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Intelligent Transport Systems

25+ Shaping Future Transport

SHAPING FUTURE TRANSPORT

WEBINAR

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4G / 5G for High Performance ITS

An industry view on Cellular V2X

ITS-Australia Webinar – answers to questions

Panel

Moderator

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Qualcomm

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Ford

Craig Greene, Senior Technical Engineer, Ford Motor Company

Questions

Can we discuss security challenges in V2X and V2V and how are they being tackled? How can we make these vehicles safe if the data and/or the communications is compromised?

The security solution for the connected, C-ITS environment is called a Security Credential Management System (SCMS). Whether messages are delivered over 4G network or short-range radio, the SCMS facilitates confidentiality and integrity of C-ITS messages. The SCMS also handles revocation of compromised end users, if any are found. There are a range of other security services which will also apply depending on the specific application - for example, services over the 4G/5G network will also benefit from the 3GPP authentication.

SCMS infrastructure is being considered a "sovereign" deployment in other jurisdictions, deployed and operated on a national basis to facilitate C-ITS.

Relevant further reading:

https://austroads.com.au/publications/connected-and-automated-vehicles/ap-r585-18

https://5gaa.org/news/5gaa-efficient-security-provisioning-system/

Security is also addressed in the way the technology is designed and operated as critical infrastructure, and not an internet application, and in the way that the technology is integrated into vehicles, with hardware and software barriers to reduce the possibility of unauthorised use.

What are the expectations for latency for 5G? What is the primary advantage of 5G over 4G in the ITS context? When will NR-V2X will be ready and compatible with the Release 16 of the standards. Are there many 5G compatible devices available in the automobile Industry? What is the cost of rolling out 5G and timing to cover such a dispersed country as Australia?

#1 of 3:

The Cellular V2X architecture includes short range (V2V / V2X) "sidelink", and wide area (V2N / V2N2X) mobile network radios.

NR-V2X (5G sidelink) is being engineered to provide sub-millisecond latency over the radio interface for advanced time critical use cases.

LTE-V2X (4G sidelink) can already achieve 4 ms latency.

NR-V2X adds in another valuable capability for distance-based multicast communications, which enables a more reliable link for complex interactions and manoeuvres, which is significantly valuable for autonomy.

Relevant further reading:

https://www.qualcomm.com/news/onq/2018/04/25/lets-set-record-straight-c-v2x

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#2 of 3:

Mobile network latency will vary depending on the location of the vehicle and the services it is interacting with. For edge-located services connected to a 5G NR mobile network, this could similarly approach 1 ms for URLLC and Factory automation. For more centralised services, or when devices are connected to 4G LTE, latencies will be in the order of tens of milliseconds.

5G is applicable to future, advanced V2X use-cases, requiring extremely low latency and/or high data throughputs. 5G is designed to work in conjunction with 4G, which is the foundation for V2X services as they are initially available. The initial NR-V2X sidelink specifications are part of the 2020 Release 16 deliverables, and will continue to benefit from improvements thought subsequent releases. In terms of chipset and modem product, there haven't been any announcements at this time.

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#3 of 3:

In Australia, Telstra has built 5G coverage to over 47 cities as at June 2020, with a range of (non automotive) 5G end-user devices readily available.

Telstra's 4G coverage extends to more than 99% of the population of Australia, and a significant proportion of the urban, regional and outback road network.

Qualcomm has introduced the SA515M which is amongst the first chipset solutions targeted at the automotive industry, including 5G connectivity to mobile networks. Vehicles with C-V2X technology are expected to enter the roadways in the 2022/2023 timeframe.

Ford has demonstrated a commitment to connectivity with 90% of all new global vehicles to have a 4G modem fitted as standard by the end of 2020. With 5G being the natural evolution, we are likely to see this capability in vehicles in the near future.

You'll soon be able to drive around most of Sydney through tunnels, will 5G V2X (and GPS) work throughout the whole tunnel network?

#1 of 2:

Precision location is an important adjacent technology to enabling C-ITS as safety use cases require an understanding of lane level accuracy. Global / Radio Navigation Satellite System (GNSS / RNSS) is also important for cellular technologies which leverage the timing information to optimize communications. The 3GPP is currently specifying network-based positioning which will be helpful.

There are several approaches to providing location services when direct "sky view" is not available. One of the most important is the implementation of dead reckoning in vehicle in conjunction with GNSS / RNSS systems. This can be in the form of internal measurement units, or based on vehicle sensors such as video, or more likely, a combination of sources.

Relevant further reading:

https://www.qualcomm.com/products/automotive/vepp

You'll soon be able to drive around most of Sydney through tunnels, will 5G V2X (and GPS) work throughout the whole tunnel network?

#2 of 2:

There is also work underway to study GNSS repeaters for the purposes of providing some (albeit limited) GNSS / RNSS in tunnel networks. There are other similar approaches, including the installation of other wireless radio beacons to facilitate positioning in these locations and these improvements will have significant benefits to autonomy and C-ITS.

Relevant further reading:

https://www.acma.gov.au/consultations/2020-05/arrangements-jamming-devices-and-radiocommunications-device-exemptions-consultation-152020

To address the question around 5G V2X (sidelink) operation in tunnels, this radio communication originates from the vehicle itself, so this will continue to operate in these environments.

What about behavioural studies on how human drivers interact with the new alerts and info available whilst driving? Is it distracting?

With the range of technology integrated into vehicles today, considerable attention through research, testing and education is placed on the human machine interface. Safety of the vehicle occupants is at the forefront of this. Adopting this, relevant warnings and alerts for driver assistance features are prevalent in a current vehicle without C-V2X. With C-V2X, those warnings can now be issued in a more accurate, informative and timely manner given the co-operative nature of the communication.

Within Australia, relevant further reading:

https://www.ntc.gov.au/transport-reform/ntc-projects/driver-distraction

What role do you see Governments playing in future of ITS - at a Federal, State and Local level?

This is a complex topic, and the subject of significant prior work by Austroads, the National Transport Commission, and others. Government has a major role to facilitate ITS, broadly in two areas:

- Providing the appropriate national technical frameworks for ITS in Australia, for conformance, standardisation, and interoperation, but also to operate or facilitate some critical portions of ITS infrastructure more directly (e.g. SCMS).
- Investment in readiness of state, local and privately operated road and transport assets, both digital (e.g. APIs, data exposure) and physical (e.g. road side units, intersection controllers). ITS depends on the reliability and availability of digital infrastructure as much as effective implementation in vehicles themselves.

It has been encouraging to see how Government has facilitated the uptake of automated vehicles in Australia. V2X and C-ITS technologies are a pathway to more rapid improvements in road safety and efficiency, and are important precursors to automated driving.

Technically the deployment is possible and shows broad benefits - has a full system cost benefit analysis been considered? Do the speakers have a view of the adoption of this technology and what the financial model is to see its realisation. Is this model likely to encourage adoption for road safety outcomes given the cost of crashes mostly falls as a public cost. In terms of cost of implementations how these solutions compare with other treatments such as infrastructure itself ?

Cost analyses of the impact of C-ITS solutions have been undertaken in many jurisdictions. One such study prepared by the 5GAA is available here:

https://5gaa.org/wp-content/uploads/2017/12/Final-report-for-5GAA-on-cellular-V2X-socio-economic-benefits-051217_FINAL.pdf

A Cellular V2X system deployed based entirely on sidelink is possible, and would have a similar cost basis for infrastructure given comparable needs for road side units and other components. However, Cellular V2X also supports the complementary use of wide area mobile networks. This can substantially change the overall cost to deliver C-ITS uses and the potential impact to the public purse. Relevant further reading:

https://5gaa.org/wp-content/uploads/2019/01/5GAA-BMAC-White-Paper_final2.pdf

Cellular V2X makes it far more likely for automakers to adopt as well given how sidelink is now a feature of the cellular communications platform that is already placed in vehicles for Telematics and Connected Infotainment services. Combine this with global efforts to add V2X applications to safety ratings developed by New Car Assessment Programs (NCAP) along with the level of integration for automakers, and the value to cost analysis shows significant promise.

How do you identify which vehicles to send SPAT/MAP to? If CAM is used from Vehicles how do you scale and how do you manage privacy?

Cellular V2X supports the use of road side units which can directly broadcast SPAT/MAP and other messages using the LTE-V2X sidelink interface.

In the case that these messages are delivered over the mobile network, SPAT/MAP type messages can be routed to vehicles based on their general location, which can be indicated or inferred without explicitly uploading CAM messages. The relevancy area for a particular vehicle will change depending on whether it is an urban, or regional/rural setting.

Privacy is maintained by allowing vehicles to change temporary communication identifiers at any time, in the same way that is protected for traditional V2V / V2I communications. Because of the use of temporary identifiers, CAM messages, and other ITS messages, are not expected to contain any personally identifiable information.

Relevant further reading:

https://5gaa.org/wp-content/uploads/2019/05/06.Virtual_RSU_Architecture.pdf

How long should we wait for newer technology to save lives if there is already technology here that can do it? How does will it work if part of the fleet is on CV2X and some of the fleet is on DSRC? If manufacturers use different technologies CV2X and DSRC and they aren't compatible how does road safety get delivered?

Qualcomm were amongst the pioneers who invested in 802.11p (the radio that powers DSRC), but with that radio based on 20 year old 802.11a technology, it is appropriate to select the newer radio that has performance improvements, along with the synergy with the cellular ecosystem. The reality is that neither technology today has a significant installed user base, and so it is appropriate to select the best possible approach given the options available which include OBUs and RSUs publicly announced and commercially available from: Applied Information, Chemtronics, Cohda Wireless, Danlaw, Ficosa, Genvict, iSmartWays Technology, Kapsch TrafficCom, Lacroix City, Nebula Link, Neusoft, Savari and many more that are working directly with automakers or who are engaging the industry in private discussions .

Additionally, as 4G and 5G modems are being integrated into vehicles anyway for Telematics and Connected Infotainment services, the integration of C-V2X direct communications is very compelling, along with the improved link performance and planned evolution.

For infrastructure communications based on direct communications, the cost may be acceptable in the interim in certain markets to add both DSRC and LTE-V2X radios. However, when we start considering the volumes of new vehicles, only a single radio solution could be considered practical.

C-V2X Direct communications benefits from the fine work that 802.11p charted, but DSRC radio technology is quite old. This approach preserves the investment and decades long work on upper layer protocols and standards, use-cases and benefit to road safety.

Is there backwards compatibility between LTE-V2X and NR-V2X? What is the panels view on the lifecycle of the CV2X (short duration) and its compatibility with a vehicle lifecycle (10-20 years)?

LTE-V2X is defined by 3GPP Release 14/15 for basic safety use cases, and is followed by Release 16 and beyond to support advanced use cases. Chipset solutions are expected to include both NR-V2X along with LTE-V2X, so both legacy and newer future vehicles will all be able to communicate via LTE-V2X for the basic use cases whilst the newer future vehicles will have added new benefits. This is similar to a 5G mobile phone today, which is also capable of (sometimes simultaneously) connecting to 4G, 3G and 2G networks, depending on availability.

In contrast, 802.11bd, the in development IEEE specification, is expected to revert back to 802.11p when such radio is detected, removing any advantages that 802.11bd offer. Cellular technologies for years have had backwards compatibility handled in the chipset solutions, so this is standard industry practice.

Is there backwards compatibility between LTE-V2X and NR-V2X? What is the panels view on the lifecycle of the CV2X (short duration) and its compatibility with a vehicle lifecycle (10-20 years)?

Cellular networks typically have a 25 year network deployment, though the chipsets continue to support backward compatibility from 5G all the way back to 2G. For C-V2X Direct Communications, it is well noted that vehicles have a long life and that is why C-V2X has been designed to be both future compatible as well as backward compatible, so newer future vehicles getting a newer 3GPP release will support both the advanced use cases enabled by NR V2X, whilst also being able to continue to communicate with LTE-V2X use cases including basic safety.

In terms of reliability, there is a significant difference between devices intended for consumer electronics applications and those used in mission critical situations. Mobile network connectivity has had widespread uptake for “machine to machine” connectivity in a variety of industries, and mobile network communications technology has been routinely deployed into vehicles for telemetry and other applications for decades.

There has been discussions about new vehicles, unfortunately Australians are conservative in replacing older vehicles, is there an opportunity for retro-fitting the technology? Are Heavy Vehicle owners the most likely candidates? I'm interested to understand what the thoughts are about a heavy vehicle applications and if there are different considerations being made for those vehicles in comparison to passenger vehicles.

Yes, there is an interested aftermarket community which a number of commercially available devices today that offer cellular Telematics services, and some very recent product introductions offering C-V2X Direct communications capability. We fully expect the aftermarket to support existing fleets of vehicles perhaps first focused on specific fleets before gaining larger traction by the consumer market. These solutions do benefit from additional information available through cooperation with automakers to gain access to high-quality in-vehicle network data.

In particular, fleets which have a long history of integrating aftermarket mobile network and telematics solutions are expected to be 'early adopters', such as taxis, emergency vehicles, heavy vehicles, public transport, and so on. These fleets will necessarily have different use-cases compared to mass-market passenger vehicles, because they have different needs: for example, priority intersection and/or lane access, dangerous goods routing and notification, and so on.

Given C-V2X features may be used for safety applications, appropriate controls for the fitment of aftermarket devices / systems should also be considered. This forms another opportunity for Government and industry engagement, similar to what has been applied for automated vehicles.

What are the safety barriers around 5G technology and how will the industry handle them?

There is no evidence that 5G or similar technologies cause adverse health impacts. This position is supported by health authorities in Australia, such as the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA), and around the world, such as the World Health Organization (WHO). Relevant further reading:

https://www.health.gov.au/news/safety-of-5g-technology

https://www.arpansa.gov.au/news/misinformation-about-australias-5g-network

https://exchange.telstra.com.au/5g-electromagnetic-energy-eme-and-your-health-here-are-the-facts/

Does the 4G/5G mobile network utilise 5.9GHz for C-V2X or is it operating at the cellular network frequency? Thus what are the priorities and how to differentiate these (latency) from normal mobile operations

The 4G and 5G mobile networks operate on spectrum licensed by the Australian Communications and Media Authority (ACMA). When vehicles and other transport users communicate using the wide-area networks, it is using the same commercial networks and frequencies built for a variety of other users - such as voice calls and mobile broadband.

4G has had the ability to provide differentiated quality of service (QoS) to different types of users since inception, and 5G extends this capability. This is used today, for example, to ensure that a 4G voice call can continue even when the network is busy. The same mechanisms are used to differentiate and where needed, prioritise V2X services on these networks. Telstra and Ericsson have demonstrated this in trials in Victoria.

Relevant further reading:

https://www.ericsson.com/en/networks/cases/cellular-v2x-creating-safer-roads

C-V2X direct sidelink communications operates in the 5.9 GHz ITS spectrum. The Australian Intelligent Transport Systems Class license for 5.9 GHz is not specific to any particular technology type. This same spectrum is used by all vehicles, and is not related to the spectrum vehicles may use when communicating over a commercial mobile network.

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Thank you