The Automotive Value Proposition of Cellular-V2X
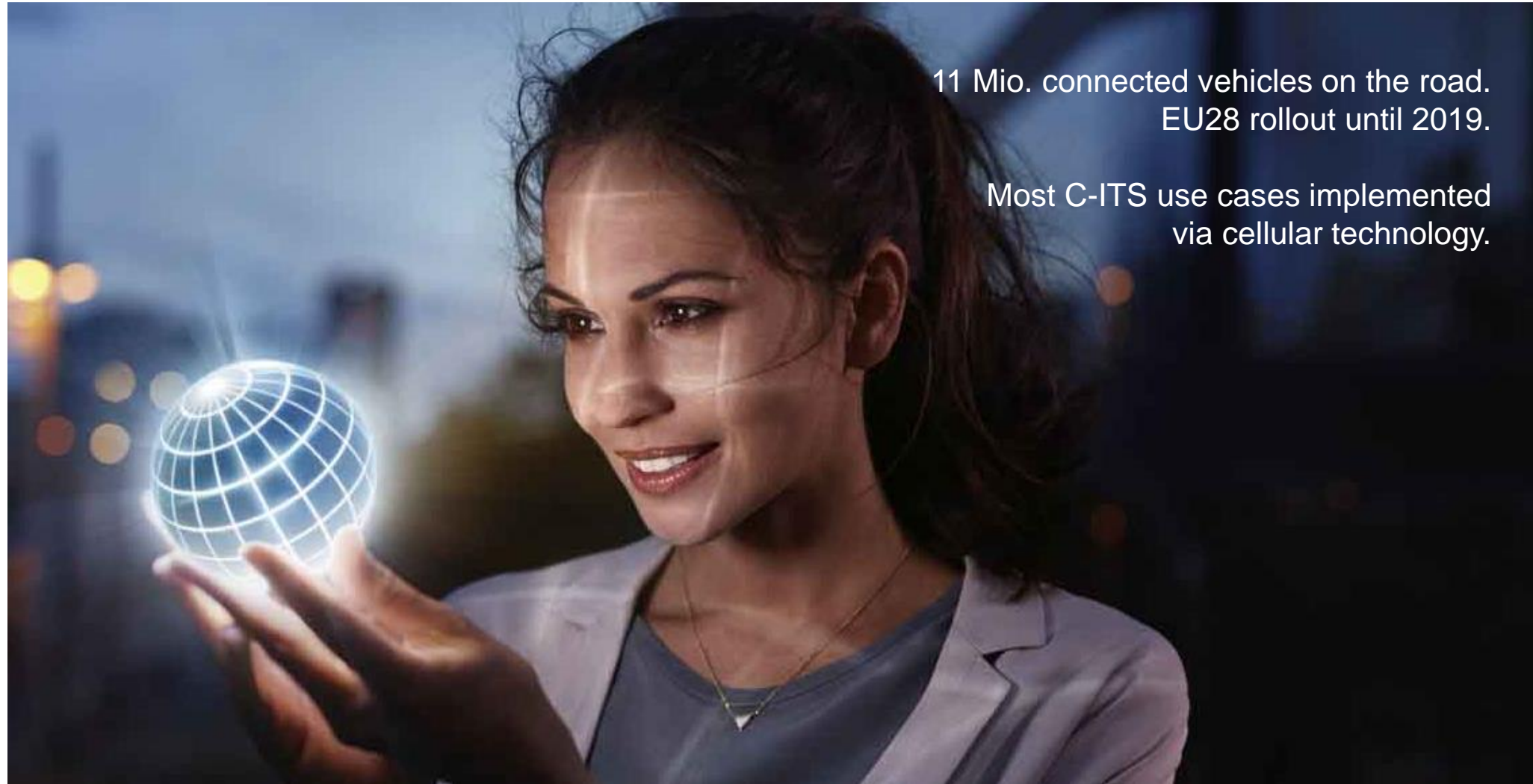
Joachim Göthel

Senior Manager Project 5G-Alliance - 5GAA Board Member

C-V2X started 20 Years ago @ BMW

11 Mio. connected vehicles on the road.
EU28 rollout until 2019.

Most C-ITS use cases implemented
via cellular technology.

Existing services improve safety today.

Day 1 C-ITS services list

Hazardous location notifications:
- Slow or stationary vehicle(s) & traffic ahead warning;
- Road works warning;
- Weather conditions;
- Emergency brake light;
- Emergency vehicle approaching;
- Other hazards.

Signage applications:
- In-vehicle signage;
- In-vehicle speed limits;
- Signal violation / intersection safety;
- Traffic signal priority request by designated vehicles;
- Green light optimal speed advisory;
- Probe vehicle data;
- Shockwave damping (falls under European Telecommunication Standards Institute (ETSI) category 'local hazard warning').

Day 1.5 C-ITS services list
- Information on fuelling & charging stations for alternative fuel vehicles;
- Vulnerable road user protection;
- On street parking management & information;
- Off street parking information;
- Park & ride information;
- Connected & cooperative navigation into and out of the city (first and last mile, parking, route advice, coordinated traffic lights);
- Traffic information & smart routing.

Driver alert

- <u>Majority</u> of 'Day 1' and 'Day 1.5' use cases can be implemented via a cellular network & server approach.
- Cellular technology with back-end solution benefits from <u>multi-stakeholder</u> approach and already existing infrastructure.
- Limitations of existing cellular technology required new approaches, enabled by C-V2X

What is V2X (Vehicle to Everything)?

V2N

- Cellular connectivity enabling more advanced applications including advanced traffic routing, and long-range information and cloud based services

V2V & V2I

- C-V2X allows for low latency, direct safety, communication to function **without network coverage**

V2P

- **Planned to be integrated in LTE handsets.**
- Ability for VRUs and vehicles without embedded V2V interface (i.e. legacy fleet) to use smartphone connectivity (PC5, or Uu) will be a key benefit of C-V2X.
- In contrast, ad hoc communications defined by 802.11p suffers a host of deployment issues for widespread adoption in handsets./
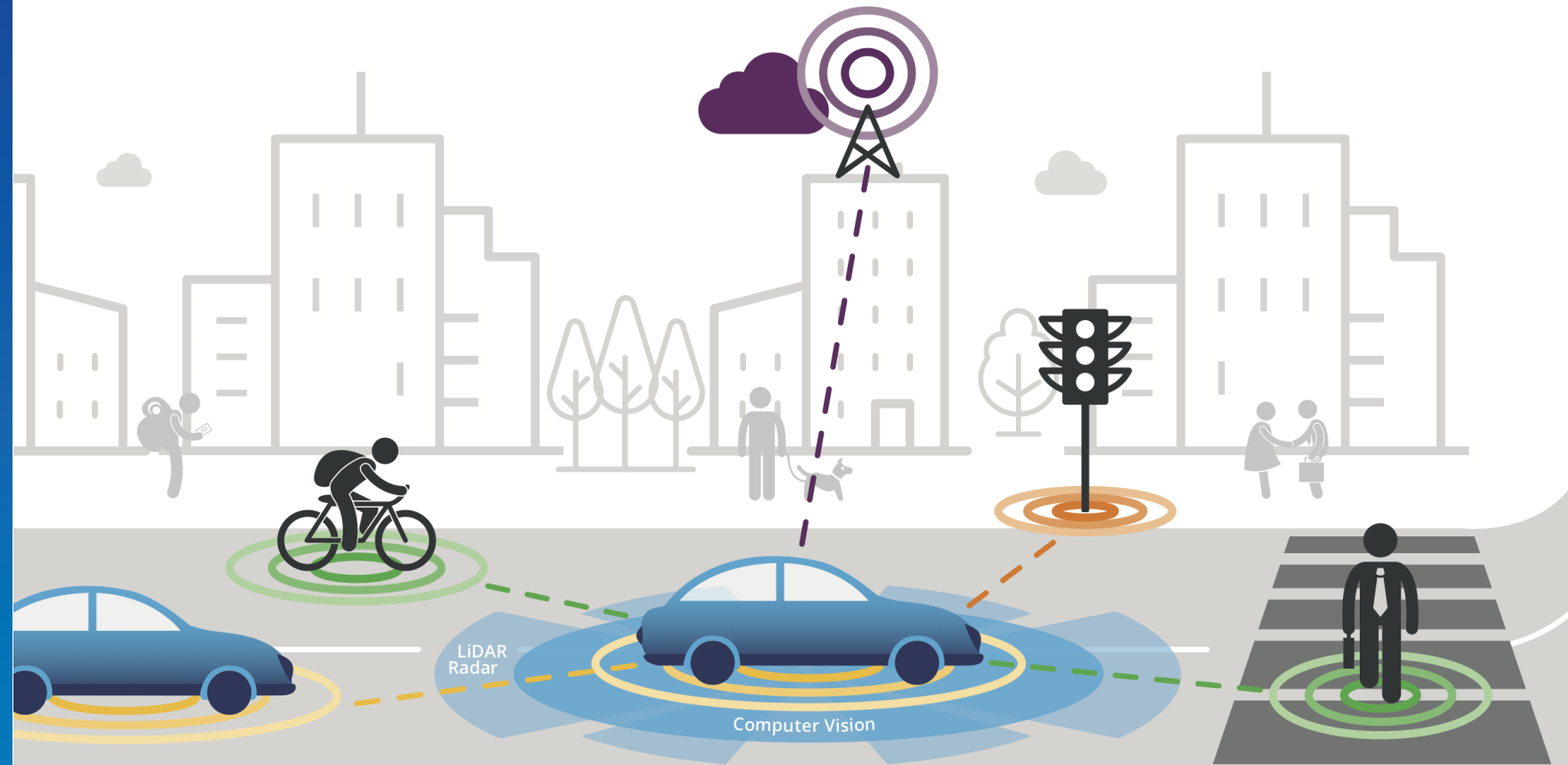
LiDAR Radar

Computer Vision

C-V2X has two complementary communication modes

Network

V2N operates in traditional mobile broadband licensed spectrum

I2N
(Uu)

V2N
(Uu)

V2N
(Uu)

P2N
(Uu)
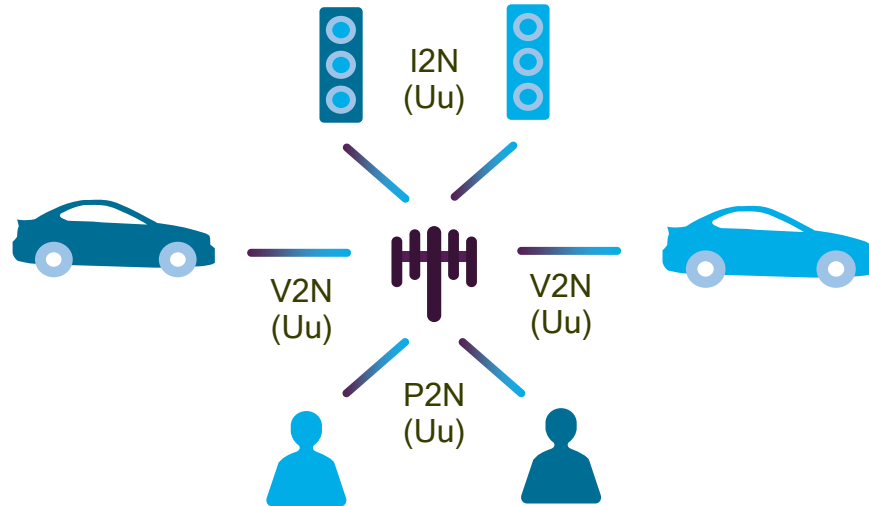
Long range (>1 km). e.g. accident ahead
Implemented over "Uu interface"

Direct

V2V, **V2I**, and **V2P** operating in ITS bands (5.9 GHz) independent of cellular network

V2I
(PC5)

V2I
(PC5)

V2V
(PC5)

V2P
(PC5)

V2P
(PC5)
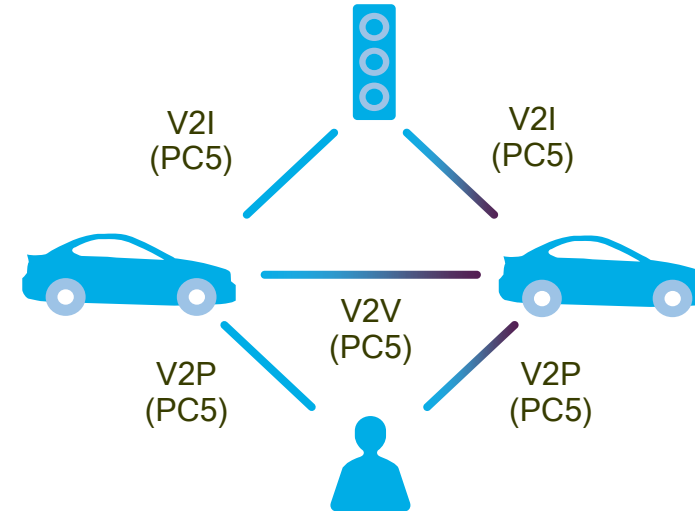
Short range (<1 km), location, speed ...
Implemented over "PC5 interface"

C-V2X has two complementary communication modes

Network

V2N operates in traditional mobile broadband licensed spectrum

Direct

**V2V**, **V2I**, and **V2P** operating in ITS bands (5.9 GHz) independent of cellular network

It´s ONE cellular technology

→ fully integrated chipset solution
→ one antenna system
→ reduced complexity and cost (on-board & infrastructure)

Long range (>1 km). e.g. accident ahead
Implemented over "Uu interface"

Short range (<1 km), location, speed …
Implemented over "PC5 interface"

Rollout of C-ITS Infrastructure – the Challenge.

RSU*
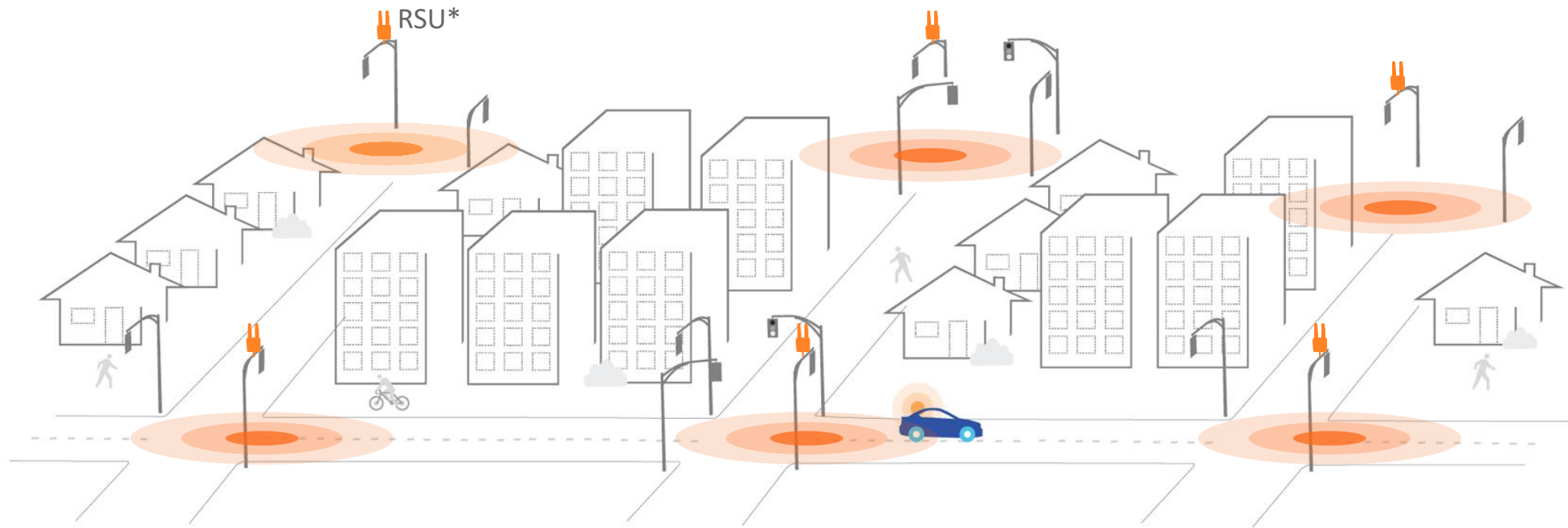
Road operators need to install RSUs across a large area

There is a high cost to deploy, backhaul, and maintain such equipment

* RSU: Road side unit supporting here WiFi 802.11p

Rollout of 4G/5G Infrastructure – the opportunity.

4G/LTE-V and 5G mass rollout starts in 2020 providing service for cooperative, connected and automated mobility.

Combined Rollout of 4G/5G and ITS Infrastructure – The beneficial Approach.
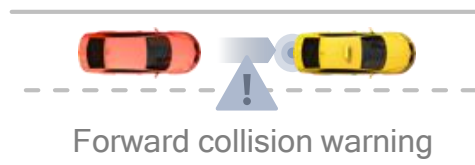

C-V2X

Upgrading existing eNodeBs* and integrating C-V2X-based RSUs with 4G/5G small cell will lower costs and accelerate deployment for road operators while providing additional cell sites for MNOs.

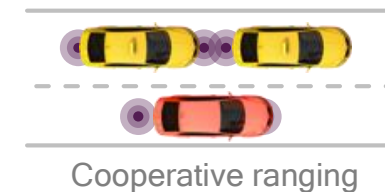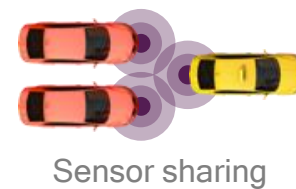* eNodeB: Evolved Node B is radio element in E-UTRA of LTE

C-V2X is the first step towards 5G that can leverage future improvements in cellular radio technology.

1H17	2H17	1H18	2H18		2H20

◆Rel14 ◆Rel15 ◆Rel16

Basic and enhanced safety
C-V2X R14/R15 with enhanced range and reliability

Autonomous driving / Automation
5G NR based C-V2X R16

- Basic safety messaging
- Dual (direct and network) support

- Backward compatible
- HD sensor and intent sharing

Forward collision warning

Sensor sharing

Cooperative ranging

5GAA Automotive Association   BMW GROUP

Opportunities for Wireless Communication

Strategic decision 4G → 5G

90+ MEMBERS

Worldwide Trends and Ecosystem

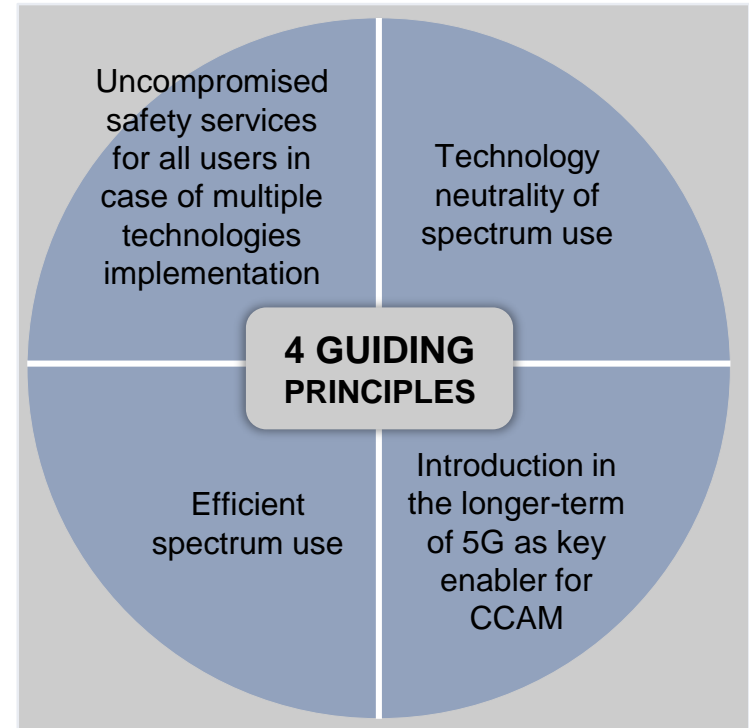🇨🇳 C-V2X Technology

🇺🇸 NPRM pro DSRC on-hold (G5 = 802.11p = Wi-Fi)

🇪🇺 Hybrid communication (Direct & Network based)

🇯🇵 C-V2X Technology

EU: Due for speeding up

Uncompromised safety services for all users in case of multiple technologies implementation

Technology neutrality of spectrum use

4 GUIDING PRINCIPLES

Efficient spectrum use

Introduction in the longer-term of 5G as key enabler for CCAM

100% of new cars in the EU equipped with cellular technology since April 2018

C-V2X Showcase in Washington DC (April 2018)

5GAA, Audi, Ford and Qualcomm Showcase C-V2X Direct Communications Interoperability to Improve Road Safety

WASHINGTON, D.C., April 26, 2018 – C-V2X Communications' Superior Performance, Synergies with Telematics Units and Evolutionary Path Towards 5G Offers Greater Potential to Save Lives; World's First Showcase Across Vehicle Manufacturers Shows Readiness for Industry Deployment as Early as 2020.

Featuring Audi and Ford vehicles which incorporate the C-V2X technology utilizing the C-V2X chipset from Qualcomm Technologies, the showcase exhibited various scenarios of how C-V2X communications is beneficial for road safety. These scenarios included situations with obstructed or no visibility, including Left Turn Assist and Emergency Electronic Brake Light use cases, in which vehicle-to-vehicle (V2V) communications alerted surrounding vehicles when cars were turning left or braking. Additional use cases were featured, including a vulnerable road user (VRU) demonstration showcasing what can be possible with future vehicle-to-pedestrian (V2P) communications. Use cases for vehicle-to-infrastructure (V2I) communication were also demonstrated, which showcased how direct communications can work closely with traffic signal controllers to ensure reduction in carbon emissions and optimization of traffic efficiency in cluttered intersections and dense environments.

Demo Scenarios
① Left turn assist (V2V)
② Emergency electronic brake light (V2V)
③ Traffic signal timing (I2V)
④ Intersection movement assist (V2V)
⑤ Video streaming RSU (I2V)
⑥ Cyclist road crossing alert (P2V)

11

- C-V2X leverages a very significant portion of the V2X work & investment already done
- Existing V2X transport layers and application protocols: safety Apps developed for ITS-G5 will work unchanged with C-V2X radios

C-V2X Showcase Today

- First implementation on motorcycles
- First multi-OEM proof of interoperability