Now that the Vehicles are Connected: What Next?

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Learn more at WWW.5GAA.ORG

5GAA bridges the automotive and telecommunication industries in order to address society's connected mobility and road safety needs with applications such as automated driving, ubiquitous access to services, integration into intelligent transportation and traffic management

AUTOMOTIVE INDUSTRY

Vehicle Platform, Hardware and Software Solutions

TELECOMMUNICATIONS

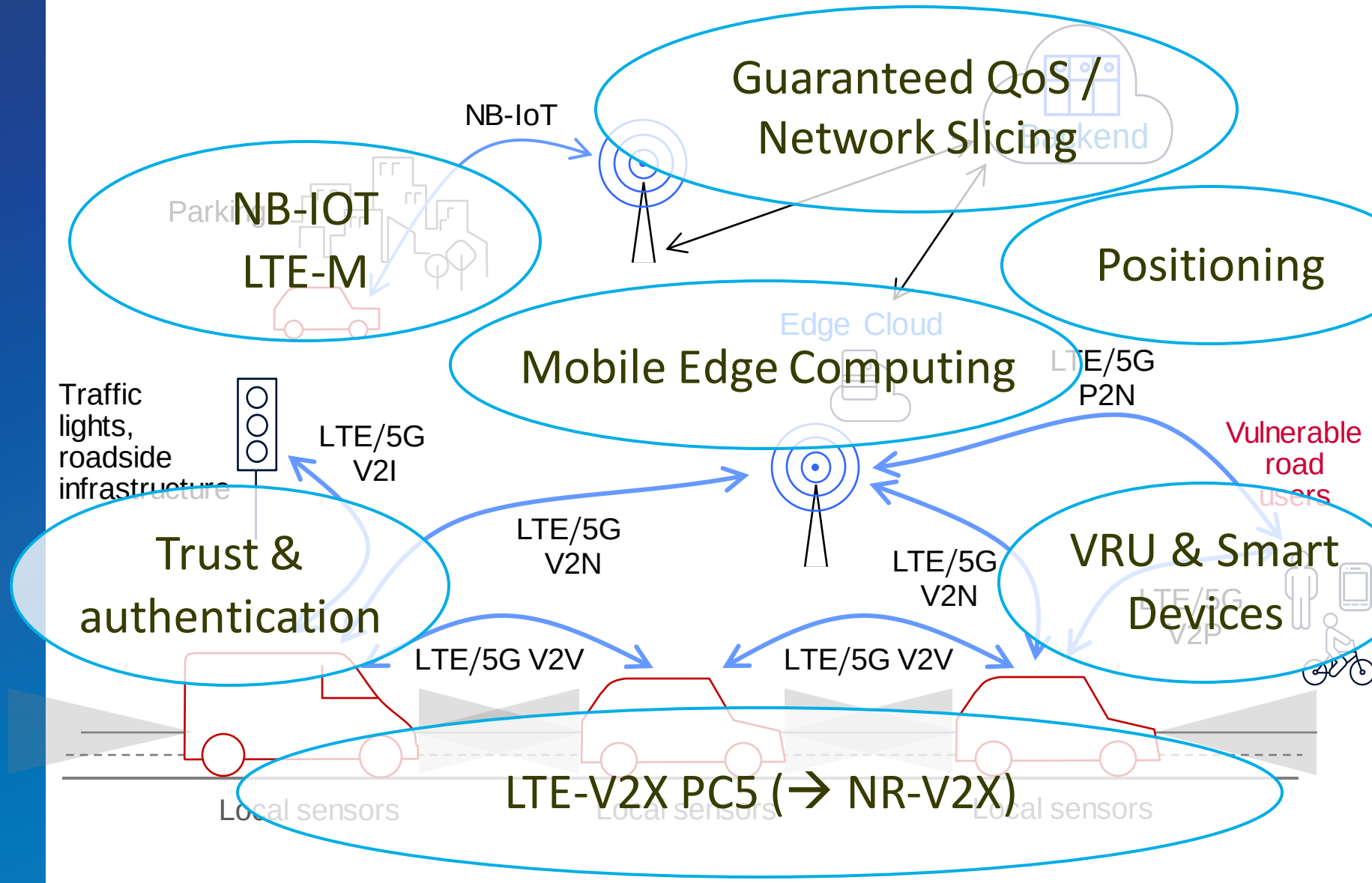
Connectivity and Networking Systems, Devices and Technologies

5GAA unites today 125 members from around the world working together on all aspects of C-V2X including technology, standards, testing, security, spectrum, policy, regulations, business models and go-to-market

Automotive Connectivity Landscape

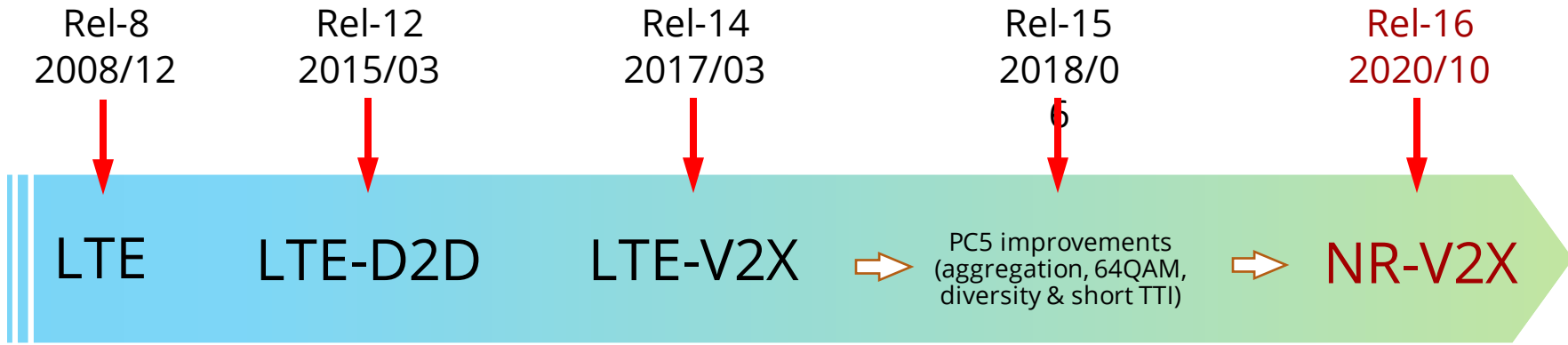
C-V2X is a unified technology platform which integrates:

- Short-range, network-less, direct communications, independent of network coverage
- Long-range cellular network communications via 4G/LTE or/and 5G



3GPP time plan: from LTE-V2X to 5G NR-V2X

- Current version of C-V2X is called LTE-V2X as part of 3GPP Rel-14 & 15.
- NR-V2X as part of Rel-16 comes as an improvement to support automated driving.
- NR-V2X will complement, co-exist and support interworking with LTE-V2X i.e. operation of NR-V2X alone is not considered.



- NR-V2X study item started in June 2018.
- Subsequent NR-V2X work item by Oct 2020.

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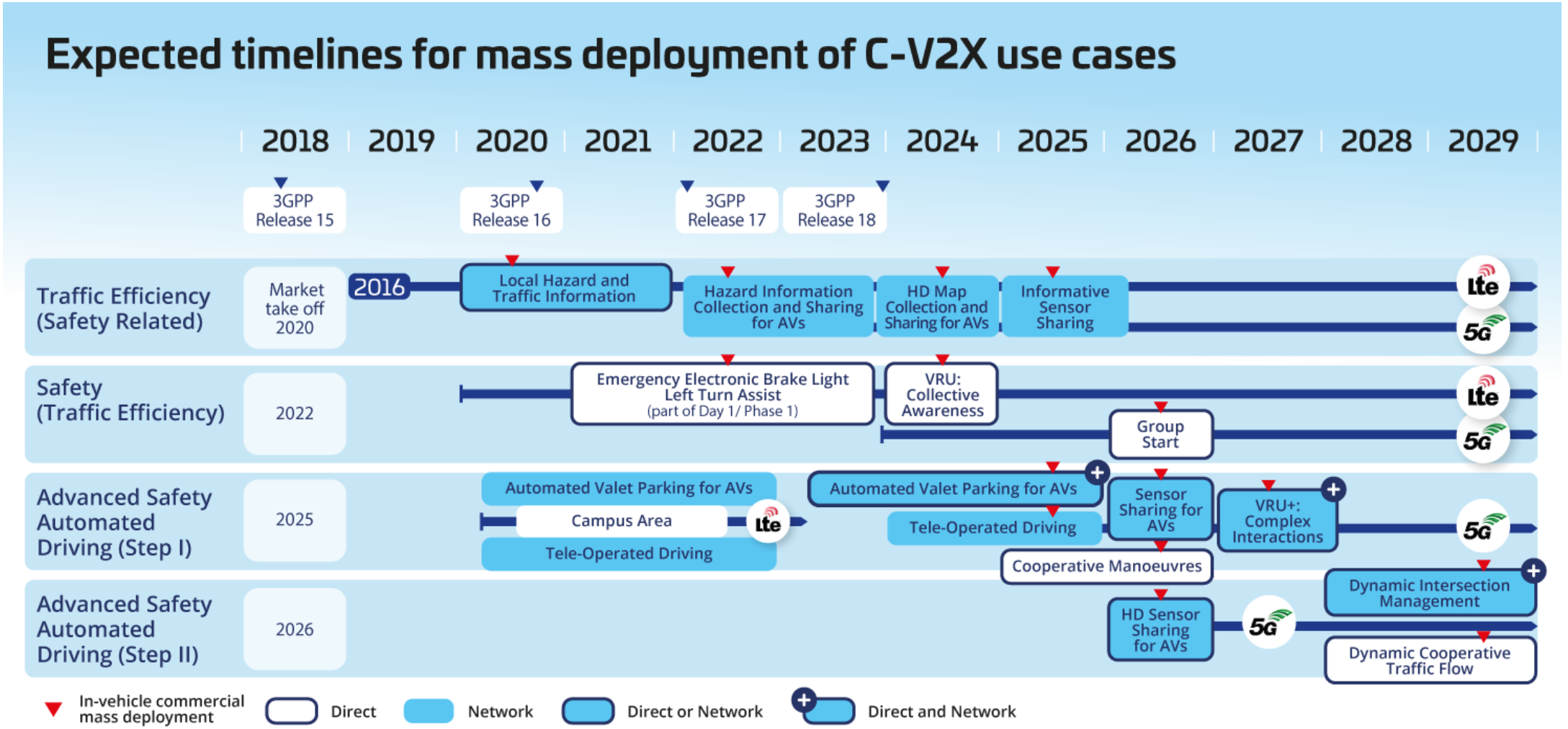
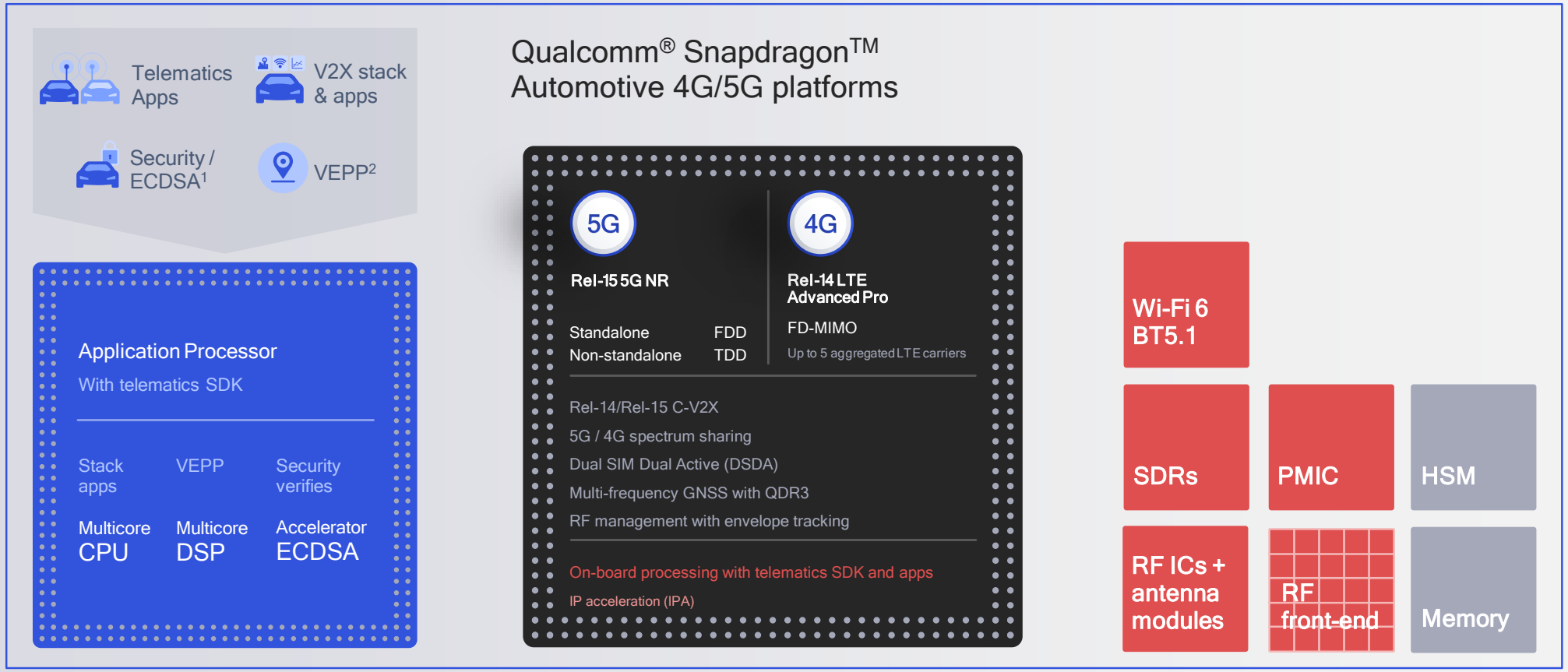
Global point of view

Expected timelines for C-V2X Use Cases



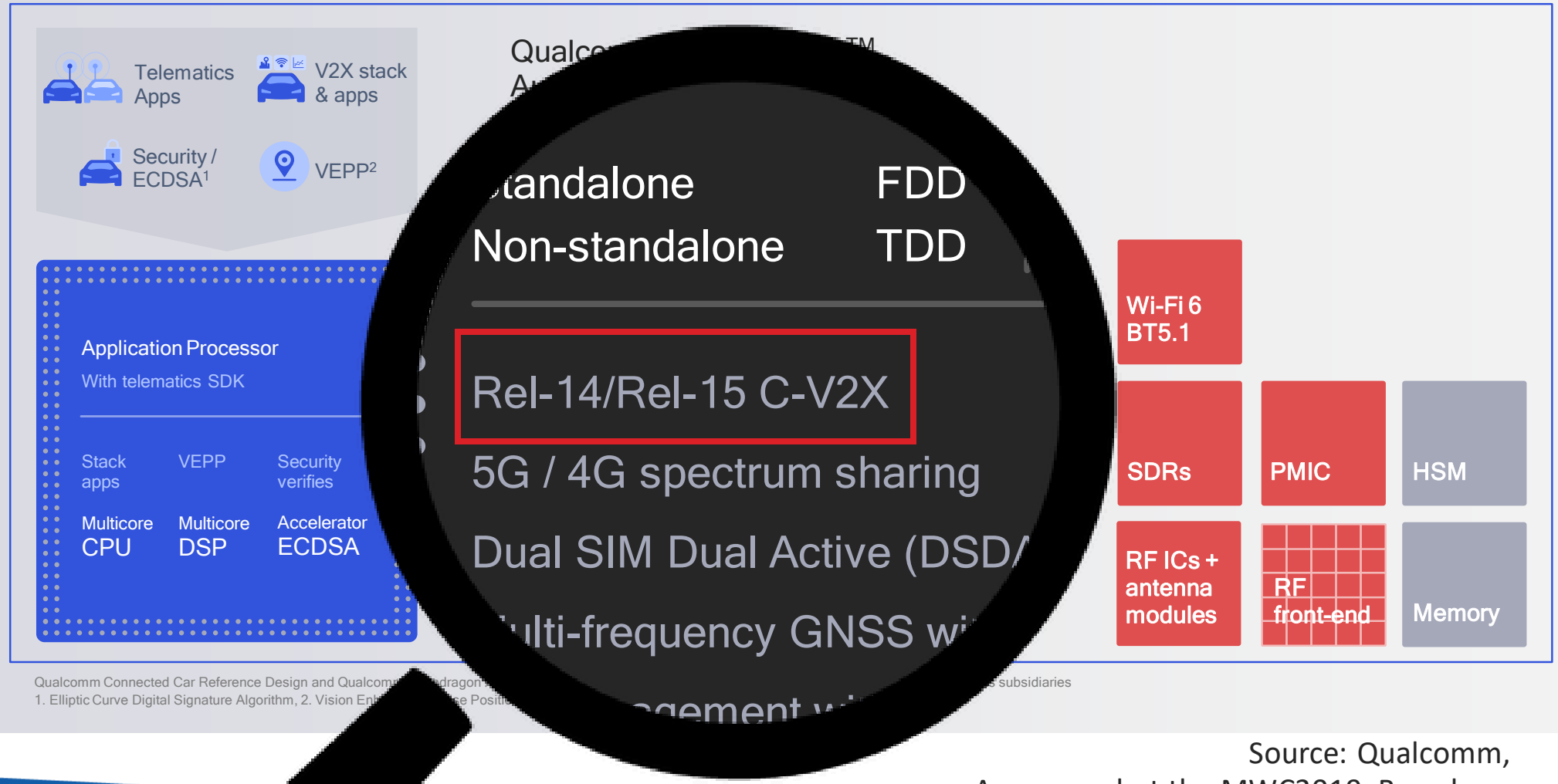
Qualcomm® Connected Car Reference Design, Gen 2



Qualcomm Connected Car Reference Design and Qualcomm Snapdragon Automotive 4G/5G Platforms are products of Qualcomm Technologies, Inc. and/or its subsidiaries
1. Elliptic Curve Digital Signature Algorithm, 2. Vision Enhanced Precise Positioning

Source: Qualcomm,
Announced at the MWC2019, Barcelona

Qualcomm® Connected Car Reference Design, Gen 2



Source: Qualcomm,
Announced at the MWC2019, Barcelona

Next Generation Automotive 5G Products

Alps Alpine Develops, Starts Shipping Samples of 5G NR Module for Automotive Use

"Newly developed UMNZ1 Series 5G NR Module for Automotive Use with C-V2X features, is compliant with 3GPP2 Release 15. Teaming up with a Chinese C-V2X chip supplier, Alps Alpine developed an All In One communication module with a built-in V2X protocol stack. Sample shipments began in March with aims to accelerate social implementation of 5G solutions for automobiles. The UMNZ1 Series is intended for global use outside China."

Source: Alps Alpine, March 2021

Fibocom Launches 5G Smart Module SC161 Based on Qualcomm QCM6350

"Fibocom SC161 can be widely applied in IoT scenarios such as smart wireless payment, C-V2X, smart cities, smart home, robot, VR, AR, etc. It is an outstanding core system solution for global IoT applications. The mass production of Fibocom SC161 smart module is planned to start in Q3 2021."

Source: Fibocom, April 2021

Quectel announces Marelli collaboration and deals to supply European automotive OEMs

In addition, Marelli and Quectel have established a joint basis to advance work on 5G and C-V2X platforms. The two companies have also enabled evolved LTE connectivity utilizing the Quectel AG520R and AG55xQ platforms. The relationship, which is Quectel's first with an automotive industry customer outside China, enables both companies to be fully-prepared for requests for quotes (RFQs).

Source: Quectel, April 2021

Samsung-Harman 5G-ready TCUs

5G-ready TCU	4G NADs capable of handling 5G protocol
	RF front-end limited to 2G, 3G and 4G bands
	"Re-farmed" channels will begin to come available for 5G by 2026
	5G may be activated via OTA
	Reduced price compared to full 5G-ready NAD (below)
Fully 5G-ready TCU	Hardware supports 5G bands n77, n78, n79 (sub-6 GHz)
	Purchase of 5G upgrade possible at any time at dealer or through e-commerce direct to consumer
	5G functionality can be activated via OTA
	Activation can be ordered by OEM, MNO or customer

Source: Samsung-Harman, 2021

LG Innotek Unveils 5G Communication Module for Automotive

5G w/ C-V2X Standalone Type	*Solution: Qualcomm 3GPP Release 15, 5.9GHz PC5 interface GNSS supported (L1 + L5)*

Source: LG Innotek, Oct 2019

C-V2X devices and sample of dual-mode RSUs

List of C-V2X Devices (last update November 2020)

- This document intends to provide an overview of the C-V2X Devices which we understand are already publicly available on the market. This overview is based on publicly available information.
- The sources are referenced. 5GAA does not accept any liability for information provided by third parties. 5GAA has not verified whether the information provided by third parties is accurate. 5GAA does not in any way validate the information provided by third parties by including particular devices in this list. This document is only intended to provide an overview, the list of devices is not necessarily complete.
- This list does not necessarily include factory-fit telematics/V2X boxes directly under contract with automakers.

Kapsch RIS-9260 dual-mode C-V2X Roadside ITS Station

Source: Kapsch

Commsignia ITS-OB4 and ITS-RS4 (DSRC & C-V2X dual mode)

Source: Commsignia

LACROIX City Neavia V2I Station 4G integrated & scalable to 5G

Source: LACROIX City

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State-of-Play on C-V2X China

Status in China: 8 C-V2X Enabled Vehicles Commercially Launched

In 2019, 15 OEMs announced mass production of C-V2X cars as of 2020

C-V2X commercial launch time: 2020H2 to 2021H1, OEMs have made the V2X launch plan.

8 C-V2X enabled vehicles already launched in China

OEM	Model	Launch Time
BYD	Han	2020
GAC	V Aion	2020
FAW	E-HS9 Hongqi	2020
GM/SAIC	GL6 BUICK	2020
GM/SAIC	GL8 BUICK	2020
Ford	Mustang Mach-E	2021
Ford	Explorer	2021
Ford	Edge Plus	2021
Ford	EVOS	2021
BJEV	Arcfox	2021
Weltmeister	W6	2021
Great Wall	WEY Mocca	2021
Human Horizons	HiPhi X	2021
NIO	ET7	2022

Applications/User Cases standardized in China

Category	Communication type	Service
safety	V2V	Forward Collision Warning
	V2V/V2I	Intersection Collision Warning
	V2V/V2I	Left Turn Assistant
	V2V	Blind Spot Warning
	V2V	Do Not Pass Warning
	V2V-Event	Emergency Brake Warning
	V2V-Event	Abnormal Vehicle Warning
	V2V-Event	Control Loss Warning
	V2I	Hazardous Location Warning
	V2I	Speed Limit Warning
	V2I	Red Light Violation Warning
	V2P/V2I	Vulnerable Road User Collision Warning
efficiency	V2I	Green Light Optimal Speed Advisory
	V2I	In-Vehicle Signage
	V2I	Traffic Jam Warning
	V2I/V2V	Emergency Vehicle Warning
information	V2I	Vehicle Near-Field Payment

Category	Communication type	Service
safety	V2V/V2I	Sensor Data Sharing
	V2V/V2I	Cooperative Lane Change
	P2X	Vulnerable Road User Safe Passing
efficiency	V2I	Cooperative High Priority Vehicle Passing
information	V2I	Guidance Service in Parking Area
	V2I	Differential Data Service
managment	V2I	Probe Data Collection
driving	V2V	Cooperative Platooning Management
safety & efficiency	V2I	Cooperative Vehicle Merge
	V2I	Cooperative Intersection Passing)
information & efficiency	V2I	Vehicle Near-Field Payment
efficiency & management	V2I	Dynamic Lane Management

Day 2

Day 1

Progress of C-V2X Infrastructure Monitoring Platform

Distribution of RSU in different cities in phase I

Shanghai

Wuxi

Changsha

Chongqing-Highway

Chongqing-City

Progess of Platform Access RSU

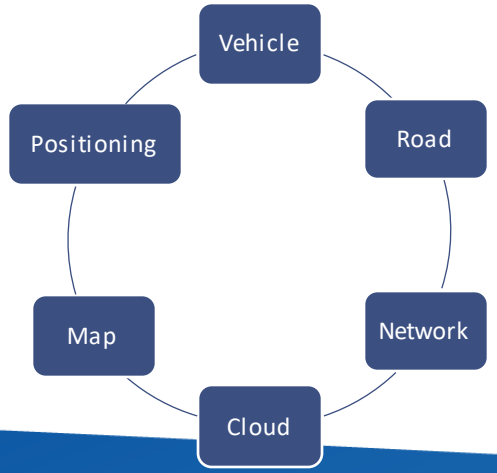
Phase	City	Number	Distribution
Phase I → 2020	Chongqing	382	Yubei District：30，Peiling District，236，Fengdu District：116
	Wuxi	184	Xishan District：2，Binhu District：96，Liangxi District：77，Xinwu District：8
	Changsha	304	Yuelu District：304
	Shanghai	14	Jiading District：14
	Xiamen	5	Jimen District：5
Total		889	
phase II	Deqing	approximate 1000	TBD
	Wuxi	approximate 300	TBD
	Tianjin	approximate 250	TBD
	Chongqing	approximate 200	TBD
	Beijing-Shanghai Expressway （G2）	approximate 200	TBD
	Liuzhou	approximate 150	TBD
	Chengdu	approximate 70	TBD

G5021 Shizhu-Chongqing Highway

G5021 Shizhu-Chongqing Highway

Gohigh Data Networks Technology Co., Ltd (Datang GOHIGH) and China Communications Construction Company Limited (CCCC) jointly upgraded the road infrastructure of this C-V2X demonstrative section, which become a C-V2X enabled complex Highway in operation.

Complete System



Complex Condition

- Tunnel, bridge
- Sharp curve, Steep slope
- Foggy, Ponding, Crosswind
- Tunnel close to exit

Large Scale

- ~130 kilometer with 100% C-V2X coverage
- 300+ RSU
- 400+ Roadside sensing/ compute/display devices
- 12 tunnels,8 interchange site,5 accident black spot

High utility

- Fully measurable, visible and controllable, fine control on key sub-sections
- Cost-efficient map engine, reduce HW cost of mass deployment
- Automatic V2X HD map segmentation, distribution and updating
- High precision positioning service in all environment
- Centralized O&M, with remote upgrade, config and alarm

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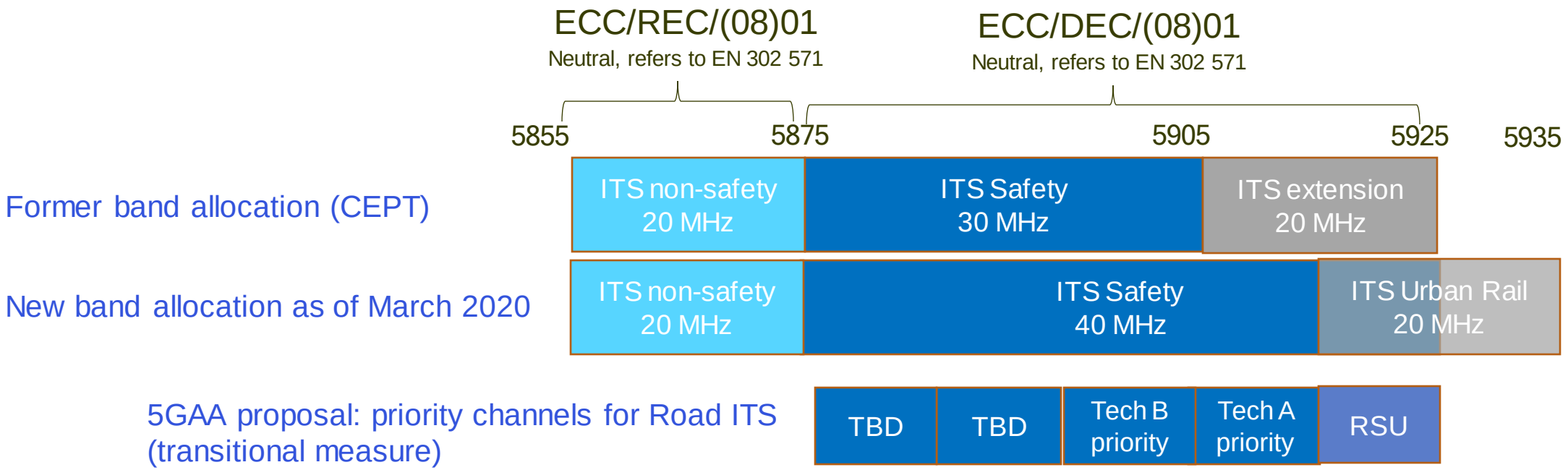
State-of-Play on C-V2X Europe

V2X EU ITS Spectrum in 5.9 GHz

2018 EC Mandate to CEPT & ETSI (updated)

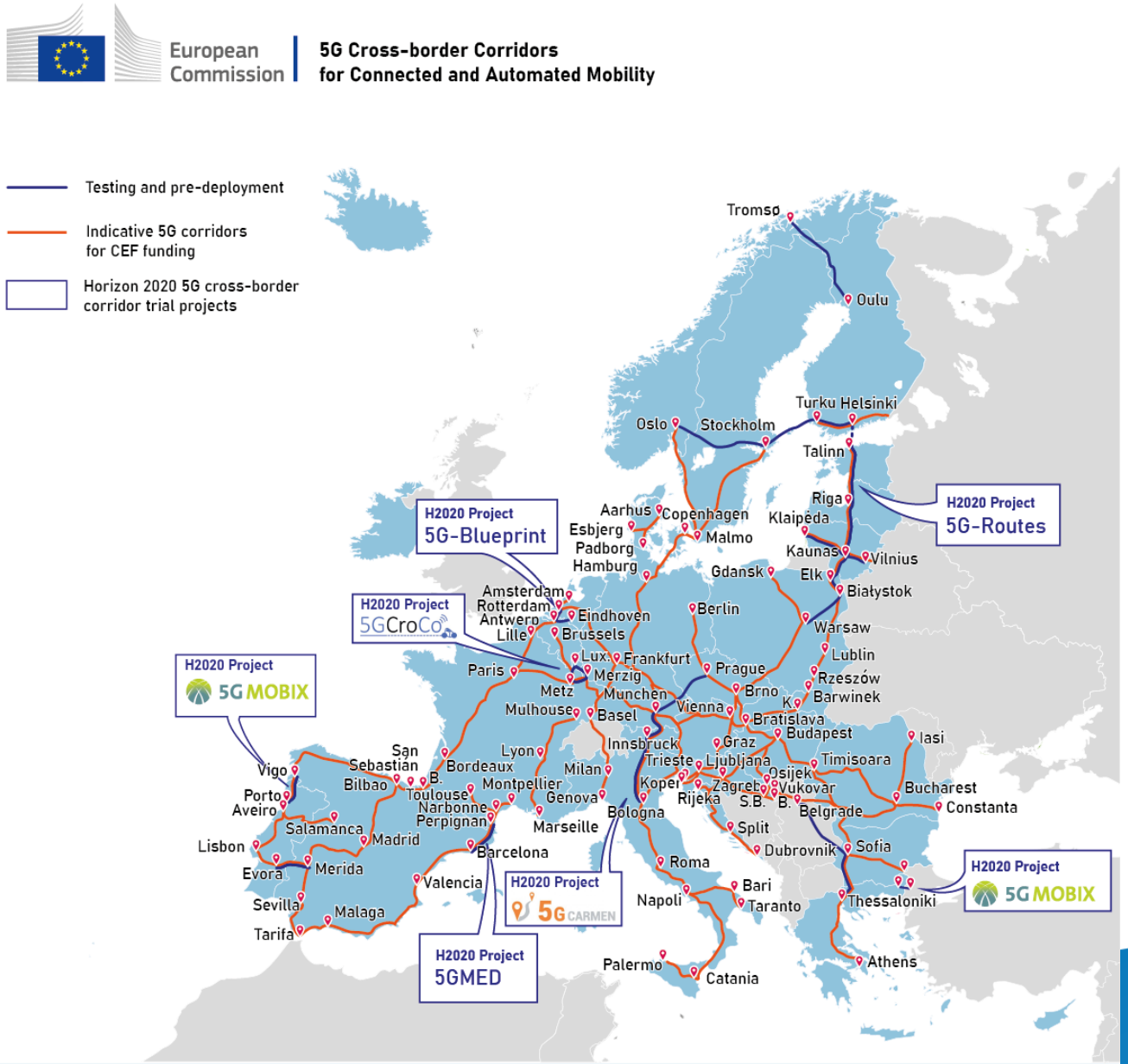
- Definition of Road-ITS coexistence solutions in 40 MHz
- Extend the mandate to cover the band up to 5935 MHz for Urban Rail.

➢ **Update EC Decision 2008/671/EC on 5.9 GHz – Q1 2020**



5G corridors:What is the project about?

- 5G transport corridors as an **EU flagship infrastructure to lead in 5G mobility ecosystems**
- **Uninterrupted** 5G coverage, **high quality** ("CAM-ready") and **low latency** (path to "edge computing") by 2025
- Trigger **private investments** through significant **public funding**
- Initial target: 26,000km of CEF 5G corridors (Estimate € 5,4bn). More ambitious targets can be achieved **in combination with RRF funding**
- **Pan-European dynamics** through EU coordination of geographic complementarity, especially re. **cross-border sections**



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Status in Europe

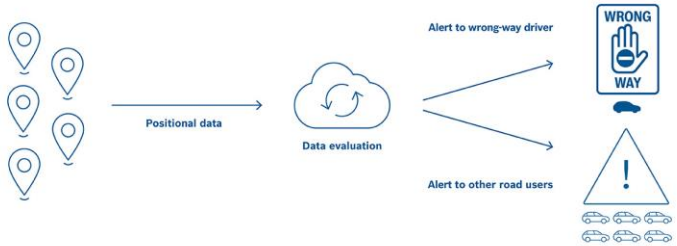
BMW and Samsung to offer 5G in the iNEXT as soon as 2021

"BMW Group has set itself the goal of having the largest over-the-air upgradeable fleet of any manufacturer in the world by the end of 2021. By that time, a total of over 2.5 million vehicles from the BMW brand will be able to receive Remote Software Upgrades."

Source: BMW Group, Jan 2020 and BMW Group, March 2021

Bosch's wrong-way driver warning system now a feature in ŠKODA vehicles and deployed in NL with via Talking Traffic

2.5 million unique active users per month already in Europe



Source: Bosch, August 2020 & Bosch, Feb 2021

Audi is introducing the V2I service "Traffic Light Information" to Europe.

Source: Audi, 2019 and Audi, 2020

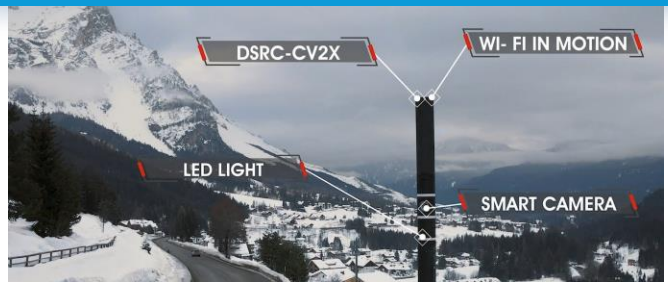
"The FCA Uconnect system will use 5G technology"

Source: La Repubblica, Nov 2019

"Local Hazard Information technology is being rolled out across more than 80% of Ford's passenger vehicle line-up by the end of [2020]."

Source: Ford, 2020

ANAS deploys dual-mode C-V2X / ITS-G5 RSUs in Italy on 80 Km of the 51 Road



Source: Le Strade dell'Informazione, Feb 2021

Telefónica, APM Terminals to deploy 5G and C-V2X at Port of Barcelona

Source: APM Terminals, March 2021

Continental continues its successful course in 5G connectivity with first order for commercial vehicles

"As of 2023, Continental will supply two European vehicle manufacturers with intelligent antenna modules and 5G telematics units."

"Continental has won a serial order from a leading European commercial vehicle manufacturer to equip its vehicles with the 5G V2X telematics platform."

Source: Continental, July 2020 & Continental, April 2021

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State-of-Play on C-V2X US

US ITS Regulatory Update

The US FCC 5.9 GHz ruling points to **C-V2X as technology of choice**:

- Allows C-V2X in upper 30 MHz after expedited waiver process
- DSRC will move to lower 10 MHz until end of phasing out period (2 years)
- FCC puts spotlight on OEMs to bring V2X to the finish line

December 2019	November 2020	2021…
		
FCC Releases 5.9 GHz NPRM	**FCC adopted 5.9 GHz First Report and Order (R&O) and FNPRM**	**Awaiting R&O and FNPRM publication in Federal Register**

Status in the US

Ford commits to deploy C-V2X in all new vehicle models in the US beginning in 2022

source: Ford, Jan 2019

Audi of America, Virginia DOT and Qualcomm Announce Initial C-V2X Deployment in Virginia

source: Audi USA, Jan 2020

Blue Bird join Audi, Applied Information on connected vehicle deployment to boost school bus and school zone safety

source: Blue Bird, March 2021

Auto Industry Unites Behind Safety Technology by Committing at least 5 Million V2X Radios and Devices by the End of 2025

source:
Alliance for Automotive Innovation, April 2020

General Motors and Qualcomm extend long-standing relationship to transform next generation vehicles

"As an extension of the relationship, GM worked with Qualcomm Technologies for C-V2X, which has launched with the Buick GL8 MPV now available in China."

source: Qualcomm, Jan 2021

Verizon & Honda test how 5G enhances safety for connected and autonomous vehicles

"Using Cellular Vehicle-to-Everything (C-V2X) communication, Honda SAFE SWARM™ enables vehicles to communicate with other road users and share key information such as location, speed, and vehicle sensor data"

Source: Verizon, April 2021

What’s Next with 5G-V2X

Cliquez et modifiez le titre

Basic Safety use cases

Advanced Driving use cases

Upper layers
Mapping use cases to transport profile

LTE-V2X sidelink
Rel. 14/15
Basic messages with Broadcast

NR-V2X sidelink
Rel. 16 and beyond
QoS with Groupcast

5G-V2X sidelink

5G NR C-V2X

Communication augments autonomous driving

Perception

Sharing of high throughput sensor data and real world model

Path planning

Intention and trajectory sharing for faster, yet safe maneuvers

Real-time local updates

Real-time sharing of local data with infrastructure and other vehicles (e.g. 3D HD maps)

Coordinated driving

Exchanging intention and sensor data for more predictable, coordinated autonomous driving

Source: Qualcomm

Enable complex interaction Use Cases (perception, negotiation, multi-lateral agreements)

Source: Continental

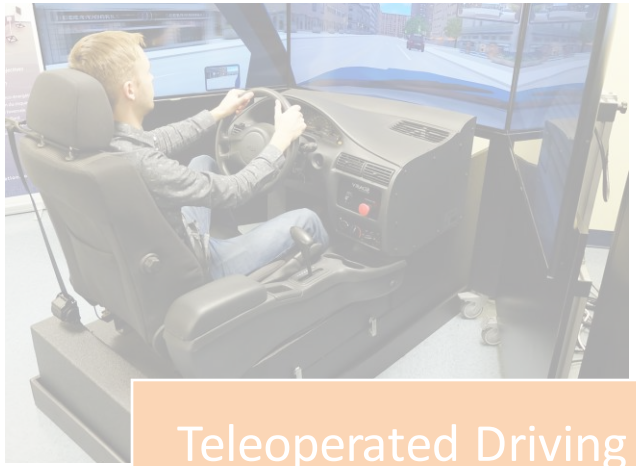
Cooperative Parking

Group Start

VRU Crossing

Virtual road monitoring

Cooperative Traffic Gap



Teleoperated Driving

Thank you!

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