Intelligent Transportation and Autonomous Vehicles

Introduction to Dr. Keqiang Li

- **Professor** of Automotive Engineering, *Tsinghua University*
- **Chairman** of Expert Committee, *CAICV* (China Industry Innovation Alliance for Intelligent and Connected Vehicles)
- **CTO** of *CICV* (China ICV Research Institute Co., Ltd.)
- **Research interests**: Connected and intelligent vehicles, Vehicle dynamics and control.
- Authored or co-authored over 200 peer reviewed journal papers
- Received more than 80 patents.

Organizer:

The Base Platform of ICV System and Its Industrialization Approach in China

**Keqiang Li**
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Chairman of Expert Committee, CAICV (China Industry Innovation Alliance for ICV)

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Background and Motivation for ICV Base Platforms

Industrialization Approach for ICV Base Platforms

New Technology Trend of Automated Vehicles

Autonomous vehicles

Intelligent and Connected Vehicles (ICV/CAV/CAD)

Connected vehicles

Automation

Connection
"Autonomous Vehicle" + "Connected Vehicle" = ICV

The path toward connected vehicles will ultimately lead to automated vehicles.

**Connected Vehicle**
Communicates with nearby vehicles and infrastructure; Not automated

**Connected Automated Vehicle**
Leverages autonomous automated and connected vehicles

**Autonomous Vehicle**
Operates in isolation from other vehicles using internal sensors

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**Automation Levels of ICV**

<table>
<thead>
<tr>
<th>SAE Level</th>
<th>Name</th>
<th>Narrative Definition</th>
<th>Execution of Steering and Acceleration/Deceleration</th>
<th>Monitoring of Driving Environment</th>
<th>Failback Performance of Dynamic Driving Task</th>
<th>System Capability (Driving Modes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No Automation</td>
<td>The human driver monitors the driving environment</td>
<td>Human driver</td>
<td>Human driver</td>
<td>Human driver</td>
<td>n/a</td>
</tr>
<tr>
<td>1</td>
<td>Driver Assistance</td>
<td>The driver assists the human driver in steering and accelerating/decelerating</td>
<td>Human driver and system</td>
<td>Human driver</td>
<td>Human driver</td>
<td>Same driving modes</td>
</tr>
<tr>
<td>2</td>
<td>Partial Automation</td>
<td>The driver assists the human driver in steering and accelerating/decelerating</td>
<td>System</td>
<td>Human driver</td>
<td>Human driver</td>
<td>Same driving modes</td>
</tr>
<tr>
<td>3</td>
<td>Conditional Automation</td>
<td>The driving system monitors the driving environment and assists the driver</td>
<td>System</td>
<td>System</td>
<td>Human driver</td>
<td>Same driving modes</td>
</tr>
<tr>
<td>4</td>
<td>High Automation</td>
<td>The driving system monitors the driving environment and assists the driver</td>
<td>System</td>
<td>System</td>
<td>System</td>
<td>Some driving modes</td>
</tr>
<tr>
<td>5</td>
<td>Full Automation</td>
<td>The driving system monitors the driving environment and assists the driver</td>
<td>System</td>
<td>System</td>
<td>System</td>
<td>All driving modes</td>
</tr>
</tbody>
</table>
### Connection Levels of ICV

<table>
<thead>
<tr>
<th>Connection Levels</th>
<th>Name</th>
<th>Narrative Definition</th>
<th>Control</th>
<th>Typical Scenario</th>
<th>Transmission Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Connected Information Interaction Assistance</td>
<td>Realize auxiliary data acquisition including navigation and upload of information including driving and driver operation data based on Vehicle-Road and Vehicle-Backend communication</td>
<td>Human</td>
<td>Map traffic flow; traffic signs; fuel consumption; mileage, etc.</td>
<td>Low requirement on real time and reliability</td>
</tr>
<tr>
<td>2</td>
<td>Connected and Cooperative Perception</td>
<td>Acquire real time surrounding traffic environment data based on Vehicle-Vehicle, Vehicle-Road, Vehicle-Pedestrian and Vehicle-Backend communication. Infuse with perceived data by onboard sensors and then input for self-vehicle decision-making and execution systems</td>
<td>Human and system</td>
<td>Position of surrounding vehicles/pedestrians/non-motorized vehicles, phase position of traffic light, and road pre-warning, etc.</td>
<td>High requirement on real time and reliability</td>
</tr>
<tr>
<td>3</td>
<td>Connected and Cooperative Decision and Control</td>
<td>Acquire reliable surrounding traffic environment data and vehicle decision-making data based on V-V, V-R, V-P and V-B communication, transportation participants including V-V and V-R interact and infuse data and then form collaborated decision making and control among the participants</td>
<td>System</td>
<td>V-V, V-R collaborated control data</td>
<td>Highest requirement on real time and reliability</td>
</tr>
</tbody>
</table>

### Classification of ICVs

```
<table>
<thead>
<tr>
<th>Connected and Cooperative Decision-making and Control</th>
<th>Connected AD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Connected Cooperative Perception</td>
<td>Connected DA</td>
</tr>
<tr>
<td>Connected Information Interaction Assistance</td>
<td>Autonomous DA</td>
</tr>
<tr>
<td></td>
<td>Autonomous AD</td>
</tr>
</tbody>
</table>
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National ICV Innovative Development Strategy -- Vision Goal

**Long-term vision**

Build China solution of ICVs!

**Short-term vision**

- **System Construction**: By 2020, we will take initial shape of the independent technology innovation system of intelligent vehicles, and the industrial ecological system of cross-border integration, advanced and complete road network facilities system, systematic and perfect regulations and standards system, scientific and standardized product supervision system, and comprehensive and efficient information security system. And the national intelligent vehicle innovation and development platform has basically been completed and put into substantial operation.

- **Market scale**: Intelligent vehicles account for 50% of new cars, including 10% of conditional automatic driving (L3) and above. The market share of self-brand intelligent vehicles is over 30%, and the new vehicle assembly rate of network automatic driving reaches 10%.

- **Infrastructure**: The demonstration operation of key areas has achieved positive results. And the constructions of intelligent road traffic system and vehicle network system are coordinated, in which the national coverage rate of vehicle wireless communication network LTE-V is 90%.

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**China Solution of ICV**

**What is the China solution of ICV?**

- **Meet the infrastructure standards in China**
  
  Meet standards of infrastructure including road, mapping data, V2X communication and transportation rule in China.

- **Meet the connection operation standard in China**
  
  Meet the standards of ICV admittance qualification, network operation supervision, cyber security in China.

- **Meet the new architecture standards of automotive product in China**
  
  Meet the standards of new architecture of automotive product in China, such as the standards of intelligent terminal, communication system, cloud platform, gateway, driver assistance system and autonomous driving system.
Why we need the China solution of ICV ?

- **Adapt to distinct traffic environment and driving behavior in China**
  Different from western countries, the traffic environment is complex and driving behaviors are special in China. Thus adaptability is required for ICVs.

- **Utilize the development features of integration of informatization and industrialization**
  China has the powerful ICT, Internet industry foundation and innovation capability. Deep integration of ICT and automobile industry will be the development feature of ICV in China.

- **Develop China’s institutional advantages**
  Different from western countries, the governance mechanism of China will benefit in coordinating resources and promoting the development of ICVs.

- **Assure national cyber security and industrial security**
  Involved with cyber security, data security and industry security, the standard system of ICV has to be established.
The Strategic Tasks for ICV Innovative Development

1. Independent and controllable technological innovation system for ICVs
2. The crossover integrated ICV industry ecosystem
3. Advanced and complete road and IC infrastructure system for ICVs
4. Complete regulation and standard system for ICVs
5. Scientific and regulated product supervision system for ICVs
6. Comprehensive and efficient cyber security system for ICVs
In Beijing, the establishment of CICV (China ICV Research Institute Co., Ltd.) is for the national ICV innovation center.

The China ICV Industry Alliance was established on June 12, 2017. Minister of Miao Wei of MIIT served as Director of Alliance Steering Committee. Minister Miao suggested that the Alliance should take the lead in establishing the National ICV Innovation Center.

The innovation center is launched jointly by C-SAE, CAAM and the Alliance. The relying units mainly include industrial alliances, and universities, vehicle and parts enterprises, information and communication enterprises. The operation subject of innovation center is China ICV Research Institute Co., Ltd. (CICV).

China ICV Research Institute Co., Ltd. was established on March 19, 2018. The registered address is Beijing Economic-Technological Development Area, with a registered capital of 1.05 billion Yuan at the end of the year. The company is located in the southwest of Beijing.

The innovation center shareholder units are gradually increasing.

- The 12 founding shareholders invested 600mio CNY, each with 50mio CNY, so far all investments have been in place.
- The second round of 9 investors have been reviewed and approved by the board of directors, the registered capital will rise to 1billion CNY.
- Currently a number of international companies are in discussion with the Innovation Center to be in the third round of investors.
Positioning of functions: state-level core think tank of innovation strategies, R&D center of innovative technologies, public platform of innovative service and nurturing base of innovative talents

Positioning of roles: cultivator of emerging industries (guidance), promoter of industrial development (incubation) and collaborator of corporate R&D (transfer & service)

Benefits to Partners by CICV

OEM
- Urgently demanded basic service for the development of industries (industrial and technological development strategy, cross-field ICV systems and structures, standards and regulations, generic database of driving scenarios)
- Urgently demanded generic crossover system modules for the R&D of ICV (HAD base map, base modules for intelligent terminals, intelligent base computing platform, cloud-control base platform, cybersecurity platform, HMI driving system, etc.)
- Reduce R&D costs, improve development efficiency, bring new functions to the system (jointly support the generalization and industrialization of non-competitive major technologies)

ICT Companies
- Basic service for cross-sector integration (industrial and technological development strategy, definition of vehicle products, standards and regulations, base data service, business model innovation, etc.)
- Cross-section generic and crossover modules (vehicle intelligent gateway, intelligent computing platform, HMI and co-driving modules, design proposal for test scenarios of IoV, etc.)
- Establish a cross-sector collaboration and innovation platform, lower the industry’s access threshold and improve working efficiency (ICV Platform for technology transfer and collaborative development between ICT enterprises and automotive industry, application demands and standard interface between the automated driving and C-V2X, Big data platform of IoV, etc.)

Parts Suppliers
- ICV industrial cooperation interfaces (strategic cooperation platform with OEM, technological cooperation platform with research institutes, and cultivation of professional talents)
- Urgently demanded middleware and general platforms (HD base map, intelligent computing platform, cloud-control base platform, cybersecurity platform, software & hardware service protocol)
- Improve product development and test validation capabilities (transportation scene data, driving behavior data, AI training data, test-reference design)

Research Institutes
- Support of research projects
- Commercialization of research achievements (promote the industrialization of research achievements)
- Industrial innovation platforms (Cross-industry integrated innovation platform; jointly promote innovations of generic technologies and the formulation of technical standards with different parties)
- Professional think tank of State (help with the top-level design, strategic planning and the division of tasks)
Initial Tasks of CICV

Principles of first stage tasks selection

- Provide demanding support service of foresight and fundamental research for crossover industrial development;
- Provide cross-field common and crossover base modules, middleware units, and base platforms for various enterprises (no competition with existing companies).

Breakthrough on 7 Common ICV Technologies

1. ICV Development Strategy
   At the level of national top design, strengthen the research and guidance of ICV development strategy to promote sustainable development

2. ICV Cyber-Physical Systems Architecture
   Research in architecture of ICV. Propose layered architectures based on user service, logical framework, physical framework, application system and standards. Develop and combine multi-source information fusion technology with vehicle control, and realize collaborative control of vehicle intelligent system

3. ICV Technology Standards
   Promote the establishment of ICV standard and regulation system, and facilitate the formulation and improvement of our ICV policies and regulations.

4. Test, evaluation and base database
   Establish base database of ICV on different levels of driving automation systems, and meet requirements for test and evaluation from different levels of ADS

5. Intelligent driving & automotive AI
   Combine AI open source algorithms, open data, and open standards of automated driving, establish base core algorithm open-source platforms and ecosystem of DL, brain-like intelligence, group intelligence, etc. Enhance coordination and cultivation of cross-disciplinary research resources

6. Intelligent security and HMI
   By sharing of base data of natural driving behaviors, as well as design of common standards and general interface specifications, establish a professional package HMI proposal applied in control, security, communications and infotainment. Build a shared service platform for test and validation of performance of HMI co-driving system.

7. Level 4 automated driving system under China standards
   Define function of Chinese Level 4 ADS. Carry out the research in key generic technologies for intelligent security, intelligent mobility and intelligent city. Promote and build up competences of design and development, system integration, test and evaluation of Level 4 automated driving vehicles in China
Industrialization Support for 5 Base Platforms of ICV System

1. ICV Base Computing Platform

   Build Chinese standard ICV base computing platform framework, research in heterogeneous base hardware and software, and develop toolchain, realize decoupled and modularized H/S design, assure flexibility of H/S selection and high efficiency and high quality of product development.

2. ICV Base Terminal Platform

   Provide uniform interfaces for in-vehicle and external communications and HMI of ICV, simplify complexity between various modules of AD vehicles, integrate functions of modules including multi-modal communications, routing gateway, multi-modal positioning and HMI, build a new generation of ICV-oriented onboard intelligent platform products.

3. ICV Base Cloud Control Platform

   Provide dynamic base data including vehicle operation, infrastructure, transportation environment, and traffic control to intelligent vehicles and their users, control and service agencies, the platform has base service mechanism that covers data storage, data maintenance, big data analysis, cloud computing and cybersecurity, etc. it is a base support platform that meets practical application demands of ICV.

4. ICV Base HAD Map Platform

   Formulate standards and norms of HAD map, research in common technologies of HAD dynamic base map generating and application, initiate SOP of HAD dynamic map base data, provide fundamental assurance for national geographic cybersecurity and ICV industry development.

5. ICV Base Cybersecurity Platform

   Build up terminal-to-terminal security protection and a 3-level in-depth protection system of “Cloud-Tube-Terminal” for ICV in aspects of standard system, security framework, detecting technologies, monitoring technologies and supervision platform, etc.

ICV Base Computing Platform – the “Brain” of Vehicle in Future

The computing platform (software & hardware platform) perceives real-time external environment through high-performance computing technology and highly trusted software, and optimize control and decision for the vehicle, it is the core of autonomous driving technology, and the dominating position in the development of ICV.
Computing Platform is the Core of ICV

ICV

Traditional Vehicles
- Chassis
- Powertrain
- Electronics/electrical
- The body of the vehicle

Intelligent network system
- Perception
- Computing Platform
- Connected
- Control

Base Computing Platform
- Hardware
  - Information processing unit
  - Computing processing unit
- Software
  - Operating system and platform software
  - Intelligent software
  - Execution control software

Accelerate the development of independent software and hardware computing platform
Seize the opportunity of ICV strategic development
Fill in the gap of intelligent computing network platform with China characteristics

ICV Vehicle Computing Platform Structure – "Terminal-Channel-Cloud"

Vehicle computing platform
- Hardware architecture
- Operating system
- Algorithm
- Data

Channel-V to V
- Vehicle computing platform
- Channel
- Vehicle computing platform
- Algorithm
- Data
- Cluster server
- Cloud operating system
- Algorithm/Model
- Data

Channel-V to C
- Central cloud Computing Platform
- Edge cloud Computing Platform
- Vehicle Terminal Intelligent Computing Platform

Development resource
- Driver program
- Debugging Tool
- Compile tool
- Editing tool
- Software code
- Core algorithm
- IP core
- Developer community
**Definition of computing platform / base computing platform**

**Industrial chain of conventional automotive electronics**

- Tier 1: Heterogeneous technology & software
- Tier 2: Cyber security
- Tier 1.5: National Standards

**Industrial chain of automated driving electronics**

- Tier 1: Customized software
- Tier 1.5: Base computing platform company
- Tier 2: Base computing platform

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**Definition of computing platform/base computing platform**

- According to the differentiated demand of OEM's Tier 1 may achieve mass supply of computing platform products via customized base software and the development of the software.
- Chip design and manufacturing, OS and IP stay in Tier 2.
- Base computing platform use heterogeneous multi-processor hardware structure such as CPU, GPU, FPGA, and ASIC.
- Powerful processor consist of chips with different structures.

- Base computing platform is the prototype system of vehicle computing system which provides base common soft hardware for different models.
- Base computing platform is the indispensable bridge between Tier 1 and 2 which enables the complete functions via hardware tailored or extended and application load.

Base computing system is the prototype system based on base hardware and common software such as chip and processor which fulfill the functions of vehicle intelligent computing platform via the customization of base soft/hardware and load of software according to differentiated demand.
Hardware Implementation for Vehicle Base Computing Platform

Incremental integration by sustainable improvement, mid-term targets
PCB-level integration, long-term chip-level integration

Function Integration  PCB-level Integration  Chip-level Integration

Function integration is a sufficient support for building of H/S architecture and collaborated algorithm test, etc. but it is not the final proposal for reasons of costs and power consumption.

PCB-level integration is an interim proposal that adopts imported main chips, it is not fully autonomous and not controllable.

Advance deployment of chip-level integration and occupy strategic dominating points of ICV computing platform.

Software Architecture for ICV Vehicle Base Computing Platform

Support basic algorithm middleware cluster which includes algorithm API, acceleration of GPU, DL and machine vision algorithm.

With virtualization technology (hypervisor), support the combination of heterogeneous multi-core processors and multi-operation system, decouple and isolate impact from multi-source heterogeneous software on system.

High performance computation adopts high-efficiency and real time architecture (such as Adaptive AutoSAR), real time control supports Classic AutoSAR standards, and abstract and standardize base software cluster.

Design realtime driving OS with general system framework, including high functional safety, cybersecurity, V2X and highly efficient communications and performance, etc. meet the requirement of function safety levels.
Establish an industrial ecosphere in which innovation center provides the coordination and support, platform company develops base products, companies on industry chain roll out and promote application.
Business Model of China ICV Base Computing Platform

Based on technology and base layer product by computing platform company, automatic driving providers and OEMs build their application products, and thus formulate China's own ecosystem of computing platform supply chain.

**Cooperation Zone (The platform)**

- Base hardware
- Base software
- Security system
- Reference design
- Protocol, standard interface
- Development toolchain

**Competing Zone (Tier 1 and OEM)**

- OEM A
  - Application A
  - H/S solution A
  - Base computing platform

- OEM B
  - Application B
  - H/S solution B
  - Base computing platform

(Automated driving developers, OEM application)

Business model of base computing platform

**Cooperation area (Base computing platform)**

- Tier 1.5
  - ICT
  - OEM
  - Map
  - Technical Service

**Competitive area**

- Tier 1
  - Development Team A
  - Application A
  - Soft hardware design A
  - Base computing platform

- Tier 1
  - Development Team B
  - Application B
  - Soft hardware B
  - Base computing platform

With the broad industrial resources of Tier 2, access to base technology of platform company, and the open third-party developing platform, suppliers of automated driving program. Tier 1 and OEMs could establish top-level application demonstration, verification environment, so to develop Chinese eco-industrial chain of computing platform.
Cloud Control Platform System — Based on CPS Principle

- **Intelligent Computing based on Real Data**
  - Coordination applications as for security, energy saving, and efficient travel ecology (cloud)
  - Informative expression of physical space - data intelligent processing and basic database (cloud)

- **Standard car**
- **Unified platform**
- **Standard resources**
- **Different brands**
- **Different platform**
- **Different resource**
- **Real physical space**

Using sensing, communication, computing, control and other technologies, realize the correspondence of vehicles, traffic environment and other elements between physical space and information space based on standardized communication protocols and using the big data computing of cloud ability to solve systemic resource optimization and configuration problems, promote on-demand response, rapid iteration, dynamic optimization of pedestrian-vehicle-road system, and finally achieve collaborative automated driving.

Definition of Base Cloud Control Platform

**Cloud Control System**

**Base Cloud Control Platform**
- Standardized interconnection
- Common technical support

**Cloud Control Application Platform**
- Industry chain application

- Standardized communication protocol reduce the difference in understanding when multi-domain collaboration is achieved.
- Design standardized infrastructure system deployment and segmentation implementation path for the practical application requirements of vehicle and various resources interconnection.

- Provide basic and common technical services for the specific application of ICV, including data security management, storage, operation and maintenance, big data calculation, simulation and test evaluation technology, etc.
- Provide a series of standardized development interfaces and toolkits to address business needs such as heterogeneous integration and interoperability.

- Provides intelligent, efficient, energy-saving ICV driving applications, as well as a series of new automotive applications including shared cars and electronic payment.
- Provide collaborative business applications for test development systems, public service systems, insurance systems, and healthcare systems.
The Base Cloud Control Platform is the “Cloud Brain” for the operation of ICV.

The Cloud Control Base Platform is a data collaboration center, the computing center and resource optimization configuration center that supports the practical application of ICV.

Definition of cloud control platform/ base cloud control platform

The network service industry chain of traditional automobile

OEM

Internet service

network application platform

Tier 1

Terminal platform

Computing platform

Tier 2

Vehicle and Cloud Interconnected standard architecture and facilities

Data interaction standards and application specifications

Data management and computing for ICV applications

Map platform

Information security platform

Public/private cloud

Storage

Operation maintenance

Algorithm developer

Solution provider

The network service industry chain of ICV

OEM

Internet service

network application platform

Tier 1

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Tier 2

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Map platform

Information security platform

Public/private cloud

Storage

Operation maintenance

Algorithm developer

Solution provider

Cloud Control Base Platform

Tier 1.5

Standard Interconnection

Basic data specification

Simulation test evaluation

Effective real-time and big data and cloud computing services

Standardized real-time database

Information security service

Basic service of platform

network application service

Infrastructure

Public/private cloud

Operation maintenance

Algorithm developer

Solution provider
**Definition of cloud control platform/ base cloud control platform**

The network service industry chain of ICV

- **Tier 1.5 Cloud Control Base Platform** is the basic support platform for all kinds of network connection application services of ICV. It provides dynamic basic data such as vehicle operation, infrastructure, traffic environment and traffic management for ICV and their users' management and service organizations. It has basic service mechanisms such as high-performance information sharing, high real-time cloud computing, big data analysis, information security and test evaluation.

- **Tier 1.5 Cloud Control Base Platform** is an indispensable chain for the construction of the whole ICV industrial ecology. It is the basic condition for Tier 1 and Tier 2 to realize the upgradation of their service for the new demand of the industry of automatic driving, and to improve production efficiency and reduce service costs.

- Through resource collaboration and authorization, the **Cloud Control Base Platform** is the core supporting technology for collaborative autopilot and its application and operation.

**The Architecture of Base Cloud Control Platform**

- **Central Cloud**
- **Regional Cloud**
- **Edge Cloud**

- **Standardized Facilities In Cloud**

- **Inter-connect**

- **Upgrade**

- **National unified service platform**

- **Road Cooperation Unit (RCU)**

- **4G/5G**

- **C-V2X**

- **Standardized In-Vehicle CDS**

- **Standardized Facilities In Vehicle**
ICV Cloud Control Base Platform—Main Tasks

Main Tasks for Base Cloud Control Platform

Base Architecture and Function Design
- Multiple architectures and deployment of terminal-marginal cloud-central cloud
- Design of basic function middleware for multi-mode communication, dynamic HD map, high precision positioning and timing, etc.
- Safety function design for cloud data access control of cyber security, certification and authentication, and multi-domain connection, etc.
- Cloud control standard protocol mode and function design to shield of hardware difference

Core Technology Development
- Big data processing for simultaneous mass data eruption and low-delay transmission
- Cloud service technology by ASIL D grade functional safety requirement
- Collaborative decision-making and control technology of multi-data resource sensing, multi-target optimization
- Multi-application collaboration and vehicle cloud resource management technology based on automatic driving
- Automatic driving simulation and test technology combined with real vehicle and road data

Construction of Standard and Ecosystem
- Standardized data architecture and data transmission protocol for ICV data sharing
- Standardized cloud service configuration and parameters that serve vehicle-cloud integrated automatic driving
- Automatic driving oriented standard OS and development environment system
- Application release and operation ecosystem based on cloud control base platform

Top-level plan, innovation, application → Industry cultivation
ICV Base Cloud Control Platform—Business Model

Base Cloud Control Platform provides multiple types of base data and network service support for ICVs and government supervision. With the data and service, AV developers, intelligent transportation companies and developers can adopt the differentiation strategy for each specific market.

Vehicle operating data
- Speed
- Acceleration
- Brake
- Steer
- Driver state
- Fault state
- Operation state
- Perception

Traffic/road data
- Congestion
- Control
- Dynamic sign
- Traffic sign
- Road regulation
- License plate control

Environment/public service data
- Meteorological
- Road
- Fire control
- Medicine
- Rescue

Other platforms
- Map platform
- Security platform
- .......

The method of access to vehicle generated data
Role of the neutral server

Neutral Server

Vehicle Manufacturer A
Vehicle Manufacturer B
Vehicle Manufacturer C
Customer 1
OTA

Customer 1 + VIN, vehicle position + battery range data. For use by Company X in Charger App

Charger App = vehicle position + battery range + charging station location + charging station status
Base HAD Map Platform—Industrialization

- OEM
  - ADAS/AV
  - Application
- Map companies
  - Collaborative data collection
  - Online map service
  - Transportation application
- Other Technology companies
  - Transportation application
  - Government control data service

Institute
- National ICV innovation and development platform
  - Collaborate and collect nationwide road high-precision map base data, implement map production
  - Build base data public service cloud platform, support industry application
  - Multi-platform dynamic data fusion, realize dynamic data update
  - Map sales and business model development

Industry integration development company
- Multi-platform dynamic data fusion, realize dynamic data update
- Map sales and business model development

Government
- Data regulation

Base HAD map platform—Main Tasks

Main tasks for base HAD map platform

High-precision map production
- Integrate resources and reduce cost of high-precision map production
- Build mass production system of HAD map by technology integration
- Realize mass production, and cover from highway to city road

Cloud service platform establishing
- Authorized by government
- Build HAD map platform
- Operate online HAD High-precision map platform

Standard and guideline system construction
- Data standard and exchange format
- Unify standard of static/dynamic data, provide data service
- Make data release and control standard that guarantees national geographic data security

The National ICV Innovation Center organizes and support HAD map platform company in the three main tasks
Base HAD map platform—Business Model

Take autonomous driving as an example, map platform completes base data acquisition and releases, while various planners/OEMs keep upper-level operation and maintenance for the business.

Competitive area (Graphic and special application services)

Cooperation area (Base HAD map platform)

Road management agency
- Congestion
- Traffic accident
- Road information
- Road planning
- Dynamic sign

Mobile measurement technology
- Point cloud
- Photo
- Trajectory

V2X device
- Signal light
- Roadside equipment
- Smartphone
- Vehicle sensor

Dynamic data
- Point Cloud, Street View
- Vector data
- Mobile measurement technology

Static data
- Road management agency
- Dynamic data
- V2X device

Base HAD map platform—Industrialization

Terminal Application
- Function definition
- Hardware selection
- Application Layer Service Development and acceleration
- System-level test matching

Data and platform
- Adaptive AUTOSAR software platform
- Heterogeneous software Hypervisor
- Standard interface API
- FOTA safety architecture & verification
- High-level SoC development

Application service

Product development

Participants

Car Companies
Parts Suppliers
Other Companies
Shareholder
Shareholder
Shareholder

Base Intelligent Terminal Platform

Standard\support

Communication specification
Exchange format
In-vehicle switchboard

Overall architecture

New network architecture
- Domain controller
- ICV redundant design

Technology

Standard Protocol

Financing

Market support

ICV Research Institute
ICV Integration Company
National ICV platform

Participants

ICV Research Institute
ICV Integration Company
Government
Standard supplier
Investment
Supervision

National ICV platform

National ICV platform

Government

Standard supplier
Investment
Supervision

National ICV platform

2018/11/21
**Base Intelligent Terminal Platform—Business Model**

Base Intelligent terminal platform completes base SW&HW and general interface (based on cyber security and functional safety design), while various Tier1 suppliers/OEMs keep upper-level application and integration for the business.

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**Cooperation area (Base Terminal Platform)**

Base System Architecture

Base SW&HW General Interface

Base Hardware Module

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**Competitive area (Base Platform of Intelligent Terminal)**

OEM A

OEM B

OEM C

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**Industrialization of ICV Base Cyber Security Platform**

**Primary Task for Innovation Center**

- Cooperate deeply with other platforms in the innovation center.
- Collaborate with 7+5, develop security service.

**Breakthroughs of 7 generic Technology**

- Common technology modules of Level 4 automated driving system
- ICV Development Strategy
- ICV architecture and security system
- Intelligent driving and autonomous AI
- Intelligent safety and human-machine interaction
- ICV technology standard
- Testing, evaluation and underlying database
- HAD-map Base Platform
- ICV Cloud Control Base Platform
- New ICV Terminal Base Platform
- Intelligent Computing Base Platform
- ICV Cyber Security Base Platform

**Five Base Platform Supporting the Industrialization**

- Provide Support
- Deep

**Cyber Security Platform**

1. Base HAD-map Platform
2. Base Cloud Control Platform
3. Base Intelligent Terminal Platform
4. Base Computing Platform
Synergies by Industrialization of the Five Base Platforms

National development strategy

Tremendous demands in the industry

Top-level design

Fundamental research

Scientific research demands/technical achievements

Universities, colleges and scientific research institutes

Technical companies

(Technical chain)

Scientific research demands/technical achievements

Scientific research/technical achievements

Universities, colleges and scientific research institutes

Technical companies

(Technical chain)

Base VAD Map Platform

Base Computing Platform

ICV Base Cloud Control Platform

Base Intelligent Terminal Platform

Base Cyber Security Platform

(OEM)

(OEM)

Bottom-level design

Fundamental research

Key techniques

Industrial applications

Capital/market demands

Technical achievements

Technological enterprises

Parts & components

The end

Thank you for your attention