C-V2X Enabling Smart Transportation and Autonomous Driving

Lu Xiaofeng
General Manager of LTE-V2X Product Line
Huawei at a Glance

- 180,000 Employees
- 80,000 R&D employees
- 170+ Countries
- 14 R&D institutes/labs/centers
- No. 70 in Interbrand’s Top 100 Best Global Brands
- No. 72 in the Fortune Global 500
Vehicle + Road + Network Evolution Enable ITS Evolution

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

Cellular 2G / 3G / 4G

From 1997
Telematics

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

Cellular-V2X (LTE-V)

2018 – It’s now!
V2X / C-ITS

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

C-V2X (5G NR-V2X)

2025~
ITS / MaaS

Network Everywhere + Vehicle Automation + Road Digitalization
Automobiles Becoming Intelligent Mobile Terminals

C-V2X full-scenario connection

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

In-vehicle entertainment (Telematics)

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**
- V2N
- V2I
- V2V
- V2P

**Advantages of C-V2X**
- Bad weather
- Traffic light identification
- Non-line-of-sight communication
- Internet access
- Medium- and long-distance communication

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
- 500,000 cameras
- 1 million traffic lights
- 100 million road markings
- 300 million road sensors

Completed intelligent reconstruction
HD road condition broadcast
Completed networking reconstruction
Real-time information networking
Real-time road monitoring

Landslide
Vehicle-Road Collaborative Evolution Lowers the Automatic Driving Threshold by Digitalization and Network Connections

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

In the future, all people, vehicles, and road traffic elements are connected.
LTE-V2X Smooth Evolute 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

"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"

More than 102 member companies
- 5GAA is now a global, cross-industry organisation

September 2016

Q3 2018
Worldwide C-V2X Trials

Test Conclusion

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

Source: 5GAA
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
City level covering 170 km²
240+ crossroads
10,000 to 100,000 connected car users

Wuxi Project
Phase II
Open road implementation and operation

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
Formally Release the LTE-V2X Spectrum for IoV

IoV (Internet of Vehicle) direct communication 5905 – 5925MHz Spectrum Usage Regulation

- 5905-5925MHz spectrum used for IoV base on LTE-V2X technologies
- Encourage different cites to deploy demo and trial IoV network based on the principle of moderately advanced, inter-operation, safe and high efficient, intelligent and green.
Huawei Provides E2E C-V2X Solutions

- **Huawei Cloud**: Supporting 3rd Parties Services
- **C-V2X Network E2E Solution**: V2X Server, Base Station, Core Network
- **World 1st Dual Mode C-V2X RSU**: LTE Uu + PC5
- **C-V2X Commercial Chipset**: Balong765
- **C-V2X OBU and Module**: C-V2X Chipset Inside

**Services**
- Telematics Services
- ITS Service

**Platform**
- V2X Server
- EPC
- MEC

**Network**
- RAN
- RSU

**Vehicle / Infrastructure**
- Signaler
- PC5

**Diagram Key**
- Huawei Cloud
- C-V2X Network E2E Solution
- World 1st Dual Mode C-V2X RSU
- C-V2X Commercial Chipset
- C-V2X OBU and Module
RSU: Connected with Roadside and Terminal-Side Devices to Enable Multiple Vehicle-Road Coordination Scenarios

Road-Side Unit (RSU)

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

Factory-installed

Dealer-installed: rear view mirror

Mobile App
Abundant Connected Car Applications Have Entered People's Lives
Thank You.