Innowireless

O-RAN Test Solutions

2025.09.18 기술마케팅팀 오지영

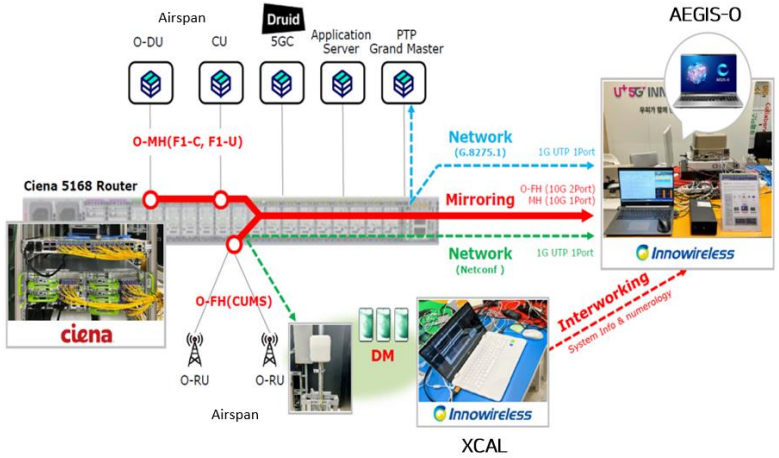


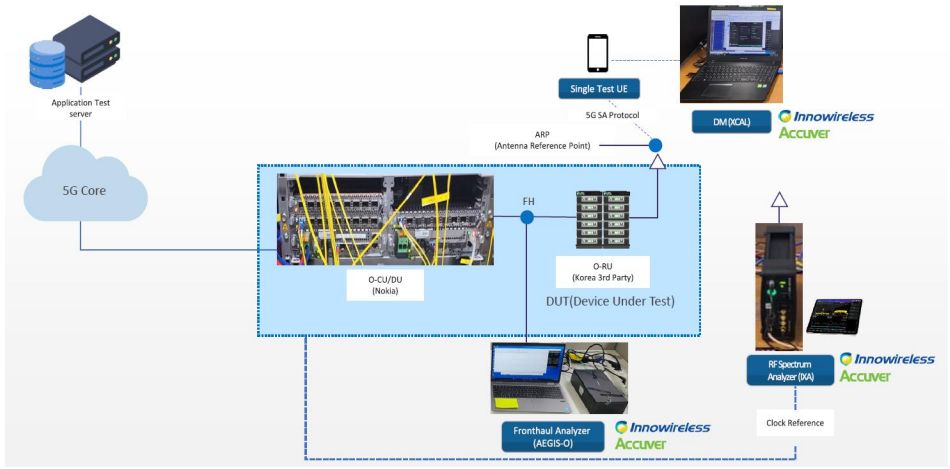
Contents

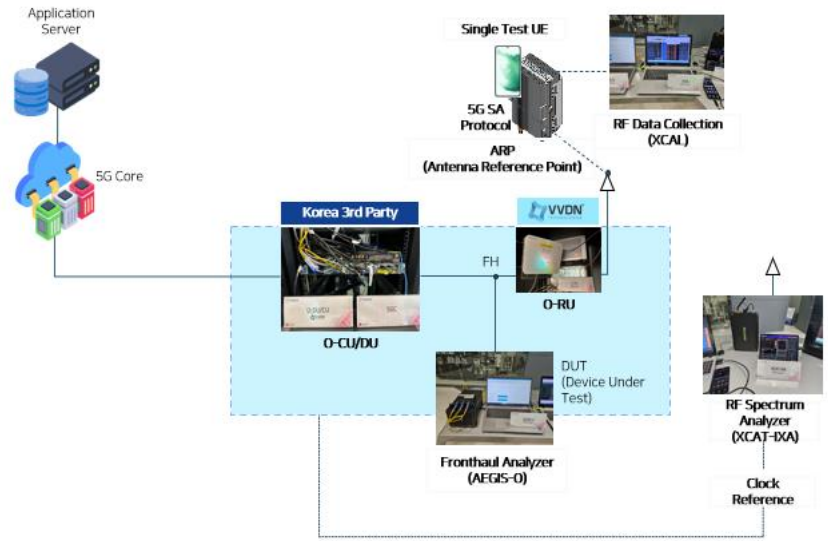
1. O-RAN PlugFest Participation
2. Innowireless O-RAN Test Solutions
3. WG4/WG5 IOT in PlugFest
4. TIFG E2E Test in PlugFest
5. XCAL-ART
6. XCAL-MUbox

O-RAN PlugFest Participation

이노와이어리스는 O-RAN Alliance 멤버로 2022년 부터 2024년까지 지속적으로 PlugFest 에 참여하고 있음

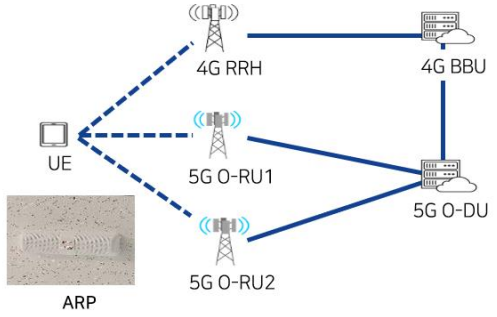








XCAL-Mate
(Indoor Field Test)



ARP



XCAL-Manager
(Log Analysis)

Innowireless O-RAN Test Solutions

테스트 실행부터 로그 분석, 결과 보고서 자동 발행까지 전체 O-RAN 테스트 프로세스를 지원하는 올인원 솔루션 제공

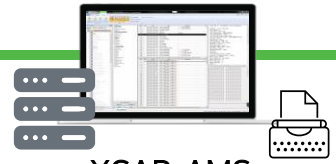
- **Test Management**
- **Log Analysis**



XCAL-Manager

O-RAN WG4 IOT | O-RAN WG5 IOT

O-RAN E2E Test



XCAP-AMS

- **TIFG.E2E Test Scenario Building**
- **Automatic E2E Test Report Generation**

Device Log Collection



UEs/DM

UE Simulator/DM

Throughput
Load/Scalability

XCAL

Field to Lab

Channel Emulator



XCAT-MAIS/AIS

Shield Box



XCAT-Shield Box

Spectrum Analyzer



XCAT-IXA

Clock Reference

O-RAN Network Test

Protocol Analyzer



AEGIS-O

Visibility
Trouble shooting

- **WG4/WG5 Test Scenario Building**
- **Automatic Badging Report Generation**



User Device



Radio Network



Management



Core Network

O-RAN | **O-RU** | **O-DU** | **O-CU**

WG4/WG5 IOT in PlugFest

AEGIS-O는 O-RAN 네트워크 성능을 모니터링 하고 프로토콜 적합성을 분석. XCAL의 UE 로그 와 네트워크 장비 간 패킷을 통합 분석하여 결과 도출

O-RAN WG4 IOT O-RAN WG5 IOT



XCAL UEs/DM

Easy trouble shooting linking with XCAL



XCAT-IXA Spectrum Analyzer

Clock reference

AEGIS-O



- Real-time packet trace and KPI analysis
- Monitoring of O-FH/MH/BH interface possible
- WG4/WG5 Test Scenario Building
- Automatic Badging Report Generation

Protocol Analyzer

Tapping

O-RAN eCPRI Fronthaul interface tapping
3GPP F1 Midhaul interface and Backhaul NG interface tapping
UE L3/NAS/PCAP trace

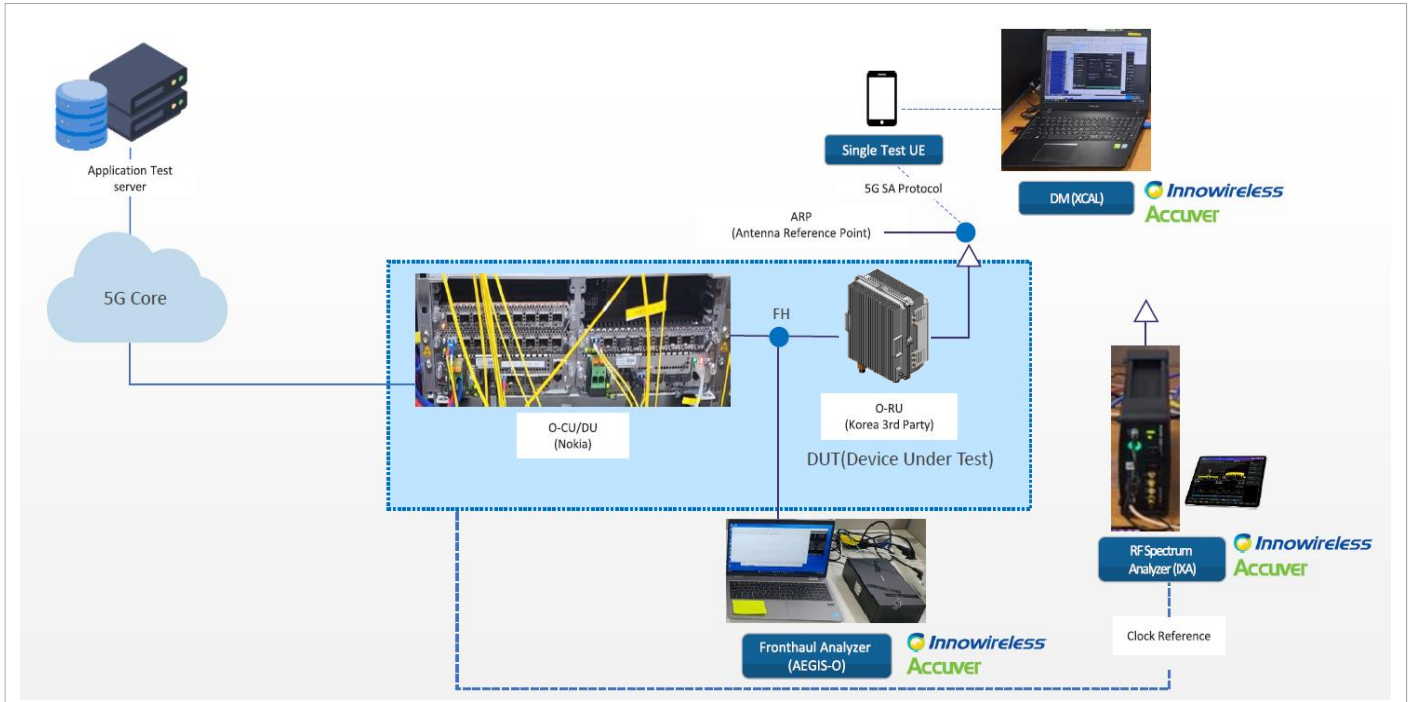
O-RAN | O-RU | Fronthaul | O-DU | Midhaul | O-CU | Backhaul | 5G Core

WG4/WG5 IOT in PlugFest

2023년 LGU+ PlugFest Fall – WG4 M/S/C/U-Plane IOT Test

O-RAN WG4 IOT

Chap.	M-Plane IOT Test
2.2.1.1	Start-up in hierarchical mode
Chap.	**S-Plane IOT Test**
2.2.2.1	Functional test of O-DU + O-RU using ITU-T G.8275.1 profile (LLS-C1)
2.2.2.8	Performance test of O-DU + Two O-RUs using ITU-T G.8275.1 profile (LLS-C1)
Chap.	**C/U-Plane IOT Test**
2.2.3.1	Radio Layer 3 C-Plane establishment and Initial Radio U-Plane data transfer
2.2.3.2	Radio U-Plane downlink data transfer (Downlink throughput performance)
2.2.3.3	Radio U-Plane uplink data transfer (Uplink throughput performance)
2.2.4.5	Delay Management #3, normal fronthaul latency

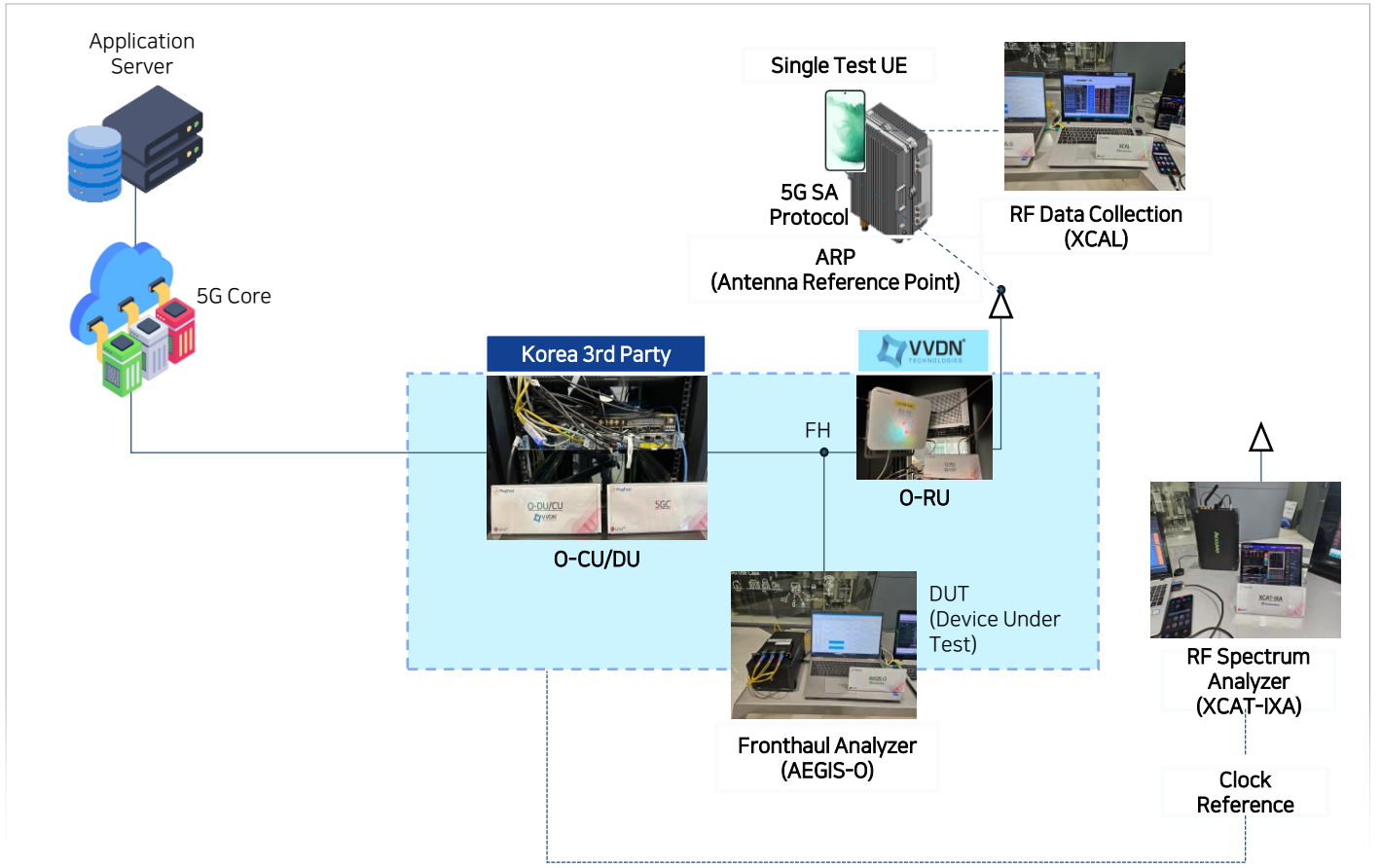


WG4/WG5 IOT in PlugFest

2024년 LGU+ PlugFest Spring – WG4 M/S/C/U-Plane IOT Test

O-RAN ALLIANCE **WG4 IOT**

Chap.	M-Plane IOT Test
2.2.1.1	Start-up in hierarchical mode
Chap.	**S-Plane IOT Test**
2.2.2.1	Functional test of O-DU + O-RU using ITU-T G.8275.1 profile (LLS-C1)
2.2.2.8	Performance test of O-DU + Two O-RUs using ITU-T G.8275.1 profile (LLS-C1)
Chap.	**C/U-Plane IOT Test**
2.2.3.1	Radio Layer 3 C-Plane establishment and Initial Radio U-Plane data transfer
2.2.3.2	Radio U-Plane downlink data transfer (Downlink throughput performance)
2.2.3.3	Radio U-Plane uplink data transfer (Uplink throughput performance)
2.2.4.5	Delay Management #3, normal fronthaul latency



TIFG E2E Test

Lab 및 Field 환경에서 XCAL, XCAT-MAIS, XCAP-AMS, AEGIS-O를 활용하여 자동화된 테스트 및 Handover 분석 지원

O-RAN TIFG E2E

Field



XCAL-Mate UEs/DM

- Walking Test/ Benchmarking solution



XCAL UE/DM

- Easy trouble shooting linking with XCAL

Lab



XCAL-MUbox UE Simulator

- Modem-based Scalable Multi-UE traffic generator
- Base station Load & stress testing



XCAT-MAIS Channel Emulator

- Massive-MIMO Air Interface Simulator
- Real-time Multi-cell/Multi-UE



XCAL-Manager

- Test Management
- Log Analysis

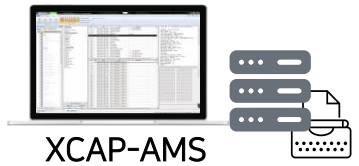


AEGIS-O Protocol Analyzer

- Real-time packet trace and KPI analysis
- Monitoring of O-FH/MH/BH interface possible

Tapping

O-RU — O-DU — O-CU — 5G Core



XCAP-AMS

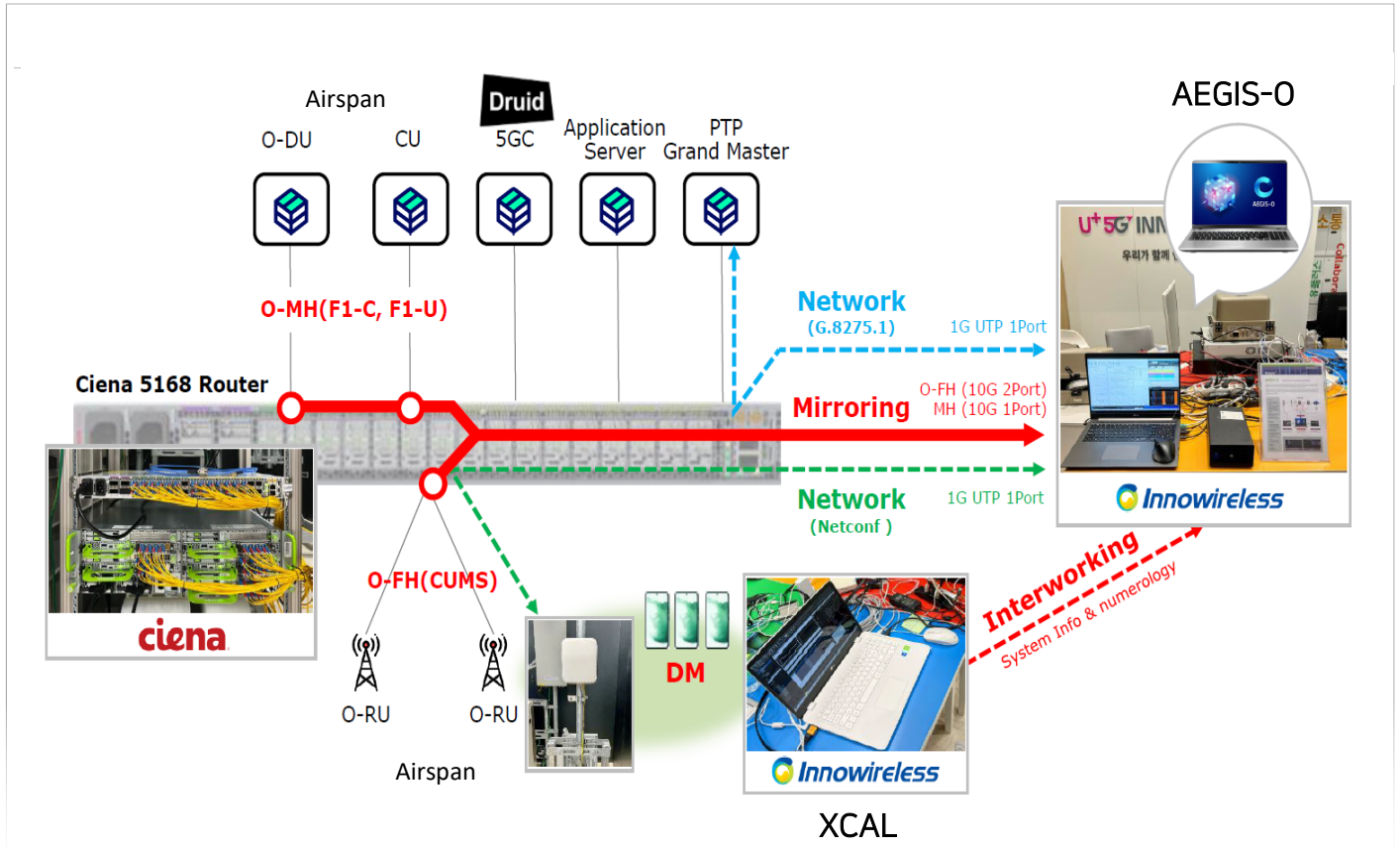
- TIFG.E2E Test Scenario Building
- Automatic E2E Test Report Generation

TIFG E2E Test

2022년 LGU+ PlugFest Fall – Intra O-DU Mobility Test , Throughput Test

O-RAN ALLIANCE **TIFG E2E**

Chap.	Test Item
4.3	5G SA registration(Attach) and deregistration(Detach)
4.4	Connected mode Intra- O-DU mobility _ NR HO
4.9	Idle Mode Intra- O-DU mobility _ NR HO
5.2	Downlink peak throughput (UDP)
5.3	Uplink peak throughput (UDP)
5.4	Downlink throughput in different radio conditions(TCP)
5.5	Uplink throughput in different radio conditions(TCP)
5.6	Bidirectional throughput in different radio conditions(TCP)
5.7	Downlink coverage throughput
5.8	Uplink coverage throughput
5.9	Downlink aggregated cell throughput
5.10	Uplink aggregated cell throughput
6.1.2	File upload/download(TCP)
Etc.	O-FH M-Plane Netconf Interworking
Etc.	O-FH CUS-Plane Timing & Abnormal Analysis
Etc.	O-MH Packet Trace & Decoding



TIFG E2E Test

2024년 LGU+ PlugFest Fall – Intra O-DU Mobility and Throughput Test in a Real NSA O-RAN Network Environment

O-RAN TIFG E2E

Chap.	Test Item
5.1	LTE/5G NSA attach and detach of single UE
5.2	LTE/5G NSA attach and detach of multiple UE
5.4	Intra O-DU mobility
6.2	Downlink peak throughput
6.3	Uplink peak throughput
6.4	Downlink throughput in different radio condition
6.5	Uplink throughput in different radio condition
6.6	Bidirectional throughput in different radio condition



XCAL-Mate
(Indoor Field Test)



ARP



XCAL-Manager
(Log Analysis)

XCAL-ART Testbed based on real UEs

Innowireless

1-1

XCAT-MAIS

- Provide Full-Matrix connections
- Provides fading channel effect and Path-loss control
- Control interference environment (various SNR environment)

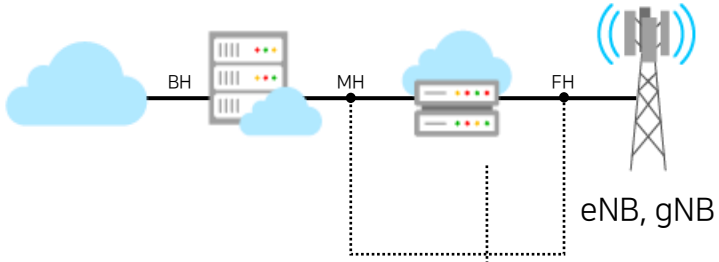
1-2

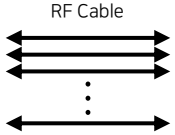
XCAT-AIS C

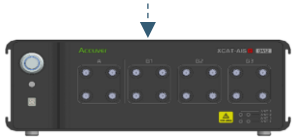
- Provide Path-loss control
- Provides fixed matrix connection between BS and UE

2

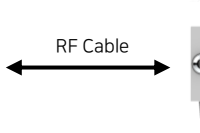
XCAT-Shield Box

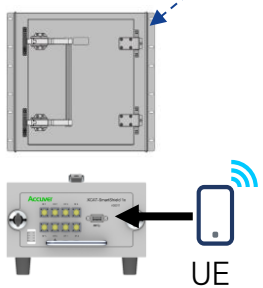












5

Report Automation

- Post Processing
- Report Automation through API

6

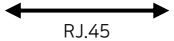
AEGIS-O



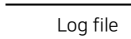














- Packet decoding, tracing and searching
- Collaborative analytics through UE, O-RAN and Core
- O-RAN Alliance Test Case support (Interoperability, E2E)

4

Test Harmonize

- Orchestrate the Lab test components
- Multiple Test component(s) Synchronization

3

Test Automation

- Call (voice/data) automation
- L1/L2/L3 trace and decoding
- Multiple UE control
- KPI report

XCAL-ART Testbed based on UE Simulator

Innowireless

1-1

XCAT-MAIS

- Provide Full-Matrix connections
- Provides fading channel effect and Path-loss control
- Control interference environment (various SNR environment)

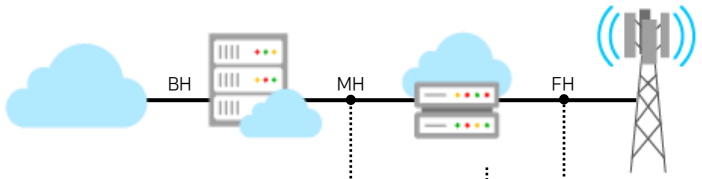
1-2

XCAT-AIS C

- Provide Path-loss control
- Provides fixed matrix connection between BS and UE



XCAT-AIS C



RF Cable

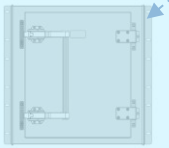


XCAT- MAIS

RJ.45

2

Shield Box



RF Cable



XCAT-Shield box

UE

5

Report Automation

- Post Processing
- Report Automation through API



XCAP-AMS

6

AEGIS-O

- Packet decoding, tracing and searching
- Collaborative analytics through UE, O-RAN and Core
- O-RAN Alliance Test Case support (Interoperability, E2E)



AEGIS-O

RJ.45



TM2.0

RJ.45



4

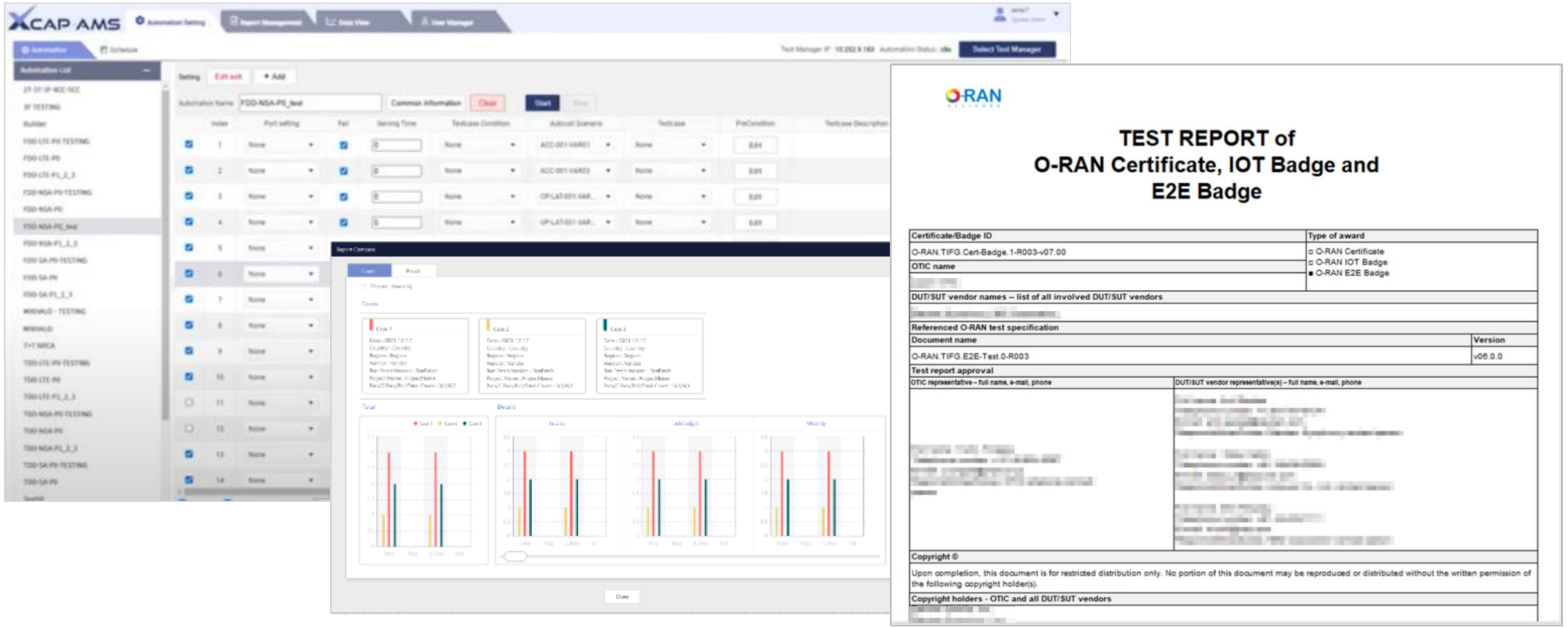
Test Harmonize

- Orchestrate the Lab test components
- Multiple Test component(s) Synchronization

3

- Call (voice/data) automation
- L1/L2/L3 trace and decoding
- Multiple UE (>40) control
- KPI report

O-RAN 인증 IOT 배지와 E2E 배지의 '테스트 보고서(TEST REPORT)'를 자동으로 생성

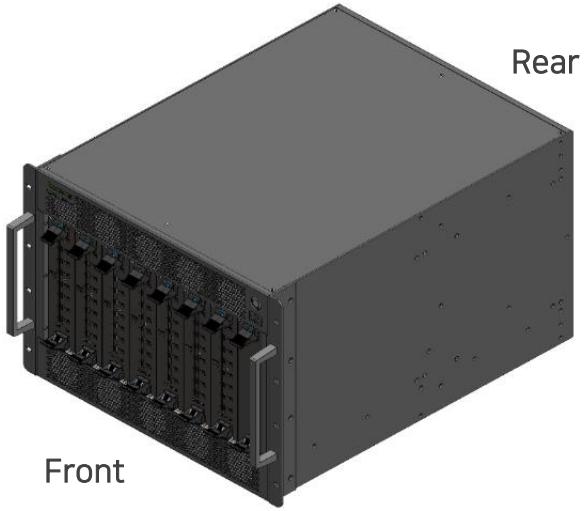


Innowireless O-RAN TC List and Related Solutions

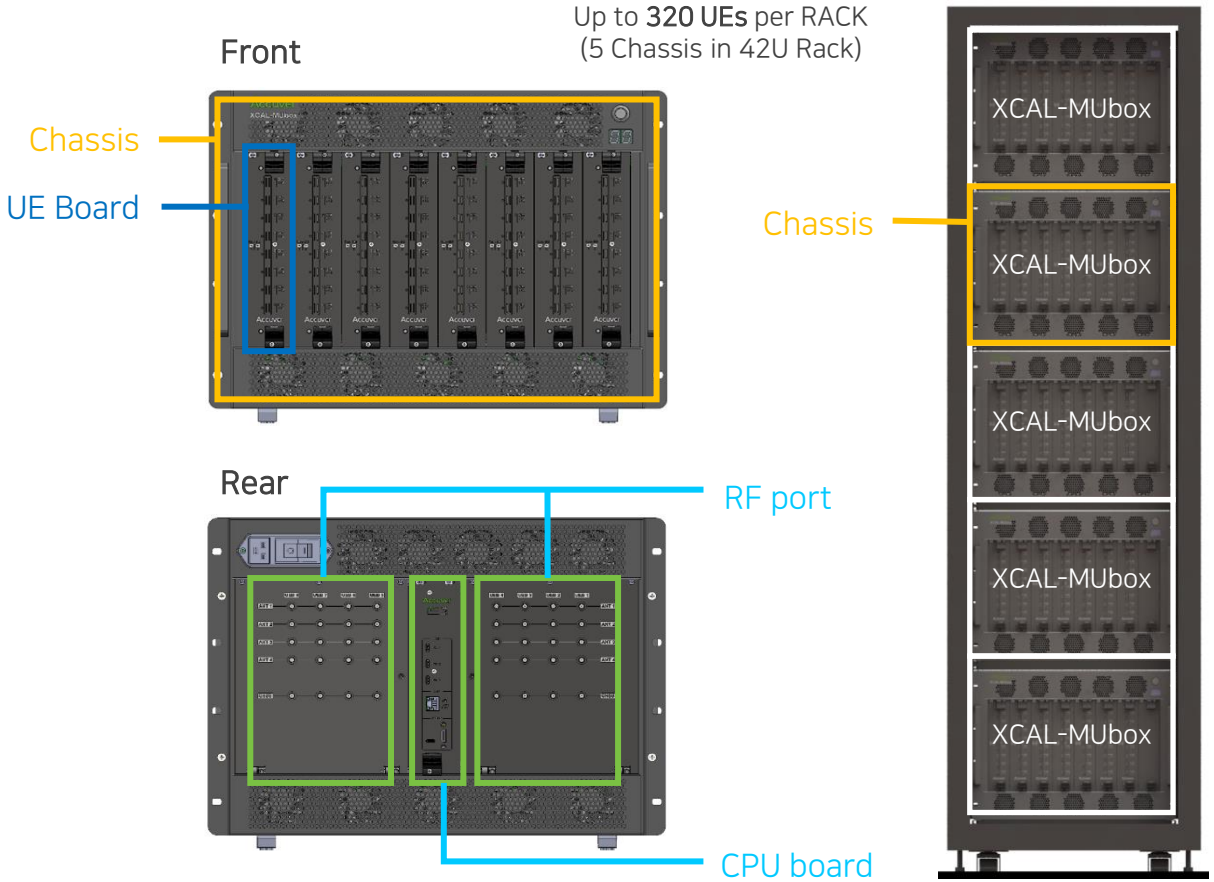
NO	TEST CASE NAME	CATEGORY	CALL TYPE	TEST TYPE	TECH	DESCRIPTION	AEGIS-O	MAIS Fading	MAIS Non-Fading	AIS-C	XCAL	AMS	TM	MUbox
1	TIFG-E2E-5.1	Functional	Call processing	NSA Attach	NSA	NSA(LTE&NR) attach and detach of a single UE		O	O		O	O	O	O
2	TIFG-E2E-5.2	Functional	Call processing	NSA Attach	NSA	NSA(LTE&NR) attach and detach of multiple UEs		O	O		O	O	O	O
3	TIFG-E2E-5.3	Functional	Call processing	SA Attach	SA	5G SA registration(Attach) and deregistration(Detach) of single UE		O	O		O	O	O	O
4	TIFG-E2E-5.3A	Functional	Call processing	SA Attach	SA	5G SA registration(Attach) and deregistration(Detach) of multiple UEs		O	O		O	O	O	O
5	TIFG-E2E-6.2	Performance	Tput	DL Max. Tput	NSA	Downlink peak throughput		O	O	O	O	O	O	O
6	TIFG-E2E-6.2A	Performance	Tput	DL Max. Tput	SA	Downlink peak throughput		O	O	O	O	O	O	O
7	TIFG-E2E-6.3	Performance	Tput	UL Max. Tput	NSA	Uplink peak throughput		O	O	O	O	O	O	O
8	TIFG-E2E-6.3A	Performance	Tput	UL Max. Tput	SA	Uplink peak throughput		O	O	O	O	O	O	O
9	TIFG-E2E-6.4	Performance	Tput	DL Tput	NSA	Downlink throughput in different radio conditions		O	O		O	O	O	O
10	TIFG-E2E-6.4A	Performance	Tput	DL Tput	SA	Downlink throughput in different radio conditions		O	O		O	O	O	O
11	TIFG-E2E-6.5	Performance	Tput	UL Tput	NSA	Uplink throughput in different radio conditions		O	O		O	O	O	O
12	TIFG-E2E-6.5A	Performance	Tput	UL Tput	SA	Uplink throughput in different radio conditions		O	O		O	O	O	O
13	TIFG-E2E-6.6	Performance	Tput	DL&UL Tput	NSA	Bidirectional throughput in different radio conditions		O	O		O	O	O	O
14	TIFG-E2E-6.6A	Performance	Tput	DL&UL Tput	SA	Bidirectional throughput in different radio conditions		O	O		O	O	O	O
15	TIFG-E2E-6.7	Performance	Coverage	DL Tput	NSA	Downlink coverage throughput (link budget) (single cell, single UE scenario)		O	O		O	O	O	O
16	TIFG-E2E-6.7A	Performance	Coverage	DL Tput	SA	Downlink coverage throughput (link budget) (single cell, single UE scenario)		O	O		O	O	O	O
17	TIFG-E2E-6.8	Performance	Coverage	UL Tput	NSA	Uplink coverage throughput (link budget) (single cell, single UE scenario)		O	O		O	O	O	O
18	TIFG-E2E-6.8A	Performance	Coverage	UL Tput	SA	Uplink coverage throughput (link budget) (single cell, single UE scenario)		O	O		O	O	O	O
19	TIFG-E2E-7.1.1	Services	Data service	-	Common	Web Browsing		O	O		O	O	O	
20	TIFG-E2E-7.1.2	Services	Data service	-	NSA	File upload/download		O	O		O	O	O	O
21	TIFG-E2E-7.1.2A	Services	Data service	-	SA	File upload/download		O	O		O	O	O	O
22	TIFG-E2E-7.2.1	Services	Video streaming	-	NSA	Stationary Test		O	O	O	O	O	O	
23	TIFG-E2E-7.2.1A	Services	Video streaming	-	SA	Stationary Test		O	O	O	O	O	O	
24	TIFG-E2E-7.2.2	Services	Video streaming	Intra O-DU HO	Common	HO_Intra O-DU	O	O	O		O	O	O	
25	TIFG-E2E-7.2.3	Services	Video streaming	Inter O-DU HO	Common	HO_Inter O-DU Intra O-CU	O	O	O		O	O	O	
26	TIFG-E2E-7.2.4	Services	Video streaming	Inter O-CU HO	Common	HO_Inter O-CU	O	O	O		O	O	O	
27	TIFG-E2E-7.2.5	Services	Video streaming	NSA MeNB HO	Common	different MeNB while staying connected to same SgNB	O	O	O		O	O	O	
28	TIFG-E2E-7.3.1	Services	VoLTE	Basic	NSA	Stationary Test		O	O	O	O	O	O	O
29	TIFG-E2E-7.3.3	Services	VoLTE	HO	SA	LTE and NR handover tests		O	O		O	O	O	O
30	TIFG-E2E-7.5.1	Services	VoNR	Basic	SA	Stationary Test		O	O		O	O	O	
31	TIFG-E2E-7.6.1	Services	ViLTE(Video)	Basic	NSA	Stationary Test		O	O		O	O	O	
32	TIFG-E2E-7.6.3	Services	ViLTE(Video)	HO	SA	LTE and NR handover tests		O	O		O	O	O	
33	TIFG-E2E-7.8.1	Services	VONR(Video)	Basic	SA	Stationary Test		O	O		O	O	O	
34	TIFG-E2E-6.9A	Performance	Tput	DL Tput	SA	Downlink aggregated cell throughput (cell capacity) (single cell scenario, multi-UE scenario)		O			O	O	O	O
35	TIFG-E2E-6.10	Performance	Tput	UL Tput	NSA	Uplink aggregated cell throughput (cell capacity) (single cell scenario, multi-UE scenario)		O			O	O	O	O

XCAL-MUbox

8개의 모뎀 모듈이 장착된 Slot-based scalable Multi-UE 시뮬레이터



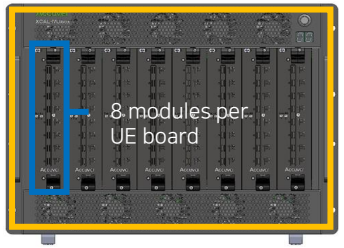
Form Factor	
Size	436.8 x 354.5 x 637.0 (mm)
Weight	45 (kg)
Structure	**64 UEs** per Chassis 8 UE Boards(8 Modules per UE Board)



XCAL-MUbox

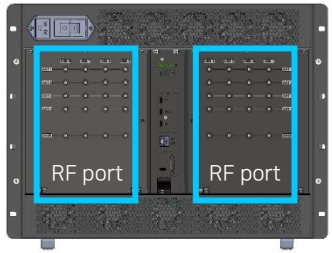
LTE/5G 기지국의 트래픽 용량과 신뢰성 테스트에 적합한 랙 타입 다중 UE 박스

8 UE boards per Chassis



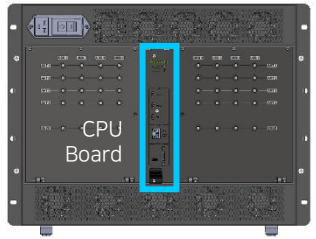
Communication Module Integrated Structure

- Equipped with a communication module featuring an embedded Qualcomm modem chip
- Each UE board consists of 8 communication modules
- Each chassis includes 8 UE boards (64 UEs per chassis)



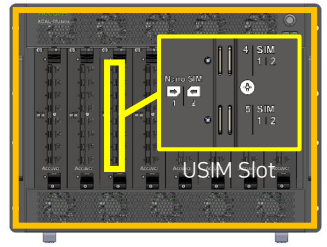
Wired RF Port

- Provides an optimal MIMO environment using a wired RF connection interface



Built-In CPU Board

- Equipped with a built-in CPU board allowing testing with only a monitor and input devices without the need for an external PC connection



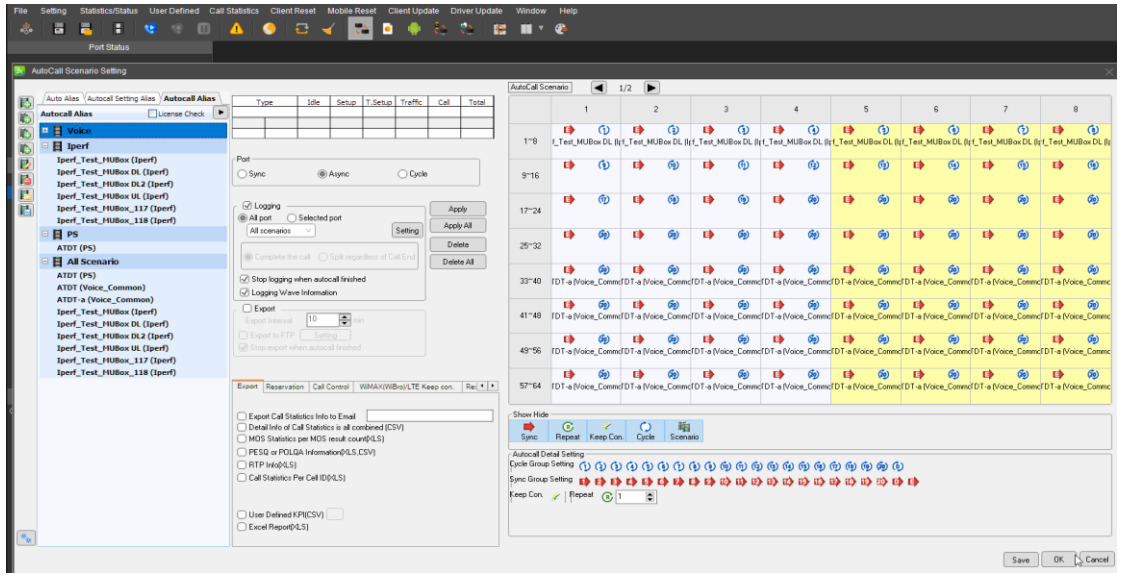
USIM Slot

- Supports replaceable USIM slots
- Select one SIM of Dual SIM slot

XCAL-MUbox

기지국 부하 생성을 위한 트래픽 및 UE 동작 제어

Provides the same user environment as the existing XCAL



The dashboard allows monitoring of all modules of the equipment, providing information on up to 64 devices



Traffic model

- PING
- iPerf
- VoLTE

UE control with Dashboard

- AT/QC command (ATTACH/DETACH,BAND LOCK)
- External Power Control

XCAL-MUbox

Category	Key Features	Description
Control	Test Manager Software	Integrated control of cascaded XCAL-MUbox units AIS/MAIS control functions for mobility testing(Handover, Link budget)(Optional) Test automation functions(Optional)
Mass Operation	64 UE Real Time Logging & Decoding	Supports real-time decoding for 64 UEs simultaneously via dedicated Logmask - captures all protocol messages across NR/LTE/WCDMA
	MUbox Cascade	TM chaining enables up to 320 UEs per rack, scalable to over 1,000 UEs via multi-rack expansion - unified control and monitoring through central TM GUI
Autocall	Random Offset	Minimizes setup failure by assigning randomized RACH start times to each UE to prevent collision
	Simultaneous Multi-Service Calls	Concurrent execution of VoLTE, iperf DL/UL, Attach/Detach - realistically simulates UE, service, network load
Real Time Visualization	Dashboard KPI Streaming	Visualizes key metrics like Throughput, Drop, and Pending in graphs, tables, and real-time event tracking
Port Automation	Auto Port Setting	Automatic mapping is triggered by simply assigning a Mobile Alias. Devices without designated port settings are automatically switched to airplane mode to prevent test data contamination
Logging & Data Management	Unified Logging Policy	Categorized logging by call/scenario/time/usage, real-time *.drx compression, PCAP conversion, and FTP/SFTP auto-upload supported.
Alarm System	Custom Alarms	Freely define alarms (e.g., No Coverage, Low TP, Setup Fail) - supports timed alerts, event tagging, and immediate issue trace logs
Remote Control	TMRAC / REST API	Remote monitoring and control of MUbox status, logs, and Autocall scenarios via API

	Frequency Bands
5G NR SA	- n1/n2/n3/n5/n7/n8/n12/n13/n14/n18/n20/n25/n26/n28/n29/n30/n38/n40/n41/n48/n66/n70/n71/n75/n76/n77/n78/n79 - DL 4 x 4 MIMO: n1/n2/n3/n7/n25/n30/n38/n40/n41/n48/n66/n70/n77/n78/n79 - UL 2 x 2 MIMO: n38/n41/n48/n77/n78/n79
5G NR NSA	- n1/n2/n3/n5/n7/n8/n12/n13/n14/n18/n20/n25/n26/n28/n29/n30/n38/n40/n41/n48/n66/n70/n71/n75/n76/n77/n78/n79 - DL 4 x 4 MIMO: n1/n2/n3/n7/n25/n30/n38/n40/n41/n48/n66/n70/n77/n78/n79
LTE	- FDD: B1/B2/B3/B4/B5/B7/B8/B12/B13/B14/B17/B18/B19/B20/B25/B26/B28/B29/B30/B32/B66/B71 - TDD: B34/B38/B39/B40/B41/B42/B43/B46(LAA)/B48 - DL 4 x 4 MIMO: B1/B2/B3/B4/B7/B25/B30/B38/B40/B41/B42/B43/B48/B66
WCDMA	- B1/B2/B4/B5/B8/B19

64개 모든 모듈을 각각 모니터링할 수 있으며 모듈별, 셀별 네트워크 성능 정보를 실시간으로 제공



Call Statistics

Network Connection Statistics

Total Throughput

UE Attach/Detach Control

LTE/5G NR Connection PCI Info of UE

Mobile reopen / Reset

Cell throughput (Table view)

PCI Connection Statistics

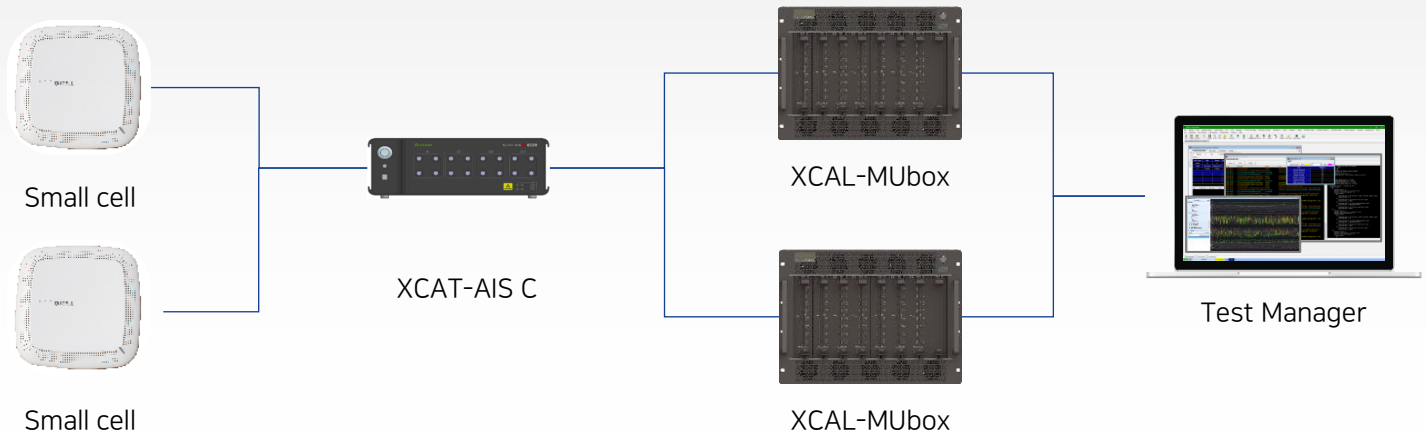
Cell throughput(DL) (Graph view)

스몰셀 Load & Capacity Test 환경 예시



Connection Setup

- The signal from the Small Cell is connected to the XCAT-AIS C, allowing for signal strength control and handover scenario creation
- The signal output from the XCAT-AIS C is then split and connected to two XCAL-MUbox units (each with 64 UEs), enabling simultaneous measurement with up to 128 UEs
- Testing was conducted by connecting two XCAL-MUbox units to the TM, enabling simultaneous control of 128 UEs



감사합니다

Innowireless