BMW GROUP FUTURE MOBILITY - C-ITS FOR SAFER ROAD TRAFFIC.

04.12.2018 Dr. Maik Böres

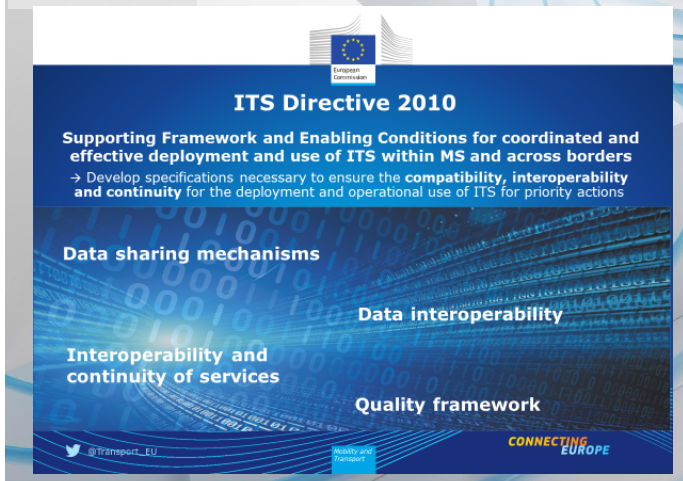
BMW GROUP

THE NEXT 100 YEARS

Rolls-Royce Motor Cars Limited

OBJECTIVE OF COOPERATIVE INTELLIGENT TRANSPORT SYSTEMS (C-ITS): INCREASE ROAD SAFETY AND TRAFFIC EFFICIENCY VIA INFORMATION SHARING.

- EU Strategy on road safety successful in place, but further increase on safety only with information sharing possible.
- Further implementation of transport policy goals with C-ITS contribute to traffic efficiency as well as decrease of casualties and fatalities.
- Core idea of the system: vehicles inform their direct environment about their behavior (i.e. “I share where I am and what I hear”*) and in return receive information. Road infrastructure contributes by data concerning traffic situation and information.



EUROPEAN COMMISSION

Brussels, 30.11.2016
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COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS

A European strategy on Cooperative Intelligent Transport Systems, a milestone towards cooperative, connected and automated mobility

Aim for C-ITS ‘day-one’ applications

Better predictions about the traffic situations and improvement of accident prevention

Initial applications have informative character only and do not intervene into driving**

* GPS-position, speed, direction, dangerous event,…
** The driver remains in full control of the vehicle and is liable for the actions of the vehicle

C-ITS INFORMATION SHARING NEEDS A COMBINATION OF DIRECT AND BACKEND BASED COMMUNICATION.

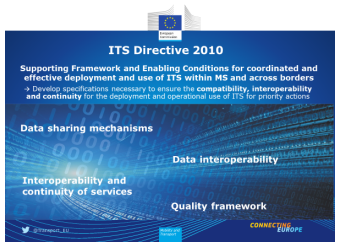
- Implementation of C-ITS applications requires hybrid approach: Direct and backend/network based communication.
- Ubiquity of C-ITS Trust model (PKI) relies on the presence of cellular networks – available everywhere.
- V2X-Communication is possible with both LTE-V/5G and WIFI (IEEE 802.11p) technology.
- Aggregation, verification and storage of shared information is essential.

EXISTING INFRASTRUCTURE CAN BE USED TO COVER MOST ‘DAY-ONE’ USE CASES AND ACHIEVE NETWORK EFFECTS RAPIDLY.

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.

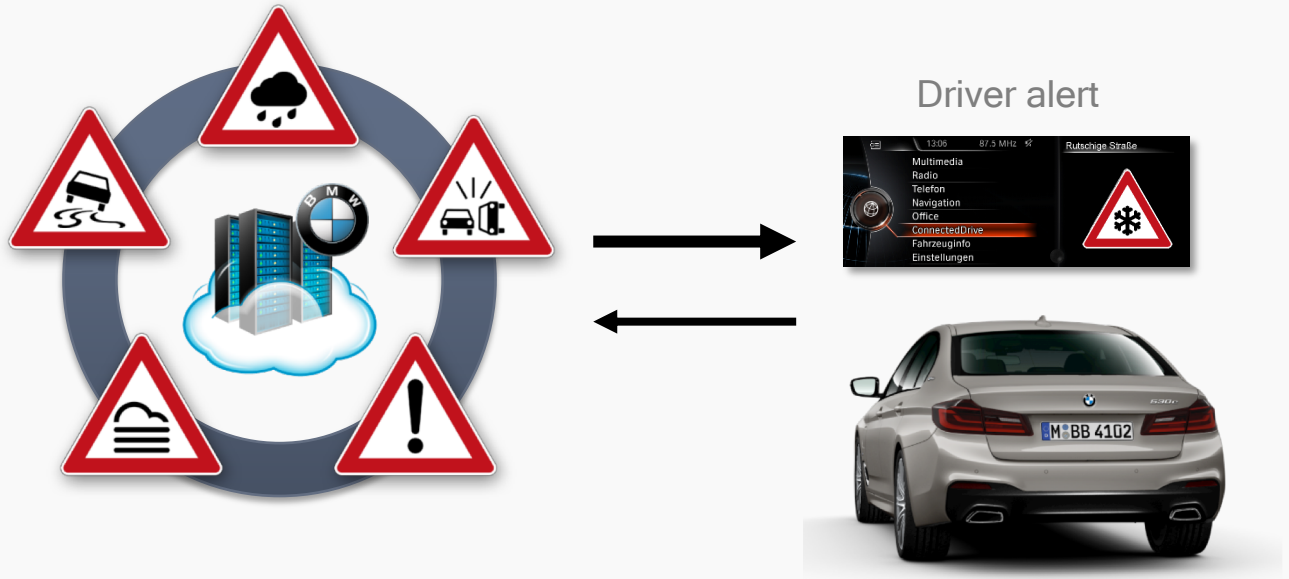


Signage applications:

- 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.



- Majority of ‘day-one’ and ‘day-1.5’ use cases can be implemented via a cellular backend/server approach.
- 2 use cases only with low latency requirements (“real time”) need direct communication, but need HD maps via 5G as a base.
- Cellular Technology with Back-End-Solution benefits from Multi-Stakeholder approach and already existing infrastructure.

poss. V2V functionality: specification and piloting pending

A SHARED DATA PLATFORM ALLOWS TO COMBINE AND VALIDATE INFORMATION OF MANY OEMS / SOURCES AND SEND EVENTS ONLY TO THE CARS AFFECTED.

Far range sensors
~200m

Short/Mid range sensors
~70m

Cooperative ITS
C-V2X based >500m
WiFi based <500m

Back-End based
Infinity

Dynamic Data
Live mapping

Cross-Industry Network
Maximum transparency of data transmission

Efficient transmission of data only to affected vehicles

Connected vehicles transmit sensor data to the location platform

Continuous update of live map and delivery to the vehicles

Vehicle security
Data security

Processing and Verification

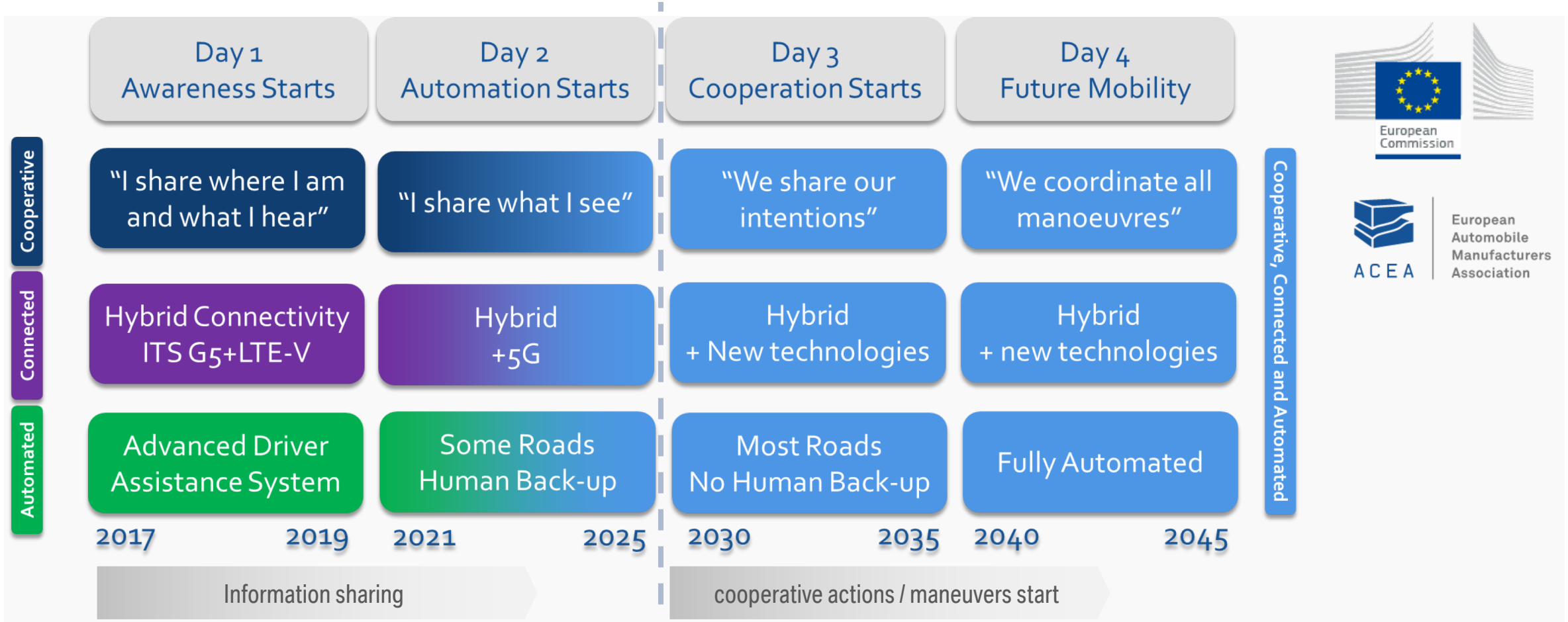
BMW APPLICATIONS TODAY – EXAMPLES FOR SIGNAGE & INFORMATION: ON-STREET PARKING SERVICES AND SPEED LIMIT PREVIEW.

Find a parking spot where you need it:

SPEED LIMIT preview based on daily map updates from fleet sensor data:

- BMW provides on-street parking availability, off-street parking garages with free spot information, occupancy of e-charging stations, charging cost and fuel prices in todays series vehicles, from the 1 series to the 7 series.
- BMW cars detect and collect 10 million traffic signs per day (more than 650 thousand cars 02/2018).
  These are used to validate and update the onboard map so that e.g. speed limit information is as precise and fresh as possible.

5G EVOLUTION PATH AGREED BY DG MOVE'S VISION TOWARDS COOPERATIVE, CONNECTED AND AUTOMATED MOBILITY.



- CCAM with Day 3 & 4 Use Cases needs C-V2X with 5G ff. as key enabler for the further development.

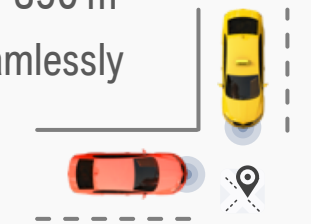
BENEFITS OF C-V2X AND IT'S 5G EVOLUTION ROADMAP.

LTE (today)

LTE-V (2020)

5G (2025)

- Range allows **earlier** driver warning, LTE-V: 700 m (with Backend infinite) compared to WiFi: 200 – 350 m
- LTE-V does not need LTE network coverage for V2X communication, but combines LTE/LTE-V seamlessly
- 5G designed for high density areas with up to 1 Mio devices per km²
- High reliability of hazard warnings through verification in backend system
- C-V2X is able to start first **low** investments in infrastructure



Bird's eye / HD map

Basics direct device to device interface

High speed support
High density support

Higher throughput
Lower latency

Direct Device to Device R12/13 (LTE)*

Broadcast D2D communication

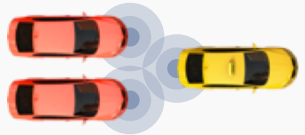
Basic Safety
C-V2X R14 (LTE)

Enhanced Safety
C-V2X R15 (LTE)

Forward collision warning

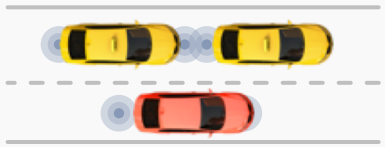
Support automated driving
C-V2X R16 NR (backward compatible with R14/15)

Higher reliability
Higher throughput



Sensor sharing

Lower latency
Wideband ranging&positioning



Cooperative ranging

- C-V2X with 5G is prerequisite / key enabler for the further development of cooperative, connected and automated mobility*.

* 3GPP Releases: R12/12 for LTE, R14 for LTE with C-V2X,…
**CCAM: Cooperative, connected and automated mobility

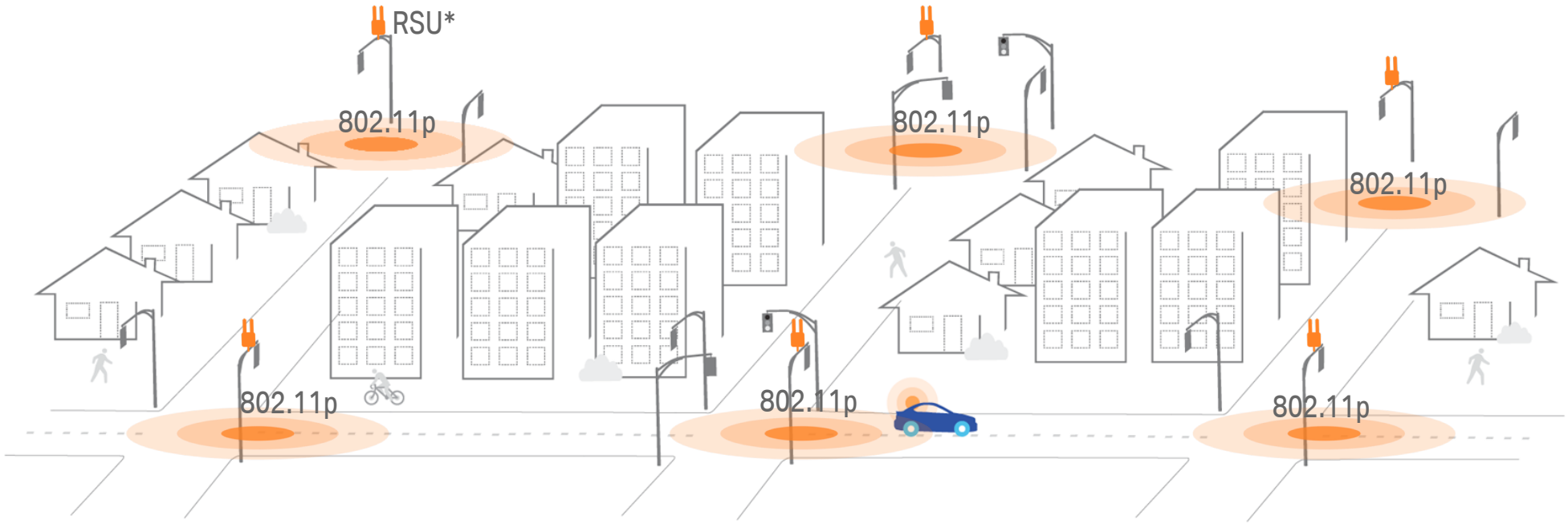
STATUS QUO OF C-ITS C2X COMMUNICATION TECHNOLOGY.

Physical Layer	Hybrid communication (Direct & Network based)**	NPRM pro DSRC** (= G5 = 802.11p = WiFi)	Cellular Technology	Cellular Technology	Cellular& DSRC
Strategic Targets	**2019:** Deployment of C-ITS Signage and Warnings **Later:** Cooperative Use- Cases	**2018:** Release of NPRM for DSRC **Today:** Low priority for mandate	**2020:** 1) ICV = 50% of new registration 2) LTE- V2X deployment rate 90% highways/ megacities **2025**: 1) ICV = 100% 2) LTE-V2X deployment rate 100%	No clear execution plan yet.	No clear rollout plan for direct communication. 5G rollout to start in 2020.

- Asian countries & Mexico support C-ITS via cellular technology. First trials successfully performed. NDRC Director Wu Wei committed to C-V2X.
- Decision in EU and US expected in 2018/2019.

*C-V2X: Cellular Vehicle-to-everything
** Decision pending

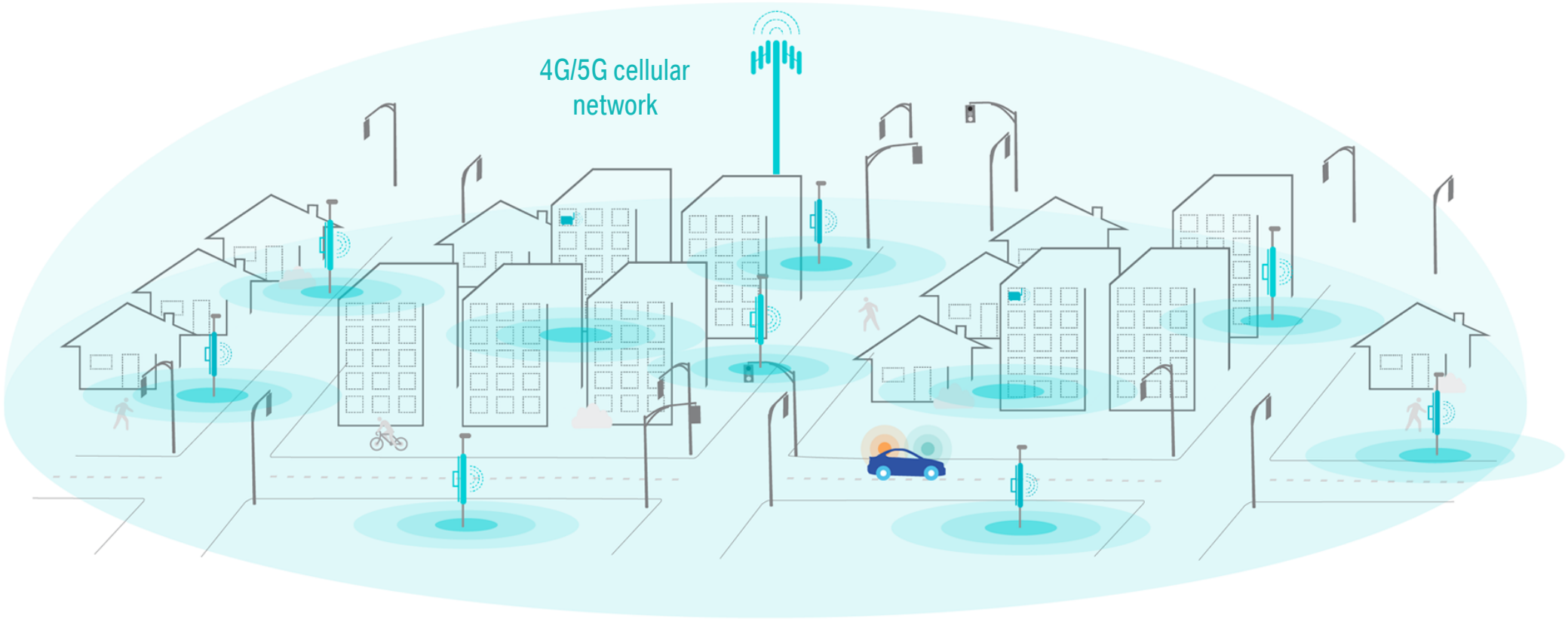
ROLLOUT OF C-ITS INFRASTRUCTURE – THE CHALLENGE.



- Road operators need to install RSUs across a large area. There is a high cost to deploy, backhaul, and maintain such equipment.

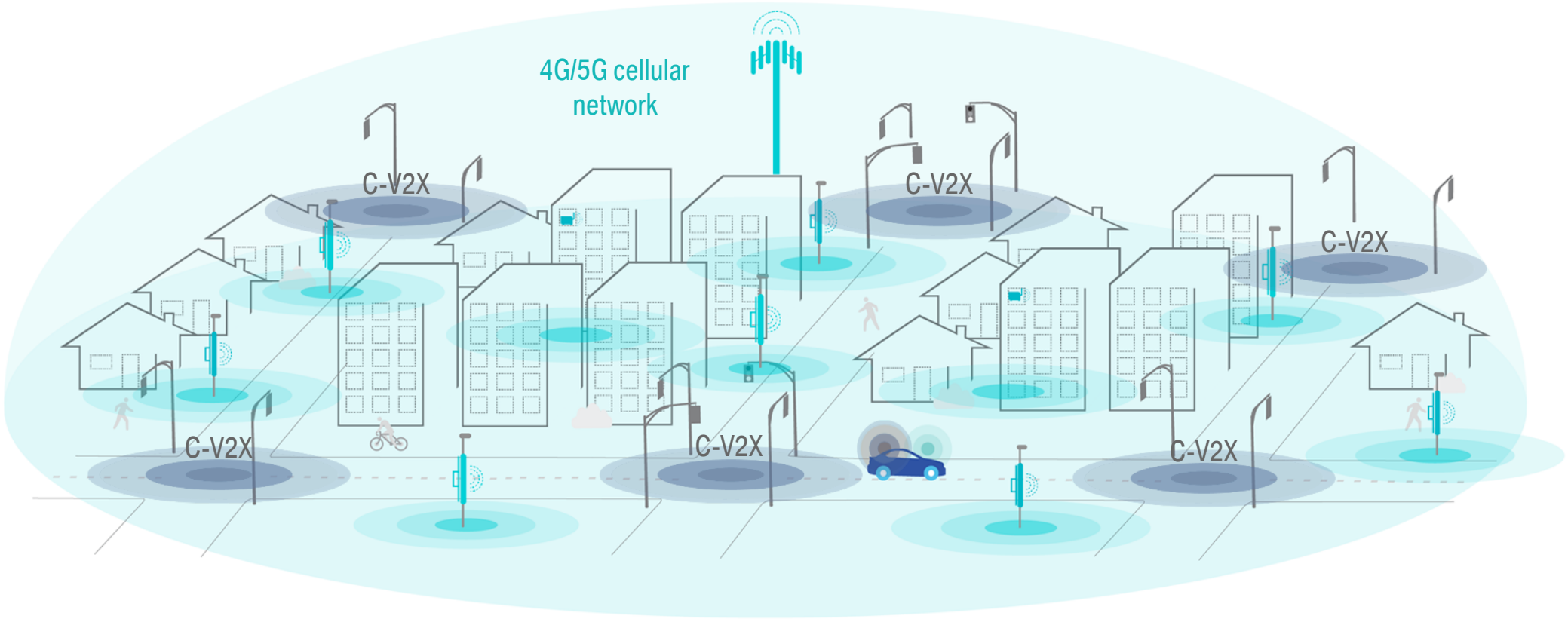
* RSU: Road side unit supporting here WiFi 802.11p

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.

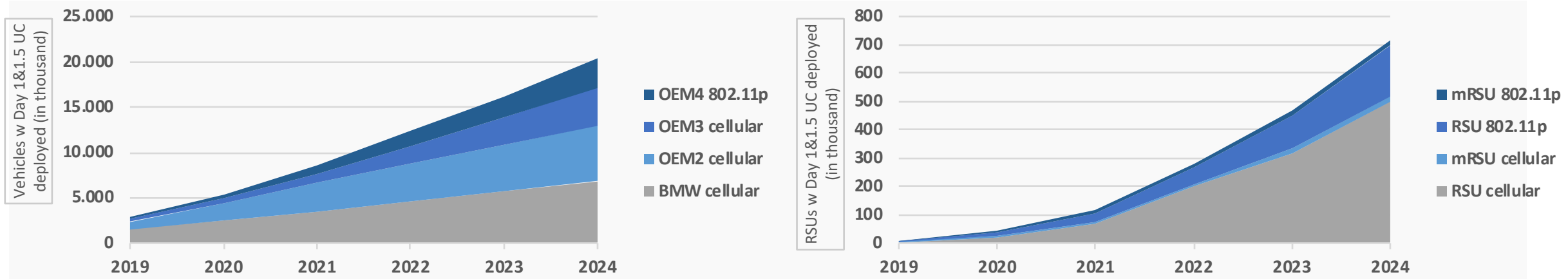
COMBINED ROLLOUT OF 4G/5G AND ITS INFRASTRUCTURE – THE APPROACH. BENEFITS OF CELLULAR C-ITS WITH C-V2X.



- 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

PENETRATION ON VEHICLE AND INFRASTRUCTURE SIDE IS KEY FOR SUCCESSFUL IMPLEMENTATION OF DAY 1 & 1.5 USE CASES.



Rollout on WiFi 802.11p side depends on:

- OEMs – currently one single OEM to start in 2019
- Road operators – slow ramp up expected, as no synergies with other technologies and verticals, low motivation as only an intermediate technology step, will become redundant with planned 5G rollout (by DG Connect) for i.a. automated driving

Rollout on cellular / C-V2X side depends on:

- OEMs – currently multiple single OEM to start in 2019 with Day 1 & 1.5 use cases
- MNO-Infrastructure & Road operators – Day 1 & 1.5 use cases need barely no addition infrastructure, integrating existing and future 4G/LTE-V + 5G telco radio infrastructure (e.g. easily be upgraded) to implement C-V2X serving use cases up to Day 4

- The cellular / C-V2X approach achieves a significantly higher penetration compared to the WiFi-only scenario.

THANK YOU!