Intelligent Vehicle Systems

Southwest Research Institute

Moving at Lightning Speed: The Future of Transportation and Technology

SwRI®

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Automated Vehicle Technology

- **Basic question:**
  - **What is the PURPOSE of a driverless vehicle?**

- **Possible answers:**
  - **Ultimate solution to the driver distraction problem**
  - **Should reduce accidents (although until a significant penetration the overall effect is questionable)**
  - **Should enable a reduction in traffic fatalities**
  - **Make transportation systems much more efficient (more vehicles in the same space)**

- **Sustainability of the technology (at what functional level) – consider driving levels model – expected duration of autonomy:**
  - **5 seconds**
  - **30 seconds to 1 minute**
  - **> 1 hour**

NHTSA / SAE Driving Levels

- **Descriptive**
- **Minimum levels**
- **Compare to:**
  - **Germany Federal Highway Research Institute (BASt)**
  - **NHTSA**

Source: SAE

SAE level	SAE name	SAE narrative definition	Execution of steering and acceleration/ deceleration	Monitoring of driving environment	Fallback performance of *dynamic driving task*	System capability (*driving modes*)	BASt level	NHTSA level
Human driver monitors the driving environment								
0	No Automation	the full-time performance by the *human driver* of all aspects of the *dynamic driving task*, even when enhanced by warning or intervention systems	Human driver	Human driver	Human driver	n/a	Driver only	0
1	Driver Assistance	the *driving mode*-specific execution by a driver assistance system of either steering or acceleration/deceleration using information about the driving environment and with the expectation that the *human driver* perform all remaining aspects of the *dynamic driving task*	Human driver and system	Human driver	Human driver	Some driving modes	Assisted	1
2	Partial Automation	the *driving mode*-specific execution by one or more driver assistance systems of both steering and acceleration/deceleration using information about the driving environment and with the expectation that the *human driver* perform all remaining aspects of the *dynamic driving task*	System	Human driver	Human driver	Some driving modes	Partially automated	2
Automated driving system ("system") monitors the driving environment								
3	Conditional Automation	the *driving mode*-specific performance by an *automated driving system* of all aspects of the *dynamic driving task* with the expectation that the *human driver* will respond appropriately to a *request to intervene*	System	System	Human driver	Some driving modes	Highly automated	3
4	High Automation	the *driving mode*-specific performance by an *automated driving system* of all aspects of the *dynamic driving task*, even if a *human driver* does not respond appropriately to a *request to intervene*	System	System	System	Some driving modes	Fully automated	3/4
5	Full Automation	the full-time performance by an *automated driving system* of all aspects of the *dynamic driving task* under all roadway and environmental conditions that can be managed by a *human driver*	System	System	System	All driving modes		

Semi-Autonomous Driving – available TODAY

Who is Developing Autonomous Vehicle Capabilities

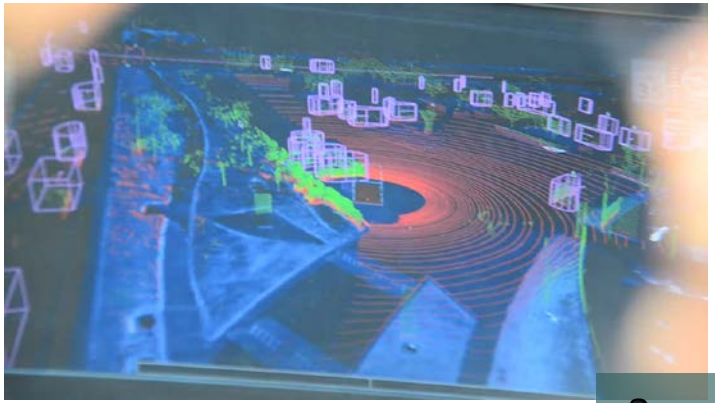
(list may incomplete because information is not openly shared)

- **US OEMs:**
  - GM
  - Ford
  - Tesla
- **European:**
  - Mercedes
  - BMW
  - Audi
  - Volvo
  - Renault
  - Scania (trucks)
  - Jaguar Landrover
  - Deihl
  - RUAG
  - Rheinmetall Defence
- **Japan:**
  - Nissan
  - Honda
  - Toyota
  - Hino
  - Isuzu
- **Tier 1 Suppliers:**
  - Bosch
  - Continental
  - Delphi
- **US non-OEMs:**
  - Lockheed Martin
  - Southwest Research Institute (SwRI)
  - Smaller Defense Contractors:
    - TORC, GDRS, ASI, etc.
  - University Research
    - CMU, Stanford. Virginia Tech
    - California PATH, VTTI
  - Google
- **Government (non DoD)**
  - US:
    - Human Factors for Vehicle Highway Automation
    - USDOT Automation Program
  - European Union:
    - CitiMobil and CyberCars
    - Safe Road Trains for the Environment (SARTE)
  - Japanese Government Energy ITS Project

State of the Practice (commercial): Google

- **Pros**
  - **Well funded**
  - **Previously only freeway, adding arterial capability**

Source: Google



Source: Google

Cons

- **Expensive sensor suite**
- **Must pre-drive route**
- **Requires high precision map database**
- **For the U.S. - only 3,200 km of the 6.4M kms of highway “mapped”**

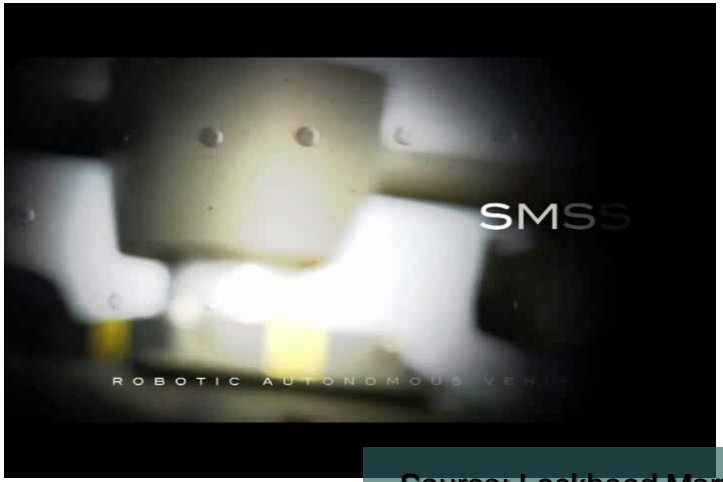
State of the Practice (military): AMAS (LM)

- **Autonomous Mobility Appliqué System (AMAS)**
- **Portable Autonomy:**
  - **A-kit (autonomy)**
  - **B-kit (vehicle interface)**
  - **C-kit (payload)**

Source: Lockheed Martin

State of the Practice (military):
(mules and support tools)

- **Squad Mission Support System (SSMS)**
  - **Active sensor technology**
  - **Carry loads over difficult terrain**



Source: Lockheed Martin

- **Dismounted Solider Autonomy Tools (DSAT)**
  - **Passive and active sensor technology**
  - **Supports 3 unique platforms**

State of the Practice (agricultural/mining): John Deere / Komatsu

- **Deere**
  - **Agriculture**
  - **Constrained environment**

Source: John Deere

Source: Komatsu

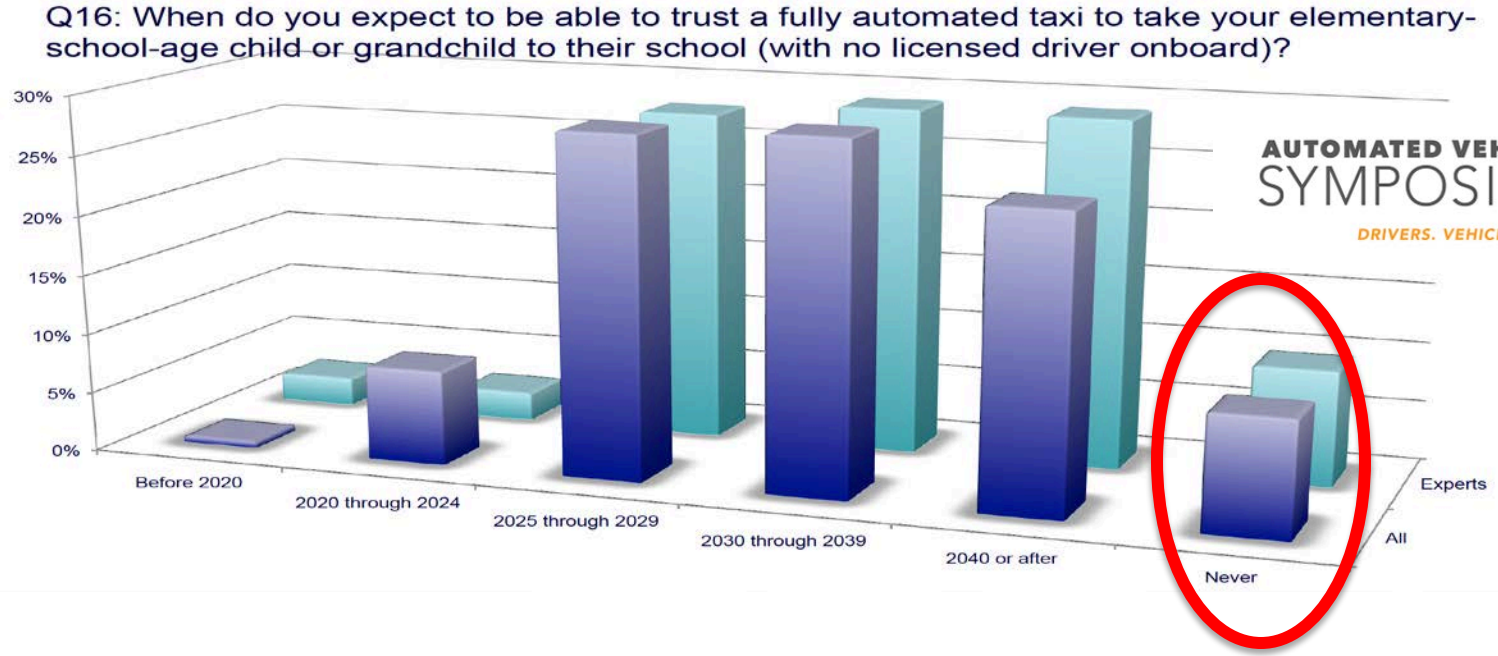
- **Komatsu**
  - **Fixed route**
  - **Very dirty conditions**

Switch the Focus

- **Lots of press and widely spread articles about on-road projects….**
- **Domains other than passenger vehicles have experienced lots of success:**
  - **Agriculture**
  - **Mining**
  - **Military**
- **Common thread in these areas include:**
  - **Constrained environments**
  - **Can accept some level of “collateral damage” (with no legal implications)**

What do the Experts (collectively) Say?

Automated Vehicles Forecast: From AVS14 – July 2014



AUTOMATED VEHICLES SYMPOSIUM 2014

DRIVERS. VEHICLES. INFRASTRUCTURE.

Looking out to the Horizon: What is Next?,

- **Constrained Environments:**
  - **Military operations can accept collateral damage**
  - **Closed operations (such as mining, agriculture) have less unpredictability:**
    - **No teenage drivers**
    - **Limited obstacles**
    - **Very well known environment (that does not change much)**

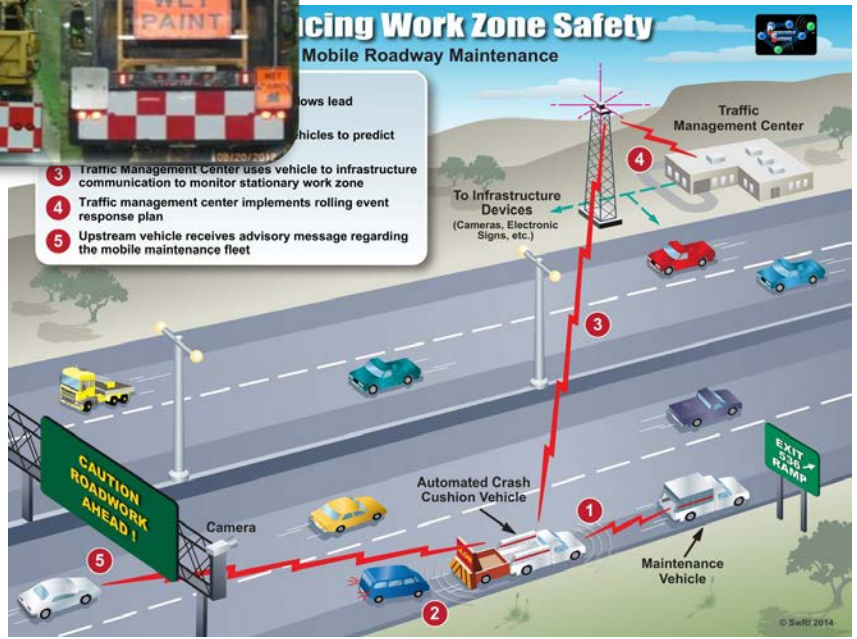
- **Short-term (3 to 10 years) we should look for:**
  - **Applications that provide a payback for the investment**
  - **Environments of which we have some control of**

Possible Applications: Transit

- **Dedicated lanes (would allow early deployment of fully automated)**
- **Lane keeping assistance**
- **Precision bus docking**
- **Platoons**

Work Zone Safety: Automated Attenuator Truck

- **Pilot Texas DOT Project**
  - **Moving work convoys:**
    - **Linear spacing**
    - **Lateral offsets**
  - **Static: reposition with hand signals**



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Thank You

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