5G Connected Cars: A Transformative Value Proposition

01 December 2021

Report Snapshot

5G connectivity is rewriting the rules of vehicle value creation and preservation. In the process, 5G is rejuvenating an automotive industry emerging from the COVID-19 pandemic and waning chip shortages.

Contents

1. Foreword

5G is no longer the next big thing in the automotive space. It has arrived and is shaping the future of connected cars, benefiting both consumers and automakers.

For drivers, it will mean a safer and more enjoyable driving experience. Thanks to new 5G technology developed specifically for automotive applications – such as the introduction of vehicle to everything (V2X) communications – road safety is being vastly improved. 5G's enhanced data rates will also enrich the driving experience, with consumers looking for cars that keep pace with other parts of their digital lives. Drivers want more than just a vehicle that gets them from A to B, and 5G will enable that.

For automakers, it will unlock new revenue streams, create a closer connection to their customers, and allow them to stay ahead of their competitors as the automotive industry increases its focus on mobility rather than machines. As this paper highlights, 5G connectivity is rewriting the rules of vehicle value creation and preservation. For automakers who tap into this opportunity, the potential rewards are clear.

5G – along with autonomous driving and electrification – is among the most exciting technological innovations for vehicles in decades. As this paper demonstrates, 5G is becoming part of the fabric of the automotive industry in both the fore and the aftermarkets – and this is only set to increase.

That's why we've launched our Avanci 5G Auto Licensing Program, bringing together automakers and patent owners to efficiently tap into this unique opportunity, as the automotive and telecommunications industries collaborate on wireless for the first time. As an independent marketplace for licensors and licensees, we want to make sharing the technologies for 5G efficient and simple for all parties, allowing our partners to focus on making the potential of 5G real for consumers.

We hope this paper, authored by experts from Strategy Analytics, offers a useful insight into the evolution of the 5G connected car and its value to automakers and consumers alike. 5G connected vehicles will be part of the fabric of multi-modal transportation networks and smart cities – safer, cleaner, and faster. The future is certainly exciting!

Kasim Alfalahi, Founder and CEO of Avanci
www.avanci.com

2. Executive Summary

Strategy Analytics has been interviewing executives in the automotive supply chain and eco-system since the onset of 5G. These conversations have included auto makers, wireless carriers, semiconductor companies, service providers, Tier 1 suppliers, regulators, and standards setting bodies.

From the earliest of these conversations it has been clear that the transition from 4G/LTE technology to 5G will be unlike any prior wireless changeover – i.e. 2G to 3G or 3G to LTE. For the first time, auto makers are facing an industry transformation touching all aspects of vehicle development and sales, and car ownership.

This report comprises the insights gleaned from those many conversations. Step by step, auto makers, wireless carriers, and their partners have described their plans to use 5G to reshape customer relationships impacting the factory floor, safety, infotainment, financing, and the corporate bottom line.

This report captures the collective sentiments and insights derived from those conversations. Here we dig into the industry vision for a market remade by enhanced wireless technology bringing greater speed and capacity and entirely new applications.

3. The Importance of Vehicle Connectivity

5G is fundamentally altering the economics of the auto industry.

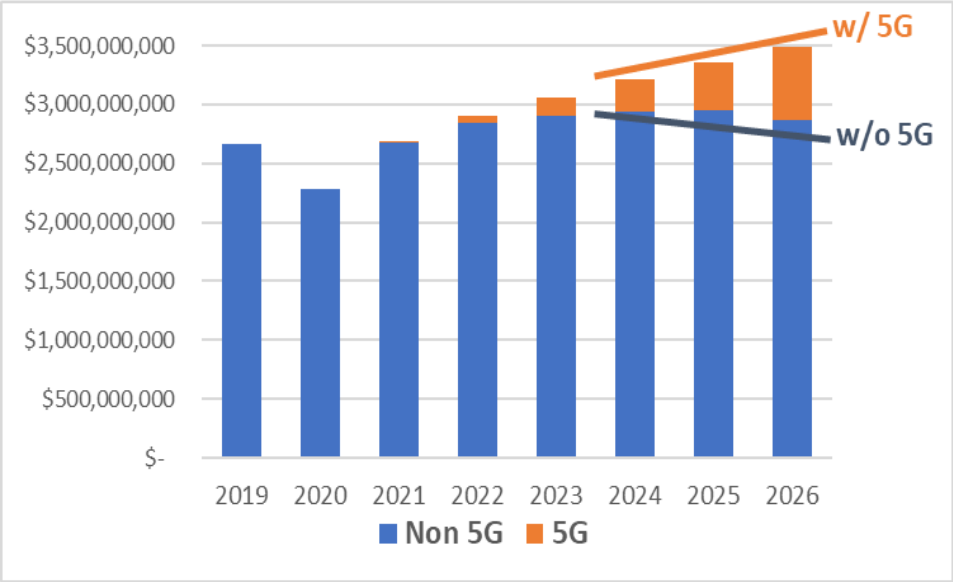
After more than two decades of innovation towards connected cars, the automotive and telecommunications industries are collaborating on wireless network standards for the first time with 5G. This activity began in the 5G Automotive Association and is ongoing. There is good reason for this collaboration. Wireless technology is both fundamentally altering the economics of the automotive industry and aligning it with the broader digitalization objectives of governments around the world.

5G connectivity will allow automakers to preserve or enhance the value of vehicles post-sale in a manner that will alter the calculation of residual vehicle

values, which in turn will influence the economics of leasing and the market value of both new and used cars. At the same time, 5G connectivity will directly assist and support the development and deployment of advanced driver assist systems capable of avoiding collisions while facilitating autonomous and semi-autonomous driving.

Across the world 5G technology is being built into specific driving corridors to support safer driving, while simultaneously being implemented in private factory networks to speed vehicle production. By transforming transportation infrastructure, enabling advances in car production, and altering the way vehicles interact with the built environment, 5G is becoming part of the fabric of the automotive industry in both the fore market and the aftermarket. Indeed, with 18 global automakers committed to deployment as of the date of this paper, prospects are bright for 5G to transform vehicle connectivity.

Figure 1: Global OEM Car Revenues

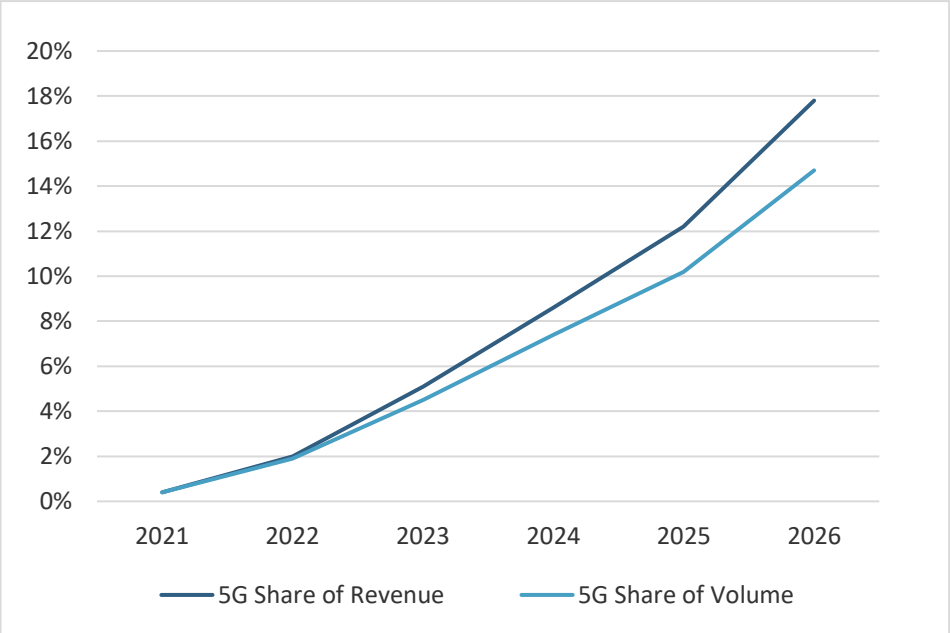


Source: Strategy Analytics

5G connected cars will capture an increasing share of unit volume with an even faster capture of sales revenue.

As this roll out occurs, 5G connected cars will capture an increasing share of unit volume with an even faster capture of sales revenue. Automakers are expected to roll out 5G in premium vehicles this year, before swiftly making it the norm in worldwide markets.

Figure 2: 5G Cars Share of Volumes & Revenues



Source: Strategy Analytics

5G connected cars will capture an increasing share of unit volume, with an even faster capture of sales revenue.

4. The Evolution of the 5G Connected Car

4.1 The Connected Car of the Future is Almost Here

The evolution of connected cars began more than 25 years ago with General Motors' Project Beacon, which merged in the marketplace as OnStar. That reactive connectivity solution – capable of summoning emergency responders to the scenes of crashes – has since morphed into a software updating and data collection tool with a far greater value proposition.

It is no longer enough to track cars or detect when they have been stolen or anticipate the failure of on-board systems. The connected car of the future – infused with 5G connectivity – is intended to leverage massive data collection and processing in the form of machine learning and artificial intelligence to make driving safer and more pleasing thanks, in part, to edge computing.

5G connected cars will be better able to avoid collisions, locate available charging stations, calculate route efficiency, and fuel consumption, and assess the vigilance of the driver in real-time with embedded predictive models supported by off-board resources. The 5G connected car of the very near future

The connected car of the very near future will interact with cloud resources, infrastructure, and other vehicles – all in the interest of enhancing safety, reducing emissions, saving time and fuel.

will interact with cloud resources, infrastructure, and other vehicles – all in the interest of enhancing safety, reducing emissions, and saving time and fuel.

4.2 The Core Features of 5G Connectivity

Compared to 4G LTE, 5G New Radio (5G NR) delivers higher connection speeds, much lower latency, and the ability to connect a much larger number of devices in a given area. 5G delivers an upgrade to the radio network and, in the latest release, an upgrade to a cloud-native core network, providing a better experience to users and a more flexible, simple, and secure network for operators.

High data throughput and low latency are the hallmarks of 5G connectivity.

5G is being deployed globally to meet a wide range of use cases, delivering different network characteristics in different spectrum bands. In millimetre wave spectrum (over 24 GHz) the large amounts of bandwidth available are enabling gigabit-per-second ultra-broadband experiences over short distances. In mid-band spectrum (1-6 GHz, and, in particular, the widely used 3.5 GHz '5G' band) many operators are already delivering 300-600 Mbps enhanced mobile broadband experiences over much larger distances. And in low-band spectrum (below 1 GHz), the 600/700 MHz band is being opened up in many markets for 5G, delivering wider network coverage at lower speeds and providing a critical connectivity layer for many IoT applications.

This high data throughput is especially important for connected cars, which are increasingly defined by the millions of lines of software code and the proliferation of sensors generating terabytes of data. The challenge of managing this code and data has led to the introduction of higher speed in-vehicle processors as well as automotive grade on-board Ethernet networks. With 5G, data can be collected, exchanged, and processed at a volume and speed in the car that is on par with the speed and volume of data exchange outside the vehicle.

The high data throughput of 5G is especially important for connected cars, which are increasingly defined by the millions of lines of software code and sensors generating terabytes of data.

The low latency of 5G is also transformative for the connected car. The low latency, combined with the increased capacity, of new 5G networks create what will come to be seen as a "sentient" network – a prospect already being embraced by wireless carriers that are putting in place the infrastructure necessary to support intelligent driving solutions.

For low-latency applications, multi-access edge computing (MEC) in particular, is expected to transform the quality and availability of high-definition map data, intelligent driving support, vehicle quality control and life-cycle management, and location-based services. Among the technology enablers for 5G, multi-access edge computing is key. MEC is a cloud environment located at the edge of the network in proximity to the end users and coupled with the service provider's network infrastructure.

MEC is expected to transform the quality and availability of key service aspects including HD map data and intelligent driving support.

MEC is especially relevant to automotive safety applications where vehicles can be alerted to pedestrians, lane or road closures, or other hazards in real time via sensors and data collected at the network's edge. MEC functionality will become available even before 5G as current mobile networks already support this capability – but 5G's low latency is best suited to take full advantage. MEC is the main reason that 5G will introduce an entirely new connectivity experience for drivers.

5G's low latency is best suited to take full advantage of this functionality.

Additionally, the introduction of the PC5 interface with 3GPP LTE Release 14 has enabled vehicle-to-vehicle (V2V) communications as well as V2P (vehicle-to-pedestrian) and V2I (vehicle-to-infrastructure) applications for avoiding vulnerable road users (workers, pedestrians, and the like). While the realization of the full scope of these capabilities will require wider LTE Advanced and 5G deployment in both vehicles and infrastructure, some scenarios will deliver immediate value in the form of directly communicated road hazard alerts, dynamic speed limit updates, traffic warnings, and vehicle guidance.

Some scenarios of 5G deployment will deliver immediate value.

5G also provides for an automotive-centric form of quality of service (QoS). Vehicles connecting to 5G networks in the future will be equipped with predictive QoS capable of determining – in real-time – whether network access will be functional at a particular time and in certain circumstances and how that impacts the functioning of connectivity-dependent safety systems.

5G standards provide for an automotive-centric form of quality of service.

4.3 Key Use Case Categories Enabled by 5G

On a technical note, 5G NR supports use cases falling into three broad categories, each applicable to various scenarios for automotive connectivity:

- **eMBB** (enhanced Mobile Broadband) supports bandwidth-intensive use cases across a wide coverage area. 5G NR can support high mobility (over 500 km/h) and gigabit-per-second data rates, suitable for a broad range of

data-intensive automotive applications. Initial 5G network deployments have focused on eMBB 'capacity' improvements, being based on non-standalone (NSA) technology that adds 5G radio to existing 4G network infrastructure, in particular the 4G core network. The introduction of Standalone (SA) 5G involves the deployment of a 5G core network, which opens up 5G to the next two use case categories.

- **URLLC** (Ultra Reliable Low Latency Communications) supports mission critical and time-sensitive use cases. Low latency and high reliability are crucial for faster cloud access and processing, with target performance of 1 millisecond latency and 99.9999% reliability. This enables advanced use cases that are neither tolerant of transmission delay nor of dropped packets, ranging from remote surgery to robotics or factory automation, and autonomous transportation or remote driving.

- **mMTC** (massive Machine Type Communications) provides connectivity to a large number of devices with requirements for intermittent transmission of moderate amounts of data at lower data rates. Target performance is support for one million devices per square kilometer, data rates of 1-100 Kbps, and low power consumption that would allow sensors and Internet of Things (IoT) devices to operate with a battery life of up to ten years. mMTC will support dense sensor networks and low-cost IoT use cases and will be a key building block of smart city deployments.

4.4 New 5G Momentum in the Automotive Industry

In the past, wireless carriers and automakers worked warily with one another, warring over the cost of wireless service and the unreliability of network access. The onset of 5G finds the automotive industry actively considering the ways that 5G technology can be leveraged to improve operations, improve profitability, enhance driving safety, and increase customer retention. Each of these propositions represent significant multi-billion-dollar value propositions for auto makers, while also promising safer, cleaner, and more efficient roadway operations for the public.

Figure 3: Types of 5G Value for Automotive Stakeholders

Stakeholder	Annual Value	Lifetime Value	Value Type
Car Maker	$500 / car	$7,500	Warranty cost avoidance
Consumer	$400 / car	$6,000	Lease, loan, and insurance savings
Dealer	$300 / car	$5,000	Higher sale price, higher residual value

Source: Strategy Analytics

Intensified interest in 5G connectivity has been fuelled by moves at the United Nations Economic Commission for Europe (UNECE) and raised safety expectations within the European New Car Assessment Program (Euro-NCAP). The UNECE's WP.29 regulations require cybersecurity measures and software updates, both enabled and enhanced by 5G technology. Euro-NCAP, meanwhile, is pushing safety-centric solutions, such as Intelligent Speed Assistance, that will rely on vehicle connections.

Another driving factor is the widespread recognition by car makers of the core advantages of 5G connectivity discussed earlier: low latency, greater throughput, and higher capacity. Perhaps the greatest value proposition of all correlated to 5G, though, is the preservation and enhancement of vehicle value. 5G connected cars will come equipped with the most sophisticated sensor and diagnostic systems, enhanced processing and storage capacity, and faster on-board networks. These advances make a car that is more "intelligent," with built-in artificial intelligence and cloud access that enable it to update and evolve the capability of on-board systems. This intelligence sets the stage for a car company to add value to a 5G connected car post-sale, via over-the-air updates driven by the aggregation of insights gleaned from thousands of similarly networked vehicles.

Perhaps the greatest 5G value proposition is the preservation and post-sale enhancement of vehicle value.

Figure 4: OTA – Over-the-Air Updates

Source: T-Systems

Because 5G connected cars will better preserve their value (and can be enhanced with additional value post-sale), they will be more attractive resale and leasing candidates than their non-connected counterparts. The preservation of residual value will help offset the increased cost to the owner of built-in hardware and software – more sensors, more powerful processors, faster on-board networks.

Finally, because of the potential for automakers to stay in close contact with their customers long after the car is purchased, 5G connected cars will enable automakers to better capture service and vehicle repair and replacement opportunities. This opportunity, together with the foregoing value propositions, have the potential to contribute billions of dollars to the bottom lines of automakers and their dealers, and to keep drivers safer and more satisfied with their driving experience.

5G value propositions will contribute billions of dollars to the bottom lines of automakers.

Underlying all of these applications is the timely and optimized collection and exchange of data between vehicles and cloud resources. More than ever car makers and service providers will put vehicle data to work to enhance driving safety and improve customer retention.

4.5 Recent Regulations Require Vehicle Connectivity

The WP.29 guidelines released by the United Nations Economic Commission for Europe (UNECE) in 2020 include new regulations regarding over-the-air software updates and cybersecurity. This move cemented the essential importance of vehicle connectivity already established by the European Commission's eCall mandate, now in effect.

5G is essential for managing on board software and for preserving hardware and software integrity.

In the EU, new regulations for cybersecurity will be mandatory for all new vehicle types from July 2022 and will become mandatory for all new vehicles produced from July 2024. This makes wireless connectivity necessary not only for emergency response, but also for managing the on-board software and for preserving hardware and software integrity in a car.

In concert with this shift, connectivity is an implied requirement to fulfil the Intelligent Speed Assistant roadmap element of Euro-NCAP, which requires real-time communication of speed limit changes and is set to take effect also in 2024. And this is only one of many safety-related applications that will become regulatory requirements implicating connectivity. Such regulations are a turning point for car connectivity, as it becomes an essential aspect of vehicle safety systems, benefiting from real-time contextual inputs. In other words, wireless connectivity has evolved from a nice-to-have reactive tool, to an essential pro-active driving companion. This is precisely the role anticipated for 5G.

Connectivity has evolved from a nice-to-have reactive tool, to an essential pro-active driving companion – this is precisely the role anticipated for 5G.

4.6 5G-Enabled Network Slicing Creates a New Paradigm for the Automotive Industry

Most 5G networks today are Non-Standalone Architecture (NSA). The evolution to Standalone Architecture (SA) 5G networks requires deployment of a 5G core network, which can then offer all the control, and 5G can operate in complete isolation of 4G core/radio availability. The main benefits of 5G SA are:

- MUCH simpler network architecture;
- Significant decrease in latency; and
- All the more advanced 5G features beyond basic 'much faster' broadband experiences being touted today.

The evolution to standalone 5G core networks, already underway in 2021 in a small but growing number of 5G deployments, creates an opportunity to further transform vehicle connectivity through network slicing. Network slicing enables virtualized and independent logical networks on a common physical network infrastructure and will bring out the best of 5G in terms of enabling one network to serve the targeted demands of many different use cases efficiently and reliably. Dynamic network slicing will provide flexibility, agility, and ease of use to support a wide range of service requirements cost effectively, so that network operators can move beyond 'one size fits all' to right-sized services structured for specific value propositions.

Network slicing brings out the best of 5G by enabling one network to better serve the targeted demands of many different use cases – such as automotive.

At a high level, network slicing allows operators to commit network performance and functionality, such as volume, capacity, and latency, to individual slices and isolate these from each other. Slices can then be optimized for different use cases and any degradation in performance in one slice (for example, due to a sudden spike in traffic) will not impact the performance in other slices. This isolation of slices allows for Service Level Agreements (SLAs) to be attached to performance parameters within each slice, moving beyond the best-efforts basis of mobile services to date.

Network slicing also supports wholesale business models.

From an automaker's perspective, services to the car will reside in multiple slices with mission-critical services for connected cars in a separate slice to in-car entertainment services or remote diagnostics and management. An individual device/terminal can support multiple slices simultaneously, with slices activated based on the requirements of the application, not the device. In discussions with mobile operators, there is also a role for network slicing in supporting wholesale business models, so the potential for Mobile Virtual Network Operators (MVNOs) with specific automotive expertise to have wholesale 'ownership' of slices dedicated for their own customers.

5. The Value of 5G in a Connected Car

5.1 New Applications

The introduction of 5G will make seamless connectivity a reality, such that we can enjoy continuous service not only at home, but while on the road in a connected car. The applications enabled by 5G on a smartphone can and will be extended to connected cars, and the smartphone will interact with the vehicle. There is a broad range of new applications specific to vehicles that will

be enabled by 5G technology. The first wave of applications will be safety centric and focused on collision avoidance and some interactions with infrastructure such as traffic lights. The introduction of MEC functionality with 5G brings along yet another layer of applications that also bear on assisted driving and safety including, for example, (a) real-time situational awareness and high-definition maps for the detection and communication of road hazards; (b) "see through" access to the front facing video of the vehicle being passed; (c) cooperation lane changing (communication between vehicles of the intent to pass); and (d) vulnerable road user discovery for the detection of emergency and roadside workers, pedestrians, and cyclists near or in the roadway.

5.2 Quality of Service Issue Finally Resolved

Perhaps one of the most notable characteristics of 5G intelligent networks will be predictive quality of service (QoS). The very issue about which automakers have long complained may finally be resolved by the capabilities of the 5G network itself. Without getting into too many details, predictive QoS is part of the 5G standard and is intended to anticipate multiple network performance levels in advance. This process, designed into the network and into devices operating on the network, accounts for such network elements as latency (ms), reliability (%), packet delivery ratio (%), data rate (Mbps) and UP connection (active/inactive) and can be applied to various applications according to specified performance thresholds.

Perhaps one of the most notable characteristics of 5G networks will be predictive QoS – a solution to an issue OEMs have long complained about.

This means that a 5G connected car running a variety of applications simultaneously with different connectivity requirements could be programmed to respond to predicted network limitations related to time of day, weather, volume of traffic, or geography. Typical application examples might include tele-operated driving, high-density platooning, hazardous location warning, lane merge, software update, or streaming content.

Predictive QoS is just one example of how the capability for anticipating and adapting to varying levels of connection quality will differentiate the 5G driving experience from the early reactive solution of GM's OnStar system. Rather than simply reacting, a 5G connected car will make proactive connections associated with LTE supporting applications such as predictive maintenance and service scheduling. This can be described as a Telematics 3.0 experience – capable of infusing the network itself with

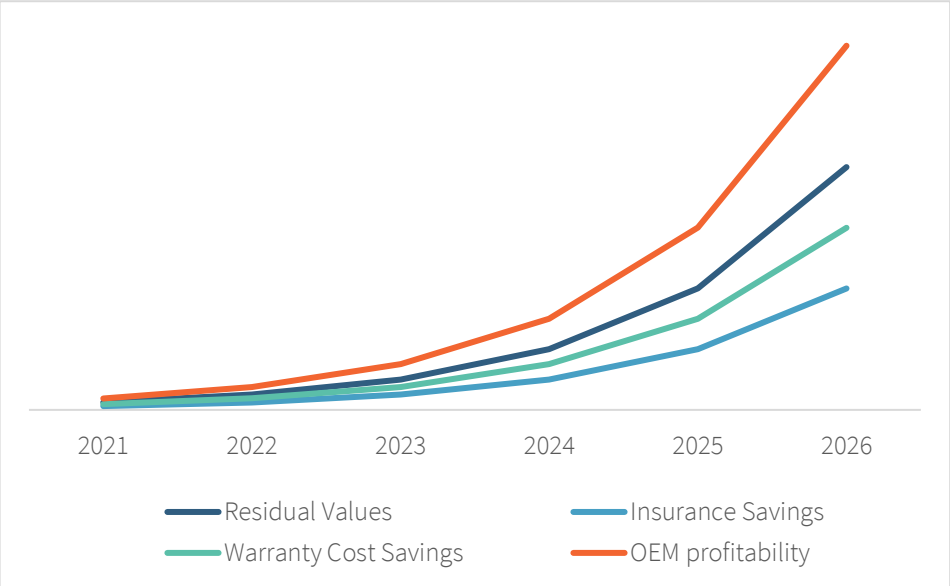
The arrival of 5G brings to the market what can be described as a Telematics 3.0.

intelligence capable of assisting drivers and enhancing the safe operation of the vehicle.

5.3 A Complete Vision of Product Life Cycle Management

The new world of 5G connected cars is characterized by a complete vision of product life cycle management. The wireless connection built into the car helps communicate the vehicles status and performance to the owner, the manufacturer, and the dealer while simultaneously assisting in avoiding collisions and preserving software and system integrity with over-the-air updates. These functions convert to dollars and cents savings for automakers and consumers and revenue opportunities for new car dealers.

Figure 5: 5G Will Create Value on Many Fronts



Source: Strategy Analytics

5G based functions and service propositions represent significant multi-billion-dollar value propositions for auto makers.

With Telematics 3.0, automakers can design their vehicle systems to maximize performance and cost savings for the consumer and minimize down time and disconnected time. As a result, the car itself will be a powerful tool for customer retention and set the stage for enhancing the value of the vehicle over time. The interaction of the vehicle with other vehicles, infrastructure, and the cloud creates a unique transformative driving experience whereby hazards are avoided, fuel efficiency is enhanced, emissions are mitigated, and traffic congestion is reduced. This is the transformation long promised by connectivity.

5.4 Richer User Interfaces and Infotainment Experiences and Support for Automated Driving

The last step in the evolution of a 5G connected car will be richer user interfaces and infotainment experiences and support for automated driving. In anticipation of this next phase, premium automakers are already introducing displays that stretch across dashboards and head-up displays with augmented reality elements.

The 5G connected car will anticipate needs and provide parking, weather, obstacle, and traffic information.

These sophisticated in-vehicle user interfaces will enhance driving by conveying urgent driving information and alerts in the most visible and non-distracting location – directly in the driver's line of sight. Artificial intelligence in the vehicle will anticipate driver and passenger needs and communicate vital travel data related to parking, weather, obstacles, and traffic enriched by dedicated 5G network resources.

5G connected cars will monitor driver health and vigilance in connection with automated and semi-automated driving functions and integrate connections to mobile devices and smart home services. Natural language digital assistants enhanced with gesture recognition will connect drivers and passengers to off-board resources. And, in the event of a crash, all critical vehicle data and the condition of vehicle occupants will be communicated to emergency responders.

For their part, autonomous vehicles will leverage 5G connectivity to enhance positional accuracy, identify road hazards, anticipate traffic light timing, and to monitor the movements of other vehicles, and vulnerable road users. And, of course, 5G connections will be there with access to vehicle controls to enable teleoperation in emergency circumstances.

6. Conclusion

The introduction of 5G technology is rapidly transforming the automotive industry from the factory floor to the highway. As 5G makes its way into mass produced vehicles over the next five years, automakers will deliver safer and more environmentally friendly vehicles and both drivers and passengers will benefit from a more contextually aware and stimulating driving experience.

These new and enhanced value propositions have required nothing less than the unprecedented collaboration of the telecommunications and automotive industries, along with the support and participation of semiconductor companies, standards bodies, and regulators. A vast eco-system and supply chain has come together to realize the prospect of an intelligent wireless network capable of fostering automated driving – still in its earliest stages of development. 5G connected cars will be part of the fabric of multi-modal transportation networks and smart cities – safer, cleaner, and faster.

Analyst Contacts

The authors of this report can be reached at:

Roger Lanctot, can be reached at rlanctotkendall@strategyanalytics.com, or by using the following telephone number: +1 617 614 0714

Phil Kendall, can be reached at pkendall@strategyanalytics.com, or by using the following telephone number: +44 1908 423 620

Andreas Koehler, can be reached at akoehler@strategyanalytics.com, or by using the following telephone number: +44 1908 423 631

Get help from Strategy Analytics

Working with Strategy Analytics gives you the knowledge you need to succeed.

Understand your customer

Business opportunities abound. But which ones are right for you and your customers? Which will give you the advantage?

Optimize your user experience

Optimize your product to give your users the best experience and you the market advantage.

Analyze the market

Understand the size of the opportunity and where your product fits using our unrivalled knowledge and world class data analysis techniques.

Explore your future

Working with us will focus you. With our insight and forecasting expertise you'll make confident strategic decisions that drive success.

Please contact us at custom@strategyanalytics.com with any questions and for further details and solutions on how we can work with you on creating a custom solution to address your specific needs.