CAICT 中国信通院

# Reflection on Enhancing Automated Driving Capabilities with Communications Technology

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2025.03

# The automated driving function is a significant indicator of the advancement of communications technology

## Individual vehicle intelligence is the foundation of automated driving

**Sensing**

Camera

Radar

Lidar

GPS

**Control**

**Computing**

Execute autonomous driving algorithm

## Communications enabling automated driving system

**Enhance the value of the scene**

**Expand perception**

- other vehicle information
- roadside sensing information
- cloud based information

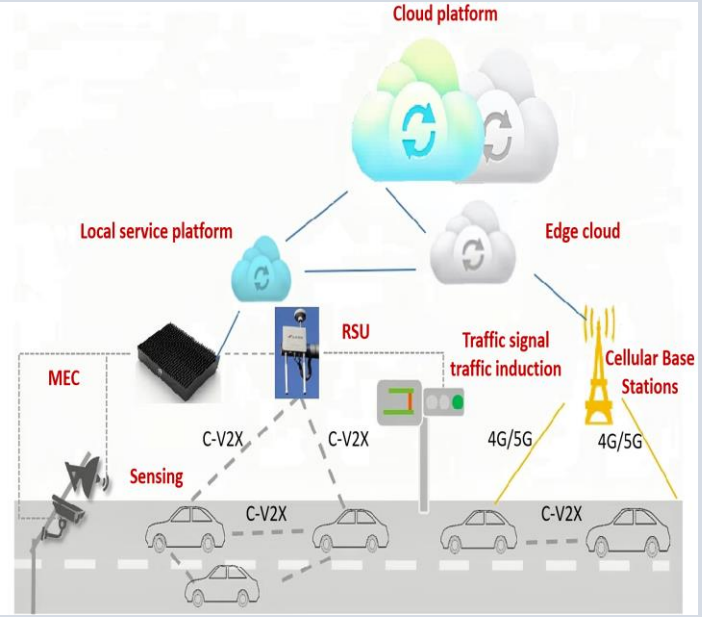
**Remote monitoring/assistance**

- monitoring L3/L4/L5 vehicle status
- L4/L5 driverless vehicle extrication

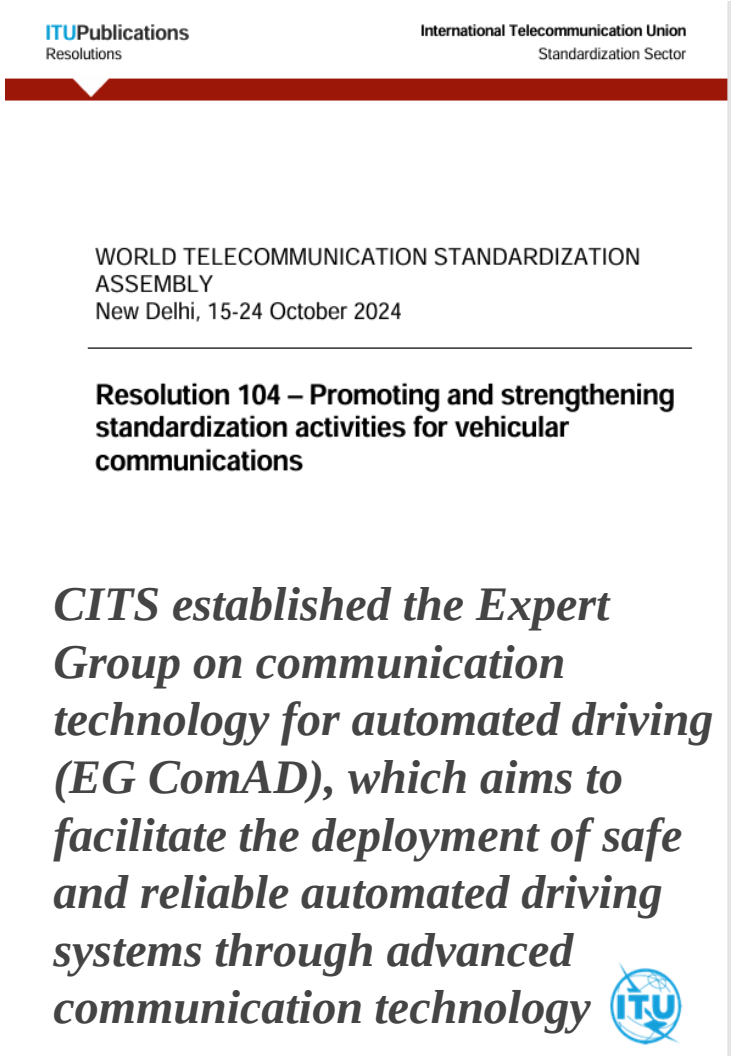
**Support algorithm training**

- data feedback
- backend computing power training algorithm

**Enhance the value of data**



# ITU New Resolution 104 - Promoting and strengthening standardization activities for vehicular communications


ITUPublications
Resolutions

International Telecommunication Union
Standardization Sector

WORLD TELECOMMUNICATION STANDARDIZATION ASSEMBLY
New Delhi, 15-24 October 2024

**Resolution 104 – Promoting and strengthening standardization activities for vehicular communications**

***CITS established the Expert Group on communication technology for automated driving (EG ComAD), which aims to facilitate the deployment of safe and reliable automated driving systems through advanced communication technology***

a) that study groups of **ITU Telecommunication Standardization Sector (ITU-T)** initiated studies on **V2X and ITS aspects** of identification, quality of service (QoS) for speech and audio, vehicle emergency calls, vehicular multimedia and information and entertainment systems, security (such as over-the-air secure software updates and network communication) and Internet of Things (IoT)-related applications;

b) that **ITU Radiocommunication Sector (ITU-R),** and in particular ITU-R Study Group 5, is responsible for the **radiocommunication aspects,** spectrum requirements and technical and operational characteristics in order to achieve the harmonization of the radio spectrum for vehicular communications, such as V2X, ITS, automotive radar and CAV;

c) that Study Group 2 of **ITU Telecommunication Development Sector (ITU-D)** focuses on **digital transformation**, in particular under study Question 1/2, aiming to study problems in promoting smart sustainable cities and communities, sharing experiences on improving connectivity and underlying infrastructures to support smart societies and smart transportation

# How the EG-ComAD fits in ITU efforts

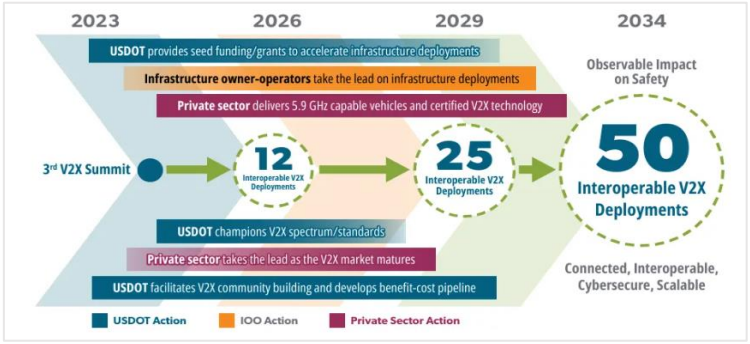
- ITU-T Study Group 2 to foster standardization activities related to **numbering, naming, addressing and identification issues related to vehicular communications**, such as V2X and ITS, including vehicular communications to support automated driving;
- ITU-T Study Group 12 to foster standardization activities of **QoS and quality of experience in relation to vehicular communications**, such as V2X and ITS, including vehicular communications to support automated driving;
- ITU-T Study Group 17 to foster standardization activities related to **security for vehicular communications**, such as V2X and ITS, including vehicular communications to support automated driving, covering comprehensive security solutions, security communication mechanisms, etc.;
- ITU-T Study Group 20 to leverage the deployment of IoT applications to contribute to a more connected, sustainable and safer transportation, looking in particular into **interoperability and backward compatibility issues**;
- ITU-T Study Group 21 to develop ITU-T Recommendations aimed at implementing vehicular communications, such as V2X and ITS, including vehicular communications to support automated driving, **covering requirements, use cases, functional architecture, interfaces, standards roadmaps, etc**., **taking into account the study outcomes of CITS/EG-ComAD** and the outcomes of ITU-R Study Group 5 on spectrum requirements;
- relevant ITU-T study groups **to determine and assess the standardization landscape for vehicular communications**, such as V2X and ITS, including vehicular communications to support automated driving, while ensuring collaboration and avoiding overlap with other SDOs

- **ITU-R WP.5A is currently working on Question 264/5, EG-ComAD will provide automotive requirements to ITU-R WP.5A**
- **ITU-T SG 21 Q10 is currently working on vehicular multimedia communications, systems, networks, and applications, like V2X, VRU etc. EG-ComAD expects to provide possible areas for standardisation**

# The development path for connected vehicle technologies has achieved international consensus

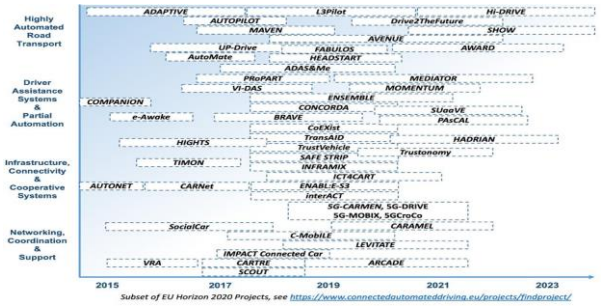
## USA

Direct communication frequency bands for C-V2X technology has allocated; *Plan to Accelerate V2X Deployment* has been issued to promote large-scale deployment of C-V2X infrastructure




## Europe

Under the EU's Horizon 2020 and Horizon Europe programs, over 100 R&D programs of connected and cooperative vehicle technologies were sponsored




## South Korea

Next-generation Cooperative Intelligent Transportation System (C-ITS) has officially designated LTE-V2X as the sole V2X communication standard


## China

**releasing the LTE-V2X direct communication spectrum (5905-5925MHz)**

- By now, **15 operators** have been authorized to deploy the RSU devices.

**The 14th Five Year Plan for the Development of the Information and Communication Industry**

- Strengthen the top-level design of the deployment of vehicle networking infrastructure based on C-V2X, and promote the coordinated construction of C-V2X with 5G networks

**Notice on Promoting the Accelerated Development of 5G**

- Promote the large-scale deployment of LTE-V2X, incorporate 5G and LTE-V2X into important communication standards and protocols

**Action Plan for the Development of the Internet of Vehicles (Intelligent Connected Vehicles) Industry**

- Strongly support the research and industrialization of LTE-V2X and 5G-V2X, and build network infrastructure based on LTE-V2X and 5G-V2X

**National Road Traffic Safety Plan for the 14th Five Year Plan**

- Accelerate the deployment of C-V2X, promote the networked transformation of transportation facilities, strengthen the networked control of traffic signals, and enhance traffic guidance services

**5G Application Sailing Action Plan（2021-2023）**

- A accelerate the penetration rate and roadside deployment of C-V2X communication modules, and promote the innovative application of C-V2X technology in areas such as parks, airports, ports

# V2X Standard Overview

## 3GPP V2X communication standard evolution

| Rel 14-15 LTE-V2X | Rel 16 NR-V2X | Rel17 NR Enhancement | Rel18 NR Enhancement | Rel19 Under research |
|---|---|---|---|---|
| **Basic traffic safety and efficiency scenarios**<br>☐ Periodic broadcasting of safety-related warning messages.<br>☐ The physical layer supports one-way broadcast, small amounts of information, and low latency | **Highly Coordinated Driving Services**<br>☐ A more flexible, higher bandwidth, more reliable, and lower latency transmission<br>☐ Supports unicast, broadcast, and multicast transmission modes | **Enhancements in high-reliability, low-power**<br>☐ Enhanced resource allocation mechanism: supports V2P and improves reliability<br>☐ Device-to-device link energy saving: discontinuous reception (DRX) mechanism | **C-V2X Application Scenarios Expansion**<br>☐ Transmission enhancements under new frequency bands and multi-carrier aggregation<br>☐ Coexistence of LTE-V2X and NR-V2X channel<br>☐ Sidelink positioning technology | **New Technology Pre-research**<br>☐ research on deployment scenarios and channel modeling for integrated sensing and communication technologies in vehicle-to-everything (v2x) networks |

**China C-V2X system and application related standards formulated by several standardization committees are used to guide the deployment of C-V2X**

| Category | Standards |
|---|---|
| General Requirements | Wireless Communication Technology of IoV Based on LTE-V2X General Technical Requirements |
| Access Layer | Wireless Communication Technology of IoV Based on LTE-V2X Technical Requirements of Air Interface |
| | Wireless Communication Technology of IoV Based on LTE-V2X Technical Requirements for OBU Supporting Direct Communication |
| | Wireless Communication Technology of IoV Based on LTE-V2X Testing Methods for OBU Supporting Direct Communication |
| | Wireless Communication Technology of IoV Based on LTE-V2X Technical Requirements for RSU Supporting Direct Communication |
| | Wireless Communication Technology of IoV Based on LTE-V2X Testing Methods for RSU Supporting Direct Communication |
| Network Layer | Wireless Communication Technology of IoV Based on LTE-V2X Technical Requirements of Network Layer |
| | Wireless Communication Technology of IoV Based on LTE-V2X Testing Methods for Network Layer |
| | LTE-V2X Technical Specification Based on ISO Intelligent Transportation System Framework |
| Message Layer | Wireless Communication Technology of IoV Based on LTE-V2X Technical Requirements of Message Layer |
| | Wireless Communication Technology of IoV Based on LTE-V2X Test Methods for Message Layer |
| | Collaborative Intelligent Transportation System Application Layer and Application Data Interaction of Vehicular Communication System(Phase I) |
| | Collaborative Intelligent Transportation System Application Layer and Application Data Interaction of Vehicular Communication System(Phase II) |
| | Interaction Data Requirements of Enhanced V2X Application Layer |
| | High Level Autonomous Driving Data Interaction Content Based on Vehicle Road Collaboration |
| | Technical Requirements of C-V2X Large Scale Test System and Interface |
| Security | Wireless Communication Technology of IoV Based on LTE-V2X Technical Requirements of Security |
| | Wireless Communication Technology of IoV Based on LTE-V2X Technical Requirements of Security Certificate Management System |
| | Technical Requirements for Misbehavior Management of Vehicle Supporting C-V2X |
| | Wireless Communication Technology of IoV Based on LTE-V2X Test Methods for Security Certification |
| | Wireless Communication Technology of IoV Based on C-V2X Technical Requirements of Authentication and Authorization System |
| Identification | Wireless Communication Technology of IoV Based on C-V2X Application Identification Allocation and Mapping |
| System Requirements | Technical Requirements of Vehicular Information Interaction System based on LTE-V2X Direct Communication |
| | Wireless Communication Technology of IoV Based on LTE-V2X Technical Requirements and Testing Methods for RSU Supporting direct communication |

**SAE V2X has established a C-V2X working group to promote the development of technical standards, including the technical requirements and testing methods for V2V safety communications based on LTE-V2X, as well as the technical requirements for vehicle equipped OBU**

| | |
|---|---|
| SAE J2735 | Dedicated Short Range Communications (DSRC) Message Set Dictionary™ |
| J2945 | Dedicated Short Range Communication (DSRC) Systems Engineering Process Guidance for SAE J2945/X Documents and Common Design Concept |
| J2945/1 | On-Board System Requirements for V2V Safety Communications |
| J2945/5 | Service Specific Permissions and Security Guidelines for Connected Vehicle Applications |
| SAE J2945/2 | Dedicated Short Range Communications (DSRC) Performance Requirements for V2V Safety Awareness |
| SAE J2945/9 | Vulnerable Road User Safety Message Minimum Performance Requirements |
| SAE J3161/1 | On-Board System Requirements for LTE V2X V2V Safety Communications |
| SAE J3161 | C-V2X Deployment Profiles |
| SAE J3016 | Taxonomy and Definitions for Terms Related to Driving Automation Systems for On-Road Motor Vehicles |

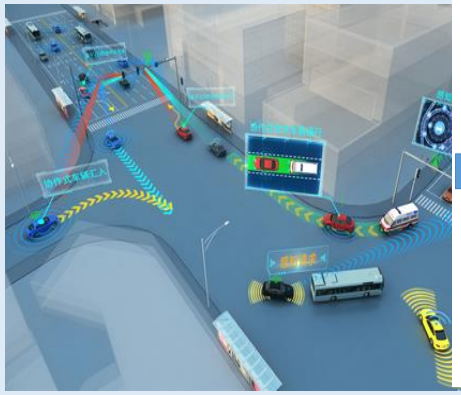
# Phase I/ II/High Level Autonomous Driving application scenarios and related standards

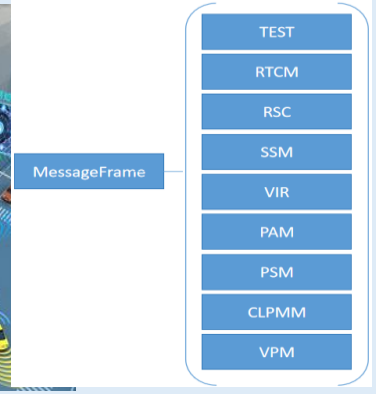
| | Application Scenarios |
|---|---|
| 1 | FCW: Forward Collision Warning |
| 2 | ICW: Intersection Collision Warning |
| 3 | LTA: Left Turn Assist |
| 4 | BSW/LCW: Blind Spot Warning/Lane Change Warning |
| 5 | DNPW: Do Not Pass Warning |
| 6 | EBW: Emergency Brake Warning |
| 7 | AVW: Abnormal Vehicle Warning |
| 8 | CLW: Control Loss Warning |
| 9 | HLW: Hazardous Location Warning |
| 10 | SLW: Speed Limit Warning |
| 11 | RLVW: Red Light Violation Warning |
| 12 | VRUCW: Vulnerable Road User Collision Warning |
| 13 | GLOSA: Green Light Optimal Speed Advisory |
| 14 | IVS: In-Vehicle Signage |
| 15 | TJW: Traffic Jam Warning |
| 16 | EVW: Emergency Vehicle Warning |
| 17 | VNFP: Vehicle Near-Field Payment |


- Cooperative intelligent transportation system—Vehicular communication application layer specification and data exchange standard **(Phase I)**
- Technical Requirements of Message Layer of LTE-based Vehicular Communication

| | Application Scenarios |
|---|---|
| 1 | Vehicle Merge |
| 2 | Identification of Vulnerable Road User |
| 3 | Cooperative Intersection Passing |
| 4 | Guidance Service of Vehicle |
| 5 | Intersection Dynamic Lane Management |
| 6 | Dynamic Optimization of Traffic Signal Timing Based on Real Time Connected Data |
| 7 | Intelligent parking guidance |
| 8 | Platooning |
| 9 | Cooperative Fleet Management |
| 10 | Flexible management of highway dedicated lanes |
| 11 | Active and passive toll collection based on vehicle road collaboration |
| 12 | Dynamic Path Planning for Electric Vehicles |
| 13 | OTA based on vehicle road collaboration |
| 14 | In the loop simulation of autonomous driving vehicle based on vehicle road collaboration |

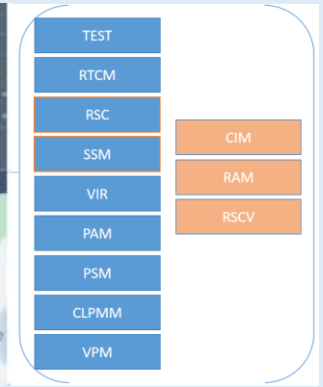
| | Application Scenarios |
|---|---|
| 1 | SDS: Sensor Data Sharing |
| 2 | CVM: Cooperative Vehicle Merge |
| 3 | CVM: Cooperative Vehicle Merge |
| 4 | CIP: Cooperative Intersection Passing |
| 5 | DDS: Differential Data Service |
| 6 | DLM: Dynamic Lane Management |
| 7 | CHPVP: Cooperative High Priority Vehicle Passing |
| 8 | GSPA: Guidance Service in Parking Area |
| 9 | PDC: Probe Data Collection |
| 10 | VRUSP: Vulnerable Road User Safe Passing |
| 11 | CPM: Cooperative Platooning Management |
| 12 | RTS: Road Tolling Service |






- The Requirements Standard for Enhanced V2X Application Layer Data Interaction
- Cooperative intelligent transportation system—Vehicular communication application layer specification and data exchange standard **(Phase II)**

| | Application Scenarios |
|---|---|
| 1 | Cooperative Sensing |
| 2 | Unsigned Intersection Passing Based on Roadside Collaboration |
| 3 | Self Driving Vehicles Extrication Based on Roadside Collaboration |
| 4 | High Precision Map Version Alignment and Dynamic Updates |
| 5 | Autonomous Parking |
| 6 | Recognition of Zombie Vehicles Based on Roadside Sensing |
| 7 | Traffic Condition Recognition Based on Roadside Sensing |
| 8 | Recognition of Abnormal Driving Behavior Based on Cooperative Sensing |




- **Data exchange** standard for high level automated driving vehicle based on cooperative intelligent transportation system

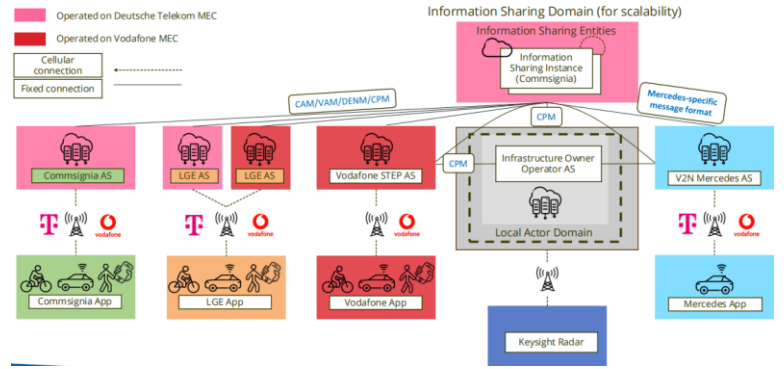
# Connected and Automated Vehicle Testing Activities Continue to Progress

- More than 400 enterprises across the industry chain, including chips, modules, terminals, vehicles, and security, are collaborating to conduct large-scale demonstration and pilot during the last 7 years

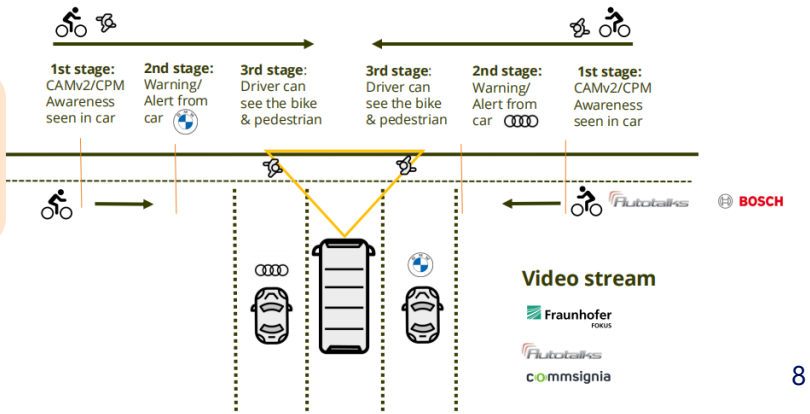
**Cross-chip module, cross-terminal, cross-vehicle, cross-security platform**


- 5GAA members have made progress in V2X-based VRU protection, demos and deployment activities, Recently, 5GAA focus on interoperability between two MEC systems, MEC platforms, or MEC application instances, and 5G-V2X Direct demo related work.

**V2N(Vehicle 2 Network)Tests**




**5G-V2X Direct Communications Demonstration**



# Penetration rate of vehicle network connection significantly increases

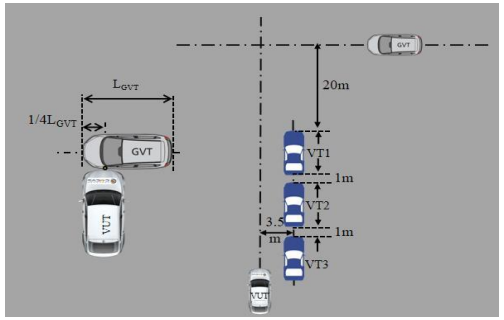
- During January to December 2024, about **19.35 million passenger cars** in Chinese market **were installed standard vehicle connected terminals(standard installation rate of 84.43% with year-on-year increase of 17.10%)**. Among them, 3.48 million pre-installed **5G terminals** (including optional installation) **(with year-on-year increase of 100.73% )**, 0.5 million pre-installed **LTE-V2X terminals(with year-on-year increase of 63.73% )**

| Brand | Vehicle Platform | Time to market | Communication mode |
|---|---|---|---|
| SAIC | Marvel R | 2021 | 5G+LTE –V2X |
| | Rising Auto R7 | 2022 | 5G+LTE –V2X |
| | IM L7 | 2021 | 5G+LTE –V2X |
| GAC AION | AION V | 2020 | 5G+LTE –V2X |
| FAW Car Co., Ltd | E-HS9 | 2020 | 4G+LTE –V2X |
| NIO | All NT2 platform models are standard | 2021-2022 | 5G+LTE –V2X |
| GWM | Tank500 | 2022 | 5G+LTE –V2X |
| BAIC | ARCFOX αS | 2021 | 5G+LTE –V2X |
| Kinglong | All self-driving cars | 2019-2022 | 5G+LTE –V2X |
| Audi | A7L、A6L | 2022 | 5G+LTE –V2X |
| BYD | YANGWANG U8 | 2023 | 5G+LTE-V2X |
| SGM | Buick GL8Avenir | 2020 | LTE –V2X |

# C-NCAP will accelerate to improve the penestration rate of C-V2X technology

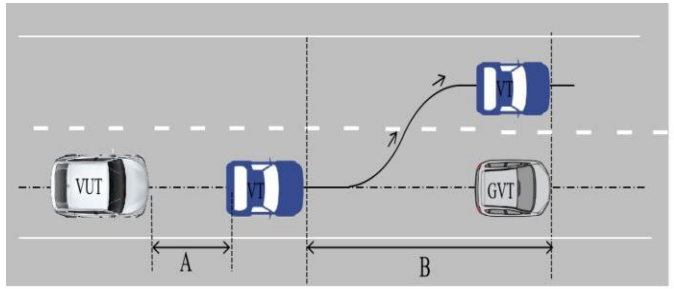
The C-V2X technology is added into the active safety section of **C-NCAP(Exposure draf) for 2024**.The description of the Global Vehicle Target (GVT) in the test project includes the words "**capable of C-V2X network communication**", which means that all the active safety section can be realized by C-V2X.

**Scenrio 1：C2CSCPO**
**(Car-to-Car Straight Crossing Path with Obstruction)**




**In the presence of obstacles**, the function avoiding collision and conflict is tested between GVT passing through a vertical angle path and a straight line at **an intersection** by VUT

**Scenrio 2：CCRH**
**(High Speed Car to Car Rear)**

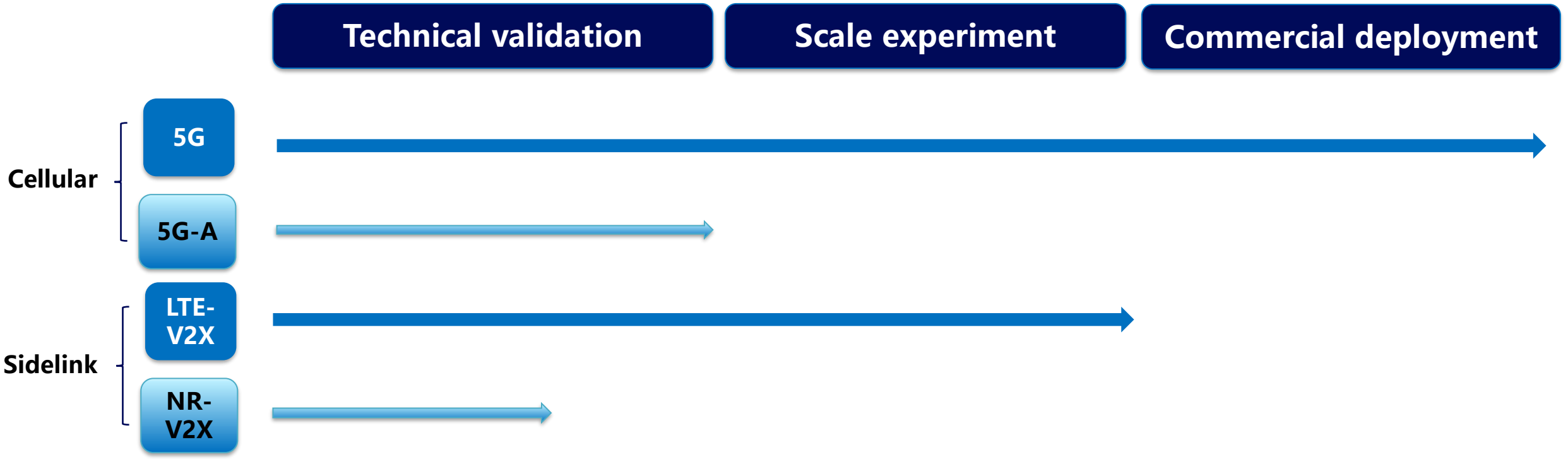



In the **high-speed scenarios**, the function of **avoiding rear end collision** is tested between VUT and GVT when VT changed the line.

**Scenrio 3：Red lights violation**

Traffic lights can have **C-V2X network communication capability**. The function of **warning VUT violating red lights** is tested.

# Cross-industry collaboration is essential for the development of the CAV industry




The development of industrial cannot be separated from cross industry collaboration such as automobiles, communications, and transportation

Driven by the demand of automated driving application scenarios

Collaboration between upstream and downstream industries such as automobiles and communications

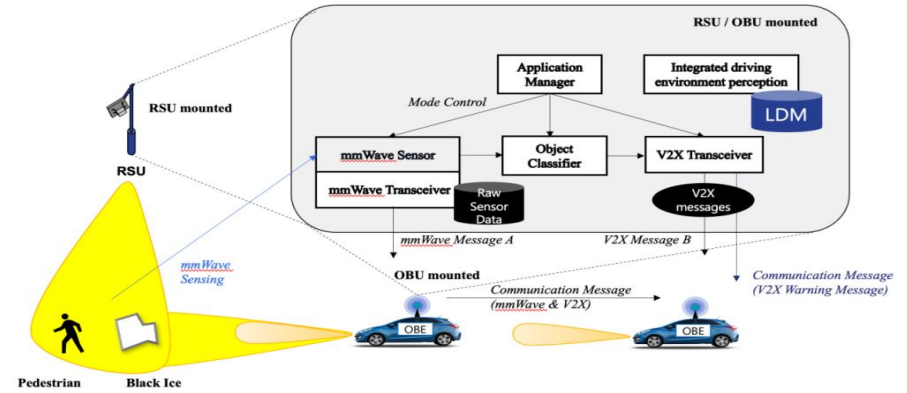
Infrastructure cross domain interoperability and service consistency

Basic guarantee: Consistent technological pace, unified standards, and comprehensive laws and regulations

# Cross industry collaboration runs through every stage of industry development

## Technology validation needs to be driven by automated driving needs

- **Traditional telecommunication thinking cannot be simply applied, and it is necessary to combine the characteristics of the automotive industry and conduct in-depth research on the unique needs of specific scenarios in order to provide effective communication support.**
  - **The development of automated driving has shifted the demand for networked communication from *Serving People* to *Serving Vehicles*, and different scenarios have different requirements for communication.**



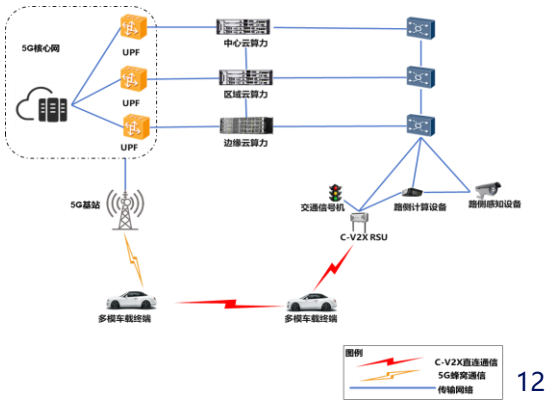

## Automotive industry chain need to collaborate to carry out scale tests

- **It is necessary to integrate upstream and downstream resources of the industrial chain to carry out collaborative research and development and scale experiments.**
  - **The industry chain of connected automated driving is very long and involves numerous enterprises in multiple industries such as automotive, communication, transportation, and so on.**


## Ensure infrastructure interoperability and service consistency

- **It needs to provide a unified reference for the deployment of cross domain networking and the construction of systematic service capabilities for infrastructure, and encourage localities to actively explore deployment solutions that are suitable for their local needs.**
  - **The widespread mobility of automated vehicles poses significant challenges for achieving the goal of wide coverage and consistency in business services.**

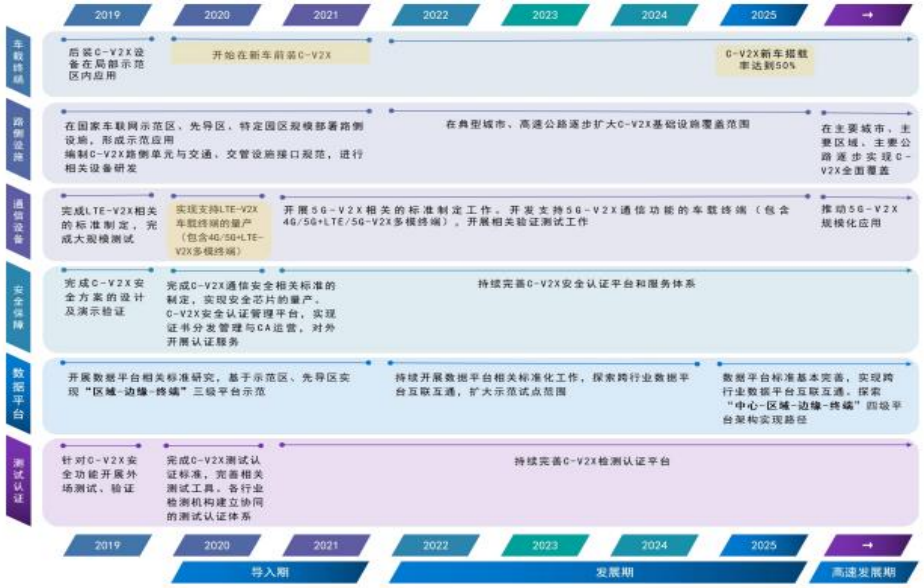

车路云一体化系统网络建设部署
参考指南
（1.0 版）
2024 年 10 月



# Basic guarantee: Consistent technological pace, unified standard system, comprehensive laws and regulations

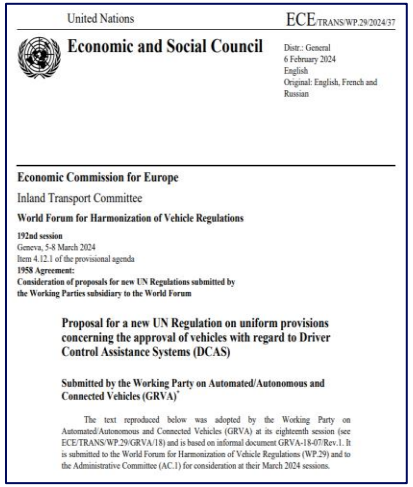
## Consistent technological lifecycle is very necessary

- **If a consensus cannot be reached on the lifecycle of technology research and development implementation, it will be difficult for the automotive and transportation industries to invest in deploying an information and communication technology that may soon become "outdated", and both of them also prone to the dilemma of waiting for each other to deploy first.**
  - **ICTs evolve rapidly and can even be iterated in 2 years, automobiles are updated in 5-10 years, and transportation infrastructures in 10-20 years or longer.**




## Standard and regulatory are the fundamental guarantees

- **If the top-level standards and regulations lack, the connected automated driving industry may stagnate or become chaotic, which requires high attention from countries and international organizations.**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World Forum for Harmonization of Vehicle Regulations

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Geneva, 5-8 March 2024
Item 4.12.1 of the provisional agenda
1958 Agreement:
Consideration of proposals for new UN Regulations submitted by the Working Parties subsidiary to the World Forum

Proposal for a new UN Regulation on uniform provisions concerning the approval of vehicles with regard to Driver Control Assistance Systems (DCAS)

Submitted by the Working Party on Automated/Autonomous and Connected Vehicles (GRVA)*

The text reproduced below was adopted by the Working Party on Automated/Autonomous and Connected Vehicles (GRVA) at its eighteenth session (see ECE/TRANS/WP.29/GRVA/18) and is based on informal document GRVA-18-07/Rev.1. It is submitted to the World Forum for Harmonization of Vehicle Regulations (WP.29) and to the Administrative Committee (AC.1) for consideration at their March 2024 sessions.

# Future work

**In the future, on the basis of respecting the development needs and laws of relevant industries, it is necessary to further strengthen cross industry collaboration, promote communication between empowerment and application parties, and form a cross industry recognized and practical development path and timeline.**

- ✓ **Facilitating the communication industry to plan communication and networking capabilities in advance**
- ✓ **Facilitating the automotive industry to plan mass production functions in advance**
- ✓ **Facilitating urban and highway construction operators to prepare infrastructure upgrade and construction plans in advance**

# Importance of the EG-ComAD

- The establishment of the expert group will help further increase the consensus on the roadmap of Communications Technology for Automated Driving. The two working groups studying the demand for communications technology from the perspective of scenarios will also provide valuable technical input (WG1 Vehicle Communications for Merging Automatically into Congested Lanes, and WG2 Vehicle Communications for Advanced Emergency Braking, Including to Protect VRUs).
- The platform linkage between the expert group and various organizations (ITU-R WP.5A, ITU-T SG 21, WP.29, ETSI, SAE, etc.) will help further strengthen the global coordination and standardization process of the regulations of Communications Technology for Automated Driving.
- The work schedule formulated by the expert group will help relevant international organizations jointly develop a coordinated progress schedule, providing a relatively stable expectation for the development of the global industry.

**Looking forward to the expert group contributing to the development of Connected and Automated Driving!**

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# Thanks