Does the autonomous car need 5G as much as 5G needs the autonomous car?

For some time, autonomous cars such as those from Google and Tesla have been driving themselves around California without much connectivity. But now we are told that ubiquitous connectivity delivering ultra-high data rate and millisecond latency is critical to the future of the autonomous car. What has changed to require this, or is this not actually a requirement at all, rather a 5G industry desperately seeking a use case?

A car might need many different forms of connectivity. A telemetry connection might enable uploading of engine and vehicle information and the download of software updates. This would typically only need to happen infrequently, such as daily, and could be achieved using cellular and even satellite for the downlink. Passengers might require connectivity for entertainment and work purposes and this is delivered today either direct to the devices using 4G or via a Wi-Fi repeater in the car, often working from a 4G connection on the roof. Finally, autonomous vehicles might need map updates, congestion information and perhaps control information. Telemetry and passenger communications are already achieved with existing connectivity, it is the autonomous operation that is considered in this article.

Two extreme views on autonomous operation could be imagined. At the one extreme, autonomy really does mean autonomy. The car is on its own with no connectivity, only the pre-loaded maps, and it navigates itself around, using on-board sensors to make decisions about accelerating, braking and so on. Let's call this "truly autonomous". At the other extreme there is no autonomy and the car is under the complete control of a network directing its every move. Let's call this "network control". Current autonomous cars are closest to truly autonomous whereas the future envisioned by the 5G community is network control.

In both scenarios, there might also be vehicle-to-vehicle (V2V) communications. The most obvious use of this is for a vehicle breaking heavily to signal to the one behind it to warn it to slow down too. That vehicle can then signal back to the one behind it as needed, and so on. This does not need network control and can be enabled with a simple wireless short-range link. Indeed, even simpler would just be for brake lights to glow more intensely the harder the braking. Humans driving non-autonomous cars could see this and take action, and autonomous cars could use light detectors to pick up the intensity. Light has the advantage of only being seen by the vehicle behind, preventing other vehicles in the vicinity, such as on the opposite lane, braking unnecessarily. V2V could also be used for warning messages, such as an icy patch, and this could be done, for example, via a particular modulation of the brake lights.

So let us assume that V2V is a useful feature that will happen independent of whether there is network connectivity or not, and not relying on any telecommunications standard such as 5G.

The truly autonomous car is clearly possible as is currently being demonstrated in trials over millions of miles of driving. Is the network control car any better? Full network control is clearly not viable. This would require connectivity across every centimetre of every road, otherwise the car would need to come to a halt and await human intervention. Such connectivity does not exist now and is unlikely to do so in a 5G era, where the higher radio frequencies deployed will result in much less coverage. Indeed, low-latency 5G connectivity might only be available in city centres. Hence, all cars need to be truly autonomous.

This leads to a refinement of the question - is a car with occasional network control better than one without network control? “Better” in this context means bringing benefits that outweigh the costs to the owner of the vehicle. Proponents of the network control car mainly argue that it is safer, with a secondary argument that it might allow greater road capacity through platooning and other congestion management techniques. Opponents note that the connectivity needed will be extremely expensive and the central computer system needed to control a nation’s cars is massively complex, liable to have bugs and need funding and regulatory approval. Low-latency connectivity then will be only available in dense areas and expensive. Let us now look at safety and road capacity in this context.

Since autonomous vehicles will spend most of their time being truly autonomous (because low-latency connectivity will not be available on much of their route) then they will clearly need to be very safe. Google and others have already demonstrated levels of safety well beyond those of human drivers and this will likely only get better both as algorithms improve and as the percentage of autonomous cars goes up. When collisions do occur they tend to be at low speed. How might network connectivity help? Imagine a case where a child runs out into the road after a ball. A centralised network will not know about this so the first car will need to detect the child using its sensors and take evasive action. It will likely warn cars behind with V2V so they will know about it. But a car coming around the corner, too far back to see the V2V signal, might be surprised on encountering stationary vehicles. In principle a network could warn it about this. In practice, a car that ensured its braking distance was always less than its forward visibility would not need such a warning. Of course, there are many more scenarios to consider, but it is hard to see network connectivity as providing a material improvement in safety, and certainly not one users will pay hundreds of dollars a year for.

Road capacity is important, and platooning can help. Here, a car might need a message to join a platoon that is perhaps a little distance ahead, so it needs to speed up until it reaches it. Such a message can be sent over existing connectivity and the car can then join the platoon and fine-tune its position using its sensors. If the lead platoon vehicle needs to brake suddenly then V2V can propagate this information backwards through the platoon probably more quickly than even a low-latency network could.

It is hard to see how low-latency 5G connectivity could add sufficient value to be worth the cost of deployment. And in any case, enough autonomous cars to make it all worthwhile - perhaps 20% of the car population - are very unlikely to appear within the next decade making this more of a 6G problem than a 5G problem. So why does the 5G community believe that autonomous vehicles are an important demand driver for 5G connectivity?

5G, to some extent is a solution in search of a problem. Those designing 5G have postulated that, just like every previous generation, faster speed is essential. Current 4G systems can deliver 100Mbits/s in good network conditions, 5G aims to raise that beyond 1Gbits/s. Higher speeds also bring lower latency (because each bit is transmitted more quickly). The 5G community asked itself what applications might want such high-speed low-latency connectivity. The existing customer base of consumers does not appear to need it; few consumers notice any improvement in connectivity when speeds increase above 1Mbits/s - a factor of 100 less than currently achievable. A new “customer” base is needed that requires this connectivity, has sufficient volume to make the hugely expensive network deployment worthwhile and has the economics to pay the monthly charges needed. The mobile community decided that autonomous vehicles came closest to meeting these requirements and propounded the myth that autonomy required network control with centimetre-

level precision. They have extoled this view with such conviction and so frequently that many have come to believe it.

Solutions in search of problems often end badly and this looks to be no exception. Precision network connectivity of cars has very little benefit, will be very expensive and will only be available in dense urban areas. In any case, the volume of autonomous cars needed to make the economics work will not exist during the lifetime of a 5G network. The answer to the question posed in the title is that the autonomous car industry does not need 5G at all, but the 5G industry badly needs the autonomous car to adopt it. I know where I'd place my bet…

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