WHITE PAPER

INSIGHTS FROM CONNECTED MOBILITY

5G in the Future connected car: How the new mobile standard makes the vision of connected driving become a reality

AUTHORS

Cristina Cipriani
Guido Dornbusch
Dr. Holger Hilmer
Ulrich Moehlmann

molex

INSIGHTS FROM CONNECTED MOBILITY

5G in the Future connected car: How the new mobile standard makes the vision of connected driving become a reality

INTRODUCTION

According to a study by Ericsson, by 2025, there will be 2.6 billion 5G subscriptions, covering up to 65 percent of the world's population and transmitting about 45 percent of the world's mobile data traffic. Forecasts also suggest LTE will peak in 2022 at 5.4 billion subscriptions and will decline to 4.8 billion by the end of 2025 as LTE subscriptions migrate to 5G.

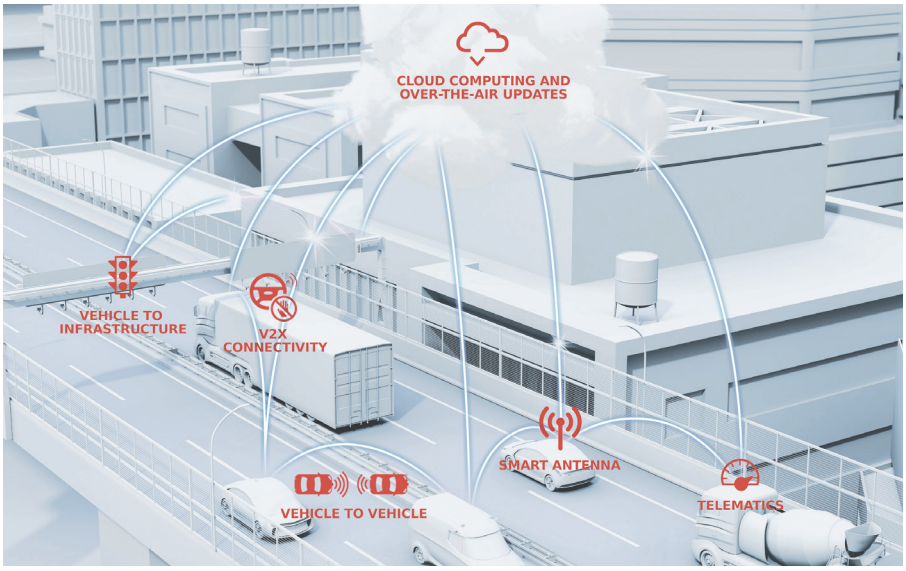

Figure 1 – The connected vehicle as part of the IoT environment

Those figures hint at 5G's incredible market potential, especially considering that the study does not include the Internet of Things (IoT) or connected cars. Yet they are a key target group for 5G devices – after all, the new standard pursues the goal of integrating "machines" optimally in mobile communications for the first time. 5G is therefore not just an issue for the telecommunications sector, but for other branches of industry as well. The automotive industry, for example, sees it as a means of achieving future visions – such as the connected car for self-driving – in the best possible way. That's a task that will require overcoming a number of obstacles ranging from the continued development of 5G standards to the implementation of security features in the connected car, to challenges like antenna alignment. This white paper addresses these 5G implementation questions, deals with challenges in relation to the development of powerful 5G antennas, and discusses the introduction of security standards in the connected car. Finally, it illustrates the possibilities that 5G offers the connected car and the economy.

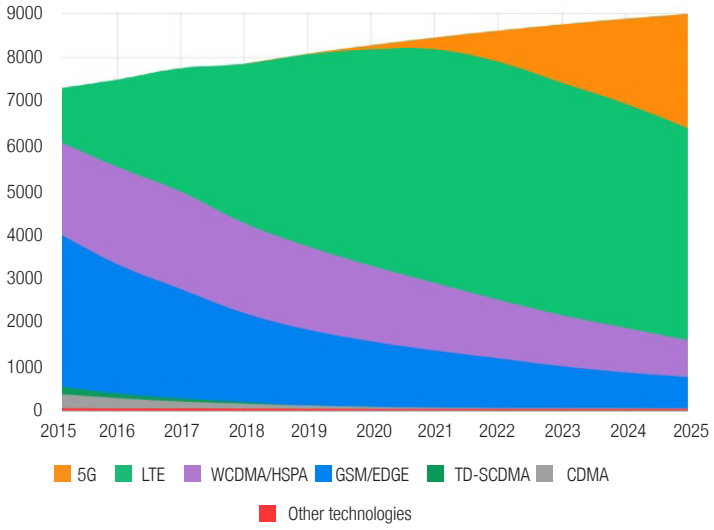

Figure 2 – Mobile subscriptions by technologies (in millions)

SOURCE:
https://www.ericsson.com/en/mobility-report

molex

Current Status and Application Areas of 5G

The introduction of the new 5G mobile standard is currently being prepared. The initial requirements for the standard have been set and now its detailed definition and subsequent implementation are being launched. The successor to the current mobile standard LTE (4G) is intended to improve latencies, deliver higher bandwidth and create the foundation for new possible applications thanks to its enhanced performance. There will be several development levels or "releases."

Standardization of 5G started with Release 15 (R15), which was published in June 2019 and mainly determines the specifications for current 5G mobile devices, including CPEs and handsets. This release set two frequency ranges: FR1 (frequency range 1) with frequency bands previously below 6 GHz and now (per R16) below 7.125 GHz; and FR2, with frequency bands below 52.6 GHz, which includes a part of the so-called mmWave spectrum. R16, impacted by COVID-19, will fix 5G/NR-V2X by mid-2020. Future releases will address other topics, such as integration of higher frequency bands up to 100 GHz. Content for R17, one of the future releases is set and targeted for completion in the second half of 2021, and R18 will address new topics with a completion target of late 2022/early 2023.

Experts Currently See Huge Potential for 5G in Three Application Areas:

The first application area is the consumer sector (enhanced mobile broadband — eMBB), in which greater traffic and lower network power consumption are expected to enable a large number of devices to be used simultaneously without network losses. That will mainly enhance user convenience and quality of experience (QoE). For instance, when there are large crowds, like at concerts or sporting events, where many private devices are used concurrently, network capacity must be adequate for these concentrated numbers.

SOURCE: "Cybersecurity for Automobiles: BlackBerry's 7-Pillar Recommendation" by Sandeep Chennakeshu

A second application area is massive machine type communication (mMTC), an issue that is becoming relevant especially in relation to networking of all types of devices as part of the IoT. The objective will be to enable communication of up to 1 million connected devices per square kilometer.

However, it is especially the third potential application area that has aroused the automotive industry's interest in 5G: ultra-reliable low latency (URLL), which ensures reliable connections and short transmission times. This is vital to progressing self-driving vehicle technology.

Since 5G optimizes the integration of machines and cars in mobile communications, several stakeholders are involved in defining the 5G standards. Whereas the big players in the communications industry defined the existing standards, such as UMTS and LTE, new players are getting into the act with 5G. For this purpose, the automotive industry has established the 5GAA, a body for defining requirements for 5G standardization. A common definition is important so that efficient communication between devices from different manufacturers is possible — for instance, in road traffic.

Challenges Relating to Omni-Directional Antennas and Signal Strength

Even though the automotive industry is very optimistic about the future of 5G, there are still many details that have to be addressed to implement the technology. One challenge is integrating mobile communications when it comes to antenna technology, with the ultimate goal of creating a high-performance vehicle communication system. Currently, signals are transmitted via cable connections from an antenna on a vehicle's roof to the onboard electronics, which are often located in the driver's cockpit. With the need for more bandwidth, 5G will explore a wider operating frequency range from 6 to 100 GHz, where sending signals from the antenna to the electronics via cable would result in large losses. That means the electronics, and thus signal processing, must be positioned close to the antenna – i.e. directly under the roof or in the antenna. One problem with that is the fluctuating weather conditions the electronics are

then exposed to. High temperatures and fluctuations under the roof and in the antenna itself take a heavy toll on the electronics' performance and operating lifecycle. Only a few manufacturers are able to develop concepts that combine multiple hidden antennas with electronics under such conditions. Molex calls its concept Telematics Antenna Fusion.

Moreover, the expansion of the frequency range from 6 GHz to 100 GHz increases radio field attenuation, which means signals can be received only from a shorter distance. That results in problems with omni-directional antennas, which cannot then receive signals or can do so to a limited extent only. Although the distance can be increased through the pinpointed alignment of the antennas, devices then have to be fitted with a large number of antennas. As a result, only the antennas in the direction of the transmitter can be used. Roadside units must also be equipped with directional antennas in order to transmit the signal to devices in passing cars. Some antenna manufacturers, including Molex, and car makers are already working together to solve this problem.

The Future of 5G in the Connected Car

5G will progressively replace the current mobile LTE standard. Experts estimate there are already millions of networked cars and trucks on roads worldwide and that the promised scenario of "zero accidents" will encourage this trend going forward. In other words, the future vision of the connected car appears within reach.

Until that can become a reality, carmakers are attaching great importance to installing all safety- and security-related sensors in the car itself so that it can act autonomously without any networking and does not have to rely on wireless connections. Functions that operate using wireless connections will be used to enhance, first, convenience and then, in the long perspective, driver safety. For example, through wireless networking, the car is informed of a traffic jam caused by an accident ahead and can independently select an alternative route to avoid unnecessary waits. Even though all the cars on our roads will not become "smart" at one stroke our experience to date with the introduction of new mobile standards means we can expect the dawn of a new age in which mobile communications act more and more as an enabler for future visions as part of the IoT.

Molex as a 5G Vehicle Communication Systems Manufacturer

Molex is a global leader in the field of radio frequency (RF) technology — from development and production to life-long system support. Molex is currently the only tier 1 vendor that can unite expertise in wireless and wired vehicle communication solutions, offering the automotive industry a complete end-to-end system, from the cloud to the sensors and back. Enhanced mobile broadband is crucial for Molex: 5G will use FR2, the extended mmWaves frequency bands, 10 times broader than the LTE band. That is vital to the development of Telematics Antenna Fusion systems, which Molex is steadily driving forward.

5GAA

The 5GAA, which was established at the end of 2016, develops, tests and promotes communications solutions; supports their standardization; and accelerates the commercial availability of relevant products and solutions. Its goal is to address the desire for connected mobility and safety concepts with applications such as connected autonomous driving and comprehensive access to services. Molex is currently the only tier 1 supplier that unites experience in wireless and wired ultra-high-speed communication from the antennas to the automotive Ethernet. As a member of the 5GAA, the company supports technical working groups and the development of GNSS and high-speed wireless technology to meet future need for 5G networks. Integration of 5G will make the connected car part of the IoT ecosystem. Cars will then communicate not only with each other (this is possible also using LTE based modules — see the Molex offering of such systems) but also with other vehicles, such as bicycles, or even with infrastructures like parking systems. This will increase road safety and pave the way to autonomous driving.

molex

Security in the Connected Car

Security testing will be of special importance in the future in the battle against cybercrime. In particular, penetration tests reveal security gaps. The tester deliberately tries to penetrate the system with the means and methods used by hackers. The results supply information regarding the current security strength, which engineers then use as the basis for countermeasures to eliminate critical weaknesses.

In addition, the organization and development processes need to be adapted to the new circumstances. End-to-end risk analyses, for example, have not traditionally been the rule, but should be one of the absolute requirements manufacturers ask of their suppliers. Such an analysis investigates potential attacks on all the components in the chain, their effects on data security and, ultimately, functional safety. Engineers can use the results to define suitable protective measures. The success of this procedure depends upon the cooperation, from an early stage of development, of the OEM, the back-end solution supplier and the control unit manufacturers.

Road Safety Enabler

5G not only offers new commercial possibilities for the automotive industry. The new mobile standard and the innovations it produces will also improve road safety. With 5G, road operators could conceivably use connected vehicle data to ensure traffic flows and avoid crowded environments that could lead to accidents. Additionally, crucial alerts like left-turn assistance will support the driver in challenging situations. The new 5G-based infrastructure will create a less stressful driving experience. For example, traffic-light-optimized speed-advisory systems will regulate traffic from intersection to intersection. Likewise, self-driving vehicles could use privileged lanes and thus enable convenient driving and mobility. With 5G, the ambitious vision of zero-accident vehicles seems to be within reach.

Order No. 987652-0261 Rev. 2 USA/0K/GF/2020.05