

**"Strategic Innovation Promotion Program (SIP) for
Automated Driving Systems/Large-Scale Field
Operational Test/Dynamic Map/Change Detection and
Automated Mapping for Dynamic Maps "**

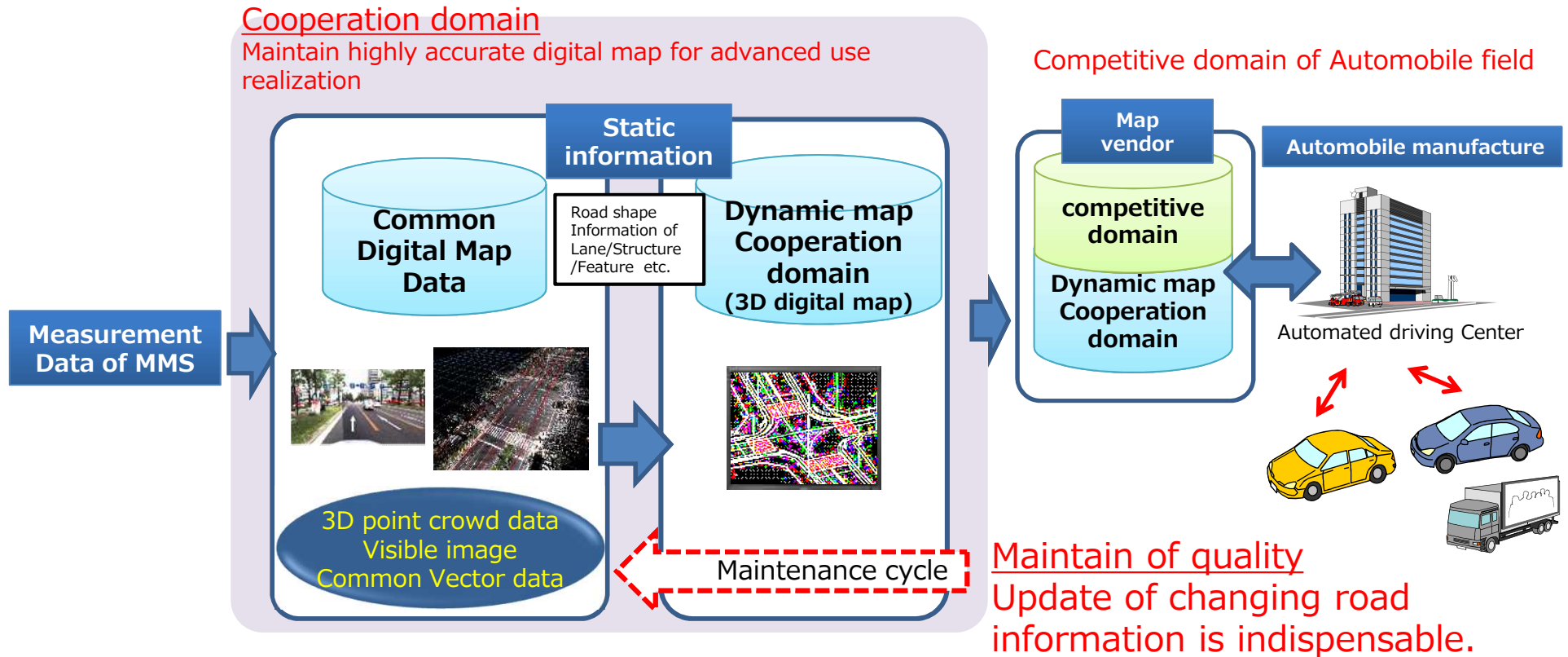
2018 verification results report

February 22, 2019

Mitsubishi Electric Corporation

1. Purpose of R & D
2. Verification of Real Time Automated Mapping and Change Detection Technology
3. Conclusion

1. Purpose of R & D



For spread and promotion of use of Static high-precision 3D maps :

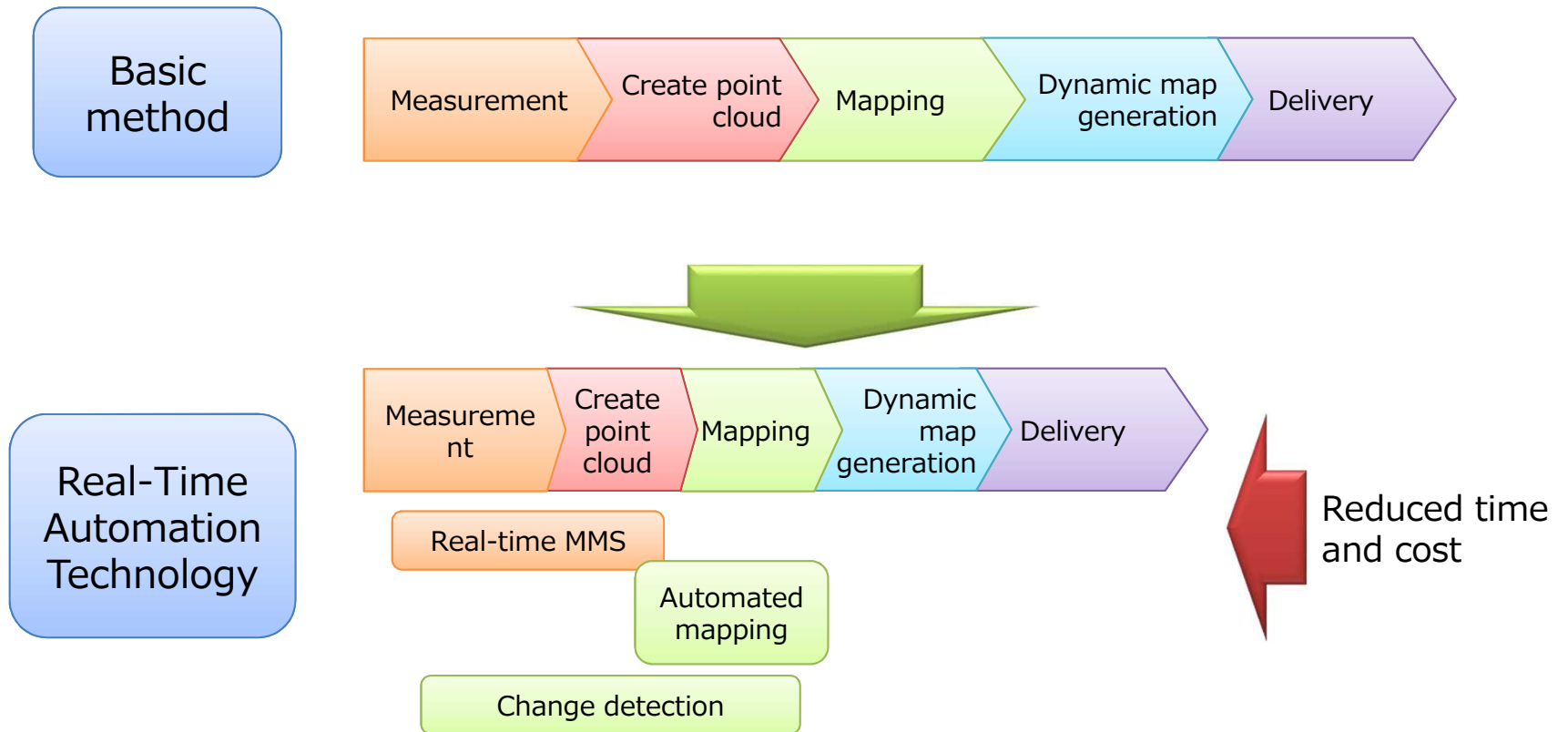
- Securing the quality of the map that contributes to the operation of the automatic driving system
⇒ Shorter map creation time
- Reduction of user burden cost ⇒ Reduction of cost of mapping



Purpose of this work : Verification of improvement effect of map creation / update by application of automation technology

1. Purpose of R & D

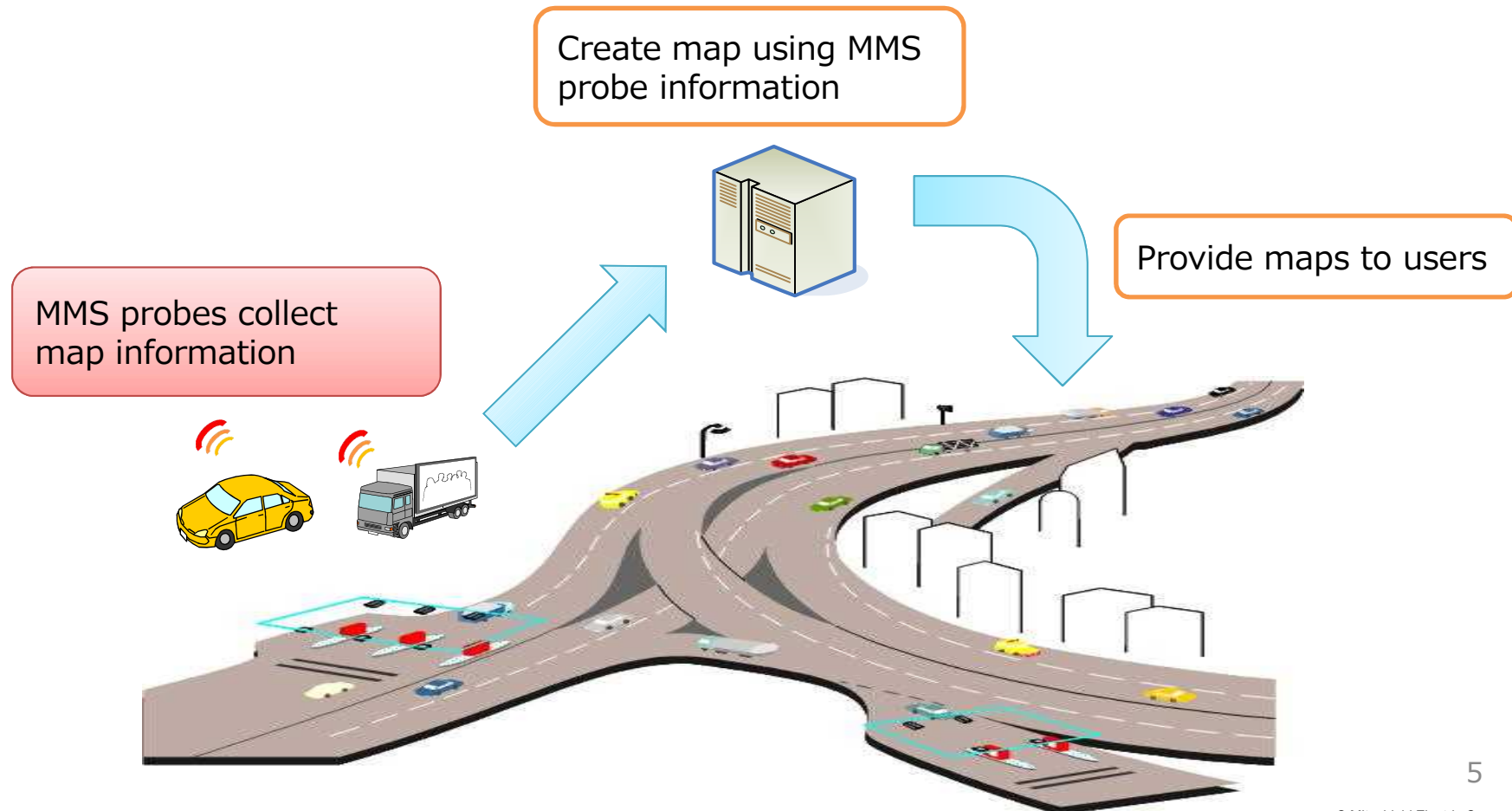
To spread the dynamic map, it is necessary to reduce the map creation time and cost.



1. Purpose of R & D

- Concept of MMS probe

Map information collection by MMS probe equipped with real-time MMS and automated technology



1. Purpose of R & D

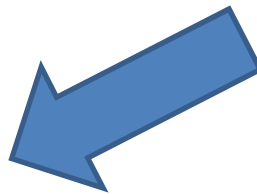
- Development of MMS



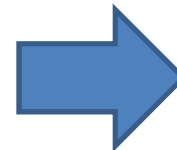
MMS-K320



MMS-G220
Release in 2017



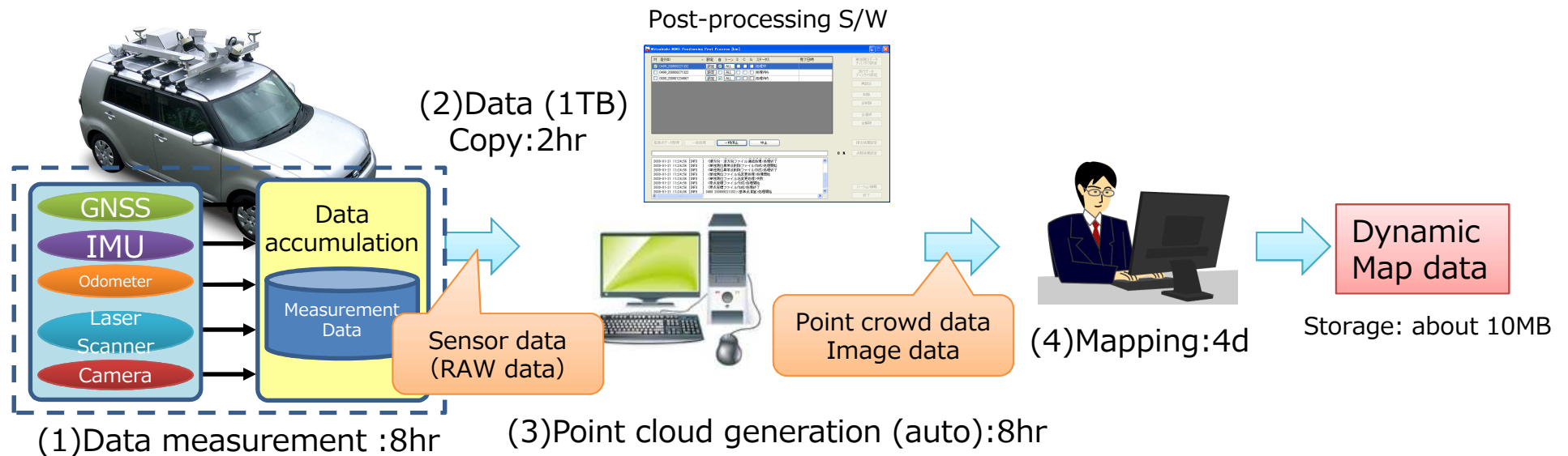
MMS-G
Release in 2018



MMS-Light
Released in 2019

2. Verification of Real Time Automated Mapping and Change Detection Technology

- Measurement, point cloud generation and mapping of basic method



Example of from measurement by MMS to generation of dynamic map data

It is necessary to shorten the overall process.

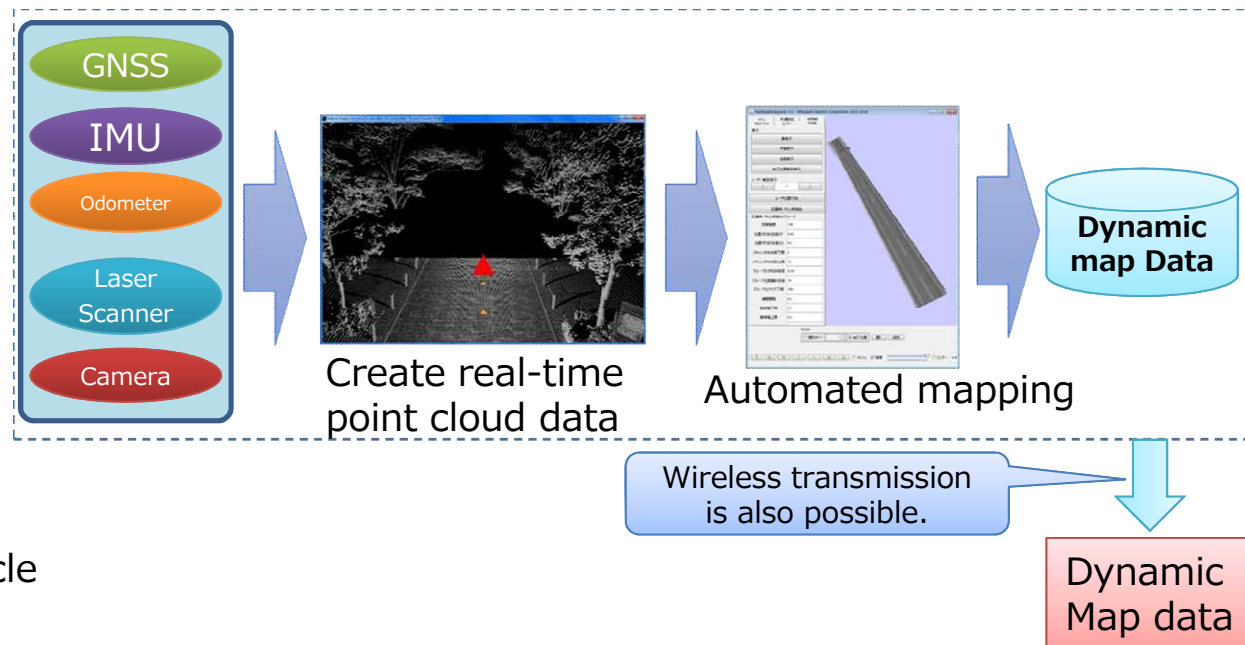
2. Verification of Real Time Automated Mapping and Change Detection Technology

- Measurement, point cloud generation and mapping by real-time MMS and automated technology

Combined with real-time MMS technology, Real time implementation of automation technology.



Installed in our laboratory vehicle



Storage: about 10MB

2. Verification of Real Time Automated Mapping and Change Detection Technology

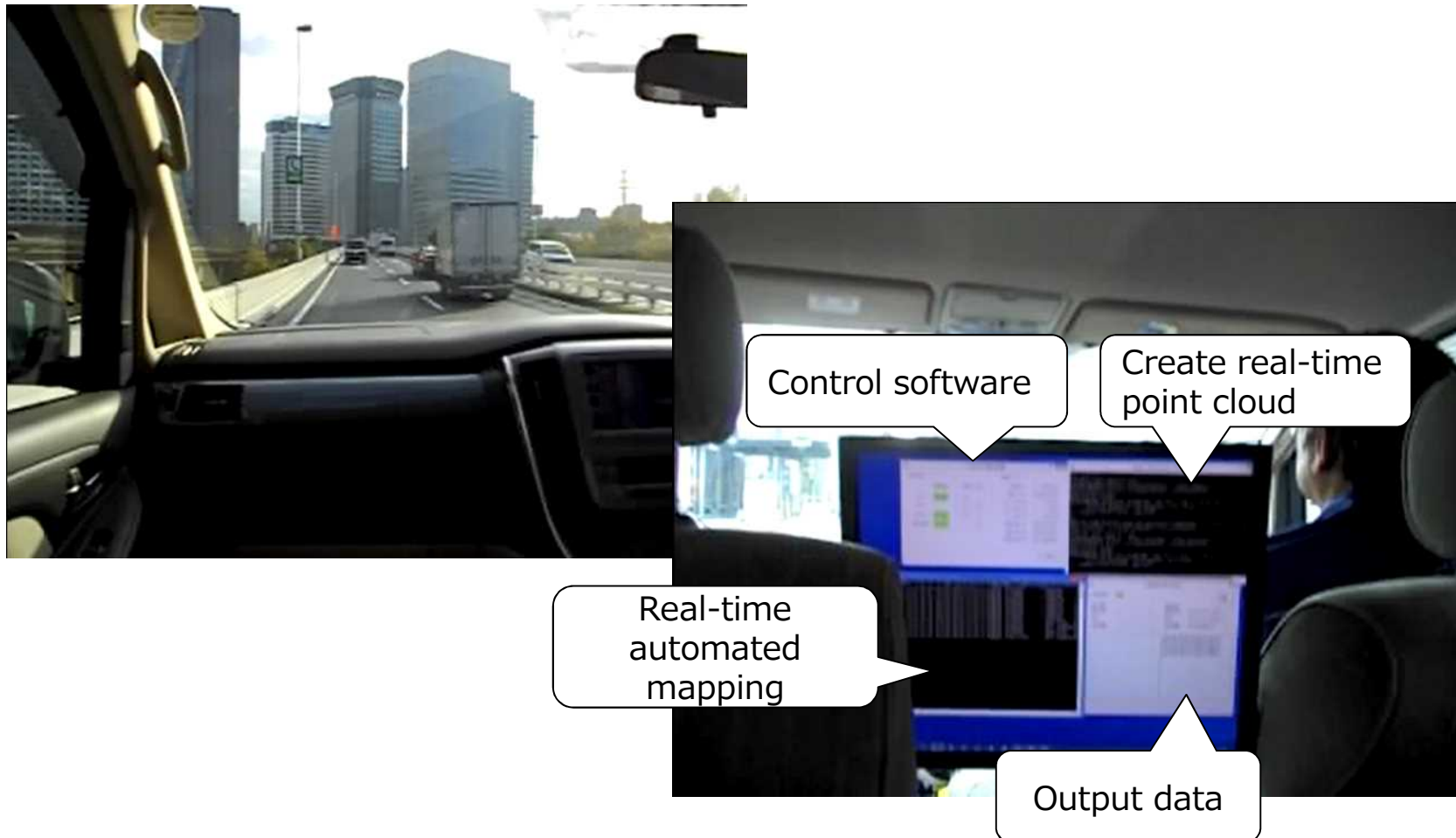
● Schedule

LN		Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
1	Planning	→											
2	Confirm data		→										
3	Simulation			→									
4	Check specification change of QZSS					→							
5	Specification change						→						
6	Measurement								→				
7	Evaluation of automated mapping									→			
8	Evaluation of change detection									→			
9	Summarize the results										→		

The final specifications had been changed for the launch of the QZSS in November. Added work for LN 4 and 5 that were not planned in the initial plan.

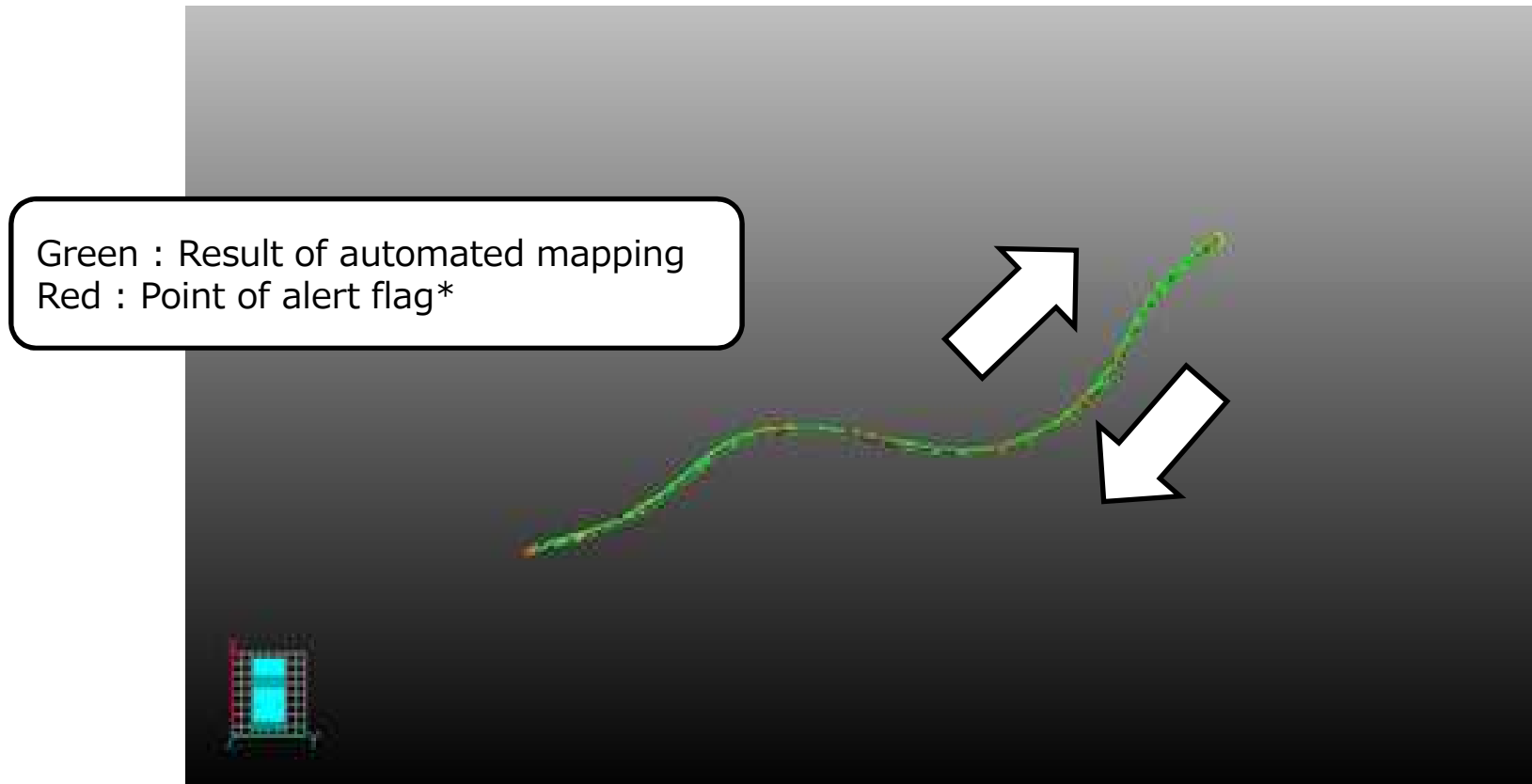
2. Verification of Real Time Automated Mapping and Change Detection Technology

- Measurement on expressway



2. Verification of Real Time Automated Mapping and Change Detection Technology

- Result of evaluation course 1: Tomei Expressway



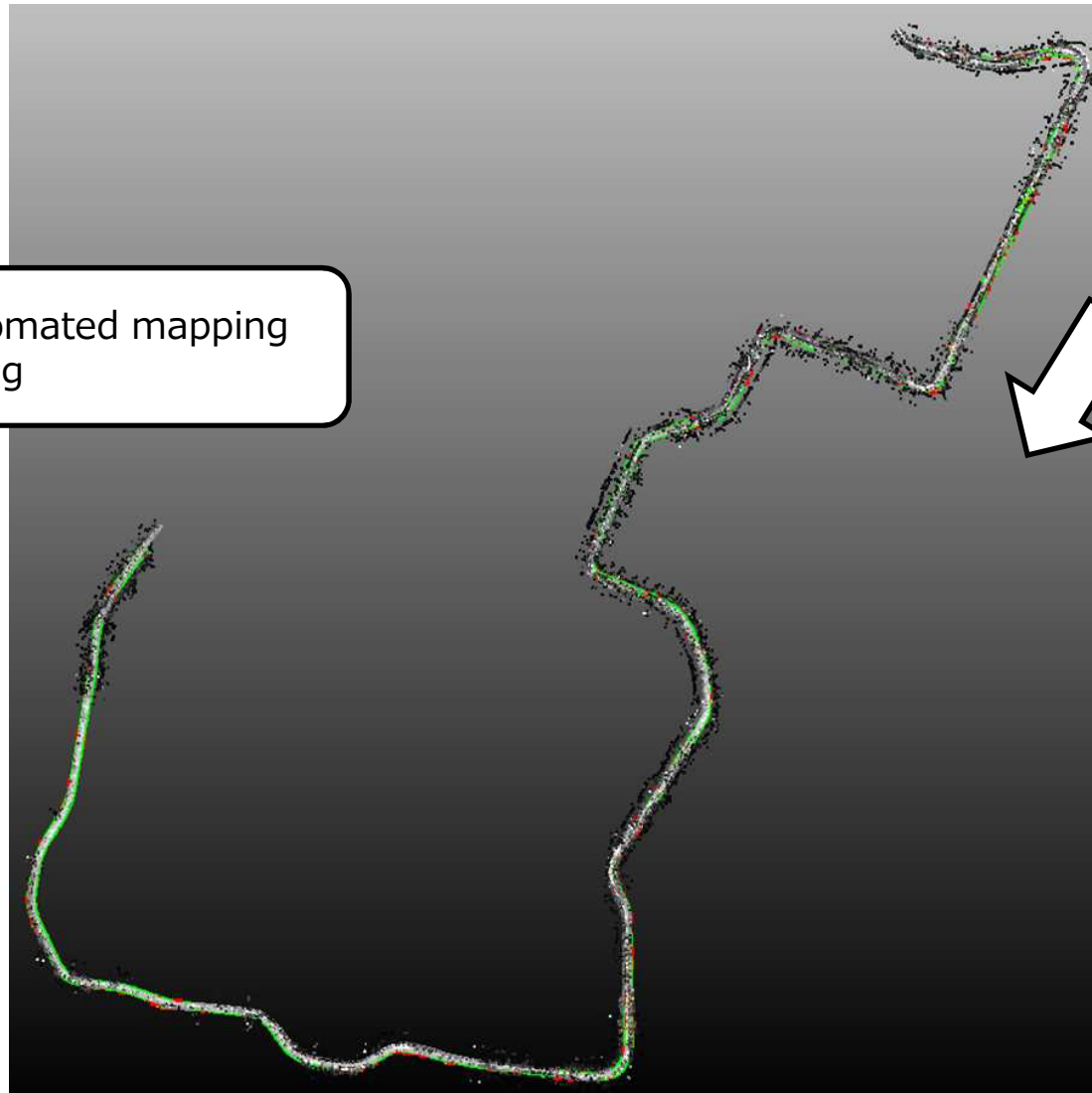
*alert flag

Flag indicating that the reliability of the automated mapping is low

2. Verification of Real Time Automated Mapping and Change Detection Technology

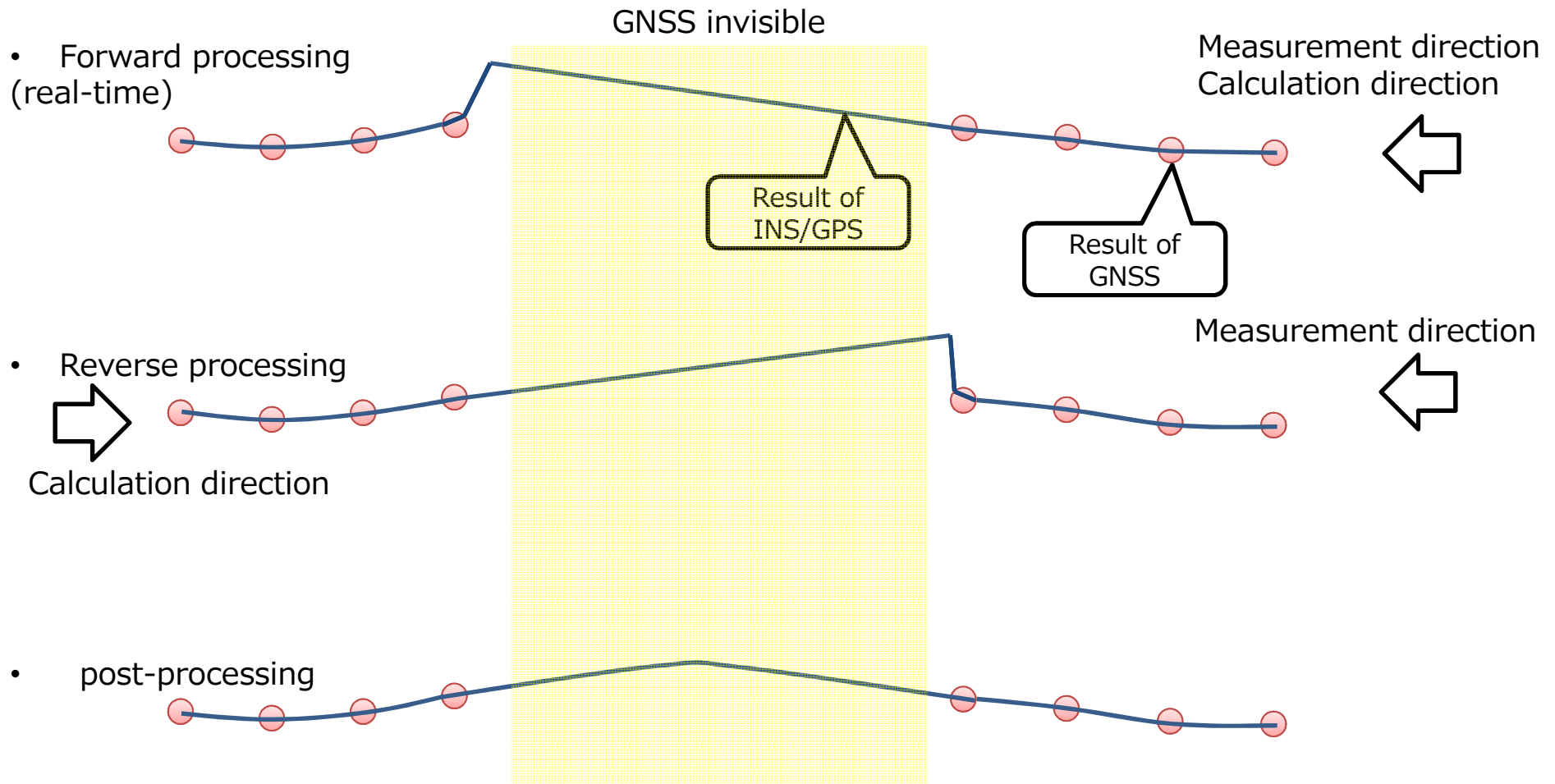
- Result of evaluation course 2: Metropolitan Expressway

Green : Result of automated mapping
Red : Point of alert flag



2. Verification of Real Time Automated Mapping and Change Detection Technology

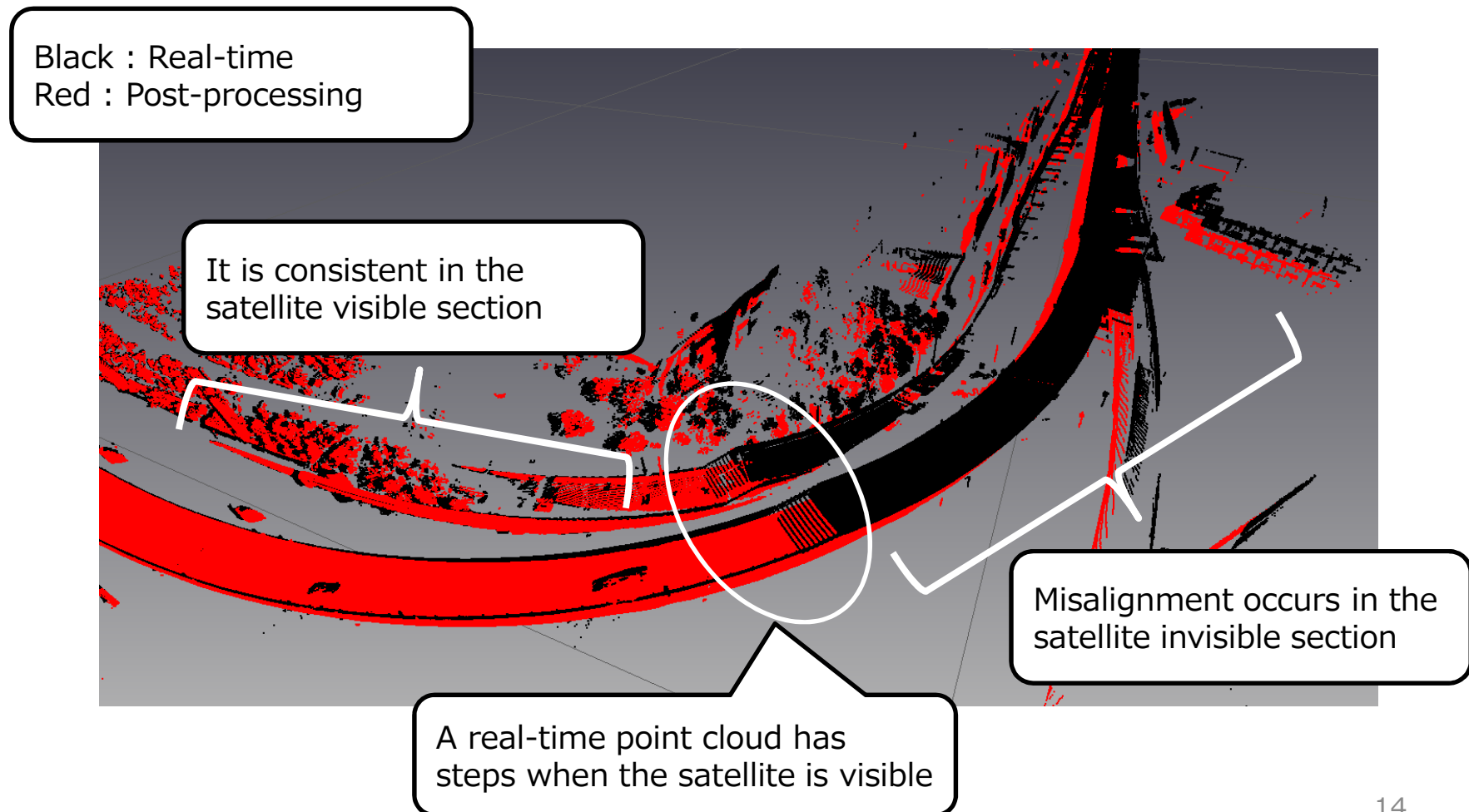
- Difference between post-processing and real-time



In the post-processing, the results of forward processing and reverse processing are integrated

2. Verification of Real Time Automated Mapping and Change Detection Technology

- Post-processing and real-time point cloud comparison



- Evaluation of real-time automated mapping

It is dependent on the satellite environment that it can be judged that point cloud by real-time is equal to post-processing

Percentage where the prediction error of the point cloud is under 25 cm

Evaluation course	Post-processing	Real-time
1 : Tomei Expressway	95.9%	89.6%
2 : Metropolitan Expressway	40.3%	36.9%

Evaluation course 2 is a severe satellite environment.
It can be improved by adopting multi GNSS for real-time MMS.

2. Verification of Real Time Automated Mapping and Change Detection Technology

- Evaluation of real-time automated mapping (Evaluation course 1)

Post-processing (Coverage : 95.9%)

Road extremities	Result
Correct answer rate	92.2%
Detection rate	92.7%
False detection rate	7.9%
Undetected rate	7.3%

Road lines	Result
Correct answer rate	96.4%
Detection rate	97.3%
False detection rate	3.6%
Undetected rate	2.7%

Real-time (Coverage : 89.6%)

Road extremities	Result
Correct answer rate	91.8%
Detection rate	91.7%
False detection rate	8.2%
Undetected rate	8.3%

Road lines	Result
Correct answer rate	96.1%
Detection rate	97.4%
False detection rate	4.0%
Undetected rate	2.6%

In the area where the positional accuracy of the point cloud is good, equivalent performance was obtained in post-processing and real-time.

2. Verification of Real Time Automated Mapping and Change Detection Technology

- Evaluation of real-time automated mapping (Evaluation course 2)

Post-processing (Coverage : 40.3%)

Road extremities	Result
Correct answer rate	83.9%
Detection rate	85.2%
False detection rate	16.4%
Undetected rate	14.8%

Real-time (Coverage : 36.9%)

Road extremities	Result
Correct answer rate	84.0%
Detection rate	85.8%
False detection rate	16.4%
Undetected rate	14.2%

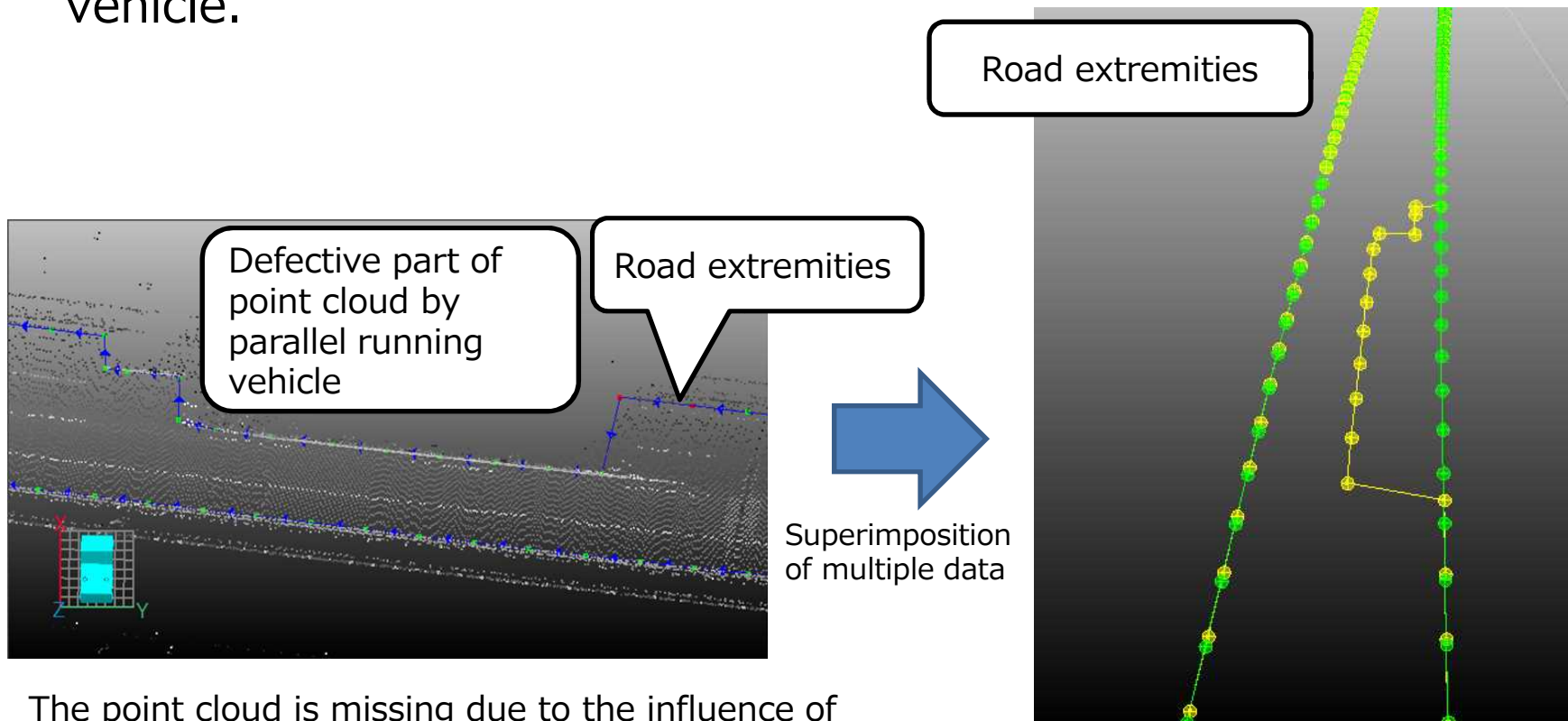
Road lines	Result
Correct answer rate	92.6%
Detection rate	83.0%
False detection rate	6.7%
Undetected rate	17.0%

Road lines	Result
Correct answer rate	96.1%
Detection rate	81.8%
False detection rate	3.4%
Undetected rate	18.2%

The influence of traffic jams and parallel running cars is large in the evaluation course 2, causing an increase in false detection / undetected.

2. Verification of Real Time Automated Mapping and Change Detection Technology

- Evaluation of real-time automated mapping
Consideration on false detection by influence of parallel running vehicle.

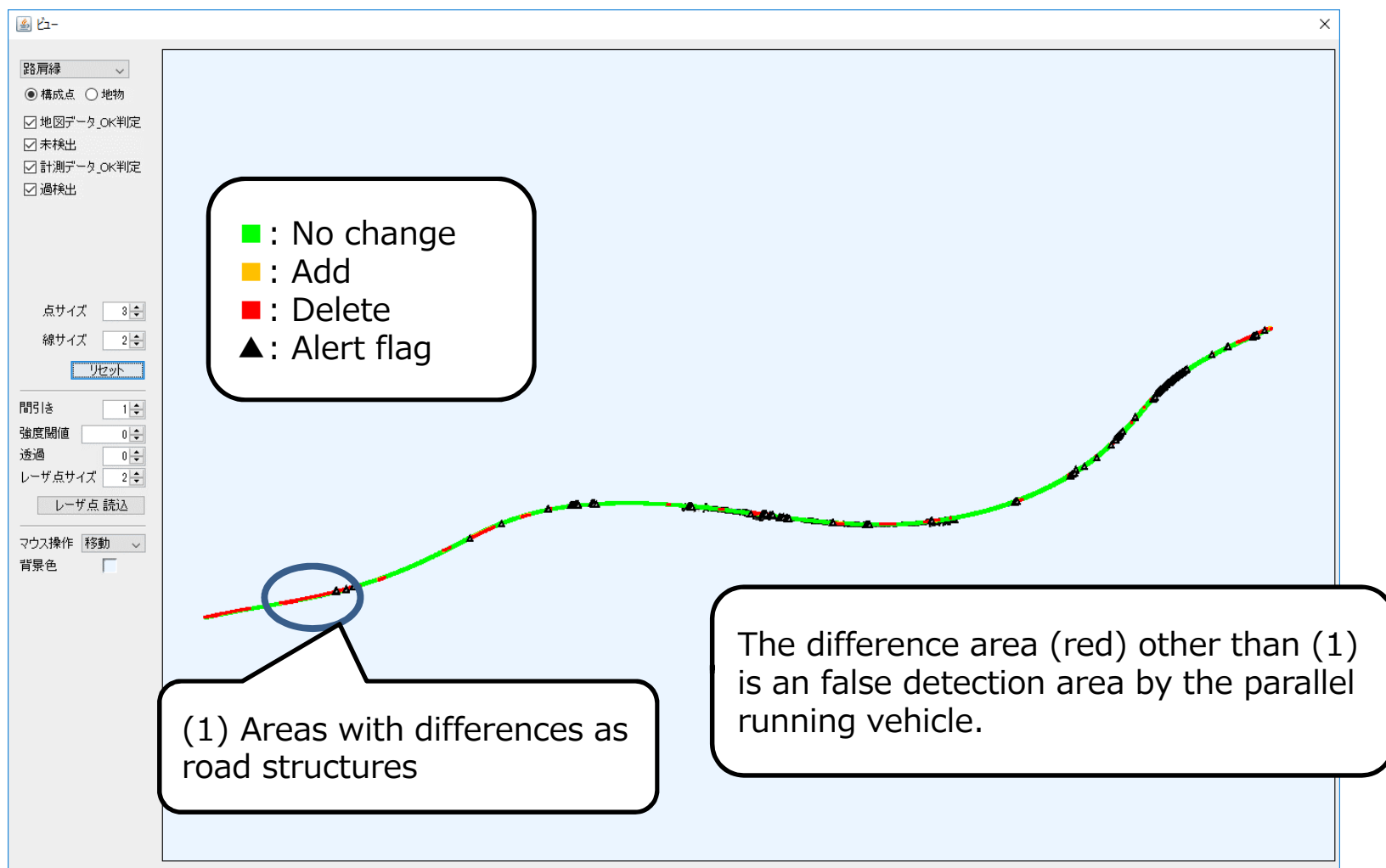


The point cloud is missing due to the influence of the parallel running vehicle, and the side of the parallel running vehicle is false detected as a road extremities

The false detection can be removed by majority decision.

- Evaluation of change detection

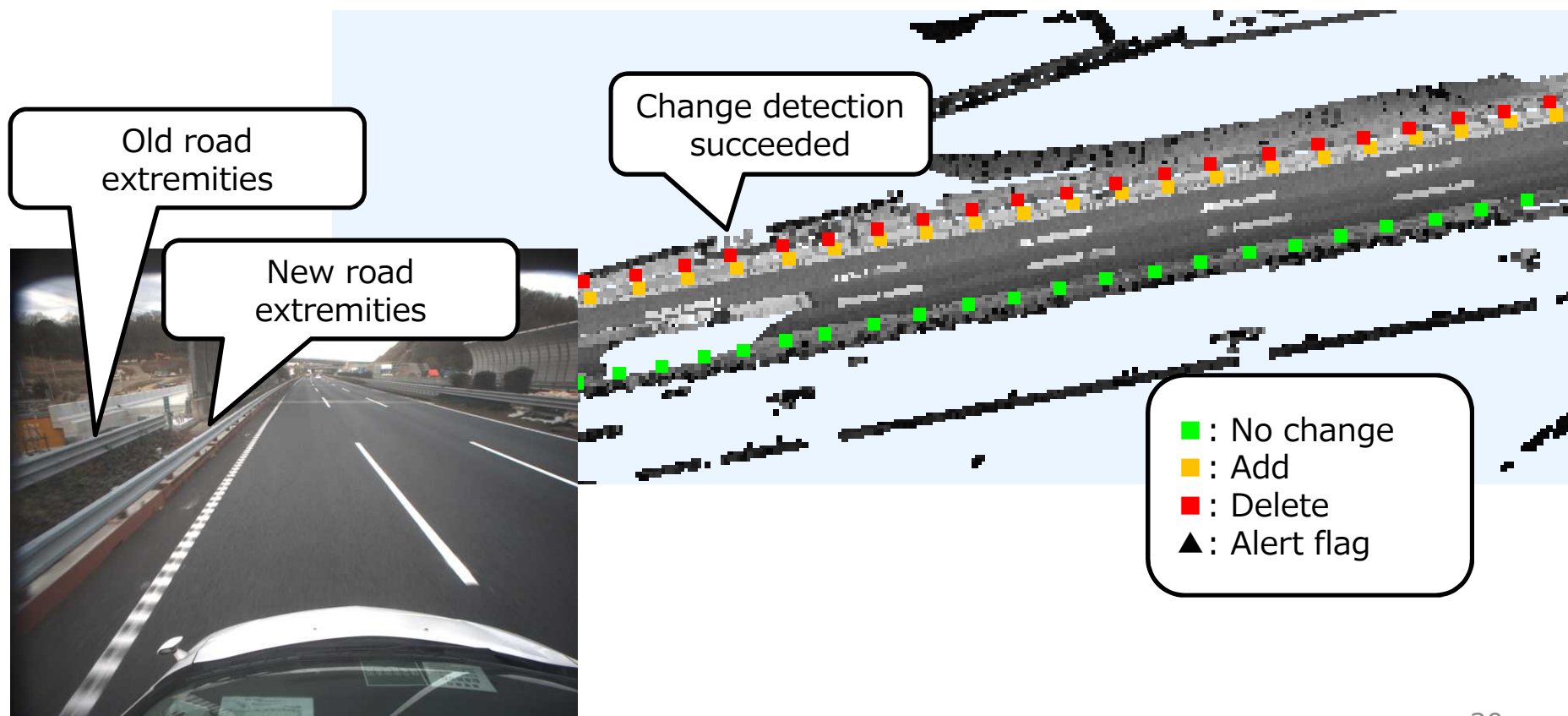
Results in evaluation course 1



2. Verification of Real Time Automated Mapping and Change Detection Technology

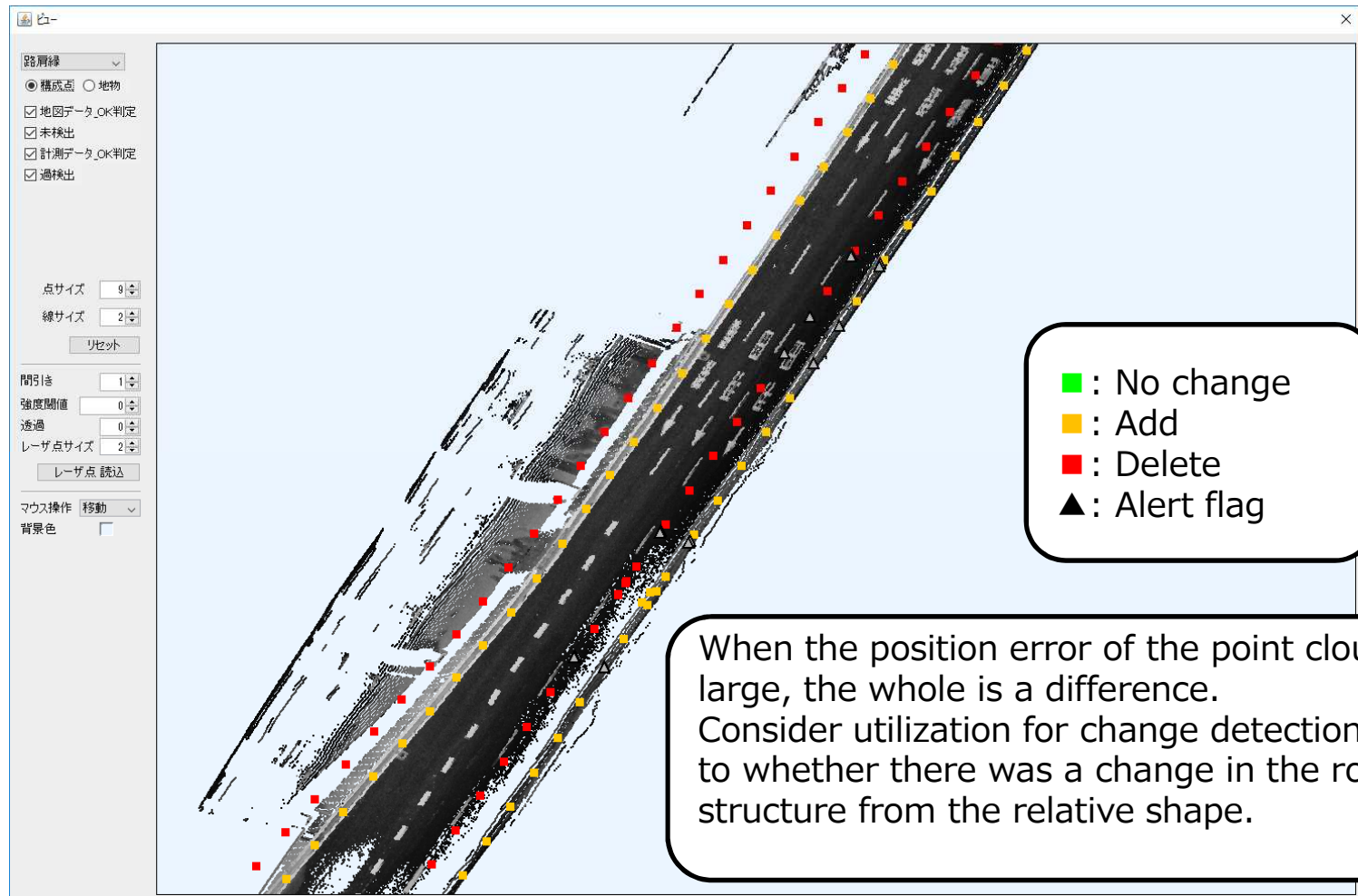
- Evaluation of change detection

Results in evaluation course 1(1)



2. Verification of Real Time Automated Mapping and Change Detection Technology

- Evaluation of change detection (Error case)



3 . Conclusion

- We evaluated the real-time and automation technology, confirmed the effectiveness.
- In the area where the positional accuracy of the point cloud is good, equivalent performance was obtained in post-processing and real-time.
- The prediction error of the point cloud depend on satellite environment. It can be improved by adopting multi GNSS for real-time MMS.
- Our software of Change detection can detect differences of road structures.