C-V2X Technology

Tech Marketing

Qualcomm

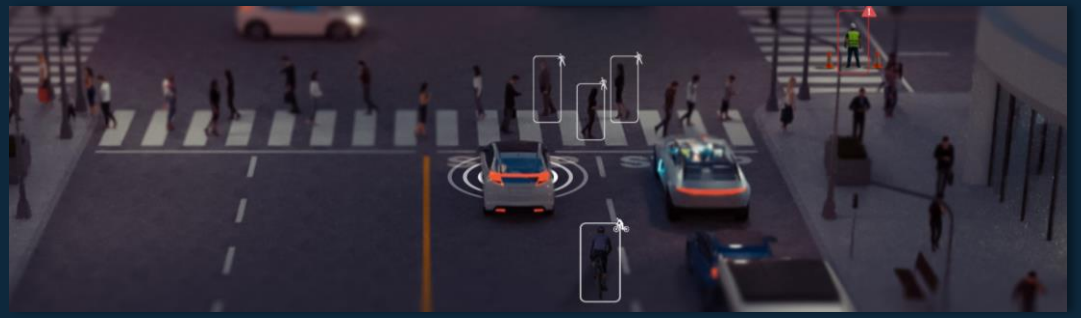
V2V Vehicle-to-vehicle e.g., collision avoidance safety systems. C-V2X messages on a sidelink channel provide a Non-Line of Sight (NLOS) sensor for vehicles

V2I Vehicle-to-infrastructure e.g., Red light violation warning. Roadside Units (RSUs) broadcast messages on a sidelink channel to enhance safety at intersections

C-V2X

Connects vehicles to everything around them
Enhancing the safety of an intelligent transportation system

V2N Vehicle-to-network e.g., real-time traffic/routing, cloud services.V2N messages enable value-add use cases for drivers, vehicle OEMs and road operators



V2P Vehicle-to-pedestrian e.g., safety alerts to/from Vulnerable Road Users (VRUs) like bicyclists/pedestrians. Vehicles/VRUs broadcast messages on a sidelink channel allowing other actors to take appropriate action

C-V2X

Introduced in 3GPP Rel 14

Operates in dedicated spectrum at 5.9 GHz

Distributed operation with no infrastructure and SIM required

C-V2X already deployed commercially in China; U.S. deployment targeted in 2022

Broad industry support with 5GAA, GSMA and 5G Americas

C-V2X sidelink complements 5G networks

Managing intersections combining C-V2X with 5G

C-V2X sidelink
(collision avoidance and safety alerts)

Cellular networks
(TMC-based traffic monitoring and advisory)

Edge AI
(AI-based vision systems for enhanced safety)

1 TMC is Traffic Monitoring Center 2 GLOSA is Green Light Optimized Speed Advisory

Smart RSUs with on-device processing form a connected intelligent edge

Central cloud

Traffic management center

Big data, AI training, less delay sensitive content, storage,…

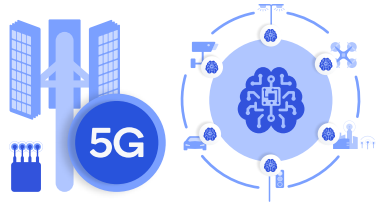
Compute intensive, real-time data

Edge cloud

Neighborhood/city/highway

Compute/processing, context, control, storage, closer to vehicular network

Vehicular networks are highly dynamic



On-device intelligence

Smart RSUs

Sensing, processing, security, intelligence

- Realize 5G's low latency
- Scalability
- Performance
- Additional resources
- New deployments, (private networks)

Latency could be over 100s ms today ← Cooperation between road operators, MNOs[1], infra vendors, cloud providers,… → Latency as low as 1 ms

- 5G value maximizes from operators and services
- Deliver enhanced and new services
- Host, content, processing,.. for 3rd party
- Local analytics, management

- Immediacy–tasks on device
- Efficient use of bandwidth
- Scalability

1 MNO is mobile network operator

Strong global momentum and ecosystem support

Sep. 2016
5GAA founded

Jan. 2017
ConVeX trial in Germany announced

Sep. 2017
First C-V2X chipset introduced

Mar. 2017
Rel-14 C-V2X spec finalized

Jun. 2018
1st US deployment in Denver

Apr. 2018
First multi-OEM demo in D.C.

Oct. 2018
C-V2X functional and performance test report published

Jul. 2018
Europe's first multi-OEM demonstration in Paris

Nov. 2018
Reaches 100 members

Nov. 2018
China-SAE ITS Stack Compatibility

Jan. 2019
Cooperative driving live interactive demos in Las Vegas

Jan. 2019
Announcing C-V2X implementation in Las Vegas

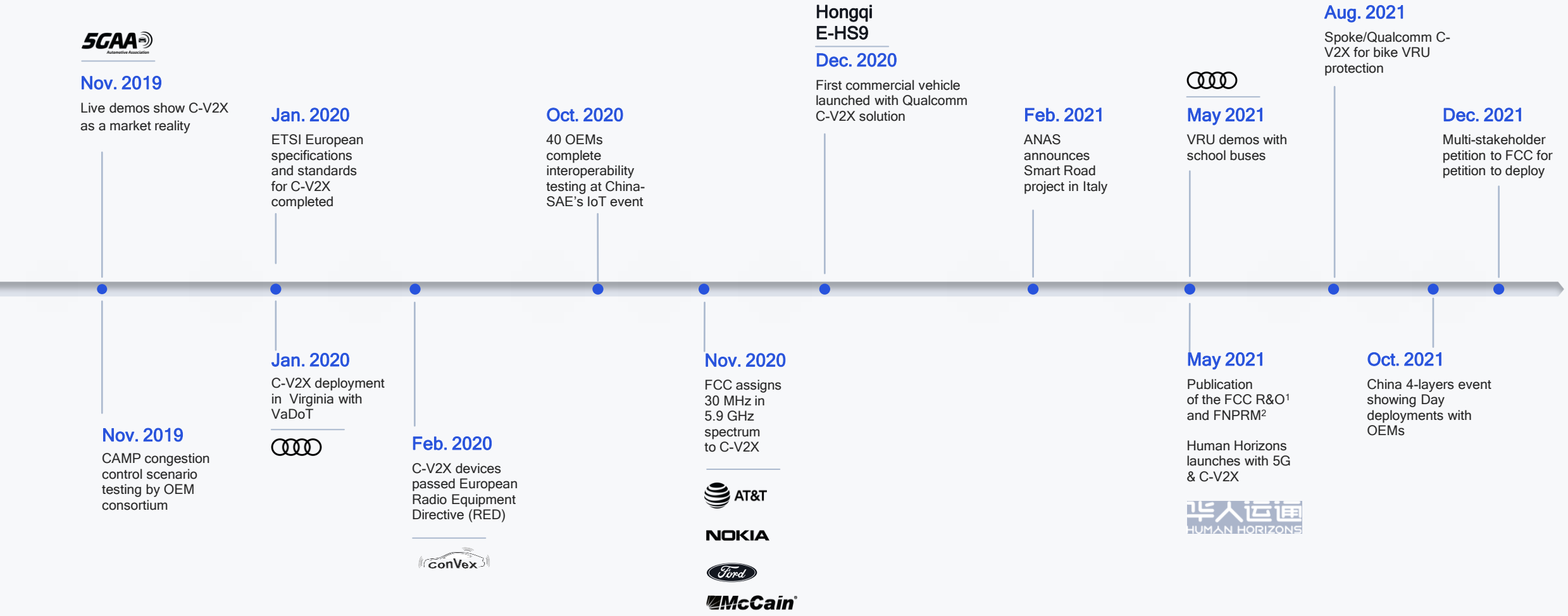
Feb. 2019
C-V2X integrated with Qualcomm® Snapdragon™ Automotive 4G/5G platforms

Feb. 2019
TELEFÓNICA/ SEAT's live C-V2X/ 5G demo at MWC Barcelona

Oct 2019
Showcase commercial readiness for C-V2X direct communications in China

1 Report and order 2 Further Notice of Proposed Rulemaking

Strong global momentum and ecosystem support



1 Report and order 2 Further Notice of Proposed Rulemaking

Working with regional standards to define applications globally

SAE International for North America, ETSI ITS for Europe, C-SAE/C-ITS/NTCAS/CCSA for China; IEEE & ISO globally

Supporting emerging use cases

Standardizing messages for new use cases (e.g., sensor data sharing among vehicles)

Providing interoperability

Allowing vehicles from different automakers to benefit from new use cases

Specifying minimum requirements

Defining application layer-specific minimum requirements for new messages

Reshaping our neighborhoods

Cellular + C-V2X networks

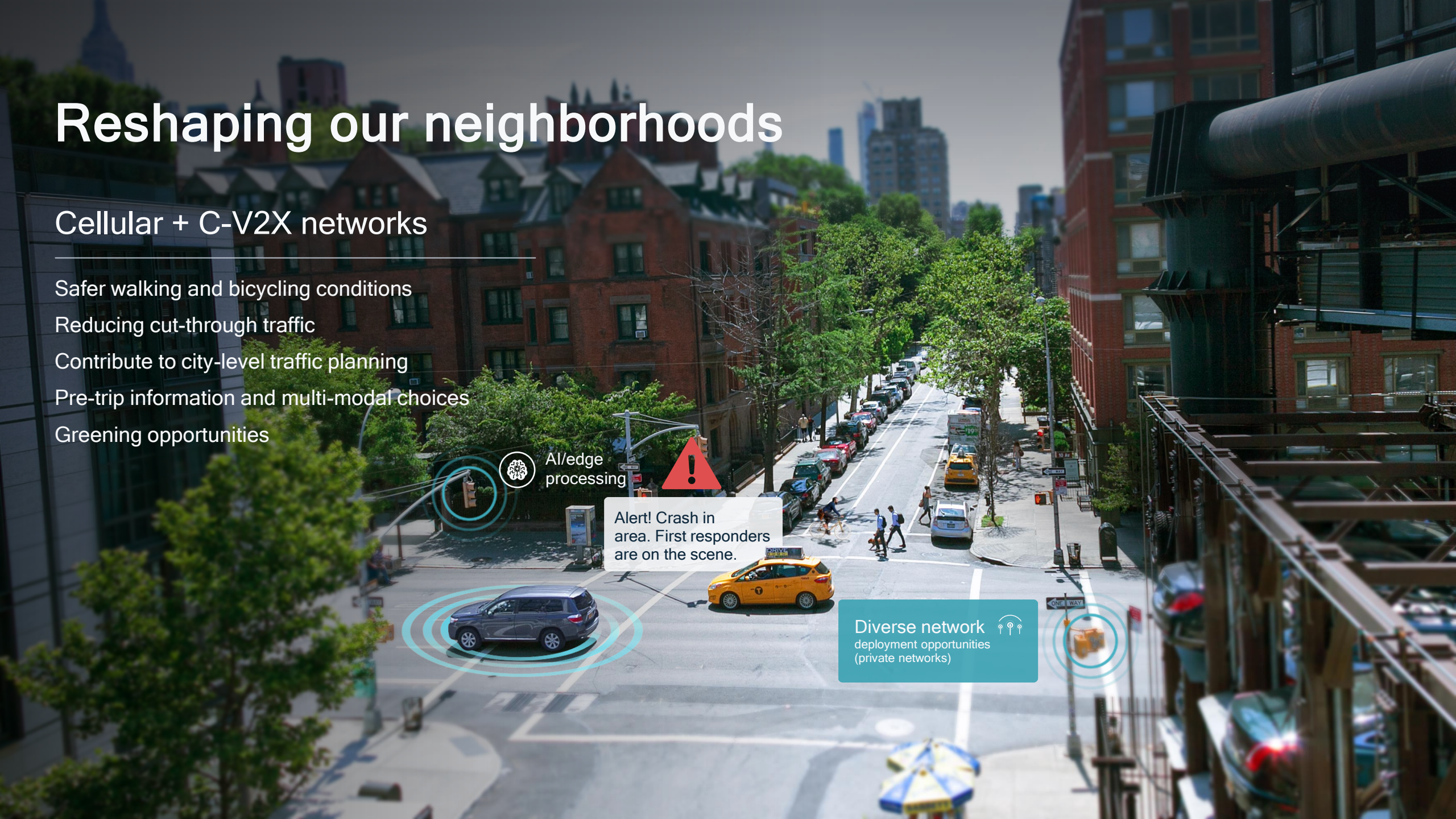
Safer walking and bicycling conditions

Reducing cut-through traffic

Contribute to city-level traffic planning

Pre-trip information and multi-modal choices

Greening opportunities



Safer and smarter arterials and other urban roads

Combining C-V2X RSUs and cellular networks

1 TMC is Traffic Management Center

Advanced traffic management

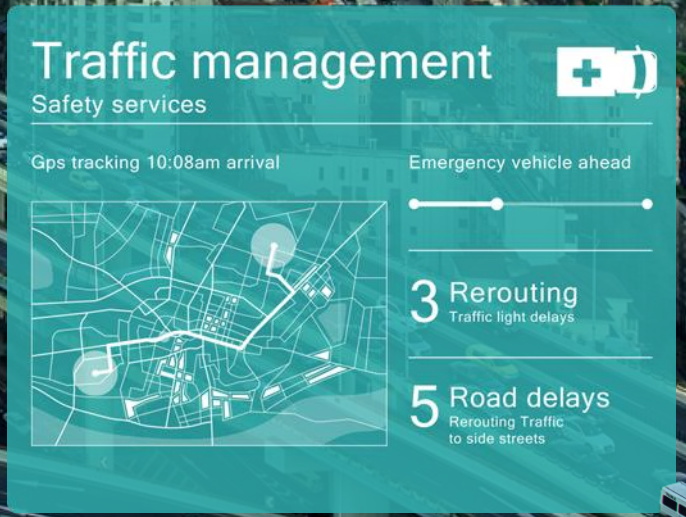
Smooth traffic flow delivered by C-V2X

Autonomous vehicles

Roadside units (RSUs)

Smart lighting

Truck platooning



Live 3D Maps

Smart transportation with C-V2X can revolutionize logistics

Protecting VRUs

2019 National Highway Traffic Safety Association stats for pedestrian and cyclists

6,205 pedestrians were killed in traffic crashes

- ~one person every 85 minutes, up 27% since 2015
- 17% of all traffic fatalities

846 pedal cyclist fatalities, accounting for 2.3% of all traffic fatalities

~49,000 pedal cyclists were injured, a 5.4% increase over 2018

https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/813197

C-V2X is a critical component of our vision

The safety component of the Digital Chassis

Vehicle-to-Infrastructure (V2I)

e.g. Red Light Violation Warning

Vehicle-to-Network (V2N)

e.g. real-time traffic / routing, cloud services

Vehicle-to-Vehicle (V2V)

e.g. collision avoidance safety systems

Vehicle-to-Pedestrian (V2P)

e.g. safety alerts to pedestrians, bicyclists

Enhanced range and reliability for direct communication without network assistance

Qualcomm® 9150 C-V2X chipset commercialized starting 2018

Integration of C-V2X into the Qualcomm® Snapdragon™ Automotive 4G (SA415M) and 5G (SA515M) Platforms starting 2019

Smart transportation benefits from C-V2X

Connecting vehicles, RSUs and VRUs

With our leadership in technology, 5G roadmap, and AI capabilities, we are shaping a new era of smart transportation with C-V2X for a cleaner environment and sustainable future

C-V2X and cellular networks can deliver efficient smart transportation solutions

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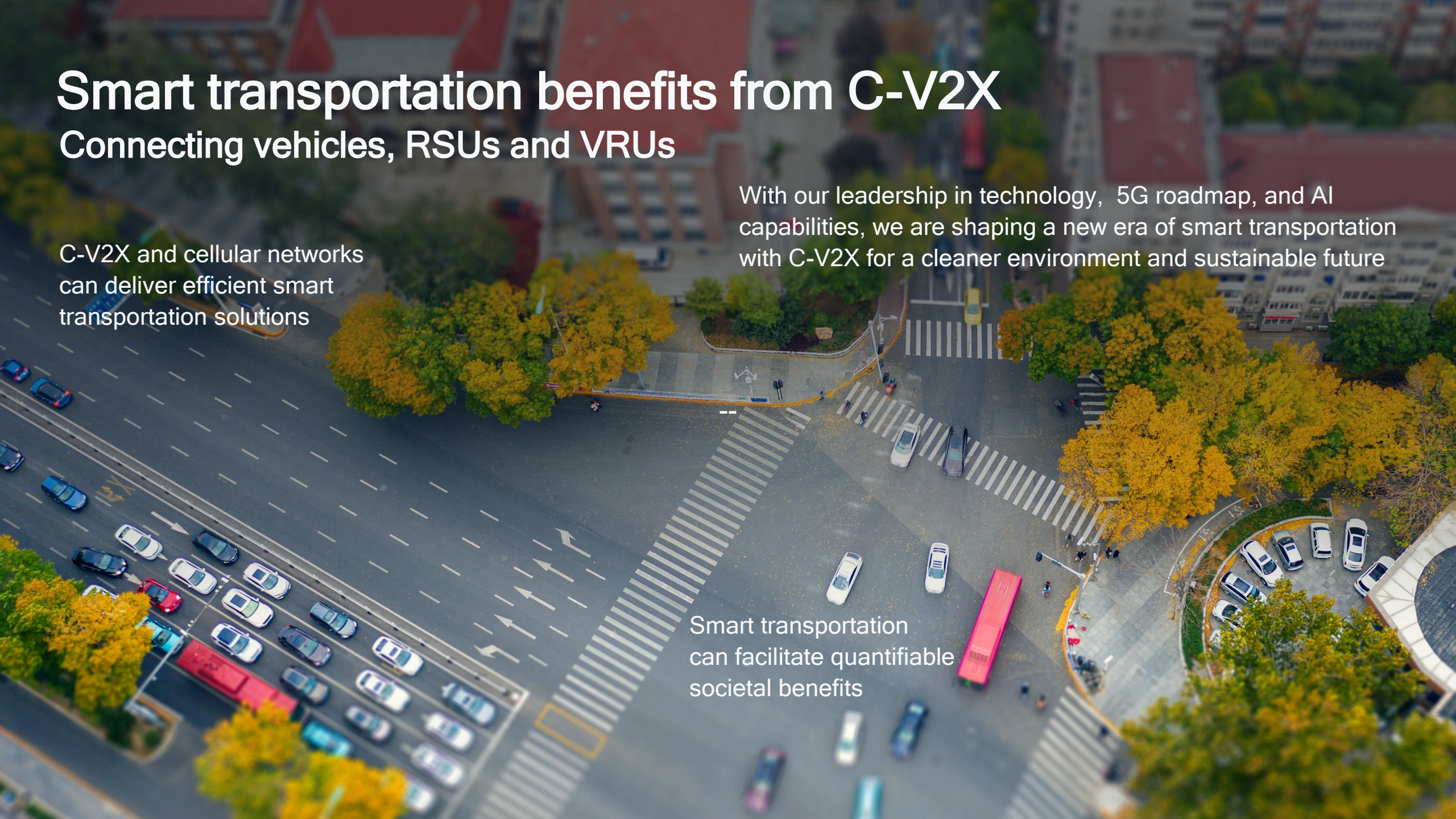
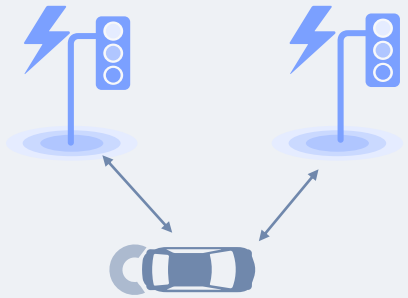
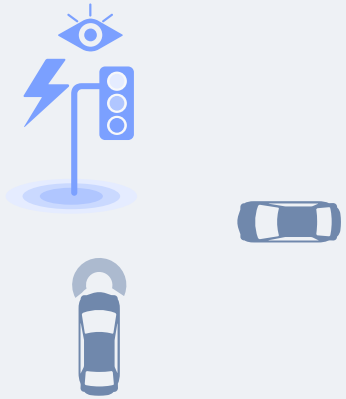
Smart transportation can facilitate quantifiable societal benefits





Sidelink positioning

Improve positioning accuracy
in GNSS challenged areas



Evolving smart RSUs

Enhanced network effect

Optionally supplement ADAS

Enhance VRU safety

Combining V2X with upper layer
software enhancement

C-V2X use cases continue to grow

From Day One safety for vehicles and VRUs to enabling new use cases for intelligent transportation

Qualcomm

Thank you

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