FUTURO DELLA MOBILITÀ: LA PAROLA A NOKIA

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Connecting cars with 5G

Autonomous Driving, as well as new concepts in the area of shared mobility, are intensively debated these days. Environmental aspects, improved traffic safety as well as the time we all spend in traffic jams in big cities are drivers to re-think our current mobility concepts.

When we talk about autonomous driving it is now common sense in the automotive industry that these autonomous cars will need the capability to communicate to each other, but also to communicate with road side infrastructure and several network services to really make it happen. The same applies for the new car sharing businesses: they are all based on cloud services and require users and cars to be connected to work efficiently. Generally, the industry talks about CCAM (*Cooperative Connected Automated Mobility*).

The European Commission also recognizes the need for cars and vehicles to be connected in the future: In May 2018 they released the paper “On the road to automated mobility: An EU strategy for mobility of the future” [**nota 01**], where it was emphasized the fact that an integrated approach for automation and connectivity will be followed.

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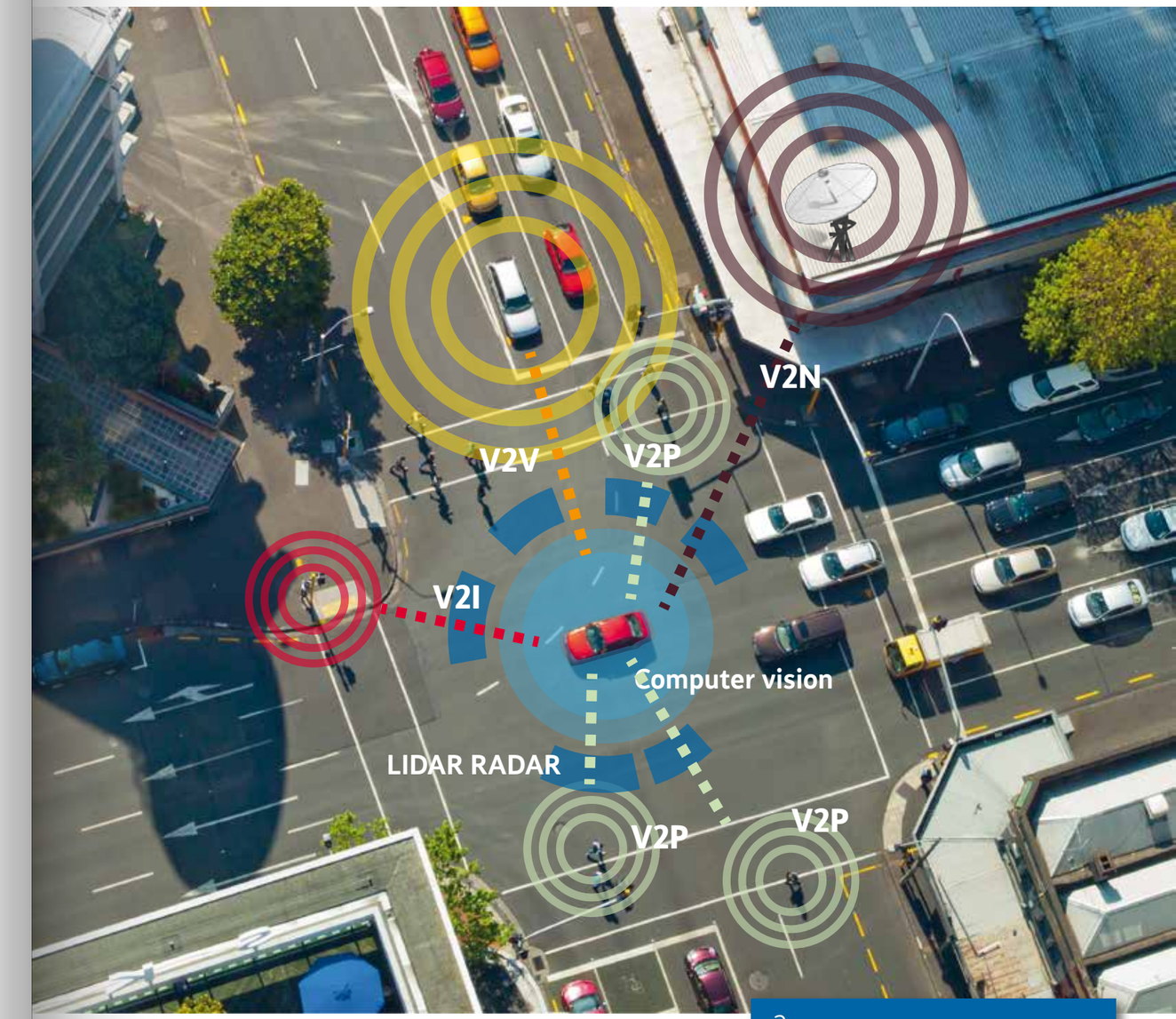
Mobile Networks will play a key role in connecting vehicles for increased traffic safety and to enable automated driving
[source: Nokia]

Cellular-V2X: designed for the automotive industry

There are different communications needs that need to be addressed by a technology that should improve traffic safety and enable autonomous driving. Cars not only need to be able to communicate with each other (V2V or vehicle to vehicle). They also need to communicate with traffic infrastructure such as traffic lights and road signs (V2I or vehicle to infrastructure), with the network infrastructure for value added cloud services (V2N or vehicle to network) and, last but not least, with passengers or the so-called vulnerable road users that are also part of the overall traffic scenarios. The 3GPP based cellular technology that enables these connections is summarized as “Cellular-V2X” or C-V2X.

Making vehicles smarter and safer with C-V2X

Communication and connectivity are key to the development of autonomous vehicles. Cellular based technologies will be essential for transforming the entire mobility ecosystem thanks to V2X: vehicle-to-everything communication. This new protocol allows vehicles to communicate with other vehicles (V2V), pedestrians (V2P), networks (V2N) and the surrounding infrastructure (V2I).
With a strong evolutionary path to 5G, C-V2X technology will offer superior performance to support connected vehicles communicate with transport infrastructure, leading to less congestion, reduced emissions and a smoother driving experience.



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What is C-V2X (Vehicle to Everything)?

C-V2X will additionally improve safety on roads by tremendously facilitating the flow of information between vehicles, pedestrians and road infrastructure. This will enable connected vehicles to anticipate and avoid dangerous situations, reducing collisions and potentially saving lives.

Automotive and telecommunications world meet in the 5G Automotive Association (5GAA)

One of the big challenges of the connected car is that two large industries like automotive and telecommunications have to come together to go from vision to reality. There is a full eco-system of strong players that need to work hand-in-hand to implement the vision of co-operative, connected, automated mobility: Telecommunication Service Providers, Telecommunication equipment manufacturers, car manufacturers and their suppliers, map providers, road operators – just to name a few. It is a true eco-system play.

To start this eco-system with the right focus, in 2016 the leading car manufacturers and telecommunications companies founded the "5G Automotive Association" (5GAA). Since then, the number of members of the 5GAA has increased to almost 100 members, all following the joint goal to bring Automotive and Telecommunications together to harmonize and accelerate the introduction of intelligent transport and communication solutions. The target is to successfully implement the concepts of Co-operative Intelligent Transport Systems (C-ITS).

A quick look into Co-operative Connected Automated Mobility with LTE

Already today, all newly released cars are connected to the back-end clouds of the manufacturers using cellular 3G/4G connectivity. These connections are now increasingly used by the technology leaders in the car industry to introduce cloud network services for traffic comfort and safety. Warnings about broken down vehicles along the roadside, vehicle accidents, variable working areas on highways and bad weather conditions are more and more becoming a reality.

In 2017, version 14 of the 3GPP standards for mobile networks was released. This version enables the LTE based communication between two vehicles (V2) and between vehicles and infrastructure (V2I) with very low latency (below 50ms). Initially the focus on this technology is to enable applications for traffic safety. This LTE based communication works harmoniously with existing mobile networks, but also when the network is down or not available, thus increasing the reliability of this direct-link communication.

With the introduction of the 3GPP release 14 the automotive industry has now and for the first time a unified Cellular-V2X network technology available meeting the requirements in terms of reliability, latency and flexibility. The direct communication between cars and between car and infrastructure works over a few hundred meters. It is nicely complemented by the network services (V2N) that practically work over any distance (long range).

This long-range communication is based on an edge cloud architecture that builds an abstraction layer between the telecommunications and the automotive world. It hides the complexity of how cars are connected (in which cell is the car, to which service provider the car is connected, cell handovers, needed core network functions and much more) and offers an IT-like interface for the automotive industry. The automotive eco-system can then run applications on top of this edge cloud independent from the changes that the mobile telephony networks usually have.

This edge cloud will be regionally deployed. This increases the reliability of the network services for connected cars and reduces the latency for the C-V2X services. It also enables new applications like the pre-processing of the car's sensor data which would be impossible with a central backend cloud architecture.

The automotive industry and the C-V2X solution benefit from the large investments already done to deploy LTE mobile networks worldwide.

The following picture shows an impression from the first tests of this technology with an implementation in cars from Audi and Ford. It was proven that the requirements of the automotive industry are fulfilled, and that the technology is interoperable between different car manufacturers.

There is a common understanding in the automotive industry that this technology enabled by the 3GPP release 14 will be introduced in volumes by 2020.

Additional benefits for Co-operative Connected Automated Mobility with 5G

3GPP Release 15 introduces the 5G New Radio (5G-NR) which enables new capabilities related to the network communication at the Car-to-Network interface. 5G NR provides higher data rates and lower latencies for V2N network communications. We expect that the first chipsets supporting 5G-NR will be commercially available in consumer devices and ready for testing in vehicles by 2019. Consequently, the first deployments of those features in commercial vehicles are expected to start as early as 2021. Release 15 also includes some minor enhancements to the direct V2V communications.

3GPP Release 16 is the 5G release dedicated to the introduction of massive Machine-to-Machine com-

munications that also applies to the automotive industry. Additional capabilities on top of 5G NR will also be introduced, specifically in terms of short range direct V2V communication, increasing bandwidth and reducing latency even further. This is often referred to Ultra Reliable Low Latency Communications (URLLC). 5G-V2X offers key features which are paramount to have a fully automated and cooperative driving, like the exchange of:

- Sensor data sharing for collective perception (e.g. video data from the car in front)
- Control information for vehicle platooning (a number of cars driving synchronously with very short distance of only a few meters to safe fuel)
- Vehicle trajectories to prevent collisions (cooperative decision making)

Consequently, use cases like:

- Real-Time Situational Awareness & High-Definition Maps
- Cooperative Maneuvers of Autonomous Vehicles for Emergency Situations
- Software Update
- High Definition Sensor Sharing

will be supported with substantially improved performance or can be implemented for the first time. These enhancements are feasible thanks to the 5G technology and they are not available with other competing technologies for V2V and V2I communication like WiFi based on the 802.11p standard.

3GPP release 16 is still in specification phase, with anticipated release freeze in late 2019. First deployments using Release 16 may be expected at earliest in 2023. Although the physical radio layers of LTE releases and 5G NR are very different, the chipsets and associated communication stacks will integrate the different radio technologies supporting smooth operation and backward compatibility at service level.

5G CARMEN: A joint European effort to implement 5G connected cars across borders

In the Italian, Austrian, German Corridor Bologne-Brennero-Munich, TIM and Nokia, together with many other eco-system players, have engaged in the EU funded project “5G-CARMEN”. The goal of this project is to prove the value of Cellular-V2X and 5G for co-operative, connected and automated mobility in cross-border traffic. Different use cases, like vehicle maneuver negotiation (“first talk then act”), vehicle emission control and smart living in Level 3/4 autonomous vehicles, will be implemented. For these services to work effectively, an Edge Cloud architecture will be implemented that works across borders, across different network operators (TIM, T-Mobile Austria, Deutsche Telekom) and across network equipment vendors (Nokia, Ericsson, Huawei) , allowing the deployment of seamless services in this European corridor.

This project will demonstrate that edge cloud technologies can build an abstraction layer to allow the whole eco-system jointly collaborate on an open platform across borders, across car manufacturers and across different telecommunication providers. This is one of the key pillars to get the C-V2X technology introduced as “the” technology for co-operative, connected and automated mobility ■

Note

[1] https://ec.europa.eu/transport/sites/transport/files/3rd-mobility-pack/com20180283_en.pdf

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In 2017 Martin Beltrop was appointed Head of Car2X Business for Nokia Mobile Networks. In this role, he oversees Nokia’s connected car business and the associated research and development activities. Nokia, as a founding member of the 5GAA, is heavily engaged in the definition, development and market making of connected car solutions for improved traffic safety and highly autonomous driving.

Martin has 20 years of mobile telecommunications experience. Before this assignment as Head of Car2X Martin held various roles inside Nokia from Research and Development Program Management and Head of Product Management to Head of Portfolio and Strategy for advanced mobile network solutions serving various vertical markets like Transportation (Automotive, Railways), Energy and the Public Sector. Martin is passionate about digitalization, 4IR and the value of mobile network technologies like 4G and 5G for industry and vertical businesses.

Martin holds a M.Sc. in Theoretical Physics from Westfälische Wilhelms-Universität in Münster. He lives in Düsseldorf, North Rhine Westphalia, Germany ■