C-V2X standardisation in China

5GAA Automotive Association
Technical Report

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Contents

Foreword

This Technical Report (TR) has been produced by 5GAA.

The contents of the present document are subject to continuing work within the Working Groups (WG) and may change following formal WG approval. Should the WG modify the contents of the present document, it will be re-released by the WG with an identifying change of the consistent numbering that all WG meeting documents and files should follow (according to 5GAA Rules of Procedure):

x-nnzzzz

(1) This numbering system has six logical elements:

(a) x: a single letter corresponding to the working group:

where x =

T (Use cases and Technical Requirements)

A (System Architecture and Solution Development)

P (Evaluation, Testbed and Pilots)

S (Standards and Spectrum)

B (Business Models and Go-To-Market Strategies)

(b) nn: two digits to indicate the year. i.e. ,17,18 19, etc

(c) zzzz: unique number of the document

(2) No provision is made for the use of revision numbers. Documents which are a revision of a previous version should indicate the document number of that previous version

(3) The file name of documents shall be the document number. For example, document S-160357 will be contained in file S-160357.doc

1 Scope

This Technical Report is to shed light on the typical C-V2X-related standardisation organisations and industry alliances in China comprising stakeholders from ICT, automobile, transportation and traffic management industries. It analyses their working scope, main role, list of ongoing standards, etc. to help prioritise 5GAA input.

2 References

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies.

3 Abbreviations

For the purposes of the present document, the following symbols apply:

CAST	China's Association for Science and Technology
CAICT	China's Academy of Information and Communication Technology
CAAM	China Association of Automobile Manufacturers
CAICV	China's Industry Innovation Alliance for the Intelligent and Connected Vehicles,
CCSA	China's Communications Standards Association
C-ITS	China's ITS Industry Alliance
C-SAE	China's Society of Automotive Engineers
C-V2X	Cellular Vehicle-to-Everything
IEC	International Electro-technical Commission
IEEE	Institute of Electrical and Electronics Engineers
IoV	Internet of Vehicle
ISO	International Organisation for Standardisation
ITU	International Telecommunication Union
MNR	Ministry of Natural Resources
MOHURD	Ministry of Housing and Urban-Rural Development
MOST	Ministry of Science and technology
MoT	Ministry of Transport
MPS	Ministry of Public Security
NTCTM	National Technical Committee on Traffic Management of Standardisation Administration of China
SAC	Standards Administration of China
SAE-C	Society of Automotive Engineers of China
SDO	Standards Development Organisation
3GPP	3rd Generation Partnership Project

4 Overview

In 2017, the framework agreement on strengthening cooperation for China's Internet of Vehicle (IoV) standards among automobile, intelligent transportation, communication and traffic management was endorsed. From 2018, China's Ministry of Industry and Information Technology (MIIT), Standardisation Administration (SAC) and related ministries jointly issued guidelines to construct the Internet of Vehicle standard system. As showed in Figure 1, these guidelines included overall requirements, intelligent connected vehicles, communications, electronic products and systems, intelligent traffic systems, and traffic management. In this TR, communication part is main focus.

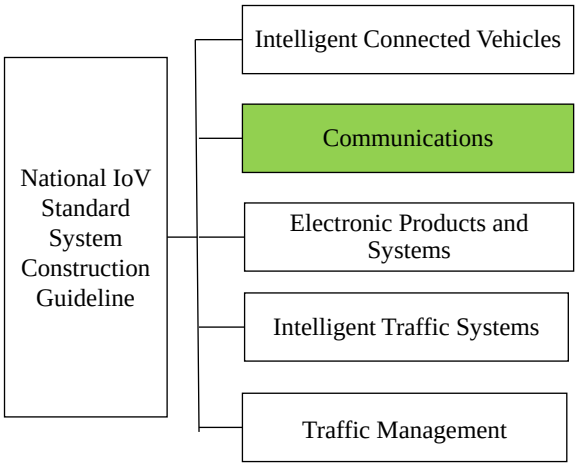

Figure 1: China's connected vehicles standard system guidelines

Cellular Vehicle-to-Everything (C-V2X) is the fundamental technology underlying IoV developments. Figure 2 defines China's C-V2X protocol stack. The standards cover the technical requirements for the C-V2X service requirements, architecture, spectrum resources, air interfaces, network layer, application message layer, security, and related equipment and test specifications.

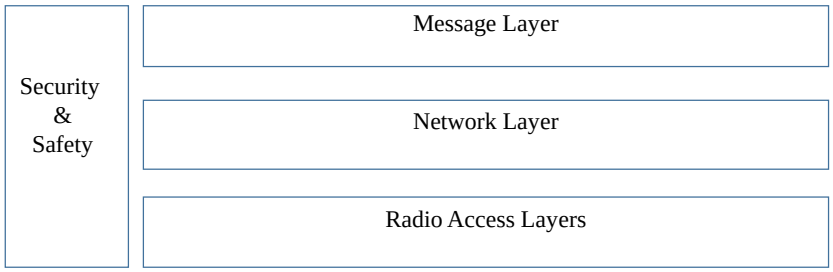

Figure 2: China's C-V2X protocol stack

Figure 3 illustrates the overall C-V2X-related standard development organisations and alliance. According to the C-V2X standard cooperation agreement, CCSA is mainly working on C-V2X requirements, architecture and the communication part (i.e. not only LTE-V2X, but also 5G-related), C-ITS is mainly working on the ITS application part, SAE-C/CAICV/NTCAS is mainly working on the vehicle related part, and NTCTM focuses on traffic management part. See above abbreviations for the full name of these organisations.

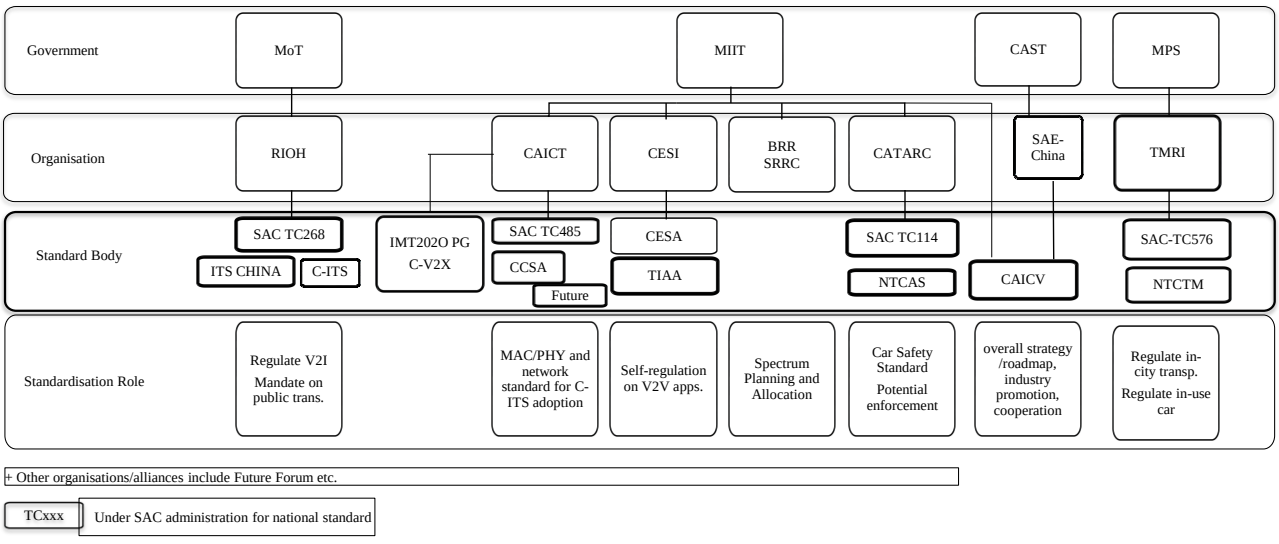

Figure 3: Overall C-V2X-related standard development organisation and alliances

5 Key SDOs or industry alliances

5.1 IMT2020 (5G) PG C-V2X WG

IMT-2020 (5G) Promotion Group (www.imt2020.org.cn) was set up by three ministries in China, namely the Ministry of Industry and Information Technology, National Development and Reform Commission, and Ministry of Science and Technology in February 2013, based on the original IMT-Advanced Promotion Group. The structure of IMT-2020 PG is illustrated in Figure 4. The group is now operated by China's Academy of Information and Communication Technology to promote the R&D, standardisation and commercialisation of cellular technologies such as 5G. It is one of the most influential 5G organisations in the industry with close links to other international standards bodies such as ITU, 3GPP, IEEE, CCSA, etc.

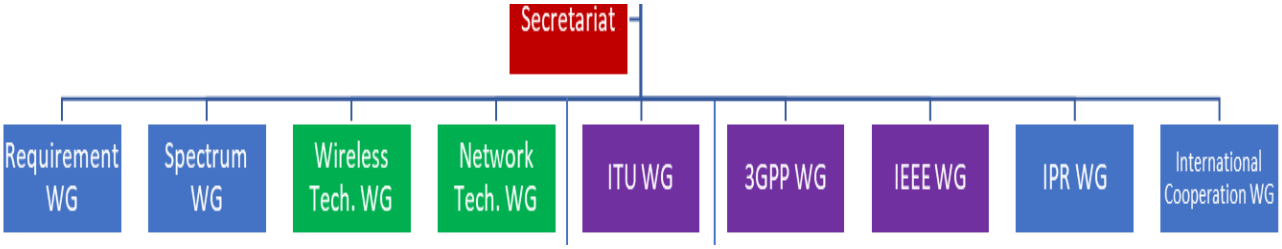

Figure 4: Structure of IMT-2020 PG

The IMT-2020 (5G) Promotion Group C-V2X working group (http://v2x.caict.ac.cn/topics.html) was established in 2017. It is responsible for organising C-V2X developments including LTE-V2X and 5G NR-V2X research, test verification, industry and application promotion, and other work. In late 2021, it counted 319 members from scientific research institutes and enterprises. It has become the most important C-V2X cooperation platform for "production, research, development and application", and played an important role in promoting close collaboration among automobile, information and communication, transportation and other related industries.

The working group has carried out work in C-V2X's deployment and on key technology requirements and innovations, including communication and networks, testing and verification, MEC (Multi-access Edge Computing) platform, security, regulation and operation, service requirement and application, etc. Figure 5 illustrates the main focus and milestones of the C-V2X working group.

Figure 5: IMT-2020(5G) PG C-V2X WG focus and milestones

On the following pages is Table 1 listing the completed study items in C-V2X working group.

Table 1: Completed study items in C-V2X working group

Timeline	Topics	Overview	Output
2017-2018	Deployment and Networking Solution	Study of interconnection based on LTE-V2X PC5 and LTE-Uu interfaces	Research Report
2017-2018	IoV Application Promotion and Business Model	Study of existing IoV business models in China and other markets, early stage of LTE-V2X and its future	Research Report
2017-2018	LTE-V2X Spectrum Requirement and Assignment	Study of spectrum requirements for safety applications for vehicles and roads and coexistence with existing spectrum interference	Research Report
2017-2019	C-V2X Service Requirement and Evolution	Study of 5G+C-V2X usage coverage to include VRU, AI, high-accuracy positioning in conjunction with the development of autonomous driving, road automation and remote driving. The research also includes C-V2X service under special working environments such as mining, etc.	C-V2X Service Requirement and Evolution Whitepaper
2018-2019	Integration of MEC and C-V2X Usage Scenario	Study of deployment of C-V2X application on MEC (Uu and PC5) to take advantage of its proximity for low-latency AI, compute and storage at the edge, reduced backhaul bandwidth consumption, high-quality localisation services to finalise and realise pedestrian-vehicle-road-cloud cooperation	Integration of MEC and C-V2X Usage Scenario Whitepaper
2018-2019	Service Exposure Capability and Open Interfaces Requirements for MEC and C-V2X Integration	Study of requirements towards MEC service exposure capability for vehicle-road cooperation and open API standardisation	Research Report
2018-2019	MEC and C-V2X Integration for Vehicle-Vehicle Cooperation Solution and Validation	Study of MEC plus road infrastructure applications with respect to different vehicle-road cooperation usage scenarios and end-to-end service flow	Research Report
2018-2019	LTE-V2X Security Mechanism & Requirement	Study of LTE-V2X security mechanisms and requirements for China's usage scenarios, commercialisation/deployment, data security and privacy protection	LTE-V2X Security Technical Whitepaper
2018-2019	High-Accuracy Positioning	Study of existing positioning technology, analysis of IoV positioning requirements in combination with sensory information from LiDAR, radar, and cameras for better and higher accuracy positioning	Vehicle High Accuracy Positioning Whitepaper
2018-2019	C-V2X Conformance Test Framework	Conformance test framework recommendation for RSU and OBU by integrating requirements from the communication industry and vehicle industry	C-V2X Conformance Test Research Repot
2019-2020	V2X Specific Usage Scenario	Study of V2X architecture and application requirements for mining usage scenario	C-V2X with Autonomous Driving for Smart Mining Whitepaper
2019-2021	C-V2X Networking Classification	Study of classifications of C-V2X functionality in association with the vehicle type and road type	Research Report
2019-2021	Ship-Port Cooperation Technology Research	Study of ship-port cooperation can be achieved based on navigation data, ship equipment data, cargo information and other sensory information.	Research Report
2020-2020	C-V2X Security System Level Testing	Trials on testbeds based on 'LTE-V2X Security Certificate Management System Technical Requirements' to validate the security of certificate management, flow of authentications towards deployment and recommendations for commercialisation	Test Specifications and Trials

2020-2021	Positioning Technology Based on MEC	Study of how positioning technology can be further enhanced through the integration of MEC and C-V2X technology.	Positioning Technology MEC Whitepaper
2020-2021	5G IoV Communication Technical Requirement Research	Analysis of the technical requirements and key 5G technologies to support different end-to-end V2X usage scenarios	Research Report
2020-2021	C-V2X Radio Environment Research	Study of V2V/V2I radio characteristics on highways, V2I characteristics inside tunnels and a comparison with WINNER II standard models	Whitepaper
2020-2021	Vehicle-Road Cooperation Infrastructure Operation and Maintenance Management System Research	Study of road infrastructure operations and maintenance management systems covering RSUs, cameras, radar, LiDAR and MEC	Whitepaper

Table 2 lists the ongoing study items in C-V2X working group.

Table 2: Ongoing study items in C-V2X working group

No.	Project Name	Description	Category
1	Highway Vehicle-Road Cooperation Network Requirements	Study of requirements on the bearer network to support smart highway vehicle-road cooperation, which includes the network between the RSU and the road C-V2X Centre, and the latter's connection to the provincial C-V2X Centre. The requirements relate to the service flow analysis, application deployment scenario analysis, cyber-security analysis of vehicle-road cooperation, as well as the network connection between road infrastructures	Communication and Network
2	Usage Scenario Analysis and Communication System Requirements of Remote Driving Based on 5G Network	Study of remote driving definition and categorisation including the function and performance requirements of 5G networks, the system structure and application layer communication interface of 5G network to support remote driving, and typical industry scenario requirements and suggestions, with advice on different application scenarios such as in mines, parks, urban settings, on highways, etc.	Application
3	Vehicle-Road Cooperation Application Based on Smart Phone	Study of vehicle-road cooperation application requirements, system structure, connectivity performance, data interface as well as the applications (i.e. APP, mini-program, mini-scenario, etc.) based on smart phones	Application
4	Technical Requirements and Test Method of C-V2X Network Performance	Performance evaluation system for C-V2X network based on former research results, which includes KPI, test methods, result analysis methods, and so on	Platform
5	Evaluation and Test Method for C-V2X Roadside Application	Study of a testing and evaluation system for C-V2X roadside application functions based on defined C-V2X scenarios and existing research results (i.e. KPI, test methods, result requirements, etc.)	Platform
6	MEC and C-V2X Integration: Roadside Smart Infrastructure	Study of all roadside smart infrastructure that can collect information, edge computing, information publishing and communication; descriptions of application requirements for roadside infrastructure in vehicle-road cooperation, especially scenario classification and specification settings for the traffic status and environment, infrastructure status and vehicle micro-behaviour	Platform
7	MEC Cross-Region Interaction for Vehicle-Road Cooperation	Study and scenario analysis of vehicle-road cooperation, cross-region cooperation demand, as well as MEC cross-region processes and context specifications during the MEC handover (i.e. mainly to better define specs during C-V2X service migration and to maintain application-level continuity for heterogeneous MEC service providers)	Platform
8	Roadside Sensor Fusion System Based on MEC and Related Communication System	Study and analysis of the hardware performance requirements, software algorithm function and performance, and data interface of the roadside sensor fusion system	Platform

	Requirements		
9	Cloud Data Transmission for the Open-air Mining Vehicles	Study to define/classify data transmission interaction between the vehicle end and the cloud, as well as the function, performance requirements and application recommendations of the 5G communication system behind data transmissions from open-air mining vehicles to the cloud	Platform
10	Blockchain Application in IoV Usage Scenarios	Study of the IoV data-sharing standard based on blockchain; the data format in IoV industry is very different which hinders data-sharing between different parties	New Technology
11	IoV Infrastructure Construction and Operation	Study of the overall IoV infrastructure solution so all parties can cooperate using standard device interfaces, network connections, platform services and cyber-security solutions. For IoV service operation, all parties 1) jointly discuss licenced application of the IoV direct communication frequency band, IoV telecommunication service and trialled commercialisation, 2) explore business model maturity by scenario, 3) collaborate on verification, demonstration, and scaled commercialisation of IoV applications, and 4) prepare the timetable and roadmap for these actions	Regulation and Operation
12	Compatibility Design of C-V2X Application Message	Study of requirements for C-V2X application message compatibility design, investigating the compatibility of domestic and foreign messages and other system compatibility mechanisms; the outcome is to analyse and test candidates for carrying C-V2X application messages, proposal compatible solutions (rules, methods, test cases and subsequent platform establishment), and report the findings	Regulation and operation (Whitepaper)
13	C-V2X Identification System	Study of requirements for using identification in C-V2X systems; involves providing a definition of various OBUs, RSUs, network, platforms related to existing standards, and proposing design suggestions to fill knowledge gaps (i.e. missing ID) and complete the whole C-V2X identification system	Regulation and operation

5.2 CCSA

Building on the foundations of the former research group of communication standards, China's Communication Standardisation Association (www.ccsa.org.cn) was established on 18 December 2002. It acts as unified national communications standardisation organisation which is responsive to market conditions and in line with international standards and national conditions.

The CCSA is a non-profit entity run by members from both private and public organisations, approved by the competent business authorities and registered by the National Association Registration Administration. The Association carries out standardisation activities in the field of information and communication technology throughout the country. It currently has 800 members. The Membership is open to the whole of society, and widely attracts representatives from manufacturing, communications and internet sector, scientific research and academia (colleges and universities), technology developers, design centres/institutes, social organisations, and others.

The Association is responsible for organising and centralising the development and revision of national standards, industrial standards and CCSA standards in the field of information and communication technologies. The secretariats of the National Technical Committee 485 on Communications of Standardisation Administration of China (TC485) and the National Technical Committee 543 on Communications Service of Standardisation Administration of China (TC543), which are approved by the People's Republic of China are duly set in the CCSA.

The General Assembly, Strategic Steering Committee, Board of Directors, Board of Supervisors and Technical Management Committee are considered part of the management group. The Technical Committee, Special Task Group, Standards Promotion Committee and other technical bodies are set according to the needs of technology research and standards development. The secretariat serves as a standing administrative body, which carries out the routine work.

V2X-related work in the CCSA mainly involves the preparation and revision of national standards in the fields of communication networks, system and equipment performance requirements, basic communication protocols, and related test methods. Figure 4 shows how the Association's work is organised.

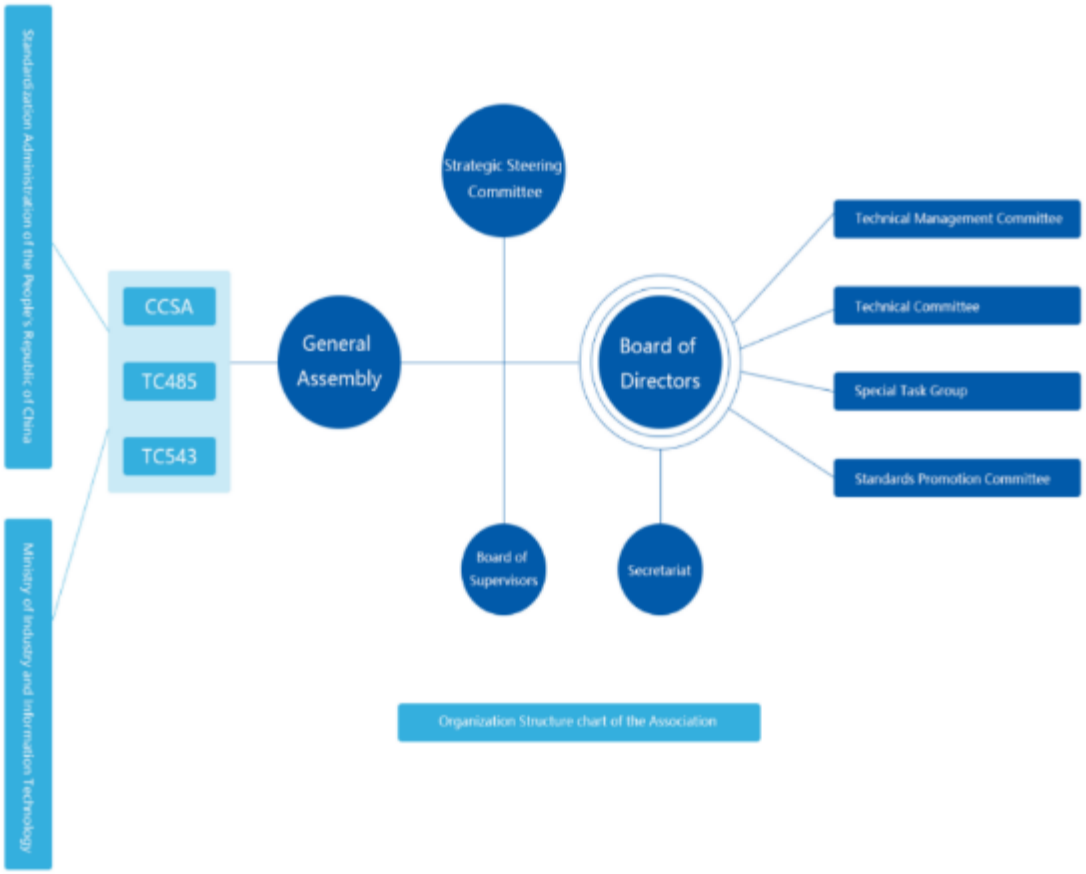

Figure 4: CCSA org. architecture

Table 3 shows the V2X-related activities that the CCSA works on.

Table 3: C-V2X related working groups in CCSA

Technical Committee (TC)	Working Group	Duties and Scope of Research	Correspondence with International Standardisation Organisation
TC5	WG5: Wireless Security and Encryption Working Group	Research and development of wireless mobile encryption and network security	3GPP, OMA and other security-related organisations
	WG6: Frontier Wireless Technologies Working Group	Advanced wireless technology requirements, key technology and programme research	ITU-R, WWRF
	WG8: Frequency Working Group	Radio spectrum planning-related research; Research on electromagnetic compatibility in and between radio service systems; research and formulation of equipment radio frequency index and radio monitoring technical standards (ITU-R's counterpart studies WRC conference topics and radio service frequency related issues)	ITU-R, APT, 3GPP RAN4
	WG9: Mobile Communications Radio Working Group	2G/3G/4G/5G mobile communication wireless network-related standards research and formulation	3GPP RAN, ETSI NFV-ISG
TC10	WG1 SWG1 V2X	Research, standardisation and related open source activities of the overall needs, architecture, general security, and related open source activities in intelligent manufacturing, edge computing, IoT, big data, etc. covered under the IoV umbrella	3GPP RAN, ITU-T
Special Task	Working Group	Duties and Scope of Research	

Group (ST)			
ST9	WG4	Navigation and Location Services	

The Table 4 summarises the full list of V2X standards that CCSA has published and is working on.

Table 4: Full list C-V2X standards studied in CCSA

Working Group	Standard	Status	Standard Category	Note
TC5 WG3	YD/T 3400-2018 General Technical Requirements of LTE-based Vehicular Communication	Published	Industrial Standard	The overall business requirements, system architecture and basic functional requirements of LTE-based car networking wireless communication technology are specified
	YD/T 3340-2018 Technical Requirements of Air Interface of LTE-based Vehicular Communication	Published	Industrial Standard	The requirements of air interface technology based on LTE-based car network wireless communication technology are specified
TC5 WG5	YD/T 3594-2019 General Technical Requirements of Security for Vehicular Communication Based on LTE	Published	Industrial Standard	Specifies the general technical requirements for IoV communication security applicable to LTE-V2X
TC5 WG8	C-V2X Direct Communication Spectrum Needs, Candidate Band and Coexistence Study	Published	Technical Report	Concluded for LTE V2X, V2V and V2I need 20 MHz, V2V/V2I and V2P need 30 MHz, and the coexistence and compatibility on 5.9 GHz band for LTE-V2X with the incumbent services in the same frequency band and adjacent frequency bands is feasible
	5G NR-V2X Direct Communication Spectrum Needs Study for Automated Driving	Published	Technical Report	Concluded at least 40 MHz spectrum @5.9 GHz is needed for NR V2X
	5G NR-V2X Direct Communication Spectrum Candidate Band and Coexistence Study	Published	Technical Report	Concluded that the coexistence and compatibility on 5.9 GHz band for NR-V2X with the incumbent services in the same frequency band and adjacent frequency bands is feasible
TC5 WG9	YD/T 3755-2020 Technical Requirements for Roadside Equipment of Wireless Communication Technology of Internet of Vehicles Based on LTE	Public Notification by MIIT	Industrial Standard	Set technical requirements for roadside equipment that supports the 3GPP R14 LTE-V2X communication protocol
	YD/T 3756-2020 Wireless Communication Technology of Internet of Vehicles Based on LTE/Technical Requirements for On-board Terminal Equipment Supporting Direct Communication	Public Notification by MIIT	Industrial Standard	Specifies the technical requirements of on-board terminals supporting the 3GPP R14 LTE-V2X communication protocol
	YD/T 3847-2020 Test Method of Sidelink-enabled Roadside Unit for LTE-based Vehicular Communication	Published	Industrial Standard	For roadside equipment supporting LTE-V2X PC5 direct communication, test methods for LTE-V2X communication function, performance, RF index, etc. are specified
	YD/T 3848-2020 Test Method of Terminal for LTE-based Vehicular Communication	Published	Industrial Standard	Provisions support 3GPP R14 LTE-V2X communication protocol in-vehicle terminals in business functions, etc.
	YD/T 3592-2019 The eNodeB Equipment Technical Requirements of Vehicular Communication Based on	Published	Industrial Standard	Technical requirements for base station equipment supporting 3GPP R14 LTE-V2X communication protocol

	LTE			
	YD/T 3629-2020 Test Method of Base Station Equipment for LTE-based Vehicular Communication	Published	Industrial Standard	Specify the test method of base station equipment of Internet of Vehicles wireless communication technology based on LTE
TC10 WG1 SWG1	Test Method of Message Layer of LTE-based Vehicular Communication (2019-0005T-YD)	published	Industrial Standard	This standard specifies the message layer test method of LTE-based car networking wireless communication technology
	Test Method of Network Layer of LTE-based Vehicular Communication (2019-0003T-YD)	Published	Industrial Standard	This standard specifies the test method for the network layer (above the 3GPP PDCP layer) of the LTE-based car networking wireless communication technology
	LTE based V2X Communication – Technical Requirements of MEC Platform (2019-0008T-YD)	Published	Industrial Standard	The standard specifies the technical requirements of the MEC platform in LTE- based wireless IoV communication technology including: MEC platform architecture, platform function and performance requirements, interactive interface between platform and access terminal, interactive interface between platform and other platforms, etc.
	Requirements and Architecture of MEC for LTE-V2X Business (2019-0006T-YD)	Published	Industrial Standard	The research framework is as follows: 1) capability requirements of MEC for LTE-V2X service, 2) service capability architecture of MEC for LTE-V2X, 3) service capability open interface requirements of MEC for LTE-V2E, 4) access adaptation requirements of MEC for LTE-V2X network layer
	Technical Requirement of Security Certificate for LTE-based Vehicular Communication (2019-0021T-YD)	Published	Industrial Standard	The objective of this standard is to propose technical requirements for IoV communication security certification applicable to LTE-V2X, including 1) LTE-V2X communication security certification requirements, 2) overall technical requirements for LTE-V2X communication security authentication mechanism, 3) LTE-V2X communication security authentication interaction process and interface technical requirements
	Standard of 5G V2X Support Advanced Automation Driving: Use Case Analysis and Dataset (2019-0009T-YD)	Published	Industrial Standard	This standard mainly specifies the advanced V2X scenarios, service requirements, technical and performance requirements of 5G
	Perception, Decision and Control in Automated Driving Based on V2X: Use Case and Data (2019-0010T-YD)	Published	Industrial Standard	This standard studies the data content of interaction for vehicle-road collaborative applications such as obstacle perception, trajectory decision-making, traffic control and data update in L4 and L5 advanced automatic driving
	Performance Evaluation of V2X Network and Research of Sidelink Wireless Channel (2020B114)	Published	Technical Report	It studies the communication performance evaluation system and sidelink wireless channel model of the Internet of Vehicles. The main research contents include: 1) network performance evaluation system, and 2) channel model research
	Research on 5G Communication Technology for Internet of Vehicles (2020B62)	Published	Technical Report	It evaluates 5G communication system architecture and key technologies to support advanced V2X use cases
	Technical Requirement of	Published	Industrial	This standard specifies the technical

	Authentication and Authorisation System for C-V2X Vehicular Communication (2021-0580T-YD)		Standard	specifications for the system architecture, management process and interface of C-V2X Internet of Vehicles to achieve AAA functions
	Test Method of Security Certificate for LTE-based Vehicular Communication (2019-0022T-YD)	Published	Industrial Standard	It specifies the safety certification test methods of LTE-based car networking wireless communication technology, including 1) test requirements, 2) test system framework, 3) test control interface and process requirements, 4) protocol conformance test cases, and 5) interactive process
	Operation and Maintenance Management Platform for Vehicle-Road Collaborative Roadside Equipment of RSU (2021-CCSA-29)	On-going	Alliance Standard	This standard specifies technical requirements for the RSU operation and maintenance management platform for vehicle-road collaboration, including 1) interface protocol, 2) configuration, 3) alarm, and 4) security and privacy
	Research on the Coordinated Deployment of Smart Pole/Tower and Vehicle-Road Collaboration Roadside Facilities (2021B62)	On-going	Technical Report	Studies the key issues and related solutions in the coordinated deployment of smart towers and roadside facilities
	Technical Requirements of V2I Basic Information Unicast of LTE-based Vehicular Communication (2021-0138T-YD)	On-going	Industry Standard	This standard defines the upper-level unicast interaction process for near-field payment information and vehicle identity information management (including road inspection) services
	Technical Requirements of Vehicle Misbehaviour Management for C-V2X (2021-0187T-YD)	On-going	Industry Standard	This standard specifies technical requirements applicable to abnormal behaviour management of vehicles in C-V2X Internet of Vehicles communication
	5G-Enabled Remote Driving: Technical Requirements for 5G Communication System (2021-CCSA-30)	On-going	Alliance Standard	This standard specifies the technical requirements of the communication system for 5G systems to support remote control driving services. The main research scope involves 1) definition and classification of remote-control driving services, 2) functional requirements and performance requirements of different types of remote-control driving services, and 3) architecture and interface definition of remote control driving
	Research on Infrastructure Studying Data Collaboration and Sharing Technology Based on V2X （2020B138）	On-going	Technical Report	Research scenario requirements and business processes exploring infrastructure data collaboration models, research infrastructure data collaboration sharing architecture based on vehicle-road collaboration, and typical scenario-oriented infrastructure and data collaboration/sharing solutions
	Technical Requirements of Cross-domain Collaborative Interaction Based on Edge Computing (2021-0137T-YD)	On-going	Industry Standard	It specifies the context requirements of C-V2X mobile services/applications in MEC migration services, and establishes MEC pre-relocation mechanisms
	LTE-based V2X Communication – Test Methods of MEC platform (2019-0007T-YD)	On-going	Industry Standard	This standard specifies the test method of the MEC platform in the LTE-based car networking wireless communication technology, including 1) the function test method, 2) performance test method, and 3) interface protocol test method of the MEC platform in the LTE car networking wireless communication

				technology
	Measurement Methods of Roadside-LiDAR in Vehicle-Infrastructure Cooperation System （2021-1033T-YD）	On-going	Industry Standard	This standard specifies the test methods for the main parameters of the roadside LiDAR for vehicle-road cooperation
	Technical Requirements and Test Methods of Roadside Sensing System for Vehicle-Road Collaboration	On-going	Industry Standard	This specification defines the technical requirements and test methods for the roadside perception system for vehicle-road cooperative, including 1) the performance index system for road traffic participants, 2) functional index requirements for vehicle-road fusion perception, and 3) evaluation of various indicators, test methods etc.
	Data Interface Specification and Data Format Requirements for C-V2X Large-scale Test	On-going	Industry Standard	This standard specifies the C-V2X test interfaces (i.e. Uu and PC5) including: 1) C-V2X scale test node data interface definition and data exchange process, 2) OBU test data return, record interface definition and data exchange process, and 3) RSU test data return, record interface definition and data exchange process
ST9 WG4	Overall Technical Requirements of High-precision Positioning in V2X Application Scenarios （2021-1054T-YD）	On-going	Industry Standard	This standard specifies the overall technical requirements based on high-precision positioning, including 1) high-precision positioning service architecture for IoV applications, 2) high-precision positioning interaction process for IoV applications, and 3) supporting IoV application scenarios' precise positioning requirements

5.3 NTCAS: SC34

The National Technical Committee of Auto Standardisation (SAC/TC114, www.catarc.org.cn) is responsible for the centralised management of road motor vehicle standards, such as automobiles and motorcycles, and is an important technical support organisation helping the Chinese government manage the automobile industry. The NTCAS is the executive agency for the international exchange of standards and bilateral and multilateral cooperation in China's automobile industry. It has 30 sub-technical committees and, as such, has the largest number of sub-profession committees and commissioners in China.

The standardisaton work carried out by the Committee has strongly supported the development and management of China's automobile industry, helping it become a pillar of China's economy. The Subcommittee (SC) 34 which is working on Intelligent and Connected Vehicle belongs to the National Technical Committee (TC) 114 which is working on Road Vehicles of Standardisation Administration of China, and it is funded and guided by the Ministry of Industry and Information Technology (MIIT). It is responsible for the standardisation of driving environment awareness and warnings, driver assistance, autonomous driving, and in-vehicle information services directly related to the act of driving.

The standards related to networking functions and applications are shown in Table 5 below.

Table 5: C-V2X standards studied in NTCAS

Standard	Status	Remarks
Road Vehicles – Extended Vehicle (ExVe) Methodology – Part 1: General Information	Submit for Approval	ISO 20078-1 Standard Transition
Road Vehicles – Extended Vehicle (ExVe) Methodology – Part 2: Methodology for Designing the Extended Vehicle	Submit for Approval	ISO 20078-2 Standard Transition
Technical Requirements of Vehicular Communication System based on LTE-V2X Direct Communication	Project Initiation	Equipment Requirements

Performance Requirements and Test Procedures for Application Scenario of Vehicle Safety Warning Based on Connected Vehicle Technology	Project Initiation	Application Function Requirements and Test Methods

5.4 C-SAE/CAICV

China's Society of Automotive Engineers (www.sae-china.org) was founded in 1963 to promote the healthy and sustainable development of the country's automotive industry. At present, C-SAE has tens of thousands of individual members and thousands of corporate members. China's Industry Innovation Alliance for the Intelligent and Connected Vehicles (www.caicv.org.cn) was established on 12 June 2017. It is an industry alliance under C-SAE and China's Association of Automobile Manufacturers that focuses on Intelligent Connected Vehicles (ICV) and related technology development and industry promotion. The supporting and administrative ministry is the China Ministry of Industry and Information Technology. The CAICV now counts more than 500 members covering automotive manufactures, Tier 1s and Tier 2s, ICT companies, ITS players, universities and research institutes. There are 13 working groups under the CAICV.

Figure 5 below shows how it is organised.

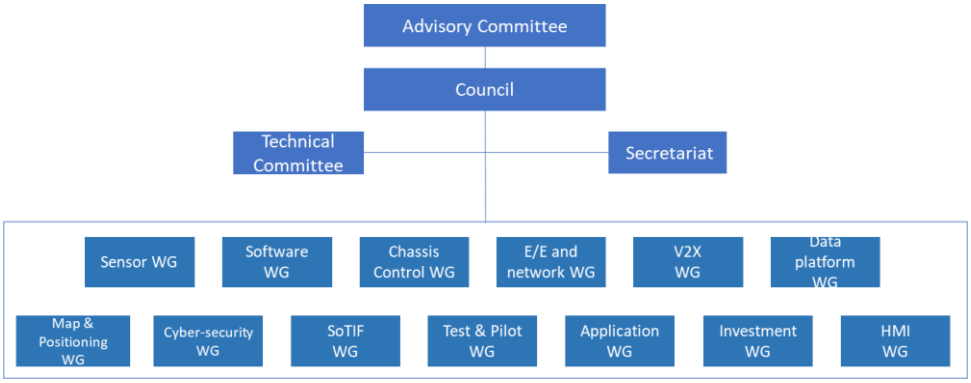

Figure 5: CAICV organisational structure

Table 6 on the following page shows the V2X-related work carried out by the WGs.

Table 6: Working group in CAICV

Working Group	Area	Note
V2X WG	Application layer and message set, functional standard	Main WG working on V2X standard
SoTIF WG	SoTIF aspect of V2X	
Map&Positioning	HD mapping and positioning solution	Technology be used by V2X applications

On the standards front, as illustrated in Figure 6, CAICV works on ICV-related standards, including autonomous perception, vehicle control, HD mapping and positioning, V2X/cooperative vehicle and infrastructure systems, FuSa/SoTIF, vehicle electronic and electrical and in-vehicle networks, etc. The figure below gives an overall picture of the standards that CAICV works on. Among those, the communication part targets the application layer addressing interoperability related standards. The cooperative vehicle and infrastructure side impacts V2X on a system level, including cooperative processing and communication of RSUs, roadside sensors, platforms, MEC, etc., and provides the vehicle data and information.

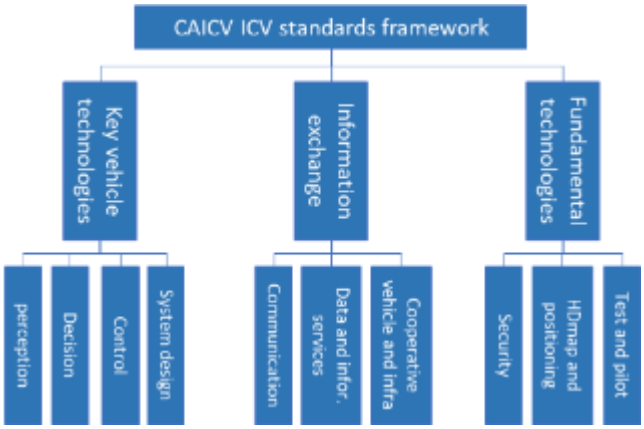

Figure 6: CAICV ICV standard architecture

The Committee has been working on V2X-related standards since 2017, shortly after it was established. The focus of this work is on the V2X-related message set and application standards as well as related profile standards.

Table 7 gives a full list of the V2X standards that CAICV has published and worked on.

Table 7: List of the V2X standards in CAICV

Standard	Status	Standard Category	Note
T/CSAE 53-2020 Cooperative Intelligent Transportation System: Vehicular Communication Application Layer Specification and Data Exchange Standard Phase I	Published	Consortium Standard	Phase I application requirement and message set (BSM, RSI, SPaT, MAP, RSM); there is also a copy in C-ITS and CCSA
T/CSAE 157-2020 Cooperative Intelligent Transportation System: Vehicular Communication Application Layer Specification and Data Exchange Standard Phase II	Published	Consortium Standard	Phase II application requirement and message set (PAM, PMM, PSM, RSC, RTCM, SSM, VIR, VPM, RSI and TEST)
T/CSAE 158-2020 Data Exchange Standard for High-level Automated Driving Vehicle Based on Cooperative Intelligent Transportation System	Published	Consortium Standard	Message set for L4/5 autonomous driving (CIM, RAM, RSCV etc.); there is also a copy in CCSA/C-ITS
T/CSAE 159-2020 LTE-based Vehicular Communication – Direct Communication System Roadside Unit Technical Requirements	Published	Consortium Standard	RSU message transmission profile, defining how to send RSU-related messages (content, congestion control, priority, RF etc.); there is also a copy in C-ITS. It is being upgraded to National Standard in SAC TC260
Code of Practice Test and Evaluation for V2X System Warning Application Function of Intelligent and Connected Vehicles	Under Drafting	Consortium Standard	V2X application test, defining test cases and performance metrics for V2X applications
Profiles for C-V2X Certificates in Security Credential Management System	Under Drafting	Consortium Standard	C-V2X security profile, defining how the certificate being used and formed

5.5 ITS

5.5.1 ITS China

China Intelligent Transportation Systems Association (ITS China, www.its-china.org.cn) was jointly initiated in May 2008 by the Chinese Ministry of Science and Technology, Ministry of Public Security, Ministry of Transport China, Ministry of Housing and Urban-Rural Development, China Railway Corporation, and the Civil Aviation Administration

of China with voluntary participation of enterprises, institutions, social organisations and individuals in the field of intelligent transportation.

ITS China is a non-profit legal entity that seeks to build bridges between government agencies and enterprises for market-driven, enterprise-oriented, cross-industry collaboration with the aim of: 1) integrating R&D resources and professional knowledge in the industry, 2) promoting the development and innovation of intelligent transportation system technologies, 3) accelerating progress towards smart, digital, and networked transportation, 4) promoting the transfer and spread of intelligent transportation technologies between industries, universities and research institutes and between enterprises, 5) cooperating internationally with intelligent transportation organisations of major countries to exchange and share knowledge, technologies, success stories and business cooperation opportunities in the field of intelligent transportation.

Figure 7 below shows how ITS China is organised.

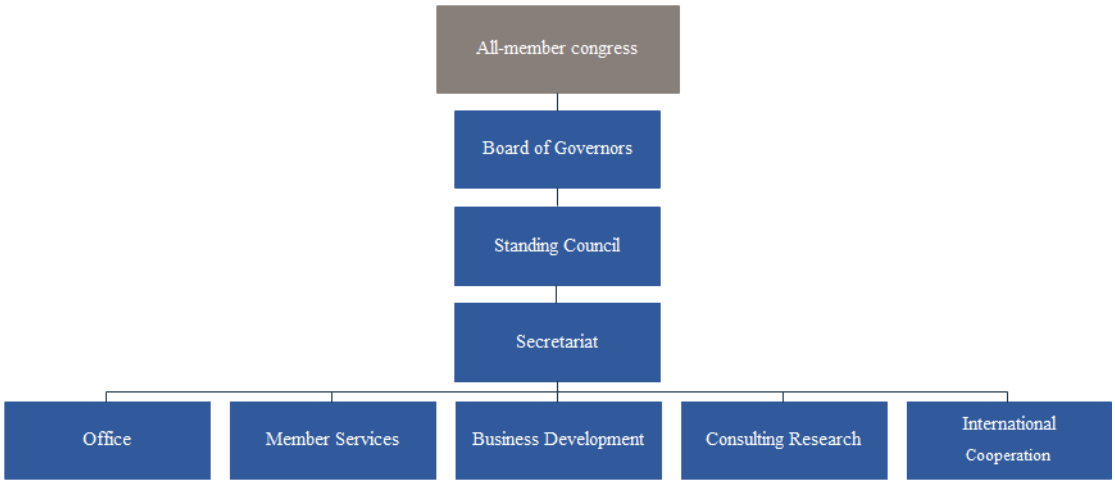

Figure 7: ITS China organisational structure

According to the *Administrative Measures on Group Standards of China Intelligent Transportation Association*, ITS China's functions involves decision-making, management coordination as well as preparation work for new standards.

Figure 8 shows the composition of each work level and their relationships.

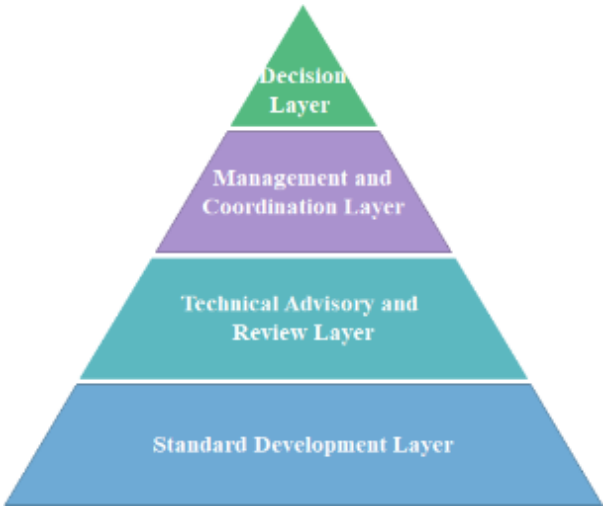

Figure 8: ITS China standardisation work architecture

Again based on the relevant provisions of the *Administrative Measures on Group Standards of China Intelligent Transportation Association*, group standards have been approved by the Standardisation Technical Committee of China Intelligent Transportation Association.

Table 8 below gives a list of the V2X standards released to the industry.

Table 8: List of C-V2X standards in ITS China

Standard	Status	Remarks
Data Communication Protocol between Ring Structure Traffic Signal Controller and Host Terminals (T/CITSA 07-2020)	Published	Structure of the data communication protocol and requirements for the physical layer, MAC layer, network layer, and application layer
Collaborative Service Information Interaction Specification between Connected Vehicle Platforms (T/CITSA 18-2021)	Published	Specification for data transmission of traffic information service between intelligent connected vehicle operation platforms
Intelligent Vehicle Infrastructure Cooperative Systems; Data Standard in Application Layer (T/CITSA 09-2021)	Published	Data formats and message formats required by the ITS
Spatiotemporal Big Data Format of Urban Traffic (T/CITSA 10-2021)	Published	Basic concepts and contents of urban traffic spatiotemporal big data

5.5.2 C-ITS

China's ITS Industry Alliance (C-ITS, www.c-its.org.cn) was established in 2013 by 45 well-known enterprises, scientific research institutes, and institutions of higher learning related to intelligent transportation in China with the support and guidance of the MOT, MIIT, Ministry of Natural Resources (MNR), and the Chinese Standardisation Administration.

Based on standard formulation and testing, the Alliance carries out work related to intelligent transportation standards formulation, technical testing, project declaration, conversion of scientific and technological achievements, trade and protection of intellectual property rights, and international exchanges and cooperation. It was approved and registered by the Civil Administration in February 2015. The Alliance is a member of the board of ITS Asia-Pacific and a member of ITS World Congress. As of December 2020, the Alliance has 322 members, 95% of which come from the global intelligent transportation industry.

Figure 9 below shows how it is organised.

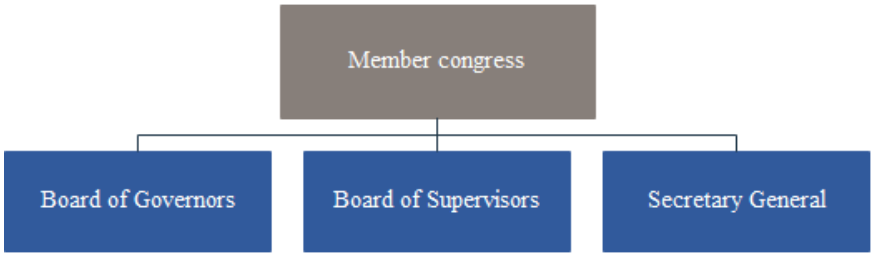

Figure 9: C-ITS organisational structure

The Alliance teamed up with the Xiong'an New District Smart City Innovation Federation to develop standards to help promote China's major C-V2X strategy and construt hub for the Beijing-Tianjin-Hebei economic triangle.

Other standards related to C-ITS are also listed in the following Table 9.

Table 9: List of C-V2X standards in C-ITS

Standard	Status	Remarks
LTE-V2X Standard Technical Specifications Based on ISO ITS Framework (T/ITS 0066-2017)	Published	Based on ISO intelligent transportation system framework, a communication interface named ITS-LTE-V2X is defined in the access layer
Technical Requirements of Network Layer of LTE-based Vehicular Communication (T/ITS 0108-2019)	Published	The network layer of LTE-based vehicular communication
Technical Requirements of Message Layer of LTE-based Vehicular Communication (T/ITS 0109-2019)	Published	The message layer of LTE-based wireless communication technology for vehicular Internet
Technical Requirements for Interface of Intelligent Road Traffic Signal Controller (T/ITS 0170-2021)	Published	Innovation Cooperation with Xiong'an New District Smart City Innovation Federation
Technical Requirements of Road Camera Interface for Intelligent Transportation (T/ITS 0171-2021)	Published	Innovation Cooperation with Xiong'an New District Smart City Innovation Federation
Interface Technical Requirements of Traffic State Detector for Intelligent Traffic Millimetre-wave Radar (T/ITS 0172-2021)	Published	Innovation Cooperation with Xiong'an New District Smart City Innovation Federation

5.5.3 SAC/TC268

In September 2003, the National Technical Committee 268 on Intelligent Transport Systems of Standardisation Administration of China (SAC, http://jtst.mot.gov.cn) was established with the approval of the Standardisation Administration. The number in China is SAC/TC268, corresponding to the ISO Intelligent Transportation System Technical Committee (ISO/TC204).

As shows in Figure 10, SAC/TC268 will be directly managed by SAC, specifically engaged in the technical organisation of national intelligent transportation system standardisation work and responsible for centralised standardisation technology in the field of intelligent transportation system. Its main scope of work includes: 1) advanced traffic management systems in the field of ground transportation, 2) advanced traffic information service systems, 3) advanced public transportation systems, 4) electronic toll collection and payment systems, 5) freight vehicle and fleet management systems, 6) smart highways and advanced vehicle control systems, 7) transport-specific short-range communications and information exchange, and 8) standardisation of technology and equipment in transport infrastructure management information systems. On 17 April 2020, three working groups were established: 1) Digital Infrastructure and Vehicle-Road Collaboration, 2) Intelligent Driving, and 3) Mobility Services covering public security traffic management, highway construction, information communication, vehicle manufacturing, technology R&D, and operation services.

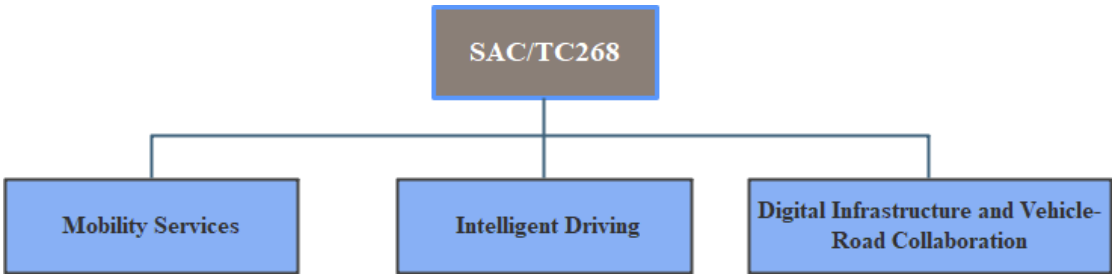

Figure 10: SAC/TC268 working groups

The tasks of SAC/TC268 include: 1) proposing guidelines, policies and technical measures for standardisation work to relevant administrative departments responsible for standardisation in the State Council, 2) formulating plans and annual programmes for national standards and industry standards according to requirements, 3) carrying out the examination and re-examination of national and industrial standards, 4) presenting and interpreting standards, and 5) standardising technical business work corresponding to the technical committees such as the International Organisation for Standardisation (ISO) and the International Electro-technical Commission (IEC).

As of June 2020 and shown in Table 10, SAC/TC268's V2X-related national standards include:

Table 10: A list of C-V2X std. in TC268

Standard	Status	Remarks
Cooperative intelligent transportation systems – Dedicated Short-range Communications – Part 1: General Technical Requirement (GB/T 31024.1-2014)	Published	Application of a special short-range communication subsystem in cooperative intelligent transportation systems
Cooperative Intelligent Transportation Systems – Dedicated Short-range Communications – Part 3: Network Layer and Application Layer Specification (GB/T 31024.3-2019)	Published	Design and development of a special short-range communication network layer and application layer for cooperative intelligent transportation systems
Communication Technology Requirements for Traffic Data Broadcasting (GB/T 37372-2019)	Published	Construction and application of traffic data broadcasting systems
Application Data Exchange Protocol to Support ITS Service Provision for Personal Intelligent Transport System Station (GB/T 37380-2019)	Published	Application data exchange protocol to support ITS services

5.6 NTCTM

The National Technical Committee 576 on Traffic Management of Standardisation Administration of China (NTCTM, www.tmri.cn/msc-detail.aspx), numbered SAC/TC576, is mainly responsible for the revision of standards in the field of road traffic management. The Bureau of Science and Technology and Information Technology of the Ministry of Public Security is responsible for daily management, the Traffic Administration Bureau of the Ministry of Public Security is responsible for business guidance, and the Institute of Traffic Management Science of the Ministry of Public Security is responsible for the secretariat.

The NTCTM is an unincorporated technical organisation engaged in the drafting of national and industrial standards and technical examination in the field of road traffic management. Its main tasks include: 1) to propose to the relevant administrative departments the guidelines, policies and technical measures for standardisation work, 2) formulate plans and annual programmes for national standards and industry standards according to requirements, 3) carry out the examination and re-examination of national and industrial standards, 4) handle publicity, implementation and interpretation of the standards, and 5) undertake standardisation-related work assigned by SAC, Science and Technology Information Bureau of the Ministry of Public Security, and Transportation Administration Bureau of the Ministry of Public Security.

Until now, 184 standards have been centrally managed, including 27 national standards and 157 industrial standards. There are 60 standard plans under centralised management, including 11 national standard plans and 49 industry standard plans.

NTCTM's (TC576) V2X-related national standard is named "Specifications for the Information Release Interface of Traffic Signal Controller (GA/T 1743-2020) ", which specifies the information release of Road Traffic Signal Controller for Internet of Vehicles Application and has been published.

5.7 FuTURE Forum

Supported by China NDRC, MOST, MIIT and NSFC, FuTURE Forum (www.future-forum.org/en) is a non-profit international organisation jointly created in 2005 by mobile telecommunication operators, mobile communication device manufactures, research institutes and universities from both China and abroad.

FuTURE Forum endeavours to establish and develop an open, neutral, fair and just international platform to encourage technology R&D and industry cooperation including technology and information exchanges in future mobile communication. In 2015, a dedicated Internet of Vehicles working group was set up to focus on frequency demand planning and basic technologies needed for 5G vehicle-vehicle communication, thematic research on information-based vehicle services and evaluations of service requirements for safety-based traffic services.

Table 12 below gives a full list of the V2X-related reports and white papers that FuTURE Forum has published and is working on.

Table 12: full list of C-V2X projects in FuTURE Forum

White papers/reports	Status	Category	Note
C-V2X Direct Communication Spectrum Needs Study	Published	White Paper	Concluded for LTE V2X, V2V & V2I need 20 MHz, V2V/V2I and V2P need 30 MHz, and the coexistence and compatibility on 5.9 GHz band for LTE-V2X with the incumbent services in the same frequency band and adjacent frequency bands is feasible
C-V2X Basic Application White Paper	Published	White Paper	'Day-1' applications
ICV Connection Capability Evaluation Test Methods	Published	White Paper	NA
5G V2V Communication Technology White Paper	Published	White Paper	NA
5G V2X Applications White Paper	Published	White Paper	'Day-2' advanced applications
5G NR-V2X Direct Communication Spectrum Needs Study for Automated Driving	Published	White Paper	Concluded at least 40 MHz spectrum @5.9 GHz is needed for NR V2X
NR V2X Key Technology Study	Published	White Paper	
5G V2X Applications White Paper-Phase 2	Published	White Paper	'Day-2' advanced applications
5G NR-V2X Direct Communication Spectrum Candidate Band and Coexistence Study	Published	White Paper	Concluded that the coexistence and compatibility on 5.9 GHz band for NR-V2X with the incumbent services in the same frequency band and adjacent frequency bands is feasible
C-V2X Performance Under Large-scale Deployment	Published	Test Report	Verified the C-V2X direct communication performance under density deployment (~200) and proved vehicle and RSU share the same resource pool outperform the case they use the separate pool
C-V2X congestion control study	Published	White paper	Congestion control mechanism
C-V2X channel measuring and modelling study	Published	White paper	NA

5.8 TIAA

Telematics Industry Application Alliance (TIAA) was founded on February 4, 2010. It is a non-governmental organisation. Its target is applying advanced electronic information technology to automobile, transportation and other industries. TIAA has more than 600 members from automobile, electronics, software, communication and internet & information services. The members are from 12 countries and regions. TIAA has established ten committees including market, technology, standards and intellectual property (legal affairs) as well as three sub-committees such as smart parking, charging and replacement. It also has several national representative offices in countries/regions like Russia. Since its establishment, TIAA has hosted nearly 400 various activities, and 100000 Chinese and foreign technicians have participated in these activities.

Table 13 below gives a full list of the V2X-related standards and white papers that TIAA published or is working on.

Table 13: List of C-V2X projects in TIAA Forum

Standard	Status	Standard category	Note
IoV Data Collection Requirement	Published	Consortium Standard	NA
Security Requirements for Sharing Data of Intelligent and Connected Vehicles	Published	Consortium Standard	NA
IoV Telematics Service Data Exchange Format	Published	Consortium Standard	NA
Data Security and Sharing Reference Architecture of Intelligent Connected Vehicles	Published	Consortium Standard	NA
On-board Telematics Terminal Requirement	Published	Consortium Standard	NA
The Specification of the Connectivity between Vehicle Terminals and	Published	Consortium Standard	NA

Portable Terminals			
Vehicle Telematics – Information Classification and Code	Published	Consortium Standard	NA
On-board LTE Terminal RF and Communication Performance Requirement (Part 1-6)	Published	Consortium Standard	NA
LTE V2X Spectrum Co-existence Study and Test Report	Published	Consortium Standard	Coexistence study and test on 5.9 GHz
IoV Cyber-Security Protection Requirement	Published	Consortium Standard	NA
Requirements of Intelligent and Connected Vehicle On-board Terminal Cyber-Security	Published	Consortium Standard	NA
eCall Series Standard (Part 1-3)	Published	Consortium Standard	eCall architecture, platform and device standard
Technical Requirements for V2X Information Services Based on Sidelink and cellular dual-mode Synergy	On-going	Consortium Standard	Integrated usage of Uu and PC5 to provide unified information service

6 Summary and proposal

Considering the above progress in China, it can be observed that C-V2X standardisation based on LTE-V2X is maturing not only on the communication side but also basic applications and security aspects. There is evidence of step-wise integration and deployment of LTE-V2X and 5G, with MEC developments under investigation. With more widespread collaboration among vehicle, road, edge, cloud and network players, the possibility for new and advanced applications (e.g. high-level autonomous driving, tele-operating driving, intelligent traffic system and mobility-as-a-service) are opening up.