C-V2X Technology
Tech Marketing
C-V2X

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

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.

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.

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.
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)

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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,…

Edge cloud
Compute intensive, real-time data
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

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

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

Latency could be over 100s ms today
Cooperation between road operators, MNOs¹, infra vendors, cloud providers,…

¹ MNO is mobile network operator
Strong global momentum and ecosystem support

- **Sep. 2016**: SGAA founded
- **Mar. 2017**: 3GPP
- **Apr. 2018**: First multi-OEM demo in D.C.
- **Jul. 2018**: Europe’s first multi-OEM demonstration in Paris
- **Oct. 2018**: C-V2X functional and performance test report published
- **Nov. 2018**: China-SAE ITS Stack Compatibility
- **Jan. 2019**: Cooperative driving live interactive demos in Las Vegas
- **Feb. 2019**: C-V2X integrated with Qualcomm® Snapdragon™ Automotive 4G/5G platforms
- **Oct. 2019**: Showcase commercial readiness for C-V2X direct communications in China

- **Jan. 2017**: ConVeX trial in Germany announced
- **Sep. 2017**: First C-V2X chipset introduced
- **Jun. 2018**: 1st US deployment in Denver
- **Oct. 2018**: China-SAE ITS Stack Compatibility
- **Nov. 2018**: Reaches 100 members
- **Jan. 2019**: Announcing C-V2X implementation in Las Vegas
- **Feb. 2019**: TELEFÓNICA/SEAT’s live C-V2X/5G demo at MWC Barcelona
Strong global momentum and ecosystem support

- **Nov. 2019**: CAMP congestion control scenario testing by OEM consortium
- **Jan. 2020**: ETSI European specifications and standards for C-V2X completed
- **Feb. 2020**: C-V2X devices passed European Radio Equipment Directive (RED)
- **Nov. 2020**: FCC assigns 30 MHz in 5.9 GHz spectrum to C-V2X
- **Dec. 2020**: First commercial vehicle launched with Qualcomm C-V2X solution
- **Jan. 2020**: C-V2X deployment in Virginia with VaDoT
- **Oct. 2020**: 40 OEMs complete interoperability testing at China- SAE’s IoT event
- **Feb. 2021**: ANAS announces Smart Road project in Italy
- **May 2021**: VRU demos with school buses
- **Aug. 2021**: Spoke/Qualcomm C-V2X for bike VRU protection
- **Dec. 2021**: Multi-stakeholder petition to FCC for petition to deploy

*1 Report and order 2 Further Notice of Proposed Rulemaking*
Working with regional standards to define applications 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

Alert! Crash in area. First responders are on the scene.
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
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-Vehicle (V2V)**
e.g. collision avoidance safety systems

**Vehicle-to-Pedestrian (V2P)**
e.g. safety alerts to pedestrians, bicyclists

**Vehicle-to-Network (V2N)**
e.g. real-time traffic / routing, cloud services

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

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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.

Smart transportation can facilitate quantifiable societal benefits.
C-V2X use cases continue to grow

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

- **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
Thank you

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