Understanding, Applications and Suggestions of OpenDRIVE

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Automotive Data Center

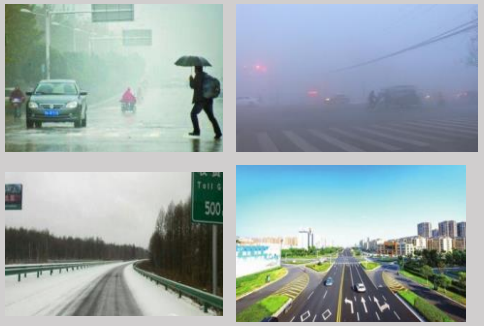
Contents

1 Virtual Scenario Test and OpenDRIVE

Intelligent and Connected Vehicle Virtual Test

- ICV cars Road test is limited by environment and infrastructures, it cannot completely realize testing scenarios' coverage.
- But virtual simulation test can cover road test's short, realizing unlimited choices, building varied scenario, doing vehicle dynamics' parameterized simulation and user defined driver's model;
- Virtual test field has four features: unlimited scenario test, extendable, mass test and test automatically.

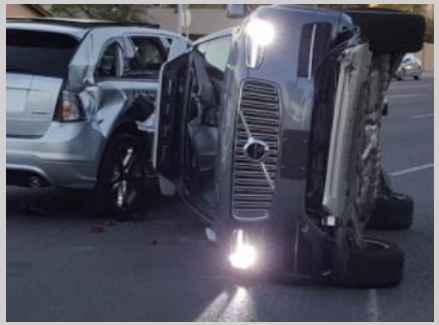
Road test



Enviroment like weather

Coverage is limit

High cost



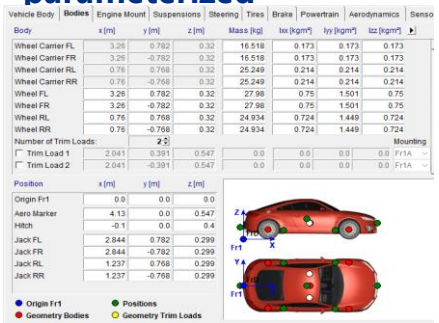
High safty risk

Virtual Test

Simulate any weather

Road and traffic can be changed easily

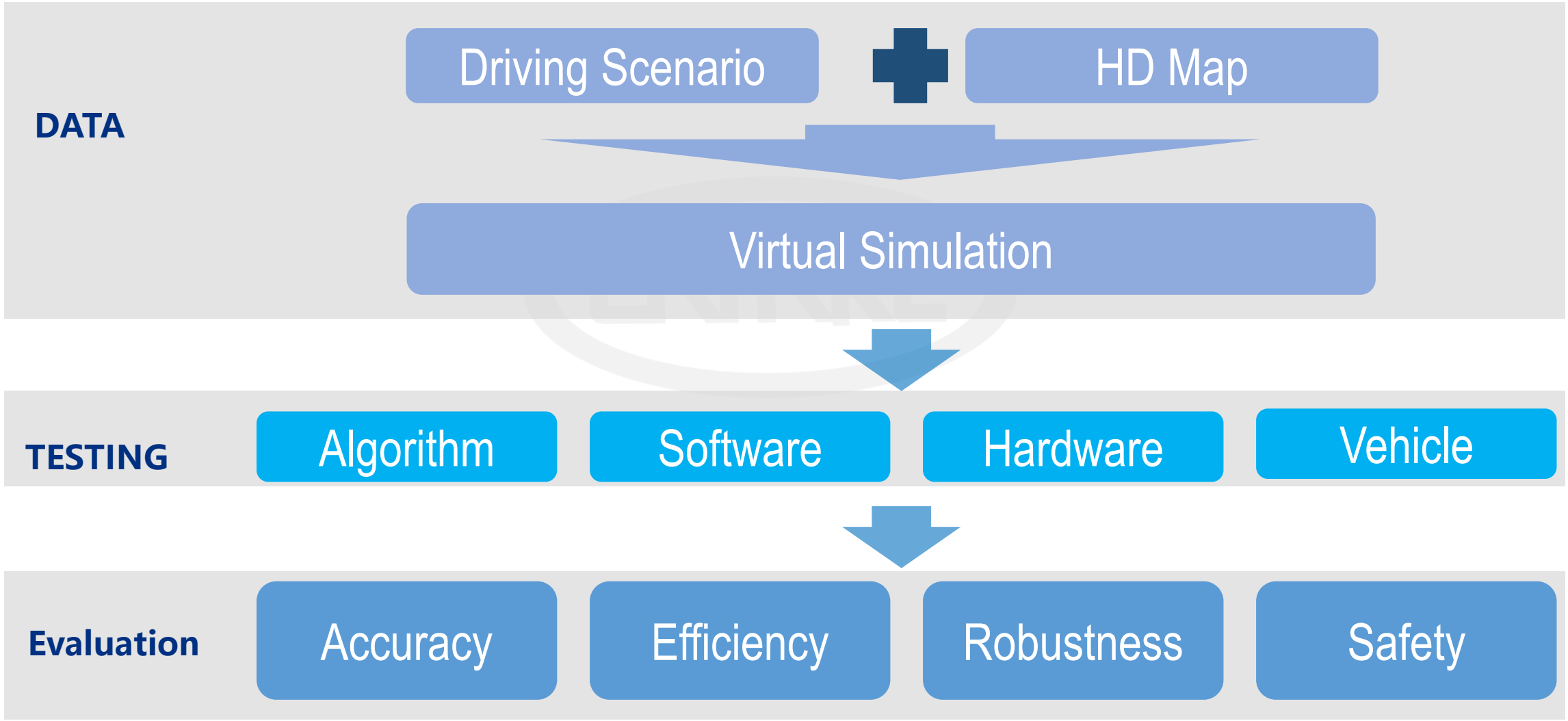
vehicle dynamics is parameterized



user defined driver's model

Virtual Scenarios Data and HD Map are indispensable

- **Implementing virtual test using scenario data, HD map and virtual simulation environment/tools.**



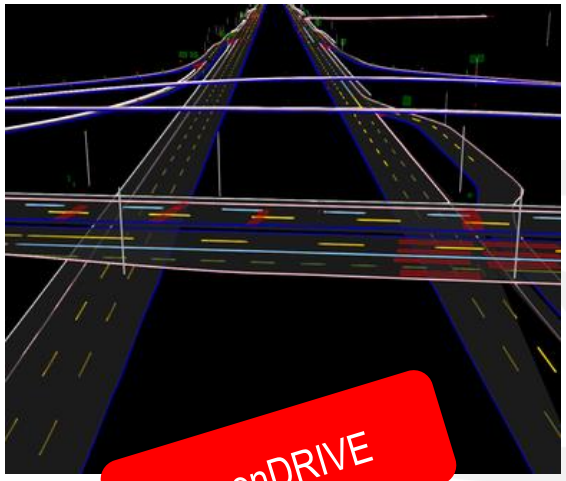
Overall Data Structure and Requirement of Virtual Test

- For static scenes, HD map (OpenDrive) data format is needed, meanwhile, static scene combinations are also critical
- For dynamic scenes, the description of the routes, velocities and maneuvers (OpenScenario) are fundamental

HD Map imported

Map providers importing

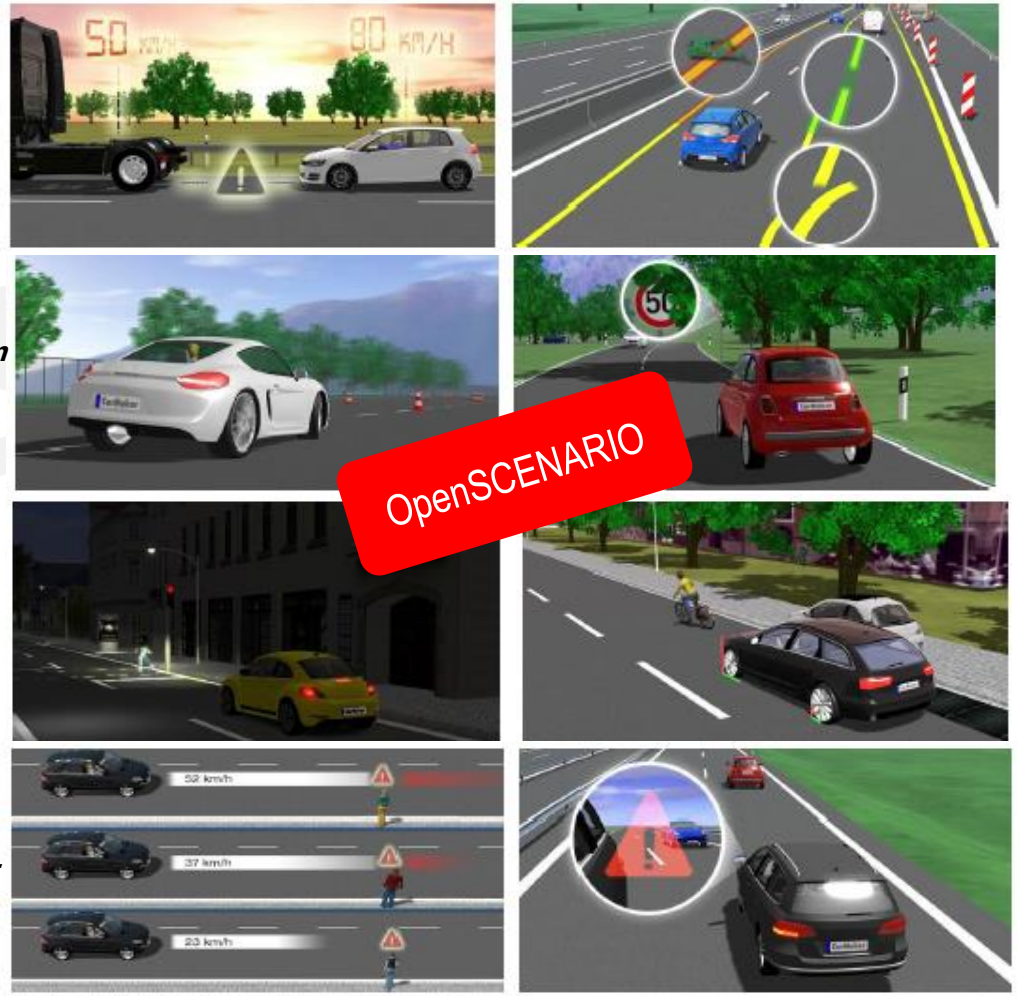
Compatible with openDRIVR;
Compatible with navinfo HD maps;
Providing HD map collection and virtual scene generation for specific areas;



Customized virtual testing

Static scene combinations

Expressway main roads;
Expressway ramps;
Main urban roads;
Urban secondary trunk roads;
Urban branch roads;
Residential roads;
School roads;
Shopping malls and stations;
Rural roads;
Tunnels;
Mountain roads;
Bridges...

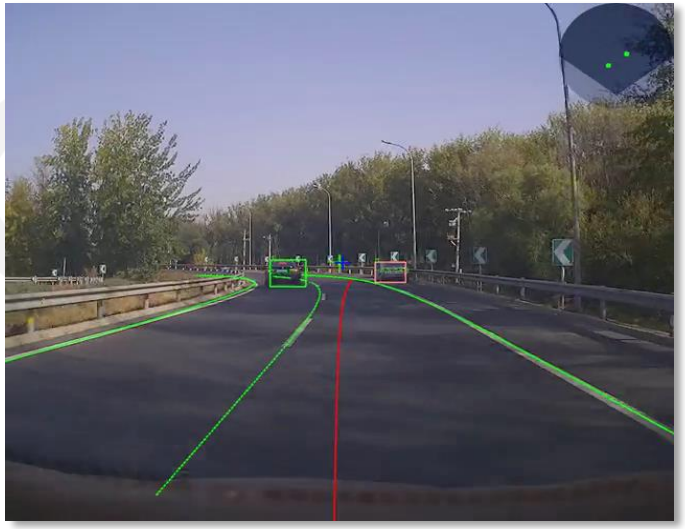


Scenarios Data Derives from Real Driving Maneuvers

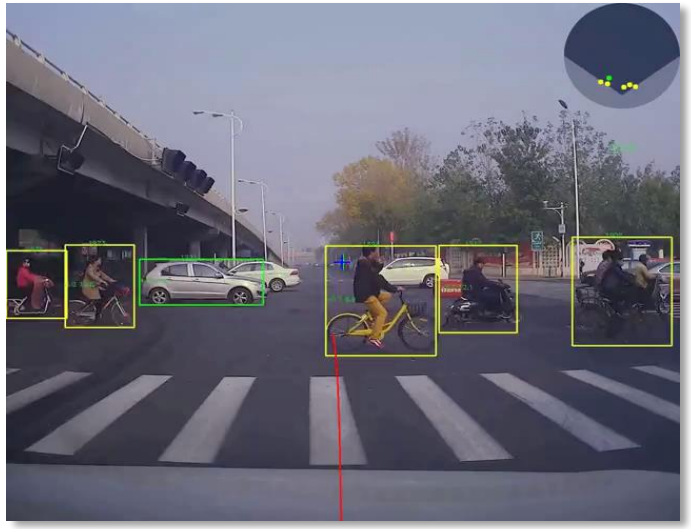
■ CATARC ADC has collected a lot of driving scenario on Chinese Highway, City Road and Parking lot.

- 500 Parking lots' cleaned driving scenario in Shanghai and Tianjin
- 300K km highway cleaned driving scenario data in Beijing, Tianjin and Hebei
- Thousands kilometers of city driving scenario in Beijing, Tianjin and Shanghai.

Parking Scenario



Highway Scenario



City Scenario

Data: Over 30TB;

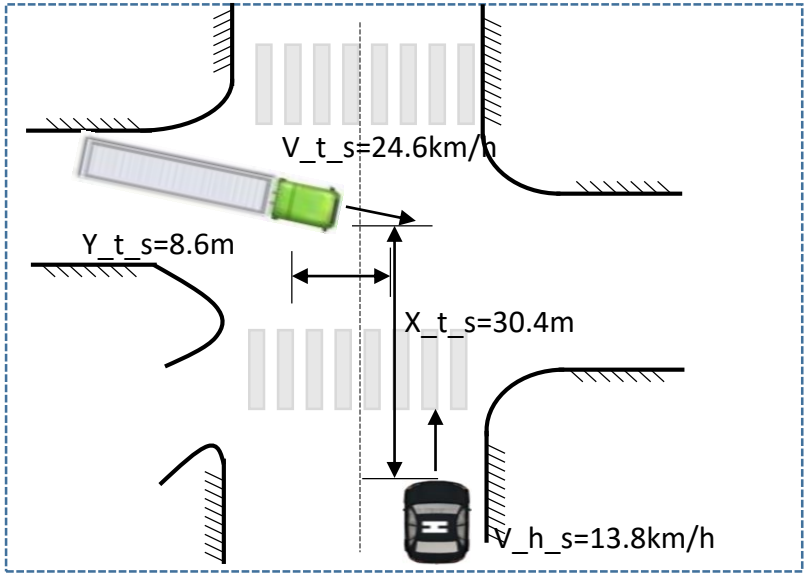
Content: 500+ Parking lots; 300000+km Highway driving scenario; 500000+ carefully marked pictures; 30000+structured scenario data;

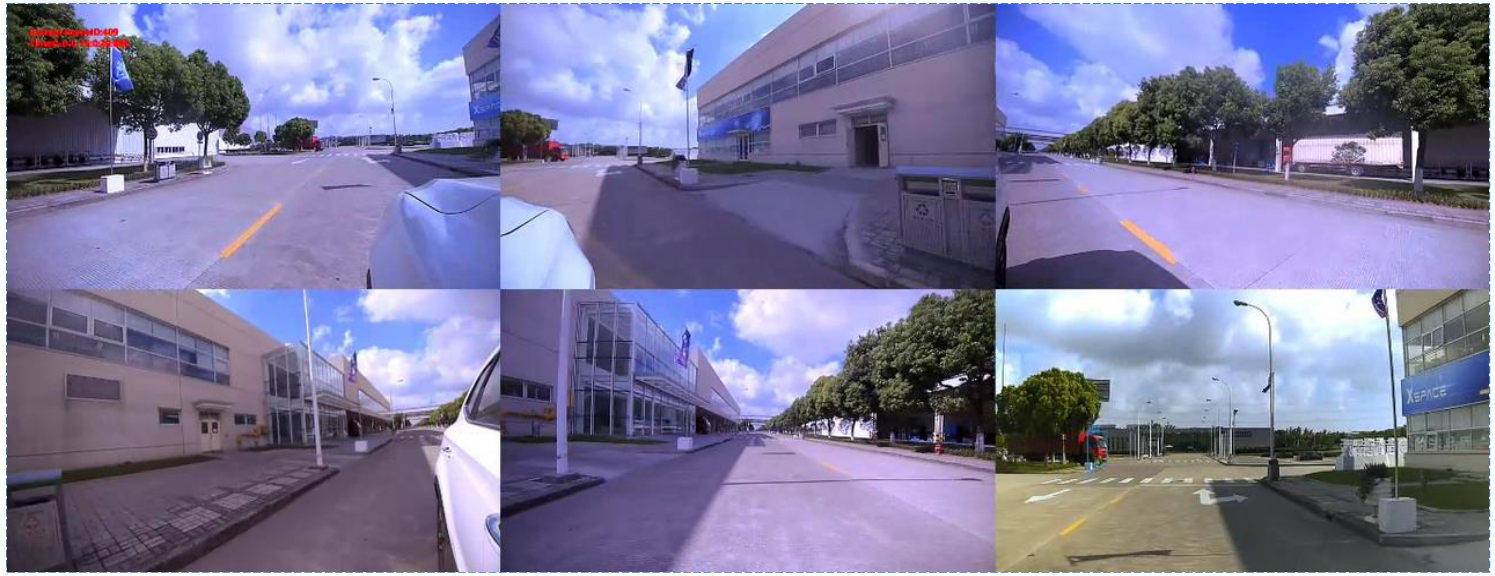
Real Driving Scenarios Analysis

■ Analysis, Descript and Record Chinese driving scenario data.

Case ID	echo			target			echo_target		TTC
	初始速度 V_h_s (km/h)	平均速度 V_h_aver (km/h)	最大速度 V_h_max (km/h)	初始速度 V_t_s (km/h)	平均速度 V_t_aver (km/h)	最大速度 V_t_max (km/h)	相对纵向距离 X_t_s (m)	相对横向距离Y_t_s (m)	碰撞时刻 (s)
1	13.8	13.8	14.8	24.6	34.6	56.8	30.4	8.6	1.46
2	12.2	12.6	13.9	22.9	30.2	38.3	25.5	-9.3	1.4
…	….	….	….	….	….	….	….	….	….

Case 1 description： Echo car move a s 13.8km/h， At the positon of Long direction distance 30.4m, cross direction distance 8.6m, there's an another vehicle cross with speed 24.6km/h. Scenario beginning status' TTC=1.46s。





IC vehicle Virtual Test Lab. In ADC, CATARC, China

- CATARC Automotive Data Center has built an IC vehicles virtual test platform, which consisted of virtual modeling software, SIL/HIL test facilities and driving emulators.

Virtual testing field

1. Scenario display
2. Scenario design
3. Field & Environment design

HIL test

4. Camera simulator display
5. Camera HIL platform
6. Algorithm testing platform
7. Driving simulator

Driving simulator

8. Driving simulator data monitor

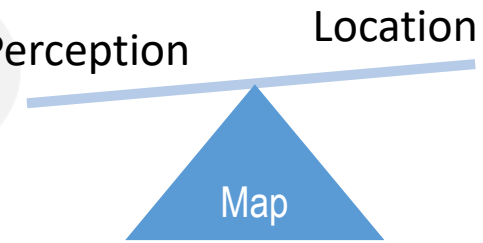
2 Applications of OpenDRIVE in CATARC

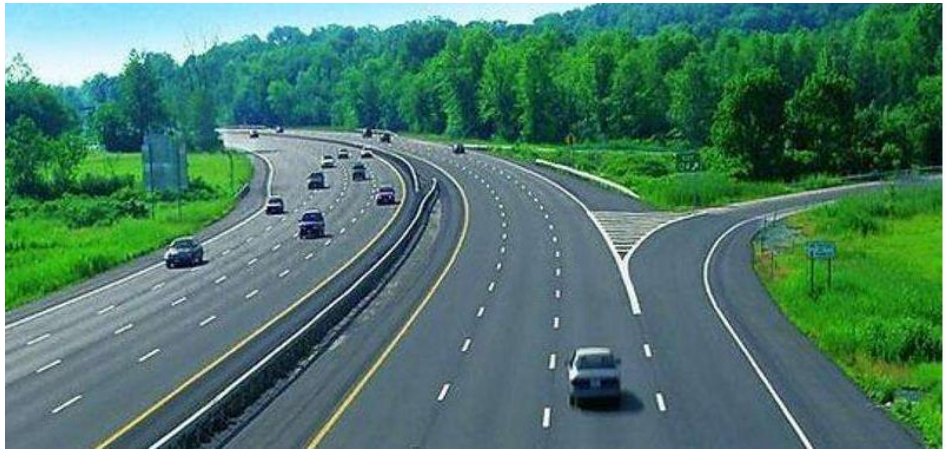
Importance of HD map in Auto-Drive

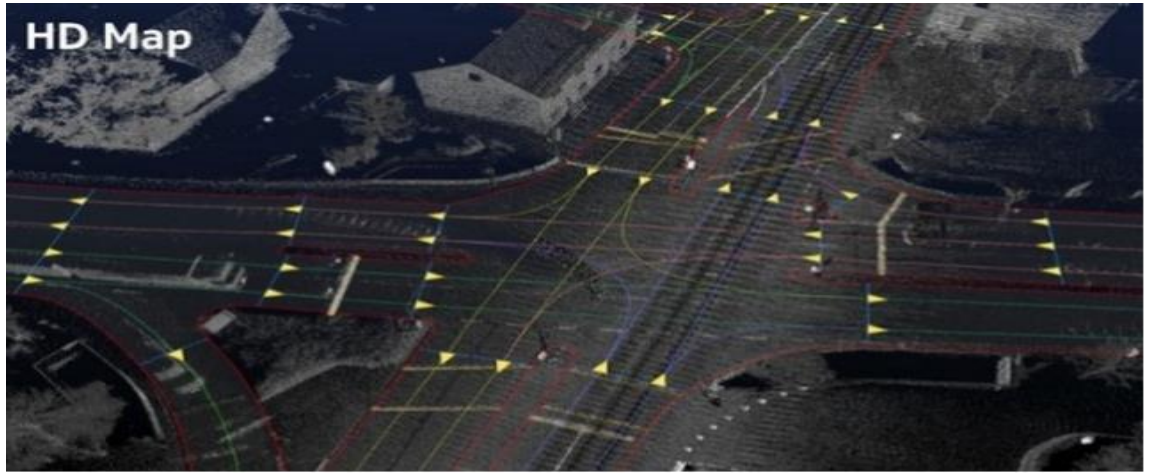
- **HD map is one of the most important base of autonomous driving techniques, not only for location, but also for perception.**

HD Map + Sensor Data ➡ Enforce Location

HD Map + Location ➡ Enforce Perception



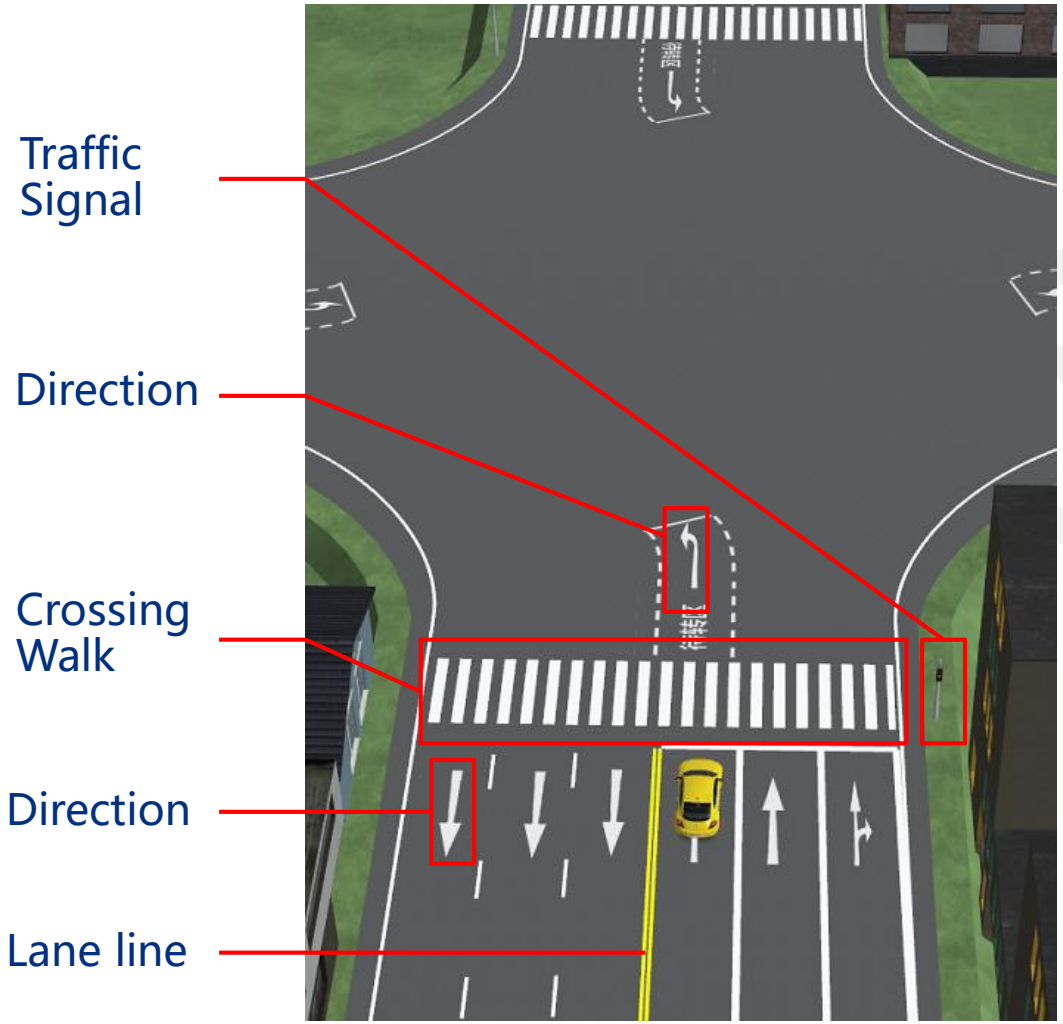




HERE HD Map

What does auto-drive expected from OpenDRIVE

- **OpenDrive file can give necessary information for a vehicle running on road in simulation.**



Precise localization can give:

ID	Class	Information
1	Lane	1. Lane direction 2. Lane line 3. Lane change
2	Traffic Rule	1. Speed limit 2. High limit 3. Weight limit 4. Vehicle Restriction
3	Traffic Signal	1. Position 2. Signal
4	Important Area	1. Crossing walk 2. school area

Examples of OpenDrive usage

- **Virtual environment for Intelligent and Connected vehicle auto-drive function testing, including multiple types of road and intersection.**
- **Tools include VTD, Scanner, Carmaker and Panosim, one of a Chinese simulation tools.**

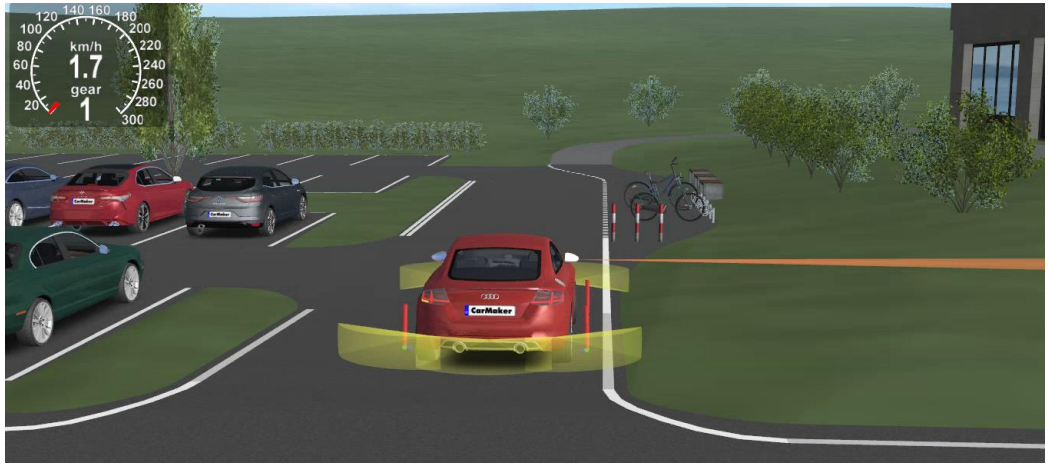
Importing OpenDrive files and running simulation in Panosim

Build Road on Virtual Environment

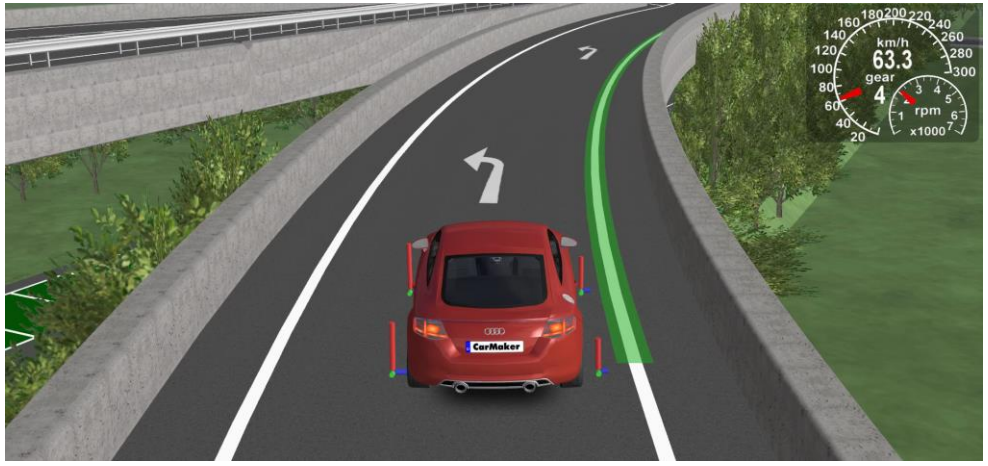
- **Besides using OpenDRIVE, we also build more types of road features, including all kinds of bridges, tunnels, viaducts, ring roads and parking lots.**

Bridge

Viaduct



Parking lots

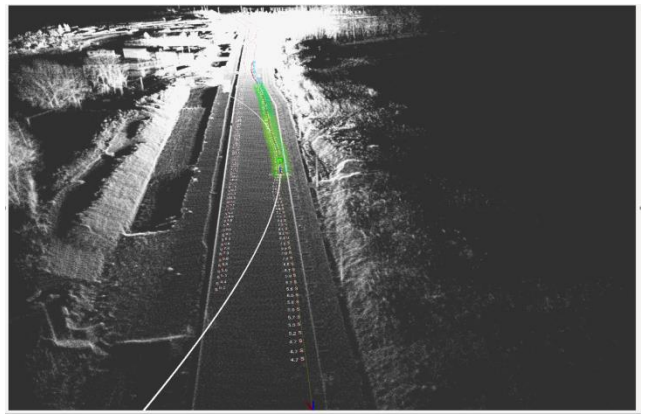


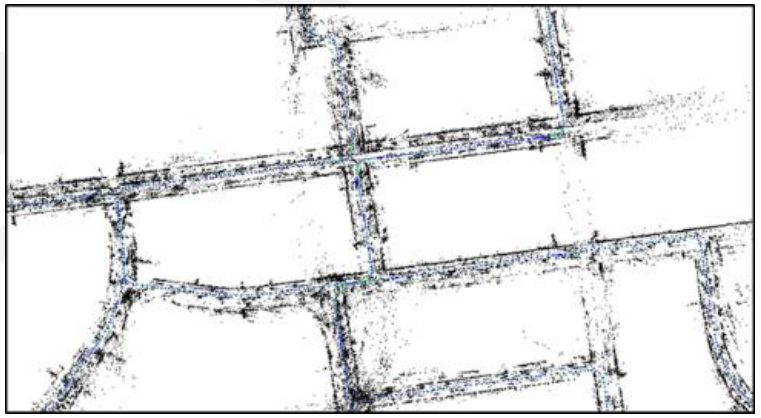
Ring Road

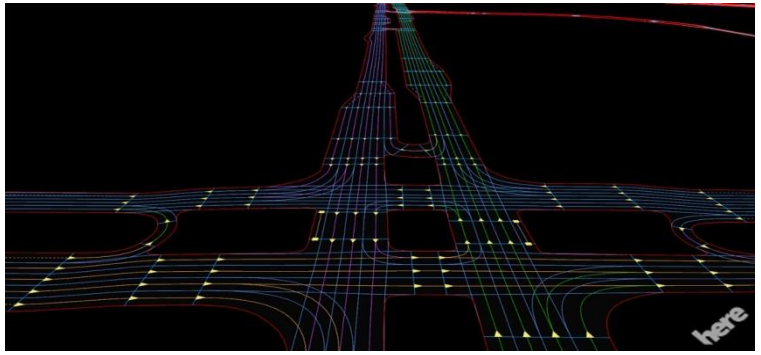
3 Suggestions of OpenDRIVE

Suggestion 1: more easier to transfer road to OpenDrive

- We collect real road data using lidar and camera and try to rebuild it in simulation environment. However, transferring real road data into OpenDrive is not as easy as creating a new road.
- We suggest OpenDrive using coordinate series to descript reference line, or creating tools to transfer coordinate series to reference line.





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</geometry>
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    <line/>
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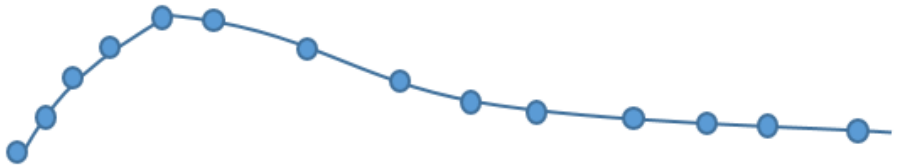
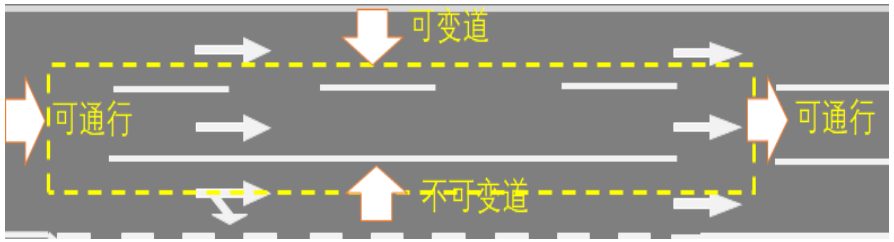
```

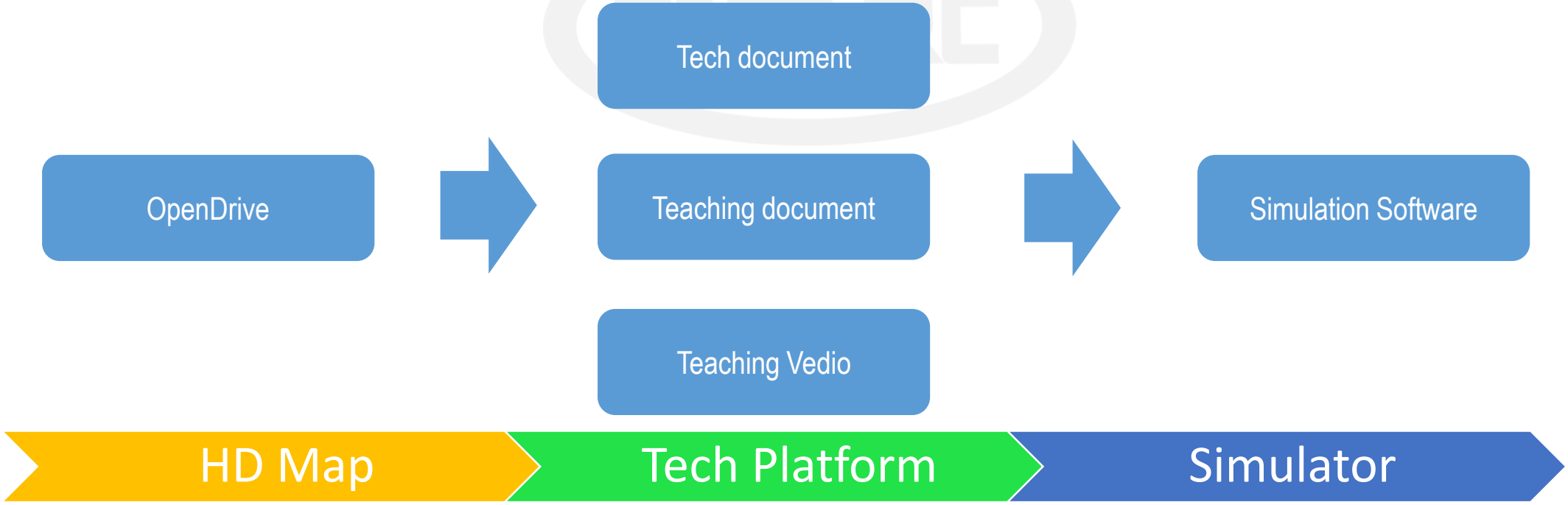
Suggestions 2: consider complicated roads and open fields

- **There are many Chinese openDRIVE users and HD map suppliers, hope to add more functions and features to fit complicated Chinese streets and roads.**

ID	illustration	Suggestion
1		The traffic signs are useful to autonomous driving, however, there is a lack of clear definition in OpenDrive data format. More descriptions of object type are necessary.
2		The fundamental element in openDrive is road, but open field like parking spot is difficult to display. Hope to define a additional node property like road for open field.
3		Use bool number express the lane's changeable or available or passable.

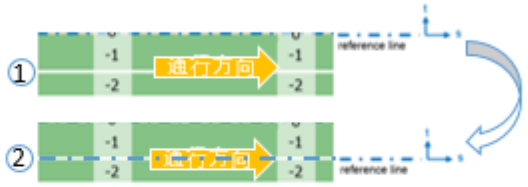
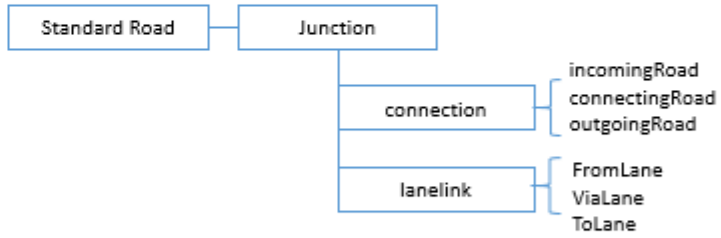
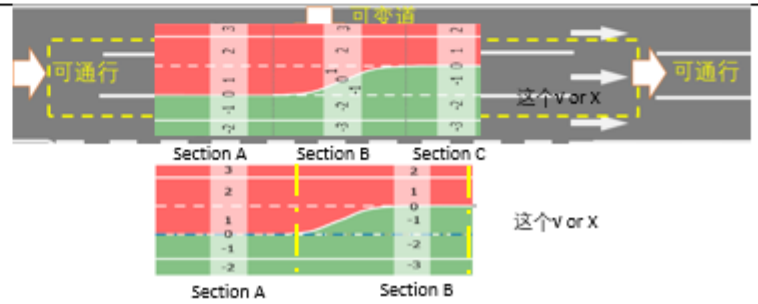
Suggestion 3: need more technique details and examples

- **Only one tech spec on official website, the number of technology files are insuffient. For encourage more engineers using OpenDrive, we need to open more technical detail to public.**
- **We suggest creating more technical documents, creating more teaching videos and upload to public platform, building a technique platform for communication.**



More specific and technical questions

- **More specific and technical questions and suggestions. We may discuss in the future.**

序号	大类	分类	节点位置	文档位置	OpenDRIVE表达	建议	建议图解	理由
2	理解	参考线 (Reference Line)	OpenDRIVE |-road | |-lanes | | |-laneOffset	Page 51	lane zero 的位置是不是reference line的位置?	如图中蓝色线条位置是参考线位置吗?		P51 中写的是 chord line 不是reference line，不理解chord line是什么?
3	建议	参考线 (Reference Line)	OpenDRIVE |-road | |-lanes | | |-laneSection | | | |-center	Page 53	Importanct Note : the actual distinction of lanes according to their meaning for the traffic …… (center: lane 0)用来区分道路左右侧交通通行的	只有单方向的道路，reference line的位置选择在道路面的中央，而lane 0选择在道路通行方向的左侧道路边沿，laneOffset表示偏移 如图中状态（2）		这样，双向通行道路与单向通行道路均可以绘制道路参考线在道路面中央，而车道0仍然可以设置在用来区分交通行驶方向的位置
4	建议	路口 (Junction)	OpenDRIVE |-junction | |-connection | | |-laneLink	Page84 to 85	路口内的连通进入路和连接路采用表connection和laneLink表来表达，但连接路到相应的退出路在ROAD LINK 记录中（5.3.2）	能否进入路、连接路、退出路都在Connection和laneLink中表达? 能否说明进入路（incomingRoad与predecessor）在什么情况下一致，行驶方向能否写出来?		这样路口连通集合和标准道路连通集合可以独立开来；另外路口内连通集合的（predecessor）与（incomingRoad)也能通过行驶方向明确规定下来
6	理解	横断面 (laneSection)	OpenDRIVE |-road | |-lanes | | |-laneSection	Page 20 and Pa	Page 20中的Lane Offset的figure像只有2个Lane Sections 但是Page 51中的Road Lane Offset Record中的figure却有3个Lane Sections	车道面逐渐增宽至一个完整的车道面时，这段作为一个laneSection，还是与下一段一起作为一个laneSection		可能判断为Section A,B,C三个上面那组好一点，变宽处的相当于车道的connection

4 Brief Introduction of CATARC

PROFILE

Established in 1985, China Automotive Technology & Research Center Co., Ltd. (CATARC) is a central government-level enterprise belonging to SASAC (State-owned Assets Supervision and Administration Commission of the State Council) and a comprehensive science and technology corporate group with extensive influence in the automotive industry home and abroad.

MANAGEMENT FOR AND SUPPORT TO THE GOVERNMENT

Per the authorization of the government and industrial authorities, CATARC carries out the management of investment project consultation and evaluation, catalogue management, and VIN/WMI.

Investment project consultation and evaluation

- Undertake the consultation and evaluation of the investment projects entrusted by NDRC and MIIT and provide consultation and evaluation advice to the government

Catalogue management

- Audit the vehicle manufacturer admission permit
- Audit the vehicle product admission permit

VIN/WMI management

- VIN management office
- Inspection of VIN and WMI

POLICY RESAEARCH

As the first ranking national think tank in the automotive industry oriented to the government, society and enterprises, CATARC provides analysis report and policy suggestions on the macro control and the drafting of medium and long term industrial development plans and key industrial policies for all levels of governments.

- National development plan for the automotive industry
- Automotive industry policy
- Management of investment and admission
- Automotive finance and taxation
- NEV (New Energy Vehicle)
- Management of energy saving
- Technology policy
- Low carbon, IT and intelligentization
- Trade and investment policy of WTO/FTA/BIT
- Import and export
- ELV(end of life vehicle) and recycling
- Vehicle dealing and after-market
- Finance and insurance
- Regional industrial development
- Study on corporate strategy and competitiveness

TESTING AND INSPECTION

Largest 3rd party proving ground with the most complete facilities and most advanced technical specifications in China

The winter proving ground has various terrains and the most complete testing items

The most advanced EMC chamber for whole vehicle and key components

The climatic chamber can simulate the highest altitude in the world

The lab conducts the most vehicle crash tests per year in the world

CERTIFICATION

Focusing on the development of the automotive industry, CATARC provides the holistic certification services covering the entire automotive industrial chain to the customers.

China Compulsory Certification (CCC)

Certification coverage

- Vehicle (only pure EV)
- Seatbelt
- Horn
- Brake hose
- Exterior lighting and signal device
- Indirect vision device
- Interior trimming
- Door lock and maintaining parts
- Fuel tank
- Seat and headrest
- CRS

Voluntary product certification

PHEV Green Rating

China Green Tyre Rating Assessment （C-GTRA）

Quality management certification

ISO9001

ISO14001

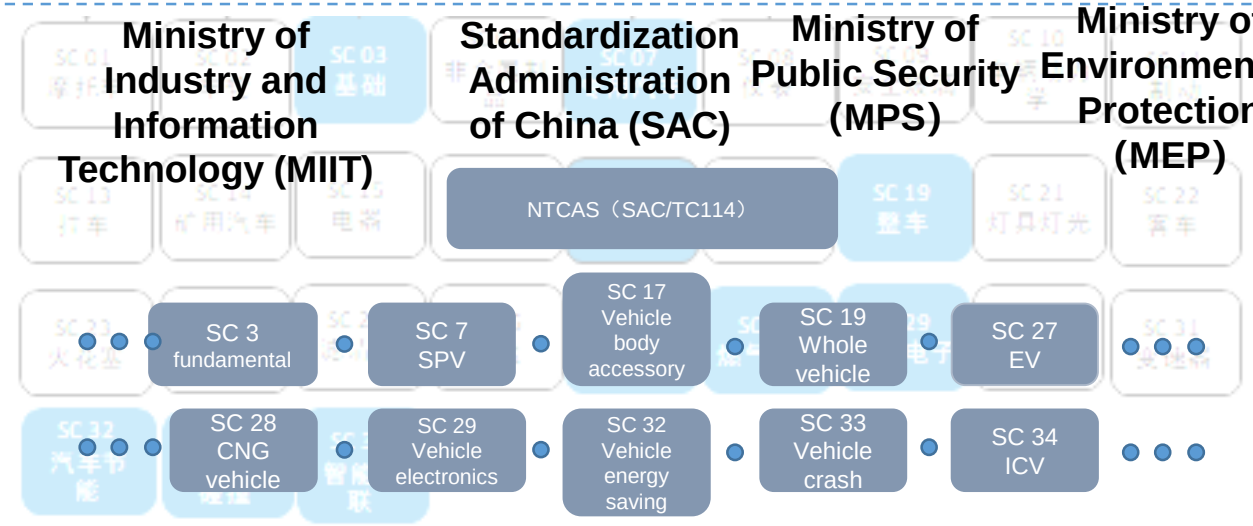
OHSAS18001

Service certification

Product after-sales service certification (maintenance and repair service)

STANDARDS AND REGULATIONS

CATARC is in charge of the centralized management of the national standardization and technical regulations of the national automotive industry.



CATARC plays the roles or conducts the work as below:

1

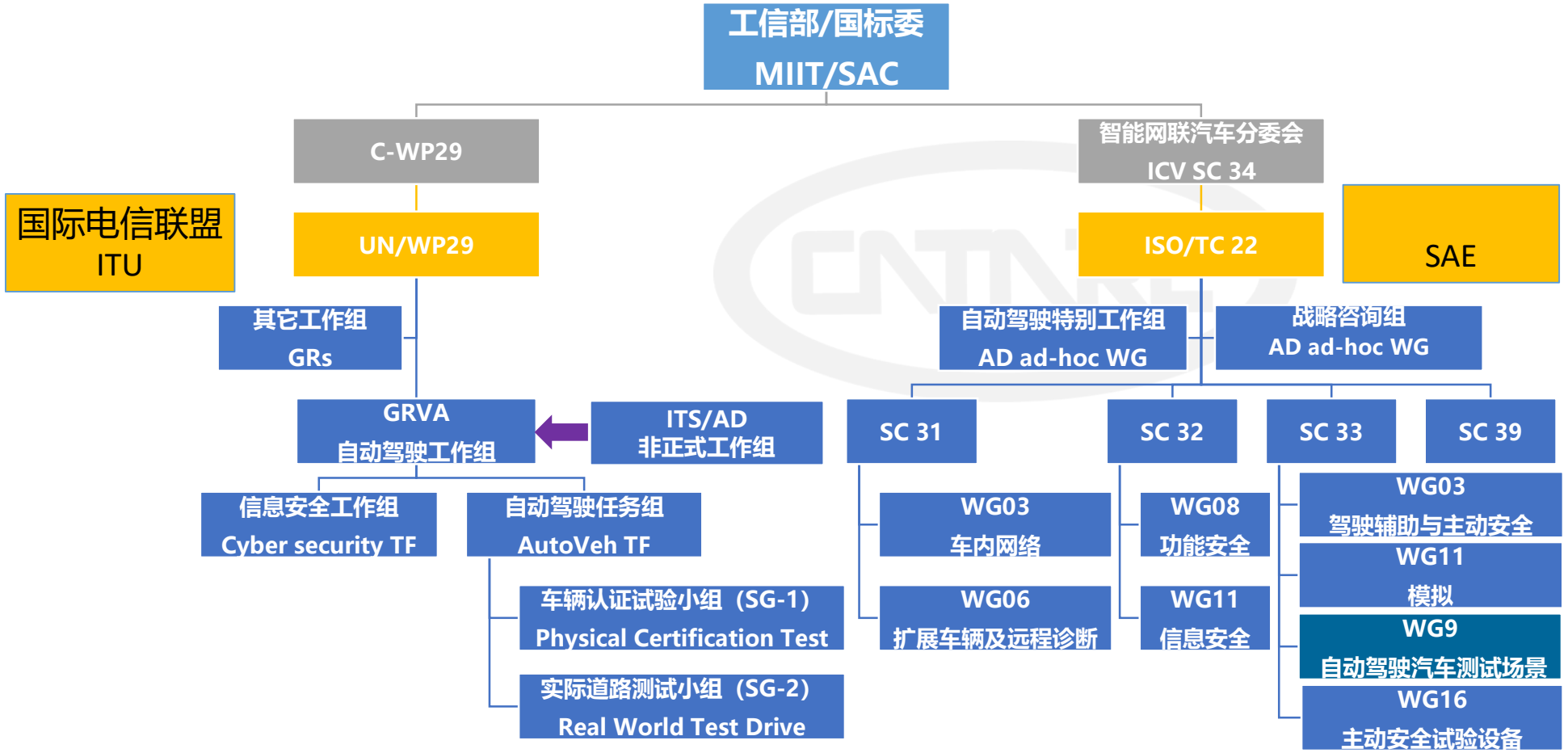
- Secretariat of NTCAS (National Technical Committee of Automotive Standardization
- Secretariat of Automotive Branch of China Association for Standardization
- Secretariat of over 10 branches of fundamental and whole vehicle areas etc.
- Standards research in the key areas
- Standard information service and consultation for the automotive industry

2

- Secretariat of Chinese WP29 Working Committee
- Centralized administration body for international standards as ISO, IEC etc. in China
- Study on the export market certification regulations/ admission system
- Harmonize the regulations among various countries and regions and participate in bilateral or multilateral technical exchange

AUTONOMOUS DRIVING STANDARDS

- CATARC attends ISO/TC22/SC33/WG9 and UN/WP29 GRVA ICV standards working group.
- Domestically, CATARC leads to make test scenario and certifications for autonomous driving.



Thank you for Listenning

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