# Private 5G

Provision of Private 5G Infrastructure for Smart Factory



2025.04



### Background •••



## WiFi Roaming issue



### Background •••

Public 5G TDD(Time Division Duplexing) frame structures employed for South Korean mobile operators.



## BACKGROUND

INDUSTRY 4.0 The optimal infrastructure for digital transformation is Private 50

Background



#### **Our Business**

# Flectory is Private 5G Core specially Company

Private 5G is an Industry 4.0 core infrastructore where consumers have control over communication, like WiFi.



### **5G Components**

Years of network operation experience

#### Collaborating with various 5G terminal/gNodeB manufacturers



- UE(User Equipment) : The equipment designed for consumer use
- gNB(gNodeB) : 3GPP-compliant implementation of the 5G-NR base station

- Access Network : The network which physically connects UEs to the routers.
- 5G Core : 5G Core is the heart of a 5G network, controlling data and control plane operations.



#### **5G Product Lines**



#### Sites Large sites such as airports and ports

Small to medium-sized site with an area of 3 international standard soccer fields (approximately 21,487 m<sup>2</sup>)

• CU(Central Unit) : User data transfer, mobility control

• DU(Distribution Unit) : Digital signal processing

• RU(Radio Unit) : Acts as an antenna

• Small Cell : Small base stations covering areas of tens of meters



### VoNR

#### High-quality voice service support using IMS and 5G Core Network technologies.



- IMS(IP Multimedia Subsystem) : A network framework developed by 3GPP to deliver multimedia services over IP networks
- VoNR (Voice over New Radio) : A technology that supports both voice calls and data transmission using 5G networks

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### **X-CORE(5G CORE)**

사항원형 : 물약도시 55 Xore 사항원위사 (PGD) 23 (Child) 전 사항원과 · 사항 유리사, 사항 원과 유민사 한 사항 문과사 환자

한국전자통신연구원장

(관인



		Performance
	E2E data transmission latency	
	Maximum number of subscribers	
	Maximum number of small cells	
re	Concurrent Network Slicing per Subscriber	
	Number of concurrently supported DNNs per subscriber	
	User Plane Processing Performance	

% The above performance is based on ThinkEdge SE450. Core performance may vary depending on H/W specifications.

ltem	Specification
Size	445 x 87 x 383 (W x H x D mm)
CPU	40core Intel(R) Xeon(R) Silver
Memory	125GB
NIC	Intel 25G SFP28 * 2 Broadcom 10G Ethernet * 8 / I350 1G Ethernet * 4
Storage	1.8TB SSD
Available Small Cells	500

- Docker : Docker is an open-source project that uses process isolation technologies in Linux to run and manage applications in containers
- Kubernetes : A platform that automates the deployment, management, scaling, and monitoring of containerized applications

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·시험·방목 16개 방류이며, 이학인 방목



#### **X-CORE MINI**

计算机算行程序 [ThinkSystem SE350] [PL64 S7012MN]

item	Specification
Size	400mm x 215mm, 1U high.
CPU	One Intel Xeon D-2100 Series processor
Memory	64GB
NIC	2x 10GbE SFP+, 2x 1GbE RJ45 (support 10/100 Mbps), 2x dedicated ports for remote management
Storage	SSD 1TB

item	Specification
Size	119.7mm x 199.7mm, 33.9mm high.
CPU	Intel alder lake core i7-1255U
Memory	64GB
NIC	Intel I225V LAN, 2.5Gbps Intel I219V LAN 1Gbps
Storage	SSD 1TB

• NIC(Network Interface Card) : A hardware device that allows a server to connect to a network

• SFP (Small Form-factor Pluggable) : SFP is a compact, hot-swappable transceiver that connects networking equipment to fiber optic or copper cables for data transmission.



### 5G Small Cell(gNB/Indoor)





#### [QUCELL AIO]

- 5G+LTE(option) Support
- All-in-One Type (CU+DU+RU, DU+RU)
- Plug and Play Support
- Reduce installation costs with PoE++ support
- NSA, SA network option support
- IEEE1588v2/GPS support as synchronization source

Item	Specification
Frequency	5G Sub-6 GHz (n79)
Max Transmit Power	30dBm (EIRP)
Bandwidth	100MHz (Max)
RF Antenna	Internal : 2T/2R
Max. Modulation	256QAM (Max)
Cell Capacity / Layers	1 cell / DL 2 layers, UL 2 layers
Max Connected Users	32(NSA*) / 64(SA)
Synchronization	IEEE1588v2/GPS (Optional)
Interface	Backhaul - 1G/2.5Gbps Ethernet x 1 port - SFP+ (for optical) x 1 port (Option) Management - 1Gbps Ethernet x 1 port
Power Input	External 19~24VDC, PoE++
Size/Weight	260 x 260 x 55 (W x H x D, mm)/<2.5kg
Operating Temperature	-5~40℃
IP Grade	IP30
Mount Type	Ceiling / Wall Mount

- Sub-6 : Frequency in band below 6 GHz
- N79 : 4.72 4.82 GHz bandwidth

- PoE(Power Over Ethernet) : A technology that uses UTP cables to transmit data and power
- IEEE1588 : A network-based time synchronization communication protocol



### 5G Small Cell(gNB/Indoor)



- Plug and Play Support
- 4x4 MIMO
- Support for SA network options
- Supports IEEE1588v2/GPS as a synchronization source

Item	Specification
Band	n78: 3.3~3.8GHz / n79: 4.4~5.0GHz
<b>RF Tx Power</b>	24dBm (250mW) /ANT
Bandwidth	Customized Bandwidth : 100Mhz,80MHz, 60MHz etc.
Tx/Rx Path	4T2R(HW)
Modulation	DL: 256QAM / UL: 64QAM
MIMO Order	DL: 4 Layers UL:2 Layers
Active Users	64
Synchronization	GPS, IEEE 1588v2, Sync-E
Interface	Backhaul: 10G SFP+, 10G RJ45
Power Supply	54 Vdc
Power Consumption	90W
Temperature	-5~45°C
Humidity	5% ~ 95%
Dimensions	303 x 239 x 83 mm
Ingress Protection	Indoor: IP30
Mounting	Wall mount or ceiling mount

- MIMO(multiple-input and multiple-output) ; A technology that uses multiple antennas at both the transmitter and receiver to improve wireless communication performance
- RF Tx Power: RF transmit power



### 5G Small Cell(gNB/Outdoor)



ltem	Specification
Frequency	5G Sub-6 GHz <b>n79</b>
Bandwidth	100MHz
MIMO	4T x 4R
Maximum Tx Power	5W (37 dBm) / Port
RF Port	RF 4.3-Type Connector x 4
Users	64 UEs
TDD Configuration	4:1/6:4
Modulation	DL 256 QAM, UL 256 QAM
Interface	<ul> <li>- 1G / 2.5G / 10 Gbps Ethernet port * 1</li> <li>- SFP+ (10Gbps) interface for optic * 1</li> <li>- 1 Gbps Ethernet port for management/debug * 1</li> </ul>
Synchronization	PTP / GNSS
Power Input	AC 100 – 200 V (50 / 60Hz)
Size/Weight	300 x 370 x 145 (W x H x D mm) / < 18.2 kg
IP Grade	IP67
Mount Type	Pole / Wall Mount



### **5G Radio (O-RU/Indoor)**



#### [WNC-R1220 RU]

- SA Network Architecture
- 3GPP Release 15
- n48, n77, n78, n79
- 4T4R

ltem	Specification
Frequency Bands	N48 (3550-3700MHz) / n77(3700-4000MHz) / n78(3300-3600MHz) / n79(4600-4900MHz)
Max Transmit Power	24dBm
Antenna	4* embedded OMNI antenna or 4* SMA type connectors for external antenna SKUs
Fronthaul	10BASE-R SFP+
Management	1000BASE-T RJ45 Gigabits Ethernetport with PoE++ type 4 PD
Synchronization	IEEE1588-2008 PTPv2 Holdover: 1.5μs over 30minutes
RX Sensitivity	-40dBm ~ -93dBm @100MHz CBW
Modulation	OFDM-CP, Downlink256QAM, Uplink 64QAM
Operating Temperature	0~40℃
Operating Humidity	95% RH
IP Grade	IP30
Dimensions	254mm x 254mm x 66mm (W x D x H)
Input Power	PoE++ type 4





#### **5G Radio (O-RU/Indoor)**



- 4x4 MIMO
- Support for SA network options

Item	Specification
Band	FR1 Sub-6GHz : n78, n79
<b>RF Tx Power</b>	24dBm(250mW) /ANT
Bandwidth	Customized Bandwidth : 10 ~ 100Mhz.
Tx/Rx Path	4T4R(HW)
Modulation	DL: 256QAM / UL: 64QAM
MIMO Order	DL: 4Layers UL: 4Layers
Active Users	32
Synchronization	GPS, IEEE 1588v2, Sync-E
Interface	Backhaul: 10G SFP+, 1G RJ45
Power Supply	54 Vdc
Power Consumption	65W
Temperature	-5~45°C
Humidity	5% ~ 95%
Dimensions	252 x 252 x 62.7 mm
Ingress Protection	Indoor: IP30
Mounting	Wall mount or ceiling mount



### **5G Radio (O-RU/Outdoor)**



ltem	Specification
Frequency Bands	N48 (3550-3700MHz) / n77(3700-4000MHz) / n78(3300-3600MHz) / n79(4600-4900MHz)
Max Transmit Power	24dBm
Antenna	4x embedded sector antenna or 4x Ntype connectors for external antenna SKUs 1x N type connector for the optional GPS antenna
Fronthaul	10BASE-R SFP+
Management	1000BASE-T RJ45 Gigabits Ethernetport
Synchronization	IEEE1588-2008 PTPv2 / SyncE / GNSS Holdover: 1.5μs over 4 hours
RX Sensitivity	-40dBm ~ -93dBm @100MHz CBW
Modulation	OFDM-CP, Downlink256QAM, Uplink 64QAM
Operating Temperature	-40~55℃
Operating Humidity	95% RH
IP Grade	IP67
Dimensions	320mm x 425mm x 120mm (W x D x H)
Input Power	-48VDC, max power consumption 160W



### **5G Radio (O-RU/Outdoor)**

[SERA O-RU] • N41/N48/N53/N77/N78/N79 • O-RAN Compliance Category A, Split 7.2a

• Software Defined Radio

Item	Specification
Band	n41, n48, n53, n77, n78, <b>n79</b>
RF Tx Power	24dBm(250mW) / ANT port
Tx/Rx Path	4T4R
Modulation	DL: 256QAM / UL: 256QAM
Synchronization	GPS, IEEE 1588v2, Sync-E(option)
Interface	10G SFP+ Ethernet * 1 1G RJ45 * 1
Power Supply	54 Vdc
Power Consumption	<40W
Dimensions	325 x 250 x 63 mm
Ingress Protection	IP65
Mounting	Ceiling/Wall mount/Pole





- 5G-NR Modem
- FR1(Sub6) + FR2(mmWave) Dual Connectivity
- 3gpp Rel16 support
- PoE support

ltem	Specification
Callular tachpalagu	5G: FR1(Sub 6G), optional FR2(mmWave)
	4G: CAT. 20 (2Gbps) on DL, CAT. 13 (150Mbps) on UL
	5G: n1/2/3/66/7/41/77/78/79
4x4 MIMO	4G: B1/25(2)/3/66(4)/7/30/40/41(38)/42/48
Diversity/2nd Rx	4G: all operating bands
	Support for SIM
USIM port – dual voltage	Class B and Class C support
	Clock rates up to 4 MHz
	Application processor to run customer application code
Application processor	32 bit ARM Cortex-A7 up to 1.5 GHz
	4Gbit NAND Flash + 4Gbit LPDDR4 MCP is supported
Port	USB type-C Connector
	RJ45 Connector

• MIMO(multiple-input and multiple-output) : Multi-antenna technology, minimizing channel loss and user-to-user interference





 Power supply and Ethernet connection via USB type-C

Item	Specification
	5G: FR1(Sub 6G), optional FR2(mmWave), Rel 15
Celiular technology	4G: CAT. 20 (2Gbps) on DL, CAT. 13 (150Mbps) on UL
	5G: n1/2/3/66/7/41/77/78/79
4x4 MIMU	4G: B1/25(2)/3/66(4)/7/30/40/41(38)/42/48
Diversity/2nd Rx	4G: all operating bands
	Support for SIM
USIM port – dual voltage	Class B and Class C support
	Clock rates up to 4 MHz
	Application processor to run customer application code
Application processor	32 bit ARM Cortex-A7 up to 1.5 GHz
	8bit NAND Flash + 8bit LPDDR4 MCP is supported
Port	USB type-C Connector

- FR1 : band below 6 GHz
- FR2 : band above 6 GHz

• Class B/C : Class B/C are classifications indicating electromagnetic compatibility, where Class B supports 3V and Class C supports 1.8V





Item	Specification
CPU	2.7 GHz Octa Core Processor (QC6490)
Operating System	Android 12(Upgradeable to Android 16)
Memory	4GB RAM/ 64GB UFS Flash 8GB RAM/ 128GB UFS Flash (Optional)
Radio Frequency Band	Worldwide - 5G FR1 : n1/2/3/5/7/8/12/13/14/20/25/26/28/29/38/40 /41/48/66/71/77/78/79 - 4G : B1/2/3/4/5/7/8/12/13/14/17/18/19/20/25/26/28 /38/39/40/41/42/43/48/66/71- 2G : 900/1800/850/1900
Data Rates	6GHz: 802.11a/n/ac/ax (WIFI 6E) >160MHz — up to 2400 Mbps; 5GHz: 802.11a/n/ac/ax >20MHz, 40MHz, 80MHz — up to 1201 Mbps; 2.4GHz: 802.11b/g/n/ax4 >20MHz — up to 286.8 Mbps
Interface	USB Type C Connector (USB 3.1) Docking Connector (Charging) Rear 10-pin connector





- 5G Mobile Internet Hotspot
- Receives 5G frequency as input and converts it to WiFi
- Better performance than existing Tethering

Item	Specification			
Cellular Connectivity	5G, 4G LTE (Cat 19)			
EMEA / Rest of world	5G: n1, n2, n3, n5, n7, n8, n12, n20, n25, n28, n34, n38, n39, n40, n41, n48, n77, n78, n79 4G: B1, 2, 3, 4, 5, 7, 8, 12, 17, 18, 19, 20, 25, 26, 28, 34, 38, 39, 40, 41, 42, 43, 48			
Rugged	IP68 DUSTPROOF + WATERPROOF, MIL-SPEC 810H, DROP TESTED			
Dimensions	127.8 x 80.8 x 26.3mm			
Weight	~280g			
Battery	User swappable 5300mAh Li-ion Battery, 10 hours usage, 1000 hours standby Usables as an emergency power bank			
WiFi	WiFi 6, 802.11 a / b / g / n / ac / ax 2x2 MIMO Connect up to 32 client devices Security modes supported: WPA-PSK, WPA2-PSK Support for private networks			
Chipset	MTK 5G T750			

LECTOR Y



#### **Cell Planning**







### Management

#### • Network Management

System Status			RAN Status	
Core Server	UPPS	aver .	hape	
UP Tare: 22 hours 46 minutes	UP Time: 33 days 21	Libours 23 minutes	Active phil	3
(21) Marrie Date	a (2) ba			
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Network Status				
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1 100				

- Real-time UE status monitoring
- Real-time gNB status monitoring
- Data visualization
- Various widget functions such as capacity and ping check
- Data Collection: SNMP, IPMI, etc.
- Supported OS: Window, Linux , Mac OS, etc.
- Network status alarm
- PDU Session monitoring

#### • Subscriber Management

LECIORT	ii Dashboard	El Subecriber	hi Doubvert	Gebbelinen				
	No.	MS	APN	Pré	Location	Purpose of use	Renarka	Actions
	1		PLECTORY	90.1.10.101	Offee	Streaming Service	sonarka	Seve
	2		PLECTORY	10.1.13.182	Office	lant - scil	Rollin Laptop	Reve.
			FLECTORY	90.1.10.103	Office	5G Cam	Energie CPE	Seve
			PLECTORY	90.1.13.104	Office	purpose of ease	remails	line
	6		FLECTORY	90.1 10 105	Office	purpose chase	senado	Save
	6		FLECTORY	90.1.10.105	Office	purpose of ann	senarita	Seve
	7		PLECTORY	90.1.13.187	Office	purpose chase	senarits	384
	0	0008	FLECTORY	90.1.10.100	Office	purpose chase	tertaria	Seve
		0009	PLECTORY	10.1.13.109	Offee	purpose of ease	remetis	Take
	10		FLECTORY	93.1.13.110	Office	purpose chase	terma fia	Seve
			PLECTORY	10.1.12.111	Offee	purpose of ane	remarks	Seve
	12	5613	FLECTORY	10.1.10.1102	Office	purpose chase	anna fas	Seve.
	12		FLECTORY	10.1.10.115	Office	purpose of ane	venaña.	See
	14		PLECTORY	10.1.13.154	Office	purpose of east	senatis	Reve
	15		FLECTORY	10.1.10.115	Office	purpose chane	senaria	Seve
	95		INTERNET	10.1.13.196	An Extra CPE			Reve .
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	95		PLECTORY	10.1.13.118	An Extra CPE			Seve
	19		FLECTORY	10.1.13.119	An Extra CPE			18v4
	20		PLECTORY	90.1.13.120	An Extra CPE			Seve

- User information management
- USIM registration management
- Subscriber registration for VOIP users

#### • Equipment Management



 Site-specific equipment installation location management

#### • Configuration Management

FLEC

			DI MNI Configuration
,	PLMN Comparate	on	PLMN Coniguration
	PLMNPhblic Land Meblie N	deox(은 전세계 통신사 네트웨었다가 무리된 고류 시설선으며 우리 프로이다.	DIRANDAS I STANAS NALIZAS STATI STU MENDARI MAS DA UMARA DE TONO
	BRI Candolitika JR223	MACE REPORT	PDBIN(Public Calls Mobile NetWork)은 전세계 중전자 데프웨크라다 두여진 모두 역동전호역 국제 표준하다.
	11542 1 88 PLW 25	- CHE2 2 C (0101010010110000000000	3자리 MCC(Mobile Country Code)와 2~3자리 MNC(Mobile Network Code)의 조함으로 구성된다.
	- 36PP 75 23 800 wintion 11	120-028 NZ	현재 Care5G에서는 2자리의 MNC만 지원한다.
	Current MCC: 359 C	unvert MINC: 30	
	MOG	MMC .	네트워크 시험용 PLMN 코드는 다음과 같다.(00101/001001/9999999999999)
	MCC3-dgt number(org-101)	MIC2-dytometry P1 Relativity	- 3GPP TS 23.003 version 19.2.0 12절 참조
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- PLMN Configuration (support 99999, 00101, etc..)
- APN(DNN) Configuration for QoS
- Get Current S-NSSAI

#### • 5G Core Management



- Providing License Information
- Log Download for Seamless Maintenance



### **Operation Strategy**

#### **Flectory Private 5G System**

Simplifying and miniaturizing system structure to minimize operational complexity







#### CASE #1 FOOD CLUSTER

- Site Name: Iksan Food Cluster
- Interlocking Applications: Forklift, AMR, IoT Sensor, IP Camera, etc.
- **Details**: The food cluster consists of five independent buildings, each serving different purposes. All centers are connected via optical fiber, utilizing a single core without the need for a separate UPF
- Deployment Date

Initial Setup: September 2022 Expansion: November 2024 Further Expansion: Planned for 2025

- Site Name: Amusement Park in Changwon
  Interlocking Applications: Shuttle Robot, IP Cameras, etc.
- **Details**: A private 5G network is installed in the Manufacturing Robot Pavilion within the amusement park. The shuttle robot, which is operated in the distribution center, runs on private 5G, and visitors are also able to control it.Establishment
- **Deployment Date**: November 2022, with plans for private 5G expansion to the Robot Convention Center.

#### CASE #3 Changwon

- Site Name: Changwon Automobile Parts Factory
- Interlocking Applications: AMR (Autonomous Mobile Robot)
- **Details**: This site had Eric's 5G installed three years ago. Due to maintenance issues and high licensing costs, it has led to a shift in preference toward our products.
- Deployment Date: November 2024

#### CASE #4 Vietnam

- Site Name: CMES Vietnam Hanoi
- Interlocking Applications: CMES Robot Management System
- Details: This is a POC (Proof of Concept) site for foreign companies entering Vietnam.

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• Deployment Date : September 2023

### CASE #5 Taiwan

- Site Name: Liteon Taiwan Taipei
- Interlocking Applications: IP Camera, MiFi, etc.
- Details: A POC site currently under construction in collaboration with LITEON in Taiwan.

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• Deployment Date : May 2024



FLECTORY

#### THE NEXT BIG THING WILL START OUT LOOKING LIKE A TOY

-CHRIS DIXON









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