VSC development in Japan

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Outline

- 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

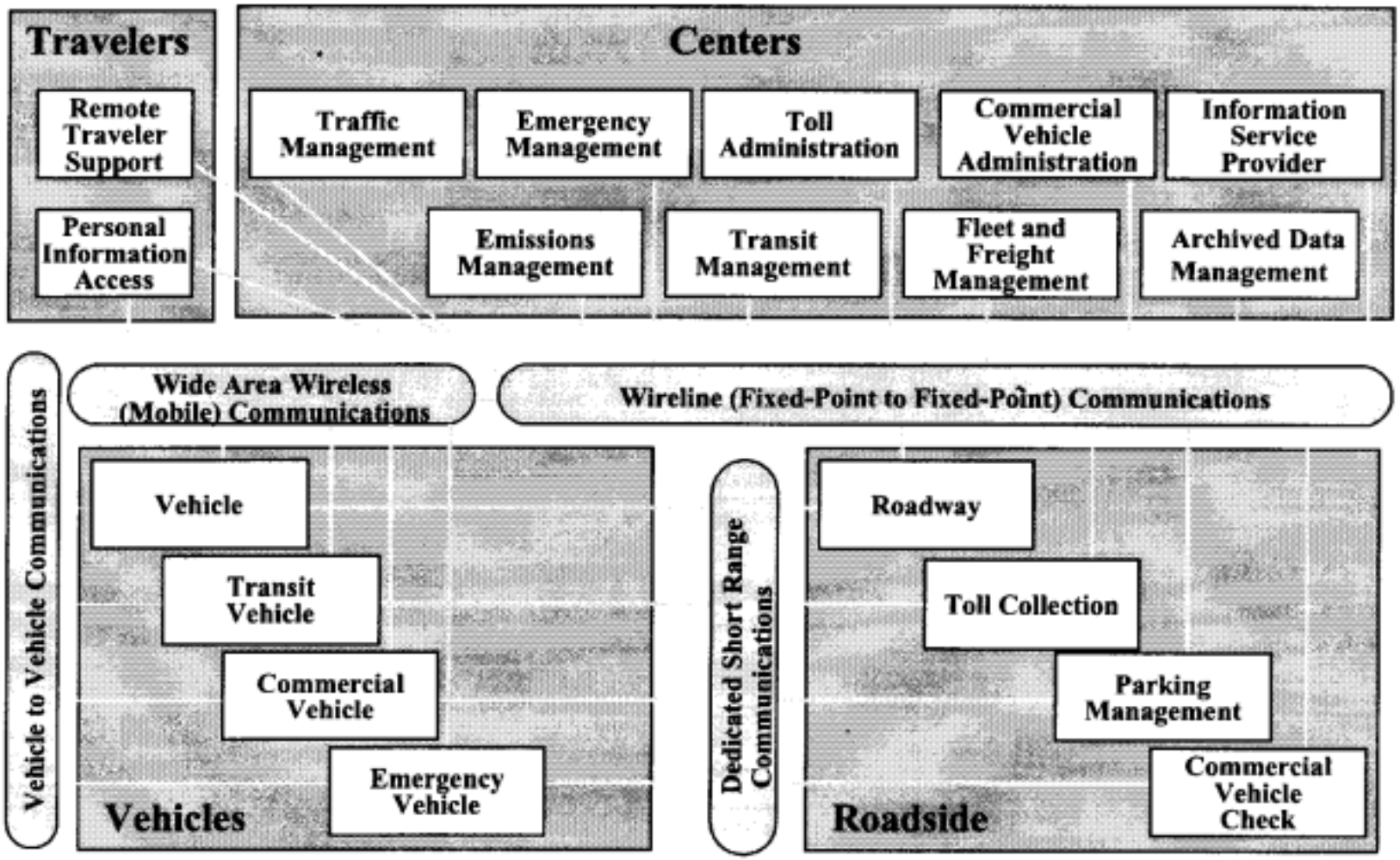
- Vehicle safety and communication
- ITS and business
- Safety is a public matter or a private matter?

- [Terminology] Dedicated Short Range Communications
  - Vehicle-to-Vehicle Communication
    (Inter-vehicle Communication)
  - Roadside-to-Vehicle Communication

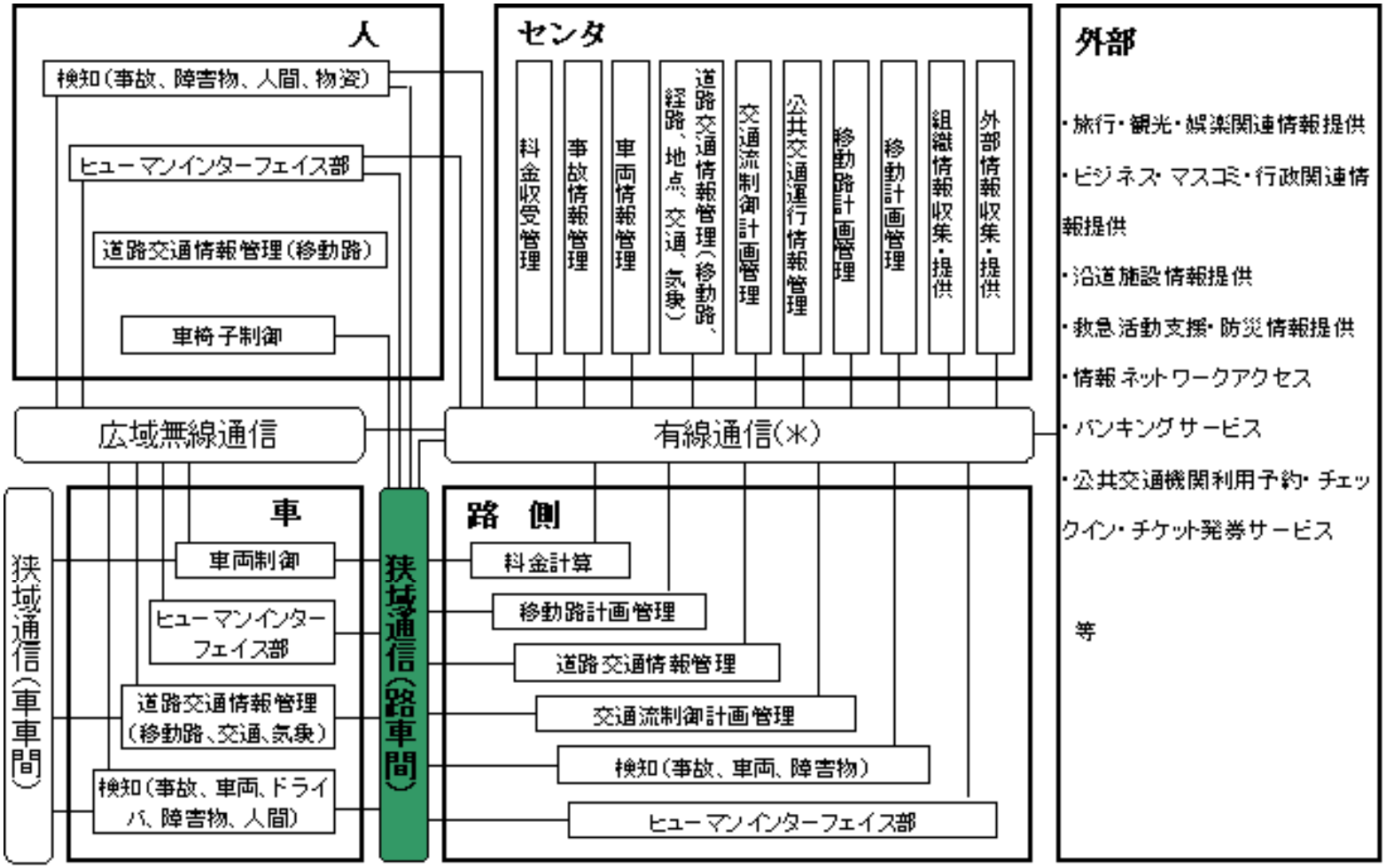
  - V-R-V Communication

  - 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

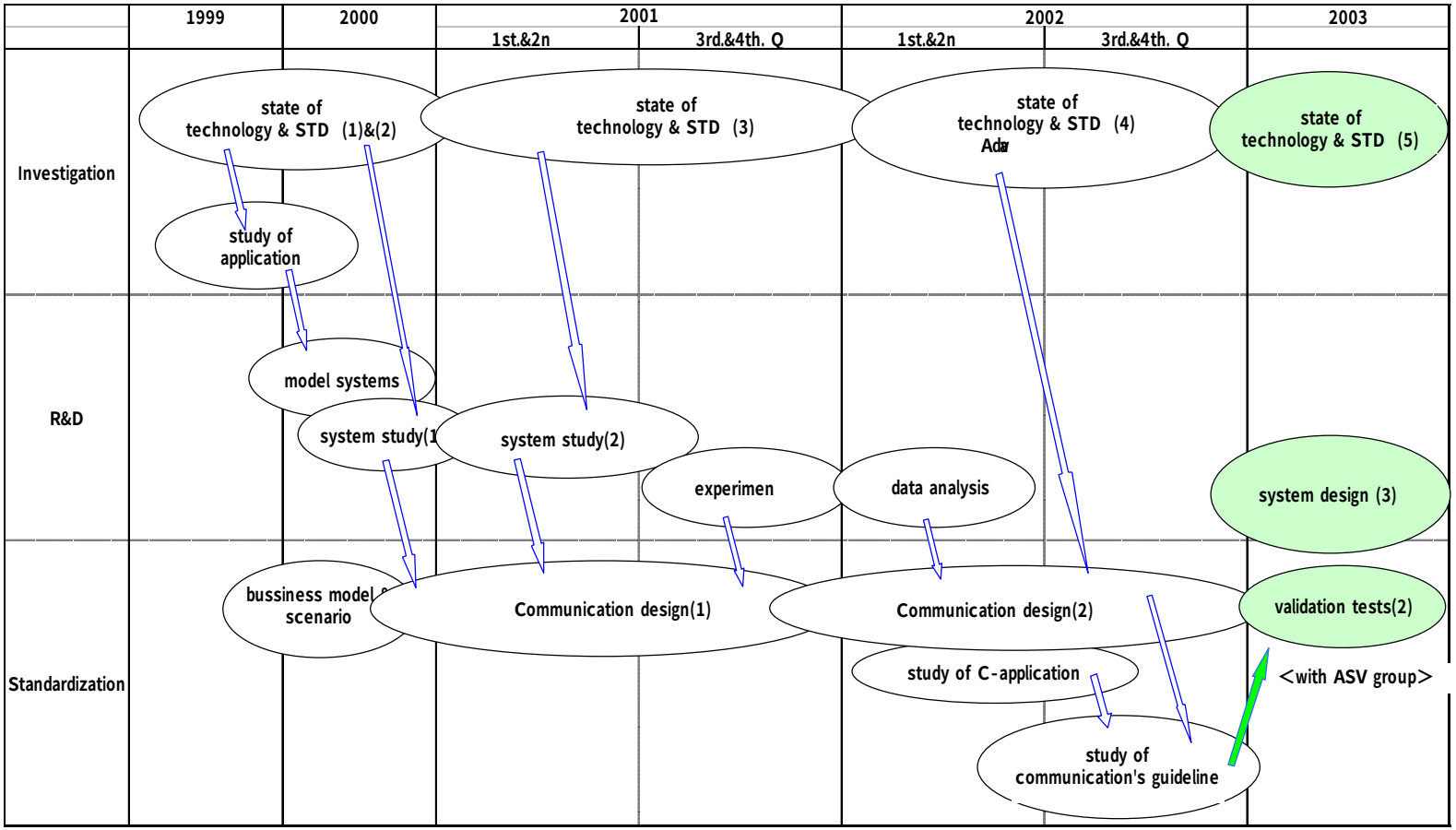
VSC activities in Japan

- 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)

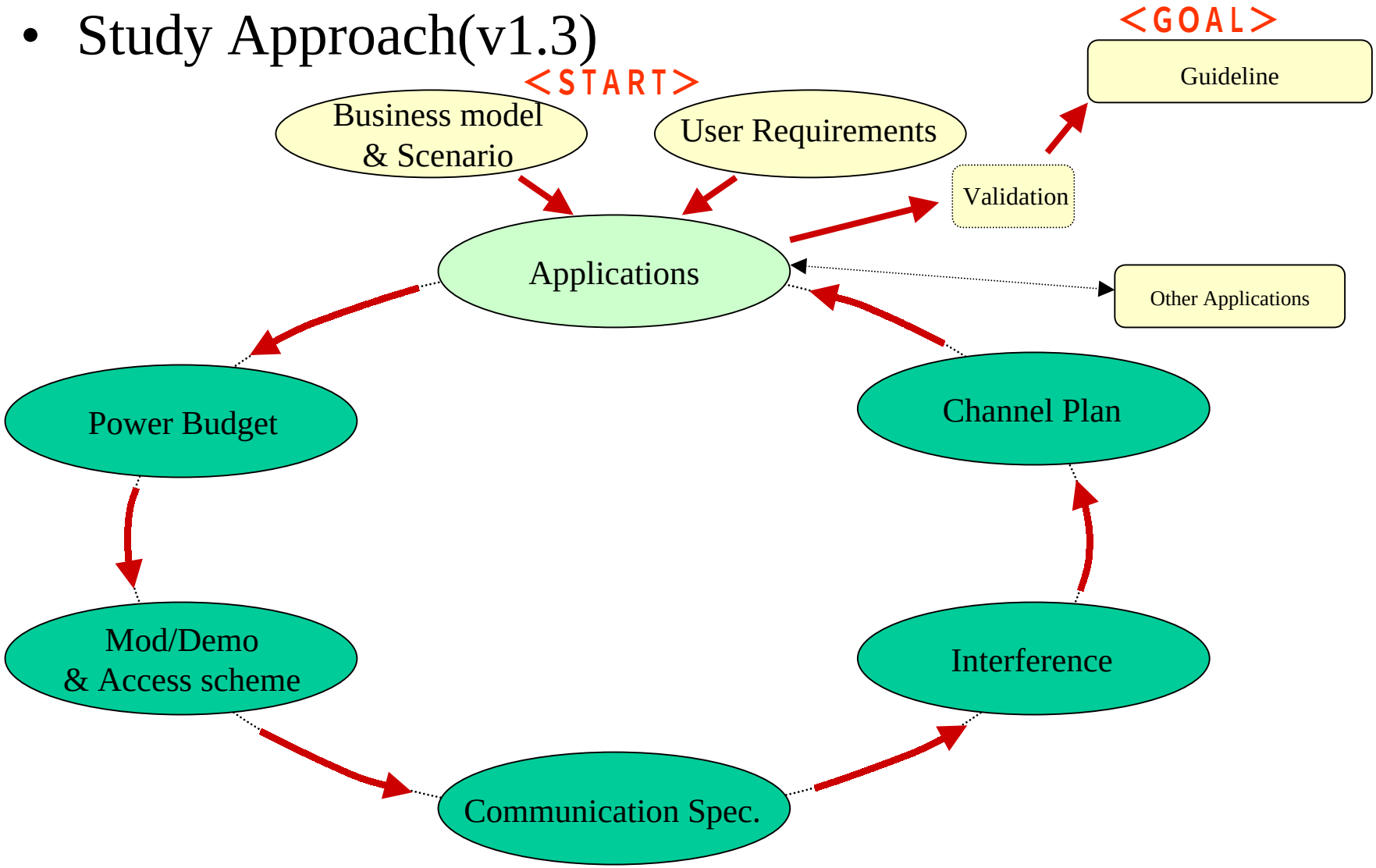
- Study Approach of Vehicle-to-Vehicle Communications



ITS Info-communications Forum

Inter-Vehicle Communications Systems Expert Group(2)

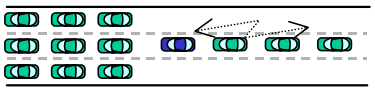
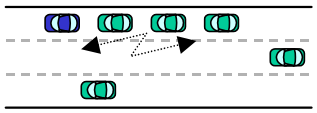
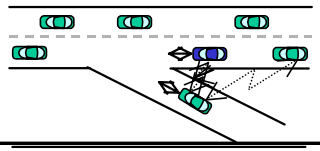
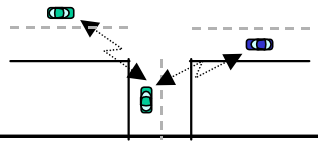
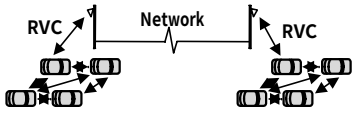
- Study Approach(v1.3)



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 waring Slowing down vehicle warning		△	○	
4	Merging & lane change warining	Cars of main line and a car merging comunicate for safe and smooth line change		○	△	
5	Intersection & winding curve collision warnig	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)

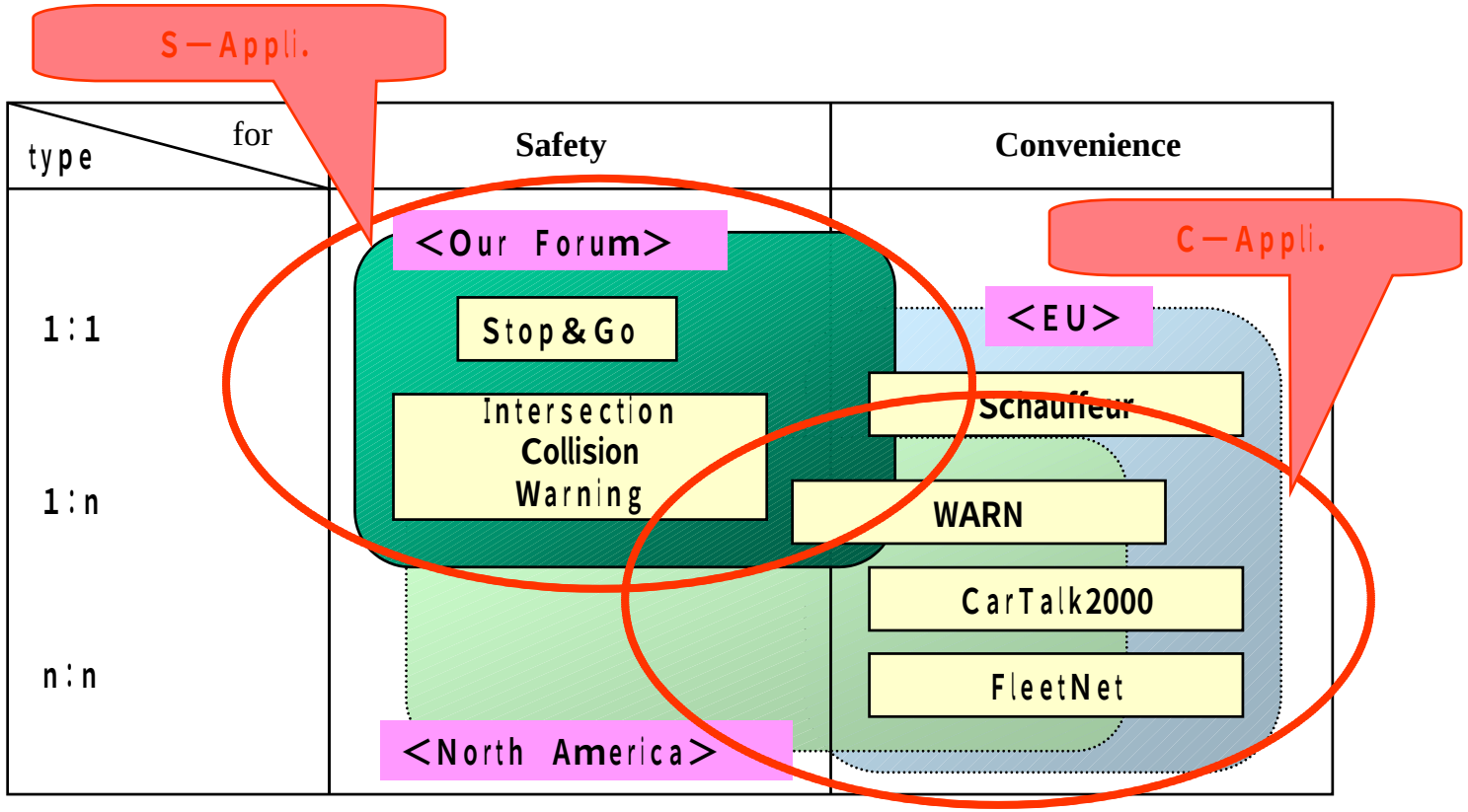
- Communication specifications

	Stop & Go	Intersection Collision Warning
Frequency Band	60 GHz	5.8 GHz
Modulation	FSK	π/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

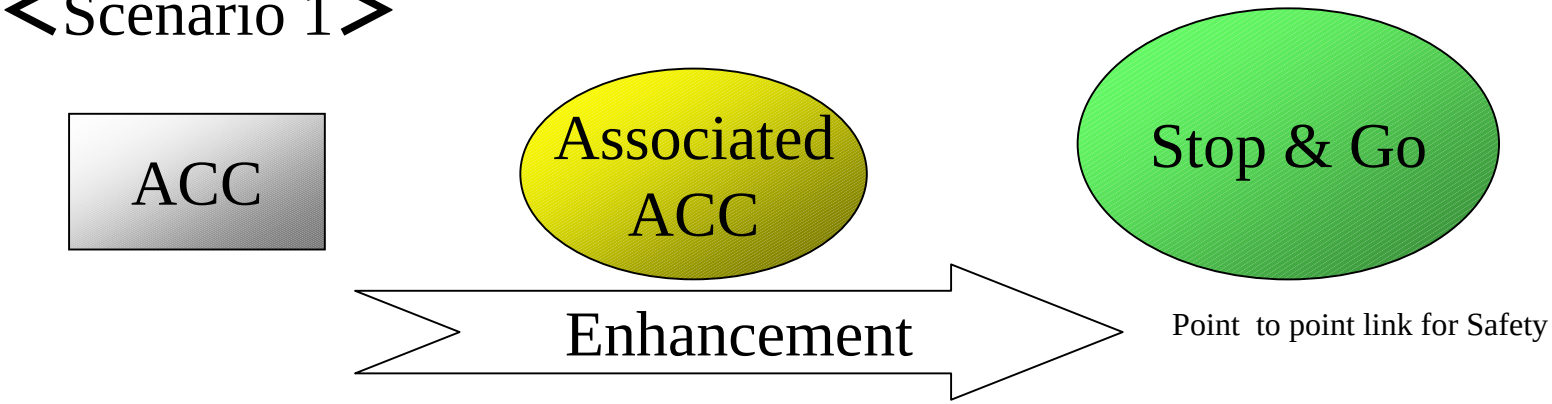
AVCSS: Advanced Vehicle Control and Safety Systems

ITS Info-communications Forum

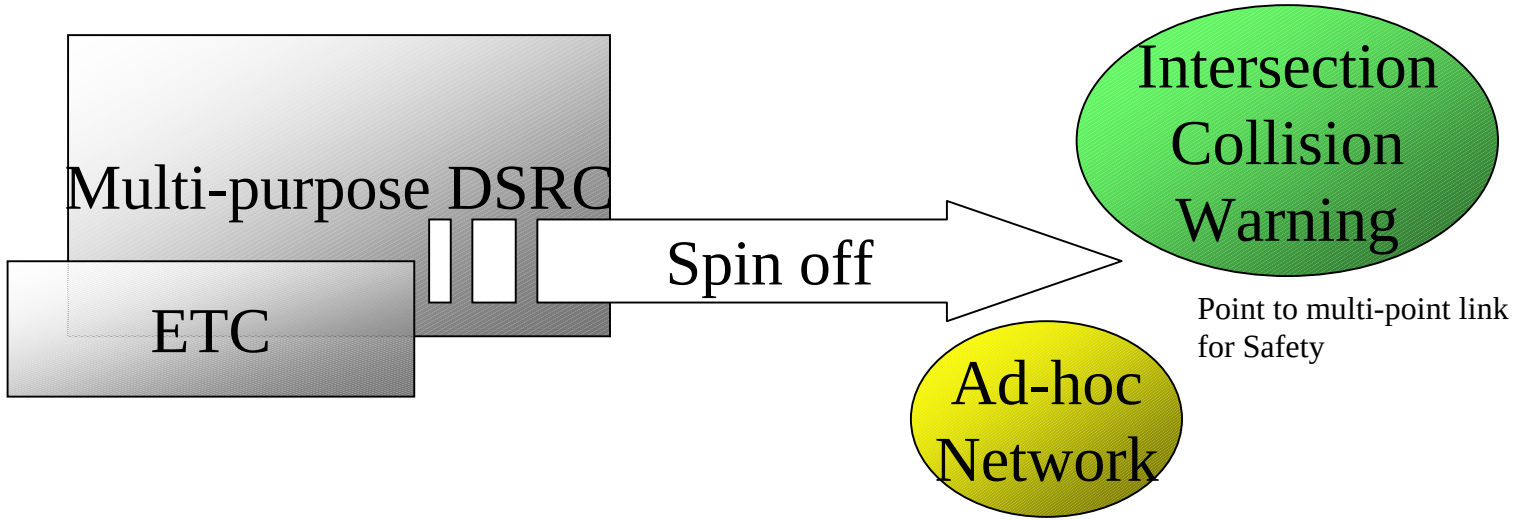
Inter-Vehicle Communications Systems Expert Group(6)

- V2V Deployment Scenarios

<Scenario 1>

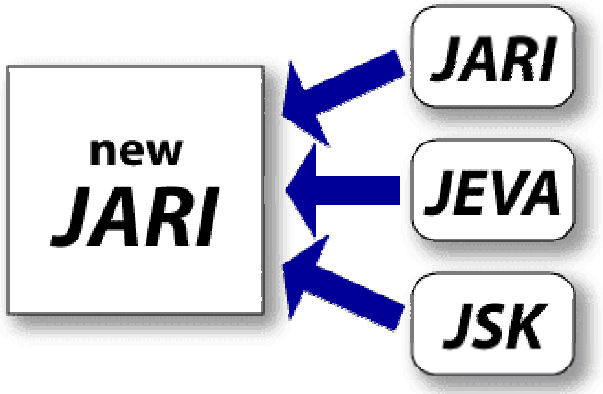


<Scenario 2>



JARI ITS-Center(1)

- 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)

- 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)

- 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.

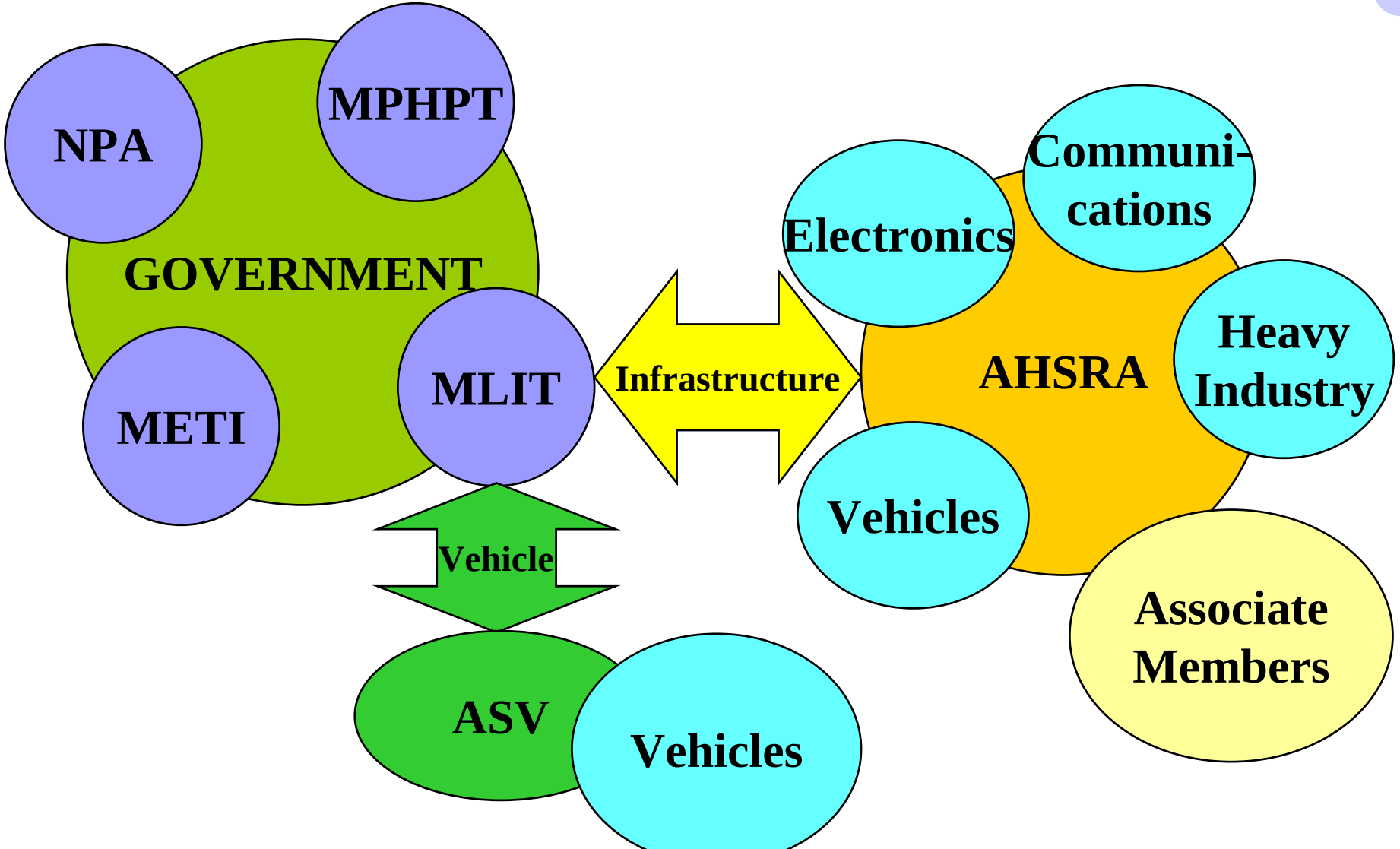
Profile of AHSRA(1)

Name	**Advanced Cruise-Assist Highway System Research Association (AHSRA)**
Leading Ministry	**Ministry of Land, Infrastructure and Transport (MLIT)**
Research Trust	**National Institute for Land and Infrastructure Managements (NILIM)**
Objective	**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.**

Profile of AHSRA(2)

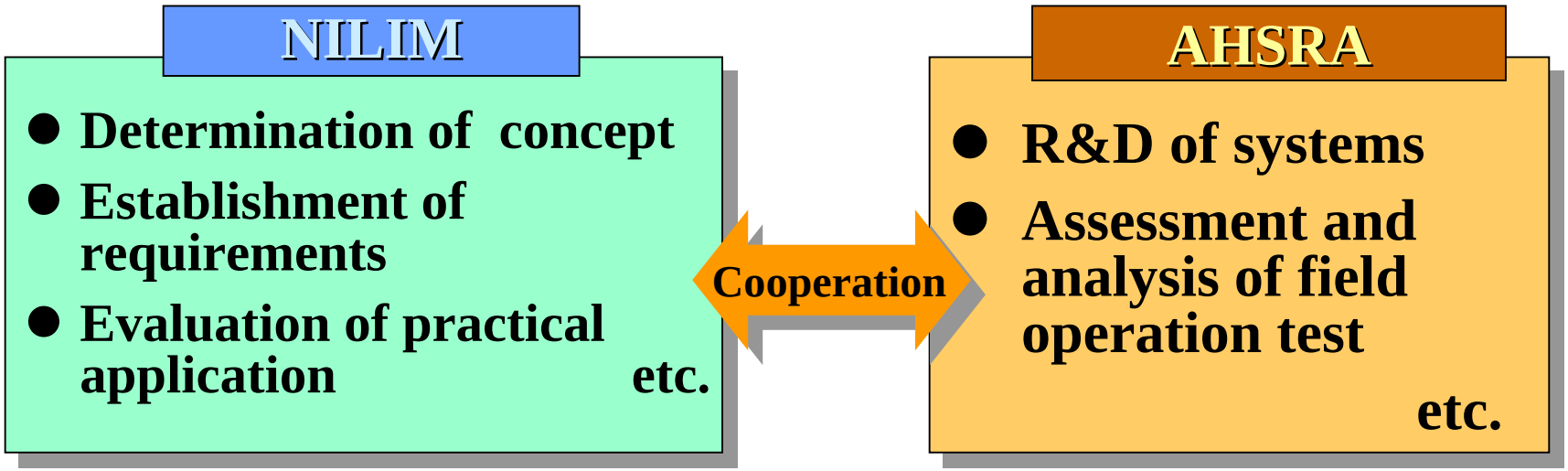
Established	**September 25, 1996, based on the Mining research Association law and with approval from the Minister of Construction (since renamed)**
Members	**18 Japanese Private Companies**
Associate Members	**350 Organizations and Persons**

Positioning of AHSRA

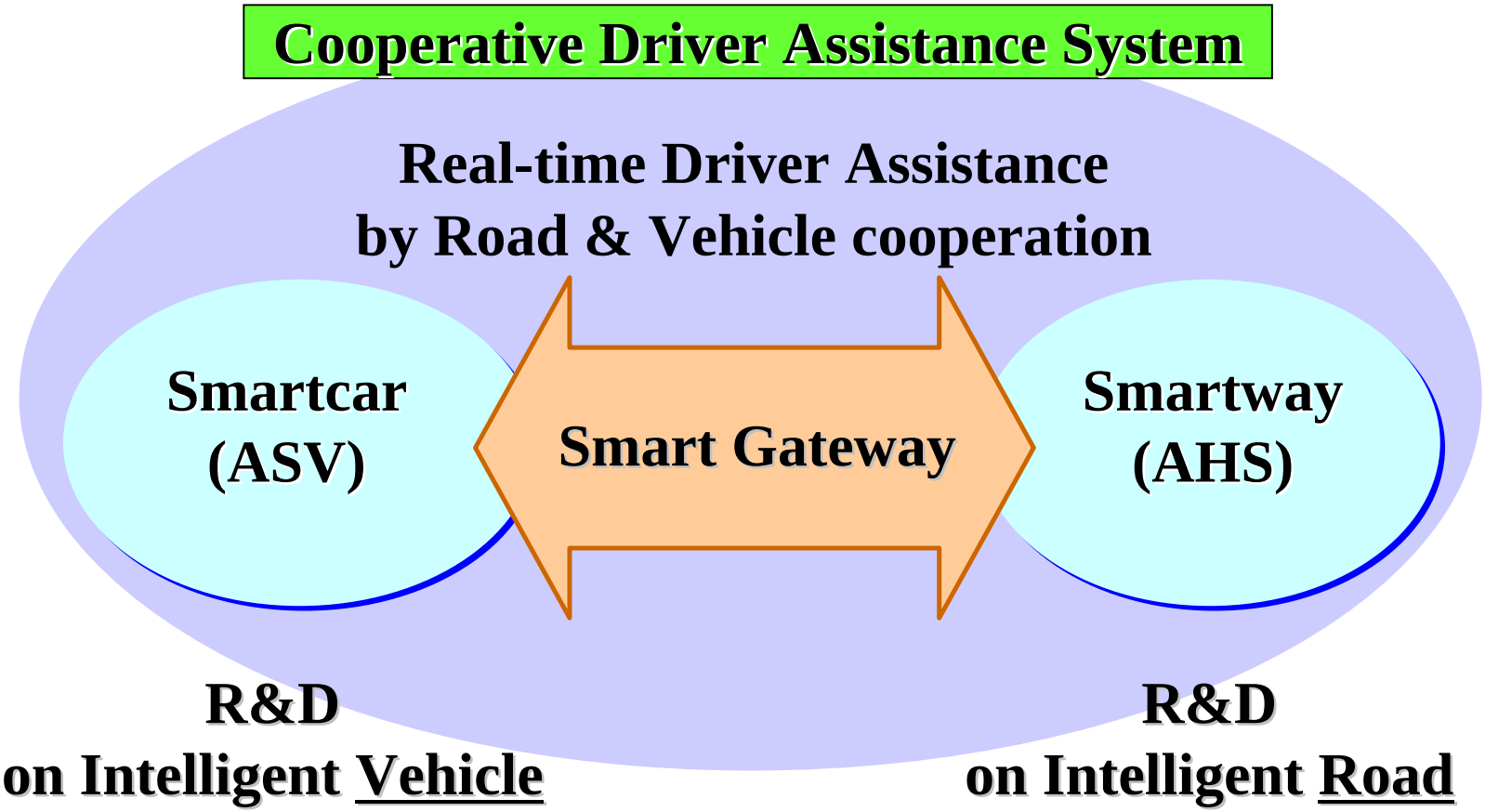


Cooperation between Public and Private

- **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.**

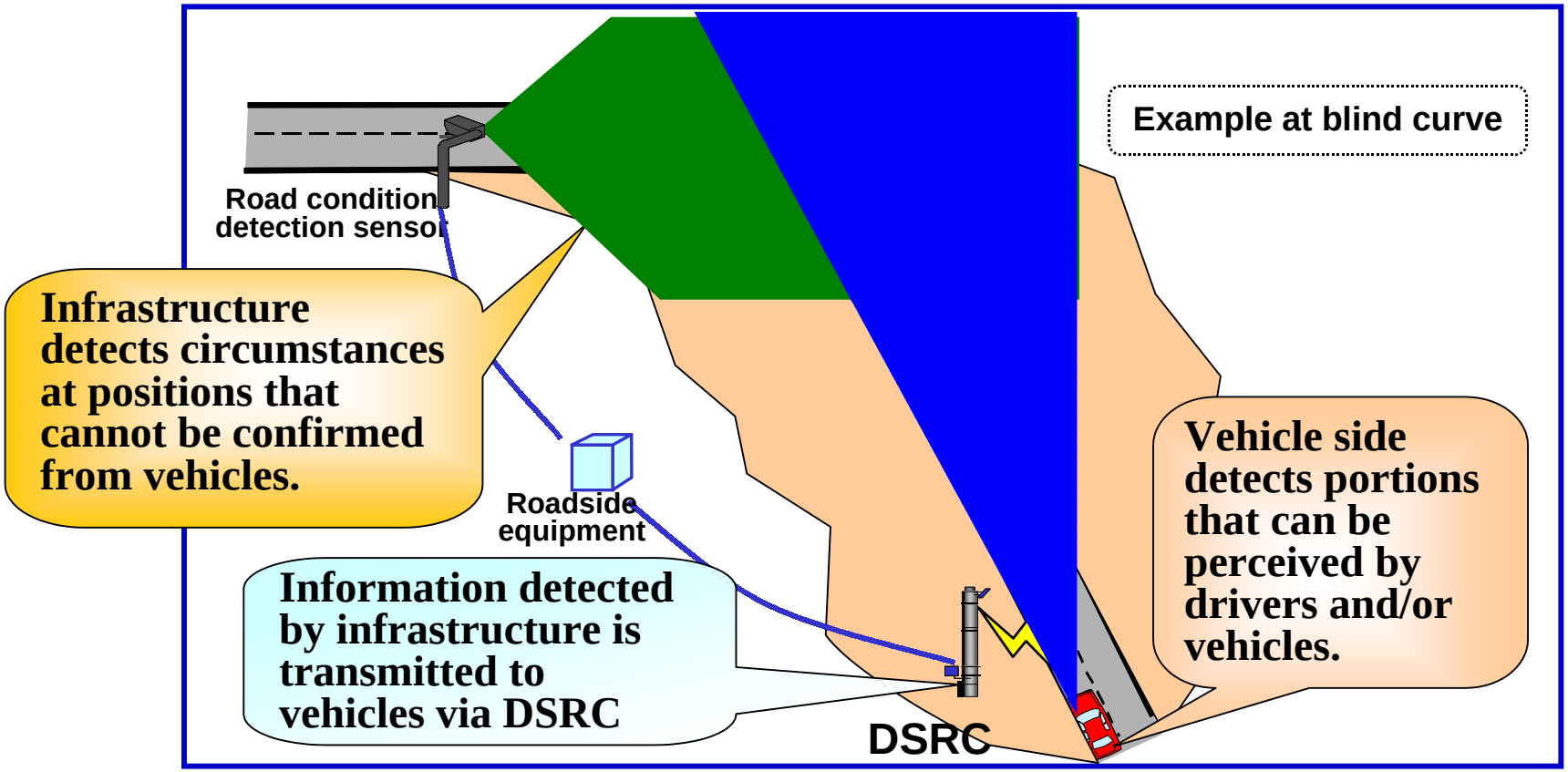


Cooperative Driver Assistance System



ASV: Advanced Safety Vehicle
AHS: Advanced cruise-assist Highway System

Basic Concepts of AHS

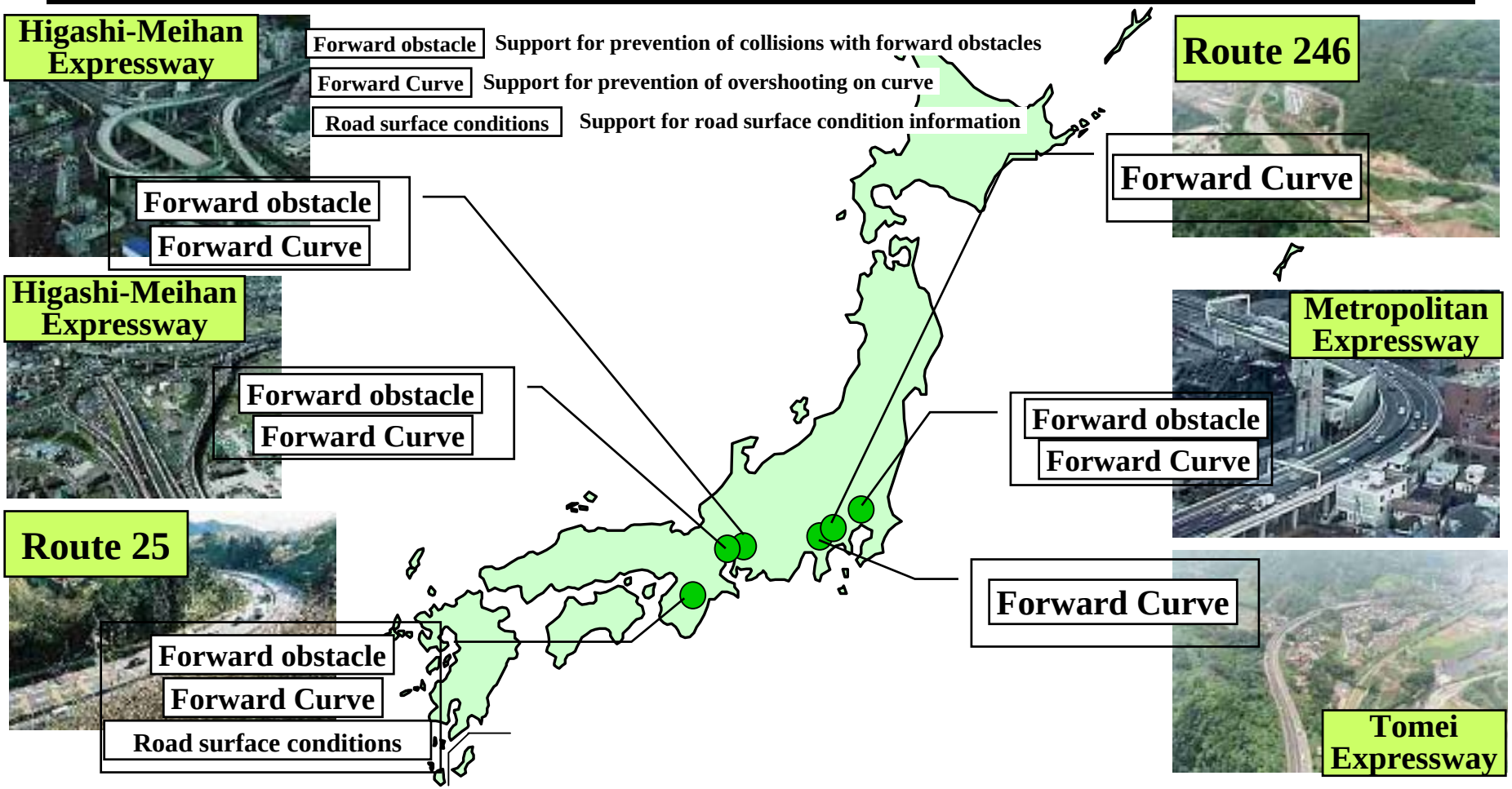


Infrastructure
- Takes charge of the range that is difficult or impossible to perceive by drivers and/or vehicles.

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.

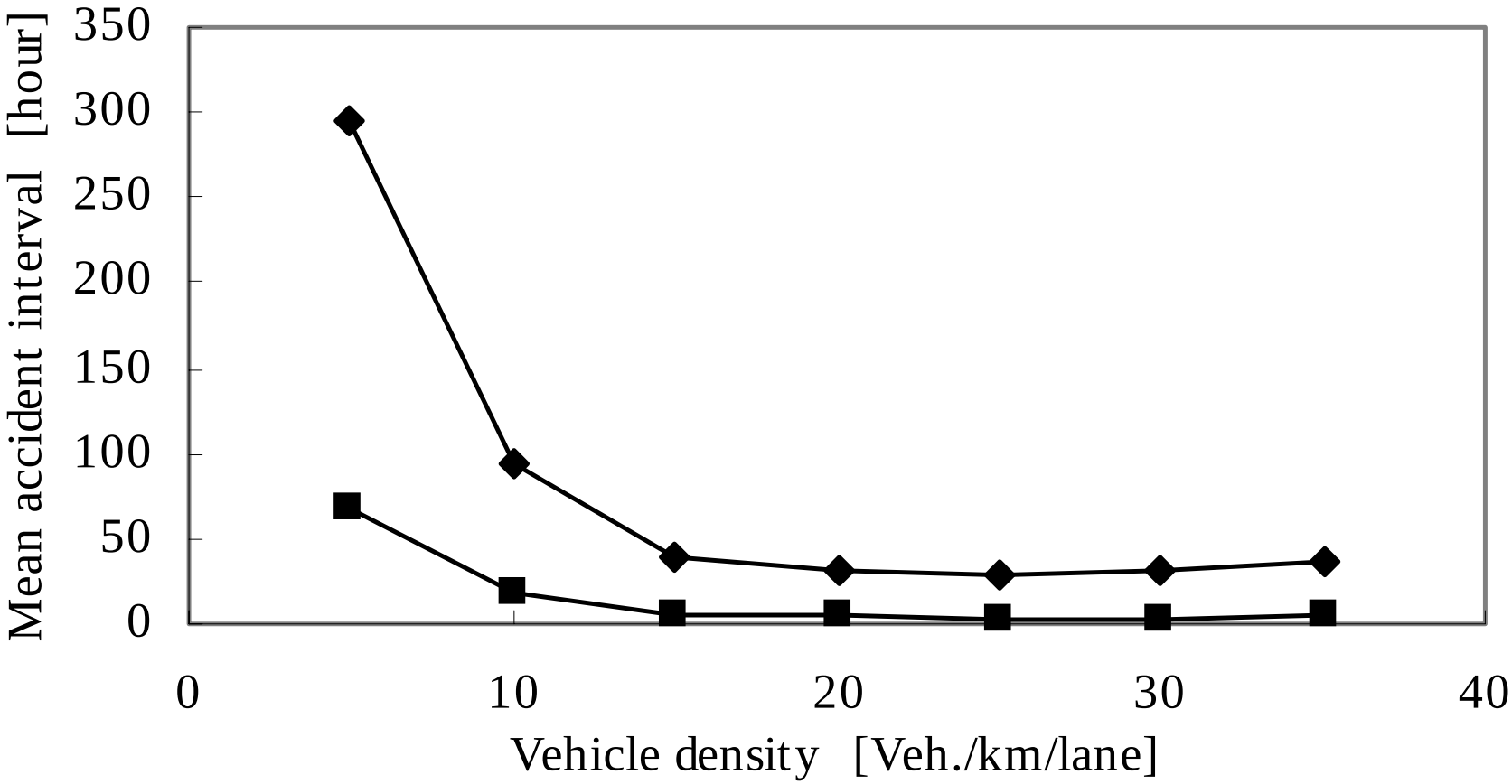


Personal view on vehicle safety and communication

- 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)

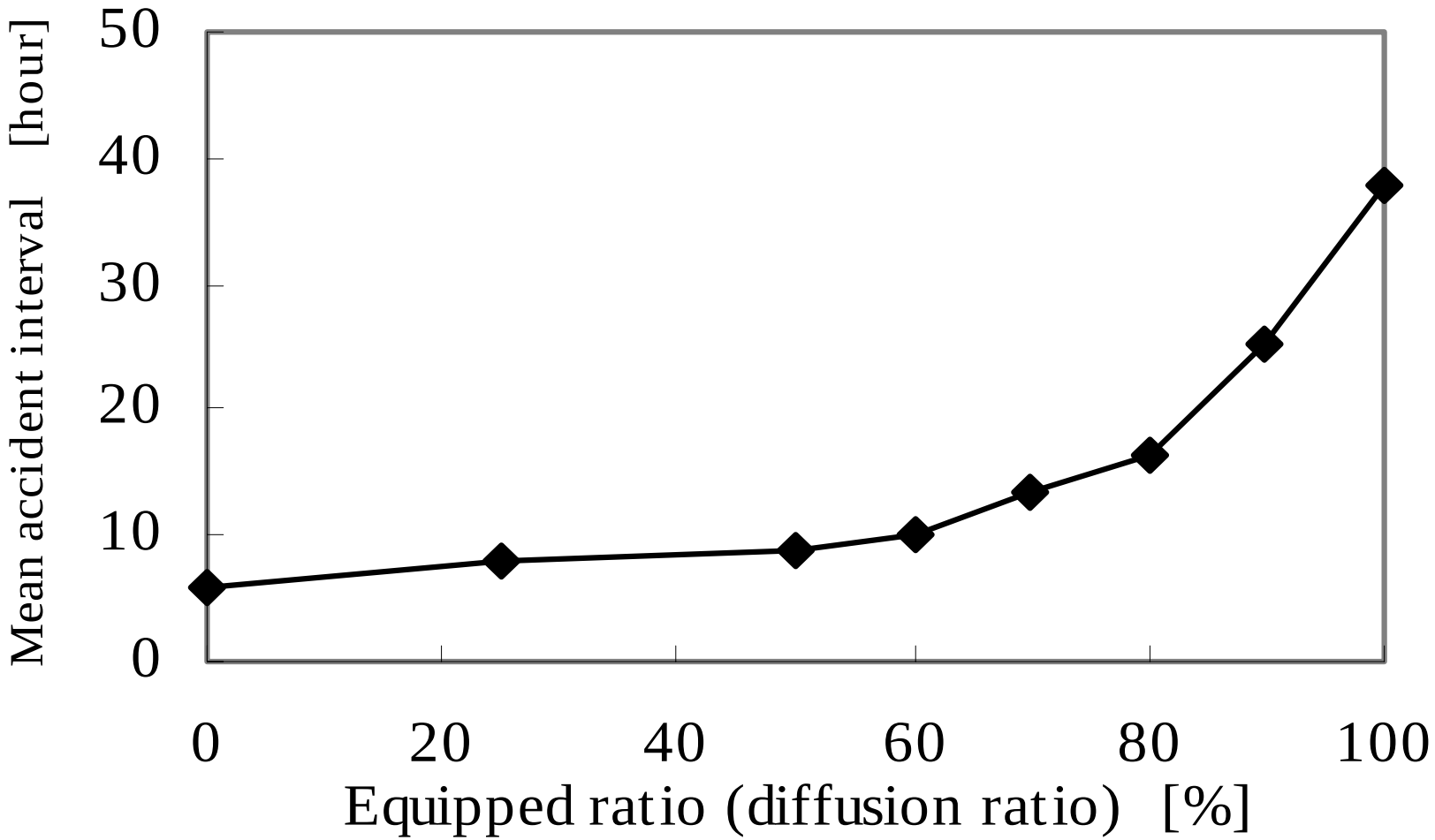
- Two types of VSC evaluation indexes
  - From the viewpoint of road administrators

    Accidents frequency within an area
  - From the viewpoint of drivers

    Accidents frequency for each driver

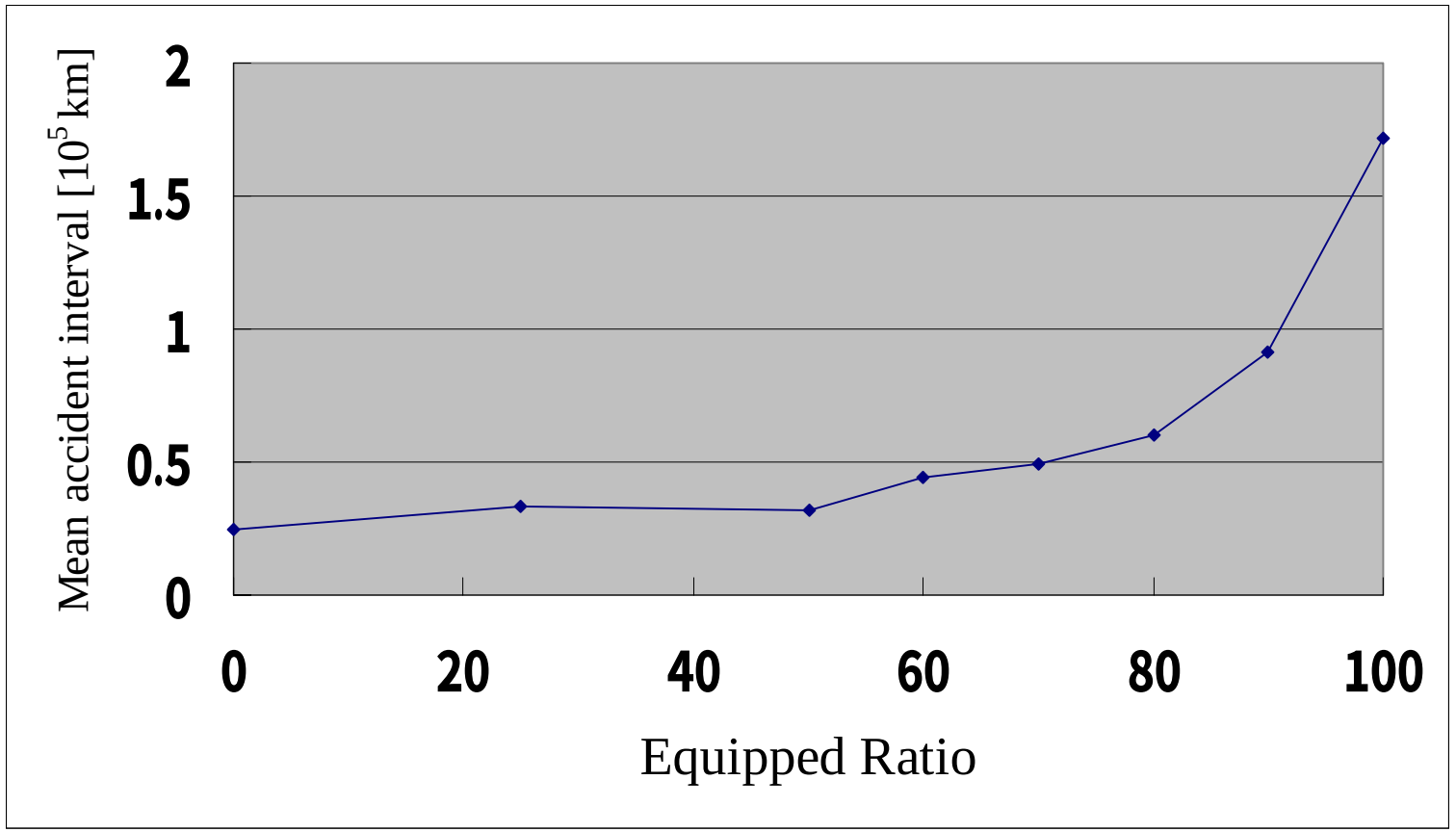
Effect of VSC from results of our simulations(3)

- Equipped ratio property



Effect of VSC from results of our simulations(4)

- Equipped ratio property (from the viewpoint of drivers)



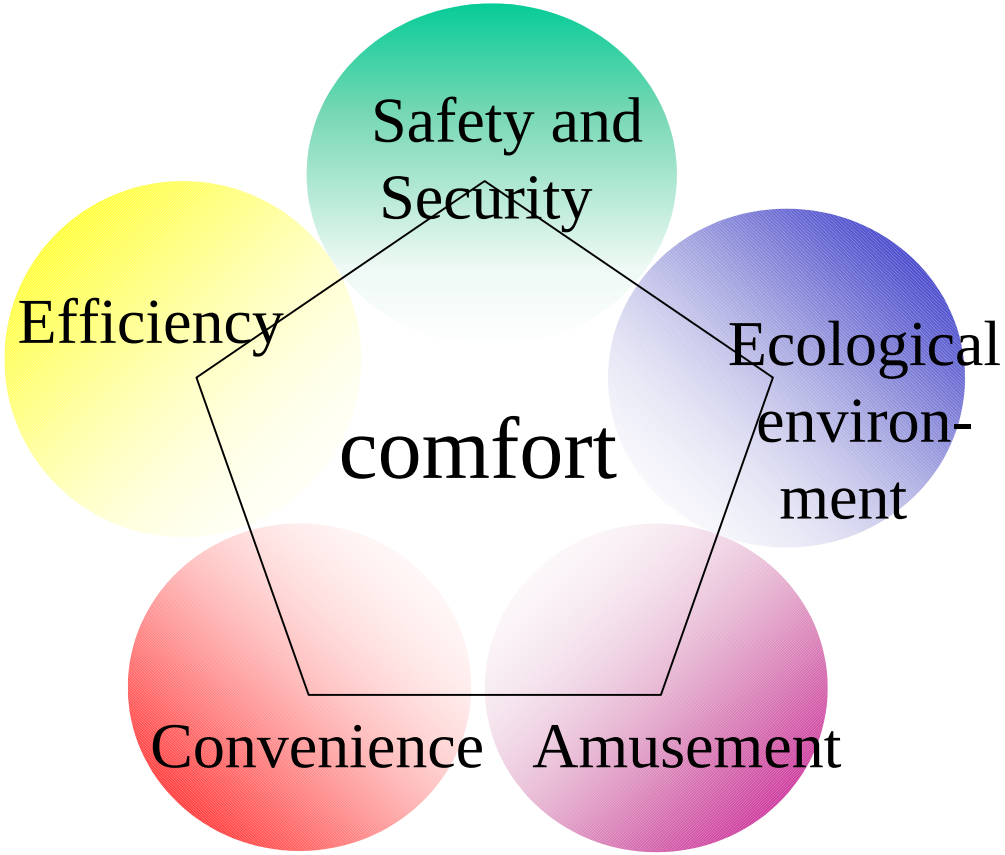
My plain definition of ITS

- 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

- 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

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

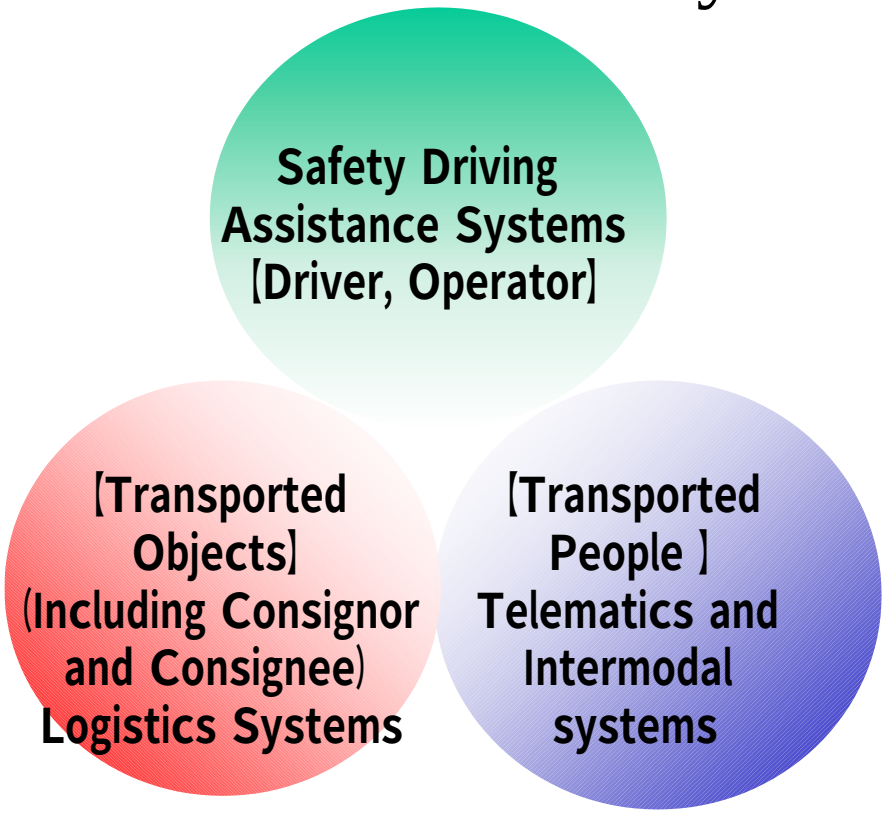


Fig. ITS end-user triangle.

Driving assistance system

- 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)

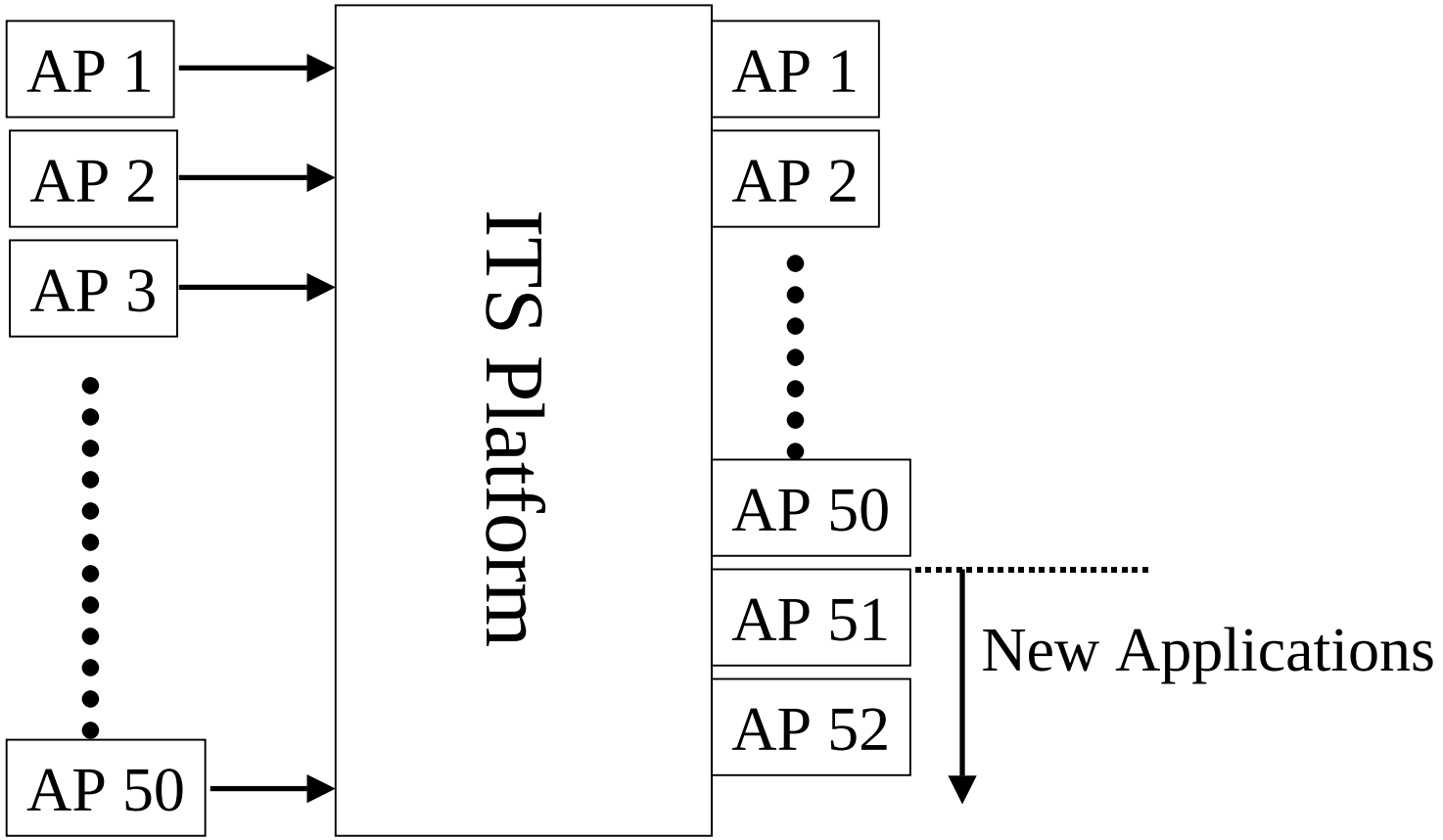
【Spatial conscious Information processing and communication】

【Handling】

Third Category ITS Platform
(RFID-Tag system's positioning and communication)

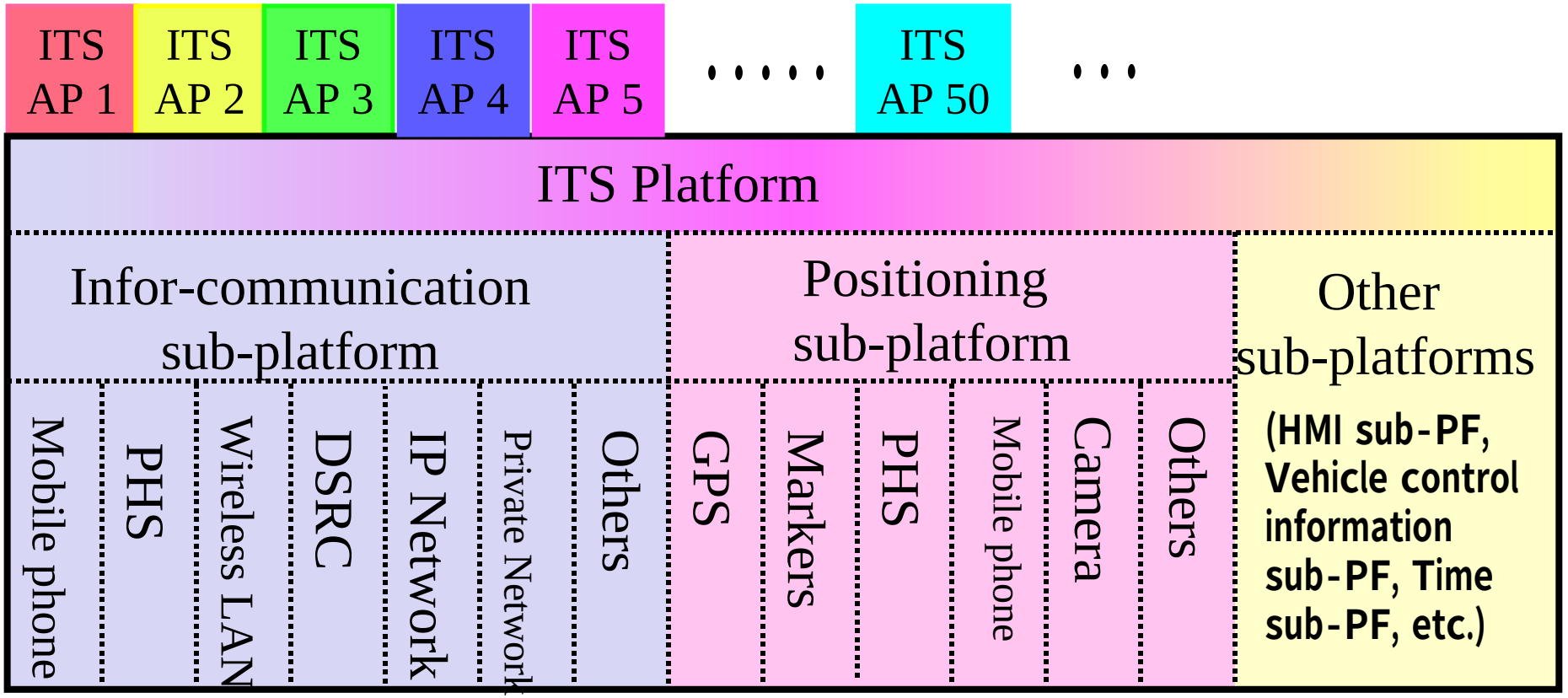
Construction of ITS Platform

- Example of construction from 50 ITS applications



Evolutional Ubiquitous Platform for ITS (EUPITS)

- Architecture of EUPITS

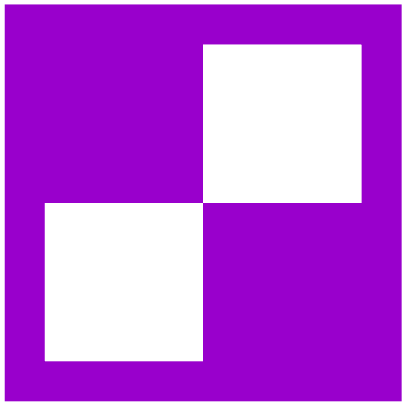


(Medium selection depending on QoS and other conditions)

“M-CubITS” Positioning System

- Elements of M-sequence Multimodal Marker for ITS (M^3 for ITS; M-cubed for ITS; M-CubITS)

(ref.:PNCMM)



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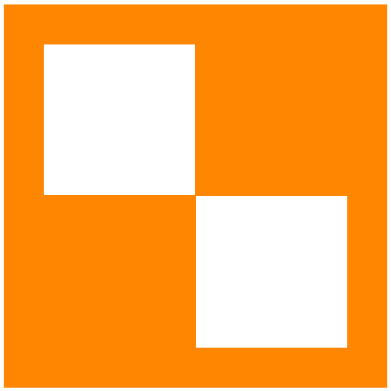

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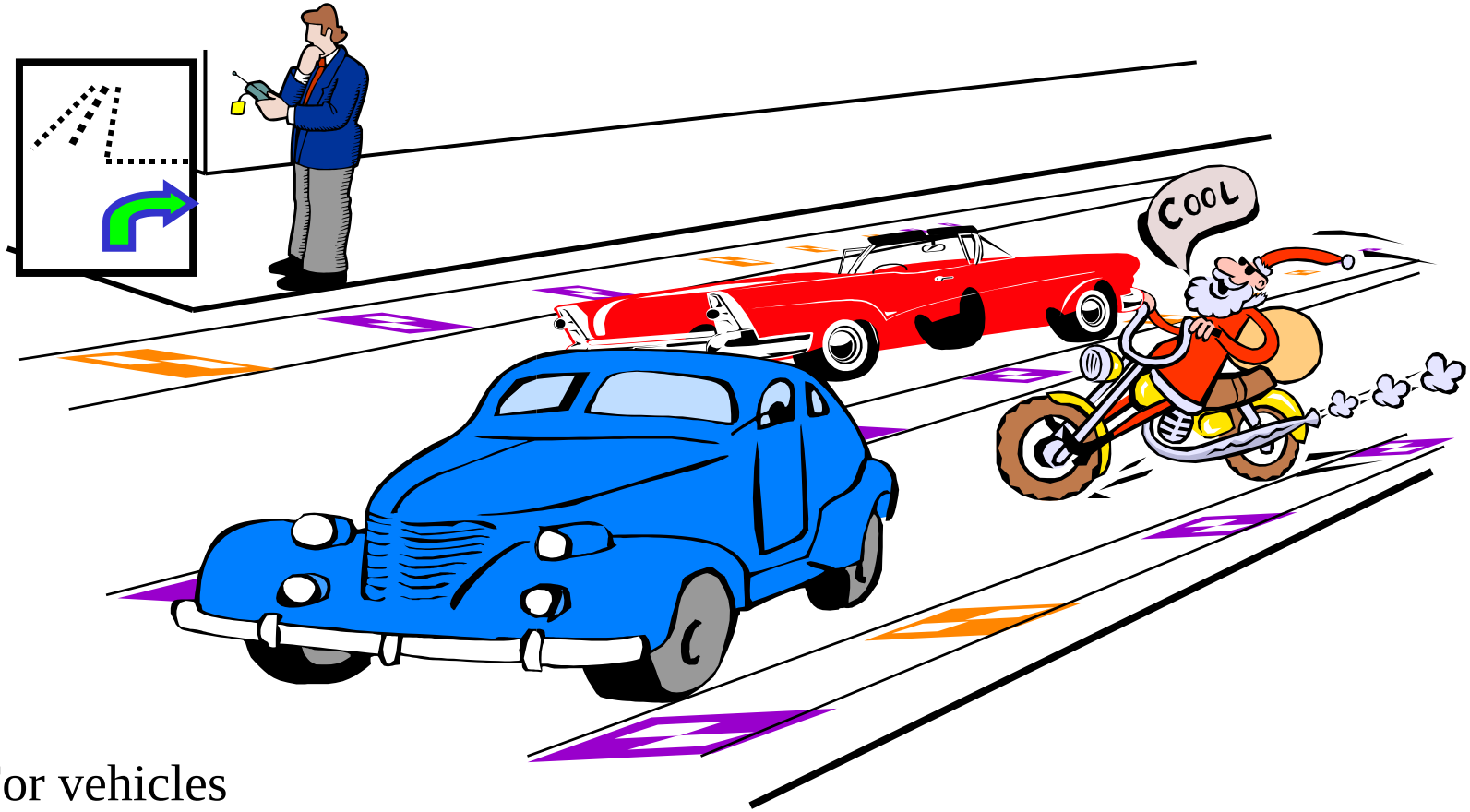
M-CubITS and Application Image(1)

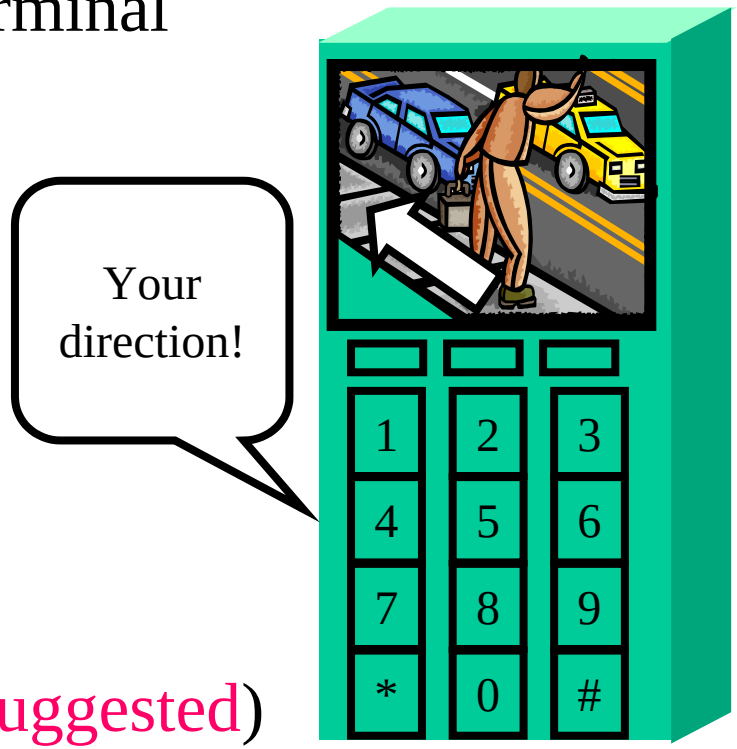
- On the street (Pedestrian/Vehicle/Motor bike)



- 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)

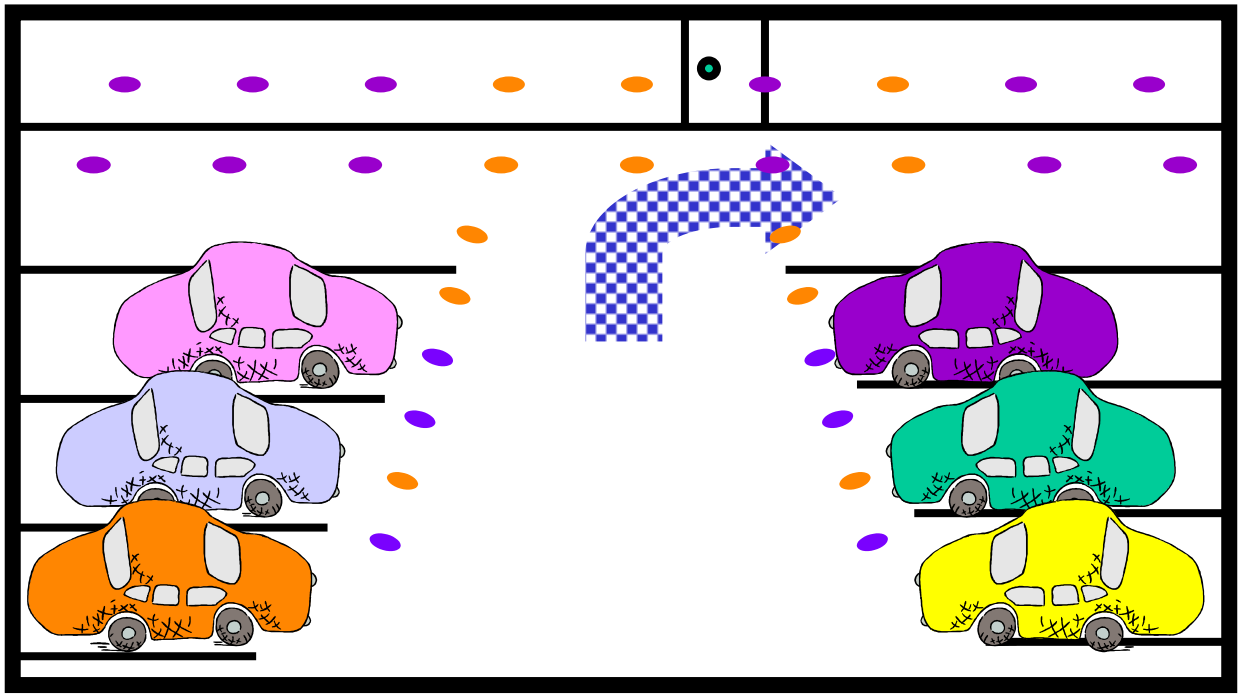


(WYSIWYG:
What You See Is What You Get
As the corresponding concept,
WYSIWYAS:
What You See Is What You Are Suggested)

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)

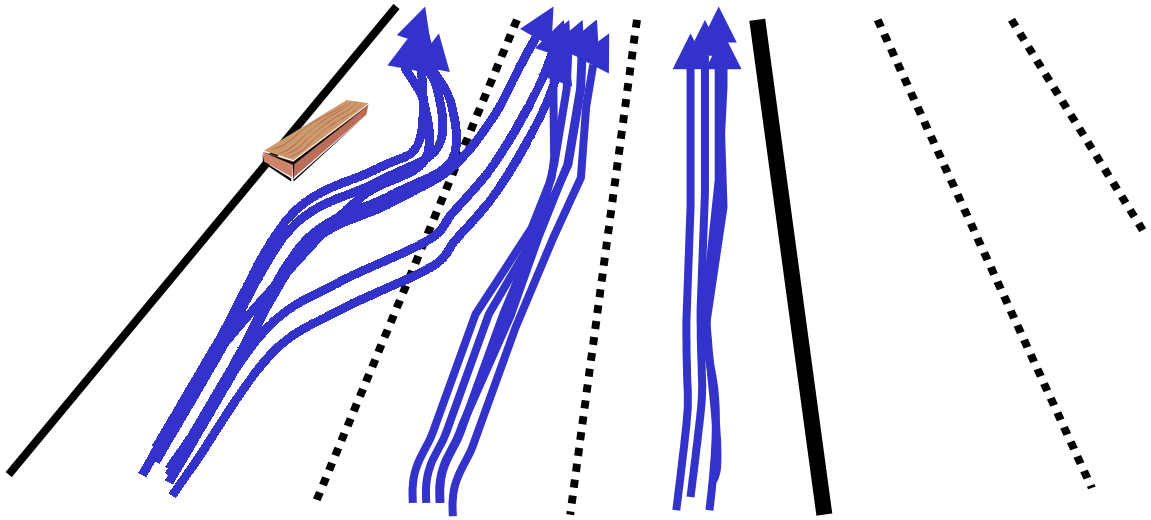
- First category and Second category
  (Different requirements for sub-systems)
- Determination of position and direction
- Communication
- WYSIWYAS navigation HMI

- 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.

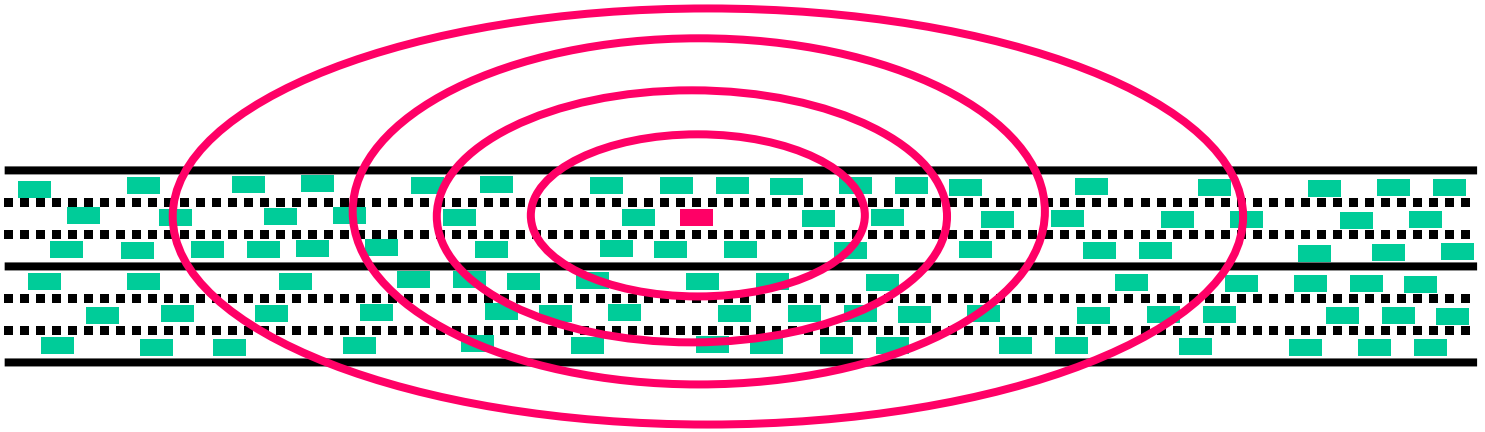
Discussion(2)

- 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)

- Communication sub-platform and positioning sub-platform

Next Gen. DSRC

Wireless LAN
PHS
Mobile phone

Marker

GPS

Discussion(4)

- DSRC: R2VC and IVC
- Data sharing

- Integration of IVC and R2VC

Conclusions

- 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.)