Flash Memory in the emerging age of autonomy

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Lucid Motors
CORPORATE SNAPSHOT

• Founded in 2007
• 300+ employees
• Headquartered in Menlo Park, California (Silicon Valley)
• 300+ issued and pending patents
• $200m+ funding to date (Series C closed in 2014)
State of the Industry

L3 systems entering consumer market

L4 pilots operational

State testing legislation & initial federal policies
NHTSA Federal Automated Vehicles Policy
September 2016

• Vehicles should record, …, all information relevant to the event… [accident, crash]
• … should collect, store and analyze data regarding positive outcomes …
• … explore a mechanism to facilitate anonymous data sharing …
State Legislative Guidelines

California Proposed Driverless Testing and Deployment Regulation
March 10, 2017

• “Autonomous technology data recorder”
• …for 30 seconds prior to a collision and at least 5 seconds after a collision …
• … data recorder that captures and stores … sensor data for all vehicle functions that are controlled by the autonomous technology

Nevada Administrative Code Chapter 482A - Autonomous Vehicles
Revised April 2014

• … to capture and store the autonomous technology sensor data for at least 30 seconds before a collision occurs…
Where does the data come from and how much are we really talking?

<table>
<thead>
<tr>
<th>Sensor Type</th>
<th>Count</th>
<th>Bandwidth per Sensor (Mbit/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>RADAR</strong></td>
<td>4-6</td>
<td>0.1 - 15</td>
</tr>
<tr>
<td>LIDAR</td>
<td>1-5</td>
<td>20 - 100</td>
</tr>
<tr>
<td><strong>CAMERA</strong></td>
<td>6-12</td>
<td>500 - 3500</td>
</tr>
<tr>
<td><strong>ULTRASONIC</strong></td>
<td>8-16</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td><strong>VEHICLE MOTION, GNSS, IMU</strong></td>
<td></td>
<td>&lt;0.1</td>
</tr>
</tbody>
</table>

**TOTAL SENSOR BANDWIDTH:** 3Gbit/s (~1.4TB/h) or 40 Gbit/s (~19 TB/h)
What does this mean for storage KPIs?

Let’s make some assumptions… a “medium” sensor bandwidth CAV in California

\[(30s + 5s) * 5 \text{ Gbit/s} = 22 \text{ GB per Event}\]

Americans drive an average of 17,600 min/year[1]

\[17,600 \text{ min/year} * 5 \text{ Gbit/s} = 660 \text{ TBW / Year}\]

What does it mean for CAV storage projects?

- High bandwidth interfaces
- Diverse density & lifetime requirement
- Shorter design & validation cycles
Summary

- There will be vastly different bandwidth requirements
- Legislation will continue to evolve
- Validation is an ongoing process
- Storage requirements no longer just driven by features and functions for the customer