C-V2X Enabling Smart Transportation and Autonomous Driving

Lu Xiaofeng
General Manager of LTE-V2X Product Line
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1. C-V2X Brings More Value for Industry

2. Huawei’s Dedication in Promoting the C-V2X Industry
Vehicle + Road + Network Evolution Enable ITS Evolution

**Optimizing - Individual**
- E-Call
- Navigation, Remote control
- Infotainment

**Optimizing - Surrounding**
- V2V, V2P, V2I, V2N
- Assisted Driving
- Initial Road Digitalization

**Optimizing - Overall**
- Traffic Info Fusion
- Autonomous Driving
- Mobility as a Service

From 1997
Telematics

2018 – It’s now!
V2X / C-ITS

2025~
ITS / MaaS

Network Everywhere + Vehicle Automation + Road Digitalization
C-V2X Promotes People-Vehicle-Road Collaboration with Automobiles Becoming Intelligent Mobile Terminals

In-vehicle entertainment (Telematics)

Vehicle to Network (V2N)
Vehicle to Vehicle (V2V)
Vehicle to Pedestrian (V2P)
Vehicle to Infrastructure (V2I)

C-V2X full-scenario connection

Seamless connection
WAN and direct communication

High-speed connection
100 Mbps -> 1 Gbps

Low-latency connection
20 ms -> 2 ms

Highly reliable connection
99.999%
Seamless Combination of C-V2X and ADAS: A Future Trend

**ADAS**
- Long-range radar
- Mid- and short-range radar
- Laser radar
- Cameras
- Ultrasonic radar

**C-V2X**
- V2V
- V2I
- V2P
- V2N

96% Accident prevention

15% 45% 36%

Intelligent vehicles alone cannot realize completely automatic driving.
Sensing + Communications co-provide more Information for Autonomous Driving

- Comprehensive
- Sharper
- Wider
- Real-time
Digitalize Road Infrastructure to Make Roads Smarter

By 2025, the world will have:

- 300,000 km of highways
- Completed intelligent reconstruction
- 500,000 cameras
- HD road condition broadcast
- 1 million traffic lights
- Completed networking reconstruction
- 100 million road markings
- Real-time information networking
- 300 million road sensors
- Real-time road monitoring
- 500,000 cameras
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Vehicle-Road Collaborative Evolution Lowers the Automatic Driving Threshold by Digitalization and Network Connections

Automatic driving levels

NHTSA: National Highway Traffic Safety Administration

Digital transformation

Previously
Physical marking

About to
Vehicle-road coordination networking

In the future
All people, vehicles, and road traffic elements are connected.

Level 0
Manual driving

Level 1
Advanced Driver Assistant System (ADAS)

Level 2
Manual monitoring and automatic driving

Level 3
Automatic driving based on specific conditions

Level 4
Automatic driving

Road

1995

Now
Mobile network

2005

2015

2020

2025

2030

Vehicle

Mobile network

Digital transformation

Physical marking

Vehicle-road coordination networking

Now
LTE-V2X Smooth Evolve to 5G-V2X

- **Uu @ LTE band**
  - PC5 @ 5.9Ghz ITS band
  - ~500km/h relative speed
  - High Reliability
  - Quick discovery in dense scenario

- **Uu @ NR band**
  - PC5: LTE-PC5@5.9GHz + NR-PC5@new band
  - 5.9GHz + New Band CA
  - Relay

Converged LTE-V2X and 5G V2X support long term ITS and autonomous driving requirement
5GAA as a Key Enabler for C-V2X

September 2016

“Audi, BMW Group, Daimler AG are teaming with Ericsson, Huawei, Intel, Nokia, and Qualcomm to create the 5G Automotive Association (5GAA), which will help develop, test, and promote 5G standards”

“Scope of the alliance is focused on bringing connectivity solutions to market addressing technical, business, and regulatory challenges”

Q3 2018

- More than 102 member companies
- 5GAA is now a global, cross-industry organisation
**Worldwide C-V2X Trials**

**Test Conclusion**

- **500Km/h** Relative Speed
- **> 600m** Reliable comm.
- **< 20ms** Latency
- **> 2000/km²** Density

### Locations

- **Spain**
  - MWC 2016, 2017
  - ConVeX (A9)
- **France**
  - MWC 2016, 2017
  - ConVeX (A9)
  - InOut C-V2X Demo France
  - V2V C-V2X radio performance tests Michigan, USA
- **Germany**
  - MWC 2016, 2017
  - ConVeX (A9)
  - Mobitunk (A9)
  - DT (A9)
  - Car2X (A9)
  - 5G-CM (A9)
  - MEC pilot project Germany
- **England**
  - UK CITE
- **China**
  - Wuxi City-wide LTE-V2X Project China Wuxi
  - C-V2X Performance Test @ SIAC China, Shanghai
- **Korea**
  - 5G and cellular communication showcase trials
- **Japan**
  - C-V2X Trials
- **U.S.**
  - U.S. deployment of C-V2X Colorado USA
  - C-V2X Connected Car Technology Trials San Diego USA

**Source**: 5GAA

**Test Conclusion**

- **> 600m** Reliable comm.
- **< 20ms** Latency
- **> 2000/km²** Density
China Promotes C-V2X Commercial Use Based on Maturity Verifications in Pilot Areas

Urban roads: World’s first city-level LTE-V2X vehicle-road coordination project

- City level covering 170 km²
- 240+ crossroads
- 10,000 to 100,000 connected car users

Wuxi Project Phase I

Wuxi Project Phase II

Highways: Pilot Projects of the digital transformation of smart roads in nine provinces

- Beijing
- Hebei
- Henan
- Jiangxi
- Jiangsu
- Zhejiang
- Fujian
- Guangdong

Test site in Tongzhou District, Beijing
RSU: Connected with Roadside and Terminal-Side Devices to Enable Multiple Vehicle-Road Coordination Scenarios

- Road status inspection notification
- Roadside sign:
  - Speed limit notification
  - Reversible lane notification
- Smart camera:
  - Road-crossing pedestrian notification
  - Ramp vehicle arriving notification
- Traffic light:
  - Speed guidance
  - Warning for red light running
  - Traffic light control

Road-Side Unit (RSU)

Mobile App
- Dealer-installed: rear view mirror
- Factory-installed

Traffic light control
1. C-V2X Brings More Value for Industry
2. Huawei’s Dedication in Promoting the C-V2X Industry
Huawei Is Dedicated to Promoting the C-V2X Industry and Continues Solution R&D

**Standard**
Promotes C-V2X to become an international standard.

- One of the three parties for reporting the LTE-V2X standard
- Promotes LTE-V2X to become a standard
- Promotes LTE-V2X implementation in standards
- Promotes neutrality in spectrum usage

**Industry**
Bridges demands of the automobile industry with capabilities of the communications industry.

- Joint initiator
- Performs demo tests with partners in China, the UK, Germany, and Spain, and achieves good results.
- Promotes LTE-V2X at industry conferences worldwide.

**Product**
Provides E2E C-V2X solutions.

- LTE-V2X chip
- RSU
- T-Box
- V2X server

With a deep understanding of basic technologies, Huawei jointly develops solutions with automakers.

Shanghai  
Xi’an  
Shenzhen  
Beijing  
Dallas  
Munich
Huawei Cooperates with Automakers and Ecosystem Partners to Promote the Application of C-V2X in Production

Worldwide demonstration activities held by Huawei and our partners in the past two years
Huawei Fosters Open Cooperation with Industry Partners to Promote the Development of the C-V2X Industry

Emerging Applications

E2E Solutions

102 members

Mobile carriers

Autonomous cars

Application providers

Governments

Tier 1

OEM

Road operators
Abundant Connected Car Applications Have Entered People's Lives
Thank You