The Top Technologies Enabling the Self-Driving Car
By Dr. Ali Abaye, Senior Director of Automotive, Broadcom Corporation

Today's advanced in-car technologies are ushering in the most dramatic evolutionary leap in automotive history since the Ford Motor Company was founded in 1903: Vehicles that operate without human intervention and a world where car crashes are history. While technology is being blamed for dangerous new driver distractions, it also promises to redefine the very meaning of highway safety. Technology never daydreams, never falls asleep, never reaches for hot coffee, and never tries to text on the freeway.

Driver-assist to the Self-Driving car

Reducing human error was the auto industry's push toward intelligent driver-assist packages with smart features like self-parking, lane-keeping, warnings of obstacles, and automated acceleration or braking. Everything needed for a driverless car is already on wheels—literally. Google's experimental fleet of self-driving vehicles has logged more than 700,000 accident-free miles on major highways. The industry is now focused on the software refinements required to navigate bustling city streets based on input from multiple sensors detecting hundreds of objects at once—including that stop sign in the hand of a crossing guard.

The "Driving" Technologies

Requirements for the self-driving car begins with sensors and camera images that provide 360-degree sight, along with intelligent software to analyze sensor/camera input and initiate action. A central computer receives and distributes data throughout the system, sending software commands to the car's electronic controls and actuators. Digital maps and a satellite navigation system are essential for orienting and driving from point A to point B. Down the road, self-driving cars will need to communicate with each other and highway infrastructure such as traffic signals and toll booths.

Laying the Groundwork

The industry is already working toward Vehicle to Vehicle (V2V) communications that will enable a dynamic wireless exchange of data between your car and other vehicles. The anonymous exchange of "Here I Am" data will revolutionize the very way our roadways work by providing 360-degree awareness of other vehicles based on position, speed and location. Drivers will rely on this flow of data that senses and identifies upcoming threats and hazards to act preemptively and avoid crashes.

The U.S. Department of Transportation has been piloting vehicle-to-everything (V2X) technology with the University of Michigan's Transportation Research Institute in Ann Arbor for the past few years. Experts believe V2X technology, when properly deployed, will save lives by dramatically reducing the number of automotive accidents. When available, V2X will also add data such as traffic signal timing, upcoming curves or obstacles, surface conditions, number of highway lanes, and other critical alerts.

Let's take a closer look at the enabling technologies behind the curtain:

- **Cameras & Sensors**

  A roof-top sensor and 360-degree camera will play a key role in enabling the driverless car by using laser rays to measure distance to objects at ranges up to 650 feet, enabling 3D maps and the ability to "see" hazards. Another camera installed in the windshield together with long- and short-range radar sensors will keep an eye on vehicles in front of and behind the car. A rear-mounted aerial can receive geo-location data from GPS satellites, while ultrasonic sensors assist with maneuvering tight spaces.

  Each sensor technology offers strengths and weaknesses. While both work well in the dark, Lidar remote sensing technology measures distance by illuminating a target with a laser and analyzing the reflected light, providing focused views in specific directions and uses radar for broader coverage. Lidar technology can also gauge velocity and distance better than cameras but are less efficient at identifying objects. Ultrasonic sensors that are useless at higher speeds become essential at very close range.

- **Wi-Fi**

  Inside a vehicle, Wi-Fi is such a game changer that analysts expect eight-fold growth in Wi-Fi enabled applications by 2019. Software upgrades and new features can be pushed directly to the vehicle. Drivers can use a smart mobile device to check remotely on their car's location, gas levels and mileage—and that same device can receive alerts on vehicle performance and diagnostics. Wi-Fi technology also enables seamless streaming of content from mobile devices to the car's infotainment system and rear-seat display.

  With the recent introduction of latest wireless 802.11ac standard, drivers and passengers can easily sync and stream content from mobile devices to the car’s infotainment system and rear-seat displays.
  Wi-Fi technology within the vehicle is becoming more common place. Just this year, GM announced the availability of a Wi-Fi connectivity as standard equipment throughout the entire fleet, enabled by its proven On-Star technology. Wi-Fi will play a key role in V2X communications and the enablement of the self-driving vehicle, particularly as standards continue to evolve to support Gigabit speeds and beyond.

- **GPS/GNSS**

  Most people are familiar with digital mapping and GNSS satellite navigation, better known as GPS. GPS will also play a key role in V2X communications. Together with Wi-Fi, these technologies will enable V2V (vehicle-to-vehicle) and V2P (vehicle-to-person) communications.

  Through the anonymous, wireless exchange of data, including location-based data, vehicles will be sharing information on their position, speed, and location. V2V and V2X both rely on a type of Wi-Fi known as dedicated short range communications. The peer-to-peer standard of Wi-Fi

Direct will also allow V2P communications, allowing pedestrians and cyclists to use a smartphone app to alert cars of their location.

- **Near Field Communication**

  NFC is a set of standards that establishes a wireless connection between smart devices, either by brief contact or very close proximity. NFC pairing, also known as “tap-to-connect” technology simplifies the set-up process for mobile device connectivity within the vehicle and enables a range of comfort and convenience applications including keyless entry and vehicle settings.

  By leveraging NFC technology, drivers can pair a mobile device by simply tapping it against the dashboard, rather than navigating menus on two separate screens. Integration of NFC in the windshield allows an NFC-enabled digital key to exchange data such as authentication, user profile and vehicle information – this can be especially useful in simplifying the car rental process. NFC-enabled digital keys use can also be extended beyond the vehicle for tasks such as mobile payments and access to restricted buildings or parking garages.

- **Ethernet** Protecting the connected car is of growing concern for the industry, particularly in the self-driving car. This is where high-speed Automotive Ethernet steps in, turning the entire vehicle into a centralized, secure network. As it has done in the Enterprise and Data Center for decades, Ethernet technology offers proven standards of performance, compliance, and network security — innate features that can protect the car from potential hackers.

  Serving as the car’s network backbone, wired Ethernet connectivity provides features such as standard packet format, VLAN isolation, bandwidth awareness, device/message authentication and data encryption to protect the network from malicious attacks, eavesdropping, and the installation of non-service-approved devices.

Ethernet offers a variety of mature and widely supported and deployed options to protect the car from malicious attacks and secure the network infrastructure. These innate features are just one of the reasons Ethernet is well primed to play a critical role in securing the connected car for years to come.

Not If, but When?

Analysts expect autonomous capabilities to eventually permeate every aspect of personal transport, including driverless delivery fleets, taxis and shuttles and even driverless armored vehicles. Photo Courtesy of Volkswagen

According to research firm IHS, 90 percent of American cars will be self-driving in some, if not most, circumstances as early as 2055. Only four states in the U.S. have passed laws allowing self-driving cars but the entire United Kingdom is allowing self-driving vehicles in 2015. From this vantage point, the evolution toward driverless cars and V2X highway systems may be closer than you think.

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Author Bio

Dr. Ali Abaye serves as Senior Director of Broadcom Corporation's Automotive, responsible for the company's portfolio of automotive networking devices. Prior to Broadcom, Abaye served as Director of Strategic Planning and Product Management at Centillium Communications and as System Architect for the Broadband and Wireless System Engineering division at Nortel.

Dr. Abaye holds a Ph.D. in Electrical Engineering from Southern Methodist University. He is a renowned published expert in the automotive sector and is a regularly featured speaker at industry events, most recently at the 2014 South by Southwest Interactive festival.

Reach the author @Broadcom.