



Charge-free TVWS Wireless Local Networks with AI Servers for Smart Life & Public Safety

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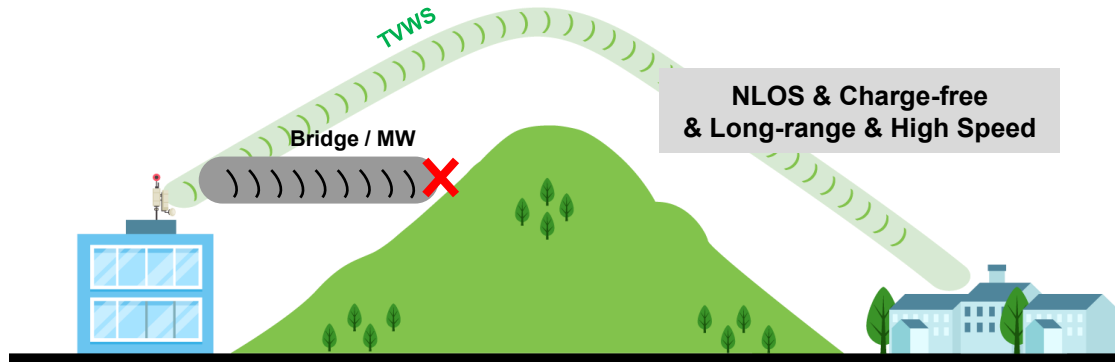
How to Connect Internet Economically for Smart Life and Emergency Situation ?



TVWS & UN SDGs(Sustainable Development Goals)

TVWS

- Temporally and Spatially Empty Channels in D-TV band
- Allocating Available CHs from TVWS DB Server Based on GPS



Item	RF Bridge	Wi-Fi	TVWS
Frequency	2.4/5 GHz	2.4/5/6 GHz	470 ~ 698 MHz
Max. Service Distance	> 5 km	> 150 m	> 10 km @ Fixed TVWS CH (EIRP 36dBm) < 1km @ Portable CH (EIRP 20dBm)
Beamwidth	About 7 degree	360 degree	About 40~50degree
P2MP	X	O	O
NLOS	X	X	O
GI (Guard Interval)	0.8us (250m)	0.8us (250m)	6us (1,800m)
Max. Throughput	> 100 Mbps	> 500 Mbps	26 ~ 40 Mbps
Wi-Fi Interference	O	-	X
Weather Effect	O	-	X
Application	LOS, Fixed Object	LOS, Near Range	LOS/N-LOS, Fixed & Movable Object

SDGs

12(of 17) Global Challenges such as Poverty, Education, Health, Energy, Environment, Climate, Inequality, Economic Growth, Peace

Items	Relevant SDGs	Explanation
LEO satellite backhaul + wireless local network	SDG#9 Industry, Innovation SDG#10 Reduced Inequality	Eliminate communication blind spots, ensure digital access rights through public-private collaboration
Internet & Wi-Fi	SDG#9 Industry, Innovation SDG#10 Reduced Inequality	Bridge the digital divide, provide access to online education
AI e-Learning platform	SDG#4 Quality Education	Improve access to remote education for rural and low-income students
Telemedicine & Healthcare	SDG#3 Good Health and Well-being	Improve access to local healthcare & support preventive medicine
Two-way village Broadcasting	SDG#11 Sustainable SDG#16 Peace, Justice	Deliver real-time local news and emergency alerts,
Smart delivery (location and etc.) management	SDG #9 Industry, Innovation SDG #12 Responsible	Optimize cold-chain delivery of medicine, fresh food, reduce waste
Vehicle, farming machine & fishing vessel GPS tracking	SDG#8 Decent Work & SDG#13 Climate Action	Improve energy efficiency, reduce accidents, and enable sustainable ..
Greenhouse & crop IoT	SDG#1 No Poverty SDG#2 Zero Hunger SDG#12 Sustainable SDG#15 Life on Land	Optimize crop yield, reduce water/fertilizer/pesticide use, protect biodiversity
Renewable energy (solar, etc.)	SDG#7 Affordable & Clean SDG #13 Climate Action	Enable energy independence & carbon reduction through clean energy
Emergency comm. during disasters	SDG#9 Infrastructure SDG#11 Sustainable Cities	Emergency comm. during disasters like wildfires/floods using solar-powered network
Integrated platform Operation	SDG#17 Partnerships for Goal	Facilitate data sharing and platform cooperation between governments, NGOs, and private

Why Innovation ?

“Diverse TVWS Devices for Rural, Urban, Construction Sites, Disaster/War Zones”

Charge-free & High-speed Data & >10km Long Range & LOS/NLOS & Wide Beamwidth

Fixed Type for IoT



Diverse Interfaces

Charge-free LOS/N-LOS Long Range
TVWS Backhaul

IoT Interfaces of Wi-Fi, Ethernet, BLE &
LoRa G/W, RS-485, USB, DC12V

Security Module for Local
Governments and Military

Powered by Solar Power Generator

Easy to Operate

Mobile Type for Public Safety



Backpack & Vehicle BS

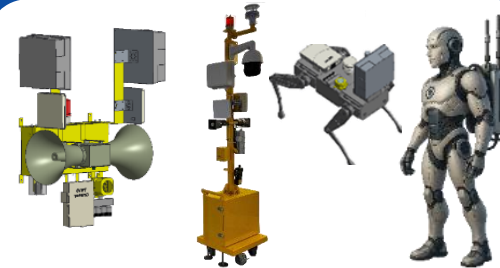
LEO Satellite Backhaul Backpack TVWS
Base Station

LEO Satellite Backhaul Backpack Wi-Fi

Patented in Korea, US, Europe, China

Requested by Forest Service, National
Fire Agency, National Police Agency,
Ministry of National Defense, and
Ministry of Interior and Safety

Regulation Sandbox



Smart Construction, Robot Dog & Fire Truck BS

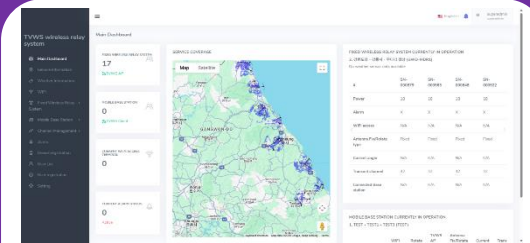
Fixed-channel Ferry Service

Underground TVWS Smart
Construction Safety System

Fixed-channel Use in Fire
Truck/Portable/Trailer BS in Stop
Status

Underground Backpack TVWS
Base Station and TVWS Robot
Dog Service

AI Servers and App



Optimization, e-learning, Smart Farm... Server

Optimized Server for TVWS Service
Coverage Display, Optimal TVWS CH
Allocation, and Wi-Fi Usage
Measurement.

Smart Farm Server for Low-speed and
Low-cost Operation.

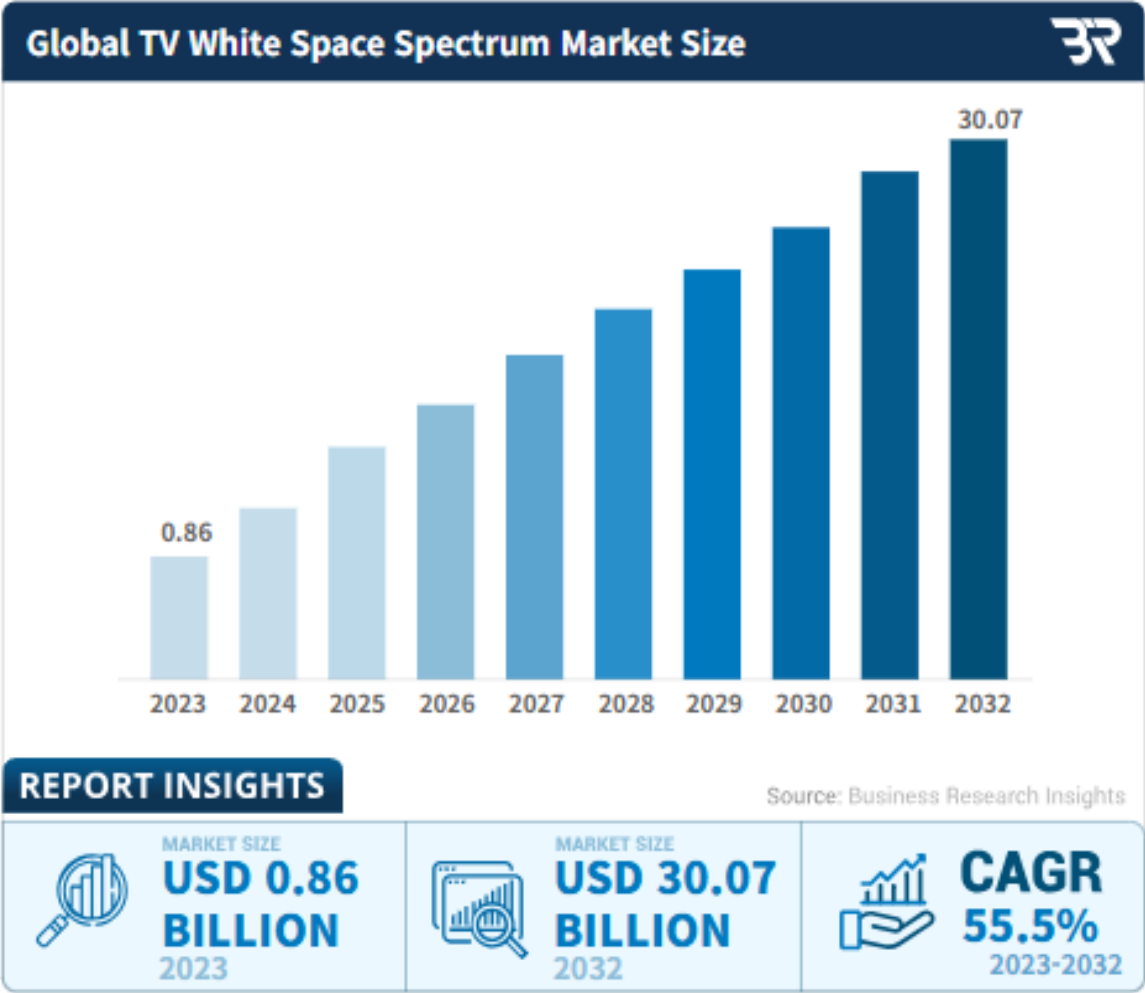
Public Safety Server for Public Safety
and Smart Construction.

Integrated with AI technology.

TVWS Market & Global TVWS Players

TVWS Market

▪TV White Space Spectrum Market Size, September 2025, Business Research Insights



Global TVWS Players

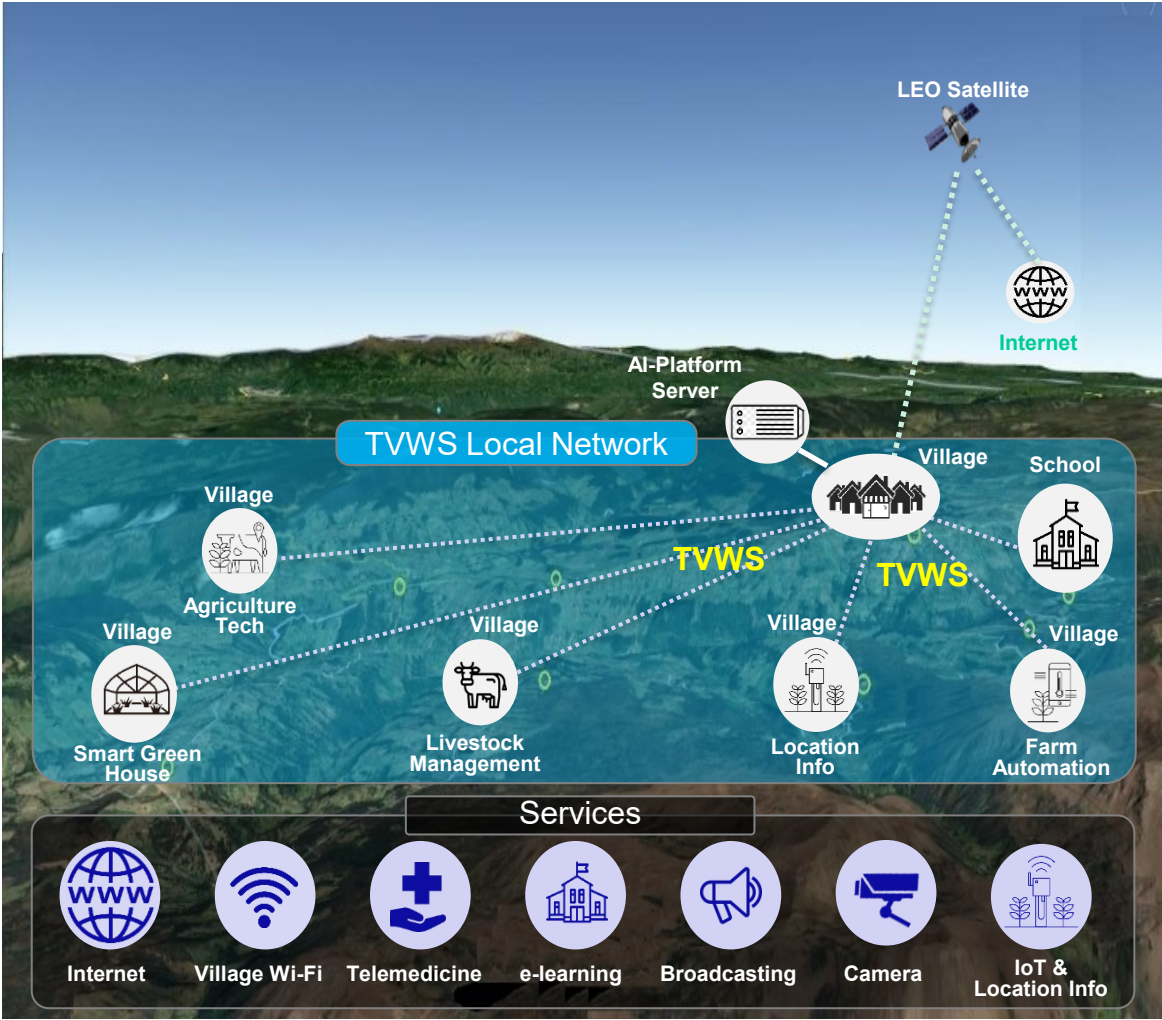
▪Microsoft Airband partners, Carlson Wireless, Adaptrum, 6Harmonics, WiFrost, etc

Category	INNONENT (South Korea)	Global TVWS Manufacturers
Core Tech	TV White Space (TVWS) wireless local network platforms	TVWS-based broadband access, rural connectivity solutions
Unique Features	- Long-range (>10km) LOS/NLOS connectivity - Charge-free local networks - Solar-powered, portable, and vehicle mounted BS (base stations) - Integration with AI servers	- Focus on fixed rural broadband - Emphasis on backhaul for last-mile connectivity - Mostly fixed CPEs (Customer Premises Equipment)
Main Products	- Fixed TVWS Gateway (BHHST10) - Backpack TVWS Relay BS (BRTBS10) - TVWS Backpack Wi-Fi (BTCPE10) - TVWS Edge Device (USSII10B)	- Fixed Base Stations- Outdoor CPEs - Limited mobility products (fewer portable/backpack solutions compared to Innonet)
Applications	- Smart City (bus stops, tunnels, safety) - Smart Village (telemedicine, e-learning, IoT) - Disaster response (forest fire, flood, emergency comm.) - Military/police mesh network (robot dog...)	- Rural broadband for underserved communities - IoT agriculture - Public Wi-Fi in remote areas - Education connectivity
Certifications	- FCC (Fixed TVWS G/W, Backpack Wi-Fi) - CE (Fixed Gateway & Backpack Wi-Fi) - ICASA (South Africa TVWS Gateway)	- FCC/CE depending on region - Generally comply with PAWS protocol - Fewer field certifications for mobile/public safety
Global Deployments	- South Korea (smart farms, smart cities, construction sites) - Africa (South Africa, Tanzania) - Middle East (Saudi Arabia) - Latin America (Colombia, etc.)	- Africa, Southeast Asia, North America - Primarily focused on rural connectivity pilots and commercial rollouts
Innovation Edge	- First-mover in mobile & backpack TVWS solutions - AI-integrated servers for telemedicine, safety, smart farming	- Stronger in scaling fixed broadband deployments - Larger commercial presence but less innovation in mobile/emergency use cases

Smart Village & Smart City Network

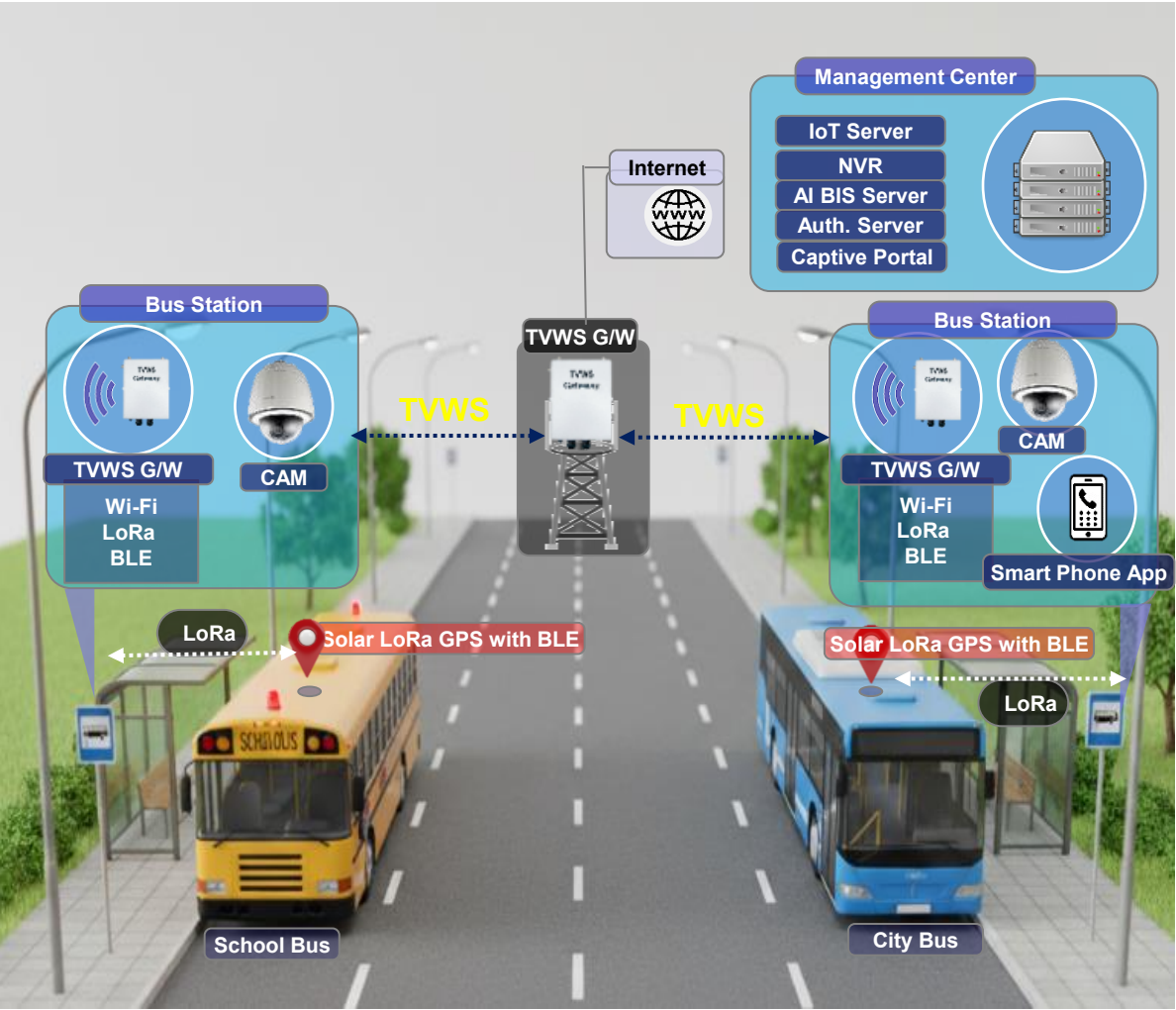
Smart Village

- Low-orbit Satellite Backhaul Internet/Wi-Fi, Telemedicine, e-learning, Broadcasting, Camera, IoT and Location services



Smart City

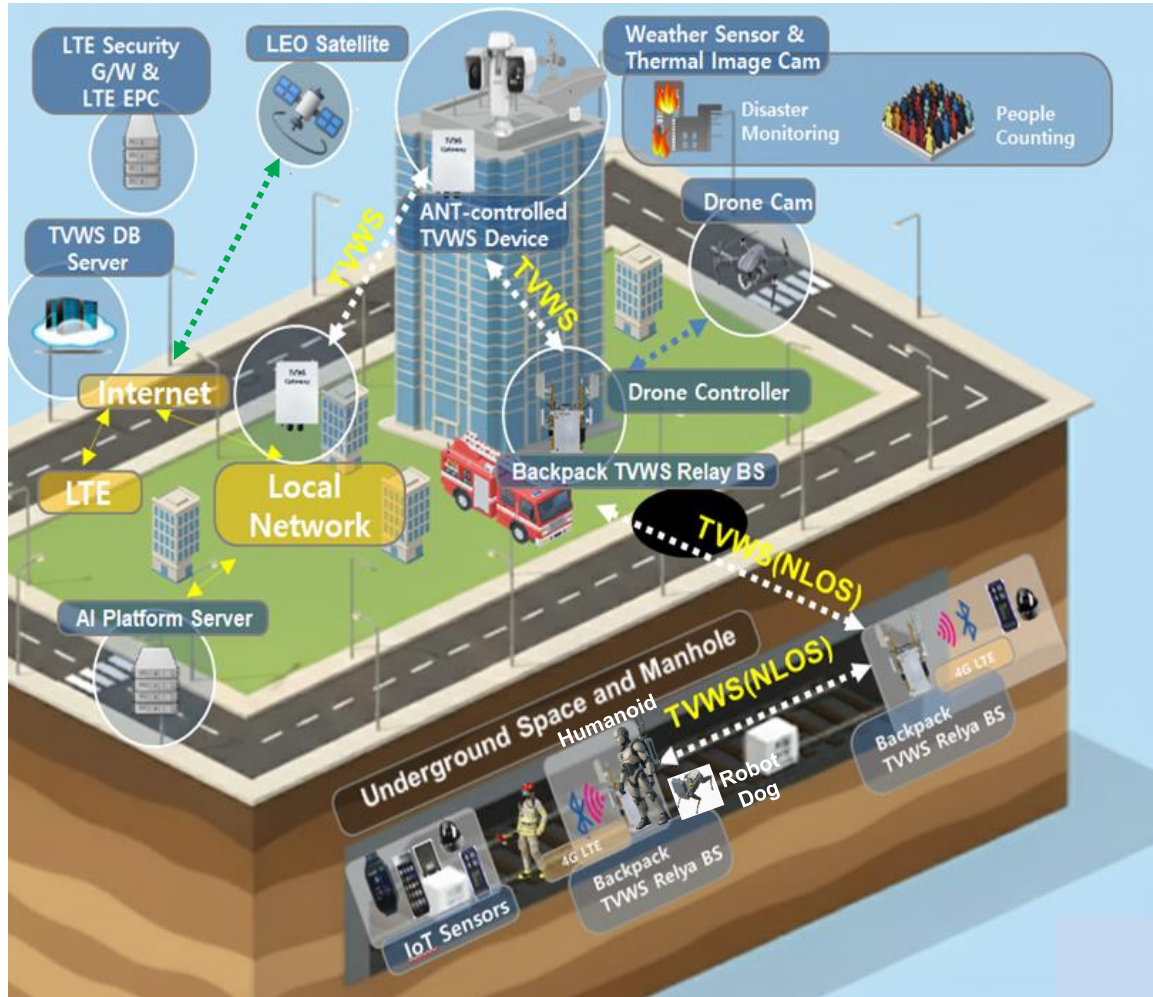
- Smart bus station with Wi-Fi, Cam, IoT, emergency button, BIS LED display & Bus IoT and location with LoRa GPS



Public Safety Network for City and Mountain

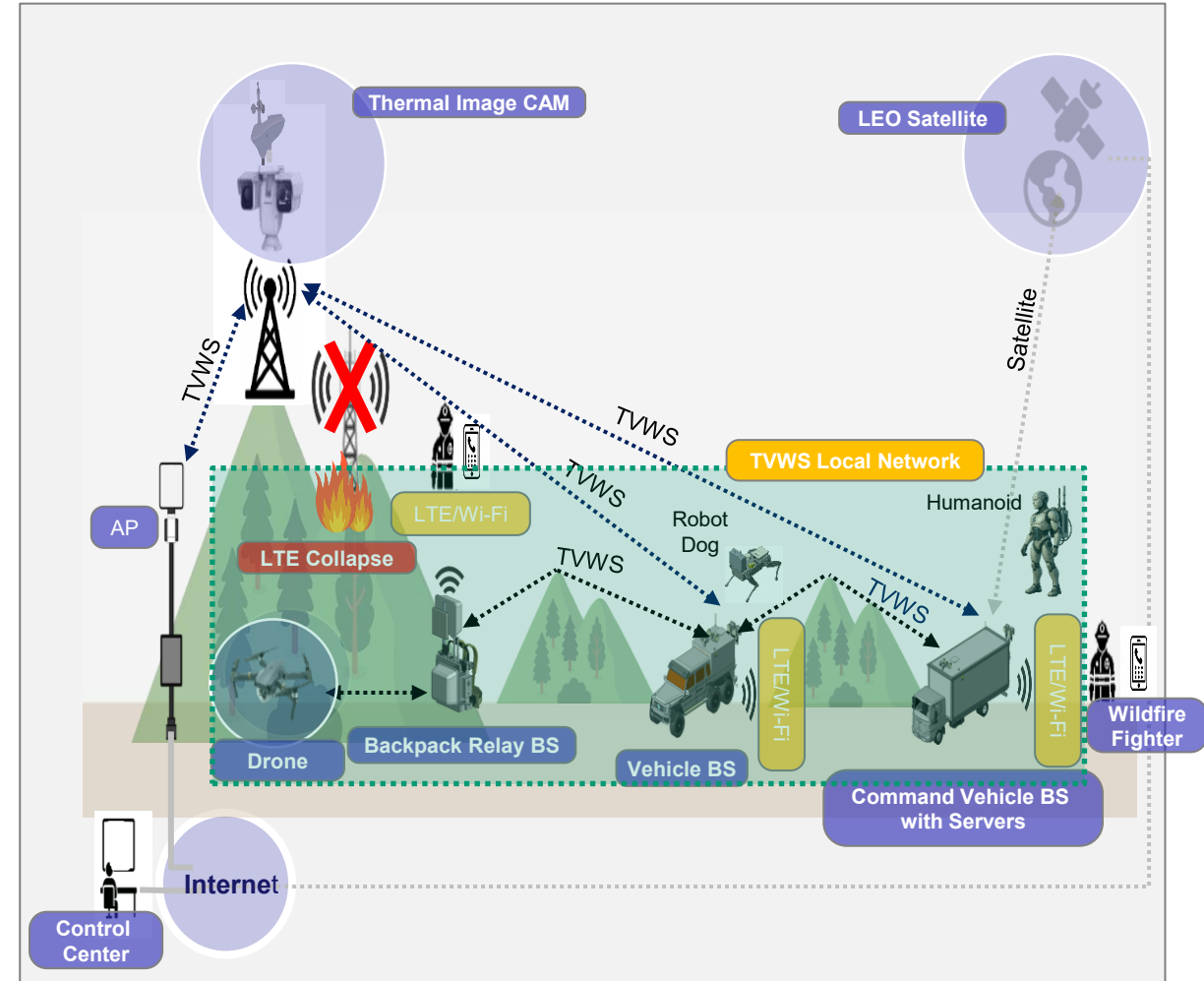
Public Safety

- Collapsed Networks Due to Disaster/War & Underground Disaster
- TVWS Backhaul Mobile BS Network is Required to Fixed(PS-LTE) Network



Smart Mountain

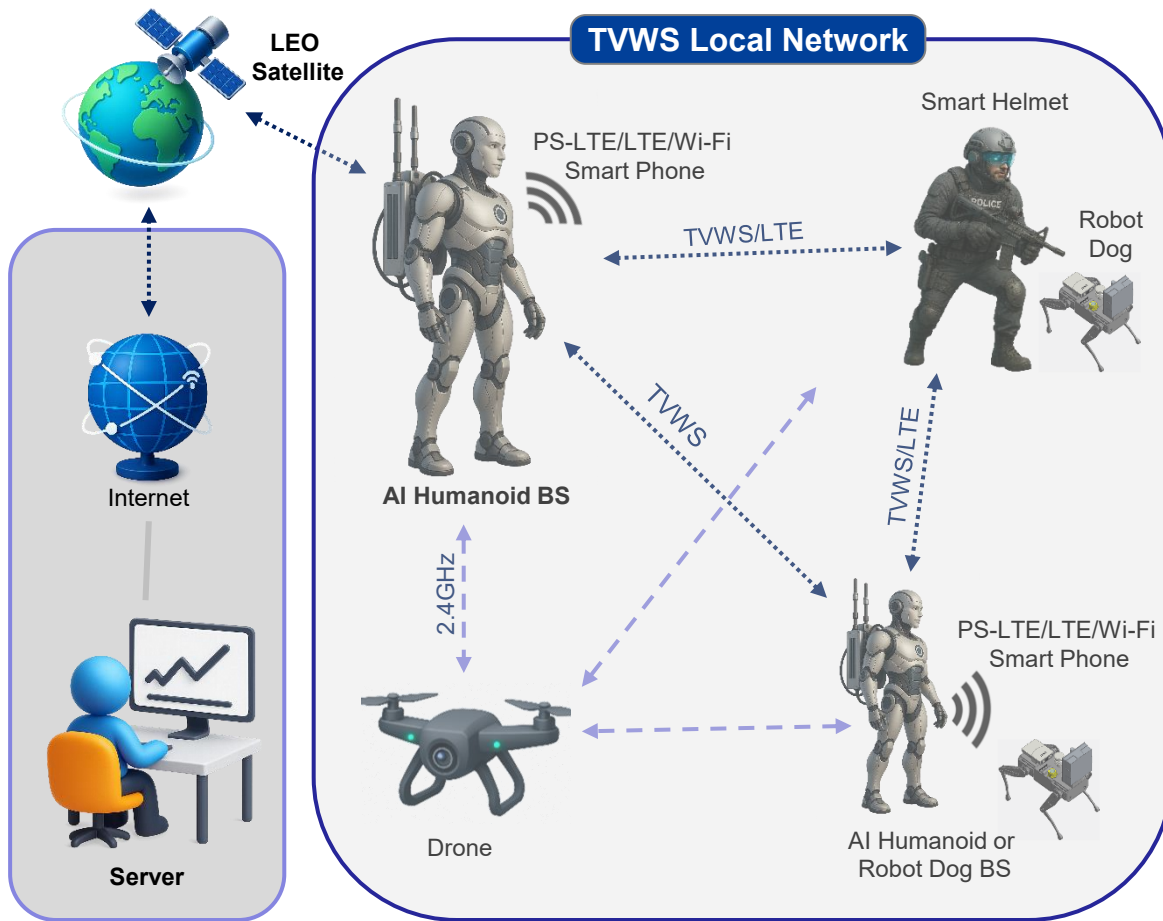
- LEO Satellite Backhaul TVWS Local Network in Big-scale Forest Fires
- Backpack Relay, Vehicle(Fire Truck, Trailer) BS with Satellite Backhaul



Public Safety Network for Police/Military & Smart Construction

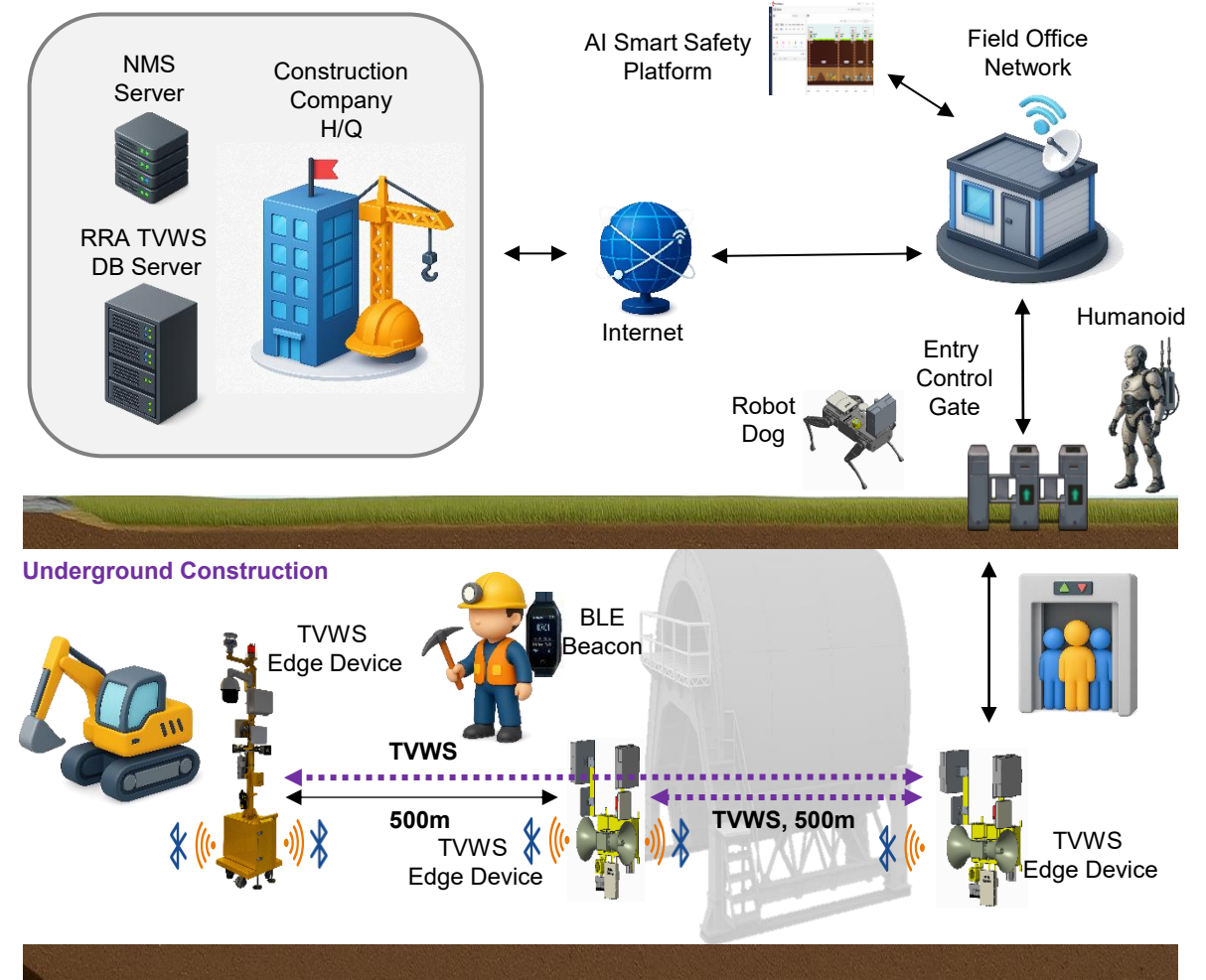
Police/ Military

- LEO Satellite Backhaul TVWS Mesh Network Between Humanoid, Smart Helmet, Robot Dog and etc.



Smart Construction

- Tunnel Wi-Fi, BLE, LoRa zone
- Worker/Vehicle Location, Gas IoT, Broadcasting..



Main TVWS Products

TVWS G/W

- Fixed TVWS G/W for Smart Village, BIS
- Smart Edge Devices for Smart Construction and Mine



Item	Specification	Item	Specification
Name(Model)	Fixed TVWS G/W (BHHST10)	Name(Model)	TVWSEdge Device(USSII10B)
TVWS Frequency	470~698MHz	TVWS Frequency	470~698MHz
TVWS TX Output	Max. 27dBm	TVWS TX Output	Max. 27dBm
TVWS Distance	> 10km	TVWS RX Sensitivity	-98dBm
TVWS RX Sensitivity	-98dBm	Wi-Fi Distance	>350m
RX Filter Bank	8-band	Camera	PTZ, x25(O), x16(D), IR150m
Wi-Fi	2.4GHz, 18dBm ±2dB	IP Speaker	50W, Two-way talk
Ethernet Port	2ea	BLE	2.4GHz, 2ea
BLE Gateway	2ea	IoT Sensor	Weather/Environment/Gas
LoRa Gateway	1ea	BLE Distance	>400m
RS-485 Port	1ea	Shape	Fixed & Movable
Electric Power	AC220V, Solar	Electric Power	AC220V, 24V Battery

Backpack TVWS

- TVWS Backpack Wi-Fi for Emergency Network, Drone
- Backpack TVWS BS for Emergency Network

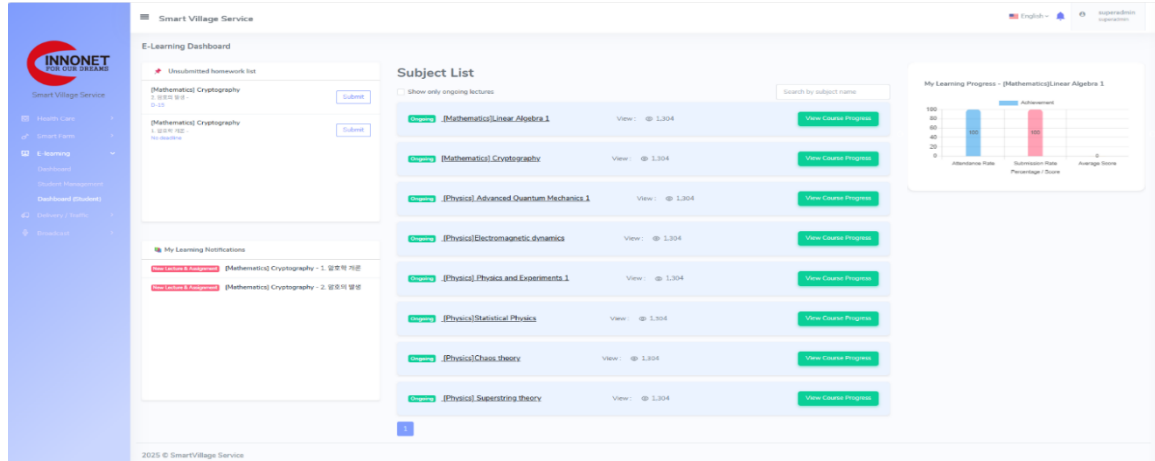
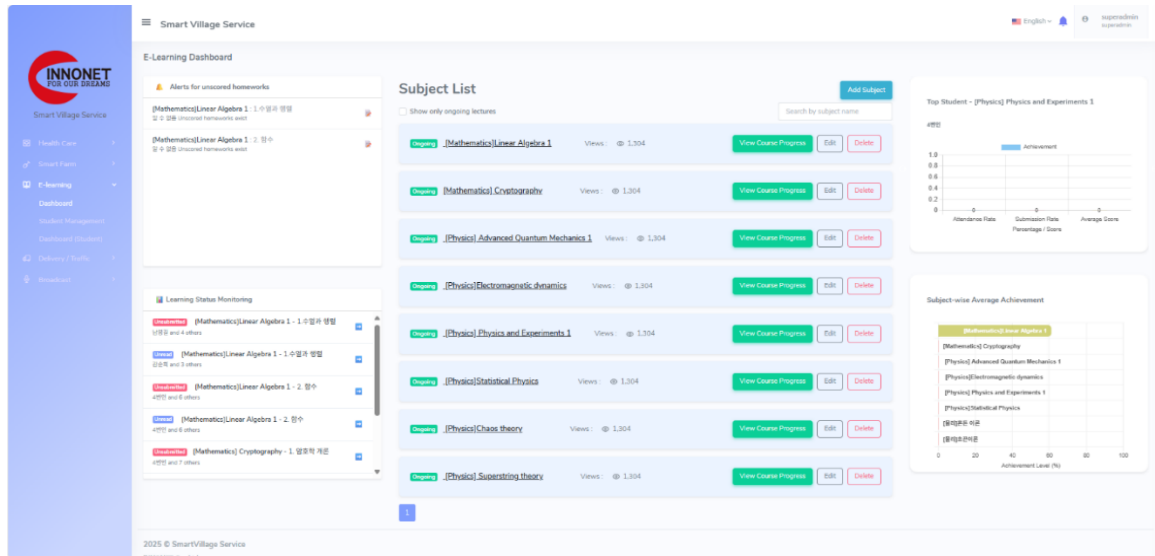


Item	Specification	Item	Specification
Name(Model)	TVWSBackpack Wi-Fi(BTCPE10)	Name(Model)	BP TVWS Relay BS(BRTBS10)
TVWS Frequency	470~698MHz	TVWS Frequency	470~698MHz
TVWS TX Output	Max. 27dBm	TVWS TX Output	Max. 27dBm
TVWS Distance	> 10km	TVWS RX Sensitivity	-98dBm
TVWS RX Sensitivity	-98dBm	RX Filter Bank	8-band
RX Filter Bank	8-band	LTE	1.8GHz Small Cell (200mW)
Wi-Fi	2.4GHz, 18dBm ±2dB	Wi-Fi	2.4GHz, 18dBm ±2dB
Ethernet Port	2ea	TVWS Path	2ea
BLE Gateway	1ea	BLE Gateway	1ea
ANT Poles	0.7m * 4ea	Camera	Portable
Weight	12kg	Gas Detection	O2, CO, H2S, LEL
Electric Power	AC220V, 24V Battery	Electric Power	AC220V, 24V Battery

AI e-learning & Smart Farm Server

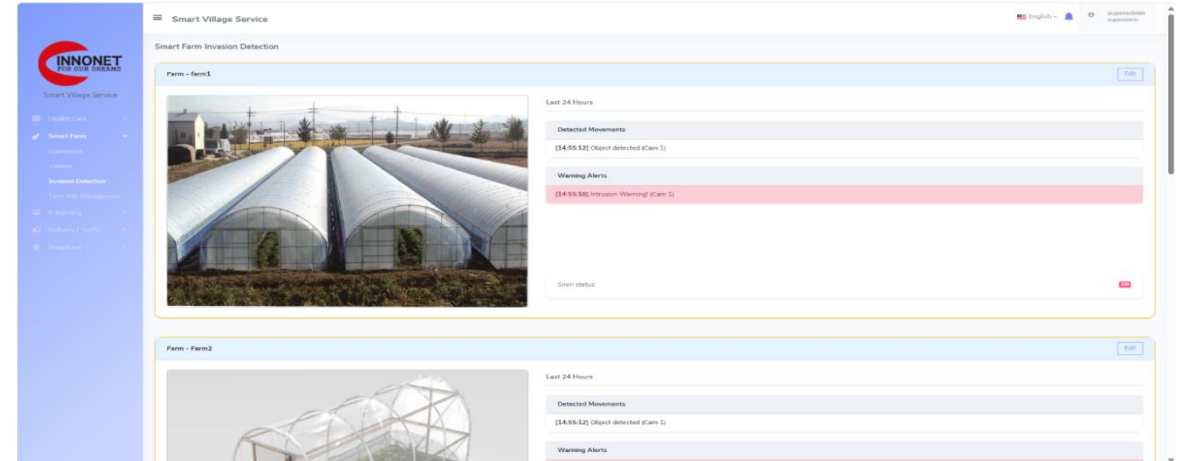
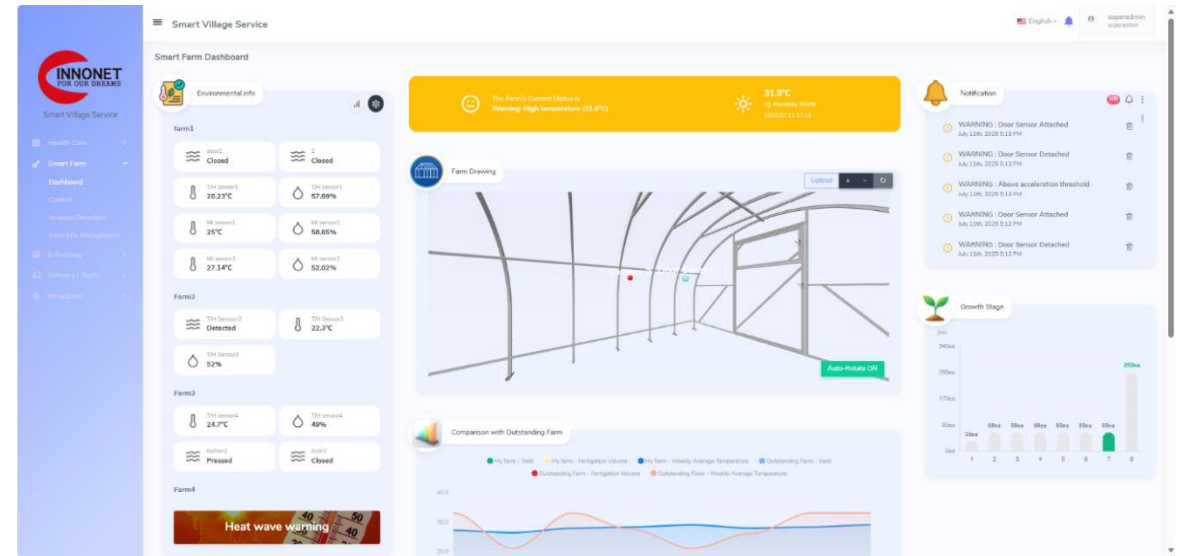
AI e-learning

- Operated in School, Villages, Home and etc.
- Text/PDF Based Operation. Facetalk Option. Because of Low Internet Speed



AI Smart Farm

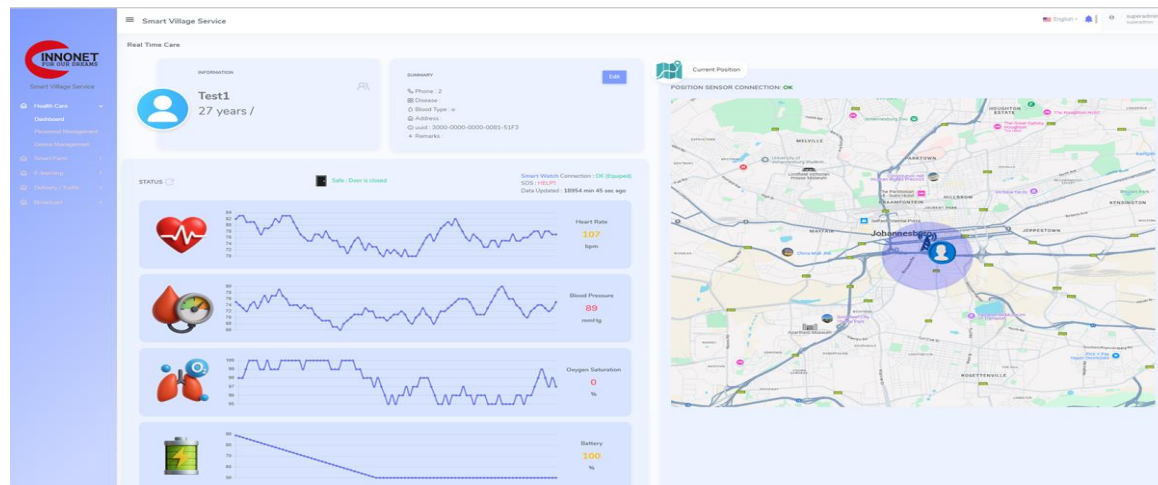
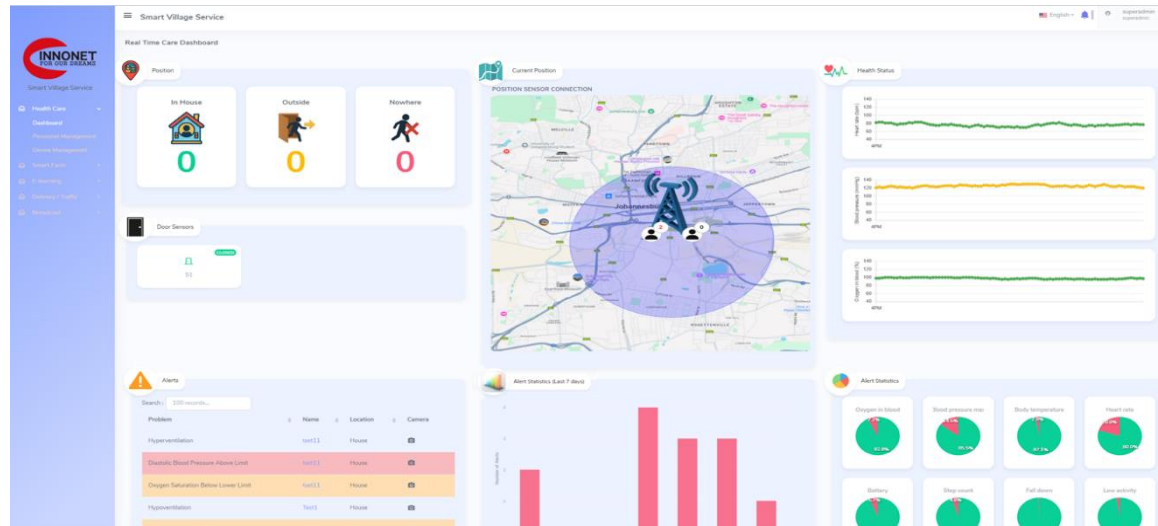
- Diverse IoT through Wi-Fi, Ethernet, BLE, LoRa, RS-485, USB
- Installation Visualization Service with 3D modeling



Healthcare & Delivery Server

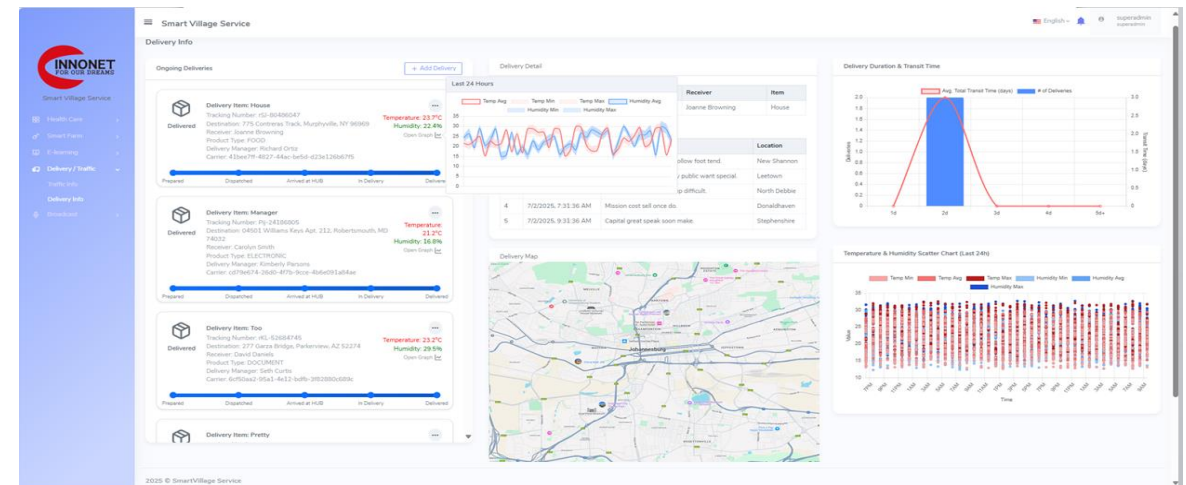
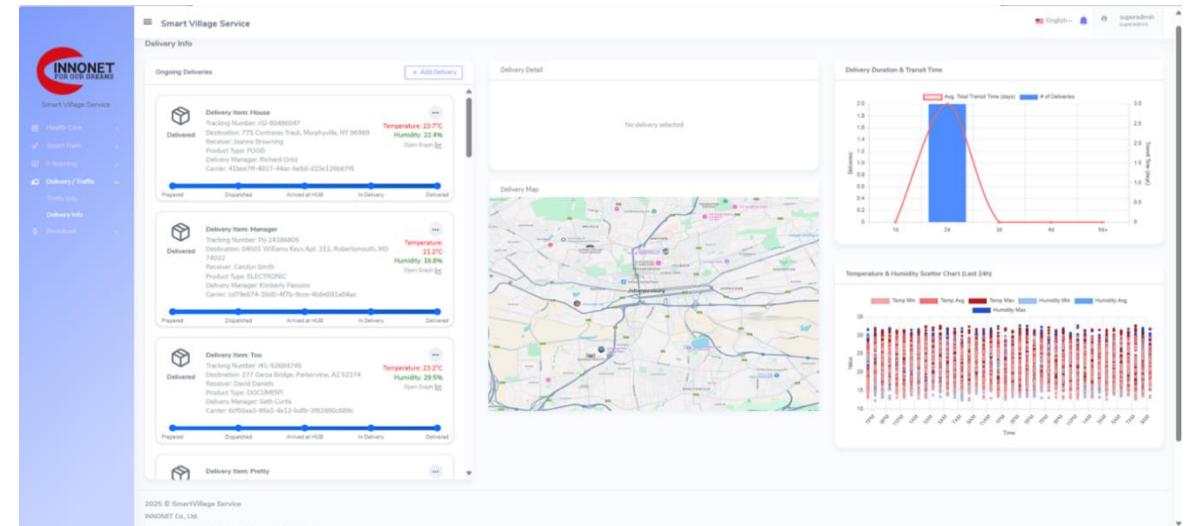
Healthcare Server

- Healthcare for Dementia Patients, the Elderly, and the Elderly living alone. Alarm Information is Provided to Guardian and Administrators.



Delivery Server

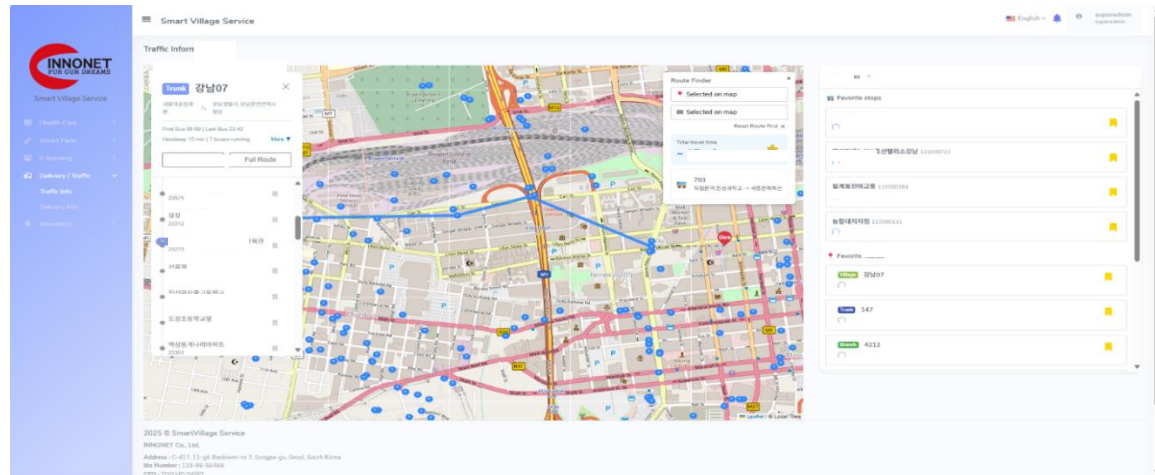
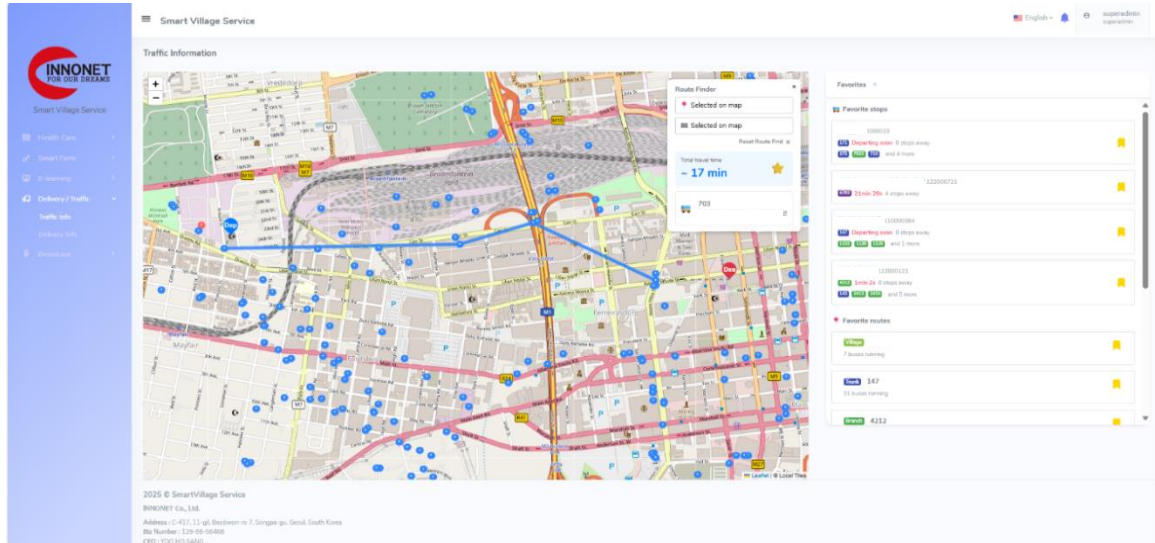
- Medicine Delivery Service for Healthcare Centers
- Temperature, Humidity, Location Management of Fresh Food Vehicles



AI-BIS & Two-way Village Broadcasting Server

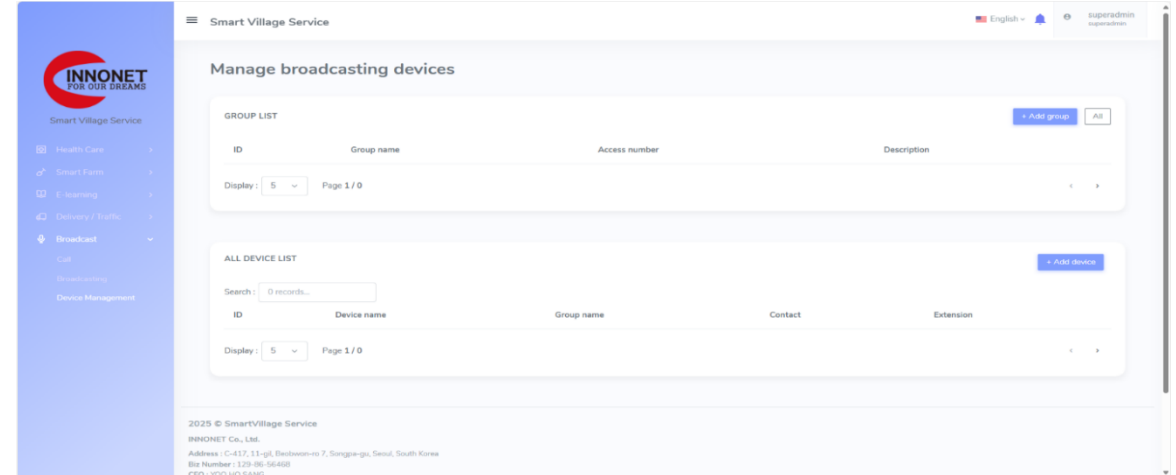
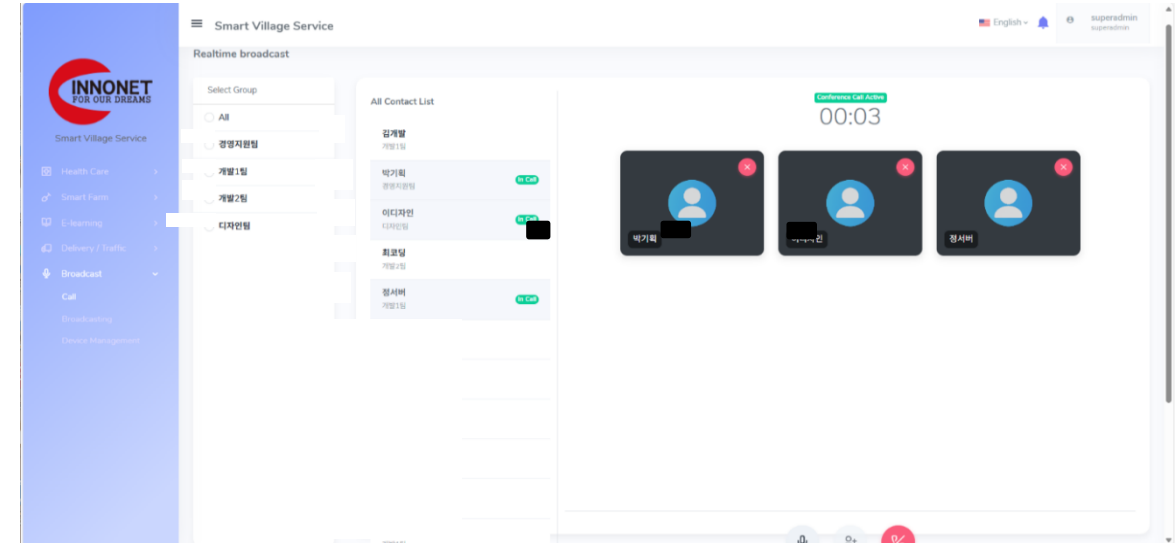
AI-BIS Server

- Solar LoRa GPS with Sensors to Track Bus Locations. LED Displays and Captive Portals Provide Bus Arrival Information..



Village Broadcasting

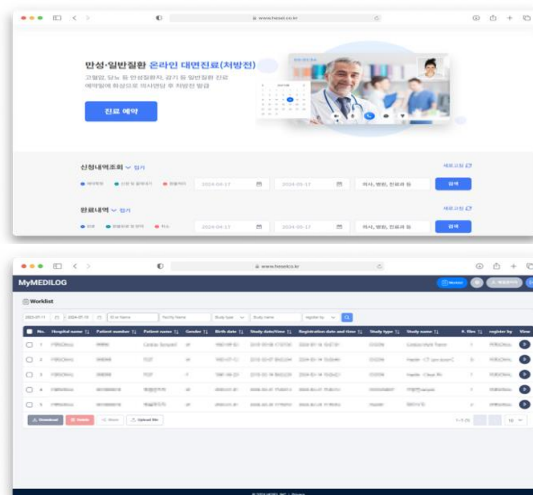
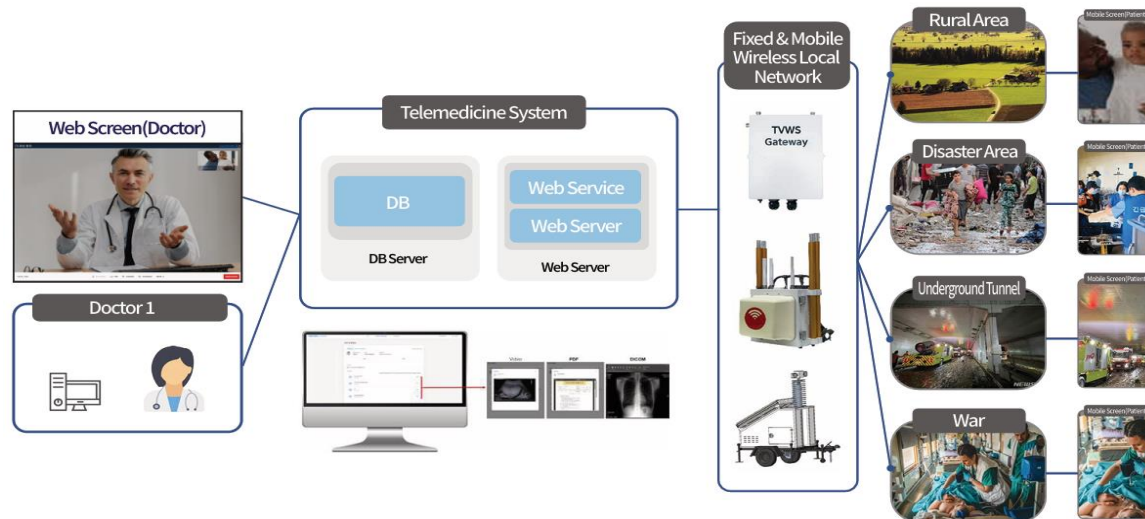
- Bi-directional IP Speaker with Two-way Talk
- Automatic Disaster Broadcasting Possible with Emergency Button



AI-Telemedicine & Optimization Server

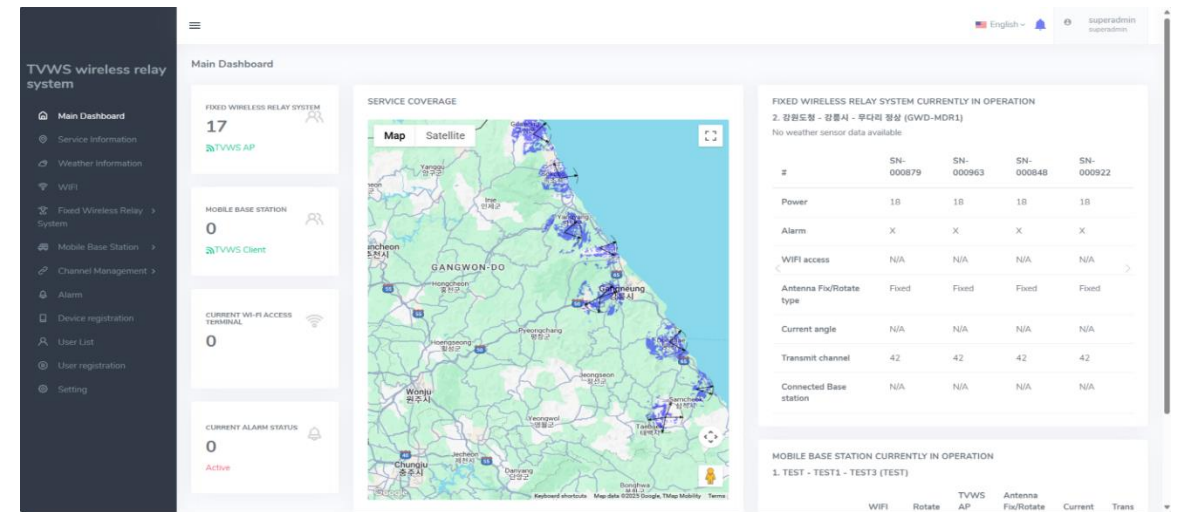
Telemedicine Server

- AI-Telehealth Platform is an HESEL(Our Partner) Product
- Rural and Disaster Area Services with Various TVWS Devices



Optimization Server

- Interference & CH Management of Neighboring TVWS devices
- TVWS Service Coverage Display, Wi-Fi Access Management



TVWS wireless relay system

Interference Analysis

DEVICE SELECT

관원도형

장비사

모형사

SN-000887

Apply

INTERFERENCE ANALYSIS

Serial Number : SN-000887

Ch 14 (1)	Ch 15 (1)	Ch 16 (1)	Ch 17 (1)	Ch 18 (2)	Ch 19 (2)	Ch 20 (2)	Ch 21 (2)	Ch 22 (3)	Ch 23 (3)
Ch 24 (3)	Ch 25 (3)	Ch 26 (4)	Ch 27 (4)	Ch 28 (4)	Ch 29 (4)	Ch 30 (4)	Ch 31 (5)	Ch 32 (5)	Ch 33 (5)
Ch 34 (5)	Ch 35 (5)	Ch 36 (6)	Ch 37 (6)	Ch 38 (6)	Ch 39 (6)	Ch 40 (6)	Ch 41 (7)	Ch 42 (7)	Ch 43 (7)
Ch 44 (7)	Ch 45 (7)	Ch 46 (8)	Ch 47 (8)	Ch 48 (8)	Ch 49 (8)	Ch 50 (8)	Ch 51 (8)		

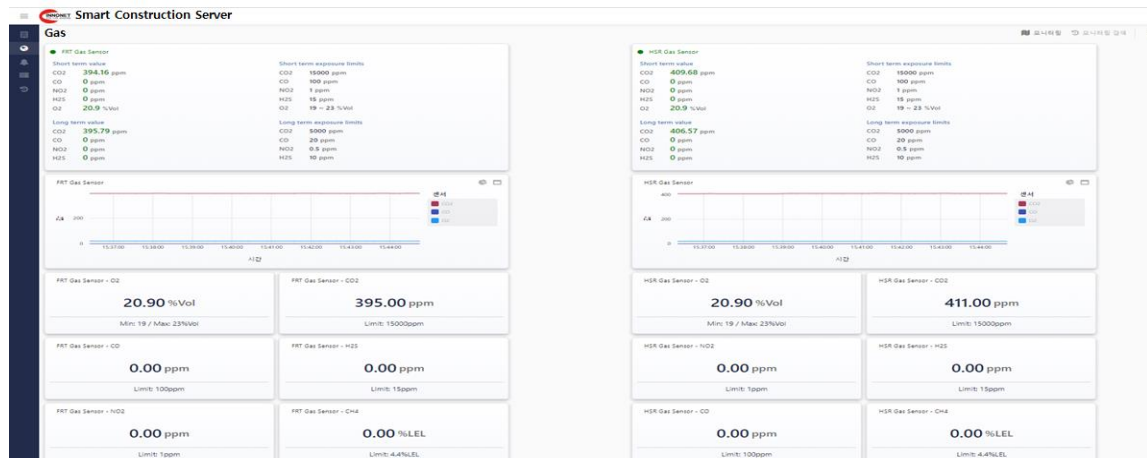
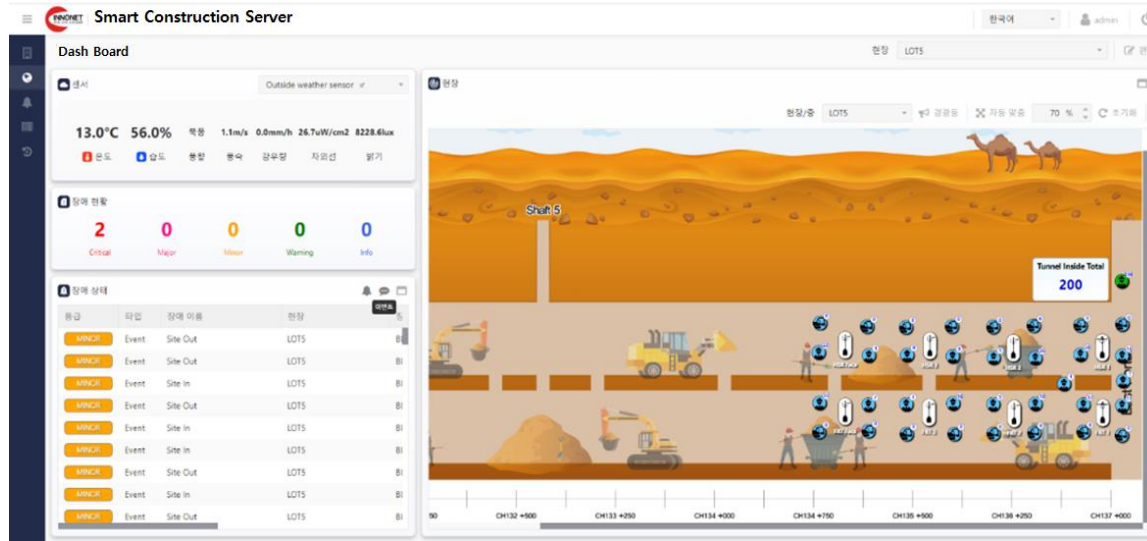
Save Auto Calculated Save

Interference Device 1	Interference Device 2	Interference Device 3	Interference Device 4	Interference Device 5	Interference Device 6	Interference Device 7	Interference Device 8	Interference Device 9	Interference Device 10	TOTAL SUM

Smart Safety Server

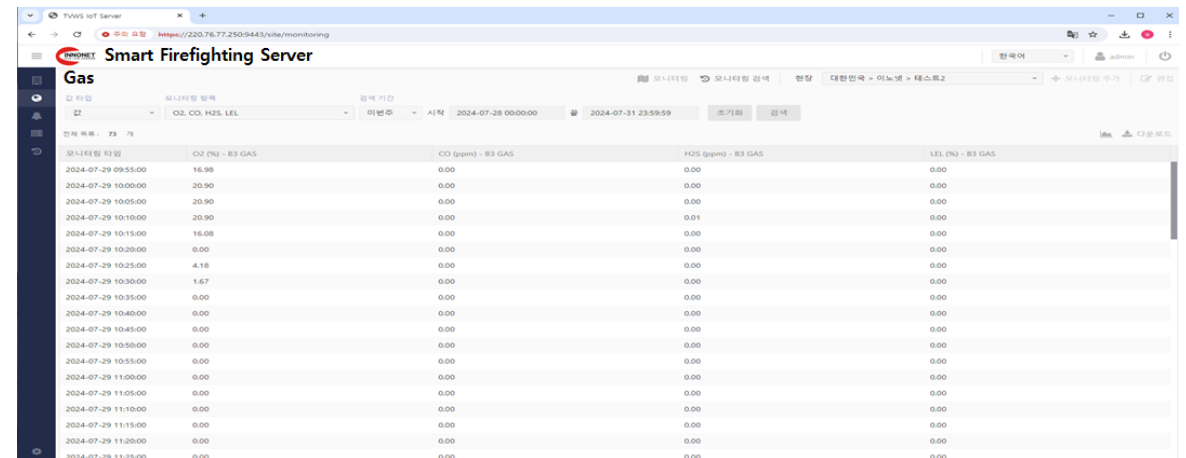
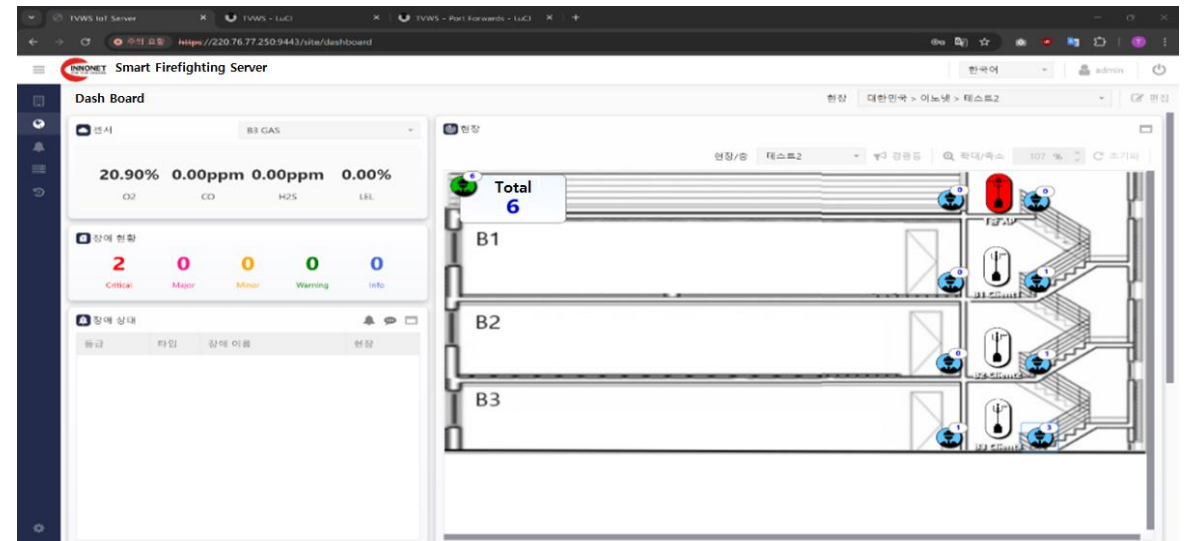
Smart Construction

- Number and Location of Workers and Vehicles inside Tunnel
- Monitoring Gas/Environment/Power/Weather IoT Sensors



Smart Firefighting

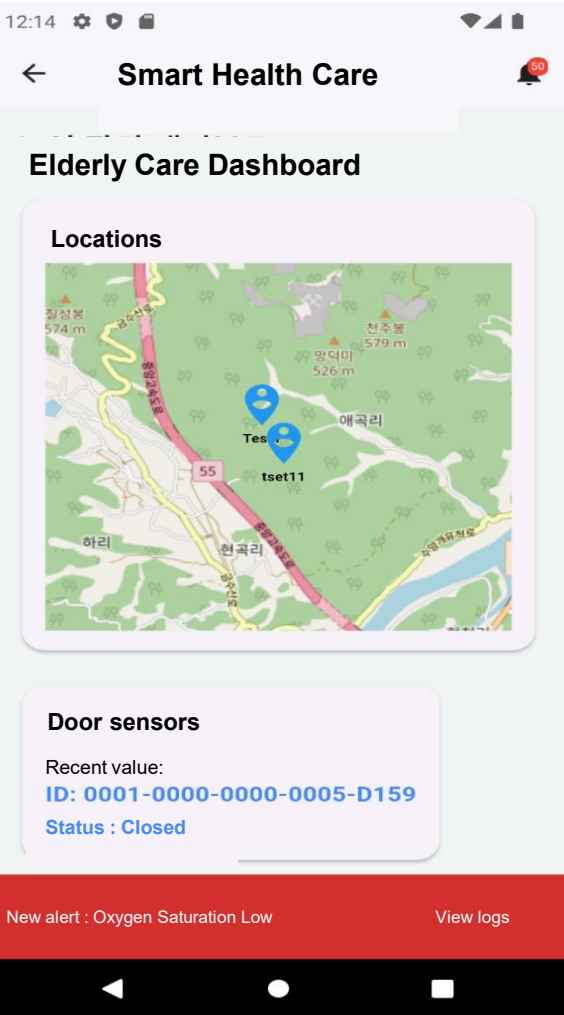
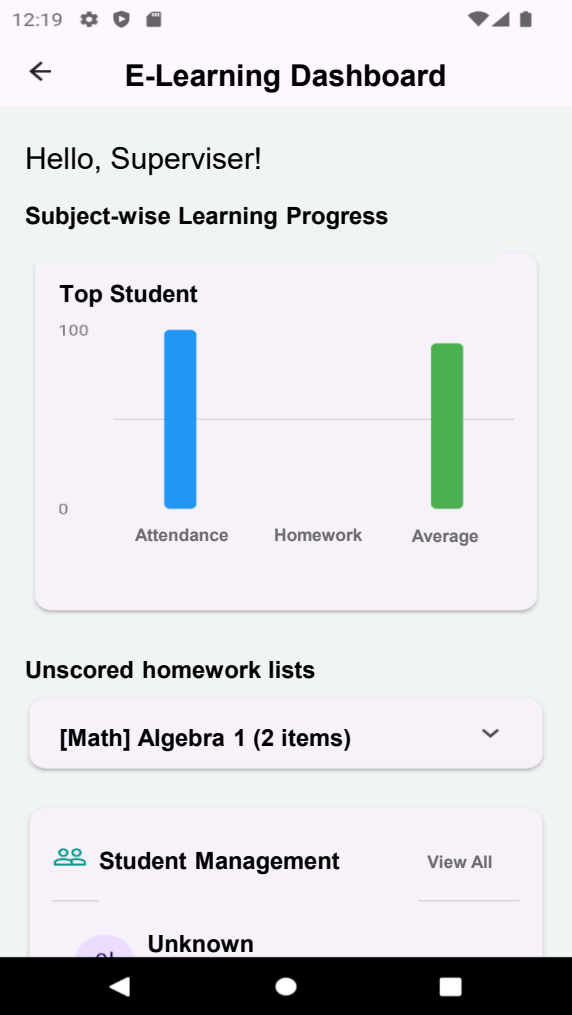
- Number and Location of Firefighters in Underground
- Monitoring Gas IoT sensors



Smartphone App

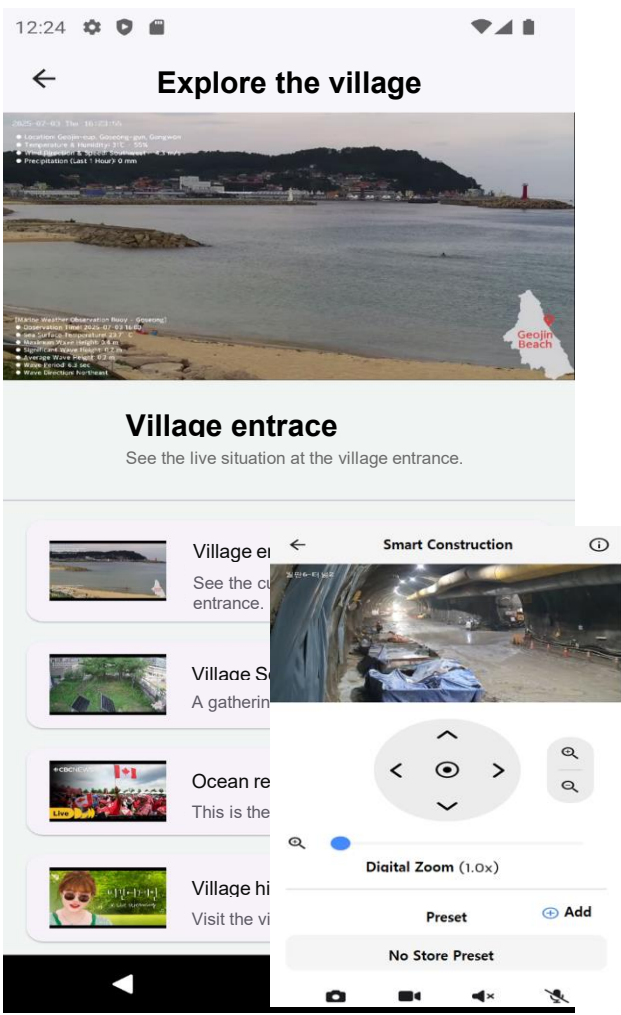
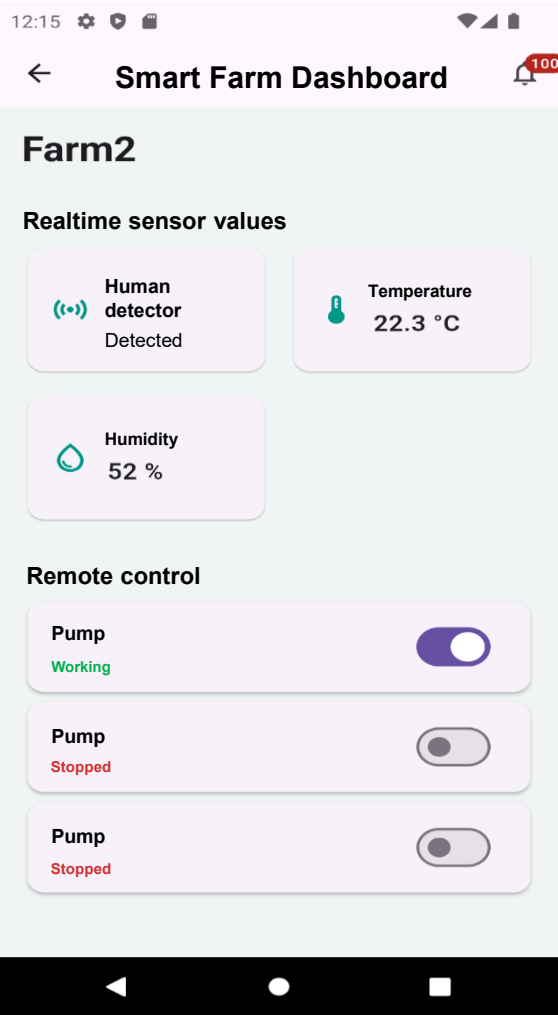
Smart Village

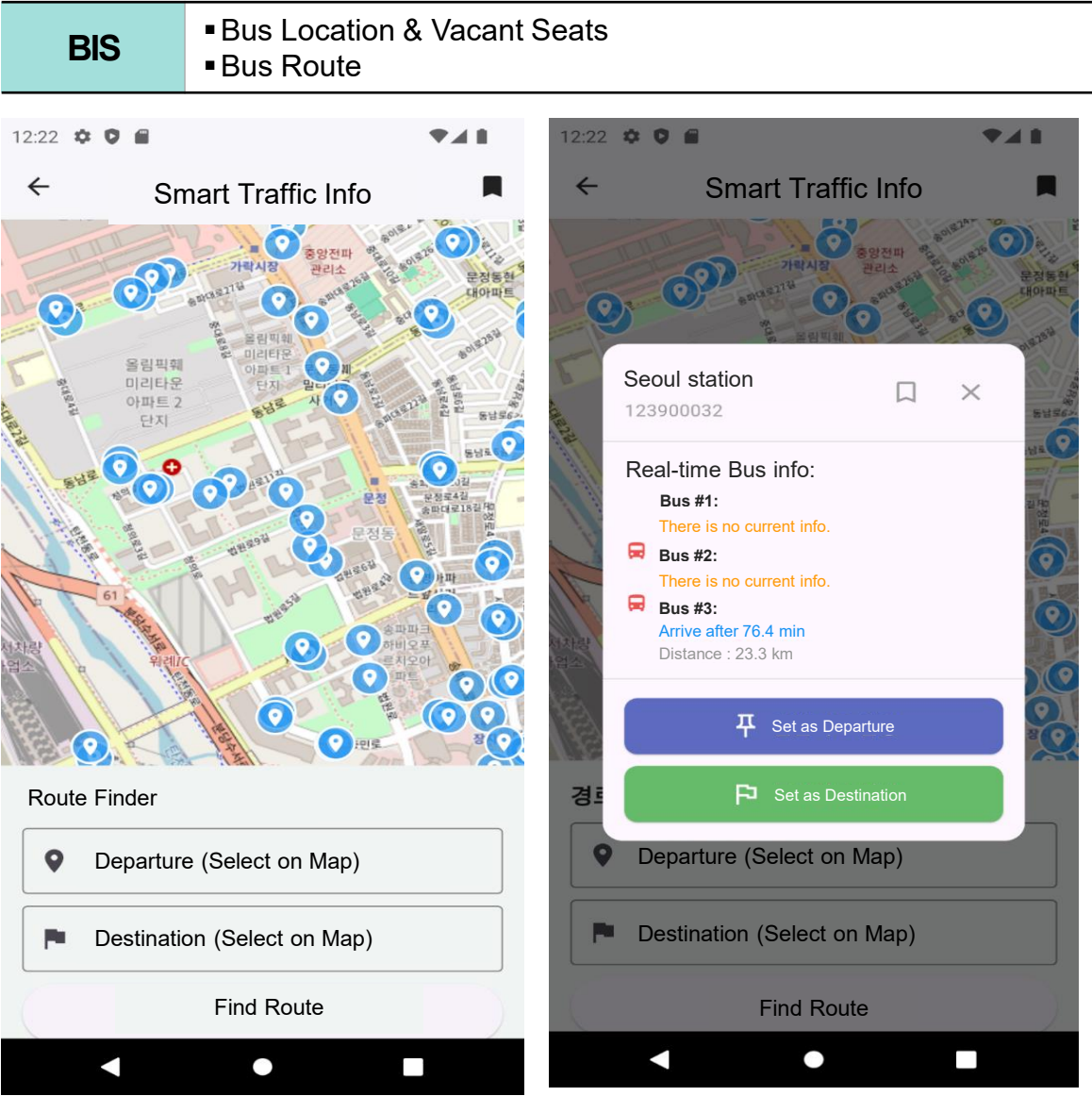
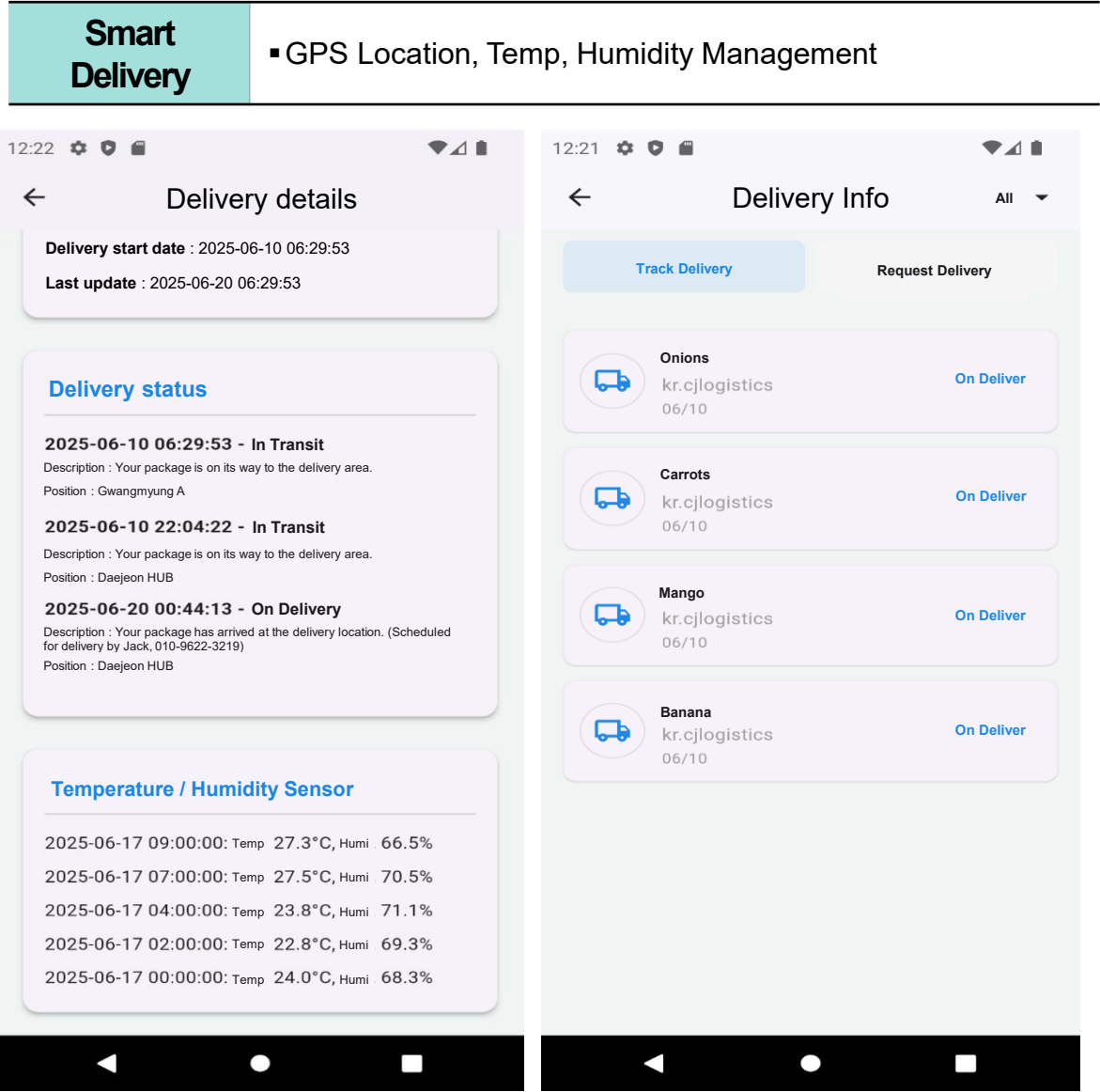
- e-learning App
- Smart Healthcare App



Smart Farm

- Smart Farm App
- Camera App for Village Youtube Service & Smart Construction, etc.





Smart Village

'18.12. Jeonnam Province and 18 Cities and Counties Internet and IoT



'18.12. Jeonnam Province and 18 Cities and Counties Internet and IoT



'20.11. TVWS Smart Farm in Gwangju



'21.12. Solar TVWS device in Jecheon City



'22. 12. YouTube live in Gosung County



'24.10. Gyubon Temple, Hwasun County

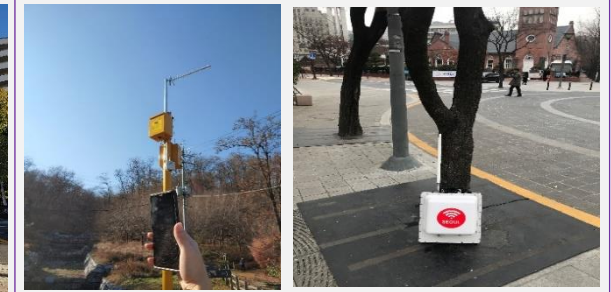


Smart City

'19.12. Seoul Seocho-gu Bus Stop Wi-Fi



'19.12. Seoul City Hall Event Wi-Fi



'22.12. Jeju Transportation Corporation Road Monitoring



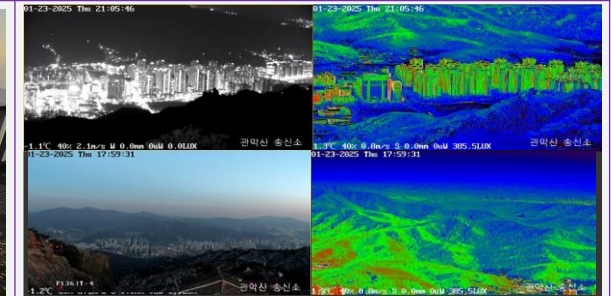
'25.1 Gwacheon Fire Station Fire Truck Mast and TVWS Device Installation



'25.1. Thermal Image Camera of Mt. Gwanak



'25.1. Real and Thermal Camera Image at Mt. Gwanak



Public Safety

'20.12. Wonju City TVWS Forest Fire Surveillance and Emergency Network



'20.12. floating solar TVWS device in Hoengseong-gun



'20.12. Donghae City Solar TVWS Device



'21.08. Sokrisan National Park Forest Fire Watch and Wi-Fi



'21.08. Sokrisan National Park Forest Fire Watch and Wi-Fi



'22.07. Danyang NFMO Mt. Taehwasan Forest Fire Surveillance and Emergency Network



'22.07. Danyang NFMO Mt. Youngdu Forest Fire Surveillance and Emergency Network



'22.07. SamCheok NFMO TVWS BS Test



'23.10. Drone Video Transmission of Trailer TVWS Base Station



'23.10 Installation and linkage of TVWS in Seonjaryeong, Gangneung City



'23.10. Forest Service Portable Base Station Test



'25.02. Trailer TVWS Mobile Base Station Demonstration



Smart Construction

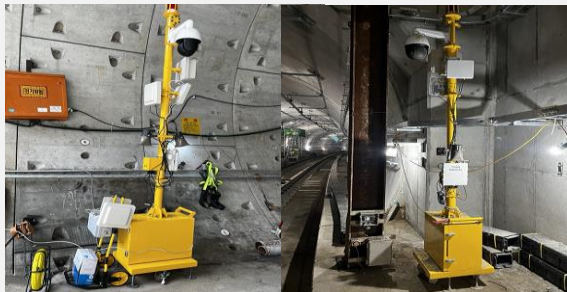
'22.02. Hyundai Construction Byeolnae Line TVWS Device



'23.01. GS Construction Shinbong Underground Tunnel TVWS Device



'24.04. Hyundai Construction Geomdan Line Underground Tunnel TVWS Device



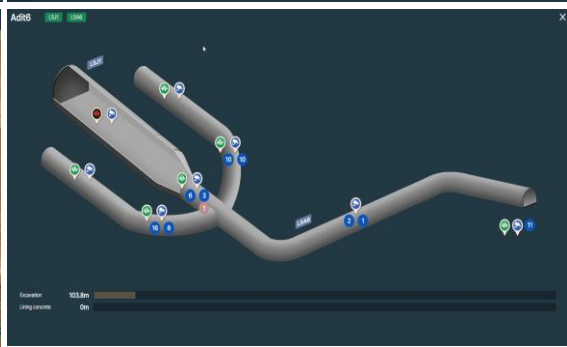
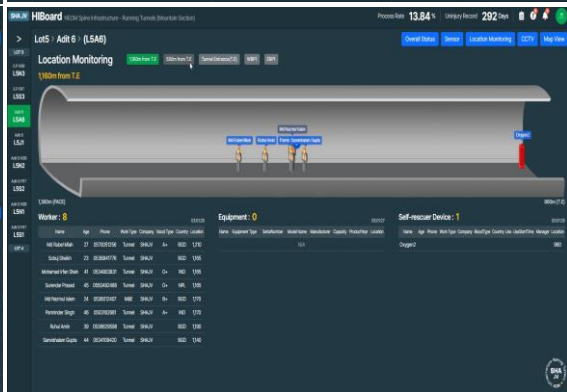
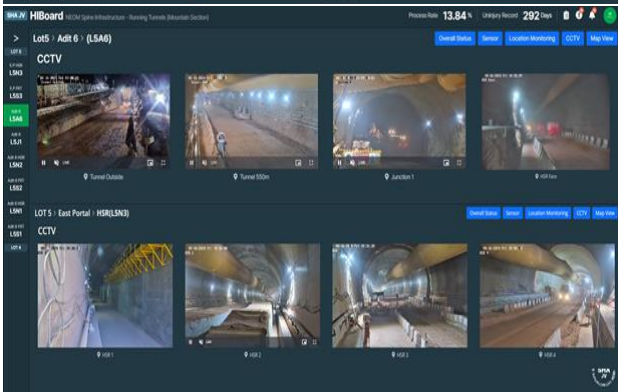
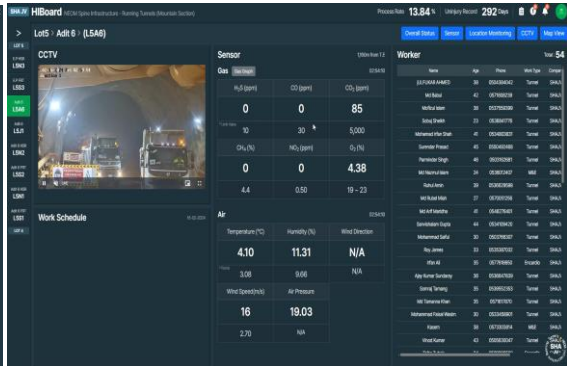
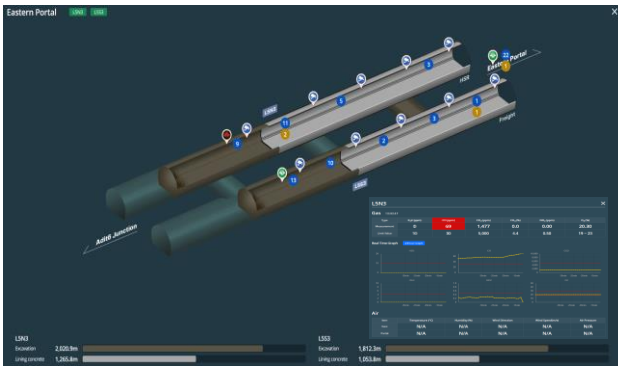
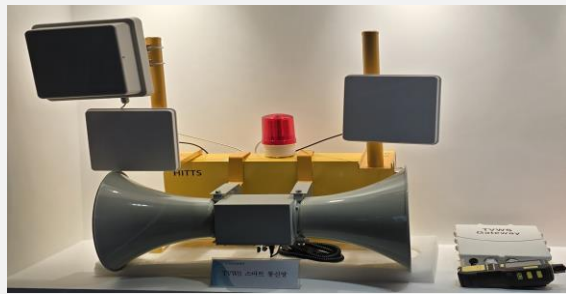
'24.11. National Land Safety Management Agency Water Tunnel Network



'25.05. Hyundai Construction Wolpan Underground Tunnel TVWS Device



'25.06. Hyundai Construction Namyangju Wangsuk Smart Construction Exhibition



Global Cooperation

RSA Certification

- ICASA: Fixed TVWS Gateway
- PAWS Protocol Test with Secondary TVWS DB Server in RSA

FCC/CE Certification

- FCC: Fixed TVWS Gateway & TVWS Backpack Wi-Fi
- CE: Fixed TVWS Gateway & TVWS Backpack Wi-Fi

'18. 09. UN ESCAP Demonstration and Presentation



'20.09. South Africa CSIR Backpack Wi-Fi Validation



'22. 04. South African Coal Mine TVWS Demonstration



'22.04. South African Hotel and Farm Demonstration



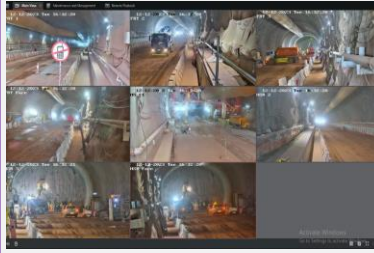
'23.09. KSA Tunnel



'23.11. South Africa CSIR Cooperation



'23. 12.KSA Tunnel



'24. 05. South Africa CSIR-National Radio Research Agency Meeting



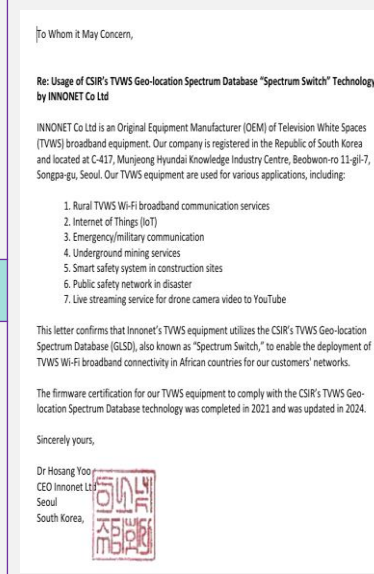
'24. 05. South Africa CSIR-NIPA Regulatory Sandbox Meeting



'24. 02. Colombia Zacarias TVWS Device



'24.08. CSIR Endorsement



'24.10. South Africa ICASA Certification



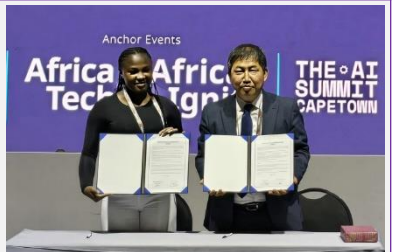
'25.03. TVWS Device in Buenaventura, Colombia



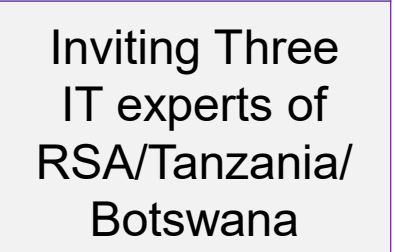
'24. 11. Zambia Mining Association Meeting



'24. 11. Participating in the Africa Tech Festival in South Africa



'25.11. Invitation Training by Government Program



Inviting Three IT experts of RSA/Tanzania/Botswana



TVWS Application

- Fiber Optic + TVWS, LEO satellite + TVWS
- Internet & Wi-Fi → IoT → Wireless Local Network Platform

Regulation Sandbox

- Fixed CH in Ferry, Public Safety Vehicle, Underground
- Underground Robot Dog & Backpack BS

TVWS Pilot Project with CATV ISP @2013

- Wi-Fi/CAM in island, tourist sites and city
- Pilot Project at the Fire Department

Safety in Mountains of Gangwon-Province

- BIS & Smart City in Seoul
- Korea Forest Service Forest Fire Surveillance System
- Smart Farm in Jeonnam Province...

TVWS Pledge of New President @2025

- Selected by K-Humanoid Alliance with SAT backhaul Humanoid TVWS BS
- TVWS backhaul fire truck/portable/trailer BS...

TVWS regulation sandbox for underground smart construction @ 2022 & emergency vehicle @ 2024

TVWS Regulation in Korea @ 2017

- Pilot Project with Local Governments
- Pilot Project in Bandung, Indonesia

TVWS regulation sandbox for marine @ 2019

Smart Construction in KSA @2023/2024

- Installed at Hyundai E&C, Samsung C&T, GS Eng, KT, Hyundai Engineering, Samsung Engineering,
- Backpack TVWS Relay BS
- RSA/Tanzania/Colombia TVWS

TVWS regulation sandbox for underground robot dog & backpack BS @ 2025

2011~2014

2015 ~ 2017

2018~2021

2022 ~ 2024

2025 ~

Certification & Patents

Certification



Patents

Domestic Patent

[10-1136994-00-00]
[10-1265779-00-00]
[10-1343066-00-00]
[10-1558306-00-00]
[10-1565599-00-00]
[10-1577630-00-00]
[10-1587766-00-00]
[10-1690239-00-00]
[10-1751786-00-00]
[10-1839968-00-00]
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[10-2131338-00-00]
[10-2105693-00-00]
[10-1823293-00-00]
[10-1920486-00-00]
[10-1937251-00-00]
[10-2631820-00-00]
[10-2598037-00-00]

- SYSTEM AND METHOD FOR DETECTING THE LOCATION AND AMPLITUDE OF PASSIVE INTER-MODULATION DISTORTION SIGNAL IN PASSIVE COMPONENT
- DEVICE AND METHOD FOR REDUCING ELECTRIC POWER CONSUMPTION OF RF COMMUNICATION SYSTEM IN MULTI-BAND MOBILE COMMUNICATION SERVICE ENVIRONMENT
- SYSTEM FOR TRANSMITTING MULTIPLE MULTI-INPUT MULTI-OUTPUT SIGNAL BY REMOVING PASSIVE INTERMODULATION SIGNAL OF MOBILE COMMUNICATION FEED CABLE
- Apparatus and method for power efficient multi-hop multi-carrier TWWS backhaul system
- TV system to eliminate interference signals
- TV system to eliminate interference signals and the operation method
- TERMINAL TEMPERATURE MONITORING SYSTEM and TERMINAL TEMPERATURE DETECTING DEVICE OF POWER FACILITY
- Device and method for TV white space wireless transceiver
- TERMINAL TEMPERATURE MONITORING SYSTEM and TERMINAL TEMPERATURE DETECTING DEVICE OF POWER FACILITY
- Mobile TWWS Apparatus and Operation Method thereof
- Wireless Backhaul Apparatus using Mobile TWWS for Bus Communication Network and Operation Method thereof
- Missing person searching system using VHF and UHF wireless backhaul based Drone with camera and mobile communication base station
- High-speed wireless network system using TWWS
- COMMUNICATION SYSTEM PROVIDING RECEIVING AND TRANSMITTING SIGNALS BY USING TV WHITE SPACE FREQUENCY BAND
- Backpack Type VHF/UHF TWWS Backhaul-based LTE Mobile Base Station capable of Self-Operation Wireless Network and Group/Private Communication
- DUAL WIRELESS BACKHAUL SYSTEM
- Video Monitoring System using TWWS
- CONTROL METHOD OF COMMUNICATION SYSTEM USING TWWS DIRECTIONAL ANTENNA
- WIRELESS BACKHAUL SYSTEM USING TWWS FOR INDOOR AND UNDERGROUND TUNNELS WHERE GPS RECEPTION IS NOT AVAILABLE

Abroad Patent

[US 9,998,900 B1]
[3324554]
[201680041722.9]
[2020-03328]

- USA : BACKPACK-TYPE MOBILE BASE STATION SYSTEM AND METHOD BASED ON TWWS AND SATELLITE BACKHAUL
- EUROPE : BACKPACK-TYPE MOBILE BASE STATION SYSTEM AND METHOD BASED ON TWWS AND SATELLITE BACKHAUL
- CHINA : BACKPACK-TYPE MOBILE BASE STATION SYSTEM AND METHOD BASED ON TWWS AND SATELLITE BACKHAUL
- REPUBLIC OF SOUTH AFRICA : BUS COMMUNICATION NETWORK WIRELESS BACKHAUL SYSTEM USING MOBILE TWWS AND OPERATING METHOD THEREOF



Thank you