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The 5G Highway for Autonomous Vehicles

By: Mike Wolfe

The current pandemic has given us many glimpses of the future, one of which is the growing importance of autonomous vehicles.

A recent and illustrative example is The Mayo Clinic's use of self-driving vans to shuttle samples from its drive-through COVID-19 testing sites in Florida to its Jacksonville laboratory—freeing up healthcare workers to attend to other tasks, while minimizing their infection risk.

But, in many ways, this headline application, which supports the case for autonomous vehicles, concurrently highlights the many limitations of today's autonomous driving technology. The Jacksonville Transportation Authority, for example, had to block off a route specifically for the self-driving vans to eliminate both pedestrian and motor vehicle traffic. It is also running a mobile command center to actively oversee the service. Finally, the onboard technology in the vans—like many other approximations of autonomous vehicles—focuses primarily on the self-contained operation of each vehicle through a combination of sensors, GPS, odometry, and machine learning.

At present, autonomous driving isn't yet autonomous.

In order to achieve that level of operation (read: Level 5), there must be an underlying network to support, connect, and integrate the incredible advances in real-world vehicle technology and tomorrow's autonomous applications. 5G is the leading candidate to provide this vital infrastructure and bring autonomous vehicles into the realm of everyday reason.

The case for 5G

As a network for powering safe and effective autonomous driving, 5G has several key advantages in its favor: wireless delivery, high-capacity, high-reliability, low-latency, and slice-ability.

Wireless Delivery: It goes without saying that autonomous driving will rely on a wireless network. But the ability to provide a wireless network with the capabilities (reliability, capacity, etc.) traditionally associated with wired networks is among 5G's chief advantages.

High-Throughput: 5G is capable of delivering throughput of up to 10 Gbps. Driving applications such as real-time, high-resolution map and traffic layouts and uploading vehicle sensor data to the cloud are expected to require a minimum of 150 Mbps, so ensuring a healthy ceiling of bandwidth to support mission critical applications is a key mark in favor of 5G.

High-Reliability: Wireless networks for autonomous driving will assume a role similar to that of a utility in managing the increasing reliance on high-speed wireless connectivity. 5G, as an evolution of previous standards of wireless connectivity, has the advantage of building on trusted network technology that also enables critical fallback to 4G as well as specifications that dictate seamless hand-offs from one 5G node to another.

Low-Latency: 5G's potential for ultra-low latency (<1ms) make it an ideal candidate to address real-time connectivity needs. Although there is a natural tradeoff between maximizing latency, throughput, and reach, network slicing will allow 5G infrastructure to dial in connectivity and latency quality-of-service baselines for specific applications.

Network Slicing*:* By portioning out 'slices' of the 5G network to support particular use cases—such as enhanced mobile broadband, low latency with ultra-high-reliability, and machine-to-machine communications—operators can allocate resources and optimize network topology to address specific service level agreements. They can also ensure that the security requirements of V2X communications are met, supporting high-quality vehicle-to-vehicle communications as well as situational awareness applications like vehicle-to-network and vehicle-to-infrastructure communications.

Requirements beyond 5G

While 5G provides a firm foundation for building the future of autonomous driving, it will require enhancements from a variety of supplemental technologies and configurations to achieve the redundancy, reliability, and connectivity to satisfy a successful foray into the mainstream. Some of the most important include other communications technologies like DSRC, architectures like mobile edge computing, and supporting networks such as mmWave, small cell, and fiber.

Here is a closer look at each of the technologies that will enhance the network to support autonomous vehicles:

DSRC: Dedicated Short-Range Communications are designed specifically for automotive applications. And while they also can be seen as a competitor to 5G, the likely case is that they'll provide a dedicated system to support secure and reliable V2X communications applications.

Mobile Edge Computing: By integrating computing, storage, and networking resources into the base station, mobile edge computing brings the cloud closer to the edge of the network and the end user—offloading huge amounts of computing and storage activity from the 5G network. One of the primary advantages of this system in the context of autonomous driving is its ability to reduce network latency to the required <10ms level that would not be possible with 5G radio technology alone.

Multi-Layer Architecture: Redundancy is a hallmark of any mission-critical framework, and ensuring reliable connectivity will likely require a combination of low-, mid-, and high-frequency 5G layers to provide both the coverage and capacity to meet the rigorous demands of autonomous driving.

Support Networks: 5G is a network that will sit on the shoulders of other networks. Well-established 4G networks will offer fail safes. Fiber networks will connect the infrastructure. mmWave point-to-point links will provide high-speed backhauls. And small cells will deliver the required high-density coverage, especially in urban areas.

5G phases

Over the past few years, 5G has evolved from a core set of technical specifications into two distinct phases of standards development associated with the release of complete 5G standards sets, called Release 15 and Release 16. The latter is slated for summer 2020, while the former, ratified in 2018, defined the requirements for 5G Standalone (SA) as well as 5G New Radio (NR) networks.

In effect, Release 15 laid out the track for delivering an end-to-end 5G network capable of sending and receiving wireless signals from clients like phones, computers, and cars to and from the cellular network. These specifications are required to take full advantage of the incredible speeds, low latency, and network-slicing functions of 5G network technology.

In fact, for years, mobile operators have been building out the infrastructure for the networks themselves, including the installation of the many thousands of additional cell sites that will be required to support 5G—especially in the high-powered mmWave part of the spectrum. Tower upgrades for low-band, sub-6 spectrum and mid-band deployments are also in the works.

Many operators who started with the first track release of non-standalone 5G in 2017 got ahead of the game early to start delivering 5G services sooner. They will be making the transition to standalone 5G NR networks in the coming years, and we expect to see many operators make the switch by 2025.

T-Mobile, for example, lighted up 2.5Ghz mid-band spectrum in Philadelphia and New York City in April and was the first to switch on 5G last year with its foundational 600Mhz low-band network in locations across the US. Meanwhile, Verizon and AT&T both deployed high-capacity mmWave in various municipalities. And network slicing is in trials with a number of operators throughout the country.

The next steps will be the continued buildout of 5G network infrastructure, preparing operators to make the full switch to standalone 5G. This phased rollout gives device and automotive manufacturers time to dial in the autonomous driving technology that will eventually interface with the network.

Autonomous driving technology has many years of exciting developments ahead. And with vendors, operators, and municipalities jumping on board to address the many demands that COVID-19 has prompted, we'll be seeing an increased focus on robust 5G networks and their ecosystem to support increased levels of self-driving technology.

The future is already here. 5G networks are growing and coming online. Driverless cars have been driving and collecting data. The exciting part is happening right now as the networks carve out a path for the driving technology to follow. It is precisely here where the rubber hits the road.