Past and Future of Transportation in Korea

Taekwan Yoon, Ph.D.

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Introduction

Taekwan Yoon, Ph.D.

Ph.D. in Civil Engineering (Transportation) with Chancellor's Honor, University of Tennessee, Knoxville

Chief Director, Korea Research Institute for Human Settlements (2017.5.~)

Specialist, LG CNS (2014.8.~2017.5.)

RA/TA, University of Tennessee, Knoxville (2011.8.~2014.5.)

Specialist, Cote d'Ivoire, KOICA (2014.12.)

Research Assistant, Korea Institute of Civil Engineering and Building (2009.9.~2011.7.)

Research Assistant, Seoul National University (2006.8.~2008.8.)

Interests: Traffic Engineering (ITS, C-ITS, Autonomous Vehicle), Sustainable Transportation

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History of Transportation in Korea

[Number of vehicles]

- Gradually increasing and around 25 million vehicles registered now (1veh/2person)


<1950s>


<1970s>


<1990s>


<2020s>

[Transportation modes]


Walk (~ 1945)


Streetcar (1945 ~ 1970)


Bus (1971 ~ 1985)


Car (1986 ~)

History of Transportation in Korea

[Number of vehicles]

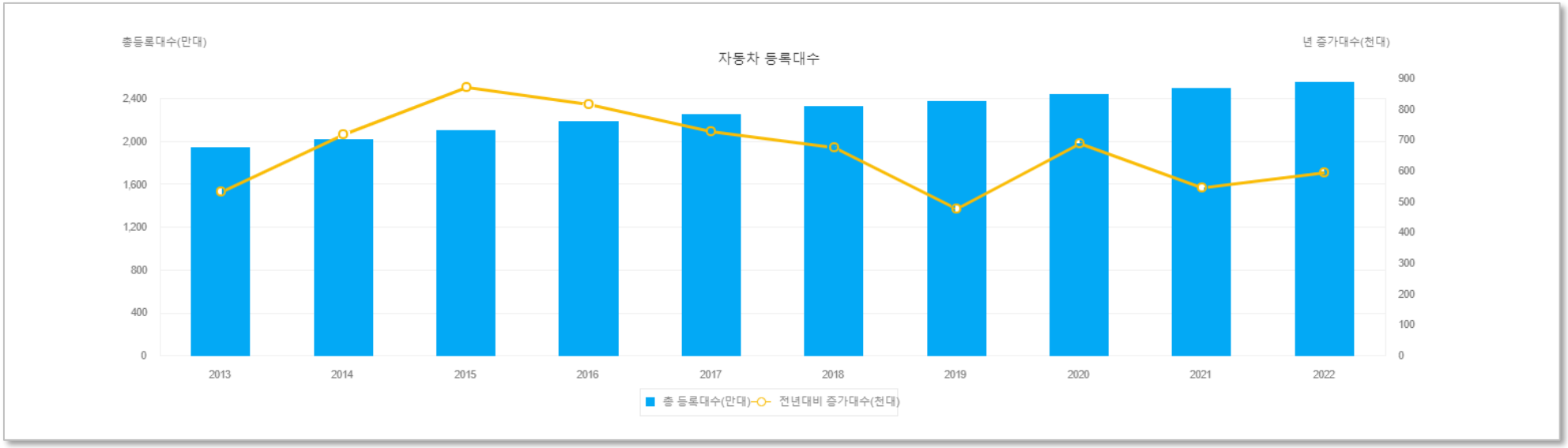
- Gradually increasing and around 25 million vehicles registered now (1veh/2person)

<1950s>

<1970s>

<1990s>

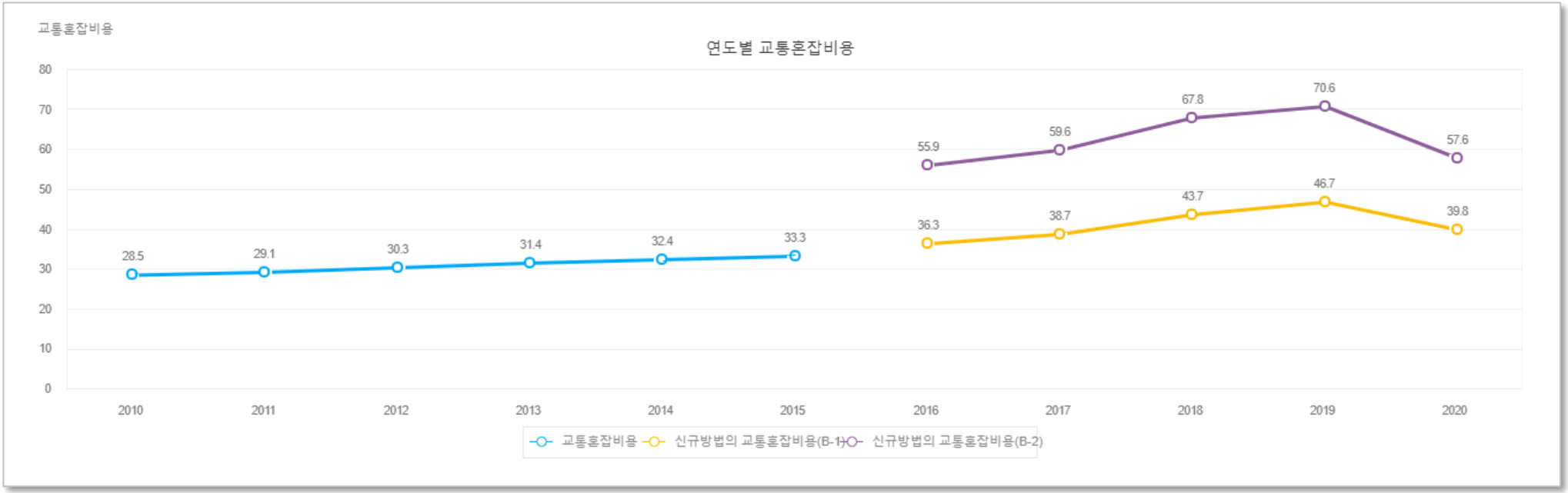
<2020s>



History of Transportation in Korea

[Delay and Pollutions]

- Traffic delay and pollutions are getting worse and worse
- Due to traffic delay, the Korean society lost $53 billion (road traffic congestion fee)
- More vehicles and traffic delay → More emissions → Pollution



History of Transportation in Korea

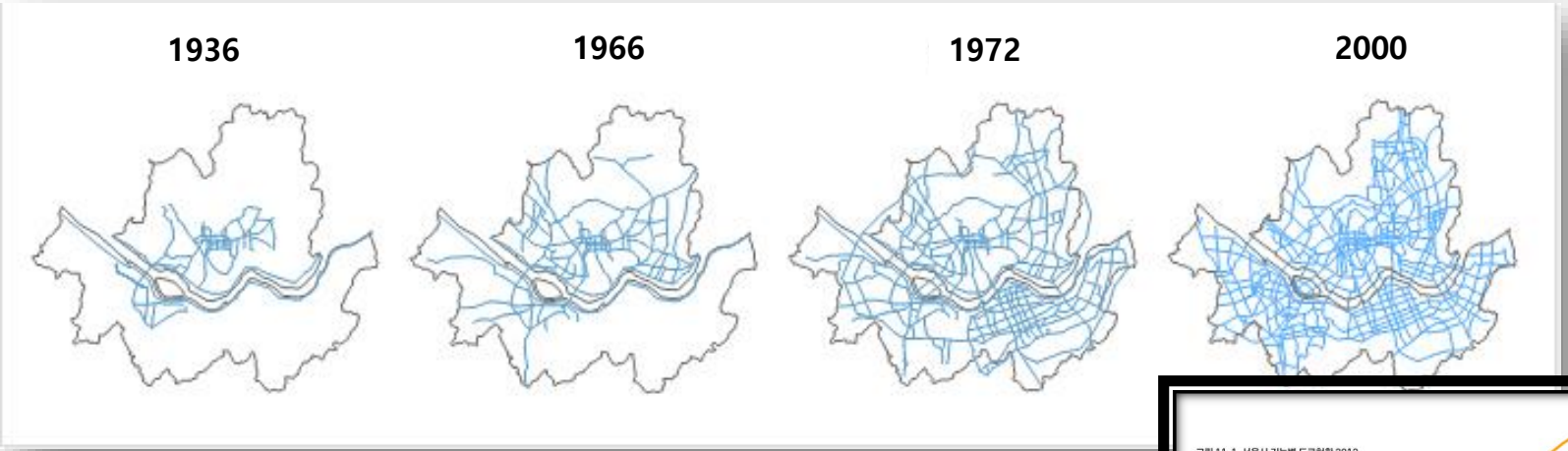
[Historical Review]

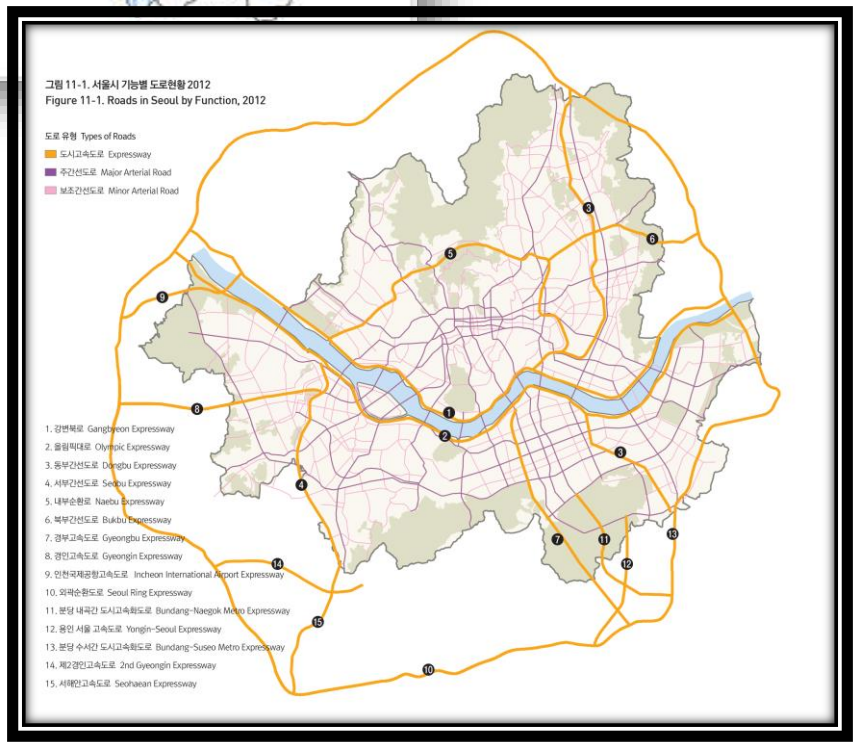
200 passengers on a bus(60~70 limit)
in 70's

Poor quality service of bus in 80-90's

History of Transportation in Korea

[Road network in Seoul city]

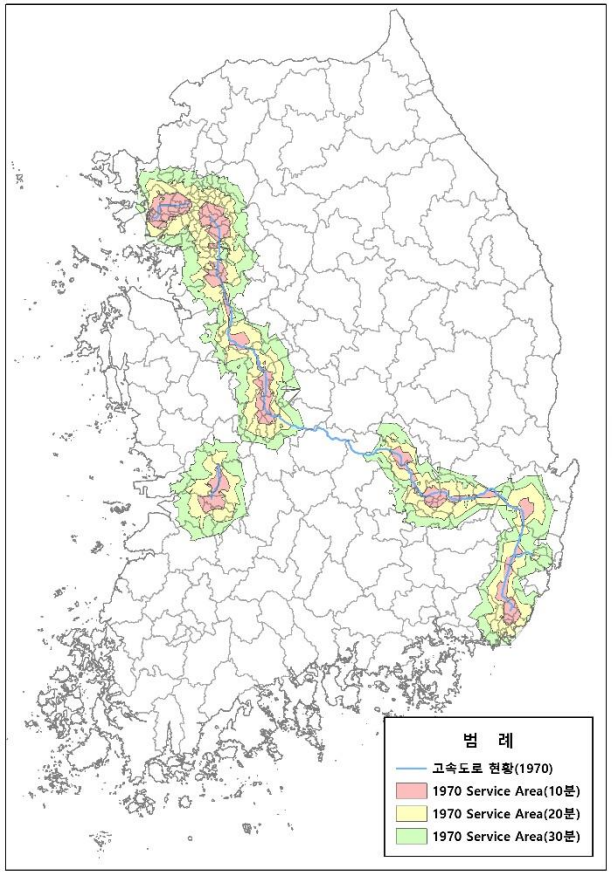




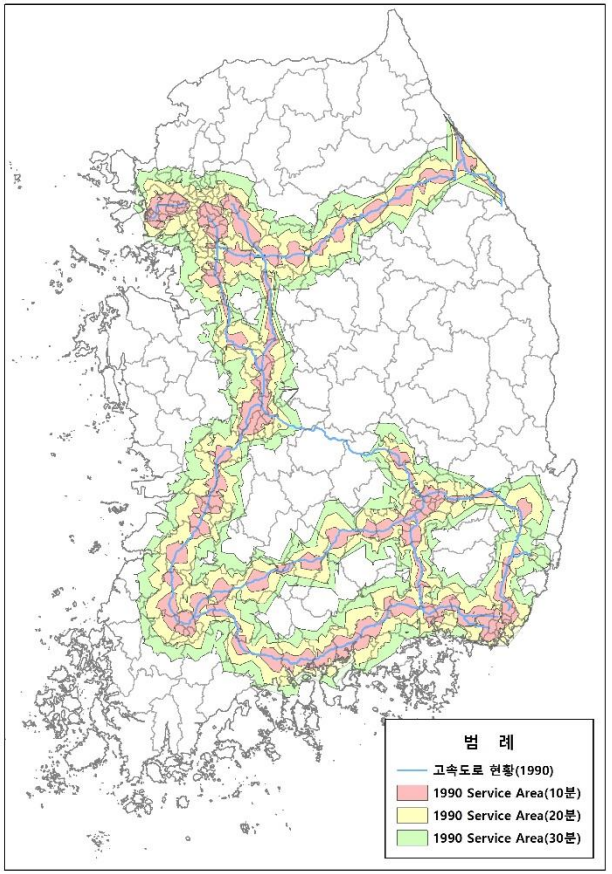
History of Transportation in Korea

[Highway Network]

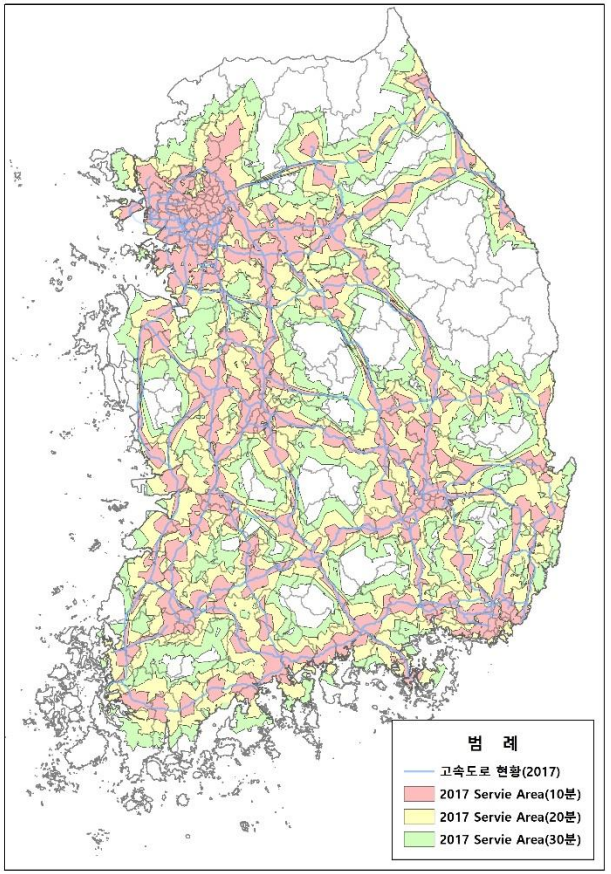
Road network expansion → Most regions are covered by the constructed highway



1970 Highway Network



1990 Highway Network

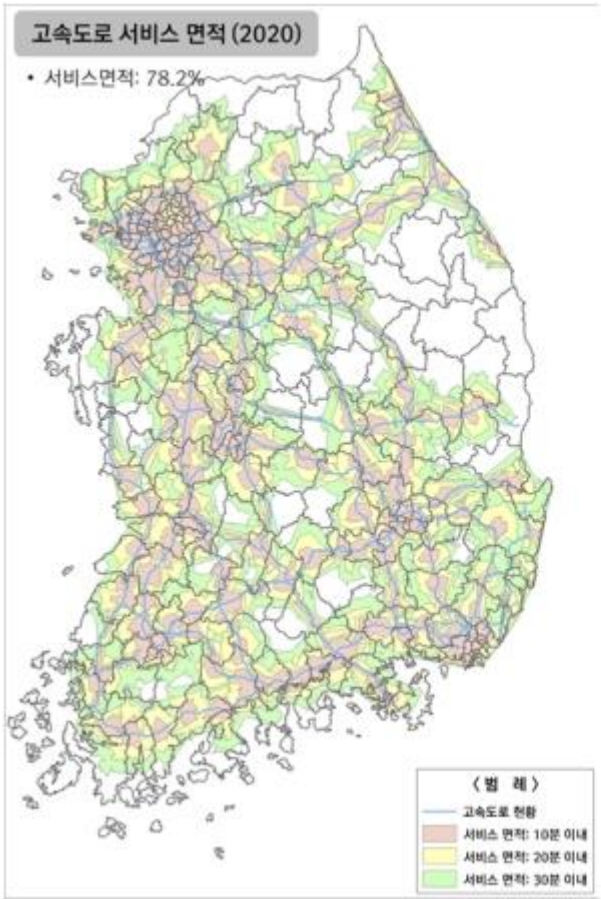


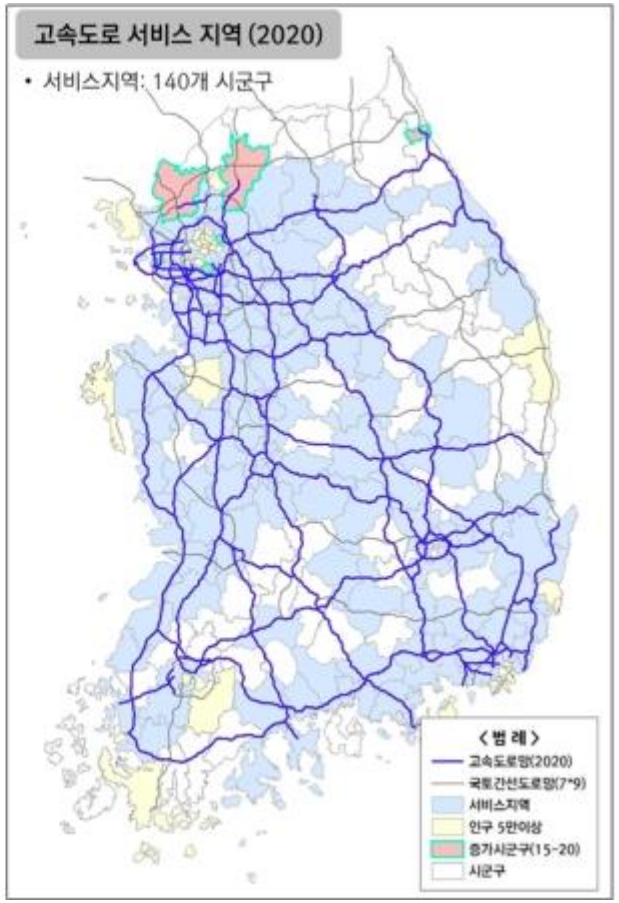
2017 Highway Network

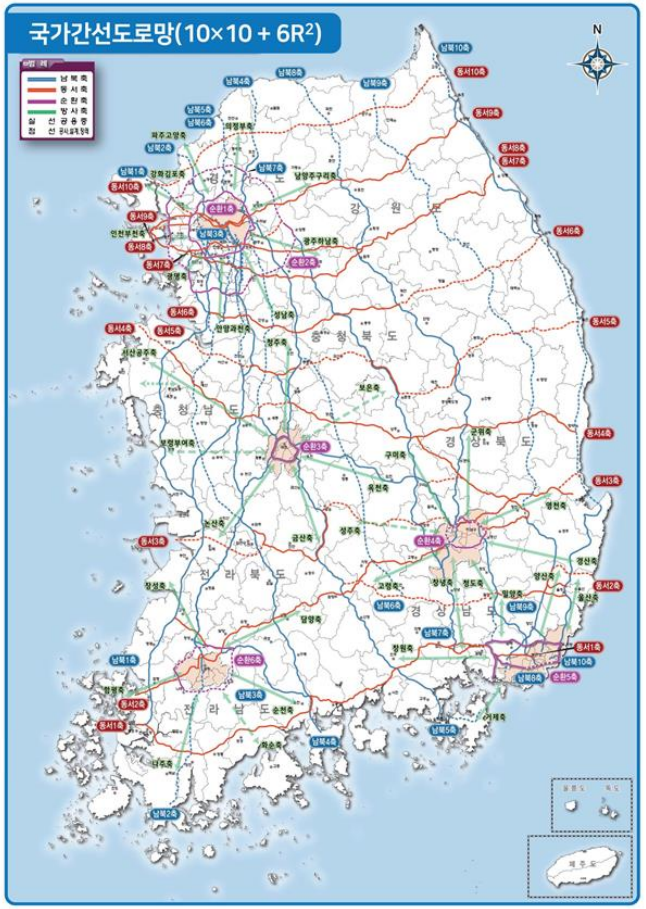
History of Transportation in Korea

[Highway and National Arterial Road Network]

Road network expansion → Most regions are covered by the constructed highway





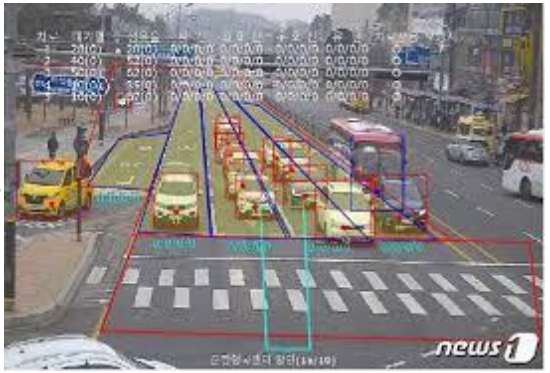


History of Transportation in Korea

[Traffic Signal: Control vehicles at the intersection]

- The first traffic signal (gas-lit) was installed in London, 1868
- Detroit, USA installed first electric traffic signal in 1914 and operated by officers
- 'Green-yellow-red' traffic signal was adopted at 5th Ave. NY in 1918
- [Current status] Advanced traffic signal (e.g. adaptive, AI, time of day) is operated





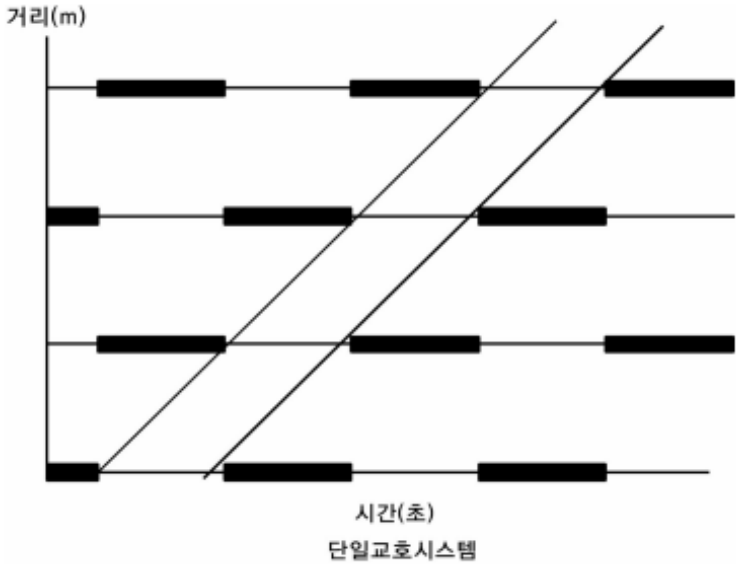
History of Transportation in Korea

Fixed signal system

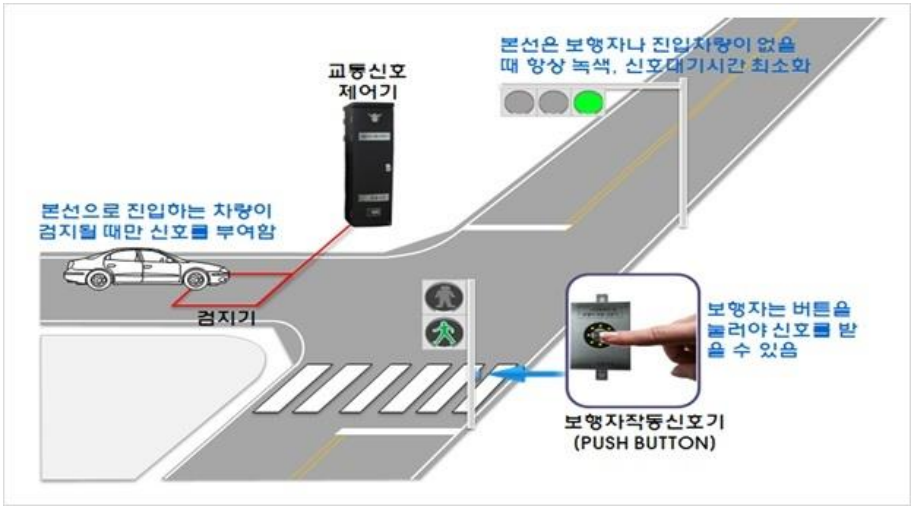
- Control by signal setting (ex. Time of Day)
- Effective at intersections with low traffic volume fluctuations by day and time of week, but ineffective when fluctuations are severe
- Limit to reflect real-time traffic conditions

Actuated signal system

- More advanced than fixed
- Detect the vehicle presence and queue length → Signal on/extension
- Ex. Left turn signal (actuated)



<Intersection signal interlocking)

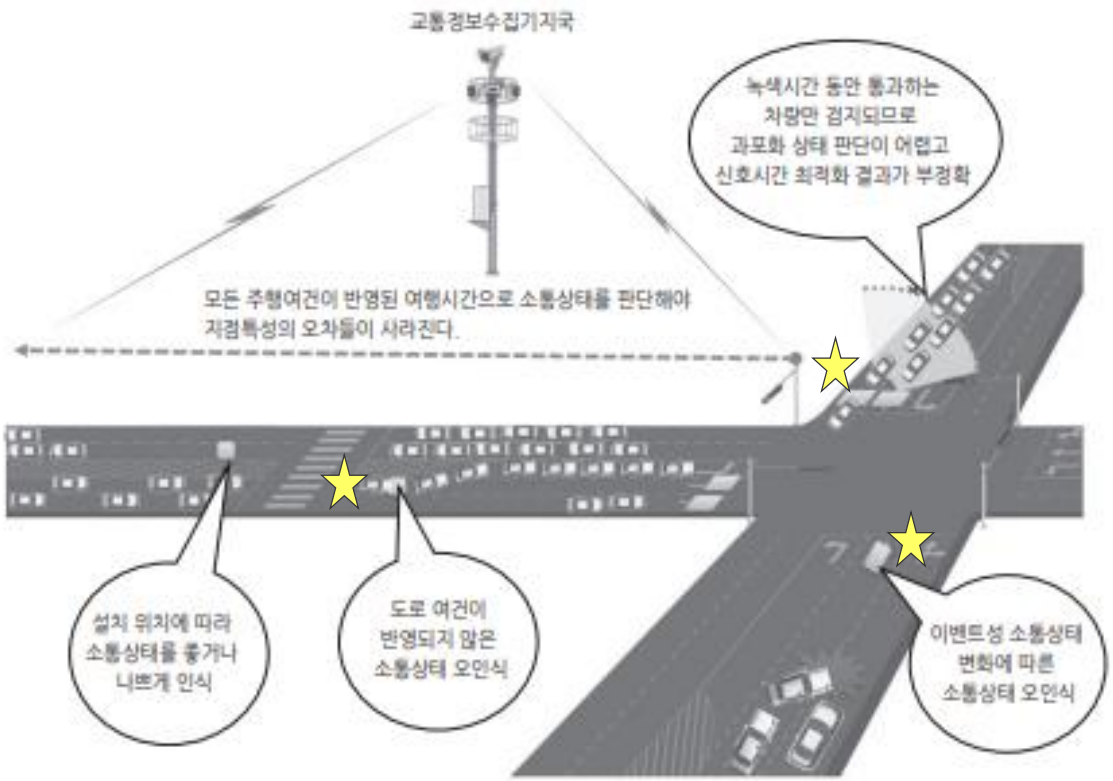


<Left turn signal(actuated)>

History of Transportation in Korea

[No vehicle detection→ Can't make optimized signal → Congestion still exists]

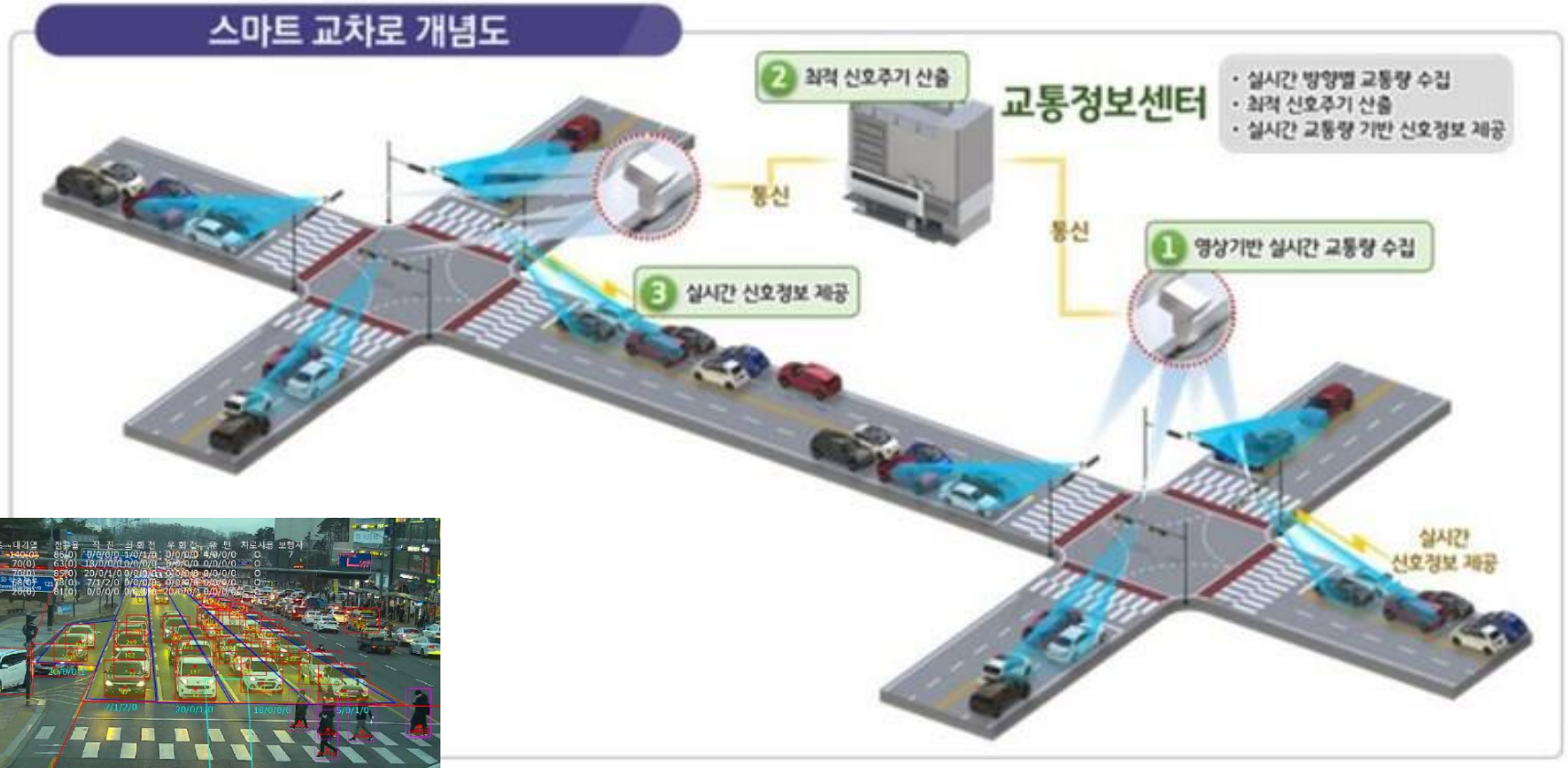
- Only detect the number of vehicle through loop detection on green time → Unable to judge supersaturation
- Errors occur based on the loop detector location (ex. If the event occurs before the detector)
- Could not consider road conditions



History of Transportation in Korea

Smart Intersection

- Real-time optimization signal operation through analysis of traffic volume by lane, traffic demand, queue length, etc. using image recognition deep learning technology
- Using traffic big data to establish an optimal operating signal system for the entire road network and lay the foundation for providing signal information for autonomous vehicles



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Future of Transportation

More vehicles on the road

Congestion | **Traffic Accident** | **Pollution**

Target year: 2030

Connectivity

- V_2X communication
  → Improve safety and efficiency


Autonomous

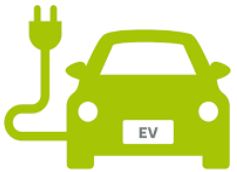
- Reduce traffic accidents by human errors and use the limited road efficiently


Shared

- Sharing economy → change life patterns for sustainability

Electrification

- Less GHG emissions from transport sector

Post COVID-19

- New travel patterns such as untact and personal modes

Big Data & AI

- Big data and AI will inform better understanding of traffic engineering

Keyword [1] Connectivity

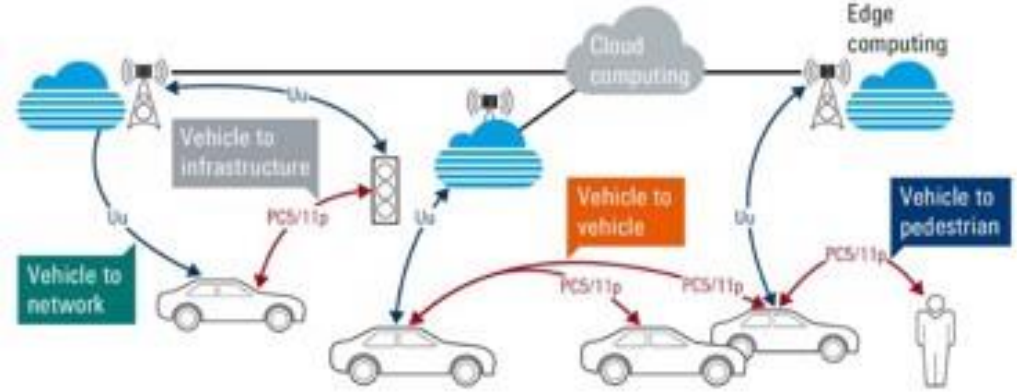
Current status

From the statistics, around 230,000 traffic accidents occurred and 3,350 people have died

(2019, Taas data)

2030

- V_2V communication systems warn you of potential hazards
- Even the vehicle can communicate with pedestrian and improve safety

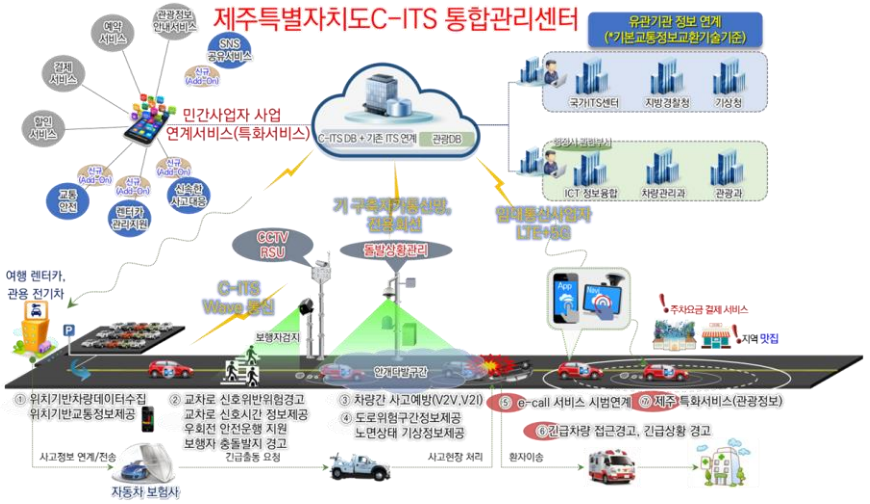


Keyword [1] Connectivity

96% of new vehicles shipped globally with built-in connectivity in 2030

[1] V_2X communication

- [As-Is] WAVE communication → [To-Be] Cellular V_2X-5G
- ITS technical regulations and standard establishment required



[2] C-ITS impact analysis

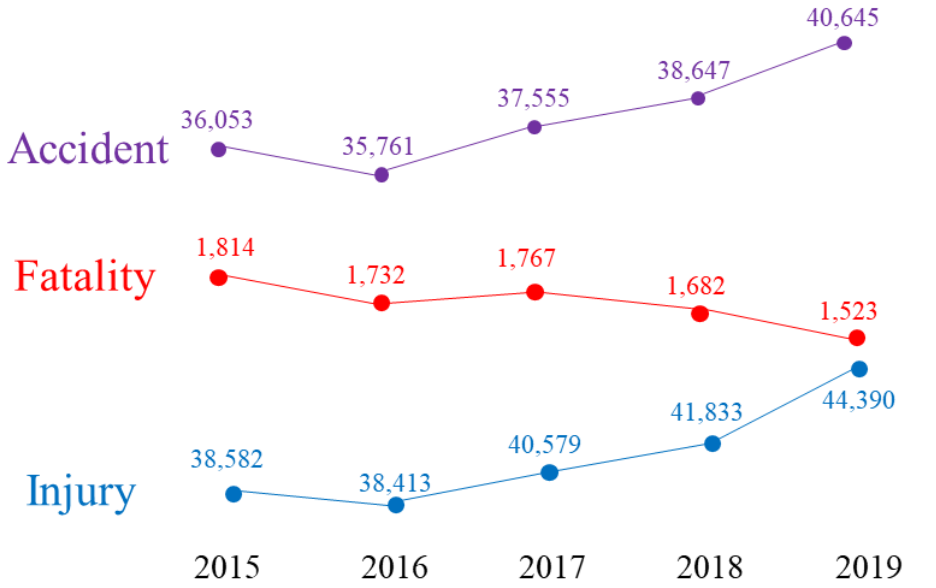
- 42 municipalities will construct C-ITS with New Deal funding
- Set up standardized methodology for impact analysis

Keyword [2] Autonomous

Current status

- ✓ Somewhere between 94~96% of all motor vehicle accidents are caused by some type of human error (NHTSA, 2020)

Traffic accident trend by elderly drivers



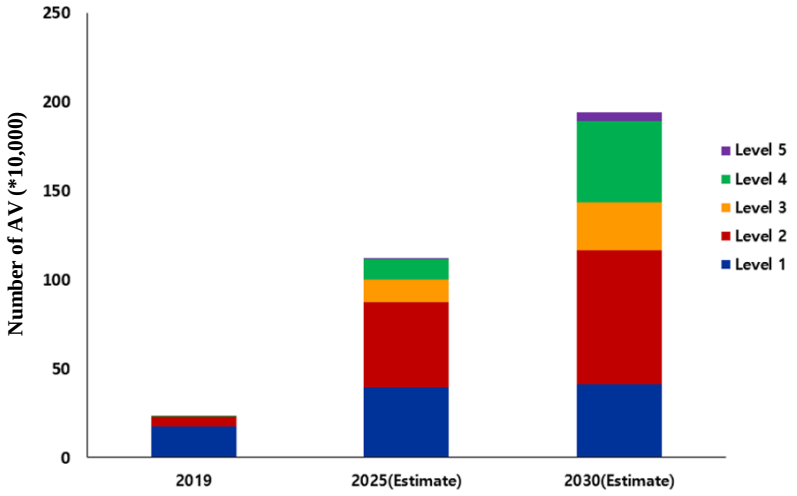
(Data source: TAAS website) (unit: number of case, people)

2030

"Autonomous vehicle can improve traffic safety"

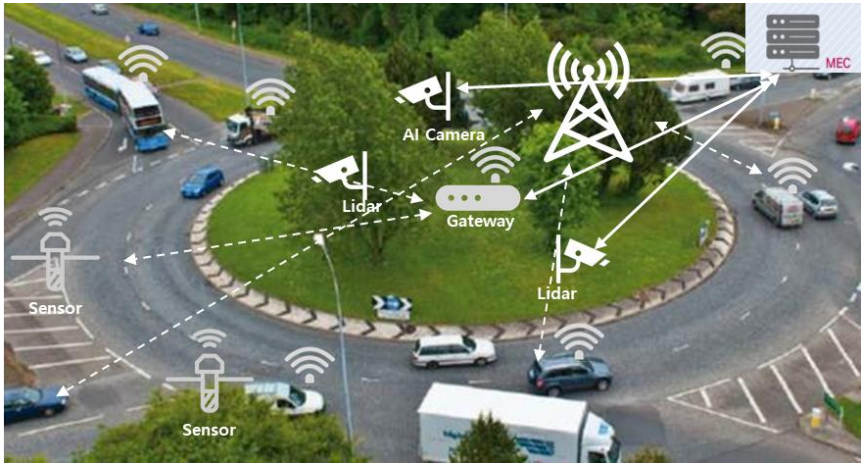
Aging Society
1 of 3 is elderly

[Autonomous Vehicle Forecast by Level in the World]



Keyword [2] Autonomous

15% of new cars sold that have autonomy level 2 or higher in 2030

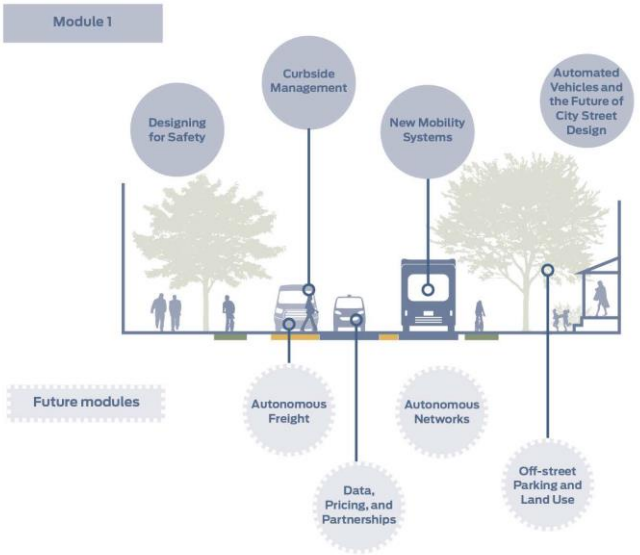


[1] Mixed traffic

- Mixed traffic with regular and autonomous vehicles is unavoidable
- Infrastructure guidance required at un-signalized intersection, roundabout, and etc. to improve traffic safety

[2] New urban design

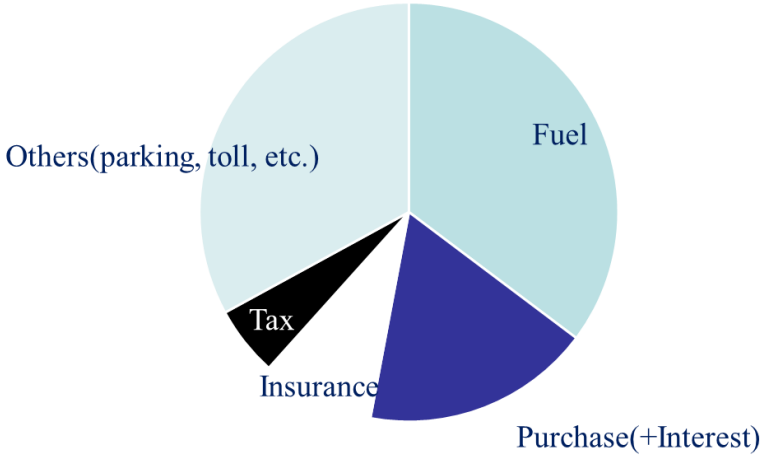
- Imagine how the urban city looks like with autonomous vehicle adoptions
- Strategies to use the spaces that were used for vehicles



Keyword [3] Shared

Current status

- ✓ Every month, you pay **780,000 won** to own a vehicle (Seoul Institute, 2015) + Depreciation costs





2030

Keyword [3] Shared

We will share as many as we can in future, and sometimes it causes new issues

[1] Shared mode relocation problem

- Optimize fleet distribution
- Relocation strategies
- Solve issues on floating shared mode

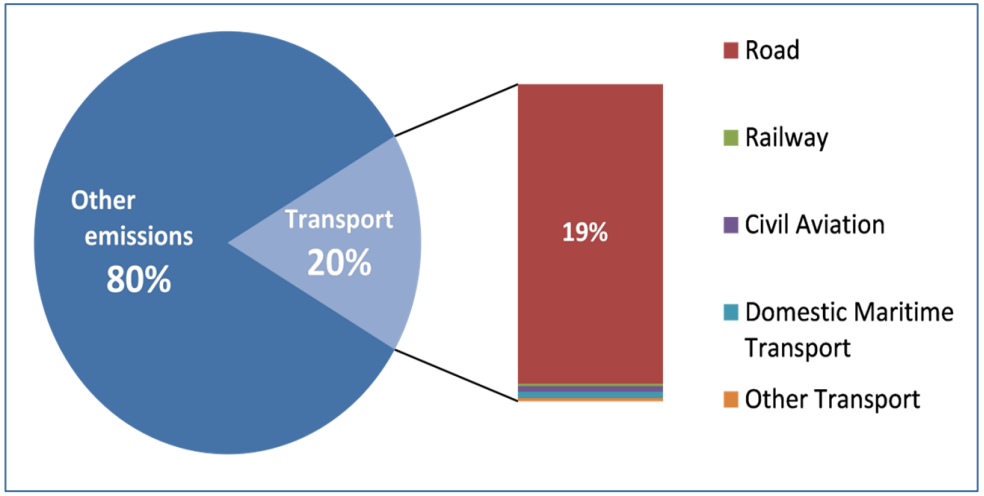
[2] First/last mile

- Infrastructure for efficient mode transfer
- Integrated platform to reserve each mode (Mobility as a Service)

Keyword [4] Electrification

Current status

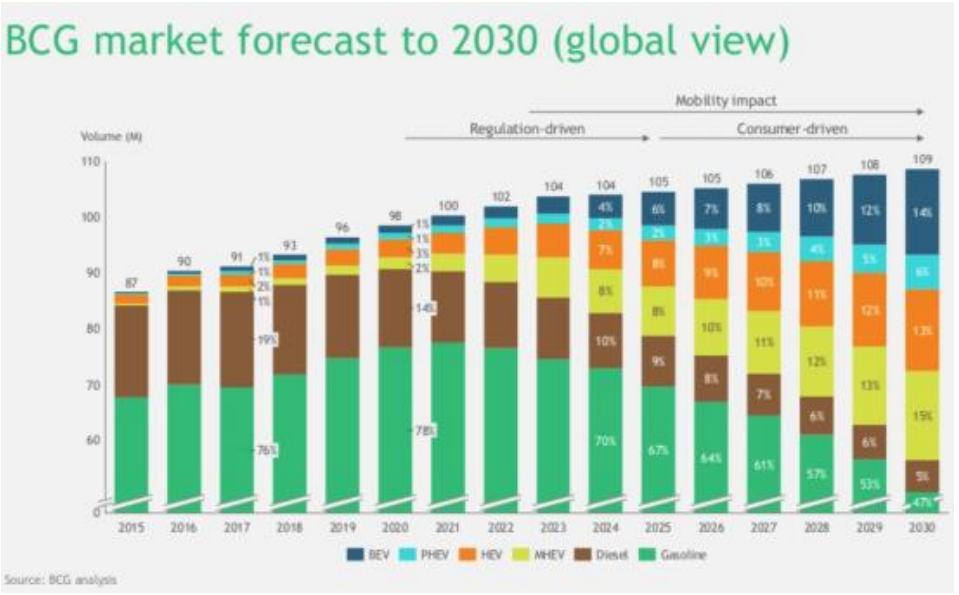
- ✓ Transport accounts for **20%** of GHG emissions



- ✓ Full EV sales are growing faster than plug-in hybrid or hybrid vehicles

2030

- ✓ Combination of hybrid and fully electric powertrain will cut the global market share of internal combustion engines by about **50%** by 2030

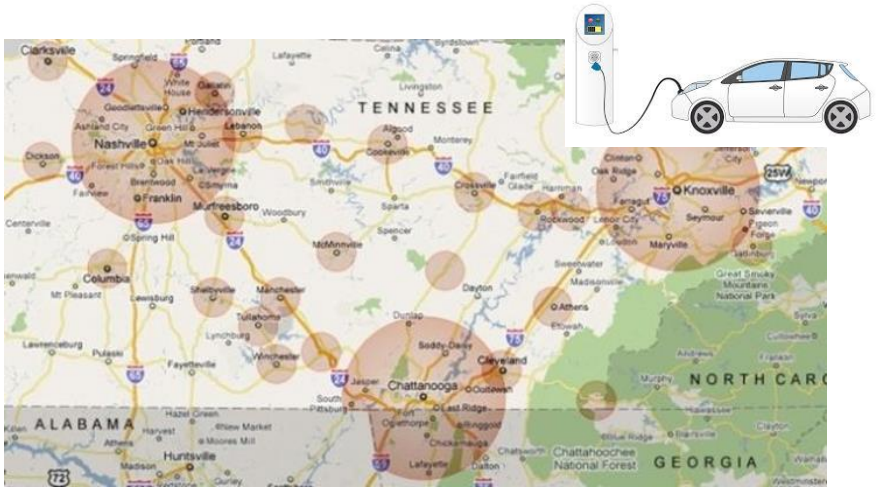


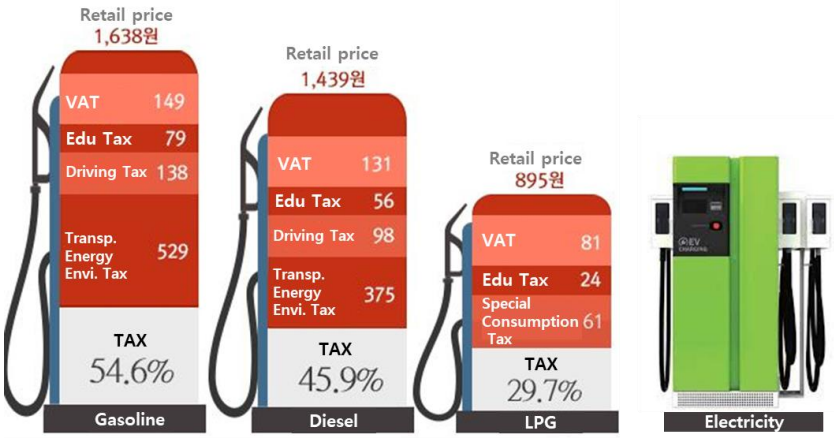
Keyword [4] Electrification

24% of new cars sold that are electric vehicles (including BEV/BHEV) in 2030

[1] Charging infrastructure

- Predict charging demand and patterns
- Analyze the infrastructure size
- Optimize the location to meet the demand





[2] Tax collection

- Now, EV users only pay VAT and Electricity Individual Fund
- How will the Government collect taxes?

Keyword [5] Post COVID-19

[1] Prefer personal mode

- More congestions on road; strategies to control the heavy traffic
- Less transit usage; Need more subsidy for captive riders or vulnerable

[2] Untact mobility

- Social distancing → More untact mobility usage such as bike, kickboard, and other
- Infrastructure and laws are required


윌 버틀러-애덤스는 브롬톤 바이크의 CEO는 최근 주문이 급증했다고 한다

Keyword [6] Big Data & AI

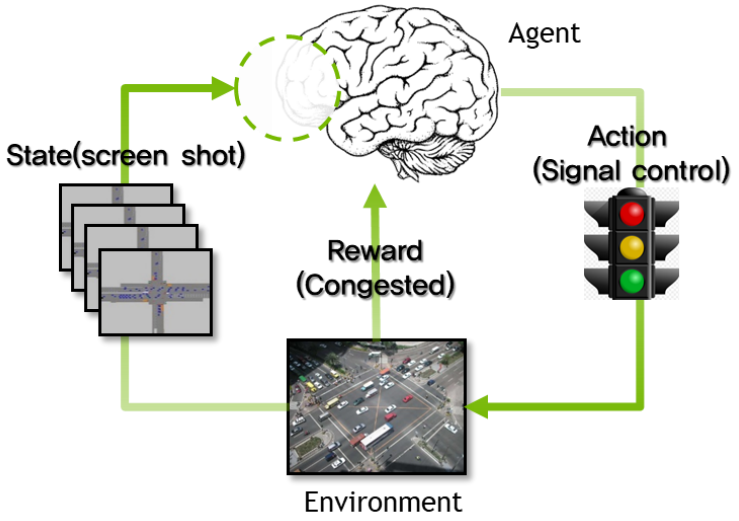
We are responsible to use the HUGE data WELL.

[1] Road maintenance

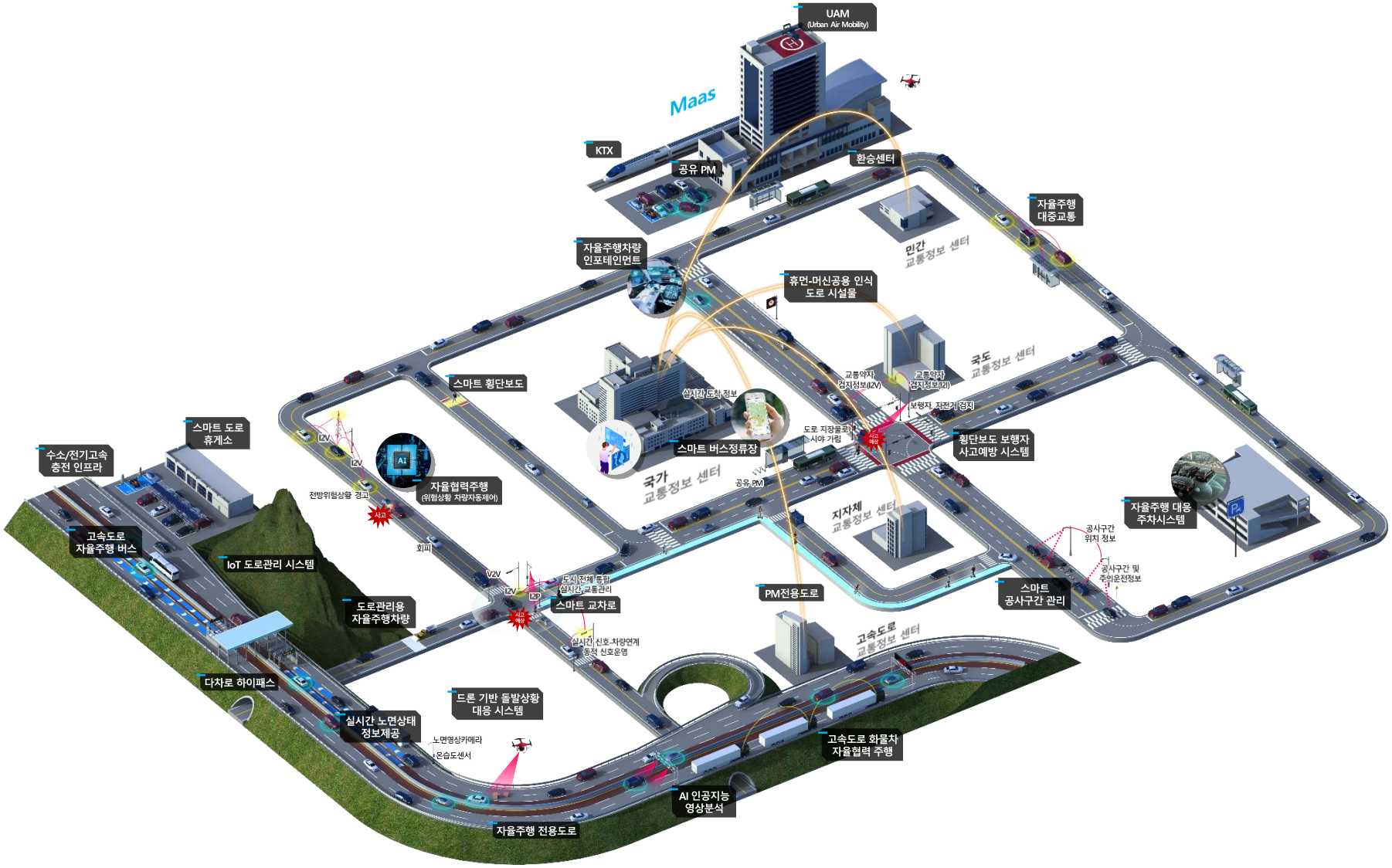
- AV data including radar, lidar, other cameras collected can be used for road maintenance
- Check road condition and geometric design

[2] AI-based traffic signal optimization

- Reduce delay and number of waiting vehicles at intersection
- Optimize the signalized intersection network
- Digital twin required to test in same environment as real situation



2030 Future Transportation Conceptual Design



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Q&A
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