Alex Oyler
Director, North America
at SBD Automotive

The Software-Defined Automaker's Hierarchy of Needs
The Automaker's Hierarchy of Needs

A structured view of what it takes to commercialize software-defined vehicles

COVESA All-Member Meeting
Dearborn, MI
October 19, 2022
SBD Automotive Mission

Delivering confidence through clarity, insight and vision

Our Areas of Expertise

Connected
Autonomous
Shared
Electric
Secure
Alex Oyler
Director – North America
SBD Automotive
Ann Arbor, MI
/alex-oyler
Our research shows CASE activity at all-time high

<table>
<thead>
<tr>
<th># of stories</th>
<th>Trending companies</th>
<th>Top themes</th>
</tr>
</thead>
</table>
| **C**  
Connected | Apple, Android, BMW, NIO, Honda, Mercedes-Benz | The impact of the tech sector continues to grow as OEMs battle with s/w sourcing decisions |
| **A**  
Autonomous | UNECE, Mercedes-Benz, Stellantis, Tesla | More OEMs announce plans for L3 autonomy just as pressure from regulators/press grows |
| **S**  
Shared | gm, Hyundai, Baidu, Pony.ai, Cruise, Argo.ai | Robo-taxi programs transition from testing to operational services |
| **E**  
Electric | Mercedes-Benz, Stellantis, Tesla, Europcar, 01, VinFast, Marelli, Ford, Volvo | Demand for EV’s outpaces supply as OEMs explore and invest in new business models |
| **S**  
Secure | CARConnectivity Consortium, Hyundai, Tesla, Lexus, Honda | More OEMs get involved in the development of the next-generation smartphone key |

Source: SBD Automotive – Report 220 – Quarterly Wrap-Up (Q2 2022)
Software Defined Vehicles

What’s driving car makers forward?

Increase
- Speed-to-market
- Aftersales revenue
- Customer satisfaction
- Brand loyalty

Decrease
- Bill of materials
- Recall rate
- Depreciation
- Vulnerabilities
The software-defined automaker’s hierarchy of needs

1. E/E and Vehicle Platform
2. Software-Defined Vehicle & Car-to-Cloud
3. Organization & Development Process
4. Customer Experience
5. Commercialization
E/E and Vehicle Platforms
SoC scalability will drive consolidation and abstraction, enabling entry points for edge computing.

Source: SBD Automotive – Report 213 – Advanced Computing
Platform investments are often tied with EV ramp-up

EVs will be the lion’s share of the auto tech addressable market, but don’t forget ICE & alternatives.
EV innovators lack leverage, supply chain but own platforms

EV startups should be taken seriously as both potential competitors as well as useful data points

Source: SBD Automotive – Report 211 – Disruptor OEMs
Software-Defined Vehicles & the Cloud-to-Car Ecosystem
Most automakers require multiple “stops” to SDV

Most OEMs can’t make the jump “straight” to SDV – it’s a more iterative engineering journey

<table>
<thead>
<tr>
<th>Vehicle 1.0</th>
<th>Vehicle 2.0</th>
<th>Vehicle 3.0</th>
<th>Vehicle 4.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Functional</td>
<td>Digital</td>
<td>Updateable</td>
<td>Software-defined</td>
</tr>
<tr>
<td>New feature? Let’s add a new box</td>
<td>Let’s focus on digitizing our IVI</td>
<td>Let’s keep the car fresh</td>
<td>Let’s fully decouple SW from HW</td>
</tr>
</tbody>
</table>

-logos: Stellantis, Ford, Volkswagen, Tesla, Renault-Nissan-Mitsubishi, Daimler, BMW, XPENG
### SDV Architecture Starts with Abstraction from Car to Cloud

Abstracting compute runtime from hardware opens doors for a wide range of reusable applications.

#### Cloud Services
- OTA Services
- Connected & Location-Based Services
- Personalization & Identity Services
- AV/ADAS Services
- Vehicle Data Lake & Digital Twin
- Digital Services

#### Shared Services (In-Vehicle)
- Edge Data Services
- 5G & V2X Connectivity
- Over-the-Air Updates

#### Vehicle Applications
- ADAS Applications
- Data Applications
- IVI Applications

#### Platforms & Middleware
- Container Runtime
- Application Middleware
- Services Middleware

#### Operating System & Virtualization
- Real-Time Operating System (RTOS)
- General Purpose Operating System (GPOS)
- Type 1 Hypervisor

#### Hardware & E/E
- High-Performance Computer (HPC)
- Gigabit Ethernet
- High-Performance Computer (HPC)
- Digital Cockpit Controller (IVI)

Source: SBD Automotive – Report 636 Software-Defined Vehicle
## Top SW Spenders

<table>
<thead>
<tr>
<th>Rank</th>
<th>Company</th>
<th>Outsourced (%)</th>
<th>Insourced (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Volkswagen Group</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Toyota Group</td>
<td></td>
<td></td>
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<tr>
<td>3</td>
<td>Stellantis</td>
<td></td>
<td></td>
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<tr>
<td>4</td>
<td>Mercedes-Benz Group</td>
<td></td>
<td></td>
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<tr>
<td>5</td>
<td>BMW Group</td>
<td></td>
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<tr>
<td>6</td>
<td>Renault-Nissan-Mitsubishi</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>General Motors Group</td>
<td></td>
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<tr>
<td>8</td>
<td>Hyundai Group</td>
<td></td>
<td></td>
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<tr>
<td>9</td>
<td>Ford Group</td>
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<tr>
<td>10</td>
<td>Honda Group</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Tesla Motors</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Tata Motors Group</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Developer ecosystems, communities, and tools are the “secret sauce” to OEM-supplier partnership.

“Our #1 barrier to achieving greater in-house software development goals is recruitment.”

Software Director at Major OEM

Source: SBD Automotive - Market analysis
Critical interfaces & novel tech power car, edge, and cloud.

The complex supply chain behind SDVs requires cooperation on definitions, interfaces, toolchain.

- Far & In-Vehicle Embedded Edge
  - Intelligent sensors
  - Independent modules
  - Containers
  - Cloud-native apps
  - Running in-vehicle via HPC

- Network Edge
  - Containers
  - Cloud-native apps
  - Running in network infrastructure

- Cloud
  - Containers or virtual machines
  - (Usually) shared data center
  - Supporting regional and global workloads

- On Premise
  - Centralized
  - Private to OEM
  - Proprietary, mission-critical or sensitive data and workloads
  - Dev environments

Source: SBD Automotive – Report 213 – Advanced Computing
Organization & Development
Process Transformation
Successful delivery of SDVs requires complexity reduction

The vehicle development process doesn’t scale, so legacy OEMs must simplify before mass-market SDVs.
OEMs struggling to find the balance between old & new

SDVs require decoupled development, but OEMs need better tools, discipline, and processes to do this.
Supplier disruptors offer a new way of working for OEMs

Vertical integration of software is only one approach – some larger disruptors see partnership paths

Disruptor leverages SW expertise to provide established OEMs ready-to-integrate software solutions

Disruptor bundles together ready-to-integrate full-stack solution and delivers it to established OEMs

Disruptor OEM designs vehicles and develops own SW/UX but partners with an established manufacturer to build vehicle

Disruptor OEM controls the end-to-end stack and manufactures own vehicles that are sold directly to consumers

Source: SBD Automotive – Report 213 – Advanced Computing
Customer Experience
Connectivity is enabling a 2-way connection with drivers

Almost all new vehicles (including non-SDVs) will be accessible, sending data to various cloud apps

Source: SBD Automotive – Report 536 Connected Car Forecast
The auto industry is slowly entering the 4th wave of connectivity.

The feature & data race is giving way to competing on connected experiences after the car has shipped.
Experiences will be main value creator for OEMs with SDVs

Helping OEMs build experiences while maximizing efficiency will be a differentiation point for suppliers

**Value Creation**
- Brand loyalty
- Subscription loyalty
- Vehicle upgrades/FaaS
- Residual value

**Cost Reduction**
- Fewer mid-cycle actions (MCAs)
- Fewer platforms
- Fewer suppliers
- Fewer parts
Commercialization
Fresh, dynamic experiences underpin future commercialization

While platforms are coming online, OEMs need help "actualizing" the process of OTA software updates

Over-The-Air Enablement

Agile Release

Tesla has significantly increased OTA SW release velocity year-over-year:

All OEMs: Telematics Devices

Most OEMs: Infotainment Software (SOTA)

Emerging: Full ECU Firmware (FOTA)

FOTA Leaders:

Features-as-a-Service: the next aftersales frontier

OEMs that support FaaS in 2022:

% of feature types supported by OEMs that have adopted FaaS:

- Connectivity: 89%
- ADAS: 89%
- EV/Perform.: 56%
- Lighting: 44%
- Comfort: 44%
- Infotainment: 33%

% of consumers who are very interested in FaaS: 57%

Forecast growth in % of OEMs supporting FaaS:

Key drivers & barriers for FaaS Adoption:

<table>
<thead>
<tr>
<th>Top-5 Drivers</th>
<th>Top-5 Barriers</th>
<th>Consumers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>OEMs</strong></td>
<td><strong>Consumers</strong></td>
<td></td>
</tr>
<tr>
<td>Incremental revenues</td>
<td>Add services post purchase</td>
<td></td>
</tr>
<tr>
<td>Vehicle price reduction</td>
<td>Get latest features</td>
<td></td>
</tr>
<tr>
<td>Vehicle simplification</td>
<td>Improve re-sale value</td>
<td></td>
</tr>
<tr>
<td>Consumer demand</td>
<td>Individualized feature set</td>
<td></td>
</tr>
<tr>
<td>E/E Architectures</td>
<td>Get vehicle at lower price</td>
<td></td>
</tr>
<tr>
<td>Consumer acceptance</td>
<td>It’s not fair</td>
<td></td>
</tr>
<tr>
<td>Risky business model</td>
<td>OEM ability to switch off</td>
<td></td>
</tr>
<tr>
<td>Operational maturity</td>
<td>Don’t need it</td>
<td></td>
</tr>
<tr>
<td>Dealer acceptance</td>
<td>Expect it at purchase</td>
<td></td>
</tr>
<tr>
<td>Certification/insurance</td>
<td>Already paid enough</td>
<td></td>
</tr>
</tbody>
</table>

Source: SBD Automotive - Report 639 Features-as-a-Service
Automakers are heavily competing to provide ADAS experiences.

Experiential requirements for ADAS drive significant SDV requirements downstream.

1. **SAE Level 0**
   - ADAS providing safety warnings to the driver and/or providing corrective maneuvers.
   - All the OEMs

2. **SAE Level 1**
   - ADAS automating EITHER the basic human input (braking/acceleration OR steering) but not simultaneous.
   - All the OEMs

3. **SAE Level 2**
   - Systems capable of automating both lateral AND longitudinal control (Hands on, eyes on).
   - OEM offering SAE L2 hands-on driving

4. **SAE Level 2+**
   - Systems capable of automating both lateral AND longitudinal control (Hands off, eyes on).
   - OEM offering SAE L2+ hands-free driving

5. **SAE Level 3**
   - Systems capable of automating both lateral AND longitudinal control (Hands off, eyes-off, intermittent supervision).
   - Germany (California, Nevada USA target in 2024+), Japan in limited numbers in 2021.

Source: SBD Automotive – Report 534 ADAS Guide
With the shift to self-driving, plenty of AV pain points to solve

Breaking down the AV evolution reveals numerous testing, in-vehicle and connected opportunities

- **Operation**: What types of teleoperation are needed?
- **Insurance**: How will risk be priced?
- **Infrastructure**: Who will build AV-specific infrastructure?
- **Maintenance**: How do self-driving vehicles self-heal?
- **Mapping**: How can HD mapping be scaled up?
- **Cities**: What role will cities play in controlling services?
- **AI**: Can AI be robust enough and what role will digital twins play?
- **Accessibility**: Will the disadvantaged be included?
- **Homologation**: What will the process be?
- **Computing**: How much onboard vs offboard?
- **UX**: What happens when drivers are removed?
- **Business model**: Can services be profitable?

Collaborative vs Individual

Technical vs Commercial
The software-defined automaker’s hierarchy of needs

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Thank you!

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