Global engineering: Enabling a Connected Transport future

Joel Obstfeld
Chief Technology & Architect’s Office
Connected Transportation Sectors

Connected Maritime

Connected Freight and Logistics

Connected Aviation

Connected Roadways

Connected Vehicle

Connected Mass Transit

Connected Rail
The Automotive sector is changing

• Changing engagement models with customers, partners and suppliers
• Mobility as a Service
• Shared ownership
• Electrification
• ‘Softwareification’ of the vehicle
• Unprecedented data volume challenges

Changes occurring in every market across the globe
It’s all about the data
“Each autonomous vehicle will be generating approximately 4,000 GB – or 4 terabytes – of data a day”

Brian Krzanich, Intel, 2016
Cellphone data consumption

Cellphones receive more data than they transmit. Carrier networks are dimensioned accordingly.
What are vehicle maker’s gathering?

<table>
<thead>
<tr>
<th>Type of data</th>
<th>Examples of information collected</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vehicle status</td>
<td>Mileage, battery voltage, door and hatch status</td>
</tr>
<tr>
<td>Position and movement</td>
<td>Time, position, speed</td>
</tr>
<tr>
<td>Vehicle service</td>
<td>Due date of next service visit, oil level, brake wear</td>
</tr>
<tr>
<td>Dynamic traffic</td>
<td>Traffic jams, obstacles, signs, parking spaces</td>
</tr>
<tr>
<td>Environmental</td>
<td>Temperature, rain</td>
</tr>
<tr>
<td>User profile</td>
<td>Personal profile picture/avatar, settings as navigation, media, communication, driver’s position, climate/light, driver assistance</td>
</tr>
<tr>
<td>Sensor</td>
<td>Radar, ultrasonic devices, gestures, voice</td>
</tr>
</tbody>
</table>

*Example from BMW I-series*
The driven hour - 2019

11,200 miles per year

261 working days per year

43 miles per day

average transit time
53.8 minutes
The driven hour - 2019

Average daily commute distance (US) - 43 Miles

Average daily commute time (US) - 54 Minutes

Streamed music
36MB

‘Live’ navigation
5MB

Vehicle Telemetry
12MB
The driven hour - 2019

Average smartphone daily data volume (US)  
286MB

Equates to daily volume of  
5.3 vehicles
The driven hour – 2024

Average daily commute distance (US) – 45 Miles

Average daily commute time (US) – 55.6 Minutes

Streamed music 37MB

‘HD’ navigation 450MB

Vehicle Telemetry 350MB

ADAS Data 7.5GB

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The driven hour - 2024

Average vehicle daily data volume in 2023
8.33GB

Equates to daily volume of 5.2 smartphones in 2024
OEM - Data volume generation by region

Forecast based on current global vehicle production figures
### Application-based vehicle communication options

<table>
<thead>
<tr>
<th>Application</th>
<th>V2X</th>
<th>Fleet operator</th>
<th>3rd Party</th>
<th>Public Operator</th>
<th>Safety or Value-added</th>
<th>Hi/lo Data volume</th>
<th>Time-sensitive (*not low latency)</th>
<th>Frequency of exchange</th>
<th>Primary comms path</th>
<th>Secondary comms path</th>
</tr>
</thead>
<tbody>
<tr>
<td>ITS Safety</td>
<td>V2V, V2I</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Safety</td>
<td>Low</td>
<td>Yes</td>
<td>High</td>
<td>DSRC/C-V2X</td>
<td></td>
</tr>
<tr>
<td>Predictive Health Maintenance</td>
<td>V2C</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Value-added</td>
<td>Low</td>
<td>No</td>
<td>Periodic</td>
<td>Wifi</td>
<td>Cellular</td>
</tr>
<tr>
<td>Navigation Services</td>
<td>V2C</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Value-added</td>
<td>High</td>
<td>Yes</td>
<td>Periodic</td>
<td>Cellular</td>
<td>Wifi</td>
</tr>
<tr>
<td>Advanced Driver Assistance Services</td>
<td>V2C</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Value-added</td>
<td>High</td>
<td>No</td>
<td>Periodic</td>
<td>Wifi</td>
<td>Cellular</td>
</tr>
<tr>
<td>Real-time logistics planning</td>
<td>V2C</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Value-added</td>
<td>High</td>
<td>Yes</td>
<td>Streamed</td>
<td>Cellular</td>
<td>Wifi</td>
</tr>
</tbody>
</table>

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Applications are key

Key questions

• WHO values the data?

• Who pays for the comms and the cloud services
  • If no one values the data, it doesn’t leave the vehicle

• What is the ‘cost’ of the required compute & storage?

• Where can the application be executed most ‘cost effectively’?
Where is the ‘Edge’ compute?

- In-vehicle
- Corridor-cloud
- Regional-cloud
- Cloud
- OEM-DC
- Fleet-DC
- Roadside Unit
  - or
  - Traffic Signal Controller
## Data volume transmission – Time

<table>
<thead>
<tr>
<th>Market year</th>
<th>Description</th>
<th>Daily transmitted data volume (GB)</th>
<th>Upload time (9Mbps Cellular upload BW)</th>
<th>Upload time (17Mbps Broadband upload BW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2018</td>
<td>Vehicle telemetry</td>
<td>0.013</td>
<td>12sec</td>
<td>6sec</td>
</tr>
<tr>
<td>2019</td>
<td>Predictive Health Maintenance suite</td>
<td>0.05</td>
<td>48sec</td>
<td>25sec</td>
</tr>
<tr>
<td>2021</td>
<td>1\textsuperscript{st} Gen Connected Car application suite*</td>
<td>0.33</td>
<td>5m 88sec</td>
<td>2m 43sec</td>
</tr>
<tr>
<td>2024</td>
<td>2\textsuperscript{nd} Gen Connected Car application suite*</td>
<td>50</td>
<td>13h 15m 22sec</td>
<td>7h 1m 5sec</td>
</tr>
</tbody>
</table>

* Data processed on-board prior to transmission.
* Intent is to deploy suite across all models in that year
## Data volume transmission – Cost for Carrier

<table>
<thead>
<tr>
<th>Market year</th>
<th>Description</th>
<th>Daily transmitted data volume (GB)</th>
<th>4G/LTE</th>
<th>5G – forecast (30% cost reduction vs 4G)</th>
<th>Wifi</th>
</tr>
</thead>
<tbody>
<tr>
<td>2019</td>
<td>Vehicle telemetry</td>
<td>0.013</td>
<td>$.025</td>
<td>$.0175</td>
<td>$.0008</td>
</tr>
<tr>
<td>2020</td>
<td>Predictive Health Maintenance suite</td>
<td>0.05</td>
<td>$.095</td>
<td>$.0665</td>
<td>$.003</td>
</tr>
<tr>
<td>2022</td>
<td>1&lt;sup&gt;st&lt;/sup&gt; Gen Connected Car application suite</td>
<td>0.33</td>
<td>$.594</td>
<td>$.4158</td>
<td>$.019</td>
</tr>
<tr>
<td>2025</td>
<td>2&lt;sup&gt;nd&lt;/sup&gt; Gen Connected Car application suite</td>
<td>50</td>
<td>$82.22</td>
<td>$57.554</td>
<td>$2.73</td>
</tr>
</tbody>
</table>

- Assumption – 3% reduction in cost per annum, based on Deloitte Industry reports
Wifi opportunities

- Public parking
- Private parking
- Gas Station
- Residential parking
- EV Charge point
- Other hotspots
- Dealership locations
Connected Car and the Communications challenge

• What does the application need?
• Cellular AND Wifi not Cellular or Wifi
• Ethernet over power (EV charging)?

• Requires policy-driven routing to select the ‘right’ path on an application-by-application basis
The Internet of Threat
Evolution of the Cyber Threat

Early Hacks (2010~2015)
- **March, 2010:** Fired auto dealer employee disabled 100 vehicles via Remote Immobilization System
- **May, 2010:** UCSD and UW researchers hacked into an unnamed mid-price sedan
- **August, 2013:** Scientists found a way to steal vehicle key authentication, Volkswagen blocked research publication

Recent Hacks (2016-2018)
- **July 2012:** Anonymous video showed keyless BMW hacked
- **January 2015:** Hacker hacks Toyota Tundra via OBD2 dongle
- **February 2015:** DARPA-funded researchers hacked into Ford Explorer and Toyota Prius
- **February 2016:** Researcher discloses Nissan Leaf vulnerability
- **February 2017:** Kaspersky Labs discloses connected vehicle mobile app vulnerabilities
- **April 2018:** Researchers showcase an infotainment hack via SMS text RAT
- **August 2018:** Hackers shut off key automated components, including safety mechanisms.

- **July 2015:** Researchers hacked a Jeep Cherokee while being driven on a highway
- **July 2016:** Researchers expanded findings on 2015 Jeep Cherokee hack
- **August 2017:** Hackers shut down 2 OEMs' mfg. operations
- **May 2018:** Researchers find 14 vulnerabilities in BMW models that allow physical or remote access to the IVI
- **September 2018:** Hackers showcase how to steal a Tesla Model S by cloning the key fob

**Key Events**
- **January 2012:** Start the CyberAuto Challenge
- **November 2014:** Researchers hacked a car with Zubie device
- **July 2015:** Researchers hacked a Jeep Cherokee while being driven on a highway

**Timeline**
- **March, 2010:** Fired auto dealer employee disabled 100 vehicles via Remote Immobilization System
- **May, 2010:** UCSD and UW researchers hacked into unnamed mid-price sedan
- **July, 2013:** DARPA-funded researchers hacked into Ford Explorer and Toyota Prius
- **February 2015:** DARPA’s Dan Kaufman demonstrates vehicle hacking to CBS
- **August, 2015:** Researchers demonstrated hacking a Tesla Model S and planting a remote-access Trojan
- **February 2016:** Researcher discloses Nissan Leaf vulnerability
- **February 2017:** Kaspersky Labs discloses connected vehicle mobile app vulnerabilities
- **April 2018:** Researchers showcase an infotainment hack via SMS text RAT
- **August 2017:** Hackers shut off key automated components, including safety mechanisms.
- **May 2018:** Researchers find 14 vulnerabilities in BMW models that allow physical or remote access to the IVI
- **September 2018:** Hackers showcase how to steal a Tesla Model S by cloning the key fob
Why attack for one, when you attack many?

<table>
<thead>
<tr>
<th>Getting In</th>
<th>Hackers target many weak spots in cars to gain access</th>
</tr>
</thead>
<tbody>
<tr>
<td>Servers</td>
<td>21.3%</td>
</tr>
<tr>
<td>Keyless entry</td>
<td>19.1</td>
</tr>
<tr>
<td>Onboard diagnosis port</td>
<td>10.4</td>
</tr>
<tr>
<td>Infotainment</td>
<td>7.4</td>
</tr>
<tr>
<td>Mobile app</td>
<td>7.4</td>
</tr>
<tr>
<td>Cellular network</td>
<td>4.8</td>
</tr>
<tr>
<td>Wi-Fi</td>
<td>4.3</td>
</tr>
<tr>
<td>USB port</td>
<td>3.5</td>
</tr>
<tr>
<td>Bluetooth</td>
<td>3.0</td>
</tr>
<tr>
<td>Sensors</td>
<td>3.0</td>
</tr>
<tr>
<td>Telematic control unit</td>
<td>2.6</td>
</tr>
<tr>
<td>Onboard diagnosis dongle</td>
<td>1.7</td>
</tr>
</tbody>
</table>

Source: Upstream Security
Govt to urge infrastructure data be kept on servers in Japan

“Guideline for Establishing Safety Principles will stipulate the storage of data on servers governed by domestic law as a “desirable security measure.” Since there are limitations to applying domestic law to servers located overseas, the government is effectively asking operators to keep data within Japan.”

End-to-End Security Architecture

Visibility and Mitigation
- Identity, Authorization, Audit
- Security Management
- Data Sovereignty
- Data processing & storage
- Content & Applications
- Shared intelligence
- Secure Onboarding & Management
- Secure data exchange for applications: Intelligent driving, HD Map, etc.
- OEM and Regional DCs
- SP Network (5G, 4G, Wifi, other)
- Consistent policy enforcement
- Visibility and Mitigation
- Identity and entitlement
- Name Services
- Firewall
- Data Privacy
- Secure Onboarding & Management
- Secure data exchange for applications: Intelligent driving, HD Map, etc.
So what about those autonomous vehicles?
1 Vehicle = 2500 smartphones
Data volume generation – Autonomous Vehicle control software vendor comment

- Data is not required in real-time for vendor’s purposes
- Current generation software stack, generates 200–250GB per driven hour
- Expect to reduce to 50–70GB ‘in regular operation’
- Will be able selectively enable and disable data-storage subject to encountered events
Global automotive
Global scale
Global challenge
Automotive Distributed Computing Architecture

Global DC data processing + insight generation

In-region data processing

In-vehicle compute, data processing + results

Data volume reduction

Enterprise Digital Platform

Data Lake

Regional Digital Platform

Data Lake

PRIVATE

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Heterogeneous Service Consumption

1. Dealer network
2. Carrier Network
3. Regional Availability Zone

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Summary
Challenge

• How do we design, build and operate communication networks to support these data volumes, cost effectively and securely?
  • For Vehicle manufacturers
  • For Fleet operators
  • For Communications Service providers
  • For end users

• How does 5G enable new business opportunities?

• What other technologies do we need to consider?

How can we do things differently?
Carry on your learning

https://blogs.cisco.com/sp/connectedcar-theDrivenHour-wp