

EU-Japan Smart Mobility Public-Private Roundtable

Activities for Utilization of CLAS(Cm Level Augmentation Service) from QZSS and Proposal for Cooperative Work for SOL Applications

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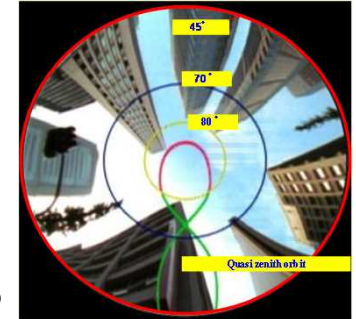
1 June, 2016



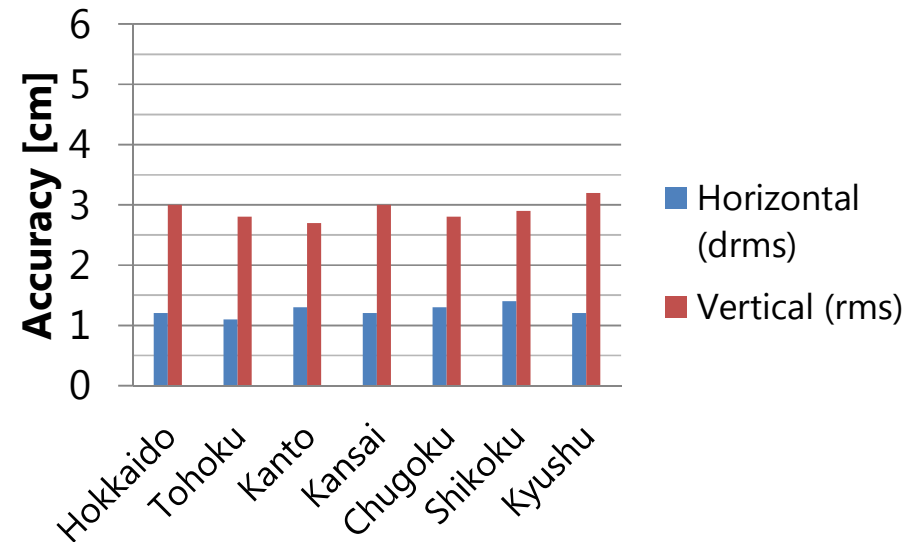
Unique Characteristics of QZSS

Realization of cm Level High Precision 3D Positioning

- QZSS has 2 major functions
 - GPS Complementary : Enhance positioning signal availability
 - Positioning Augmentation : Provide cm level high precision 3D positioning
- Cm level high precision 3D positioning is unique characteristics of QZSS
- MELCO has responsibility to generate and provide signal for Cm Level Augmentation Service, CLAS, from QZSS
- By using CLAS signal, GPS/QZSS positioning error correction information is available for all over Japan to realize cm level high precision 3D positioning



Example of
Positioning Accuracy
by CLAS

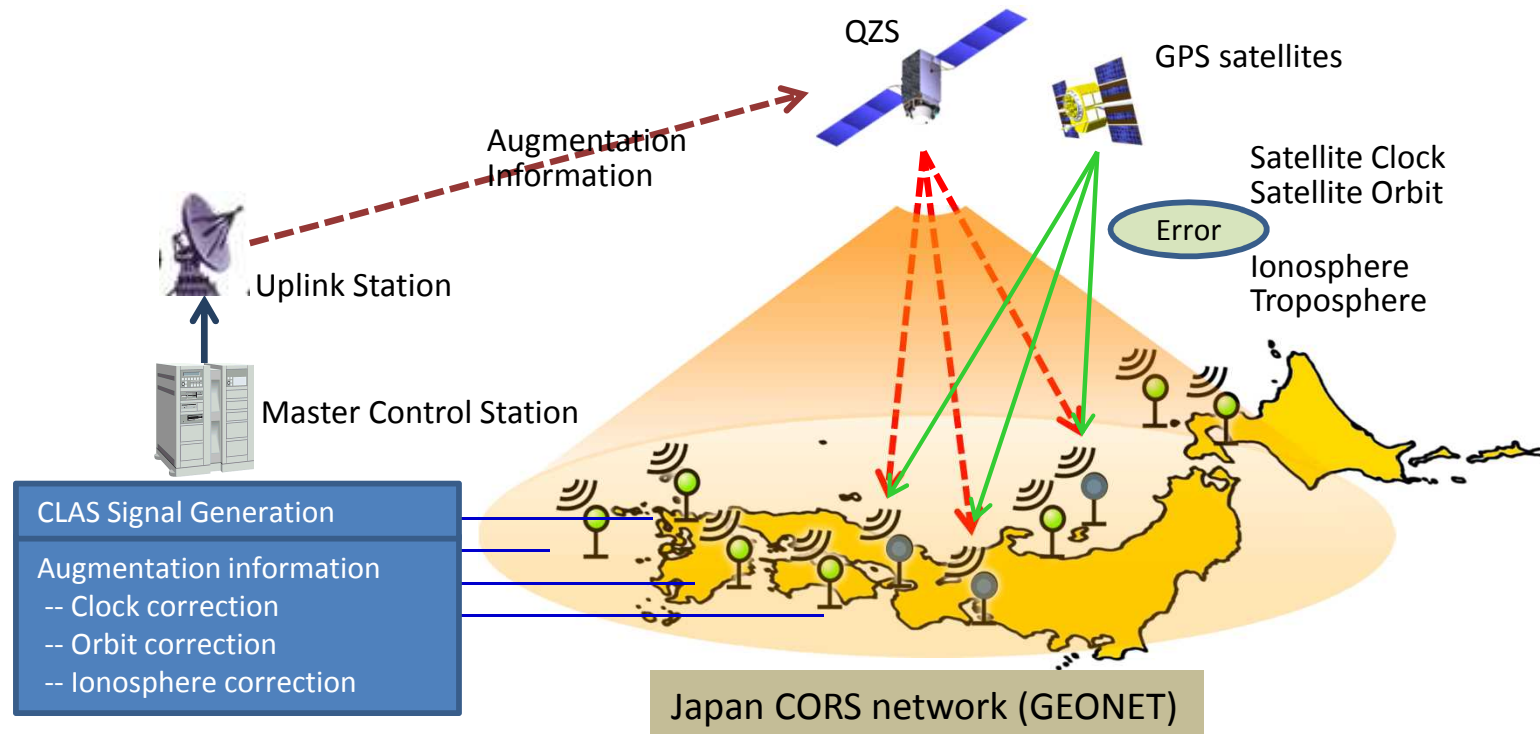


Static 2 days test result in February-October of 2010

Unique Characteristics of QZSS

How to generate CLAS signal

- Major sources of satellite navigation error are
 - 1) Ionospheric and Tropospheric delay,
 - 2) Satellite Orbit and Clock Determination Error,
 - 3) Satellite Signal Bias
- In Japan, there are more than 1,300 Continuously Operating Reference Stations (CORS)
- On each station, Multi-GNSS receiver is continuously tracking the signals from GPS, QZSS and Galileo satellites
- The signals monitored in CORS are processed in Master Control Stations to determine the correction data for each major error sources in real-time
- The error correction information is broadcasted from QZS



Various Possibility of CLAS Utilization

Utilization of cm Level High Precision 3D Positioning

- Utilization of cm level high precision 3D positioning has potential to create new innovative services and new industries that contribute creation of “Smart Society”

IT-Construction



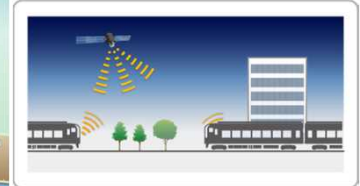
IT-Agriculture



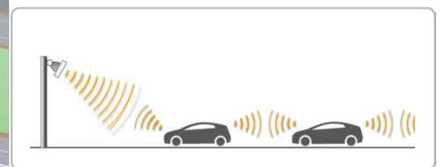
Marine Observation



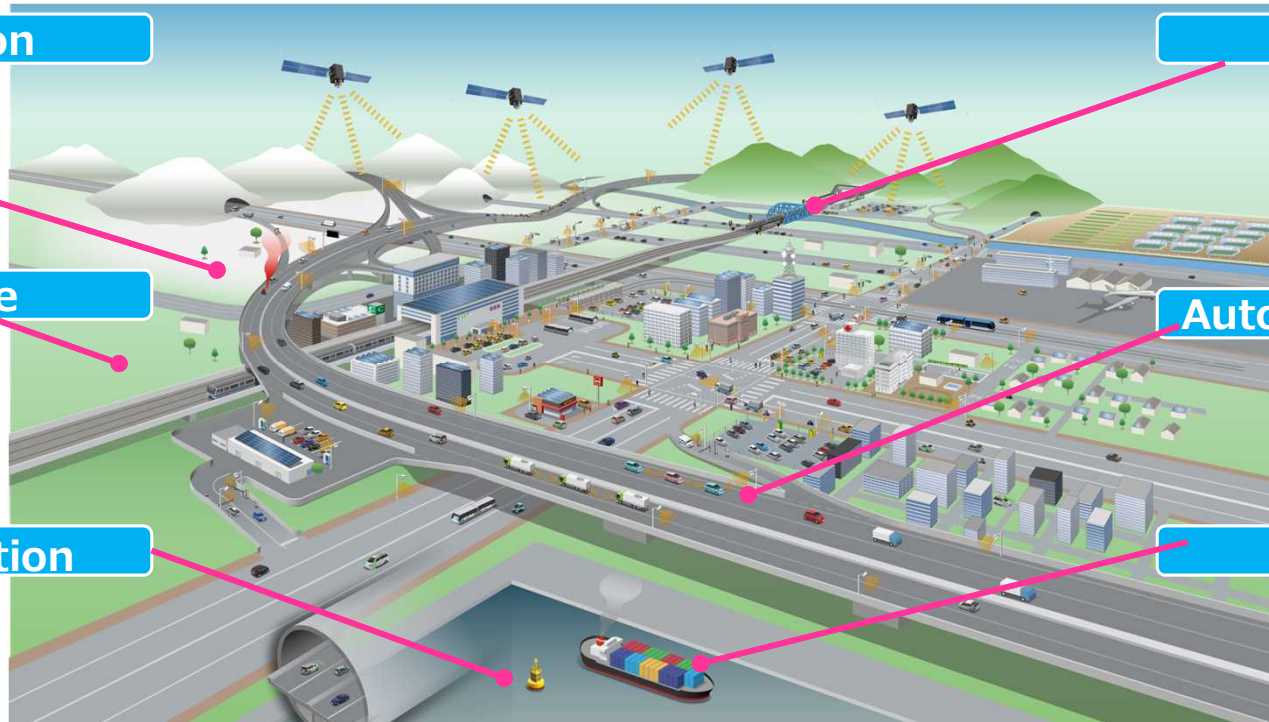
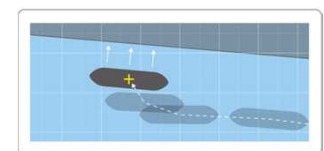
Train Control



Automated/Safe Driving



Ship Control



Various Possibility of CLAS Utilization

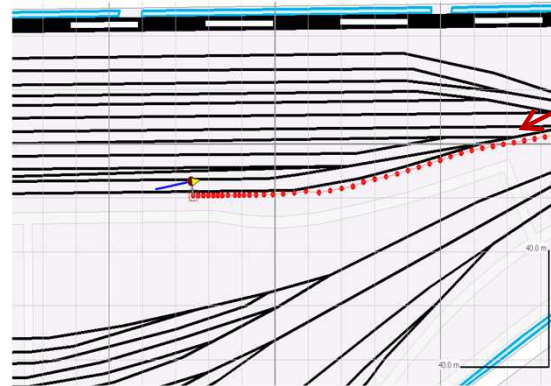
Major Application Areas of cm Level High Precision 3D Positioning



AR : Augmented Reality

Various Possibility of CLAS Utilization

Major Application Areas of cm Level High Precision 3D Positioning

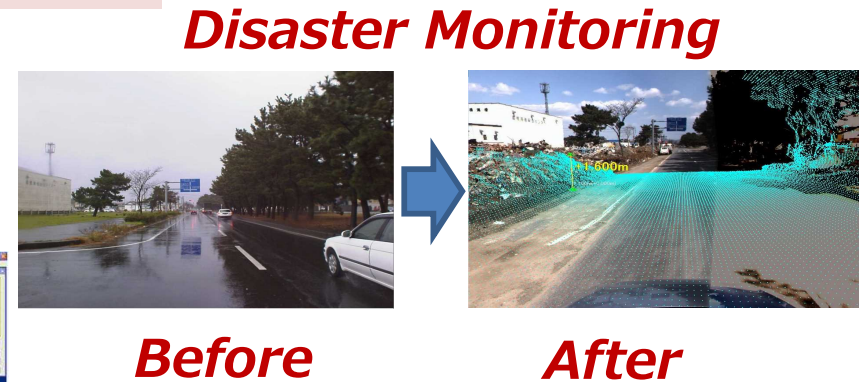
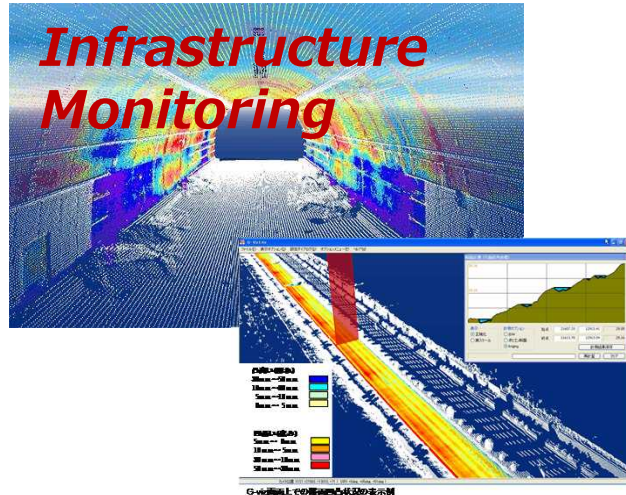


Demonstration Example

Movement of the train can be detected precisely using cm level high precision 3D positioning from QZS

Ref: kanai, Yokoyama and etc.
(East Japan Railway Company)
51th Railway Cyberne Symposium,
2014, Tokyo

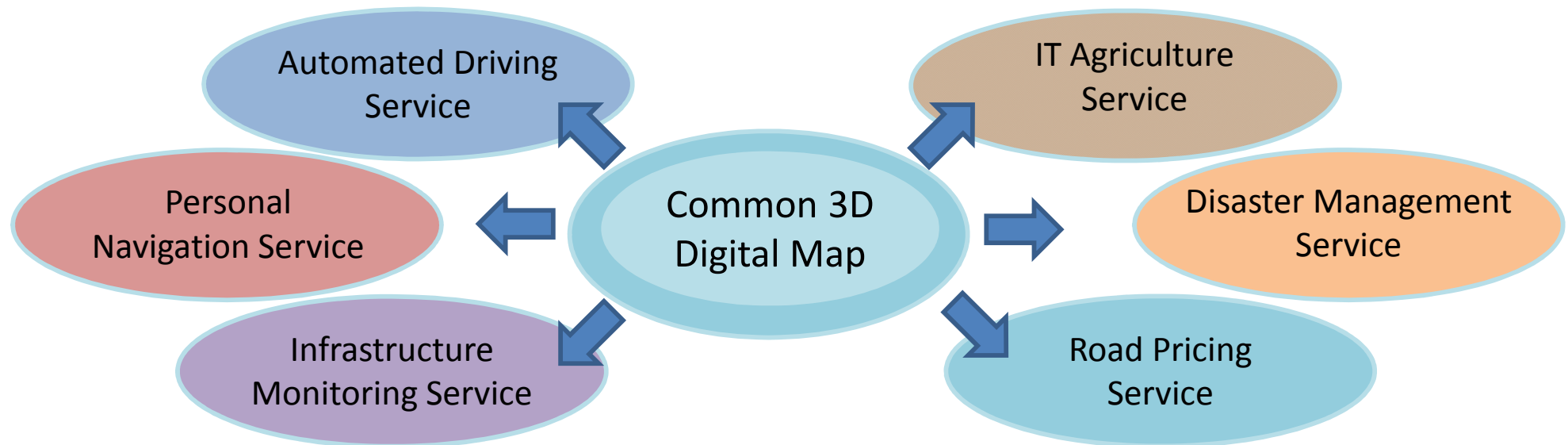
Utilization of 3D Digital Map



Common 3D Digital Map

Common 3D Digital Map Concept

- Various application businesses are under planning using high precision 3D navigation information using **CLAS**.
- To use high precision 3D navigation results, 3D map having same level positioning accuracy is required.
- It is more efficient and beneficial to develop 3D map that can be used for various application areas.
- From this point of view, “**Common 3D Digital Map Concept**” has been investigated through “**COCN(Council on Competitiveness-Nippon) activities**”



Common 3D Digital Map

Accuracy Requirements for Common 3D Digital Map

- Concept of “Common 3D Digital Map” has been investigated through COCN activities
- Following Table shows accuracy requirement for “Common 3D Digital Map” from each application area.
- 10cm-30cm accuracy is required for “Common 3D Digital Map”.

Accuracy Requirements for Common 3D Digital Map

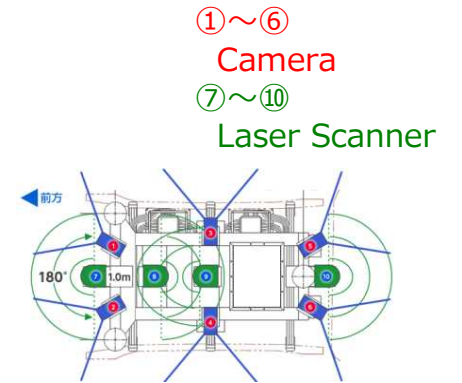
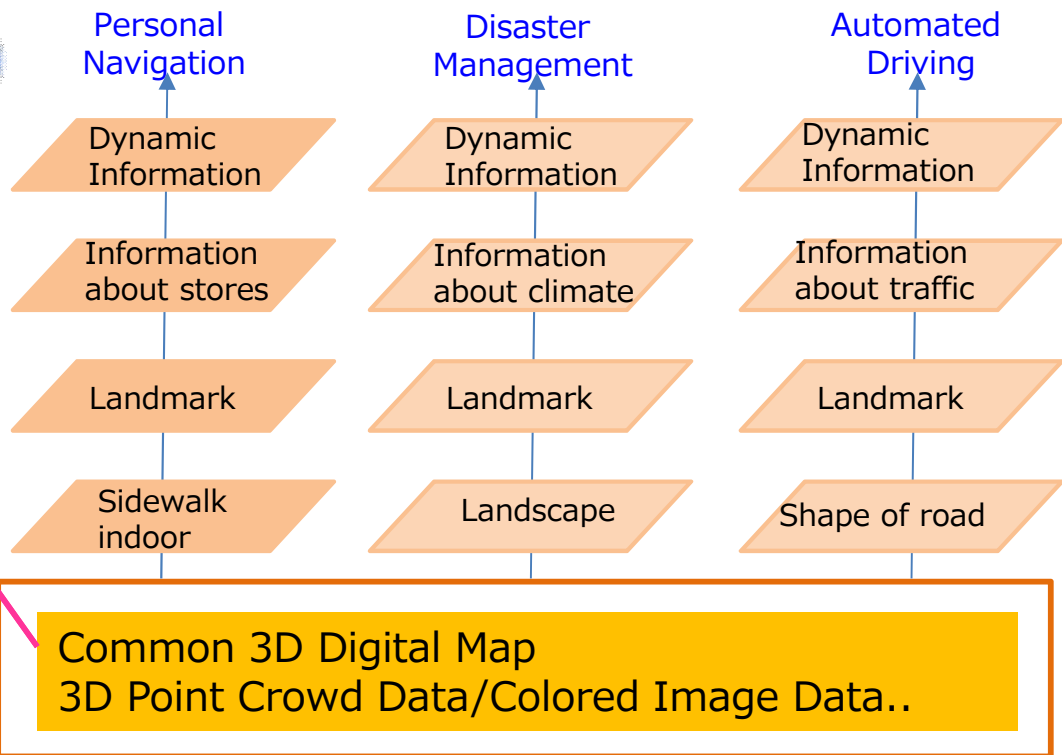
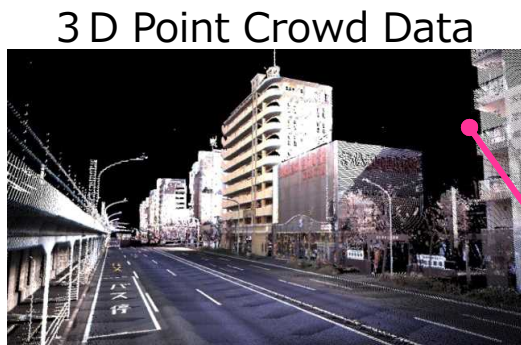
	Automatic Driving	Road Pricing	Maintenance of Infrastructure	Disaster Management	IT agriculture	Personal Navigation
Required 3D Map Data	Road	Road	Road (incl. Surface) Tunnel Bridge	Road	Road	Road
Accuracy 1m						
10cm-30cm						
1cm- mm-						

Ref: COCN Report 2015 <http://www.cocn.jp/report.html>

Common 3D Digital Map

Structure of Common 3D Digital Map

- “Common 3D Map” will be consist from following digital data
 - 3D Point Crowd Data/Colored Image Data/Common Vector Data
- 3D Point Crowd Data can be obtained by MMS(Mobile Mapping System) with Laser Profiler, Color Image Sensor and High Precision GNSS Receiver.
- Various information layers are overlaid on the information extracted from the “Common 3D Digital Map”



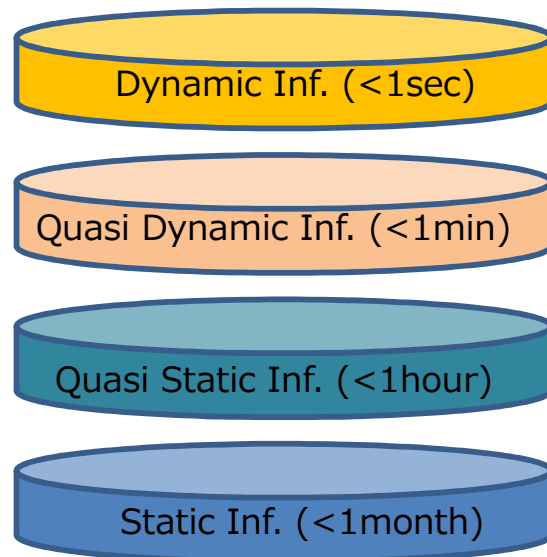
Mobile Mapping System (MMS)

Ref: 2nd SIP-adus Workshop, “Activity Plan of Dynamic Map Study for SIP-adus, Oct.,2015”

Common 3D Digital Map

Dynamic Map for Automated Driving

- In SIP-adus, “Dynamic Map” is investigated for Automated Driving.
SIP-adus : Cross-Ministerial **S**trategic **I**nnovation **P**romotion Program
 Innovation of **A**utomated **D**riving for **U**niversal **S**ervices
- “Dynamic Map” include static and dynamic information required for Automated Driving and consists of 4 information layers generated from “Common 3D Digital Map”.



Information through V to X

- surrounding vehicles
- pedestrians
- timing of traffic signals

Traffic Information

- accidents
- congestion
- local weather

Planned and forecast

- traffic regulations
- road works
- weather forecast

Basic Map Database

- digital cartographic data
- topological data
- road facilities

Common 3D Digital Map



Ref: 2nd SIP-adus Workshop, “Activity Plan of Dynamic Map Study for SIP-adus, Oct.,2015”

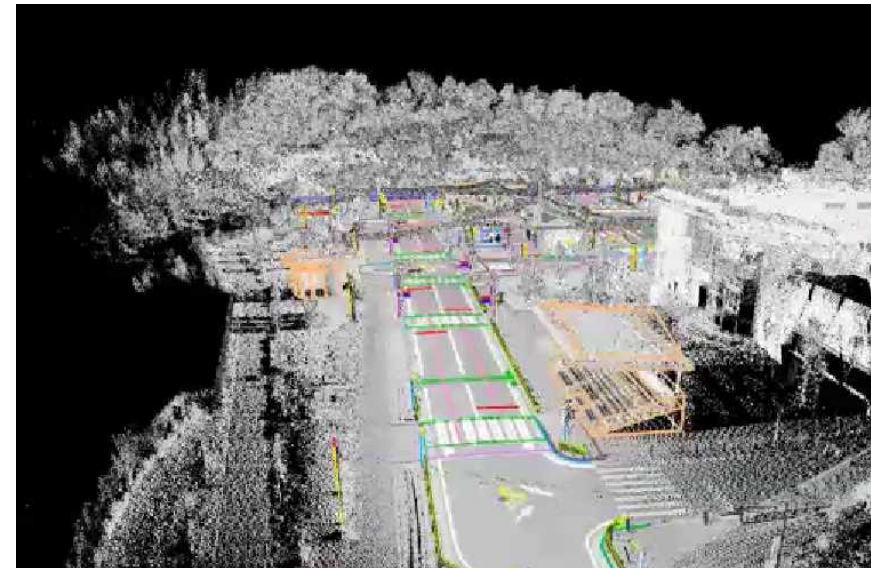
Common 3D Digital Map

Example of Prototyping of Dynamic Map

- “Dynamic Map Prototyping” has performed based on the investigation results of “Dynamic Map Data Structure” and “Dynamic Map Data Updating”.
- 3D digital map information around “Odaiba” is used for this purpose.
- To evaluate the behavior of the Dynamic Map, “Dynamic Map Viewer” is also developed.



Area for Prototyping
(Odaiba, Tokyo)



Dynamic Map Viewer

Utilization of High Precision Positioning for SOL Applications

- Various applications are included in SOL(Safety Of Life) fields using cm level high precision positioning.
- Automobile, Rail, Maritime and etc. are major application fields of SOL.



Proposal for Joint Investigations for SOL Applications

- For cm level high precision positioning, **Galileo provides PPP and QZSS provides CLAS.**
- However, **to promote and extend utilization of cm level high precision positioning for SOL applications, followings should be investigated, clarified and demonstrated.**
 - **How to provide continuous and accurate navigation solution** under restricted navigation satellite viewing conditions
 - **How to judge reliability of navigation signal** from each navigation satellite (including discussion of **ARAIM**)
 - **How to utilize integrity** in SOL applications
 - **How to realize authentication scheme** in SOL applications
 - **How to standardize the “Common 3D Digital Map”** for utilization of high precision positioning and etc.
- MELCO proposes to make joint investigations regarding above mentioned topics.

Thank you for your attention



for a greener tomorrow