Technology and Industry Development of Connected and Automated Vehicles

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Outline

1. The Concept of Connected and Automated Vehicles
2. The Key Technologies of Connected and Automated Vehicles
3. The Industry Development of Connected and Automated Vehicles
4. Development and Promotion of Connected and Automated Vehicles in CHINA

The Concept of Connected and Automated Vehicles

Connected and Automated Vehicles (CAVs) is a new Industry, which integrate the traditional industries of Automobile, ICT, Transportation and Traffic Management. Basing on the new generation of ICT technologies, which could realize the full V2X (Vehicle to Vehicle, Person, Infrastructure and Service Platform) connectivity and data interaction, so to construct a new Auto Society, and to improve traffic efficiency and users' driving experience

Related Items

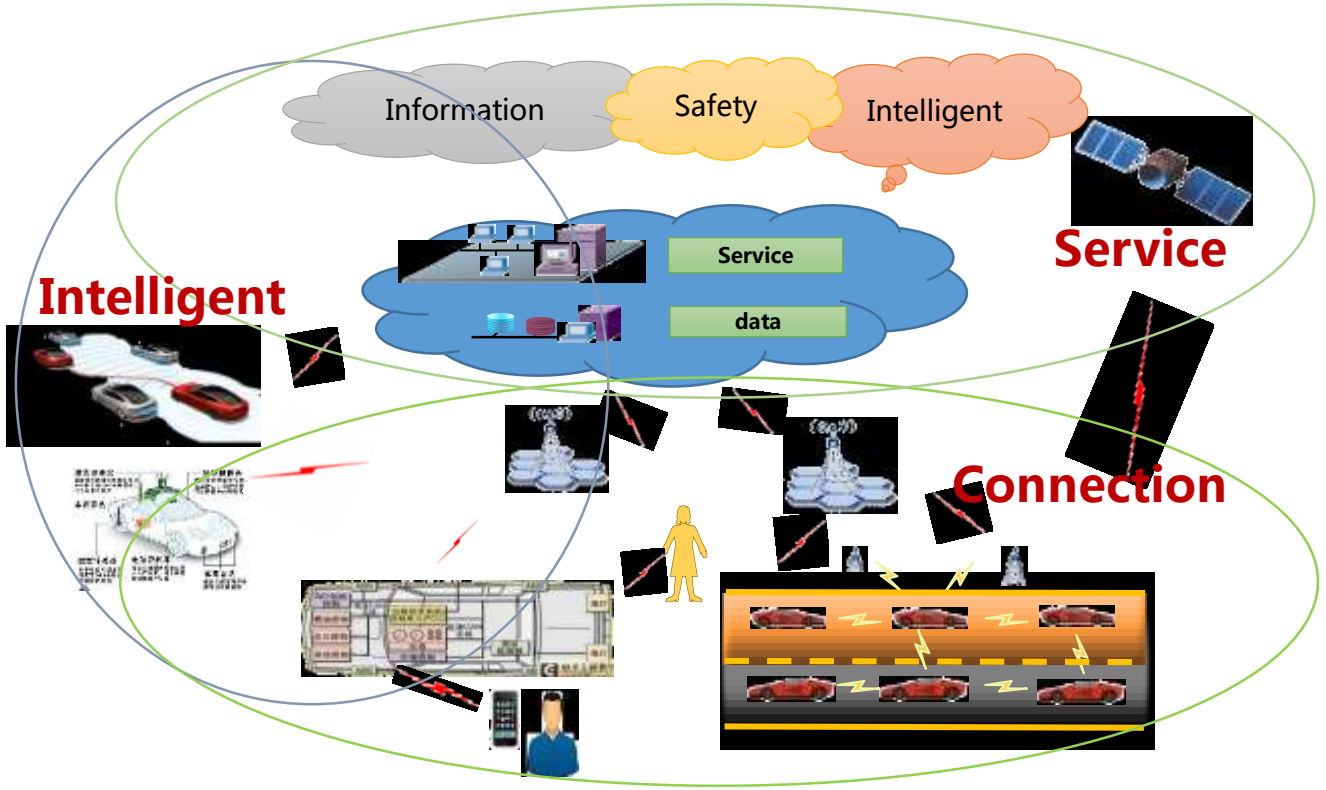
CITS-Cooperative Intelligent Transportation System

Automatous Driving

Internet of Vehicles

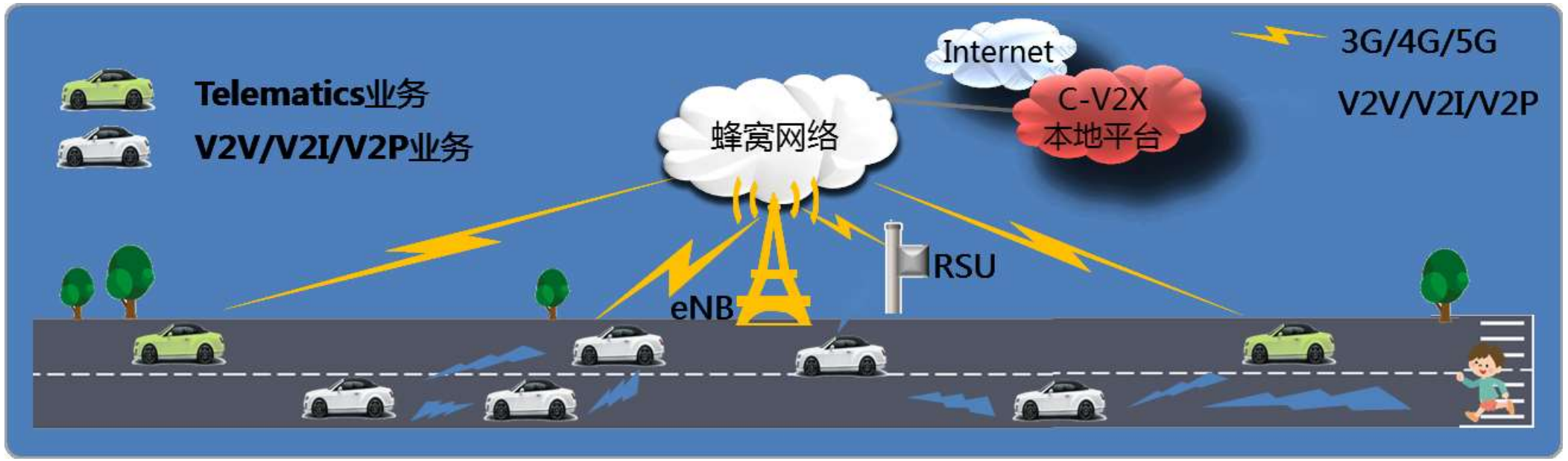
ICV-Intelligent Connected Vehicles

Intelligent Traffic Management



Connected Vehicles Industry Overview

Based on the information communication technology, **the connected vehicles industry** provides comprehensive information services through telematics, as well as V2V, V2I, V2P, and V2X connection and data interaction. This new form of industry is a deep integration of the automotive, electronic, information communication, and road transportation industries.



Significance of developing the connected vehicles industry: connected vehicles promotes smart transportation, enables automated driving, increases information consumption, saves energy, and reduces emission of automobiles. The connected vehicles industry is significant for China's implementation of innovative driving development, promotion of structural reform on the supply side, and construction of a manufacturing and network power.

Why we need the Connected and Automated Vehicles

Connected and Automated Vehicles becomes a highly integration and application of the IoT and smart vehicles, is an important field of the integration of informationization and industrialization

To promote industrial transformation and upgrading

Manufacturing → Service

Connected and Data

To accelerate the integration of new technologies

Accelerate IoT technologies evolution into a new stage of "Cross integration, integrated innovation and large scale development "

To solve the prominent social problems

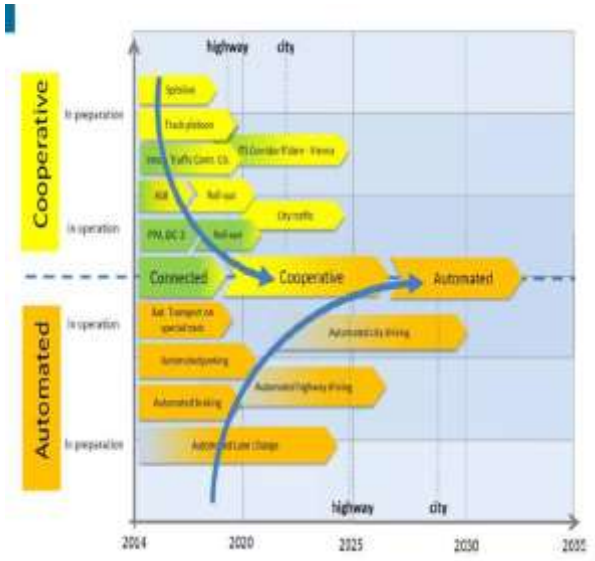
Traffic safety

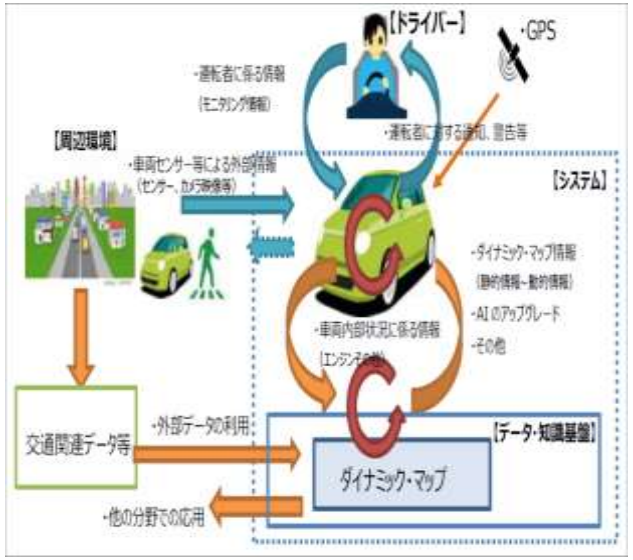
Transportation efficiency

Green development

Networking and intelligence of automobile becomes a global consensus

USA | EUROPE | CHINA | JAPAN





USA NHTSA：Intelligent Transportation System (ITS) Strategic Plan 2015-2019

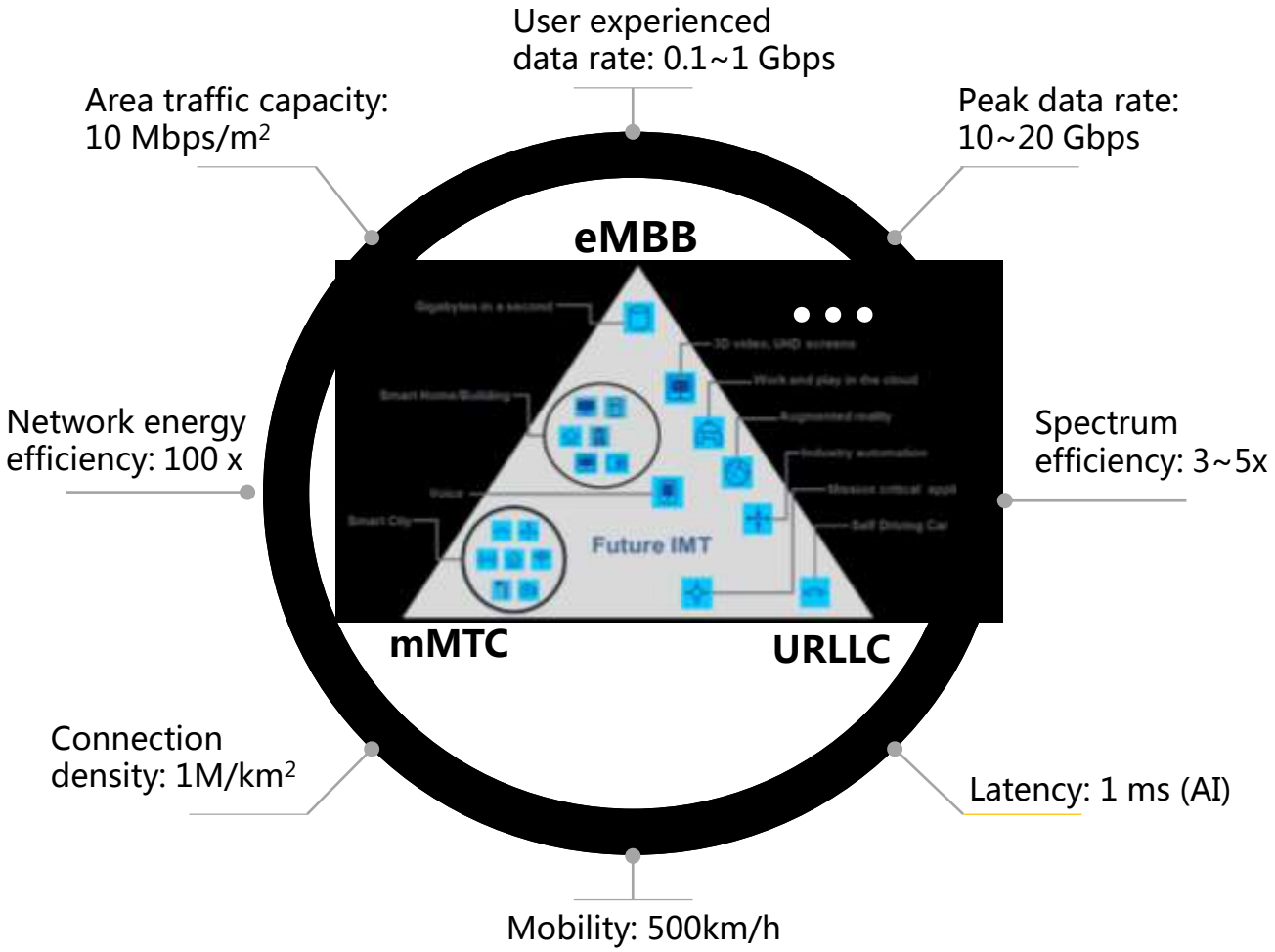
EU：Roadmap on Highly Automated vehicles

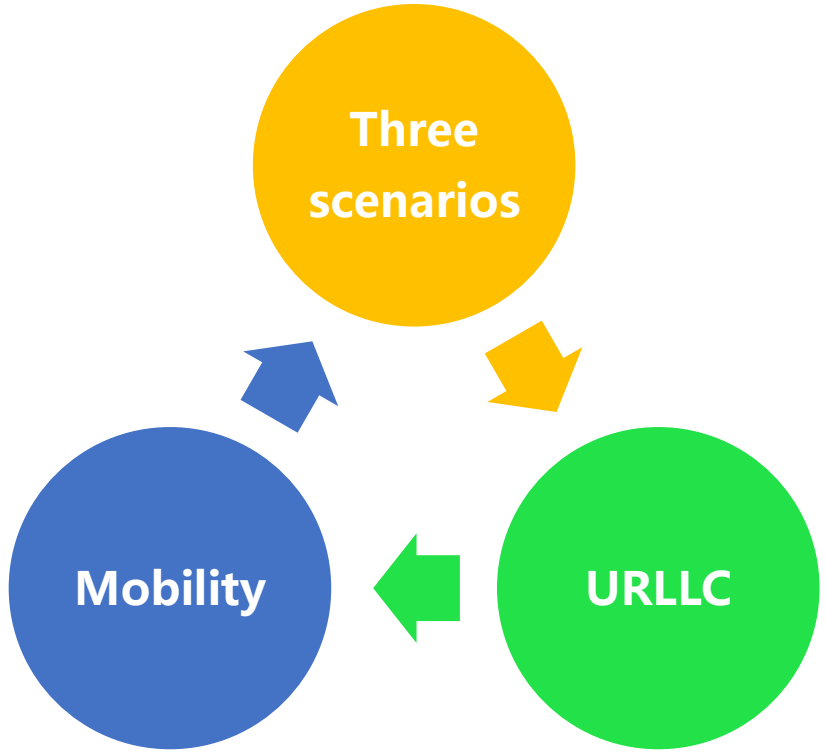
CHINA： CAVs Technology roadmap, Industry Policies, National Projects

JAPAN：SIP（Innovation of Automated Driving for Universal Services）

5G from mobile internet to IoT, Connected Vehicles is the key scenario

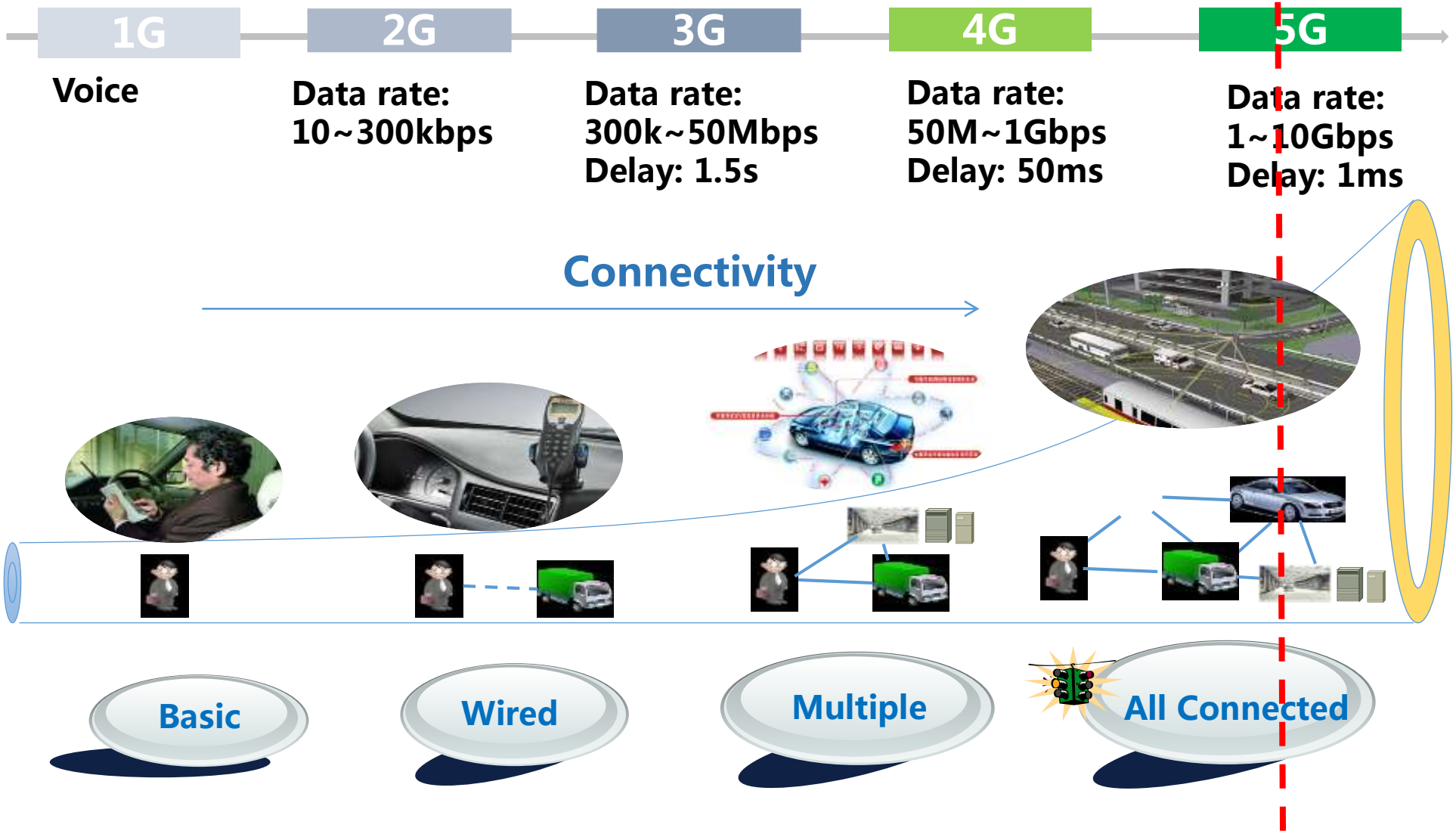
ITU IMT-2020 Vison





URLLC is the key technology for Vehicles, Industry and other related vertical industries

Mobile communication technology & Connected and Automated Vehicles



With the help of 5G technology, communications between CAVs would achieve more advanced characteristics such **higher density, very low latency, high reliability, high data rate**.

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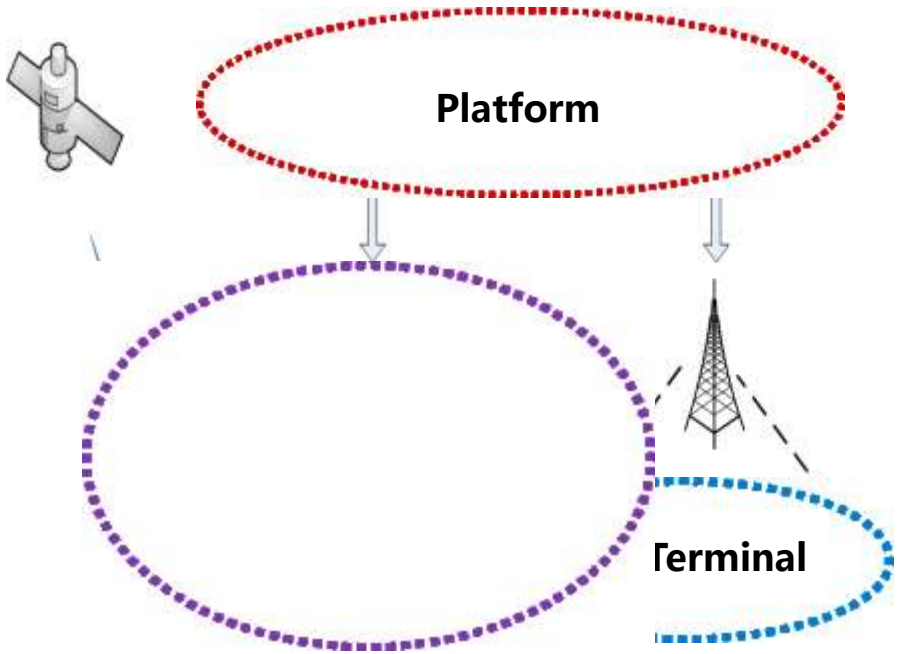
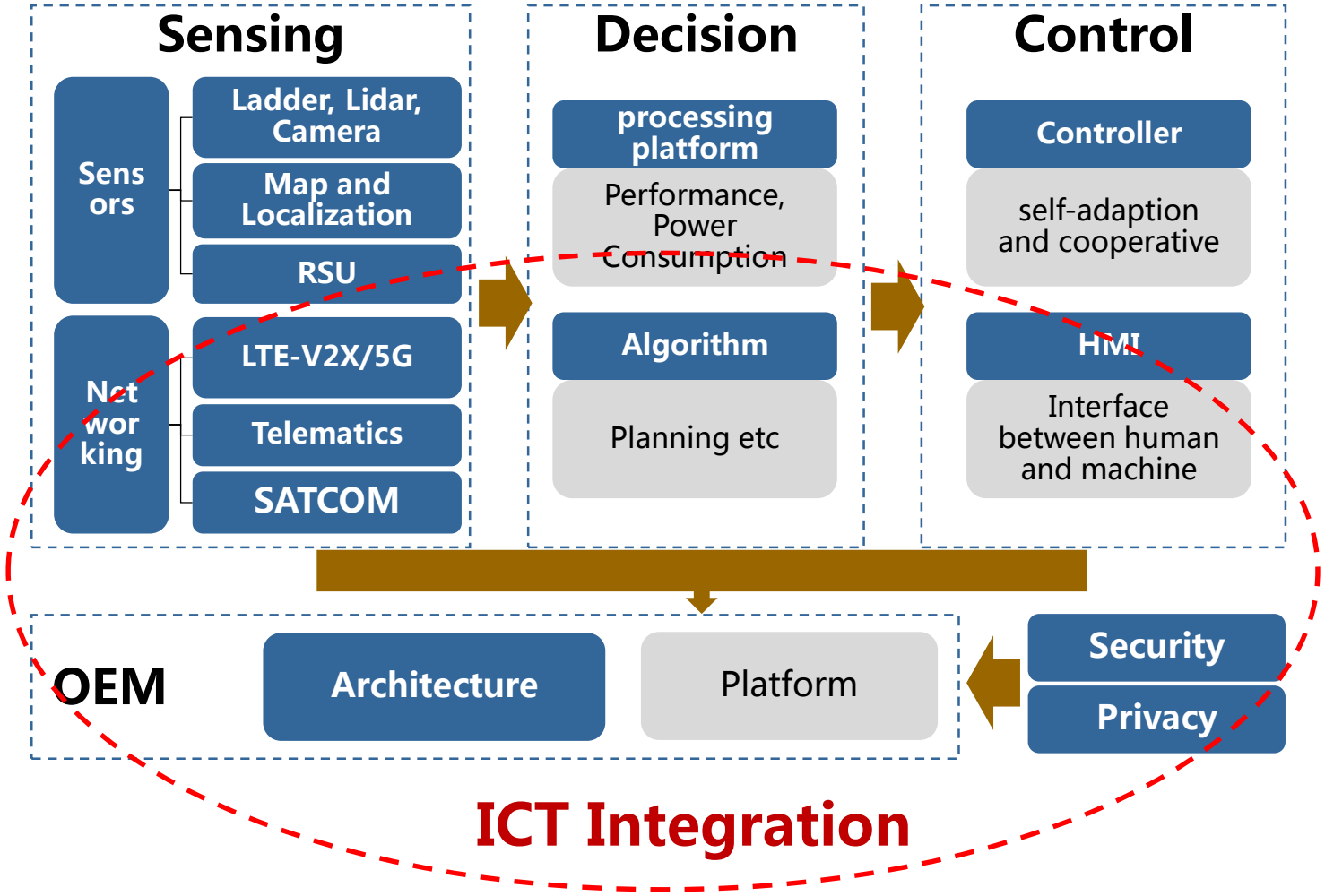
Technical Architecture for CAVs

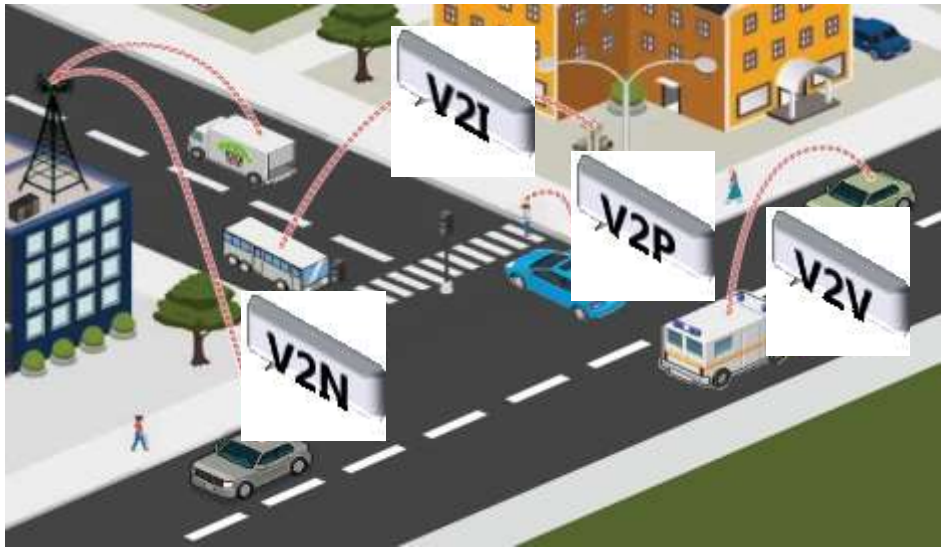
Regulation and Management



Security and Privacy



The understanding and advantages of V2X technology



With the help of new generation IC technologies , realizing **the full connection and information interaction of V2X (Vehicle to Everything):**

- ✓ V2V
- ✓ V2P
- ✓ V2I
- ✓ V2N

navigation

Voice&Video

Multimedia

Safety:
Intersection collision warning

Platooning

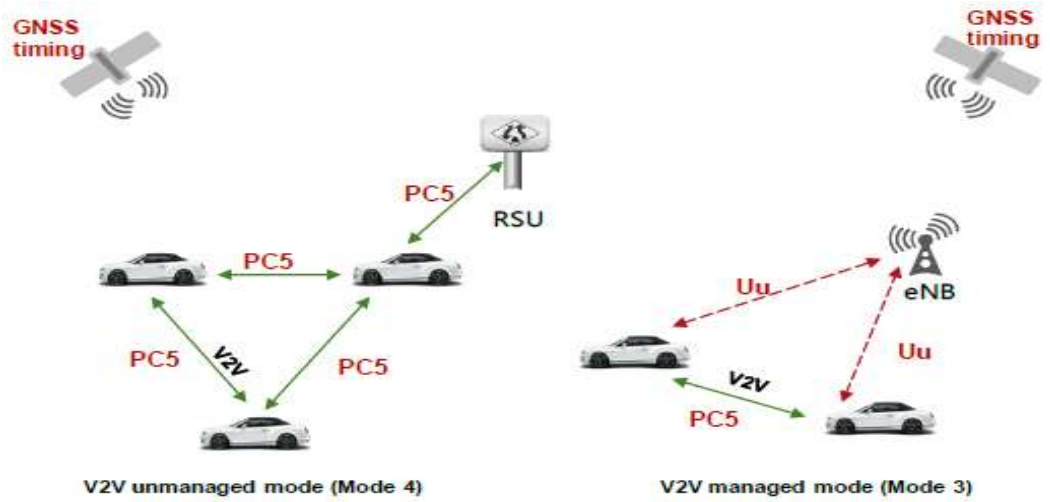
Efficiency:
Traffic speed guide

Collaboration
Awareness
Control

V2X communication faces technical path selection: 3GPP, IEEE

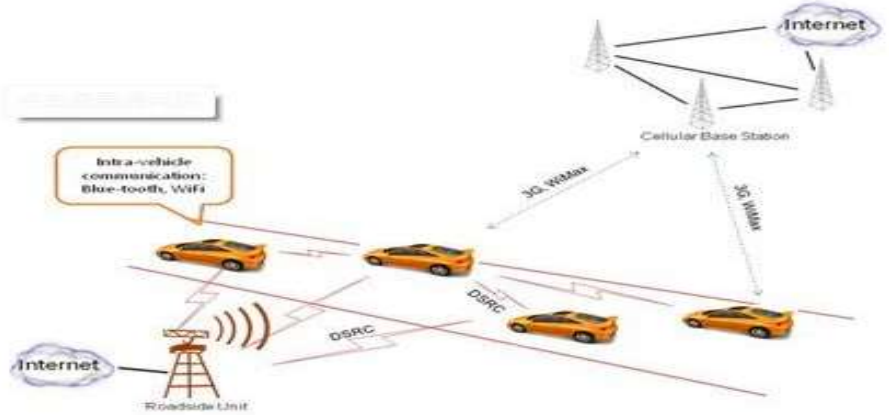
3GPP： LTE-V2X

- ✓ LTE - V2X is a V2X wireless communication technology based on LTE network technology. Through direct communication and cellular communication, two technologies support V2X



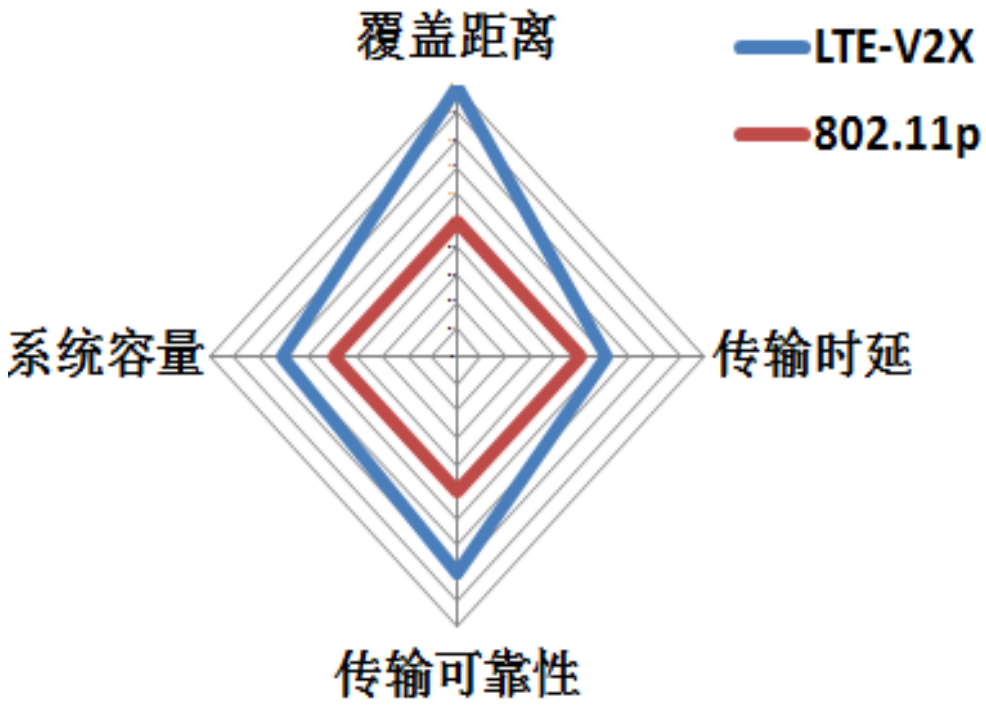
IEEE：802.11P

- ✓ The V2X wireless communication technology based on IEEE 802.11p provides the technology of short-range wireless transmission, and the vehicle and car road communication is the main application mode



- ✓ China and Europe jointly lead the 3GPP LTE-V2X standards, and China's huawei, datang are the main reporters, and have a speaking right in standardization, IP rights and other aspects. The 802.11p standard and IP are mainly control by USA.

Technical performance: LTE - V2X coverage, reliability and other advantages



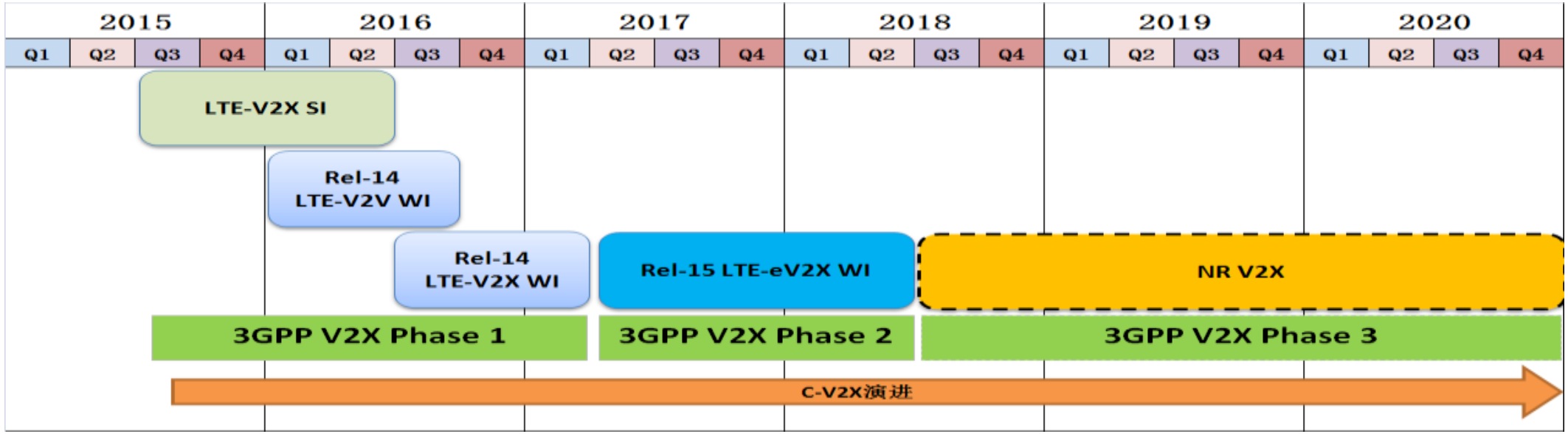
Comparison between LTE - V2X and 802.11 p

LTE - V2X has a technical advantage over 802.11p

- ✓ Far Cover distance
  - Twice the cover distance compared to 802.11p, and the vehicle can be notified earlier
- ✓ High Transmission reliability
  - The single link is about 60% higher than 802.11p
- ✓ Large System capacity
  - It is about 40% larger capacity than 802.11p and supports more dense vehicle scenarios
- ✓ low delay
  - Delay of 802.11p increases significantly in intensive scenarios

The understanding of C-V2X technology

- ✓ C-V2X is a kind of Cellular communication technology including direct communication working mode and cellular communication working mode.
- ✓ Better wireless communication performance , Advantage of deployment and promotion , evolution towards 5G



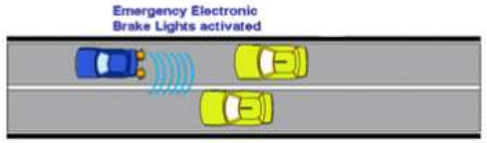
The evolution of C-V2X technology

V2X
3GPP R14

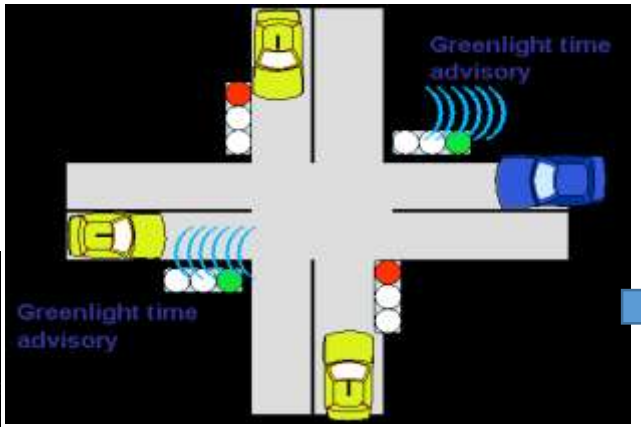
V2V,V2P,V2I,V2N
Safety-critical Use
Multimedia Service

Advanced V2X
3GPP R15，R16

Longer Range
Higher Density
Very low latency
High Reliability
High data rate

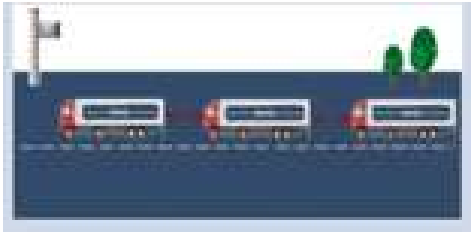


Emergency Brake



Road Speed limit Warning

Traffic light advisory



Platooning

Advanced Driving

Extended Sensors

Remote Driving

C-V2X, Enabling Intelligent, Connected Application Services on Diverse Automobiles

Information service

Infotainment services, such as online navigation, congestion notification, and multimedia download, based on the 2G/3G/4G public mobile network; and innovative services, such as shared travel, personalized vehicle experience, vehicle full-service life-cycle management, and IoV insurance, that are derived thereafter

Made in China 2025 (technical roadmap for key fields): C-V2X coverage rate	
2020	2025
> 50%	> 80%

Security and efficiency service

Low-latency, high-reliable security advisory (SA); traffic efficiency improvement; and partial-automated driving services, driven by LTE-V2X

V2X communications, with an enhanced driving environment sensing capability, help avoid most collision accidents.

Collaboration service

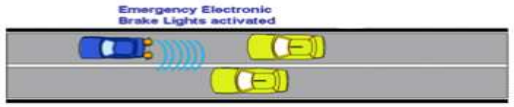
Highly collaborative interconnection environment of "human-vehicle-road-cloud," driven by 5G and eV2X; advanced driving services, such as vehicle-road collaborative control, vehicle-vehicle collaborative formation, and remote operations, providing support for ultimate full-automated driving services

With the continuous evolution of wireless communications technologies, smart automobiles are developing towards advanced levels and more complex applications.

The application and enhancement of LTE-V2X technology

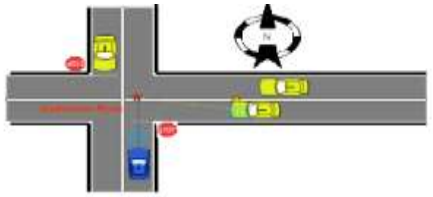
LTE-V2X Applications :

Safety :



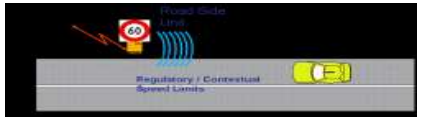
FCW: Forward Collision Warning

DNPW: Do Not Pass Warning

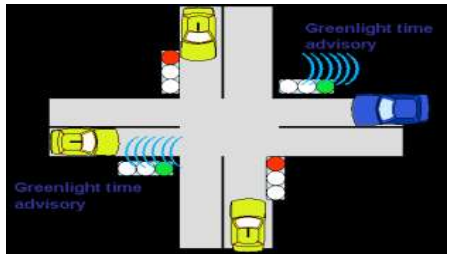


ICW: Intersection Collision Warning

Efficiency :



SLW: Speed Limit Warning



TLOSA: Traffic light optimal speed advisory

3GPP SA1 eV2X User Cases :

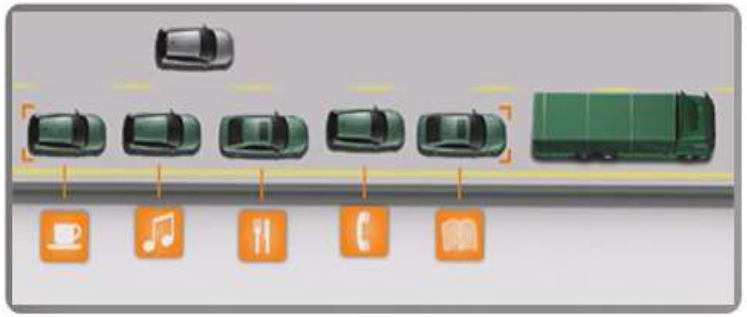
Use case	Illustration	Description	Payloads (Bytes)	Latency (ms)	Data rate (Mbps)	Range (meters)	Reliability (%)
Vehicles platooning		Vehicles dynamically form a platoon travelling together. Vehicles in the platoon obtain information from the leading vehicle to manage this platoon.	50 - 6500	10 – 25	0.012 - [65]	80 - 350	90 - 99.99
Advanced driving		Vehicle/RSU shares its own perception data obtained from its local sensors with vehicles in proximity and that allows vehicles to coordinate their trajectories.	300 - 12000	3 – 100	10 - 53 (including UL: 50 DL: 0.5)	[360] - [700]	90 - 99.999
Extended sensors		Exchange of data gathered through local sensors or live video images among vehicles, RSUs, Pedestrian and V2X server.	[1600]	3 - 100	10 - 1000	50 - 1000	90 – 99.999
Remote driving		Enables a remote driver or a V2X application to operate a remote vehicle.	-	5	UL: 25 DL: 1	-	[99.999]

- 3GPP start R15 LTE-V2X enhancement research, plan to finish 2018.06. Maintain the compatibility with R14 LTE-V2X, to improve PC5 performance, including reliability, data rate and delay

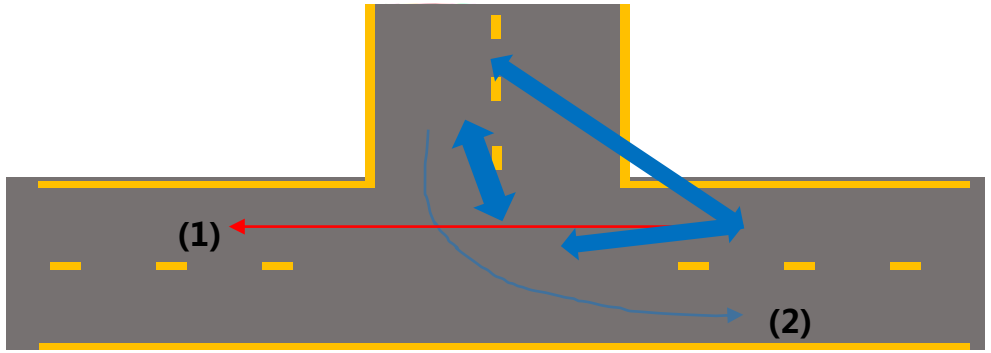
5G-V2X, high level and more complexity applications

5G Stage, vehicle networking evolution to cooperative, final to support Full Automatous

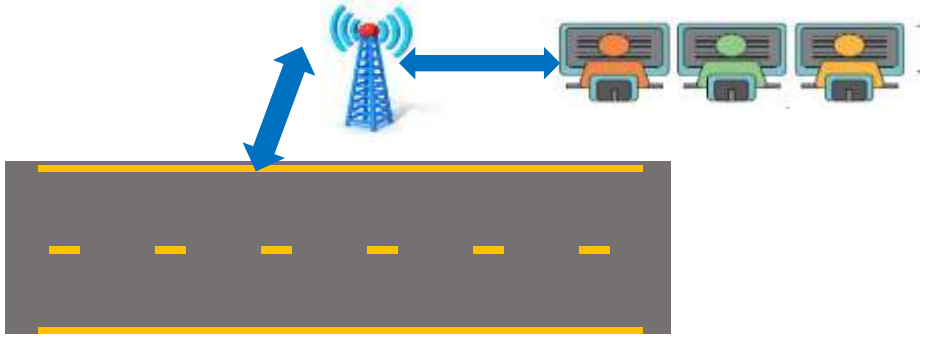
Platooning



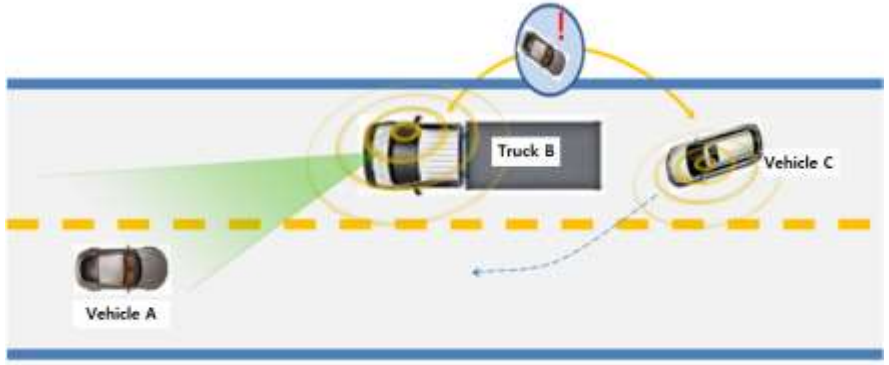
Intention Sharing



Remote Driving



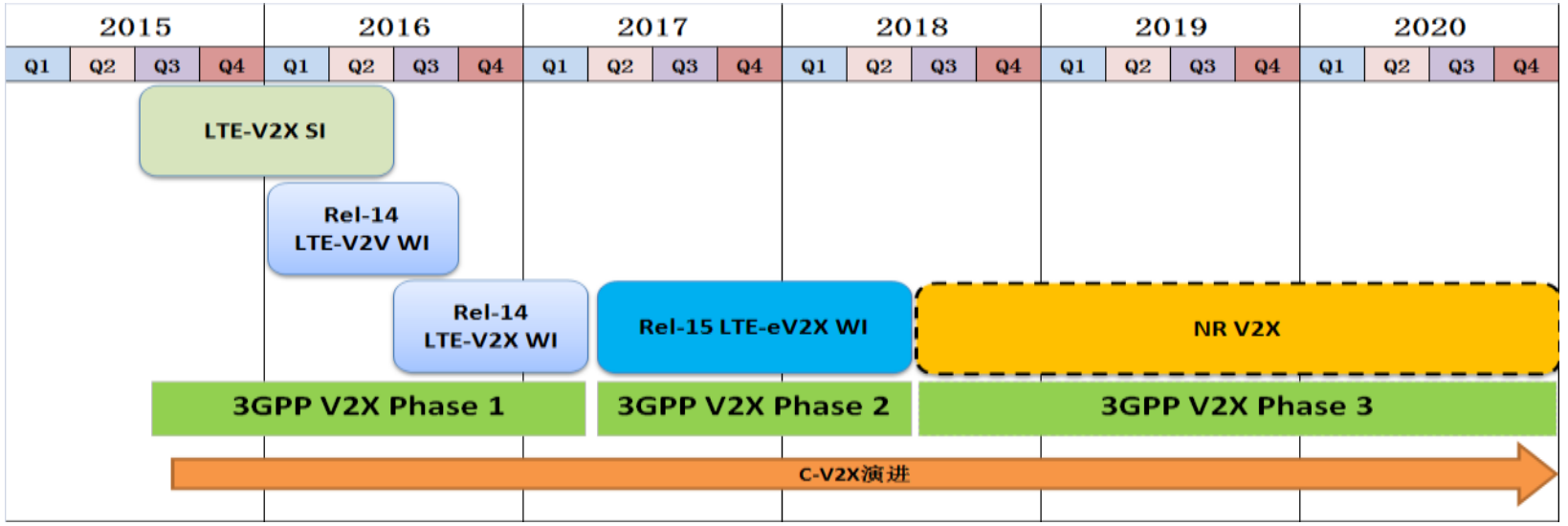
Extended sensor



International C-V2X Standardization Plan and Progress

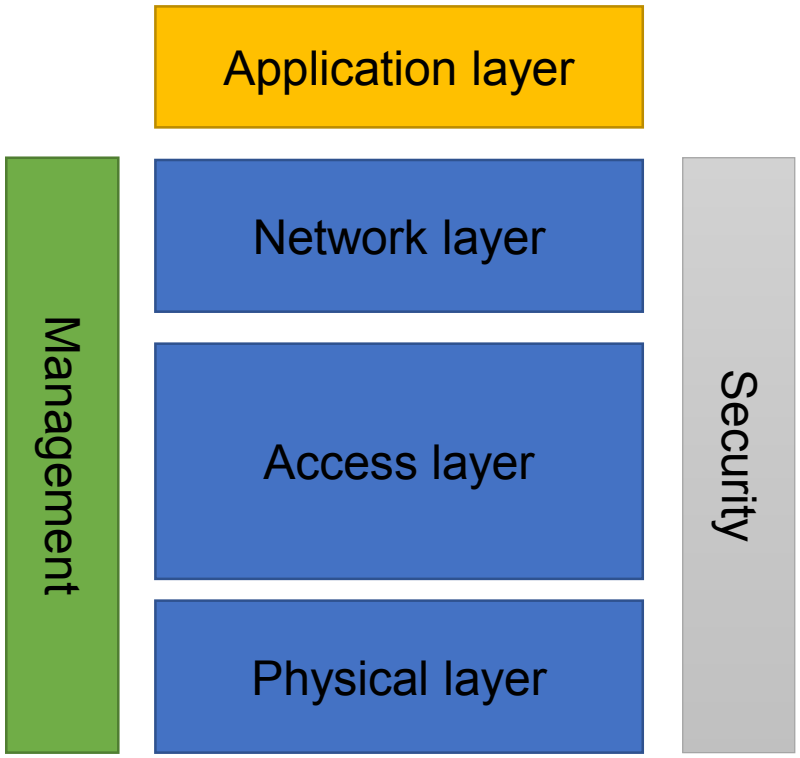
Three phases of 3GPP C-V2X standardization

- 3GPP release 14 that supports LTE-V2X has been officially released in 2017.
- 3GPP release 15 that supports LTE-V2X enhancement (LTE-eV2X) has been officially released in June, 2018.
- 3GPP release 16+ that supports 5G-V2X has been announced in June, 2018, and will complement LTE-V2X/LTE-eV2X.



Preliminarily Systematized LTE-V2X Standardization in China

- LTE-V2X standardization in China has been preliminarily systematized, covering **LTE-V2X overview, air interfaces, network and application layers, and security.** The overall architecture supports LTE-V2X R&D and application at different layers.



C-V2X standard protocol architecture in China

Category	Standards Name	Standards Type	Standards Organization	Progress
Overview	Overall technical requirements for LTE-based IoV communications	Industry standards	CCSA	Submitted for review
Application layer	Cooperative intelligent transportation system – Dedicated short range communications – Part 3: Technical requirements for the network layer and application layer	China national standards	TC/ITS and CCSA	Submitted for review
	Cooperative intelligent transportation system – Application layer and application data interaction standards for vehicle communications	Alliance standards	SAE-C and C-ITS	Released
Network layer	Cooperative intelligent transportation system – Dedicated short range communications – Part 3: Technical requirements for the network layer and application layer	China national standards	TC/ITS and CCSA	Submitted for review
Air interface	Technical air interface requirements for LTE-based IoV communications	Industry standards	CCSA	Submitted for review
Security	Technical security requirements for IoV communications based on the public LTE network	Industry standards	CCSA	Soliciting opinions

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The developing pattern of CAVs is basically stable

The research on CAVs by various organizations and enterprises is deepening, and the government support is increasing.

01 Government policies

- Us advances demonstration testing, as of January 2018, 49 road-testing licenses have been issued in California
- EU launches "adaptive" program to promote research and development of intelligent driving technology, technical standards and road traffic regulations to match automated cars
- Japan has developed a road map for the popularization of autonomous driving and revised relevant regulations

02 Research institutions and universities

- The University of Michigan's M-City project has become the world's largest test site for automated cars, with autonomous commuter cars being developed for use on campus
- Nagoya University develops Open Source Framework for Autopilot "AutoWare", Integrated Open Source Software for Urban Autonomous driving
- The Pegasus project in Germany brings together 17 business institutions to develop a standard process for testing and ensuring autopilot

03 OEM and technology companies

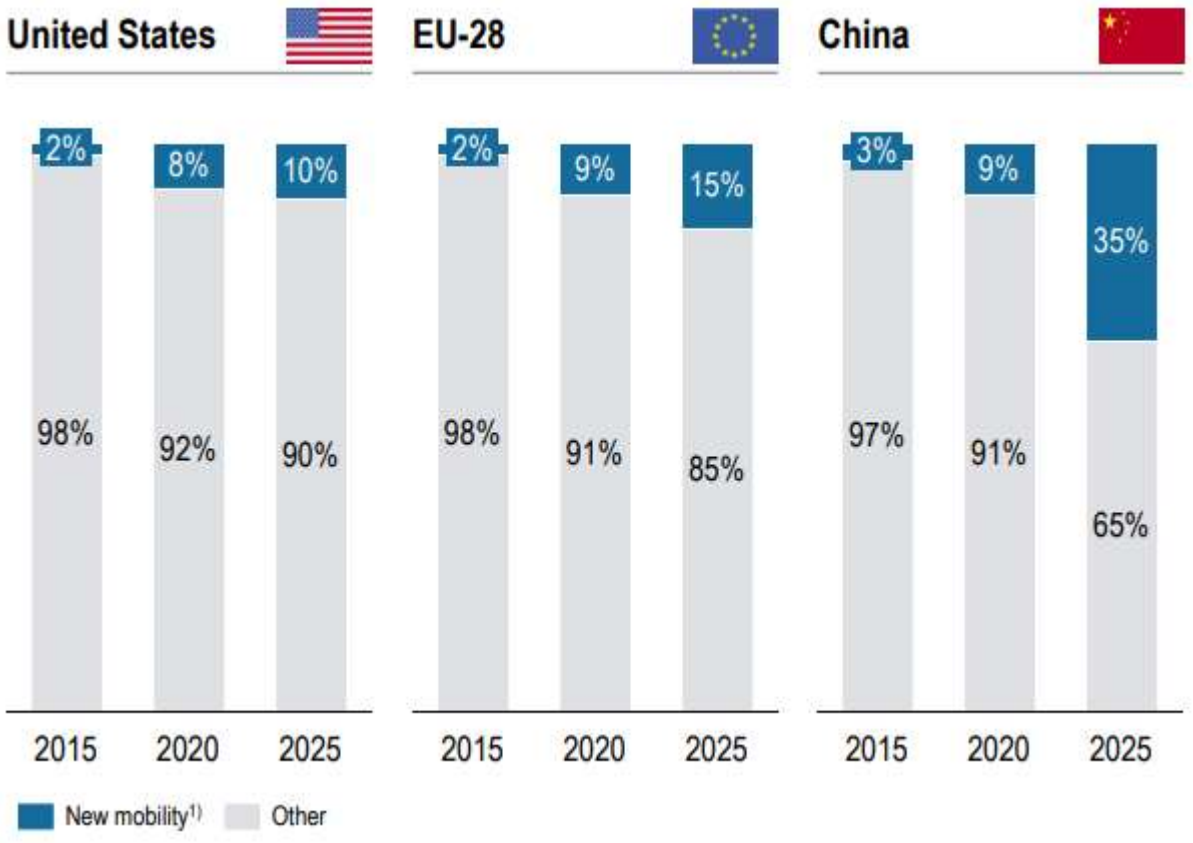
- Google is currently leading the world in autopilot technology and has been targeting the L4 since its inception
- Electric and autopilot are two key directions of Tesla's technology research and development. Autopilot has close cooperation with chip suppliers
- OEM has the advantage of vehicle technology integration, and has the communication protocol of vehicle core

04 component suppliers

- Traditional suppliers already have a head start at the ADAS product level, and the high level autopilot business is growing more frequently
- Chip manufacturer provides technical support for Tier1, Tier1 provides application practice platform for map, data, communication and other technical vendors

Vehicle sales for new mobility services are expected to exceed 10% of new car sales by 2025 in the US and the EU

Share of vehicle sales for New Mobility[1)] [% passenger car sales]



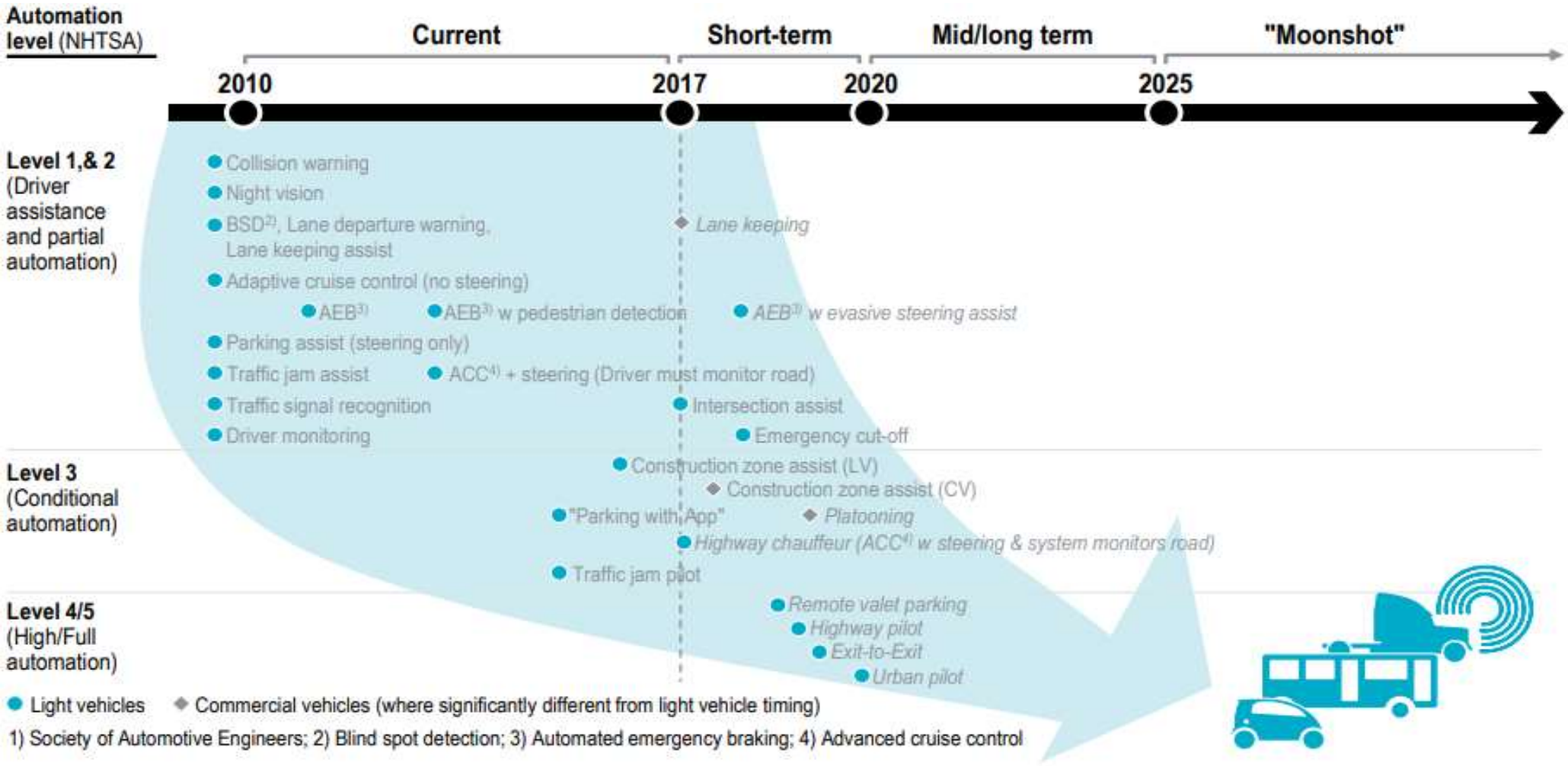
- New mobility sales are expected to grow through 2025 due to:
  - Changes in car ownership patterns
  - Growing urbanization
  - Enhancements in technology & mobility business models
- The disruption potential in China is higher due to its relatively lower base of ownership levels today (1 car for 7 people vs. 1 for 2 in EU and 1 for 1.25 in US)
- Post 2025, the introduction of RoboCabs could drive a significantly larger share of sales to new mobility

1) Includes forecast for car sharing, ride hailing, ride sharing, and Robocabs. Does not include sales for conventional taxis or rental car fleets

Source: Roland Berger

Automated driving is set to arrive at fast pace – With new entrants and real-life pilots already under way

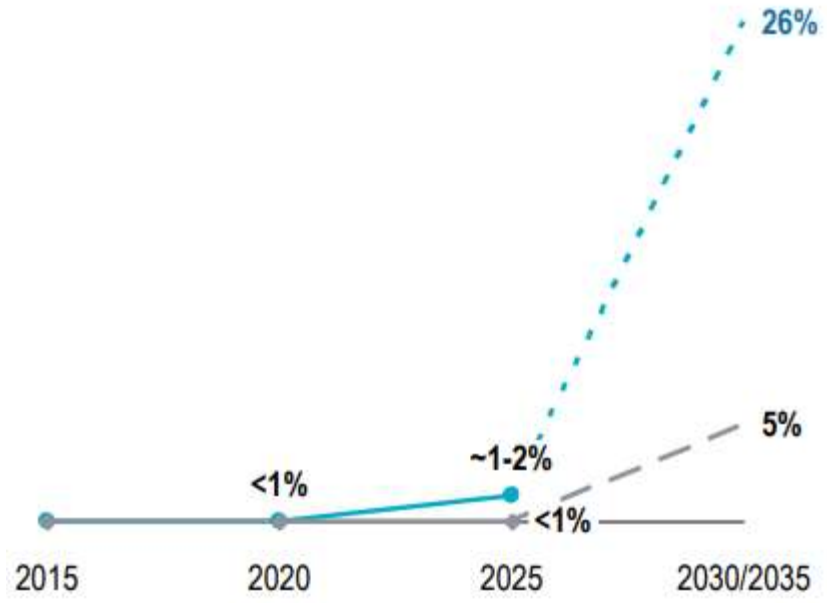
Commercialization timeline of automated driving functionality by SAE[1] levels



Source: Roland Berger

Future penetration of highly automated vehicles will depend on overcoming current hurdles and convergence on shared mobility

Autonomous driving – Penetration rate of highly automated cars (SAE Levels 4/5)*



*In % passenger car sales; includes RoboCabs and private autonomous cars

Disruptive/High scenario

- Sharing proliferates with high acceptance of car/ride sharing services
- High penetration of autonomous vehicles in shared fleets and privately owned premium and volume vehicle segments
- Autonomous, shared vehicles, called RoboCabs provide on-demand mobility services to consumers and businesses
- High use of autonomous vehicles by ride sharing services drives down costs significantly

Low scenario

- Shared mobility confined to early adopters in dense urban areas
- Automated driving penetration primarily in flagship premium models
- Continued use of human drivers renders ride sharing services' business models mostly unsustainable

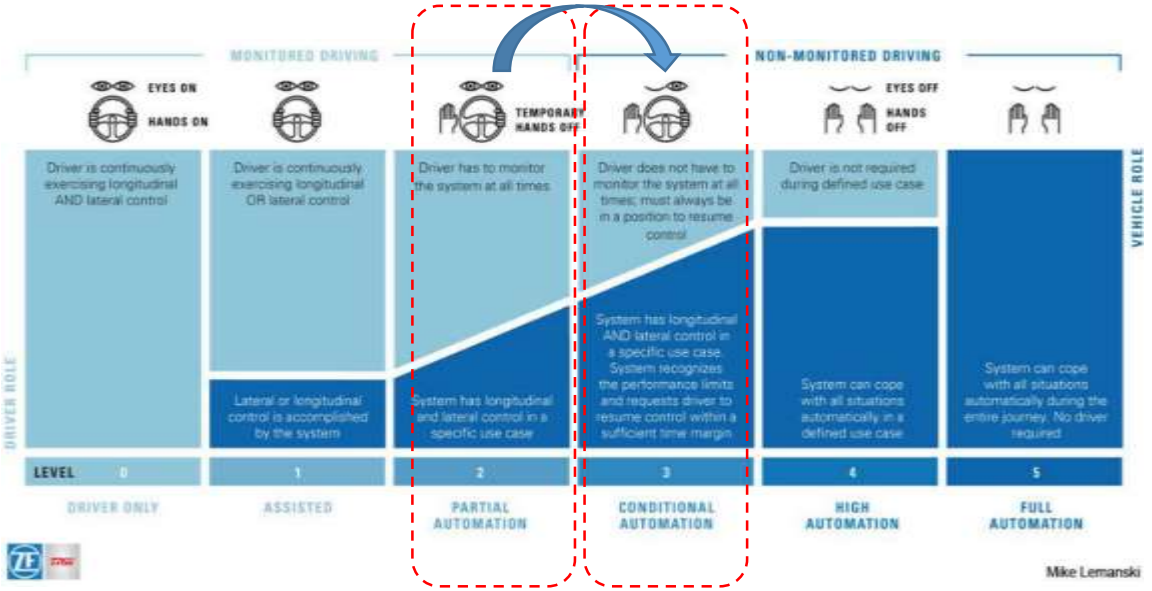
In addition, according to the forecast of Boston Consulting Group, the CAV will have 20 years' high speed development from 2018, and will occupy about 25% of the new car market in the world by 2035.

Trend1: Tradition automobile company using AI and ICT technologies actively

Daimler AG in CES2017 publish "**CASE-Connected、Automated、Sharing、 Electronic**" strategy

Toyota using new AI technology develop a **car emotion engine**

Basing on AI and other related new generation ICT technologies, also with the development of ADAS evolution, the Automated Driving technology is develop from **Level 2 to Level 3**, and toward to the development of Level 4 automatous driving



Trend2: ICT companies expand the layout of automobile field actively

Connectivity

Google, Android Auto, the ecosystme

Apple, Carplay more than 3000 users

Baidu, Carlife the HMI connection

DATANG LTE-V2X car terminal

Automated Driving

UBER Automated driving cars research and test

Lyft and NuTonomy, automated driving car sharing

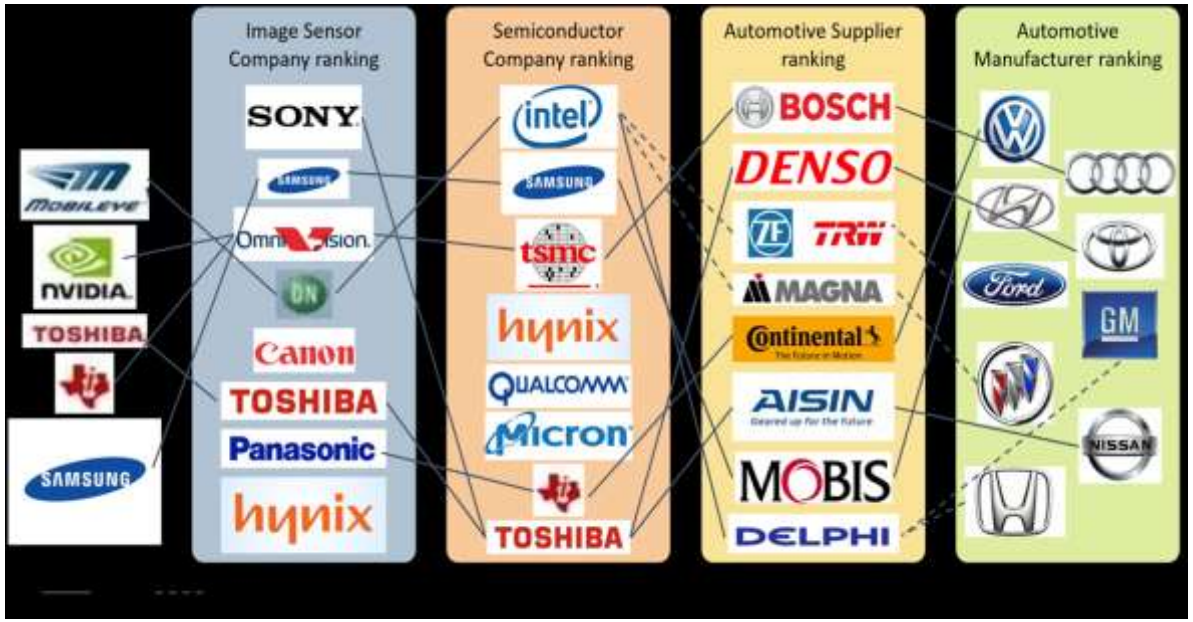
Innovative Car company

Tesla

NEXTEV, high performance electromobile

UISEE

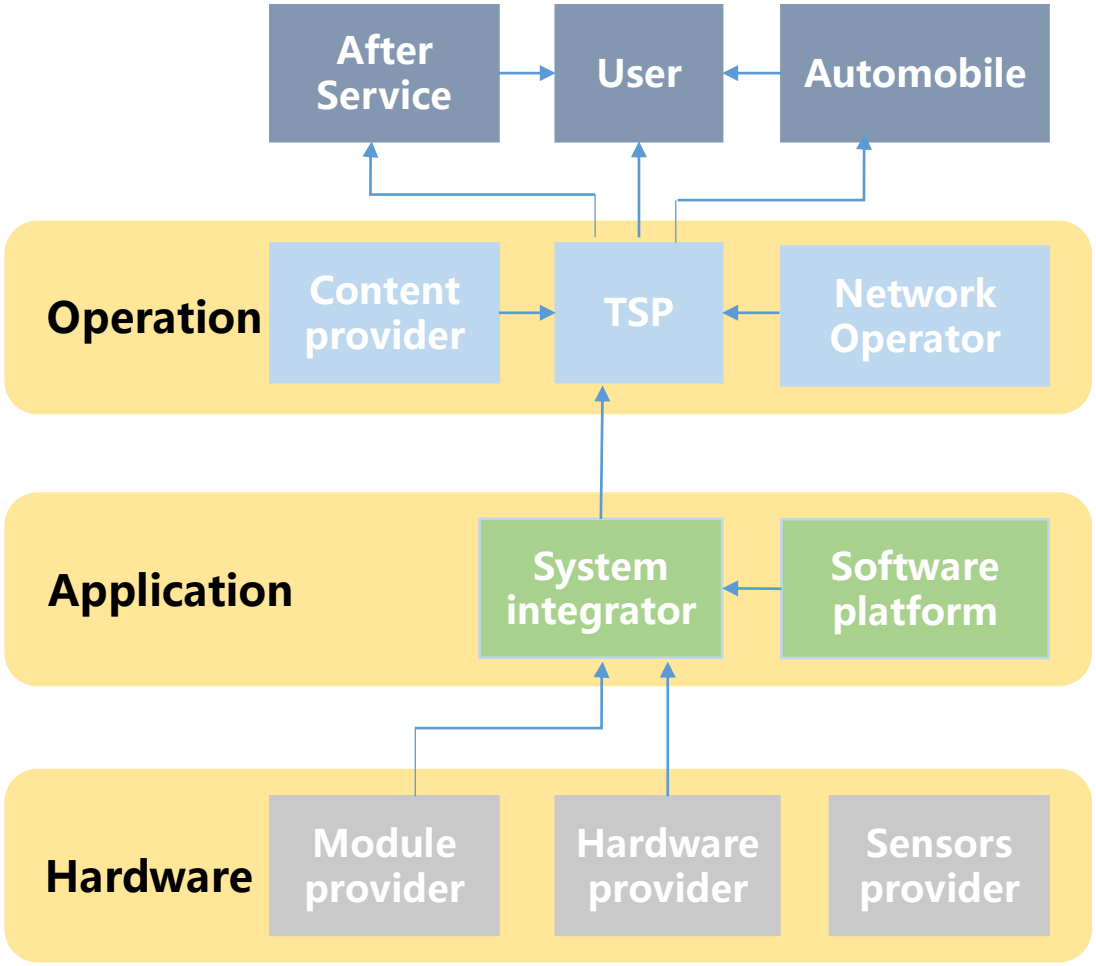
Trend3: Cross Industry cooperation

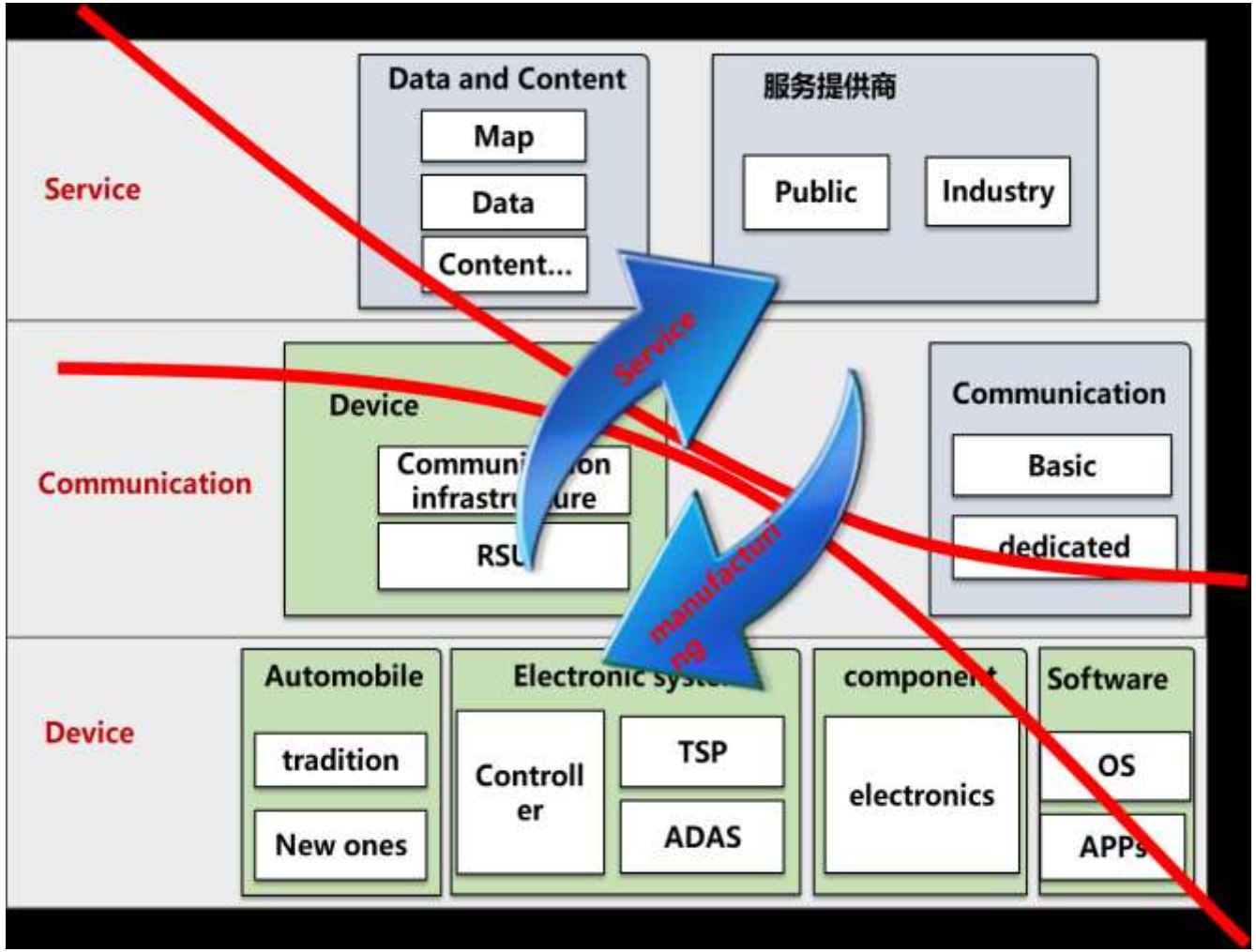


The cross industry cooperation between traditional automobile company and ICT company is more becoming more and more obvious, like BMW, Intel and Mobileye, Lyft and GM, BOSCH and NVIDIA

The same situation in China, **ICT company joint with automobile company to promote the development of CAVs**, like Baidu and Chery, Alibaba and SAIC, like Changan and Huawei

The integration of Industry Chain





“Sharing, Automated, Connected, Electric”, to construct a new ecosystem

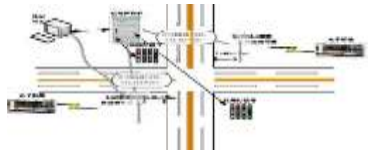
An interconnected network for information exchange among people, vehicles, roads, and cloud

Active safety warning application

Entertainment and transportation integrated information service

Not only

A data platform with information and things integrated



Traffic guidance and traffic control management

Production and manufacturing such as **personalized customization**

But also

A new ecological system of services and business models

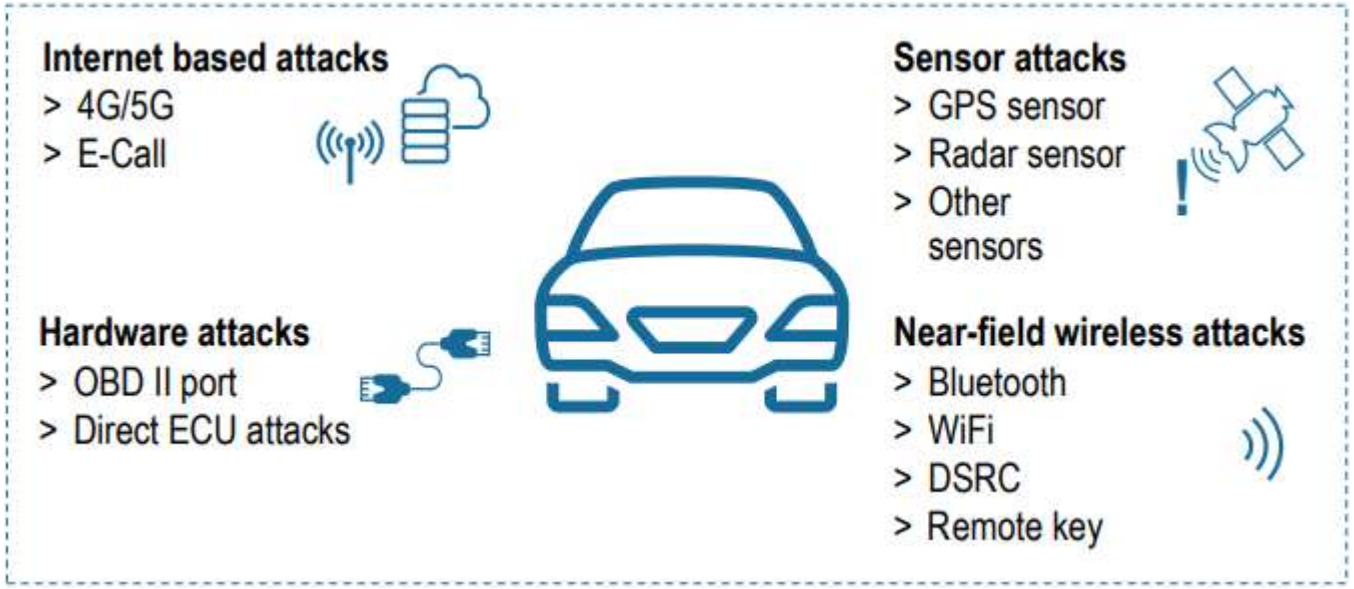
Self-driving applications such as vehicle queuing

Smart traveling applications such as vehicle sharing

Smart transportation system

However, improved internal & external connectivity will make modern vehicles vulnerable to an increasing number of cyber threats

Cybersecurity threat vectors



- Threat vectors span all connected vehicle components and systems
- Suppliers must design E/E architectures to prevent component-level attacks and understand the design implications for integration into vehicle sub-systems)
- Organization structures and design processes must adapt accordingly
- Evolving legal and regulatory requirements for data security & protection and product safety must be addressed as well

Action items for holistic security concept

Secure processing (secure boot, run-time integrity, OTA updates)	**Secure network** (message authentication, CAN ID killer, distributed intrusion detection)	**Secure gateway** (domain isolation, firewalls/filters, centralized intrusion detection)	**Secure interfaces** (secure M2M authentication, secure key storage)

Source: Roland Berger

Security is still an important issue for CAVs

- Uber fatal crash: Self-driving SUV saw pedestrian, didn't brake

- 49-year-old Elaine Herzberg was killed in March in Tempe, Arizona, when she was struck by the self-driving Uber. Herzberg was crossing the street with a bicycle when she was hit. The car was in autonomous mode, but an operator was inside the vehicle at the time.

The method of judging accident responsibility is urgently needed in CAV Road Tests

Outline

1. The Concept of Connected and Automated Vehicles
2. The Key Technologies of Connected and Automated Vehicles
3. The Industry Development of Connected and Automated Vehicles
4. Development and Promotion of Connected and Automated Vehicles in CHINA

Improving Integration and Innovation Environments

The collaborative development of intelligent and internet of **automobile** has become a global consensus. As **new-generation information communications technologies, such as 5G,** are increasingly integrated into Internet of Things (IoT), cellular vehicle-to-everything (C-V2X) has become an important application scenario.

Strengthen Top-level Design

Key tasks

Key technology research and development + **Research on standards and spectrum** + **Trials and demonstration**

Assurance measures

Enhanced department coordination

Enhanced international cooperation

Policy Environment: Strengthen Top-level Design and Issue Guidance

Ma Kai, the deputy prime minister, has officially approved to establish **CAV industry development inter-ministry coordination mechanism** under the **great country of manufacturing leadership team**, with the joint effects from 20 departments under the Ministry of Public Security, the Ministry of Transport, and the National Development and Reform Commission, in order to tackle the major challenges of CAV development.

- In May 2015, the state council officially launched ***Made in China 2025***.
- To promote R&D and industrialization of **intelligent transportation tools**
- The technology roadmap for key fields has been worked out, and the following systems will be established : **smart vehicle self-development innovative system,** and **smart vehicle industry chain** and **smart transportation system**.

中华人民共和国中央人民政府
The Central People's Government of the People's Republic of China
国务院关于积极推进“互联网+”行动的指导意见

- In July 2015, the State Council officially issued ***Guidance on Internet+ Action Promotion***.
- **Transportation based on Internet+** helps promote intellectual technology applications, such as Internet of Vehicles (CAV).
- **Artificial Intelligence based on Internet+** helps quickly accelerate the development and application of intelligent-assisted driving, complex environment awareness, and vehicle-mounted smart devices.

中华人民共和国工业和信息化部

- In June 2016, the China Ministry of Industry and Information Technology strengthened top-level design, assigned overall planning and key tasks for CAV, and launched ***Promotion Plan on CAV Innovation and Development***.
- The CAV development has been promoted from the following six key tasks (involving 20 sub-tasks): **key technology research and development, research on standard systems, establishment of platforms and experimental sites, infrastructure development, application and promotion, as well as network and information security protection**.

中华人民共和国工业和信息化部

- In April 2017, the China Ministry of Industry and Information Technology, together with NDRC and Ministry of Science and Technology (MOST), issued **Medium-and Long-term Automobile Industry Development Plan**.
- Green and smart automobiles are taken as breakthrough points to lead the industry transformation and upgrade. **The smart automobile promotion project has been proposed, with specified goals at the DA, PA, and CA phases.**

National **CAV industry integration and innovation guidance** and **Guidelines for construction of CAV industry standard system** will be issued.

Phased Tests and Verification of LTE-V2X Technologies

- The IMT-2020 (5G) promotion group has conducted LTE-V2X direct communications tests on **the 5.905-5.925 GHz band (20 MHz bandwidth in total)**.
- **According to the progress of LTE-V2X R&D and industrialization, LTE-V2X tests are conducted in different phases.**

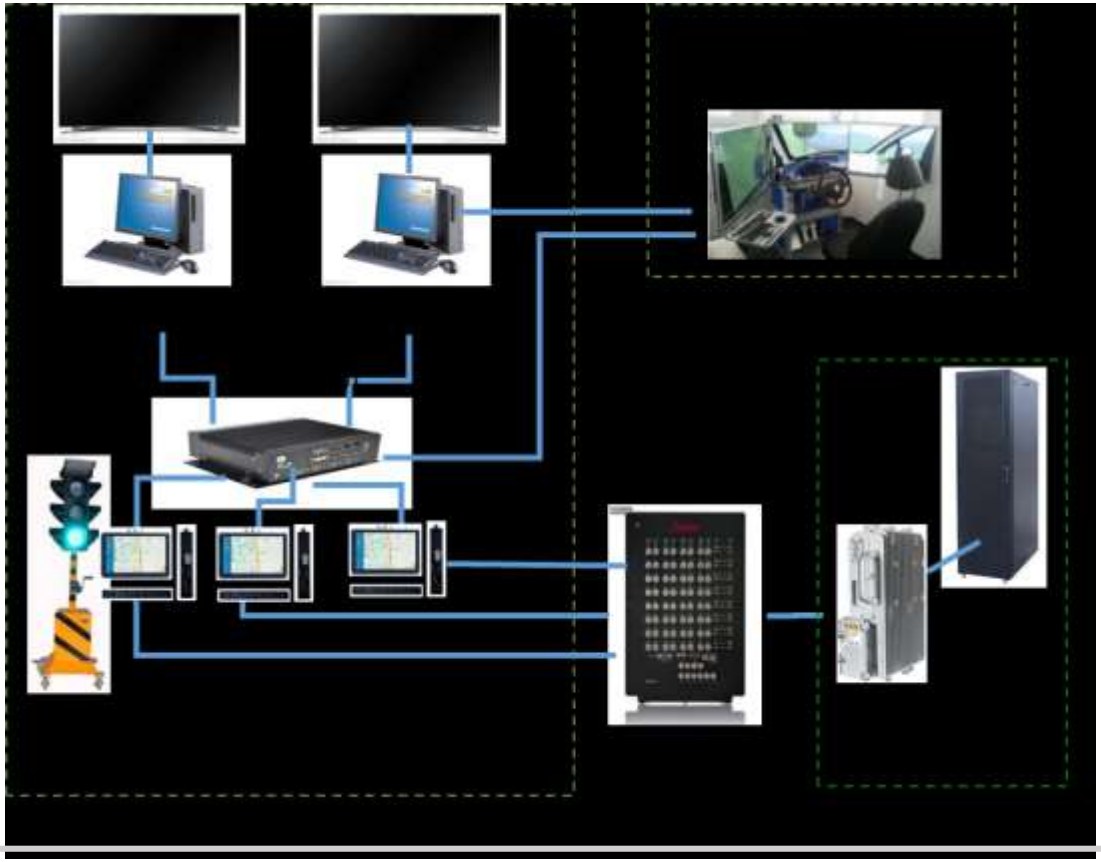
A series of test specifications have been formulated for phase 1 and phase 2 tests.

- Terminal Equipment Requirements
- Base Station Requirements
- Communication Modules – Technical Requirements for T-Box Interfaces
- Lab Test Specifications – Terminal PC5 Basic Functions
- Lab Test Specifications – Base Station PC5 Basic Functions
- Lab Test Specifications – Terminal Interoperability
- Lab Test Specifications – PC5 Performance
- Test Specifications on Network Layer and Application Layer Protocol Consistency for LTE-V2X Terminals

- Field Test Specifications – PC5 Basic Functions
- Field Test Specifications – Terminal Interoperability
- Field Test Specifications – PC5 Performance
- Field Test Specifications – PC5 Service Application

- Tests in phase 1 and phase 2 have been completed (a few of vehicles covered in the lab and in the field).
- **Phase 3: It is planned to carry out performance tests and E2E application verification on many vehicles to promote industrialization.**

Phase 1: LTE-V2X Lab Tests and Verification



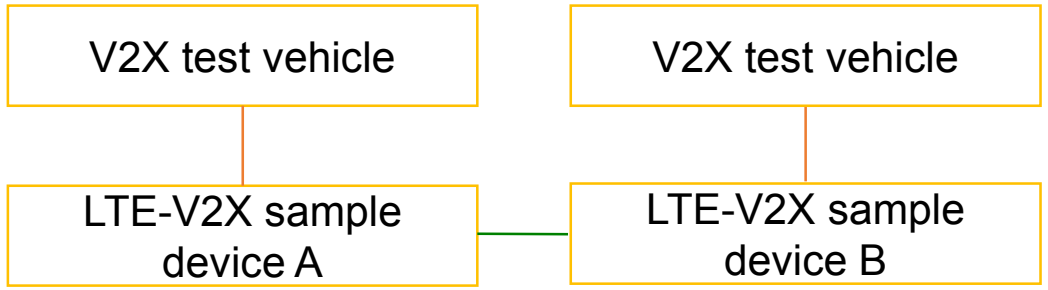
Test capability

LTE-V2X function test	LTE-V2X communication module interoperability test (including protocol consistency detection)
LTE-V2X performance test	T-Box (application) interoperability test (including protocol consistency detection)
Software simulation test	Hardware-in-the-Loop test

- Simulate different traffic scenarios and various vehicle-vehicle wireless communications environments **to test LTE-V2X (V2V) performance counters, such as the E2E delay and packet sending success rate**.
- Organize interoperability tests of direct communications on LTE-V2X terminals in the lab and in the field to implement multi vendor (MV) interoperation in compliance with the international standard 3GPP release 14.

Phase 2: Field V2X Performance Tests and Typical V2X Application Verification (Chongqing Demonstration Area)

- Test site: test fields of China Automotive Engineering Research Institute and Chang'an Automobile
- Test scenario: Simulate a LOS scenario in urban areas, an NLOS scenario in urban crossroads, and a LOS scenario in express ways.

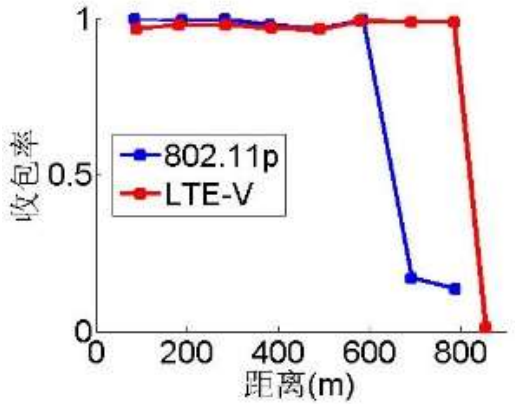


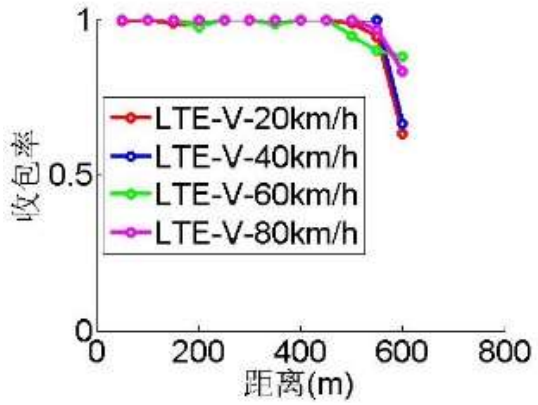
Performance Test Scenario	Coverage Distance	E2E Delay	Data Packet Transmission Reliability
Express way (LOS) Absolute vehicle speed: 60 km/h	340 m	≤ 100 ms	≥ 90%
Crossroad (NLOS) Absolute vehicle speed: 20 km/h	120 m	≤ 100 ms	≥ 90%

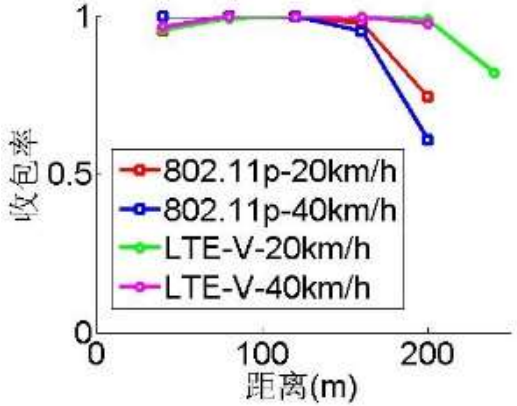
Conclusion: In the field, each V2X test vehicle is integrated with one LTE-V2X sample device of a vendor to verify typical V2V applications, such as forward collision warning and cross-intersection collision warning.

Phase 2: Field V2X Performance Tests and Typical V2X Application Verification (Shanghai Demonstration Area)

- Test site: closed test field of National Intelligent Connected Vehicle (Shanghai) Pilot Zone
- Test scenario: a) Two test vehicles stay still. b) Two test vehicles drive towards each other (turning left or overtaking). c) Two test vehicles drive towards a crossroad from different directions, where there are obstacles (collision avoidance).



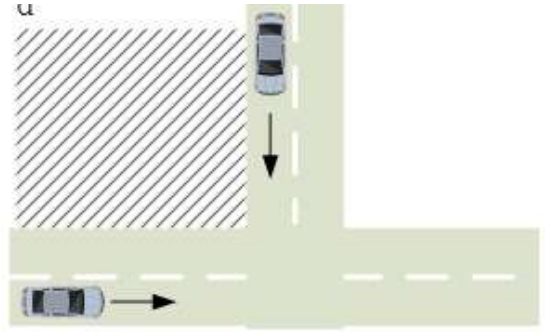




a)

b)

c)



Conclusion: In the field, LTE-V2X functions and performance are preliminarily tested. LTE-V2X PC5 communications are available, and performance counters, such as the coverage distance, E2E delay, and data packet transmission reliability, meet the requirements of typical V2V services in different scenarios (delay ≤ 100 ms; reliability ≥ 90%).

Phase 3: Organizing LTE-V2X Large-Scale Tests, Verification, and Application

In 2018, the IMT-2020 C-V2X work team is set up to plan and organize LTE-V2X large-scale tests, verification, and application in both Shanghai and Chongqing demonstration areas.

- Conduct communications function and performance tests on many vehicles, and verify MV, cross-layer interoperability in more test scenarios.
- Comprehensively evaluate the impact of C-V2X technology on vehicle operation security and traffic efficiency improvement, and collect user feedback to form a C-V2X industry shared database.

Vehicle scale and auxiliaries:

- More than 3000 vehicles, providing C-V2X communication applications
- Various vehicle types, including cars, buses, and trucks
- Mapping between standardized data collection and information services

Vehicle source:

- SIAC – EvCard
- SIAC – AppAdvice
- Buses and official vehicles in Jiading district
- Company buses and enterprise vehicles in SIAC
- Voluntary vehicles
- Test vehicles of OEMs and tier-1 vendors

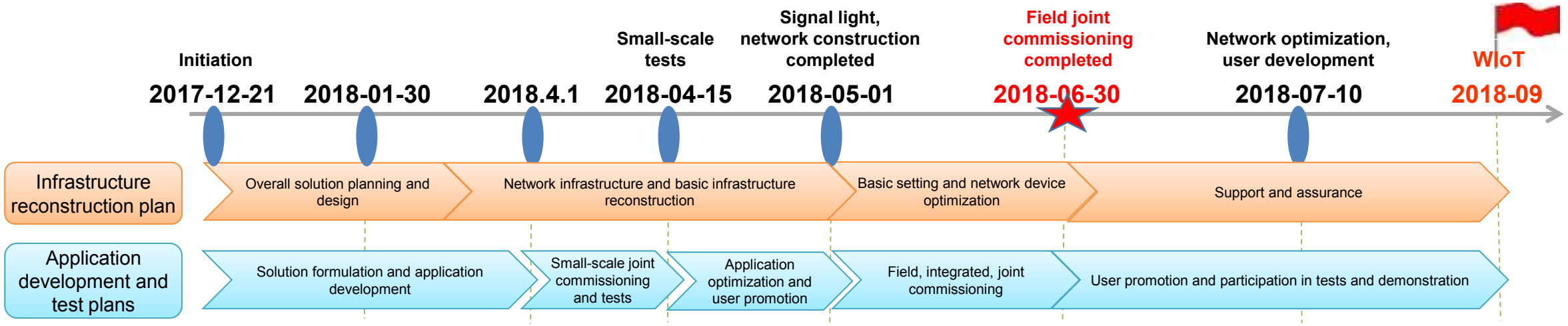
Phase 3: Establishing an LTE-V2X Public Road Showcase

In Wuxi demonstration area, verification and application of typical V2I applications

Scope of the demonstration area:
Wuxi Taihu New City, a key district in the main urban area, is connected to the airport, high-speed railway station, and main roads of new and old urban areas. There are about **222 crossroads** in total.

Number of target users:
Tens of thousands to hundreds of thousands users, including rear-vision mirror users, app users, and enterprise cooperation users

Project completion time:
The network is expected to be constructed by the end of June, 2018, to be open to friendly users, and to be exhibited in **September** at WIoT.



Mature Service Industry, Need for Accelerating the Construction of the C-V2X Test, Certification, and Assessment System

Promote the construction of the C-V2X test, certification, and assessment system for cross-industry collaboration of automobiles and information communications, and promote the unified mutual certification with international industry organizations.

Conveners

2018-05 | 2018-09 | 2018-12 | 2019-03

Research on current certification systems

- Automobile announcement, CCC certification
- Network access license, model approval, CCC certification
- Qualification requirements for tier-1 vendors
- Research on international C-V2X certification

Test items and specifications

- Communication modules, parts, and OEM vehicles
- Suggestions on test items and specifications planning

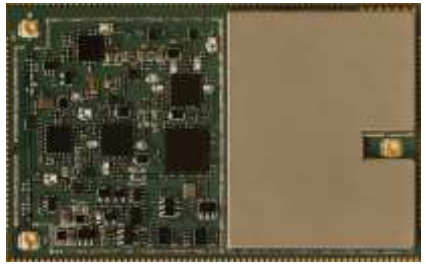
Collaborative certification system

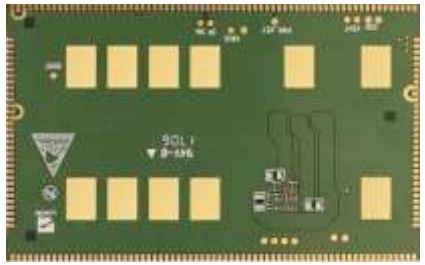
- Collaboration of test items and specifications
- Research report output

International unified certification

- Connection with 5GAA, OmniAir, and GCF certification systems and test specifications

Significant Breakthroughs in LTE-V2X R&D, Support for Industry Development





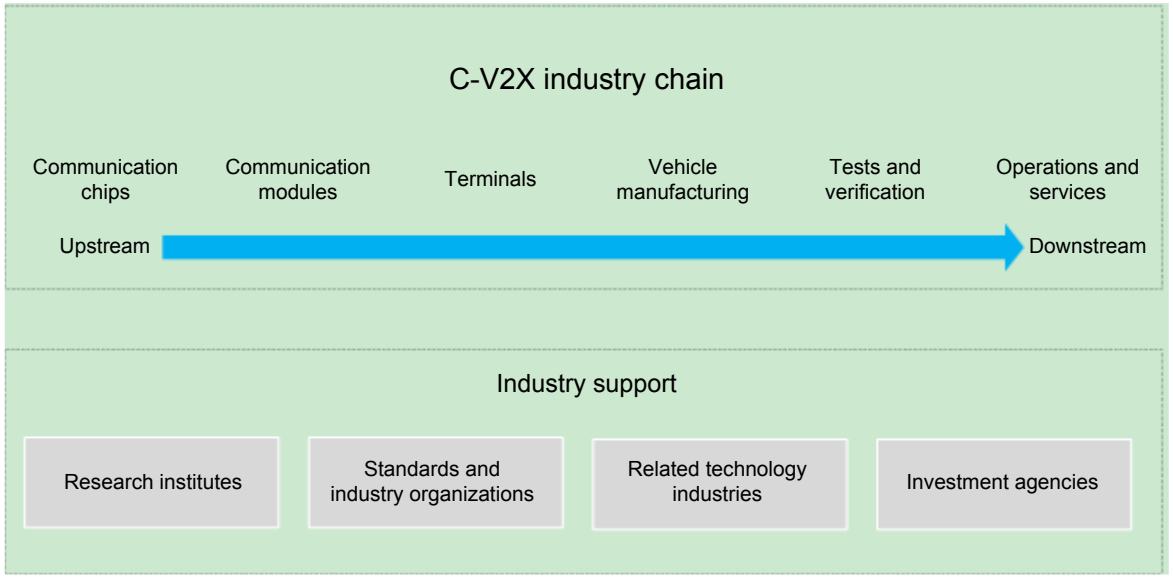
On November 16, 2017, Datang launched the **LTE-V2X commercial communication module DMD31**, RSU (DTVL3000-RSU), and OBU (DTVL3000-OBU), providing solutions for the upstream and downstream of the industry chain.

During the Mobile World Congress 2018, Huawei officially released **Balong 765, a commercial chip based on LTE-V2X**. This chip, in compliance with 3GPP release 14 specifications, has a peak rate of 1.6 Gbit/s, and supports the PC5 and Uu interfaces in Mode 3/Mode 4.

On September 1, 2017, Qualcomm released its first C-V2X commercial solution, **Qualcomm® 9150 C-V2X chipsets**, based on 3GPP release 14 specifications and oriented to PC5 direct communications. The chipsets are expected to be put into commercial use in the second half of 2018 to meet the mass requirements of automobile manufacturing enterprises to ensure road safety.

Gradual Layout of the C-V2X Industry

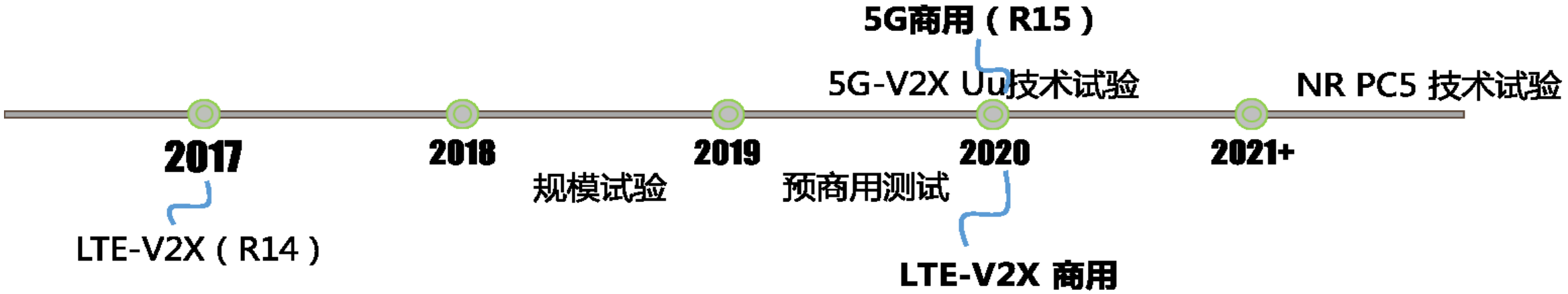
C-V2X industry chain



C-V2X industry map

Preliminary Planning of the C-V2X Industry Implementation Path

C-V2X technical test and commercialization plan



Problems facing the commercial deployment of the C-V2X industry

- Key products have not been commercialized.
- The C-V2X business model has not been clarified, and the network deployment solution is not determined.

Commercialization roadmap of the C-V2X industry

Connection establishment | Capacity enhancement | Application upgrade

Commercialization mode of the C-V2X industry

- Ensure that the industry strategy for C-V2X devices is supported.
- Construct smart highways, and conduct information upgrades for urban road facilities.

Building a Cross-Industry Innovation Platform to Conduct Tests and Verification, Accelerating Product Maturity and Industrialization

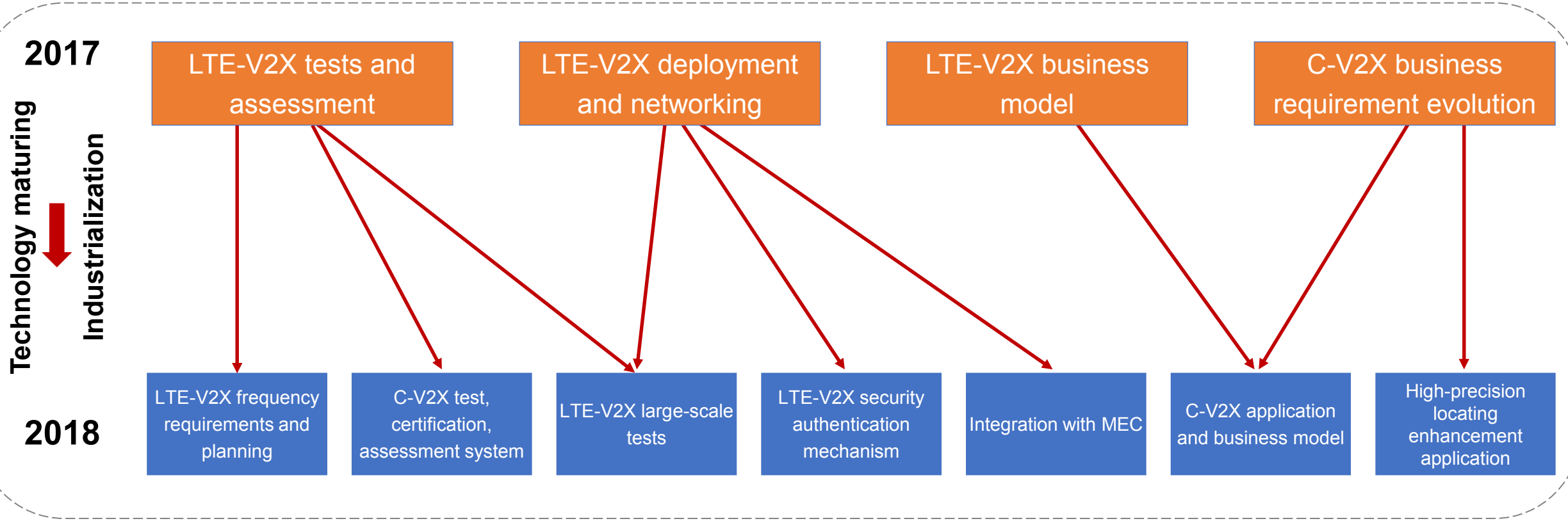
The IMT-2020 (5G) promotion group has set up the C-V2X work team to organize technical researches, tests, verification, and industry and application promotion of LTE-V2X and 5G-V2X. A total of 75 research institutes and enterprises have joined to form an alliance for"production, learning, research, and use" cooperation and "automobile, information communications, and transportation" collaboration.

Memorandum of cooperation signing with 5GAA

China-Korea joint symposium on 5G and IoV

Key Tasks of the IMT-2020 C-V2X Work Team

Organize technical researches, tests, verification, and industry and application promotion of LTE-V2X and 5G-V2X.



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