



SIP-adus Workshop2019
Dynamic Map

High Definition 3D Map

Activities for Data Maintenance Solution

November 13th, 2019

Dynamic Map Platform Co., Ltd.

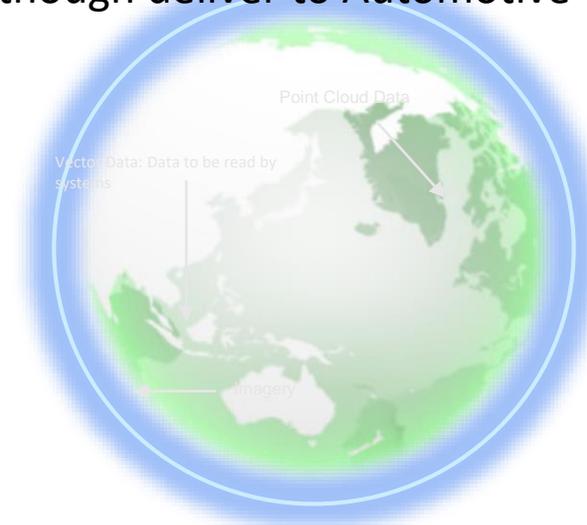
“ Remodeling of the earth “

Deliver 3S to the Society through our 3D Digital Data :

SAFETY ▪ **S**AVING ▪ **S**EAMLESS



Multipurpose though deliver to Automotive



Provide High Definition 3D Map by utilizing satellite for high precision positioning and measurement.

Our Business Area

Satellite positioning

Develop position correction technology



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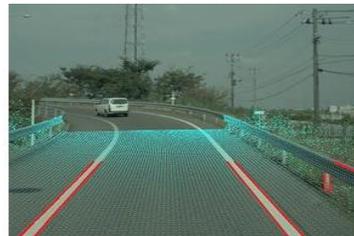
Measurement

Generate point clouds with Mobile Mapping System (MMS)



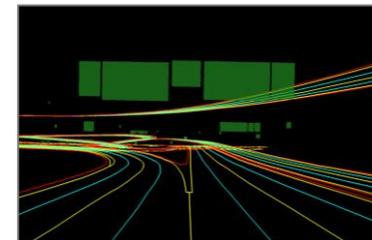
Mapping

Plot geographical objects from point clouds

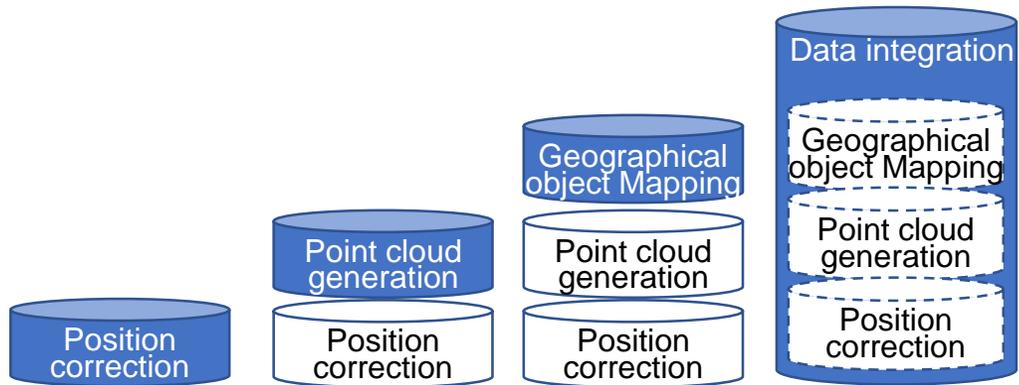
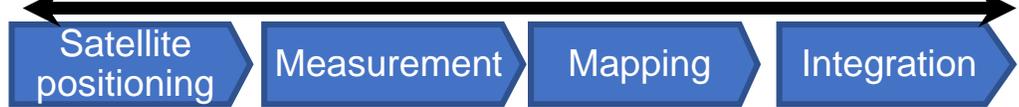


Integration

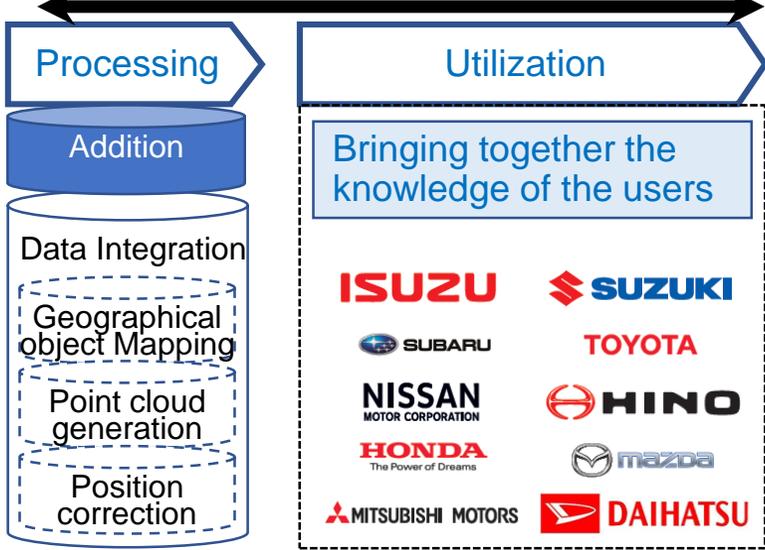
Integrate various data



“High-Precision Three-Dimensional Map Data” Cooperation Areas



Competitive Areas



Multipurpose Utilization

HD-Map Data Characteristics

Traditional Electronic Maps



Source :
Geospatial Information
Authority of Japan

Maps for people (drivers) to read

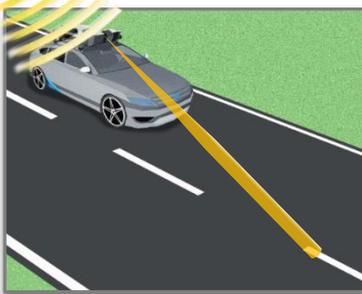
Routing and Guidance



Example of Navigation Map by IncrementP



Map developed by High Precision Positioning and Laser Scanning



Survey by using Mobile Mapping System

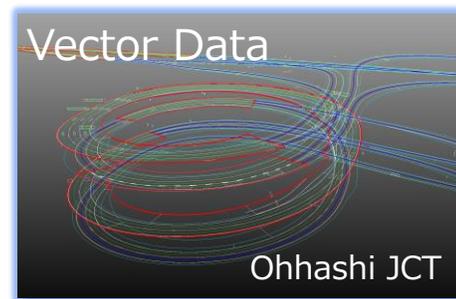
Maps for automated driving

Point Cloud Data



- cm Level of Absolute Accuracy
- Modify by Application
- Efficient Data Survey Method

Vector Data



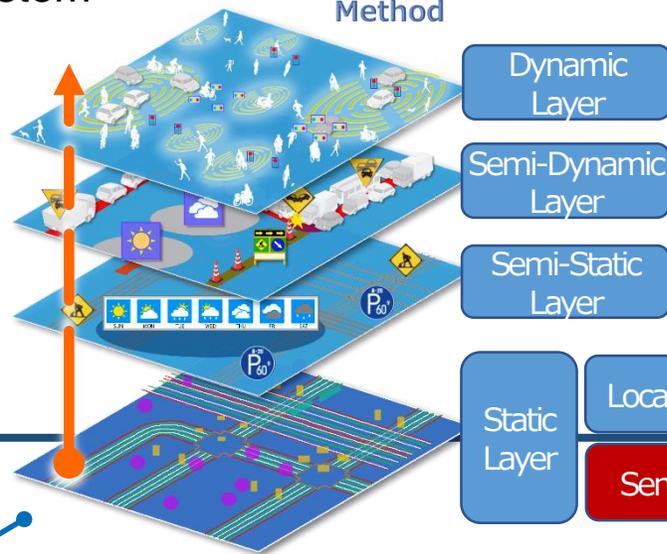
- Suited Data for Automated Driving
- Road Networking with Absolute Accuracy
- Method to Annotate the related data

Nearby vehicles, pedestrians, traffic signals, etc.

Accidents, traffic jams, spot weather conditions, etc.

Traffic regulations, road works, regional weather conditions, etc.

Traffic lights, traffic signs, etc.



Dynamic Layer

Semi-Dynamic Layer

Semi-Static Layer

Static Layer

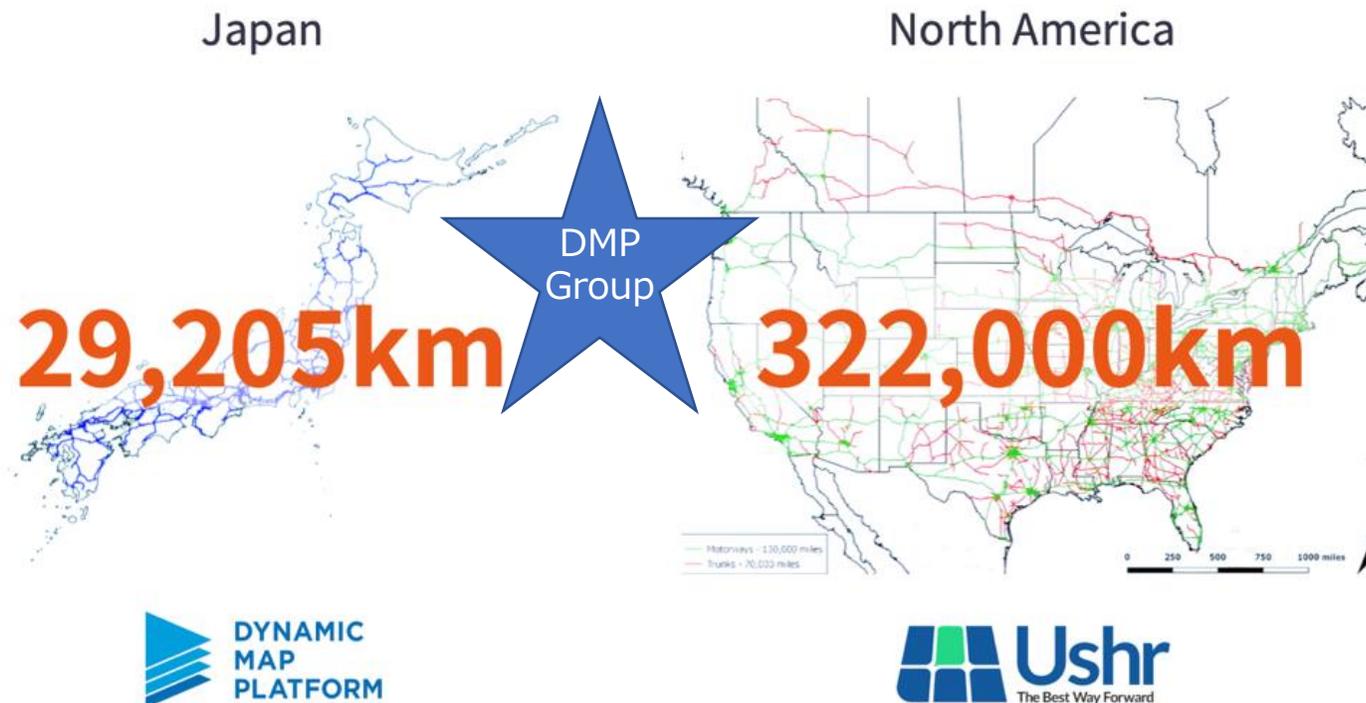
Localization

Semantic

Basic road structures

DMP Group : Ushr Acquisition (2019 Apr)

- Ushr became DMP Group Company in 2019 Apr
- Promote HD-Map for Social Infrastructure in Global World by Integrating On-Hand Technology of DMP Group.



DMP: Complete 29,205km of Highway Data in Japan
Ushr: Complete 322,000km of Highway and major roads Data in NA.
Continue measuring ordinary roads.

Automated Driving selects DMP/USHR 3D HD-Map

➤ GM “Cadillac” selects Ushr HD Map for the World 1st Hands Free Driving.



Cadillac “Super Cruise” (2017 in North America)

➤ Nissan Motor “ProPILOT 2.0” selects DMP HD Map(*) for it’s Intelligent Highway Driving.

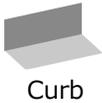
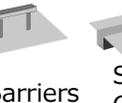
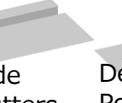
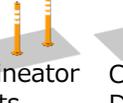
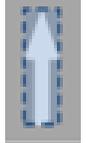
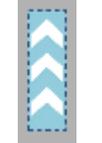
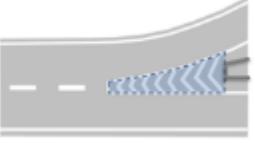
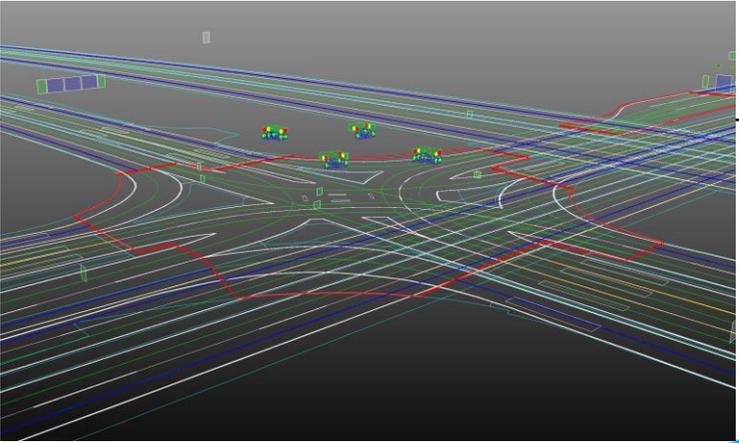
(*) DMP provide Cooperation Area Data for Map



Nissan Motor “ProPILOT 2.0” (Fall 2019 in Japan)

※ 出典 : <http://www2.nissan.co.jp/SP/SKYLINE/PROPILOT2/?rstid=20140314rst000001001>

3D HD-Map Road Features

Road Features	Examples
Carriageway Markings	  Road Studs  Deceleration Markings  ← Outline of Channelizing strip
Multiple Carriageway Markings	  
Shoulder Edge	 Curb  Protection Walls  Guardrail  Road Fence  Rigid Barriers  Side Gutters  Delineator Posts  Cushion Drum  Barricade Blocks
Road Marking	    ← Fill of Channelizing Strip
Traffic Regulation	 非常駐車帯  50  登坂車線 SLOWER TRAFFIC  本線 THRU TRAFFIC  16 横浜 町田 Yokohama Machida 4 出口 1km EXIT  ETC 一般  ETC車 
Vehicle Traffic Light	  

3D HD-Map Data provide with "Vector Data" composed by above road features.

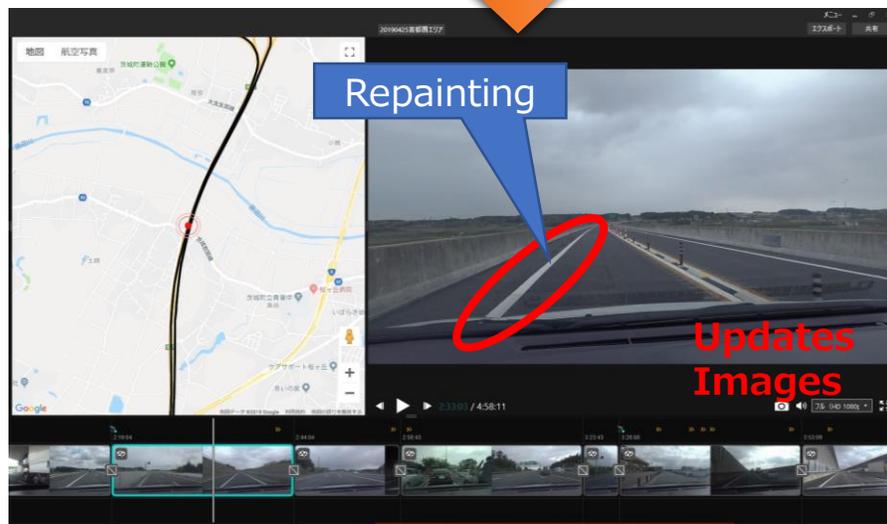
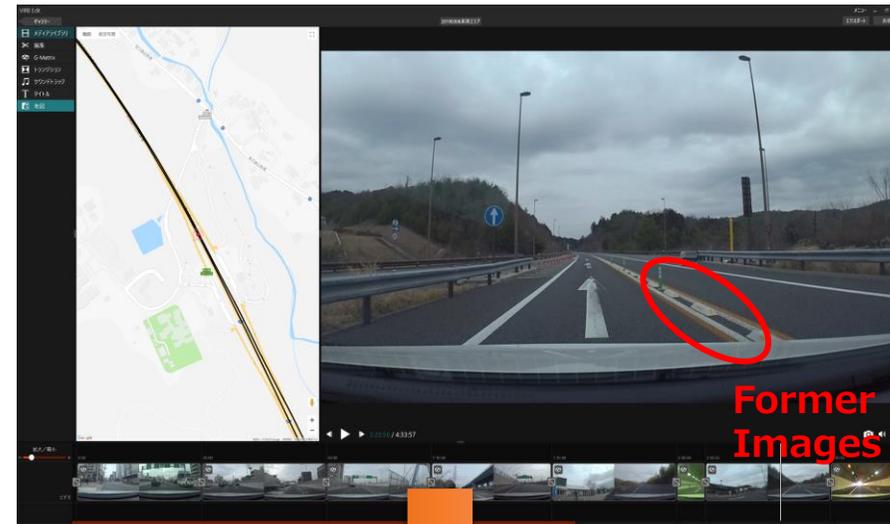
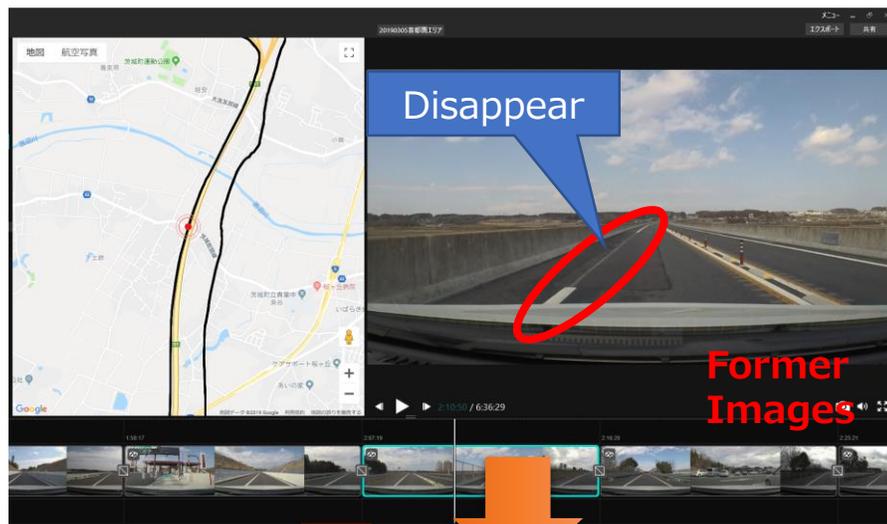
Today's Status : 3D HD-Map Maintenance Concerns

Manual checks are required to capture the non-structured road changes, so maintaining the “Freshness” and “Maintenance Cost” are major issues .

Geographical Feature Changes		Today's Status			
		From Whom	How	When	
Road Structure Changes	New Road Development	✓ Road Operators' Information	✓ Monitoring the Website of Road Operators' ✓ Direct Interview	✓ 1month ahead of Changes	
	Road Extension				
	Changes to lane shape				
	Changes to number of lanes				
	Widened roadways				
	Add/remove/change ICs				
	Add/remove/change SA/Pas				
	Add/remove/change JCT				
	Add/remove/change toll gates				
Changes in merging lanes					
Beside Road Structure Changes	Changes to number of lanes	✓ Ditto	✓ Ditto	✓ 2 to 4 weeks ahead of changes	✓ Incomplete coverage of information
	Widened roadways				
	Changes in merging lanes	✓ None	✓ None	✓ None	✓ Difficult to detect Road changes
	Add/remove/change roadside structure				
	Add/remove/change channelizing strips				
	Add type/color of carriageway markings				
	Add/remove/change emergency stopping areas				
	Repainting of carriageway marking				
	Add/remove/change road signs				
	Add/remove/change road marking				
Add/remove/change traffic lights					

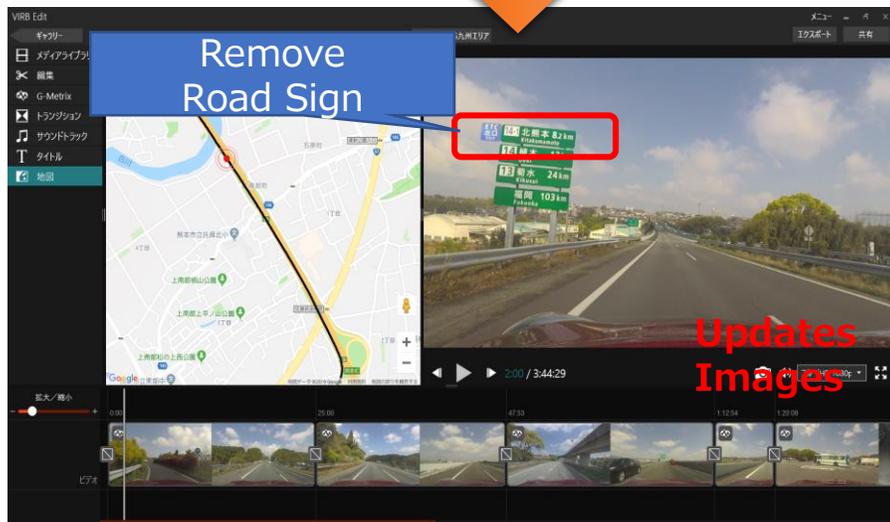
Drive the area to collect images and detect the changes by comparing with former images

- Carriageway Marking / Road Sign / Repainting Arrow

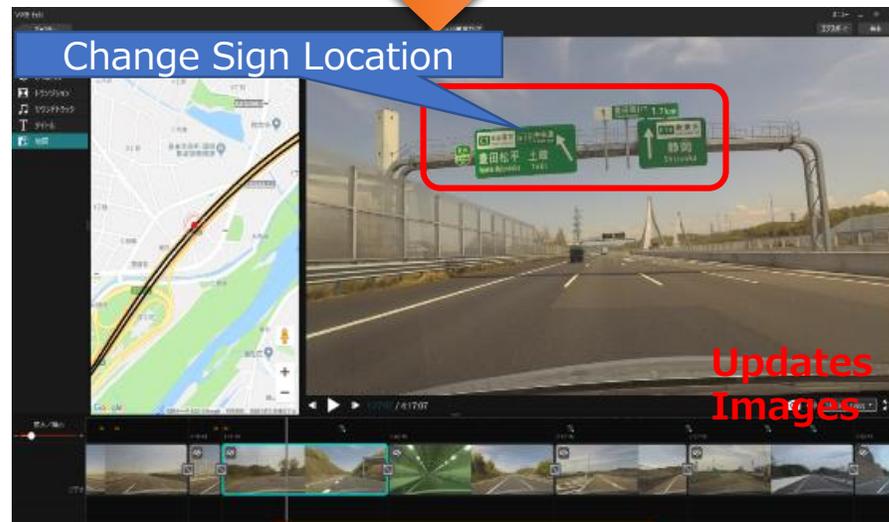
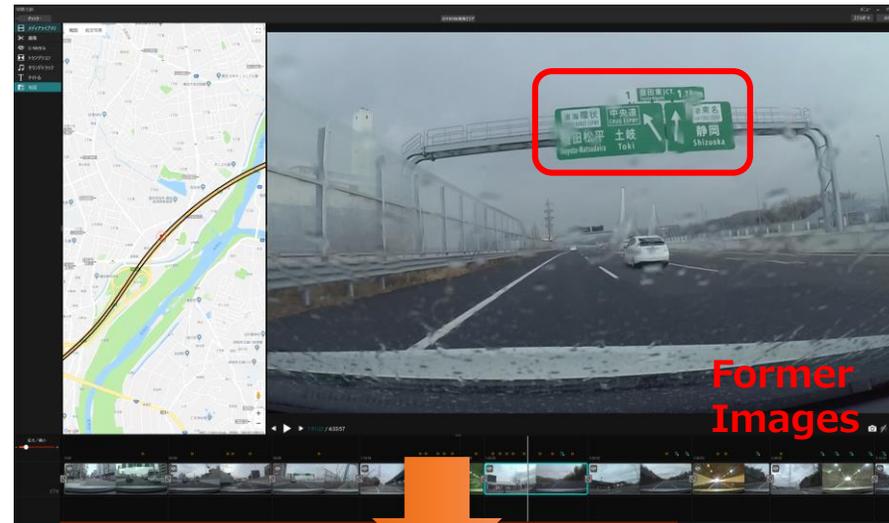


Drive the area to collect images and detect the changes by comparing with former images

❑ Remove the Road Sign

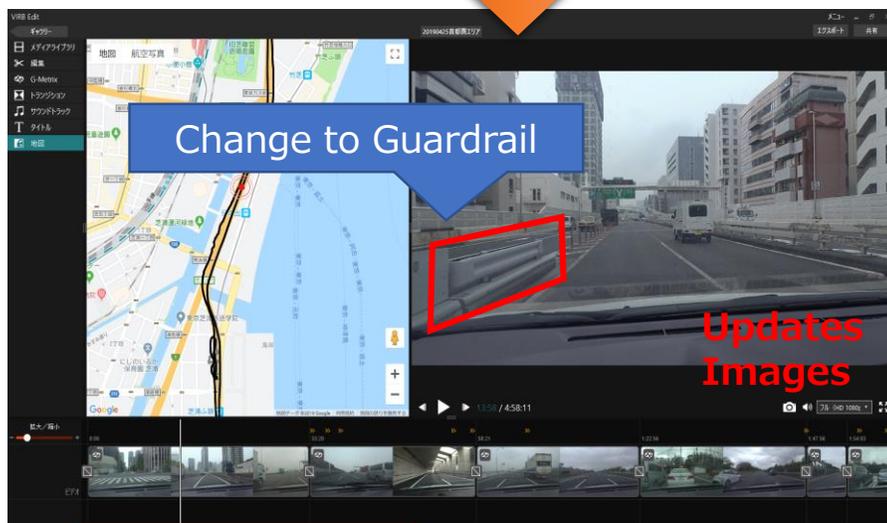
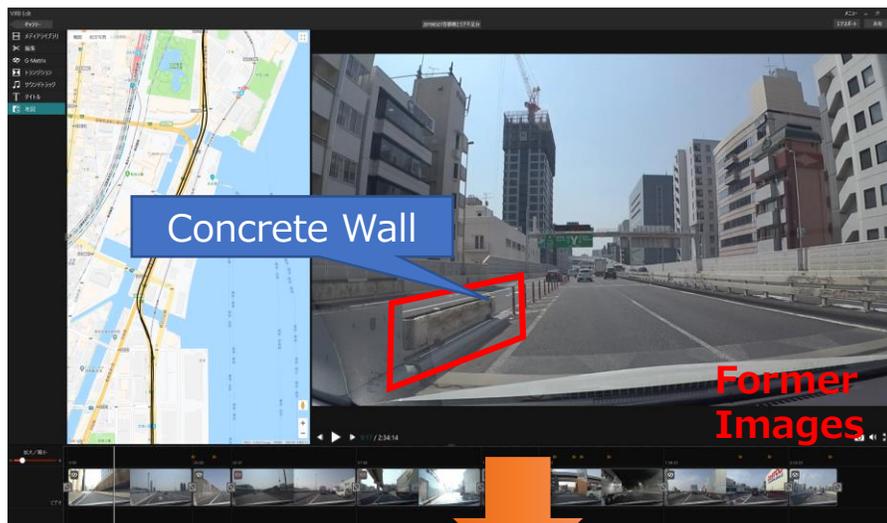


❑ Move the Road Sign

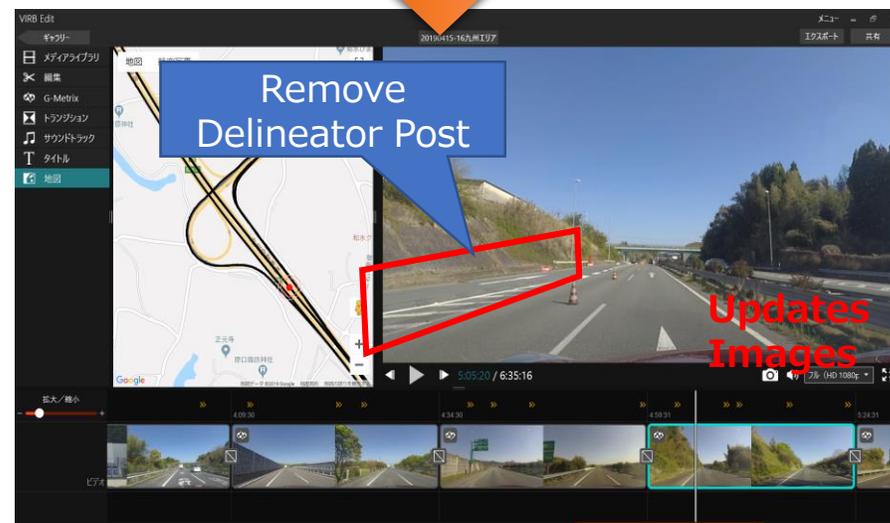
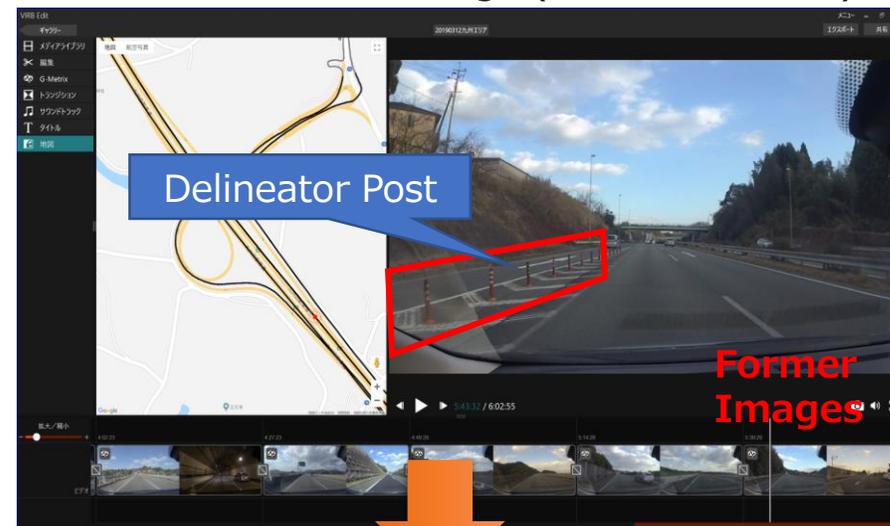


Drive the area to collect images and detect the changes by comparing with former images

- Change Shoulder Edge (Guardrails)

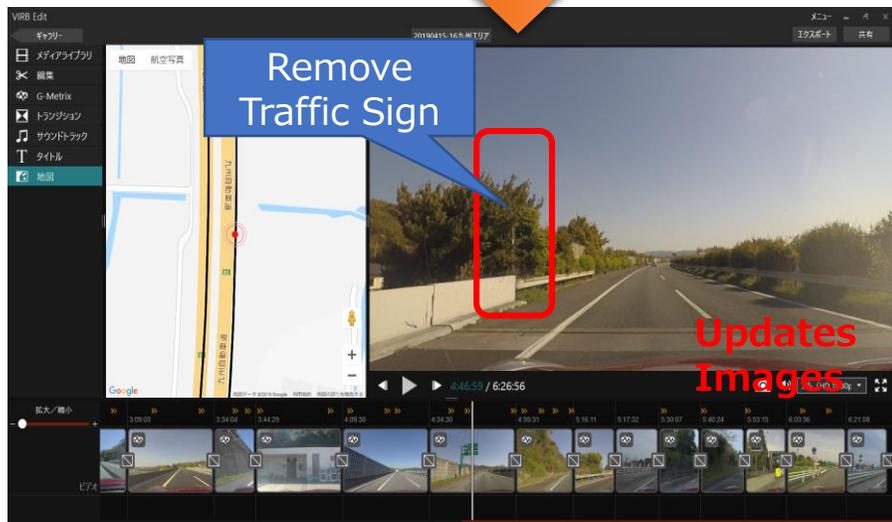
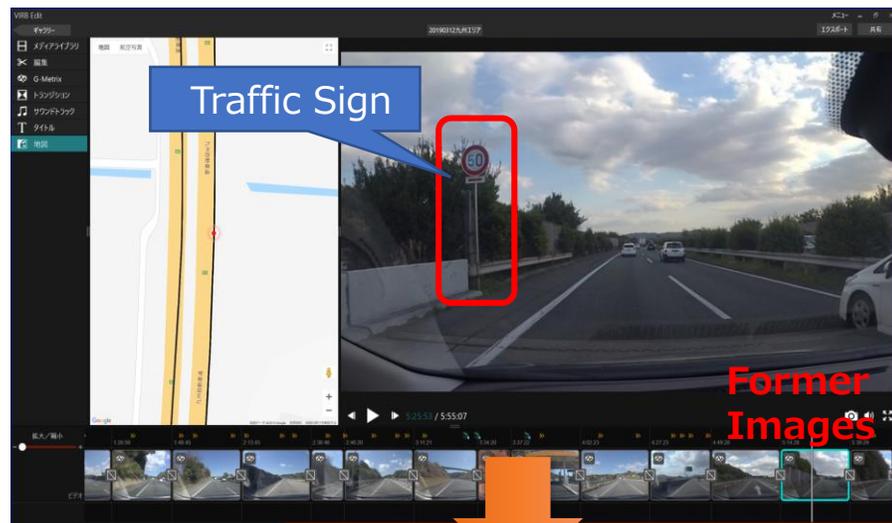


- Add/Remove Shoulder Edge (Delineator Posts)



Drive the area to collect images and detect the changes by comparing with former images

❑ Remove Traffic Sign



❑ Change Traffic Sign



Solution for 3D HD-Map Maintenance

Manual checks are required to capture the non-structured road changes, so maintaining the “Freshness” and “Cost Effectiveness” are major issues .

Geographical Feature Changes		Today's Status		
		From Whom	How	When
Road Structure Changes	New Road Development	✓ Road Operators' Information	✓ Monitoring the Website ✓ Direct hearing	1 month ahead of Changes
	Road Extension			
	Changes to lane shape			
	Changes to number of lanes			
	Widened roadways			
	Add/remove/change ICs			
	Add/remove/change SA/PAs			
	Add/remove/change JCT			
	Add/remove/change toll gates			
	Changes in merging lanes			
Beside Road Structure Changes	Changes to number of lanes	✓ No systematic way of information gathering. ✓ Difficult to detect the changes on time.	2 to 4 weeks ahead of Changes •Comprehensiveness is low	
	Widened roadways			
	Changes in merging lanes			
	Add/remove/change roadside structure			
	Add/remove/change channelization strips			
	Add to type/color of carriageway markings			
	Add/remove/change emergency stopping areas			
	Repainting of carriageway marking			
	Add/remove/change road signs			
	Add/remove/change road markings			
Add/remove/change traffic lights				

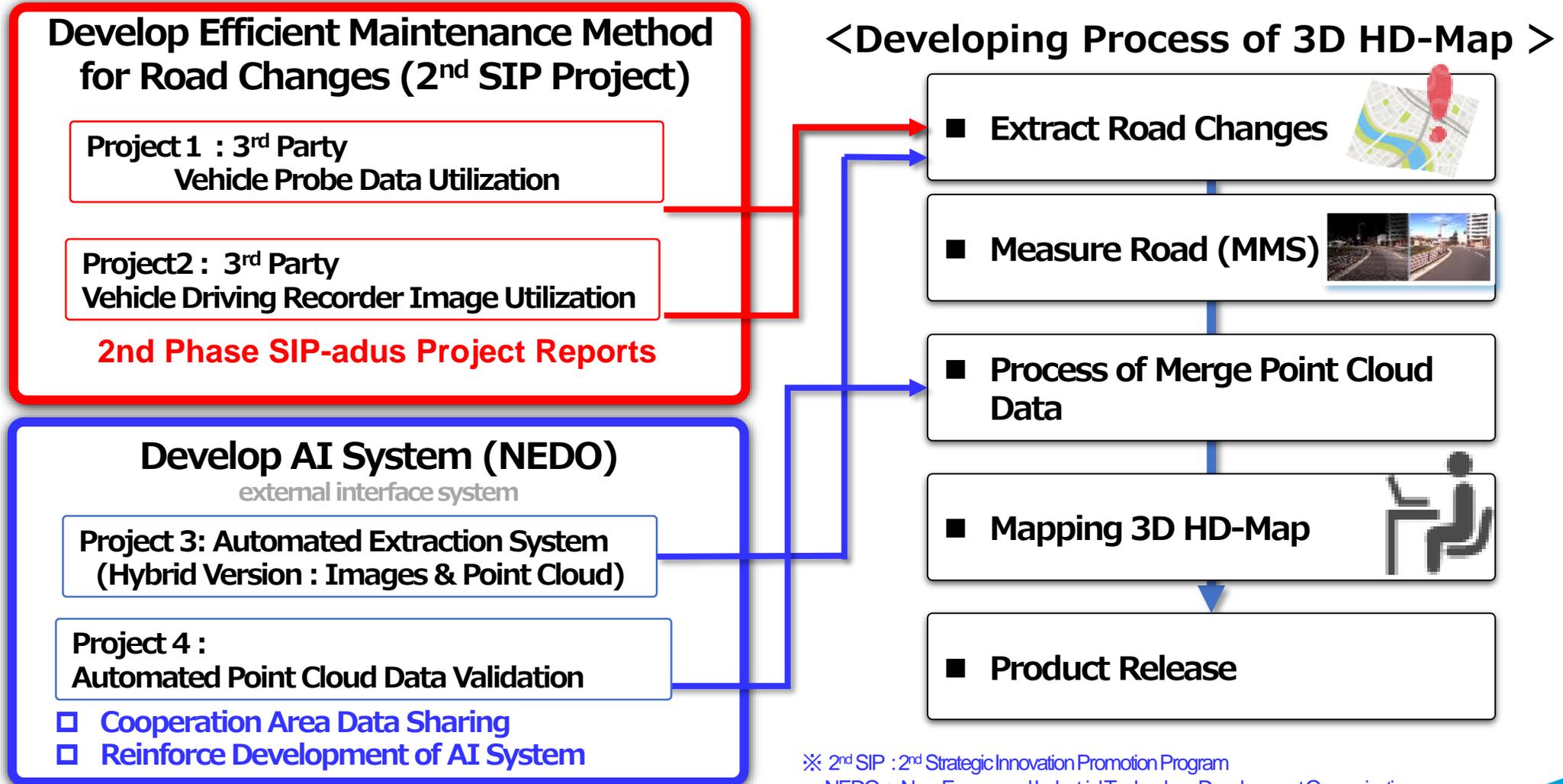
Develop Automated System for Road Change Detection

- ✓ Probing Vehicles
- ✓ Image Recognition
- etc.

“It is vital to understand the cases without structural changes”

Challenges for 3D HD-Map Maintenance Solution

Examine Effective Road Change Detection through Grant-in-AID for Scientific Research Programs: 2nd SIP/NEDO(※)

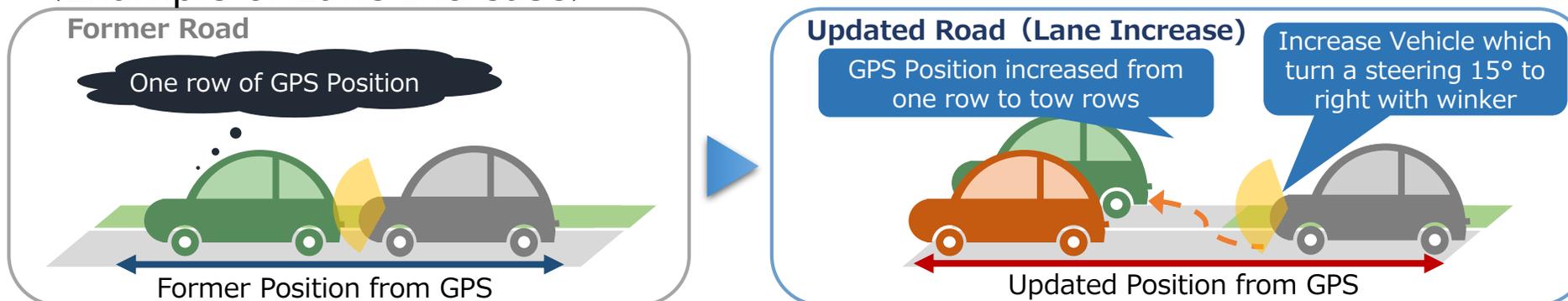


※ 2nd SIP : 2nd Strategic Innovation Promotion Program
NEDO : New Energy and Industrial Technology Development Organization

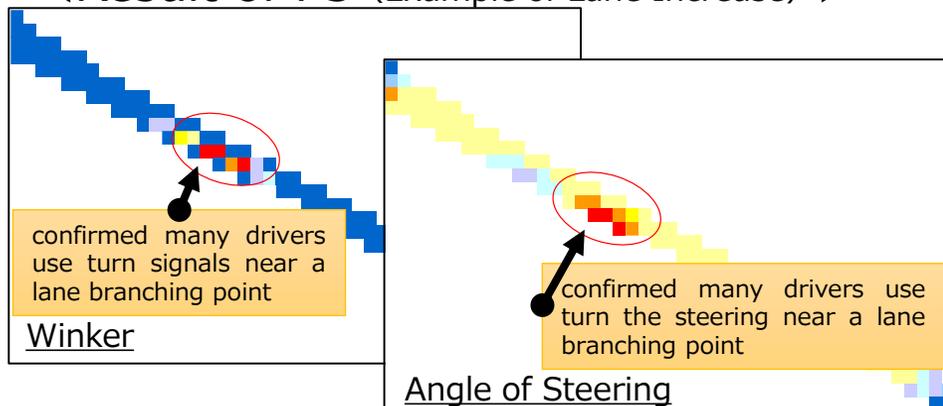
Project 1 : Vehicle Probe Data Utilization for Change Detection

- The Probe Requirements for Change Detection have been Studied
- Collect 3rd Party OEM Vehicle Probe Data (Completed Private Data Protection)
- It will be Verified Whether HD Map Change Points can be Extracted by Using Vehicle Probe Information Traveling in an Actual Traffic Environment

<Example of Lane Increase>



<Result of FS (Example of Lane Increase) >

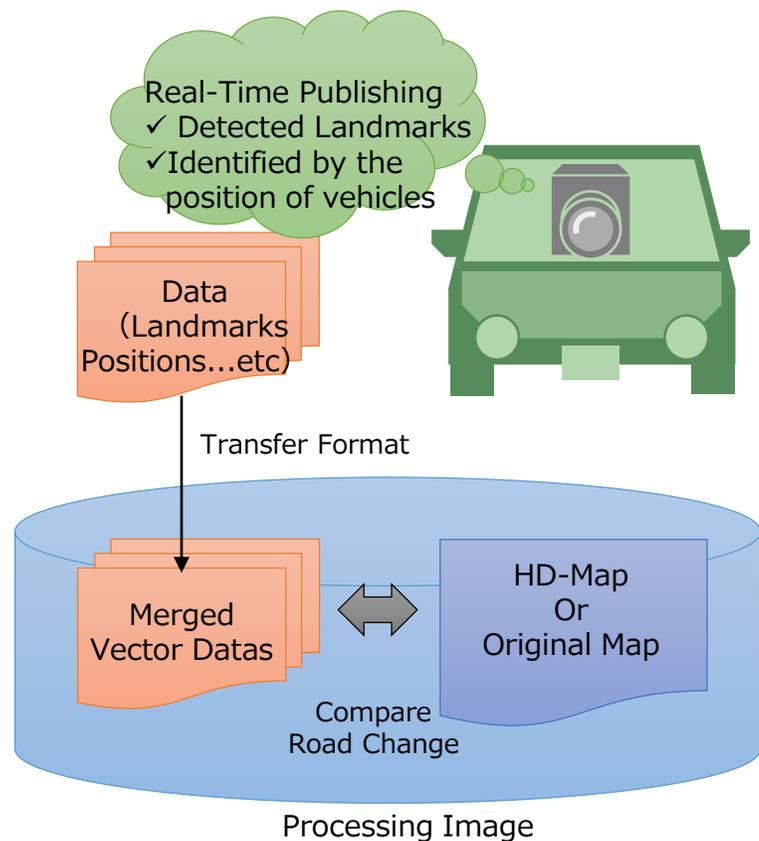


<3rd Party Vehicle Probe>

Probe Data
① Time
② Location
③ Speed
④ Acceleration
⑤ Winker on/off
⑥ Rotation Angle of Steering

Project2 : Vehicle Driving Recorder Image Utilization for Change Detection

- Visual Landmarks such as Road Signs and Road Markings can be Detected from Images Generated by Drive Recorders.
- The Positions of Visual Landmarks can be Identified by the Position of Vehicles.
- Generate Vector Data from Landmarks and Positions
- Compare The Vector Data with HD Map(Vector data)to Confirm Landmark Changes



	Extract Carriageway	Extract Road Sign
How to Extract	<p>Fuji IC⇔Shimizu IharaIC</p>	<p>Detect Traffic Sign</p>
	<p>Detect Carriageway Marking</p> <p>Yotsugi Ramp→Senju Shinbashi Ramp</p>	<p>Detect Added Traffic Sign</p>

Collect Images and Detect the Road Landmarks

Project 3: The Road Change Extraction Technology utilizing measurement information (Images & Point Cloud)

To develop a tool for automatically extracting Road Change points by using Point Cloud Data and MMS Data.

- Feature is preliminarily selected from point cloud data and MMS image data already acquired, tagged and stored as training data.

Feature Examples to Point Cloud Data

Delineator Post



Utility Pole



Feature Examples to Former Image Data

Step Pavement



Traffic Sign



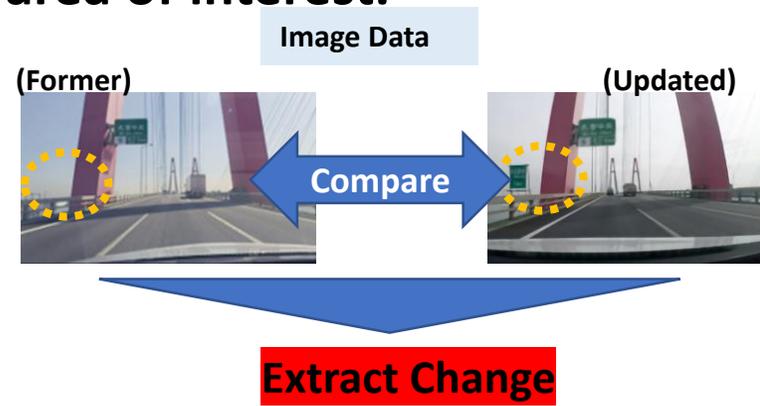
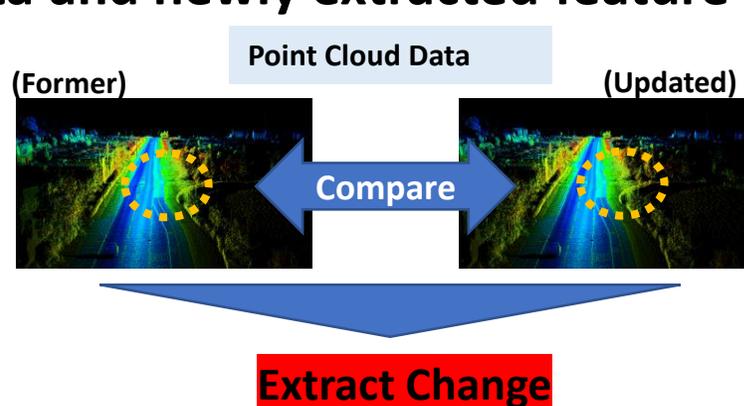
Road Lane



Zebra Zone



- Feature point extraction by deep learning is performed on new point group and new image data, using the training data to specify a feature.
- Confirm the identity and extract changes by comparing the feature of old data and newly extracted feature of the area of interest.

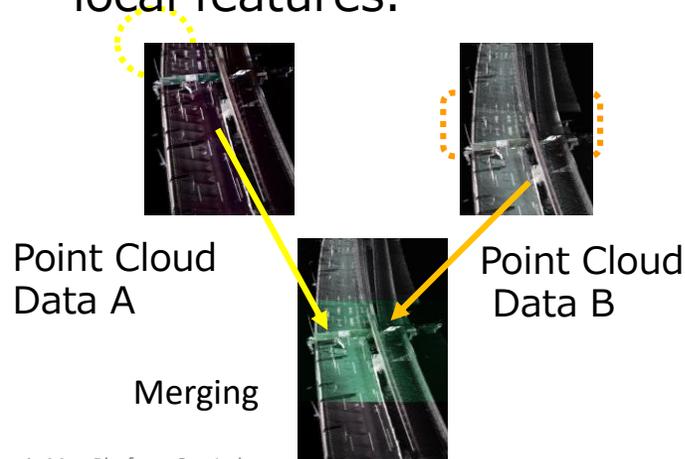


Project 4 : Automated Point Cloud Merging Technology

To develop a tool for mechanically performing Point Cloud Data joining processing using annotated Point Cloud Data.

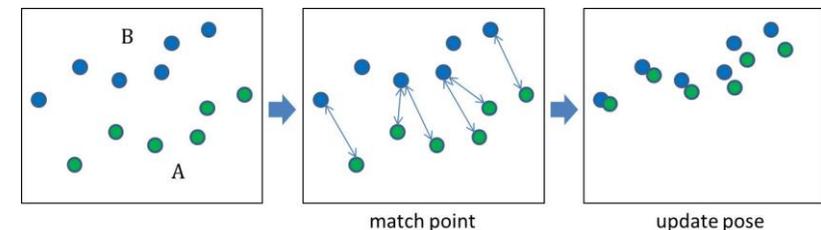
■ Method 1 : Deep Learning

- 1) Feature is previously extracted from already acquired point cloud data, and tag data is added to accumulate as training data.
- 2) Feature is extracted by deep learning using the training data from new point cloud data B.
- 3) The Point Clouds are matched with each other by using the two extracted local features.



■ Method 2 : Algorithm (ICP※)

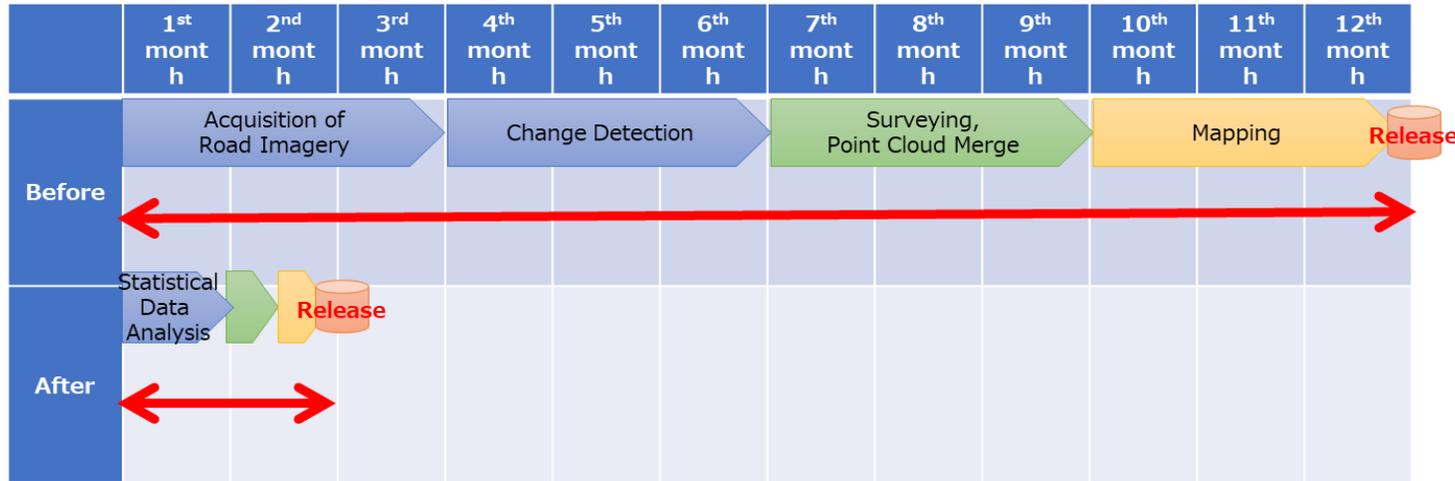
- 1) The nearest point in the Point Cloud Data B is searched from each point of the Point Cloud A by using the annotated (Label) data (geographic feature).
- 2) Adjust the each Point Cloud Data to minimize the difference between and join the Point Clouds.



- Automated Smooth Validation System, by Joining/Connecting Point Cloud Data
- Utilize above Method based on the condition/efficiency use of Point Cloud Data

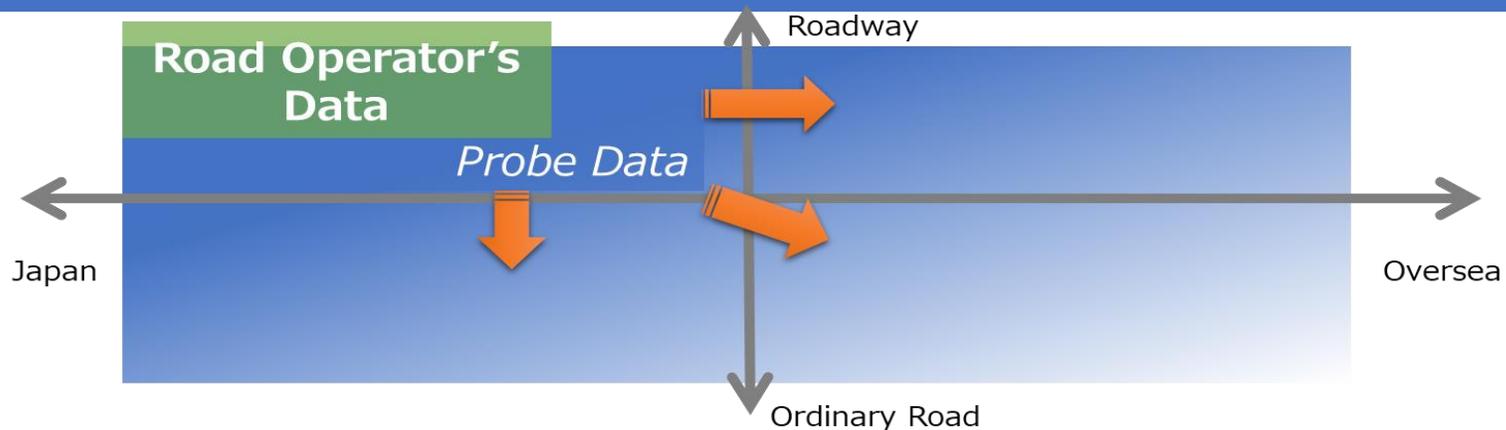
Goal of our Challenges for 3D HD-Map Solution

➤ Maintain “Freshness” of 3D HD-Map :
Drastic Reduce of Lead Time : 12months → 2months

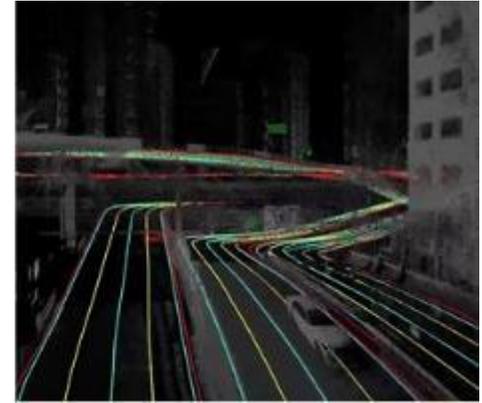


➤ Achieve DMP Goal through “Ushr Acuition” and “Automated Solution”

- Futher expansion to “Global Market”
- Widespeard into “Ordinary Road”



“ Remodeling of the earth “



DMP Group deliver “Safety” and “Comfort” to the WORLD of Automated Driving !