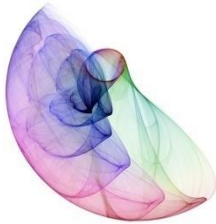


Ministry of Land, Infrastructure and Transport

Network based Precise Positioning Infrastructure for Land Transportation (NETPPI-LT)

2019. 1. 2

Korea Aerospace Research Institute

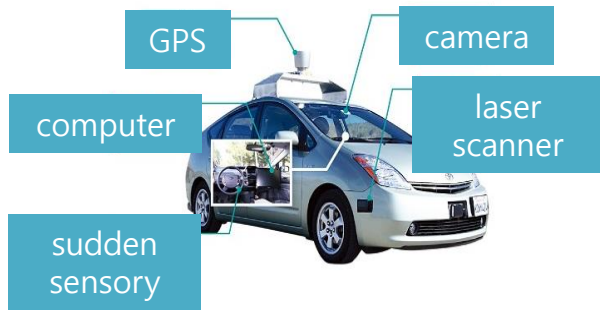


I . Introduction of the project



Objective

- Currently, use of GNSS has been limited to provide user vehicle position on the road.
- In order to use GNSS for Vehicle position, GNSS position information should be more reliable



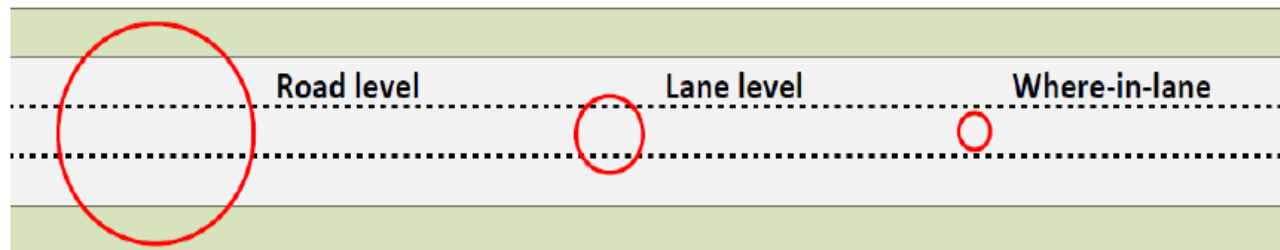
Autonomous vehicle



Platooning



Another vehicle traffic guidance in car lane

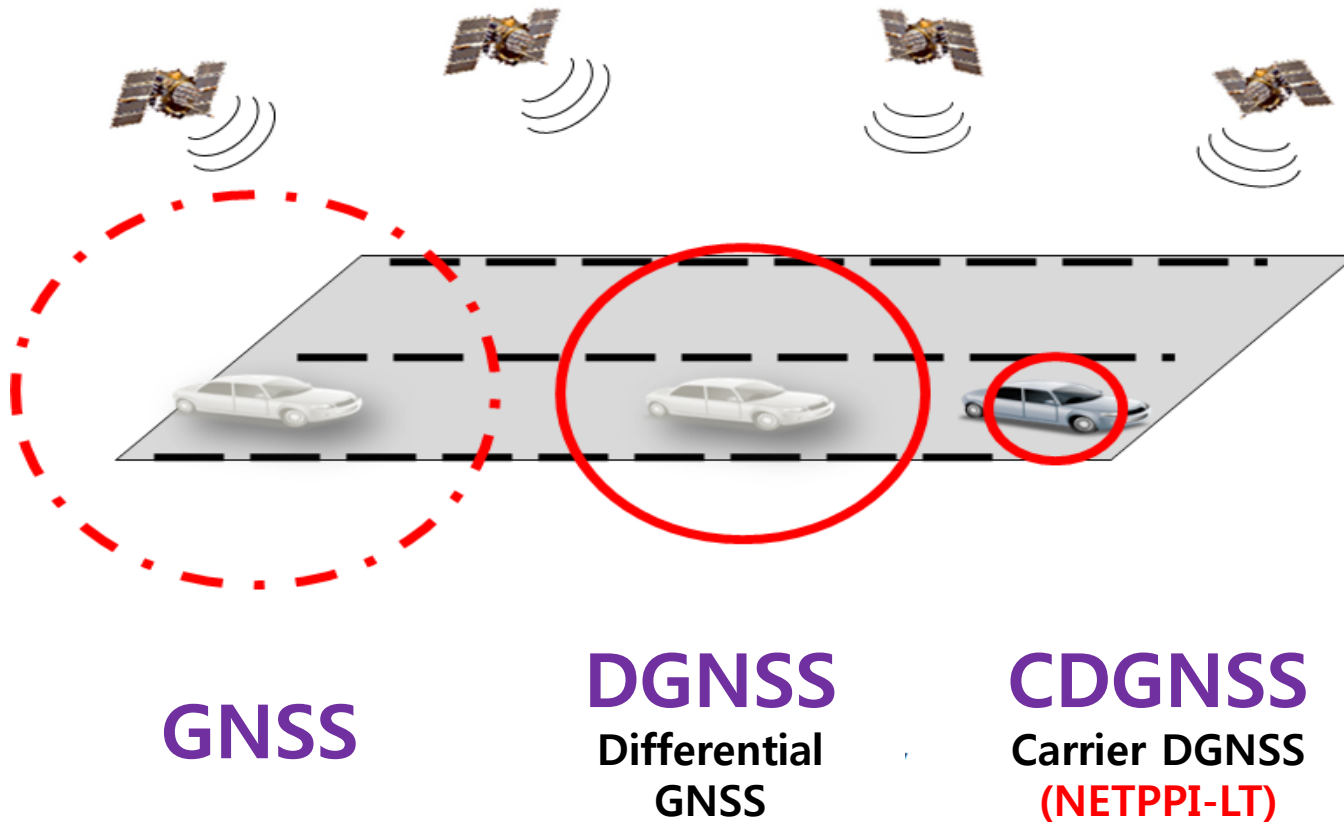


Determining performance level the position of the vehicle on the road



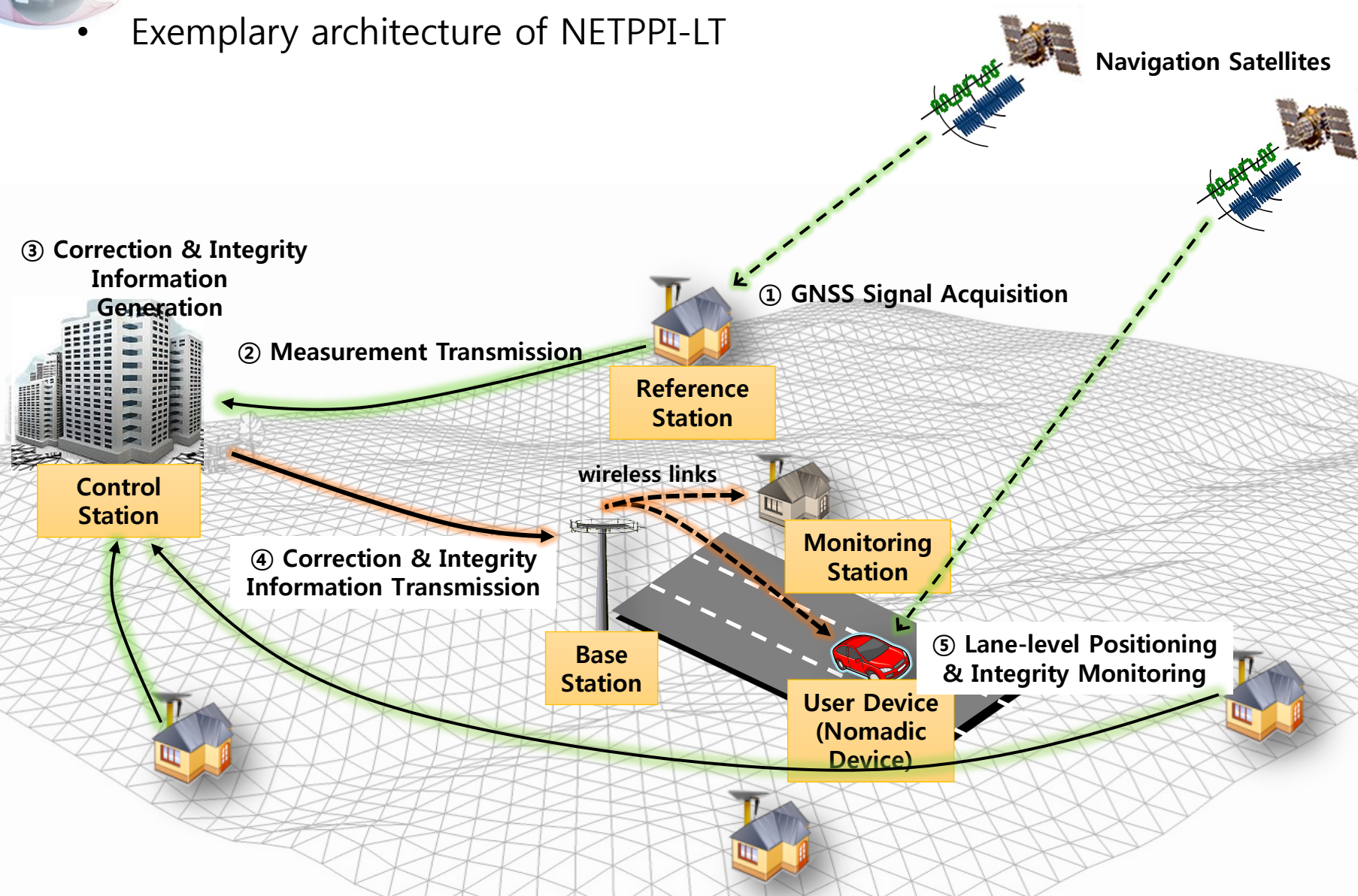
NETPPI-LT

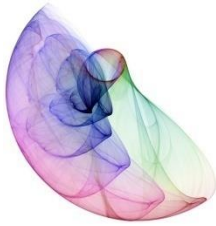
- Development of the position determination techniques using satellite navigation under land traffic environment
- Development of the core technology for lane-recognition **using** GNSS **single frequency receiver(low-price)** during driving



DEVELOPMENT OF NETPPI-LT IN SOUTH KOREA

- Exemplary architecture of NETPPI-LT





II. NETPPI-LT Components and Requirements

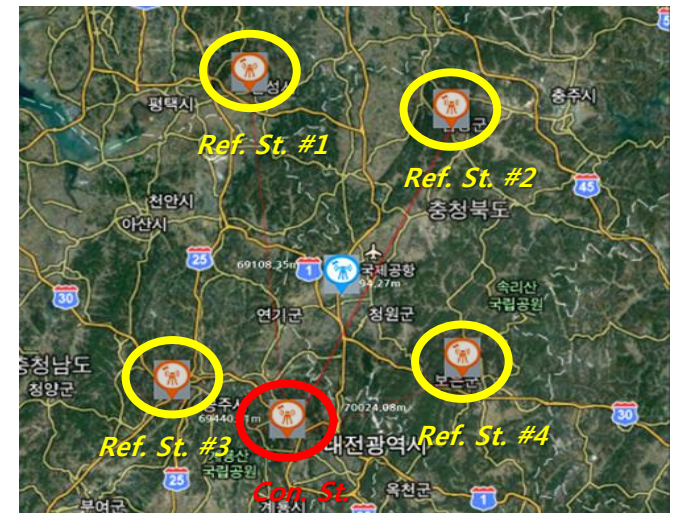


Reference Station

- Reference Station Functionalities
 - To collect GNSS signal and weather information (pressure, temperature, humidity)
 - To send the collected data to Control Station
- Requirements for Reference Station
 - Redundancy system to operate reliable system
 - High specification hardware to minimize errors from GNSS signal
 - Meteorological data acquisition to minimize errors from the troposphere
 - At least 3 reference stations in operation to secure one cluster
 - UPS system against power failure



Location of Reference Devices



Location of Reference Stations

Control Station

- Control Station Function

- To receive the collected data from Reference Stations
- To generate the carrier phase measurement correction and integrity information based on network of Reference Stations
- To broadcast the correction and integrity information to users using DMB/wireless

- Requirements for Control Station

- Redundancy system for Control Station reliability assurance
- High-throughput GNSS data processing based on multi Reference Stations
- Surveillance for fault detection of satellite navigation signal from each Reference Station
- Communication methods and protocols for correction and integrity information support
- UPS system against power failure

- Research Activities

- The Main Control Station was developed and installed in KARI
- Performance has been evaluated in real time



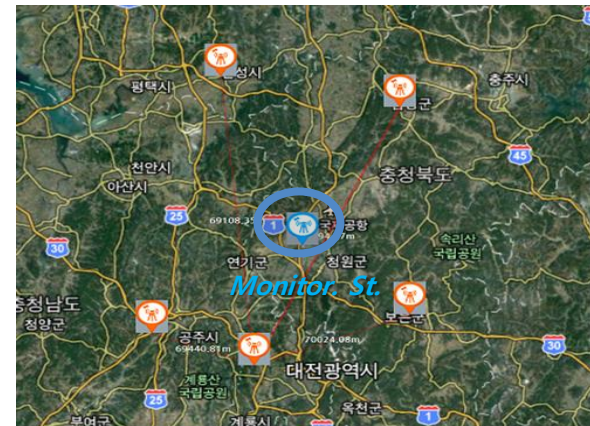


Monitoring Station

- Monitoring Station Function
 - Precise positioning for performance monitoring of correction and integrity information
- Requirements for Monitoring Station
 - High-accuracy positioning system that has similar performances as User Terminal Device
 - High-performance positioning system for performance evaluation
 - Transmission system for correction and integrity information acquisition
 - Error reporting and logging
 - UPS system against power failure
- Research Activities
 - The Monitoring Station was developed and installed in Testbed
 - Performance has been evaluated in real time



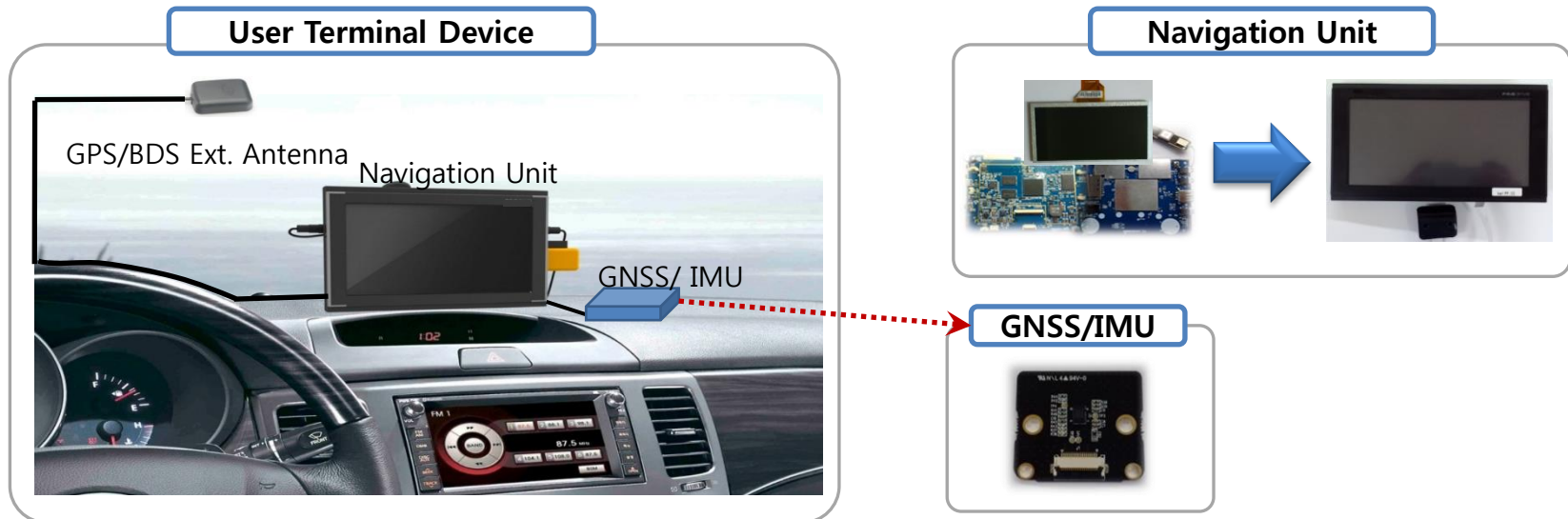
Location of Monitoring Devices



Location of Monitoring Station

User Terminal Device

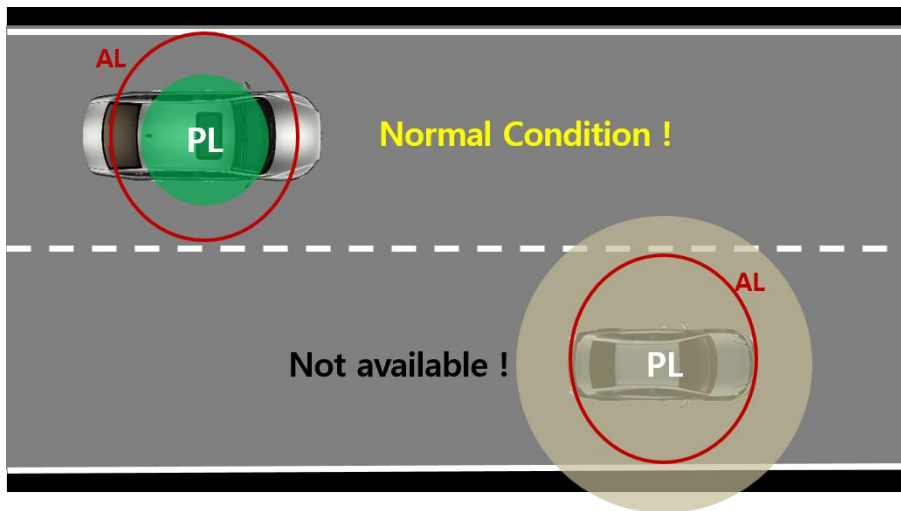
- User Terminal Device Function
 - To receive GPS/BDS signal and the correction with integrity information from Control Stations
 - To calculate precise position with low-cost GNSS receiver and IMU
- Requirements of User Terminal Device
 - Communication equipment for receiving correction and integrity information
 - Low-cost inertial sensor for reliability assurance of GNSS-based positioning
- Research Activities
 - Prototype User Terminal Devices were developed
 - Performance was evaluated in real time (Gyeongbu Expressway)



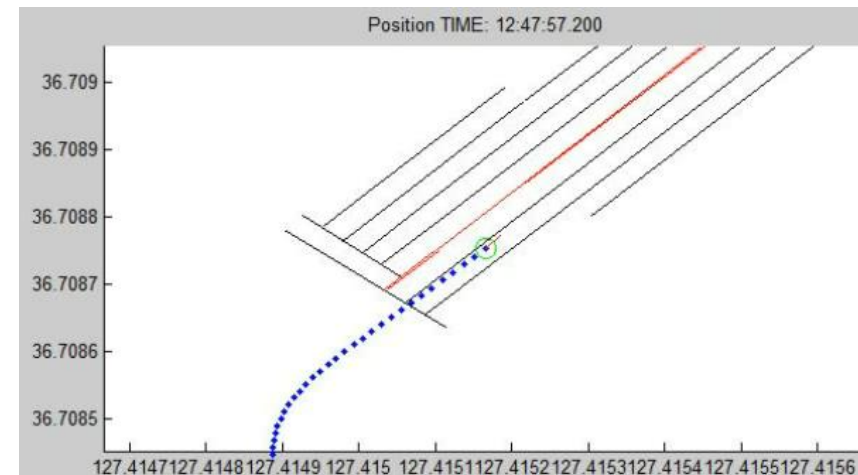


Provision of integrity information for position determination of vehicle

- Providing integrity information in order to ensure the reliability of the positioning (Protection Level) of the vehicle
 - Detection and isolation of satellite navigation signal/message failure for calculation of integrity information
 - Integrity information : predicted value of position error information by NETPPI-LT (guaranteed integrity probability : 99.99%)



System availability criteria using integrity information
(PL : Protection Level, AL : Alert Limit = 1.5m)



Result of near real time kinematic positioning
(green circle: protection level)

NETPPI-LT Current Status

- Extension of service area with multi-GNSS
 - 4 clusters construction with main control station, GPS/BDS based user device

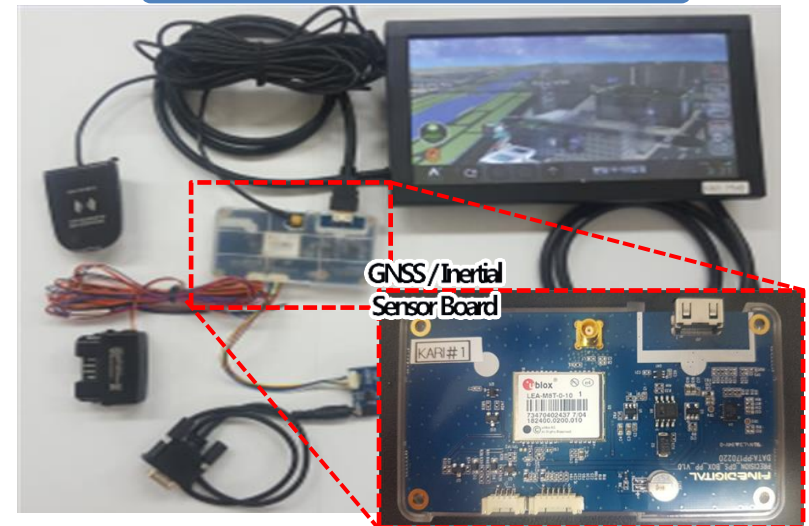
Multi-NETPPI-LT Clusters



Main Control Station



User Device (GPS/BDS Based)



User Device Display



NETPPI-LT Test Results

Test#1

NETPPI-LT Vehicle Lane Recognition and Change Test (@ Gyeongbu Expressway)

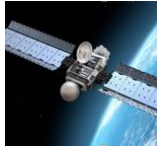
Multi-GNSS based Precision Positioning (Lane - recognition)

- Infra : broadcasting correction and integrity info. (@Cluster A)
- Vehicle : Low Cost GPS/BDS Receiver (L1 frequency)

Current Status



GPS (USA)



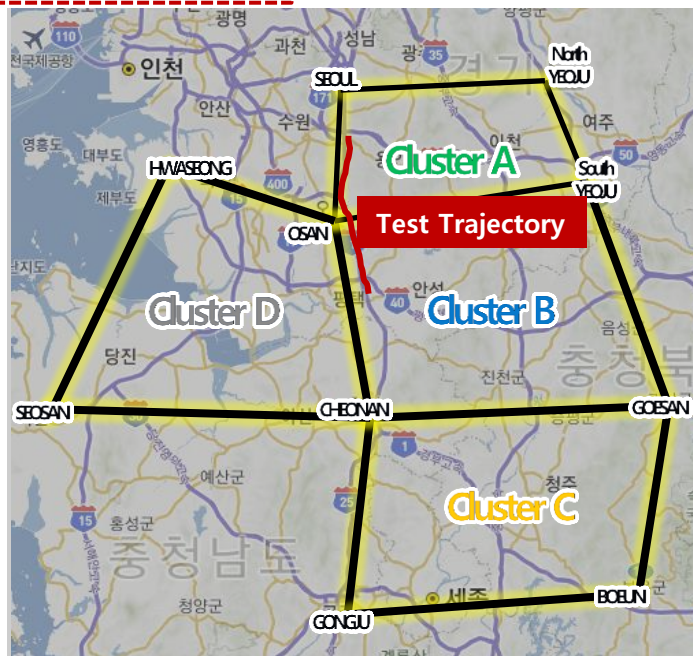
Beidou (China)



GPS (USA)



GLONASS (RUSSIA)



Test Trajectory (Kyeongbu Expressway)

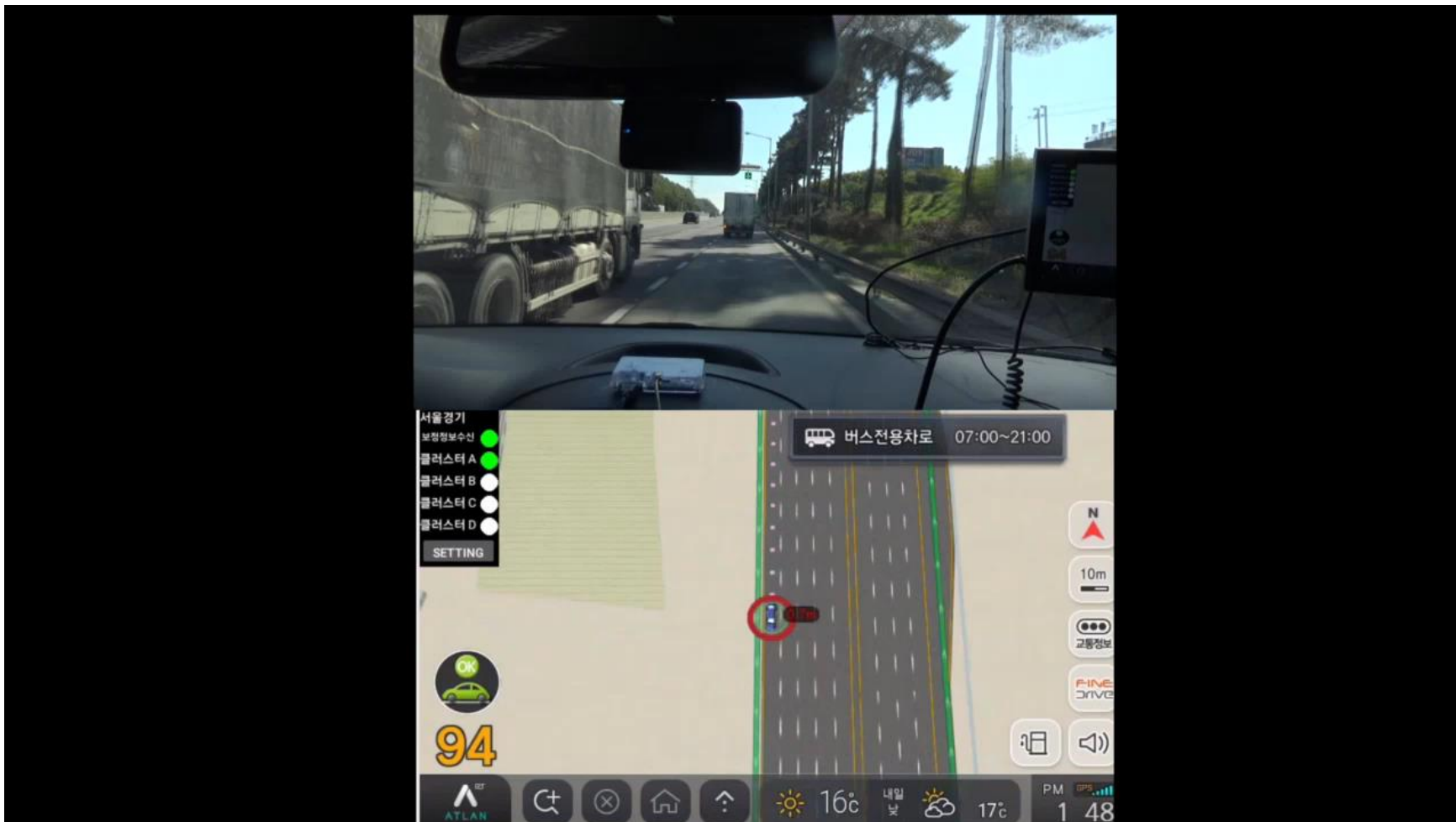


Vehicle Lane Recognition and Change Test
(5th→2nd)

NETPPI-LT Test Results (Video)

Test#1

NETPPI-LT Vehicle Lane Recognition and Change Test (@ Gyeongbu Expressway)



NETPPI-LT Test Results

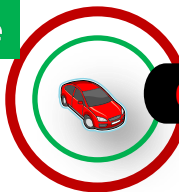
Test#2

NETPPI-LT Vehicle Integrity Test (@ Gyeongbu Expressway)

Integrity Information (Position Error Estimation) based on
GNSS signal status and satellites geometry condition

※ NETPPI-LT System is unavailable when integrity information is above 1.5m
(=NETPPI-LT cannot guarantee of lane recognition)

Available



0.4m

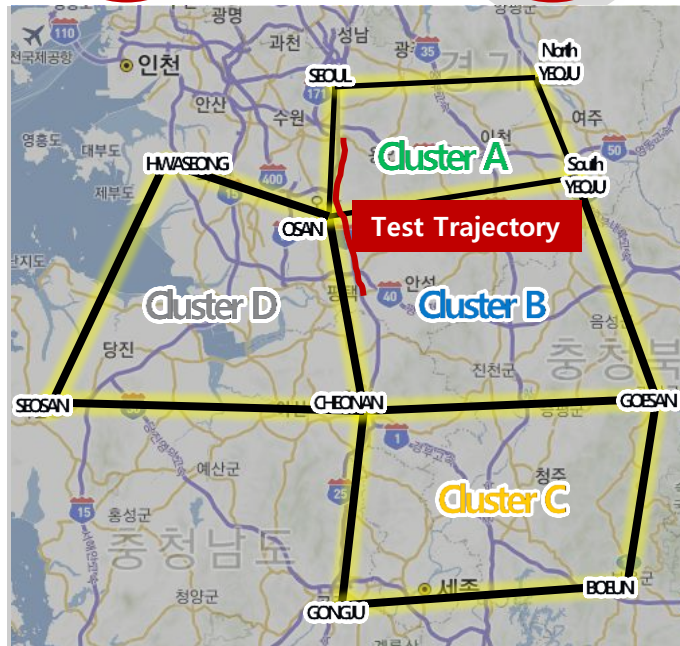
Below 1.5m

Not
Available

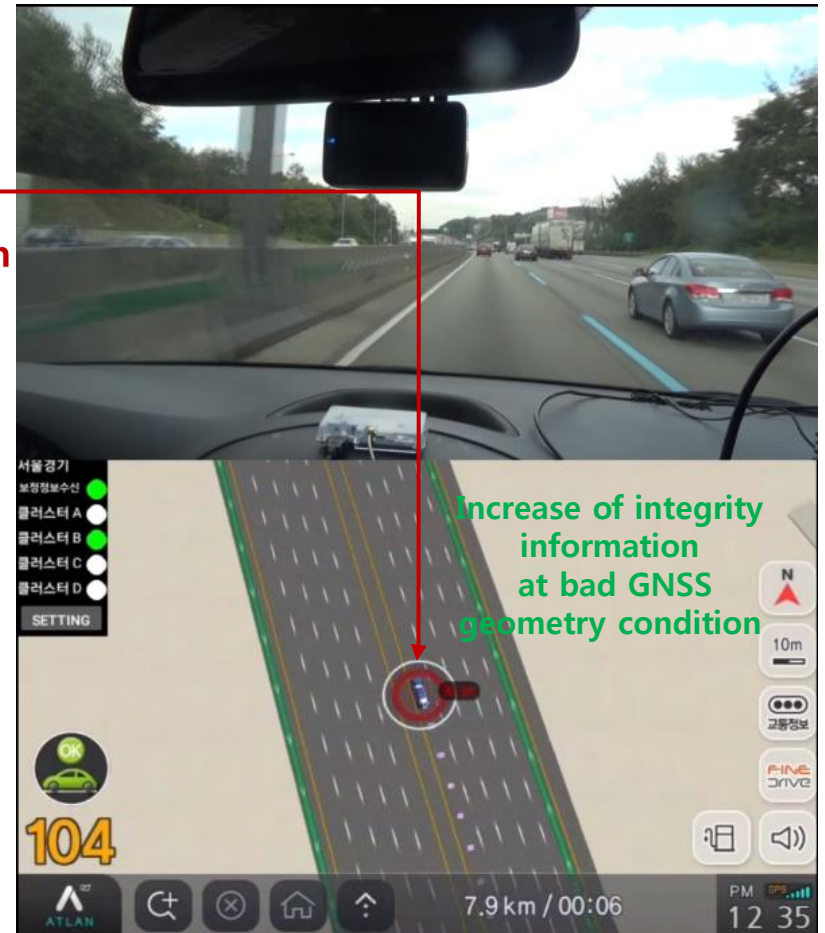


2.2m

Above 1.5m



Test Trajectory (Gyeongbu Expressway)



NETPPI-LT Test Results (Video)

Test#2

NETPPI-LT Vehicle Integrity Test (@Gyeongbu Expressway), Video



THANK YOU