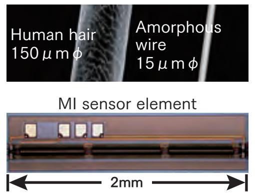
Advanced Technologies Supporting GMPS

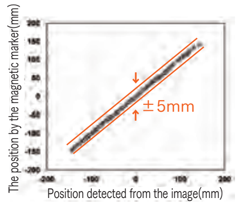
01 Ultra-sensitive magnetic sensor

Uses an ultra-high sensitivity magnetic sensor "MI sensor (magnetic impedance sensor)" that applies Aichi Steel's advanced material "amorphous wire".
It has the potential to detect the magnetic field of the magnetic marker even at a distance of 1m.
※The product is optimized for a distance of 20cm.



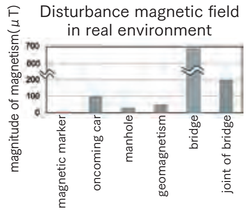
02 Vehicle position detection accuracy

Position detection accuracy of +-5 mm is achieved by actual vehicle measurement (accuracy of +-1mm in lab)
In the "precision docking" system, which closely stops at bus stops, tens of millimeters can be realized in combination with vehicle control even for large buses.



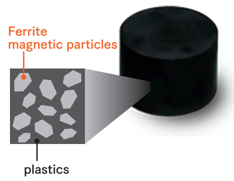
03 Magnetic noise disturbance rejection

A noise elimination process that responds only to magnetic distribution patterns of markers was developed.
We have made it possible to extract a marker signal buried in the surrounding noise.
The effectiveness of this noise removal technology has been demonstrated in a variety of road environments to date.



04 Durability of magnetic markers on road surfaces

Magnetic force of the ferrite magnet, which is the material of the magnetic marker, is semi-permanent in the natural environment.
Therefore, it has a durability that is sufficiently longer than the repair period of the road surface.



05 Acquisition of high-precision absolute coordinates

RF-ID enables the identification of individual magnetic markers.
In addition to the conventional high-precision position detection by magnetism, it is now possible to obtain absolute coordinates.

06 Preventing spoofing of magnetic markers

The position information of the newly detected marker is always compared with the last detected data.
Alarms can be issued if they differ significantly from the expected.
In addition, for markers with RF-ID, the information held can be encrypted and set it so that only the authorized vehicles can read it.

07 Method of magnetic marker installation on road

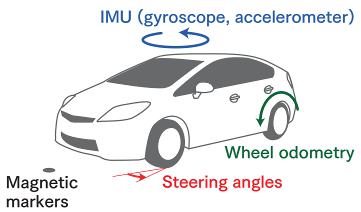
Draw an assumed driving trajectory on the road, and then bury or affix markers at predetermined intervals on it. No prior survey required.
After installation, the position can be measured in a short time using a total station, etc., starting from the position reference point.
For surface-mounted types, we are developing an automatic installation machine for continuous attachment.

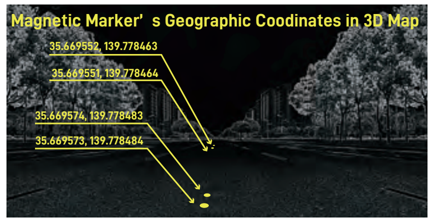
08 Cost of laying magnetic markers

・Marker uses ferrite magnetic materials, which are widely available around the world, and there are no resource problems or concerns about higher prices.
・The installation cost is expected to become cheaper by using automatic installation machines.
・There is no problem with the conventional disposal process for discarded asphalt generated at the time of road resurfacing.

09 Integration with autonomous navigation

Magnetic marker position information installed at key locations can be utilized for cumulative error correction of position, which is one of the issues of autonomous navigation, and for relocation after loss, and the accuracy of autonomous navigation can be dramatically improved.
In addition, it is possible to greatly reduce the burden of data processing required for the process of identifying the vehicle position by embedding the coordinated information of magnetic markers within digital three-dimensional maps in the future.





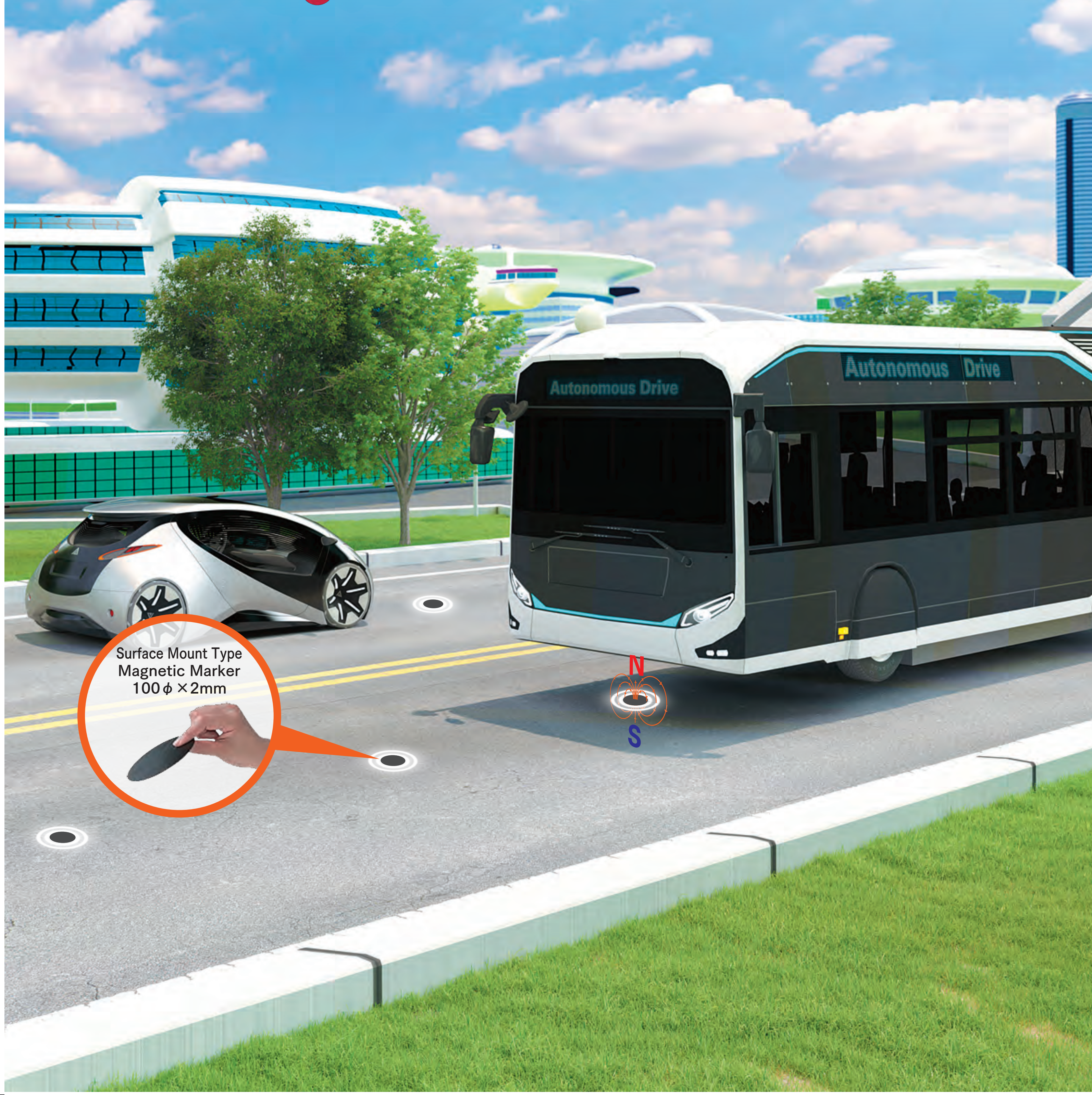
TOPIC In 2020, the Japanese Road Act was revised to position "Facilities to assist autonomous driving (Magnetic Markers, etc.) as a fixture to roads (in the case of private businesses, a road occupying structure)" under the provision of "Maintenance of Facilities that Assist Autonomous Driving in the Road Space."

Contact Aichi Steel https://www.aichi-steel.co.jp/ENGLISH/smart/mi/gmps/

Infrastructure-assisted Autonomous Driving Assist System

GMPS

Global Magnetic Positioning System



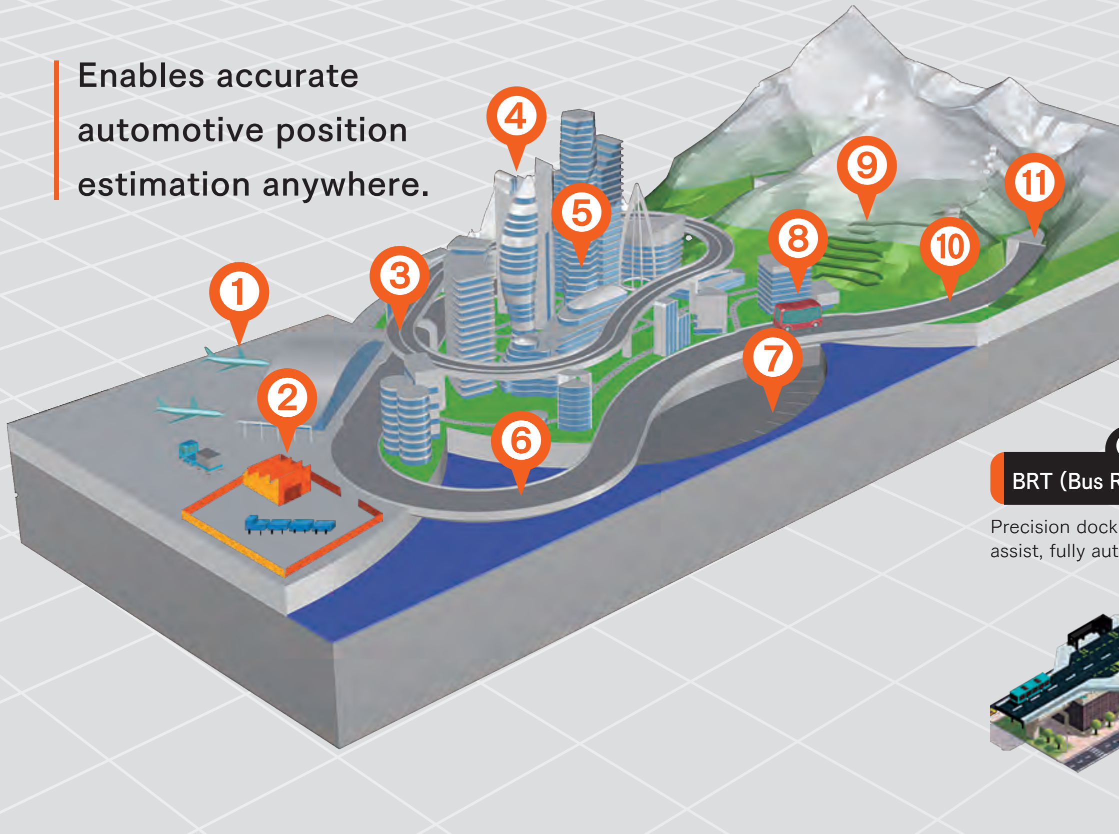
AICHI STEEL

GMPS can complement conventional autonomous driving and contribute to sooner practical implementation.

GMPS (Global Magnetic Positioning System) is an infrastructure assisted high precision vehicle position estimation system that utilizes weak magnetism.
Simply install the magnetic markers on the necessary parts of the road and mount the sensor unit on the vehicle.
Even at spots that are difficult with conventional autonomous driving, the vehicle position can be found to within millimeters.

Use Cases

Enables accurate automotive position estimation anywhere.



① Airport GSE vehicle control

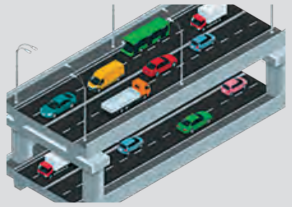
Automatic operation of AGVs in two-dimensional planes in airports and harbors by placing markers in a grid

② Factory logistics and home delivery robots

Distribution vehicles on the plant premises

③ Running under elevated railway tracks

Under elevated tracks where GPS signals do not reach



④ Driving in high-rise commercial districts

Built up streets where GPS signal multipaths occur

⑤ Office home-delivery robots

Vehicles for delivery between offices

⑥ BRT (Bus Rapid Transit)

Precision docking, lane passing assist, fully automatic operation

⑦ Underground parking and valet parking

Indoor valet parking

⑧ Precision docking at bus stops

As long as it is within the sensor width range, a single marker line can be used to achieve accurate docking by traveling in the center of the lane and shifting the width of the lane.

⑨ Snowfall

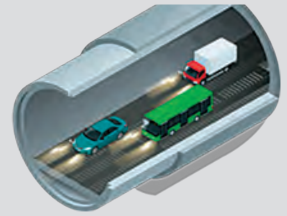
In an environment with snowfalls and fallen leaves where white line reading becomes impossible

⑩ Monotonic landscape, non-reflective environment, dense fog

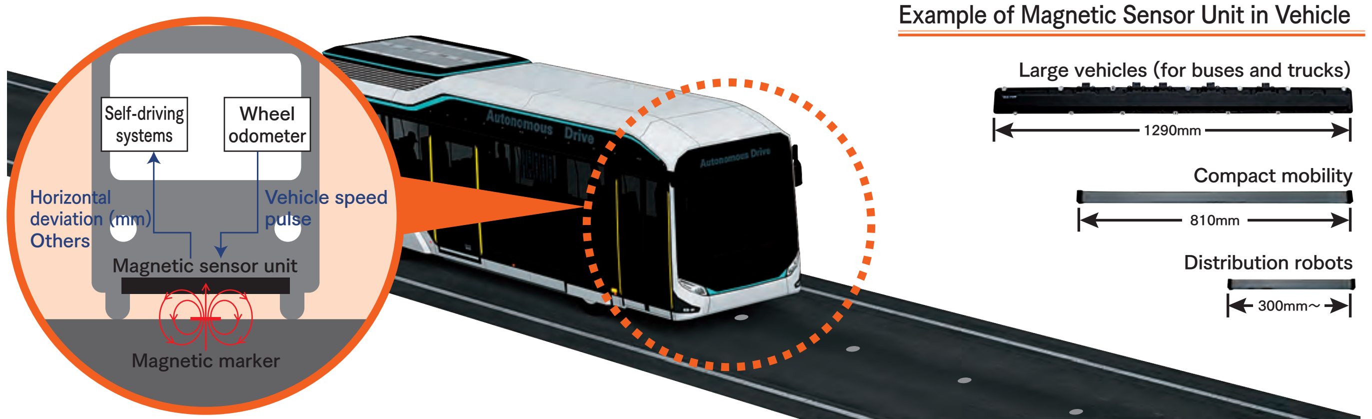
In circumstances where sensing by LiDAR is difficult

⑪ Running in tunnels

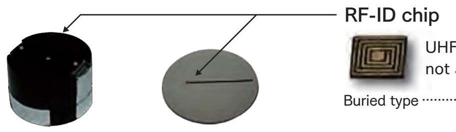
In tunnels where GPS signals do not reach



System Configuration[*1]



Magnetic marker (with unpowered RF-ID)



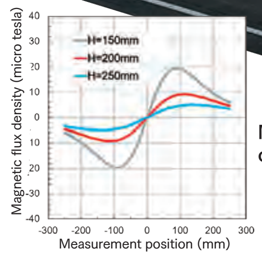
Buried type
30φ×20mm

Surface installation type
50φ×2mm
100φ×2mm

UHF-band 920MHz antenna pattern is not affected by minor surface flooding.

Buried type ········ Recommended for harsh conditions where the road surface is scraped, such as by snow-removal vehicles

Surface installation type ··· Recommended for applications where vehicles are less likely to drive over marker or for temporary priority services



Magnetic flux density of magnetic marker

*1 Specifications are subject to change without notice during development.

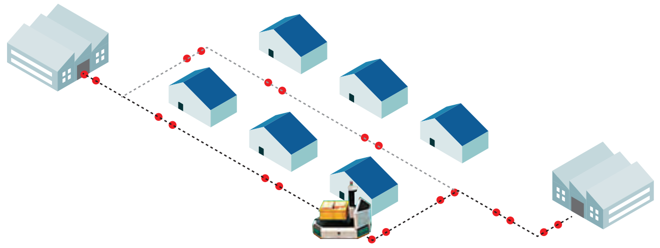
Arrangement of Magnetic Markers

You can flexibly set the arrangement pattern of magnetic markers on the road. Through the use of RF-ID data and the setting of magnetic poles, with the marker as our landmark, we are now able to realize a free trajectory.

Case1 Plant Logistics

Markers not laid down evenly but used as landmarks for correcting positions.

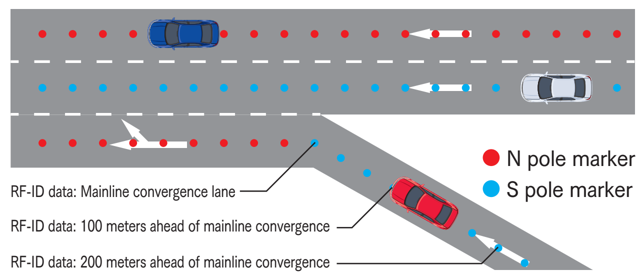
Placed as required (2m interval pair placed 10m)



Case2 Expressway

Corresponds to mergers and lane changes by utilizing N and S poles and RF-ID location information

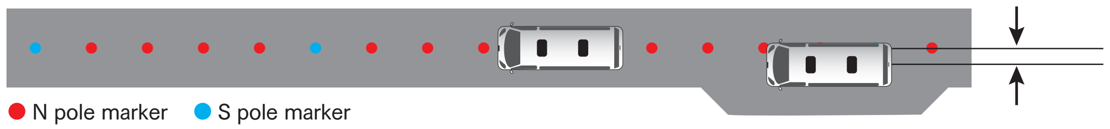
Installing different polarity by Lane + Adding RF-ID Positioning to Pre-Merger Markers



Case3 Bus only road

With a sinlge line of magnetic markers, in addition to passing by in the center of the road, it also provides offset and precision docking functions.

Four N poles (no RF-ID) and one S pole (with RF-ID) are installed at intervals of 2m each.



● N pole marker ● S pole marker

GMPS

Demonstrating Reliability in Various Environments in Japan

GMPS Demonstration and Implementation

	Timing	Region	Location	Sponsored by	Features
1	Nov.17	Higashiomi Shiga	Michi-no-Eki Okueigenji Keiryu no Sato	Ministry of Land Infrastructure, Transport and Tourism (MLIT)	Drive in mountainous areas where GPS signals do not reach
2	Dec.17	Ginowan and Kitanakagusuku Okinawa		Cabinet Office	"Implemented ""precision docking"" to accurately align with and stop at the bus stop."
3	Dec.17	Taiki Hokkaido	Michi-no-Eki Cosmall taiki	MLIT	Drive in snow where reliability of on-board cameras is not sufficient
4	Feb.18	Ina Nagano	Michi-no-Eki Minami Alps Mura Hase	MLIT	Traveling in tunnels where GPS signals do not reach or narrow dog-legs with a road width of 4.5m
5	Apr.18	Kitakyushu Fukuoka	Kitakyushu Sciece City	Kitakyushu City	Steady running at a maximum speed of 40km/h and control adjustment at the intersection left-turn
6	Oct.18	Hitachi Ibaraki	Hitachi BRT some routes	MLIT and Ministry of Economy, Trade and Industry (METI)	Exclusive bus roads and public roads using abandoned rail lines
7	Nov.18	Ina Nagano	Michi-no-Eki Minami Alps Mura Hase	MLIT	Traveling in tunnels where GPS signals do not reach or narrow dog-legs with a road width of 4.5m
8	Jan.19	Rikuzen Takata Iwate	Ofunato Line BRT Vicinity of Takekoma Station	JR East	Carried out alternate passage with oncoming vehicles on roads exclusively for buses and precision docking control
9	Jan.19	In an airport restricted area	4 airports including Haneda Airport	MLIT	Run below the boarding bridge where GPS does not reach in airport restricted areas
10	Feb.19	Tama Tokyo	Tama New Town	Tokyo Metropolitan Government	Driving on public roads that GPS cannot reach due to pedestrian bridges and street trees
11	Jun.19	Taiki Hokkaido	Michi-no-Eki Cosmall taiki	MLIT	Drive in snow where reliability of on-board cameras is not sufficient
12	Nov.19	Onagawa Miyagi		Miyagi Prefecture	Returning ultra-compact shared electric vehicles to the station by unmanned driving
13	Dec.19	Shibukawa Gunma		Gunma University	"Traveling while performing roadside-to-vehicle communication in which the vehicle receives signal information, etc. from magnetic markers installed on the road surface"
14	Feb.20	Tome Miyagi	Kesennuma Line BRT Yanaizu-Rikuzen Yokoyama	JR East	Large buses run steadily at a maximum speed of 60km/h
15	Jun.20	Kashiwa Chiba	Kashiwa Campus, Tokyo University-Kashiwanoha Campus Station	Kashiwa ITS Promotion Council	Driving on public roads that GPS cannot reach due to street trees
16	Jul.20	Sanda Hyogo		METI	Ensuring Intra-Regional Transportation to Improve the Quality of Life in Suburban Residential Areas.
17	Jul.20	Otsu Shiga		METI	Creation of new transport axes and livelihoods at urban centers.
18	Aug.20	Ota Tokyo	Haneda Airport	Cabinet Office	"Steady driving at a maximum speed of 60km/h while performing precision docking control, lane change, and right/left turn"
19	Oct.20	Tokoname Aichi	Chubu International Airport Island	Aichi Prefecture	Running on railway bridges or terminal buildings where GPS cannot reach
20	Nov.20	Kitakyushu Fukuoka		METI	Travel below elevated roads (about 1.3km) where GPS is difficult to reach between airports and railway stations
21	Dec.20	Hitachi Ibaraki		METI	Implementation of Automated Drive Buses on BRT Routes.
22	Dec.20	Tokoname Aichi	Chubu International Airport Island	Aichi Prefecture	Drive level 4 through the restricted area
23	Feb.21	Hamamatsu and Mori-machi Shizuoka	Hamamatsu SA and Enshu Morimachi PA	METI	Track-following unmanned fleet running on highway SA/PA and ramp-ways
24	Feb.21	Tome Miyagi	Kesennuma Line BRT Yanaizu- Rikuzen Yokoyama	JR East	Large buses run steadily at a maximum speed of 60km/h.
25	Feb.21	Yokohama Kanagawa		METI	Sustainable transport services in suburban residential areas in the Hill area of the Tokyo metropolitan area.
26	Sep.21	Tome Miyagi	Kesennuma Line BRT Yanaizu- Rikuzen Yokoyama	JR East	Passing each large bus on roads exclusively for buses.
27	Nov.21	Tokoname Aichi	Chubu International Airport Island	Aichi Prefecture	Installing magnetic markers every 10m on straight road
28	Nov.21	Takahata Yamagata	Around Takahata hospital	MLIT	Low speed driving by Green Slow Mobility
29	Aug.22	Shimanto Kochi	Ekawasaki Station and Michi no eki Yotte Nishi Tosa	MLIT	High-precision within ±100 mm with GMPS (only one sensor module) and IAMU only
30	Oct.22	Tokoname Aichi	AEON mall tokoname and Chubu International airport	Aichi Prefecture	First in Japan to run on toll motorway
31	Dec.22	Tome Miyagi	Kesennuma Line BRT Yanaizu- Rikuzen Yokoyama	JR East	First social implementation of GMPS in Japan
32	Dec.22	Kure Hiroshima	Town Areas	Kure City	Utilized in GPS non-delivery areas
33	Jan.23	Takahata Yamagata	Around Takahata town hall	MLIT	Low speed driving on snowy road by Green Slow Mobility

Contact Aichi Steel Corporation https://www.aichi-steel.co.jp/smart/mi/gmps/index.html