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Qualcomm

C-V2X – CAT Coalition

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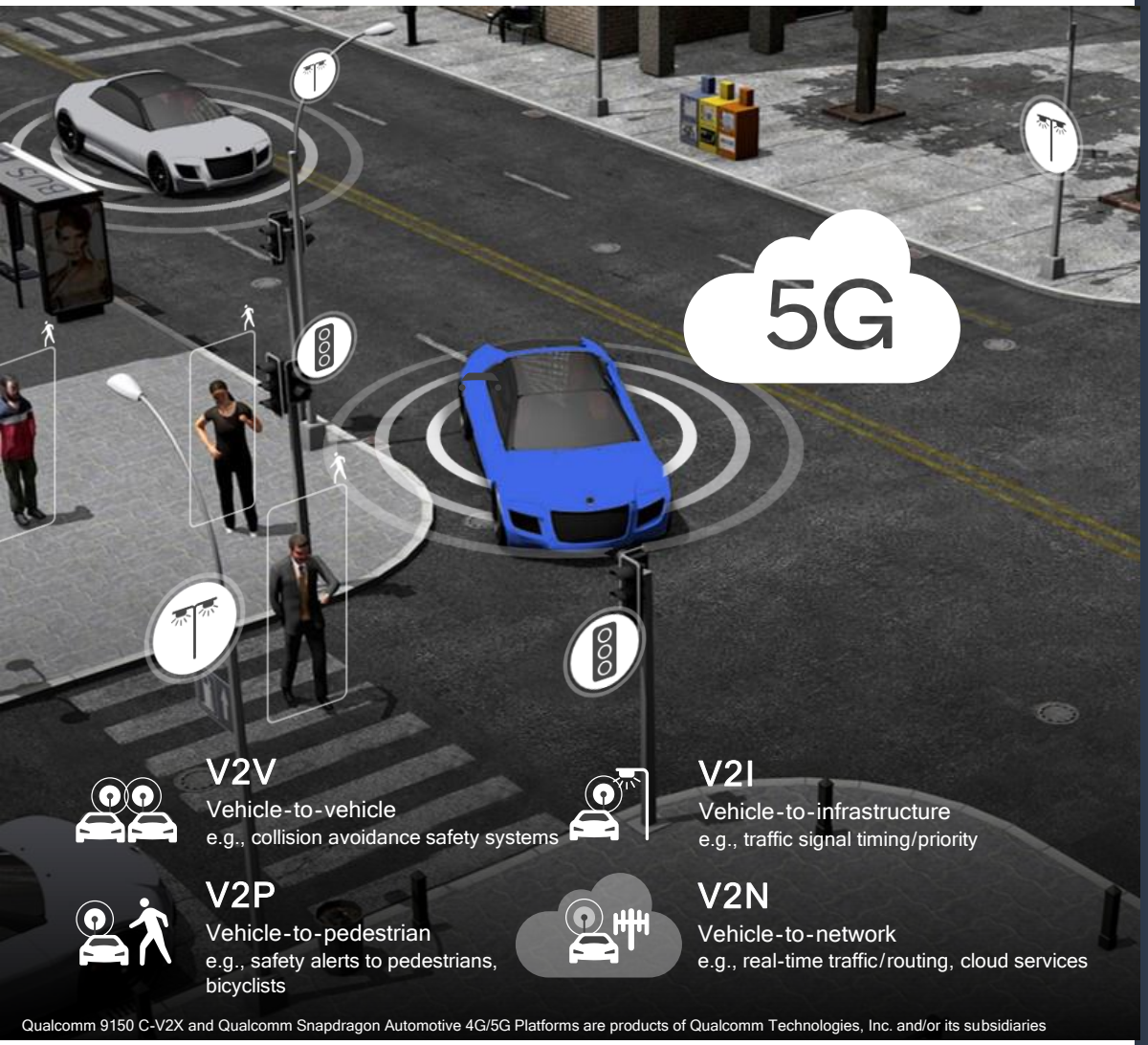


Qualcomm 9150 C-V2X and Qualcomm Snapdragon Automotive 4G/5G Platforms are products of Qualcomm Technologies, Inc. and/or its subsidiaries

C-V2X

Established the foundation of C-V2X for safety in Rel-14/15 with continued evolution in Rel-16 5G NR for advanced use cases

- Release 14/15 C-V2X standards completed
- Broad industry support with 5GAA
- Global trials started in 2017
- Qualcomm® 9150 C-V2X chipset announced in September, 2017
- Integration of C-V2X into the Qualcomm® Snapdragon™ Automotive 4G and 5G Platforms announced in February, 2019

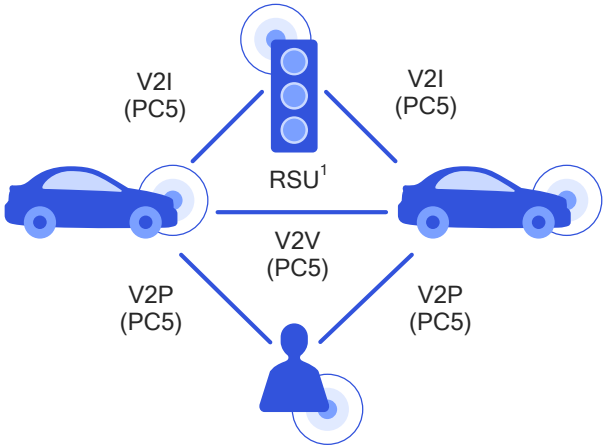
C-V2X enables network independent communication

Direct safety communication independent of cellular network

Low latency Vehicle to Vehicle (V2V), Vehicle to Infrastructure (V2I), and Vehicle to Person (V2P) operating in ITS bands (e.g. 5.9 GHz)

Direct PC5 interface

e.g. location, speed, local hazards

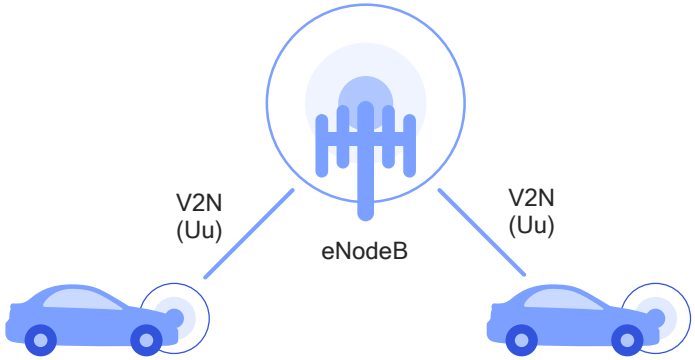


Network communications for complementary services

Vehicle to Network (V2N) operates in a mobile operator's licensed spectrum

Network Uu interface

e.g. accident 2 kilometer ahead

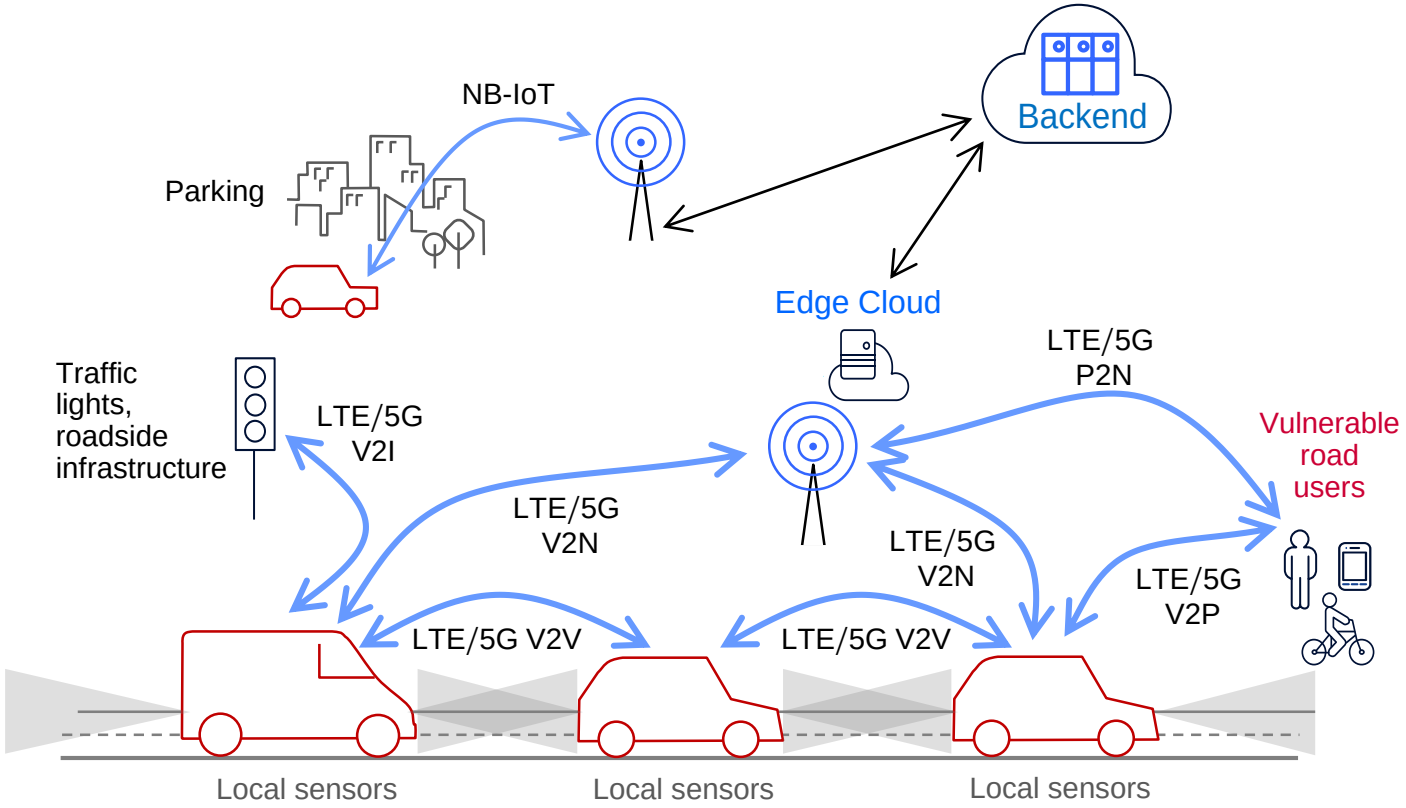


1. RSU stands for roadside unit

Cellular-V2X (C-V2X)

C-V2X is a unified technology platform which integrates:

- Short-range, network-less, direct communications (LTE-V2X PC5 today)
- Long-range cellular network communications (LTE-V2X Uu today)



Source: 5G Automotive Association

Helping bring a comprehensive ecosystem together

Working across industries to forge sustainable relationships, unlocking new value

Software companies

Test equipment vendors

Automotive	Transportation	Telecom	Internet/cloud
Vehicle OEMs	Road operators	Mobile operators	Cloud service providers
Tier 1 suppliers	Traffic industry suppliers	Telecom suppliers	Map providers

Standards

Standards development organizations

Telecom and auto industry organizations

ITS organizations

C-V2X Resources

Target: Posting by Labor Day

- C-V2X Tutorials
- C-V2X FAQ
- So, you want to acquire RSU? Product Availability
  - Dual Mode, Dual Active RSUs

Is it possible to co-locate C-V2X and DSRC RSUs?

What is the needed isolation?

How can the needed isolation be achieved?

Robust Global C-V2X Ecosystem is Ready

9150 Modules

- WNC
- Quectel
- ZTE
- LG
- LG Innotek
- SIMCom

Commercial ready module in 2018

RSU vendors

- **US** : Commsignia, Savari, Kapsch, Danlaw
- **EU** : Swarco, Lacroix, Aximum, Marben
- **China** : Nebulalink, Genevict, Neusoft
- **RoW**: Cohda, Cybercom, Oki

12+ RSU products in the pipeline. Commercial ready in Q1 2019

Tier1s/OBU vendors

- Ficosa
- Cohda
- Valeo
- Savari
- Marben
- Continental
- LG Electronics
- Nebulalink
- Commsignia
- Genevict
- Danlaw

10+ OBU suppliers the pipeline. Commercial ready in Q1 2019

System Integrators

- **Sasken**
  - Integration & support
- **Thurdersoft**
  - Integration & support

Global foot print to support system Integration

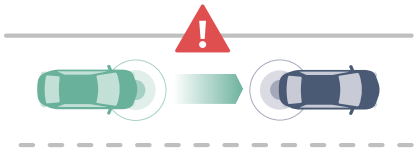
C-V2X is ready for deployment now!

Evolving C-V2X Direct Communications towards 5G NR

While maintaining backward capabilities

Evolution to 5G NR, while being backward compatible
C-V2X Rel-14 is necessary and operates with Rel-16

Basic safety
IEEE 802.11p

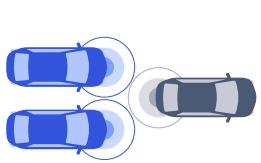


Basic and enhanced safety
C-V2X Rel-14/Rel-15 with enhanced range and reliability

Autonomous driving use cases
5G NR C-V2X Rel-16

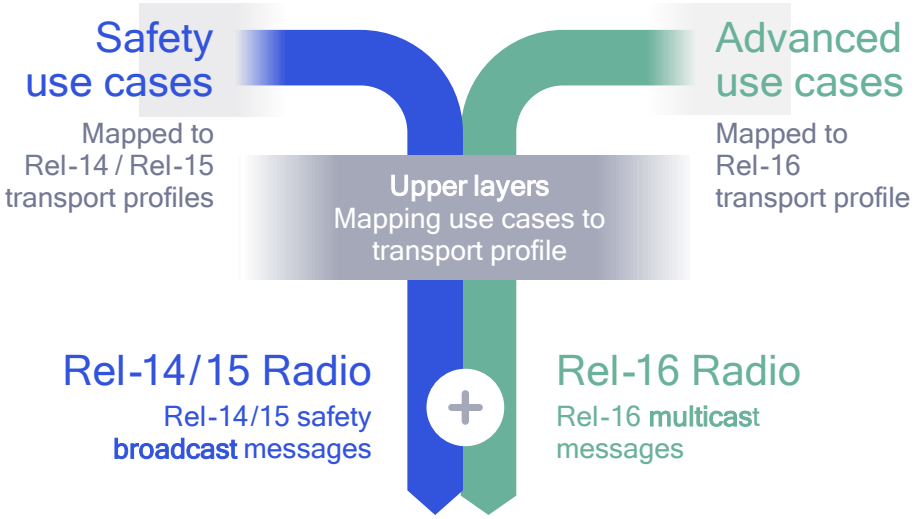
Backward compatible with Rel-14/Rel-15 enabled vehicles

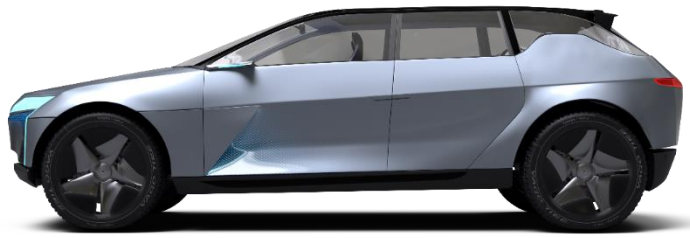
Higher throughput
Higher reliability
Wideband carrier support
Lower latency



5G NR C-V2X is backward compatible at upper layers

By enabling coexistence of Rel16 with previous releases





Rel-16 C-V2X vehicles will be designed to support Rel-14/Rel-15 for safety

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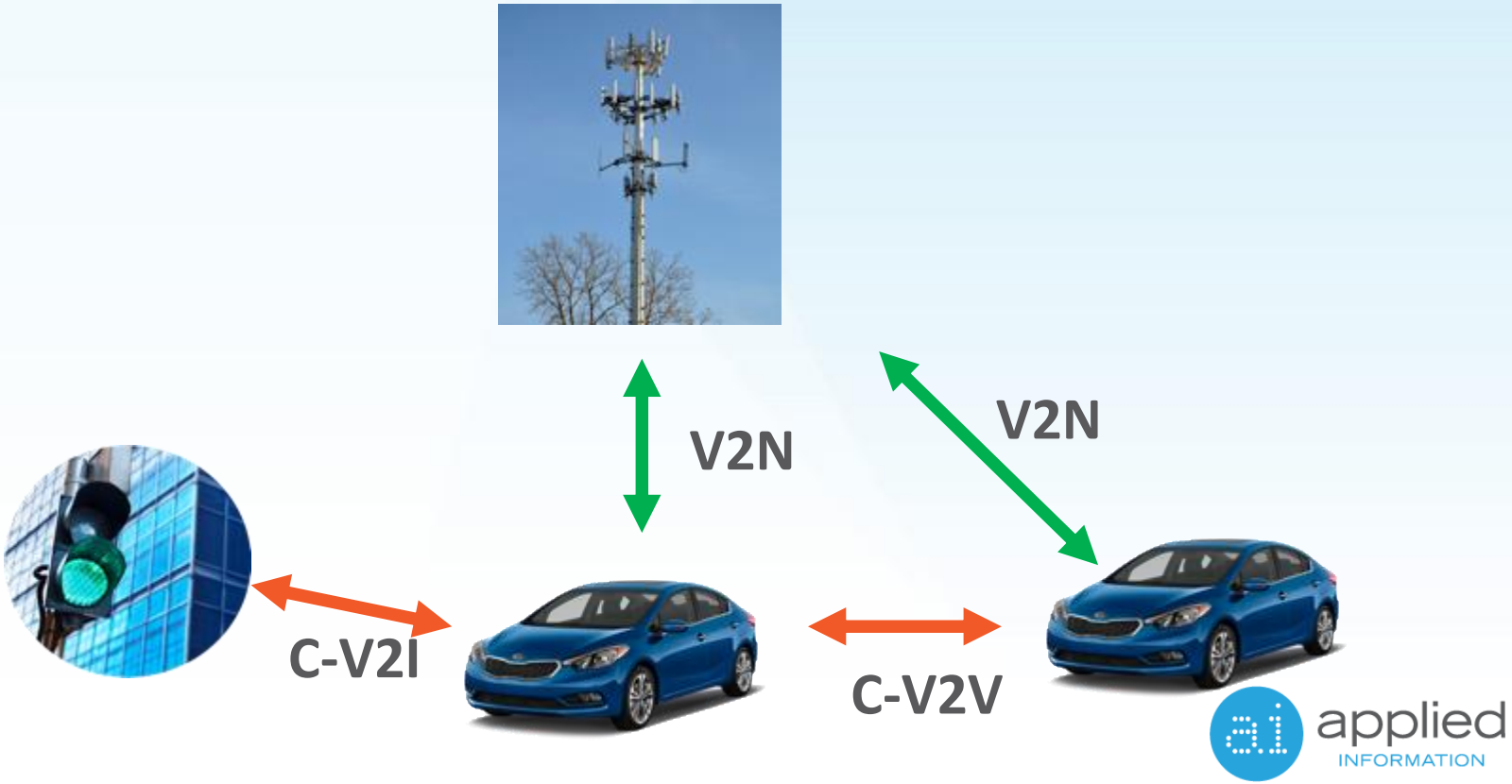
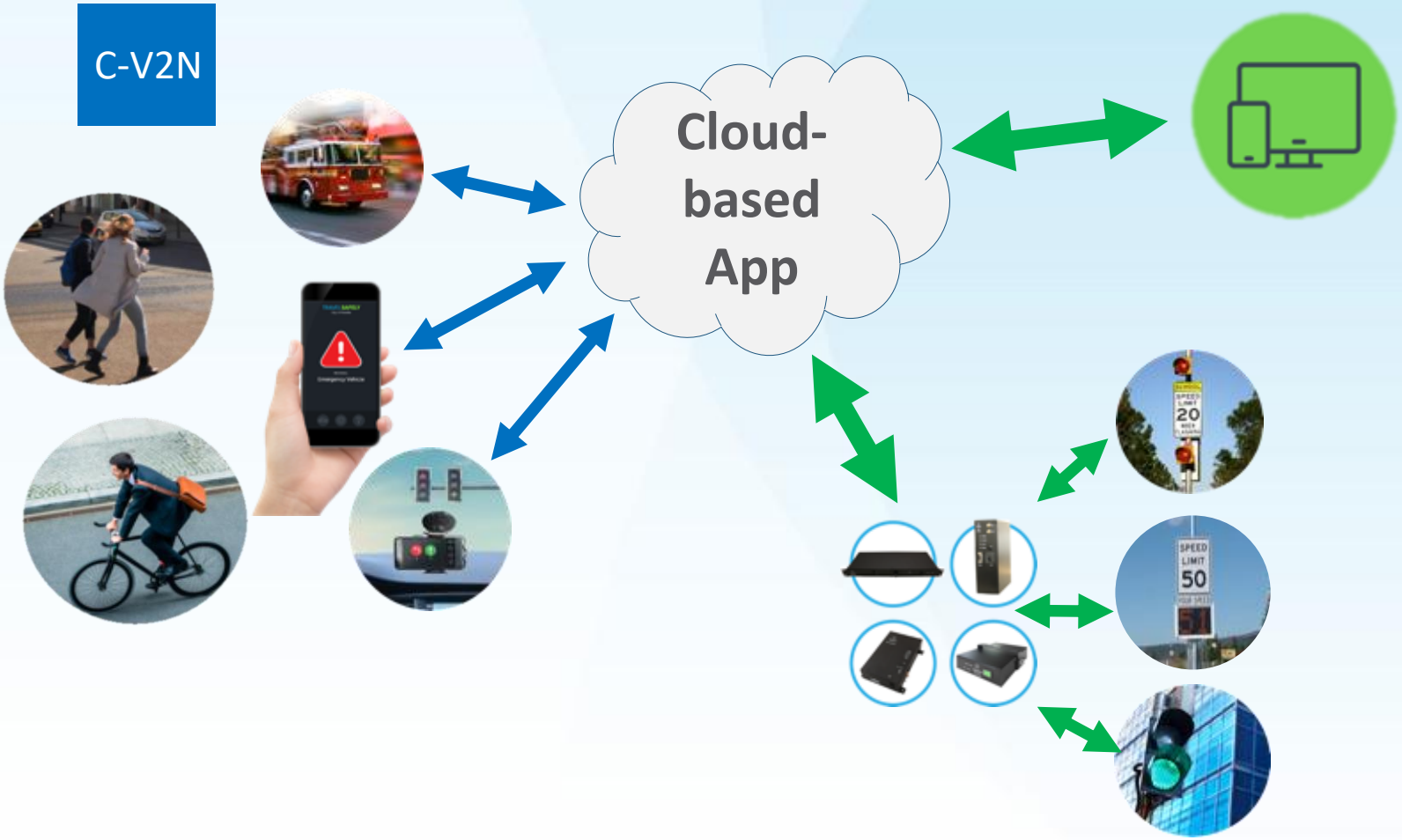
Cellular V2X (C-V2X)

- C-V2X has 2 components
  - Network C-V2N
  - Direct C-V2X (C-V2I and C-V2V)



Message Flow – Impact of C-V2N



applied INFORMATION

Over 20 C-V2N CV Applications Currently Available

- SPaT/MAP display of signal timing – V2I
- Red-light running at traffic signals – V2I
- Bus/transit priority – V2I
- Intelligent school beacons – V2I
- Emergency vehicle getting through the signal – V2I
- Emergency vehicle proximity alert? – V2V
- Motorist – Cyclist communication - V2V
- Motorist – Pedestrian communication – V2V
- Work zone warnings – V2I
- Curve warning/reduce speed – V2I
- Rear end collision warning – V2V
- Virtual/advance traffic detectors to make signals work better – V2I

Current C-V2N Connected Vehicle Applications

- School Bus Active ahead warning – V2V
- Railroad active ahead warning – V2I
- Dynamic Message Sign (DMS) Annunciation – V2I
- Unprotected Left Turn Collision Avoidance
- Multi-lane Highway Crossing Collision Avoidance
- Wrong way vehicle warning – V2I
- Active Pedestrian in Crosswalk ahead – V2I
- Weather Warning - V2I
- Freight Priority
- Event Management Parking Information – V2I

C-V2N is not only here now,
it is a link to the future.

applied INFORMATION

US DOT Policy Development

- (June 2019) USDOT CV Policy re-defined as 3 points:
  - **Protect the 5.9GHz band** for transportation only use
  - **Remove the exclusivity of DSRC** to allow other technologies to co-exist
  - Make no choice of technology solution – let industry decide and **challenge industry** to give agencies confidence in buying infrastructure equipment

Accepting the Challenge: NEMA TS 10

- Newly formed committee to develop a standard to be used for procuring infrastructure-based equipment to support connected vehicle applications
- As well as traditional signal companies, this has attracted the support of communications companies: chip manufacturers, equipment suppliers
- A “multi-radio solution” is proposed as the basis
- Available end-2019

Projected Future-proof Solution

applied INFORMATION