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# VSC development in Japan

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# Outline

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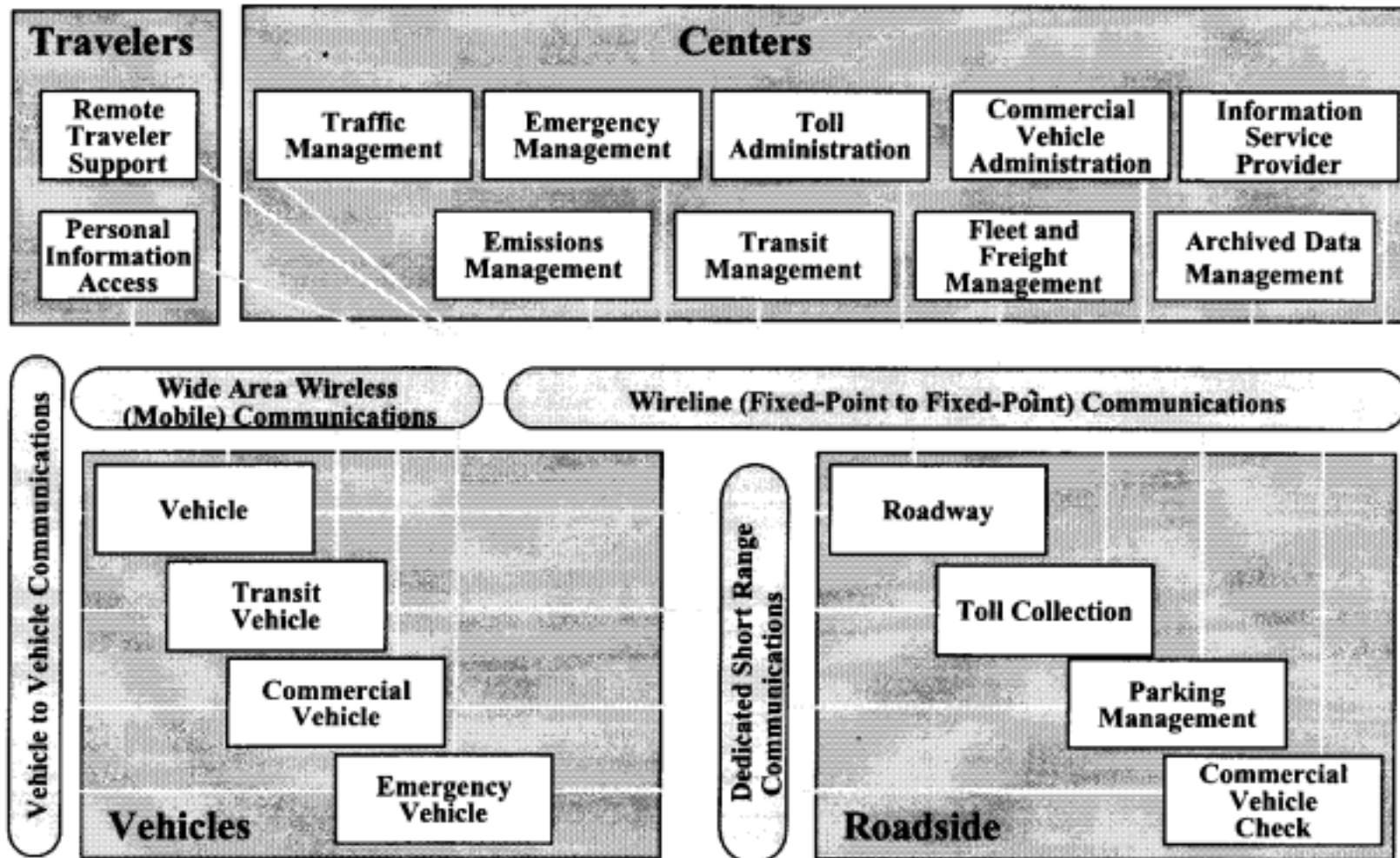
- Introduction
- Activities in Japan
  - ITS Info-communications Forum/ “Inter-Vehicle Communications Systems Expert Group”
  - JARI/ ITSC
  - AHSRA
- Personal view on vehicle safety and communication
- Conclusions

# Introduction

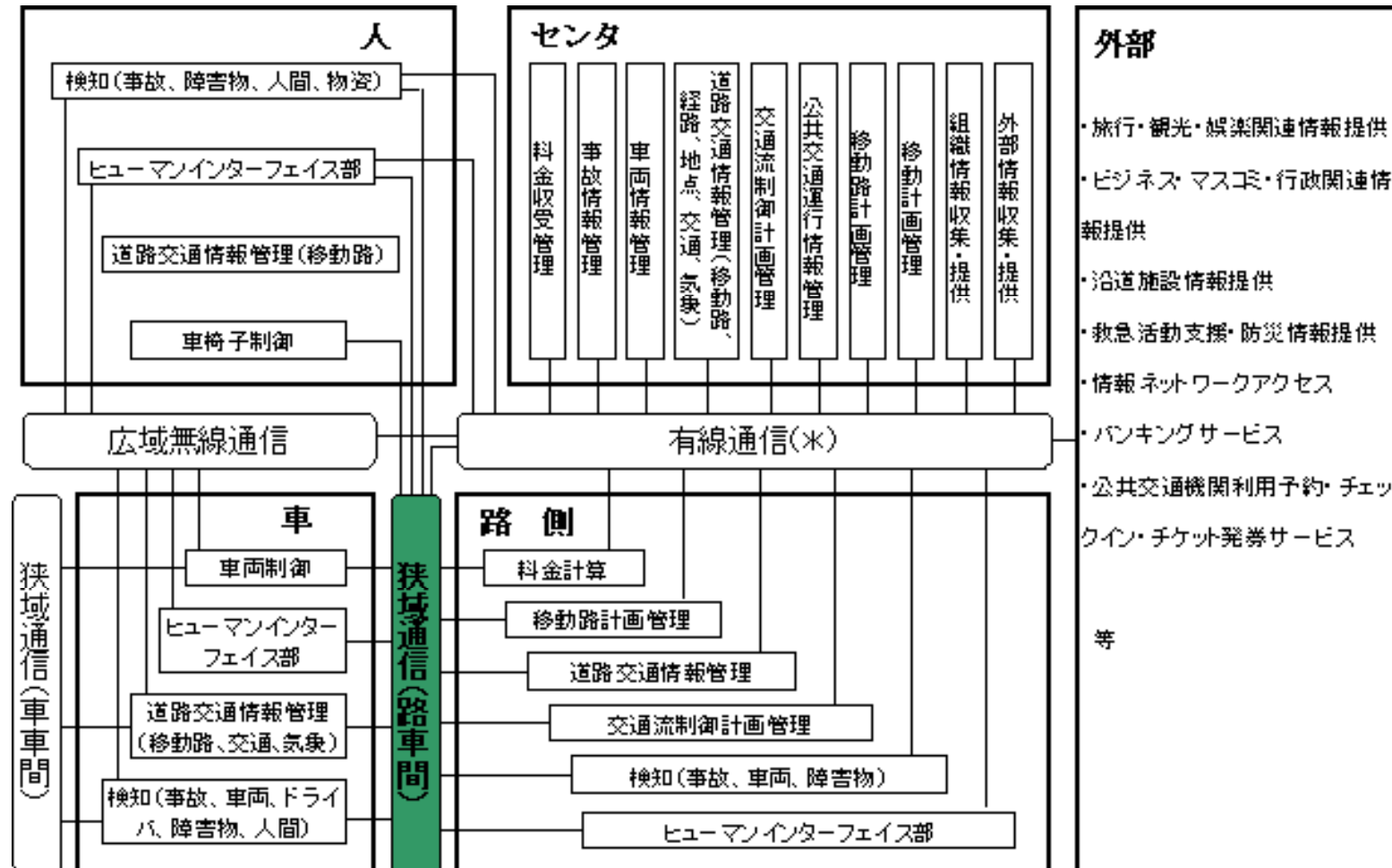
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- Vehicle safety and communication
- ITS and business
- Safety is a public matter or a private matter?
  
- [Terminology] Dedicated Short Range Communications
  - Vehicle-to-Vehicle Communication  
(Inter-vehicle Communication)
  - Roadside-to-Vehicle Communication
  
  - V-R-V Communication
  
  - Vehicle Data Sharing

# Communication systems from the viewpoint of ITS architecture (USA)



# Communication systems from the viewpoint of ITS architecture (Japan)



(\*) 有線通信は、一般的には広域有線通信であるが、衛星通信など広域無線通信での代替もあり得る。

(\*\*) 狭域通信(路車間)は、路側と車及び人の間で行われる狭域通信を示す。

■ … 高い評価点が得られたサブシステム

# VSC activities in Japan

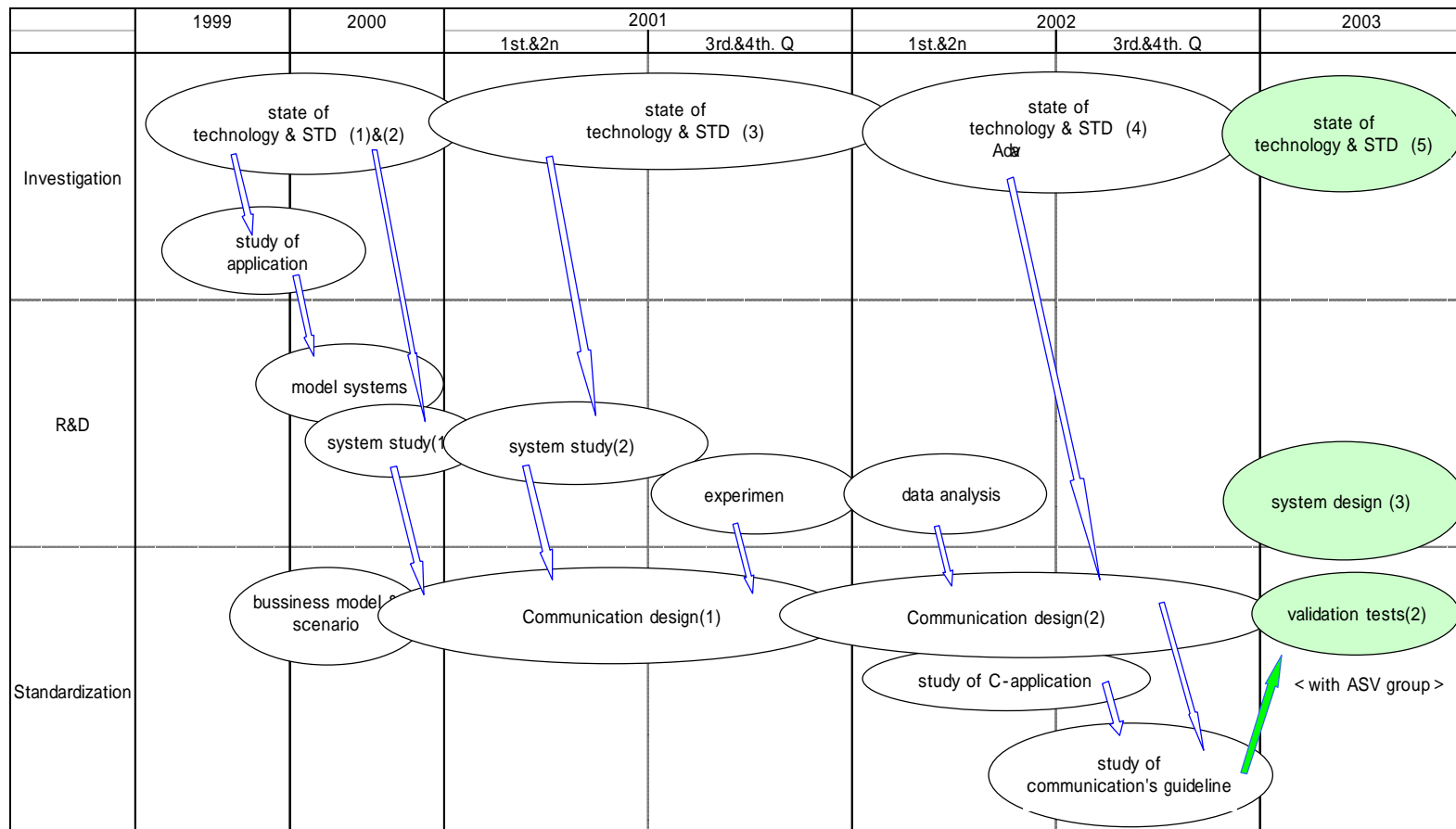
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- ITS Info-communications Forum/ "Inter-Vehicle Communications Systems Expert Group"
- JARI/ ITSC (Japan Automobile Research Institute / ITS Center)
- AHSRA (Advanced Cruise-Assist Highway System Research Association )

# ITS Info-communications Forum

## Inter-Vehicle Communications Systems Expert Group(1)

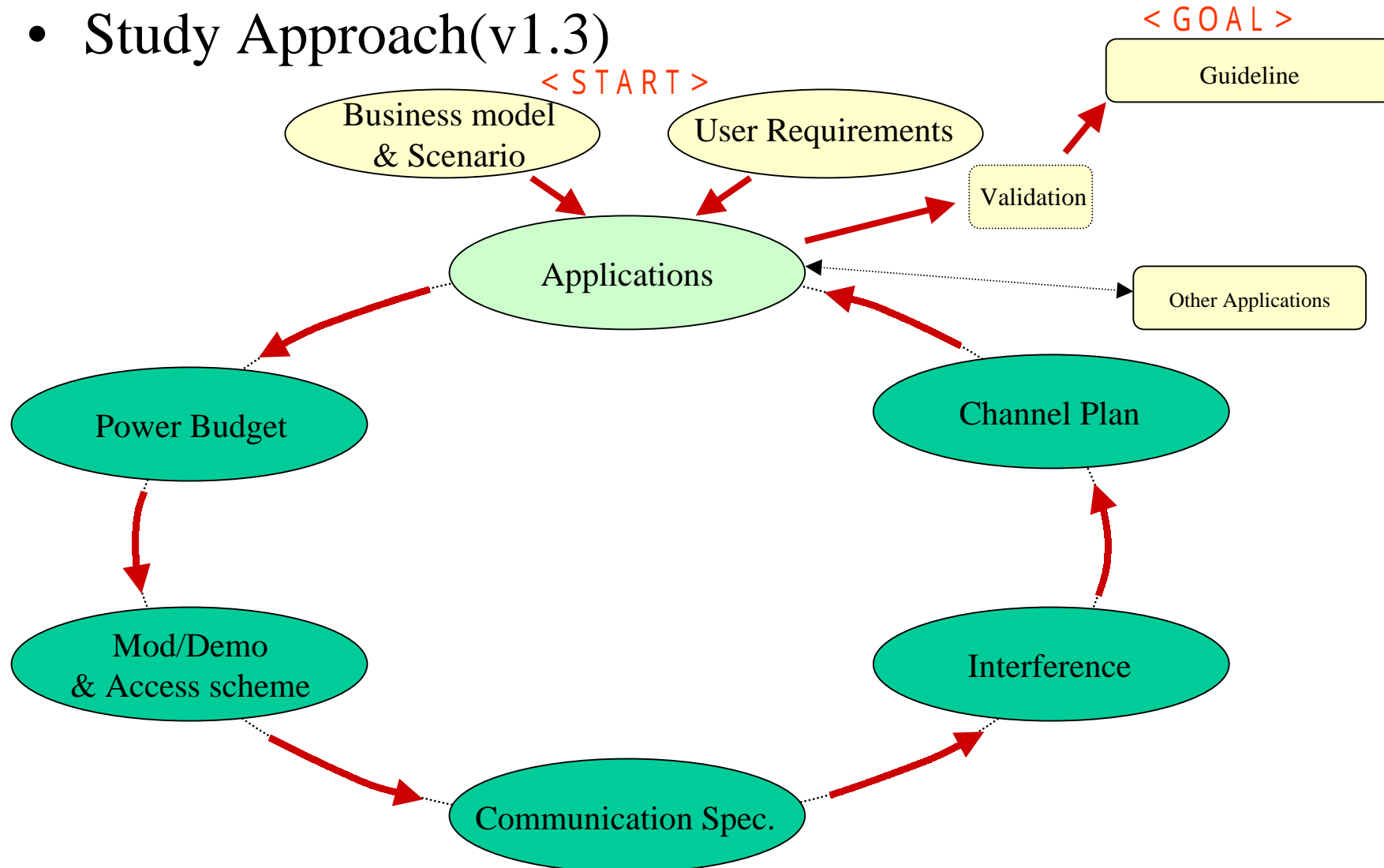
- Study Approach of Vehicle-to-Vehicle Communications



# ITS Info-communications Forum

## Inter-Vehicle Communications Systems Expert Group(2)

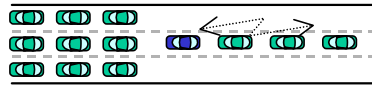
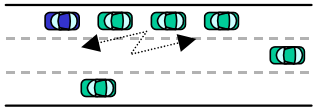

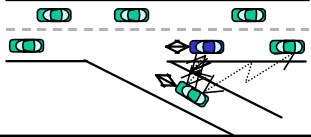
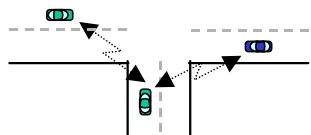
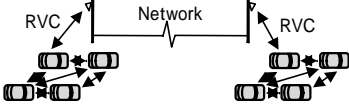
- Study Approach(v1.3)



# ITS Info-communications Forum

## Inter-Vehicle Communications Systems Expert Group(3)

- Example of vehicle communication systems

No.	Applications	Services	Service band		Discussion
			Microwave	Millimeter-wave	
1	Adaptive cruise Stop & Go	Automatically stop and go smoothly, when cars are in traffic jam. 			(1st.)
2	Cooperative driving	Cooperative driving by exchanging respective cruising data 			
3	Hazard warning	Obstacle warning Stopped vehicle warning Slowing down vehicle warning 			
4	Merging & lane change warning	Cars of main line and a car merging communicate for safe and smooth line change 			
5	Intersection & winding curve collision warning	Cars out of sight communicate for safe and smooth cruise 			(1st.)
6	Inter/intra-platoon communication	Ad Hoc communication between cars 			

# ITS Info-communications Forum

## Inter-Vehicle Communications Systems Expert Group(4)

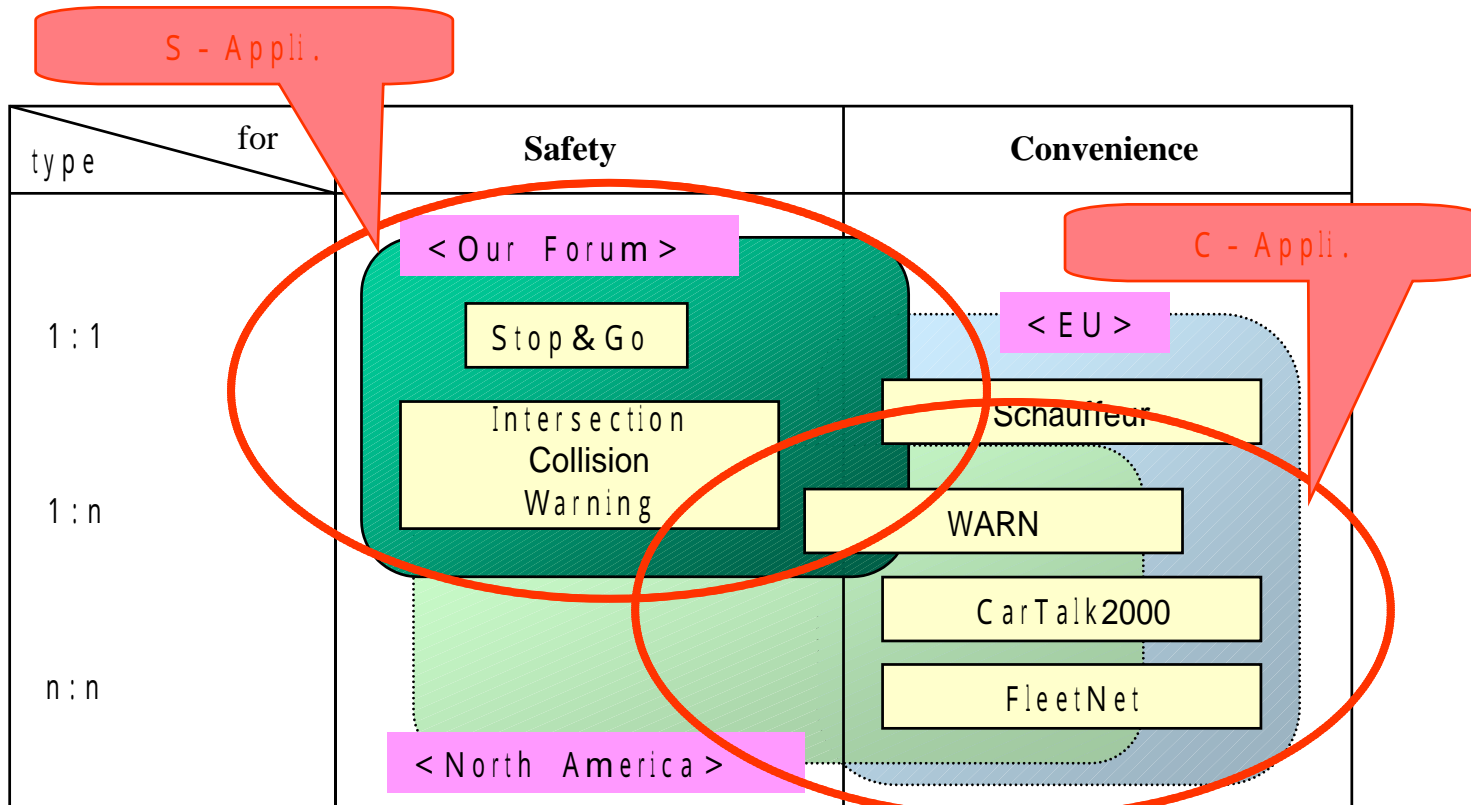
- Communication specifications

	Stop & Go	Intersection Collision Warning
Frequency Band	60 GHz	5.8 GHz
Modulation	FSK	/4-QPSK(ASK)
Modulation Speed	512 Kbps/128 kbps	640 kbps/4 Mbps
Media Access	CSMA	CSMA
Emission Power	less than 10 mW	less than 10 mW

# ITS Info-communications Forum

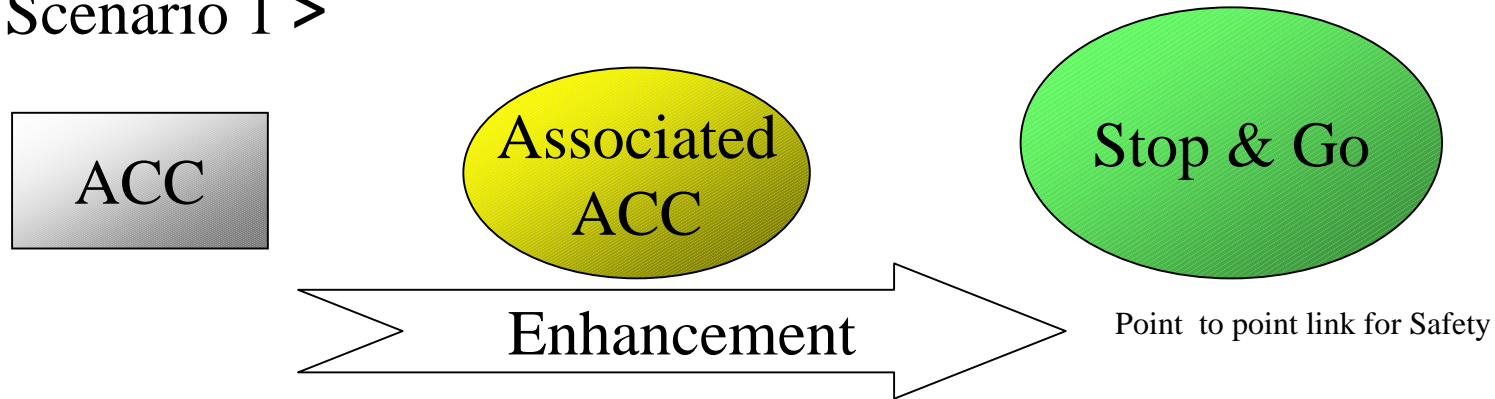
## Inter-Vehicle Communications Systems Expert Group(5)

- IVC Mapping

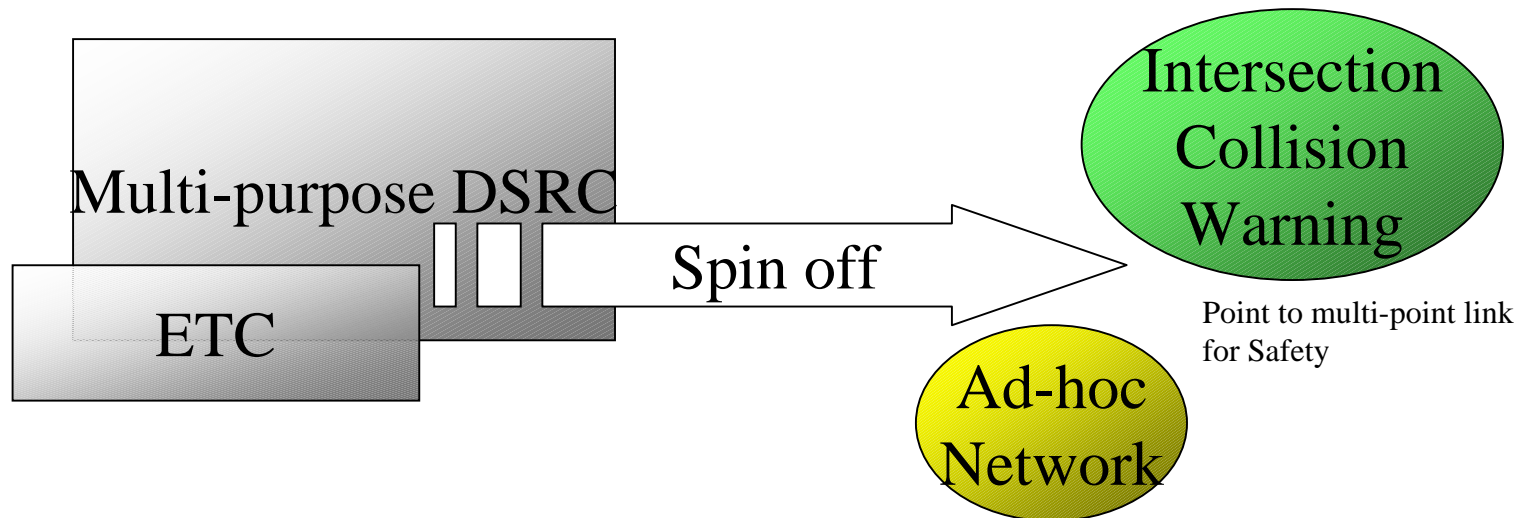


IVC: Inter-Vehicle Communication  
 AVCSS: Advanced Vehicle Control and Safety Systems

- V2V Deployment Scenarios  
    < Scenario 1 >



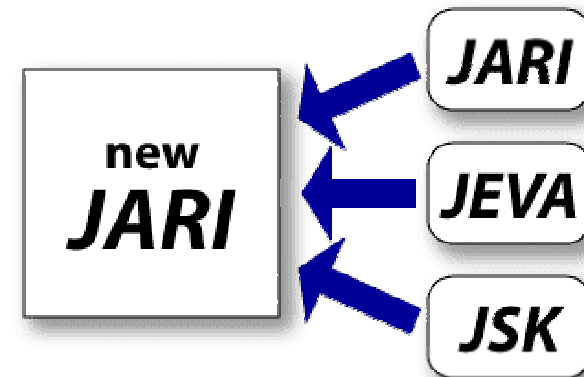
- < Scenario 2 >



# JARI ITS-Center(1)

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- JARI ITS-Center was established on July 1st 2003
- It takes over the activities of JSK (integrated into new-JARI)



- There are two main fields of activity:
  - Research (pre-competitive phase)
  - International standardization (ISO/TC204)

# JARI ITS-Center(2)

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- JSK started Inter-vehicle Communication study in the early 1980s.
- In 90s, the study was focused on IVC for cooperative driving .
- The study result was shown in Demo2000.
- JARI ITS-Center (Ex-JSK) started IVC standardization activity in 2003.

# JARI ITS-Center(3)

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- Two main subjects of 2002 :
  - /Construct “Concept Reference Model for IVC”
  - /Acquire DSRC field data on Intersection Collision Warning Application
- IVC is expected to support various VS (Vehicle Safety) applications.
- IVC standardization is inevitable to realize VS applications.

# Profile of AHSRA(1)

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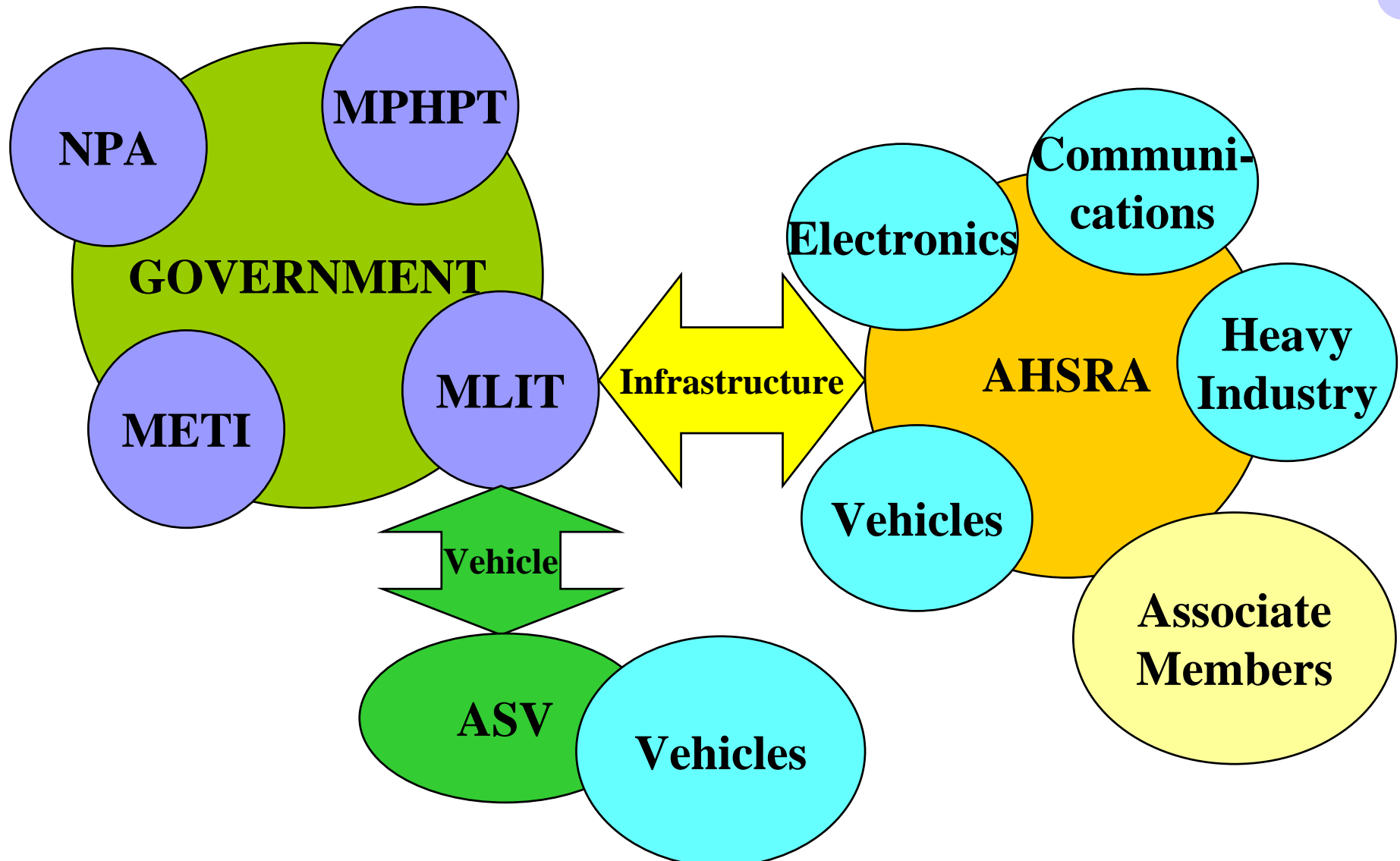
<b>Name</b>	<b>Advanced Cruise-Assist Highway System Research Association (AHSRA)</b>
<b>Leading Ministry</b>	<b>Ministry of Land, Infrastructure and Transport (MLIT)</b>
<b>Research Trust</b>	<b>National Institute for Land and Infrastructure Managements (NILIM)</b>
<b>Objective</b>	<b>The purpose of AHSRA is to develop the Advanced Cruise-Assist Highway Systems (AHS), which will achieve significant improvements in road traffic safety and efficiency by applying information technology (IT) to road infrastructure.</b>

# Profile of AHSRA(2)

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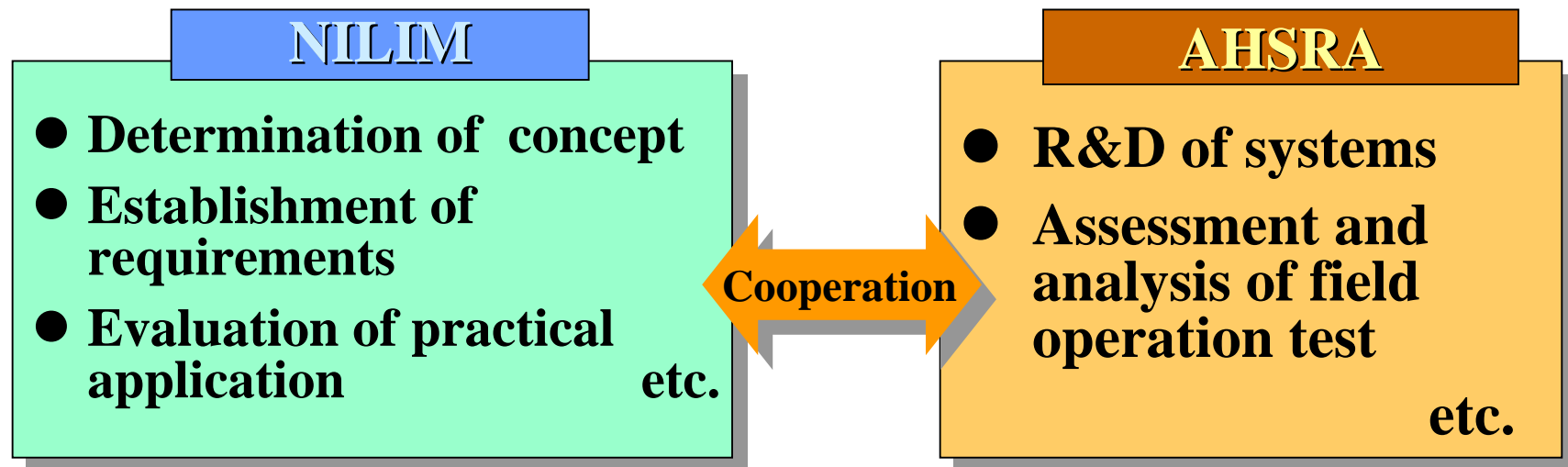
<b>Established</b>	<b>September 25, 1996, based on the Mining research Association law and with approval from the Minister of Construction (since renamed)</b>
<b>Members</b>	<b>18 Japanese Private Companies</b>
<b>Associate Members</b>	<b>350 Organizations and Persons</b>

# Positioning of AHSRA

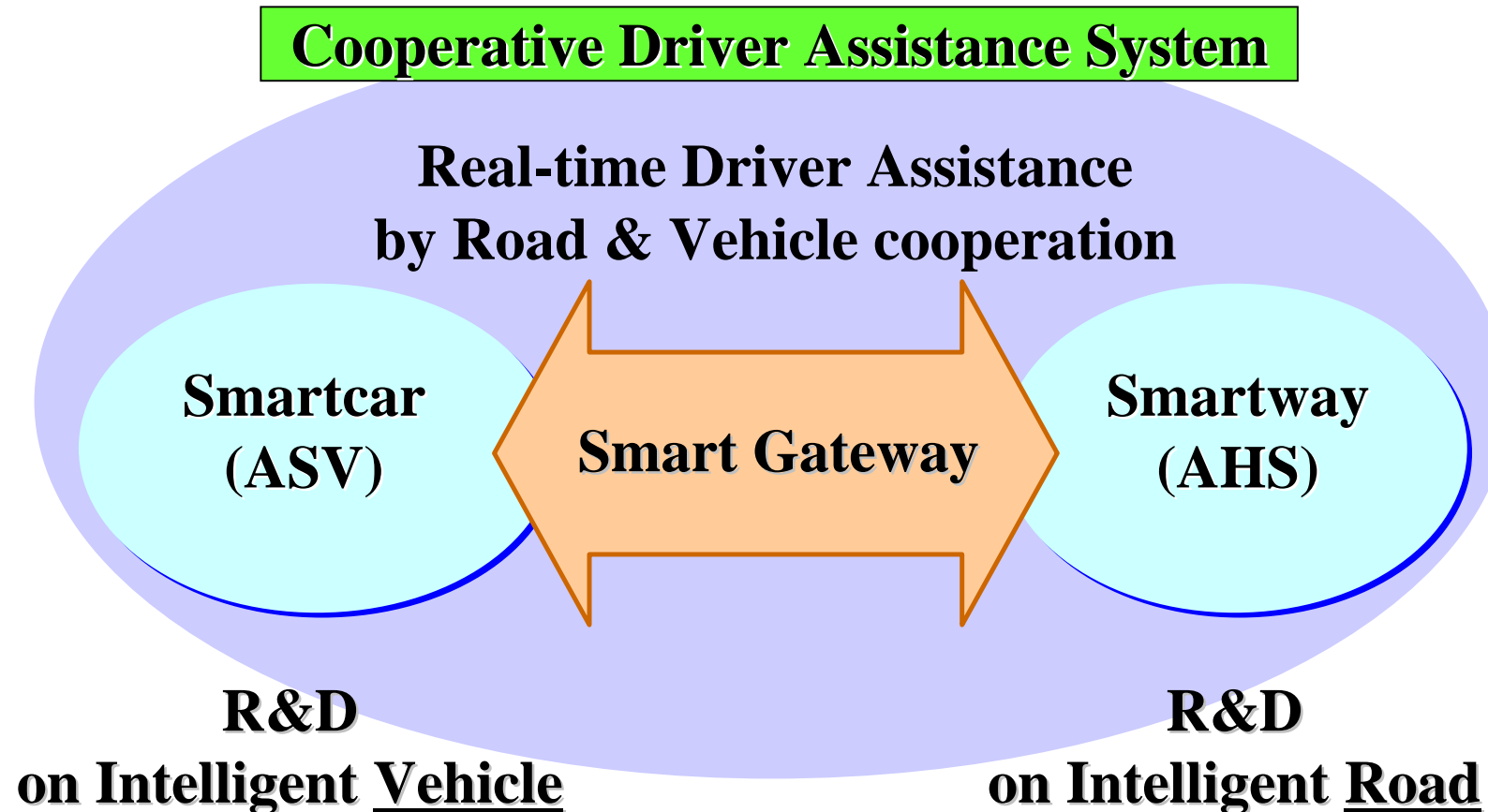


# Cooperation between Public and Private

- The MLIT (Ministry of Land, Infrastructure and Transport) establishes top policy for AHS.
- The NILIM (National Institute for Land and Infrastructure Management) of the Ministry of Land, Infrastructure and Transport carries out R&D of AHS in cooperation with AHSRA.



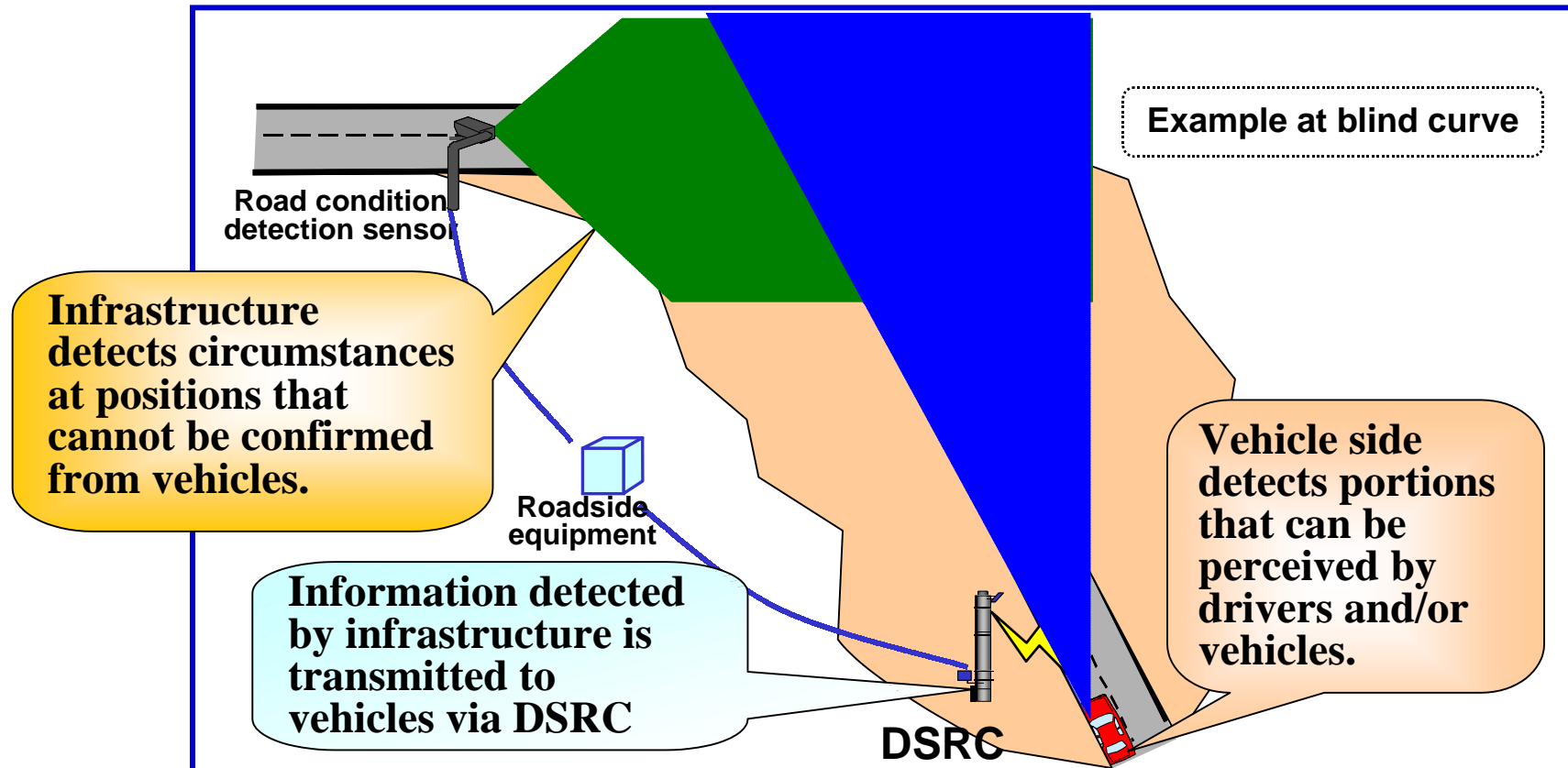
# Cooperative Driver Assistance System



ASV: Advanced Safety Vehicle

AHS: Advanced cruise-assist Highway System

# Basic Concepts of AHS



## Infrastructure

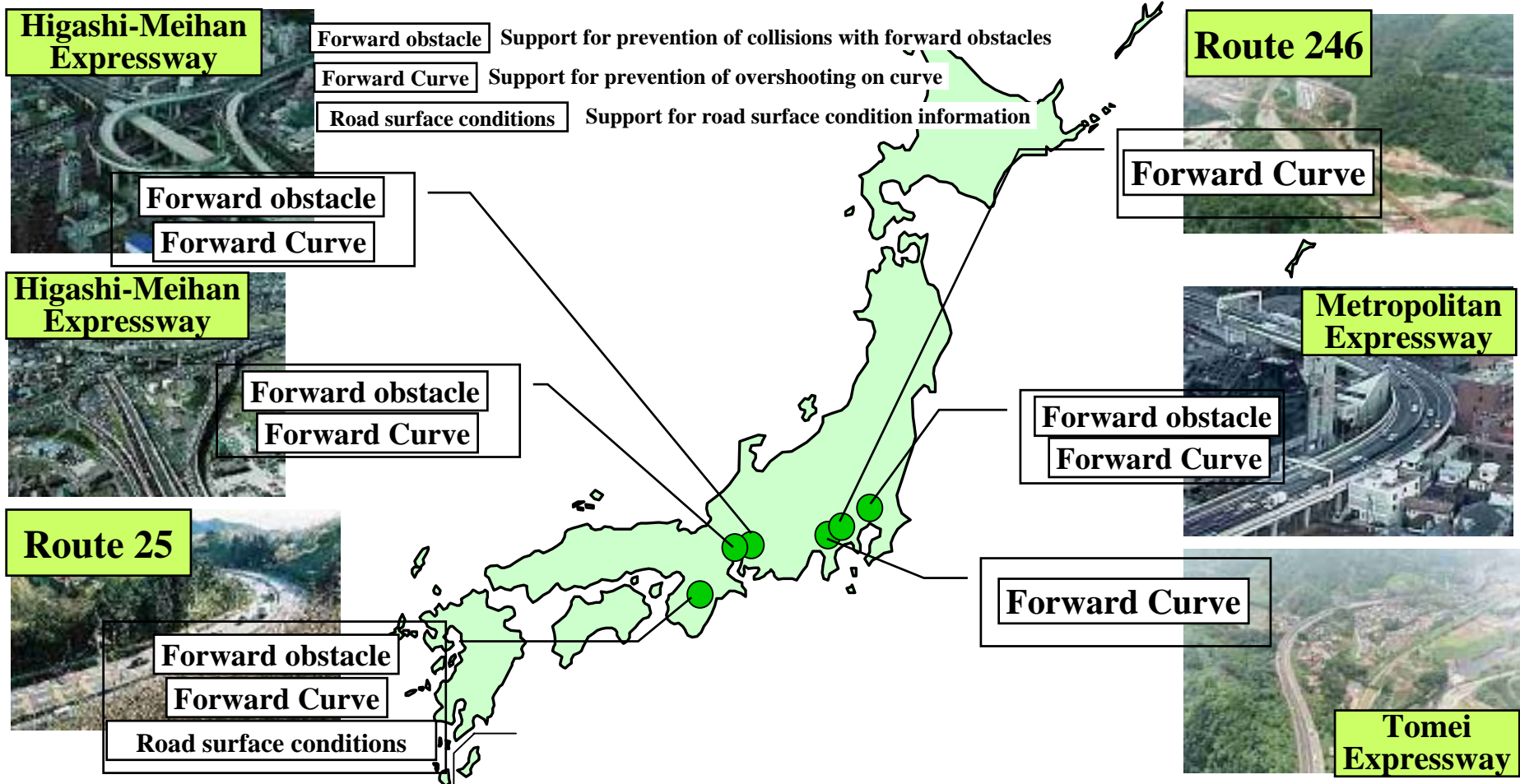
- Takes charge of the range that is difficult or impossible to perceive by drivers and/or vehicles.

## Vehicle

- Vehicle side takes charge of portions that can be perceived by drivers and/or vehicle sensors.

# Tests on Actual Roads of AHS

Proving tests on actual roads were conducted for AHS using DSRC at 6 test sites.



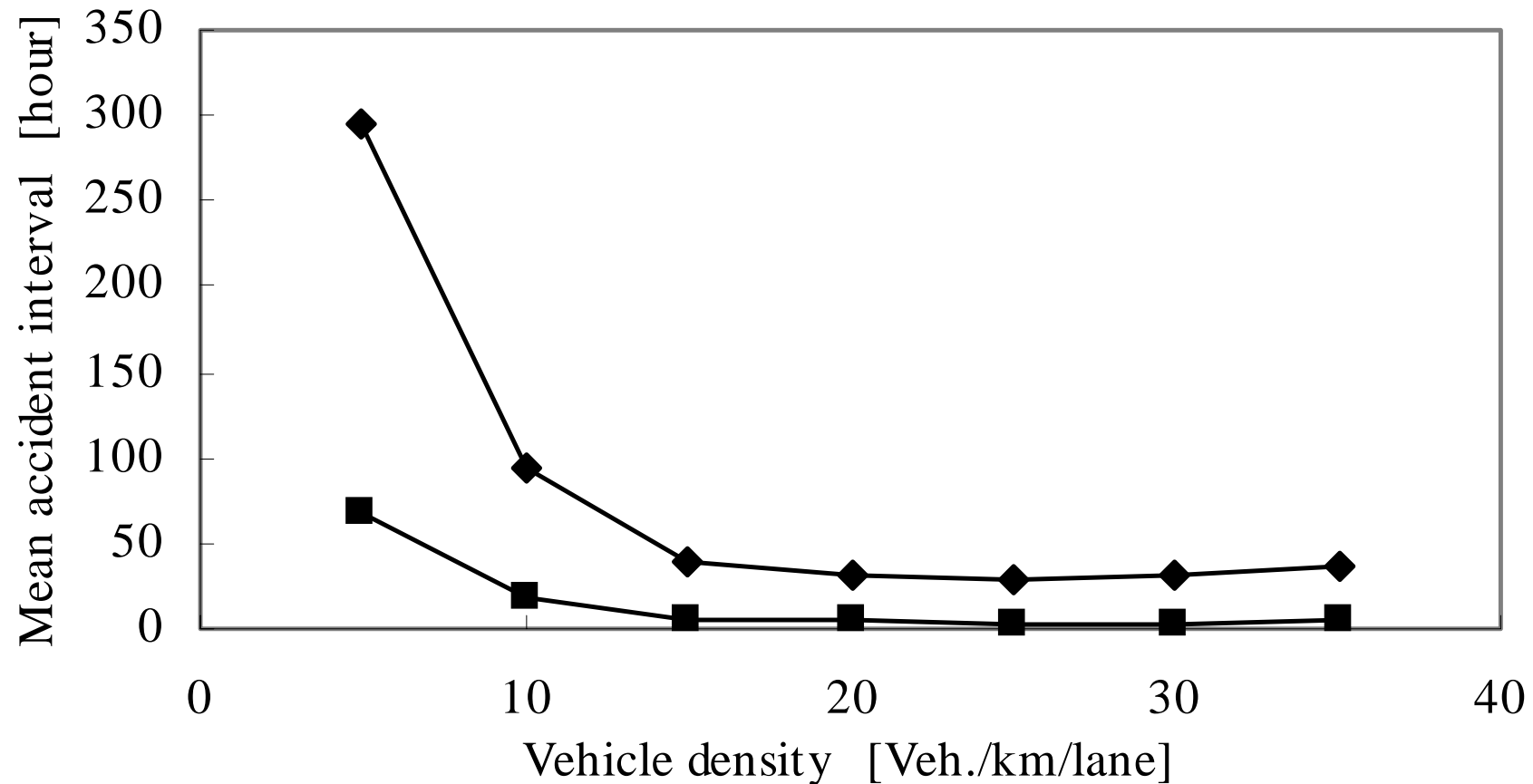
# Personal view on vehicle safety and communication

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- Today's Theme
  - Vehicle safety and communication

# Effect of VSC from results of our simulations(1)

- Vehicle density property (10km, three lanes)



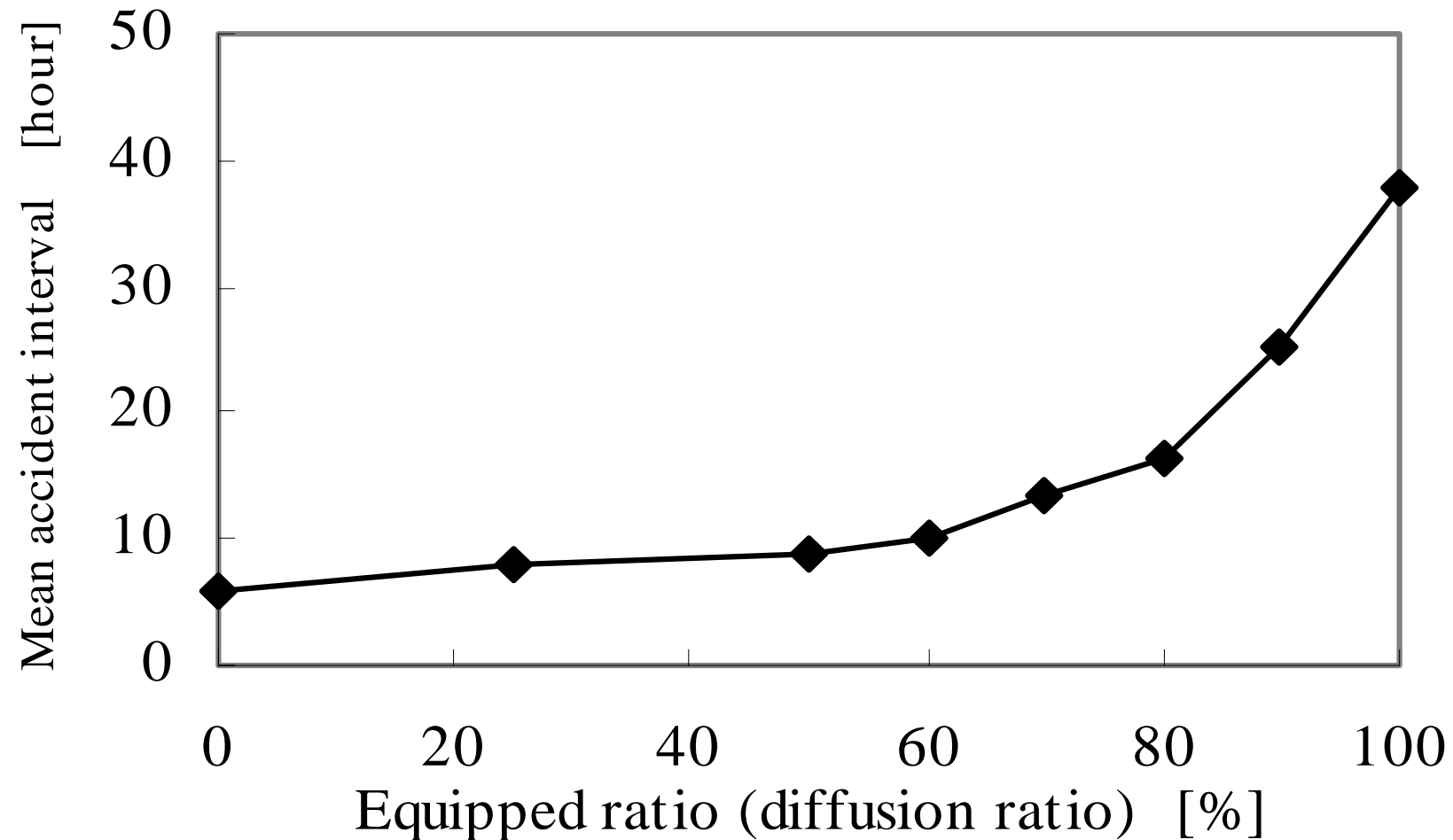
# Effect of VSC from results of our simulations(2)

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- Two types of VSC evaluation indexes
  - From the viewpoint of road administrators
    - Accidents frequency within an area
  - From the viewpoint of drivers
    - Accidents frequency for each driver

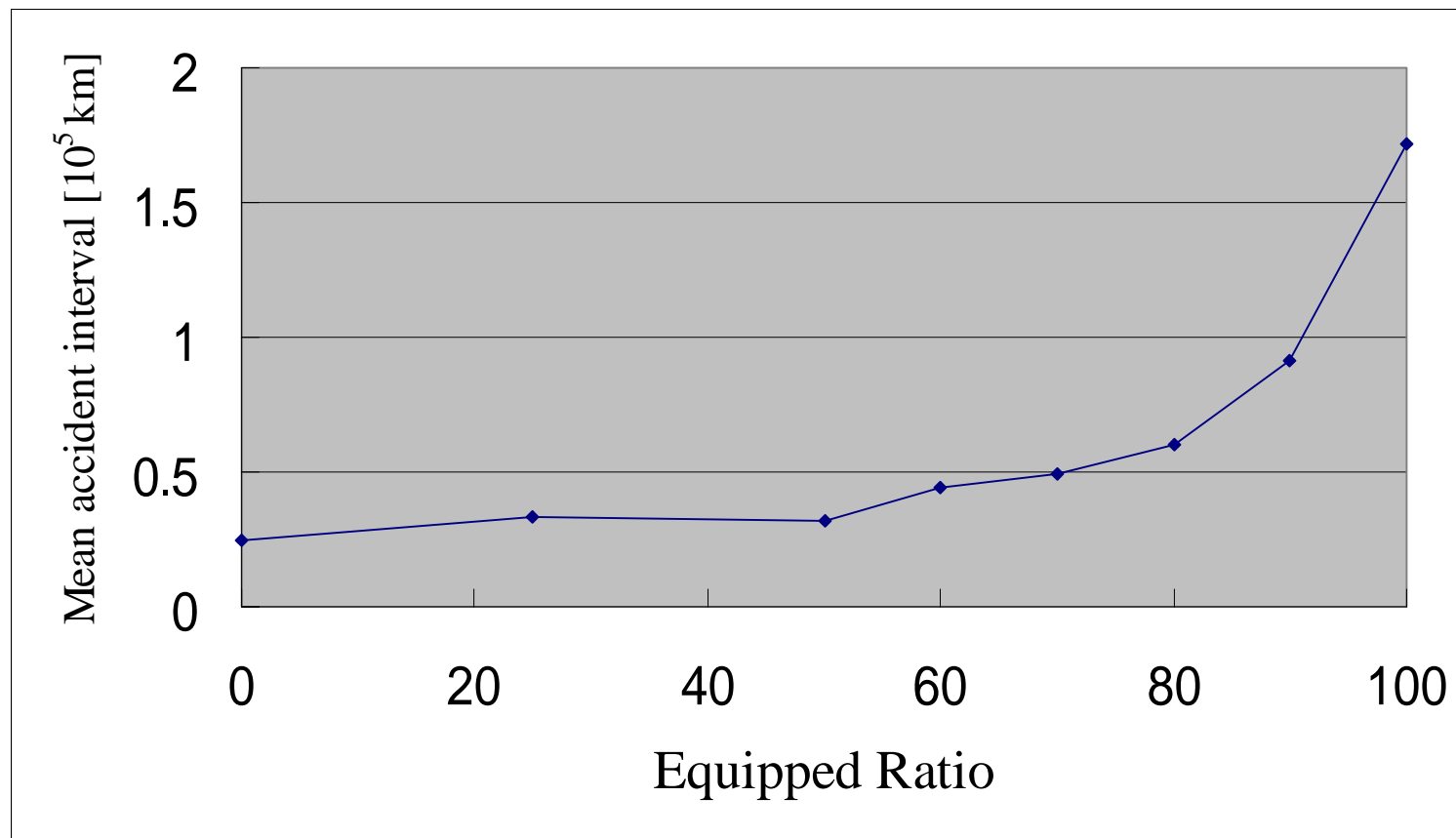
# Effect of VSC from results of our simulations(3)

- Equipped ratio property



# Effect of VSC from results of our simulations(4)

- Equipped ratio property (from the viewpoint of drivers)



# My plain definition of ITS

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- Human and objects transport systems sophisticated by IT
- Road, Human, Vehicle, Train, Airplane  
Mobility of human and objects

# ITS Pentagon

- Systems' objectives in order, and concretization of systems' positioning



# Systems Innovation

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- Functions
  - I/O
- Costs
  - B by C
  - Neither “seeds oriented” nor “needs oriented”, but “Platform oriented”
  - Not “limited number” but “infinite number” of applications on the platform
  - common functions provided by the platform
- Migration
  - Migration of the platform itself
  - Migration of sub-platforms -> 2G to 3G, GPS receivers
  - Migration of our life styles -> many pedestrians and vehicles will have cameras

# End-user Triangle

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- End-user taxonomy (non-exclusive)
- Correspondence end-users to systems

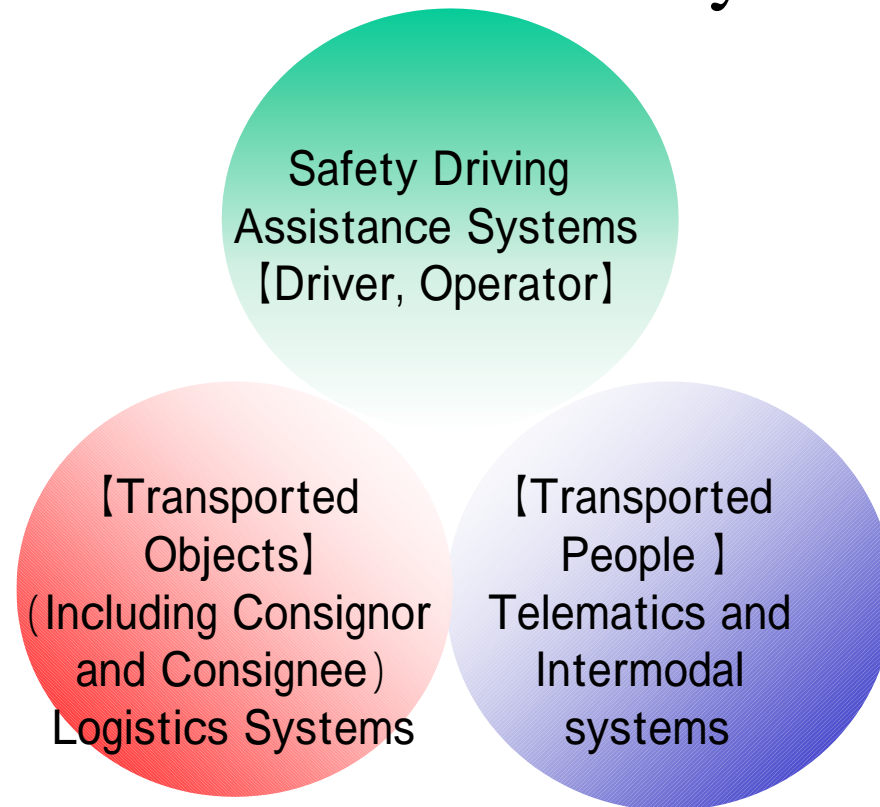


Fig. ITS end-user triangle.

# Driving assistance system

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- Incident avoidance
  - Vehicle control / Automated driving
  - Information / warning
- Functions
  - Positioning
  - Communication
  - (- HMI)
- Different level (QoS) requirements
  - Precision, delay, robustness

# First and Second Category ITS Platforms

【Driving Assistance Systems】

【Control/Automated Driving】

**First Category ITS Platform**

(Realtime seamless communication and realtime precise positioning)

【Information/Alarm】

【Telematics/Intermodal Systems】

【Logistics Systems】

**Second Category ITS platform**

(Quasi-realtime seamless communication and quasi-realtime precise positioning)

【Spatial conscious Information processing and communication】

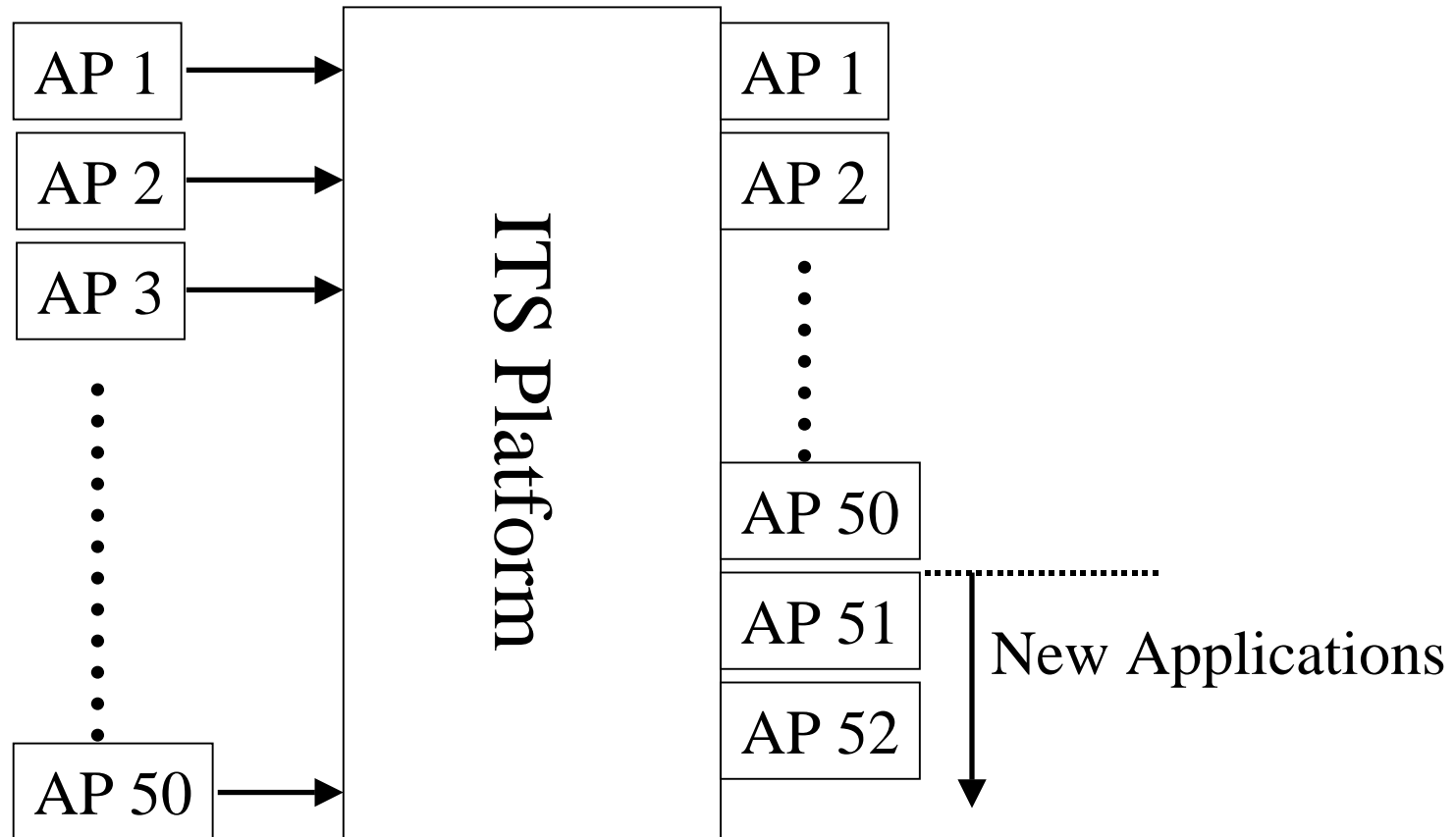
【Handling】

**Third Category ITS Platform**

(RFID-Tag system's positioning and communication)

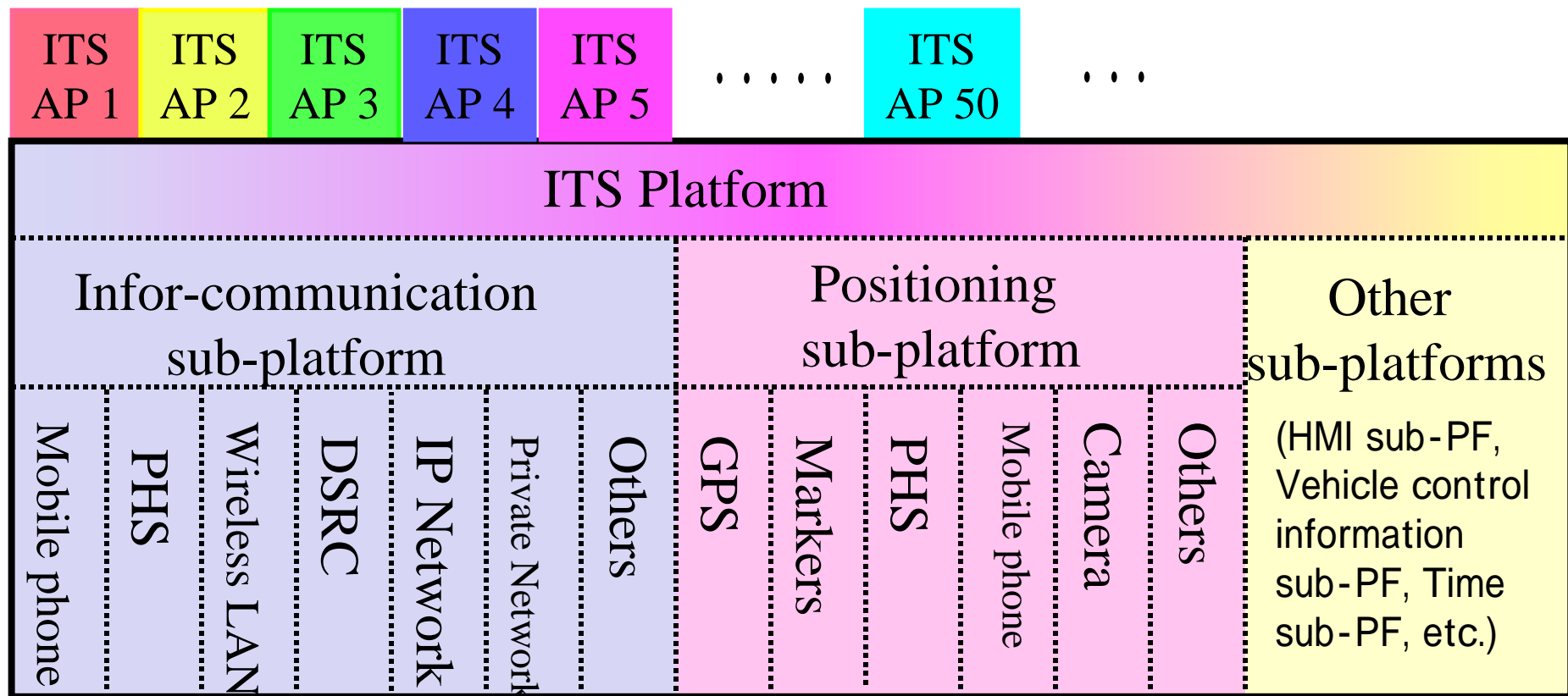
# Construction of ITS Platform

- Example of construction from 50 ITS applications



# Evolutional Ubiquitous Platform for ITS (EUPITS)

- Architecture of EUPITS

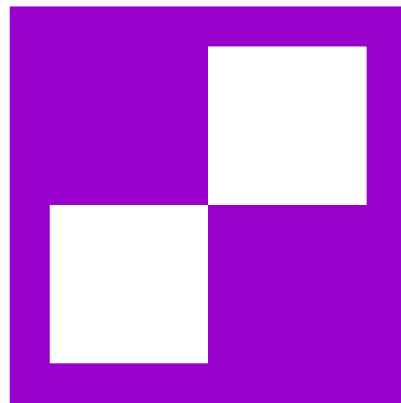


(Medium selection depending on QoS and other conditions)

# “M-CubITS” Positioning System

- Elements of **M**-sequence **M**ultimodal **M**arker for **ITS** (**M**<sup>3</sup> for **ITS**; **M**-**c****u****b****e**d for **ITS**; M-CubITS)

(ref.:PNCMM)



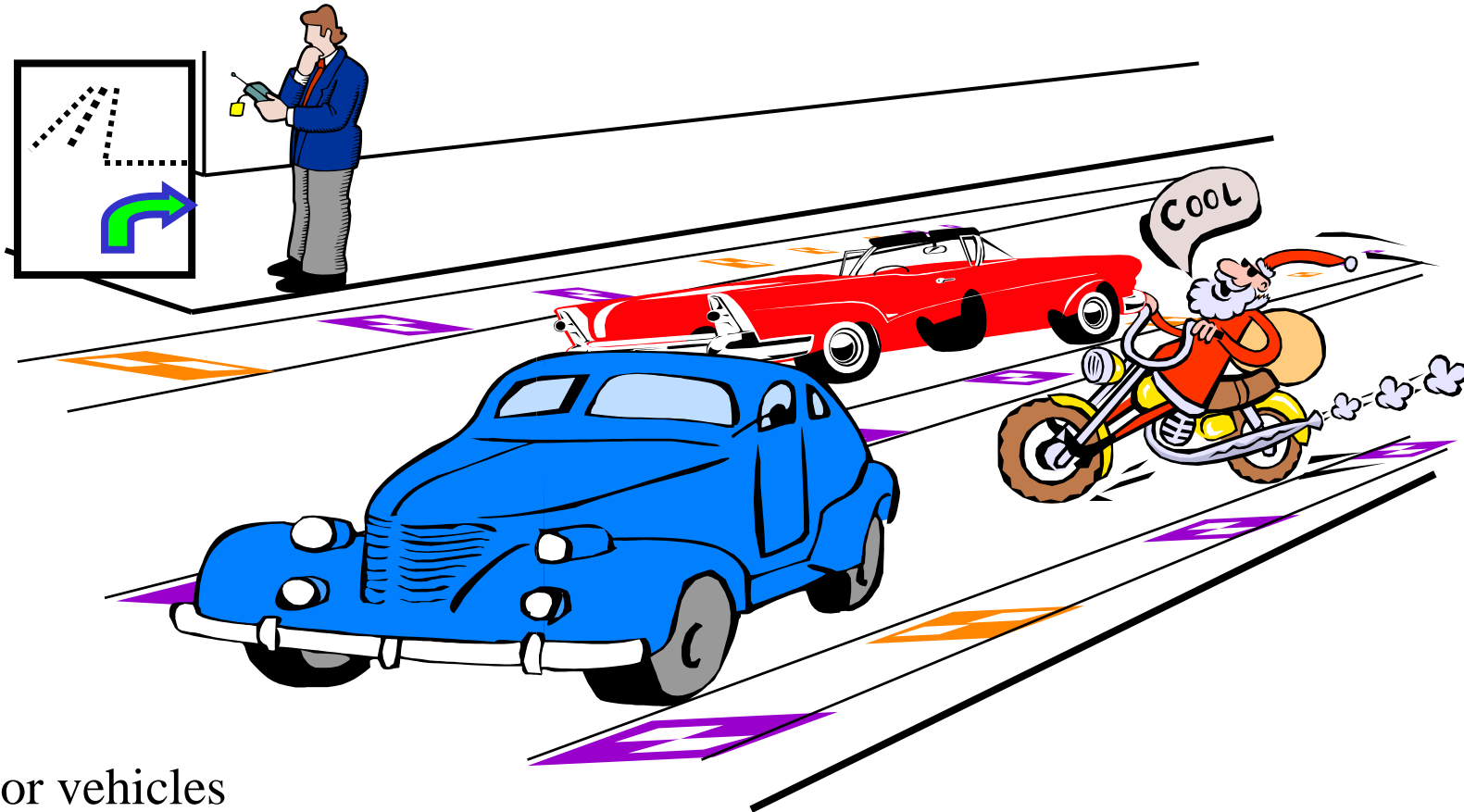
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# M-CubITS and Application Image(1)

- On the street (Pedestrian/Vehicle/Motor bike)



- For vehicles
  - Using the lane keeping system by white line detection, realization of realtime precise positioning without additional hardware.

# M-CubITS and Application Image(2)

- For pedestrians
  - Photo-oriented direct suggestion of the direction for a pedestrian → WYSIWYAS pedestrian navigation system. (assumption of Mobile phone terminal or PDA with a camera)

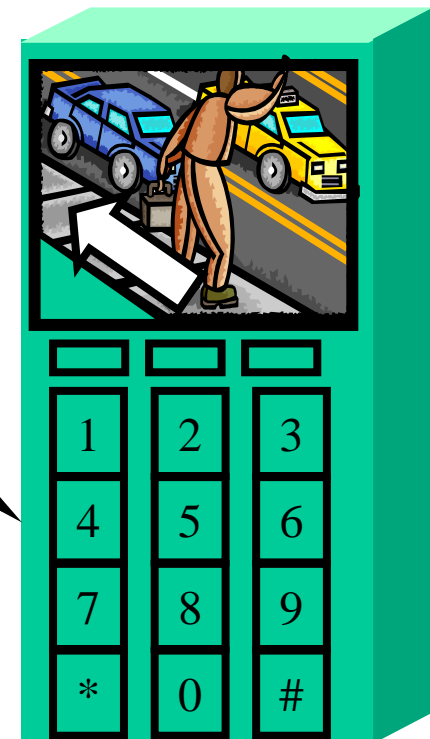
(WYSIWYG:

What You See Is What You Get

As the corresponding concept,

WYSIWYAS:

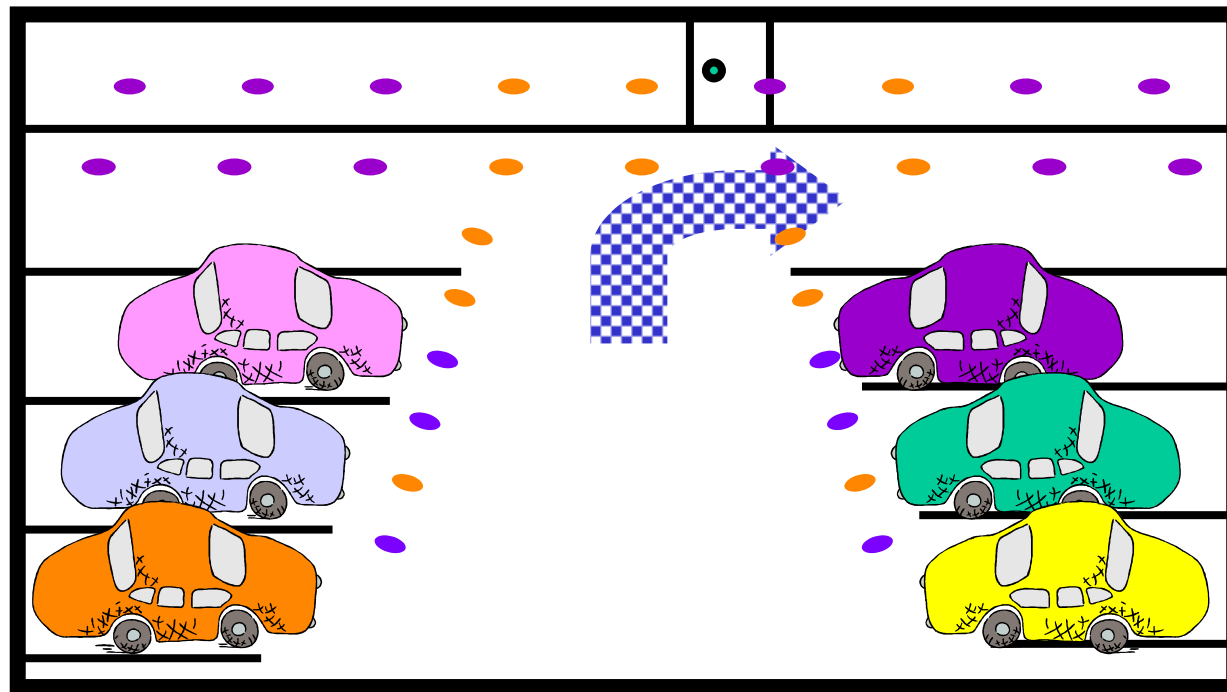
What You See Is What You Are Suggested)



# M-CubITS and Application Image(3)

- At basement car park or tiered parking lot, on the street
  - Besides determination of position and direction at GPS invalid area, empty space visual guidance in the large parking lot (using local positioning and communication functions)

-> WYSIWYAS Navigation



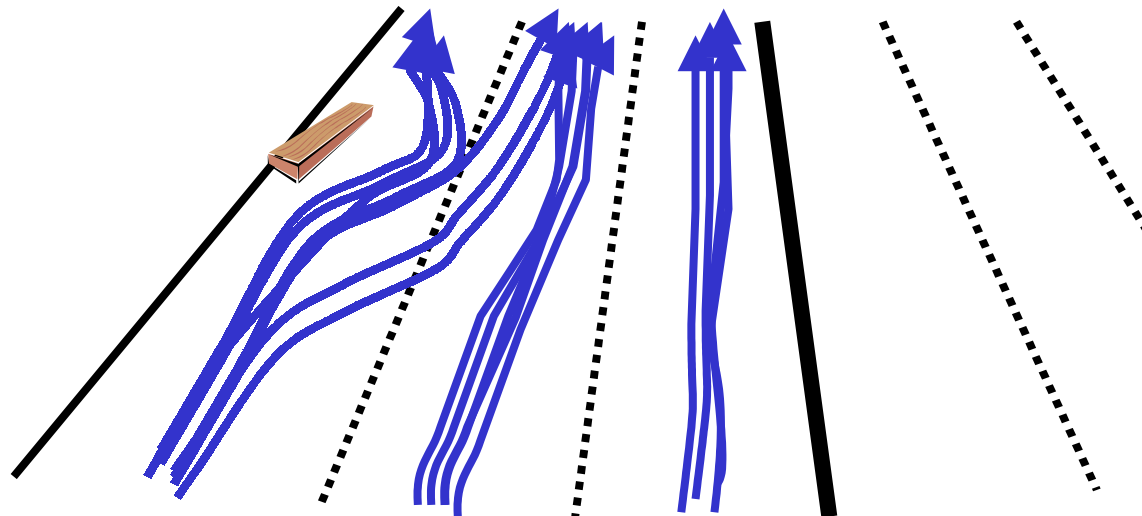
# Discussion(1)

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- First category and Second category  
(Different requirements for sub-systems)
- Determination of position and direction
- Communication
- WYSIWYAS navigation HMI
  
- Is a killer application needed?
  
- Effectiveness of communications for safety depends on not only the communication function itself but also other functions such as positioning or sensing functions.

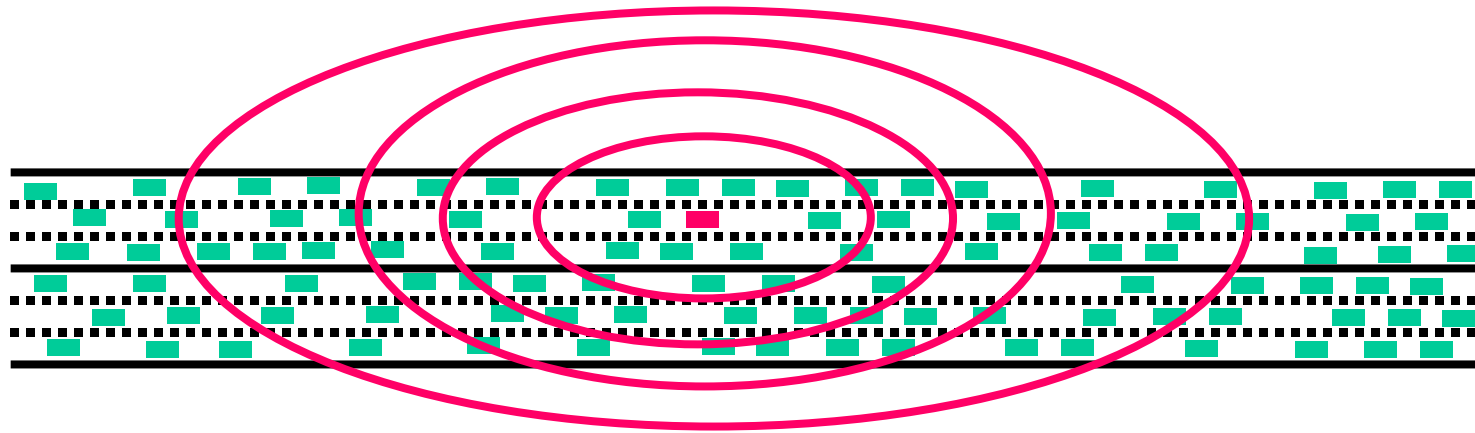
# Discussion(2)

- Realization methods of unusual situation detection
  - Monitoring by roadside cameras
  - Realtime precise positioning and communications (probe car)
    - Event driven communications of abnormal trajectory
    - Fulltime communications of trajectory



# Discussion(3)

- Communication range in IVC



- Migration of the communication paradigm
  - Telephone network: Particular point – Particular point
  - Mobile phone: Particular terminal / General area
  - ITS infor-com.: + General terminal / Particular area

# Discussion(4)

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- Communication sub-platform and positioning sub-platform

**Next Gen. DSRC**

**Wireless LAN**

**PHS**

**Mobile phone**

**Marker**

**GPS**

# Discussion(4)

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- DSRC: R2VC and IVC
- Data sharing
  
- Integration of IVC and R2VC

# Conclusions

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- Vehicle safety activities in Japan
  - ITS Info-communications Forum/ “Inter-Vehicle Communications Systems Expert Group”
  - JARI/ ITSC
  - AHSRA
- My personal view and discussion on vehicle safety and communication
  - Safety driving assistance (first and second categories)
  - Communication and positioning (not-separately, by a platform)
  
  - B by C (Platform oriented) (material and unmaterial)
  - Systems Innovation (functions, costs, migration)
  - System oriented (safety and elemental techniques such as communication, positioning, HMI etc.)
  - Safety and data sharing
  - Integrated thinking way of systems technology toward safety and elemental technology (communication, positioning, HMI etc. )