NISSAN MOTOR CORPORATION

SKY Project to Help Reduce Traffic Accidents and Ease Congestion
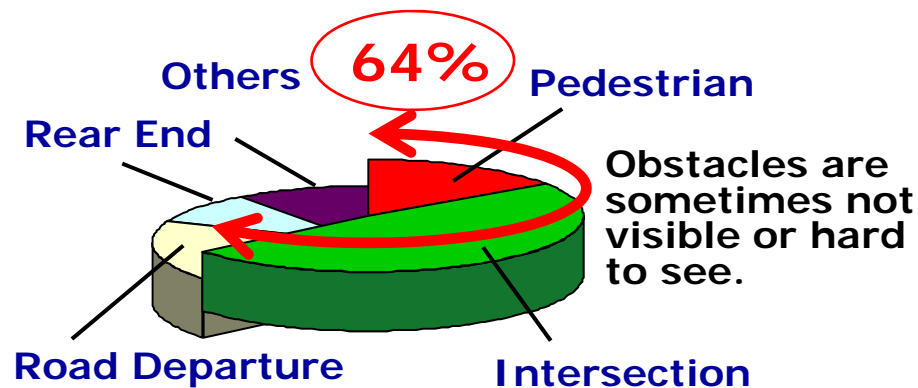
SKY Project
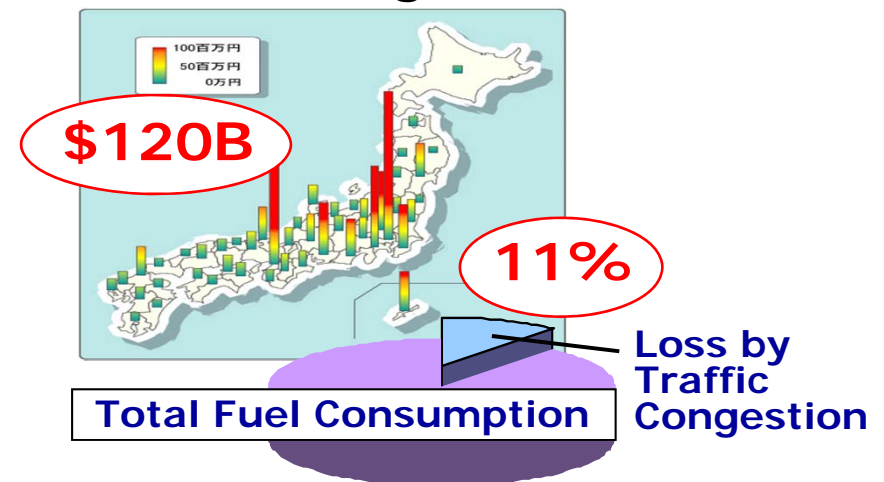
- **The SKY* project is a test of vehicle-infrastructure communication through the Intelligent Transport System (ITS), using information obtained from nearby vehicles and traffic infrastructure to alert drivers to potential danger from approaching vehicles and help reduce traffic accidents. The system also provides information on the fastest route using probe data.**

* SKY stands for "Start ITS from Kanagawa, Yokohama." The project is implemented in cooperation with NTT DoCoMo Co. Ltd., Panasonic Co. Ltd., Clarion Co. Ltd. and Nissan.
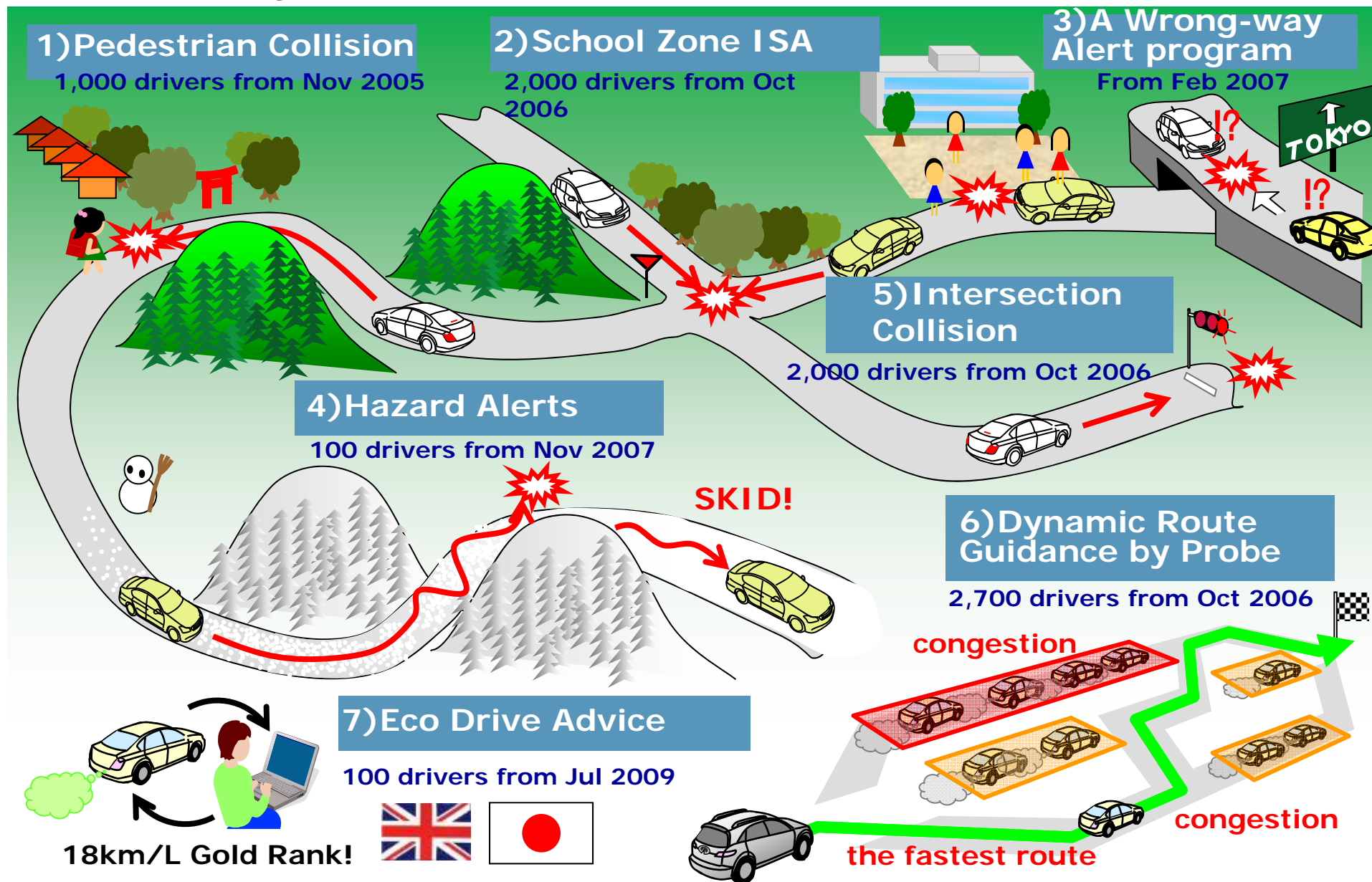
Traffic accident fatalities and serious injuries

64%

Others

Pedestrian

Rear End

Obstacles are sometimes not visible or hard to see.

Road Departure

Intersection

Economic Loss from Traffic Congestion

$120B

11%

Total Fuel Consumption

Loss by Traffic Congestion

SKY Project Field Operation Test

1)Pedestrian Collision
1,000 drivers from Nov 2005

2)School Zone ISA
2,000 drivers from Oct 2006

3)A Wrong-way Alert program
From Feb 2007

TOKYO

5)Intersection Collision
2,000 drivers from Oct 2006

4)Hazard Alerts
100 drivers from Nov 2007

SKID!

6)Dynamic Route Guidance by Probe
2,700 drivers from Oct 2006

congestion

congestion

the fastest route

7)Eco Drive Advice
100 drivers from Jul 2009

18km/L Gold Rank!
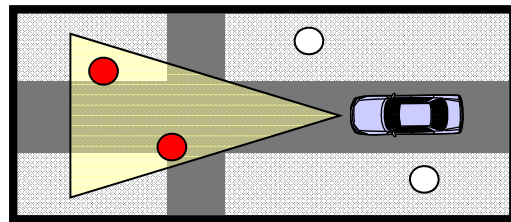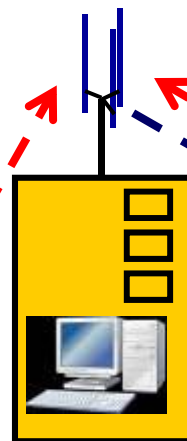
1)Pedestrian Collision Avoidance -Using GPS Mobile Phone-

Developing

- Pedestrians' location information collected through GPS mobile phone is sent to driver through car navigation system.

Be careful with a pedestrian ahead

CARWINGS®

Vehicle's location data
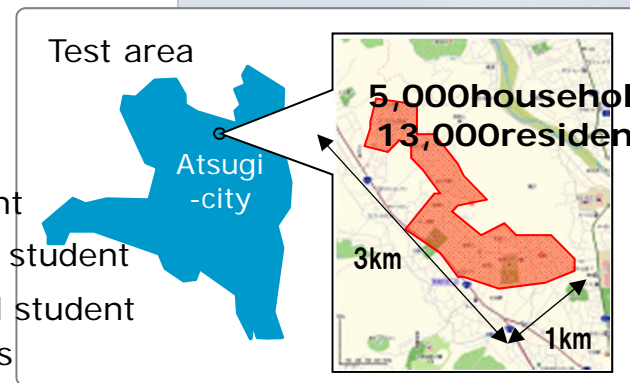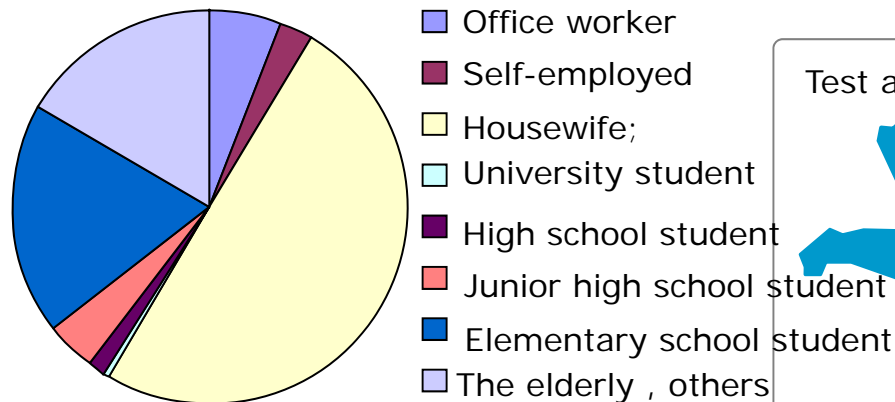
Alert for pedestrian

Pedestrian's location data

Server

1)Pedestrian Collision Avoidance -Field Operation Test-

- Purpose:Evaluate drivers behavior changes by alerts, receptivity of drivers to the system etc.
- Period:Nov-Dec 2008
- Monitors:200 drivers and 500 pedestrians

NISSAN

日産は、新技術(ITS:高度道路交通システム)を使用し、交通事故の低減と渋滞緩和を目指す
SKY PROJECTを推進しています。この実験は、SKY PROJECTの取り組みの一環として実施します。

実証実験モニター
大募集！

実証実験期間
2008年
11月1日(土)
から
12月27日(土)
まで
ご体験ください。

モニターに参加して頂いた方に、
実験およびアンケートに
ご協力いただく御礼として
QUOカード(5,000円分)を
もれなく差し上げます。

携帯電話協調歩行者事故低減システム

歩行者が持つ携帯電話とクルマを
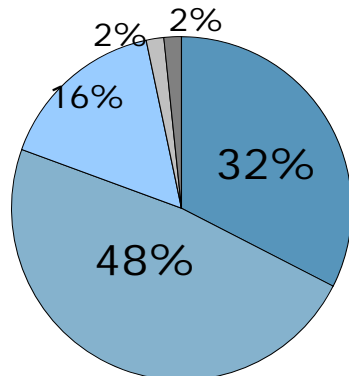通信でつなぐことによって、
「見えにくい場所にいる歩行者」の
存在をお知らせし、
クルマと歩行者との

SKY PROJECT

まずは神奈川県厚木市で始まります。
実証実験の成果は、実用化へとつながっていきます。

あなたのクルマをより安全で快適にすること。
クルマや街で暮らすみんなの安全と快適につなげたい。
高度交通システム(Intelligent Transport Systems)における
新技術の開発。幸せなネットワークを広げていきます。

Pie chart legend:
- Office worker
- Self-employed
- Housewife;
- University student
- High school student
- Junior high school student
- Elementary school student
- The elderly , others

Test area
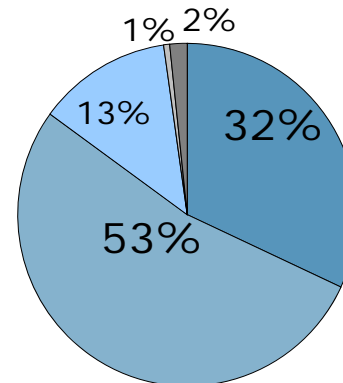
Atsugi -city

5,000households
13,000residents

3km

1km

1)Pedestrian Collision Avoidance -Field Operation Test Results-

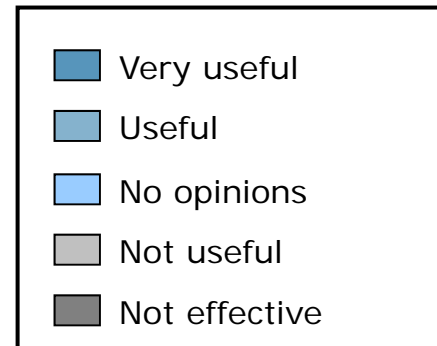■ More than 80% of monitors answered that the system is useful for safety driving in the survey.

N=159

For safety driving
- 32%
- 48%
- 16%
- 2%
- 2%

For reducing traffic accident
- 32%
- 53%
- 13%
- 1%
- 2%

Legend:
- Very useful
- Useful
- No opinions
- Not useful
- Not effective

■ 71% of the drivers reduced the speed.

N=790

| 57% | 14% | 29% |

- Put on the brake
- Released gasoline pedal
- No action

With alert

No aleart

Alert

Gas pedalOFF

Brake ON

speed km/h

Pedestrians' location at the alert

4.8 seconds

-50   0   50   100 m
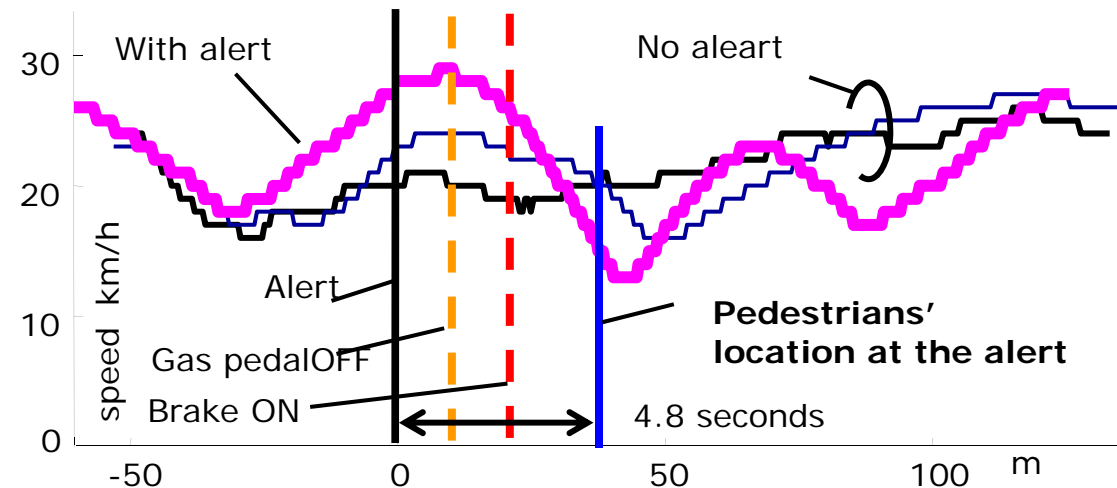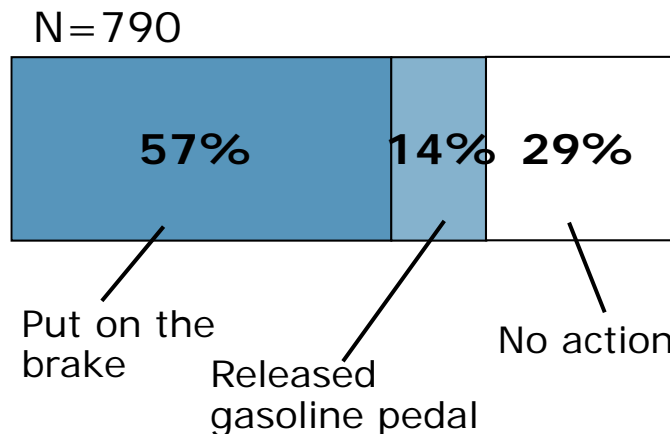
1)Communication from Vehicle to Pedestrian, Cyclist and Motor bike using Radio Frequency Identification (RFID)

Developing

ITS System

ANT

GPS

Communicator

RFID

RFID

Test car with system

Bike ahead,
Be careful.
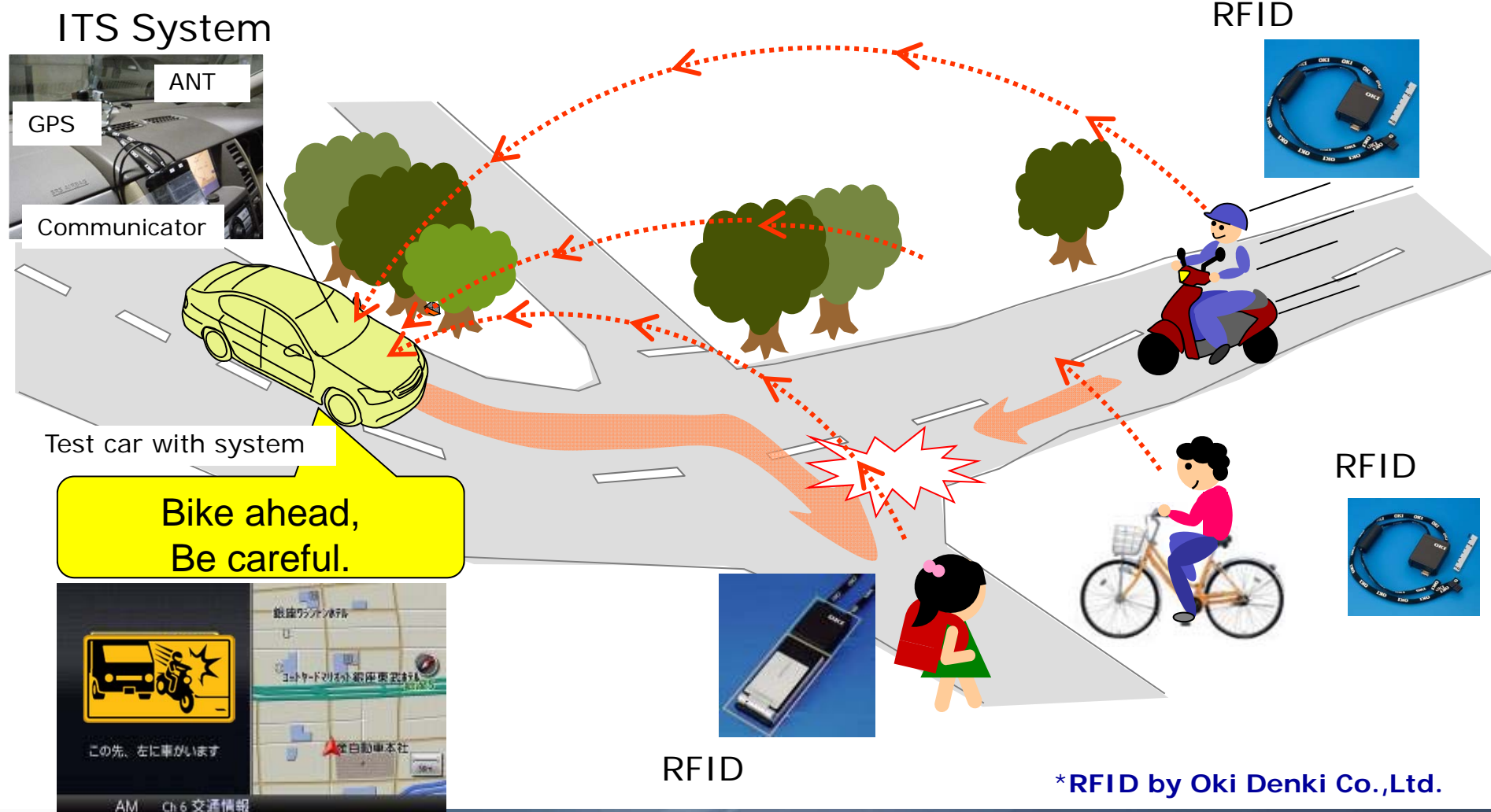
RFID

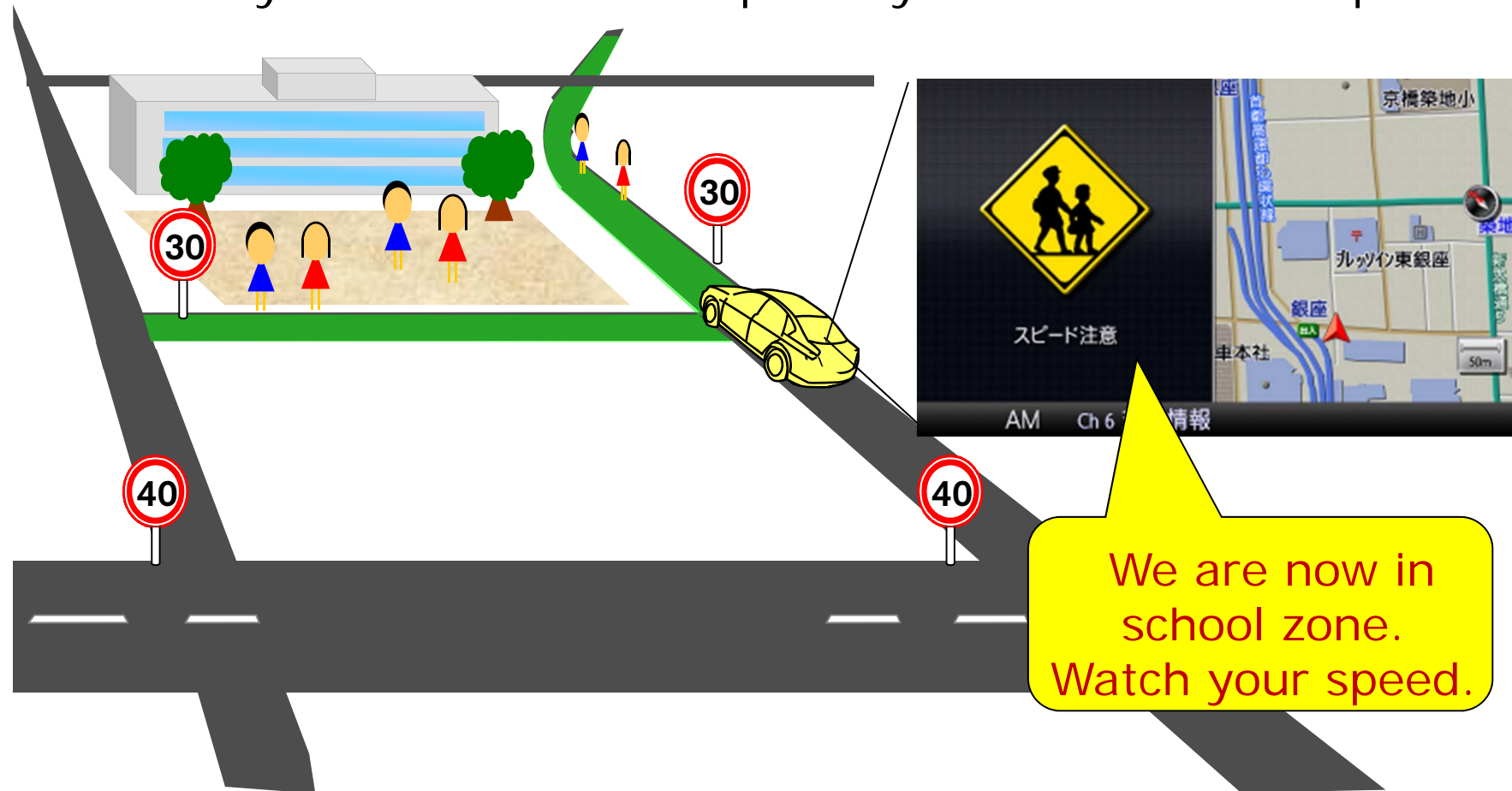*RFID by Oki Denki Co.,Ltd.

2) Intelligent Speed Advisory in School Zone

- Alert driver for excessive speed in school zone to avoid traffic accident.
- Nissan's system works around primary schools all over Japan

We are now in school zone.
Watch your speed.

3)A Wrong-Way Alert Program

- Give the driver audio and visual warnings when the system* determines the driver is going the wrong way from service area, parking area and interchange of an expressway.

  *Nissan and West Nippon Expressway Co., Ltd. (West NEXCO) have jointly developed using GPS data through cooperative research on information systems using IT, conducted since January 2009.

Caution! Wrong way!

逆走しています
「現在地」で画面を解除できます

The alert system can work by rewriting car-navigation software.

Alert the driver when he is going wrong way

3)A Wrong-Way Alert Program

■ Mechanism of On-board system
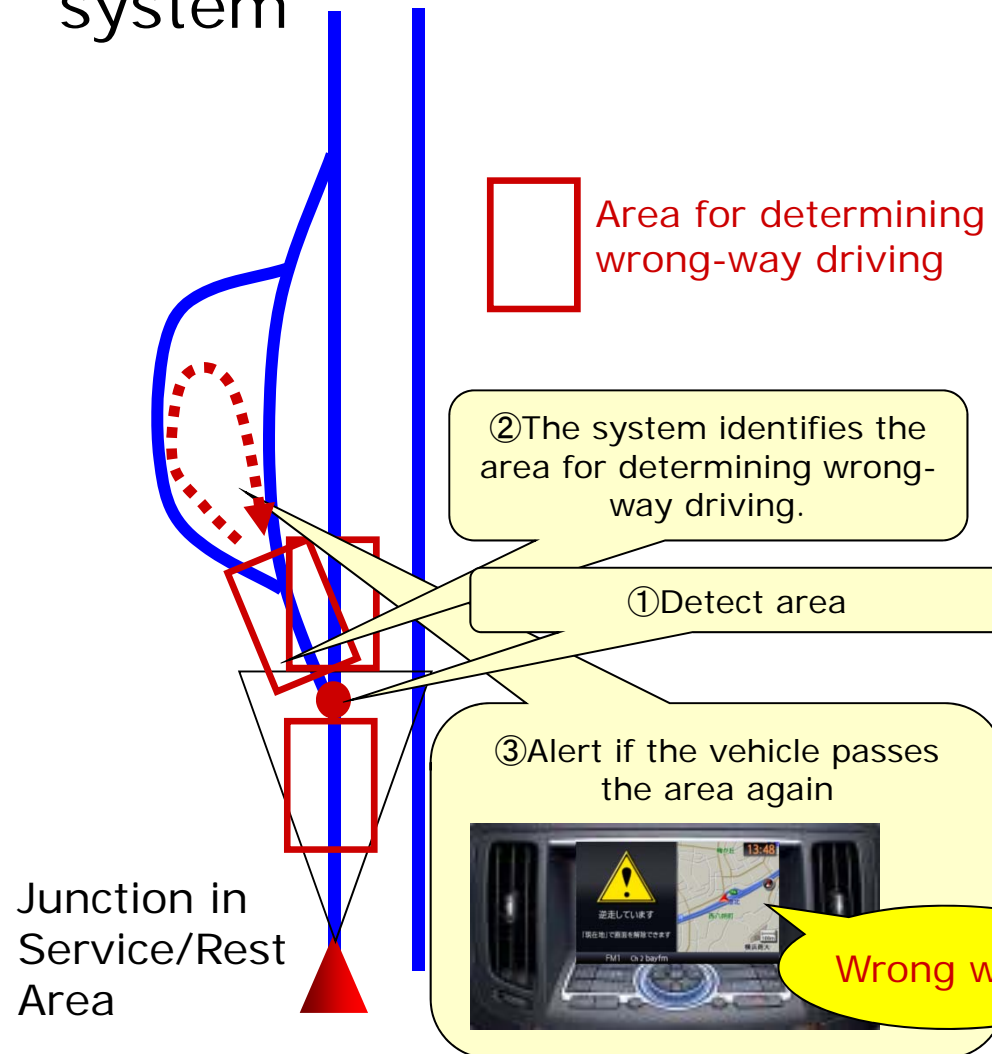
Utilize navigation system

Area for determining wrong-way driving

②The system identifies the area for determining wrong-way driving.

①Detect area

③Alert if the vehicle passes the area again

Wrong way!

Junction in Service/Rest Area

Junctions

Less than 90-degree
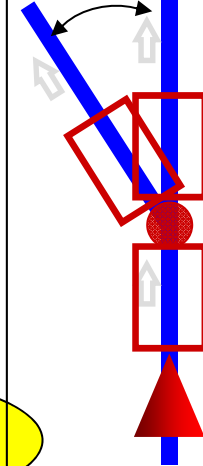
More than 90-degree
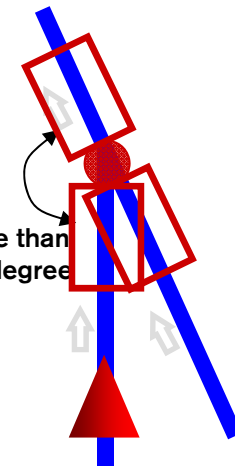
Branch point   Conjunction

4) Slip-Hazard Alert Distribution in Hokkaido

■ Alert drivers by distributing skidding accident information on the way to destination using probe data.

CARWINGS®

Distribute
• The latest slippery areas
• Areas where skid accidents happened before

Collect
• Time
• Location
• Antilock Brake System status
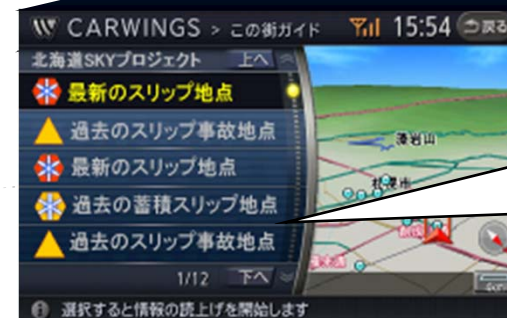
Skidding accident

There is a skidding accident ahead

Copyright 2007 ZENRIN CO., LTD. （Z08MA第036号）

4)Slip-Hazard Alert Distribution in Hokkaido

■ Utilize historical skidding accident data, as well as real-time slippery area information.

Real-time slippery areas   Skidding accidents in the past

4) Slip-Alert Hazard Distribution in Hokkaido

■ Provide road operators with skidding accident information to assist with road maintenance.

For safety

To improve condition

Skidding accident information

Information sharing

Reduce energy use

5)Intersection Collision Avoidance

-Driving Safety Support System (DSSS)-

■ Provide traffic information to driver through communication from IR beacon to car navigation and avoid traffic accident.

Car navigation

+

Three media:
VICS, beacon
and antenna

Vehicle sensors

Traffic signal

止まれ
この先、一時停止
AM Ch6 交通情報

Optical beacon

Enhance stop-sign recognition

Stop sign

この先、左に車がいます
AM Ch6 交通情報

この先、信号機あり
AM Ch6 交通情報

Prevent collision at crossing
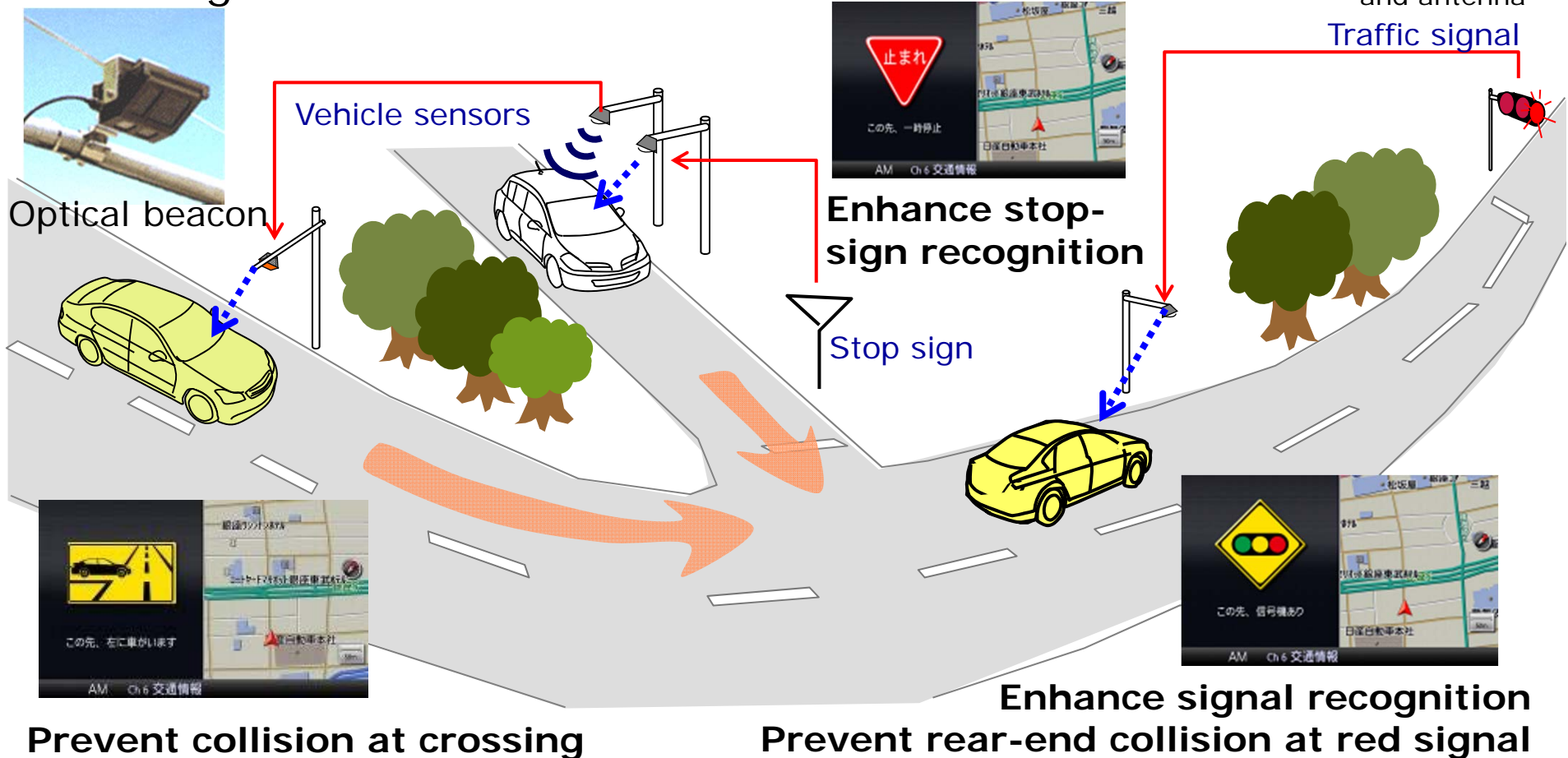
Enhance signal recognition
Prevent rear-end collision at red signal

5)Intersection Collision Avoidance-DSSS-

Traffic Sign

Road Shape

Traffic Signal

Road-side Sensor

Create Down-Link Data

Road-side unit

Infrastructure to vehicle communication

IR Beacon

On-board unit

Data filtering and timing decision

Alert by display, voice, sound…

5)Intersection Collision Avoidance-DSSS-

Mechanism of Enhance stop-sign recognition

Logic

- Service ID
- Signal, Sign info.
- Sensor info.
- Road Shape

Transmitter

START

Area in service — NO

YES

Residual distance to stop line < Distance required to stop the vehicle

NO — YES

Presence of driver's deceleration

YES — NO

Alert

Decision

END

Vehicle information

Velocity, Gas pedal info, Brake info. etc

HMI

Sound, Voice   **Display**   **Indicator, etc**

5) Intersection Collision Avoidance
## -Evaluation of Effectiveness-

- 2,000 participants; routine, daily driving.
- Data collected from vehicles as they passed monitoring points; driver behavior recorded.

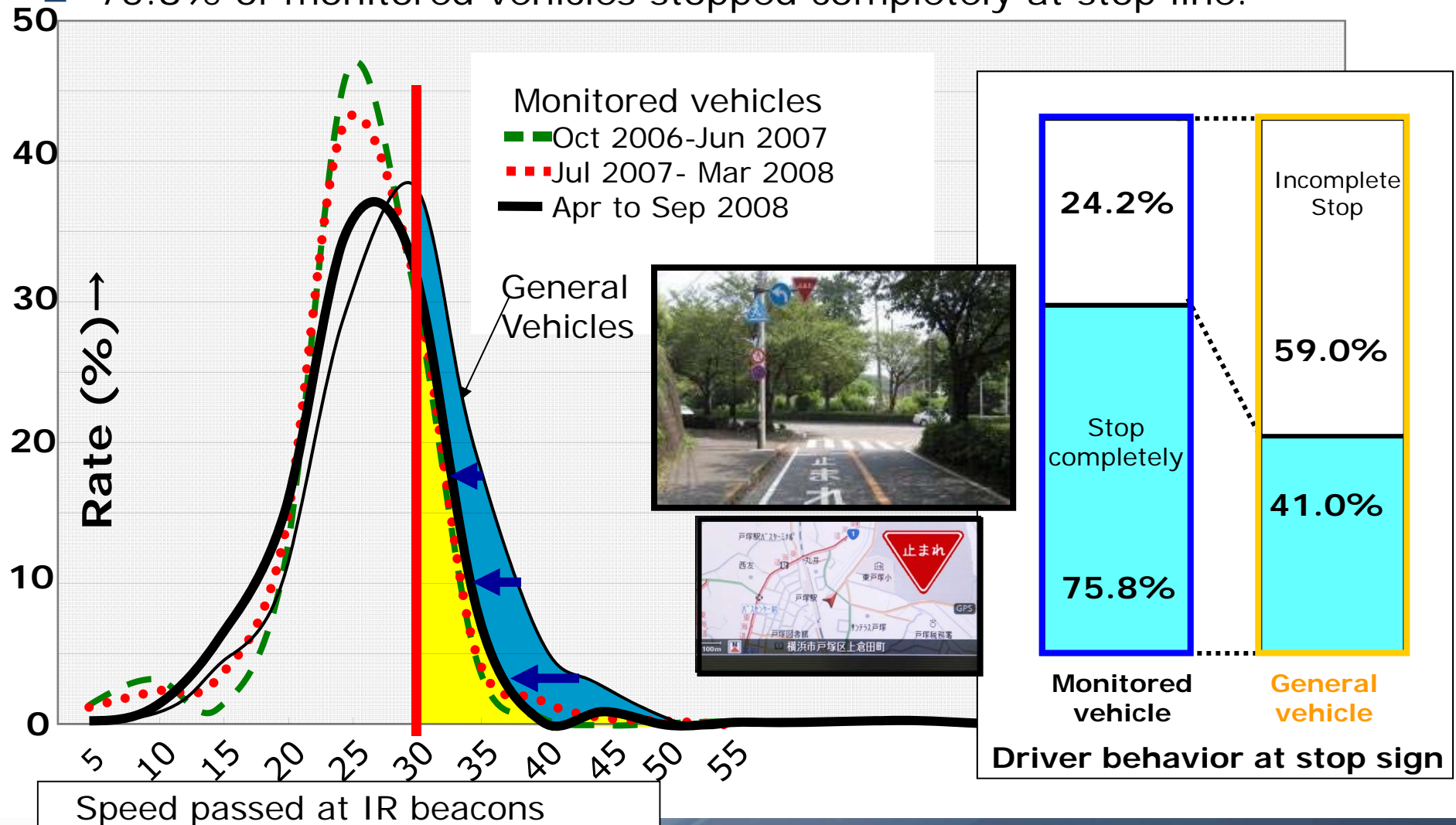| **2,000 monitored vehicles**	- Velocity, deceleration G, throttle rate, braking condition [A] [B] - Result of system decision (Presence of alert) [B] - Stopping time at stop sign [Video camera]
Others	- Velocity [A] [B] - Stopping time at stop sign [Video camera]

Video camera

IR Beacon

IR Beacon

Sensor for velocity
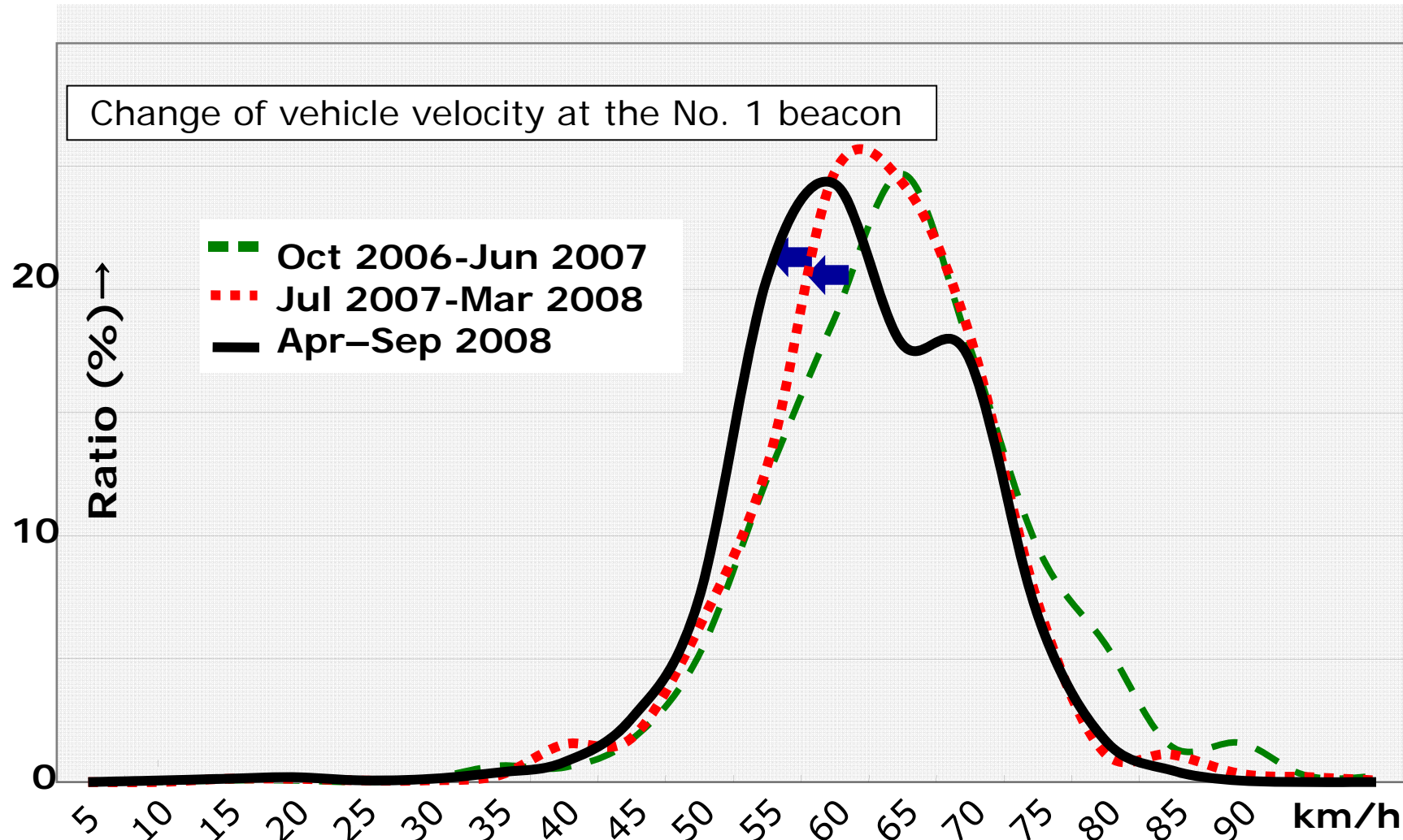
B

A
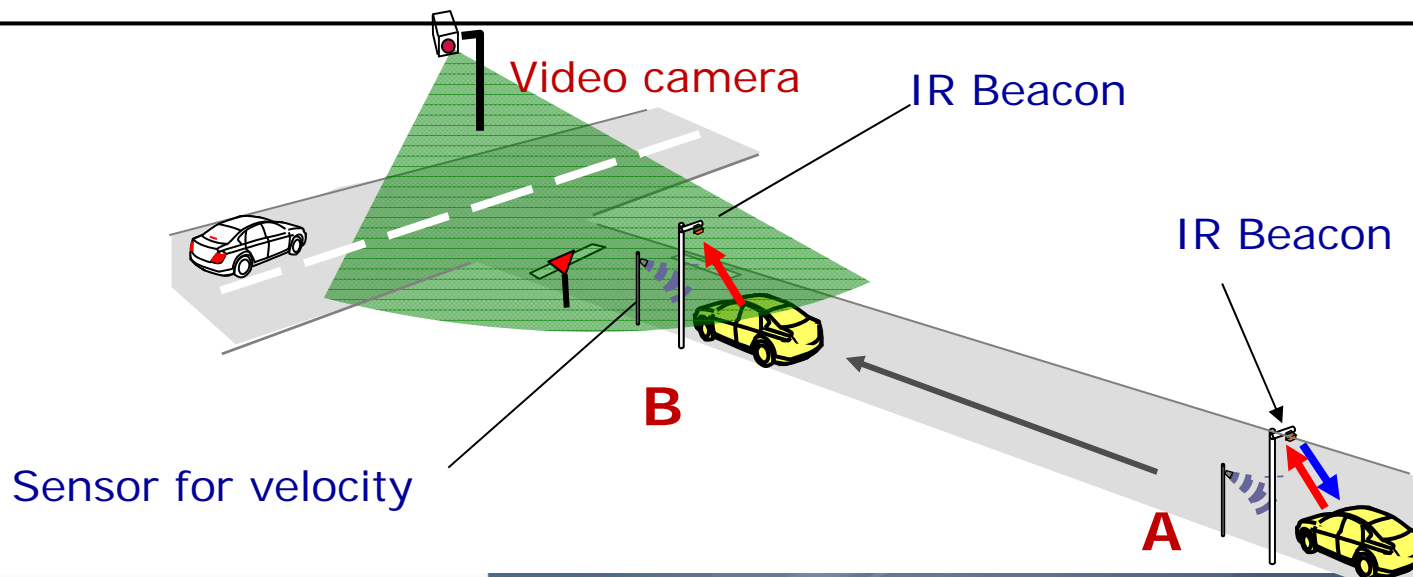
5)Evaluation -Stop Sign Recognition-

- General vehicles at excessive speed were 41%, while monitored vehicles were 23%, and they drove at slower speed.
- 75.8% of monitored vehicles stopped completely at stop line.

Rate (%) →

Monitored vehicles
- - - Oct 2006-Jun 2007
····· Jul 2007- Mar 2008
—— Apr to Sep 2008

General Vehicles

Speed passed at IR beacons

5 10 15 20 25 30 35 40 45 50 55

Monitored vehicle
- 24.2%
- Stop completely
- 75.8%

General vehicle
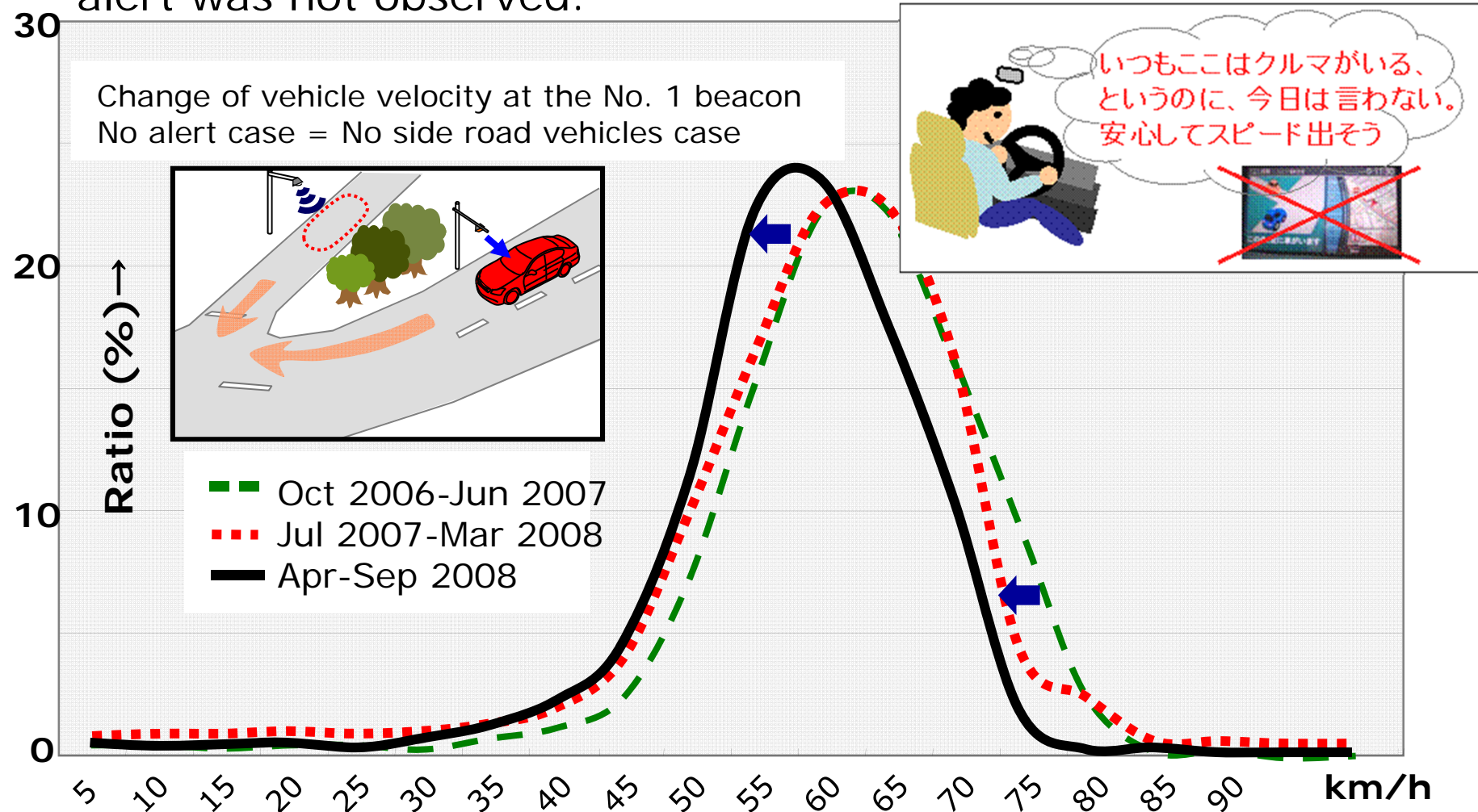- Incomplete Stop
- 59.0%
- 41.0%

Driver behavior at stop sign

5) Evaluation –Effect of Learning-

■ The speeds approaching intersection decreased over time. Drivers learn to predict potential risk.

Change of vehicle velocity at the No. 1 beacon

Ratio (%) →

- - - Oct 2006-Jun 2007
- - - - Jul 2007-Mar 2008
—— Apr–Sep 2008

km/h

5)Evaluation-In case of No Alert-

- The speeds approaching intersection decreased over time. Driver overconfidence in case the system did not provide any alert was not observed.

Change of vehicle velocity at the No. 1 beacon
No alert case = No side road vehicles case

Ratio (%)→

- - - Oct 2006-Jun 2007
...... Jul 2007-Mar 2008
—— Apr-Sep 2008

km/h

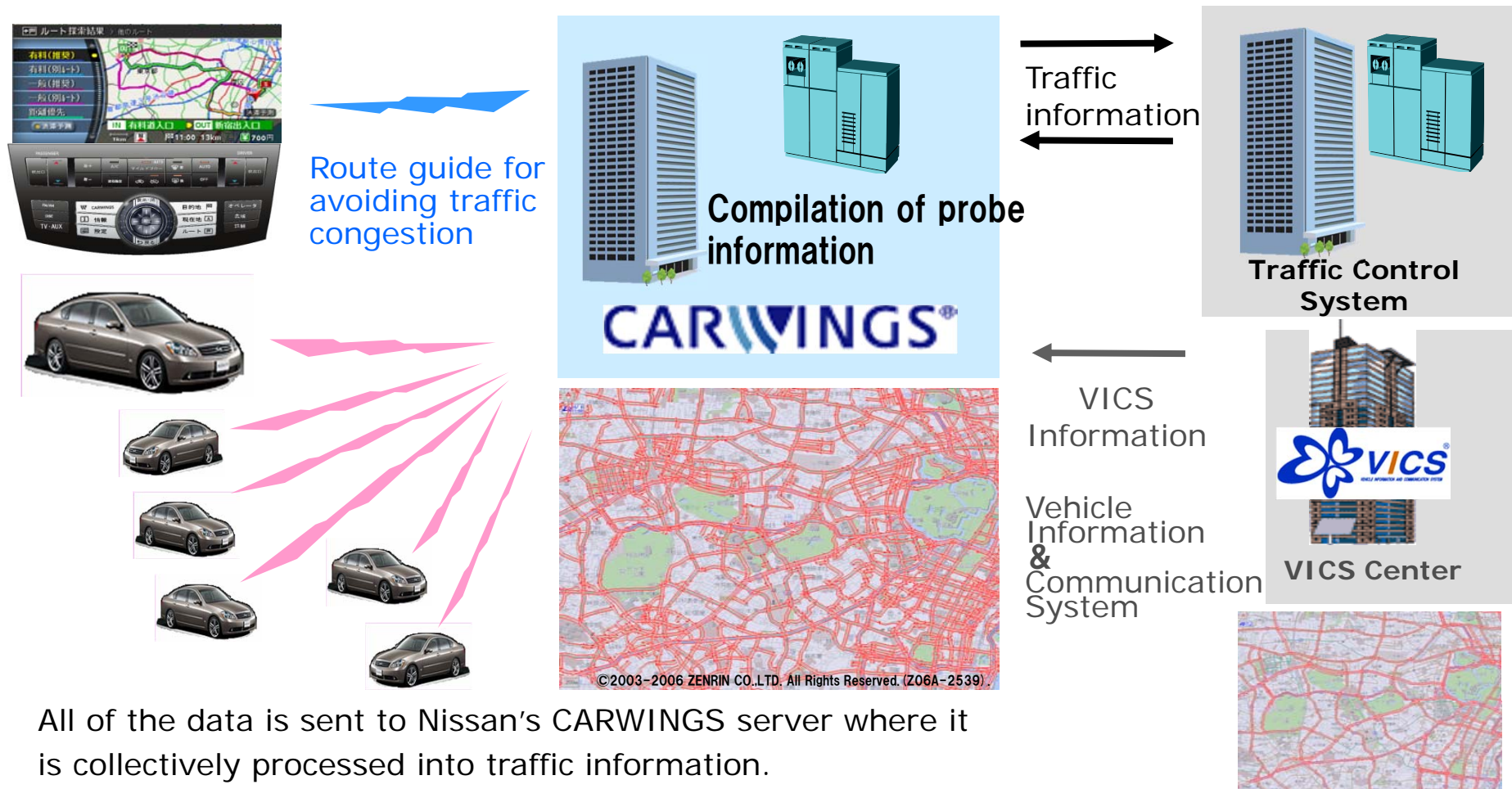いつもここはクルマがいる、
というのに、今日は言わない。
安心してスピード出そう

5)Summary

■ Change in driver behavior: Alerts contribute to changing driver behavior for safer driving.

Service		General vehicles	Monitored vehicles	Improved
Enhanced stop sign recognition	Ratio of over-speeding vehicles	41%	23%	18 points
Enhanced signal recognition		70%	56%	14 points
Prevent collision at crossing	Ratio of over-speeding vehicles that cannot avoid accident	38%	22%	16 points

■ Other driver behavior changes:
  ✓ Influence from experience cannot be found in 2.5 years monitoring.
  ✓ Influence from overconfident drivers in case of no alert provided cannot be found.
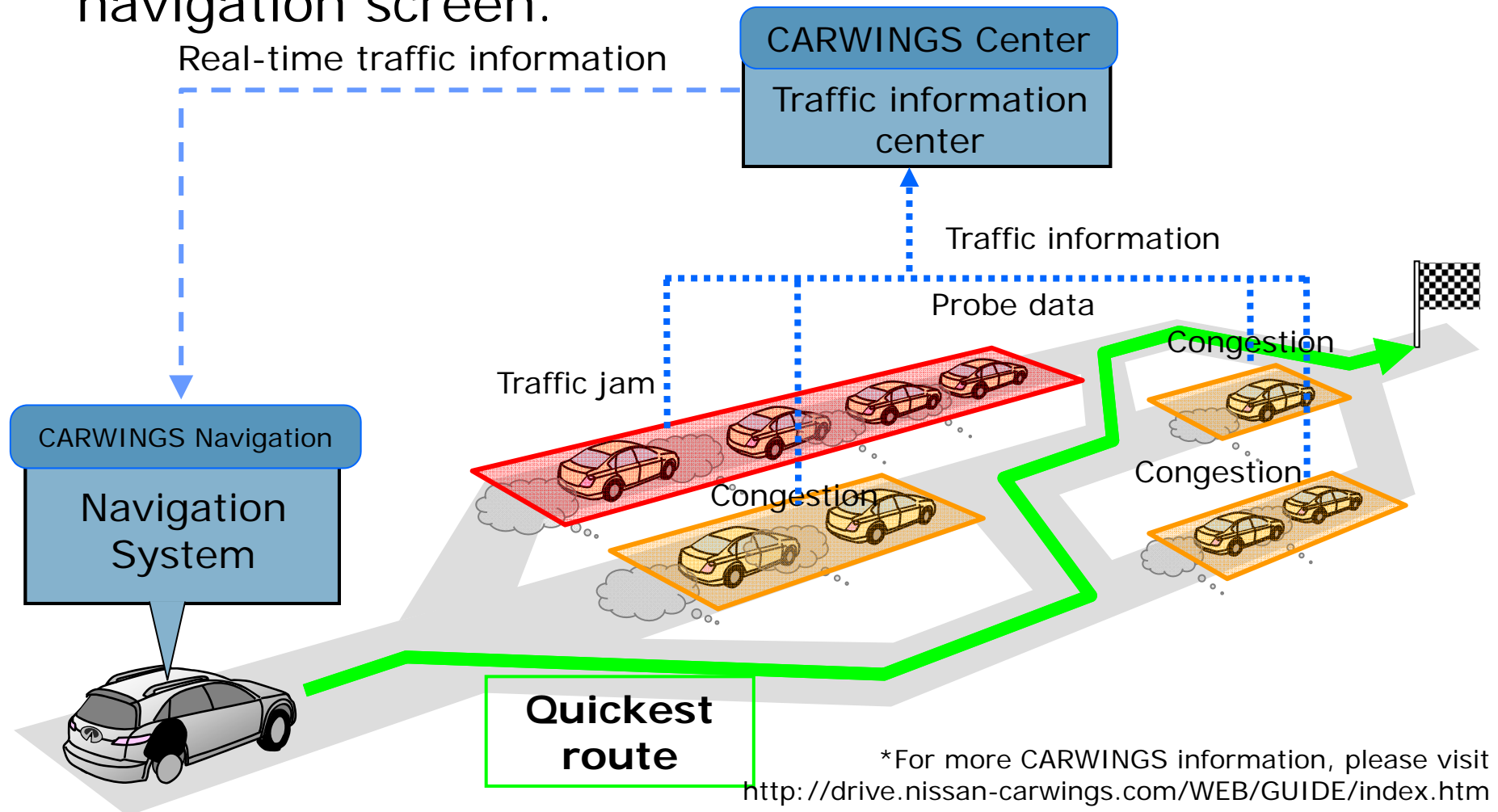
6)Dynamic Route Guidance System (DRGS)

- Dynamic Route Guidance System using probe data (information on vehicle position, speed and the like obtained by wireless technology).

Route guide for avoiding traffic congestion

Compilation of probe information

CARWINGS®

Traffic information

Traffic Control System

VICS Information

VICS Center

Vehicle Information & Communication System

©2003-2006 ZENRIN CO.,LTD. All Rights Reserved. (Z06A-2539).

©2003-2006 ZENRIN CO.,LTD. All Rights Reserved. (Z06A-2539).

All of the data is sent to Nissan's CARWINGS server where it is collectively processed into traffic information.

6)DRGS

■ Using probe data, the system informs drivers of the quickest route to their destination through the navigation screen.

Real-time traffic information

CARWINGS Center

Traffic information center

Traffic information

Probe data

Congestion

Traffic jam

Congestion

Congestion

CARWINGS Navigation

Navigation System

Quickest route

*For more CARWINGS information, please visit
http://drive.nissan-carwings.com/WEB/GUIDE/index.htm

Ref:Utilizing Probe Data

■ Collect probe data of driving distance and EV battery status; utilize to improve product quality and performance, and develop charging infrastructure.

<Japan>

<U.S.>

Los Angeles

San Francisco
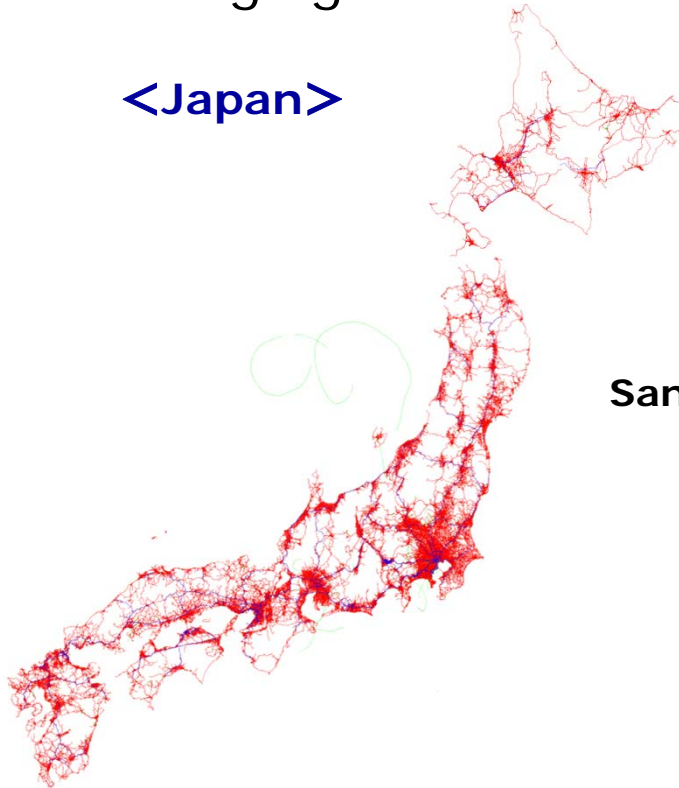
Los Angeles

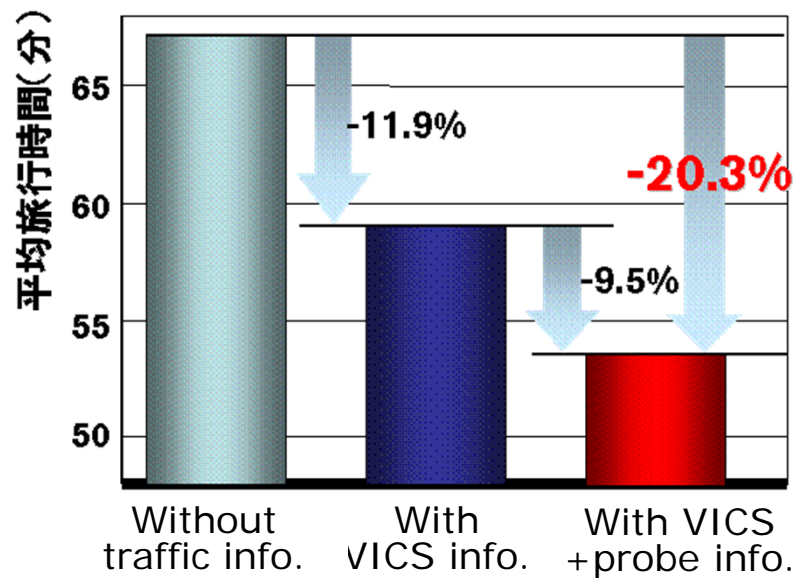Volume:5,324 units
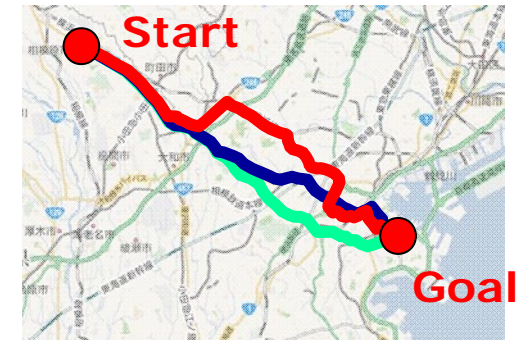Total driving distance:14.8mil.km
Period: Feb to Aug 2011

Volume:5,363 units
Total driving distance:14.2mil.km
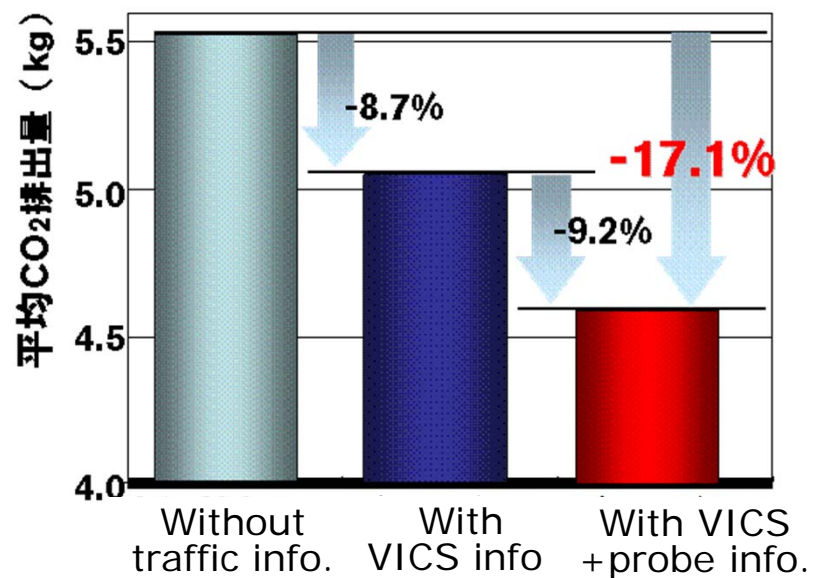Period: Feb to Aug 2011

6)DRGS for Reducing Traffic Congestion

■ Reduced driving time about 20% and CO_2 emissions about 17% compared to vehicles without DRGS.
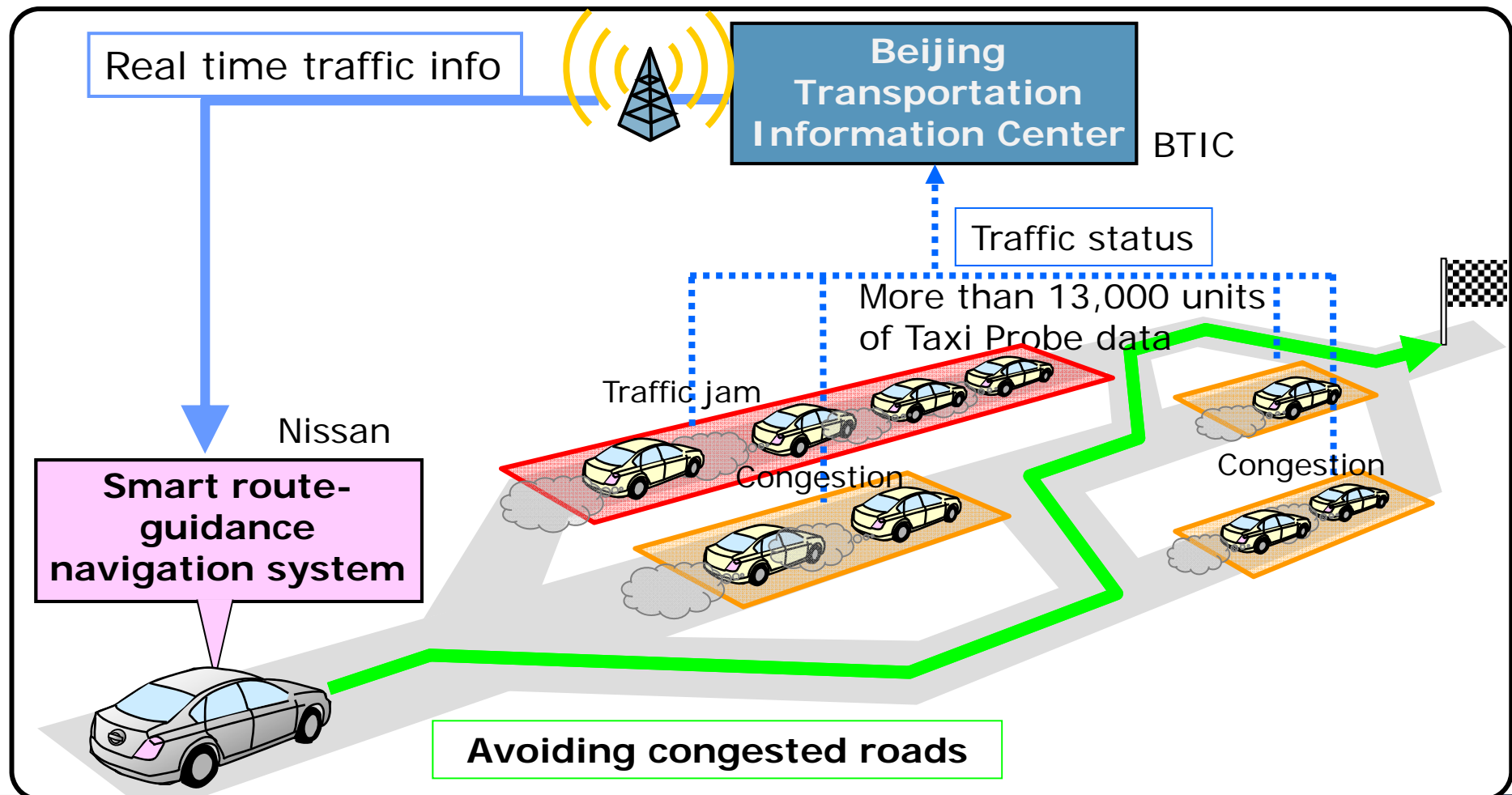

Driving time reduction

CO_2 emissions reduction

*Test conducted during traffic jam in the City of Yokohama under SKY Project

6)DRGS ―「STARWINGS」Beijing in China-

■ Offer a smart route-guidance navigation system based on real time probe data from Beijing Transportation Information Center (BTIC)

Real time traffic info

Beijing Transportation Information Center

BTIC

Traffic status

More than 13,000 units of Taxi Probe data

Nissan

Smart route-guidance navigation system

Traffic jam

Congestion

Congestion

Avoiding congested roads

7)Eco Drive Advice

■ Change driver behavior with eco-drive advice
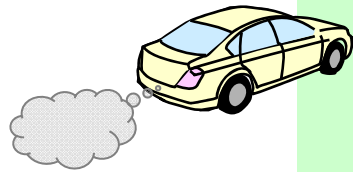
Eco drive

①Drive with fuel economy meter

Fuel Efficiency

②Check fuel efficiency in CARWINGS homepage

Fuel Efficiency Ranking

③Compare fuel efficiency with owners of the same model

Eco drive advice

④Obtain advice on efficient driving methods