5G

CONNECTED VEHICLES AND 5G “ECOSYSTEM”

Background

1. Mobile connectivity has progressed significantly over the past 30 years, with life-changing technologies and services increasing with each generation of mobile connectivity.

2. The First-Generation mobile services were launched in the UK in the mid-1980s. The handsets were big, expensive to own and operate, had limited battery life and only offered fairly unreliable voice telephony. As a consequence, the main take up was amongst senior business executives and the wealthy. Second generation mobile connectivity in the 1990s saw the introduction of text and pay as you go bundles widened popular appeal, but subscription rates remained below 50% of all UK households.

3. It wasn't until the early 2000s that the general public had access to mobile broad-band internet in the form of 3G and for the first time video services. However, for all the hype at the time, the introduction of the iPhone in 2007 and the increased take up in subscriptions to around 80% of UK households, basic broadband was not initially sufficient to support high data uses like video streaming effectively. This began to change with enhanced 3G services (3.5G) and facilitated the transformation of mobile phones from devices to simply make calls and texts, to a tool for multiple forms of communication and entertainment and business on the move.

4. This process continued with the launch of superfast broadband introduced by 4G, which allows real-time information and location-sharing. This evolution has been a disruptive technology that has heralded new applications and services like the car sharing economy and helped to give birth to companies like Uber. It has transformed automotive "connectivity" through the ability to use car related 'apps' like Android Auto, Google Maps and Waze. Subscription rates now exceed 100 million, so the penetration rate for connected devices is more than one device per head of population.

5. This massive take up and reliance by users has been reflected in significant regulatory changes, for example, to the Electronic Communications Code, with

the Government recognising and describing mobile connectivity as the Fourth Utility.

6. However, whilst extremely good, 4G is still not fast enough to support technologies that require the speed of human reflexes. That will change with 5G, which is now being deployed in the UK and this technological advance will underpin the introduction of Connected Autonomous Vehicles and the consequential and huge societal, economic, health and safety and other changes expected.

7. For autonomous vehicles, 5G will introduce a supporting network that allows cars and computers to make decisions quicker than human intervention. The promise of “connected” vehicles is challenging for all stakeholders, from potential users, mobile operators, vehicle makers and other stakeholders, such as local authorities who in the first instance will have to support the development of the necessary infrastructure.

8. The different administrations in the UK have all taken steps and continue to explore further extending permitted development rights to help facilitate the deployment of 5G infrastructure. However, many installations will still require an application for full planning permission or under the Prior Approval procedures. The extent of apparatus required for 5G upgrades and the necessary heights for coverage or ICNIRP compliance reasons, will in many cases require a degree of visual change in both townscapes and rural areas. This document, along with other supporting material is intended to help explain the public benefits that will

flow from such change, so that due weight can be placed on these matters, regarded as important by Government in an ever more competitive and challenging global economy.

9. Indeed, the UK has to act fast. Evidence suggests that the penetration of shared and autonomous mobility will happen faster in the east such as China than in the Western world. This is likely to make China the leading market for the transformation of the automotive industry and associated digital economies, competing directly against the UK Digital Economy.

5G – what can we expect?

10. 5G is likely to transform the driving experience and underpin smarter transportation systems. The diagram below shows how 5G installations will be critical to various strands of autonomous vehicles and transportation management.

Communication technology like V2V and V2X will provide car connection to 5G networks. (Credit: Qualcomm)

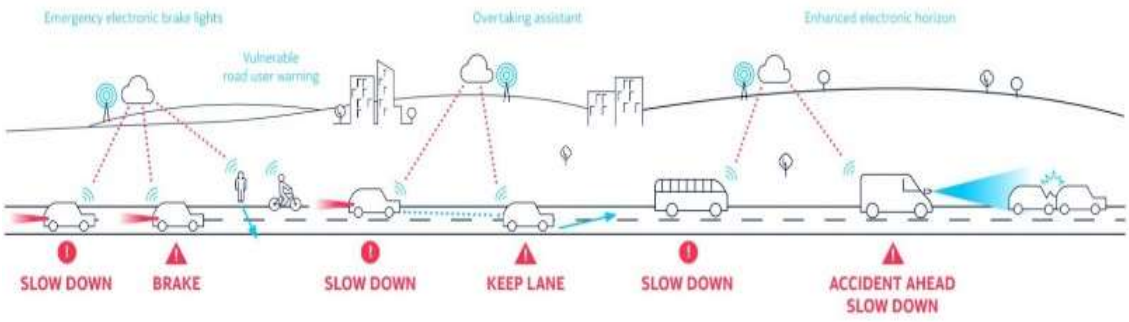
11. There is an expectation that autonomous vehicles will be equipped with hundreds of sensors collecting and receiving information all at once over a 5G network. This concept is called "Vehicle-to-everything" (V2X) but essentially 5G will help vehicles understand its real-world driving environment, so allowing for better

collision avoidance and safety of other road users like pedestrians and cyclists – Vehicle-to-Vehicle (V2V) and Vehicle-to-Pedestrian (V2P). As explained earlier, 5G and associated sensors will allow decision making to be speedier than human intervention.

12. To achieve this, the car needs to detect blind spots and avoid collisions with people, animals or other vehicles on the road. As the car drives, its sensors will pick up information about:

- weather and road conditions
- accidents
- obstacles and objects moving near the vehicle

13. Once the information is gathered, either an on-board computer will make an instant decision, or the 5G data could be sent into the cloud to be processed, and then a decision would be sent back to the vehicle. This could include slowing down the car due to adverse or expected weather change or keeping a vehicle in a particular lane in advance of a road vehicle accident or obstacle, as the diagram below shows:



Nokia Use Case: Safer and efficient highway ready for future mobility

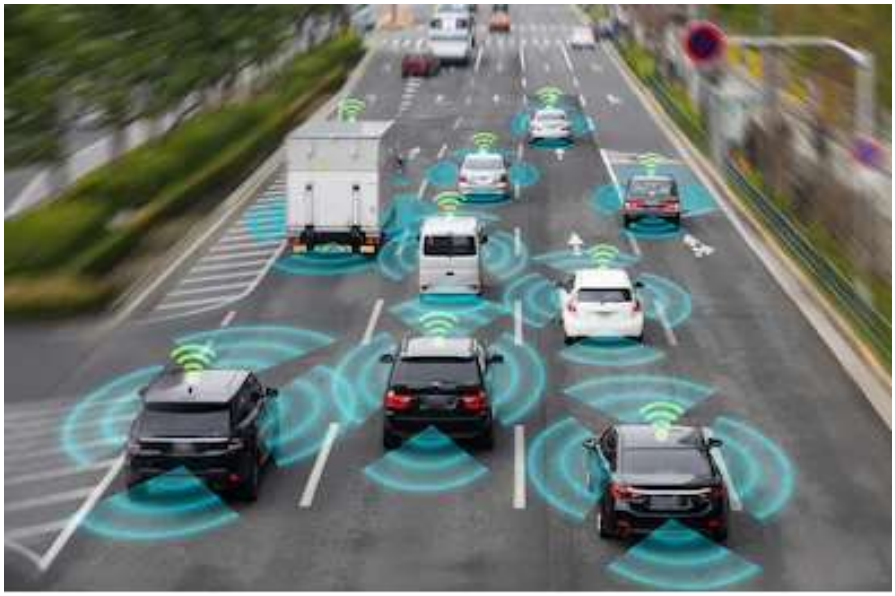
14. Fully autonomous mobility will only achieve its full potential with low latency communication between vehicles and the surrounding infrastructure, and 5G is the game-changing network to support V2I communication. Assuming all the devices on the road, the pedestrian crossings, pavements, traffic signals are connected, in effect the 'communications network', then instead of needing 50-150 milliseconds to detect an actionable event, a 5G network of connected

devices can quickly detect the event and communicate those changes in near real-time with other connected devices. This can be within a time frame potentially 20 times faster than the speed at which a human could detect and communicate.

15. To understand this further, it is worth taking an example. At a major city junction or roundabout there may be as many as several hundred cars, bicycles, scooters, pedestrians and other objects sharing the same space at a given time. Watching over the crossroad might be 15 cameras to monitor any participants that aren't equipped to communicate their own location, speed and intent.

16. However, an automated traffic management system, using 5G, can collect the data transmitted by these objects and send all relevant information to autonomous vehicles, each of which uses this data in conjunction with its own in-built sensors to decide whether to stop, move or turn. This data has to be received, processed and sent out in near real time because the traffic situation is constantly altering.

17. Such a system couldn't work without contiguous and ultra-fast and reliable 5G network. The number of connected objects, the volume of data and the tiny margin for delay requires superfast mobile connectivity and 5G will also allow vehicle makers, transportation planners and mobile operators to leverage new capabilities out of 5G. In some cases, autonomous vehicles may be automatically controlled by networked robotic control through 5G, such as controlling the safe merging onto junctions or motorways. What is clear is that 5G ***will help save lives on our roads***.



18. For safety reasons the systems will require remote human driving, or teleoperation, and may become a mandatory feature of autonomous vehicles. The autopilot on an autonomous vehicle might hand the reins over to the driver. However, it may not be possible in case of an elderly or a disabled rider. For this reason, many technology companies have been testing 'remote pilots', who are trained drivers located miles away in a simulator that can take over instantly. However, to achieve it, a stable and fast connection offered by 5G would be crucial. It is clear that autonomous vehicles are likely to need and be supported by a highly sophisticated digital service industry associated with smart vehicles and transportation. This alone brings new service business opportunities in a growing UK digital economy.

Logistics and Transportation

19. The movement towards autonomous vehicles under the umbrella of ultra-fast, highly dependable 5G coverage will bring about new uses. It is estimated that transport logistics costs could be reduced by 2030 by using robots in warehousing and digital trucks.

20. Swedish mobile operator Telia is piloting a service that supports driverless lorries hauling goods between warehouses and we can expect similar innovation in the UK. It has been operating in a commercial pilot at a logistics facility in Jönköping,

Sweden, according to Ericsson, which supplies infrastructure for it. The driverless trucks, developed by Swedish start-up Einride, operate on pre-defined routes as part of an automated logistics system. The trucks can make most of the trip on their own with inputs from onboard sensors, but there are some situations they can't navigate, said Claes Herlitz, vice president and head of Global Automotive Services at Ericsson. When that happens, a human driver in a remote operations centre takes over. [1]

21. The advent of the 'digital lorry' will completely transform how freight is transported on the UK's highways using 5G as a backbone of any communications. This could be long caravans of large delivery lorries travelling in lockstep down major motorways, while each of the lorries automatically transmits its whereabouts, estimated time of arrival, and load information to its next stop. The warehouse system can then automatically assign each delivery lorry to a loading dock, where several autonomous forklifts stand ready to unload it. Then they move the load on to another portion of the warehouse, where it is sorted by machine for local delivery routes and loaded onto the proper small autonomous electric trucks for final delivery. 5G will be able to unleash this transportation potential and redefine "just in time" deliveries and warehousing.

22. 5G will also have a profound change on the various vehicle supply chains and associated automotive services. Businesses that rely on transportation will also

see big changes. Robust 5G mobile connectivity will have major influence on public transport services and how emergency vehicles communicate. So 5G is likely not only to push forward the adoption of connected vehicles, but a wider digital economy supported by a 5G "ecosystem".

Information and Traffic Management

23. Additionally, 5G will provide passengers in self-driving cars with high-quality infotainment services that will provide real time information to help manage journeys, either remotely or through manual override, as well as a range of entertainment services. This will make the communications service provider an important partner for autonomous cars, whether for data analytics, safety, or entertainment reasons. Autonomous technology adoption should reduce the rate of accidents and put downward pressure on insurance premiums.

24. 5G-enabled sensors built along the UK's roads and motorways will be able to more accurately monitor and manage traffic flow, promising to reduce traffic congestion by 10%. Telefonica's *'The value of 5G for cities and communities report'* estimates this will save businesses £880 million a year in lost productivity, help the average commuter reclaim 3.2 hours a year and cut carbon dioxide emissions by 370,000 metric tonnes. A recent trial of such technology, by Transport for London, reduced delays by 20%. [2]

25. 5G-enabled billboards on highways will also be able to provide real-time traffic, parking and road condition information to commuters.

Efficiencies in the Rail Sector

26. In the rail sector, Telefonica [3] estimates that 5G technology will:

- Reduce train delays and cancellations caused by maintenance. 5G sensors will enable predictive maintenance, reclaiming an estimated £440 million in lost productivity for the UK economy.

- Regain the average rail commuter 2.6 hours a year, usually lost to train delays and cancellations.

- Save the average rail commuter an additional 2.4 hours per year as e-ticketing removes the need to queue for paper tickets.

Improving and making more efficient the delivery of public services

27. As vehicles become better connected, the data they and their drivers' mobile phones collect through 5G networks can be shared anonymously with local authority highway and transportation planners, helping them further develop infrastructure. Such insight will allow local authorities to prioritise which parts of the transport network need to be improved first and to ensure that planning decisions, for large scale new developments, can take account of detailed understanding of highway usage and likely trends and demands. In future, driverless cars are expected to generate unprecedented levels of data (4TB per hour), helping councils develop even more effective management plans.

28. Public services that rely on collection and delivery services will be able to utilise data communicated over 5G and associated 'Internet of Things' capabilities. Thanks to 5G, council bills could be cheaper as a result of connected bins that are only collected when they are full, so making refuse lorry usage more efficient and more targeted.

29. In the future, 5G connectivity will evolve public bus travel so commuters can purchase e-tickets, plan their onward journey using interactive maps, or transmit data perhaps to let the driver know how many people are waiting. On a broader scale, Transport for London uses anonymous, aggregated data to inform its wider transport model – helping it understand trends in how and when people travel around London and adapt its transport systems and schedules in response. In the future, collecting this data in real-time will help networks like TfL further reduce congestion – which currently costs the UK government £13 billion a year.

30. Driverless autonomous taxis will also be supported by 5G. These were going to be used at the 2020 Olympics in Tokyo with vehicle testing already in progress. However, it is clear that 5G will support a taxi service industry based around man-less, super-efficient “just in time” collection service, underpinned by 5G connectivity.

31. In a society of connected vehicles and smart transportation systems, 5G is going to be critical.

The necessary “EcoSystem”

32. "Mobility in a Digital Age," a strategic transportation report prepared for the Los Angeles Department of Transportation has stated, *"Arguably, automated vehicles are potentially the greatest transportation technology innovation since the invention of the internal combustion engine with significant implications for safety, accessibility, convenience, and our physical environment."*

33. The UK Centre for Connected and Autonomous Vehicles (CCAV) [4] was announced in July 2015. It is a joint team, with members from both the Department for Business, Energy, and Industrial Strategy and the Department for Transport. CCAV is helping to ensure that the UK remains a world leader in the research, development, demonstration, and deployment of connected and autonomous vehicle technologies. It is working with industry and academia to realise the significant potential benefits of these technologies for UK society and economy.

34. The successful delivery and adoption of autonomous driving still has many uncertainties and moving parts. The technology is still evolving with many trials and developments taking place. There are significant societal issues, such as the question of car ownership and cultural changes required to the status many attach to their cars. For towns and cities, there may be practical considerations – where and how will the vehicles be charged, where will they park, how will they be serviced, maintained and insured if not in private ownership?

35. However, whilst many of these questions remain to be properly considered, let alone answered, the one thing that every participant agrees upon is the need for 5G ultrafast and reliable mobile connectivity.

36. The application submitted for development in relation to a 5G installation, is therefore for development that help bring about a range of significant and nationally important innovations, including the deployment and take up of Connected Autonomous Vehicles. Any visual change associated with the development must therefore be balanced against these considerable benefits that will be delivered in the public interest.

Cellnex

Quoted Sources

1. https://www.lightreading.com - 11/25/2019 – "5G and autonomous cars: Flashy promise meets complicated reality"
2. www.alphr.com
3. O2 - The value of 5G for cities and communities report
4. The Centre for Connected and Autonomous Vehicles (CCAV) - UK Testing Ecosystem for Connected and Autonomous Vehicles Government response to the call for evidence

Other Reading

https://www.lightreading.com/the-edge/5g-and-autonomous-cars-flashy-promise-meets-complicated-reality/d/d-id/755912

https://www.govtech.com/products/5G-and-Autonomous-Vehicles-Turning-Fiction-into-Reality.html

https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/development-in-the-mobility-technology-ecosystem-how-can-5g-help

https://www.intel.co.uk/content/www/uk/en/communications/5g-connected-vehicle.html

https://www.nokia.com/blog/5g-ecosystem-paves-way-automated-vehicles/

https://www.machinedesign.com/mechanical-motion-systems/article/21837614/5gs-important-role-in-autonomous-car-technology

https://www.pwc.com/hu/en/industries/automotive/autonomous-ecosystem.html

https://www.gemalto.com/automotive/connect-cars

https://www.t-mobile.com/business/resources/articles/how-5g-mobile-networks-will-transform-transportation-infrastructure

https://www.synopsys.com/automotive/autonomous-driving-levels.html

https://www.futurithmic.com/2019/01/30/role-of-5g-autonomous-vehicles/

https://www.forbes.com/sites/tmobile/2019/08/01/how-next-gen-mobile-networks-will-transform-transportation-infrastructure/

https://www.bbc.co.uk/news/business-45048264