# C-V2X for Connected And Autonomous Driving

Dr. Peiying Zhu Huawei/IEEE Fellow, Wireless Research IEEE 5G For CAM, Brussels May 12, 2020





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# C-V2X Technology Overview



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# C-V2X Industry Update



## Huawei C-V2X Solution

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# **C-V2X: Utilizing the Cellular Network**





C-V2X = Uu (V2N) + PC5 (V2V, V2I, V2P)



# **5G C-V2X Standards**





#### 5G-V2X = LTE V2X + NR V2X

# **C-V2X Standards and Spectrum Status**





- determined that the frequency band 5905– 5925 MHz was dedicated to C-V2X
- On January 15, 2020, China's relevant ministries and commissions agreed that C-V2X was the only IoV technology option in China.

- On November 20, 2019, the FCC proposed to withdraw the 30 MHz 5.9 GHz spectrum originally granted to DSRC and re-allocate 20 MHz of the spectrum to C-V2X.
- In November 2020, the FCC officially finalized the above proposal.

In July 2019, the EU voted to veto the mandatory DSRC technology as the only technology of V2X, opening the door to C-V2X. In 2020, the ITS spectrum from 20MHz->70MHz

# **C-V2X Latency / Data Rate Requirements**





# **Rel-16 Uses Cases, Scenarios and Operating Band**



Use Cases	End-to-End Latency (ms)	Reliability (%)	Data Rate (Mbps)
Vehicles Platooning vehicles are formed into a group to travel together	10ms	99.99	1Mbps
<b>Extended Sensors</b> vehicles exchange raw or processed sensor data or video	3ms	99.999	50Mbps
Advanced Driving vehicles share data for semi/fully-automated driving	3ms	99.999	30Mbps
<b>Remote Driving</b> vehicle is driven by a remote driver or a V2X application	5ms	99.999	UL:25Mbps DL:1Mbps

• Support In-coverage, partial-coverage and out-of-coverage operating secretions

- Support broadcast, groupcast and unicast communication over PC-5 interface.
- Support In-device coexistence between LTE-V and NR-V
- Operating band defined for NR-V2X Rel-16 (ITS spectrum & Licensee spectrum)

NR operating band	Sidelink (SL) Transmission operating band F low – F high	Sidelink (SL) Reception operating band F low – F high	Duplex Mode	Interface
n38	2570 MHz – 2620 MHz	2570 MHz – 2620 MHz	TDD	PC5
n47	5855 MHz – 5925 MHz	5855 MHz – 5925 MHz	TDD	PC5

## **Cooperation among Network & Road & Vehicle to support CAD**





## **5G+C-V2X PC5 Network Integration Reduces Deployments Cost**





- Enhance network coverage, through the integration of direct communication technology and 5G network, to achieve allroad network connection for vehicles
- Improve network utilization, through direct communication combined with cellular network communication, to ensure different types of data transmission in the IoV
- **Resource saving and sharing,** through the co-site deployment and unified operation and maintenance of 5G base stations and C-V2X RSU, to achieve resource saving and sharing and effectively reduce deployment costs.

### **C-V2X: Evolution to 5G maintains backward compatibility**







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## The CAD business will be gradually commercialized in stages





# **C-V2X Industry Ecosystem Status**



#### E2E Ecosystem is Ready

Industry Component		Com	mercial Laur	nch		
Chipset	2018 Qualcomm9150 C-	V2X H	2018 Iuawei Balong765	5 н	2019 uawei Balong	5000
Module	2019.10 Quectel AG15	2017.2 Datang	2019 ZTE	2018.2 Huawei	2020.3 REI WNC Modu	WNC C-V2X Module D
т-вох	2018.10 Huawei YaXun	2017 NEBULA Link	2019.9 CIDI 2020 Fico	D.03 RED 20 sa FITAX S	220.03 RED avari 2000 Co	2020.03 RED ommsignia OB4
OEM	22 Mont					

#### China Launched 8 C-V2X Enabled Vehicles

OEM	Model	Launch Time
BYD	Han	2020
GAC	Aion	2020
Ford	New Explorer	2020
FAW	Red Flag E-HS9	2020
SAIC GM	Buick GL8	2020
BJEC (BAIC)	Arcfox	2021
WeltMeister (WM)	W6	2021
Great Wall	WEY Mocca	2021
NIO	ET7	2022

## **C-V2X, Intelligent Vehicle and Transport Roadmap in China**



#### Large Scale Deployments

Deployments
IoV based on 5G and C-V2X
To verify functions and

**Test and Initial** 

performances of C-V2X

11 national projects and 12

platform, modules and

other key projects.

equipment.

- Spectrum
- 5.9G spectrum available
- Chinese IoV technology standard laid down by 3 ministries

- LTE-V2X area coverage, 5G-V2X gradually applied in some cities and expressways.
- To build smart roads and a new generation of national traffic control network,
- To develop the interworking between 5G-V2X and intelligent vehicles.

#### Smart Intermodal Transportation

- By 2035, a powerful transportation system provider, for intermodal and smart transportation, building on ubiquitous advanced transportation information infrastructure and B5G-V2X
- By 2050, a leading transportation system provider. Industry standards and products for intelligent vehicles and transportation are expected being matured.

	LOLO		2021-2025 2030-2		035-2050	
Standard	5 9GHz	30+ projects	Mass Production Poadman	IoT ecosystem	i-Vista/C-NCAP	

# **C-V2X is Supported by Chinese Industry**





# **C-V2X Use Cases of 5GAA**



#### Expected timelines for mass deployment of C-V2X use cases 2022 2023 2024 2025 2026 2027 2028 2018 2019 2020 2021 2029 3GPP 3GPP 3GPP 3GPP Release 15 Release 16 Release 17 Release 18 ▼ ▼ Ite 🔶 Local Hazard and 2016 Market Hazard Information HD Maps **Traffic Efficiency** Informative Traffic Information Collection and Sharing Collection and Take off Sensor Sharing 5g 🚽 (Safety Related) for AVs Sharing for AVs 2020 **Emergency Electronic Brake Light** VRU: Ite -Safety Turn Left Assist Collective 2022 (part of Dav1/Phase1) Awareness Group (Traffic Efficiency) 5g Start Automated Valet Parking for AVs Advanced Safety Automated Valet Parking for AVs Sensor VRU+: = Ite 🕨 Sharing 2025 5**6 Campus Area** Automated Complex **Tele-Operated Driving** for AVs Interactions Driving(Step I) **Tele-Operated Driving Cooperative Maneuvers** Dynamic Advanced Safety Intersection Management HD Sensor 5g 2026 Automated Sharing Dynamic for AVs Driving(Step I) Cooperative Traffic Flow Lte 🕨 Social and Environmental 56 In-vehicle commercial mass deployment Direct and Network Direct Network Direct or Network



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### **Huawei is the Exclusive E2E C-V2X Solution Provider**







# **Huawei C-V2X Solutions**



## Huawei RSU Has Completed the Most Extensive IOTs in the Industry, Reaching the Highest Commercial Maturity Level





### Implementation of C-V2X mass production models



#### **Guangzhou Auto: 5G+C-V2X Car Aion**

#### Ford China: New Explorer with C-V2X



https://www.ford.com.cn/newsroom/2020/20200706/

https://www.gacne.com.cn/vehicles/aion\_v

## **Roadmap for Connected Automated Mobility**



AD: Autonomous Driving, CAM: Connected Automated Mobility, ADAS: Autonomous Driver Assistance Systems

# Thank You.

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