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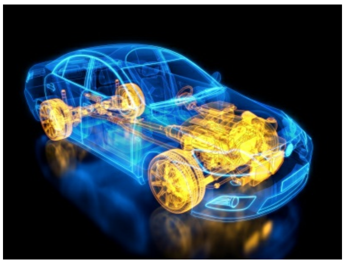
Connecting the Connected Car

By: Mark Cummings, Ph.D.



The revolution in the auto industry is creating some new and critical requirements for the cellular industry. The two most immediate are: mapping coverage holes, and making roaming work for global vehicle companies. These are needed now and will be absolutely critical for the autonomous vehicle. At the same time, they create new revenue opportunities for Cellco's. The time to respond is short and delay may limit access to this valuable market.

The automobile industry is in the throws of the most dramatic set of changes in 100 years. The rate of change is accelerating. Recent news releases indicate that autonomous vehicles will go into revenue operation within six months. As a result, the auto industry is looking for immediate fulfillment of the dream of the connected car – generating a set of requirements/opportunities that communications industry hasn't seen before. This article discusses those requirements/opportunities, the challenges inherent in them, and some possible steps that can be taken to meet those challenges and capture the opportunities. Areas left for discussion in follow-on articles include, orchestration, privacy, and security issues.

Pervasive communication is important it today's complex vehicles and with the introduction of autonomous vehicles expected in one year, it is becomes absolutely critical. Until recently we tended to think about the drive to the autonomous vehicle from the point of view of those who currently own and operate vehicles (consumers, ride hailing companies, etc.). Now, auto manufacturers are beginning to realize that they have to ship vehicles that can communicate with low latency anywhere in the world.

Looking back, one of the first auto manufacturers to include a connected car capability was GM with its On-Star product. The On-Star services evolved as cellular evolved, but today can be characterized as vehicle operation/maintenance monitoring, to drive the dealer service business, help/emergency services for the driver, and theft remediation. Tesla has added software download to vehicle operation monitoring creating a closed loop system. With today's complex vehicles, communication to support this closed loop system becomes no longer a marketing tool, but rather a safety requirement. For the autonomous vehicle with no driver to sense faults and take precautions it becomes even more important. Looking forward, there are likely to be further significant demands for pervasive communication.

The efforts of the ride hailing companies such as Uber, Lyft, Ola, etc. in autonomous vehicles are well known. The auto OEMs will sell to these OEMs and need to deliver a standard worldwide product that. But it may not stop there. Auto OEMs may offer specialized Transportation as a Service (TaaS). For example, a consumer going to the Opera Gala may contact Mercedes to arrive in an S Class. A farmer may contact International Harvester and have an autonomous combine arrive at his field at a specific time along with a set of trailers that autonomous trucks later take to the grain elevator. As passengers are no longer engaged in operating the vehicle, their demands for communication services may expand dramatically. As other parts of society go through this autonomous process, there may also be requirements for combining services. For example, a wearable diabetic monitoring system may sense that a passenger is going into a diabetic coma, and automatically redirect the vehicle on the fastest possible path to a hospital equipped to provide treatment. Finally, new transportation and new communications topologies are likely to appear.

There is a long history of communications standards efforts targeting vehicles – from IVHS (Intelligent Vehicle Highway Transportation Systems) to IEEE 802.11P and Cisco's V2X. Although there is a lot of promising work that has come out of these efforts, they will take some time before they become widely enough deployed to complement already pervasive cellular communication. The opportunity and the challenge, then, is to make the existing cellular system meet the near term requirements.

Up to now Telco's have worked on the basis of supplying automotive OEM's with a "connect and forget" service based on a SIM (Subscriber Identity Module)/simple phone module built into the car. This is proving to be far from sufficient. The critical component is becoming the TCU (Telecommunication Control Unit) embedded in each vehicle. In essence, in the short term it is a smartphone embedded in the vehicle data-bus. But it has a multi-standard cellular radio modem, global location receiver (possible multi-standard as well), WiFi and Bluetooth modules, plus a standard OBD (On Board Diagnostic) or a more enhanced vehicle system interface. Because vehicles have long useful lives, over time, additional communication modalities will need to be added. On-Star had a serious problem because its initial modem was only able to handle 1G. As 2G and 3G were deployed and Cellco's abandoned 1G, GM had to abandon a very large number of vehicles. This was a marketing problem then. A similar situation in the future will become a critical safety issue. Given the current pace of developments in the connected car, volatility is likely to greatly increase in both amount and speed. One way to minimize disruption would be to make as much of the TCU software defined (SDR, SDN, etc.) as possible.

The TCU needs to be seen as a Telco Network Element, not just a "stupid" router or pipe. It needs advanced control logic to interface with the vehicle systems. By definition this would call for at least a full specification O&M interface, preferably controlled by an integrated orchestration agent based on an end-to-end platform that can meet both today's and tomorrow's emerging requirements. This platform needs small highly efficient software components that can be deployed in fully distributed, fully centralized and hybrid architectures provisioned, configured and managed in an automated fashion. The role of the orchestration unit will become even more important as vehicle-to-vehicle, vehicle-to-road, etc. communications systems become widely deployed. Again, a full discussion of the orchestration system for the connected car will be discussed in another follow-on article.

The immediate problem today is that current cellular coverage, global roaming, and end–to-end orchestration of communications links traversing multiple networks (administrations, technologies, etc.) were designed for human users. We all know that there are coverage holes, even in leading metropolitan areas of advanced economies. We know where they are and when we are talking on our mobile phones, we say, "going into a coverage hole. If I lose you, I will call back when I get out of the hole."

It would be great if an auto OEM could assume complete global coverage, but that is not possible today. So, in this environment, the first and most important requirement is to know when there is a lack of communication, if it is a network hole or a vehicle problem. The way to do this is to break down the world into octagons and then to characterize the coverage in each one. The best way to do that is to use the TCUs that are in the field to collect that data. To minimize cost, sampling and exception techniques need to be used. Building these maps may be more complicated than it seems at first because of how global roaming is done today.

Cellular networks tend to follow national boundaries. So a vehicle in Europe may, on an average day, roam across two other national networks in addition to its home network. In the U.S. on an average day, most users only roam when they encounter a coverage hole in their contracted operator's network and another operator's network has coverage. Other parts of the world lie someplace between these two extremes.

Cellular networks have a way to assign priorities to classes of customers. Operators consider their own contracted customers who they have competed to get and keep (most even track customer acquisition cost) as having the highest priority. In some countries/networks, first responders and other critical government users may also have very high priority. On the other hand, another network's customer roaming on their network is not treated to much of any priority. For example, the CTO of a major European operator with the most expensive plan available on his home network, vacationing in a nearby country could not reliably receive text messages nor access the web. His wife, using the cheapest one-time phone purchased at a local drug store in the vacation country, was able to watch movies on her phone, etc.

Furthermore, an operator with a customer roaming on another operator's network can't send a trouble ticket to the operator supporting the roamer. So when there is trouble with roaming, it is hard for the network hosting roamers to detect and fix the problem.

These roaming problems face an automotive manufacturer seeking to sell a standard product that will work anywhere in the world. The auto OEM needs reliable low latency communication to make the product provide the best service in today's context and maybe as soon as next year to effectively operate in autonomous mode. It is not practical for the OEM to have contracts with a wide profusion of Cellco's all over the world. They need to be able to have a contract with one (or two/three for redundancy) and roam on the networks in parts of the world where it is practical to use automotive products (not all parts of the world make sense today – for example Mt. Everest).

Given the current situation, there are three steps that can be taken quickly. The first is for operators that want to service auto OEMs to start mapping connectivity. Please note that we say "connectivity" not "coverage". That is, what users roaming from the auto OEM's contracted network "see" while roaming on other networks around the world.

Second, traditional roaming contracts need to be updated to include a higher priority roaming service capability for these auto users. These higher priority SLA's (Service Level Agreements) may include expectations (and/or restrictions) on the size of the messages exchanged and the frequency of messages, etc. to manage the load on the roaming network.

Finally, these updated contracts should include the ability for the contracted network to send the roaming network trouble tickets. This way, problems that roaming vehicles face can be quickly identified and resolved.

These three steps can go a long way to meeting the immediate needs of auto OEMs without incurring great expense, while opening up a new revenue stream for Cellco's. On this foundation the additional vehicle-to-vehicle, vehicle-to-road communications services, orchestration capability, and privacy / security controls can be built. The danger is that if Cellco's don't begin rapidly to implement these steps, other less effective work-arounds will be adopted and Cellco's will face limited access to this valuable market.