



清华大学
Tsinghua University



Development of ICV and Smart Mobility in China

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Keqiang Li

Professor of School of Vehicle and Mobility, Tsinghua University

Chief Scientist, China National Innovation Center for Intelligent and Connected Vehicles

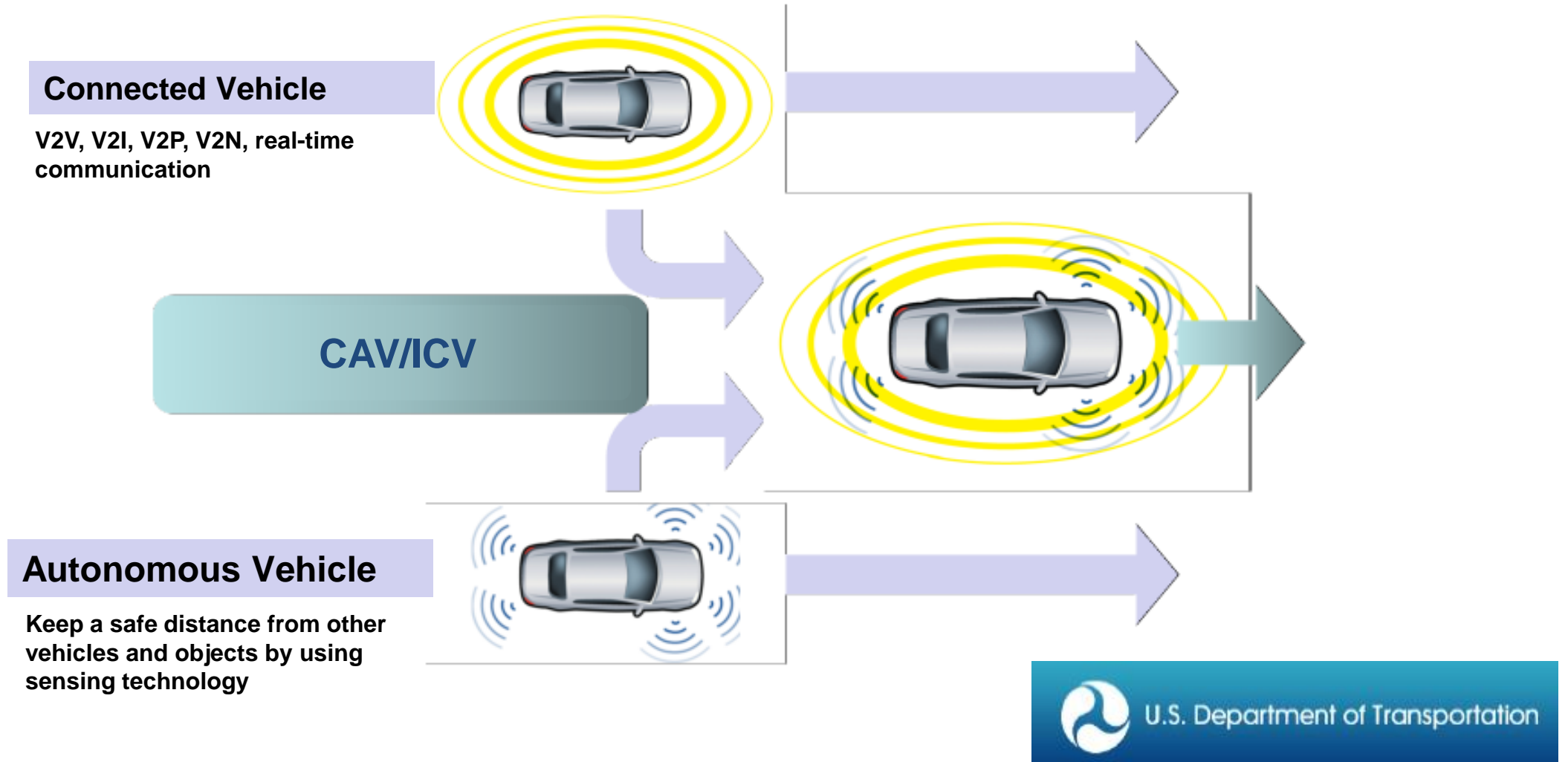
Chairman of Expert Committee, CAICV (**C**hina Industry Innovation **A**lliance for **I**CV)

CONTENTS

- **Background**
- **ICV Solution and Innovative Development Paradigm in China**
- **ICV Solution Supports to Establish Smart Mobility**

The New Stage of Automated Vehicle Development - ICD

The ICD integrates Autonomous Vehicle and Connected Vehicle, which brings out **New Product, New Paradigm, and New Ecosystem.**



Two Major Features that Distinguish ICV from Conventional Vehicles

Interdisciplinary and Cross-industry Integration

Unlike conventional vehicle, which is a **mechatronic product**, ICV requires the fusion of **mechatronics and ICT**. This underlines the industrial **integration of automotive, transportation infrastructure, information and communications infrastructure** (including 4G/5G, map and positioning, data platforms), etc.



Significance of Regional and Social Properties

The **regional and social properties of ICV are weighing much more than the conventional vehicle**. The operation of ICV requires the **support of telecommunications, maps, and data, which are under security monitoring due to national security sensitivity**. Each country has its standards, regulations and, legislations regarding this. Therefore **Localization Factor** exists in the development and application of ICV.



Main countries in the world are exploring technical roadmap and industrial development paradigm

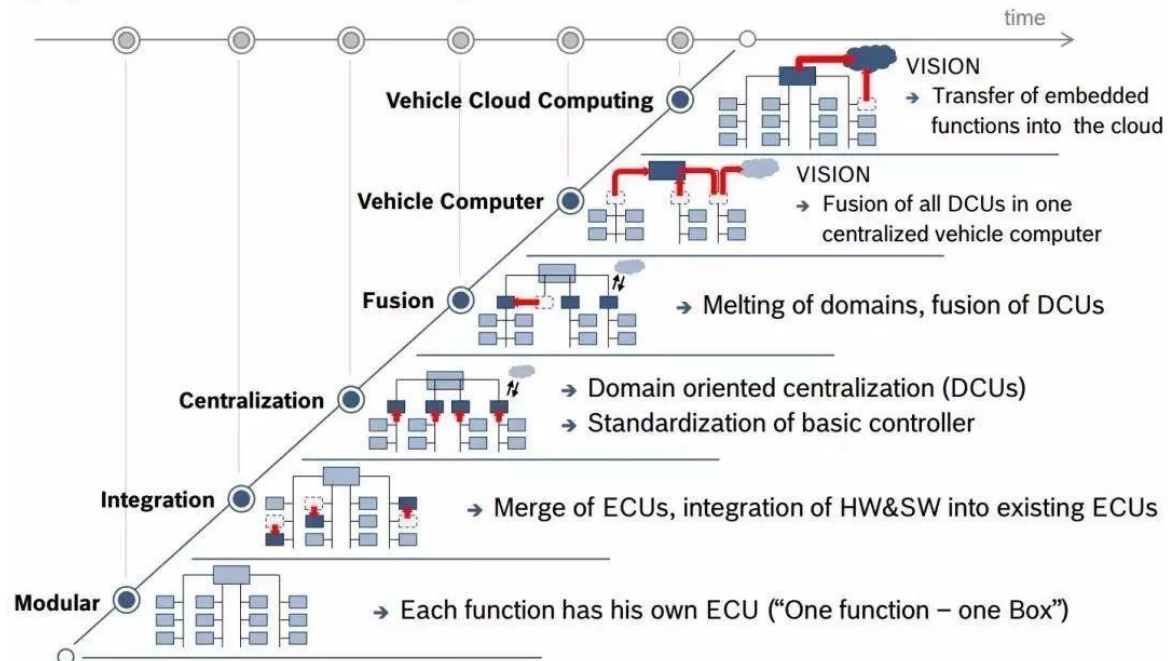
Issues of 'Single-agent Intelligent Vehicle' Development

Paradigm One

Incremental Way from Driver Assistance to Intelligent driving

Since mass production is the top priority of the OEMs that adopted this paradigm, the existing and conventional H/S architectures, which hardly meet the ever-growing requirements of autonomous driving, are heavily relied on.

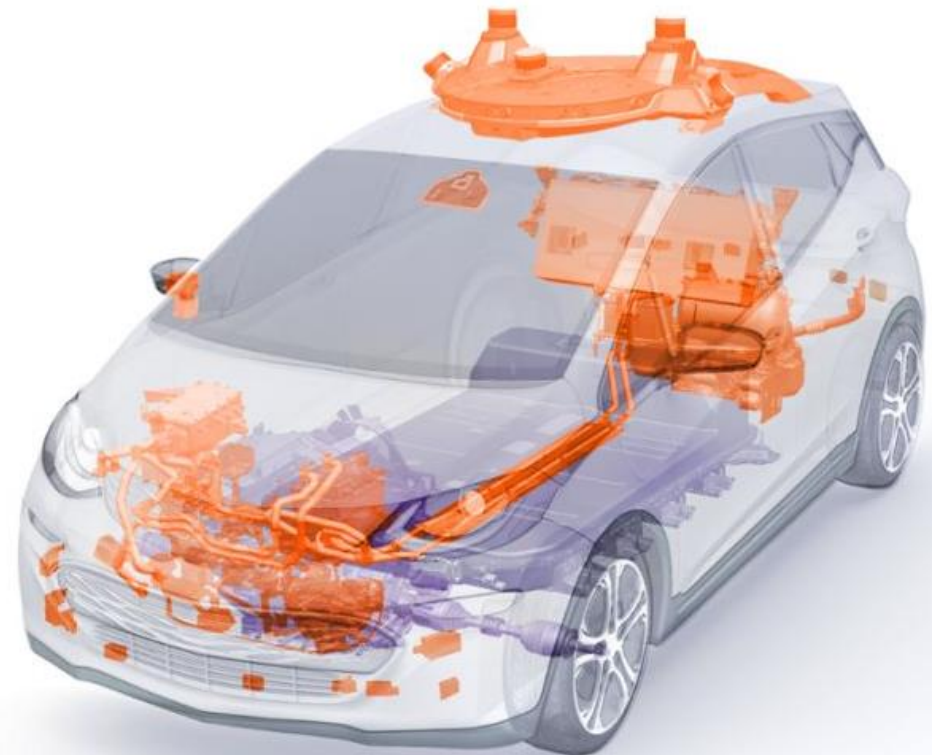
(R)Evolution of the E/E Architecture



Paradigm Two

One-shot Way that Focuses on High-level Vehicle Intelligence

The radicalness of this paradigm brings along many concerns, such as unvalidated and unproven vehicle safety and reliability. Costs and mass production capabilities are also constraints.



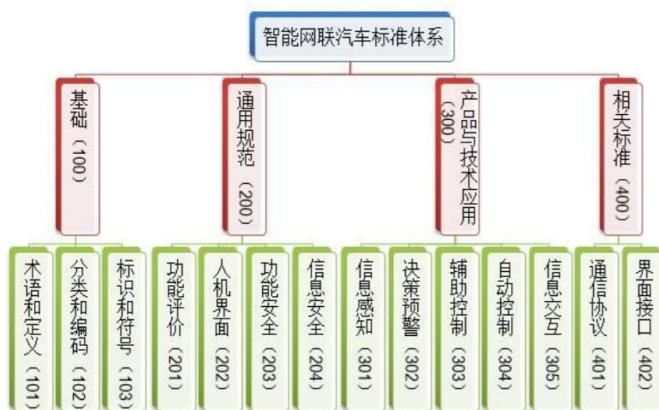
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Actively Promote the Policies and Regulations of ICV

To establish Cross-sector Coordination Process & Top-level Design

- ❑ The Ministry of Industry and Information Technology launched **ICV Development Action Plan**
- ❑ The Development and Reform Commission issued **ICV Innovative Development Strategies**
- ❑ The Ministry of Transport strengthens **Product Application and Pilot Demonstration**
- ❑ The Ministry of Natural Resources expands **Market of Map and Position Applications**



The Regulations of ICV

In 2020

The new ICV proportion will reach 50%, and the market application of medium and high-level ICV will be realized.

In 2025

A system of ICV industrial ecology, road facilities, laws & regulations, supervision & cyber security will be set-up.

In 2035

A safe, efficient, green and civilized ICV society will be build.

The Roadmap for ICV



ICV Closed Field Test Base



Enterprises with Qualifications

The Necessity for a Localized Solution for ICV in China

No experience of successful application of ICV or certainly proven paradigm exists anywhere in the world. The localized solution of ICV innovation and development in China shall be planned according to the need for cutting-edge technologies and industry development and the specific conditions of China.

Neither of the two Paradigms of 'Single-agent Intelligent Vehicle' Development is suitable for China's specific industrial conditions.



Incremental Paradigm of vehicle intelligent level improvement

- Our gaps in automotive electronics, control, and actuation would be continuously widened following this paradigm, resulting in "Hollowness" to our core technologies in the automotive industry.



Radical Paradigm that focuses on high vehicle intelligence levels

- Without the first-mover advantage in this paradigm, we could end up "strangled" by the west due to critical disadvantages on core technologies, especially in high precision sensors, high-performance central processors, computing platform and toolchains of development and test, etc.,

Reasons of the necessity for a Localized Solution of ICV in China:

1. The communication, map, and data used during ICV operations have **localization properties that cannot be ignored**. **Security** has to be **uniformly governed** by the nation. Therefore, a simple copy of foreign technologies would not be plausible.
2. There is no successful experience of ICV development worldwide due to the need for industrial integrations and cooperation. Moreover, innovations are induced by the nature of ICV, the integration of cutting-edge **ICT and automotive system technology, and integration technology of the new generation**.



New Products with Localization Properties are Required for ICV Development

Definition of Localized ICV Solution

1. Comply with Chinese Infrastructure Standards

Including standards of road infrastructure, map data, V2X communication, and transportation, etc.

2. Comply with Chinese Connected-Operation Standards

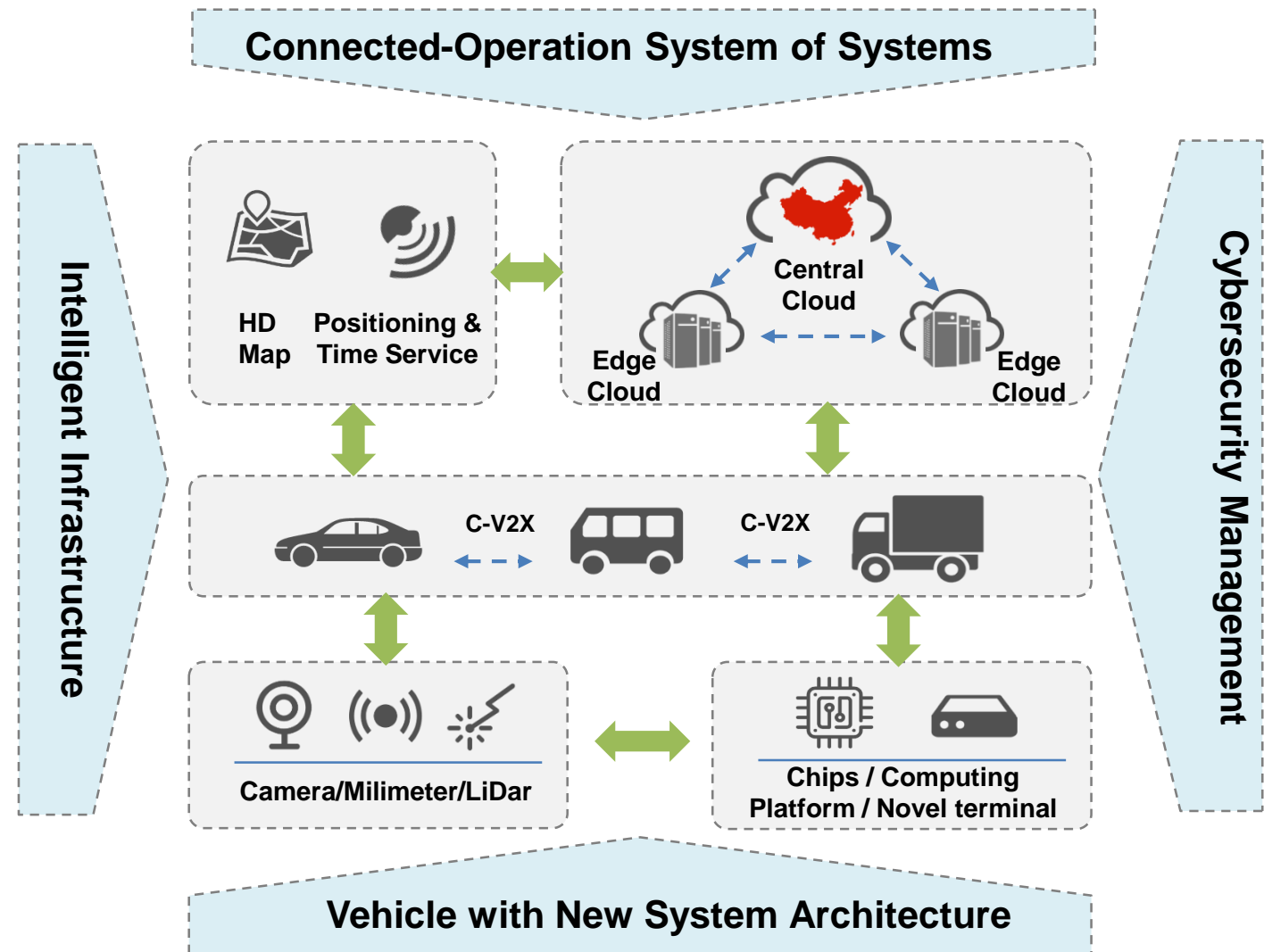
Including standards of ICV access, supervision of connected operation, information security, etc.

3. Comply with new standardized Architecture of Automotive Products in China

Including standards of intelligent terminal, communications system, cloud platform, gateways, ADAS, ADS, etc.

The paradigm of China's Localized ICV Solution

Through architecting localized solution of **ICV Cyber-Physical System** with the considerations of the combined characteristics of **automation** and **connection**, realizing China's ICV Complex, which is the embodiment of "five fundamental platforms," underlining the concept of "Human-Vehicle-Road-Cloud."



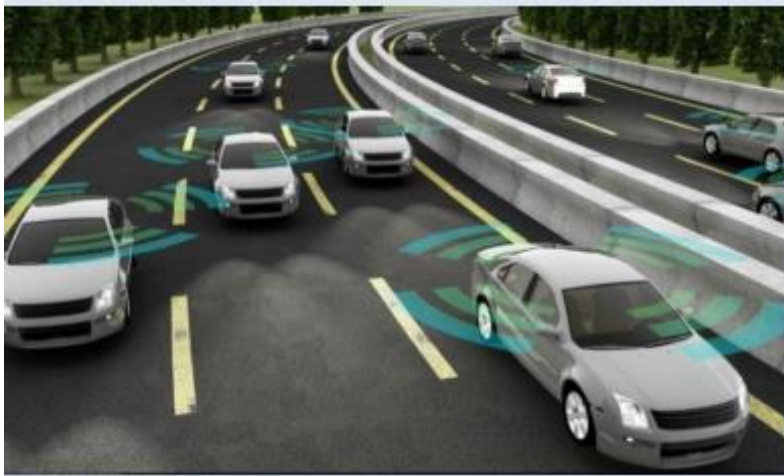
The Architecture of Localized Solution for ICV Complex

1. Top Level Design of ICV Architecture

ICV is a typical application of CPS in the automotive transportation system of systems.



ITS



ICV

ICV is a **typical complex CPS** that deeply integrates automotive, transportation, and ICT system of systems

ICV CPS



Big Data Computation Based on Real Data



Safety, energy-saving, and efficient mobility ecology-oriented coordination/collaboration application (cloud)



Digitalization of physical space - intelligent data processing and basic database (cloud)

Standardized Interconnection System

High Speed & Low Latency Communication

Standardized Interconnection System



Physical Space

To meet the complex requirements of interdisciplinary, cross-industrial development and tackle the challenges brought by regional properties, it is imperative to construct a state-of-the-art ICV CPS.

2. Deep Fusion Between Intelligence and Connection Development

China was the first country to classify the levels of intelligence and connection fusion; the technology roadmap is under continuous revision and improvement.

In 2016, the levels of intelligence and connection were proposed alongside the release of “*The Technical Roadmap of ICVs*,” we were the first country to define the three levels of connectedness, aka **connection-assisted information interaction**, **connection-enabled cooperated perception**, and **connection-enabled cooperated decision-making and control** - an innovative concept and path for industrial development.

We have further revised and improved the milestone implementation plan of vehicle intelligence and connected classification and their industrialization, further exploring the technical route of localized ICV solution.



Connected Level	Name	Definition	Typical information	Transmission needs	Typical scenes	Vehicle control body
1	Connected Auxiliary Information Interaction	Acquire auxiliary information such as navigation, and upload data such as a vehicle running and driver's operations, based on the vehicle-road and vehicle-background communications.	Maps, traffic flow, traffic signs, fuel consumption, mileage, etc.	Low requirements for transmission timeliness and reliability.	Traffic information reminder, vehicle-mounted information service, weather information reminder, emergency call service, etc.	Human
2	Connected Collaborative Perception	Acquire real-time traffic environment information surrounding the vehicle based on vehicle-vehicle, vehicle-road, vehicle-human, vehicle-background communications, and integrate it with the perceptual information of vehicle-mounted sensors as the input of auto-vehicle's decision and control system.	Digital information such as locations of surrounding vehicles/pedestrians/non-motor vehicles, signal light phase, road early warning, etc.	High requirements for transmission timeliness and reliability.	Early warning for wet and slippery roads, traffic accidents, and emergency braking, giving way to special vehicles, etc.	Human or system
3	Connected Collaborative Decision and Control	Acquire the surrounding traffic environment information and vehicle decision information based on vehicle-vehicle, vehicle-road, vehicle-cloud communications; integrate with the information of traffic participants such as vehicle-vehicle and vehicle-road; and achieve intelligent collaboration, thus realizing the collaborative decision and control between traffic participants.	Collaborative perception, decision, and control information among vehicle-vehicle, vehicle-road, and vehicle-cloud.	Highest requirements for transmission timeliness and reliability.	Guiding running speed, vehicle spacing, lane selection, collaborative formation, passing through intersections, ramp confluence, etc.	Human or system

2. Deep Fusion between Intelligence and Connection Development

The intelligent and connection fusion development roadmap is being well recognized by many countries.

Many countries are working on an AD technical roadmap based on connection communication technology

In 2019, ERTRAC announced *Connected Automated Driving Roadmap*, proposed the development roadmap of network-connected automated driving—ISAD.

Roadmap	Region	Organization	Year
Connected Automated Driving Roadmap	EU	European Road Transport Research Advisory Council (ERTRAC)-EU	2019
STRIA Roadmap on Connected and Automated Road Transport	EU	Strategic Transport Research & Innovation Agenda (STRIA) -EU	2019
Roadmap for the deployment of automated driving in the European Union	EU	European Automobile Manufacturers Association (ACEA)	2019
UK Connected and Automated Mobility Roadmap to 2030	UK	Zenzic	2019
Public-Private ITS Initiative Roadmaps	Japan	Cabinet Office	2019

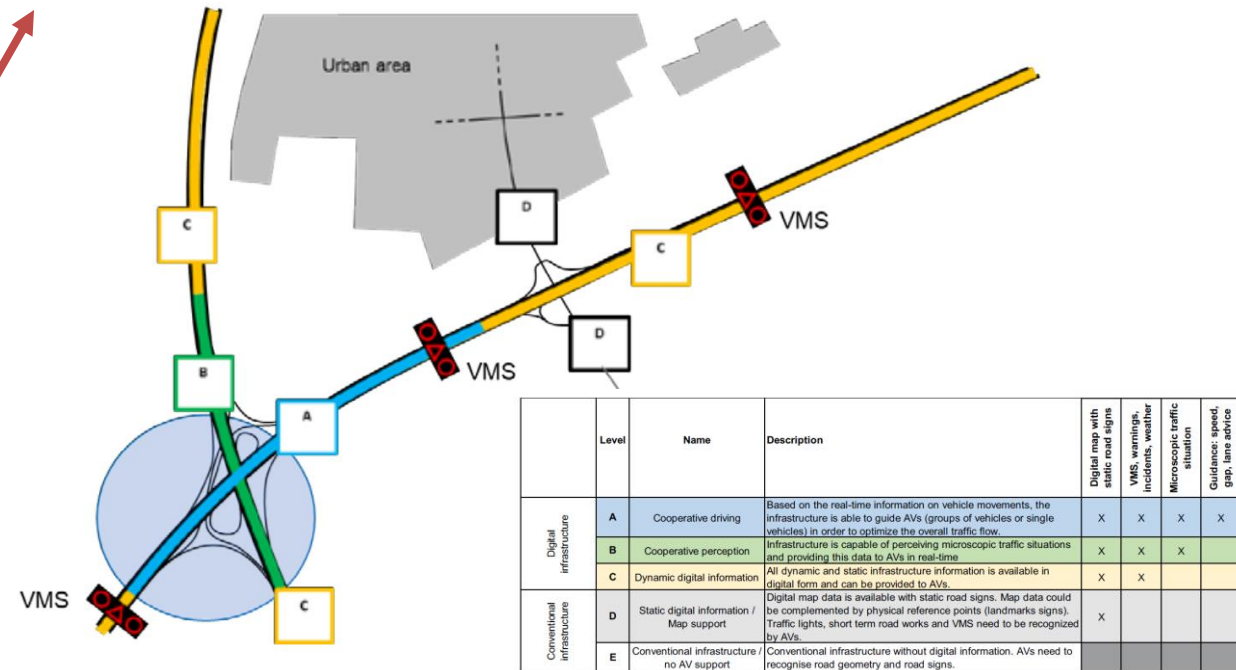


Figure 3: "ISAD Example"

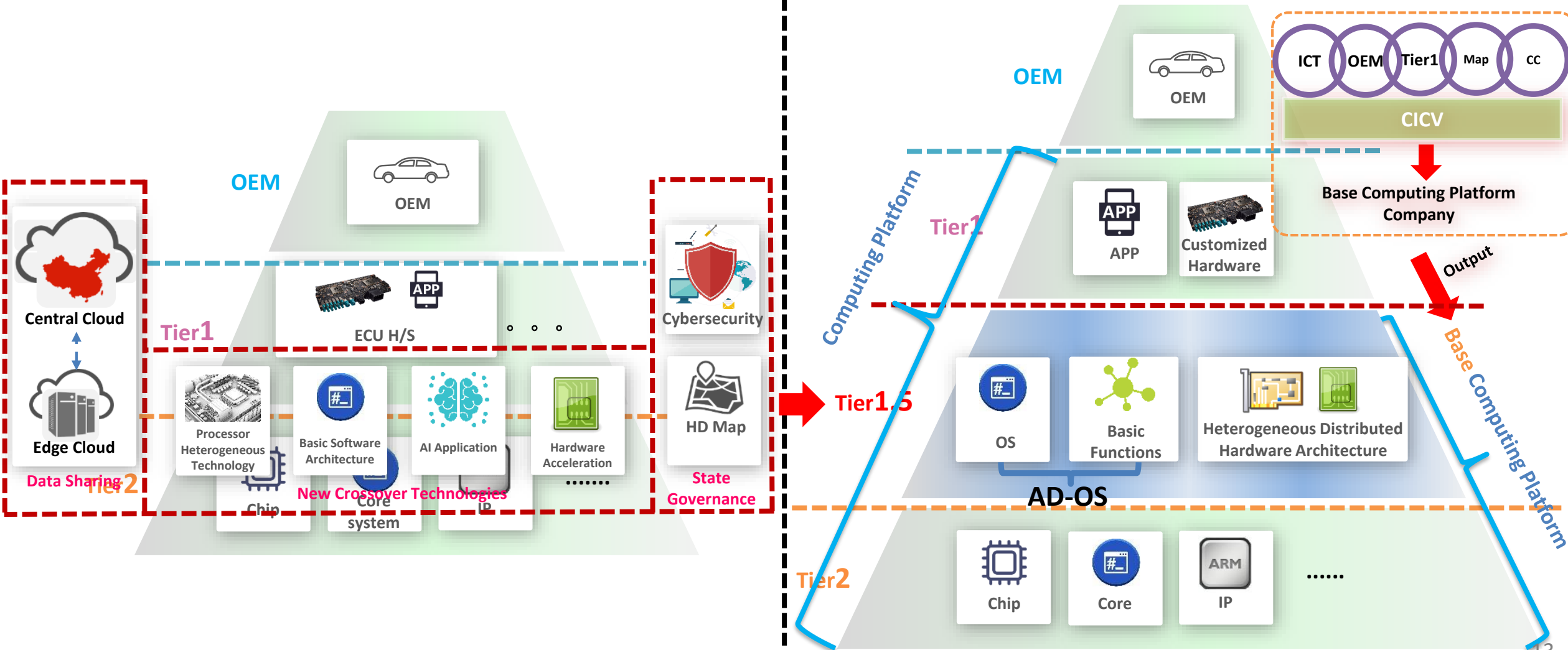
Figure 2: "ISAD Levels"

In the new version roadmap, ERTRAC stressed collaborated interconnection, increased network-connected AD contents, and explicated **Infrastructure Support Levels for Automated Driving—ISAD**.

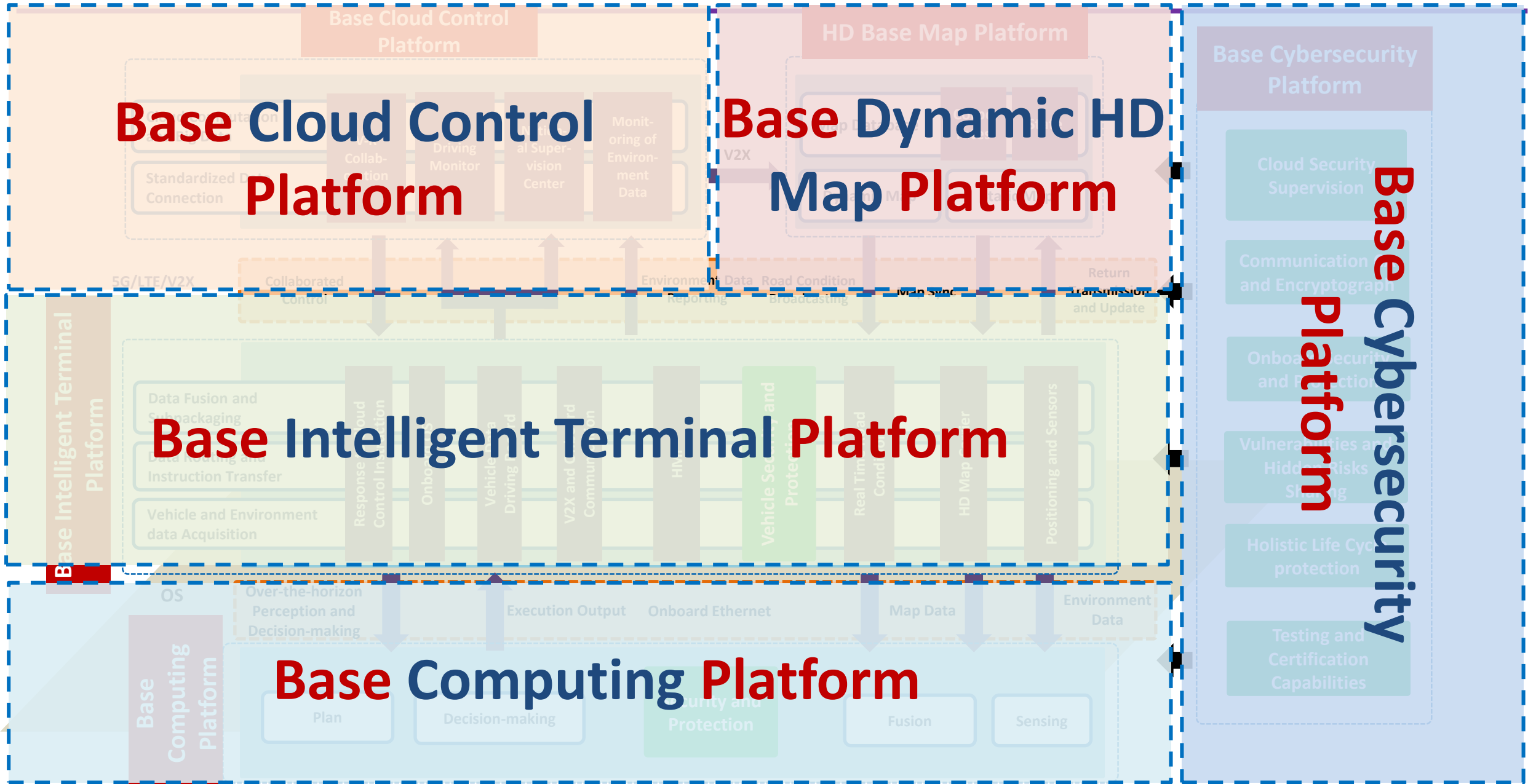
3. Construct Five Base Platforms, Build up New Ecosystem

Industrial Chain of Conventional Automotive Electronics

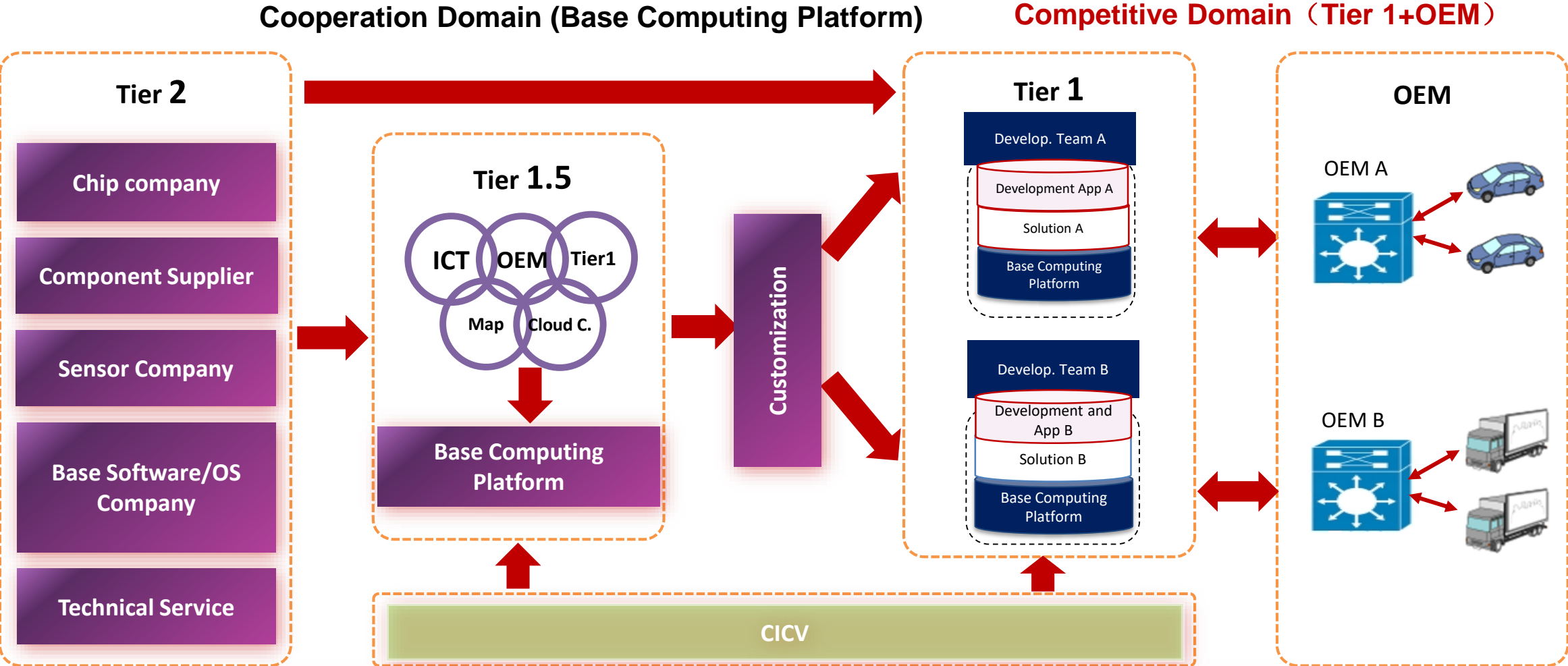
Industrial Chain of Automated Driving Electronics



ICV Development Requires for the Five Base Platforms Imperatively (New-Form Components)



Base Computing Platform—Business Model



Based on the wide Tier 2 industrial chain and by integrating the basic technology of computing platform company with 3rd party application development platform, automated driving providers, Tier 1, and OEMs to build their upper-level application, demo, and validation environment, and thus formulate the ecosystem of computing platform supply chain.

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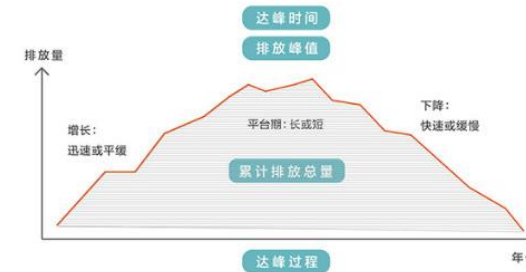
Technology Roadmap 2.0 Claims Target of Carbon Neutrality in Automotive Industry



China is willing to contribute more to the fight against climate change, as it aims to bring carbon emissions to a peak **by 2030** and achieve carbon neutrality **by 2060** with more aggressive policies and measures.

—— Chinese President Xi Jinping

2030



2060

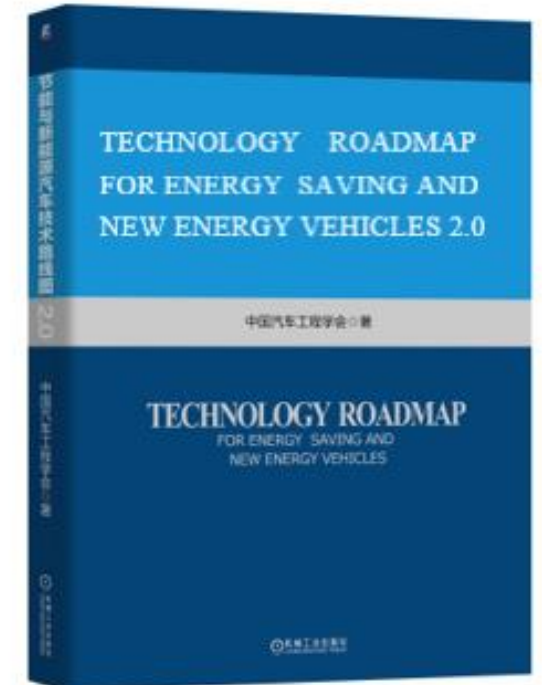
Carbon Neutral



“Technology Roadmap for Energy Saving and New Energy Vehicles 2.0”
proposed:

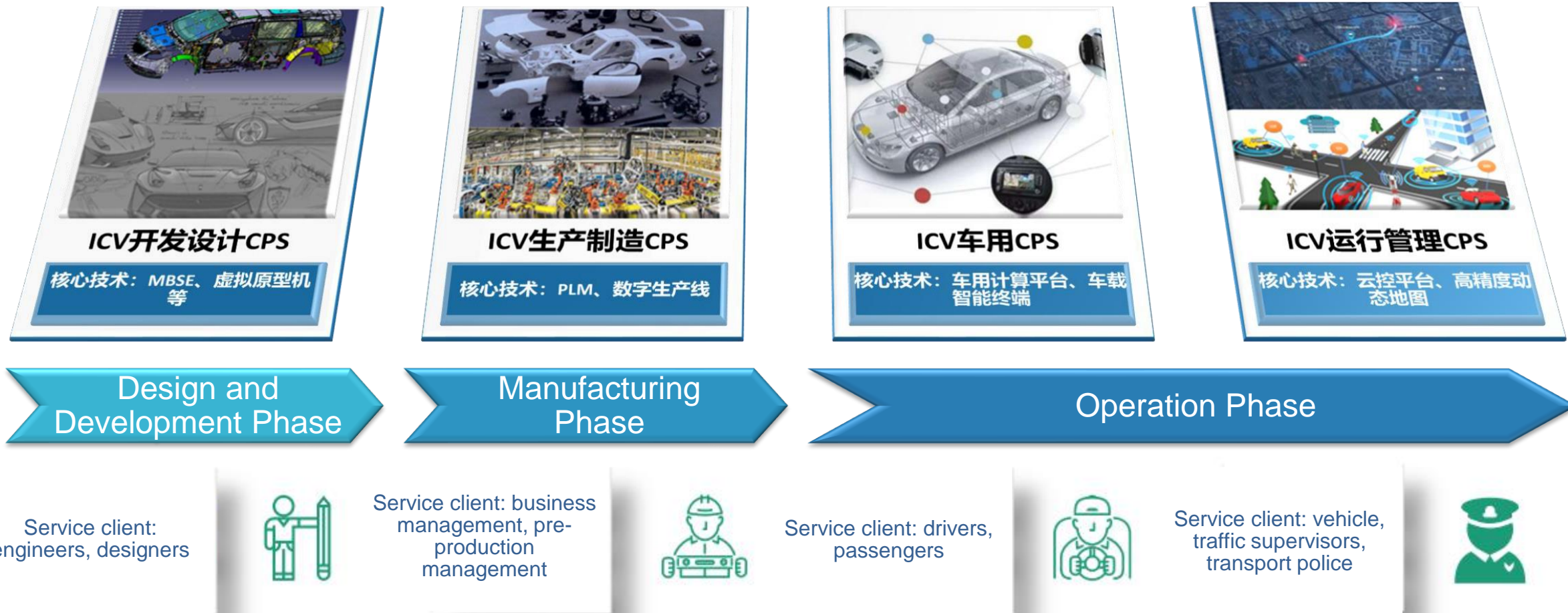
- **2028:** Achieve Peak Carbon Emission in Automotive Industry, fulfill the national commitment of Carbon Emission Reduction
- **2035:** Reduce Overall Carbon Emission more than 20% of Peak Value

China Automotive Industry will approach zero carbon emission in 2050, achieve carbon neutrality by 2060.



CPS 2.0 Architecture Prompts Low-carbon Holistic Vehicle Lifecycle

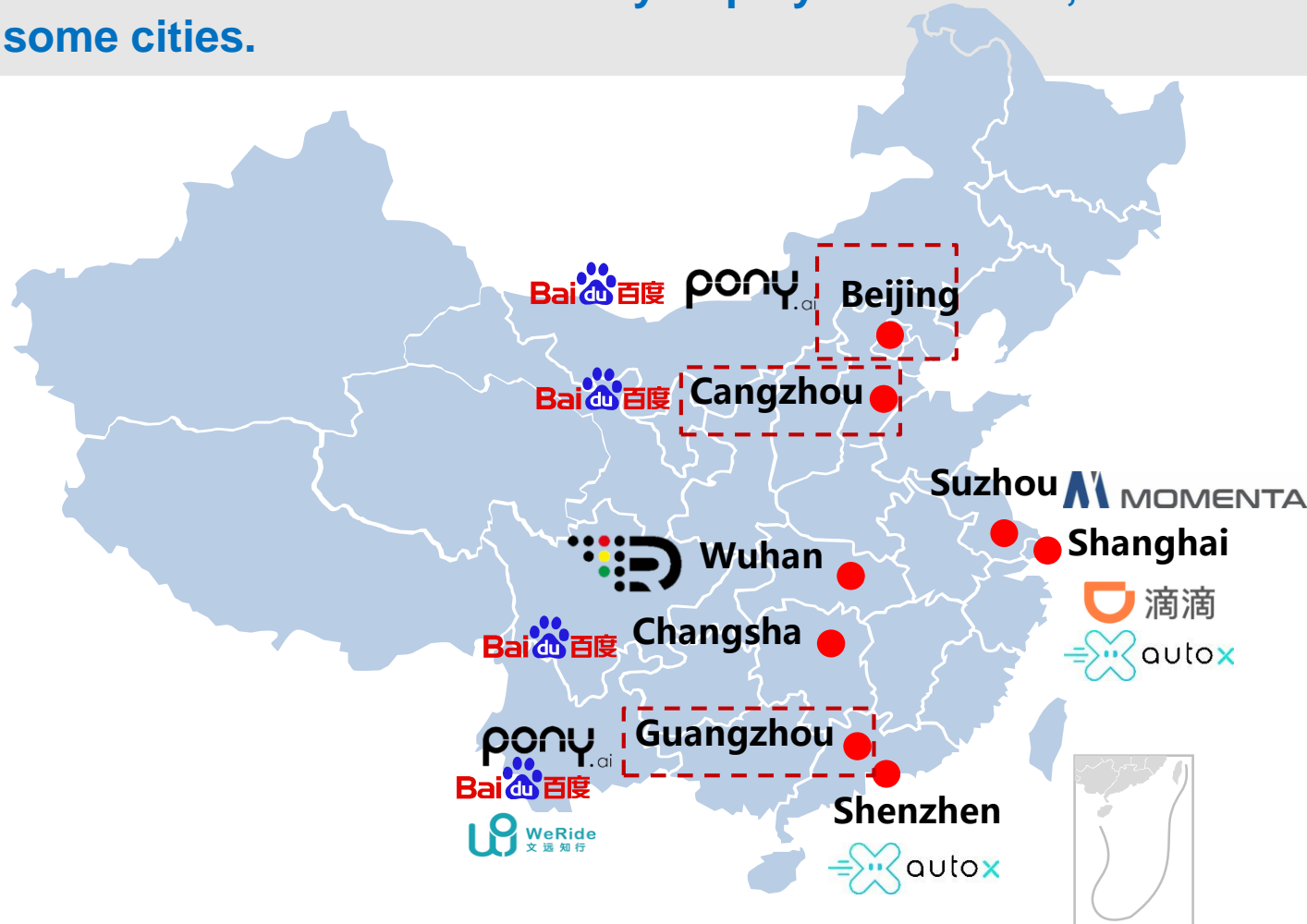
ICV Cyber-physical System CPS2.0 includes: ICV development and design CPS, ICV manufacturing CPS, ICV on-board CPS, ICV operation and management CPS, and low-carbon development for Holistic Lifecycle Phases of Automotive Industry and stakeholders.










CPS2.0 clarifies reference architecture targeting different service clients and the corresponding ICV lifecycle phase, prompts the low-carbon vehicle industry in intelligent manufacturing, green manufacturing, traffic optimization, and supports carbon neutrality.

The ICV Solution Supports to Establish Future Low-carbon Mobility Service

【Passenger Vehicle】 Energize shared mobility by intelligent and connected technology, support future mobility development, and accelerate decarbonization by shared vehicles. Autonomous driving tests with human involvement are widely deployed in China; the commercialized operation has been stimulated in some cities.



Company		Start Time
	Baidu	2020
	Didi	2020
	Pony.ai	2018
	WeRide	2019
	AutoX	2020
	DeepRoute.ai	2019
	Momenta	2020

Beijing, Guangzhou, and Cangzhou approved to provide and charge for Robo-Taxi services in specific areas.

The ICV Solution Supports to Establish Future Low-carbon Mobility Service

【Commercial Vehicle】 Compared to passenger vehicles, commercial vehicles produce higher carbon emissions. Localized ICV Solution achieves commercial vehicle platooning by vehicle-connected technology, reduces carbon emission significantly, and accelerates low-carbon development in the automotive industry.



May 2019, a large-scale public test of commercial vehicle platooning function was tested for validation of “ICV Testing methods and requirement for autonomous driving functions——Part 3: Platooning function.”



Dec 2019, Beijing Chongli Highway, L4 autonomous driving based on the C-V2X vehicle infrastructure cooperative technology and platooning function test, was demonstrated in an enclosed two-way, four-lane road

The ICV Solution Supports to Establish Future Low-carbon Mobility Service

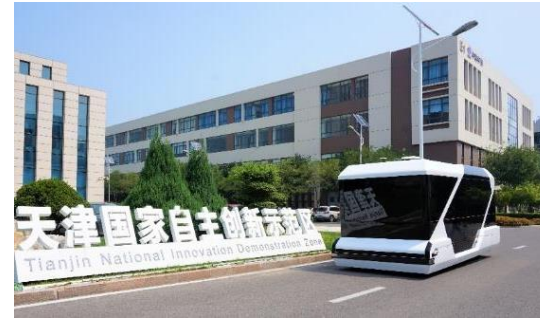
As an important **realization scenario** in the restricted area, autonomous commuter buses have attracted extensive attention from OEMs, Tier 1s, ICT, and start-ups both at home and abroad. Many cross-border products has emerged, which represent one of the more active self-driving applications in recent years.



Apollong



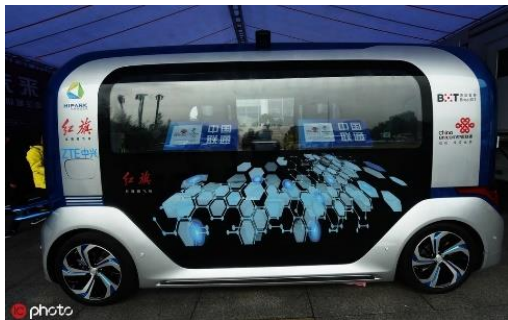
UISEE



Tsintel Technology



SAIC



FAW Hongqi



CATARC & Kinglong



Yutong



Dongfeng Sharing Van

The ICV Solution Supports to Establish Future Low-carbon Mobility Service

【Multi-Functioning Vehicle】 Localized ICV Solution accelerates a new MAAS (Mobility as a service) generation including multi-mode of transportation, shared mobility, electric vehicle, and self-driving. The next generation of autonomous driving mobile services will create a multi-traffic mode sharing intelligent travel service solution and propel the automotive industry's transformation.

Dongfeng: Sharing-VAN2.0



- The separation of the electric chassis from the cockpit is achieved, and different cabins can be replaced according to the immediate needs of the manned load.
- Provide a full range of high-quality automotive products and travel services multi-traffic mode solution and explore the next generation of public mobile travel services new model.

The ICV Solution Supports to Establish Future Low-carbon Mobility Service

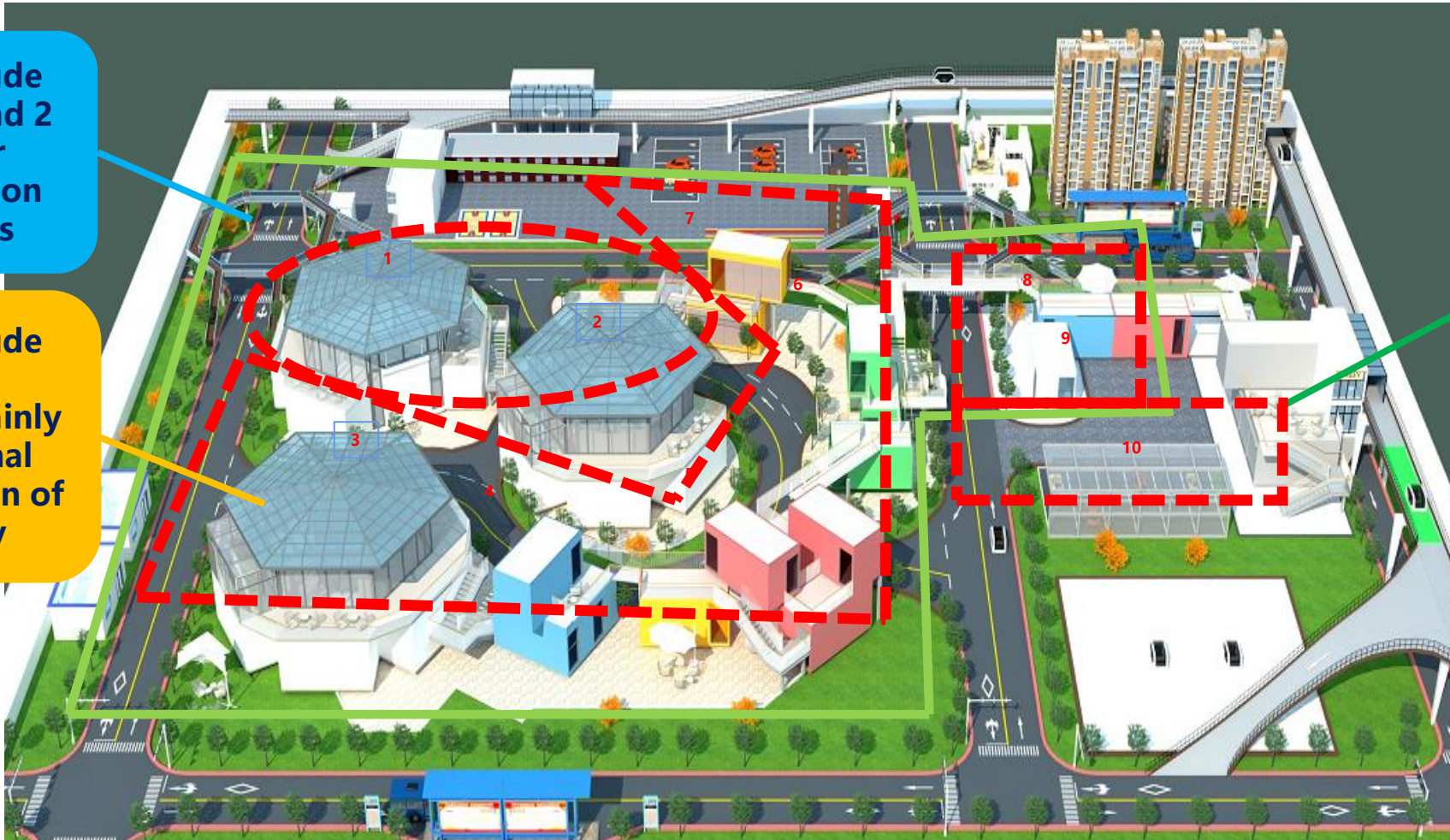
[Smart City] ICV prompts integration development of the vehicle, smart transportation, and smart city; combines passenger flow, logistics, energy flow, and information flow; achieves connectivity between vehicle and city, transportation, energy; increases city operational efficiency; and saves energy and reduces emission.

Area 1: include Stadium 1 and 2 mainly for demonstration capabilities

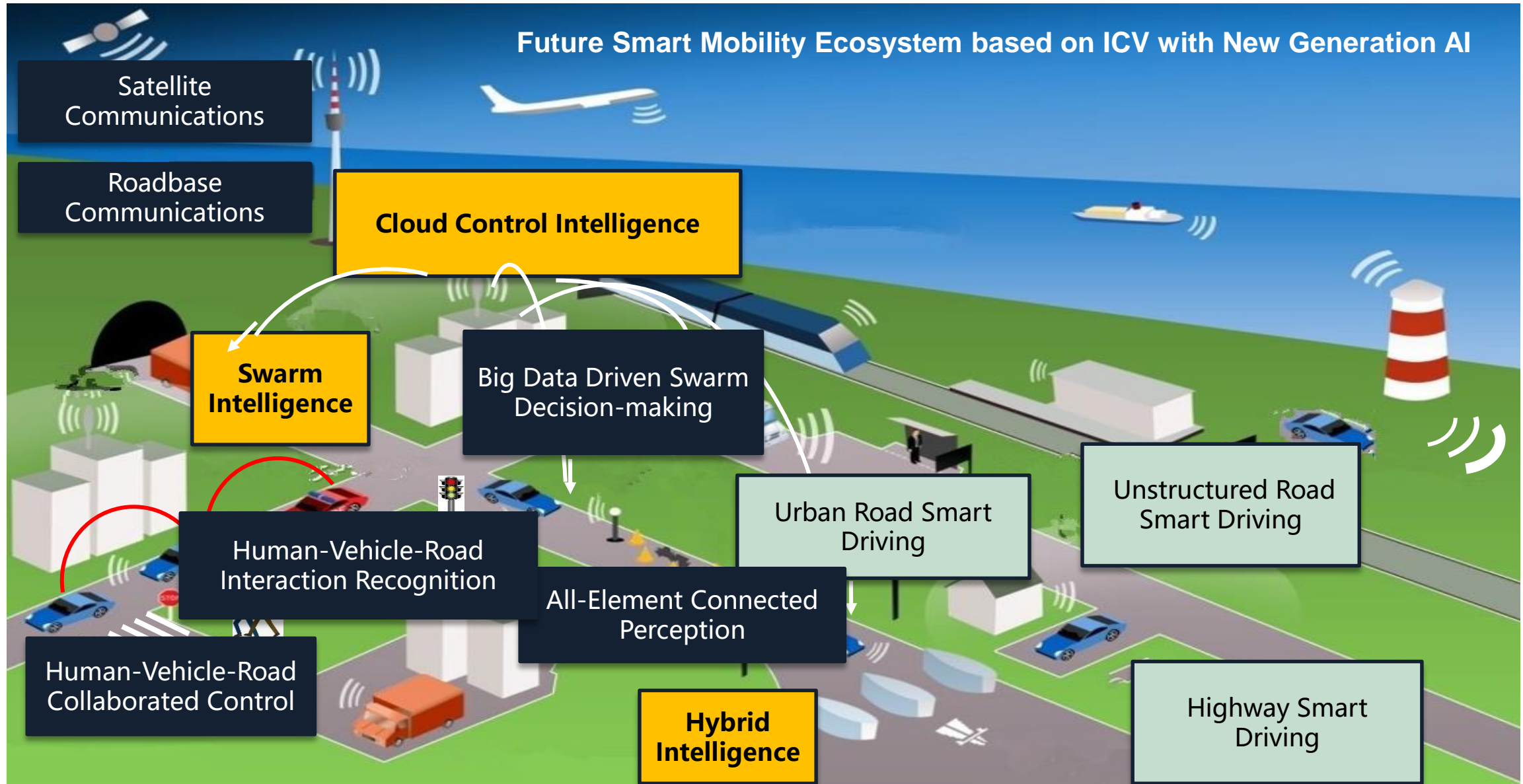
Area 2: include Stadium 3/4/5/6/7 mainly for functional demonstration of future city

DongFeng Sharing-City

Area 3: include Stadium 8/9/10 mainly for services



The ICV Solution Supports to Establish Future Low-carbon Mobility Service



Thank You for Your Attention !
