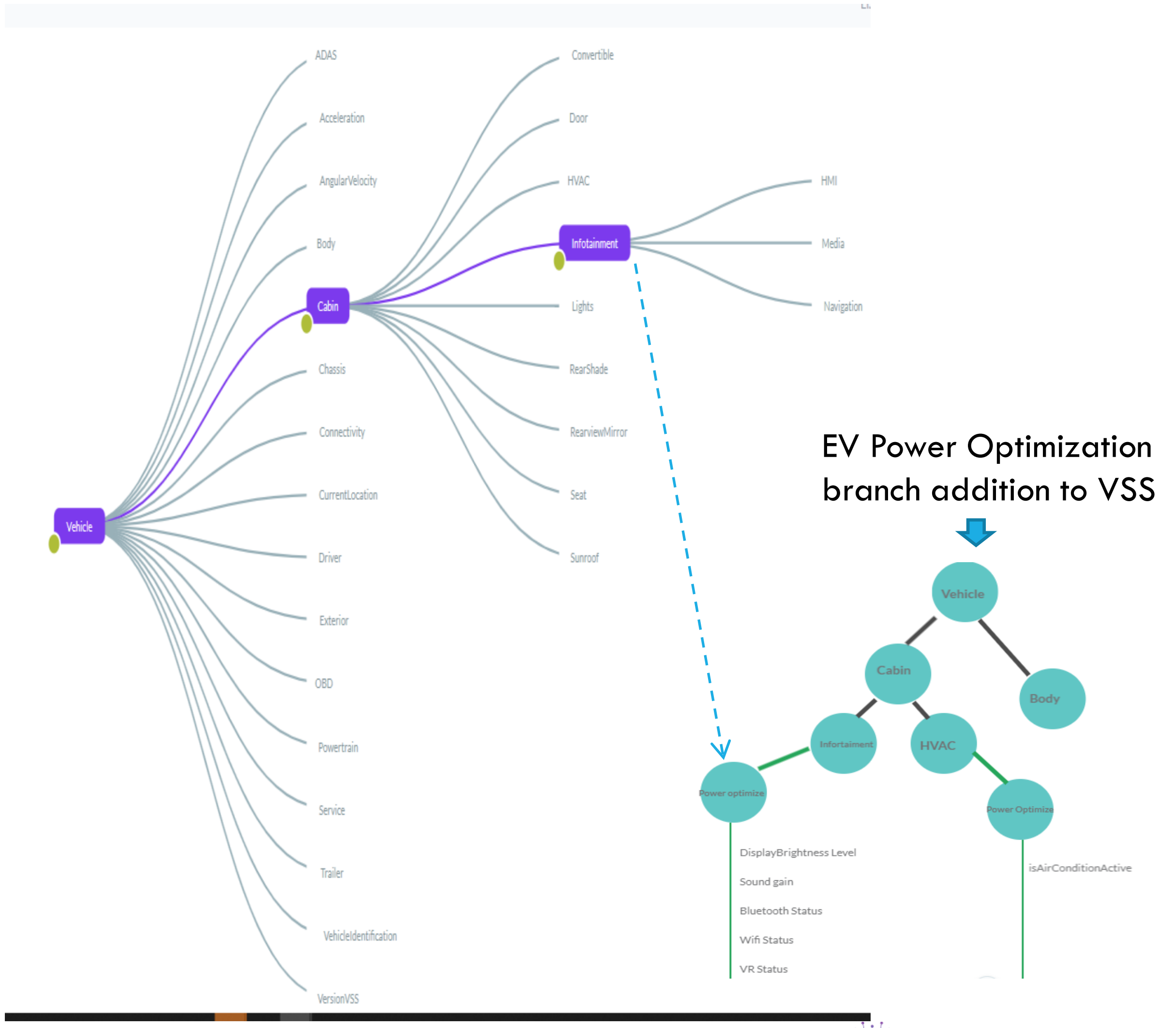
playground.digital.auto

COVESA VSS

Search

Vehicle	BRANCH
Vehicle.IteratorEnded (W)	SENSOR
Vehicle.Reset (W)	SENSOR
Vehicle.Next (W)	SENSOR
Vehicle.ADAS	BRANCH
Vehicle.ADAS.ABS	BRANCH
Vehicle.ADAS.ABS.IsEnabled	ACTUATOR
Vehicle.ADAS.ABS.IsEngaged	SENSOR
Vehicle.ADAS.ABS.IsError	SENSOR
Vehicle.ADAS.ActiveAutonomyLevel	SENSOR
Vehicle.ADAS.CruiseControl	BRANCH
Vehicle.ADAS.CruiseControl.IsActive	ACTUATOR
Vehicle.ADAS.CruiseControl.IsEnabled	ACTUATOR
Vehicle.ADAS.CruiseControl.IsError	SENSOR
Vehicle.ADAS.CruiseControl.SpeedSet	ACTUATOR
Vehicle.ADAS.EBA	BRANCH
Vehicle.ADAS.EBA.IsEnabled	ACTUATOR
Vehicle.ADAS.EBA.IsEngaged	SENSOR
Vehicle.ADAS.EBA.IsError	SENSOR
Vehicle.ADAS.EBD	BRANCH
Vehicle.ADAS.EBD.IsEnabled	ACTUATOR
Vehicle.ADAS.EBD.IsEngaged	SENSOR
Vehicle.ADAS.EBD.IsError	SENSOR
Vehicle.ADAS.ESC	BRANCH
Vehicle.ADAS.ESC.IsEnabled	ACTUATOR
Vehicle.ADAS.ESC.IsEngaged	SENSOR

VSS Tree View



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