Overview of Automated Vehicle Terminology & J3016 Levels
Overview

- Guide to SAE J3016 terminology
  - The good
  - The bad
  - The ugly
  - *SAE J3016 is not a safety standard*

- The SAE Levels Explained
  - Perhaps not what you thought
  - Debunking some myths

- A different way to look at automation modes
Basic SAE J3016 Terminology

- ODD: Operational Design Domain
  - Environment system is designed to work within
- OEDR: Object and Event Detection and Response
  - Monitoring & responding to driving environment
- DDT: Dynamic Driving Task
  - Driving vehicle, performing OEDR, avoiding crashes
- ADS: Automated Driving System
  - Computer system that can completely perform driving (DDT)
- Fallback:
  - Operating vehicle when something goes wrong (e.g., ADS failure)
- MRC: Minimal Risk Condition
  - Bringing vehicle to stop as part of fallback operation
## SAE J3016 Levels

<table>
<thead>
<tr>
<th>Level</th>
<th>J3016 Name</th>
<th>Steering &amp; Speed</th>
<th>OEDR</th>
<th>DDT Failures</th>
<th>Vehicle Failures</th>
<th>Perform Fallback</th>
<th>ODD Scope</th>
<th>Other Safety</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No Driving Automation</td>
<td>Driver</td>
<td>Driver</td>
<td>Driver</td>
<td>Driver</td>
<td>Driver</td>
<td>n/a</td>
<td>Driver</td>
</tr>
<tr>
<td>1</td>
<td>Driver Assistance</td>
<td>Split</td>
<td>Driver</td>
<td>Driver</td>
<td>Driver</td>
<td>Driver</td>
<td>Limited</td>
<td>Driver</td>
</tr>
<tr>
<td>2</td>
<td>Partial Driving Automation</td>
<td>Automated</td>
<td>Driver</td>
<td>Driver</td>
<td>Driver</td>
<td>Driver</td>
<td>Limited</td>
<td>Driver</td>
</tr>
<tr>
<td>3</td>
<td>Conditional Driving Automation</td>
<td>ADS</td>
<td>ADS</td>
<td>ADS</td>
<td>Driver</td>
<td>Driver</td>
<td>Limited</td>
<td>Driver</td>
</tr>
<tr>
<td>4</td>
<td>High Driving Automation</td>
<td>ADS</td>
<td>ADS</td>
<td>ADS</td>
<td>ADS</td>
<td>ADS</td>
<td>Limited</td>
<td>Driver</td>
</tr>
<tr>
<td>5</td>
<td>Full Driving Automation</td>
<td>ADS</td>
<td>ADS</td>
<td>ADS</td>
<td>ADS</td>
<td>ADS</td>
<td>Unlimited</td>
<td>Driver</td>
</tr>
</tbody>
</table>

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Other J3016 Terminology Notes

- Automated vs. Autonomous
  - J3016: always uses “automated” with regard to ADS
  - ANSI/UL 4600: uses “autonomous” for whole vehicle, not just ADS

- Autopilot:
  - J3016: neither defined nor used

- Robotic, Robotaxi:
  - J3016: do not use term

- Driverless vehicle
  - J3016: do not use term, although “driverless operation” is OK

- Self-driving
  - J3016: do not use term
<table>
<thead>
<tr>
<th>Operating Mode</th>
<th>Human Role</th>
<th>Driving</th>
<th>Driving Safety</th>
<th>Other Safety</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supervised</td>
<td>Eyes ON the road</td>
<td><img src="https://bit.ly/3r1dhKE" alt="Icon" /></td>
<td><img src="https://bit.ly/3r1dhKE" alt="Icon" /></td>
<td><img src="https://bit.ly/3r1dhKE" alt="Icon" /></td>
</tr>
</tbody>
</table>

**Vehicle Automation Modes**

[Link](https://bit.ly/3r1dhKE)
Driver Roles Contrasted

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**Assistive & Supervised**
- Driver attention required
  - Vehicle responds to driver
- Potential blame on automation for unsafe intervention
  - Incentivized to be conservative

**Automated & Autonomous**
- No human attention on driving
  - Vehicle cannot count on human intervention for driving safety
- ADS potentially at fault for crashes, not human driver

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Vehicle Automation Modes

Operating Mode | Human Role | Driving | Driving Safety | Other Safety
---|---|---|---|---
Assistive | Driving | ![Assistive](https://bit.ly/3r1dhKE)
Supervised | Eyes ON the road | ![Supervised](https://bit.ly/3r1dhKE)
Automated | Eyes OFF the road | ![Automated](https://bit.ly/3r1dhKE)
Autonomous | No human | ![Autonomous](https://bit.ly/3r1dhKE)
“Autopilot” systems: lane keeping + adaptive cruise control
- Tesla “Autopilot” ➔ SAE Level 2 / Supervised
- Tesla “Full Self Driving” ➔ SAE Level 2 / Supervised
- Porsche Taycan ➔ SAE Level 2 / Supervised
- Cadillac “Super Cruise” ➔ SAE Level 2 / Supervised
- ... others ...

Low Speed Automatic Lane Keeping System
- UN Regulation No. 157 ALKS; traffic jam pilot under 60 km/hr
- Announced but not confirmed deployments ➔ Perhaps SAE Level 3
  - Either Supervised or Automated depending on driver responsibility

No constant human supervision
- Waymo Robotaxi ➔ Perhaps SAE Level 4 / Autonomous
Myth: ODD means Geo-Fencing
- Other factors: lighting, weather, infrastructure failures, ...

Myth: Higher SAE J3016 Levels are necessarily safer
- Not a safety standard! SAE Level 2 & 3 are problematic as defined
  - E.g., no requirement for driver monitoring
- Higher levels introduce more automation, but not necessarily safety
- “Level 2+” is meaningless

Myth: Driver backs up ADS object detection in Level 3
- Level 3 by definition handles 100% of OEDR
- If driver can be blamed for not intervening while driving, that is Level 2

https://users.ece.cmu.edu/~koopman/j3016/
Myth: Level 3 always provides 10 seconds to take over
- “at least several seconds” ... no requirement that driver is ready
- No warning time for “evident” vehicle failure
- No requirement to maintain safety if driver does not take over
  - ADS that can always perform fallback is Level 4

Myth: Level 3 means “eyes off road”
- ADS does whole DDT, but driver needs situational awareness
  - Example: ADS not required to handle tire blow-out
- “Eyes off road” is in published graphics, but not in the standard
Other Top AV Myths

- Myth: “94% of crashes are driver error”
  - Not what the US DOT study actually says.
  - Humans played *some* role in 94% of crashes
    - Yes, drunk driving
    - Yes, other human frailties
    - But also some things that AVs will struggle with
      » “Recognition” and “Decision” errors

- Myth: “AVs don’t drive drunk, so they will be safer”
  - AVs lack common sense; will make *different* mistakes
  - Insufficient data to know how this will turn out
    - Existing Level 2 data is human+machine safety, not autonomy safety
Summary

- SAE J3016 is a terminology standards document
  - Not a safety standard
  - Defines levels that may not match what is actually built
  - Plenty of misleading and incorrect information circulating
  - Summary here: https://users.ece.cmu.edu/~koopman/j3016/

- Real vehicles might not exactly match Levels
  - Regulating or legislating using Levels is a bad idea
  - Instead, concentrate on driver role & responsibility
    - Clear statement of driver responsibility
    - Don’t let people get used as a moral crumple zone