



TVWS Devices and their Applications

- Bridging Digital Divide and Enhancing Innovative Services

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Public Safety Service



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I. Overview

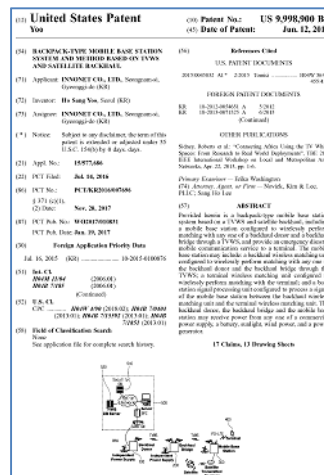
1. About Innonet

CEO Ho-sang Yoo
Foundation 2011
Homepage www.innonet.net



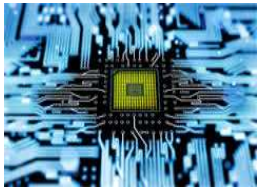
[Patents]

- PCT application statement: System and method for portable backpack base station under TVWS or satellite backhaul
- Application in Europe: System and method for portable backpack base station under TVWS or satellite backhaul
- Application in China: System and method for portable backpack base station under TVWS or satellite backhaul
- PCT application statement: Wireless backhaul apparatus using mobile TVWS for bus communication network and operation method thereof
- Registration in the US.: System and method for portable backpack base station under TVWS or satellite backhaul
- And other Korean patents



- 2015 New Radio Broadcasting Technology (Ministerial Prize)
- 2016 New Radio Broadcasting Technology (Prime Minister's Prize)
- 2016 Best Practice for SME Cooperation Funded by the NST
- 2017 Presidential Citation
- 2017 KCA ICT Best Practice

- ❖ TVWS : Temporally and spatially vacant channel in D-TV frequency band
- ❖ Low CAPEX & OPEX in rural area
- ❖ Easy & low-cost installation with Pole



Market Driven

- Ecosystem ready
- Unlicensed band
- Standard : IEEE802.11af or IEEE802.22

Limitations of Legacy

Backhaul

- Low CAPEX compared to Fiber/MW
- Low OPEX compared to LTE
- Easy installation compared to MW

New Solution

- Above than 10km LOS service
- Non-LOS service
- Lower frequency - Robust to weather affects
- Point-to-Multipoint service
- Relay service
- Low power consumption driven by solar energy



Island and mountains



Rural and etc.



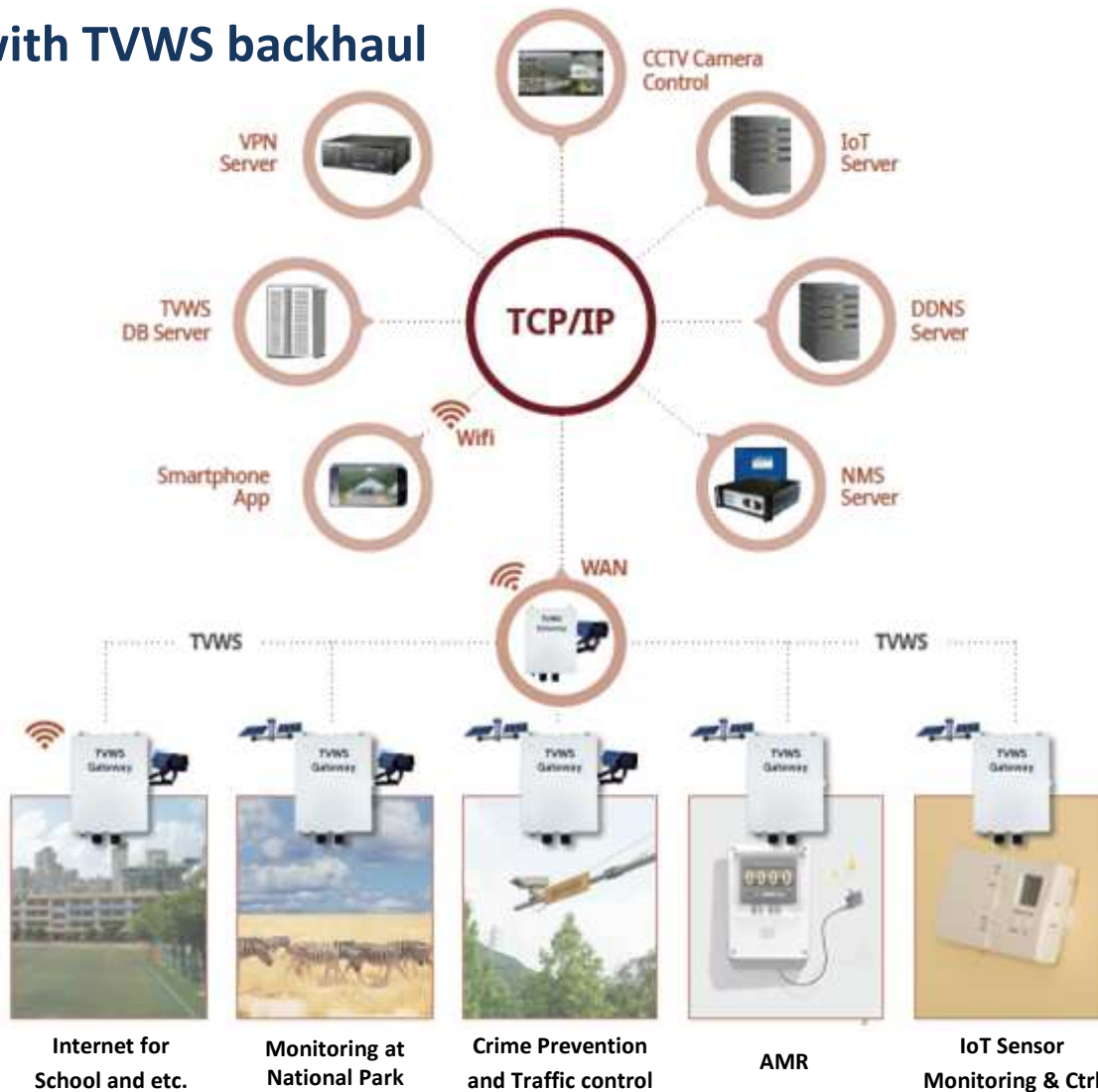
❖ TVWS : No environment impact & good refraction because of low frequency

Item	TVWS	Microwave	Wi-Fi (High Gain ANT)
Frequency	174~216 MHz or 470~698 MHz	≥ 6 GHz	2.4 GHz or 5 GHz
Service Distance	Above than 10 km	Over a dozen km	More than a few km
Point-to-Multipoint Comm.	O	X	X
Non-LOS Comm.	O	X	X
Device Cost	Middle	Very High	Low
Wi-Fi Interference	Unaffected	Unaffected	Affected
Environment Impact (snow, rain, leaves, wind, etc.)	X	O	O
Power Consumption	About 30W	About 400W	About 10W
Solar Energy	O	X	O
Installation	Pole	Big Tower	Pole

II. TVWS IoT Service

1. Network Configuration

- ❖ Providing high speed and low speed IoT service with TVWS backhaul



Item	Contents
Service	Wi-Fi, Ethernet, CCTV Camera with VPN, IoT Sensor
TVWS Frequency	174~216MHz, 470~698MHz
Phy. Interface of Service	Wi-Fi, LAN, BLE, RS- 485
Server	IoT, DDNS, VPN, NMS, TVWS DB
Smartphone App	Android, iOS
TVWS DB Server	www.tvwsDB.net
TVWS Device Operation	Web-UI or NMS Server

II.. TVWS IoT Service

2. TVWS Gateway

- ❖ TVWS Gateway : IoT gateway based on TVWS(27dBm) backhaul
- ❖ Portable TVWS Gateway : IoT gateway based on TVWS(18dBm) backhaul



Item	Specification
TVWS Standard	IEEE802.11af
Frequency	174~216MHz, 470~698MHz
TX Output Power	27dBm \pm 2dB
CH BW	6MHz, 8MHz
RX Sensitivity	IEEE802.11af Spec.
Modulation/Demodulation	QPSK, 16-QAM, 64-QAM, 256-QAM
Service Interface	Wi-Fi, LAN, BLE, RS-485
TVWS Antenna Connector	Type-N
Ethernet	10/100Base-T, RJ-45
Electric Power	PoE or DC
Mounting	Wall or Pole Mount
Operating Temperature	-30°C ~ 50°C
Packaging	Outdoor, Waterproof

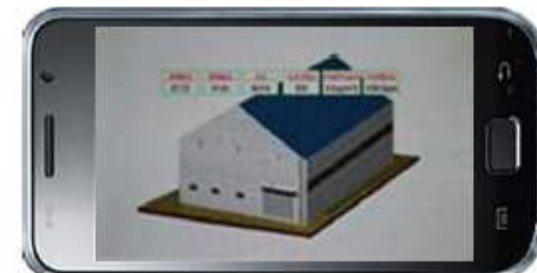


Item	Specification
TVWS Standard	IEEE802.11af
Frequency	174~216MHz, 470~698MHz
TX Output Power	18dBm \pm 2dB
CH BW	6MHz, 8MHz
RX Sensitivity	IEEE802.11af Spec.
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Service Interface	Wi-Fi, LAN, BLE, RS-485
TVWS Antenna Connector	Type-N
Ethernet	10/100Base-T, RJ-45
Electric Power	PoE or DC
Mounting	Wall or Pole Mount
Operating Temperature	-30°C ~ 50°C
Packaging	Outdoor, Waterproof

II. TVWS IoT Service

3. Server & App

- ❖ Server for IoT, VPN(Virtual Private Network), DDNS(Dynamic Domain Name System), NMS
- ❖ Smartphone App for CCTV camera monitoring, IoT sensor monitoring & control

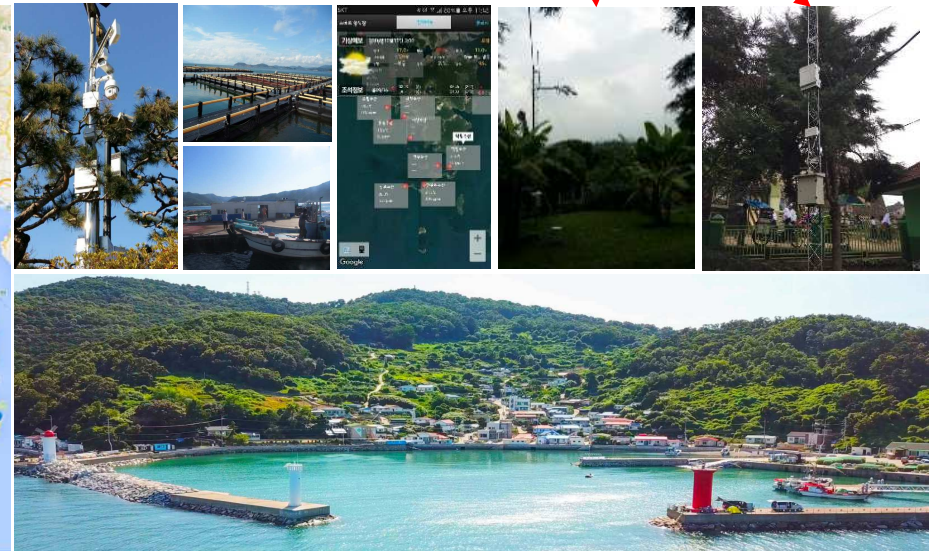
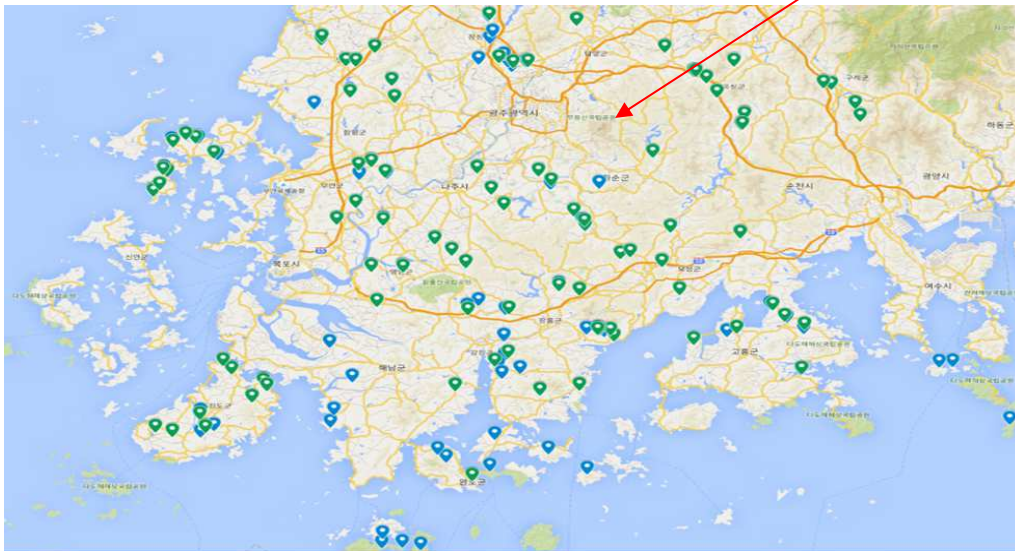
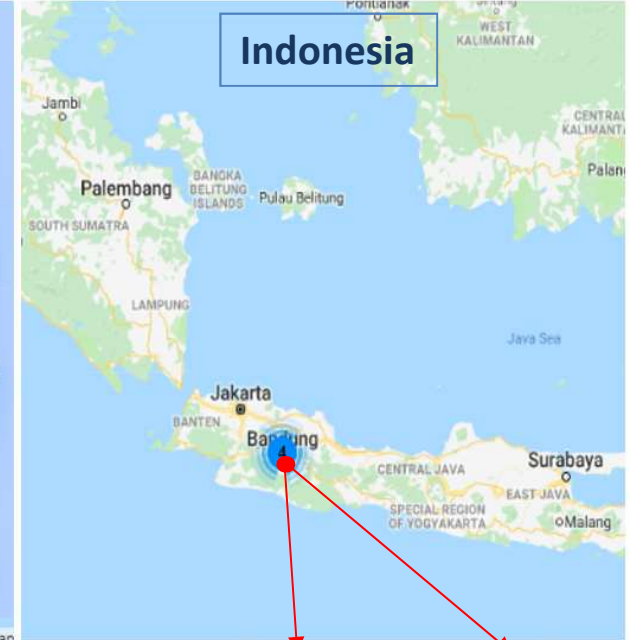
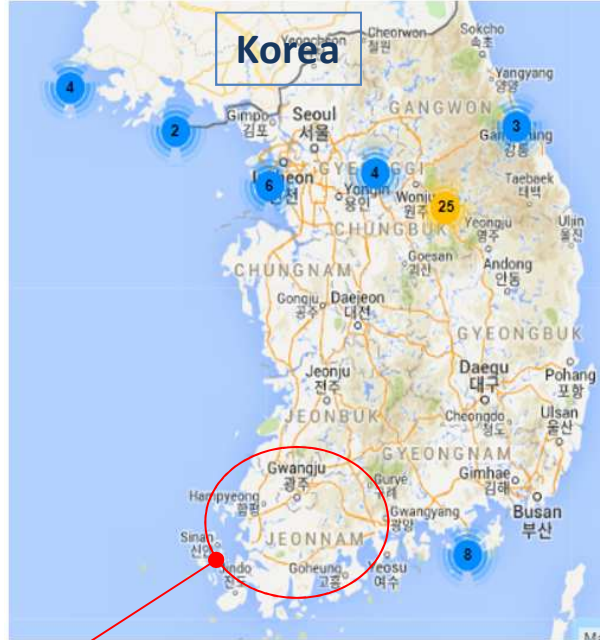
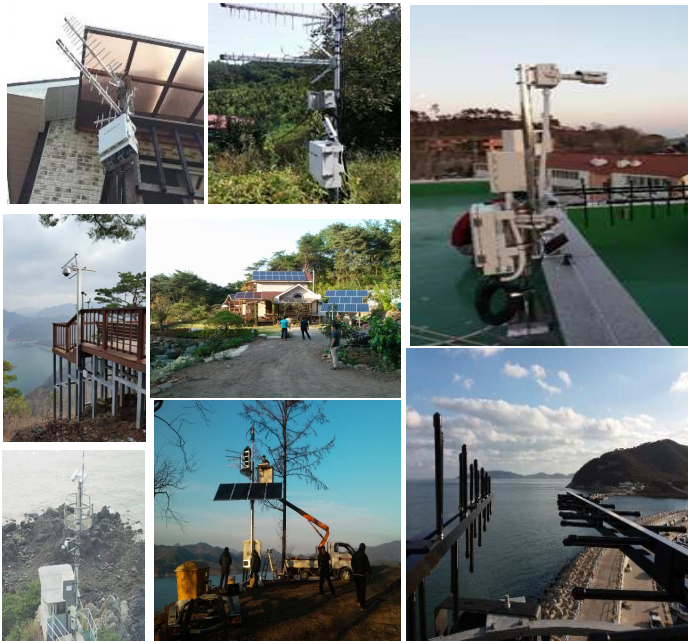


Item		Specification
IoT Server	OS	Linux
	Web-Server	Apache or NginX
	Framework	Django or Node.js
VPN Server	OS	Linux
	Block Cipher	SEED, ARIA, LEA
	Hash Function	SHA-224/256/3658/512
DDNS Sever	OS	Linux
	No. of Management Terminal	Above than 10,000
	Web-Server	Apache or NginX
NMS Server	OS	Linux
	Database	PostgreSQL or MySQL
	IP Management	Fixed IP, DDNS

Item	Specification
OS	Android, iOS
Camera Access	RTSP or Web
Monitoring of IoT Sensor	Temp., Humidity, Fine Dust, Water Quality and etc.
Control No. of IoT Sensor	Above than 3

II. TVWS IoT Service

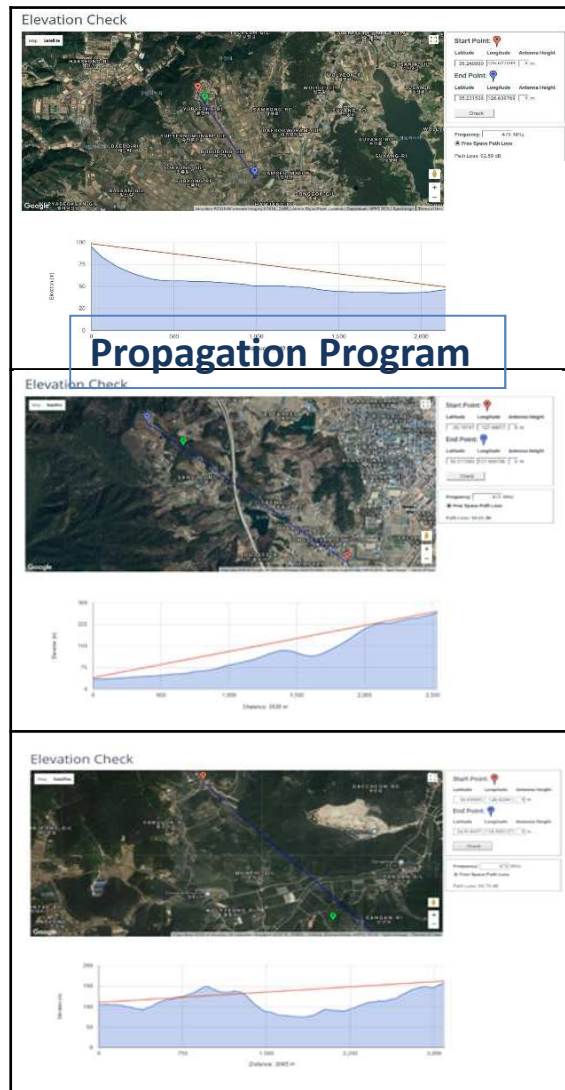
4. Installation Sites



II.. TVWS IoT Service

5. Onsite Test

❖ 30~40% non-LOS in last-mile of rural area



III. Public Safety Service

1. Network Configuration

- ❖ Minimize loss of people's lives and property
- ❖ Backpack mobile eNodeB for emergency network



Item	Contents
PS-LTE Frequency	700MHz band
BMeN Network	PS-LTE <-> TVWS <-> PS-LTE
PS-LTE TX Power of BMeN	27dBm @ 700MHz
Backpack CPE Network	LTE <-> TVWS <-> Wi-Fi
Service of Backpack CPE	Voice & video call, messenger with App
User Devices of Backpack CPE	Smartphone Smart helmet Smart glass

III. Public Safety Service

2. BMeN & Backpack CPE

- ❖ BMeN for urgent PS-LTE BS(Base Station) recovery or overload relief
- ❖ Backpack CPE for low-cost emergency network service without LTE core network



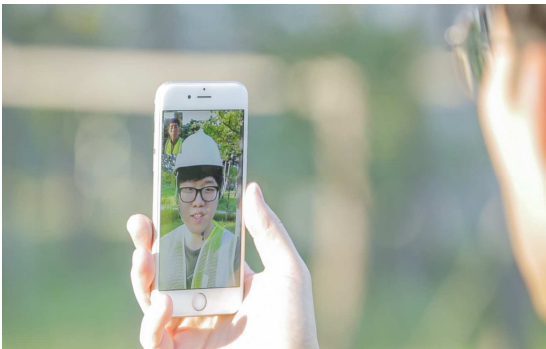
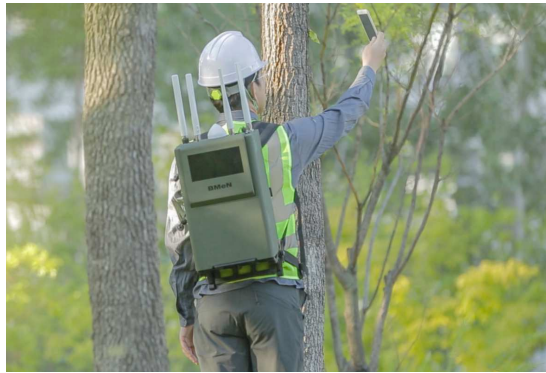
Item	Specification
TVWS Standard	IEEE802.11af
TVWS Frequency	174~216MHz, 470~698MHz
TVWS TX Output Power	27dBm \pm 2dB
TVWS CH BW	6MHz, 8MHz
TVWS RX Sensitivity	IEEE802.11af Spec.
Service	PS-LTE
PS-LTE Frequency	700MHz Band
TVWS Antenna Connector	Type-N
Ethernet	10/100Base-T, RJ-45
Electric Power	AC or DC or Battery
Mounting	Backpack
Operating Temperature	-30°C ~ 50°C
Packaging	Outdoor, Waterproof

Item	Specification
TVWS Standard	IEEE802.11af
TVWS Frequency	174~216MHz, 470~698MHz
TVWS TX Output Power	27dBm \pm 2dB
TVWS CH BW	6MHz, 8MHz
TVWS RX Sensitivity	IEEE802.11af Spec.
Modulation/Demodulation	QPSK, 16-QAM, 64-QAM, 256-QAM
Service Interface	Wi-Fi, LAN, RS-485
TVWS Antenna Connector	Type-N
Ethernet	10/100Base-T, RJ-45
Electric Power	PoE or DC or Battery
Mounting	Backpack
Operating Temperature	-30°C ~ 50°C
Packaging	Outdoor, Waterproof

III. Public Safety Service

3. Installation Sites

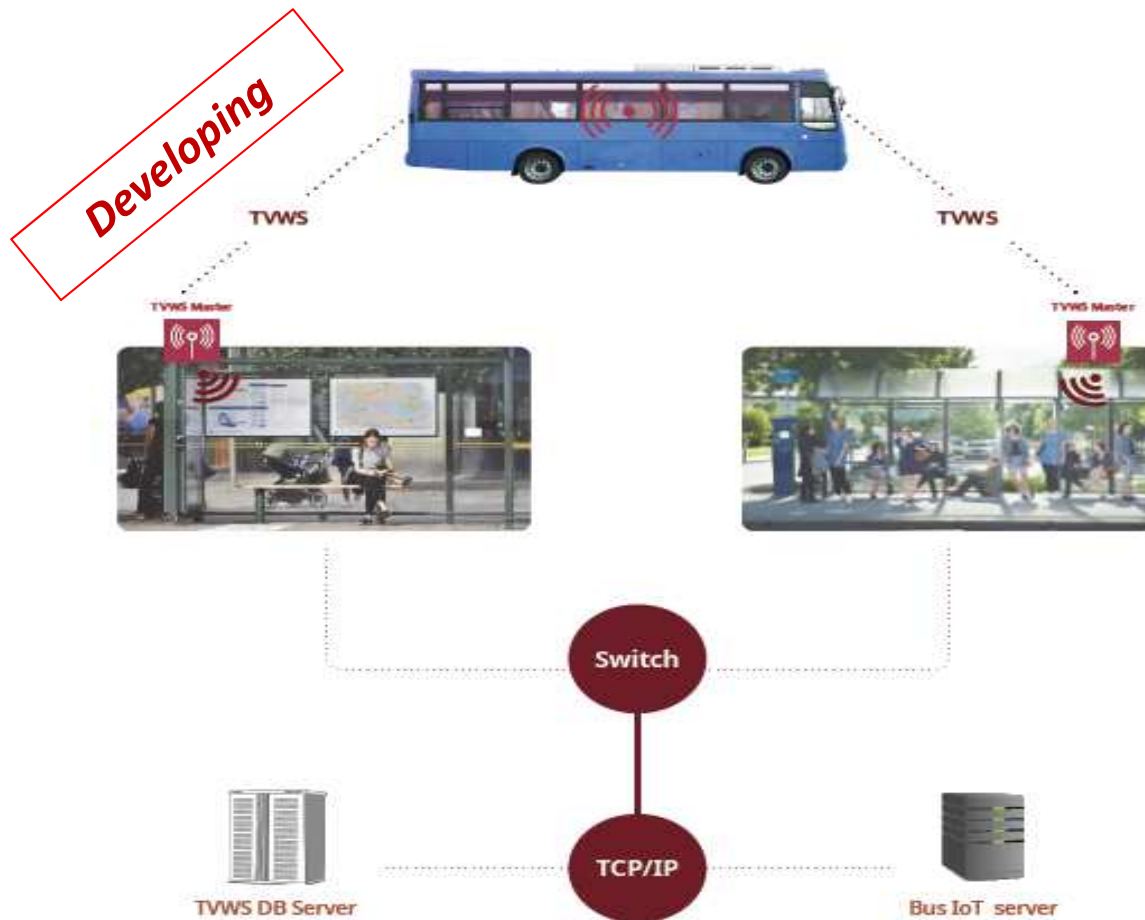
❖ Applied to Korea PS-LTE network in 2016



IV. Mobile Public IoT Service

1. Network Configuration

- ❖ LTE Problem : Expensive charges & poor service quality during commute time
- ❖ Test with Korea local government on end of this year

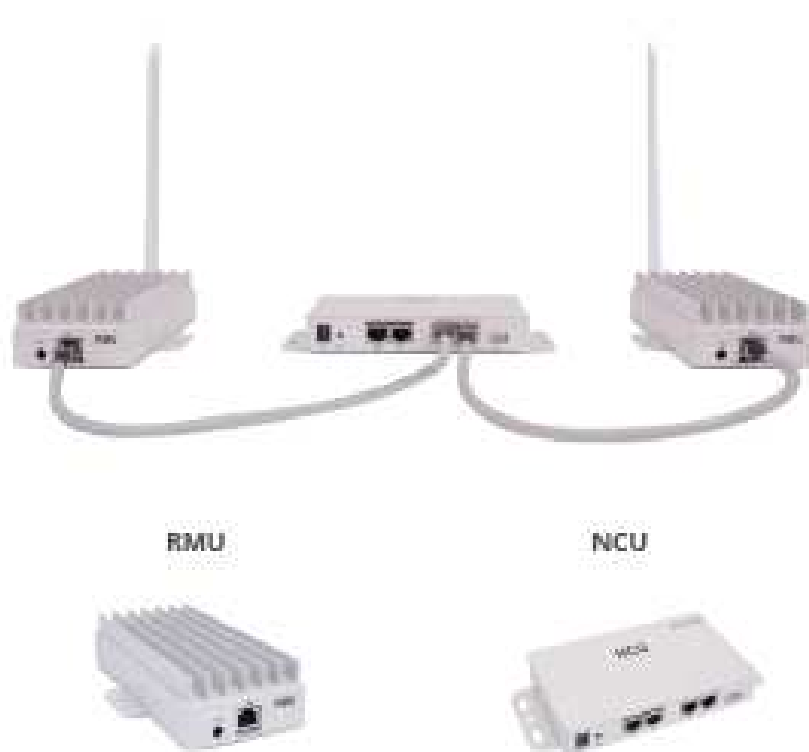


Item	Contents
Service	Wi-Fi, CCTV camera BIS(Bus Info System)
Bus Backhaul	TVWS
Max. Internet Throughput	19Mbps @ 6MHz 26Mbps @ 8MHz
Wi-Fi in Bus	IEEE802.11n
Handover	Hard Handover
Max. Bus Speed	110 km/h

IV. Mobile Public IoT Service

2. Bus Public IoT Device

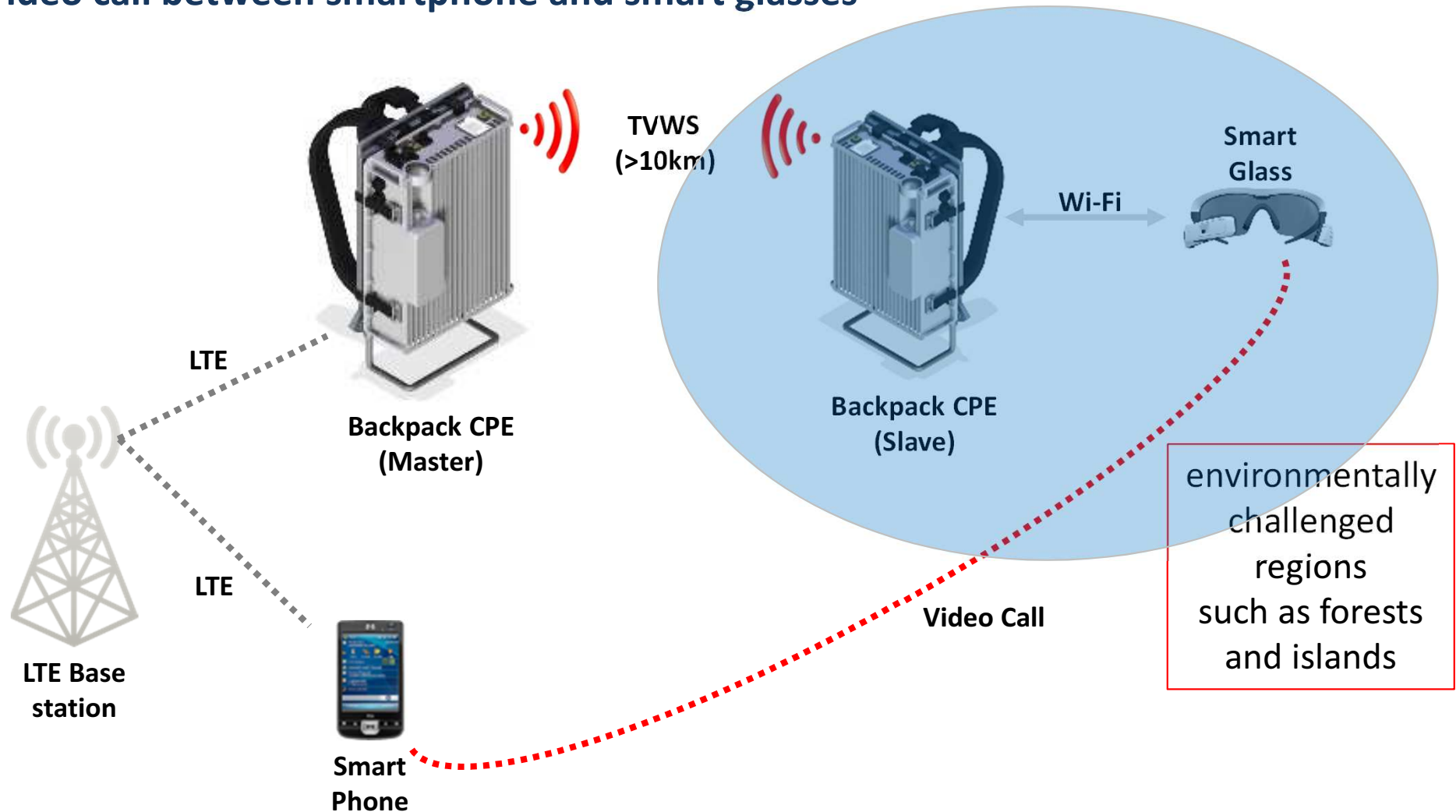
- ❖ Two TVWS RF paths for hard handover
- ❖ Internal IEEE802.11n Wi-Fi AP in NCU



Item	Specification
TVWS Standard	IEEE802.11af
Frequency	174~216MHz, 470~698MHz
TX Output Power	18dBm ± 2dB
CH BW	6MHz, 8MHz
RX Sensitivity	IEEE802.11af Spec.
Modulation/Demodulation	QPSK, 16-QAM, 64-QAM, 256-QAM
Service Interface	Wi-Fi, LAN, RS-232C
Wi-Fi Standard	IEEE802.11n
TVWS Antenna Connector	SMA
Ethernet	10/100Base-T, RJ-45
Electric Power	DC
Mounting	Wall or Pole Mount
Operating Temperature	-30°C ~ 50°C
Packaging	Outdoor & Indoor

V. Demonstration

❖ Video call between smartphone and smart glasses



Thank You



www.innonet.net
admin@innonet.net

Innonet Video for TVWS product and Installation sites

- https://www.youtube.com/watch?v=a0m92_HAq50&feature=youtu.be
- <https://www.youtube.com/watch?v=gRp-OSXgoaw&feature=share>