Korea Transportation Safety Authority
Korea Automobile Testing & Research Institute

5G Communication based
Connected & Automated Vehicle Test-bed

K-City

CONTENTS



01 KATRI's History

Safe vehicles based on the test and research

Korea Automobile Testing & Research Institute

Korea Automobile Testing & Research Institute is built in 1987 as an subsidiary research institute of Korea Transportation Safety Authority to decrease the social loss due to traffic accidents and to protect the civil rights through consumer protection.

This institute supports the technical expertise and public policies related to the transportation industry to build the safest environment for everybody to enjoy bright future and happy society with no traffic accident.

- 1987. 05 **Established**
- 1987. 11 **Designated as a safety test institute by MoLIT**
- 1994. 01 **Expansion of safety tests** (6 items → 38 items)
- 1996. 11 **Completion of indoor test facilities** (7 buildings)
- 2001. 01 **Accession to 1998 Agreement**
- 2002. 12 **Completion of 1st phase of proving ground**
- 2004. 12 **Accession to 1958 Agreement**
- 2013. 12 **Completion of advanced proving ground**
- 2017. 8 **Groundbreaking for K-City**
- 2017. 11 **Motorway Opened**
- 2017. 12 **5G Network Set-up**
- 2018. 2 **CAV Demonstration using 5G Network**
- 2018. 12 **Completion of K-City (Open to Public)**

Belong	**Korea Transportation Safety Authority (KOTSA)**
Established	**May 15, 1987**
Address	**Gyunggi-do Hwasung-si Samjon-ro 200**
Organization	**4 office 1 centers**

02 Major Work

[For a Brighter Future without Traffic Accident]

01	02	03	04	05
Vehicle Defect Investigation	New Car Assessment Program	Harmonization with Global Vehicle Regulation	Future Automobile Safety R&D	Government Commissioned Projects

03 Layout

Proving Ground

Advanced tracks

Total cost
$1.242bn

Total length
28.5km

Test track layout features

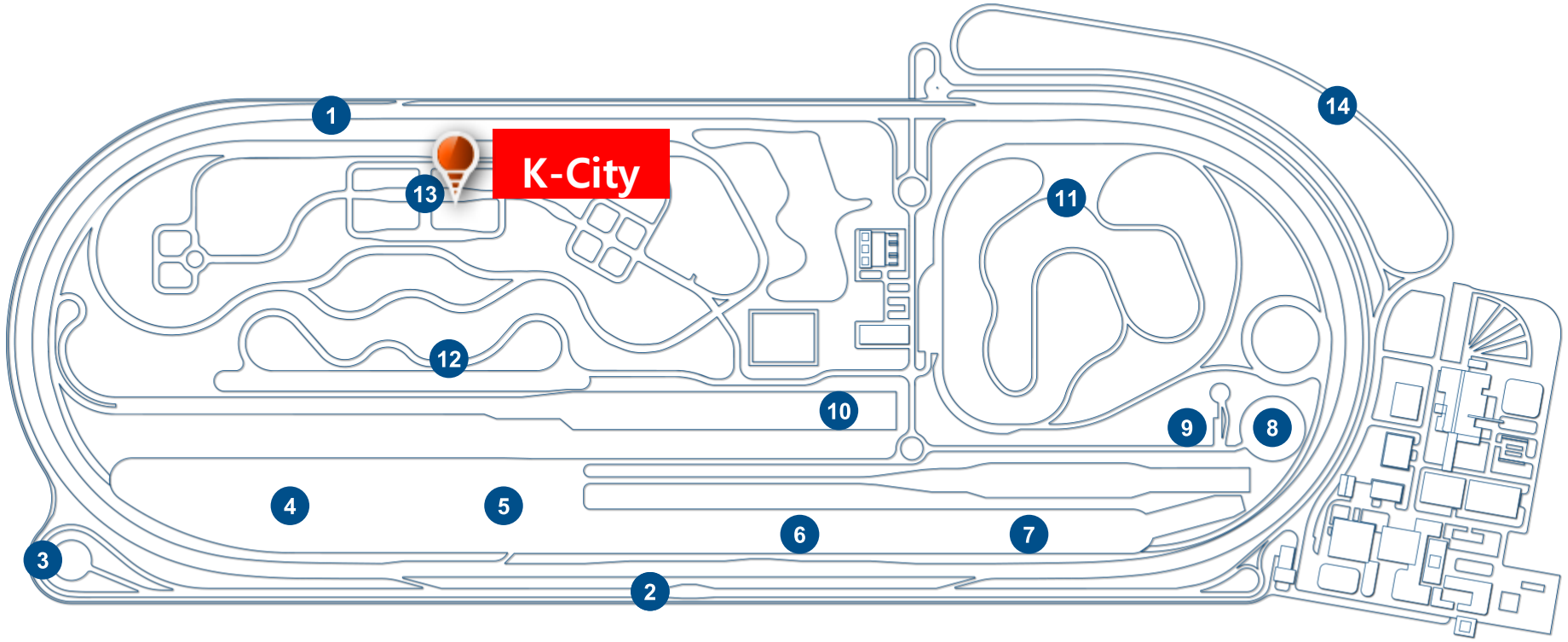
- Natural drain through existing reservoir
- Maintain original topography
- Increase Vehicle safety & Minimize R&D test track
- Easy access to every track (close entrance)
- Maximize efficiency of Test facility management
- Economic and easy to construct

Test Facility

10 of the Facility

- Construction Equipment Inspect Facility
- General Test Facility
- Environmental Test Facility
- Driving and Braking Test Facility
- Impact Test Facility
- Crash Test Facility
- Noise&EMC Test Facility
- Advanced Vehicle Test Facility
- Tire Assessment Test Facility
- Construction Equipment Safety Defect Test Facility

04 Proving Ground




1 High Speed Circuit


2 Straight Road/Noise Test track


3 EMC Test Site


4 Road Safety Features Test Ground


5 Steering Pad


6 Universal Road


7 Low Friction Track


8 Skid Pad


9 Hill Test Track


10 Wide Low Friction Track


11 Handling & Stability Track


12 Durability Track


13 ITS & Ride Comfort Track (K-city site)


14 Off-road Test Track

01 Overview of K-City

Overview of the establishment

- **(Goal) Provision of various on-road environments (road, traffic, and communications)**
  - Simulated testing of possible accidents (crashing) that may happen during the driving
    - ▶ Simulate real world and simulation to support technologies development
- **(Location)** KATRI P.G. (Hwaseong City, Gyeonggi Province)
  - **The area of the current ITS testing circuit is 360,000 ㎡** out of the total area of 2,150,000 ㎢
- **(History)** Aug. of ’17, Groundbreaking for K-City
  Nov. of ‘17, Motorway Open
  Dec. of ‘18, entire sections Open

Located at the Automated Vehicle R&D center of Korea

- Annually, **the cars are jointly used by 88 organizations (in 2018)** including Manufactures, research institutes, IT, Commutation company, and universities.

02 Government goal & Strategy

Government(MOLIT) goal for commercialization of AV

2025
Partial commercialization of Lv. 4

Goal

2027
Common use of Lv. 4

Promotion strategy

01 Improvement of laws & systems / regulations	02 Expansion of service	03 Construction of infrastructure	04 Technology development
Safety standards and insurance	Expansion of budget support, mobility-specialized city	C-ITS, Nationwide high-definition map	R&D for development and innovation of AV technology
Expansion of Pilot Zone, Simplification of Test driving permit process	Safety service for children protection zones	**Advancement of K-City**	Living lab

03 Step-by-step deployment of K-City

1st Step

Basic environment

Finish, '18.12

01 **5 Areas**
- Urban, Motorway, School, Sub-urban, Park

02 **V2X**
- 5G, LTE, WAVE

2nd Step

Extreme environment

Finish, '19~'22.6

01 **Extreme condition**
- Weather chamber, GPS Jamming

02 **Support facilities**
- Future Innovation Center
- Target robot system

3rd Step

Expansion

On-going, '22~'24

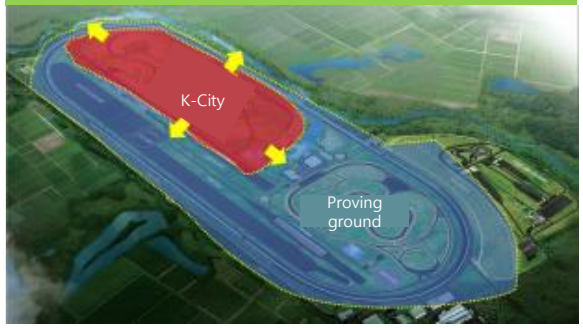
01 **Expansion**
- Intersection, Motorway, V2X

02 **Add**
- Micro road, Overpass

1st Step : Basic environmnet

2nd Step: Extreme environment

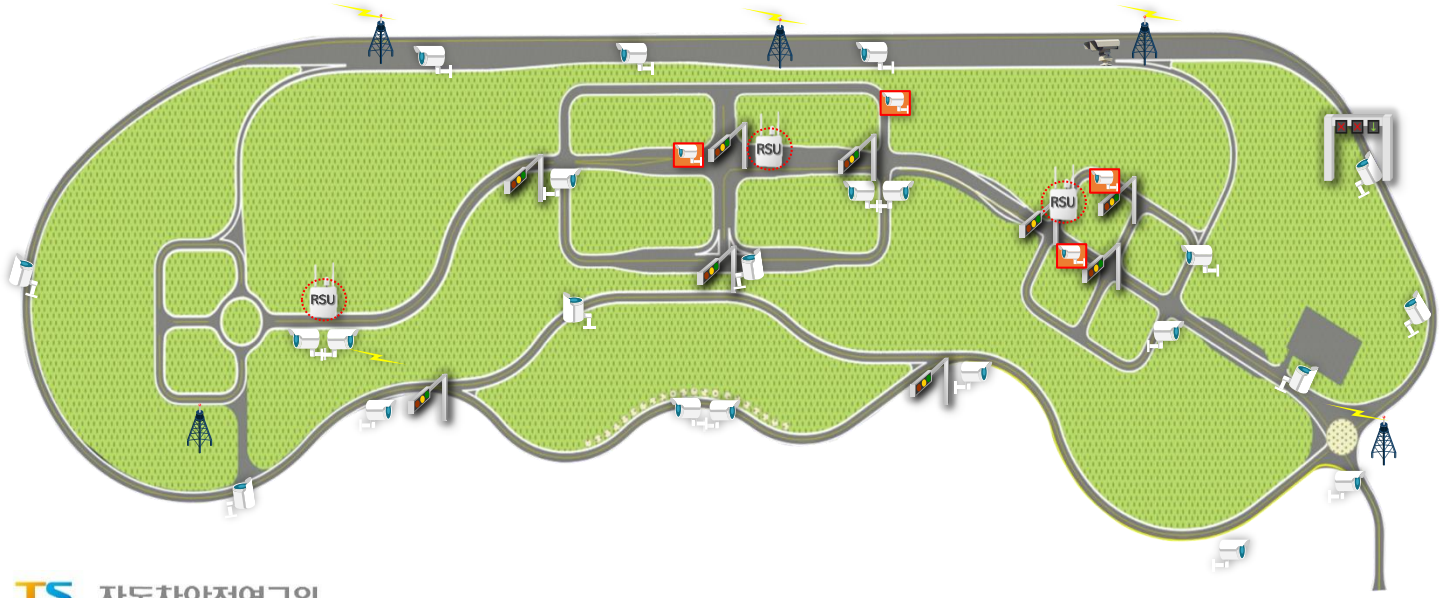
3rd Step : Expansion



04 K-City 1st Step(2018)

V2X infrastructure Control Center

- Display of test car video information (CCTV)
- Display of test car position information (by lane)
- Monitoring of information on test car condition (When car information collecting devices are mounted)
- Display of information on traffic system control (signal control, LCS, etc.)



CCTV 41

Signalized Intersection 9

RSU 4

LCS 1

detection sensor 1

5G Base Station 6

OBU 10

Artificial weather environment facility

Raining

- 5mm/h~60mm/h
- 4 step nozzle
- Rainfall control by section

Fogging

- Fog oil & Fog machine
- Visibility : min. 30M

05 K-City 2nd Step(2022)

Artificial weather environment facility & VRU Target System

Future Innovation Center (for K-City user assist & convenience)

Workshop, Office(1F)

Office, Conference room, Cafeteria(2F)

2,000m², 13 EV charging facilities

1st floor : 6 office rooms(/w workshop), common use workshop

2nd floor : 10 office rooms, conference room, resting room

06 K-City 3rd Step(2024)

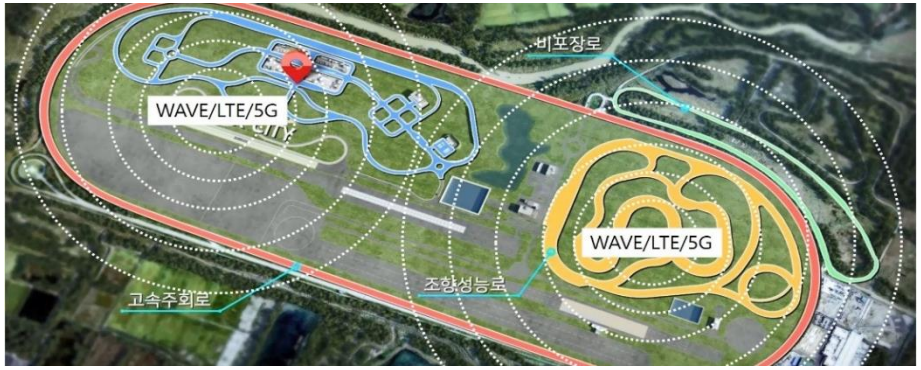
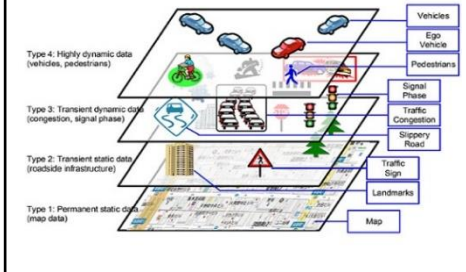
- Expansion of physical test-bed
- Assist AV algorithm development

06 K-City 3rd Step(2024)

Expansion of physical test-bed

06 **K-City 3rd Step(2024)**

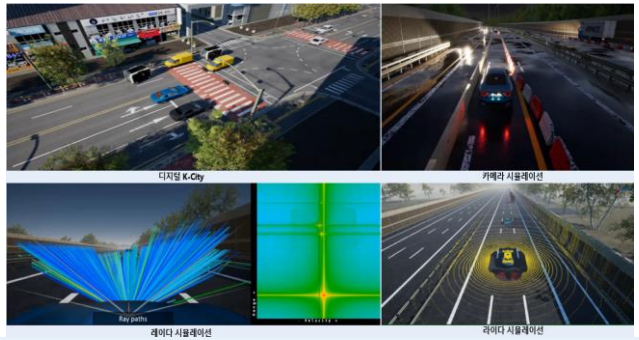
Expand V2X scope for AV test to entire playground

Test section		
	① Larger communication range (WAVE/LTE/5G)	② Larger range of integrated control (CCTV, object detection)
System		
	③ Integrated control tower	④ Dynamic precision map
		
	⑤ Level-specific assessment system	⑥ Computing upgrade

Assist AV algorithm development

Driving simulator

Virtual Env. S/W



Sensor-HIL Test Equipment

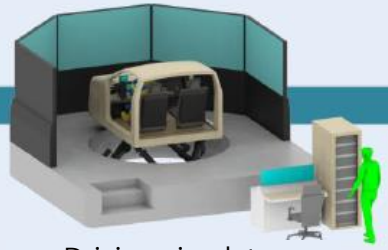
Data logging

Scenario build-up

Multi scenario build-up

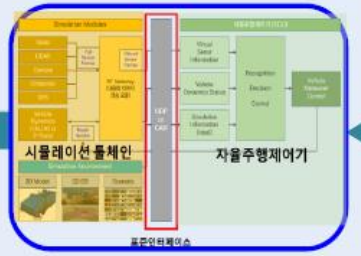
Digital twin

Analyze



Driving simulator

Sensor HIL



Standard Protocol

Interface

07 K-City with R&D

R&D Project for Lv.4

- Project : Level 4 Automated Driving Innovation R&D
- Budget : 1,100,000 Million Won(780 Million EUR) by Government
- Period : ‘21.4 ~ ’27. 12(7 years)
- Sub project : Vehicle & ICT Convergence, **Road+Traffic, AV Service, Safety ecosystem**
  (sub-projects : 53, organizations : 373, researchers : 3,474)

<Vehicle Convergence>

Development
Lv. 4 AV System

<ICT Convergence>

Development
Infrastructure, Sensor, wireless communication Technology

<Road & Traffic Convergence>

Road, Traffic Management

<ADS Service>

<ADS Safety>

Driving Safety
Simulation & System Safety
Perception Safety
EMC & V2X
Cyber Security

07 K-City with R&D

R&D Project for Lv.4

Automated Driving EcoSystem

Automated Driving (stand-alne)

- 국-16 Safety Evaluation Of Driving and Collision
- 국-17 Safety Evaluation Of Simulation And Systematic Approach
- 국-18 V2E Cognitive Judgement Safety and Evaluation for Accidents

Automated and Cooperative Driving (V2X)

- 국-19 Safety Evaluation Of Fusion Freight Vehicle and Road Infrastructure
- 국-20 Safety Evaluation Of Integrated Automotive Cybersecurity Assurance
- 국-21 Safety Evaluation Of V2X Communication, Electromagnetic Compatibility

Road-Traffic Integrated New Technology

Development of Core Infra Technology

- 국-1 Integrated Digital Platform for Road Transport Infra (Crowd sourcing) → HD map (Local Dynamic map)
- 국-2 Road Situational Awareness System
- 국-4 Infra Guidance

→ Infrastructures and Communications

Virtual demonstration env.

Virtual Environment Test (Simulation)

Testbed demonstration env.

Lv.4/4+ Automted Vehicle Test Bed (K-City)

Living lab.

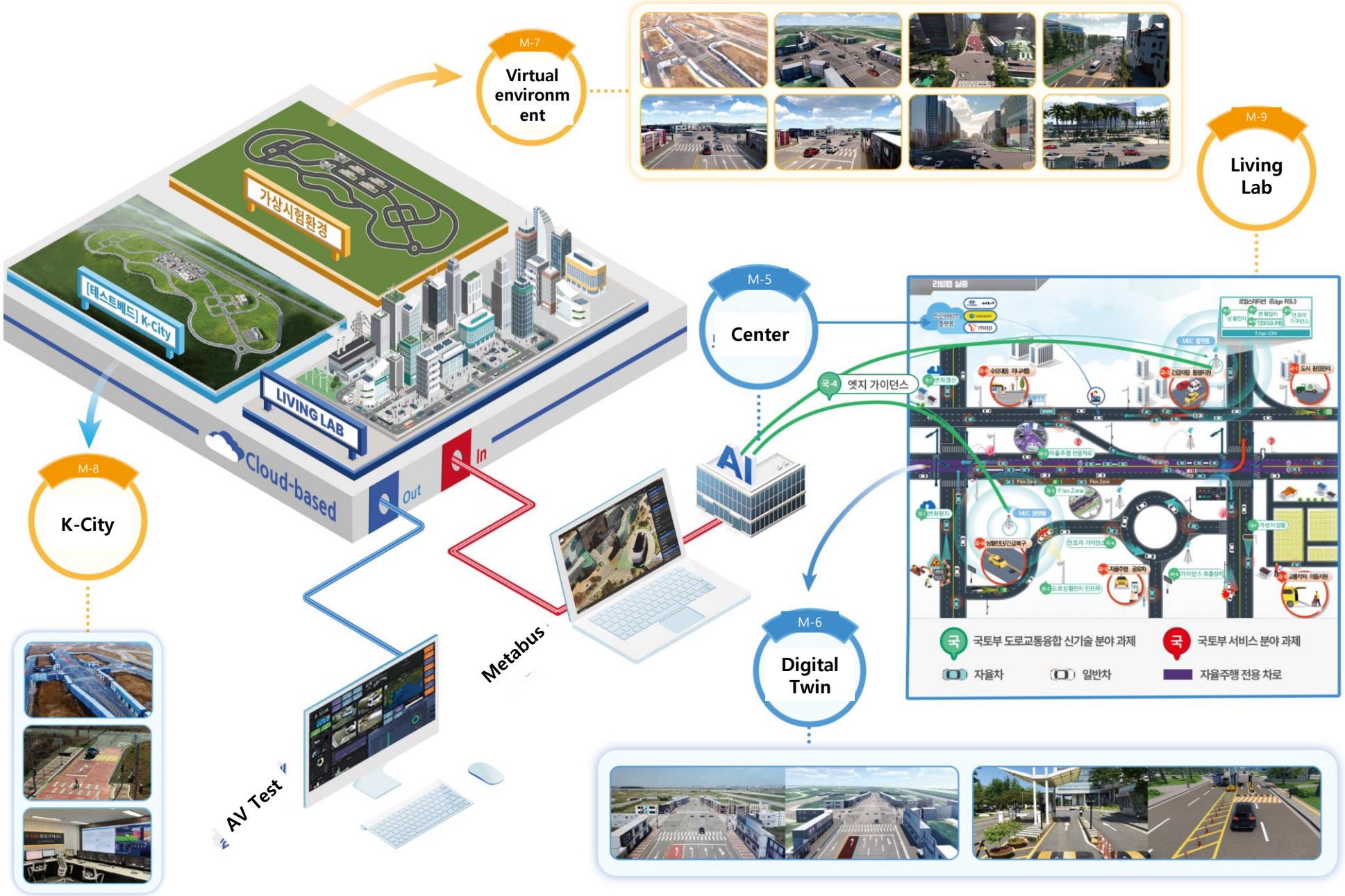
Living Lab

Demonstration of Automated Driving Technologies and Services in Living Lab

Automated Driving Service

- 국-10 Mobility Service for Transport Vulnerable — 교통약자 이동지원
- 국-11 Public Transport On-demand Mobility Service in Real-Time — 수요대응 미니셔틀
- 국-12 Automated Car-sharing Service — 자율주행 공유차
- 국-13 Service for Urban Environment Management — 도시 환경관리
- 국-14 Infrastructure Monitoring and Emergency Recovery Support Service — 인프라 모니터링
- 국-15 Assisting Emergency Vehicles and On-site Response Service — 긴급차량 통행지원

07 K-City with R&D(MOLIT-7)



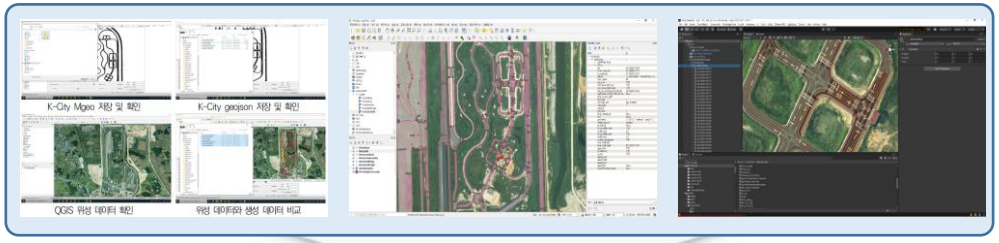
07 K-City with R&D(MOLIT-8)

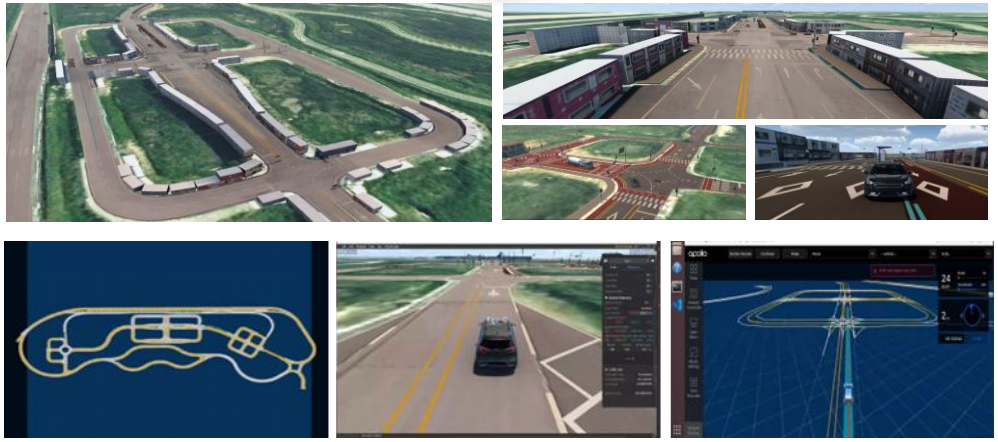
Expand to Virtual Testing (based on VILs)

Digital twin of K-City

- Construction of virtual K-City environment
- Building a K-City Virtual Environment Using National Geographic Information Institute Data
- Expand K-City Utilization through Apollo Map Deployment

Create a Driving Environment with Map Editor | Review the results of the virtual environment created | Implementing a Physical Engine-Based Virtual Environment





Virtual objects modeling for various scenarios

- Signal light, traffic sign modeling
- Animated object model

Road traffic infra

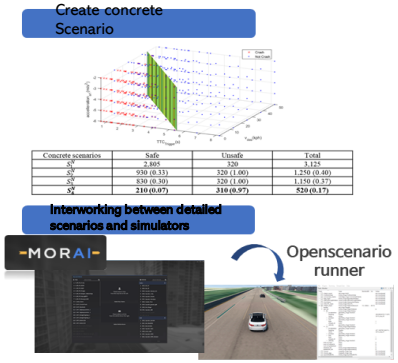
Pedestrian model

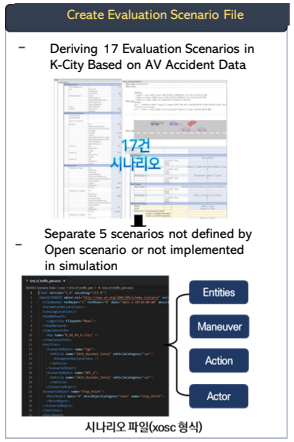
07 K-City with R&D(MOLIT-8)

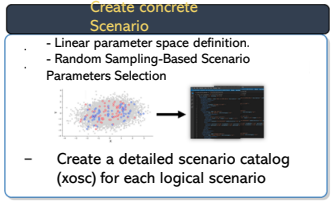
Expand to Virtual Testing (based on VILs)

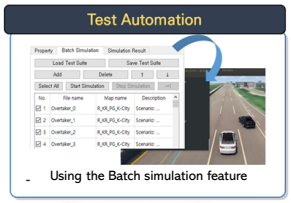
Snenario build-up & DB

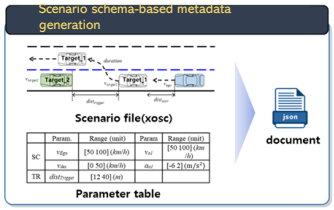
- ASAM Open scenario
- **Transform the default scenario and generate metadata for the evaluation scenario**
- **Set variable range by scenario and create detailed scenarios based on random sampling**

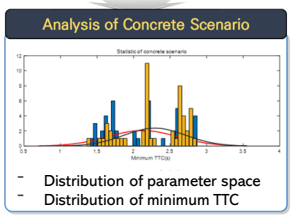








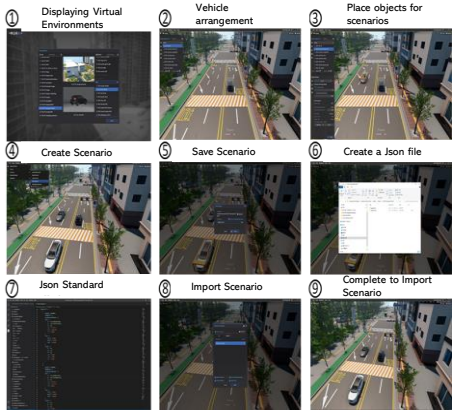


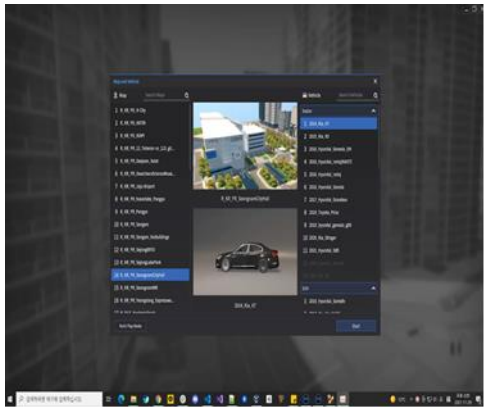


Use scenario file (Open-x ontology)

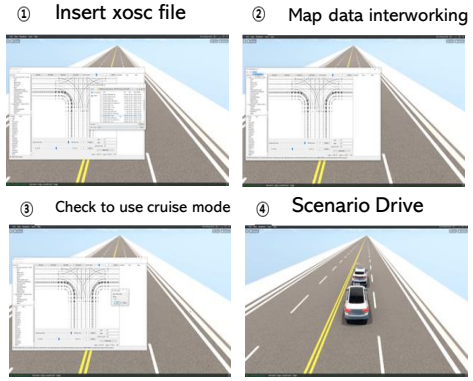
- Function to load Json format scenario file

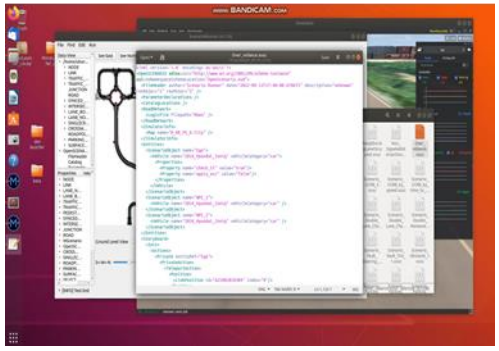
Create and run GUI-based scenarios





- Function to load Open Scenario (xosc) format scenario file



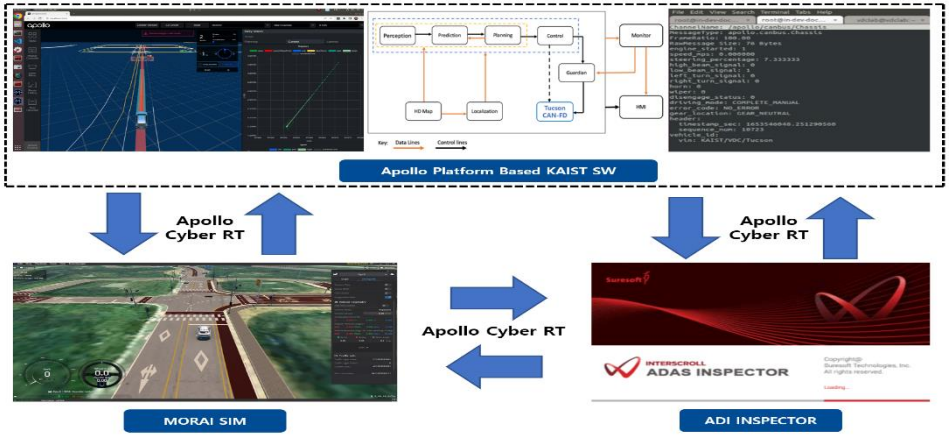


07 K-City with R&D(MOLIT-8)

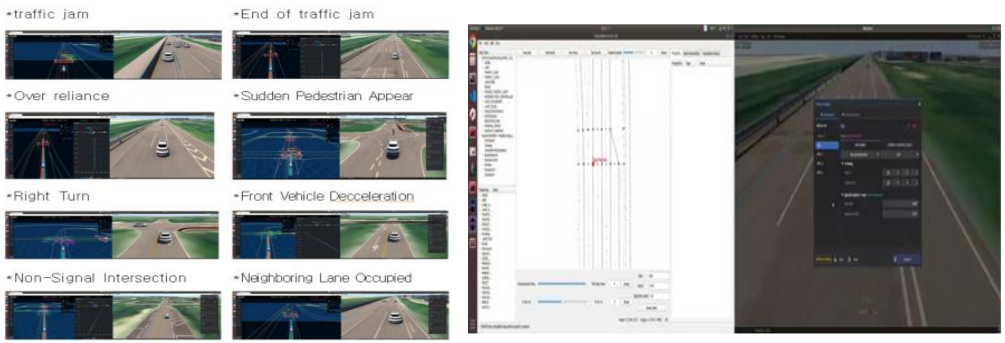
Expand to Virtual Testing (based on VILs)

SILS Test Environment

- Apollo algorithm and scenario testing by SILs

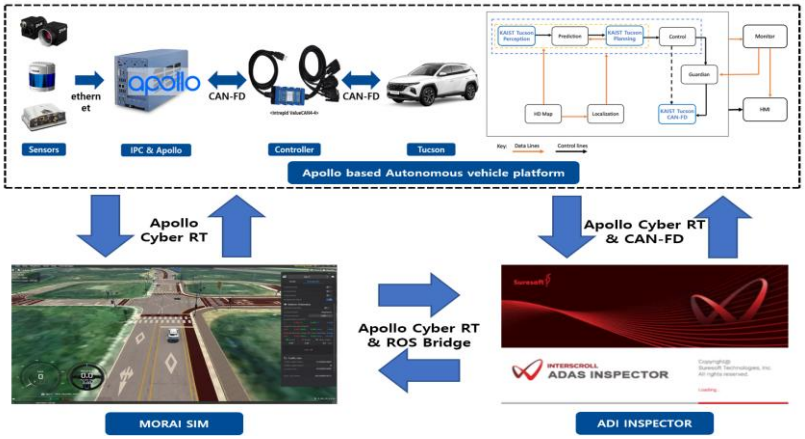


SILS(Software-In-the-Loop Simulation) Config.



VILS Test Environment

- Vehicle platform(based on Apollo Framework) testing by VILs
- K-City test snenario testing



VILS(Vehicle-In-the-Loop Simulation) Config.

THANK YOU VERY MUCH

for your attention

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