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Road Databases for Highly Automated Driving in Series Production Light Vehicles

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WP.29/GRVA, 4th Session
Geneva, Switzerland
24-27 September 2019

ITU Status on Road Databases

- Road databases for automated driving is also a new area for the ITU
- ITU is discussing a new focus group AI for Autonomous & Assisted Driving (AI4AD)
- The formal establishment of the focus group will be determined during the ITU SG 16 meeting in October
 - Road databases will be a topic for this potential focus group
- At this time, there is no ITU position on road databases for automated driving

Overview

- This presentation is about the road database approach for highly automated driving (HAD) for series production light vehicles
 - ▶ Road database approaches for HAD in other markets such as shuttles, local delivery vehicles, robotaxis, heavy vehicles, etc. might be different
- In the geofenced market (shuttles, local delivery vehicles, robotaxis), the onboard database used for localization can be a full point cloud
 - ▶ This type of vehicle usually goes to a central garage for cleaning, charging, etc.
 - At this time, large data updates can be retrieved from the vehicles and updates stored in the vehicles without over-the-air communications costs
 - ▶ Some companies working in the geofenced market believe that they do not have the vehicle cost component cost restrictions of series production vehicles
- The heavy vehicle market might use a similar approach

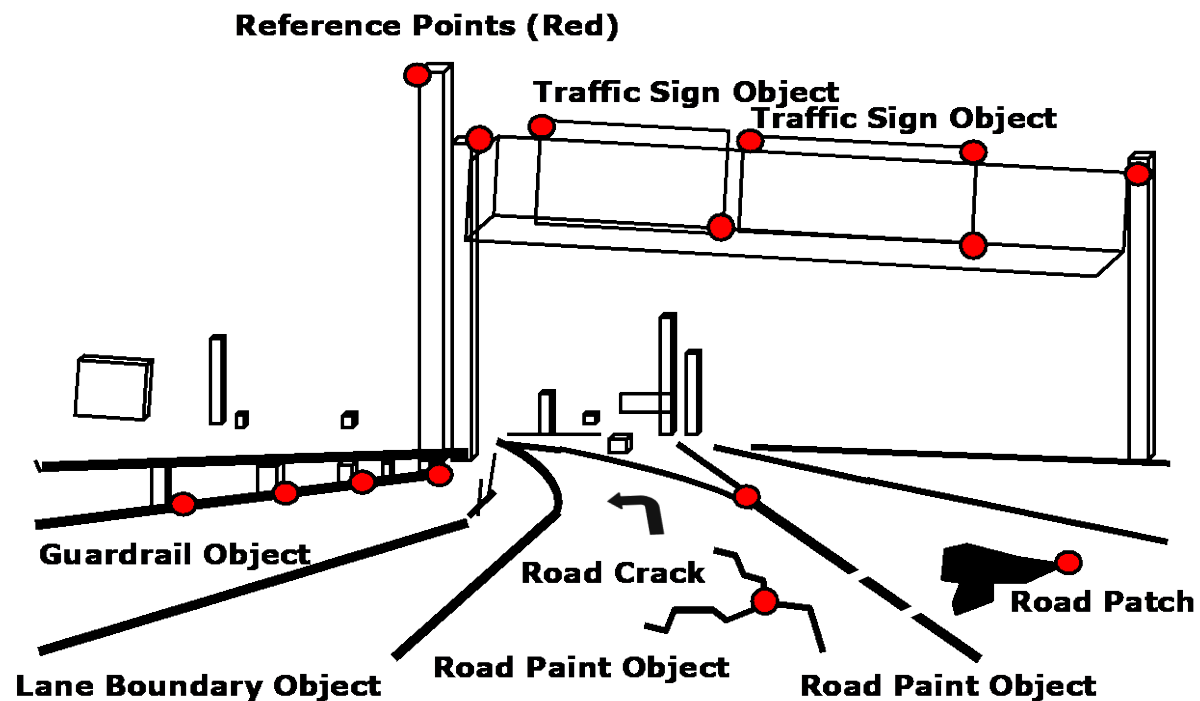
When

- Most major vehicle manufacturer software engineers working on HAD expect to include a road database in their system
- The road database approach described in this presentation is a complex software effort
 - ▶ There is no guarantee when, or even if, the road database approach will be launched in series production light vehicles
 - ▶ The road database approach is being trialed currently with five major vehicle manufacturers based in Japan, Europe, and the U.S.
- Some vehicle manufacturers are working towards 2023 launch of Level 2+/3 systems in series production vehicles on at least limited expressways

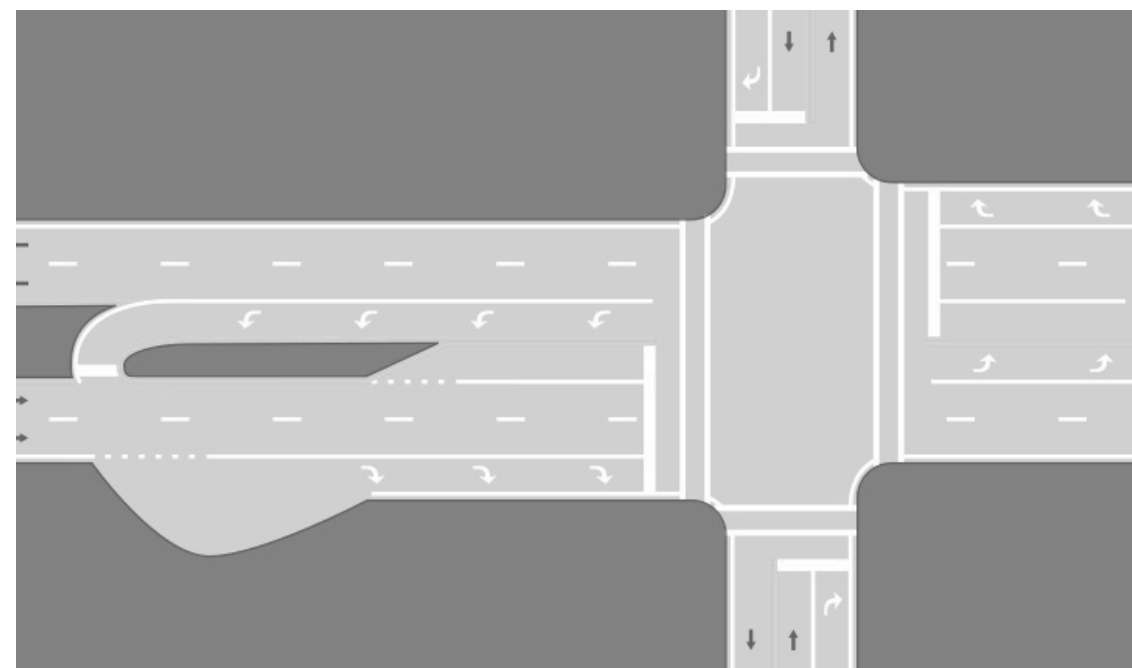
What a Road Database Is

- A CAD-type model of the empty road network

Road Database – A View from the Vehicle



HD Map – A View from Overhead



Contents of a Road Database

- Everything about the road network that can be useful for vehicle control processes
 - ▶ Lane model
 - ▶ Driving rules
 - ▶ Expected driving paths
 - ▶ Traffic signals
 - ▶ Traffic signs
 - ▶ Feature points
 - ▶ Etc.
- The target lateral and longitudinal accuracy of the road database data elements is 10 cm relative and 50 cm absolute

How a Road Database Is Created and Maintained

- Software in series production light vehicles will compare in-vehicle camera images to the contents of the in-vehicle road database to determine differences
 - ▶ All data are differences for the first equipped vehicle to drive a road
 - ▶ Millions of equipped vehicles are needed for good coverage
- The difference data messages will be sent by the vehicle manufacturer's in-vehicle communications capability over the air to the vehicle manufacturer's server
 - ▶ The vehicle manufacturer's server will manage anonymization
- The vehicle manufacturer's server will deliver the difference data messages to the server managing the road database in the area
- The server managing the road database will validate the difference data messages and apply them to the master database as appropriate

How a Road Database Is Updated in the Vehicle

- Under rules established by the vehicle manufacturer, the in-vehicle software will request updates by sending a message to the vehicle manufacturer's server requesting updates, specifying the coverage in the vehicle and the last update received
 - ▶ To control hardware and communications costs, the vehicle manufacturer will likely limit the in-vehicle coverage and frequency of updates
 - For example, a vehicle in Geneva probably does not need road data about Athens or Oslo
 - For example, a vehicle not operating in an automated mode may not need updates to its road database
- The vehicle manufacturer's server will forward the request to the server managing the road database in the area
 - ▶ The server managing the road database will return all updates to the vehicle's coverage since the last update that the vehicle received

Road Database Reliability

- Vehicle control processes must be able to rely on the content of the road database
- The creation and update of the road database must be done 100% by software without human touch
- The validation of the software to create and update the road database is a massive effort
 - ▶ A working estimate is that there are over 200,000 unique road data conditions that could impact HAD across Japan, China, Europe, and the U.S./Canada
 - Every time that there is a change in the software that manages the road database, each of these conditions has to be validated for time of day, day of year, weather, traffic, direction and lane of travel, etc.
- Each data element in the road database must have a reliability rating calculated from the difference messages received

How Will the Road Database Be Used?

- Each vehicle manufacturer will make its own choices for uses
- Uses currently being trialed by major vehicle manufacturer software engineers include
 - ▶ Determining ODD
 - ▶ Localizing the vehicle in the lane
 - ▶ Determining legal driving horizons
 - ▶ Identifying where to look for items like traffic signals and signs
 - ▶ Finding default traffic rules
 - ▶ Supplementing physical sensors as an additional sensor

Regulatory Environment

- Map databases for humans have not been regulated in most countries
- Since a road database will be a core safety component of HAD, future regulation may be appropriate

Thank You