E/E Architecture for Software Defined Vehicle

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Outline

• Introduction to Electric/Electronics (E/E) architectures

• E/E Architecture migration has started

• Migration is easier said than done

• Summary
Introduction to Electric/Electronic (E/E) Architectures

Source: NXP
Virtualization of functions, i.e., hardware abstraction

- The trend is towards connected cars that can update more frequently vehicles controlled by software
- We explore the hardware supporting these goals
- In ECUs and domain controllers, functions are embedded (hard-coded) in the hardware
- In zonal controllers and central computers, functions are implemented as software in domain-agnostic hardware
Why a migration towards zonal E/E architectures?

Enabling the Software-Defined-Vehicle

- Easier for OTA (Other-The-Air) update
- Enabling paid services and new business models for OEMs

Less ECUs, less wiring, less weight

- Reduced complexity of electronics while adding more autonomy, cockpit features.
- Reduced number of ECUs and associated wiring
- Lower weight = increased BEV range
- Potential for automated wiring harness assembly

Tesla leads the way

- 2017 Tesla Model 3 was the first vehicle with zone controllers and central computer
- Paid OTA activation of functions like L3/L4 Autonomy
- 50% less wiring compared to previous Model S
- Big reduction of number of ECUs – more than 50%
- Faster car assembly time through higher automation

Source: Tesla
E/E Architecture migration has started
Migration to Zonal E/E Architectures has started
Zonal* architecture in 39% of vehicle produced in 2034, up from 2% in 2022

Light vehicle production forecast by E/E Architecture, 2018–34 (millions)

*Zone defined as simple I/O unit, up to local zone and energy management.
Data compiled August 2023.
Source: S&P Global Mobility EE Architecture Platforms Forecast.
Migration pace towards zonal architectures varies by OEM and region

Adoption of zonal E/E platforms by region of brand

- **North America**
  - Tesla has 5-year lead
  - Jeep is advanced at Stellantis
  - Ford and GM in 2026 – 2027
- **Mainland China is rapid adopter**
  - Aggressive roadmaps, follow Tesla
  - Less legacy architecture
  - Tailor to niche sub-brand BEV
- **Europe trails mainland China**
  - Zonal adopters include BMW, Volvo and Renault, Mercedes and VW later
- **Korea trails Europe**
  - Initially focused on Domain Controller architectures.
    Now considers zones for next gen after 2030
- **Zonal architecture is not a focus for Japanese OEMs**
- **Indian OEMs may start adopting zonal E/E around 2030.**

Data compiled August 2023.

Note: Only the first brand shown by an OEM, if multiple brands from the same OEM introduced the same year, only name of the largest brand shown. Mainland China's sub-brands not shown, only parent. New brands in mainland China shown until 2028 only for clarity.

Source: S&P Mobility Global, EE Architecture Platforms Forecast.
Software-Defined-Vehicle on Indian roads

Indian OEMs are moving from Distributed ECUs architecture to domain-based architecture

• Mahindra has collaborated with Volkswagen for MEB platform and will use MEB components in its new INGLO architecture. The INGLO platform will feature 3 integrated high-performance computer (HPC).

• Maruti Suzuki and Toyota collaborated to share technology expertise.

• Tata Motor launched Gen-3 EV Architecture which is expected to have minimum range of 500 km.

Advancement in E/E architecture is driven by need of:

• Electrification
• Connectivity
• Safety

*DC : Domain Controller
Source: S&P Mobility Global
Migrating E/E Architecture is easier said than done
Tesla remains far ahead of everyone including Chinese EV brands

Zonal E/E architectures: Tesla vs the world

<table>
<thead>
<tr>
<th></th>
<th>Zonal Architecture</th>
<th>Wiring harness reduction with Zonal Architecture (est.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tesla</td>
<td>2017</td>
<td>50%</td>
</tr>
<tr>
<td>BYD</td>
<td>2022</td>
<td>n.a.</td>
</tr>
<tr>
<td>GAC (with Huawei)</td>
<td>2024</td>
<td>20%</td>
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<tr>
<td>BMW</td>
<td>2025</td>
<td>20%</td>
</tr>
<tr>
<td>Volvo</td>
<td>2025</td>
<td>20%</td>
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<tr>
<td>Renault</td>
<td>2026</td>
<td>20%-30%</td>
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</tbody>
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- Revolutionizing manufacturing
  - Automation of wiring harness
  - Faster car assembly time
- Tesla model 3 design (2017) remains 5 to 10 years ahead of rest of industry
- Further than competition in virtualization of functions in zonal and central computer — achieves greater simplification of wiring harness

Source: S&P Mobility Global
Volkswagen’s revised vision 2026 BEV portfolio

Changes to SSP plan – MEB+

- Software challenge
- Wide portfolio
  - Trying to accommodate too many requirements with single E³ 2.0 software platform for all segments from small economy to premium BEV
  - Weight of legacy hardware
    - Traditional OEMs like to reuse legacy hardware for next platform
    - Hard to break from legacy hardware to fully “virtualise” functions
  - Weight of internal structure
    - Unions in the way of building new dedicated EV factory
    - Outlook for automating wiring harness assembly thanks of new EE Architecture reduced

Source: S&P Mobility Global (based on Volkswagen presentation)
Summary

- Migration to new E/E Architecture has started to support the Software Defined Car but also:
  - Simplified wiring for reduced weight / extend BEV range
  - Ease / speed of manufacturing
- North American and Chinese OEMs are far ahead in adopting zonal architecture.
- Indian OEMs are moving E/E architecture from Distributed ECU architecture to Domain based architecture.
- Migration is tougher for OEMs with wide portfolio.
  - OEMs migrating at different rates depending on portfolio, legacy and philosophy
Appendix
E/E Architecture Platforms forecast launched on February 1st 2023
Quick Facts: Electric/Electronic Architecture Platforms

E/E Architecture Platforms | Launch Date: February 1, 2023

- New model-level forecast describing OEM migration strategy from distributed to centralized architectures.
- The forecast captures key hardware comprising of domain controllers, zonal controllers and central computers.
- Production Forecast Subscription
  - Extended forecast 2034
  - Non-extended on demand only
- 12 months access
- Quarterly updates
- Production Forecast

- Provides clarity for OEM EE migration strategies
  - Which OEMs pioneer, which are lagging?
  - What steps will an OEM take on way from distributed to fully centralized architecture?
  - Which OEMs are scaling architecture to all platforms, and which align centralized architectures to their BEV platforms roadmap?

- The forecast provides actionable insights for suppliers to understand the impact of new E/E Architecture Platforms on their business.
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