EV POWER OPTIMIZATION

Guidelines/Attributes to increase travel range for fixed battery

20 October 2022
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
- Support OEMs to analyze and derive power efficient algorithms

What?
- Seek Collaboration from the industry players
PRACTICAL USE-CASES

Driver Alert state: Please don’t go out of charge

- SOC 100%
- SOC 20%
- SOC 10%
- SOC 0%

DISPLAY
- High Brightness
- Entertainment info

SOUND CONTROL
- Too loud
- Entertainment Audio

HVAC
- 17-37% Impact on range in summer (too cool)
- 17-50% Impact on range in Winter (too heat)

Lighting
- Interior SML
- Fog Lamps

Critical SOC Drive
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 mirror
- Night Vision

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

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

Fixed Range

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

Fixed Range

Range Calculations:

<table>
<thead>
<tr>
<th>Score/Rating</th>
<th>Wh/mile</th>
<th>Miles/kWh</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excellet</td>
<td>190-225</td>
<td>5.0+</td>
</tr>
<tr>
<td>Good</td>
<td>226-260</td>
<td>4.0-4.9+</td>
</tr>
<tr>
<td>Average</td>
<td>261-295</td>
<td>3.0-3.9+</td>
</tr>
<tr>
<td>Poor</td>
<td>296+</td>
<td>0-2.9+</td>
</tr>
</tbody>
</table>
PARAMETERS EFFECTING TRAVEL RANGE

<table>
<thead>
<tr>
<th>Available Guidelines</th>
<th>To be introduced</th>
<th>Range Effecting Electronic Loads</th>
<th>% Effect on Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vehicle pre-conditioning</td>
<td>Infotainment</td>
<td>Infotainment</td>
<td>~1%</td>
</tr>
<tr>
<td>Regenerative braking</td>
<td>HVAC control</td>
<td>HVAC</td>
<td>~17 to 40%</td>
</tr>
<tr>
<td>Routine Maintenance</td>
<td>Comfort features</td>
<td>Power windows/Mirrors</td>
<td>~2%</td>
</tr>
<tr>
<td>Remove extra weight</td>
<td>Lighting</td>
<td>lighting</td>
<td>~5 to 10%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sunroof control etc.</td>
<td>~2%</td>
</tr>
</tbody>
</table>

Fixed Range

Extra mile

Optimization on HVAC, Infotainment Comfort features will add extra mile power savings

VSS Signals:
- Media
- Radio
- Display Brightness
- Sound/Speaker Gain
- Bluetooth Status
- Voice Recognition Status
- Telematics

Available Guidelines To be introduced
- Vehicle pre-conditioning
- Regenerative braking
- Routine Maintenance
- Remove extra weight

Range Effecting Electronic Loads
- Infotainment
- HVAC
- Power windows/Mirrors
- lighting
- Sunroof control etc.
**IVI USE CASES : DISPLAY(8” TFT)- POWER OPTIMIZATION**

- **Description/Objective**: Display Turn off for Energy Conservation.

- **Pre-condition**
  - Rule: For SOC 20-50% -
  1) Display goes to backlight off for 10 minutes of inactivity.

- **Optimization Rules**
  1) Screen will not show anything unless activated or navigation is going on.

- **User Impact**
  Option will be given to driver to choose the Level of Power Saving desired.

- **Power Savings**: 10-25%
USE CASES: POWER OPTIMIZATION

Use case 1(Infotainment): The Display on/off status with power efficiency parameter signal makes OEMs to analyze the optimization algorithms and select the suitable display unit.

Use case 2(Infotainment): The Speaker gain status with power efficiency parameter signal makes OEMs to analyze the optimization algorithms and collective data is useful for selection of speakers.

Use case 3(HVAC): HVAC operation status with power efficient parameter(Compressor status{Max, Min} and other parameters)
EV POWER OPTIMIZATION IN VSS

Integration of EV Power optimization signals in VSS
**PROJECT SCOPE**

**In scope**
- Primary focus on comfort features like vehicle->cabin Infotainment, HVAC, Lights, Sunroof etc.
- Define **standard guidelines** with proven scenarios and electrical power analysis.
- Define **standard signals** which can assist in deriving the optimization algorithms by OEM’s.

**Extended Scope**
- Can be considered other vehicle modules like Body, ADAS etc. to define signals.

**Assumptions**
- POC of identified scenarios/use cases shall be performed by module owned team and results shall be published along with guideline document.

**Schedules**

<table>
<thead>
<tr>
<th>Phase 1</th>
<th>Phase 2</th>
<th>Phase 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>'22,09</td>
<td>'23,07</td>
<td>'23,12</td>
</tr>
<tr>
<td>'22,10</td>
<td>'23,10</td>
<td></td>
</tr>
<tr>
<td>'22,11</td>
<td>'23,12</td>
<td></td>
</tr>
<tr>
<td></td>
<td>'22,11</td>
<td></td>
</tr>
<tr>
<td></td>
<td>'22,12</td>
<td></td>
</tr>
<tr>
<td></td>
<td>'23,01</td>
<td></td>
</tr>
<tr>
<td></td>
<td>'23,02</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>'23,12</td>
</tr>
</tbody>
</table>
APPROACH IN TRACKING TRAVEL RANGE ATTRIBUTES

- Identify the non-safety user-critical scenarios
- Define guidelines and identify the attributes
- Define signals to communicate power saving modes
- Review with VSS team
- Define API’s, Implement and Move to Github

*Energy Efficiency in the last mile
*Less stress, More satisfaction to user

Design optimized algorithms based on the attributes

OEMs access the range attributes + other attributes to understand use-case

Seek Collaboration to brainstorm and define power optimization attributes
DATA MODEL APPROACHES

**Approach 1**
- **vehicle**
  - Cabin
  - Body
  - Infotainment
  - HVAC
  - PowerOptimize
  - HMI
  - Media

**Approach 2**
- **vehicle**
  - Cabin
  - Body
  - Infotainment
  - HVAC
  - PowerOptimize
  - HMI
  - Media

<table>
<thead>
<tr>
<th>New Signals*</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vehicle.PowerOptimize</td>
<td>Infotainment</td>
</tr>
<tr>
<td>DisplayBrightnessLevel</td>
<td></td>
</tr>
<tr>
<td>Sound/SpeakGain</td>
<td></td>
</tr>
<tr>
<td>BluetoothStatus</td>
<td></td>
</tr>
<tr>
<td>Wi-Fi Status</td>
<td></td>
</tr>
<tr>
<td>AA/CP Status</td>
<td></td>
</tr>
<tr>
<td>VRStatus</td>
<td></td>
</tr>
<tr>
<td>Vehicle.PowerOptimize</td>
<td>HVAC</td>
</tr>
<tr>
<td>Compressor Status</td>
<td></td>
</tr>
</tbody>
</table>

* To be discussed with VSS core team