Joint Workshop for e-Government and Smart City

# Cooperative ITS for Smart City

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#### I. New ITS

## Cooperative-ITS(C-ITS)

- A convergence ICT enabling to seamlessly cooperate/connect between transport components(vehicle, infrastructure, and users) for safety and efficiency
  - The current ITS is mainly focused on collecting data and providing information under the separated between vehicle and infrastructure



[C-ITS definition by ISO/CEN]

A subset of the overall ITS that communicates and share information between ITS stations to give advice or facilitate actions with the objective of improving safety, sustainability, efficiency and comfort beyond the scope of stand-alone systems.

Source : www.comesafety.org



#### I. New ITS

## Comparison btw. the current ITS and C–ITS

#### Current ITS

- -Separated btw. road and vehicle
- -Data & Services are available only when passing their devices
- -Limited in quickly responding to accident (one-way)
- -Focused on managing traffic flow after accident
- ➔ Follow-up management



#### > C- ITS

- Connected btw. vehicle(V) and road(I)
  - -Continuously communicated between road, vehicle and pedestrian
  - -Co-works on site are available by V2V, V2I(two-way)
  - -Focused on recognizing and preventing before accident
  - $\rightarrow$  Advanced response and prevention



I. New ITS



## FP6 -> FP7 -> Horizon2020

mut . Lot

R&D

O EU

Key committee : eSafety forum → iMobility forum

FOT

- EC M/453(2010) → Proceeding C-ITS standards in ETSI and CEN
- FP6 → Projects for proof of concept(2002~2006) : CVIS, SAFESPOT, COOPERS

Pre-

**Deployment** 

- FP7 → Projects for FOT(Field Operational Test) : Drive C2X, FOTsis
- Pre-deployment Projects : COMOS, Compass4D (2013~2015)
- Deployment Project: ITS Corridor Project(Rotterdam-Frankfurt-Vienna) by the Amsterdam Group
- Car-makers : Car-2-Car Consortium



Deployment



FOT

## SAFETEA-LU -> MAP21

R&D

4111 . Lot

O US

- Key committee: ITS America Connected Vehicle Task Force
- Projects for proof of concept : VII, CICAS, VSC(Vehicle Safety Communication), VSC-A(Application)

Pre-

**Deployment** 

- Projects for FOT project: Safety pilot
- Pre-Deployment Project: Connected Vehicle(CV) pilot deployment(Phases I ~ III)(NY city, Florida-Tampa, Wyoming)
- Car-makers : CAMP(Crash Avoidance Metrics Partnership)
- Legislation for V2V tech. (Rule-making, NHTSA, 2014)



Deployment

**O** US

Source :Joint Meeting between Korea-MOLIT and USDOT Jan. and May 2014







#### ITS SAFETY 2010 → New IT Strategy

- Key committee : ITS committee
- Projects for proof of concept: Smartway, ASV(Automated Safety Vehicle), DSSS(Driving Safety Support System)
- Projects for FOT : ITS Safety2010
- Project for Deployment : DSSS(15 sites, 2010),

ITS Spot(1,600 sites, 2011)→ ETC 2.0

• Focused mainly on V2I and existing DSRC infra.



#### 19th ITS World Congress in Vienna, Oct. 2012 ITS SPOT → ETC2.0 Deployed nationwide mainly on Released on October 2009 expressways in Japan in 2011 ITS Spot compatible on-board units retailers <As of 31 July 2012> Car manufacturer ITS Spot Unit ITS Spot-compatible (roadside unit) car navigation P) TOYOTA Mercedes-Benz system ligh-speed and large-capacity communication (DSRC) SHIFT\_the way you move Drive@earth MITSUBISHI MO PEUGEOT CITROF Electrical equipment manufacturer ///ILPINE Pioneer **Panasonic** lobile Media Solutions deas for life 凡例 ITSURISH Clarion MITSUBISHI Our Technologies, Your Tomorrow Changes for the Better More than **35,000** OBUs as of 30 Sep 2012 ITS-spots have been installed 1,670

Source : Joint Meeting between Korea-MOLIT and Japan-MLIT

Japan

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#### • Korea



#### ITS Master Plan 2020 -> ITS Master Plan 2020(revision)

- Key committee : ITS committee
- Projects for proof of concept, FOT: u-Transportation, Smart Highway
- Projects for Pre-Deployment : Next-Generation ITS Pilot('14~'17)
- Project for Pilot Deployment : C-AVHS, Cooperative Automated Highway System('15~'20)
- Focused mainly on V2I





## III. Safety Potential of C-ITS Applications

## • Review of C-ITS Services

#### Car Crash Prevention Support(example)

- To prevent car crash caused by congested downstream, slow vehicle, and accident
- Use Cases
  - \* (Japan) Cooperative Forward Collision Warning, Traffic Jam Ahead Warning
  - \* (EU, US) Car Breakdown Warning, Post-Crash Warning, Slow Vehicle Warning
  - \* (Korea) Dangerous Driving Warning, Follow–Me Information, Fallen Object Warning

#### - V2V, I2V technology



Source : SMART Highway Project





## III. Safety Potential of C-ITS Applications

#### Effect Analysis

#### >Effect Analysis based on available C-ITS services and detailed accident data

Traffic Safety Service based on C-ITS						
No	Categories	Services				
1	Safe Driving Support	Car crash prevention				
2		Road hazard zone driving				
3		Road surface-weather information				
4		Work zone driving				
5		Traffic regulation information				
6		Merging				
7		Lane-changing & Passing				
8	Autonomous Driving Support	Cooperative car-following driving				
9	Intersection	Intersection collision prevention				
10	Driving Support	Signal information provision				
11	Transportation	Yellow bus guidance				
12		School & Silver zone warning				
13		Pedestrian collision prevention				
14	Emergency	Emergency informing				
15		Emergency-vehicle priority driving				
16		Disaster informing				

- -C-ITS services under FOT
- -objective, technical requirement
- -architecture, applicable case
- -Accident data(2007~2011)
- -vehicle, driver, Infrastructure(road)
- -weather, environment

#### - MOE

-The numbers(ratios) of accidents and casualties to be prevented



## III. Safety Potential of C-ITS Applications

## Effect Analysis(Cont.)

#### >Analysis Results

#### Effects of the proposed C-ITS Services

- The ratio of accidents to be prevented : 46.3%
- The ratio of deaths to be prevented : 48.4%
- The ratio of Injuries to be prevented : 47.4%

#### → Annually \$3.6 billions saved

Categories		# of accident	# of deaths	# of injuries
Total		181,391	4,503	278,322
Sum	Preventable	83,966	2,179	131,944
	Not- Preventable	97,425	2,324	146,378
Ratio	Preventable	46.3 %	48.4 %	47.4 %
	Not- Preventable	53.7 %	51.6 %	52.6 %



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## Urban Transportation Systems for Smart City

#### > 3 Technology Elements

- Urban Automation: Connected/Cooperative and automated driving system
- Connected Vehicles: Communication technology to <u>connect</u> components of transportation systems(vehicle, user, infrastructure)
- Intelligent sensor based Infrastructure: <u>Automatic/Connected</u> monitoring system of driving environment





#### • C-ITS for higher level of AV

#### Levels of Vehicle Automation

C-ITS

Primary (safety) controls: Steering, Braking, Throttle etc.

	Levels	Definition	Key Descriptions	Keywords			
	0	No Automation	<ul> <li>Only driver is in control of the primary vehicle controls</li> <li>Warnings(FCW, LDW, BSM, etc), secondary controls(wipers, headlights, turn signals, hazard lights, etc)</li> </ul>	• No primary automated controls			
ptional	1	Function- specific Automation	<ul> <li>Driver is solely responsible for safe operation</li> <li>Safety Supporting(cruise control, automatic braking, lane keeping, etc)</li> </ul>	• One or more controls, but separately			
	2	Combined Function Automation	<ul> <li>Driver cedes primary control on certain limited driving situations, but is responsible for monitoring the roadway and safe operation</li> <li>Hand off and foot off at the same time(lane centering+adaptive cruise control)</li> </ul>	• Two more primary controls			
uired	3	Limited Self-driving Automation	<ul> <li>Vehicle enables the drivers to cede full control of all safety-critical functions by monitoring certain traffic or environmental conditions</li> <li>Sufficient comfortable transition time</li> </ul>	• Automated monitoring			
Req	4	Full Self- driving Automation	<ul> <li>Vehicle is designed to perform all safety-critical driving functions and monitor roadway conditions for an entire trip</li> <li>Safe operation rests solely on the automated vehicle system</li> </ul>	• Both occupied and unoccupied			
	Source: NHTSA, US DOT						



#### Urban Automation

#### > 2 Strategies of Automation Roadmaps

- Passenger car & Car-sharing oriented automation: private sector, something everywhere
- Transit & disabled/elderly oriented automation: public sector, everything somewhere



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#### Urban Automation(Cont.)

#### > 2 Strategies of Automation Roadmaps

- Passenger car & Car-sharing oriented automation: private sector, something everywhere
- Transit & disabled/elderly oriented automation: public sector, everything somewhere

#### > EU: Citymobil2, WedPod, GATEway, Lutx Pathfinder, etc.









## Connected Vehicle & Sensor based Smart Infrastructure

#### > US: CV Pilot Deployment

- NYC: 3 sites(e.g., urban streets and arterial) of accident hazards and dangerous subsections
- Florida-Tampa: Reversible express lane, Connector and Tollgate
- Wyoming: Major truck corridor



#### Connected Vehicle & Sensor based Smart Infrastructure

#### > EU: C-ITS Corridor, SCOOP@F, NordicWay

- C-ITS Corridor: The Netherlands(Amsterdam)-Germany(Frankfruit)-Austria(Vienna)
- ECoAT(European Corridor Austrian Testbed)

→2 services: Work-zone information, Vehicle & Infra. information based traffic management





#### Connected Vehicle & Sensor based Smart Infrastructure

#### Japan: ETC2.0

- Already commercialized since ITS Spot
- 600,000 OBUs installed(2015.3)



#### - New services based on ETC2.0

ETC 2.0 is used to simplify oversize and overweight vehicle transit approval.
 Current
Oversize and overweight vehicles are only allowed to application for a permit has been conducted in advance
 ETC 2.0 equipped vehicles
When oversize and overweight vehicle is traveling in a sector designated by the national government as one in which the vehicle transit sencouraged, the transport routes can be freely selected.
 Able to avoid congestion and traffic accidents and achieve efficient transit





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#### Connected Vehicle & Sensor based Smart Infrastructure



#### Conclusions

## Smart city based on connected transportation systems

- Requiring of the next generation ITS
  - Limitation of the current ITS in preventing and avoiding the traffic accident
  - Key features of the next generation ITS

#### > Global efforts for deploying the next generation ITS

- R&D  $\rightarrow$  FOT  $\rightarrow$  Pilot deployment  $\rightarrow$  Deployment
- New versions of safety applications
- International cooperation for standardization

#### > Smart city based on C-ITS

- Connected transportation systems
- Connected and automated driving systems
- Strategic deployment for building the smart city
- Efforts to promote the R&D and cooperation between private and public and academic areas



# Thank you



