2016
MELBOURNE
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Dynamic Map and Standardization for Automated Driving Systems

Special Interest Session #20
Evaluation and standardization of connected and automated road transport
October 12, 2016

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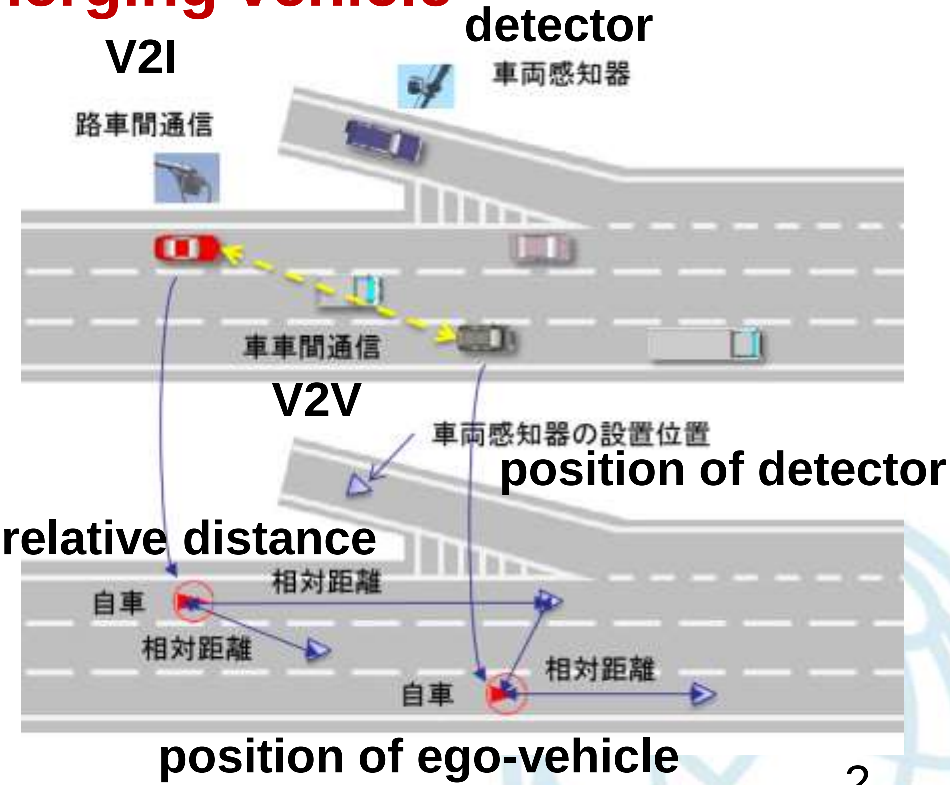
Agenda

- ✓ Use Cases for Automated Driving Systems (ADS)
- ✓ Key Requirements for ADS
- ✓ Ideas for Digital Infrastructure
- ✓ Scope of SIP-adus
- ✓ Dynamic Map (Concept, Roles)
- ✓ Requirements for Dynamic Map Standardization
- ✓ New Work Item (Scope, Schedule, Title)
- ✓ WG3 Standardization Activities for ADS and C-ITS
- ✓ Large Scale Verification Test for ADS

Use Cases for Automated Driving Systems (1)

Action of red vehicle against merging vehicle

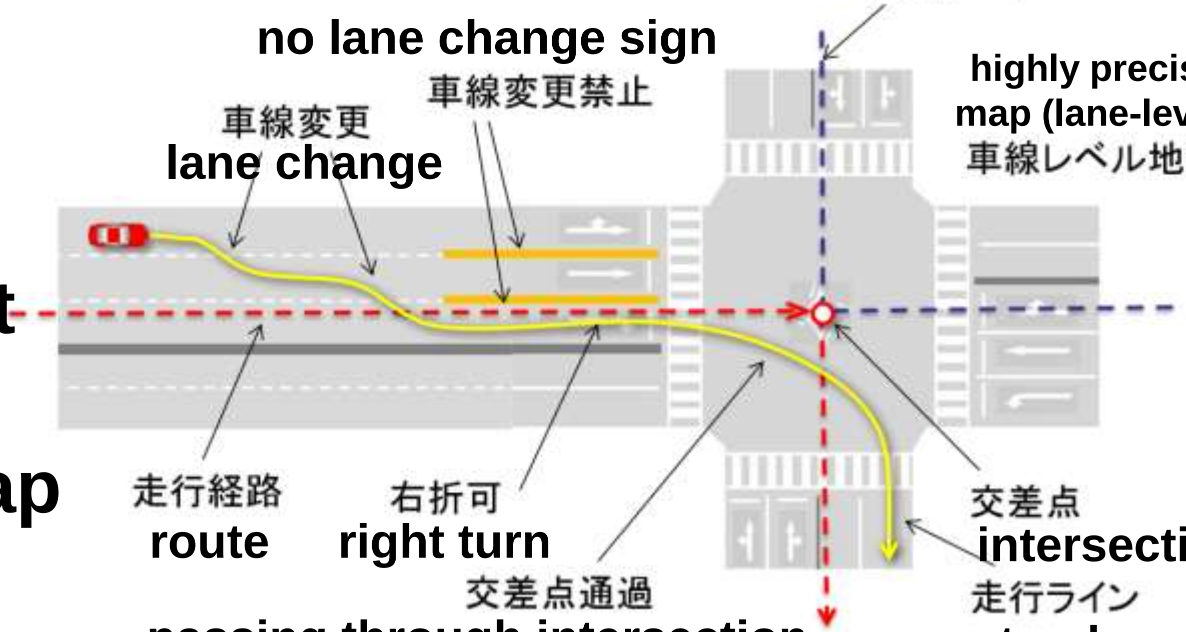
Example of lane-level location referencing and road environment recognition by V2I & V2V communications and highly precise map


V2I
路車間通信
detector
車両感知器
車車間通信
V2V
車両感知器の設置位置
position of detector
relative distance
相対距離
自車
相対距離
相対距離
自車
position of ego-vehicle

Use Cases for Automated Driving Systems (2)

Right turn at intersection

Example of lane-level location referencing and road environment recognition by highly precise map


road data
道路データ
no lane change sign
車線変更禁止
車線変更
lane change
highly precise map (lane-level)
車線レベル地図
走行経路
route
右折可
right turn
交差点通過
passing through intersection
交差点
intersection
走行ライン
track

Key Requirements for ADS

- ✓ **Lane-level Location Referencing**
- ✓ **Road Environment Recognition**

…called as "Digital Infrastructure"

DI=Digital representation of road environment required by Automated Driving Systems, C-ITS, and Advanced Road/Traffic Management Systems

- ✓ **Highly precise and highly up-to-date digital map + dynamic information including 3D-image**

Ideas for Digital Infrastructure

✓**Local Dynamic Map for C-ITS** (SAFESPOT, EC)
…short range, vehicle-centric

✓**Dynamic eHorizon for ADS** (Continental AG)
…short to middle range, cloud sourcing

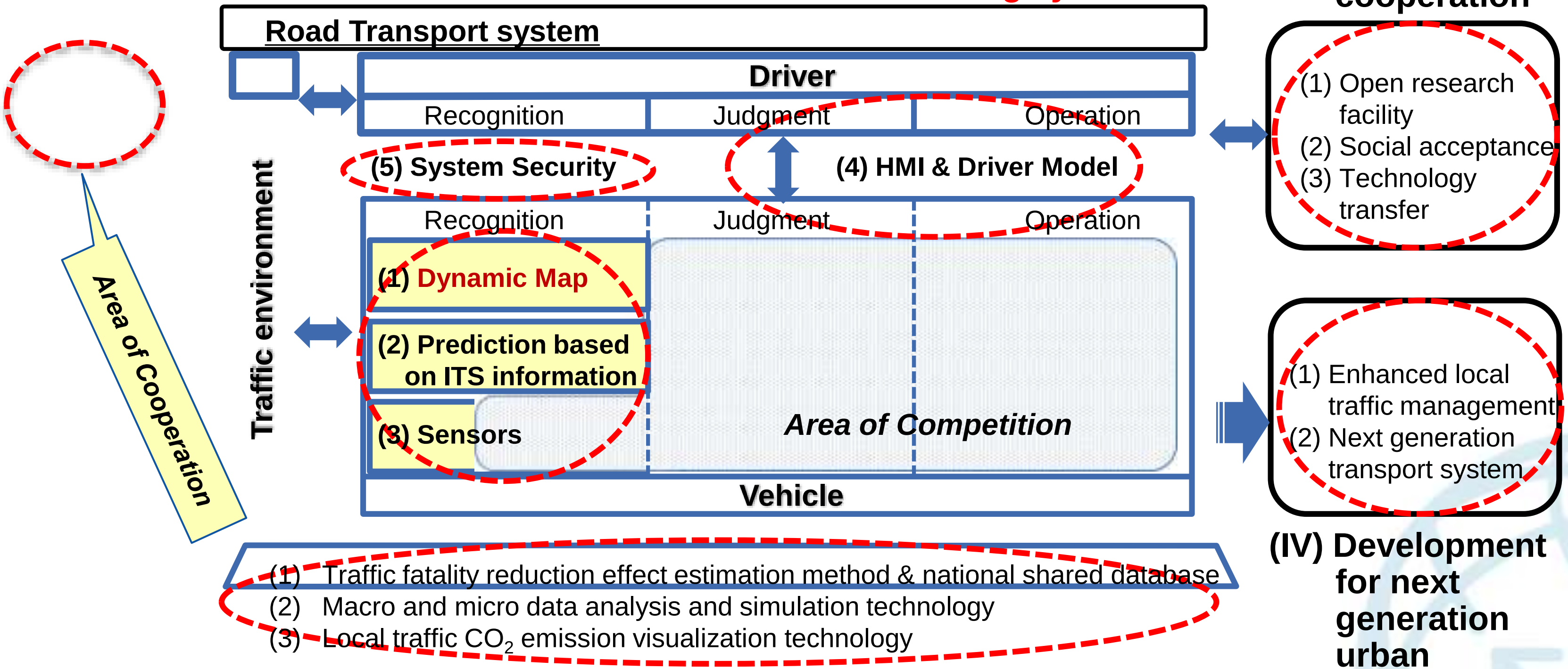
✓**Dynamic Map for ADS** (SIP-adus, Japan)
…short range to wide area, vehicle+center, cloud sourcing

Scope of SIP-adus (2014-2018)

Cross-Ministerial Strategic Innovation Promotion Program
Innovation of Automated Driving for Universal Services

(I) Development and verification of automated driving system

(III) International cooperation



Road Transport system

Driver

Recognition | Judgment | Operation

(5) System Security

(4) HMI & Driver Model

Recognition | Judgment | Operation

(1) Dynamic Map

(2) Prediction based on ITS information

(3) Sensors

Area of Competition

Vehicle

Traffic environment

Area of Cooperation

(1) Open research facility
(2) Social acceptance
(3) Technology transfer

(1) Enhanced local traffic management
(2) Next generation transport system

(1) Traffic fatality reduction effect estimation method & national shared database
(2) Macro and micro data analysis and simulation technology
(3) Local traffic CO_2 emission visualization technology

(II) Basic technologies to reduce traffic fatalities and congestion

(IV) Development for next generation urban transport

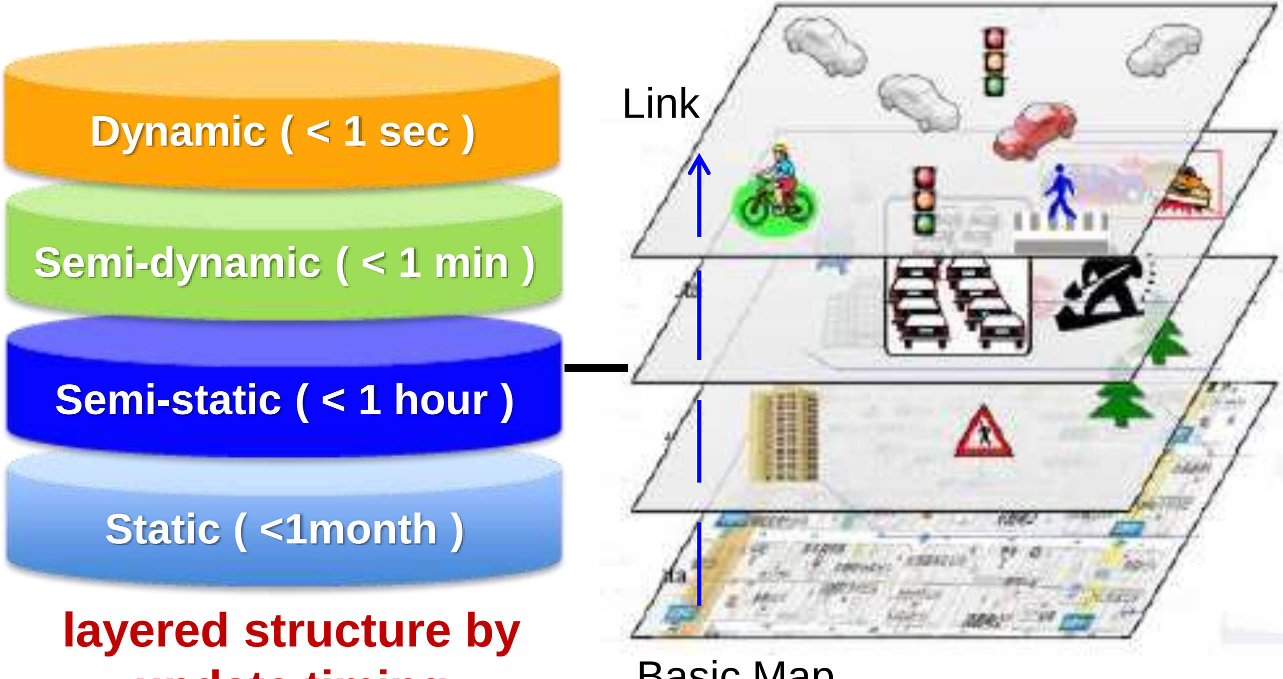
***Source: SIP-adus**

Dynamic Map Concept (1)

Advanced road traffic information database (=digital infrastructure) for all vehicles

Update timing

Linked layers


Dynamic (< 1 sec)
Semi-dynamic (< 1 min)
Semi-static (< 1 hour)
Static (<1month)
Link
Basic Map

***Source: SIP-adus, Advanced Map Task Force**

layered structure by update timing

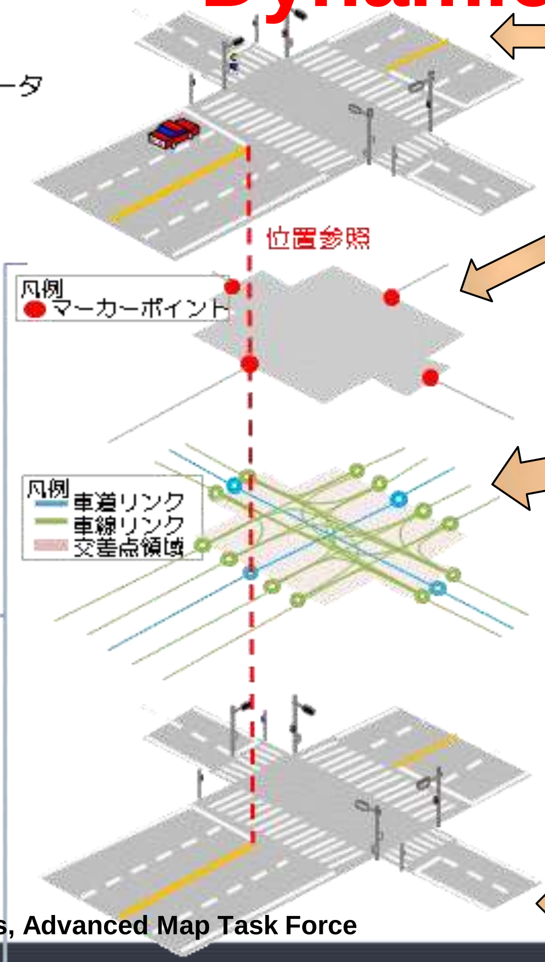
Information through V to X
- surrounding vehicles
- pedestrians
- timing of traffic signals

Traffic Information
- accidents
- congestion
- local weather

Planning and Forecasting
- traffic regulations
- road works
- weather forecast

Basic Map Database
- digital cartographic data
- topological data with road facilities

Dynamic Map Concept (2)



Dynamic information

動的データ（動的情報、准動的情報、准静的情報）
車両、人（歩行者、二輪車等）、信号を点で定義
渋滞情報、規制情報を線で定義

Foundation for LR

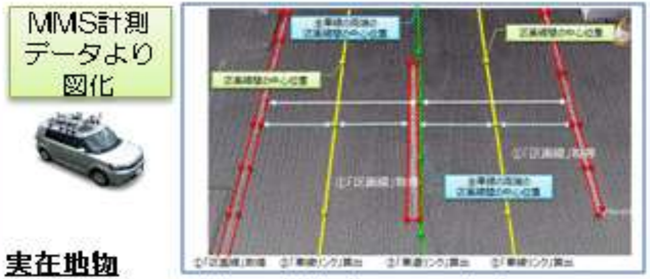
位置参照基盤
動的データと基盤的地図を関連付ける仕組み
（区間ID、マーカポイント、緯度経度）

デジタル道路地図、車線レベル道路地図

Virtual features (link, …)

実在しない地物
（車道リンク、車線リンク、交差点領域など）

MMS計測
データより
図化



実在地物
実際に存在する地物（点群データ、画像データ）
（路肩縁、区画線、停止線、横断歩道、信号機、踏

Real features (lane marking, …)

Competitive

Cooperative

Dynamic Map

ダイナミック
マップ

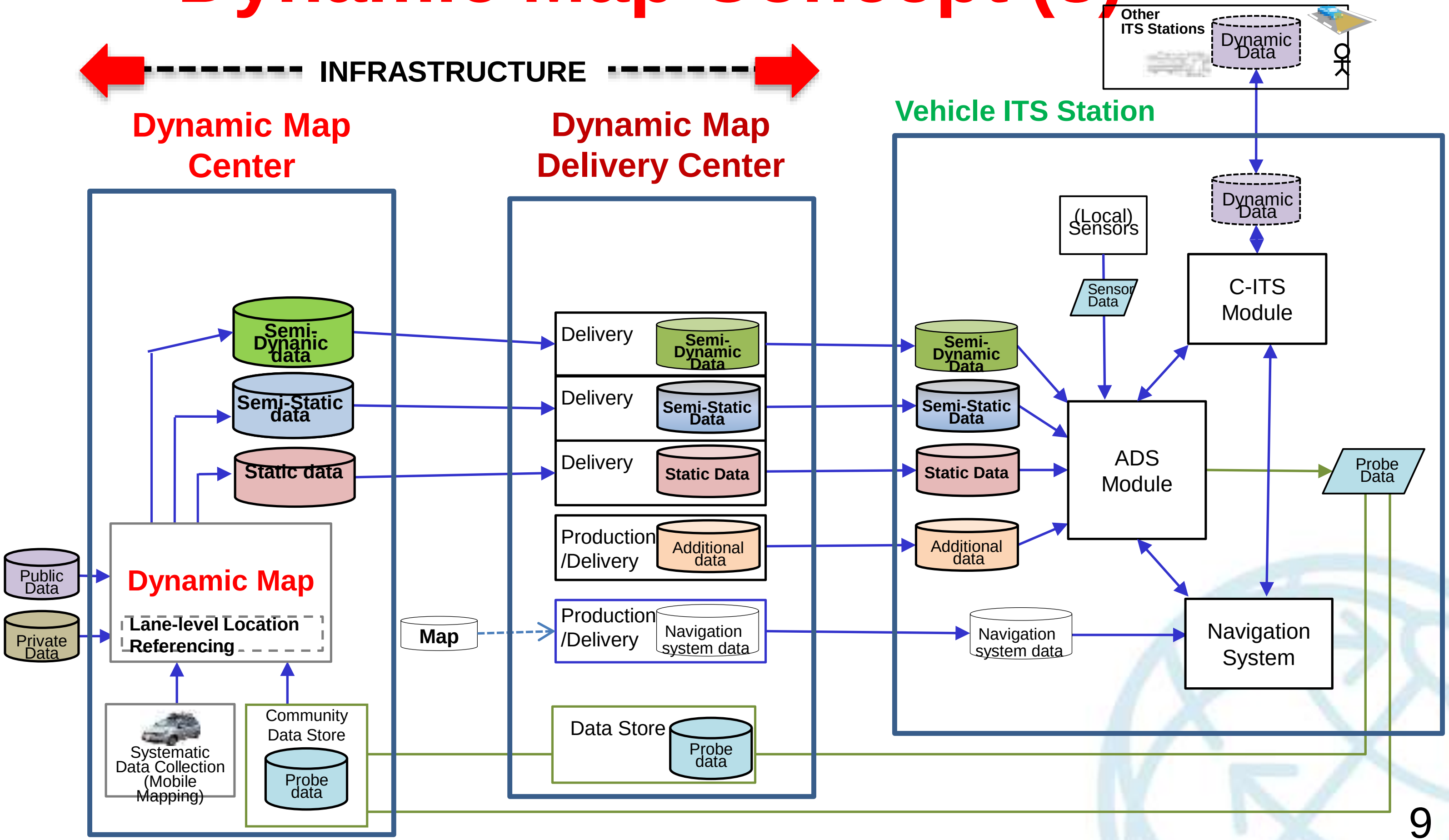
Basic Map

基盤的
地図

***Source: SIP-adus, Advanced Map Task Force**

※図はイメージでありダイナミックマップのデータ記述形式を示すものではない。

Dynamic Map Concept (3)


Other
ITS Stations
Dynamic Data
INFRASTRUCTURE
Dynamic Map Center
Dynamic Map Delivery Center
Vehicle ITS Station
Semi-Dynamic data
Semi-Static data
Static data
Public Data
Private Data
Dynamic Map
Lane-level Location Referencing
Systematic Data Collection (Mobile Mapping)
Community Data Store
Probe data
Map
Delivery
Semi-Dynamic Data
Delivery
Semi-Static Data
Delivery
Static Data
Production /Delivery
Additional data
Production /Delivery
Navigation system data
Data Store
Probe data
Dynamic Data
(Local) Sensors
Sensor Data
C-ITS Module
Semi-Dynamic Data
Semi-Static Data
Static Data
Additional data
ADS Module
Probe Data
Navigation system data
Navigation System

Roles of Dynamic Map (1)

- ✓ at Dynamic Map Center (DMC)
  - ✓ To keep traffic situation up-to-date at entire city level
  - ✓ To generate semi-dynamic and semi-static information
- ✓ at Delivery Center (DC)
  - ✓ To deliver specific information to specific vehicle
  - ✓ To deliver semi-dynamic and semi-static information to vehicles
- ✓ at Vehicle ITS Station
  - ✓ To provide specific vehicle(s) with specific information within limited area (intersection, merging section,…)
  - ✓ To provide vehicle(s), DC, and DMC with dynamic information

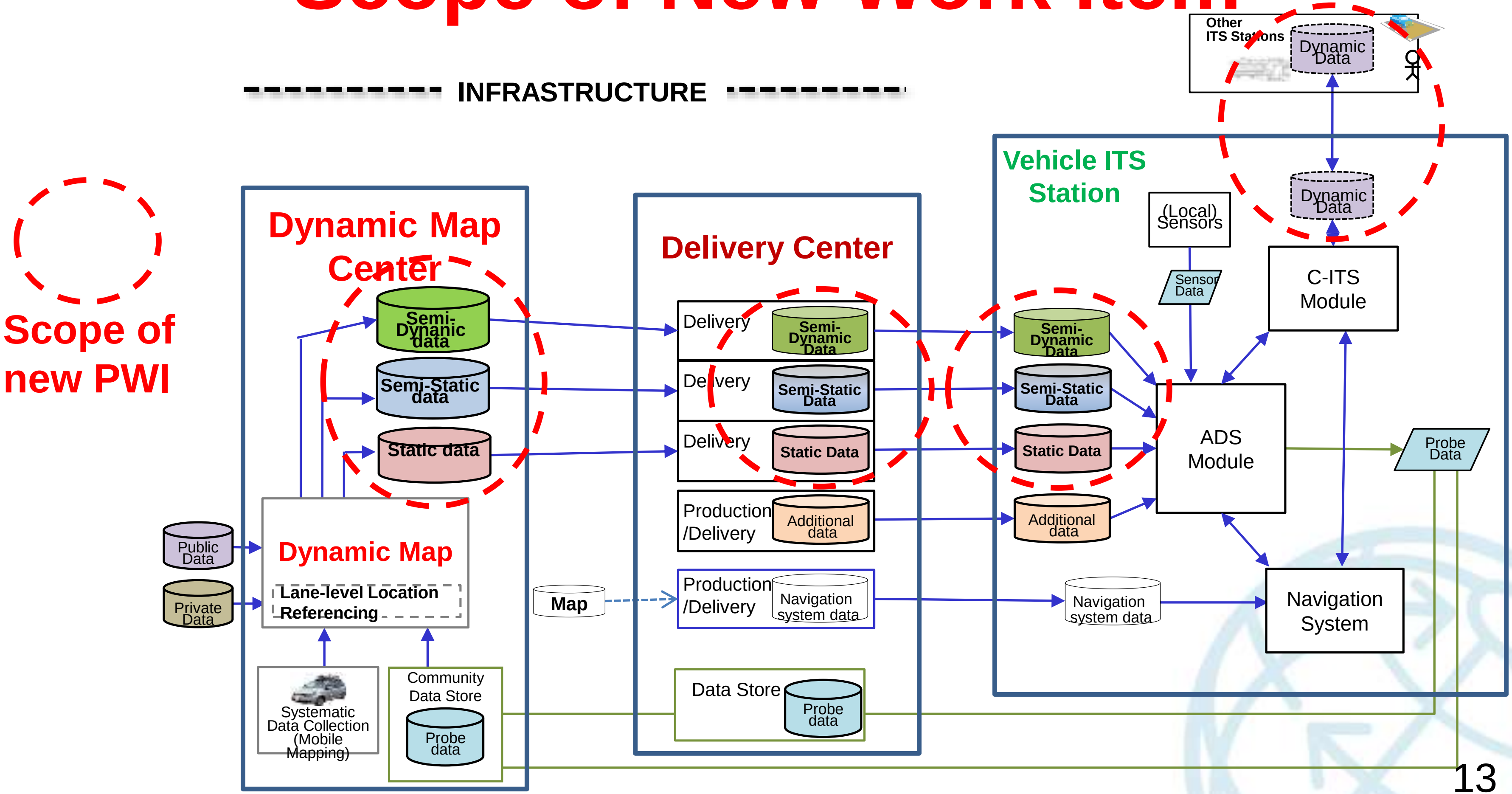
Roles of Dynamic Map (2)

- ✓ Wide-area perceivable capability allows Dynamic Map (Center) to play way more considerable role in Advanced Road/Traffic Management Systems in addition to ADS and C-ITS
  - ✓ To increase supportive stakeholders
  - ✓ To reinforce business models

Requirements for Dynamic Map Standardization

- ✓ **To enable unified process of static/ dynamic information at centers and vehicles to make various APs compatible among DMC, DC and Vehicle ITS Stations**
- ✓ **First priority area is to standardize identical data model for static/dynamic information in Dynamic Map at DMC, DC, and Vehicle ITS Stations -> See next slide**

Scope of New Work Item


Scope of new PWI
INFRASTRUCTURE
Other ITS Stations
Dynamic Data
Vehicle ITS Station
Dynamic Data
(Local) Sensors
Sensor Data
C-ITS Module
Dynamic Map Center
Semi-Dynamic data
Semi-Static data
Static data
Delivery Center
Delivery
Semi-Dynamic Data
Delivery
Semi-Static Data
Delivery
Static Data
Production /Delivery
Additional data
Semi-Dynamic Data
Semi-Static Data
Static Data
Additional data
ADS Module
Probe Data
Public Data
Private Data
Dynamic Map
Lane-level Location Referencing
Map
Production /Delivery
Navigation system data
Navigation system data
Navigation System
Systematic Data Collection (Mobile Mapping)
Community Data Store
Probe data
Data Store
Probe data

Schedule/Title of New Work Item

- ✓ Approval expected in next spring (2017)
- ✓ IS publication expected in 2020
  - ✓ Tentative title: Map database specifications for applications of ADS, Cooperative ITS, and Advanced road/traffic management systems

ISO TC204 WG3
Standardization Activities for ADS and C-ITS

Under development:

- ✓**PWI 20524: Geographic Data Files 5.1**
  - ✓**To specify map feature, attribute, and relationship for Automated Driving Systems (ADS), C-ITS, and Multi-modal Navigation (IS in 2018)**

- ✓**PWI 21718: Spatio-temporal Data Dictionary**
  - ✓**To assemble data dictionary covering ADS and C-ITS (TR in 2017)**

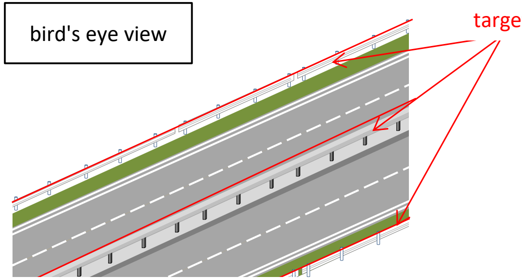
- ✓**PWI 17572-4: Lane-level Location Referencing**
  - ✓**To develop new LR methodology enabling “Which lane?” for C-ITS and “Where in lane?” for ADS (IS in 2018)**

*PWI=Preliminary Work Item

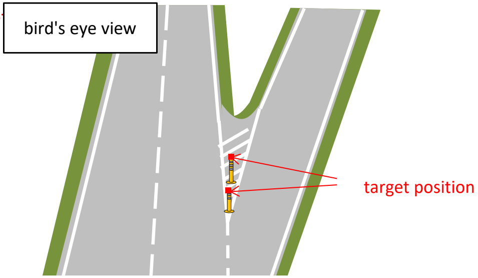
“Geographic Data Files 5.1” (PWI 20524)

SIP-adus use-cases identified 34 static map features

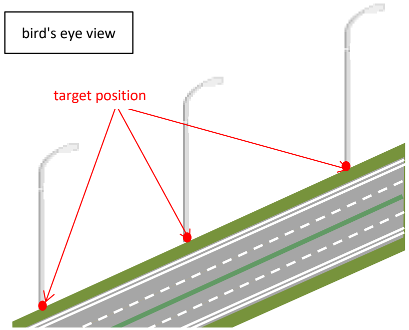
guardrail


bird's eye view
targe

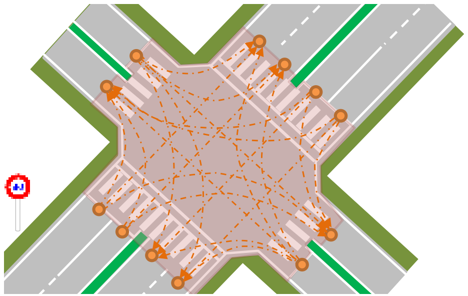
rubber pole


bird's eye view
target position

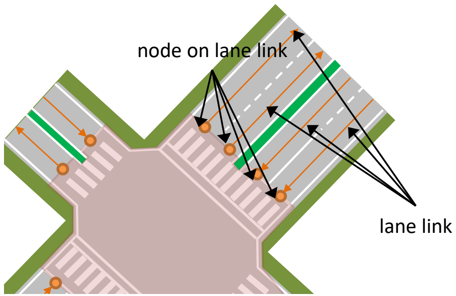
road illumination


bird's eye view
target position

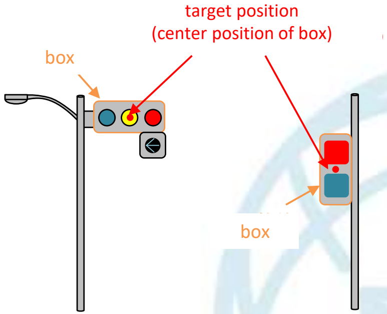
intersection lane link



lane link

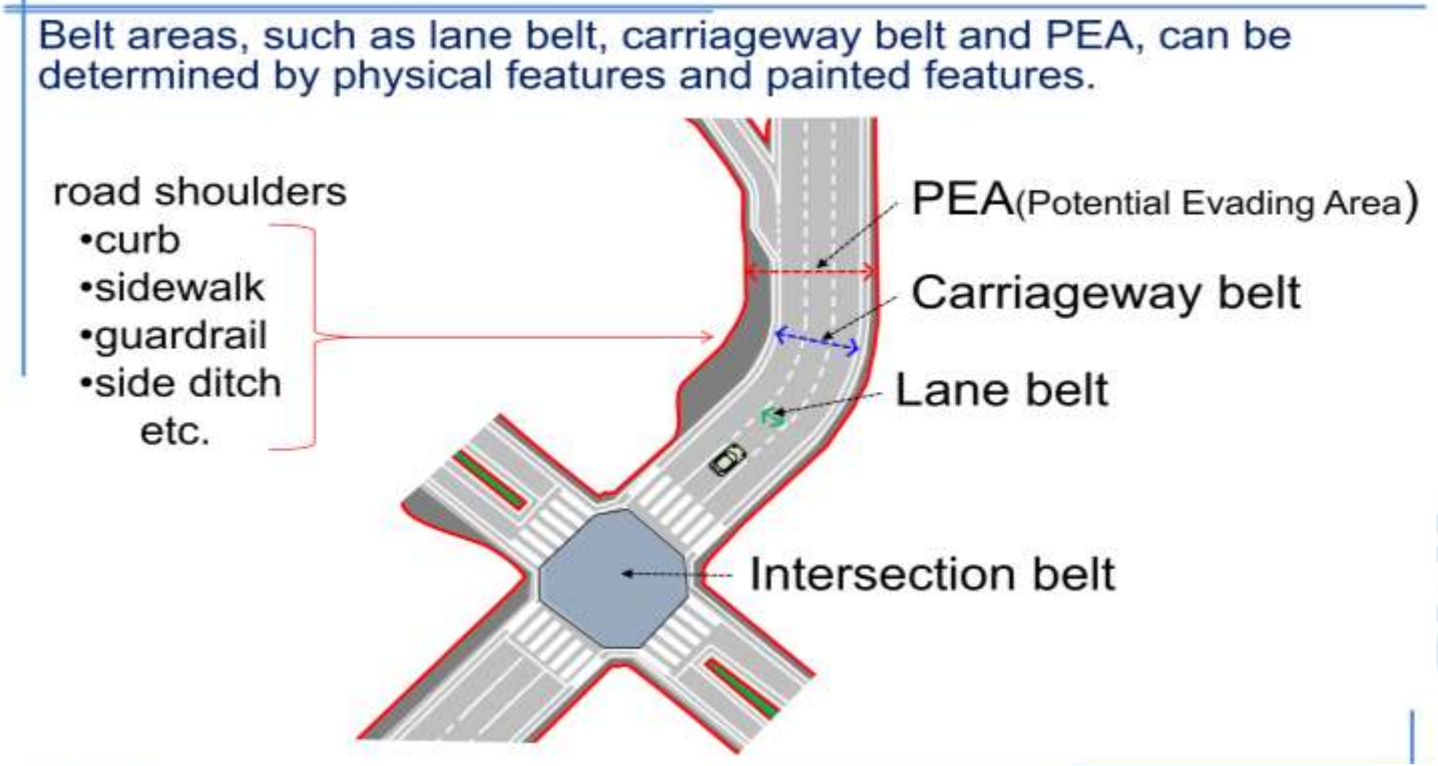

node on lane link
lane link

traffic signal


target position
(center position of box)
box
box

*Source: SIP-adus, Advanced Map Task Force

“Geographic Data Files 5.1” (PWI 20524) Belt Concept for ADS and C-ITS



Belt areas, such as lane belt, carriageway belt and PEA, can be determined by physical features and painted features.

road shoulders
- curb
- sidewalk
- guardrail
- side ditch

etc.

PEA(Potential Evading Area)

Carriageway belt

Lane belt

Intersection belt

“Spatio-temporal Data Dictionary” (PWI 21718) for ADS and C-ITS

To assemble data dictionary which describes static and dynamic data

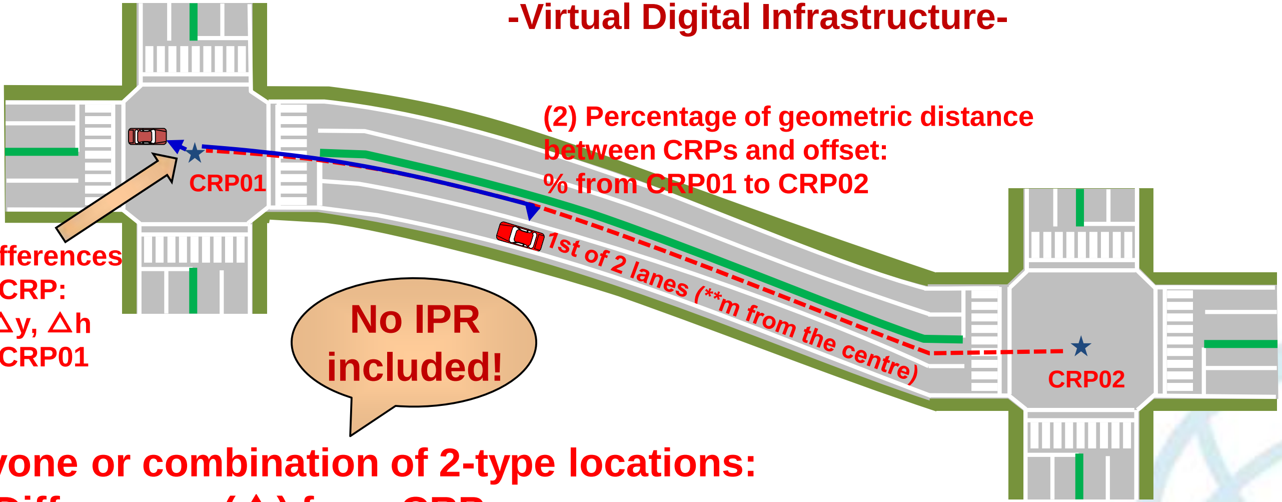
→ Targeting Technical Report (2017)

data contents	descriptive names
data type	data message / data set / data module / data frame / data element / common attribute
data category	dynamic / static
definition and description	definition and description of data contents
data structure	definition of data content by XML schema
data content author	authors who published the reference documents
reference documents	normative reference
remarks	other information

“Lane-level Location Referencing” (PWI 17572-4) for ADS and C-ITS

To develop new LR enabling “Which lane?” for C-ITS and “Where in lane?” for ADS

Common Reference Point = CRP
-Virtual Digital Infrastructure-



(2) Percentage of geometric distance between CRPs and offset:
% from CRP01 to CRP02

(1) Differences from CRP:
△x, △y, △h
from CRP01

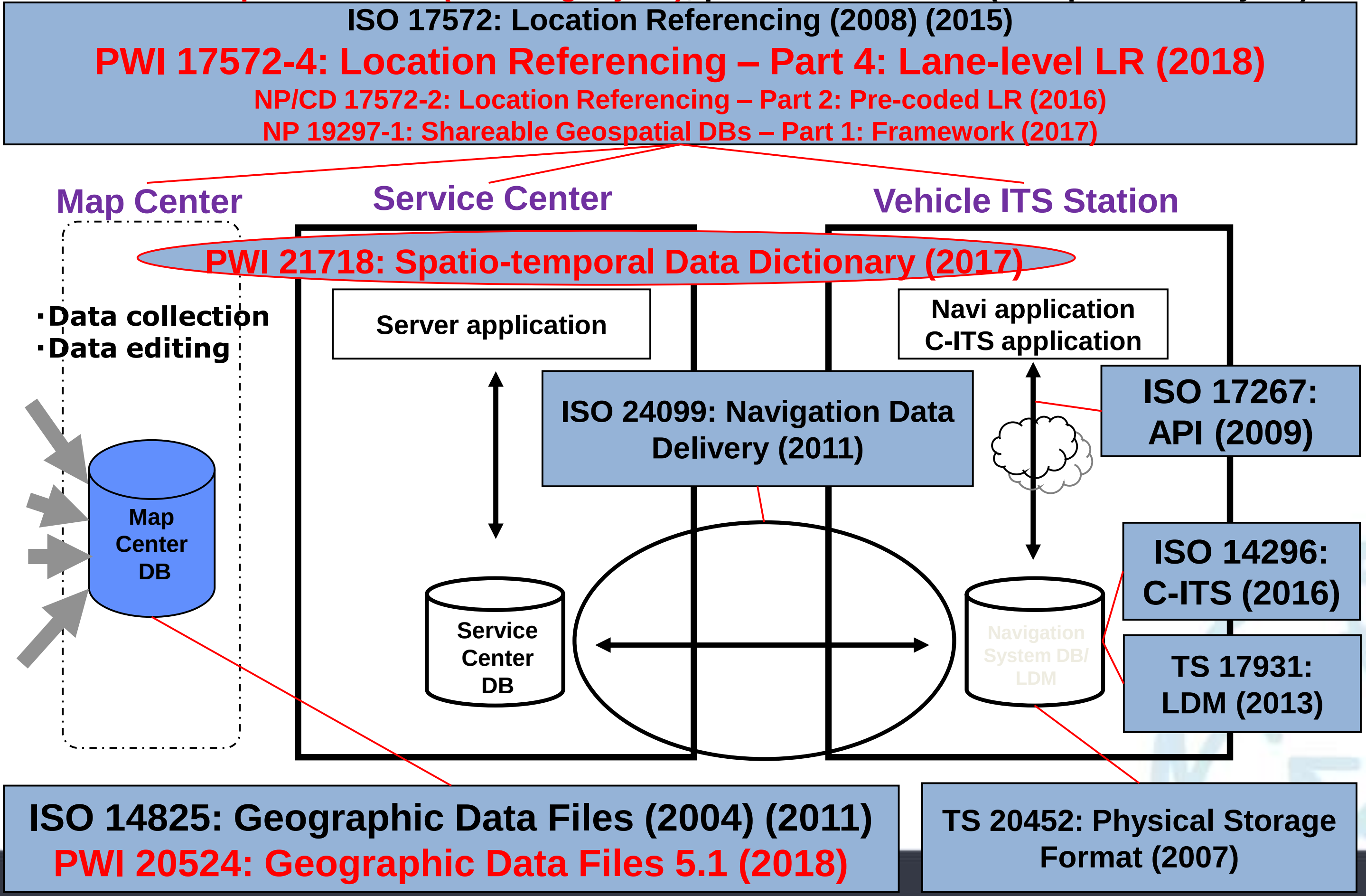
No IPR included!

Anyone or combination of 2-type locations:
(1) Differences (△) from CRP
(2) Percentage of geometric distance between CRPs and offset

*Source: Professor Nakajo, Tokyo University

FYR: Full Set of WG3 Work Items

under development=in red (with target year); published=in black (with publication year)



ISO 17572: Location Referencing (2008) (2015)

PWI 17572-4: Location Referencing – Part 4: Lane-level LR (2018)

NP/CD 17572-2: Location Referencing – Part 2: Pre-coded LR (2016)

NP 19297-1: Shareable Geospatial DBs – Part 1: Framework (2017)

PWI 21718: Spatio-temporal Data Dictionary (2017)

ISO 24099: Navigation Data Delivery (2011)

ISO 17267: API (2009)

ISO 14296: C-ITS (2016)

TS 17931: LDM (2013)

ISO 14825: Geographic Data Files (2004) (2011)

PWI 20524: Geographic Data Files 5.1 (2018)

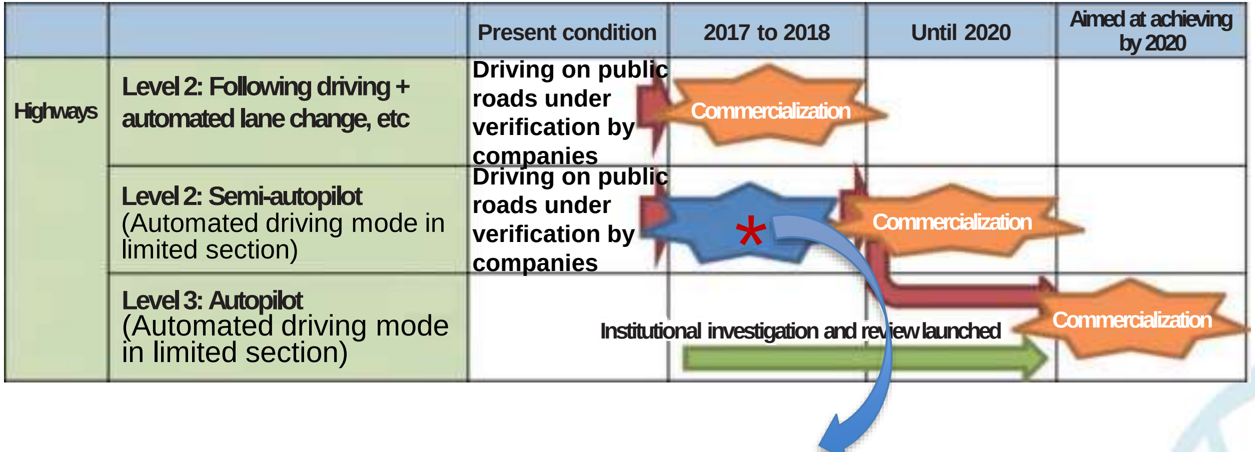
TS 20452: Physical Storage Format (2007)

Map Center
Service Center
Vehicle ITS Station
･Data collection
･Data editing
Map Center DB
Server application
Service Center DB
Navi application
C-ITS application
Navigation System DB/ LDM

Large Scale Verification Test for ADS

Expected time frame for the commercialization of automated driving systems on highways, etc

Level 2 = automation of two functions out of acceleration, steering, and braking



		Present condition	2017 to 2018	Until 2020	Aimed at achieving by 2020
Highways	Level 2: Following driving + automated lane change, etc	Driving on public roads under verification by companies	Commercialization		
	Level 2: Semi-autopilot (Automated driving mode in limited section)	Driving on public roads under verification by companies	*	Commercialization	
	Level 3: Autopilot (Automated driving mode in limited section)	Institutional investigation and review launched			Commercialization

***Large scale verification test for Dynamic Map, HMI, security, pedestrian, etc. on public roads**

***Source: Public-Private ITS Initiative, Roadmap 2016 (May 20, 2016)**

Any questions?

jshibata@drm.or.jp

***Source: ERTICO**

*Source: ERTICO