Impact of the Changing Mobility Landscape

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- Scott has degrees in Mechanical and Aerospace Engineering, a Master's in Business Administration, and Doctoral Research in Artificial Intelligence. Prior to CVTA, Scott was the first President of the VII Consortium and before that the Executive Director of the Automotive Multimedia Interface Collaboration, a nonprofit research organization of the world's largest automakers.
- In March 2012, 2014 and again in 2016, Scott was appointed by Congress to the ITS Program Advisory Committee to advise the Secretary of Transportation and Congress on matters relating to the study, development, and implementation of Intelligent Transportation Systems. In this capacity, Scott has chaired the Secretary's Security Subcommittee since 2012.
- On June7th, Scott was inducted into the Automotive Hall of Fame in Detroit, Michigan. In August, the US State Department appointed Scott as the Transportation Consultant to the Asia Pacific Economic Community.

Who We Are:
Connected Vehicle Trade Association

- CVTA is an international, non-profit trade association formed to advance the interests of industries and organizations involved in vehicle communications
- Membership is open to companies, universities, standards bodies and public agencies globally
- The Board of Directors was established with one representative from each of the 24 industries involved

What is an Autonomous and Connected Vehicle?

Autonomous Vehicles (AV)

- Vehicles that can perform all driving functions with or without human drivers, also called self-driving or driverless vehicles.

Connected Vehicles (CV)

- Vehicles with advanced technology to communicate with external systems.

Doing either requires comprehensive integration of:

- Global Positioning System (GPS)
- Inertial Navigation System.
- Laser Illuminated Detection And Ranging (LIDAR)

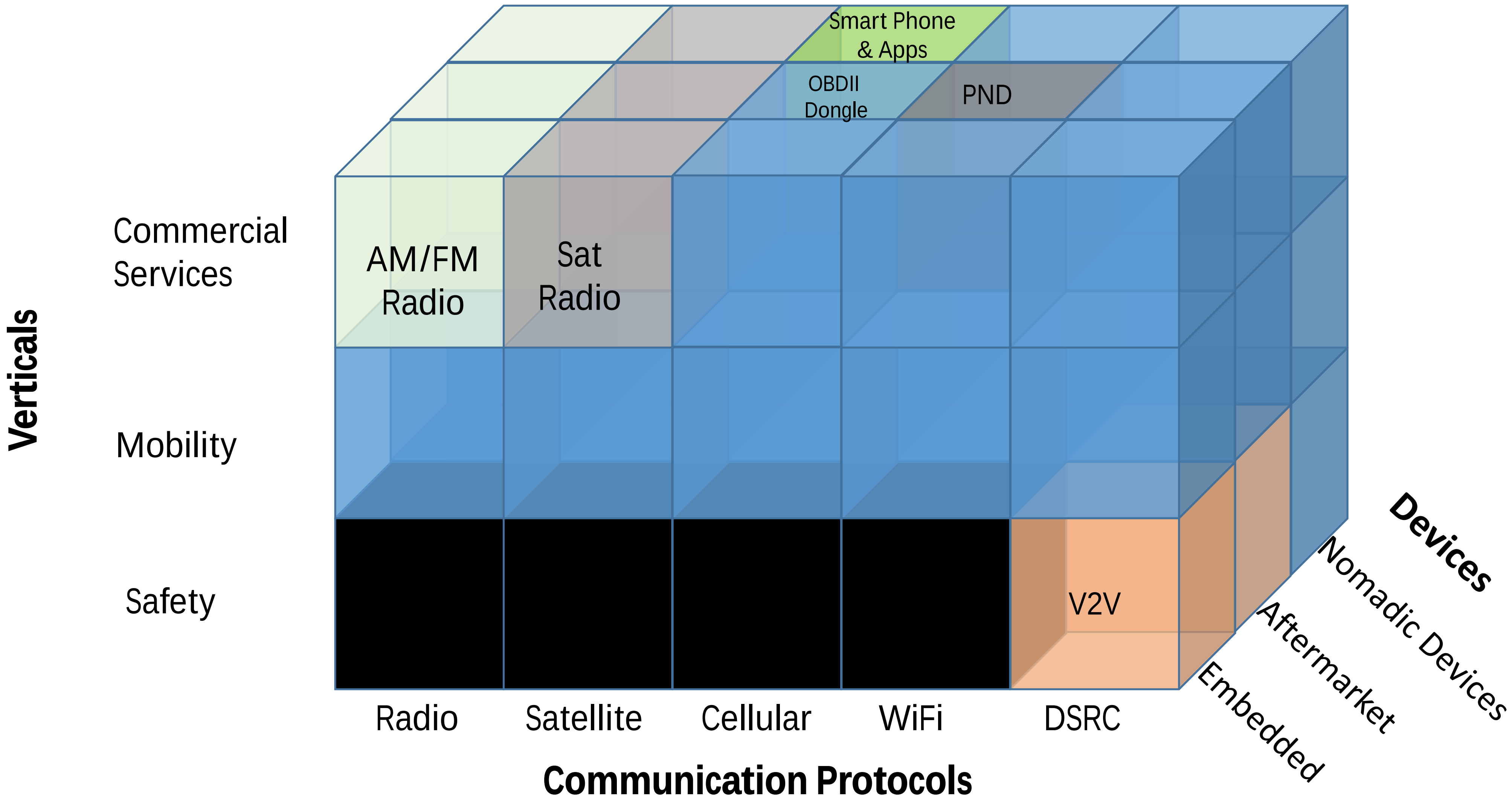
Benefits of Implementation

The key issue is safety. AV has the potential to reduce 90% of the 37,000 annual fatalities resulting from US traffic crashes that are currently attributed to human operator error.

Other key benefits revolve around:

- Reduced Driver Costs (gas, ownership, property damage/insurance)
- Increased mobility for non-drivers (shuttle bus, elderly, teenagers)
- More efficient roadway and parking capacity (efficient roadway capacity, auto parking)

Connected Vehicle Ecosystem



Autonomous Car Timeline

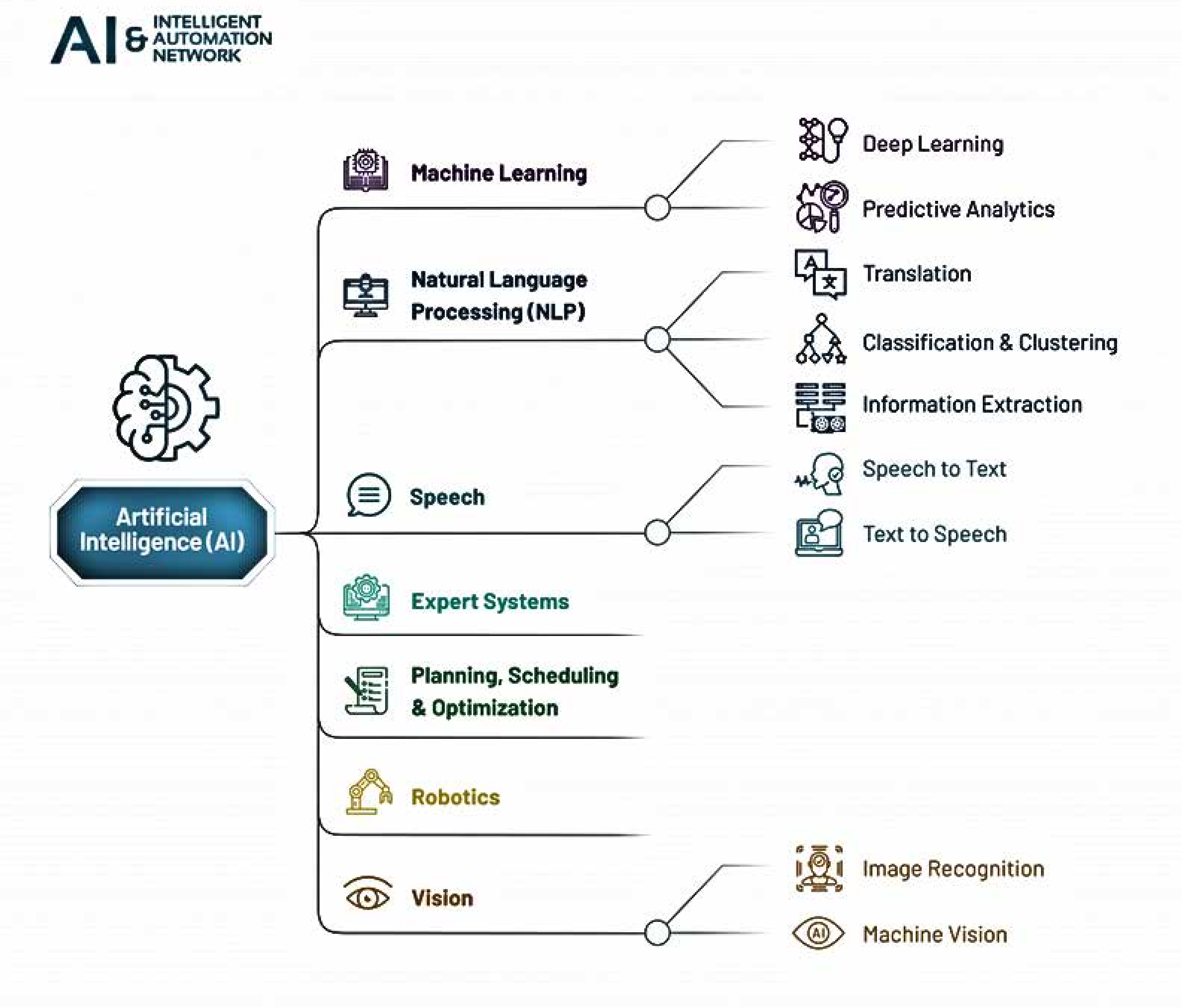
- 2018 – 2019: Driver-assistance features get more sophisticated, and will sync up with GPS and navigation. Commercial trucks are the first vehicles to hit the road autonomously.
- 2020: Cars equipped with semi-autonomous features will be able to navigate through traffic lights and intersections and stop-and-go traffic, but still require a human to take over.
- 2021 – 2024: Semi-autonomous features should work in more conditions, like in rain and at night. But automakers working on tech are unlikely to spend time bringing it to city streets. They'll be more focused on enhancing long commutes.
- 2025 – 2030: Most cars are fully automated, sales will decline: More consumers will rely on ride-sharing, or may share a car with multiple owners.
- 2045 – All cars are automated, and none are likely to be owned personally, as everyone uses ride sharing services

OEMs Leading CAV Development

- GM leads Execution
- Ford leads strategy
- Waymo is working with multiple OEMs
- Tesla is unlikely to reach Level 4 without LIDAR
- Honda and Toyota lagging, but will advance with their new partnerships with General Motors and Uber

(Source: Navigant Research)

Vehicle Intelligence



Vehicle Cybersecurity

- There has never been a malicious attack on a vehicle anywhere in the world “in the wild”.
- All attacks have been for demonstration purposes by entities wishing to evidence the potential.
- However, threat surfaces do exist and are now being discovered and addressed.
- As our vehicles become more connected, there will be greater risk of attack, breach and disruption.
- These attacks will continually evolve.
- So vehicle cybersecurity efforts will be with us from now on.

Addressing Security

- Threats exist to identity, confidentiality, data and application integrity, intrusion for malicious intent, and disrupting continuity of service.
- In-vehicle software can have up to 100 million lines of code which executes on both the primary computer board(s) and 70-100 microprocessor-based electronic control units (ECUs) networked throughout the body of the car.
- Threats exist from both bad programming and the inability to test all possible software interactions.
- A large number of vehicles communicating to each other is essentially an ad-hoc, self-forming network of devices with no server-side security.
- As vehicle communications are new to automakers, understanding and protecting the systems are a major, ongoing priority.
- As with computers, as the vehicle ages, new threats will surface.

Current Infrastructure Limitations

- According to the National League of Cities' research, only six percent of the U.S.'s largest cities' transportation plans include any language on the potential effect of driverless technology on mobility.
- In many states, only 20% of the roads are paved and marked well enough for an AV to navigate.
- The maintenance levels on most of the roadway infrastructure are based on human vision, not machine vision.
- The vehicle development is way ahead of the public policy.
- Self-driving cars vastly multiplies vehicle miles traveled in all studies.

When will the OEMs go Electric?

- GM plans for 20 all-electric vehicles by 2023.
- Ford with 13 new models slated for release by 2023.
- Toyota and Mazda no forecast
- Mercedes-Benz - offering 50 electric and hybrid models by 2022.
- The Renault, Nissan and Mitsubishi alliance plan to release 12 all-electric models by 2022
- Jaguar Land Rover plans to electrify its entire vehicle lineup by 2020
- Volvo will electrify its entire vehicle line by 2019, with five all-electric models slated to roll out from 2019 to 2021

When will the OEMs go Electric, continued?

- Volkswagen, Audi, and Porsche, plans to offer electric and hybrid versions of 300 vehicles by 2030.
- China - There are several major electric vehicle R&D and manufacturer companies in Chinese market. The companies including: SAIC, FAW, Dongfeng, Chana, BAIC, GAC, Chery, BYD and Geely.

The Problem:

If all cars in the US were electric, it would consume 25% more energy than we produce.

If California was to go all electric, it would have to install 100 charging station each week through 2050

DSRC versus 5G

- 5G is a great communication system. But it is developmental, and has been created primarily as a way to carve out spectrum.
- In the end, the carriers do not benefit from peer to peer (5G P2P) communications because they have no way to monetize it.
- There is a concerted effort by the 5G advocates to snare spectrum that will then be used to support network traffic, while the P2P applications languish.
- 5G has issues with radio interference and security that will take a long time to solve.
- 5G requires infrastructure whereas DSRC for V2V does not.
- 5G P2P using a side channel is going to be tested, and that may solve some issues

5G Peer-to-Peer Challenges

- Unlike cell phones (e.g.), communication is not brokered by a trusted third party
  - Secure communication is between end entities in the wild
  - Each entity will interact with thousands of other entities each day
  - Large message payloads provide large opportunity for potential attacks
- Little or no control over end entities after sale
  - May be modified or tampered with
  - Tampering and infection are difficult to perceive and difficult to control
- Huge opportunity for attacks
  - Each vehicle will directly interact with millions of other vehicles each year
  - 250 M vehicles interacting with 1000 unique vehicles per day represents ~100 trillion interactions each year
- Peer-to-Peer attacks can scale explosively

10 Flying Cars Available in 2019

Flying Car	Seats	Max Range	Flight speed	Takeoff Weight	Price
 PAL-V Liberty	2	310 miles	100 mph	910 kg	$0,4 million
 AeroMobil 3.0	2	430 miles	90 mph	960 kg	$1,6 million
 Terrafugia TRANSITION	4	489 miles	107 mph	650 kg	$0,3 million
 AeroMobil-4.0	2	466 miles	99 mph	960 kg	$1,6 million
 BlackFly	1	25 miles	62 mph	255 kg	–

Once flying cars leave the ground, they become part of the National Airspace System.

 Moller Skycar	4	805 miles	331 mph	1400 kg	$3,5 million
 Carplane	2	450 miles	138 mph	750 kg	–
 Samson Switchblade	1	345 miles	200 mph	794 kg	$0,12 million
 Ehang 184	1	350 miles	62 mph	360 kg	$0,3 million

Challenges of Flying Cars

- Everyone in this room knows that piloting an aircraft is a nontrivial task.
- We all see how difficult driving in 2 dimensions is for the average person.
- In order for this to become a reality we need:
    - A tremendous amount of automation
    - A tremendous amount of situational awareness
        - Weather at every altitude
        - Proximity to trees, power lines, no fly zones
        - Training, licensing, legislation, policy, etc.
    - Where would you take off and land?
    - How would you service it, fuel it, store it?
- Insurance cost is estimated at over $60,000/year

Challenges of Flying Cars,continued

- The Global Positioning System used by both cars and airplanes has three elements: a receiver that employs satellite signals to locate where you are from moment to moment; a computer processor that interprets that information to determine direction and speed; and a database that tells you how to get from where you are to where you're going.
- For aircraft, ground stations use the signals to track and monitor satellites, and these stations provide the master control station (MCS) with data. The MCS then provides precise position data to the satellites. The receiver in an aircraft receives time data from the satellites' atomic clocks.
- The car's GPS is fairly inexpensive, but lacks the database an aircraft uses. There are 62,310 GPS waypoints for aircraft, and an infinite number for the US roadway.

The Importance of GPS

- **Real-Time Data Delivery**
  - GPS sensors can be placed on objects to track them.
- **Internet Integration**
  - Internet compatibility is important for GPS function. For instance, searching for a business in your general vicinity is completed by a signal from your smartphone or mobile device to find relevant locations for your current location. The combining of GPS technology and the Internet allows your location to be revealed, but in most cases, GPS must be enabled on your device to work properly.
- **Logistics**
  - Logistics management, when distracted driving is an issue, helps fleets locate vehicles to update vendors and customers regarding shipments. Updated GPS systems are able to accurately direct a driver on a safe route, without showing roadways that don’t really exist or roadways that are not complete. Fleet managers can also track the habits of their drivers to see how each person drives, if they follow traffic laws and if the equipment is subject to any kind of abuse.

The Importance of GPS, continued

- Military and civilian users across the globe depend on the 31 satellites, in six different orbital planes above Earth, to provide continual navigation signals.
- The new capabilities of the planned 10-satellite GPS III constellation will address some of the most common risks and shortcomings of our aging nav sats.
- OneWeb plans to launch at least 900 satellites, with broadband access to begin as early as 2019; SpaceX, with its Starlink constellation comprised of nearly 12,000 satellites, is slated to begin operation as early as 2019 or 2020 (Small sats in LEO).
- Iridium constellation, by comparison has 66 satellites of the 167 presently covering the western hemisphere, and 111 covering the eastern hemisphere.

Challenges

- The state of the art in machine intelligence is nowhere near adequate to take over driving in any road, weather or traffic condition.
- Vehicle vision systems have many limitations
  - Simply speaking, the human eye is a *subjective device*. This means that your eyes work in harmony with your brain to create the images you perceive.
  - A camera, on the other hand, is an *absolute measurement device*—It is measuring the light that hits a series of sensor, but the sensor is 'dumb', and the signals recorded need to be adjusted to suit the color temperature of the light illuminating the scene.
- Only one autonomous vehicle has audio receivers – the rest are deaf.
  - Isolating the proximity and direction of another car blowing its horn in a chaotic audible environment is extremely difficult
  - Determining if evasive action is necessary, and taking such evasive action, even if the car could determine a threat is extremely complex

Challenges, continued

- We must move from Reactive to Preventative Safety
  - All vehicle ADAS systems react to road, weather or traffic conditions
  - All autonomous vehicle sensors capture movement, changes, intersecting threats and react to avoid.
  - With vehicle communications, and the machine intelligence to process the information, the vehicle will know in advance of a potential problem and threat and can preventatively adjust speed, course, trajectory well in advance of the specific problem location.
  - Communications provide for and awareness of upcoming problems or potential problems in advance of sensor range.
  - This gives the vehicle more time to react, ability to focus sensors to likeliest threats, and process the data quicker, with substantially less hardware and software.

Challenges, continued

- Policy can only be formulated once we understand what the boundaries for acceptable behavior for intelligent connected vehicles, and guidelines for best practices.
  - Are those different than from piloted vehicles?
  - Tort law covers machine failure liability. What new laws would be needed?
- Standards – you only develop standards when you know where you want to go, and what you want to make common. We don't know that yet.
- Privacy – the privacy of my car's data shouldn't be any different than it is for my phone or internet connection.
- Security – Threat surfaces exist, and more will surface the more connected we are.

Summary

- For all cars, connectivity will be a necessity.
- All automakers have some efforts underway to add levels of automation to their vehicles over time.
- Connectivity allows us to move from reactive safety to preventative safety.
- Given that there is no clear path forward, having OEMs with different strategies and implementation paths will bring about the broadest understanding of what works.
- Moving autonomous functions from dry, flat, well marked roads to those with varying road weather and traffic conditions is a monumental task and will take years.
- Charging infrastructure will not happen as fast as the OEMs plans, making ICE power plants dominant for years.

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