5G IN THE DRIVING SEAT

VISHNU SUNDARAM, VICE PRESIDENT – TELEMATICS
OCTOBER 2017
AGENDA

1. MEGATREND: TELECOMMUNICATION AND AUTOMOTIVE
2. ADDRESSABLE MARKET: DRIVE BY WIRE CARS
3. TECHNOLOGY IN THE CARS OF FUTURE
4. AUTOMOTIVE AND 5G INTERSECTION
5. MAKING COMMUTES SAFER
6. HARMAN’S ROLE
TELECOMMUNICATION EMBRACES MEGATRENDS

1960s T-GRAM REMOTE COMMN.

1980s FIXED DISTANCE CALLING

1990 GSM INTERNET ON MOVE

2000 3G INTERNET ON MOVE

2010 4G CLOUD ON MOVE

2020 5G MAINSTREAM

Drive Autonomy

Smart Phone

Internet

Desk/Laptops

Computers

TELECOMMUNICATION EMBRACES MEGATRENDS
DRIVE BY ELECTRIC WIRE CARS

Future cars will be differentiated by the intelligence embedded inside.

DERIVED FROM: IHS AUTOMOTIVE INTERNATIONAL ENERGY AGENCY

2 Million TODAY

65 Million 2025
TECHNOLOGY IN THE CAR OF THE FUTURE

1. Backbone
2. Autonomous Drive
3. Multifunctional Cockpit
4. Control & Management
5. Energy & Propulsion
6. Experience
EXPONENTIAL GROWTH OF CONNECTIVITY NEEDS IN THE CAR

Safety and Location Data
- 0.50Mbps
- 2015

Vehicle Diagnostics
- 10 Mbps
- 2017

Camera LIDAR
- 1 Gbps
- 2020

Autonomous Compute
- 5 Gbps
- 2025

TELEMATICS
# Automotive and 5G Intersection

## Use-cases

<table>
<thead>
<tr>
<th>Use-cases</th>
<th>Control</th>
<th>VR Gadgets</th>
<th>Remote Computing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pedestrian Safety</td>
<td>Road Infra Devices</td>
<td>Fog Computing</td>
<td></td>
</tr>
<tr>
<td>Safety Messaging</td>
<td>Connected Accessories</td>
<td>Video Remoting</td>
<td></td>
</tr>
</tbody>
</table>

## 5G Technology Elements

| 1ms | 1M Devices/Cell | 10Gbps |
| Latency | nB IoT | Bandwidth |

## Current

- 1ms Latency
- 10Gbps Bandwidth

## Future

- 1M Devices/Cell

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## MAKING COMMUTES SAFER

### Sensors

<table>
<thead>
<tr>
<th>2010</th>
<th>2015</th>
<th>2020</th>
<th>2025</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crash Sensors</td>
<td>Camera</td>
<td>Lidar</td>
<td><strong>V2X</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Thermal</td>
<td><strong>Cellular / 5G</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Radar</td>
<td>Lasers</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><strong>V2 &lt;Pedestrian&gt;</strong></td>
</tr>
</tbody>
</table>

### Coverage

<table>
<thead>
<tr>
<th>2010</th>
<th>2015</th>
<th>2020</th>
<th>2025</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local to car (0 ft)</td>
<td>Short Range (50 ft)</td>
<td>Medium Range (500 ft)</td>
<td>Medium Range (1000 ft)</td>
</tr>
</tbody>
</table>

### Field of View

Projection based on ETSI and NHTSA definitions

### Resulting Automation

<table>
<thead>
<tr>
<th>Automation</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Automation <strong>Level 0</strong></td>
</tr>
<tr>
<td>Drive Assist Automation <strong>Level 1</strong></td>
</tr>
<tr>
<td>Partial Automation <strong>Level 2</strong></td>
</tr>
<tr>
<td>Combined Function Automation <strong>Level 3</strong></td>
</tr>
<tr>
<td>Full Self-Driving Automation <strong>Level 4</strong></td>
</tr>
</tbody>
</table>

### Becoming Standard

<table>
<thead>
<tr>
<th>Standards</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
</tr>
<tr>
<td>eCall</td>
</tr>
<tr>
<td>ERA Glonass</td>
</tr>
<tr>
<td>NHTSA</td>
</tr>
<tr>
<td>ITS, NHTSA</td>
</tr>
</tbody>
</table>

Projection based on ETSI and NHTSA definitions

5G will play a key part
REALITY IN THE MAKING

Strong Industry Support
• Technology Developers
• Academic Organizations
• Mobile Operators
• Internet Giants

Market Investment

Clear Cooperation
• Technology Alliances
• Government Support

Transportation revolution is here to stay
First 5G (based on NSA) plug-in test schedule by 2018

Samsung support in $300m fund to invest in autonomous driving technologies

Key participation in 5GAA in the board, treasury, marketing

C-V2X Framework and Application Development

Products in the roadmap to address unconnected and under connected cars

HARMAN’S ROLE