QUECTEL

Build a Smarter World

From here to autonomy:

How to fulfil the requirements of the next generation connected car

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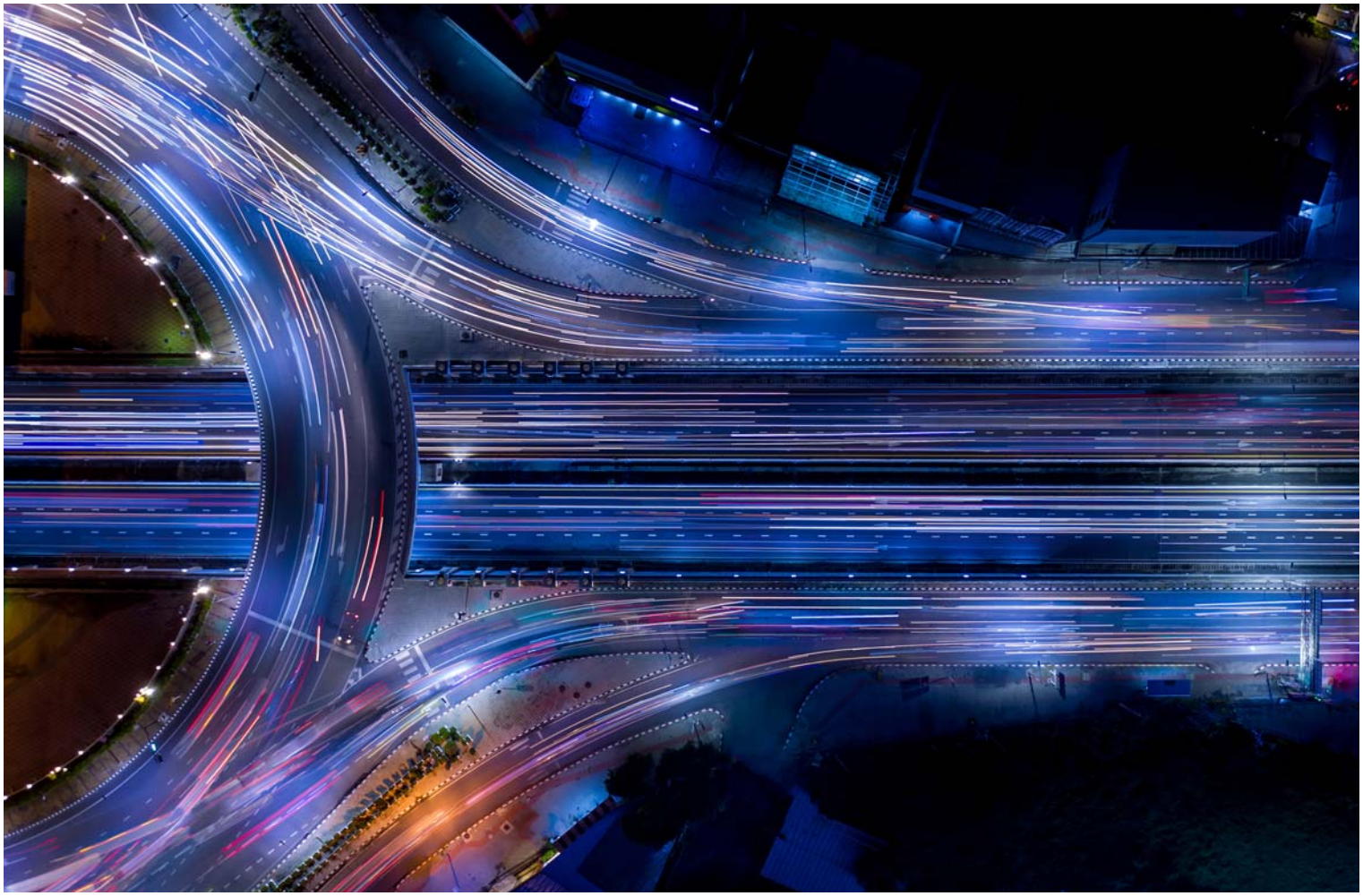
Introduction

The automotive industry is in a state of transformation as vehicles shift away from the combustion engine to electricity produced from renewable energy sources. At the same time, user behavior and their expectations of their vehicles is starting to change, bringing in new ways of interacting with vehicles which are influencing the next generation of vehicle design. Substantial excitement exists regarding autonomous driving but this – in its full extent – remains some years away because of technical and regulatory constraints. While drivers are assisted already in various ways, the willingness of the user to trust full autonomy needs to grow and this is a matter of time.

This leaves a massive market composed of realistic applications that can and are being deployed today. These extend from basic connectivity to enable infotainment and communications from the car to more complex data transmissions to enable predictive maintenance or over-the-air (OTA) software updates and new business models such as e-insurance and car sharing. These pay-as-you-use services are transforming car makers from being sellers of products to being providers of mobility services. Connectivity is the enabler of this move because such business models rely on accurate positioning, timing and robust, secure data transmission capability.



Safety first

The transformation of the automotive industry's business model is just one area of the vehicle industry that demands connectivity. Regulation, such as the European Union's eCall directive, mandates car makers must include a means for a vehicle to communicate in the event of an emergency. The directive, which has required cars and light commercial vehicles approved for manufacture after 31 March 2018 to have the eCall system installed, has equivalents in many other markets, notably the US and Russia. The mandatory inclusion of connectivity to support emergency communication provides a connectivity foundation in vehicles which can be utilized to support other services and is a key stimulus for the connected car industry.

As the technology becomes more sophisticated in the future, what it is capable of will expand

Another development helping speed uptake is the crystallization of technologies and standards. Cellular vehicle-to-everything (C-V2X) is a technology that allows vehicles to communicate with their surrounding ecosystem. Vehicle-to-vehicle (V2V) connectivity is part of the C-V2X concept which allows vehicles to communicate with one another, while vehicle to infrastructure (V2I) allows vehicles to communicate with external systems such as street lights, buildings and other road users. As the technology becomes more sophisticated in the future, what it is capable of will expand.

C-V2X systems are mainly used to increase safety and prevent collisions. In a traditional vehicle, V2X systems can convey important information to the driver about weather, nearby accidents, road conditions, and the dangerous activities of nearby vehicles. In autonomous vehicles, V2X provides extra information to a vehicle's existing navigation system.

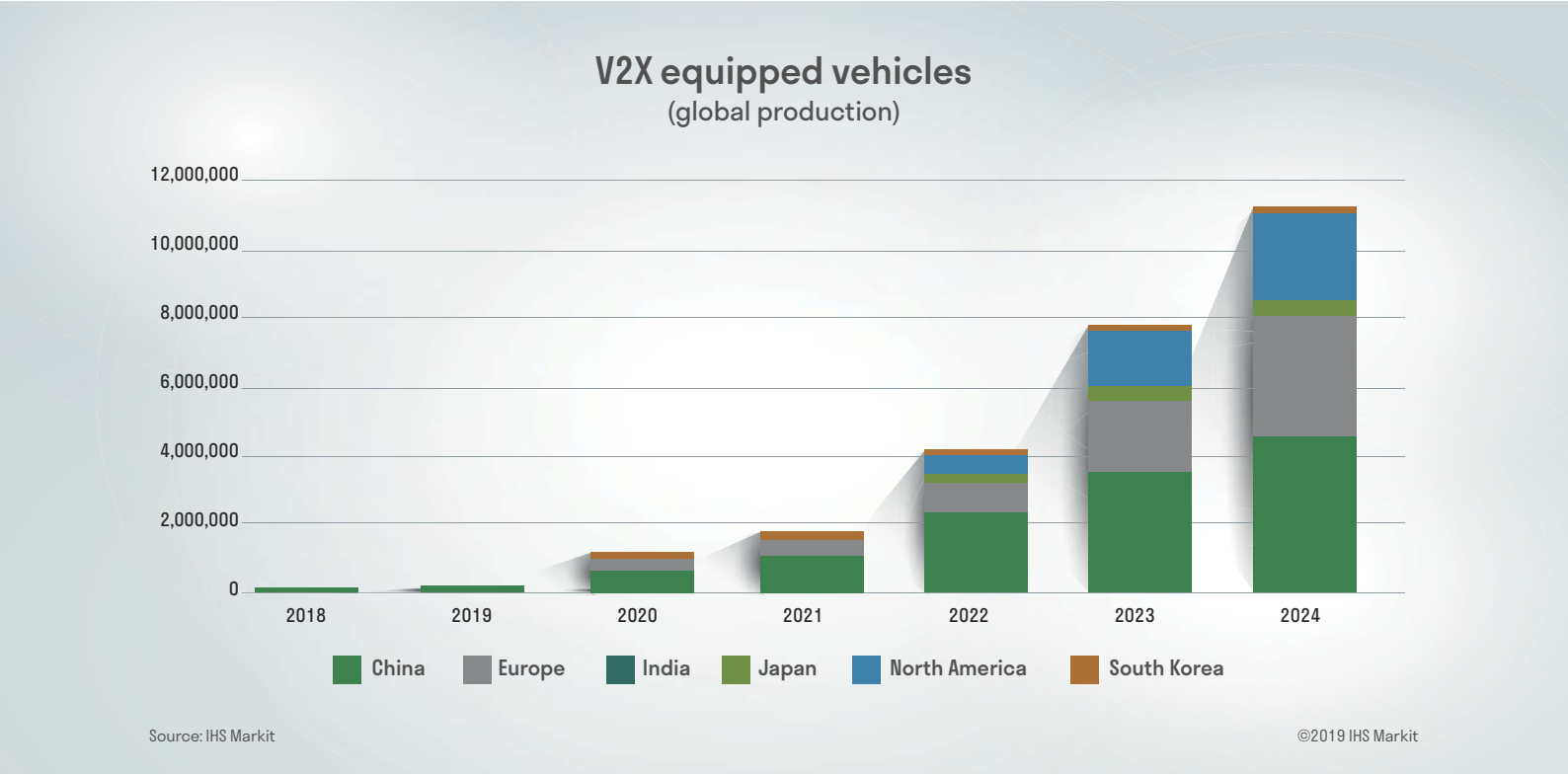


Figure 1: V2X equipped vehicles 2018-2024

ADAS can increase car and road safety through utilizing automated technology, such as sensors and cameras, to detect nearby obstacles or driver errors, and respond accordingly.

Research firm, IHS Markit, predicts in Figure 1 that more than 11.2 million light vehicles equipped with some form of V2X system will be produced globally in 2024, representing 12% of the world's light vehicle fleet. The firm has predicted that production of light vehicles equipped with V2X systems will grow from 15,000 units in 2019 at a compound annual growth rate (CAGR) of 277.5% in the period 2019-2024.

It remains relatively early days for C-V2X deployment and autonomous driving use cases are not reality. However, advanced driver assistance systems (ADAS) are starting to be adopted. Today, these systems help drivers perform some driving and parking functions. Through a safe human-machine interface, ADAS can increase car and road safety through utilizing automated technology, such as sensors and cameras, to detect nearby obstacles or driver errors, and respond accordingly. This is not autonomous driving yet but applications such as lane departure assist, adaptive cruise control and automated lighting have clear benefits.

ADAS have been categorized into levels extending from level 1, in which the driver does most of the decision-making, to level 5 in which the vehicle is fully autonomous. Levels 1 and 2 include the applications listed in the previous paragraph but applications such as a highway chauffeur require a Level 3 system while automatic valet parking is a Level 4 requirement. Neither Level 3 or 4 are in full commercial use yet.

Today, there is a growing and well-established market for classic telematics and in-car connectivity and automotive OEMs are now keen to extend connectivity across their ranges. This is because they have seen the value that connectivity provides in enabling them to become more intimate with their customers. Initially, this was not widely understood but leading car makers, such as Tesla, Audi, Mercedes, BMW and Fiat Chrysler Automotive (FCA), have been quick to recognize how they can differentiate and provide better service thanks to connectivity-enabled data collection.

Traction is underway

For the reasons outlined, the earlier phases of connected cars relied on relatively low-bandwidth, high-latency communication via early LTE connections between connected cars and data ingestion platforms to enable applications such as roadside and vehicle hazard warnings and lane-level traffic assistance. ABI Research reports that 2020 will see a move into the mainstream with the first large-scale deployment of 802.11p V2X technology on the Volkswagen Golf in Europe. This is a model that typically ships in volumes of more than 450,000 units each year and this level of uptake will enable low-bandwidth and low-latency broadcast communications between a growing number of connected cars to enable safety-critical collision avoidance.

However, the higher bandwidth, ultra-low latency capabilities that autonomous driving relies on will only be provided by 5G infrastructure, which is rolling out across the world but will not be ubiquitously available, nor embedded in vehicles for several years. This is not holding the market back today because regulation is not in place, applications have not been finalized and user education is needed. The bulk of the connected cars market is therefore made up of traditional telematics applications which continue to generate substantial growth. As Figure 2 below shows, the established applications are likely to continue to grow alongside the new applications that emerge.

5G is starting to become a reality and markets, such as China, are looking to 5G to support autonomous driving at ADAS Level 4. This provides close to fully autonomous driving and enables technologies such as LIDAR and radar sensors plus cameras to be connected. 5G roll-out is set to help address the challenges of continuous, ubiquitous connectivity but is dependent on markets embracing the technology. The arrival of national 5G coverage in some markets has resulted in automotive OEMs moving forward with their developments of technologies and solutions that rely on the connectivity of 5G.

Figure 2: The connected car market by services 2019-2027

The challenges

It's important that automotive modules are certified and are manufactured by a vendor that has the scale and expertise to achieve certifications globally.

There are significant challenges for connected cars to overcome. An important issue is the length of expected service life of a vehicle and the long development cycle of cars themselves. This means automotive OEMs have to carefully assess not only which is the best technology for today's market but also whether it will still be relevant in ten or 15 years.

A classic example was the inclusion of a PCMCIA or CF card reader, driven by various OEMs in the early 2000s. This was cutting-edge technology in 1990 but by 2008, when vehicles were still being shipped with the functionality, users were confused about what to use it for.

The hardware is therefore an important issue but wireless connectivity means much obsolescence can be avoided by upgrading the software, enabling the functional life of hardware to be extended. This may eventually apply to modules and SIM cards. SIM cards will be addressed via embedded or integrated SIM (eSIM and iSIM) solutions that can be upgraded OTA while some modules may be either software upgradable or able to be slotted in and out easily.

Another key issue is that cars are products for global markets, each of which not only has automotive regulations and certifications but also wireless connectivity rules. For car makers, shipping a global product, certifications for each market a vehicle goes to are required. It is therefore important that automotive modules are certified and are manufactured by a vendor that has the scale and expertise to achieve certifications globally. This demands a comprehensive geographical footprint and an experienced global certification, such as that Quectel already has in place thanks to its module market dominance.

Positioning capability is a vital requirement for connected car applications and will become of particular importance as C-V2X applications roll out more widely. However, vehicles have several characteristics that hinder positioning. First they are moving objects, often at speed, which necessitates they hand off continuously between cells and move from areas of abundant coverage to limited or zero coverage. The positioning system could then fallback onto an alternative network or rely on GNSS, satellite-based, positioning.

Further to this challenge, cars' chassis are constructed in principle as metal cages which can impede signal reception and the vehicles travel through urban canyons or can be parked underground all of which hinders accurate positioning.

Manufacturing automotive-grade solutions

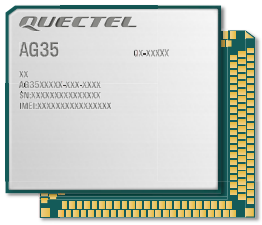
The Quectel portfolio is built on automotive industry practices with respect to quality and durability in addition to adhering to quality standards such as relevant ISO certification. Typical automotive use cases expose electronics products to a much higher range of temperatures than consumer or industrial-grade products and therefore we have focused on ensuring Quectel's solutions for the automotive market comfortably address requirements such as the interior operational temperature range of a car being between -40C and +115C. For interior products, such as our smart antenna products, detailed product planning and preparation to fulfil these requirements begins upfront.

The requirements for automotive production are much more process-driven than for IoT products, for example, so production perimeters are heavily regulated and need to be permanently monitored. Full traceability is typically required so, if one shipment of third party components later on has issues in the field, it can be easily traced and components in this series isolated so the affected cars can be identified. In addition, there is a clear no-repair rule in automotive production. What fails in end-of-life testing is analysed but then scrapped and not repaired.

Automotive components are typically more complex that those in other industries and we have adopted techniques such as underfilling to ensure durability. Chipsets have become larger and contain more technology and are often ball grid array (BGA) components that have solder balls on the bottom which are melted during the reflow soldering process when they are mounted on a printed circuit board (PCB). The larger the chipsets become the more influence they have on bending of the PCB. They might still contact and deliver a positive end-of-life test but in the car, after thousands of kilometers with vibration and temperature shocks, those solder connections can break. To avoid this, we adopt an underfill process which acts like glue to mechanically stabilize the chipset on the PCB and avoid mechanical influences on the solder connections.

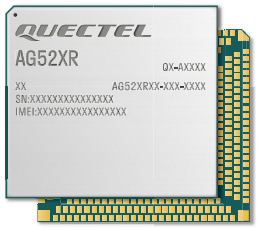
Key AG35 benefits

- Designed for automotive applications requiring IATF 16949:2016
- Multi-constellation GNSS receiver available for applications requiring fast and accurate position fixes in any environment
- Supports EU eCall and Russia ERA-GLONASS emergency call systems
- Wide operation temperature range (-40 °C to +85 °C) and supports eCall under +95 °C
- MIMO technology meets demands for data rate and link reliability in modem wireless communication systems



Key AG52x benefits

- Ideal for automotive premarket applications with IATF 16949:2016 requirement
- Wide operation temperature range (-40°C to +85°C) meets the demanding requirements for automotive devices and excellent EMC protection
- C-V2X PC5 and uu mode
- Compact SMT form factor ideal for integration in slim and size-constrained automotive solutions
- Multi-Frequency GNSS receiver and optional QDR 3.0 available for applications requiring fast and accurate fixes in any environment



Quectel product portfolio

Quectel has developed a comprehensive range of wireless modules for the automotive industry to meet the needs of the Internet of Vehicles and C-V2X applications as the industry transforms and harnesses the power of connectivity.

The AG35 is a series of automotive grade LTE category 4 modules designed and manufactured according to the IATF 16949:2016 quality management system. The series is targeted at the IoV applications and features maximum 150 Mbps downlink and 50 Mbps uplink data rates. With a wide variety of interface options to enable customers to develop applications the series also offers excellent performance in electrostatic discharge (ESD) and electromagnetic interference (EMI) protection to ensure great robustness in harsh environments.

The AG35 contains five variants (AG35-CE, AG35-E, AG35-NA, AG35-LA, AG35-J) to meet the market requirements of China, Europe, North America, Latin America and Japan. It is backwards compatible with existing EDGE and GSM/GPRS networks, enabling it to be connected even in remote areas without 3G or 4G coverage.

AG35 supports multiple-input multiple-output (MIMO) technology. The use of multiple antennas at the receiver end at the same time and on the same frequency band greatly minimizes errors and optimizes the data speed. The module also combines high-speed wireless connectivity with an embedded highly sensitive multi-constellation GNSS (GPS, GLONASS, BeiDou, Galileo, QZSS) receiver for positioning.

The AG52x is a series of automotive grade LTE category 9/19 and C-V2X modules also designed and manufactured according to IATF 16949:2016 quality management system. This series offers a maximum of 1.6Gbps downlink and 75Mbps uplink data rates. Supporting C-V2X PC5 direct communications, the AG52x series makes traffic smoother and more efficient, paving the way for automated driving and achieving the goal of fully connected traffic.

This series contains five variants (AG520R-CN, AG520R-EU, AG520R-NA, AG520R-J and AG520R-ROW) to meet different market demands. It is backwards compatible with existing GSM networks so it can operate in areas without 3G or 4G coverage. AG520R supports MIMO and combines high-speed wireless connectivity with an embedded highly sensitive multi-frequency GNSS (GPS, GLONASS, BeiDou, Galileo) receiver and optional QDR3.0 for positioning.

Key AG55Q benefits

- Automotive 5G NR module with 4G (LTE Cat 19)/3G/2G fallback, supporting both 5G NR NSA and SA modes
- MIMO technology meets demands for data rate and link reliability
- Optional C-V2X PC5 mode 4 direct communications
- Wide operating temperature range (-40°C to +85°C) and high eCall operating temperature (up to +95°C) meet the demanding requirements for automotive devices
- Excellent EMC protection makes the module operate satisfactorily in any harsh environment

The AG55x is a series of automotive grade 5G NR Sub-6GHz modules developed by Quectel, supporting both 5G NR NSA and SA modes. The modules support a maximum of 2.12Gbps downlink and 900Mbps uplink data rates for 5G NR, and maximum 2.02Gbps downlink and 75Mbps uplink data rates for LTE-A. Supporting optional C-V2X PC5 direct communications, AG55x modules are an excellent solution for automotive applications and pave the way for automated driving and achieving the goal of fully connected traffic. The series supports dual SIM dual active DSDA (optional), and provides a wide range of interfaces for customers to develop applications. Its excellent performance in ESD and EMI protection, ensuring robustness in harsh environments.

AG550Q contains multiple variants (AG550Q-CN, AG550Q-EU, AG550Q-NA and AG550Q-ROW) to meet varied market demands. It is backwards compatible with existing GSM, UMTS and LTE networks, enabling it to be connected in areas without 5G NR deployment currently as well as areas without even 3G or 4G coverage.

The AG55x series supports MIMO and the Qualcomm® IZat™ location technology Gen9VT Lite (GPS, GLONASS, BeiDou, Galileo, QZSS). The optional QDR 3.0 and the integrated multi-frequency (L1/L2/L5) GNSS receiver simplify product design greatly and provide quicker, more accurate and more dependable positioning capability.

With AG550Q, Quectel is able to provide automotive OEMs and tier-1 suppliers with secure and reliable connected car solutions as well as providing vehicle manufacturers smart and flexible solutions to build self-driving cars. More specifically, the module will be commonly found in telematics boxes (T-Box), telematics control units (TCU), advanced driver-assistance systems (ADAS), C-V2X (V2V, V2I, V2P) systems, on-board units (OBU), roadside units (RSU), and other automotive/traffic systems.

Conclusion

The road ahead for connected cars relies on secure, low latency, high bandwidth connectivity to enable highly sensitive applications such as autonomous driving. The reality, however, is that other applications will lead uptake. These include the driver assistance systems detailed in this paper and the automotive OEM applications such as predictive maintenance and in-service OTA software updating. Traditional telematics applications currently form the core of the market.

However, as this paper outlines, automotive OEMs need to play a long game because of the life of their products. They therefore need to specify wireless modules that not only meet the needs of today's users but also address the requirements of future connected cars. This will see greater levels of driver assistance and ultimately autonomy come to market. OEMs therefore need a partner with the scale to address a global market and the scope to understand the emerging trends while simultaneously addressing current market demands.

Quectel with its heritage in the wireless module market has developed the first 5G wireless module and is fully committed to the global automotive industry. Our global resources in terms of research and development, certification expertise and support set us apart from the competition and make us an ideal partner to help OEMs navigate the new challenges in this rapidly changing market.

To learn more about Quectel's automotive portfolio, contact us today.