Vehicle-Infrastructure Cooperative System and Probe Data in Japan

1. Start of ITS Spot service

2. Collecting probe data via ITS Spots

3. Utilizing probe data in road administration

4. Applicability to private-sector services

- Installation of the vehicle-infrastructure cooperative system in 2011 has made possible various services in an "all-in-one" system.
- Services are provided via 5.8 GHz DSRC that links "ITS Spots" and compatible on-board units installed in vehicles.

○**Deployed on expressways nationwide in 2011**

○**Sales commenced in October 2009**

OBU for ITS Spot

ITS Spot

5.8 GHz DSRC
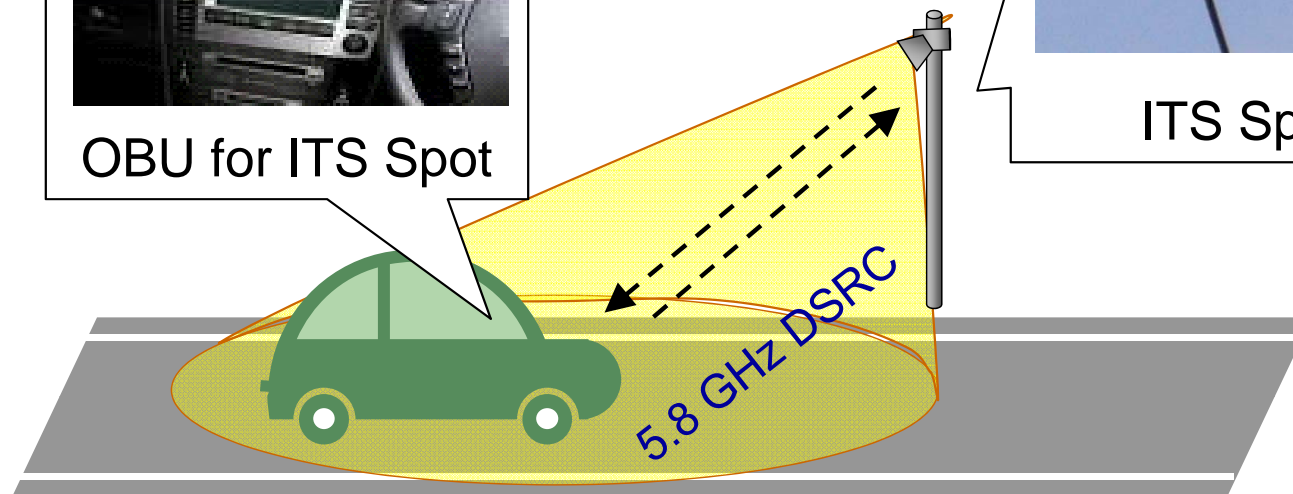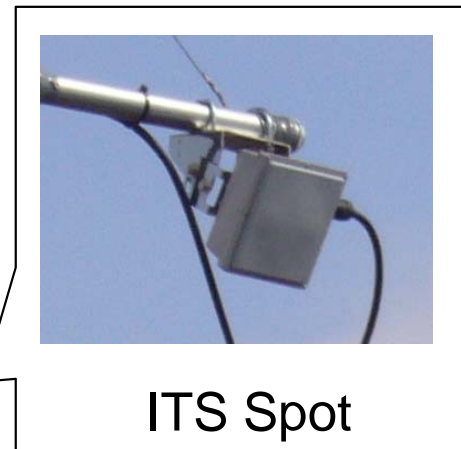
ISO 24103
ISO 29281

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Locations of ITS Spots

- Installed at approximately 1,600 locations on expressways throughout all of Japan
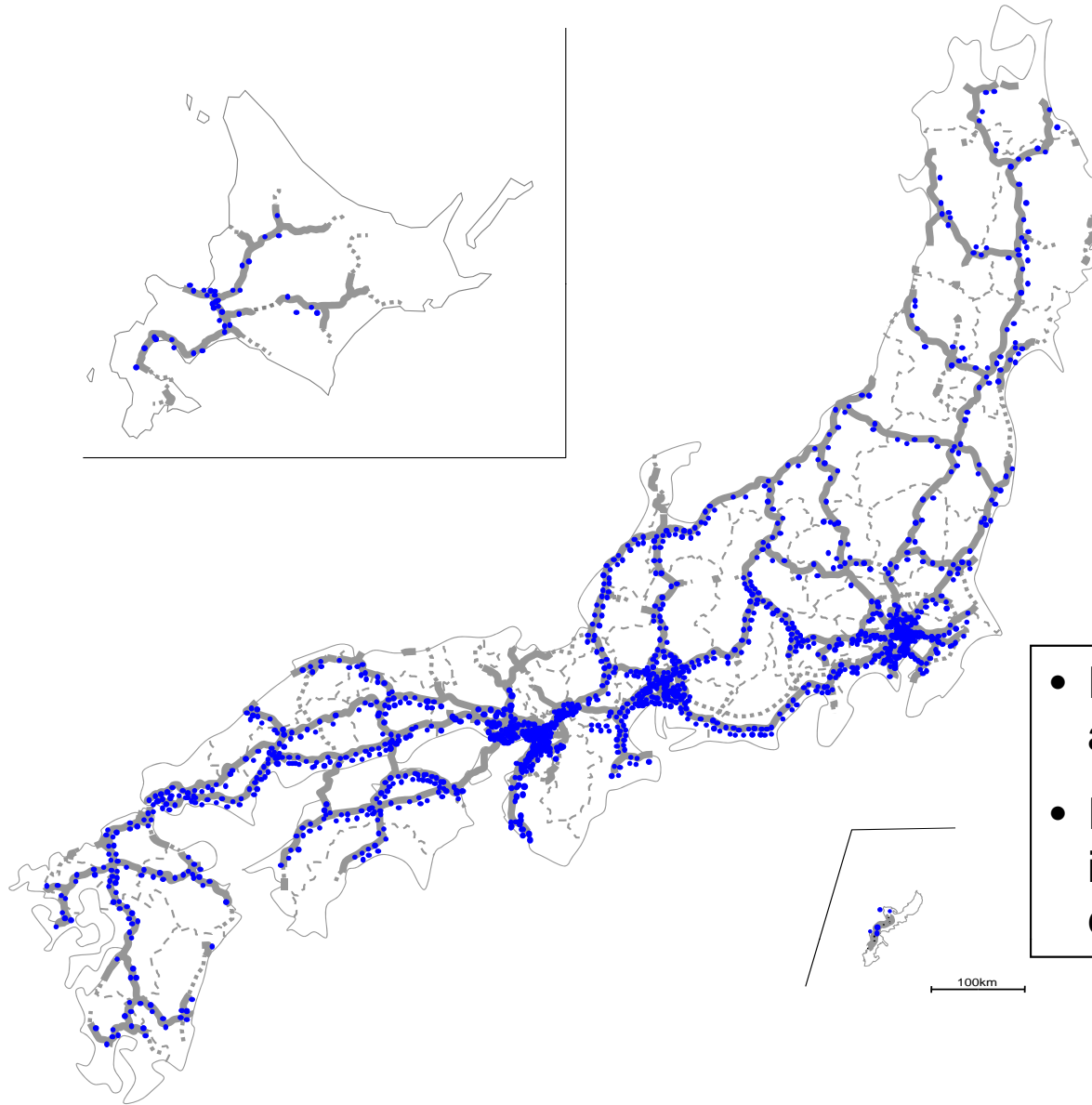
- Installed at 10 to 15-km intervals along inter-city expressways

- Installed at approximately 4-km intervals along inner-city expressways
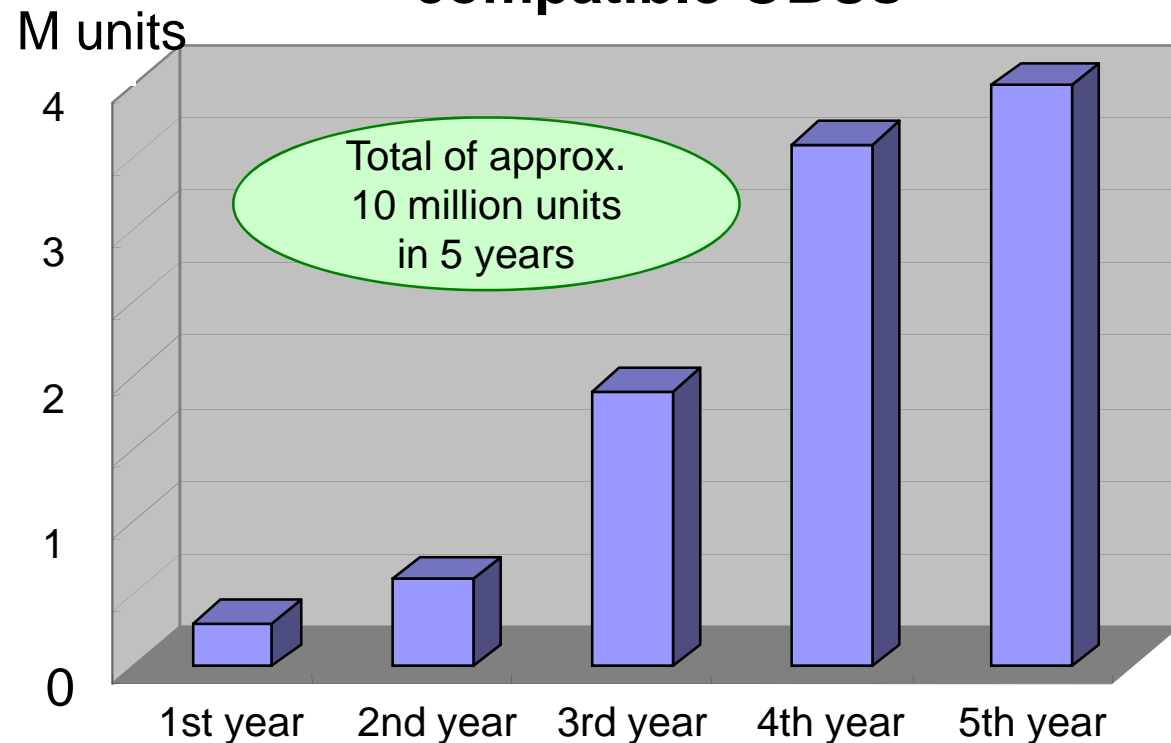
100km

ITS Spot-compatible OBUs

- ITS Spot-compatible OBUs are marketed by 7 companies.
- It is forecasted that a total of approximately 10M units will be sold over 5 years.

Manufacturers of ITS Spot-compatible OBUs

1. Toyota Motor Corporation
   (Sales started in Oct. 2009)
2. Pioneer   (Oct. 2009)
3. Mitsubishi Electric
                    (Oct. 2009)
4. Panasonic   (Mar. 2010)
5. Mitsubishi Heavy Industries
                    (Mar. 2010)
6. Nissan Motor   (Jun. 2011)
7. Alpine Electronics
                    (Jul. 2011)

Forecasted growth of ITS Spot-compatible OBUs

M units

Total of approx. 10 million units in 5 years

	1st year	2nd year	3rd year	4th year	5th year

Source: ITS Japan

1. Start of ITS Spot service

・ High-speed, high-volume communications between roads and vehicles provides road traffic information and others, and allows collection of data from vehicles.

Three basic services

Dynamic route guidance: Receipt of wide-area congestion data allows car navigation system to select routes intelligently.

Safety driving support: Reduction of close-call experiences by alerting drivers to possible dangers such as fallen obstacles.
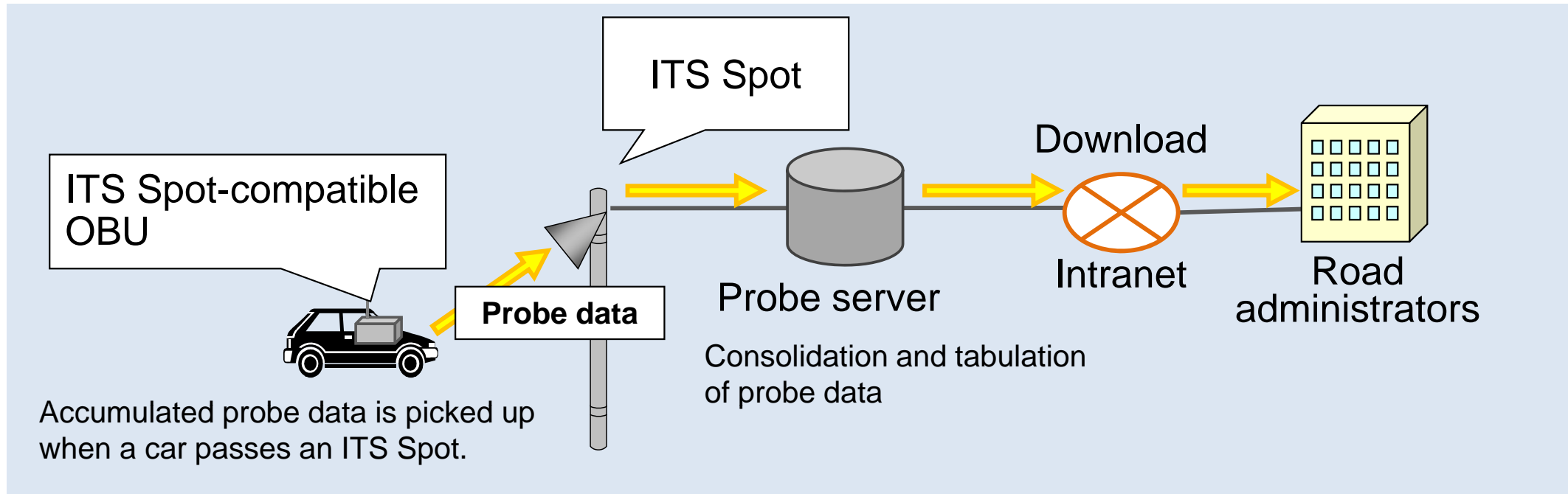
ETC: Realization of ETC services.

Collection of probe data: Collection of traveling data from individual vehicles

Other services (available with some manufacturer's OBUs)

Local sightseeing information and other information can be obtained via Internet connection.

*Additionally, services related to payments, tourism, distribution, etc., are planned for the future.

2. Collecting probe data via ITS Spots

ITS Spot

ITS Spot-compatible OBU

Probe data

Probe server

Consolidation and tabulation of probe data

Download

Intranet

Road administrators

Accumulated probe data is picked up when a car passes an ITS Spot.

- Data collected

  - Travel data ; Time, location, speed
  - Behavioral data ;Time, acceleration in all directions, yaw angle speed

  - Timing of data recording
    Location and speed: Every 200 meters of driving distance or when direction of travel changes by 45 degrees
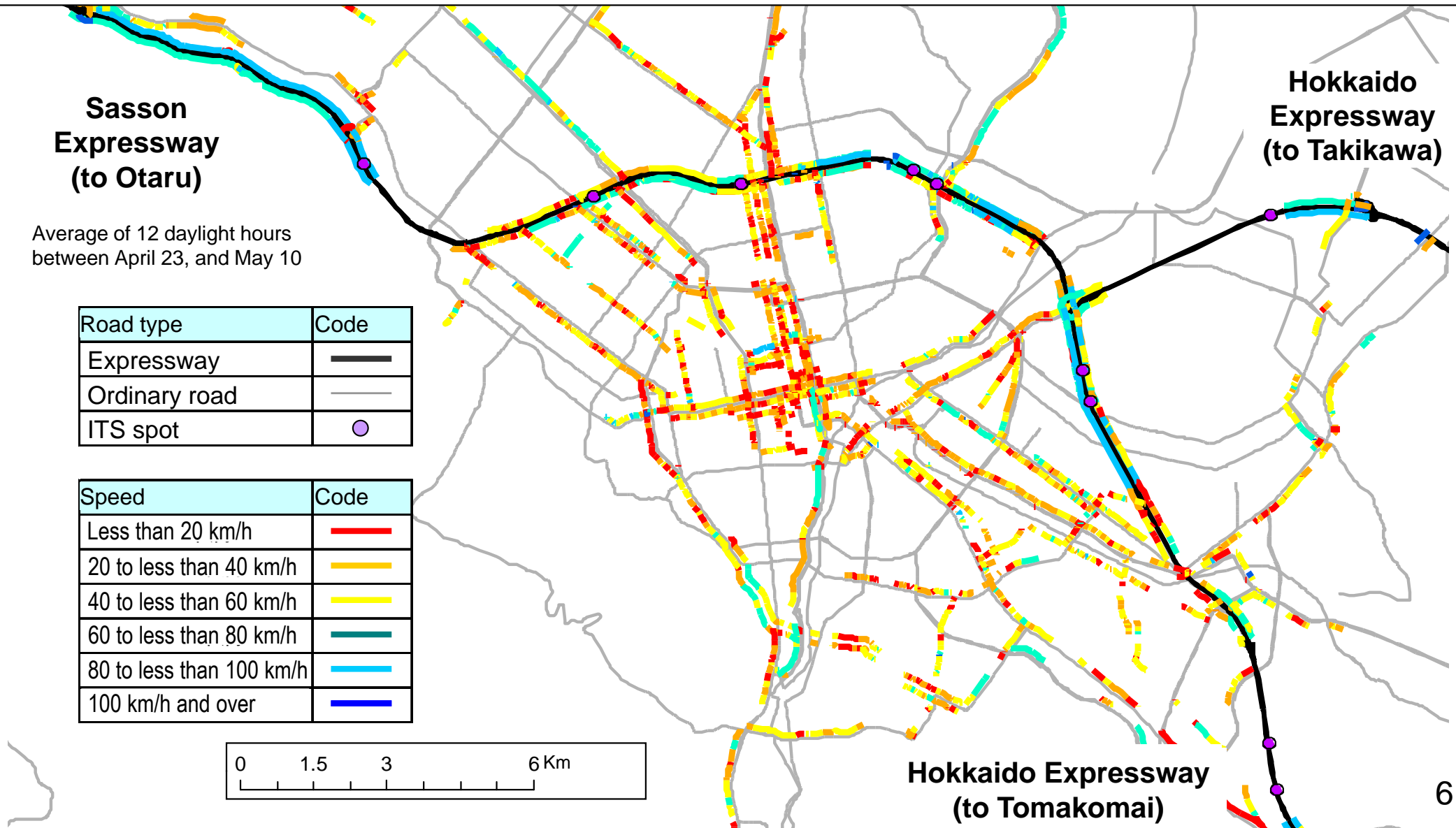   Acceleration: When 0.25 G is surpassed
    Yaw angle speed: When $\pm$8.5 deg/s is surpassed
  - Data recording distance: Approx. 80 km

Processed probe data (Sapporo City)

- Utilizing probe data collected via ITS Spots on expressways make it possible to survey whole-area travel speed on expressways and ordinary roads.

Sasson Expressway (to Otaru)

Hokkaido Expressway (to Takikawa)

Average of 12 daylight hours between April 23, and May 10

Road type	Code
Expressway	▬
Ordinary road	─
ITS spot	●

Speed	Code
Less than 20 km/h	▬
20 to less than 40 km/h	▬
40 to less than 60 km/h	▬
60 to less than 80 km/h	▬
80 to less than 100 km/h	▬
100 km/h and over	▬

0　1.5　3　6 Km

Hokkaido Expressway (to Tomakomai)
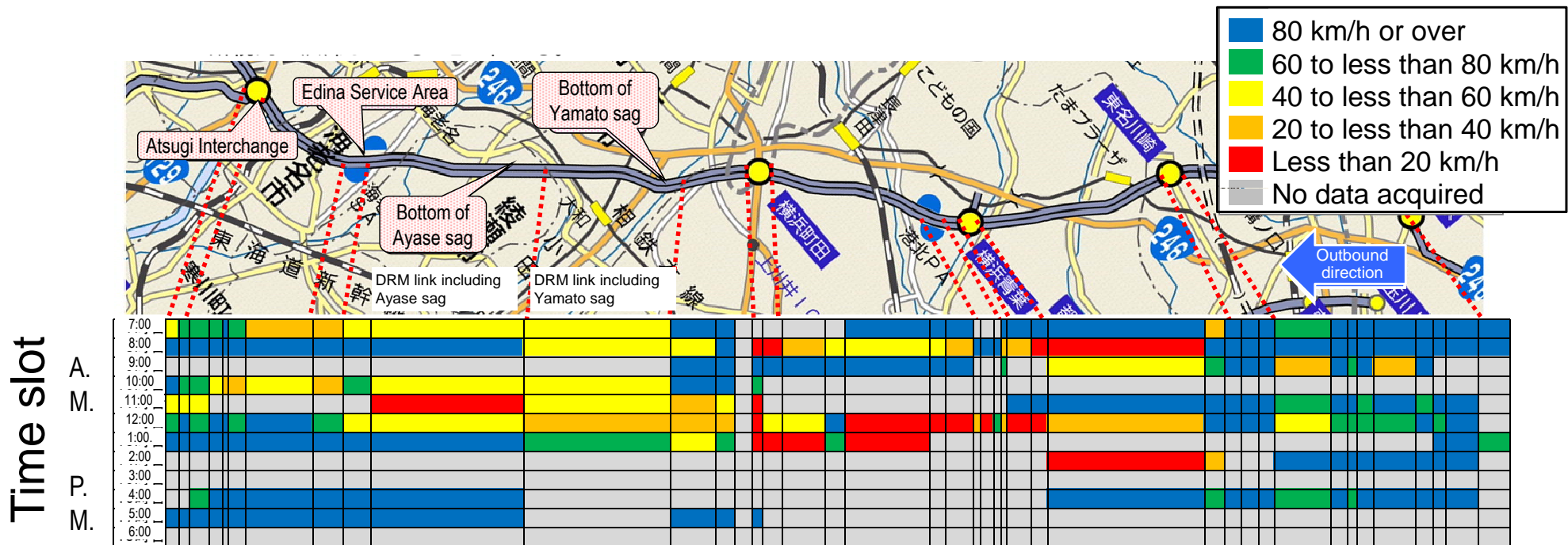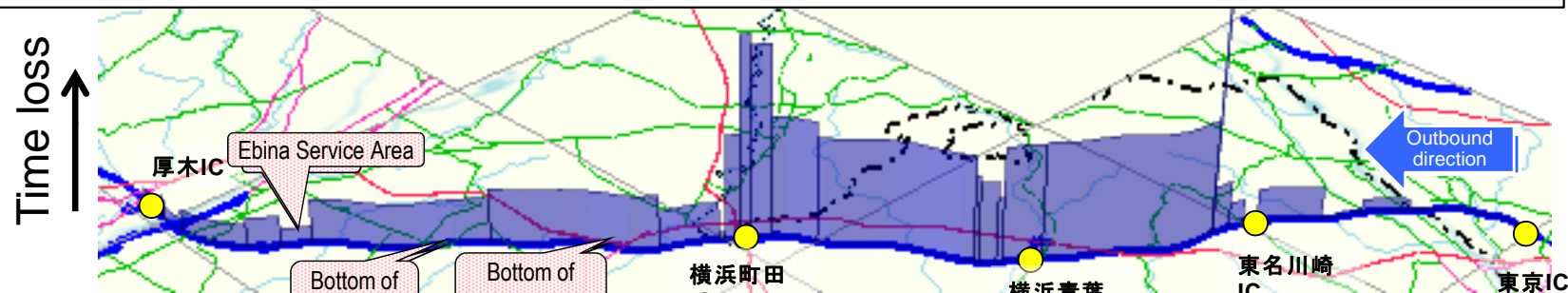
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Example of probe data analysis

Traffic conditions on the Tomei Expressway can be surveyed by section and time slot.
→ These data will be applied to administrative decisions.

Legend:
- 80 km/h or over
- 60 to less than 80 km/h
- 40 to less than 60 km/h
- 20 to less than 40 km/h
- Less than 20 km/h
- No data acquired

Atsugi Interchange
Edina Service Area
Bottom of Yamato sag
Bottom of Ayase sag
DRM link including Ayase sag
DRM link including Yamato sag
Outbound direction

Time slot — A.M. / P.M. (7:00–6:00)

Time lost to traffic congestion in each zone can be calculated

Time loss

厚木IC
Ebina Service Area
Bottom of
Bottom of
横浜町田
横浜青葉 IC
東名川崎 IC
東京IC
Outbound direction

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Probe data application menu

- Greater sophistication and efficiency can be achieved in various areas of road administration by utilizing travel records and behavioral records.

Use area	Forms of probe data use
Survey and planning	• Implementation of whole-area and continuous travel speed surveys
Congestion countermeasures	• Quantitative survey of congestion conditions • Clarification of effect of road construction on road traffic
Traffic safety measures	• Analysis of travel conditions on community roads • Identification of potential hazardous points (accident-prone areas)
Management of large-vehicle passage	• Survey of conditions concerning passage of special-purpose vehicles and vehicles carrying hazardous materials
Road management during disasters	• Identification of passable route during disasters • Survey of passage conditions during snowfall
Provision of information	• Increased sophistication of provided road traffic data

Example of application in evaluation of road policy

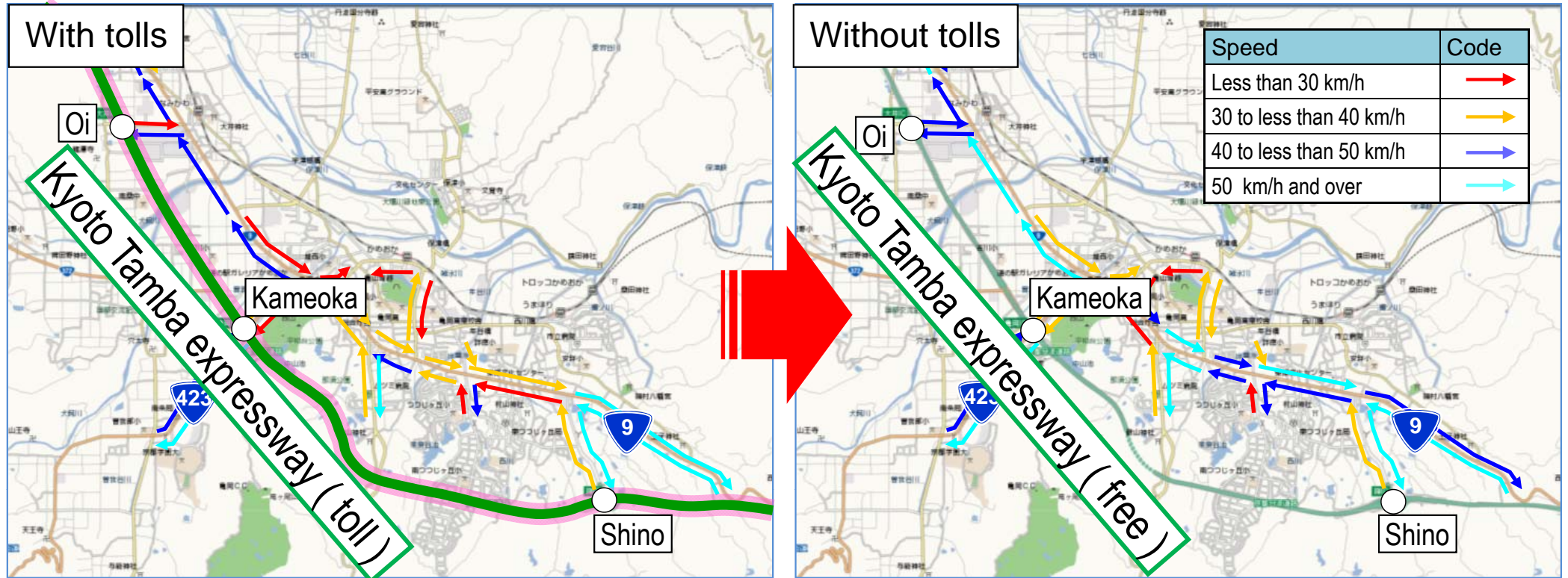- Probe data can be used to ascertain road traffic over a wide area and evaluate road policy quantitatively.

Pilot project abolishing expressway tolls
  Zone: 1,652-km zone
  Period: June 28, 2010, to March 31, 2011

■ Change in speed during peak time periods

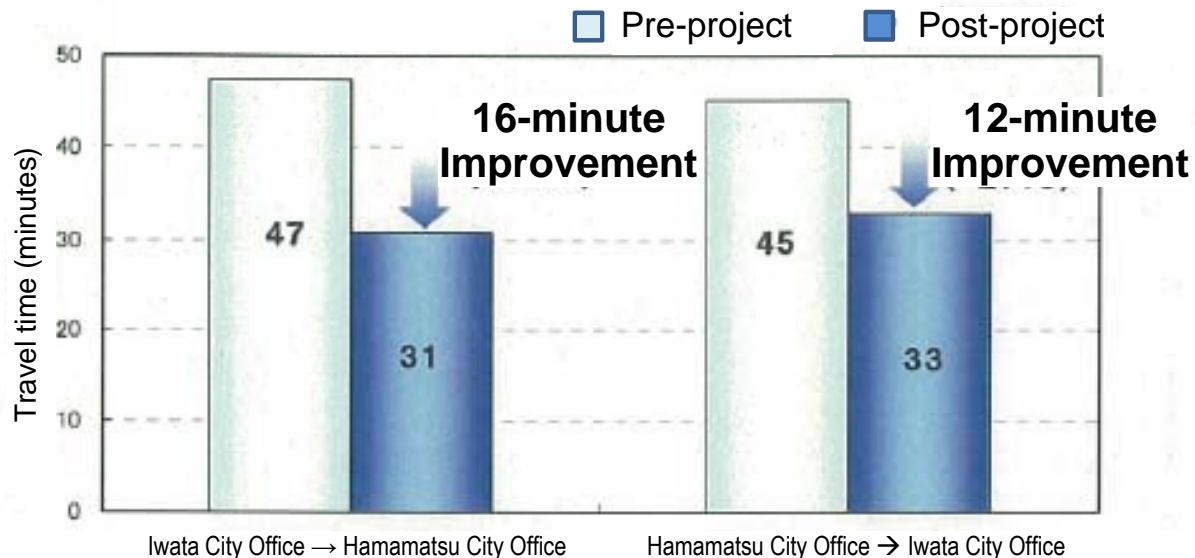| Speed	Code
Less than 30 km/h	→
30 to less than 40 km/h	→
40 to less than 50 km/h	→
50 km/h and over	→

Example of application in road project evaluation

- Utilizing probe data makes it possible to quantitatively evaluate road projects, such as lane-widening work.

Example of the effect of road-widening project on National Highway 1

- Despite an increase in traffic volume on National Route 1 from 4,100 vehicles/hour to 5,600 vehicles/hour, travel time was reduced.
- Travel time on the parallel Iwata-Hosoe Line (prefectural road) was also reduced.
- Travel speed increased from the previous 20 km/h or less to 40 km/h or more.

Change in travel time on Nat. Route 1

☐ Pre-project ■ Post-project

16-minute Improvement

12-minute Improvement

47 — 31

45 — 33

Iwata City Office → Hamamatsu City Office

Hamamatsu City Office → Iwata City Office

Travel time (minutes)

Change in travel time on Iwata-Hosoe Line (prefectural road)

Pre-project

27-minute Improvement

41

Post-project

14

Koyasu Intersection → Nagamori Intersection

Travel time (minutes)

Source: Hamamatsu Office of River and National Highway
(FY2008 project evaluation data)

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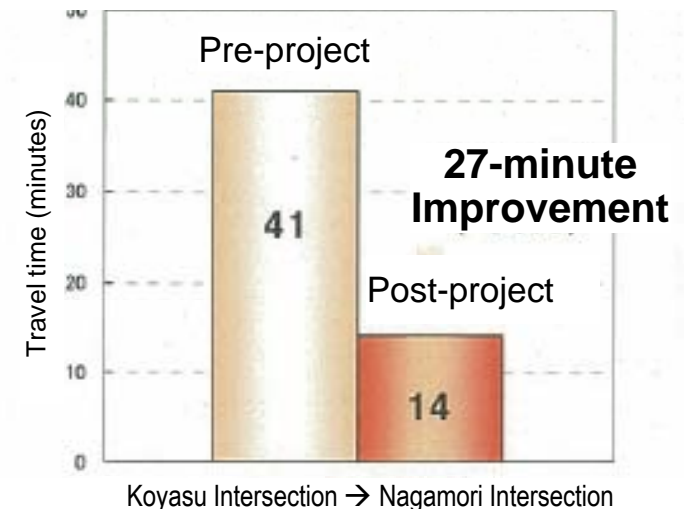
Example of identification of potential accident points

• Extracting locations of sudden braking or abrupt steering from behavioral records in probe data makes it possible to identify potential hazardous points.

Point of frequent sudden braking or abrupt steering
🟡 : 10 or more
🔴 : 60 or more

Sharp curve with high number of sudden braking/abrupt steering incidents

Sharp curve with high number of sudden braking incidents

• Tunnel with high number of accidents
• Point with high number of sudden braking incidents

• Continuous sharp curve with high number of accidents
• Point with high number of sudden braking/abrupt steering incidents

• Sharp curve with high number of accidents
• Point with high number of sudden braking/abrupt steering incidents

Sharp curve with high number of sudden braking/abrupt steering incidents

Source: AHS Research Association, NILIM
(Material of the 2007 ITS Symposium)

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Example of application during a disaster

- Probe data collected by automobile manufacturers can be used in estimating passable routes. (Great East Japan Earthquake)

  - Application in selection of routes for emergency transport vehicles
  - Ascertainment of information on whether or not routes are passable within the nuclear accident evacuation area
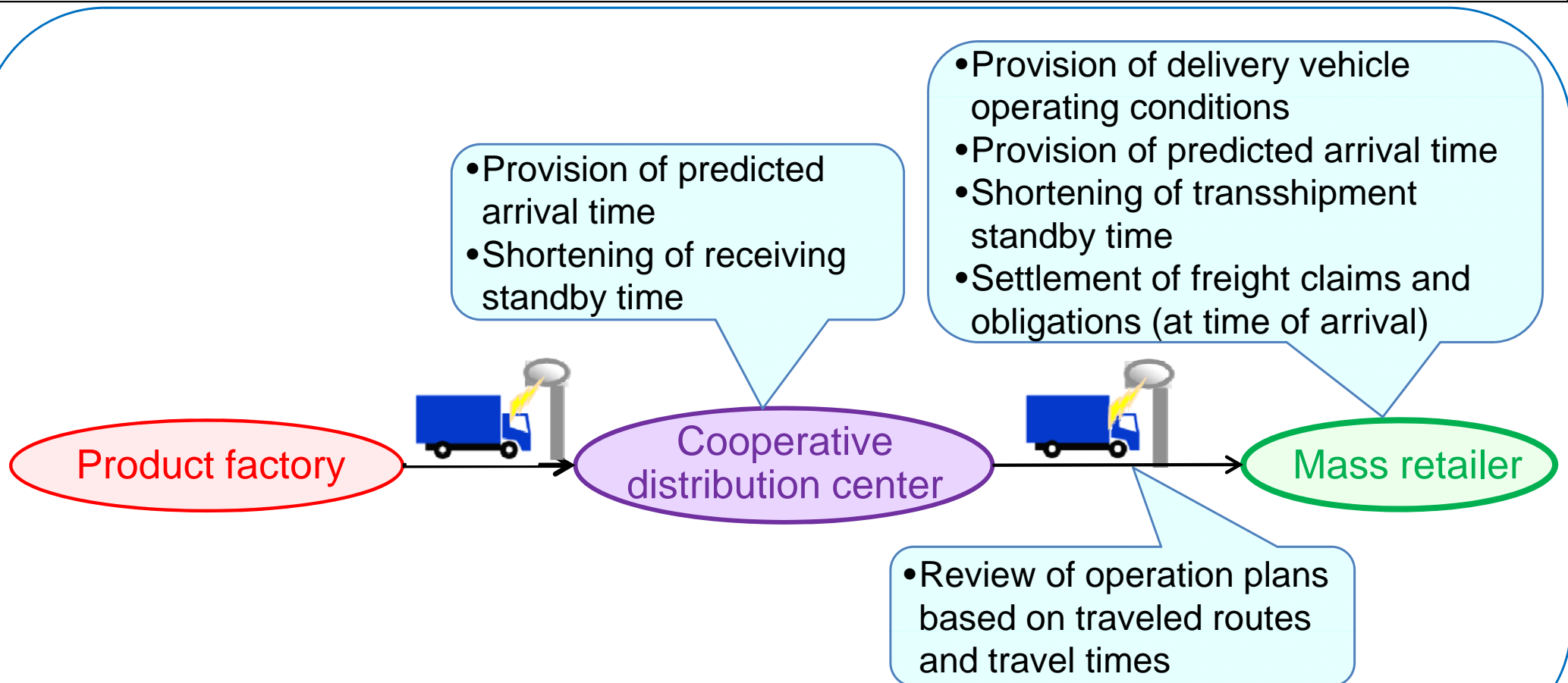

Legend
━━━ : Road with recorded passage (private-sector data)
━✕━ : Data on route closures provided by road managers (public-sector data)
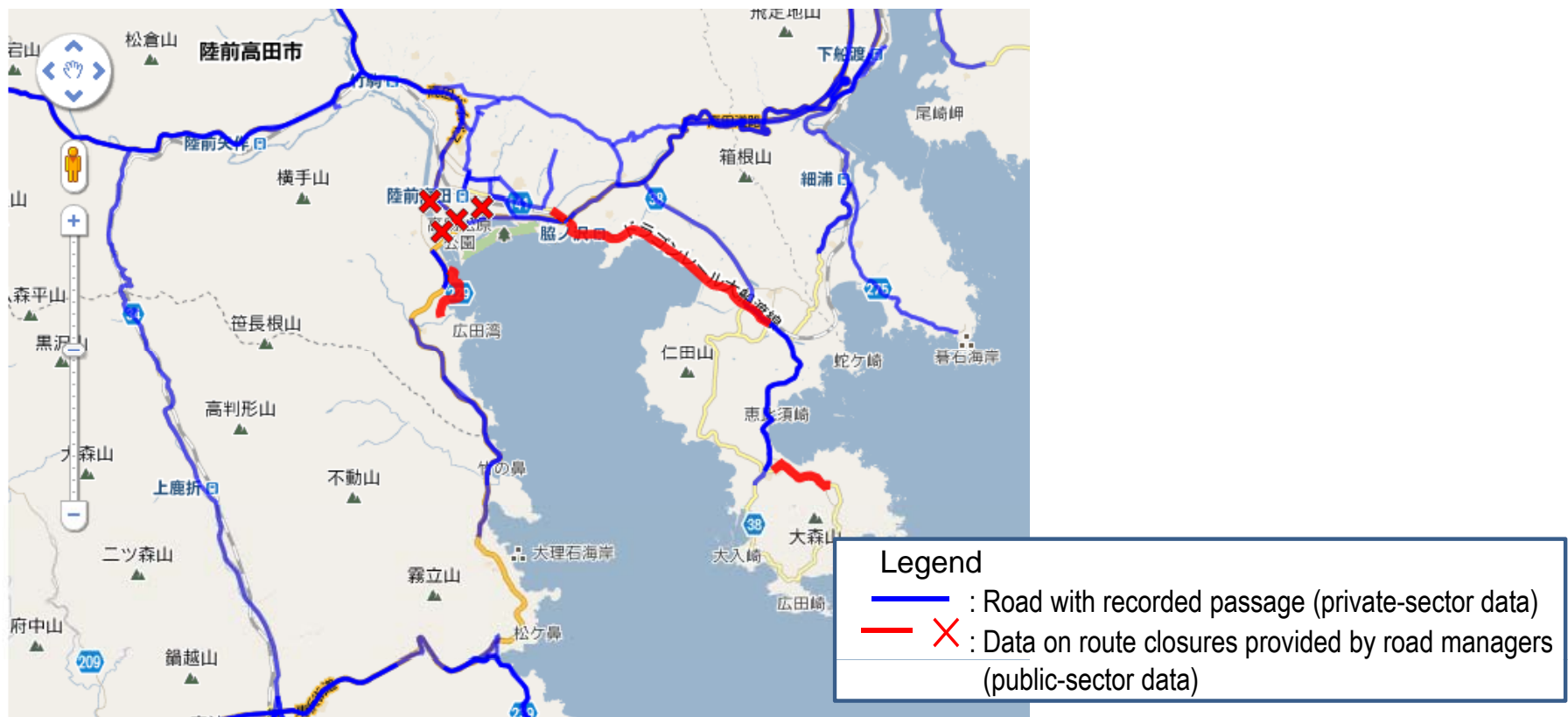
Data on vehicle passage and route closure

Source: ITS Japan

Support for distribution business

- Distribution companies can estimate product arrival times by surveying vehicle locations by probe data.
- The system supports regular reviews of operation plans and greater efficiency in receiving work by mass retailers.

- Provision of delivery vehicle operating conditions
- Provision of predicted arrival time
- Shortening of transshipment standby time
- Settlement of freight claims and obligations (at time of arrival)

- Provision of predicted arrival time
- Shortening of receiving standby time

Product factory

Cooperative distribution center

Mass retailer

- Review of operation plans based on traveled routes and travel times

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Support for scheduled express bus operation

- The system collects probe data from express buses and estimates their current locations and arrival times.
- It provides current location and estimated arrival time to expressway bus stops, thereby shortening waiting time and supporting transfers.

Bus terminal

- Provides information on operation and approaching buses via mobile phones and the Internet

- Supports transfers between express buses at key regional transport hubs.

Bus stop

Destination

Bus stop

Destination

Local bus, express bus

Bus location information (probe data)

Operation data server

Information on operation and buses approaching bus stops

Mobile phone

PC

Display board at bus stop, etc.