C-V2X Ignites Automotive Connected Revolution

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Precise positioning
Lane-level accuracy anywhere, anytime

Bluetooth
For high quality voice and audio

Wi-Fi
For in-car experiences and car OEM services

4G/5G
For car OEM services

4G/5G
For driver and passengers

C-V2X Direct Communications
For car-to-car communication

C-V2X Direct Communications
For car-to-infrastructure communication

4G/5G is referring to C-V2X network communications (i.e. V2N); C-V2X Direct Communications is referring to V2V, V2I, V2P
Smart transportation infrastructure supported by our foundational technologies

**Artificial intelligence**

**Mobile Edge Compute**

**Sensor fusion**

**Multimode 4G/5G**

**C-V2X Direct Communications**

**Precise positioning**

**Computer vision**

**Power management**

**Security**

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**Smart RSU/Small cell**
- 4G/5G small cell
- Integrated C-V2X support
- Infrastructure-to-vehicle (I2V)
- AI/perception and sensor fusion
- AI-based camera, radar, lidar
- Precise positioning and 3D HD mapping

**Smart connected cars**
- 4G/5G support
- Integrated C-V2X support
- Precise positioning
- AI/perception and sensor fusion
Qualcomm® Connected Car Reference Design, Gen 2

Qualcomm® Snapdragon™ Automotive 4G/5G platforms

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
Strong C-V2X momentum globally

- **Nov 2018**: Reaches 100 members
- **Jan 2019**: Cooperative driving live interactive demos in Las Vegas
- **Jan 2017**: ConVeX trial in Germany announced
- **Feb 2017**: Towards 5G trial in France announced
- **Oct 2017**: San Diego Regional C-V2X trial with: at&t, Ford, NOKIA, McCAIN
- **Oct 2018**: Multi-OEM performance evaluation of C-V2X
- **Oct 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
- **Nov 2018**: Announcing C-V2X implementation in Las Vegas with: McCAIN, TELSTRA, commsignia
- **Jan 2019**: TELEFÓNICA/SEAT’s live demonstration using C-V2X/5G at MWC Barcelona
Helping bring a comprehensive ecosystem together

Working across industries to forge sustainable relationships, unlocking new value

- Software companies
- Test equipment vendors

Automotive
- Vehicle OEMs
- Tier 1 suppliers

Transportation
- Road operators
- Traffic industry suppliers

Telecom
- Mobile operators
- Telecom suppliers

Internet/cloud
- Cloud service providers
- Map providers

Standards development organizations
Telecom and auto industry organizations
ITS organizations
Robust Global C-V2X Ecosystem is Ready

<table>
<thead>
<tr>
<th>9150 Modules</th>
<th>RSU vendors</th>
<th>Tier1s/OBU vendors</th>
<th>System Integrators</th>
</tr>
</thead>
<tbody>
<tr>
<td>WNC</td>
<td>US: Commsignia, Savari, Kapsch, Danlaw</td>
<td>Ficosa</td>
<td>Sasken</td>
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<tr>
<td>Quectel</td>
<td>EU: Swarco, Lacroix, Aximum, Marben</td>
<td>Cohda</td>
<td>Integration &amp; support</td>
</tr>
<tr>
<td>ZTE</td>
<td>China: Nebulalink, Genevict, Neusoft</td>
<td>Valeo</td>
<td>Thurdersoft</td>
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<tr>
<td>LG</td>
<td>RoW: Cohda, Cybercom, Oki</td>
<td>Savari</td>
<td>Integration &amp; support</td>
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<tr>
<td>LG Innotek</td>
<td>12+ RSU products in the pipeline. Commercial ready in Q1 2019</td>
<td>Marben</td>
<td></td>
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<tr>
<td>SIMCom</td>
<td>Commercial ready module in 2018</td>
<td>Continental</td>
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<tr>
<td></td>
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<td>LG Electronics</td>
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<td>Nebulalink</td>
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<td>Danlaw</td>
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</table>

Global footprint to support system integration

C-V2X is ready for deployment now!
<table>
<thead>
<tr>
<th>Ecosystem partner</th>
<th>Commercially available products (including web links)</th>
</tr>
</thead>
</table>
| WNC              | CV2X module & mPCIe card
| Quectel          | AG15 : C-V2X Module [link](https://www.quectel.com/product/ag15.htm) |
| ZTE              | ZM8350 : C-V2X Module [link](https://www.ztedevices.com/en/product/industry-user/automotive-module/zm8350) |
| LG Innotek       | LAM-V500 : C-V2X Module [link](http://www.lginnotek.co.kr/en/ltk_product/v2x-communication-module/) |
| Commsignia      | C-V2X Roadside Unit
C-V2X On Board Unit
[link](http://www.commsignia.com/software/) |
| Ficosa           | CARCOM - OBU [link](https://www.ficosa.com/wp-content/uploads/2018/12/Ficosa_On_Board_Unit_C_V2X.pdf) |
| Kapsch           | RIS 9260 : C-V2X Roadside Unit [link](https://connectedvehicles.kapsch.net/download/KapschRIS-9260datasheet.pdf) |
| Nebulalink       | V-Box : C-V2X Roadside Unit (C-SAE) [link](http://nebula-link.com/Product/view/id/5) |
| Genvict          | LB-RD10 : C-V2X Roadside Unit
| Savari           | StreetWAVE 2000 OBU
StreetWave 2000 RSU
MobiWAVE C-V2X software stack [link](http://savari.net/wp-content/uploads/2019/05/MW-2000_May2019-1.pdf)
[link](http://savari.net/technology-cv2x/) |
| Neusoft          | V2X Roadside Unit
V2X On Board Unit
Ve Talk C-V2X software stack [link](http://www.reachauto.com/product/en/396.html) |
| Danlaw           | C-V2X Aftermarket OBU
| Sasken           | C-V2X system integration [link](https://www.sasken.com/C-V2X) |
5GAA Automotive Association

Airgain • Alpine Electronics • Analog Devices • Anritsu EMEA Ltd
AT&T • Audi BAIC • Beijing University • Bell Mobility • BMW • Bosch
CATT • Cetecom • China Transinfo • China Unicorn • CMCC
Continental Daimler • Danlaw • DEKRA Denso • Deutsche Telekom
Ericsson • FEV • Ficosa • Ford • Fraunhofer Gemalto Hirschman Car
Hitachi Automotive US • Honda • Huawei Infinion • Intel Interdigital
Jaguar Land Rover • Juniper • KDDI • Keysight • KT • Laird Tech • LG
Murata • Nissan • Nokia • NTT DoCoMo • OKI • Orange • P3 Group
Panasonic • Proximus • PSA • Qualcomm • Rohde & Schwarz Rohm
SAIC • Samsung • Savari • ST • SK Telecom • Skyworks Softbank
Sumitomo • Telefonica • Telekom Austria • Telstra • TÜV • Valeo
Veriam • Verizon • Viavi • Vodafone • Volkswagen • ZF • ZTE

Key participants
driving global C-V2X activities with Qualcomm Technologies

Ford • PSA • BMW • Daimler • SAIC • China Domestic OEMs • Continental • Bosch • LG • ZTE • Quectel • Lear • Valeo • WNC • CMCC • AT&T • DoCoMo • CMRI • McCain • Kapsch • SWARCO • Genvict • Nebula • R&S • Datang • Ficosa • And more ...

Driving C-V2X global presence

North America
Ford

Europe
Audi • BMW • PSA • Nissan • SAIC • Lexus

China

Korea

Japan
Nissan

Australia

Tremendous traction across regions and broad industry sectors
From standards completion to independent field testing to early commercialization
5G NR based C-V2X

5G NR: A unified connectivity fabric to expand into new industries
5G is essential for next generation mobile experiences

- Fiber-like data speeds
- Low latency for real-time interactivity
- More consistent performance
- Massive capacity for unlimited data

Connected cloud computing

Immersive experiences

Connected vehicle

Augmented reality
5G NR based C-V2X for autonomous driving

<table>
<thead>
<tr>
<th>Feature</th>
<th>Check</th>
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<tbody>
<tr>
<td>Rel-14 C-V2X for automotive safety is gaining momentum and broad ecosystem support</td>
<td>✔</td>
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<tr>
<td>5G NR provides a unified connectivity fabric to expand into new industries</td>
<td>✔</td>
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<tr>
<td>C-V2X has a clear and forward compatible evolution path to 5G NR</td>
<td>✔</td>
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<tr>
<td>5G NR C-V2X provides URLLC and high data rate to support higher level of predictability for autonomous driving</td>
<td>✔</td>
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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 and enhanced safety
C-V2X Rel-14/Rel-15 with enhanced range and reliability

Basic safety
IEEE 802.11p

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
Advanced use cases for autonomous driving

High throughput sensor sharing
High throughput and reliability to enable the exchange of raw or processed data gathered

Intent / Trajectory sharing
High throughput and URLLC to enable planned trajectory sharing

Real-time local updates
High throughput to build local, dynamic maps based on camera and sensor data; and distribute them at street intersections

Coordinated driving
URLLC and high date rate to exchange path planning information in timely fashion

Wideband carrier support | High throughput | Ultra-low latency | Ultra-high reliability