

V2V, V2I Communication Technology for Road Safety and toward the Automated Driving Systems

2015/08/21

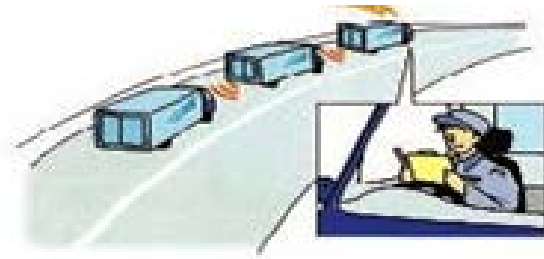
Hideaki NANBA

Project Director , DENSO CORPORATION

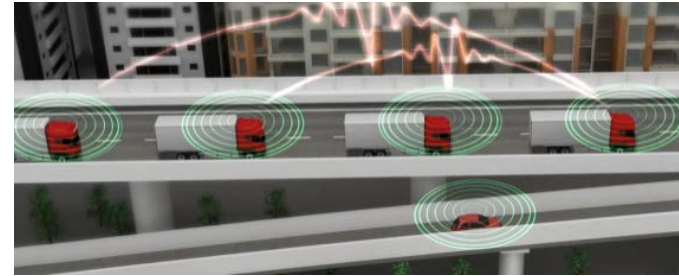
This presentation is the result of the Japanese Government's
SIP (Strategic Innovation Promotion Program)
Research and Development of Automated Driving Systems.

Toward the Automated-Driving Systems

Automated Driving for Commercial Vehicle



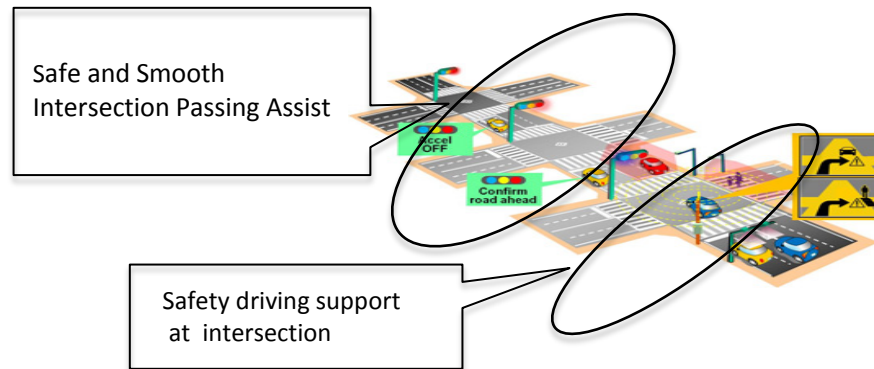
Cooperative Automated Driving



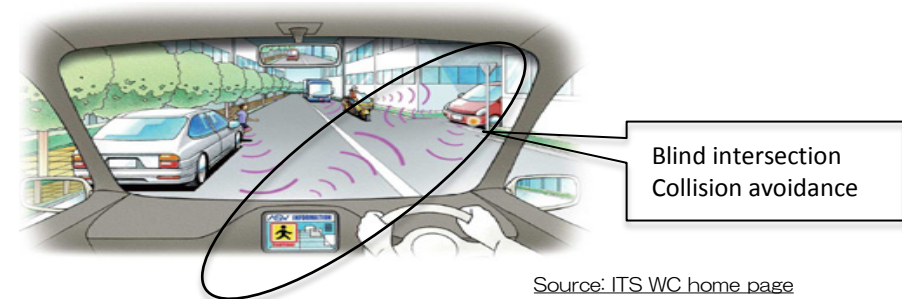
Enhanced and Sophisticated

Highly -reliable communication

Low-latency communication



Vehicle-to-Infrastructure (V2I) Communication(700MHz)



Source: ITS WC home page

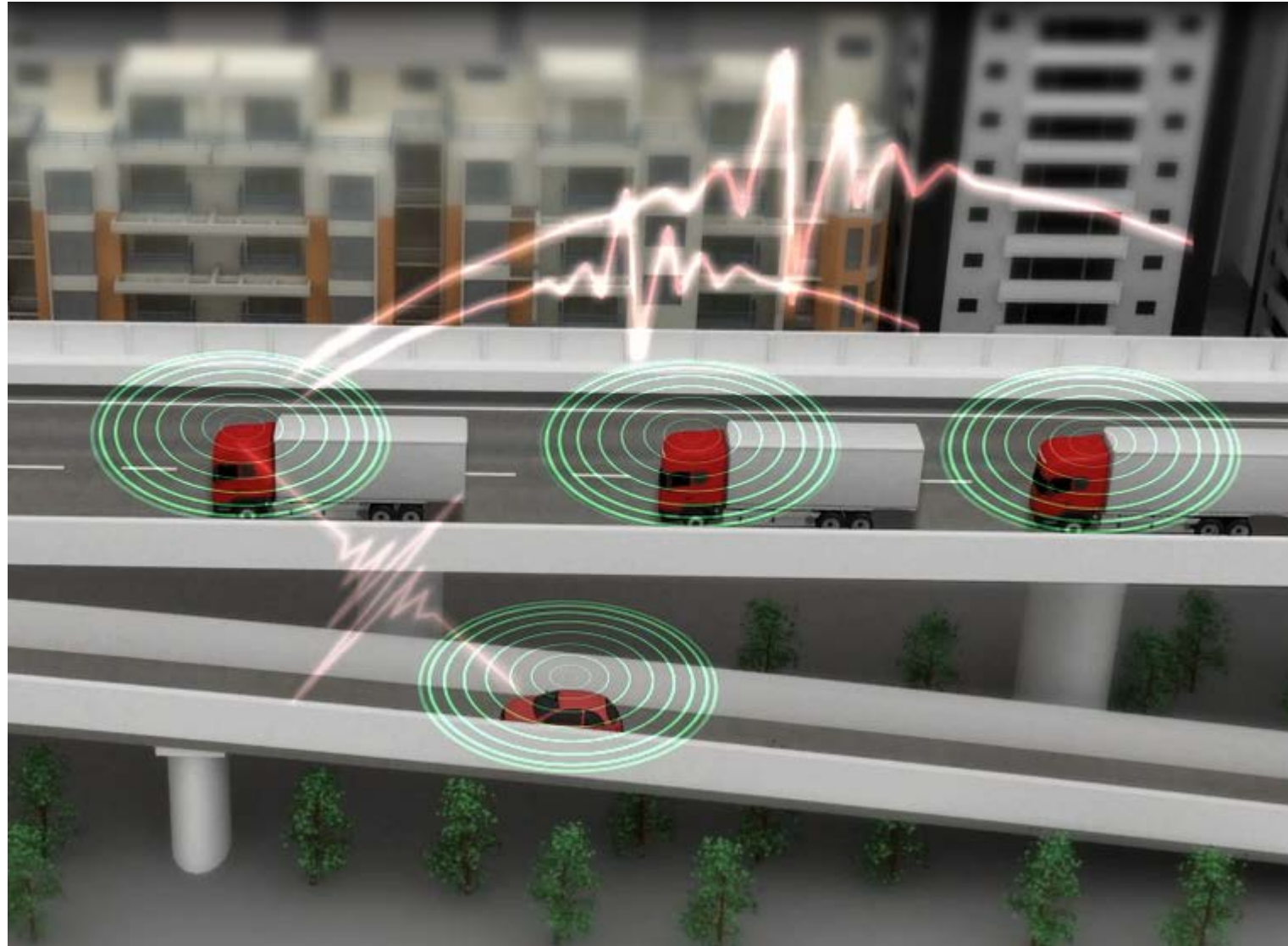
Vehicle-to-Vehicle (V2V) Communication(700MHz)

Topics of the auto-driving system



From Promotion Video of European Company

Images of Automated Driving Systems

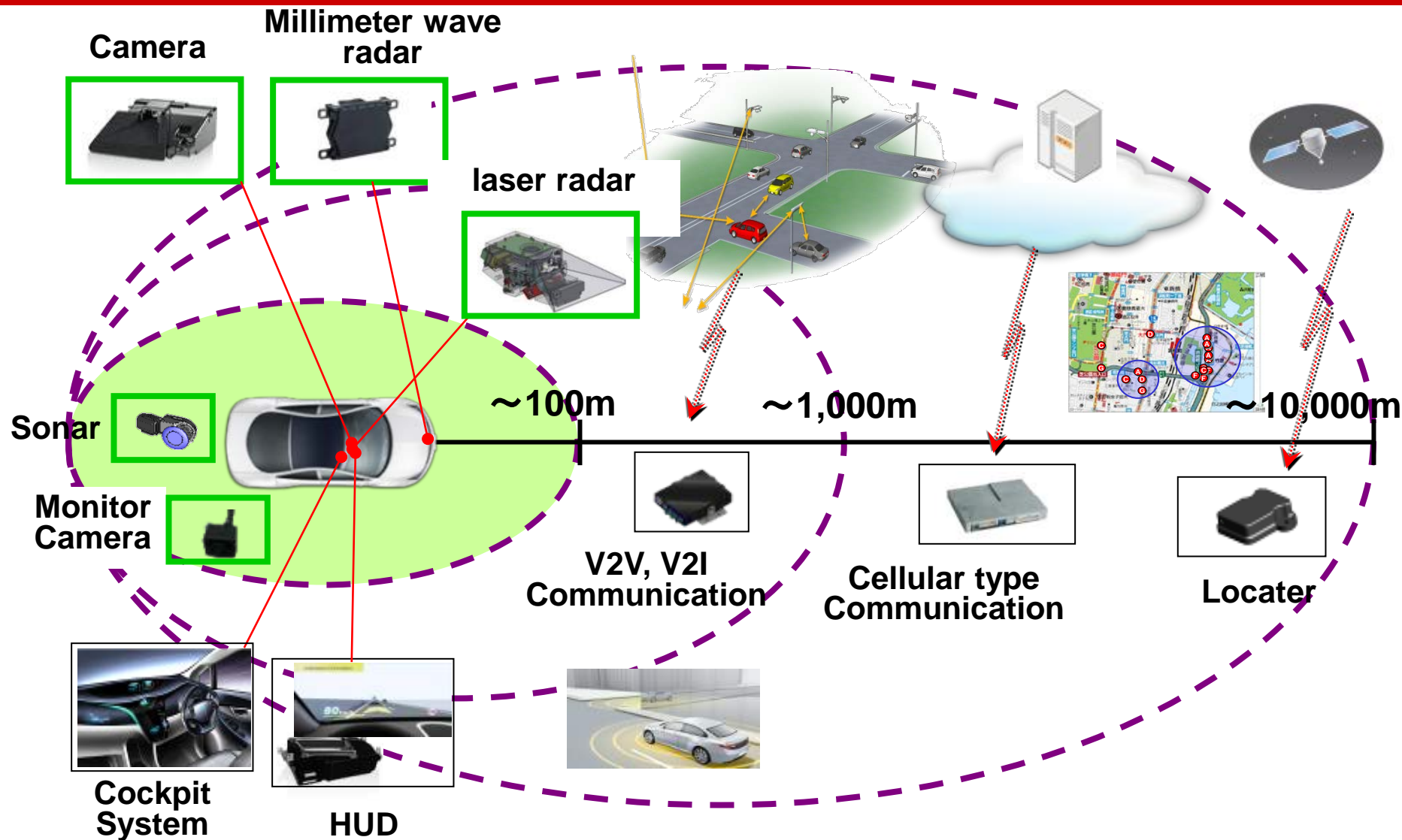


Images of Automated Driving Systems



Communication with other cars is needed

Sensing the surround of the car



Preventive safety technology



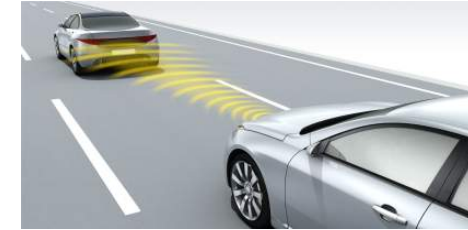
Collision avoidance support brakes



Pedestrian collision avoidance support brakes



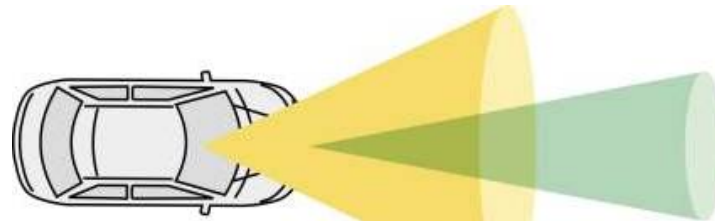
Lane keep support system



Active cruise control



Automatic high beam



Camera



Millimeter wave radar

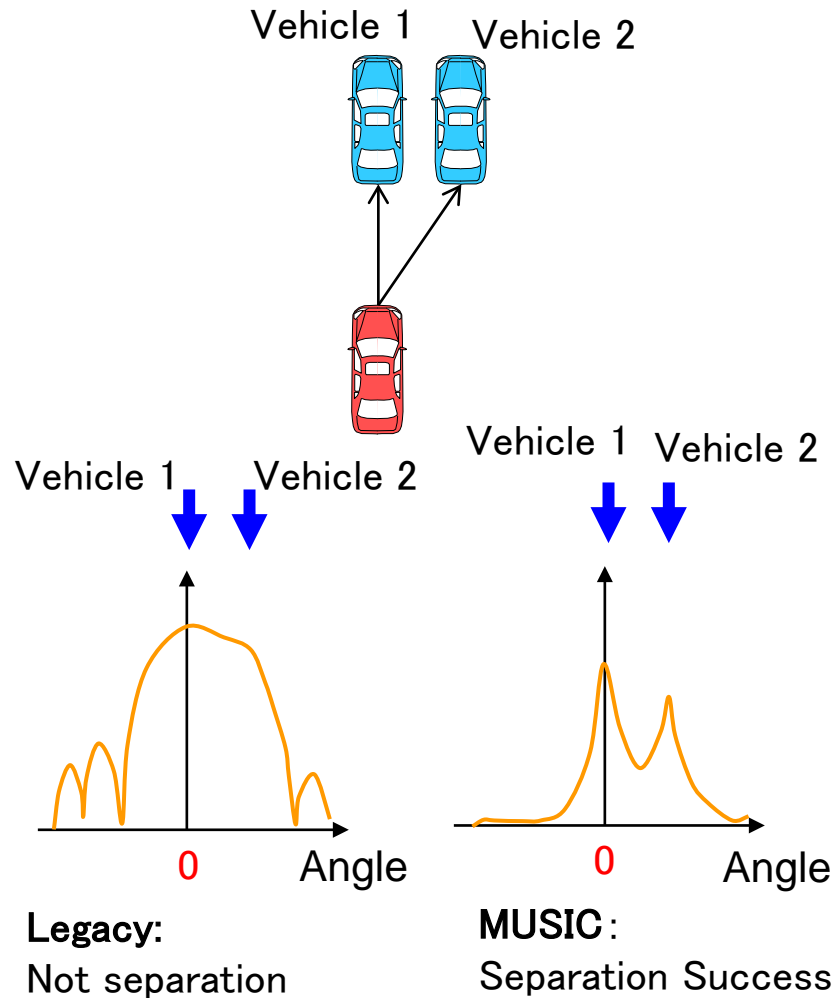


Traffic sign recognition

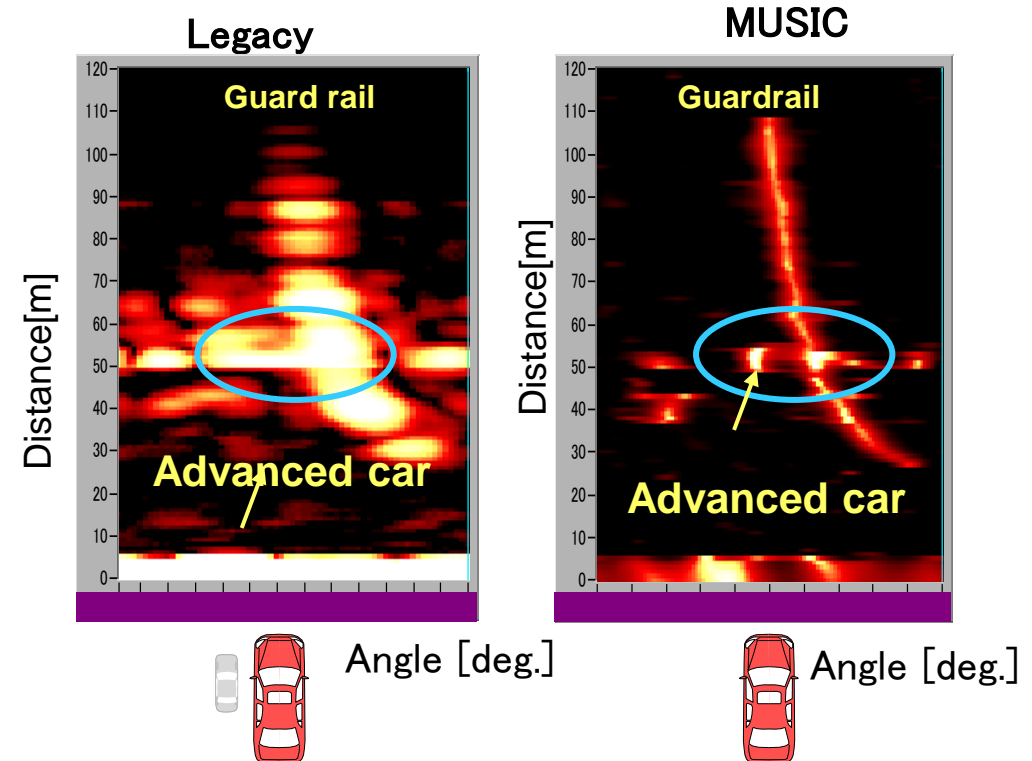
High recognition technology "MUSIC" in Millimeter wave radar

(Example)

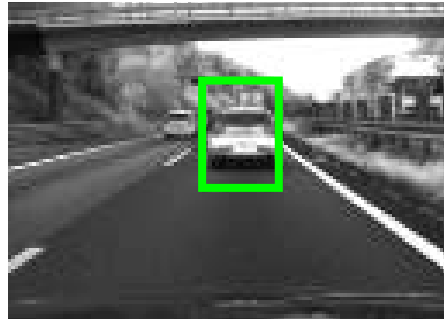
Two vehicles cruise in same speed



MUSIC: MULTIple SIGnal ClAsSification



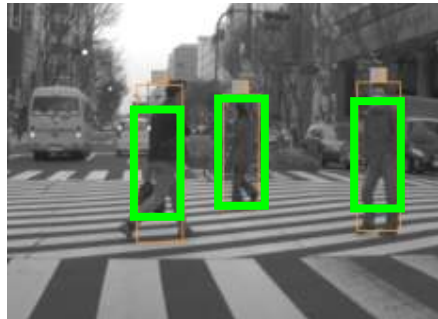
Recognition Target of Camera Images



Vehicle



Light



Walkers



Camera

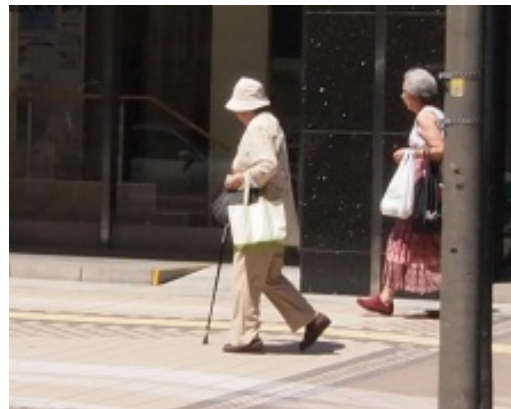
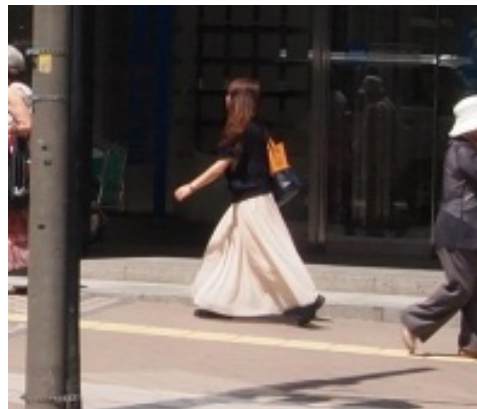


Road Lane



Traffic Sign

Walkers in many fashion



Example of the pedestrian recognition

HOG + SVM

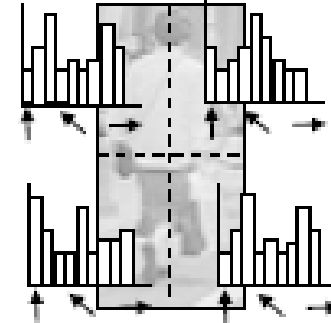
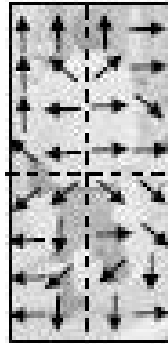
HOG : Histogram Of Gradient
SVM : Support Vector Machine



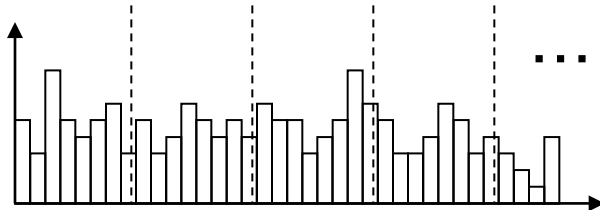
Input Image



Gradient
Calculation



Histogram per block



HOG Features

(100~1000 dimensions)



Normalizing

Proccession

Feature vector

f



Recognition Process
(SVM)

Recognition Result
(Person/non-person)

Wireless Sensors / Devices relating to Safety

radio unit



DCM



ETC

in production



V2X

prototype

sonar



in production

front camera



vision sensor
in production

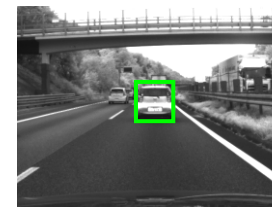
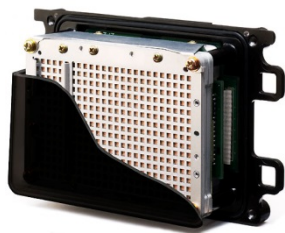


image processing
(Forward Collision Warning)



millimeter wave radar



generation #2



generation #3

in production

laser radar (LIDAR*)



ACC LIDAR

in production

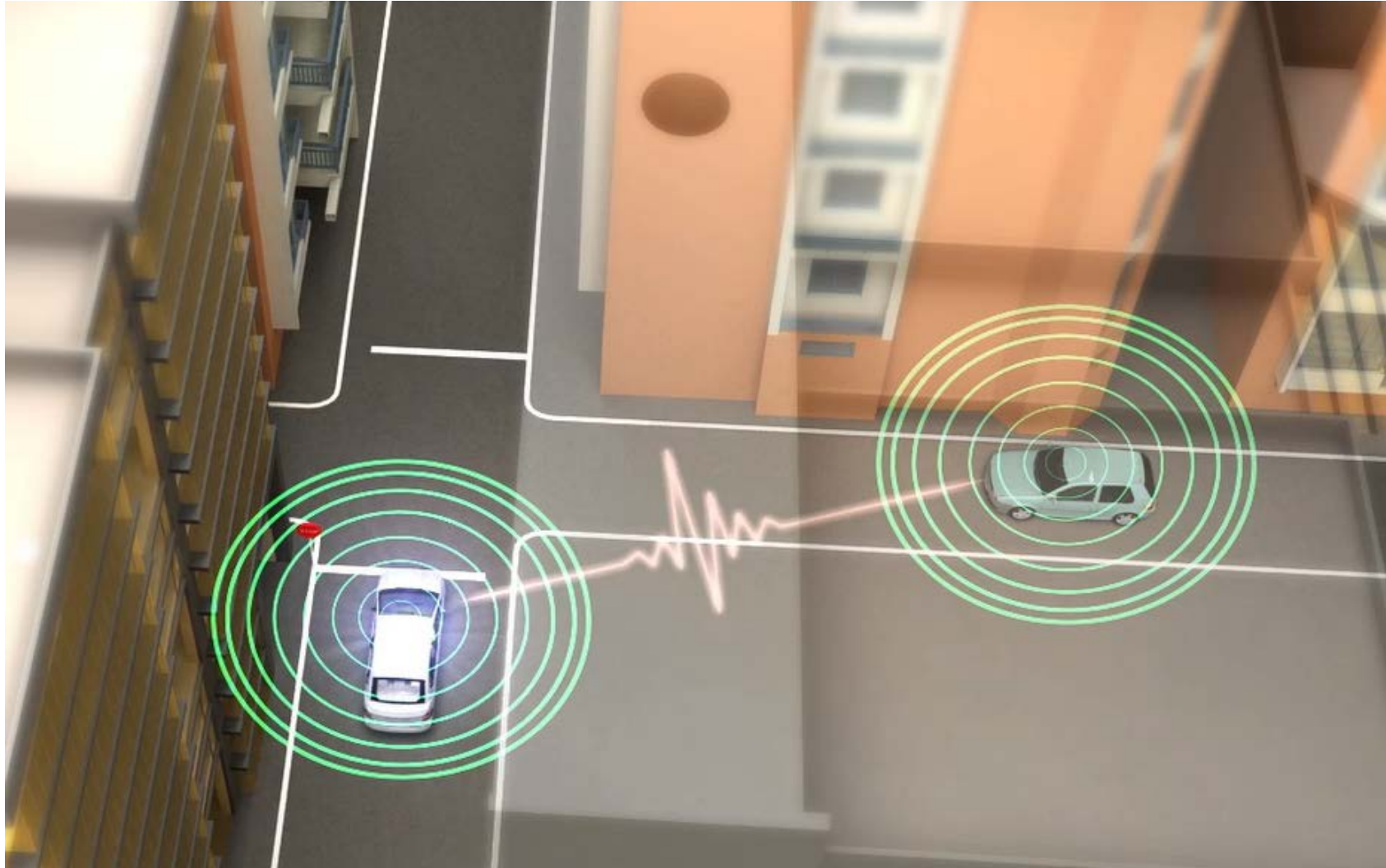


for low speed automatic
emergency braking (AEB)

in production

*LIDAR: Laser Imaging Detection And Ranging

Image of V2V communication at the blind corner

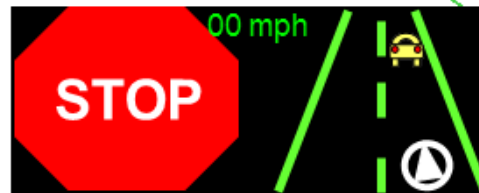
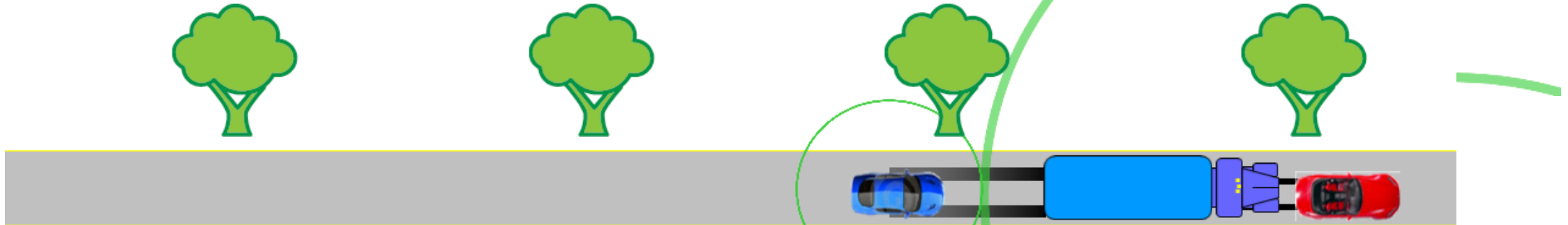


Emergency Electronic Brake Lights Safety Application by V2V

without cooperative systems



using cooperative systems



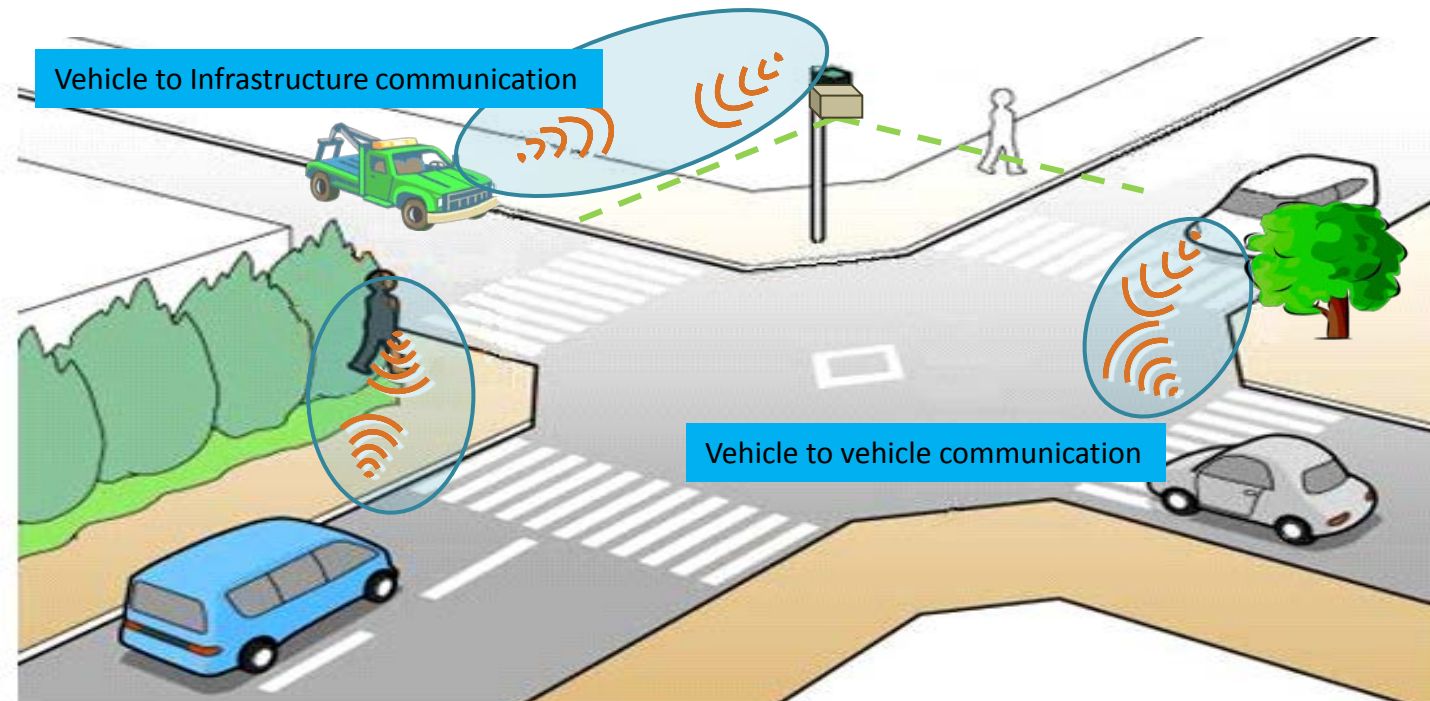
in vehicle HUD

cooperative warning allows following car sufficient time to stop safely

Background and Aims of the Research and Development

Using the predictive information on **ITS**,
Automated Driving Systems shall be realized and expedited.

(From the Cabinet Office)



Field Operation Test

Collaboration with MLIT- project and NPA- project

■ NAGOYA-city



■ YOKOSUKA-city



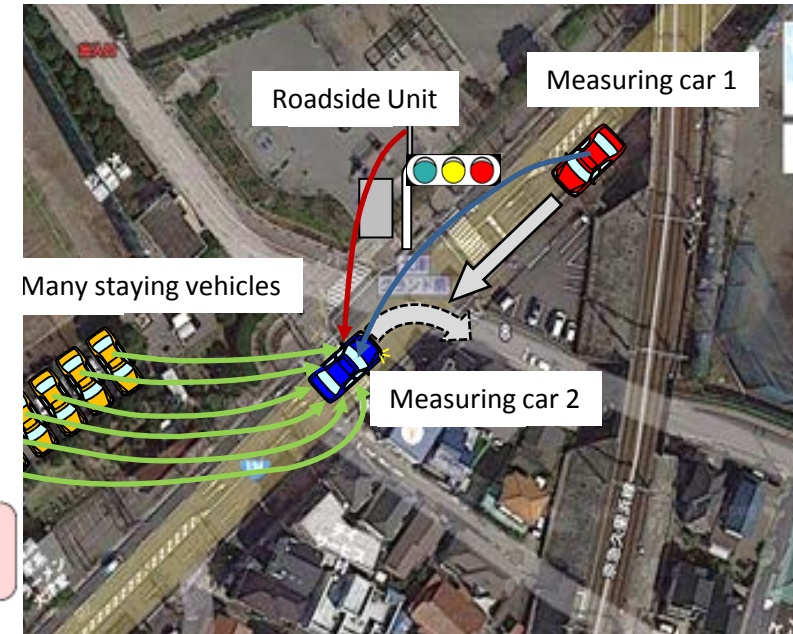
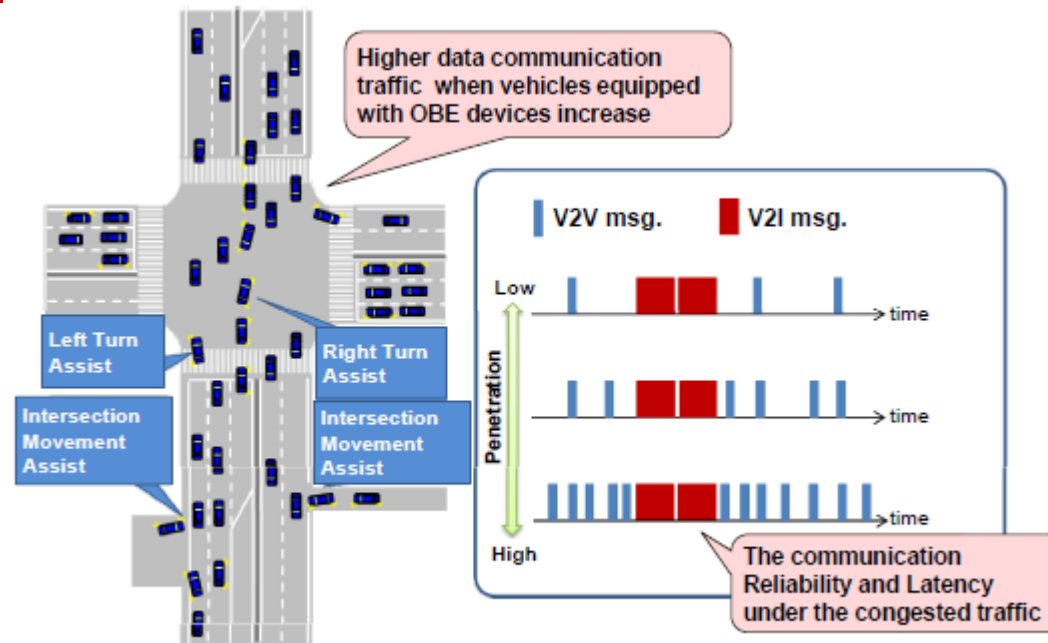
■ KOBE-city

One Road-side unit is put in place for NAGOYA and YOKOSUKA.



Six Road-side units are put in place for KOBE by NPA- project.

a) The study of communication in the cooperative system (V2V, V2I)



Communication performance at the heavy traffic jam is evaluated in the specific area.

Experimental Site : NAGOYA city, YOKOSUKA city

Outline of NAGOYA FOT

Experiment Area :

NAGOYA-city, KITA-ward, SHIROMI-street-2, Intersection

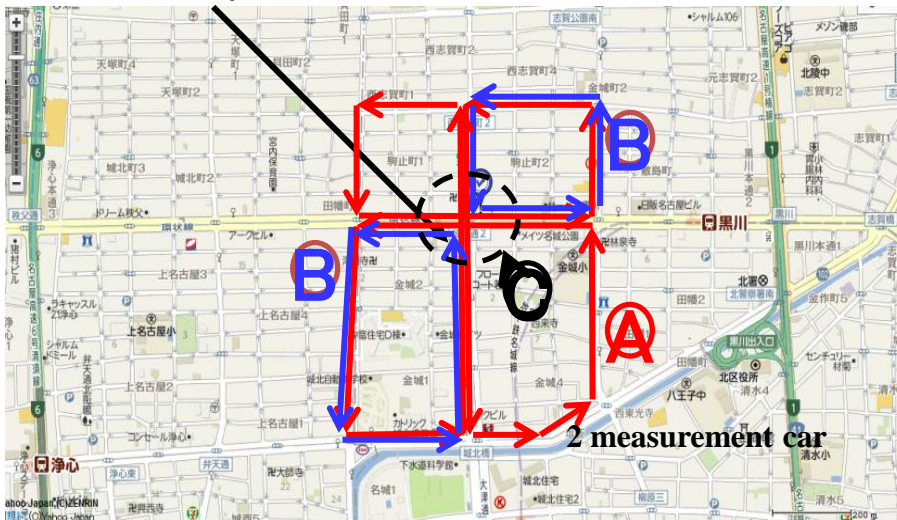
Experiment Purpose

- Verification of the communicable area
- Influence Check of the shadowing
- Influence Check of the communicating traffic increase

Experiment Scale

- 1 Road-side wireless unit
- 100 cars with wireless unit

NAGOYA-city, KITA-ward, SHIROMI-street 2, Intersection



EXPERIMENT	VEHICLE	WIRELESS UNIT
Pseudo-ambulance car	1	1
Rent-car w/ hired driver	15	15
Measurement car	2	2
Subtotal	18	18
Real ambulance car	32	32
Customer car / Commercial car	34	34
Rent car (DENSO)	10	50
Rent car (Panasonic)	5	25
Subtotal	81	141
Total	99	159

Experimenter

DENSO / 99 cars

Panasonic / 6 cars

Joint Project with MLIT and NPA project

Date

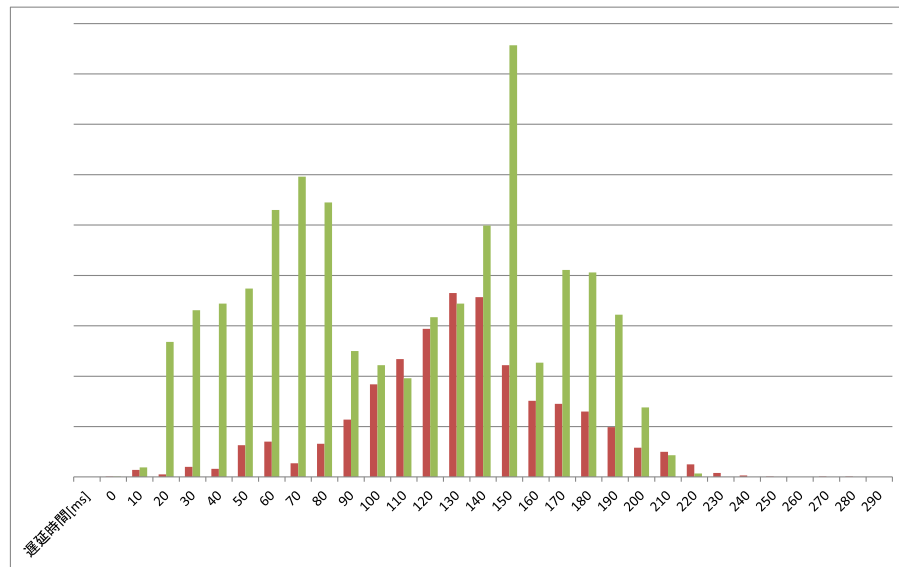
2015/02/09 -- 02/20



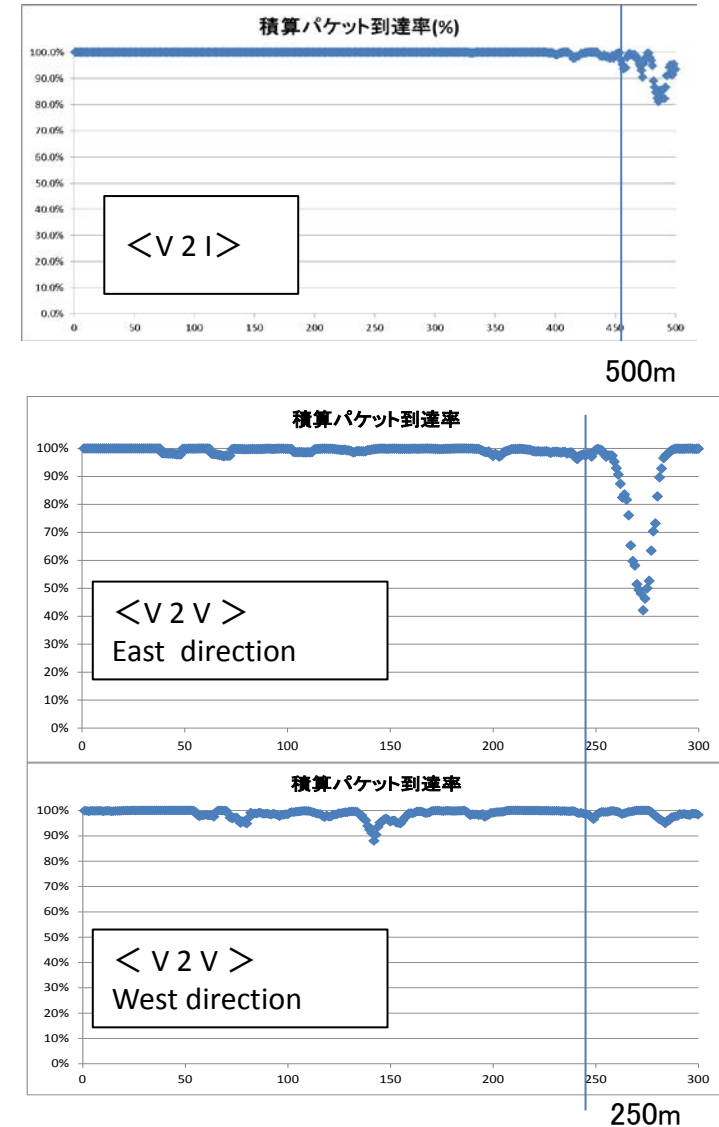
a) The study of communication in the cooperative system (V2V, V2I)

Communication performance at the heavy traffic in the big intersection area of NAGOYA-City

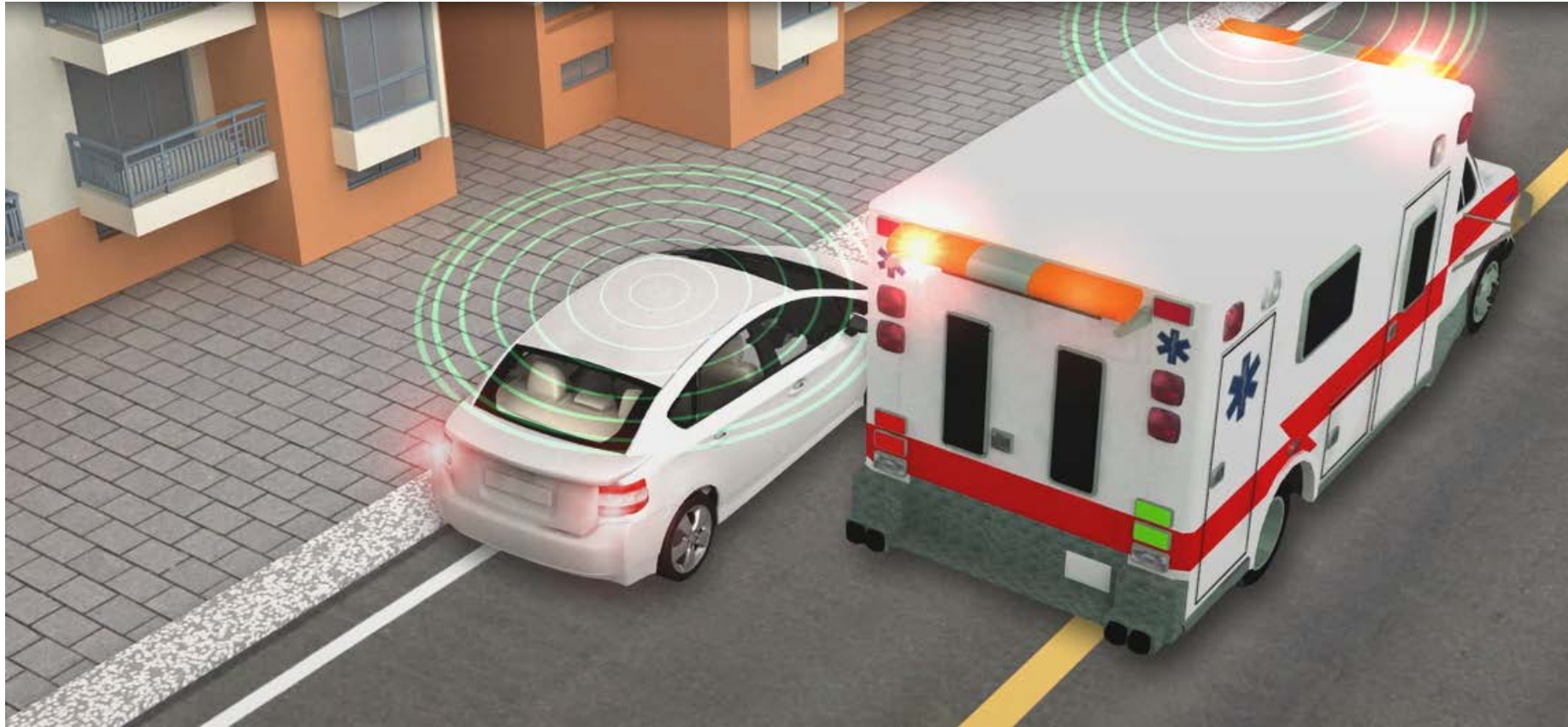
Result of the latency



Result of the packet arriving rate



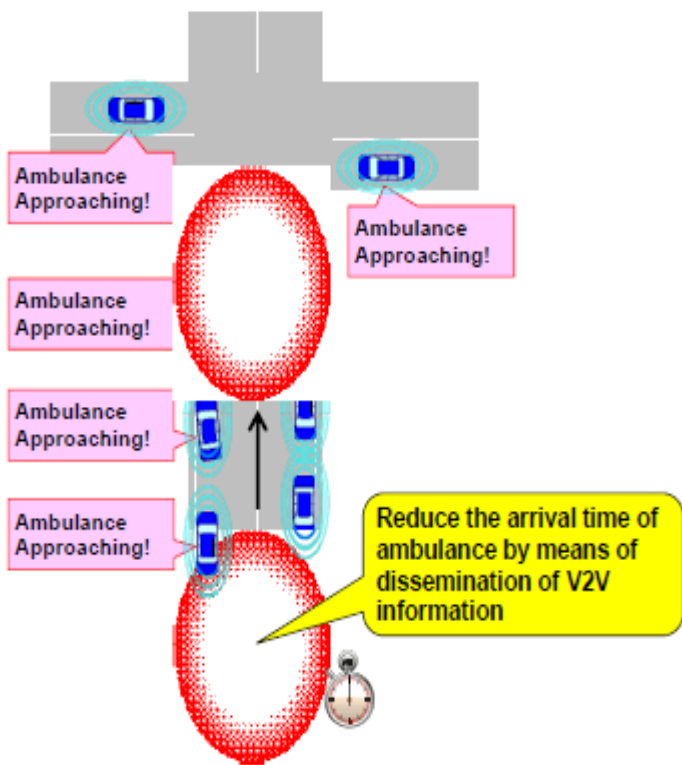
The Emergency Motor Vehicle is prioritized



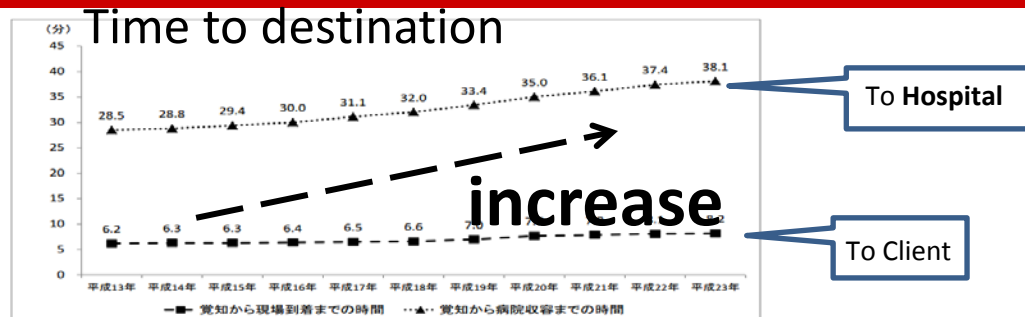
C) The study of promotion and penetration

Shorten the time to the destination of the emergency Vehicle is very controversial problem.

Assistance for emergency vehicle traveling



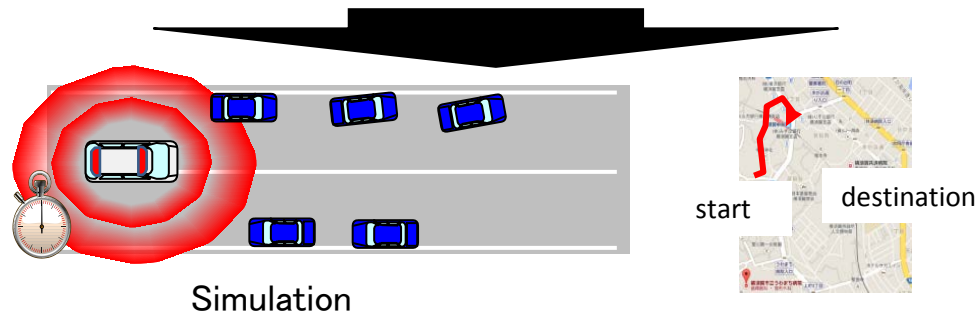
Experimental Site :
NAGOYA city, YOKOSUKA city



Fixed Camera



Ambulance vehicle with wireless unit



Simulation

Summary

■ For Road Safety

- Advanced automobile sensors support the automotive safety driving system.
- V2V technology provides the invisible information to the driver.
- Automated driving system shall evolve from the bases of V2V technology.

■ Last year's result

- As for the verification of the requested communication condition, real measurement data is collected and simulation shows the data in various penetration rates.
- As for the service confliction in the case of having the same kind information, the data is collected in the real public road.
- As for the effect of V2V application to the ambulance vehicle, the basic data is collected.

■ This year's plan

- ✂ New theme is added toward the automated driving system