Technology for Highly Automated Driving

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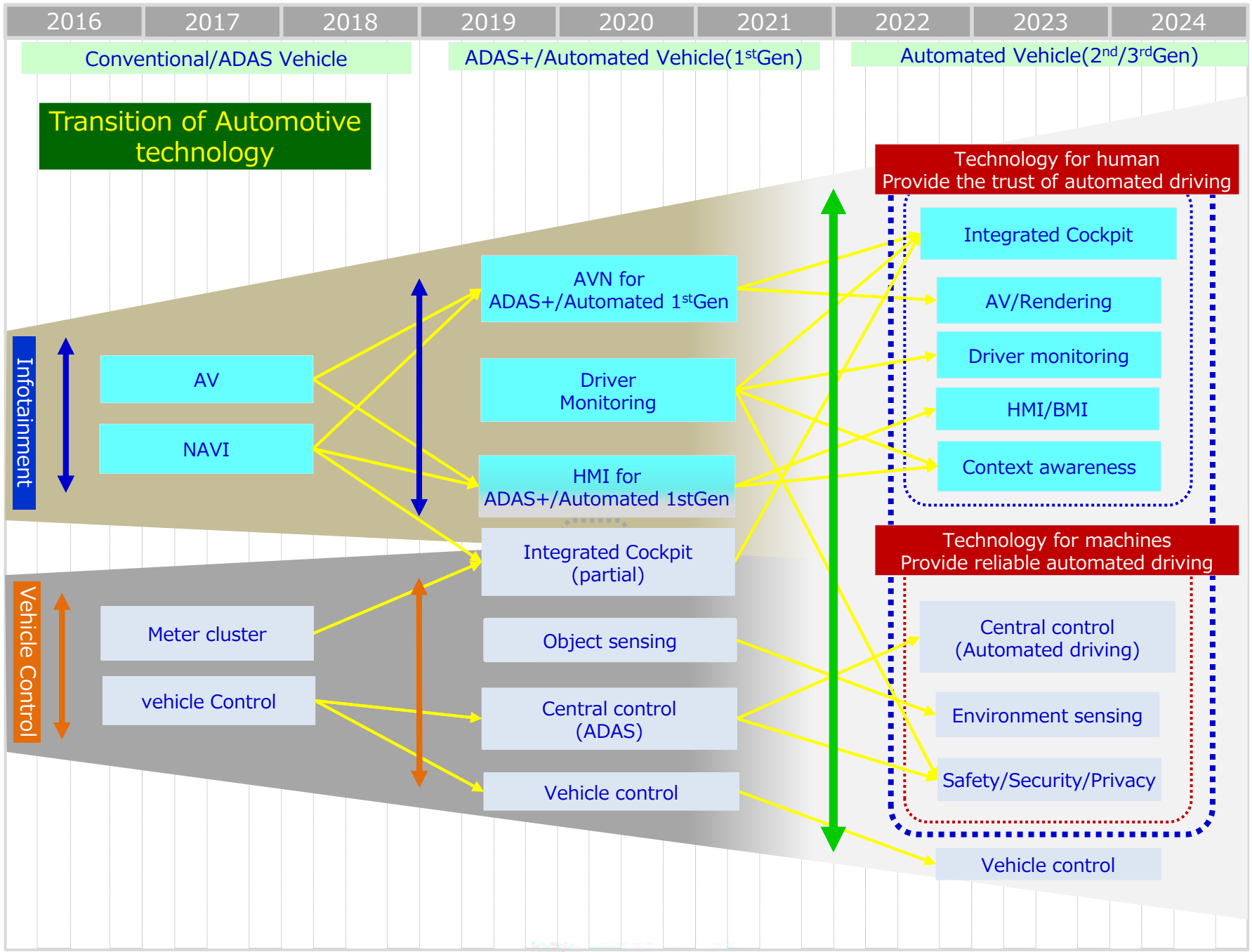
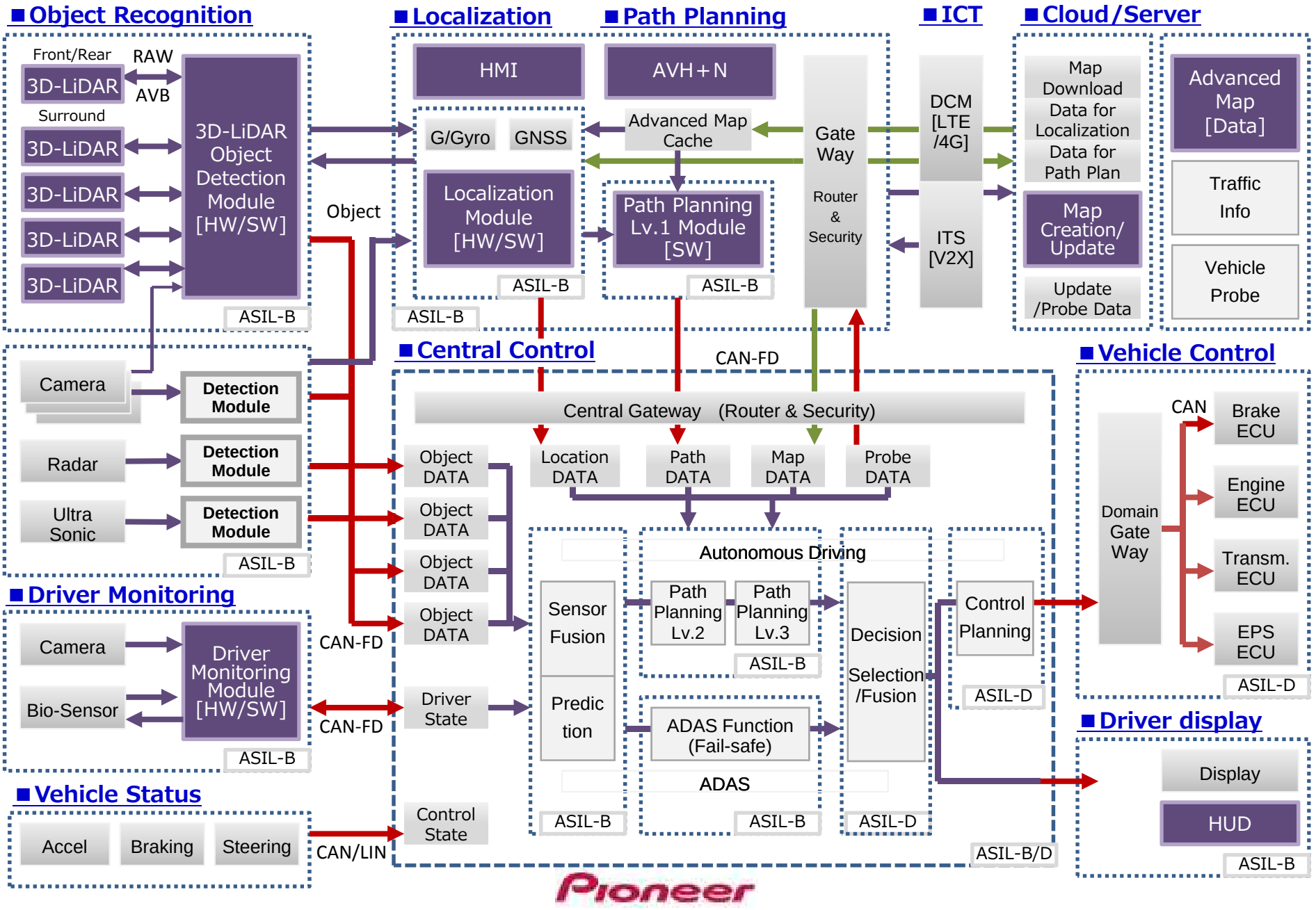
Agenda

- Introduction
  - Overview
- Architecture
  - Hardware Architecture
  - Cloud Architecture
- Key technology
  - 3D-LiDAR
  - Highly accurate self-localization of a vehicle
  - Map data for Automated driving
- Summary

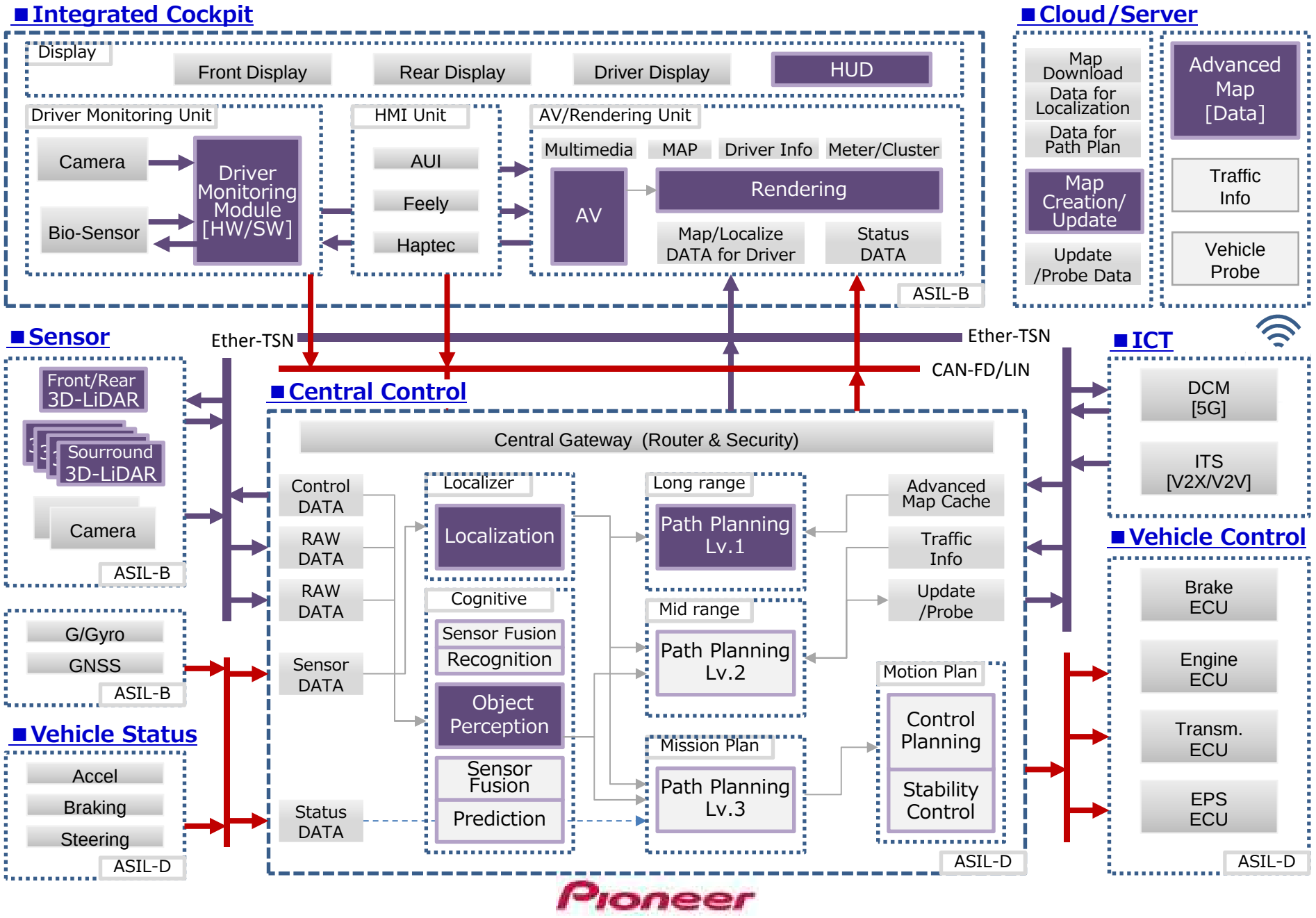
Overview/Architecture



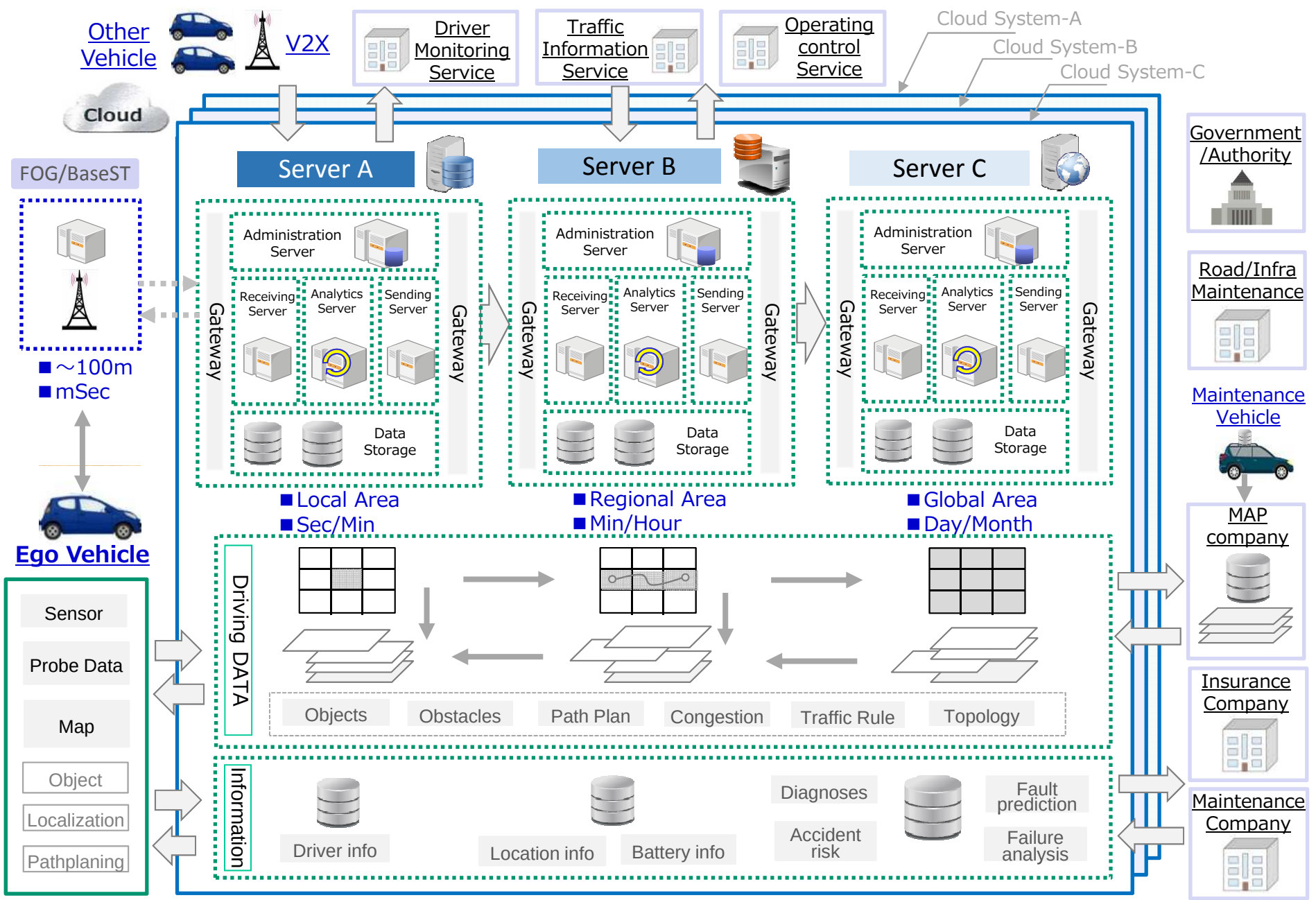
Total System : 1st/2nd Generation Automated Driving [2020～2025]



Total System : 3rd Generation Automated Driving [2025～2030]

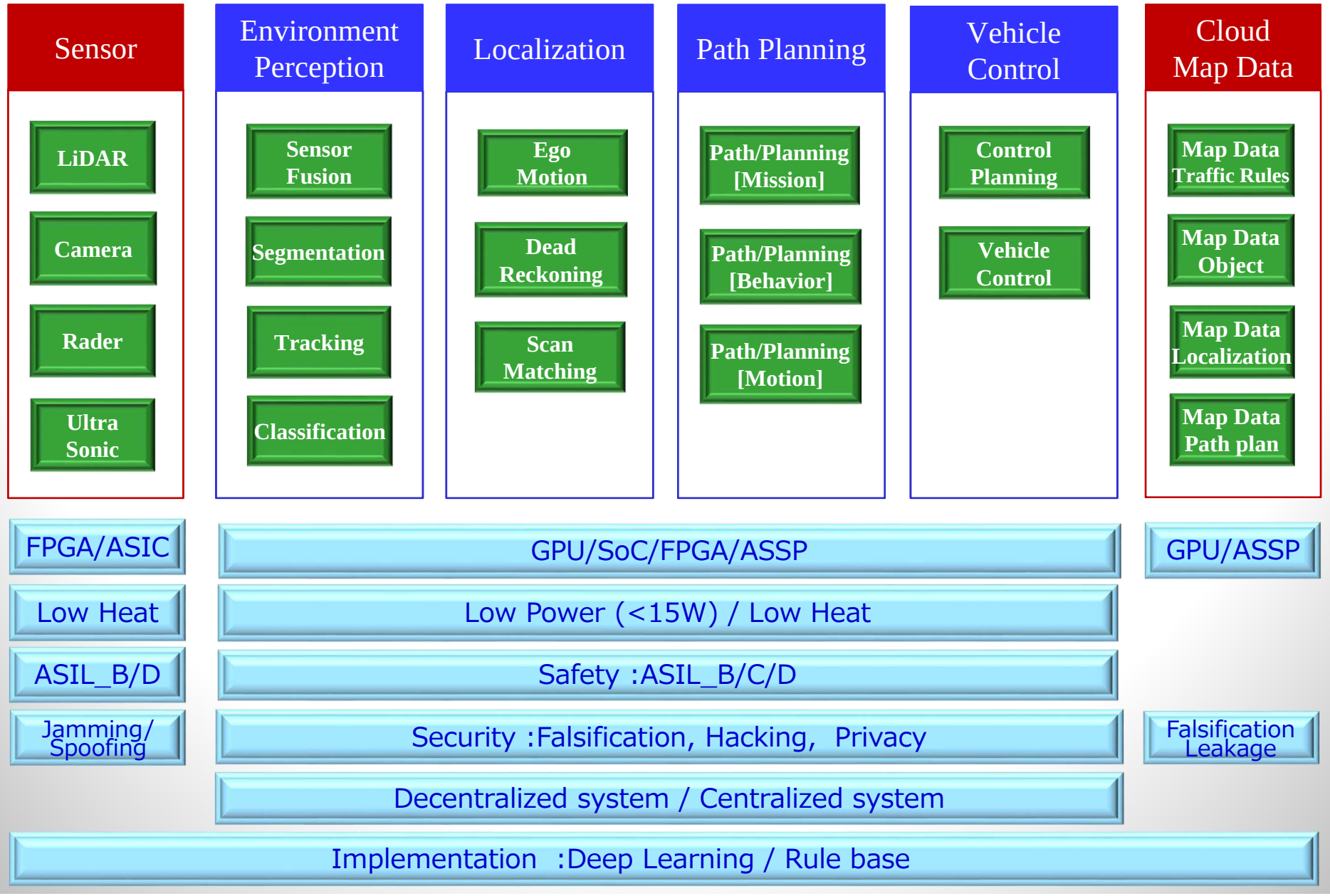


Overview of Cloud System



Key Technology

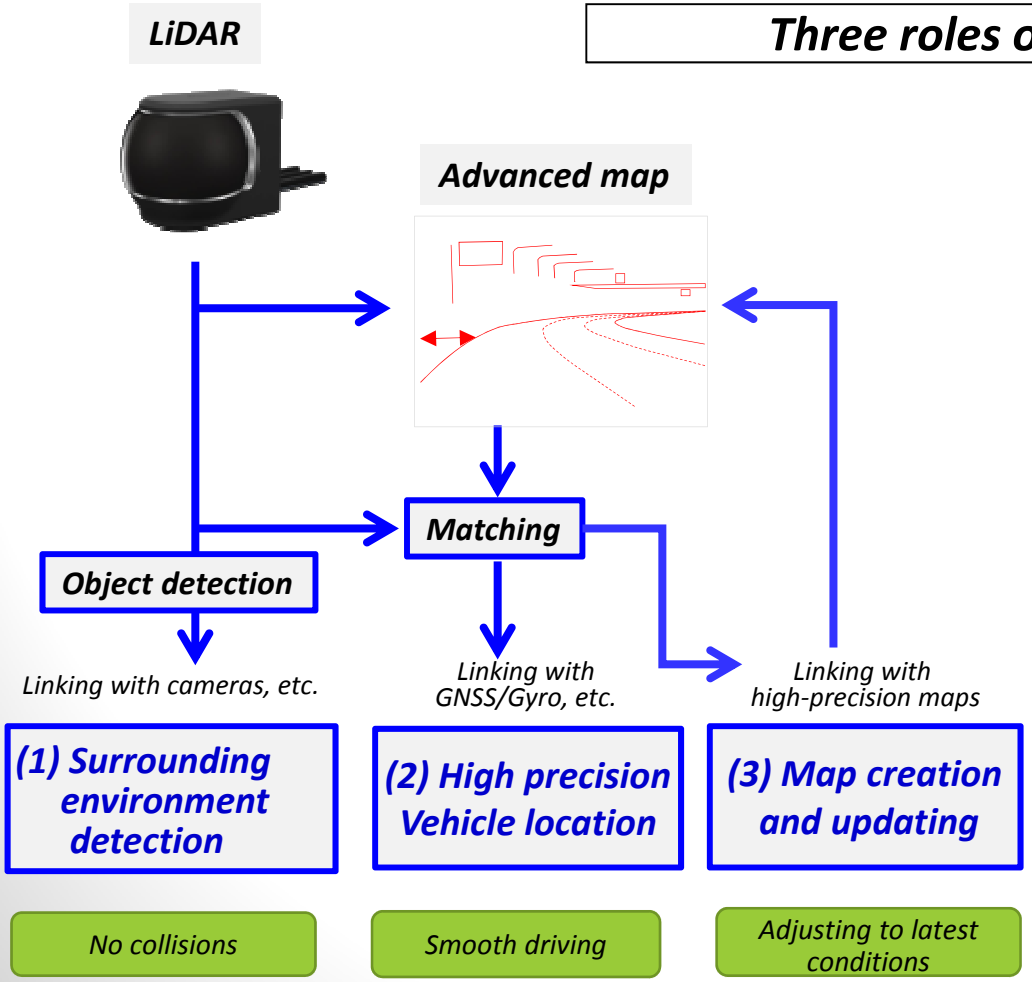
Example of Key Component/Function & Requirement

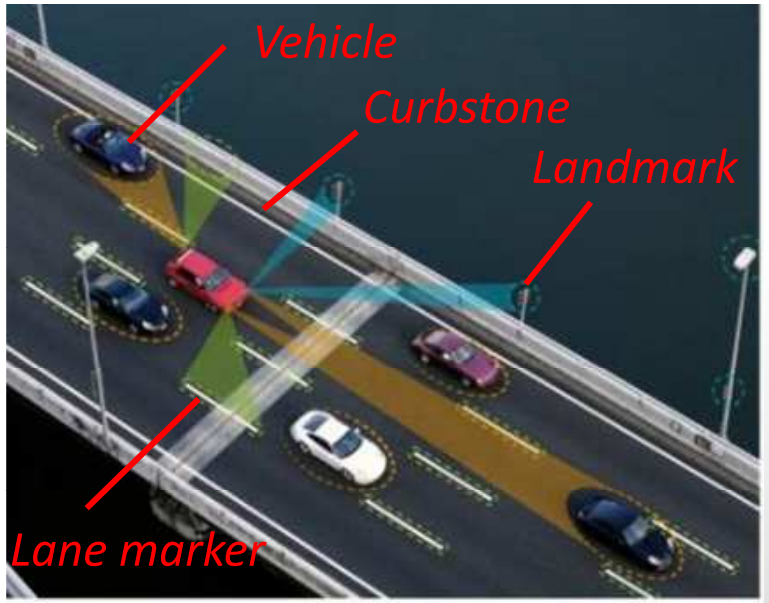


Key Technology

【Sensor】
3D-LiDAR

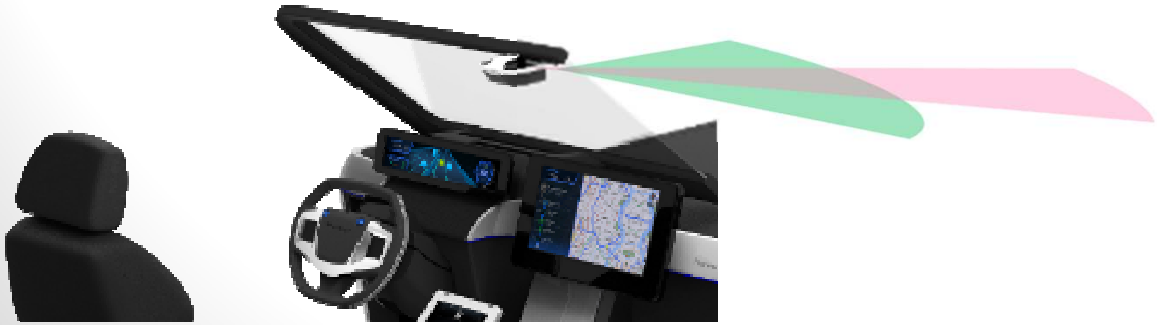
Three roles of LiDAR



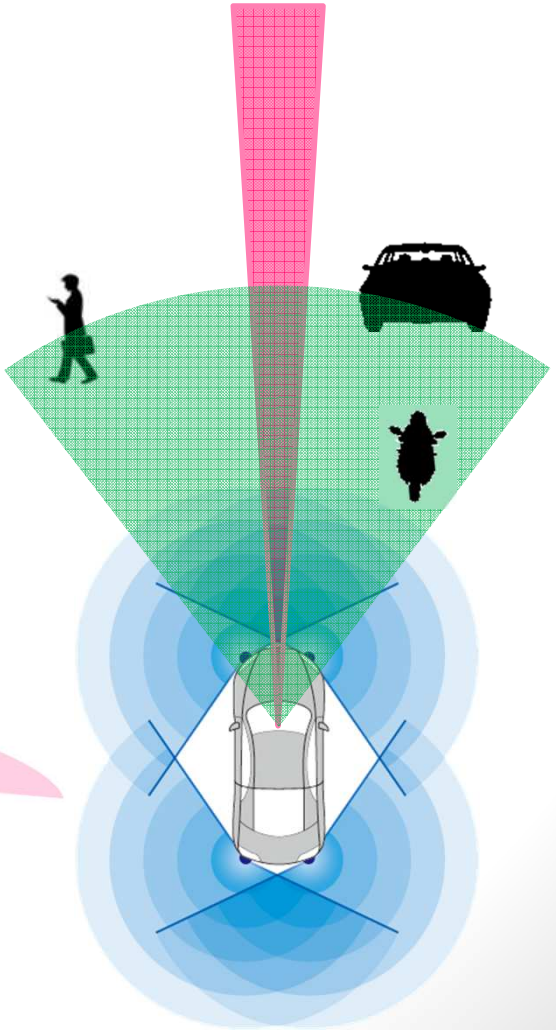


Built-in Layout Image (Tentative)

Built-in LiDAR in a headlamp unit (example)



High-mount, inside cabin (example)

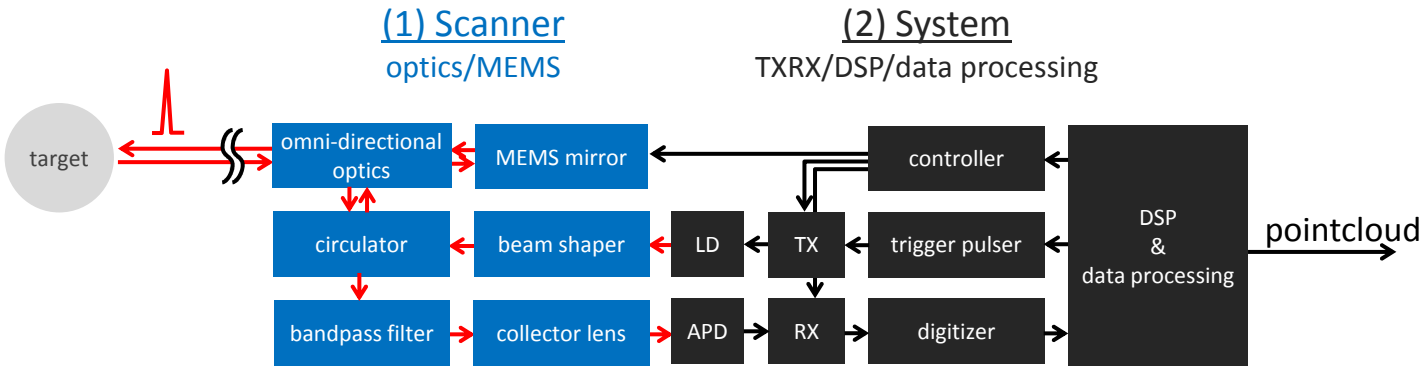


Multi-sensor configuration for omni-directional sensing

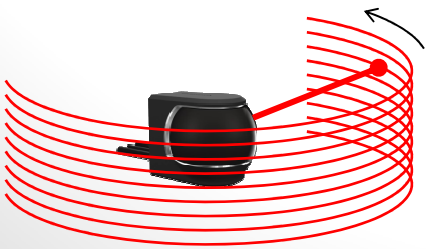
LiDAR Technical Features

Scanning of driving space

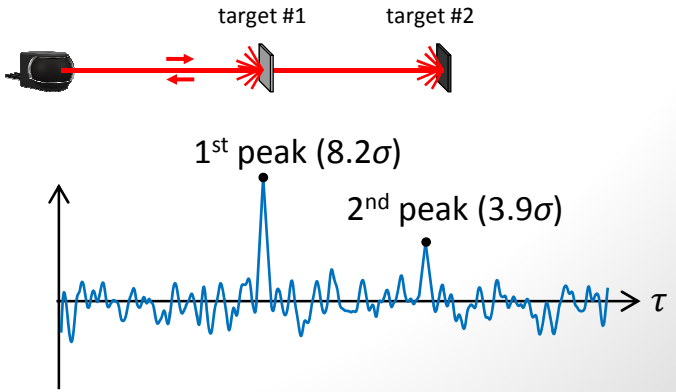
- MEMS* mirror and optics technologies enables 3D spatial scan of vehicle surroundings.
- Small angular divergence of laser beams realizes high angular resolution and it provides detailed 3D structure of the environment.



· Direct time-of-flight (TOF) detection
· Cost-effective architecture (single LD/APD + DSP)
· Unique scanner technology
· Unique system technology



Single laser ray scanned by MEMS



With well-calibrated likelihood information (without thresholding)

Key Technology

【Localization】
High accurate self-localization

Necessity of self-localization

Vehicle self-localization with map data is important for Automated Driving

- To perform appropriate path planning including lane change
  - If current driving lane is uncertain, path planning may fail
- To comply with traffic law
  - Need to stop at correct stop line if traffic signal indicates red
- To control vehicle appropriately at intersection, curve, etc...
  - Vehicle position/pose is critical when driving an intersection/curve
- To upload high quality probe data
  - If localization is inaccurate, the probe data quality will degrade even if expensive sensor is used. If accuracy of self-localization is high, reliability/quality of sensing data is increased and it facilitates detection of a discrepancy between real world and map data.

Localization Methodology

Point cloud-based
complex environment
(e.g., city area)

Landmark-based
traffic signs, lane mark
(e.g., highway)

GNSS-based
few structures
(e.g., wilderness)

Point Cloud-based

- Scan Registration localization, for example,
  - Normal Distribution Transform (NDT)
  - Iterative Closest Point (ICP)
- ❑ Pros: Easy to create data
- ❑ Cons: Data size is relatively big

Landmark-based

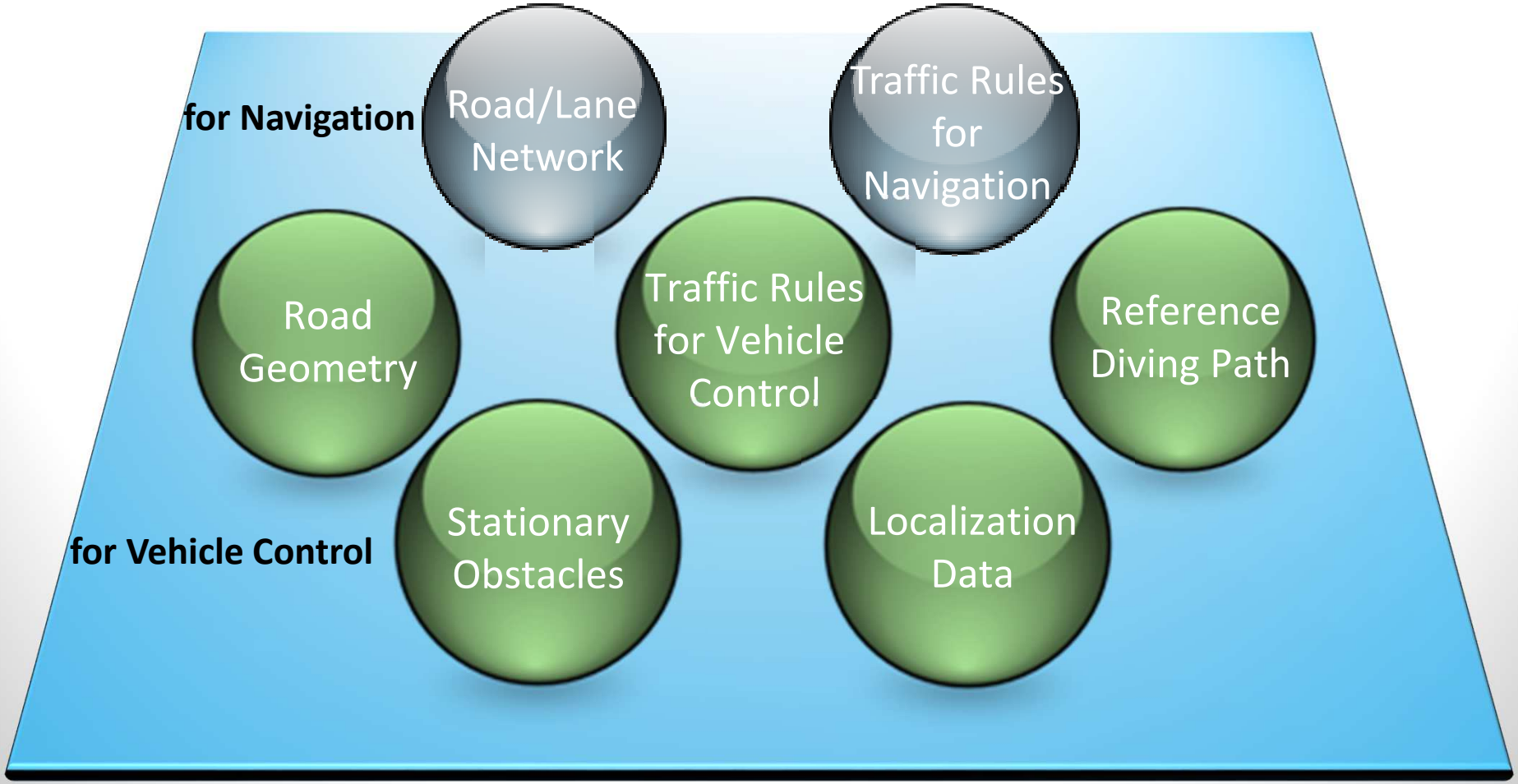
- Extended Kalman Filter (EKF) based localization
- ❑ Pros: Relatively small data size
- ❑ Cons: Ambiguity problem if similar landmark is located near by

Key Technology

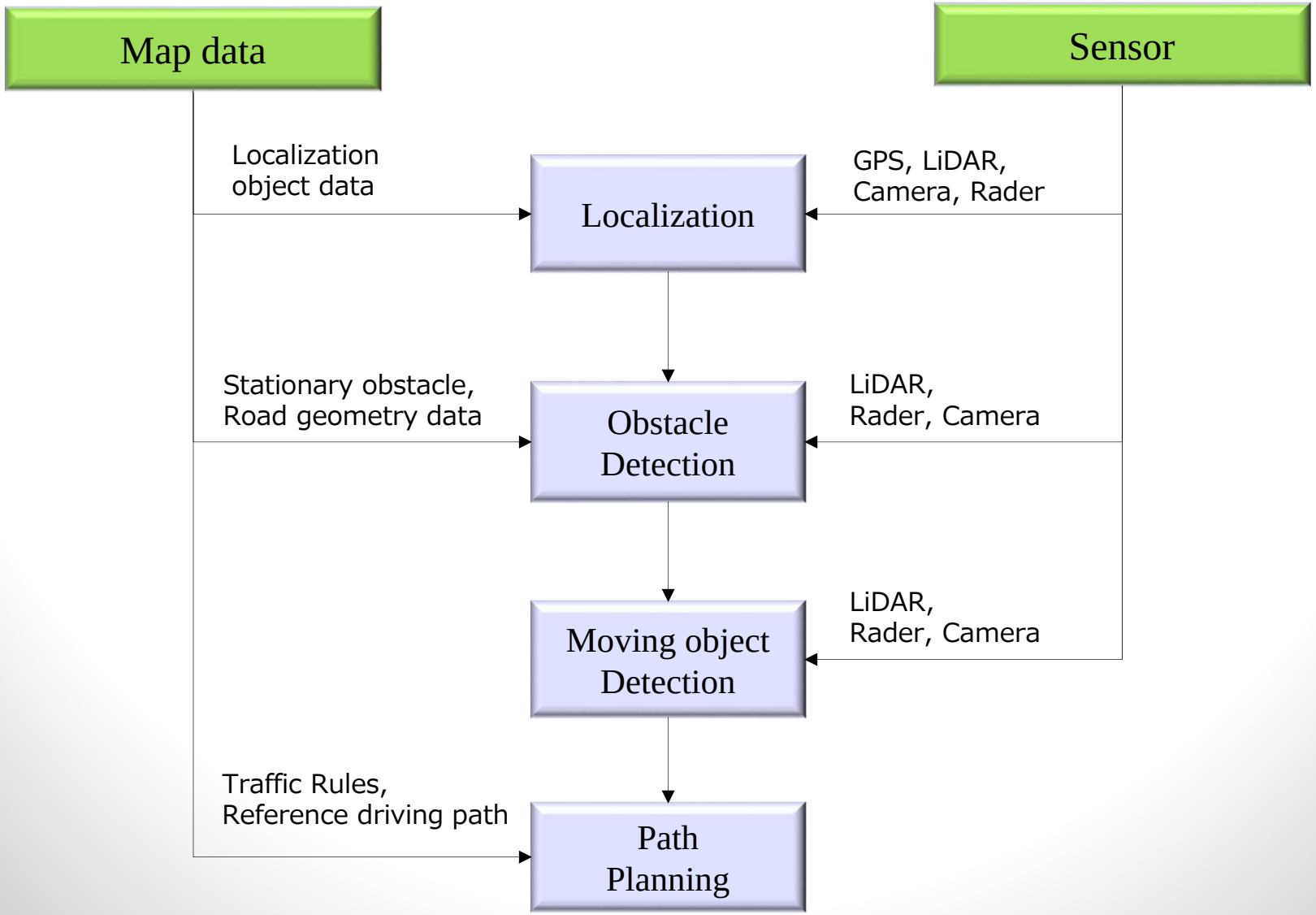
【Advanced MAP】

MAP Data for Automated Driving

Map contents required for automated driving



Key function processing using sensor and map data



Summary

Summary

- Hypothesized the total system of the automated driving
  - Looked over the whole functions for automated driving
- Key functions have following requirements to be implemented
  - Low power, Low heat, Security, Safety, Privacy
- Deep learning and Rule base are both important for implementation of the key functions
  - Realization of function and achievement of the requirements
- 3D-LiDAR and Map are key components for automated driving
- Highly accurate self-localization of vehicle is one of the key functions