GNSS-applications in Connected Vehicle and its R&D activities in Taiwan".

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Speaker

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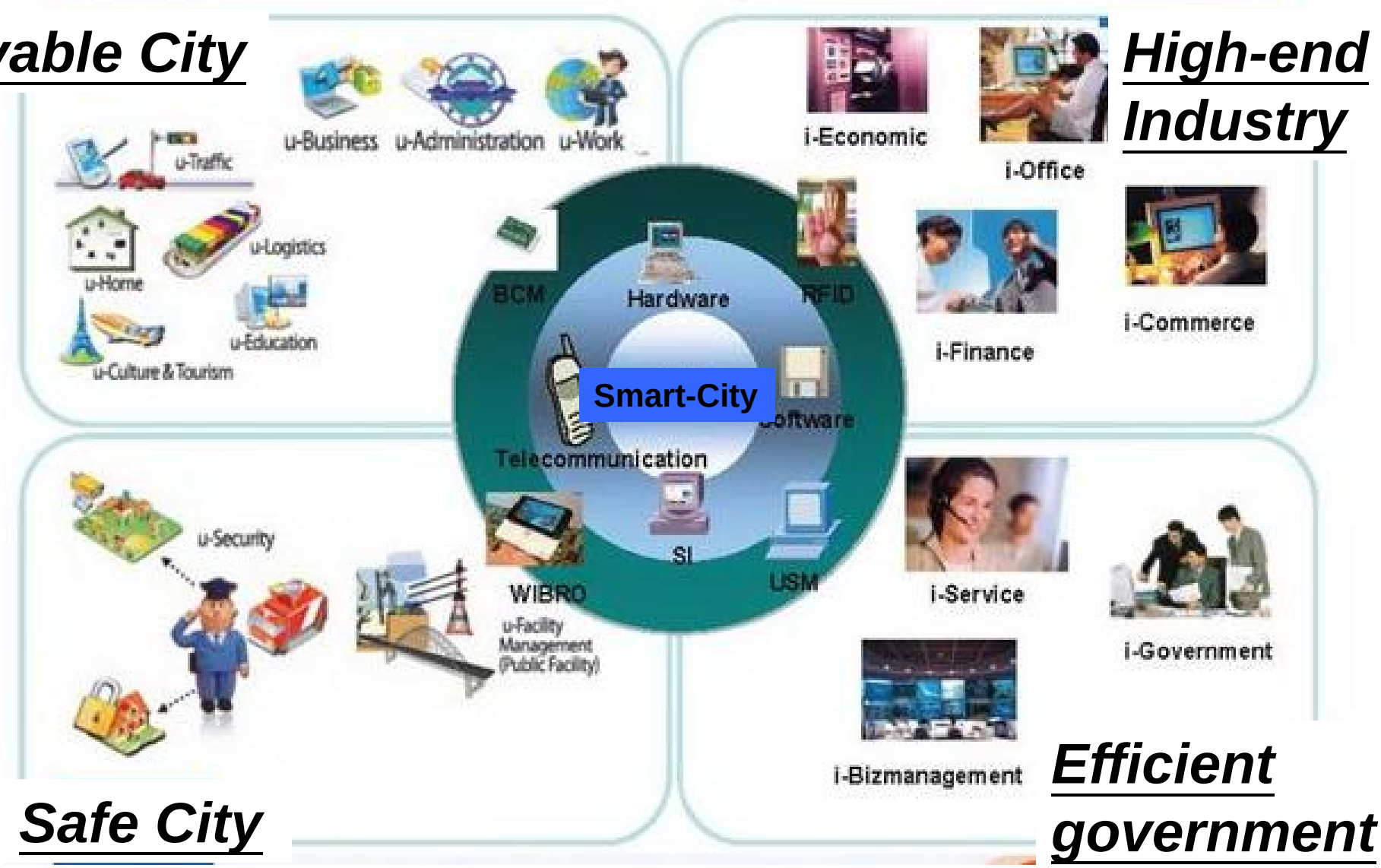
~ Frank C. D. Tsai

Smart City

Livable City



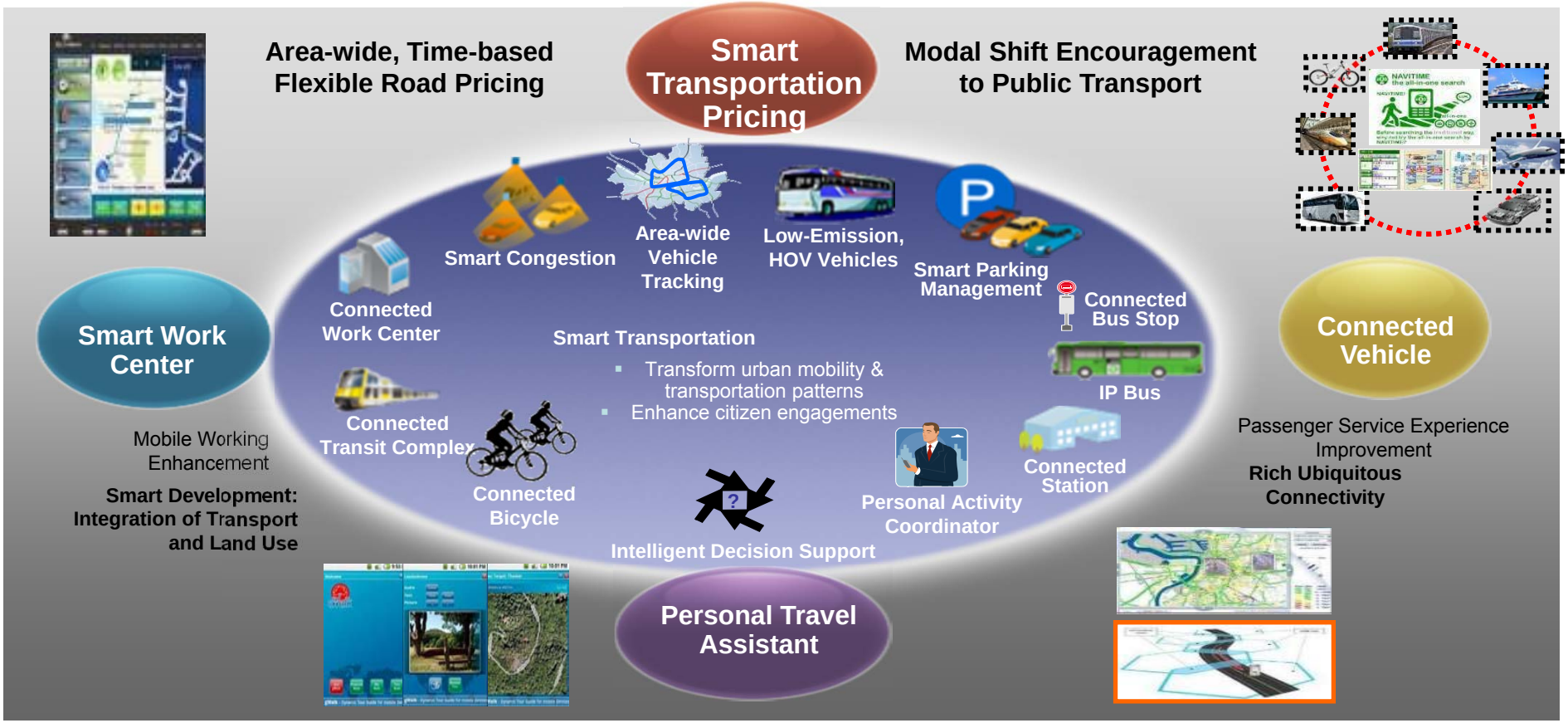
High-end Industry

Safe City

Efficient government

GNSS-related Mobility

-- Safe Driving with Green Traveling

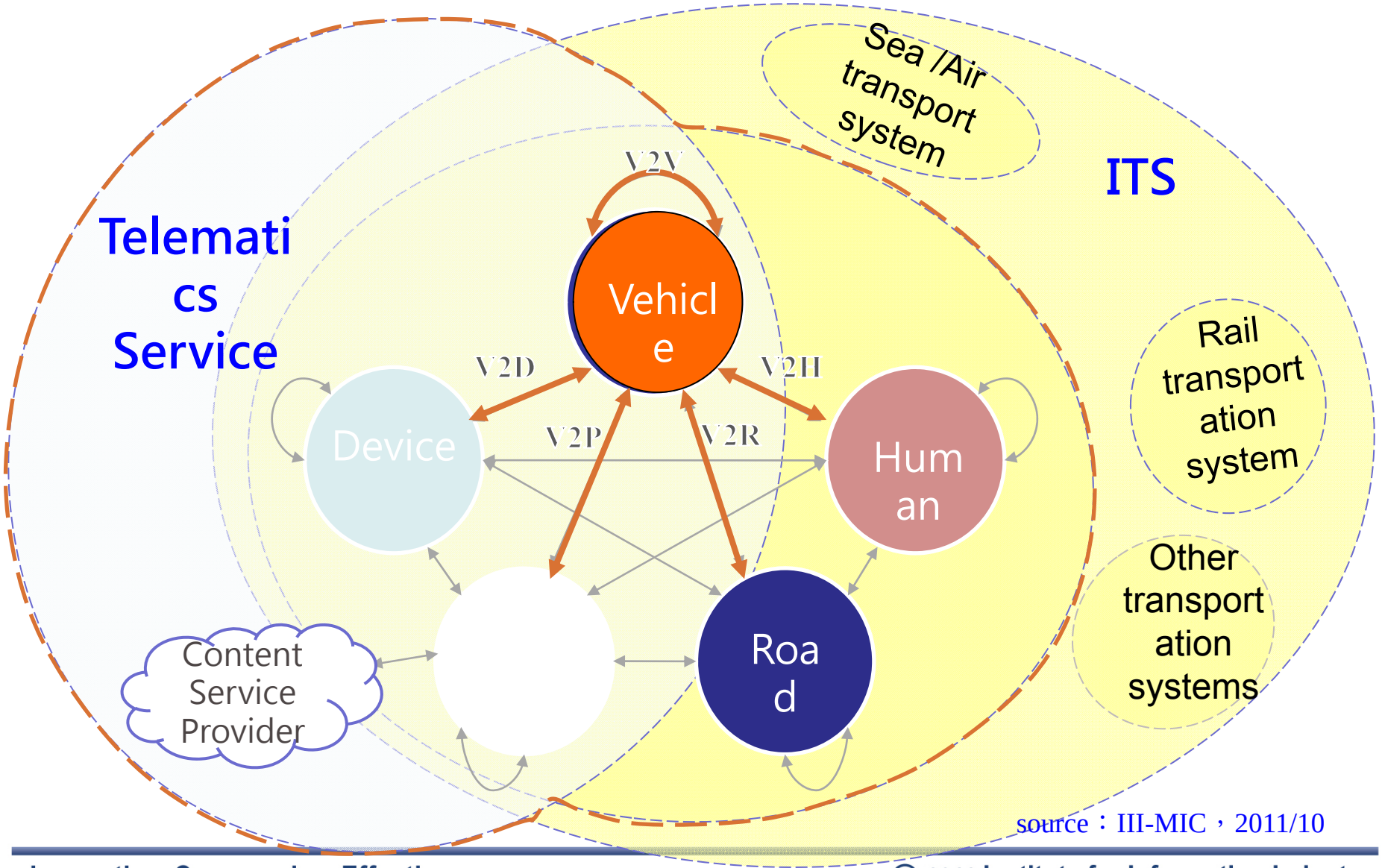


Source: partially adapted From CISCO

- USA & EU plan Green Cities with convenient transport
- Major Car Companies offer Vehicle-centric Telematics Service
- Japan, Europe and the United States: actively engaged in the DSRC-based V2I/V2V field trial

Intersection of ITS and Telematics

-- redefining driving(moving) experienvce



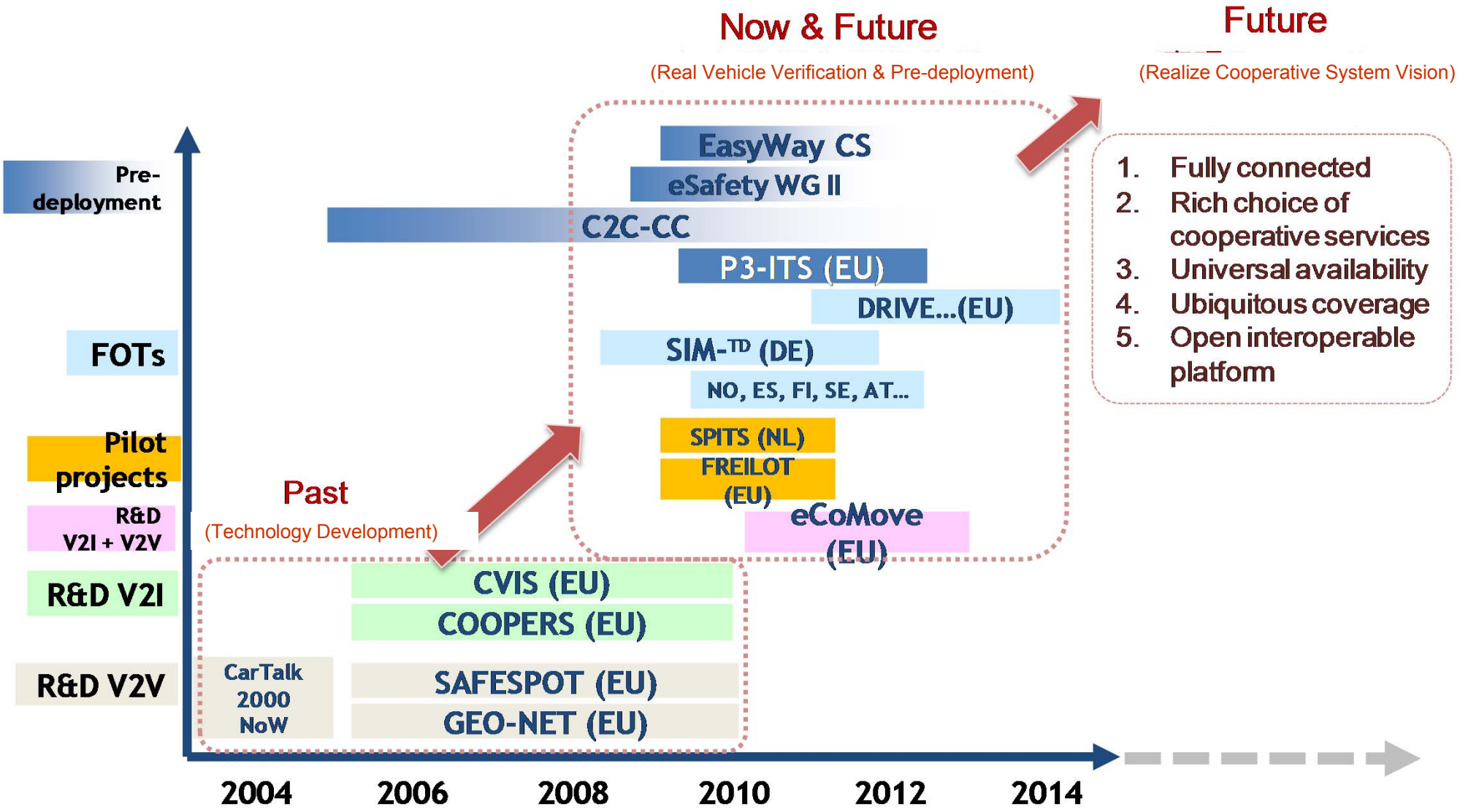
source：III-MIC，2011/10

IoT (Internet of Things) in Mobility

- **D2D (Device-to-Device) [near field]**
  - **V2H (Vehicle to Human)**
    - Vehicle to Driver, Vehicle to Passengers, Vehicle to passerby
    - E.g. Voice Recognition, Gesture recognition, TTS, HUD Display, ….
    - E.g. RFID tag in schoolbag for kids, in cane for elderly
  - **V2D (Vehicle to Device)**
    - Smart Phone, Pad, MP3 Players, PND, Image tachograph…
    - USB, BT, WiFi Direct, …
    - Terminal mode、Remote Skin、Simple UI Protocol、Media Follow-me …
- **GNSS-related [position sensitive]**
  - **V2P (Vehicle to Platform)**
    - VRM, weather, PoI, traffic information,…
    - GPRS, 3G/XML, FM-RDS/TMC, DVB/TPEG, …
  - **V2R (Vehicle to Roadside)**
    - ETC, probe car,….
    - RDS/TMC, DSRC, GPRS (bus positioning …
  - **V2V (Vehicle to Vehicle)**
    - Cooperative safety, platooning
    - DSRC (1609, GeoNetworking, …)

ERTICO towards Cooperative Systems

-- V2V + V2R with Field Operational Tests

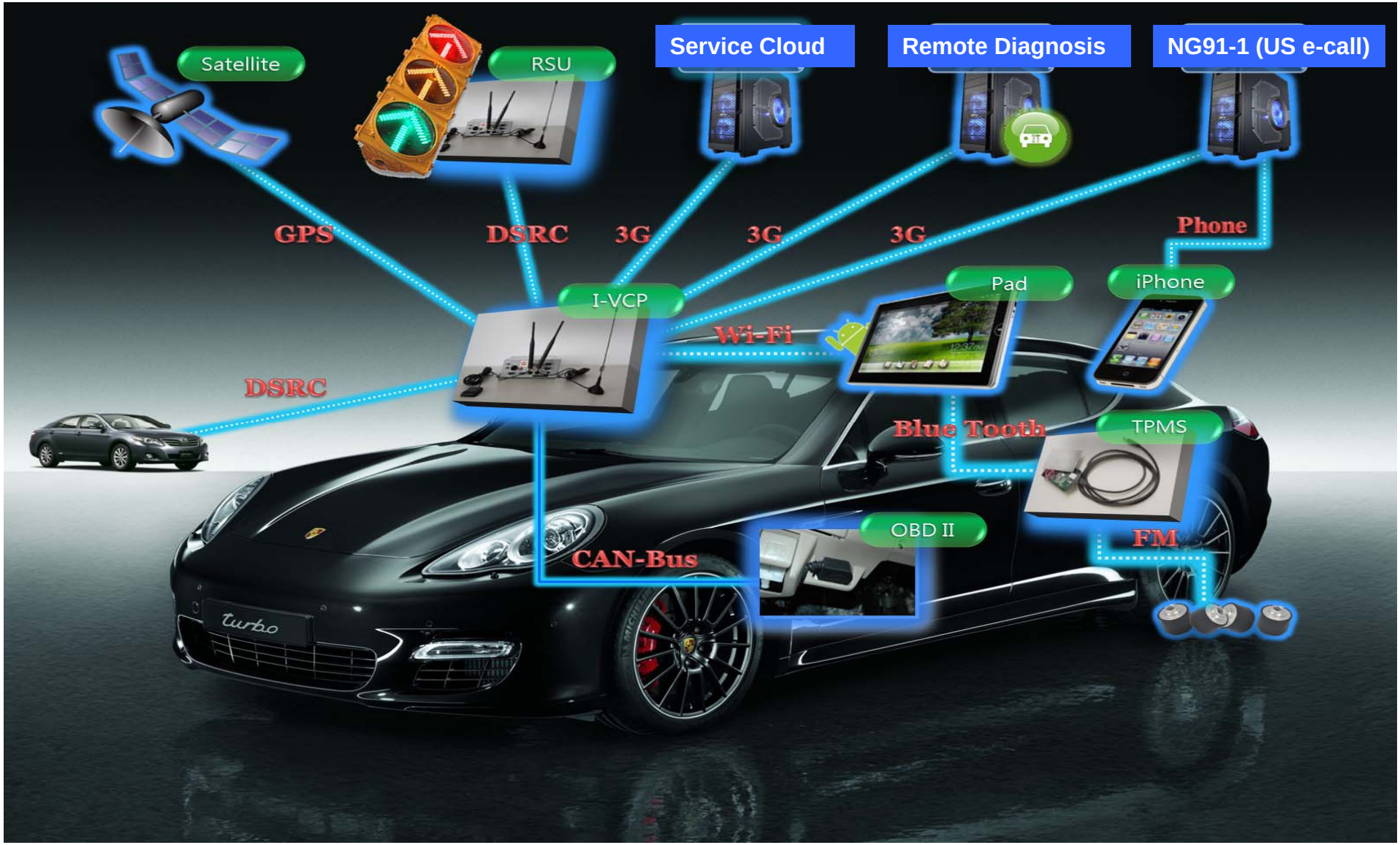


Government Policy/Regulation Matters

	EU	USA	Japan	Mainland China
Promotion Unit	**ERTICO**	**U.S. DOT**	**IT Strategic Headquarters**	**Ministry of Transport and Local governments**
Policy motives	➢ Integrate cross-border, cross-language ITS ➢ Address road congestion, traffic accidents and environmental pollution problems	➢ Address issues such as congestion, accidents and environmental pollution caused by transportation	➢ Address environmental pollution, as well as the face of an aging society, to provide a safer, more convenient transportation environment	➢ Integrate across local, cross-ministry ITS ➢ Address road congestion, environmental pollution problems due rapid vehicle increase
Vision	**Safety、Mobility、Sustainability (All GNSS-related)**			
Current policy direction	➢ infrastructure mature, V2V and V2R in real vehicle testing phase ➢ driven towards three directions (1) V2V2R integration R&D (2) real car test (3) application services	➢ infrastructure mature, integrated V2V, V2R and V2D technology development and service promotion	➢ ITS much mature, focusing on safety and on V2V2R technology development toward cooperative ITS	➢ Currently focused on the integration of the trans-regional, cross-ministry of ITS, V2V2R technology development still in early stage

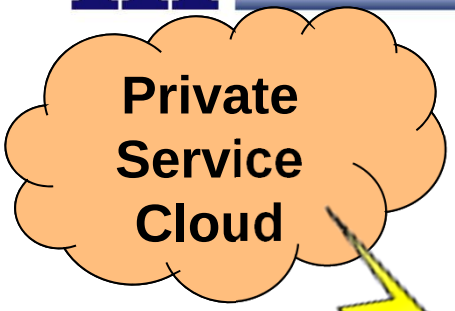
source：III-MIC, 2011/9

III Telematics V2H, V2D, V2P, V2V, V2R



III Telematics Service Mgmt Platform

III Media Follow-me (I-MF, V2D)

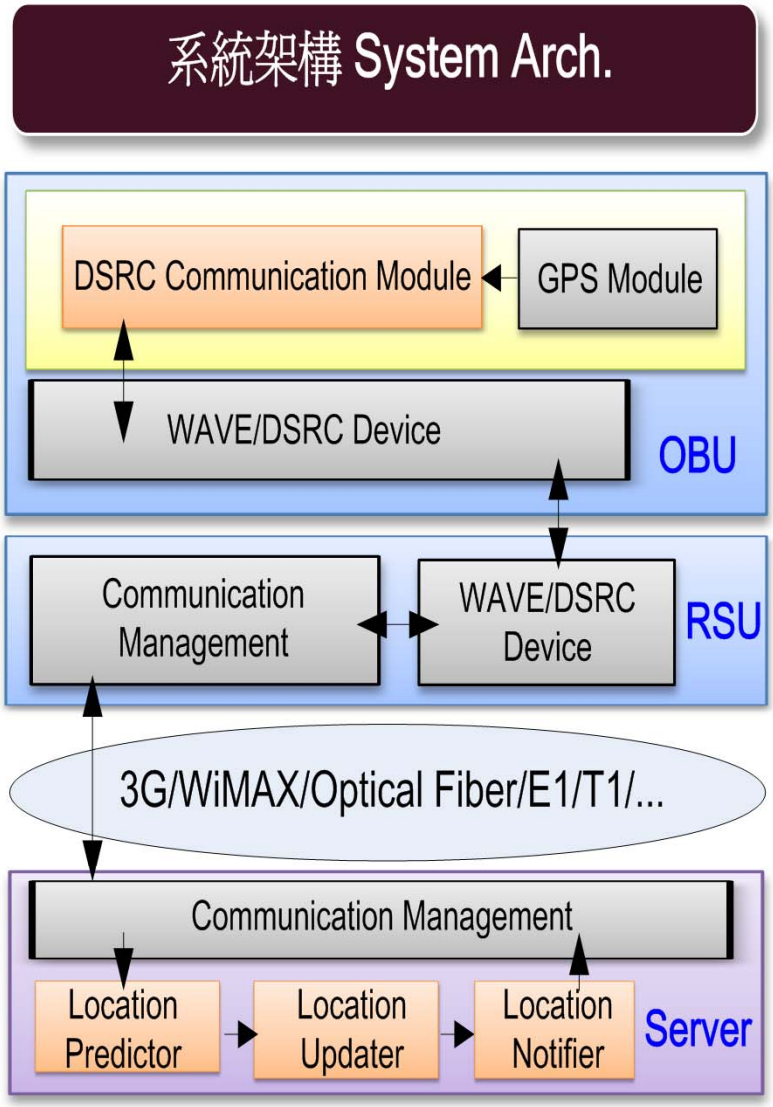


- A driver downloads multimedia (music/video) from Car Vendor's Private Service Cloud to play by the OBU.

- OBU sync meta data information of the media with the driver's handheld devices while playing.

- Arriving at the destination, the driver still revels in the music. S/he can choose to transfer the yet-to-finish media playing to the handheld and take it with him/her!

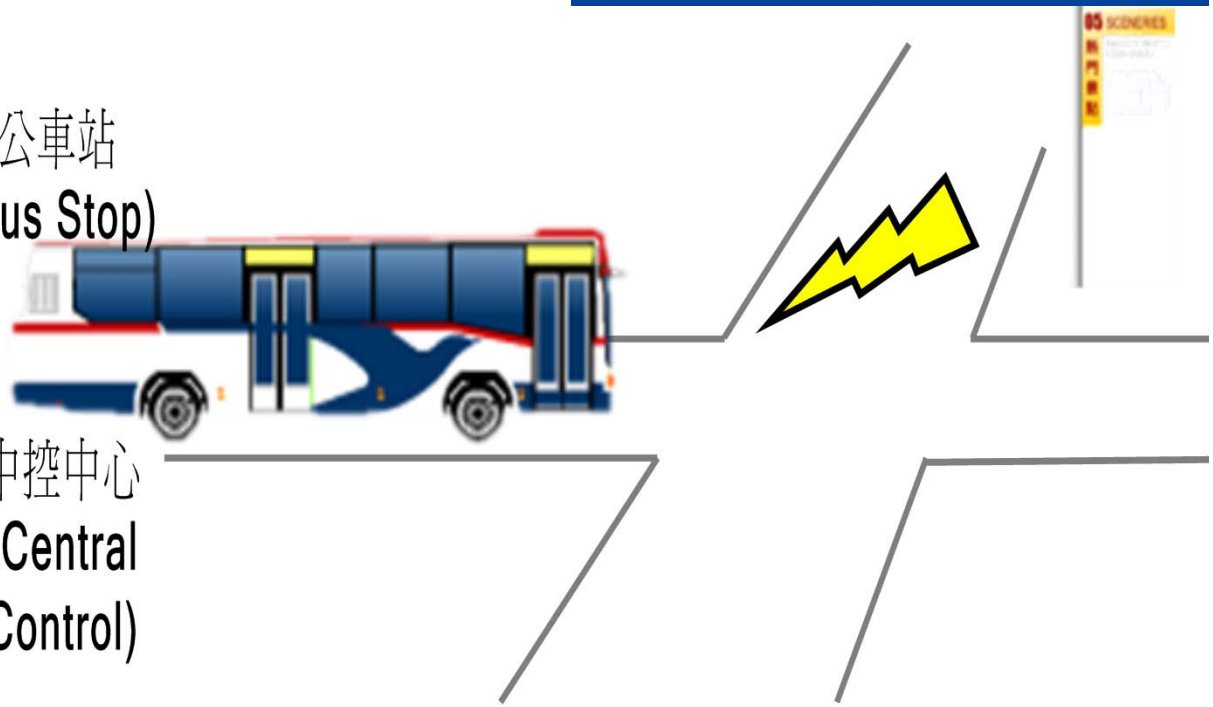
III-DSRC-Enabled Bus Under Tracking (I-DEBUT; V2R)



公車
(Bus)

公車站
(Bus Stop)

中控中心
(Central Control)



Device-based Taxi Dispatching System (D2V; R2V)

➢Local broadcasting – radius 500m ~ 1000m

➢Out of range taxis intentionally not be contacted

➢ Coverage Extensible by multi-hop (relay) comm., if necessary .

Passenger

passenger-id#, GNSS position, preference

Taxi(s)

taxi-id.#, features, ETA (estimated time of arrival)

III-Emergency Vehicle Approaching and Detouring

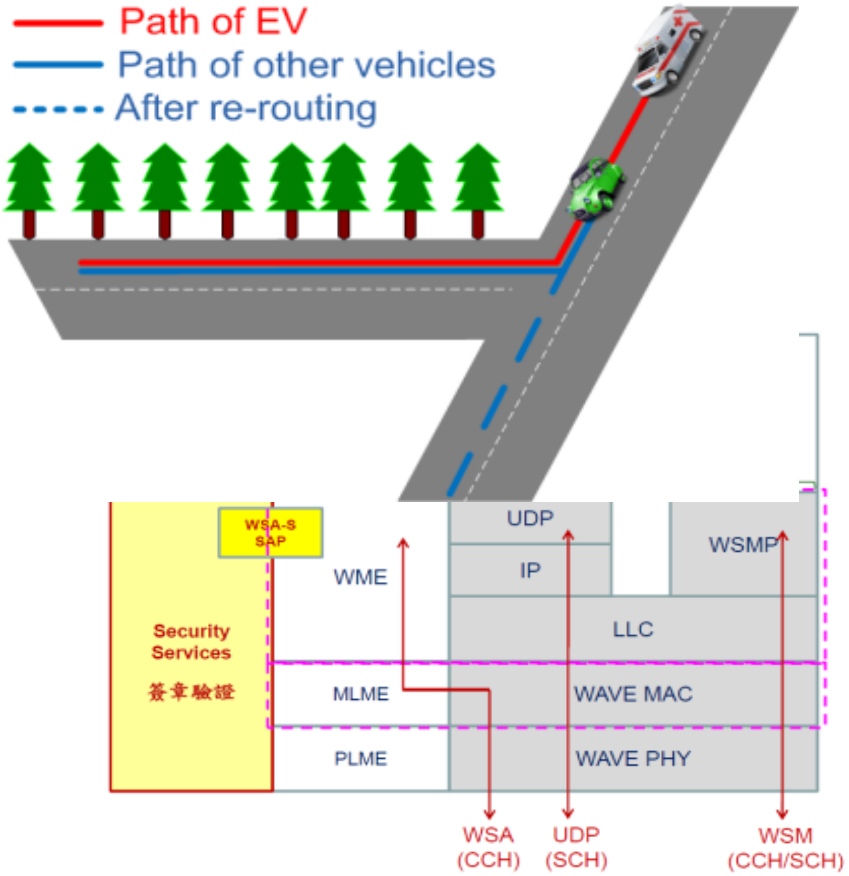
(I-EVADE, V2V/V2R)

➢Through V2V or V2R Communications, emergency vehicles' path is communicated with other vehicles well in advance with IEEE 1609.2-based security mechanism.

- ➢ Emergency path way is cleared for the priority emergency vehicles via V2V.
- ➢ Traffic lights signals can also be prioritized by V2R

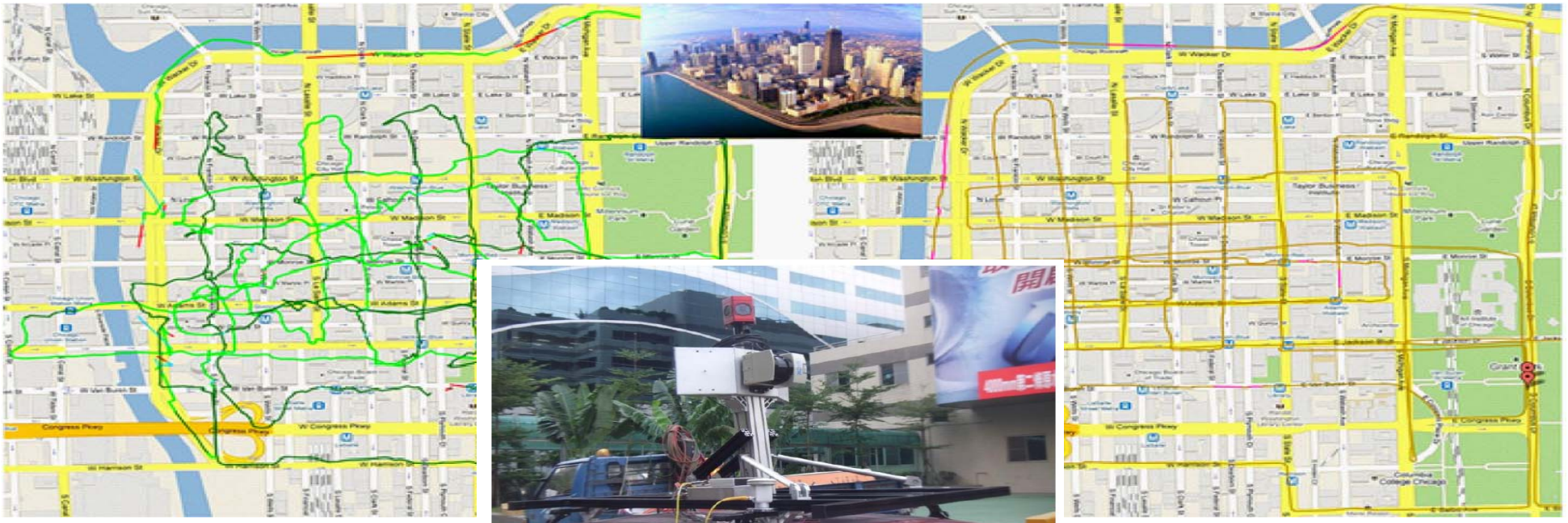
System Operation --

- The path of EV can be broadcast to other vehicles.
  - Path comparison
  - Routing/Re-routing
- Traffic light could be controlled by RSU
  - 1609.2 supporting (encryption, decryption, signing or verification)
  - Using SAE-J2735 EVA message



III Precision Position Technology (I-PPT)

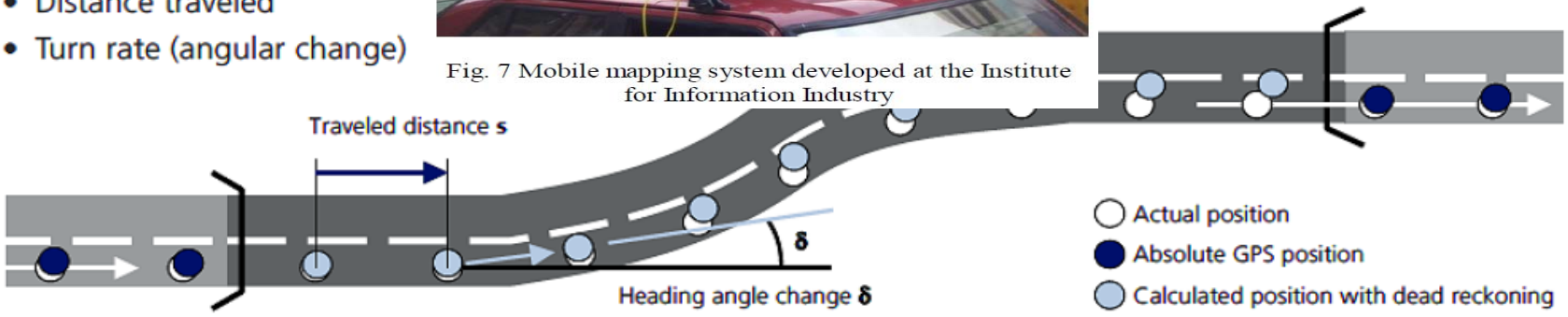
with Dead Reckoning Navigation (sensor fusion) (V2D)



Source: uBlox

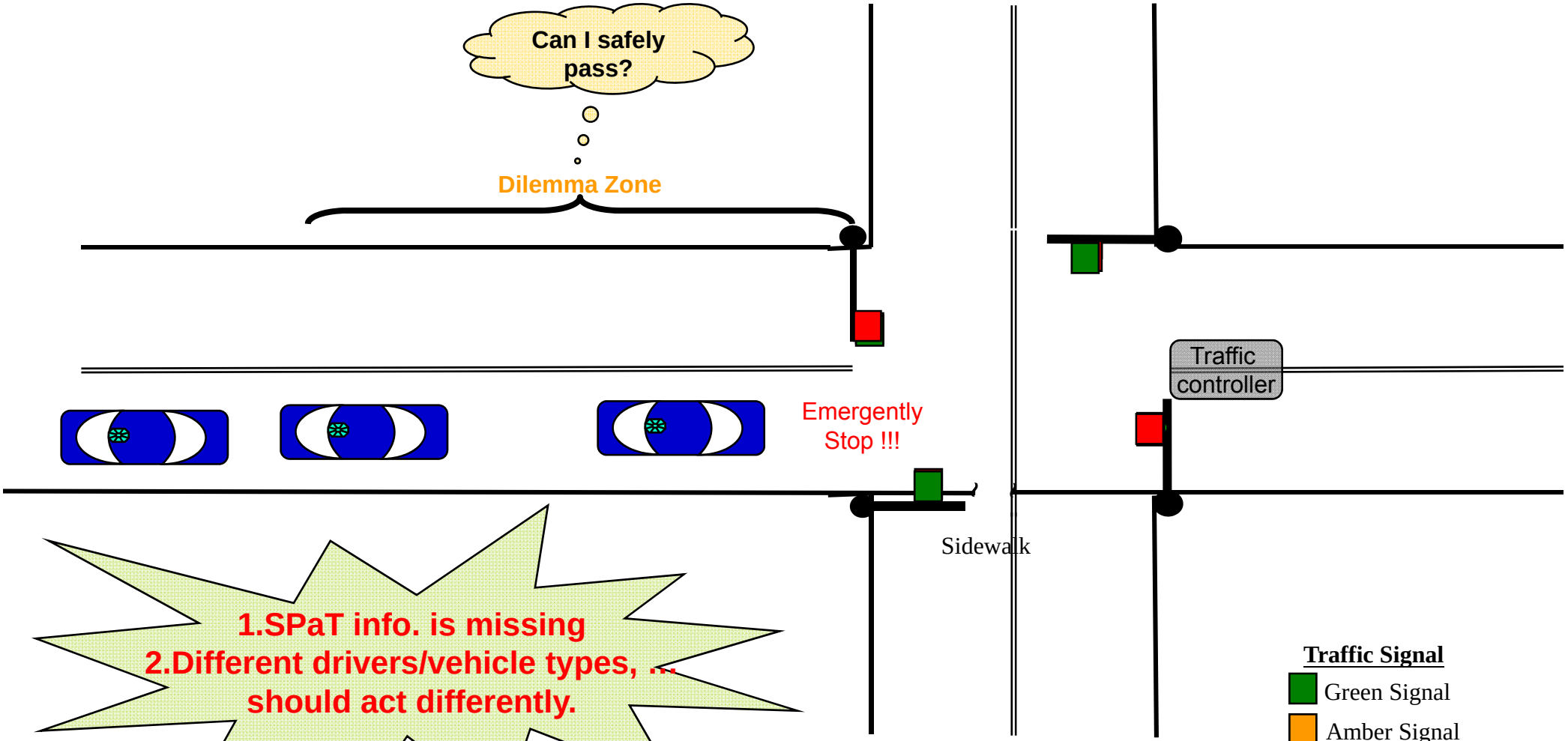
- Distance traveled
- Turn rate (angular change)

Fig. 7 Mobile mapping system developed at the Institute for Information Industry



Tunnel drive through

In cooperation with Michigan Dept. of Transportation on ITS-- Dilemma Zone Problem



Dual-Radio SPaT info. Dissemination

-- I-DRIVES (III-Dual-Radio Intelligent Voyager Embedded Solution)

GIS-enabled GUI

Pad/PND/NB

NCTIP over Ethernet

IEEE 1609

V to R

III-Onboard Unit
(OBU)

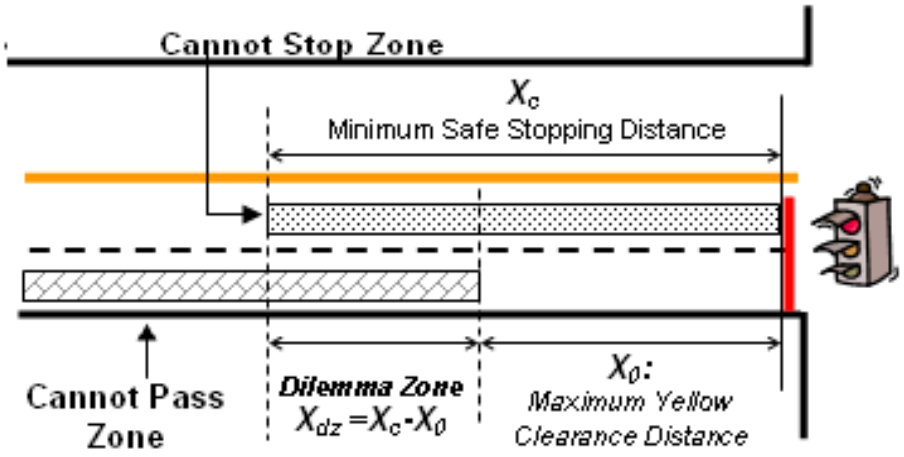
III-Roadside Unit
(RSU)

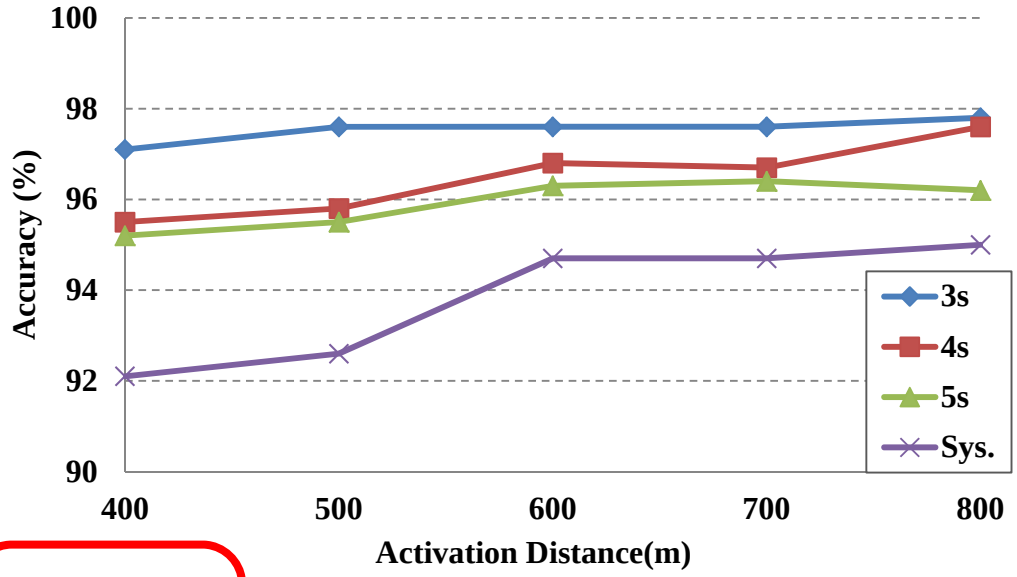
SPaT msg exchange Over SAE-J2735 With intelligent Algorithm On OBU in each vehicle

Dilemma Zone Algorithm

Dilemma Zone Estimation Algorithm

- Current Speed, Current Distance to Stopline
- Predictive Speed, Predictive Distance to Stopline
  - α-β-γ Kalman Filter





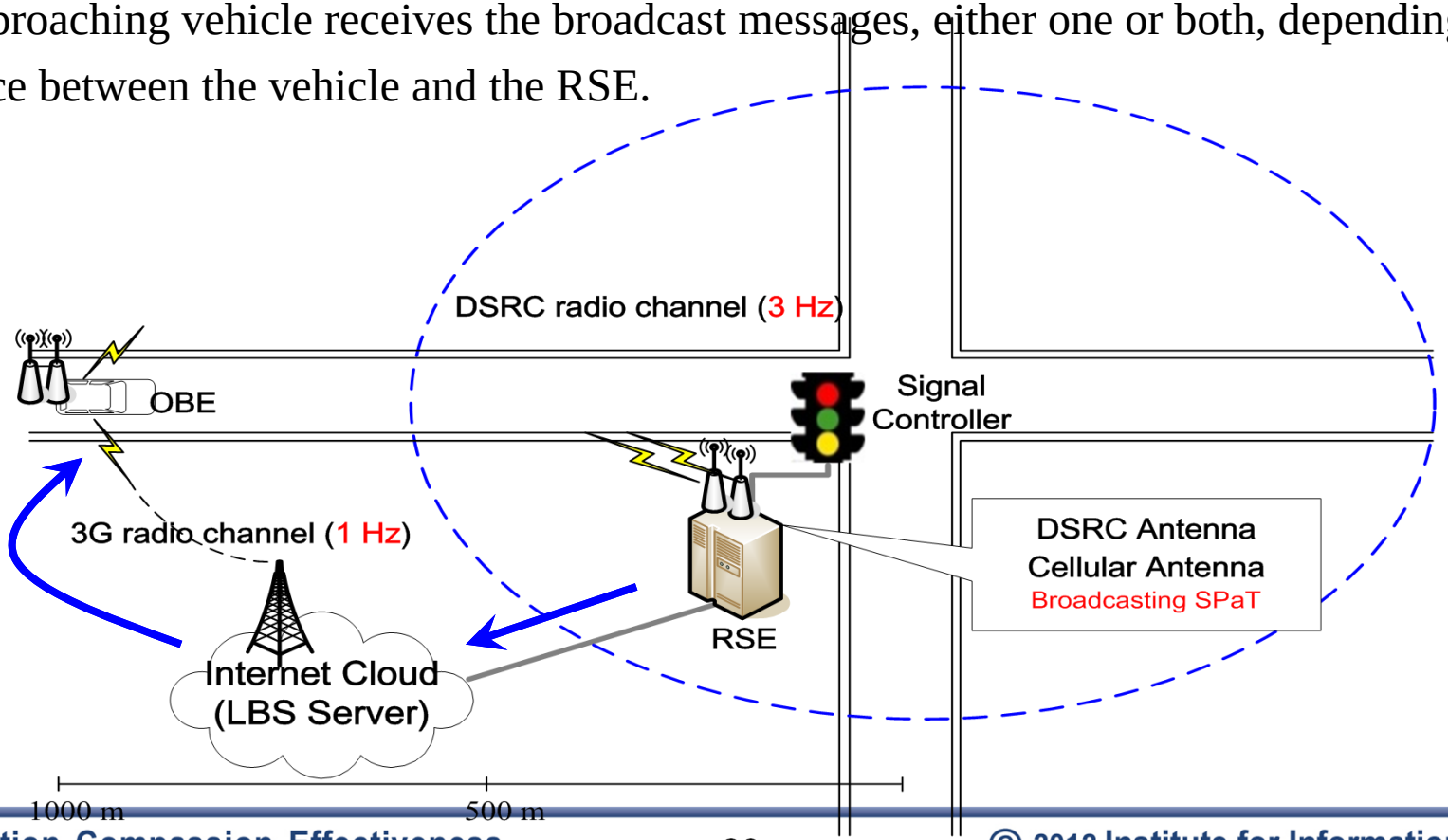
$$X_{stop} = V_0 \cdot \delta + \left(V_0 \frac{a_{max}}{J_{max}} - \frac{1}{6}\frac{a^3_{max}}{J^2_{max}}\right) + \frac{\left(V_0 - \frac{a^2_{max}}{2J_{max}}\right)^2}{2a_{max}}$$

moving distance from the initial deceleration capacity to the maximum deceleration capability

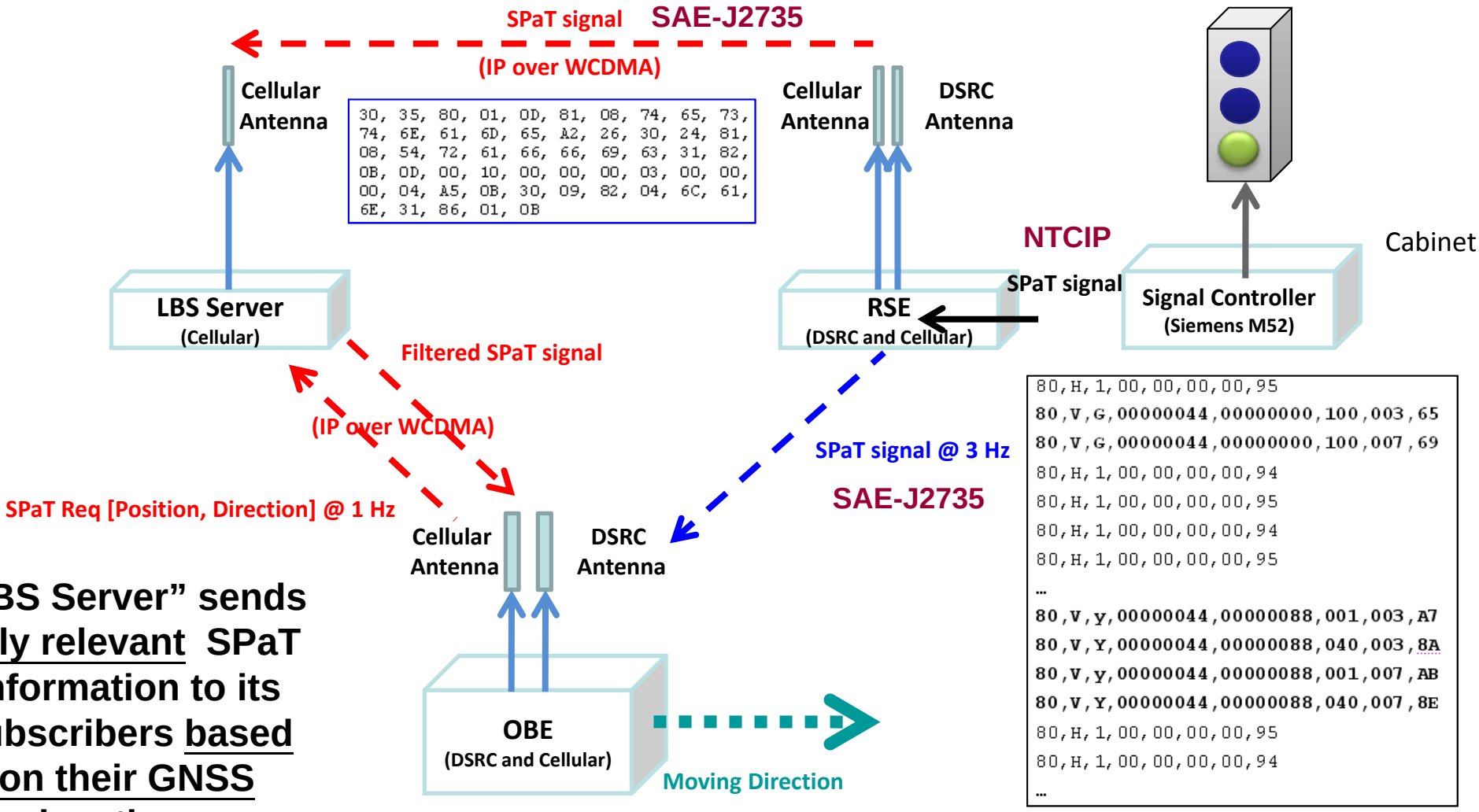
moving distance from the maximum deceleration ability to stop

System Operation

- SPaT signals will be generated by a signal controller
- SPaT signals are then sent via Ethernet to a dual-radio RSE (with DSRC/Cellular)
- The DSRC RSE wirelessly broadcast the SPaT signals through both DSRC and cellular radios.
- An approaching vehicle receives the broadcast messages, either one or both, depending on the distance between the vehicle and the RSE.

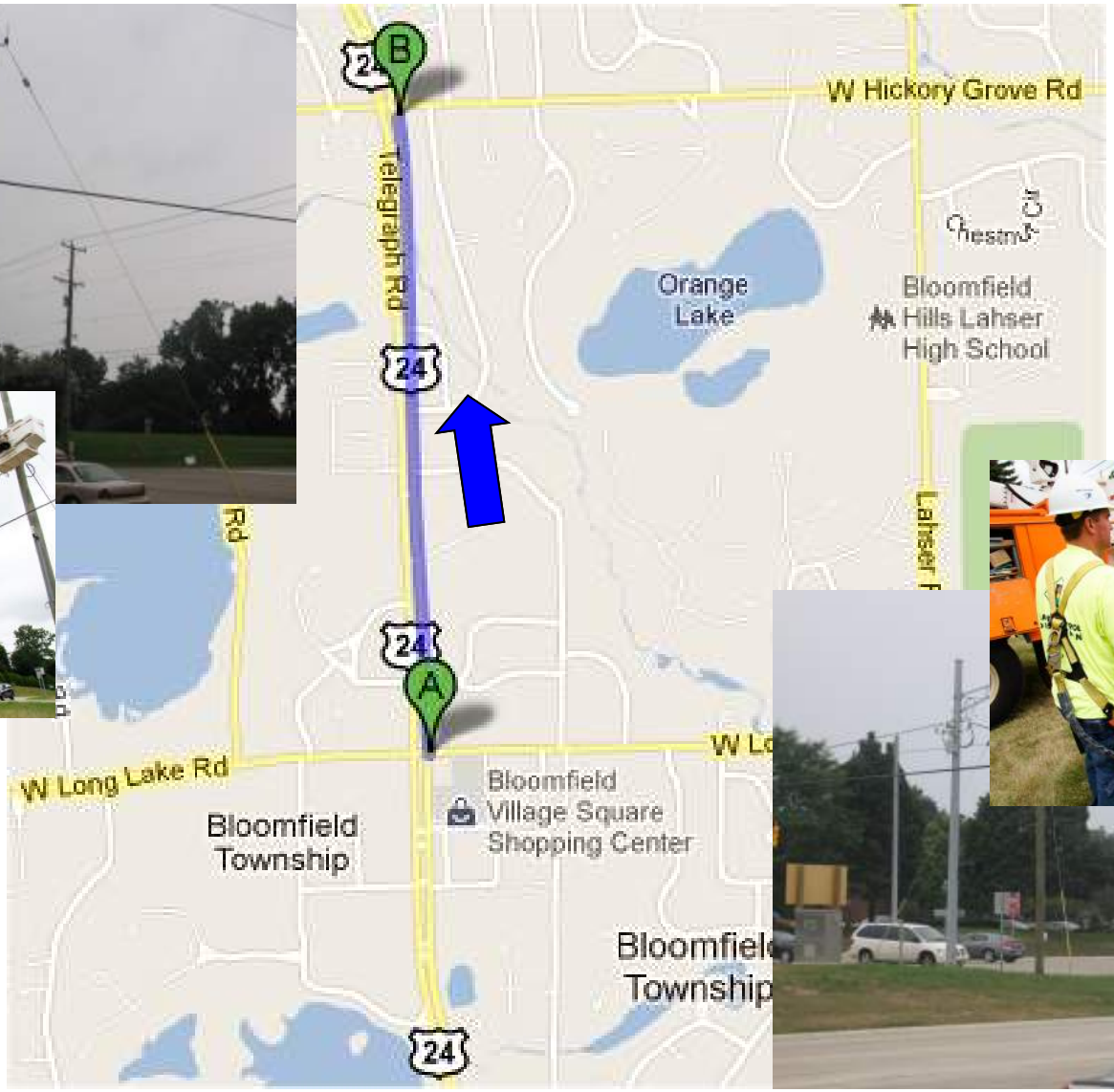


Dual-mode Communication Flow



"LBS Server" sends only relevant SPaT information to its subscribers based on their GNSS locations.

Field Trials in Michigan Oakland County



Concluding Remarks

- **Positioning technologies and applications as an important part of a Smart City**
  - Taiwanese companies have been strong on user segment side fast-growing on products/systems –
    - handheld devices and applications
    - aviation and maritime equipment/systems
    - car GPS (positioning) applications
    - leisure and other uses (payment, emergency rescue, …)
- **Integration of smart handheld and OBU as a Car industry trend**
  - Services, such as navigation, emergency rescue, traffic information, offered via OBU, can now also be obtained through the handheld device
  - How to allow OBU to interface with various handheld device to sync information and access applications is main concerns of both Telematics and Vehicle industries

Concluding Remarks (Con'd)

- **Services and contents provisioning as key growing segment**
  - The U.S. E911 Act requires operators must provide positioning services with the mobile phone industry, mostly with GPS now. Accessing position-related applications from "Cloud" is main concerns of both Telematics and Vehicle industries
  - To increase service offer flexibility, major automakers now actively engaged in developing handheld Mobile Apps for services such as navigation, vehicle condition tracking (e.g. oil, tire pressure), remote control (e.g.. door locks, air conditioning, horn)
- **Taiwan strong ICT industry on user segment side can partner with EU on GNSS-related technologies and applications**
  - Components : chipset + receiver -- semi-conductor, multi-constellation (GSP + Galileo + BeiDou + …), sensor fusion (Galileo + IMU + Gyro + …)
  - Devices: smart handheld, OBU, …
  - Applications/Systems: Telematics, LBS, ITS, Surveillance, Emergency Rescue, Disaster Recovery…..

Thank You / Merci / Danke / 謝謝/ありがとう

Your Comments Are Much Appreciated