THE NETWORK DEMANDS OF AUTONOMOUS VEHICLES

ARE YOU READY FOR THE DATA NEEDS OF SELF-DRIVING CARS?

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The advent of autonomous vehicles will have profound effects on cellular networks and their broadband backbones. Already, tens of millions of vehicles on the road in the United States are cellular-capable. As autonomous vehicles become the norm—and as they become more fully automated—the demands on cellular networks will grow rapidly. In this white paper, we'll look at where we are, where we're heading, and what it will take to get us there.

I.

CURRENT STATE: VEHICLES AND DATA

Whether you realize it or not, connected vehicles are already our reality. In the last ten years, manufacturers started embedding cellular devices into our vehicles. Our vehicles collect data from systems as diverse as our windshield wipers to our brakes. As far back in 2014, McKinsey & Company reported that vehicles were generating 25 gigabytes of data every hour.

The drive toward cellular connectivity in our vehicles—to say nothing, yet, of autonomous vehicles—progresses further every year. Here are some key statistics from the last decade of cellular-connected vehicles:

- By 2016—relatively early in the connected vehicle era—Techcrunch reported that 32% of all new cellular devices were vehicles (a higher percentage than phones or tablets).
- According to Smartcar.com, 91% of new cars sold in the U.S. in 2020 included a cellular connection. By 2030, it's likely that 96% of all new vehicles worldwide will be connected.
- Cubic Telecom reports that, as of Q2 2022, 90% of connected vehicles run on 4G. But 5G is on the rise, with more than a half million 5G-connected vehicles sold.
- Counterpoint Research estimates that 50% of all vehicles will have 5G connectivity by 2027.

In most cases, vehicles are transmitting data via cellular networks whether or not owners purchase an in-car Wi-Fi plan (such as those offered by Verizon, AT&T, and T-Mobile). This has already raised concerns about privacy from the U.S. government and article after article after article in consumer publications. That's the state of things today.

II.

FUTURE STATE: VEHICLES AND DATA

With the number of connected vehicles on the rise, it's obvious that vehicles will use more and more data as the years pass. But the data needs of our vehicle fleet will rise far faster as more autonomous vehicles take the road and present the next challenge for connected vehicles and cellular networks. If McKinsey's estimate of 25 gigabytes per hour in the section above seemed like a lot of data, consider these figures:

- A 2016 Network World article estimated that autonomous vehicles will collect four terabytes of data every day.
- Just three years later, in 2019, a Medium article estimated that those four terabytes of data will be collected every hour of driving—a petabyte (1,000 terabytes) of data every week.
- The number was updated again in 2021 by a Morgan Stanley Global Telecom study, which estimated that autonomous vehicles may generate up to 40 terabytes of data every hour. That's 1,600 times as much data as the McKinsey estimate from 2014.

Whatever the actual number turns out to be, it's clear that the data demands of autonomous vehicles will make current vehicle data usage seem almost quaint by comparison.

As we try to estimate the data needs of autonomous vehicles on cellular networks across the nation, we also have to consider the expected rise in autonomous vehicle sales. According to Statista, the number of autonomous vehicles sold worldwide will increase more than tenfold in the next seven years, from around four million sold in 2022 to 58 million by 2030. (Allied Market Research reports that the autonomous vehicle market was valued at $76.13 in 2020 and will grow to more than $2 trillion by 2030.)

In short, (1) autonomous vehicles transmit far more data than non-autonomous vehicles, and (2) the number of autonomous vehicles on the road is rising quickly. Those two factors alone make it clear that, in the future, the data demands of connected vehicles will rise exponentially. But this is only the start of the story.

III.

THE DIFFERENCES AND DEMANDS AMONG AUTONOMOUS VEHICLES

The Society of Automotive Engineers (SAE) separate vehicles into six levels of automation, from 0 to 5. Synopsys offers a good summary of the different levels:

In Levels 0-2, humans are responsible for monitoring the driving environment:

Level 0: No automation. The human driver controls every function of the vehicle.

Level 1: Driver assistance. The vehicle has an automated system that controls and monitors certain driving functions (e.g., cruise control).

Level 2: Partial automation. The vehicle has an advanced driver-assistance system (ADAS) that can control features like steering, acceleration, braking, and so on.

In Levels 3-5, the vehicle's automated system monitors the driving environment:

Level 3: Conditional automation. The vehicle can perform most driving tasks, but at times may require the human driver's intervention. A common feature of this level might be something like a "traffic jam chauffeur," meaning that the car will drive itself in heavy, slower traffic.

Level 4: High automation. The vehicle performs all the driving tasks, and—under the proper conditions—the human driver will not have to do anything. The vehicle will drive the human to local destinations and may or may not come equipped with pedals or a steering wheel.

Level 5: Full automation. The vehicle performs all the driving tasks all the time. Under any conditions, to any destination, the vehicle will be fully autonomous.

Currently, according to Mordor Intelligence, most autonomous vehicles being marketed today are at Level 3. Level 4 and 5 vehicles are being field tested—yes, that means they are out on the roads!—but are not widely available. (In February 2023, Tesla recalled 363,000 vehicles with their "full self-driving" feature—a Level 3 technology—which may be a setback to the next iterations of autonomous vehicles.)

With each successive Level, the data requirement for autonomous vehicles grows. In Levels 3-5, as vehicles are monitoring the driving environment, they will need various types of communication:

V2V: Vehicle-to-vehicle communication

V2I: Vehicle-to-infrastructure communication

V2X: Vehicle-to-everything communication (more on this in the next section)

Imagine the needs of a fully automated vehicle driving five blocks from Point A to Point B. The vehicle will communicate with traffic lights, infrastructure networks that offer detailed information about road closures and construction, other vehicles that it encounters along the way, even the cell phones of pedestrians as they cross the street. To reach fully safe and flawless Level 4 and 5 automation, massive amounts of data and constant connectivity are a must.

IV.

BEYOND DRIVING: OTHER TYPES OF AUTONOMOUS VEHICLE COMMUNICATION

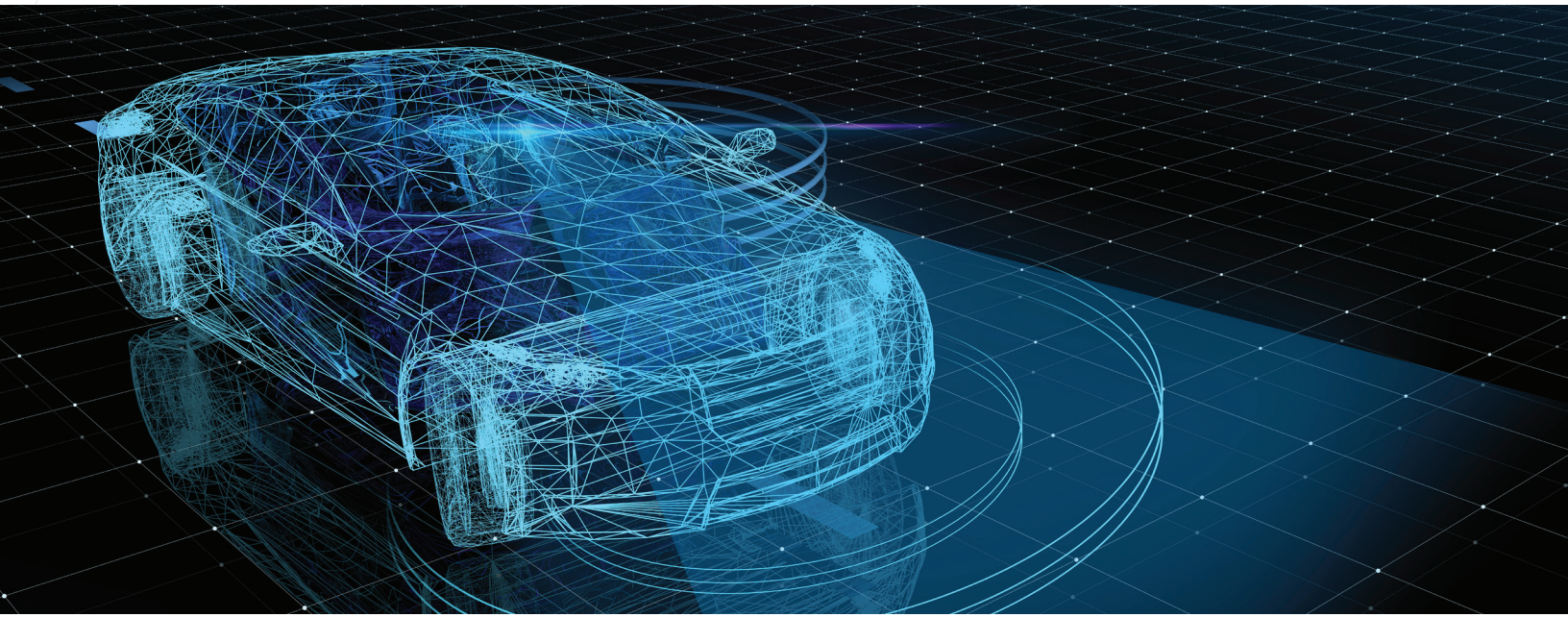
In a 2021 eBook, Cubic Telecom envisions the ways autonomous vehicles will communicate with their surroundings: “In smart cities, cars will connect with infrastructure—traffic lights, advertising hoardings, forecourt services, car parks—or with other vehicles, people and devices.” We discussed some of these connection points above, but others may surprise you. Here are some ways beyond driving that autonomous vehicles will rely on data to connect with their environment:

Maintenance: Autonomous vehicles may eventually send continuous diagnostic reports to manufacturers and/or service locations with information on the overall health of the vehicle’s hardware and software. The vehicle may even schedule its own service appointment. At a minimum, writes Allerin, “autonomous vehicles will let humans know their maintenance needs before we ask.”

Parking: Mostly, we hear about how autonomous vehicles will drive, but of course most of the time they won’t be driving—they’ll be parked. Autonomous vehicles will communicate with parking garages and local street parking systems to find a place to wait until the vehicle is needed by the human driver (rider) again.

Ads, ads, ads: Navigation services like Google Maps already suggest restaurants and gas stations. Now your vehicle will do the same, feeding up ads and real-time offers from businesses along your route. Like social media advertising and remarketing services, your vehicle will learn your preferences and make smarter suggestions the more you drive. “Autonomous cars will be a game changer for advertisers,” writes the American Marketing Association.

Essentially, if you can imagine a reason why a vehicle might communicate with another technology, it’s probably in the works. And all this connection will require the enormous amounts of data described above. Regular data reports will also be sent back to the manufacturers and firmware updates will be automatically installed, which will have immediate consequences for everyday life. (For example, according to Tesla community discussions, firmware updates tend to be 1-2 GB, and map updates can be 5 GB or more.) In urban and suburban areas, these additional data demands will put a new strain on cellular networks. In rural areas with limited or poor cellular coverage, autonomous vehicles will connect via your home Wi-Fi connection when you return after an outing. You may be surprised when your Netflix connection is buffering because your car is using all your bandwidth.



V.

SUMMARY

The push toward autonomous vehicles is progressing full speed ahead. Whether we find the new age of autonomous vehicles exciting or scary, those of us in the broadband industry ignore it at our peril. As we've seen, by 2030 the autonomous vehicle landscape will look far different than it does now and will come along with vast and constant demands for data.

Currently, there's little data about the extent to which autonomous vehicles will be adopted in urban areas versus rural areas. A study from the Netherlands suggests the difference is negligible—in fact, rural areas showed a slightly higher adoption estimate in that study. (But, of course, what is true for the Netherlands may not be true for the United States.) For that reason, if you are a broadband service provider, you may be left wondering to what extent this will or won't affect your network. The answer is that, so far, we don't know.

But what is the cost of not being ready, if autonomous vehicle adoption in your service area matches national estimates? What improvements would be required for your area's infrastructure—from both the perspective of broadband networks and cellular towers—to meet the expected data needs? Are you currently tracking the data needs of vehicles? What would happen if that traffic rose by 50%? What if it doubled? Put simply: Are you ready? Network operators must prepare for this coming data deluge or find networks unprepared and overrun by the needs of these new vehicles. In doing so, we can help pave the way for perhaps the biggest evolution in human transportation since the invention of the automobile.

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