LESI - Automotive Industry Advisory Board
Smart Cities and the Connected/Autonomous Car
Summary of Session Held March 23, 2022

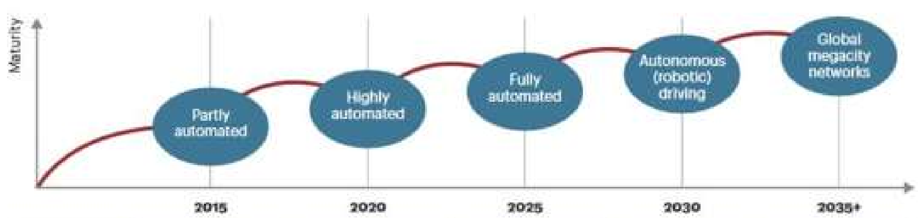
Background:

As cars become increasingly connected to the world-wide internet of things, significant value can result from linking intelligent vehicles to cities where grid improvements create attractive synergies. Cooperation and data sharing between vehicles equipped with a growing array of sensors and the road systems on which they travel represents a key enabler for optimized travel, safe operation, and fewer accidents caused by human error. Connected cars and more efficient use of road systems could reduce an estimated 7 billion hours every day from vehicles idling in traffic jams caused by too many vehicles on the same road. Connected cars that can identify and divert to faster routes save time for drivers and passengers, with significant potential to reduce greenhouse gasses generated by cars mired in traffic congestion. Smart roads and intersections will make cars and their occupants safer, as hazardous conditions are detected and broadcast to a network of connected cars.

What Is Happening:

In the US, new Federal and State infrastructure initiatives are underway that will enable connection among roads, cities, and vehicles. The roll-out of autonomous driving systems has increased focus on improving the city streets and highways where self-guided vehicles operate. The following summary outlines initiatives in the US and the needed change to infrastructure:

Autonomous driving technology will advance in waves



	2015	2020	2025	2030	2035+
Legal protection	Scoring system for preventive driving	Daily legal protection for car rental and car-to-go	Legal protection based on mobile devices	Legal protection for all kinds of devices	Legal protection for all kinds of devices
Technology	First-generation automation and control	Second-generation automation, pooling	Third-generation fixed-distance automation	Fourth-generation automated traffic junctions	Fully automated traffic flow management
Infra-structure	Highway networks	Regional or national network	Selected megacities	Micro-/mobile city metropolises	Globally interconnected megacities
Standards	Internet standards for mobility apps	Camera and image processing and interfaces	Radio frequency and interface standards	Control and automation standards	Fully automated networks/ telematics

3/24/2022 Sources: Rinspeed; A.T. Kearney analysis

Infrastructure readiness will grow for areas currently geo-fenced for level 3 autonomous systems (systems allowing "hands free" driving). Vehicles are being sold today with new self-guided control capability that enables cooperation between smart cities/Infrastructure and increasingly intelligent vehicles.

Smart Cars

Vehicles now available and others in development include systems that create a path for communication with intelligent infrastructure. These include:

Primary Available Systems

- **Adaptive cruise control down to a stop:** This feature builds on basic adaptive cruise control, a decades-old feature that maintains a selectable distance between you and the car ahead. Adaptive cruise that works at *higher* speeds is widely available, but systems that function down to a full standstill are an important next step to manage bumper-to-bumper traffic.
- **Lane-centering steering:** This goes beyond lane-departure steering assist, which intervenes only as you approach or cross the lane markings — and often pinballs you back toward the *opposite* markings — to actively center the vehicle in its lane by tracking lane markings, the vehicle ahead or some combination of the two. Such systems can often negotiate mild curves, as well, but nearly all of them require you to keep your hands on the wheel, issuing warnings and eventually deactivating if they sense a lack of steering force after a short time.
- **Hands-free steering:** This centers the car *without* your hands on the wheel. For 2019, only two systems — Cadillac's Super Cruise and BMW's Extended Traffic Jam Assistant — do this. Both require you to pay attention, intuited via driver-facing cameras.

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Some notable early adopters implementing level 3 autonomous technologies:

Who is the Closest to Automated Driving?

- The closest production car to that reality was to be the new Audi A8, equipped with the new Traffic Jam Pilot feature capable of navigating highway gridlock while you watched the morning news on the dashboard touchscreen. But regulatory hurdles forced Audi to sideline the system for U.S. shoppers, at least for now.
- Cadillac's Super Cruise hands-free adaptive cruise control system has been available since 2018 on CT6 models. Unlike other autonomous systems, the car only functions on certain mapped roads with lane markings in clear weather.
- Autopilot, Tesla's wide-reaching semi-autonomous driving system. Although Tesla bills it as a hands-on-the-wheel system, early versions allowed you to drive hands-free for extended periods of time. The automaker has since updated Autopilot's software on existing and new cars to deactivate itself if it senses drivers' hands are repeatedly off the wheel.
- All automakers who sell vehicles in the US have committed to having Automated Braking on all vehicles sold in 2022.

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Mercedes-Benz recently launched a level 3 autonomous control system on its S Class sedans. The option is sold under the brand name Drive Pilot. Mercedes vehicles with Drive Pilot operate in Germany in special Autobahn zones, at speeds of less than 50 kmph.

What Is a Connected Car?

Geotab, a supplier of products to the connected vehicle industry, groups vehicle connections into several categories based on how the vehicle is connected:

Telematics: Tracking vehicle location and activity, driver behavior, engine, and EV battery state-of-health diagnostics. Organizations can gain visibility over a large fleet's performance from a single online platform.

Vehicle-to-everything (V2X): Interacting with any object in the vehicle's surrounding environment. This communication could be vehicle-to-vehicle (V2V), vehicle-to-pedestrian (V2P), vehicle-to-network (V2N), or vehicle-to-infrastructure (V2I).

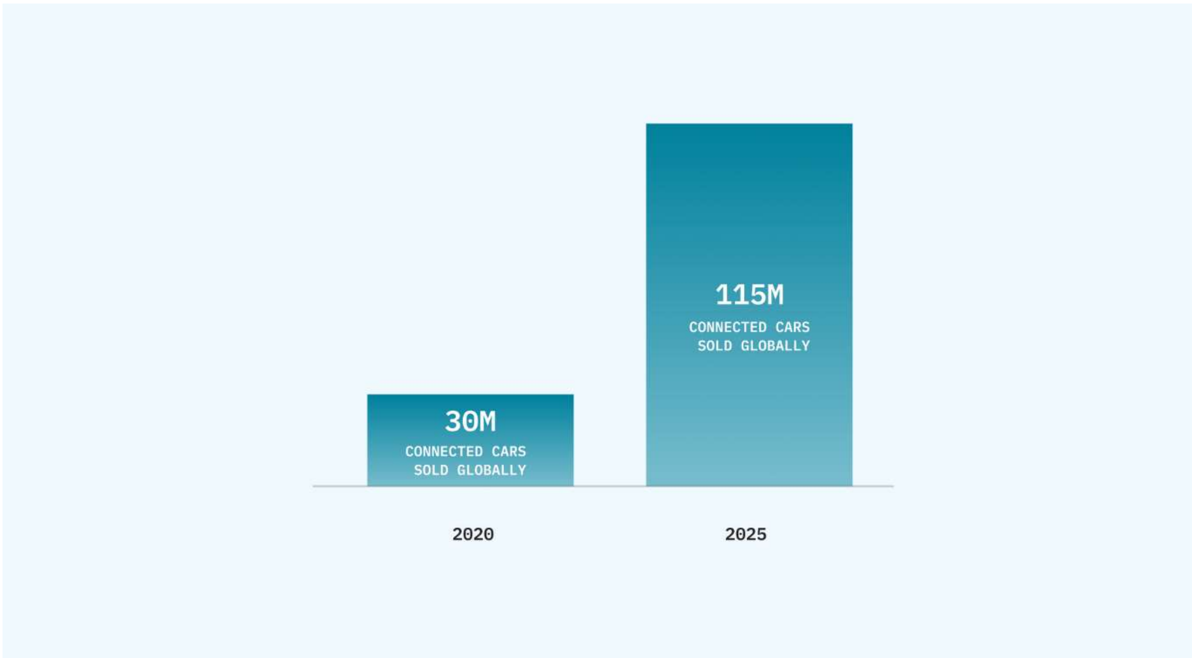
In-vehicle infotainment: Interacting with vehicle occupants. This includes audio and video entertainment as well as navigation systems.

Wikipedia cites three main advantages for connected vehicles, including road safety, traffic efficiency, and energy savings.

<u>Connected Vehicle Roll Out</u>

In 2020, global manufacturers of cars and light trucks produced about 78 million vehicles. This total production reflected a 14% reduction to the COVID-reduced economic slowdown from the 2019 global production level of 90 million units. Increasingly, these new vehicles were built with features that enable connections outside the vehicle.

Connected Vehicles Built in 2020 and 2025 projections



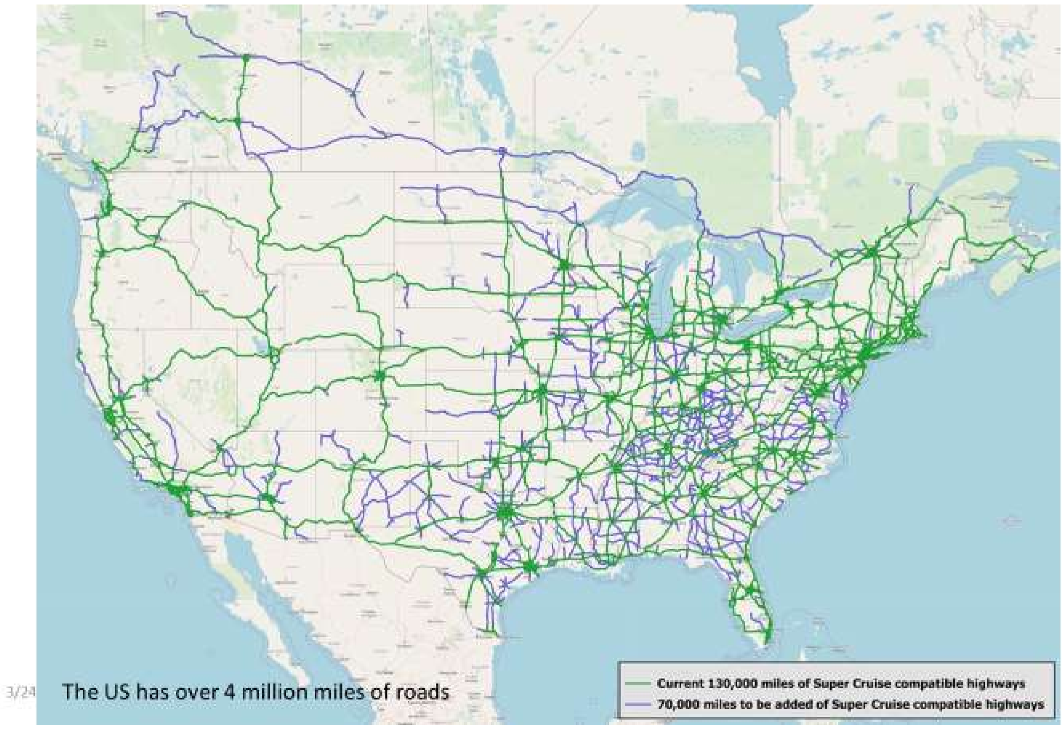
Sales of connected cars are expected to increase more than four-fold in the next five years. (Source: ABI Research). In the US, over 13 million connected cars were produced in 2020, or 91% of new cars sold were connected cars. (Sources: ABI Research, Marklines)

<u>Aftermarket Products – Connecting Vehicles</u>

Another option for taking advantage of intelligent cities and infrastructure involves connecting vehicles built without connectivity though the use of aftermarket connectivity units:

Smart Roads

In the US today, over 130,000 miles of highways are designated for use of hands-free systems like GM Super Cruise. These areas are shown on the following illustration:



Information from: https://supercruise-map-viewer.cp.gm.com/

Tesla, with its Full Self Driving system, is not restricted to geo-fenced areas in the US. The US is clearly one view, but other key vehicle markets are seeing a good deal of activity as well.

In China, Dr. Tony Qiu, co-founder of iSmartWays Technology, sees the road as the starting position for self-guided vehicles. The Chinese auto industry has been slow to react, and cities have taken the lead, with 30 to 40 test beds for automated vehicle development. Central and local governments in China continue to expand infrastructure; building new roads and bridges allows additional intelligent highway features to be integrated as the systems are constructed. Dr. Qiu noted a "debate" between the vehicle and infrastructure intelligence as to which will ultimately govern protocols and resolve incompatibilities. Sixteen cities were in the process of deploying smart infrastructure in the form of systems referred to as "live roads." Standards have yet to be established for these efforts in China.

iSmartWays Technology serves the market for the needs of smart cities and connected vehicles with a variety of products enabling communication between vehicles and smart highways seen in this graphic:

The ITS Stack has now been deployed alongside pilot cities and smart corridor initiatives. It has also been refined and continuously improved to meet various vehicle types and integration efforts, like cameras, lidar, simulation, maintenance platforms, including ADS systems and TMC platforms. Vehicle OEMs have announced that upcoming production vehicles will include standard module V2X chipsets.

Information from iSmartWays Technology website: http://ismartways.com/

<u>Smart Cities</u>

What systems make cities "smart?"

Innovations like smart intersections, intelligent traffic signals, and other infrastructure systems connected to the cloud are key elements of a smart city. These systems create intelligence in city streets and highways, enabling traffic systems that monitor vehicle traffic and detect anomolies. Smart city communication systems relay this information to connected vehicle fleets. A smart city must also be able to act upon information received from the connected vehicle fleets, respond to threats identified by vehicle sensing, and aid drivers by routing cars around traffic jams.

Other advantages of a connected grid identified in the following graphic include:

- Simplified Transportation
- High Quality Connectivity
- Improved Public Safety
- Greater Visibility and Control (for City Adminstrators for traffic control and safety)
- Enhanced Security
- Efficient Resource Management

The connected municipality.

With interconnected agencies, diverse community needs and the sheer complexity of government operations, it's more essential than ever that municipalities have reliable, next-generation connectivity. With the right infrastructure in place, you'll be able to operate more efficiently and transparently while attracting businesses and keeping residents safe.

Simplified transportation.

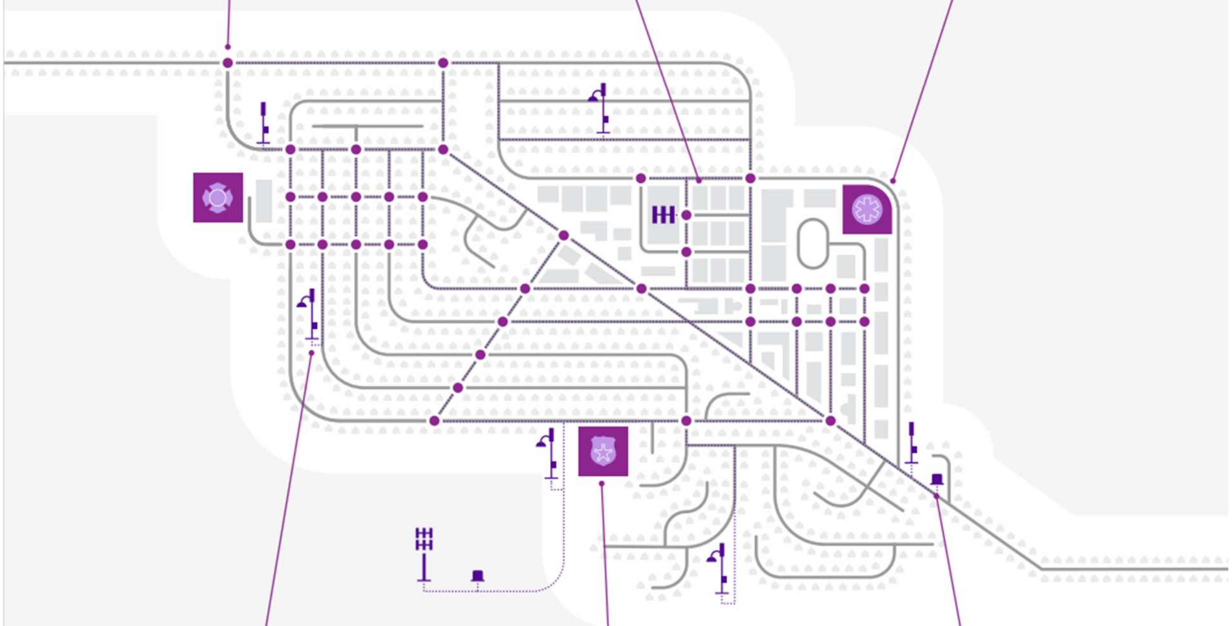
From smart traffic lights to connected public transit, new technologies are shortening commutes, reducing congestion and improving quality of life.

High-quality connectivity.

Extended wireless coverage and capacity help sustain local business operations[1] and ensure that lines are open for vital public safety communications.

Improved public safety.

We can support Project 25 (P25) integration, enabling machine-to-machine communication. Integration of 5G technologies can also facilitate faster transmission of critical data for first responders and other essential workers.



Greater visibility and control.

Connected IoT systems allow you to monitor everything from public infrastructure usage to maintenance needs throughout the city, so you can make smarter decisions with fewer resources.

Enhanced security.

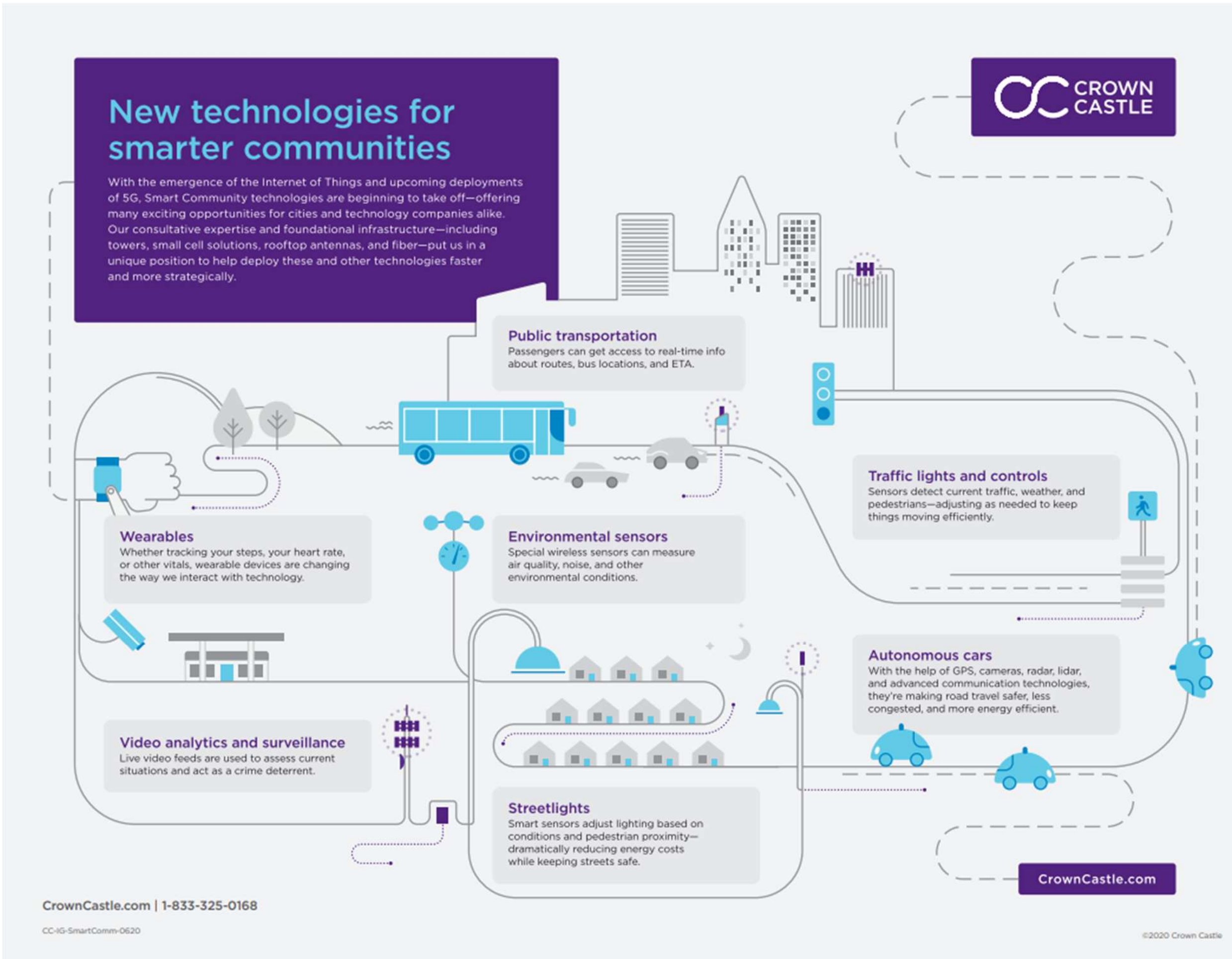
Next-gen technologies like facial recognition and biometric verification will play important roles in community safety, while technologies that utilize drones can quickly relay important visual information to arriving first responders.

Efficient resource management.

Smart-city applications could help cities reach 70% of their sustainable development goals,[3] while LED and smart lighting solutions could save 50% or more on energy costs.[4]

Sources:

1. 66% of small businesses rely on mobile networks to operate, Insight, *These Small Business Technology Statistics Are Surprising*, 2017. **2**. 80% of 911 calls originate from cell phones, NENA, the 9-1-1 Organization, *9-1-1 Statistics*, 2018. **3**. McKinsey & Co, *Smart Cities: Digital Solutions for a More Livable Future*, 2018. **4**. CDW, *The Digital Transformation Report*, 2018.



Information from https://www.crowncastle.com/resources/infographic/smart-city.pdf

<u>Smart Cities and Connected Cars – Making the Entire System Work:</u>

Improving Cities and Roads - Smart cities and smart roads are in the early stages in most of the developed world. In the US much work remains.

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.

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Improving The Vehicle:

Challenges

- The state of the art in machine intelligence is nowhere near adequate to take over driving in <u>any</u> 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 .
- No AV can "feel" rumble strips

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Challenges, continued

- We must move from Reactive to Preventative Safety
  - All vehicle ADAS systems <u>react</u> to road, weather or traffic conditions
  - All autonomous vehicle sensors capture movement, changes, intersecting threats and <u>react</u> 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 <u>preventatively</u> adjust speed, course, trajectory well in advance of the specific problem location.
  - Communications provide for and <u>awareness</u> 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.

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<u>Improving The Vehicle – Continued:</u>

What is needed?

We need substantially better automatic braking system.

- A Study by the American Automobile Association (AAA) found that in the tests, at 30 miles an hour, <u>none</u> of the test vehicles avoided a collision with pedestrians.
- In daylight, the car traveling at 20 miles an hour avoided a collision with the pedestrian 40% of the time.
- When encountering a child darting from between two cars, with the vehicle traveling at 20 miles per hour, a collision occurred <u>89% of the time.</u>
- At night, <u>none</u> of the systems detected the adult pedestrian.
- In the US, nearly 6,000 pedestrians lose their lives each year, accounting for 16% of all traffic deaths.

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<u>Summary and Conclusions</u>

<u>In summary, where are we with global efforts to enable communication and cooperation between smart cities and connected vehicles?</u>

1. We are connecting new vehicles to the cloud and to infrastructure:
   - Most new vehicles made after 2025 in major markets will be equipped with most forms of vehicle connectivity, for telematics, V2X – vehicle to everything connectivity, and infotainment.

2. Vehicle OEMs are offering subsystems that are building blocks toward self-guided vehicles systems / autonomous vehicle control:

- These systems include automatic emergency braking (AEB), lane keeping, automatic cruise control (e.g. GM Super Cruise), as well as vehicle systems that support hands-free operation (Tesla Full Self Driving, Mercedes – DRIVE PILOT, GM Super Cruise).

3. Planning groups for cities and highway systems are aware of the need to build connectivity and hazard detection into new roads and intersections being planned and constructed:
   - 5G cellular systems are being installed in major markets worldwide in support of highly profitable cellular phone markets. This system, supported in some areas by WIFI/DSRC vehicle communication systems, can serve as a communication backbone that will be installed and available for use by consumers, city planners, and highway designers.

4. Laws are being enacted to permit use of autonomous systems on public highways:
   - Germany, the United States, China, and most major markets have passed laws that allow for development of Level 4 (hands free driving). New regulations are being developed to allow for use of production Level 4 systems in special “geo-fenced” areas with other restrictions in many advanced vehicle markets.

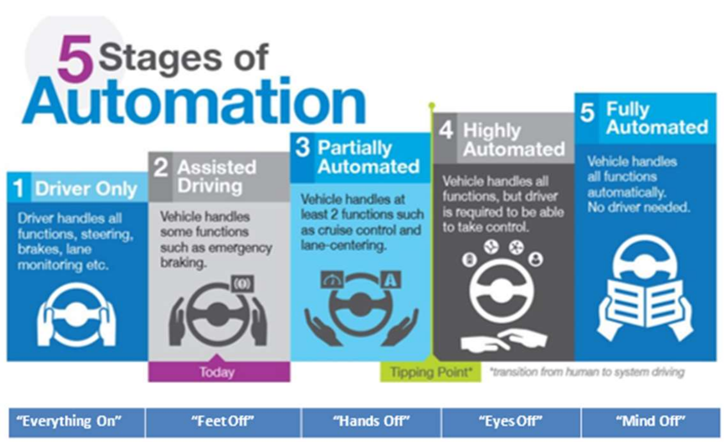
<u>What Remains to Be Done?</u>

Much work remains to make vehicle standards consistent across major markets worldwide.   Creating and formalizing a standard development environment; i.e., for what range of conditions do vehicle designers create their controls, is essential for developing a consistent approach to vehicle control and how autonomous systems are developed.

<u>What IP Is Involved & How Can the IP Profession Assist in Managing IP Rights?</u>

Software - It is becoming known to the industry that millions of additional lines of code are required for each stage we complete toward fully self-guided vehicles:

The Path to Autonomous Driving



Rapid development of reliable software will push systems developers toward use of open-source software. IP professionals should support clients in creating systems to track the source of this third-party code and clearly understand the licenses that make this code available for use.

For proprietary software developed by firms, understanding controls in place for developing and safeguarding software source code is key to maintaining competitive advantage in the markets worldwide.

Identifying and protecting proprietary business practices for development, validation, and testing of autonomous systems will be important to firms supporting clients and competing in world markets.

Standard Essential Patents – Industry Standards for smart cars and cities will continue to generate new regulations that govern their use. Licensing groups representing pools of patents, as well as rights offered by leading technology companies, are reducing the complexity of gaining necessary IP rights for new vehicle systems in areas like 4G-LTE and 5G connectivity. Supporting new efforts by standards development groups with important technology provides IP owners with long-term income streams from licensing standards essential patents. Support for standards groups allows technology leaders to keep their innovations consistent with market direction, demonstrate technical leadership, and generate cash.

Political Support for New Investments in Infrastructure – In Western democracies, willingness to invest in new infrastructure and accept tax increases for businesses and individuals will aid in the rapid deployment of new infrastructure. Other political systems in China and elsewhere can react more quickly with government-funded spending plans. Both systems are investing money in cities and highway systems. IP professionals can aid this process by supporting new “smart” infrastructure initiatives in your local political systems.

Thank you to our panelists!

On behalf of LESI and the Auto Industry Advisory Board, we would like to thank Scott McCormick President of the Connected Vehicle Trade Association, and Dr. Tony Qiu, co-founder of iSmartWays Technology, Inc., for their contribution to our discussion.

John Carney
Chair – Automotive IAB
Licensing Executive Society International
July 5, 2022

Other Suggested Readings & Resources

https://investmentu.com/taas-transportation-as-a-service/

https://www.nasdaq.com/articles/does-transportation-as-a-service-spell-the-end-of-the-family-car-2021-02-19

Standards

Connected Vehicle Communications Protocol, Standards:

Most connected vehicles today use 3G or 4G cellular technology to enable communication between the vehicle and the Internet. 5G cellular technology is replacing 3G and 4G in today's market.

In addition, vehicles will also increasingly be able to communicate directly with other vehicles and road infrastructure for ADAS, safety, and traffic management applications, among other uses. There are currently two active primary standards in use to enable these direct communications. For Global Markets they include:

802.11p – WLAN based standard from IEEE, utilizing Dedicated Short-Range Communication (DSRC)

C-V2X Utilizing – Utilizing planned 4G/LTE and 5G cellular technologies to communicate from vehicle to base station/grid and with other vehicles directly.

Cellular V2X uses 3GPP standardized 4G LTE or 5G mobile cellular connectivity to send and receive signals from a vehicle to other vehicles, pedestrians; or to fixed objects such as traffic lights in its surroundings. C-V2X was developed within the 3rd Generation Partnership Project (3GPP) to replace the US promoted Dedicated Short-Range Communications (DSRC) and the Europe-originated Cooperative Intelligent Transport Systems (C-ITS). Such standards are decisive steps towards the target autonomous driving and clues to market influence. 3GPP Release 15 introduced 5G for V2N use-cases, and 3GPP Release 16 includes work on 5G NR direct communications for V2V/V2I. (Wikipedia)

Vehicle Design Standards for Autonomous Vehicles

Society of Automotive Engineers - US SAE J3016

National Regulations

Wikipedia References

United States - September 2016, the US National Economic Council and US Department of Transportation (USDOT) released the *Federal Automated Vehicles Policy*,[333] which are standards that describe how automated vehicles should react if their technology fails, how to protect passenger privacy, and how riders should be protected in the event of an accident. Since then, USDOT has released multiple updates:

- *Automated Driving Systems: A Vision for Safety 2.0* (12 September 2017)[335]
- *Preparing for the Future of Transportation: Automated Vehicles 3.0* (4 October 2018)[336]
- *Ensuring American Leadership in Automated Vehicle Technologies: Automated Vehicles 4.0* (8 January 2020)[337]

Japan - In 2019, Japan amended two laws, "Road Traffic Act" and "Road Transport Vehicle Act",[322] and they came into effect in April 2020. In the former act, Level 3 self-driving cars became allowed on public roads.

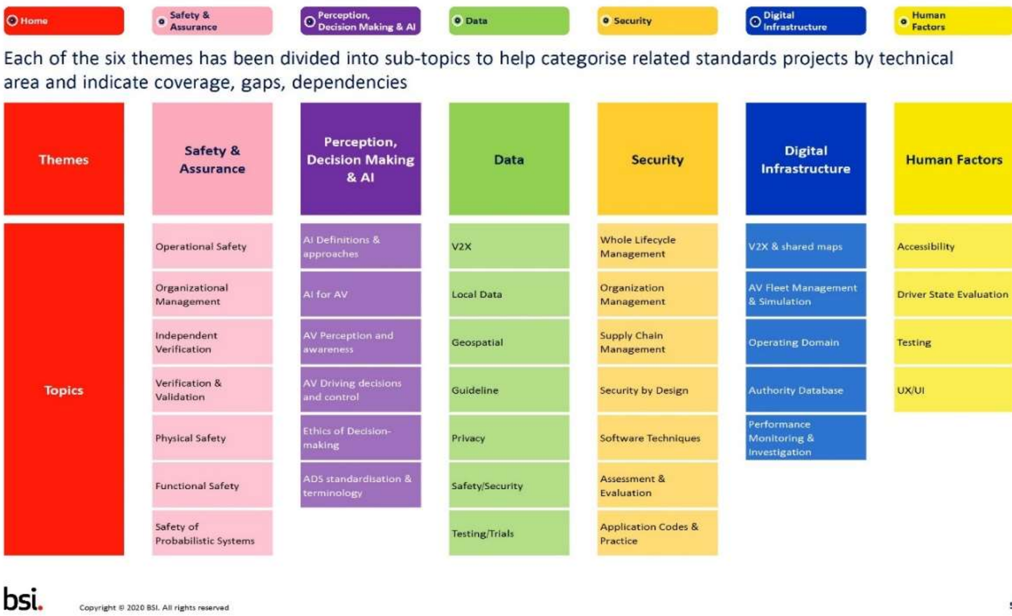
European Union – Regulation (EU) 2019/2144 of the European Parliament and the Council of 27 November 2019

China

In 2018, China introduced regulations to regulate autonomous cars, for conditional automation, high-level automation and full automation (L3, L4 and L5 SAE levels).[369]

Industry Standards

The British Standards Institute (BSI) provided a detailed summary of the multitude of international standards in play for developing and deploying self-guided vehicles on world highways. The study is organized along six major themes, with a variety of topics related to each theme:



We recommend you refer to the full study. Regulations contained are generated by a variety of standards organizations, including BSI (UK), SAE, UL, CEN, ISO, ITU, IEEE, and others.

Smart City Standards and Regulations

The International Organization for Standardization (ISO) provides guidance on smart city development, in the following areas:

- ISO 39001, Road traffic safety (RTS) management systems
- ISO 39002, Good practices for implementing commuting safety management – under development

Another useful standard in the field is:

- ISO/IEC 30182, Smart city concept model – Guidance for establishing a model for data interoperability

There are also three standards in development:

- ISO/IEC 21972, Information technology – An upper-level ontology for smart city indicators
- ISO/IEC 27550, Information technology – Security techniques – Privacy engineering
- ISO/IEC 27551, Information technology – Security techniques – Requirements for attribute-based unlinkable entity authentication

Infrastructure

• ISO/TS 37151, Smart community infrastructures – Principles and requirements for performance metrics

• ISO/TR 37152, Smart community infrastructures – Common framework for development and operation

Please refer to an excellent summary of the Smart City initiatives in this ISO publication:

https://www.iso.org/sites/worldsmartcity/assets/ISO-and-smart-cities.pdf

Other interesting efforts:

Vehicle to Infrastructure Deployment Coalition (V2I DC)

The Vehicle to Infrastructure Deployment Coalition (V2I DC) began as a concept to create a single point of reference for stakeholders to meet and discuss V2I deployment related issues. To accomplish this concept, U.S. DOT asked the American Association of State Transportation Officials (AASHTO), the Institute of Transportation Engineers (ITE), and the Intelligent Transportation Society of America (ITS America) to collaborate on organizing and managing the coalition. The V2I DC Project Team (consisting of members from AASHTO, ITE and ITS America) then created a vision, mission, and set of objectives that would guide the coalition. (from their website)

https://transportationops.org/V2I/V2I-overview

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