

# 자율주행과 도시의 미래 – Smart Mobility

여시재 세미나

Aug., 2019

**Young-Jun MOON, Ph.D., 연구단장**

The Korea Transport Institute (KOTI)

ISO/TC204 WG17 Convenor

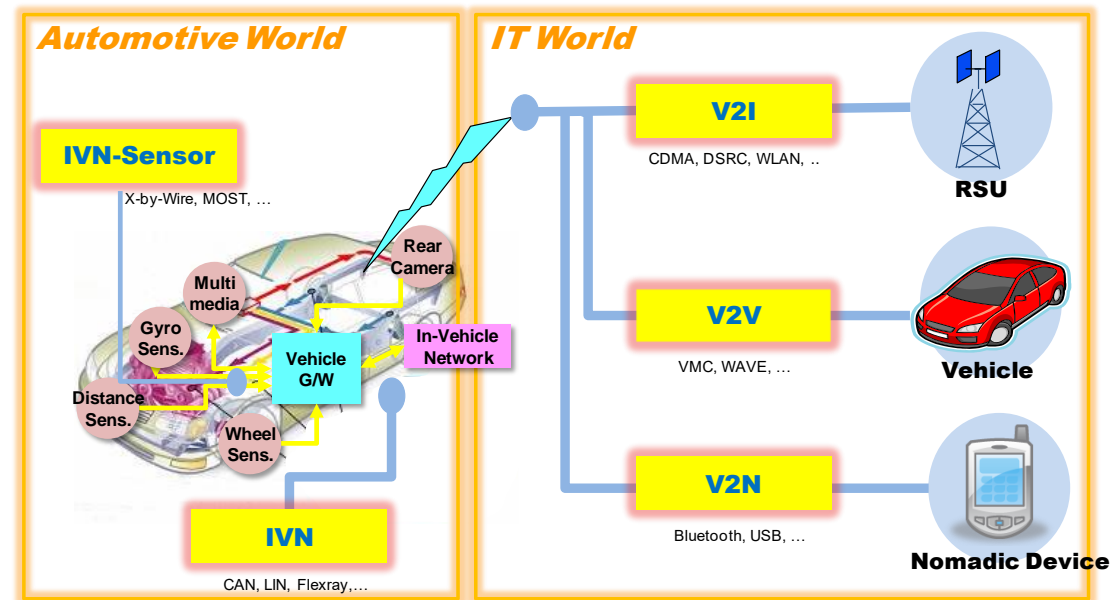
# ***Mobility Issues***

## **Sustainable Mobility for the Future**

- To be Safe, Accessible, Affordable, & Environment Friendly
- Paradigm Shifts for Reducing
  - ✓ Congestion, Road Accidents, Emissions & Air Pollutions, Health Problems
  - ✓ by
    - Avoiding the Needs to Travel by Driving
    - Shifting to Sustainable Transport Modes
    - Improving Efficiency of All Transport Modes

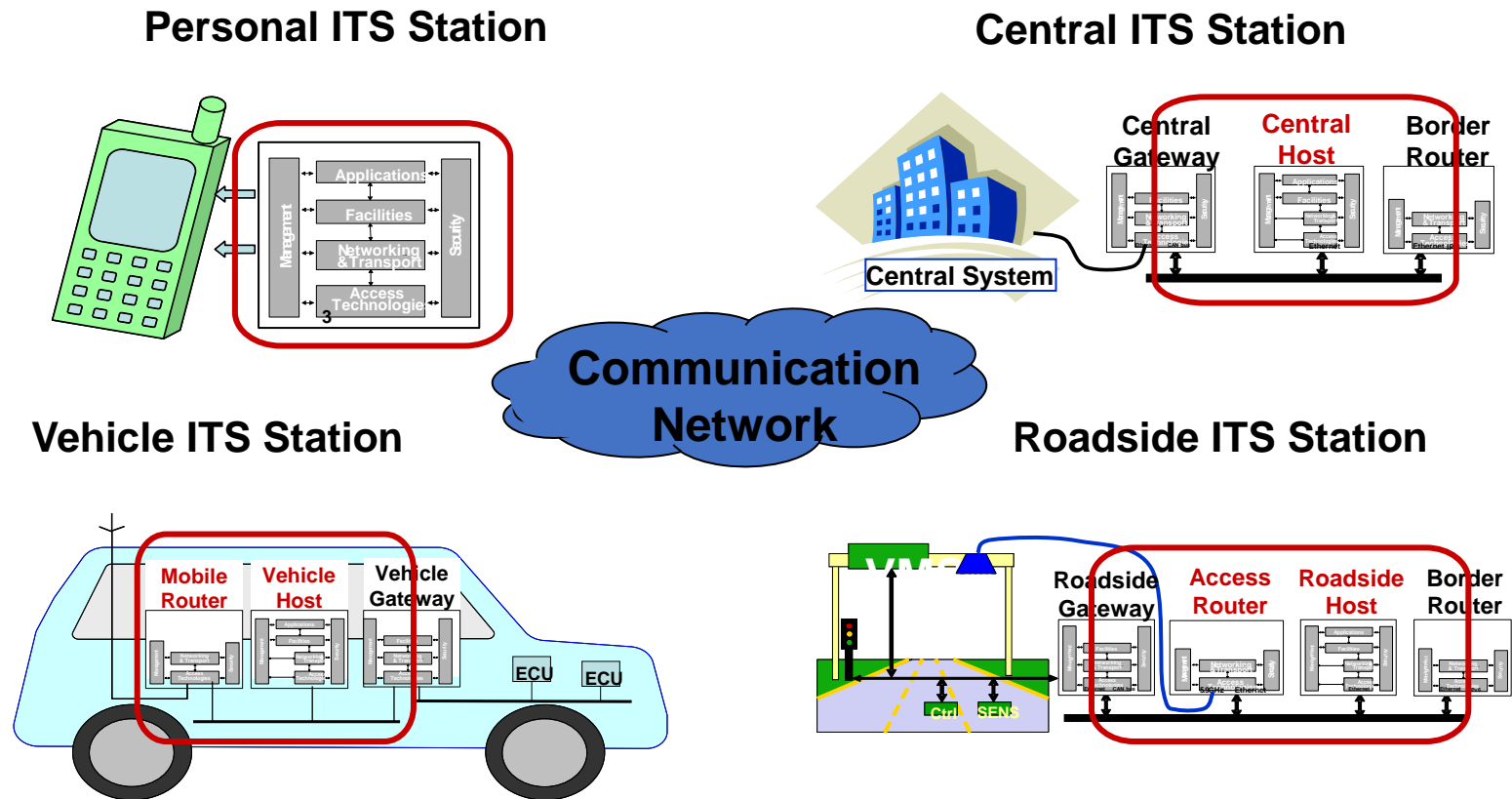
# Digitalization in Transport Systems

- Vehicle & ICT Convergence for V2X (V2I, V2V, V2N, V2P) Connectivity
- Cooperative Intelligent Transport Systems (C-ITS)



# Digitalization in Transport Systems

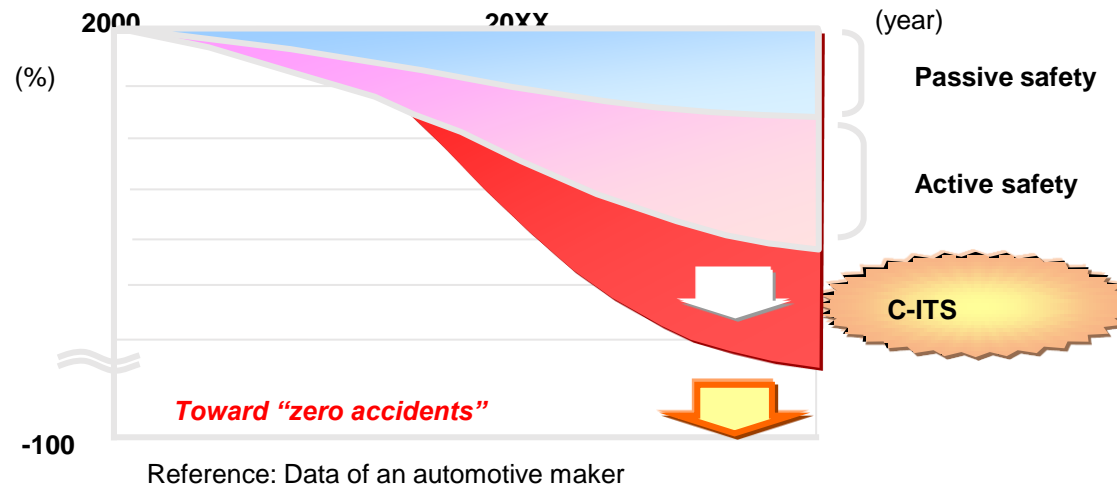
## ❖ Cooperative ITS (C-ITS) Architecture in ISO/TC204



# Digitalization in Transport Systems

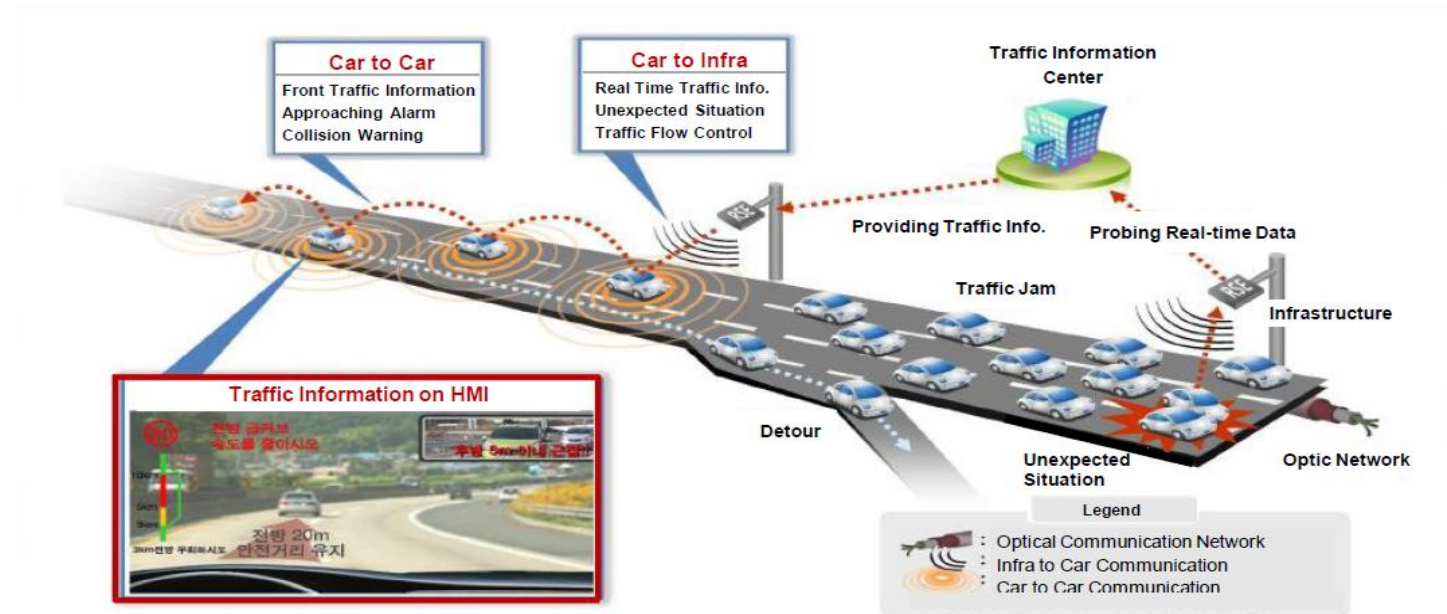
## ❖ C-ITS Benefits

- Safety
  - Zero Fatality in Accidents
- Mobility
  - Double Capacity on Highway
- Sustainability
  - Low Emission in Transport Sector



# Digitalization in Transport Systems

- ❖ 우리나라 C-ITS 시범사업: 국토교통부 주관
  - 안전성, 이동성 및 친환경성 향상 목표
  - 차량-차량(V2V) & 차량-인프라(V2I) 통신체계 구축, 오픈 플랫폼 기반 정보
  - Pilot Project (2014-2017, 세종-유성), 구축사업(2018: 서울&제주, 2019: 울산&광주)



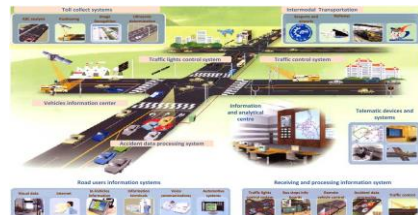
# Digitalization in Transport Systems

## ■ Challenges of a resilient investment environment for transport systems

### Intelligent Transport Systems (ITS) (1990s-2010s)

#### Information Collection & Provision

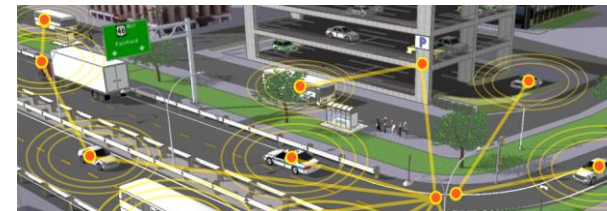
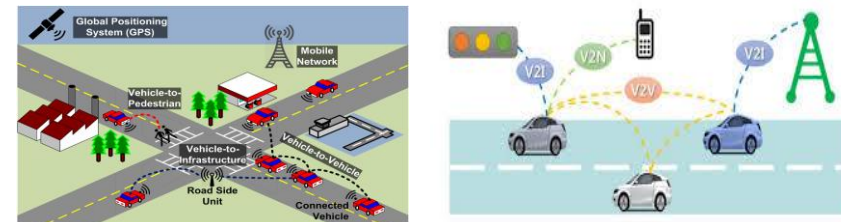
- Vehicle Detection System (VDS)
- Road Surveillance & Monitoring
- Variable Message Signs (VMS)



### Cooperative ITS (C-ITS) (2020s-2040s)

#### Information Collection & Provision

- Digital Infrastructure by ICT (V2X)
- Mobile & Nomadic Devices
- Big Data & AI for Connected & Automated Driving





# Digitalization in Transport Systems

## ■ V2X Issues for Connected & Automated Driving System



Sources : Qualcomm, 2016



# ***ICT changes Transport***

## **Societal Forces Driving Innovation of ITS**

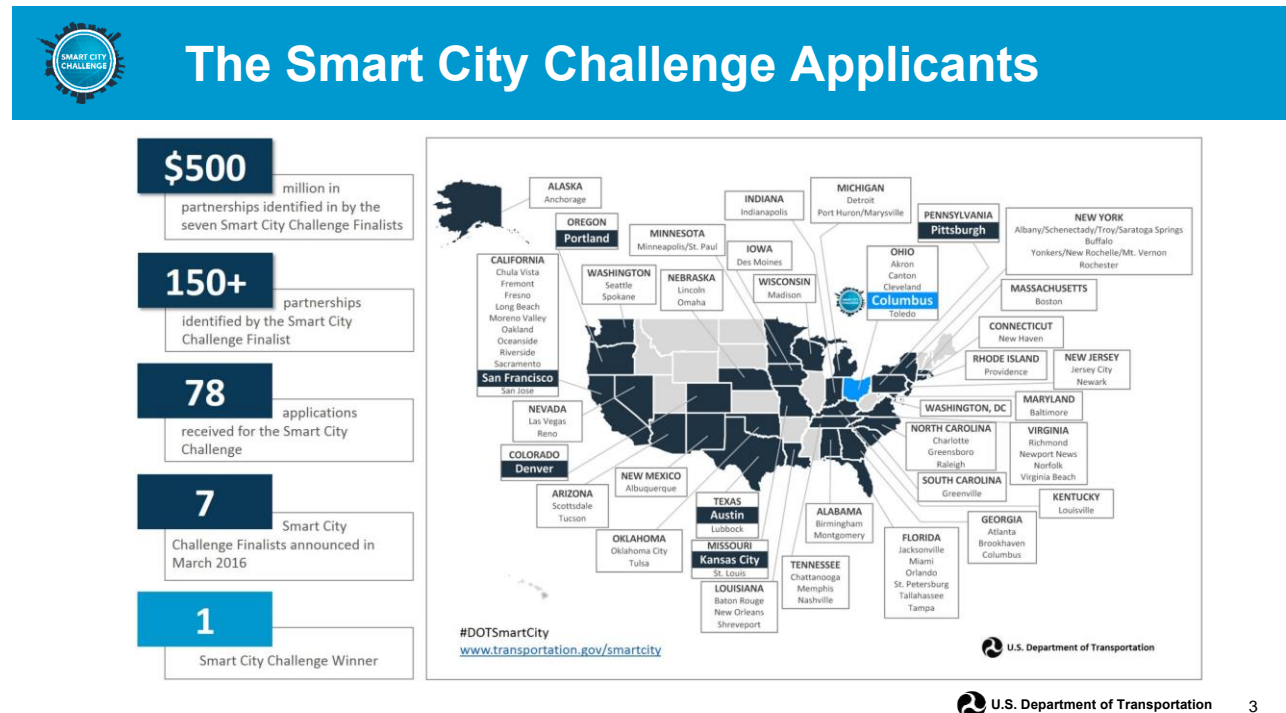
- Higher Investment & Maintenance Costs in Conventional ITS
    - Cases for ITS in Korea
  - Global Climate Change & CO2 Emissions
    - Approx. 20% due to Transportation
  - Aging Population (> 65 years) up to 20% in 2025
  - Shared Economy
- 
- ☞ Adopting a new Measure of Effectiveness (MoE) as “Green”
  - ☞ Changing Travel Behavior and Trip Patterns to be “Smart”

# Smart City Challenges

## ◆ USDOT Program : Smart City Challenges

✓ “Urban Automation & Mobility on Demand”

- 미국 내 모든 도시들의 미래상에 대한 아이디어 경쟁과 지원
- 2015년 12월 7일 공시, 2016년 6월 23일 최종도시 (오하이오 콜럼버스) 선정 발표
- 78개 도시 경합, 7개 도시 1차 선정 후 최종제안서 선정에 각각 10만불 지원



# Smart City Challenges



## Advanced Technologies and Smart Cities

### Connected-Automated Vehicles

Connected Vehicles

Vehicle Automation

Internet of Things

Machine Learning

Big Data

Sharing Economy



### Smart Cities

#### Benefits

- Order of magnitude safety improvements
- Reduced congestion
- Reduced emissions and use of fossil fuels
- Improved access to jobs and services
- Reduced transportation costs for gov't and users
- Improved accessibility and mobility



U.S. Department of Transportation

4

# Smart City Challenges

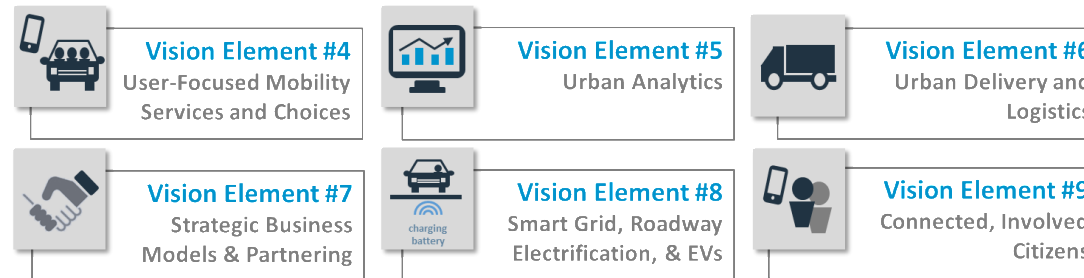


## USDOT Vision Elements

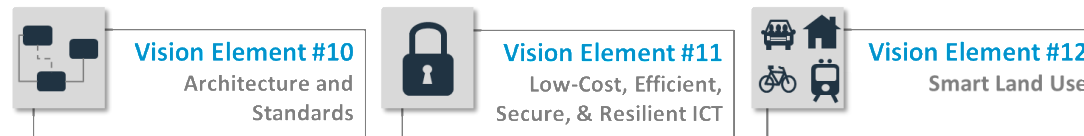
### TECHNOLOGY ELEMENTS



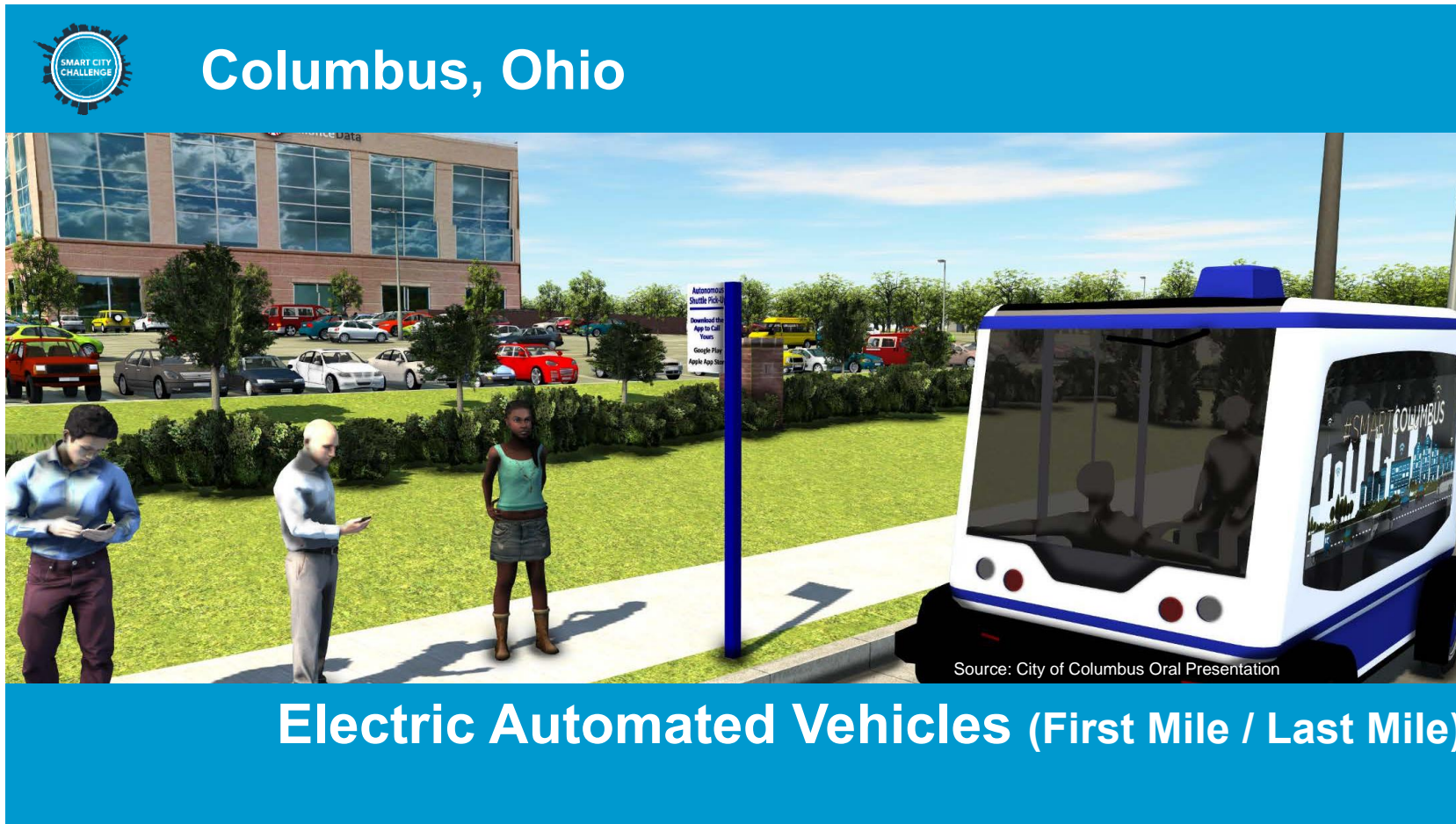
### INNOVATIVE APPROACHES TO URBAN TRANSPORTATION ELEMENTS



### SMART CITY ELEMENTS



# Smart City Challenges



# Connected Automated Driving System (CADS)

- 자율주행의 두가지 길
  - 승용차 자율주행 : High Speed & Designated Motorways
    - 2020년대 초반 Level 3 상용화로 중형승용차급 시장 진입 (OEM 중심)
  - 도심형 자율주행 : Low Speed & Urban Mobility
    - 2017년 Level 4 (무인운전) 공유형 전기버스셔틀 각 도시에 경쟁적 도입





# Connected Automated Driving Systems (CADS)

- 자율주행을 위한 차량과 도로인프라 관계
  - Level 2는 차량기술과 도로인프라의 일부 지원으로 실용화 가능
    - Intelligent Transport Systems (ITS) 인프라 활용
  - Level 3 & 4 실용화는 도로인프라의 연계 및 운영/관리/제어 필요
    - Level 3: Cooperative ITS (C-ITS) 인프라 필요
    - Level 4: Automated ITS (A-ITS) 인프라 필요
- 차량 스스로 도로인프라 정보를 인식하면 Level 3 실현 가능
  - Google Car : 차량에 부착된 각종 레이더센서 및 관련 정보화 장비 약 2억원



	Level 0	Level 1	Level 2	Level 3	Level 4	Level 5
SAE	No Automation	Driver Assistance	Partial Automation	Conditional Automation	High Automation	Full Automation
NHTSA	No Automation	Function Specific Automation	Combined Function Automation	Limited Self-Driving Automation	Full Self-Driving Automation	
KOTI	Vehicle	Vehicle	Vehicle & Road Assisted (ITS)	Vehicle & Road Cooperated (C-ITS)	Vehicle & Road Automated (A-ITS)	

# Connected Automated Driving System (CADS)

- L4 : Automated ITS (A-ITS) 도로인프라
  - 인공지능형 도로운영/관리/제어: 스마트 SOC



Sources : AUVSI 2014, San Francisco

# Smart Mobility

## ◆통합모빌리티 (Mobility Integration) 서비스

### ✓ **Networked Smart Journey (Trip) Planner (스마트 통행서비스)**

- 모바일 기반 예약 + 지불 + 정보 서비스 통합 (유럽 MaaS, 미국 MoD)
- 대중교통과 공유교통 등 모든 교통수단의 이동성 통합 (이용자 중심)
- IoT 기반 초연결성 확보(차량, 도로/시설인프라, 모바일기기 등)



# Smart Mobility

## ❖ Integrated Smart Mobility based on Connected & Digitalized Travelers

- A User-Centric Approach to Mobility-as-a-Service
- Enabling real-time (on-demand), door-to-door, multi-modal transport services
- Bringing convenience, time & cost savings to mobility users



**Intermodal Transportation**

**ICT Technology**

e.g., wireless Comm.,  
smart devices, (Big) data mining

**New Mobility System**

e.g., e-Mobility, AV

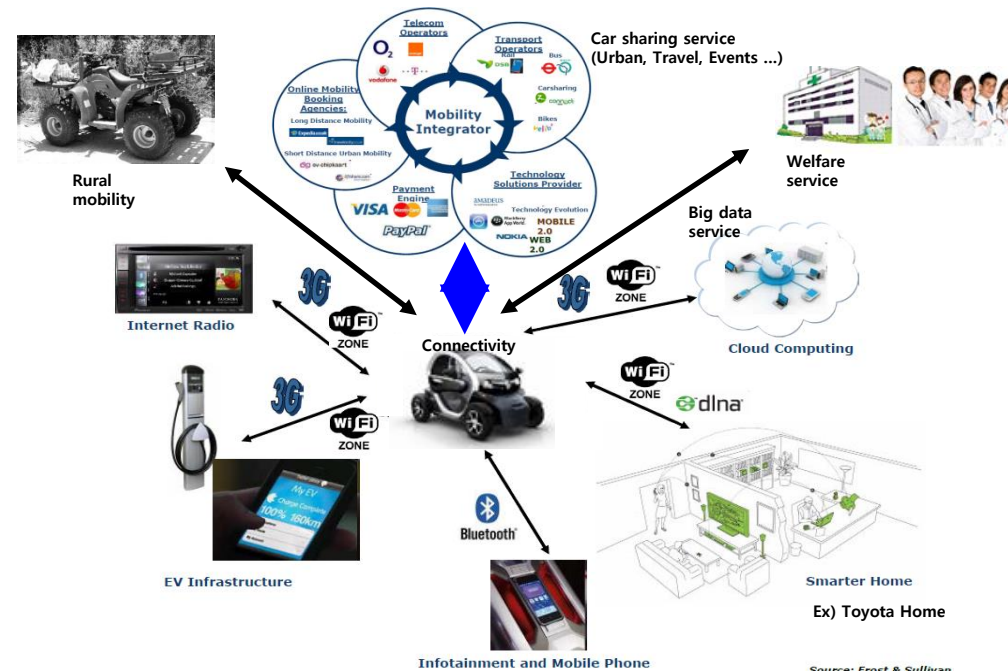


# Smart Mobility

## ◆ 공유형 자율셔틀 도심교통체계 (Electric Automated Shuttle)

### ✓ “Smart Mobility in Smart City”

- 다수단 다중시설 연계환승네트워크(Hub & Spoke Connectivity) 구축
- 전기차 기반 공유형 도심자율주행 연결 (First/Last Mile)
- 스마트모빌리티 클라우드 운영센터 구축

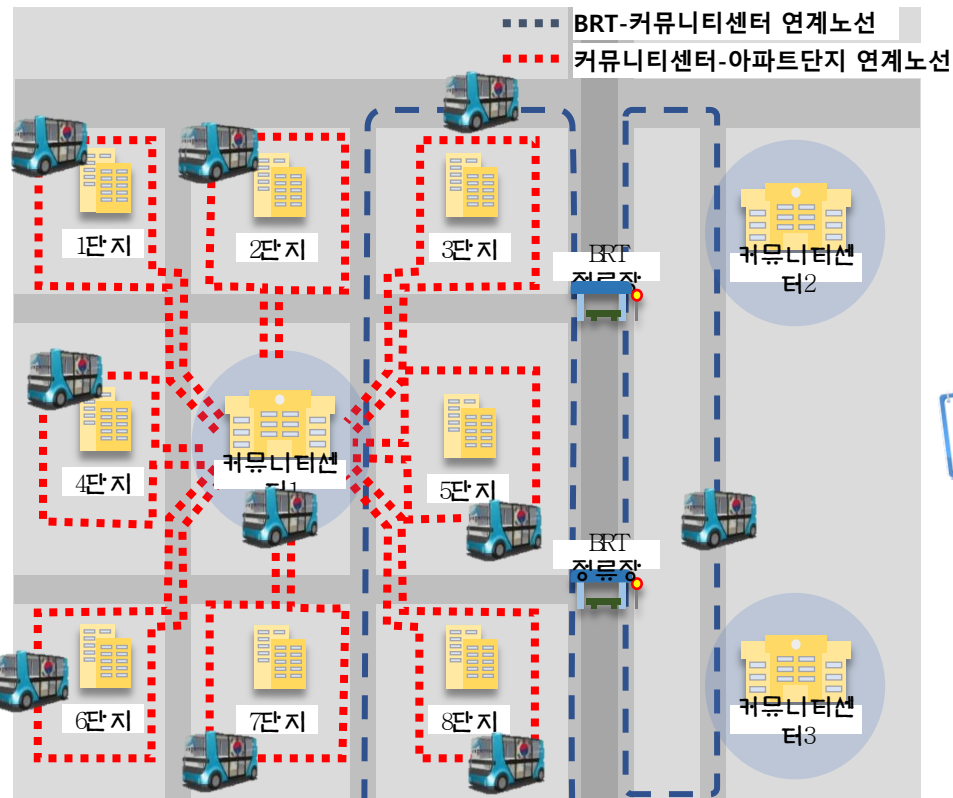


Source: Frost & Sullivan

# CADS & Smart Mobility

## ◆ 세종시 마을 주거단지별 생활문화공간 연결 자율주행셔틀 보급 개념

- 세종시 국가혁신클러스터 R&D 추진으로 기반 구축 중
  - 마을단위 복합커뮤니티센터와 주거(아파트) 단지 간 연결 및 BRT 교통연계
  - 모든 단지의 역세문화권 형성



- 마을 단위 복합커뮤니티센터와 BRT 정류장 연결 전용자율주행셔틀 운영
  - 마을 단위 교통연계 형평성 보장
  - 보행 이동거리 감소
- 마을 내 각 단지와 복합커뮤니티센터 간 단지 전용 자율주행셔틀 운영
  - 단지 별 생활문화연결 형평성 보장
  - 커뮤니티센터 활성화 및 교류 확대



# *Design the Future ... 2050*

From Yesterday



To Tomorrow

City



**Skyscrapers in Land & Ocean**

**Figures : VENUS Project, USA**

# *Design the Future ... 2050*

From Yesterday

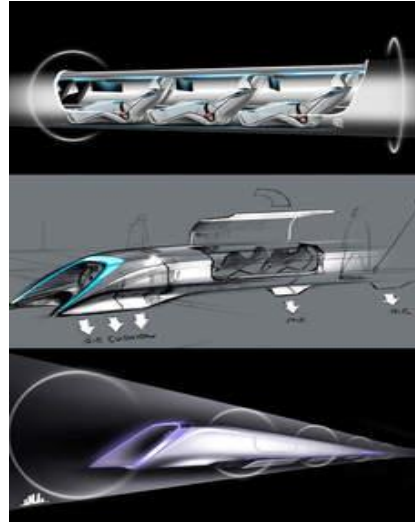


To Tomorrow

- Regional: High-speed Train
- Local: Public or Private Vehicle

Transport

- Regional: Mag-Lev or Hyperloop
- Local: VTOL or PAV



Mag-Lev or Hyperloop

Vertical Take-off & Landing (VTOL)  
or Personal Air Vehicle (PAV)

Figures : Google & VENUS Project

# *Design the Future ... 2050*

From Yesterday



To Tomorrow

- 2 Dimensional Roadways
- 자유도 (DoF) : 1
- ITS & Inter-modal Transit

Transport  
Infra.

- 3 Dimensional Roadways
- 자유도 (DoF) : 2 or 3(?)
- CADS in Space



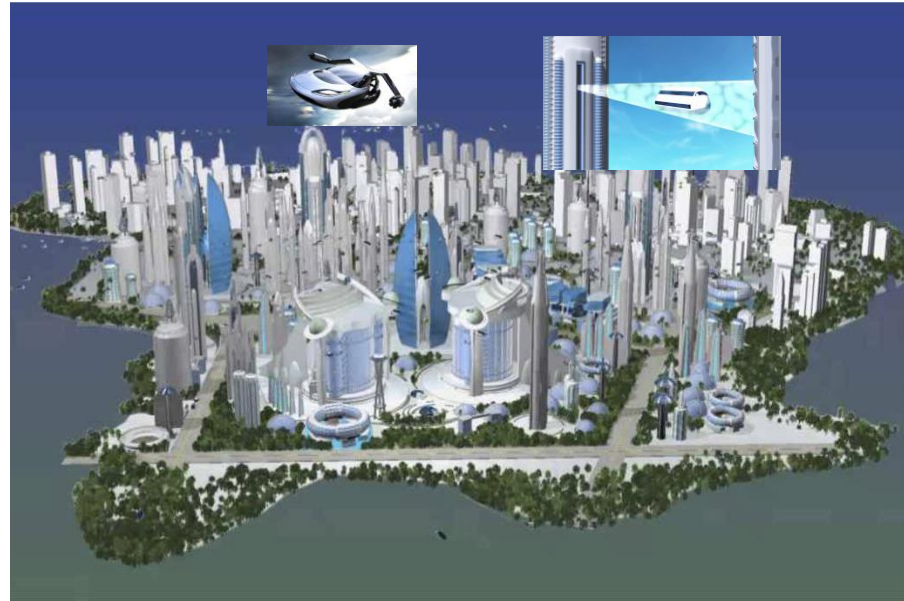
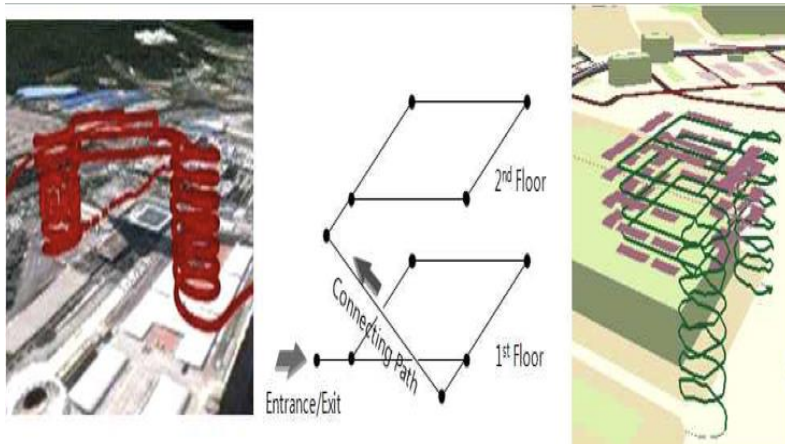
Figures : Google & VENUS Project



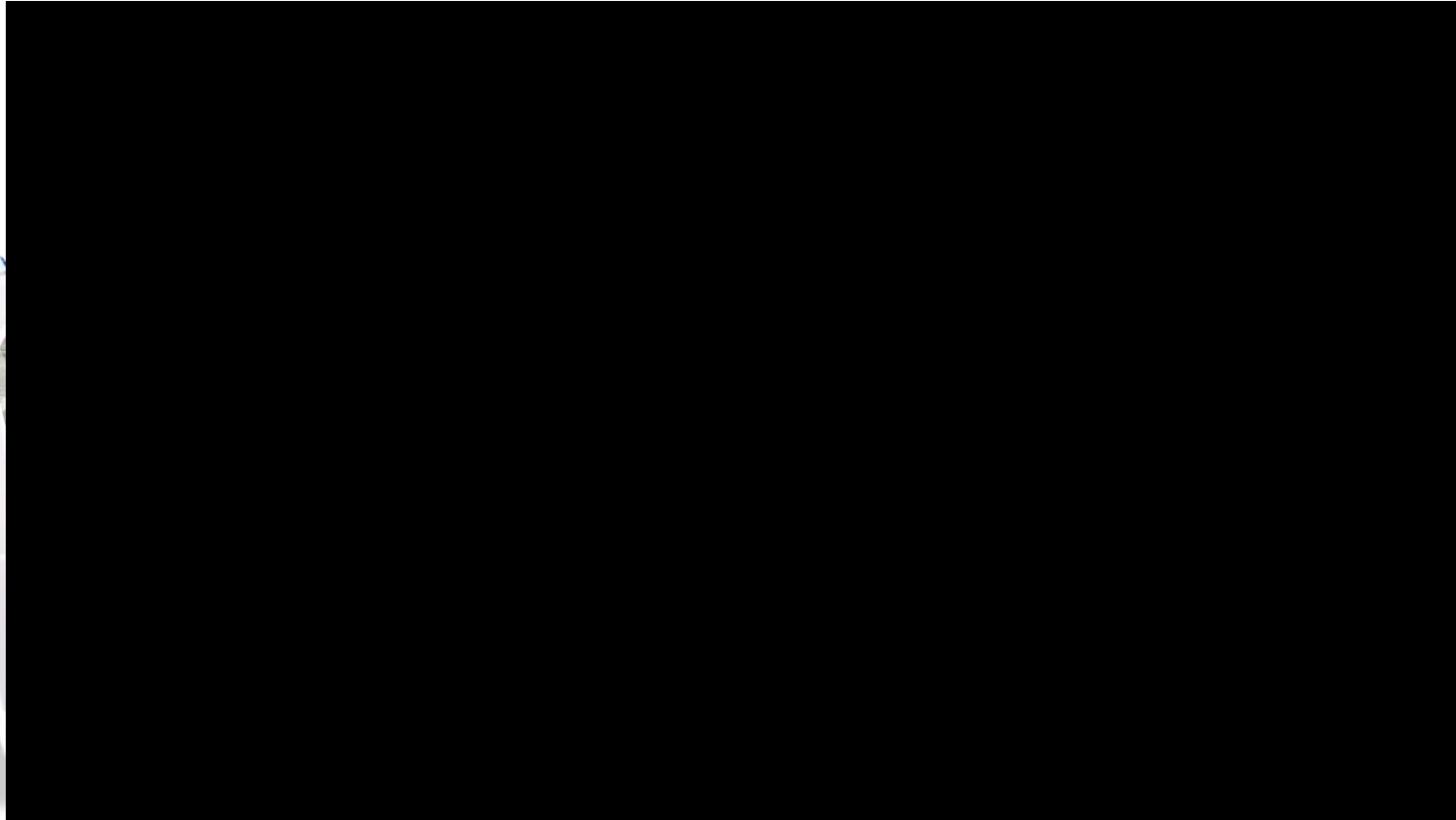
# 3D Transportation Infrastructure

## ➤ Virtual Roadways for 3D Transport Infrastructure

- Dynamic Generation/Extinction on Demand
- 3D Spatial HD Map, Network Operation & Management System, etc.



*It's time to imagine ...*



# *Issues for Future Mobility System*

- **What to do for Future Mobility to 2050**
  - **Follower until 2010:** ICT, Intelligent Transport Systems (ITS)
  - **Fast Follower until 2030:** V2X, Digital & Logical Infrastructure, CADS, Smart Mobility
  - **Potential Creator from 2030 to 2050**
    - 3D Transport Infrastructure, 3D Network Operation & Management
    - 3D Spatial HD Map, CADS in Space by V2X (5G?, or 6G~10G?)
- **How to do now?**
  - Incubating a collaboration research for ideation, feasibility, preliminary design, etc.
  - Launching a Mega Project R&D when a detail plan is ready, e.g., after 5-10 years.



***Thank you very much!***

***Young-Jun MOON, Ph.D.***

The Korea Transport Institute (KOTI)

ISO/TC204 WG17 Convenor

[yjmoon@koti.re.kr](mailto:yjmoon@koti.re.kr)