Inside IoT's earliest 5G use cases

Six verticals that uncover 5G's value in IoT

Contents

Introduction

"Quectel was early to the 5G market and leveraged its extensive R&D capabilities to accelerate commercialization of 5G IoT use cases and applications." said Dan Shey, Vice President at ABI Research. "Across all IoT sectors, Quectel has consistently increased its market presence to the point that in 2019 it not only is a leader in global cellular module shipments with 26.4% share but also revenues."

The excitement about the arrival of 5G has mostly been directed at the consumer market place but there are enormous markets in the business-to-business (B2B) arena that will be enabled by the high speed, low latency and connection density of 5G. To date, though, these are only visible in isolated areas as organizations wait for wider deployment of 5G, learn more about the capabilities and relevance of the technology to their business and seek out the 5G modules and devices necessary.

Internet of Things and business applications should not, however, be seen as a minor market for 5G. Analyst firm IoT Analytics estimates that the global base of 5G connected devices, (both IoT and non-IoT) will reach 1.2 billion by 2025, rising from around 11 million devices in 2020. We are therefore at the start of 5G in IoT and this paper sets out the benefits 5G offers, the leading use cases and the main challenges facing wider adoption of the technology.

ABI Research has recently released its "M2M Cellular Module Vendor Market Share-2019" report, which ranked Quectel as the number one cellular module vendor globally by shipment as well as by revenue.
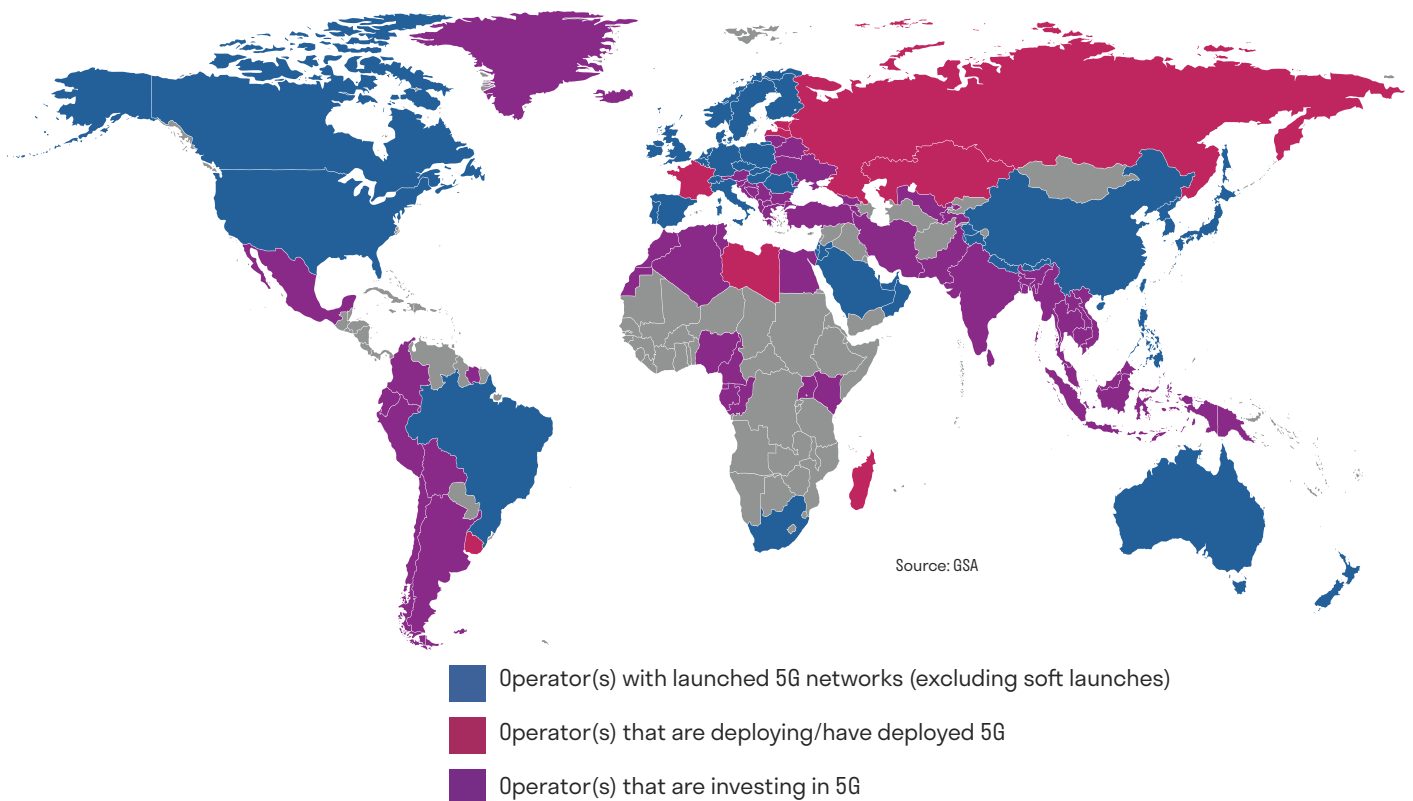
Deployment status

The GSA's Market Snapshot of August 2020 reports that there are now 92 commercial 5G networks operating in 38 countries demonstrating that there is now a large significant base of markets that have 5G coverage available for industries to exploit. In addition, more are set to roll-out 5G shortly, with 392 operators in 126 countries having announced they are investing in 5G at the end of July 2020.

Cellular industry organization, GSMA, reports that 7% of the world's population is currently covered and 5G will account for 20% of global connections by 2025. It's therefore abundantly clear that mobile operators are committed to the technology and businesses are recognising the benefits of 5G. For operators to sustain their multi-billion dollar investments in 5G infrastructure, IoT business cases will need to start emerging and high volume use cases are required to justify nationwide coverage.

To an extent, this is a chicken and egg situation. Without comprehensive, global coverage, 5G IoT applications, especially those involving moving devices, such as track and trace applications, won't be viable. While, without the revenues associated with a massive and vibrant 5G IoT market, the business case for 5G will be limited. It is, however, clear that operators across the world are committed to rolling out 5G – driven by the consumer market and the need by operators to be seen at the forefront of innovation and sufficient deployment has already been achieved in the leading countries, with many more countries still to roll-out 5G infrastructure.

Global 5G network deployment status

Source: GSA

- ■ Operator(s) with launched 5G networks (excluding soft launches)
- ■ Operator(s) that are deploying/have deployed 5G
- ■ Operator(s) that are investing in 5G

Why should organizations select 5G for IoT?

Many established IoT applications don't have requirements for the capabilities of 5G or simply don't have business cases that can justify the cost of 5G. For many IoT applications, the bandwidth offered by low power wide area networks (LPWAN), 3G and 4G/LTE is abundantly sufficient for their data transmission needs. However, with 2G cellular networks being retired and the substitution of 2G with narrowband-IoT (NB-IoT) becoming massive around the globe, the opportunity for 5G IoT is starting to crystallize.

5G's core benefits of high speed, low latency and connection density are well-known and, in essence, enable a paradigm shift in performance compared to alternatives, as detailed in Figure 1 below. To learn more about Quectel's leadership in 5G for IoT visit:

<LINK>

What are the differences between 4G and 5G?

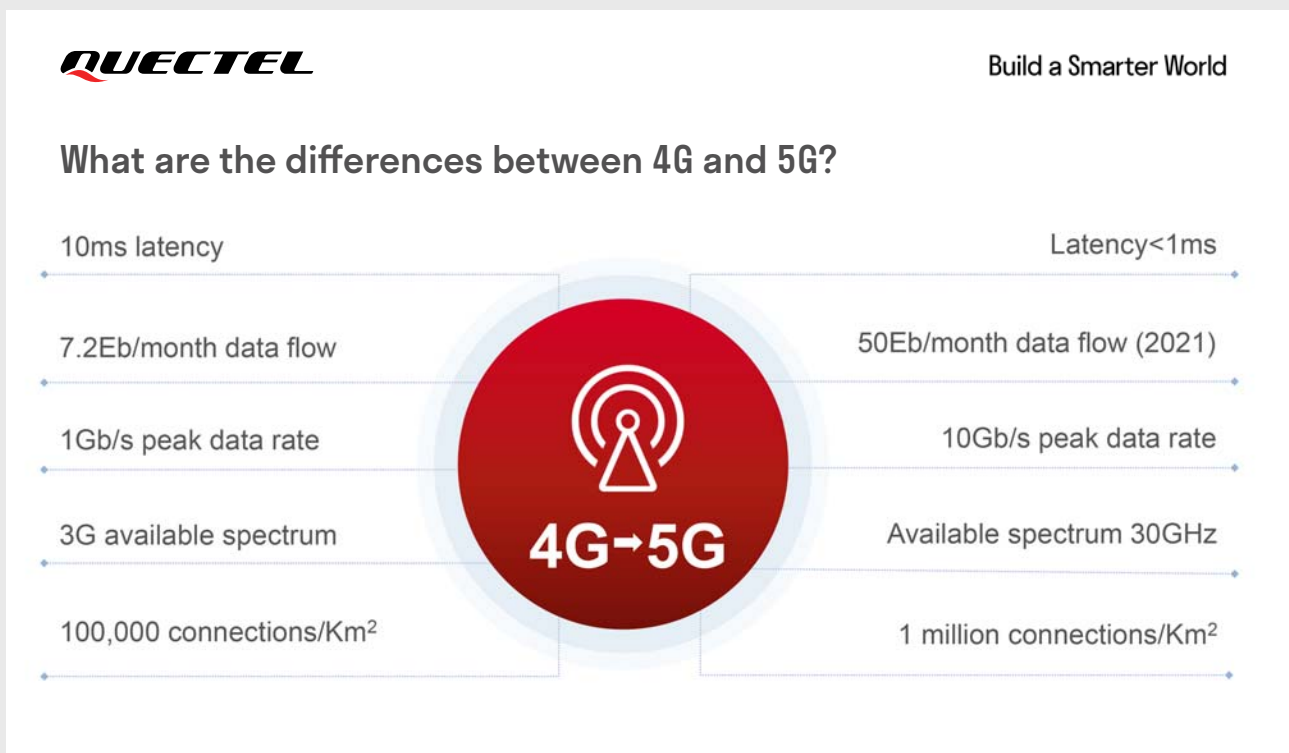| 4G	5G
10ms latency	Latency<1ms
7.2Eb/month data flow	50Eb/month data flow (2021)
1Gb/s peak data rate	10Gb/s peak data rate
3G available spectrum	Available spectrum 30GHz
100,000 connections/Km^2	1 million connections/Km^2

Figure 1: What are the differences between 4G and 5G?

Even the highest performance versions of LTE, such as LTE-Advanced and LTE-Advanced Pro, do not come close to the performance of 5G which truly brings in a step change in both data rate and low latency, demonstrated in Figure 2. This makes 5G the first cellular technology to be suitable for mission critical applications as well as media applications that are highly sensitive to latency.
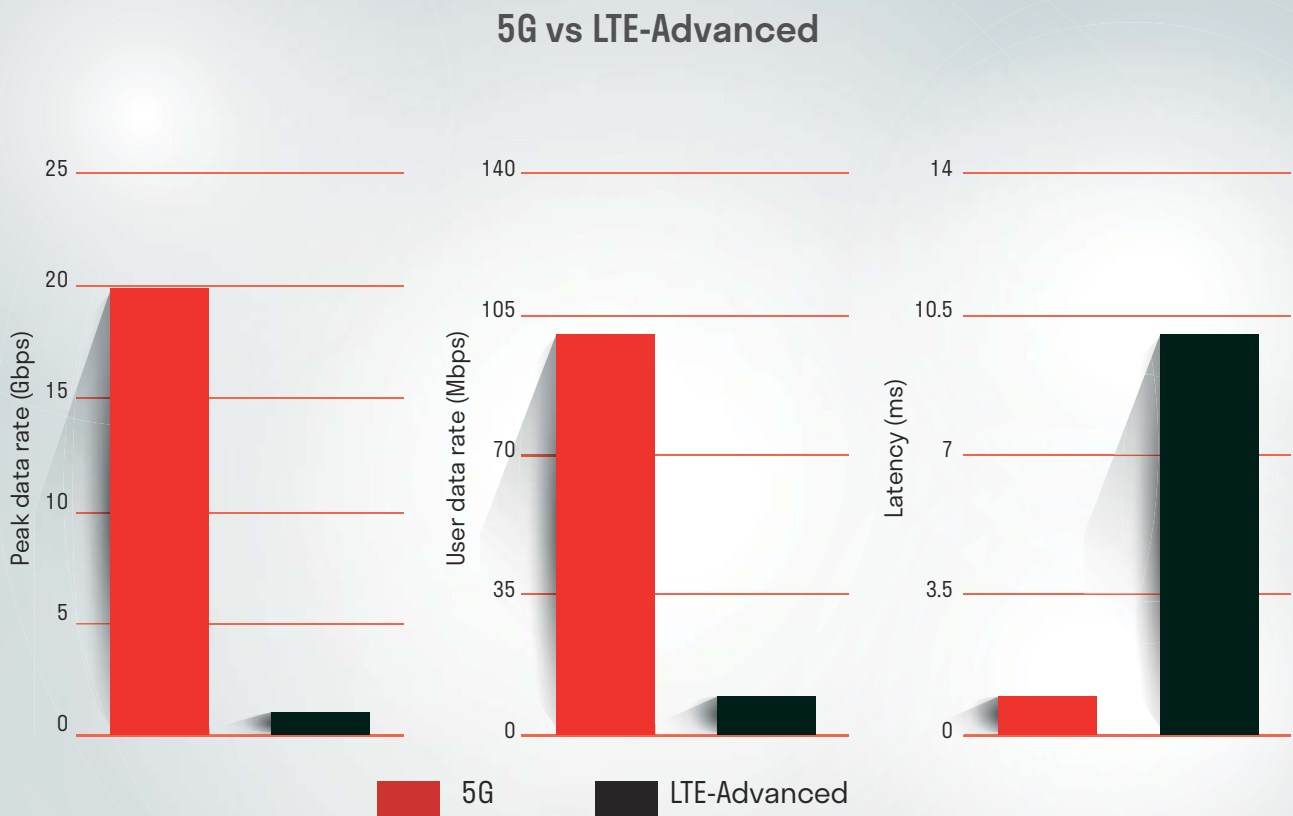
5G vs LTE-Advanced

Source: Android Authority

Figure 2: 5G compared to LTE-Advanced

This step change in performance is encouraging businesses to assess how they can harness the power of 5G in their operations and use cases are emerging that would have previously been either impossible or required non-cellular solutions.

5G functionality

5G functionality can be divided into three key areas of capability which are detailed below and illustrated in Figure 3:

eMBB

enhanced mobile broadband (eMBB) can be seen as an extension of the capabilities of 4G and it promises a better and seamless user experience by delivering faster data speeds and enabling greater coverage. eMBB has the capability to provide higher capacity in crowded situations and enhanced mobility coverage for commuters and others on the move. eMBB will also be used to enable fixed wireless access (FWA) for non-mobile users as part of wireless home broadband services. Across these two dimensions eMBB will provide the connectivity foundation for smart homes, video everywhere and virtual and augmented reality.

Mission-critical control

Mission critical applications are those that simply cannot fail. They require high security standards, ubiquitous coverage and a signal that supports ultra-reliable low-latency communication (URLLC). For emergency services URLLC provides the vital assurance that communication will be reliable and without delay. Mission critical applications include autonomous cars, remote medical surgery, robots and drones, and industrial automation.

Massive IoT

Massive IoT is called massive for a reason. It describes connecting tens of billions of devices that transmit data that is not sensitive to delay to the same extent as mission critical applications but still demands pervasive, reliable coverage. Massive IoT requires the deep coverage and density of 5G to support connected devices that have long battery lives and send low rates of data via machine type communications (MTC). Use cases include sensors in smart buildings, smart agriculture, smart cities and smart logistics.

Each of these functional areas enables a wide array of use cases, many of which have overlapping needs across the three, as set out in Figure 3. In the media industry, for example, there is a need for minimized latency, extreme data rates and deep coverage to reach challenging locations. While a connected sensor in an agricultural deployment might require the low energy, low complexity attributes of Massive IoT.
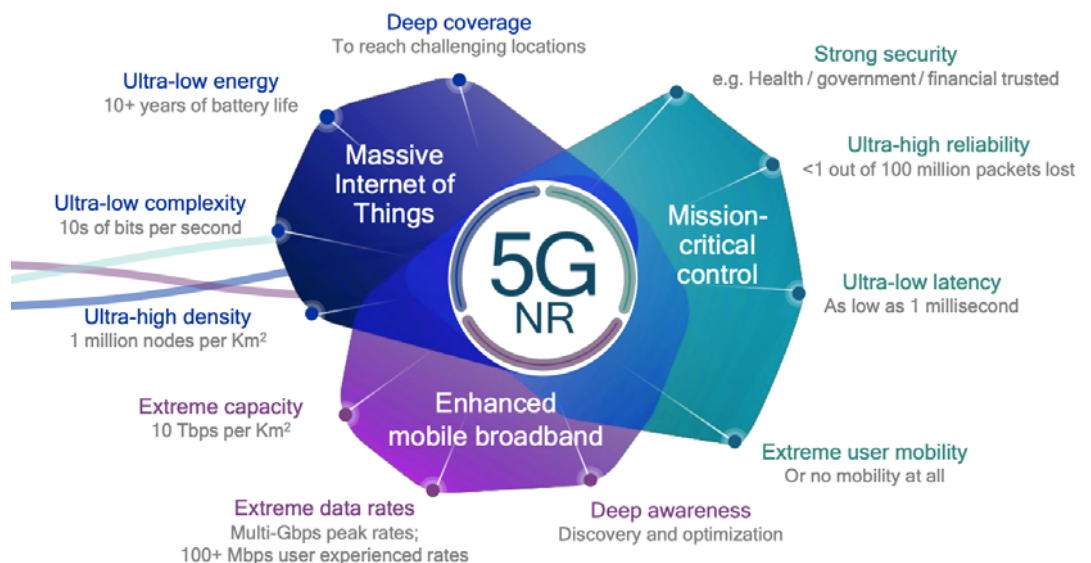

Figure 3: 5G provides ultimate scalability for different use cases

Source: Qualcomm - Making 5G NR a Reality, 2016

Private 5G: Beyond public infrastructure

A further consideration in deployment of 5G is its ability to be deployed as a private network. This enables organizations to connect all the machines in a manufacturing site with private 5G. All the advantages of 5G can be accessed with the added benefit of excellent security – because the network does not use public infrastructure and can be operated in isolation from the internet if required. In addition, private 5G puts enterprises in full control of their own networks, enabling them to manage production robots and other systems on their own infrastructure. Finally, private 5G has huge productivity advantages because its wireless characteristics mean greater flexibility can be enabled on the production floor because machines aren't wired into place and can therefore be speedily reconfigured, relocated or removed as required.

Barriers to 5G IoT adoption

Aside from the need for more countries to fully deploy 5G infrastructure, 5G in IoT needs more 5G-enabled devices to become available. Devices, enabled by 5G modules, need to be easily accessible and it needs to become simple to integrate 5G capabilities into devices. Leading developers and module makers are at the forefront of developments which are lowering the barriers to integrating 5G into IoT devices and enabling IoT applications with the power of 5G.

However, it is still early days for 5G and many applications simply do not need the capacity and low latency that 5G offers. As more 5G applications make it to the IoT market place, the technology is set to prove its value and there are specific application areas that are likely to lead the deployment of 5G in IoT which are detailed in the following section.

Six 5G IoT use cases - overview

To illustrate the variety of verticals and the wide spread of applications 5G can enable in IoT, we provide six examples of how the technology is being utilized, taking cases in which 5G is either strictly required by the application or a strong enabler of application performance. Figure 5 illustrates the use case landscape, highlighting emerging and already operational business cases for 5G in IoT.
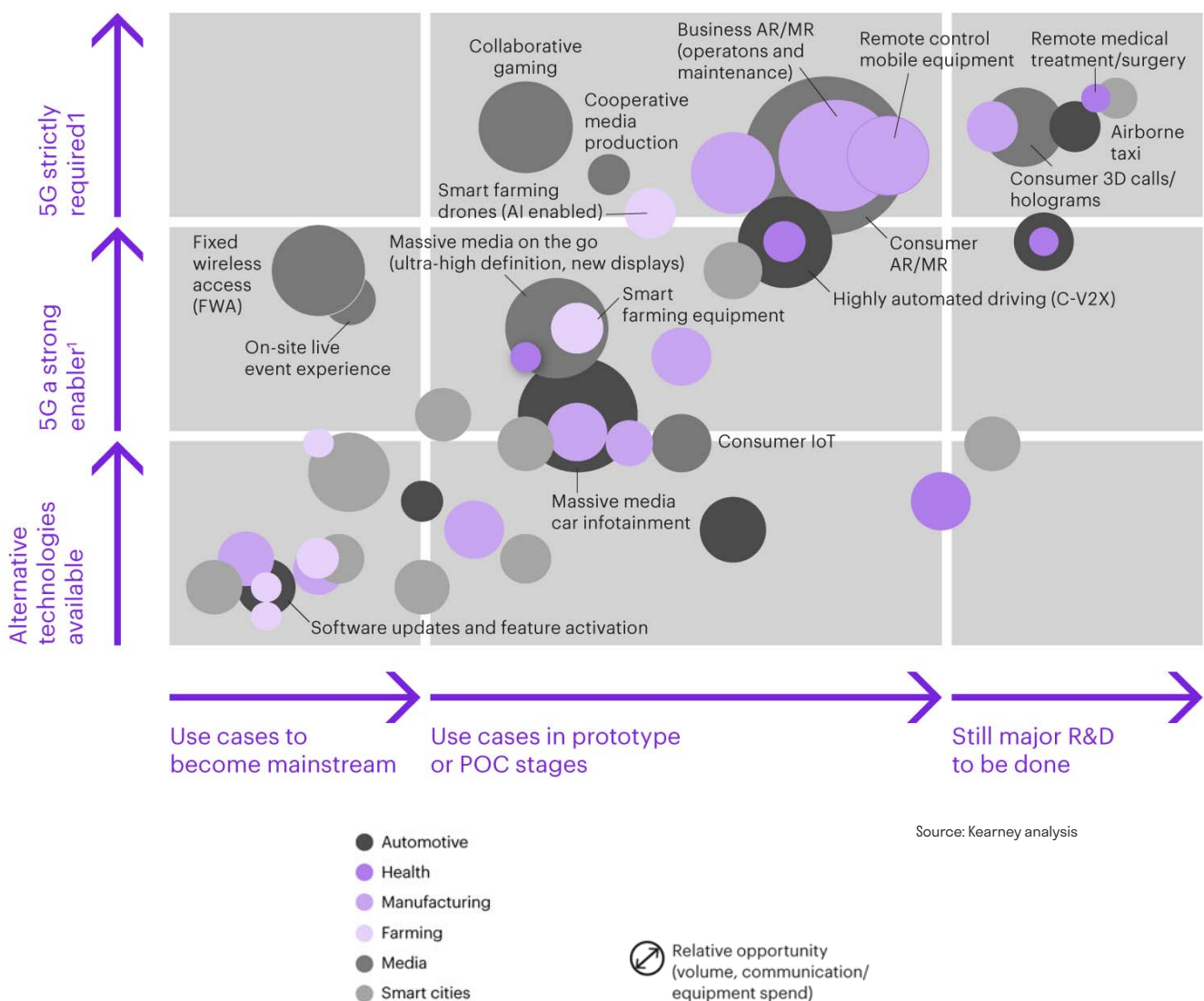
Figure 5G use cases

Figure 4: 5G use cases in IoT

Automotive

As shown towards the center of Figure 4, automotive use cases for 5G are largely in the prototype or proof of concept stage and are dependent on widespread global coverage. However, automotive OEMs are well-advanced in their considerations of how 5G will be utilized. OEMs want and need to show the latest state-of-the art technology and exploit the 5G capabilities in bandwidth, data-rate and latency on their premium vehicle lines to position themselves as innovation drivers and offer the best of services to their clients.

Modern vehicles are scanning their environment permanently with hundreds of sensors, which generates massive data that needs to be interpreted, shared and acted upon. Again, the low latency but also the bandwidth of 5G come in to solve the issue. Future iterations may see operatives being able to assume control of a vehicle if a driver has a heart attack so it can be brought to a stop safely. Applications of 5G in automotive are more likely to center around autonomous driving and encompass advanced driver assistance systems (ADAS) beyond ADAS Level 4. While the technological capabilities are progressing fast, the industry will need to see the legal prerequisites follow rapidly enough to create a reliable legal environment for cases in which the vehicle takes responsibility. Other connected vehicle applications such as tracking and tracing are well-served by LTE or LTE-Advanced networks today so the main driver for 5G will be the lower latency and the connection density 5G enables.

Low latency is clearly important for applications such as accident prevention or even the heart attack scenario detailed above, while connection density will be important to ensure robust connectivity in denser urban areas.

Use case example:

Trials are ongoing between tier one OEMs and specialist suppliers. Deployment of 5G telematics control units in vehicles is set to be pioneered next year by a tier one car maker and this will enable capabilities such as downloading of high definition (HD) maps in real-time, and V2X connectivity to deliver risk assessment and blind spot information. This is an early example of the rich functionality 5G will enable, ultimately for vehicles of all types.

In Zhengzhou, China, the 5G network and artificial intelligence (AI) systems are in trial operations in 5G autopilot buses. Functionality includes auto-parking and auto-charging when the bus needs to recharge its batteries, which improve the efficiency of bus station operations. In addition, the 5G connectivity is utilized to route the buses efficiently through traffic lights. Legislation currently mandates the continued presence of human drivers on buses but on the trial vehicles the drivers are present in a supporting role to handle emergencies or take over if the system asks them to. Further innovation being trialled in Zhengzhou involves small, automated, driverless shuttle buses that can be summoned to locations with one click of a button.

Health

The sensitive nature of healthcare makes the secure, resilient capabilities of 5G particularly attractive and, for many applications, there is a strong return on investment when you consider what 5G can enable. Examples include connected blood pressure cuffs, bed monitors, infusion pumps and monitoring of devices. Importantly 5G enables this to be achieved by patients without physical interaction with medical professionals, thereby saving time and money.

Healthcare professionals see three key 5G usage areas: in hospitals, in patients' homes and in remote locations. In hospitals, 5G enablement has similar benefits to a manufacturing environment in which 5G enables robots, eliminates wiring for medical devices and provides the ability to transmit large volumes of data for cloud processing. In patients' homes, 5G-enabled monitoring devices mean the patients do not need to connect the device, simplifying the process and keeping it more secure in addition to not requiring patients to have connectivity.

The final category of remote applications may still be a little way off. Utilizing virtual and augmented reality to enable non-experts to perform medical procedures will be possible with 5G, which can provide extremely detailed information, with minimal latency in a secure, robust environment.

Use case example:

In the UK, a remote-controlled ultrasound scan has been demonstrated over a 5G network. 5G has enabled clinicians to remotely diagnose a patient, view medical records, and sign ultrasounds. Wearing a specially equipped VR headset, the clinician is able to visualize exactly what the paramedic sees in an ambulance remote from the hospital. Using a joystick, the clinician can then remotely direct the paramedic in real-time to perform necessary scans, as well as get close-up footage of the wounds and injuries of a patient.

Manufacturing

In the industrial sector 5G is being adopted for connecting industrial robots with various degrees of mobility. These robots range from static robots that are positioned to form tasks on production lines to fully mobile robots such as autonomous guided vehicles (AGVs). Industrial robots have many sensors to enable them to accurately perform tasks and move safely through production environments to deliver goods or carry out repairs. They therefore need the ability to process data in real-time.

5G, with its low latency and high reliability, enables part of this processing requirement to be offloaded to edge computing resources or cloud-based servers, thereby minimizing on-board processing in the robot itself. This makes the robot simpler to design, more cost-effective and easier to maintain.

Use case example:

A German car maker has deployed a 5G system is already live in a real factory environment and plans are now underway to introduce 5G URLLC capabilities to the existing system for advanced factory automation and personnel safety use cases. A key benefit to the car maker is 5G's availability and low latency, both of which are critical in fast moving factory environments.

In addition, a wireless solution means the manufacturer can eliminate wires in automated factories, while being assured that the low latency, mission critical capabilities of 5G provide the same levels of resilience and robustness to ensure worker safety and uninterrupted productivity.
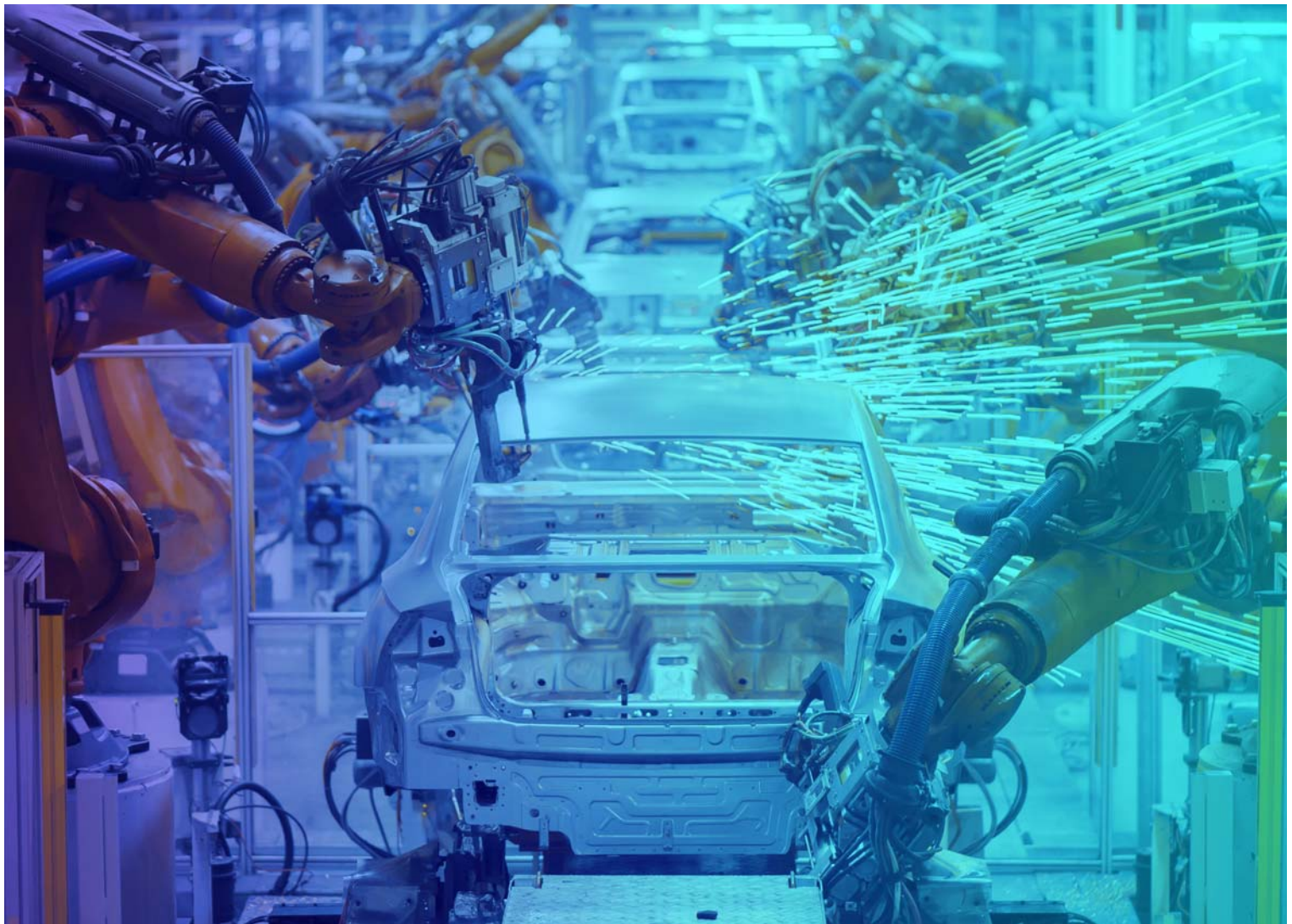
Farming

There is huge potential in agricultural IoT applications. These range from basic soil sensors that can be served by LPWANs or NB-IoT to higher value applications such as monitoring the fertility of livestock. The scope for 5G is substantial in this industry with many variables to crop-growing such as weather, fertilization and soil acidity all needing to be monitored and managed. In addition, for livestock farmers, tracking and tracing of herds enables them to ensure higher milk yields, boost stock health and increase yields.

Applications that require the low latency, connection density and high bandwidth of 5G are starting to emerge. These range from monitoring of pregnant livestock to robot-enabled crop irrigation with complex networks of sensors and actuators to ensure maximized performance. Smart, 5G-enabled drones are also being trialled which can cover large areas of agricultural land and gather important data to aid efficiency.

Use case example:

In The Netherlands, for example, one project has seen development of a 5G-enabled IoT system to automate and optimize the elimination of unwanted potato plants from fields of sugar beet. The project utilizes 5G robots, deep learning and a cloud-based edge computing solution to identify and destroy problematic potato plants. The project is currently achieving 95% accuracy and is able to cover one-third of a hectare per hour, far exceeding the speed of manual workers performing the same task.

Media

The low latency and huge uplink capacity of 5G will aid the development of video-based applications and stimulate the creation and uploading of professional-quality content from mobile devices. The media industry has obvious needs for stable, reliable, high resolution video images and typically requires a minimum of four-times the bandwidth offered by a 4G cellular connection.

In addition, media organizations have been constrained in their content creation by having to access satellites to enable content to be uploaded. Satellite communication can be affected by adverse weather conditions and connectivity can be costly. Media organizations therefore need easy-to-use, portable transmitters that can acquire, process and transmit content in a single device. Devices can be lightweight and therefore there is less need for satellite-equipped news gathering vehicles or large groups of staff that, in extreme environments, have put journalists and their crews at risk. 5G-enabled devices can be carried and operated by a single person, thereby minimizing risks but still enabling high quality content to be broadcast. This type of broadcast technology is also applicable to the emergency services who can utilize high quality, low latency video capabilities to understand the situation on the ground in, for example, large-scale natural disasters or for firefighting.

Use case example:

One cloud-based live video solutions specialist has used 5G, to help a news agency customer to broadcast live from Mount Qomolangma, utilizing the world's highest 5G tower. The tower, located at the mountain's advance base camp at an elevation of 6,500 meters, covers the north side of Mount Qomolangma, including its peak and was completed in April 2020. The 5G connectivity was used by the news agency, which has chosen a portable transmitter powered by Quectel's 5G modules, to broadcast live footage of the re-measurement of the mountain earlier this year.

Smart cities

5G's enhanced capabilities make it ideal for the real-time management and automation of smart cities. Solutions aimed at optimizing operations and maintenance by quickly detecting and responding to faults are a key smart city application and go beyond more basic applications such as tracking public transport which can readily be served by LTE. These mission critical smart city applications include ensuring utilities are operating efficiently and responding to rapidly developing situations, such as emergencies or handling large crowds.

The mission critical capabilities of 5G are vital here along with the low latency to ensure there is no delay in the transmission of information. In addition, with devices deployed throughout the smart city, it is a benefit to have the increased connection density of 5G available, which enables thousands of devices to connect to a 5G cell. Finally, the ability to use the increased bandwidth offered by 5G means devices can transmit large volumes of data for centralized cloud server processing, thereby negating the need to invest in costly processing capability in every device.

Use case example:

As power grids are upgraded to automate operations with new sensors and control systems and integrate renewable energy sources and electric vehicle charging stations, 5G is being adopted thanks to its higher deployment flexibility and lower cost compared to wired alternatives, while offering a similar level of performance. One deployment in Finland has demonstrated how URLLC technology can be applied to protection applications in medium-voltage distribution networks. In these networks, it's vital that severe faults are cleared immediately to keep the distribution network running, guaranteeing the safety of personnel and avoiding damage to equipment.
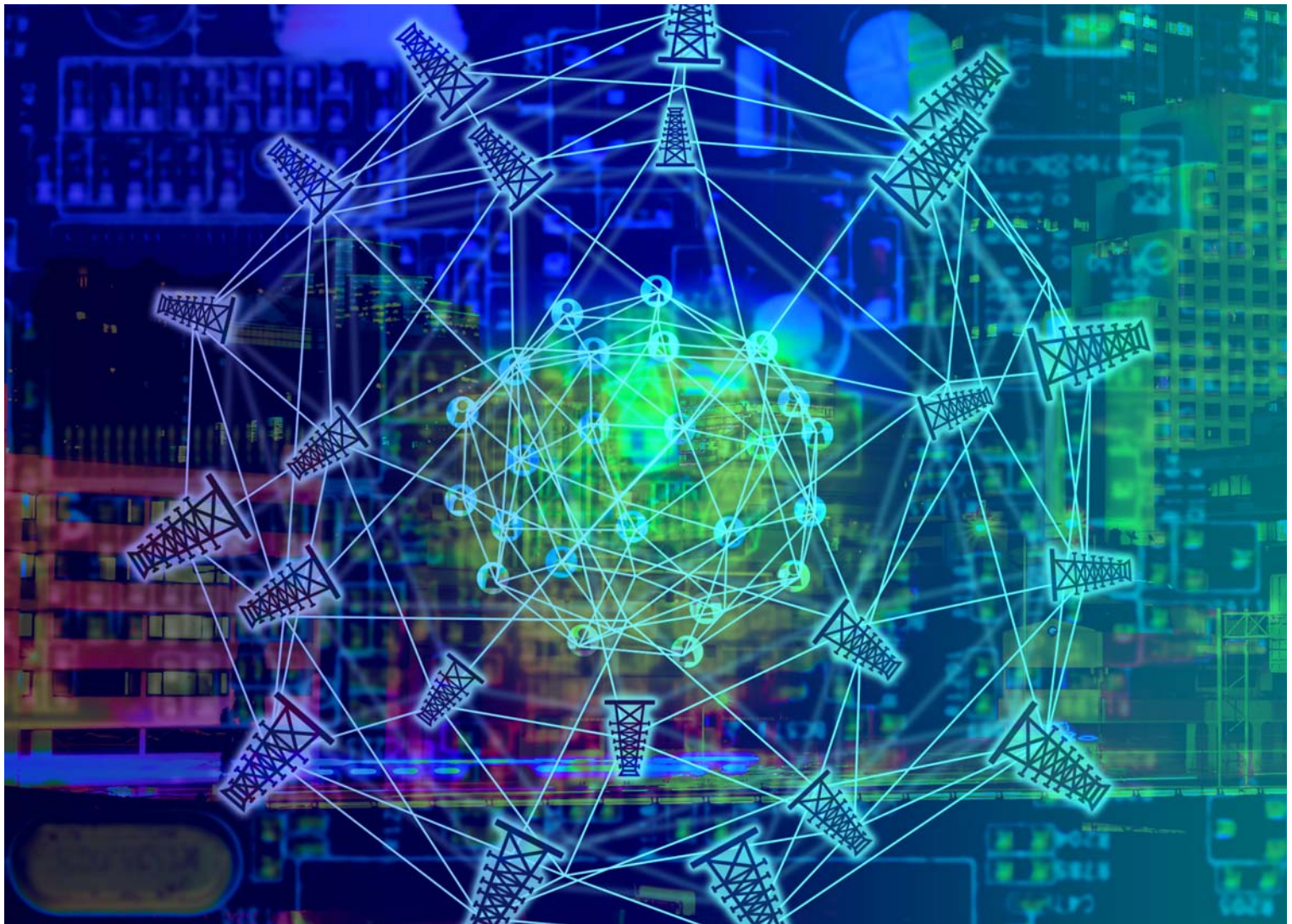
Quectel's 5G solutions

Quectel has been at the forefront of 5G module development, having designed the first ever 5G module and now has more than 1,000 design-in customers for its 5G modules. Quectel offers a portfolio of 5G module families. In the Sub-6 GHZ category, it offers the RG500Q and RM500Q family. While, in the mmWave plus Sub-6GHz category, it offers the RG510Q and RM510Q module family.

Quectel's head start in 5G means its modules contain the most advanced features and capabilities on the market. For example, the 5G modules include powerful algorithms for edge computing and storage, utilizing Cortex-A7 up to 1.5GHz as the primary boot processor, a powerful digital signal processor (DSP) up to 1.5GHz as well as including support for low-power double data rate 4X (LPDDR4X) memory at 1.8GHz. These capabilities ensure customers' devices have the processing power they need to create and broadcast high quality video content.

Its experience and heritage has also enabled Quectel to integrate up to 18 interfaces into its 5G modules, making them suitable for the widest variety of application scenarios. These include support for extended application processors, sensors, memory, Wi-Fi, Bluetooth, GNSS and Ethernet in addition to interfaces including: USB 3.1, PCIe, RGMII, PCM/12S, 12C, SPI, GPIO, SDIO, SIM, PWM and others. This gives media device makers the widest possible range of options to support the requirements and preferences of broadcast customers across the globe.

In addition, all IoT deployments demand robust security capabilities so Quectel's 5G modules feature secure boot, a secure file system and a secure execution environment as an integral foundation. For new media organizations, all the capabilities outlined above are vital for inclusion in 5G module-enabled cameras, televisions and set top boxes.

Conclusion

After many years of development and preparation, trials and testing, 5G is now becoming a reality and is beginning to show its strength across many different industries. The 5G attributes of eMBB, URLLC and Massive IoT are poised to transform businesses across multiple verticals and, in future, enable a new era of virtual, augmented and mixed reality. 5G modules are vital enablers of all this potential and Quectel is ready to provide its experience, the longest in the 5G module market, to device developers to drive forward innovations in this rich and exciting area.

For more information about how Quectel's modules can make your 5G IoT deployment a reality, contact us today.