O-RAN Overview and Test Solution

Brian Su	2020.12
Sr. Project Manager	

O-RAN Standards Situation & Plans

SOURCE: 3GPP, O-RAN ALLIANCE

2017	2018				2019				2020				2021				2022			
Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4

5G
1st Launch May'18
Qatar: Oredoo

Verizon
AT&T

SKT
KT
LG Uplus

UK: EE, 3, O2, Vodafone
Germany: DT, Vodafone

China Mobile
China Telecom
China Unicom

NTT Docomo
Softbank
KDDI
Rakuten

R15 → Commercialization

3GPP A GLOBAL INITIATIVE

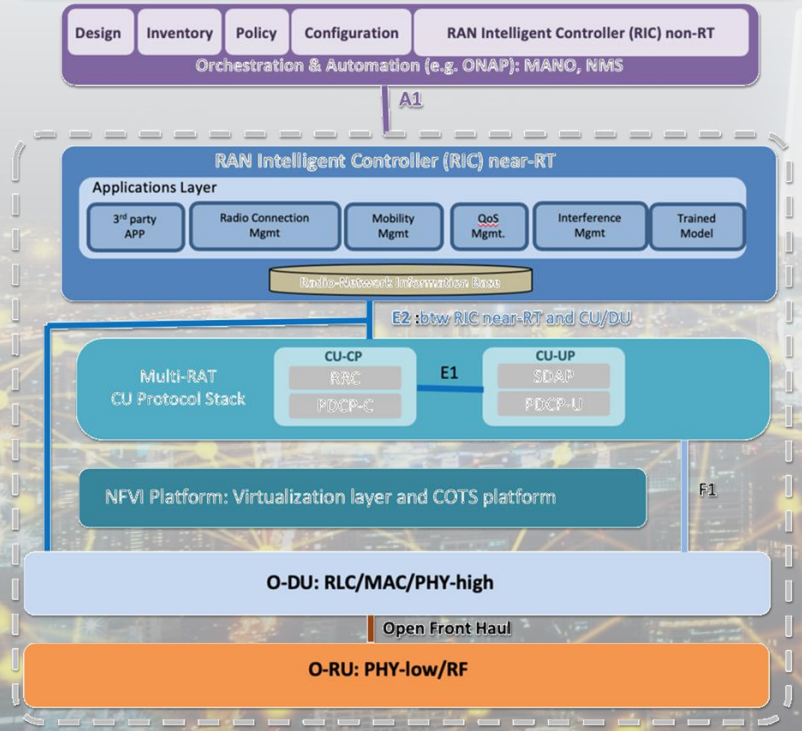
O-RAN ALLIANCE

- **O-RAN-WG4 CORE V1.0** → New 3GPP base lines (R16,17…) & New O-RAN CORE versions
  - CUS v1.0
  - MP v1.0
  - CUS & MP v2.0
  - CUS v3.0
  - MP v3.0
- **O-RAN-WG4 TEST V1.0 (FDD/FR1)** → New 3GPP (R16,17…) & New O-RAN CORE base lines
  - IOT v1.0
  - IOT v2.0
  - CONF v1.0
- **Open RAN STUDIO / UESim** → New O-RAN base lines (v3, 4 …)
- **O-RAN PROFILES** → New O-RAN Profiles
- **Keysight O-RAN PCT** → New O-RAN base lines, Test Specs & Profiles
  - TCs #1.0
  - TCs #2.0
  - TCs #3.0

KEYSIGHT TECHNOLOGIES

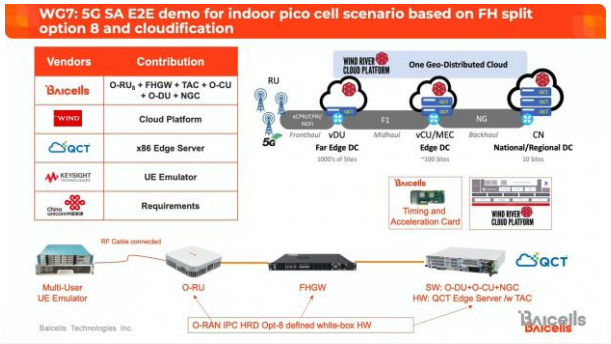
Keysight O-RAN Member Since Inception

SOURCE: O-RAN ALLIANCE



O-RAN Alliance

- WG1:Use cases & Overall architecture
- WG2:RIC(non-RT) & A1 interface
- WG4:NGFI Interface specification
- WG5:Key Interfaces & Stack Reference Design
- WG6:Cloudification and MANO Enhancement
- WG7:White-Box Hardware
- WG8: Stack Reference Design Workgroup
- WG9 - Open X-haul Transport Workgroup
- TIFG - Test & Integration Focus Group
- OSFG - Open Source Focus Group
- SDFG - Standard Development Focus Group



O-RAN Virtual Exhibition

Contributed 10+ virtual exhibitions in '20

WG4: Open FH Interface

Specify open front-haul interface(NGFI-I) btw DU and AAU, based on C-RAN and xRAN's work (IEEE 1914, eCPRI, CPRI)

WG4: Open FH Interface

Editor of the O-RAN Fronthaul Conformance and Interoperability Test Specification

WG7: Multi-Alliance PoC

Keysight, and many partners completed multiple PoC at Mobile World Congress since 2019

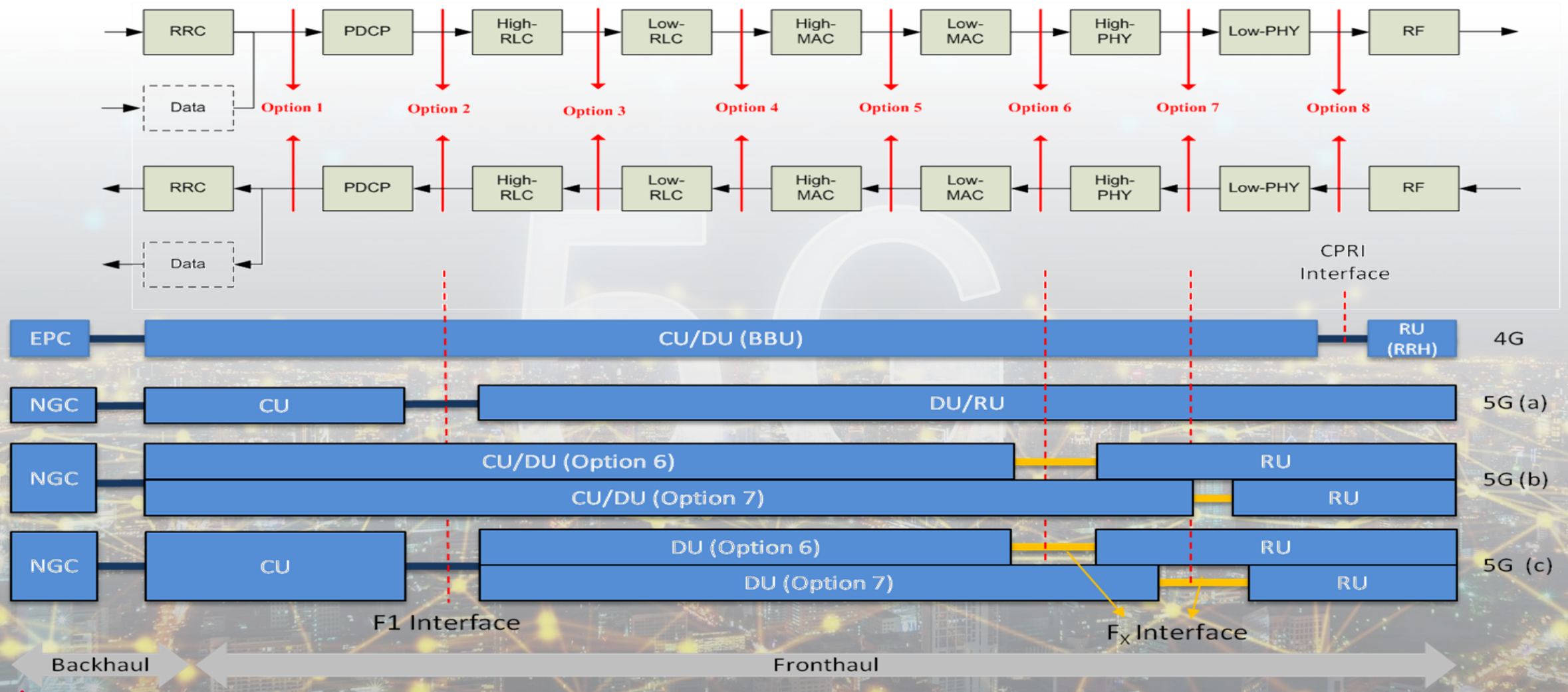
TIFG - Test & Integration Focused

Keysight is a voting member and working on Plugfest includes Joint European O-RAN & TIP Plugfest/PoC by Fall 2020

KEYSIGHT TECHNOLOGIES

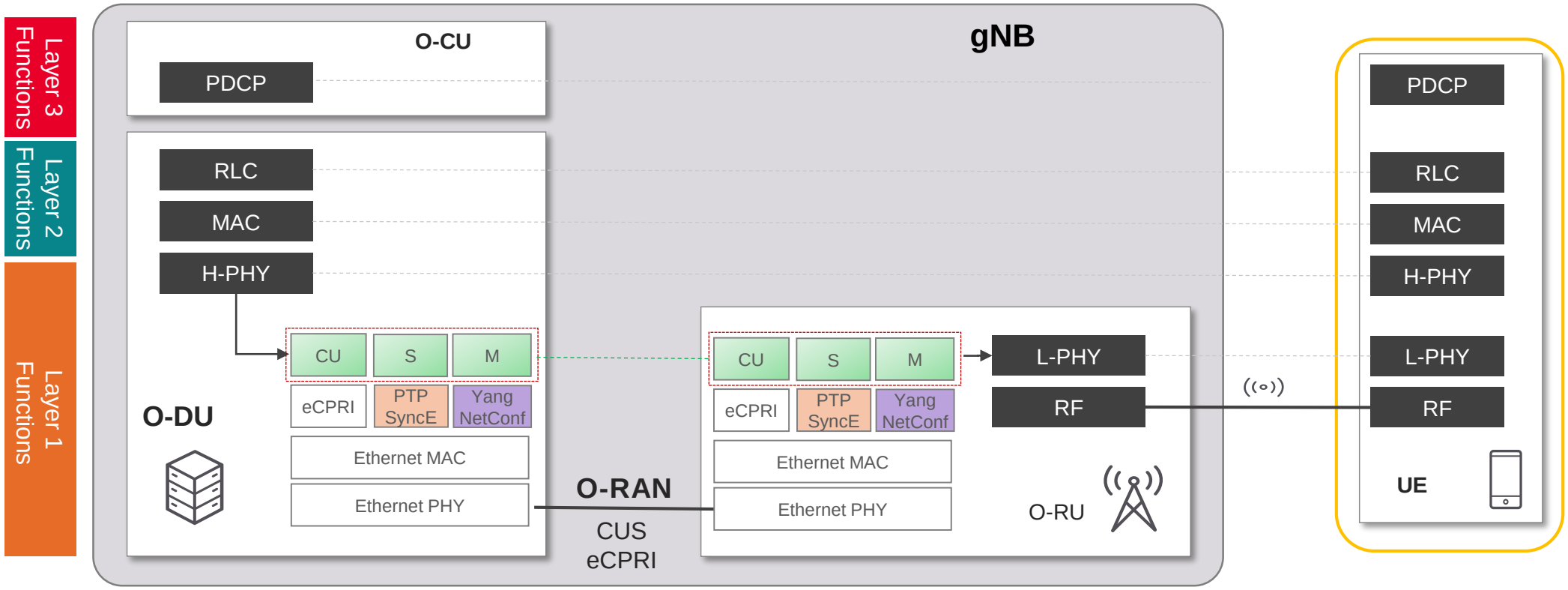
5G RAN Network – Functional Split Options

SOURCE: ITU-T GSTR-TN5G TRANSPORT NETWORK SUPPORT OF IMT-2020



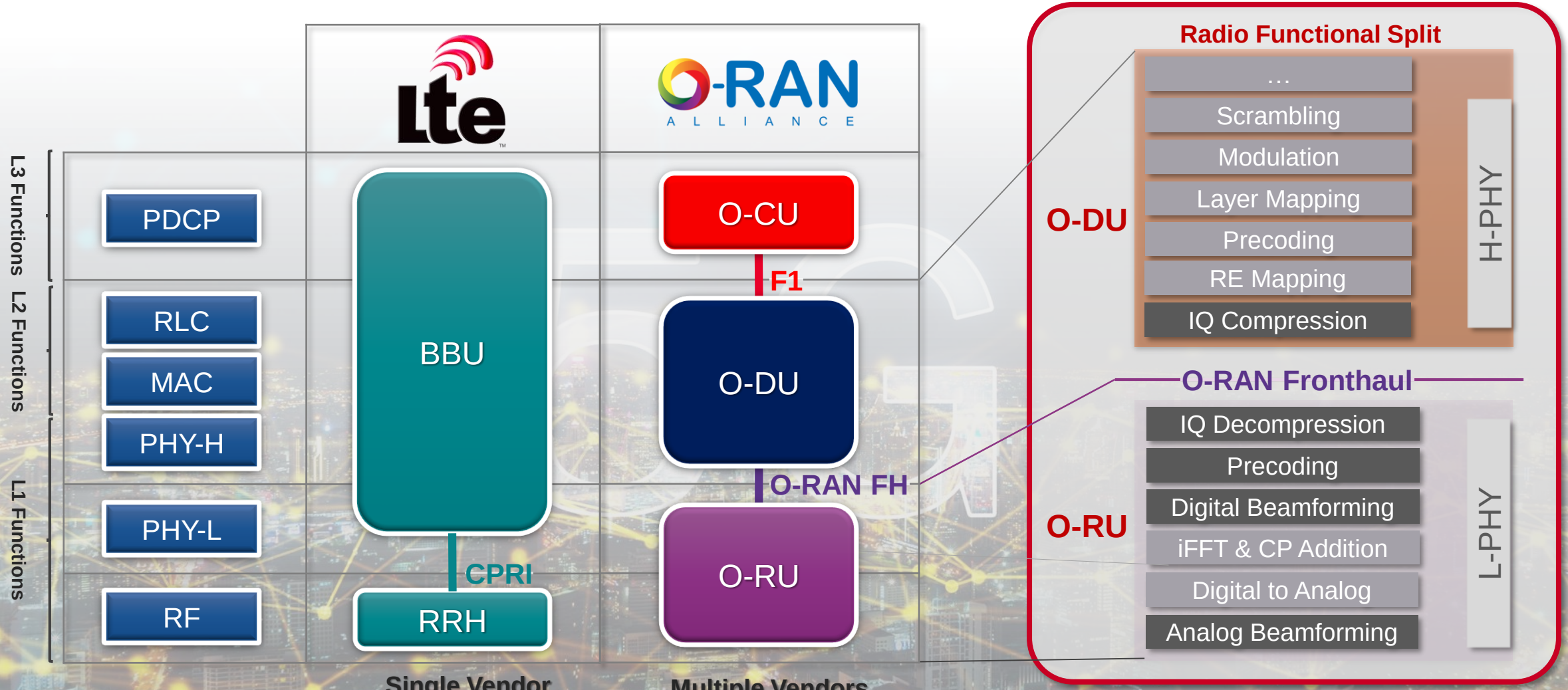
gNB Block Diagram and Protocols Mapping

O-RAN CUS-PLANE, M-PLANE



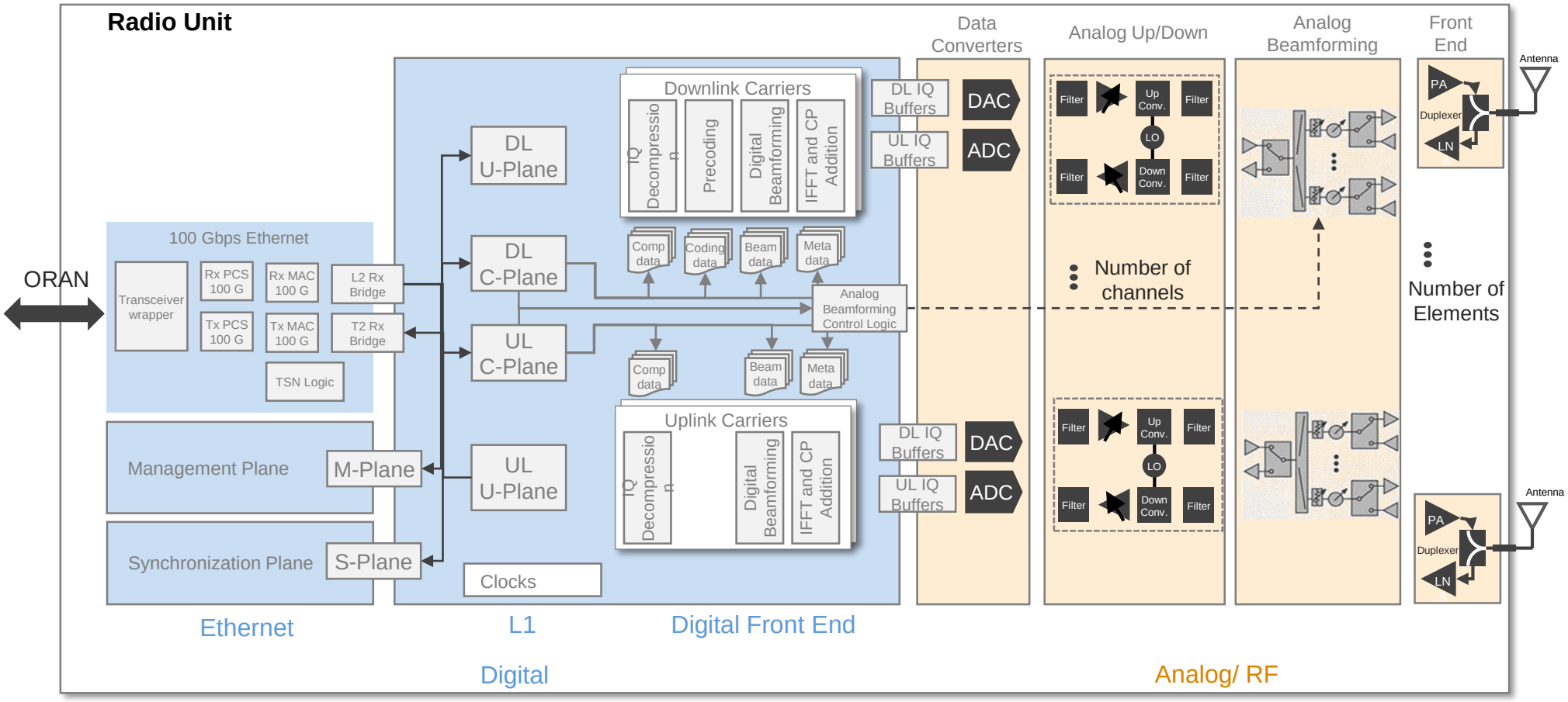
gNB Disaggregation with Functional Splits

OPEN RAN ARCHITECTURE



Radio Unit Block Diagram (O-RU)

FORMERLY CALLED REMOTE RADIO HEAD

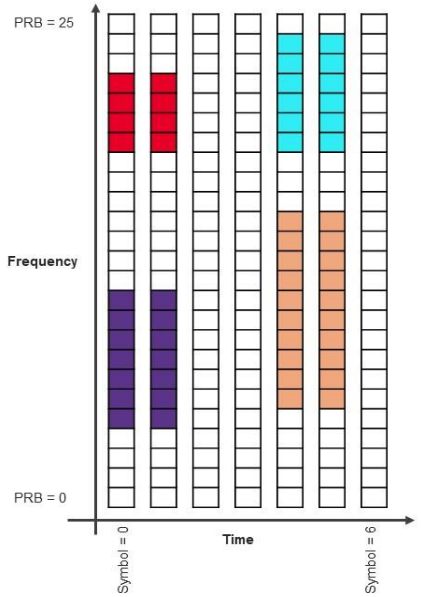


Test Strategy

O-DU to O-RU 7.2 Split Communication

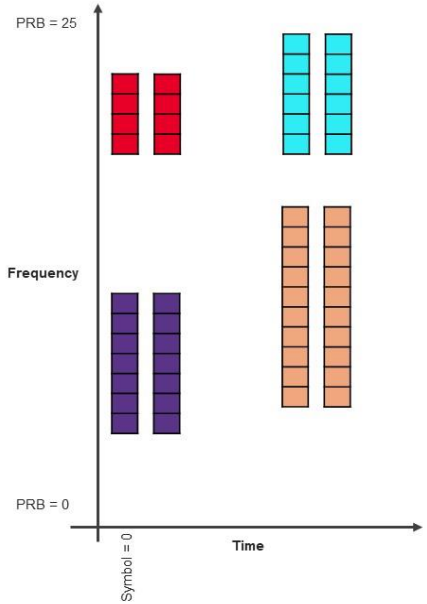
OPTIMIZE FRONTHAUL BANDWIDTH

O-DU



- O-DU knows which PRBs per OFDM symbol are empty and which are utilised
- O-DU performs FFT

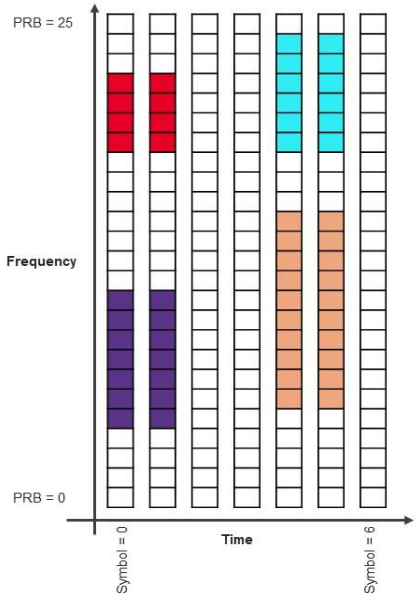
ORAN Interface



- Only utilised PRBs are sent and signalled over the ORAN interface
- Signalling includes beam information

(7.2x Split View)

O-RU



- O-RU reassembles PRBs per OFDM symbol including the empty PRBs
- O-RU performs iFFT

O-RAN Protocol Standards Mapping

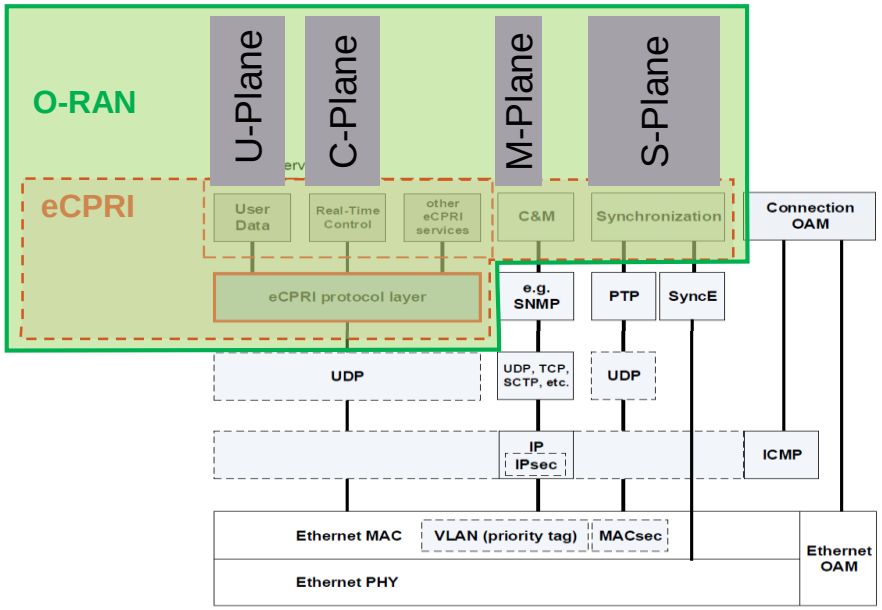
ECPRI/O-RAN STACK

O-RAN

- C_Plane – Signaling
- U_plane – IQ information
- S_plane – Synchronization
- M_Plane – Management

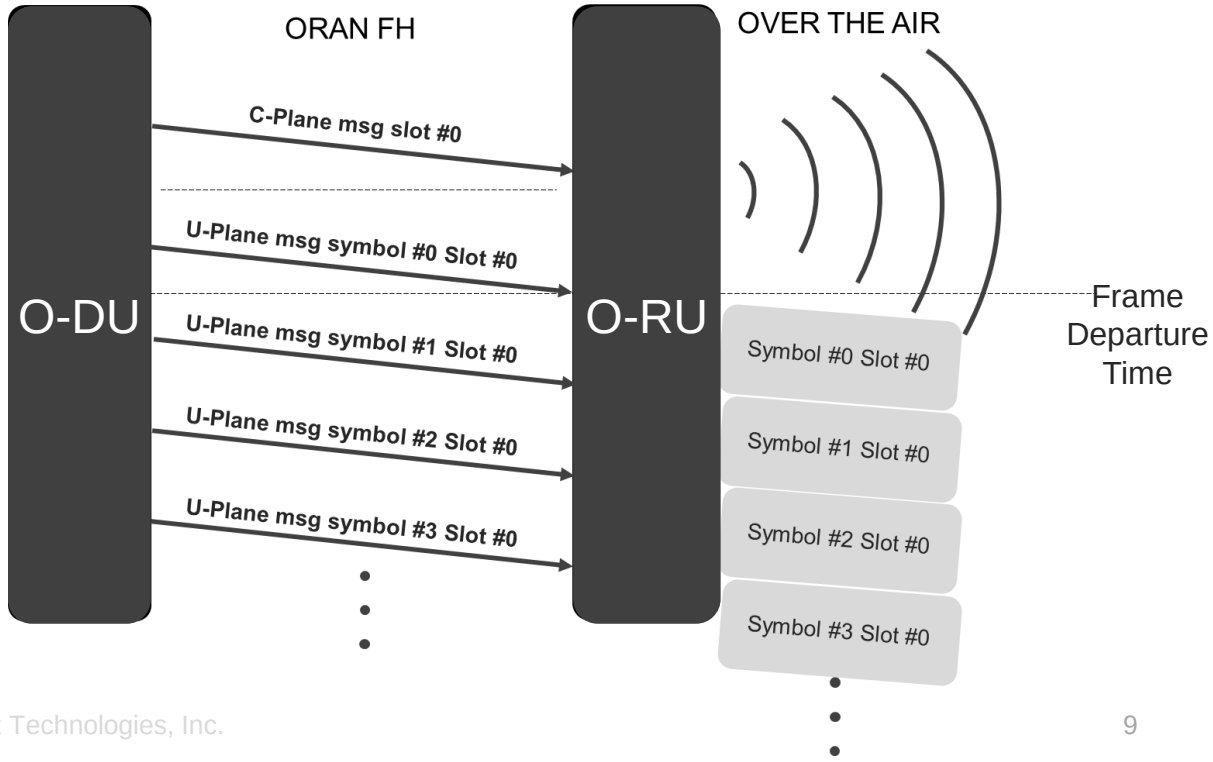
eCPRI

- Describes the mapping of split points inside the Physical Layer



MESSAGE FLOWS

- For each slot, C-Plane messages signals upcoming U-Plane messages containing data sections
- Timing windows to optimize O-RU buffer space and signal processing time

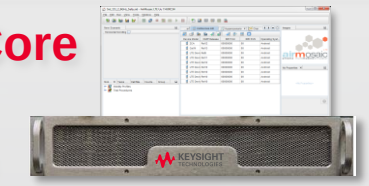


Keysight 5G Radio Access & Core Network Test Portfolio

ENABLING END TO END TESTING

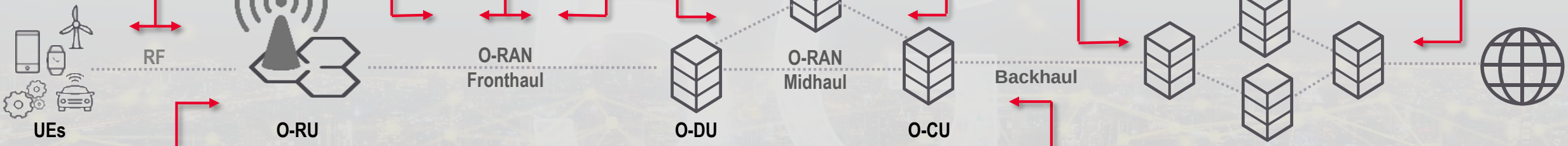
RF & mmWave Solution

Edge-to-Core O-RAN Solutions

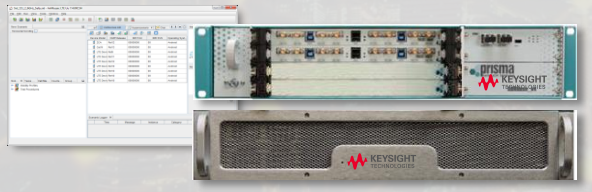


LoadCore Core Network Solutions

RuSIM | O-DU Emulation | O-RAN Studio | DuSIM | RICtest | CuSIM



UeSIM UE Emulation RAN Solutions

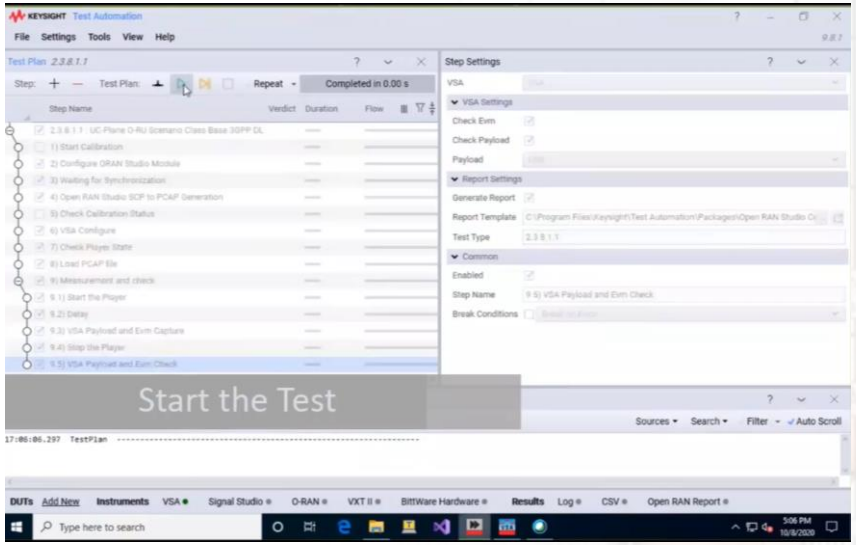


CoreSIM Core Simulation RAN Solutions

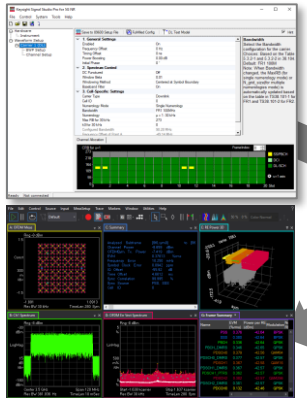
U5040BSCA Open RAN Studio

FOR O-RU SUB-SYSTEM TEST IN ISOLATION

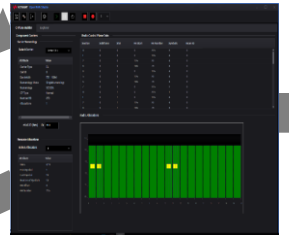
O-DU Emulator



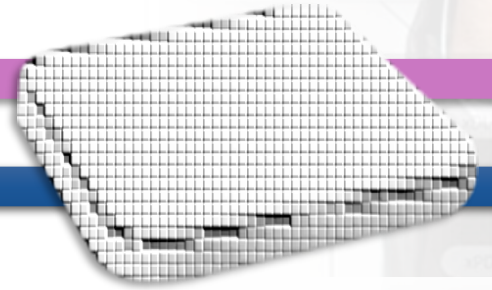
Signal Studio Pro *for 5G*



O-RAN Studio *Builder*



O-RAN Studio *Player*



O-RAN Studio *Capture*

O-RAN Studio *Recorder*

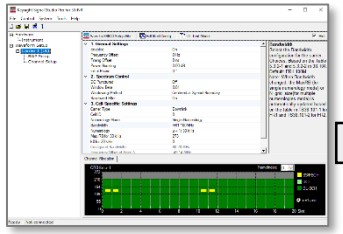
89600 VSA *for 5G*

Down Link Test Flow

ALL CAPABILITIES PROVIDED IN A SINGLE INSTRUMENT

Signal Studio
for 5G NR

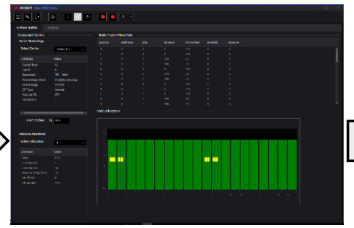
Create 3GPP compliant 5G NR Waveforms



Frequency Domain IQ and set up data

Open RAN Studio
Builder

Construct O-RAN compliant CUS stimulus



Open RAN Studio
Player

O-RAN CUS_plane Stimulus File

DUT (O-RU)

O-RAN Ethernet Frames (U and C Plane)

RF

89600 VSA Software
for 5G NR

5G NR Modulation Measurements

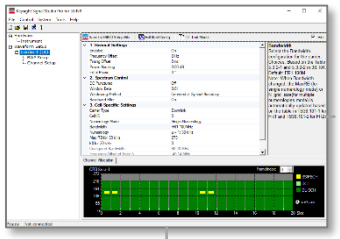
Signal Analyzer

Triggers and Clock

Up Link Test Flow

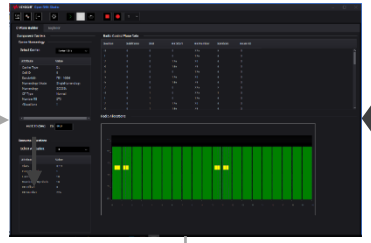
TIME ALIGNED TEST FLOW

Signal Studio
for 5G NR
Create 5G Uplink Waveform

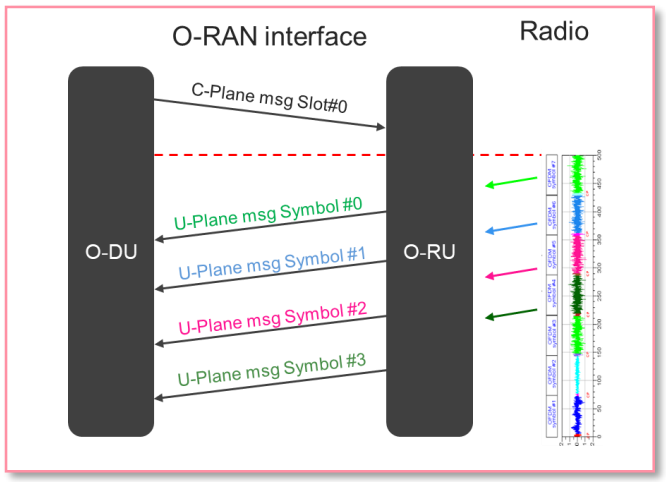


5G uplink Waveform file (time domain)

Open RAN Studio
Builder/Capture
Build C_plane messages
Explore U_plane messages



Open RAN Studio
Player/Recorder
Play C_plane messages
Record U_plane messages



5G uplink Waveform (time domain)

C_plane

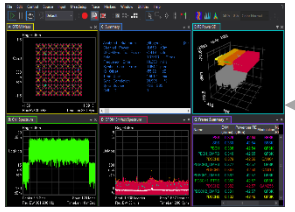
U_plane

DUT (O-RU)

RF

Signal Source

89600 VSA
for 5G NR
5G NR Uplink Modulation Measurements



IQ Extractor (optional)

Triggers and Clock

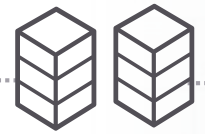
P8822S RuSIM + P8850S CoreSIM + Network Packet Broker

FOR O-DU/O-CU SUB-SYSTEM TEST IN ISOLATION

P8822S RuSIM

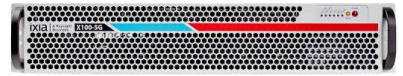
Vision Edge NPB *Monitoring*

O-RAN Fronthaul



O-DU O-CU

P8850S CoreSIM



Multi UE & RU Emulation	gNB	5G Next Gen Core	Internet

RuSIM Configuration
8 Layers, 100 MHz/layer
eCPRI 10 or 25Gbps
AirMosaic or LoadRAN GUI
Conformance & Load Testing

Network Packet Broker
2x 25 Gbps Monitoring
No limit on filter combinations on ingress, dynamic and egress stages

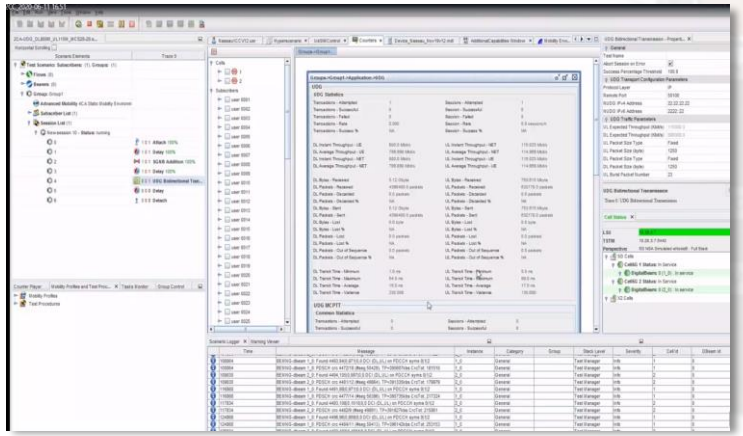
CoreSIM Configuration
Complete NGC Emulation
FTP/HTTP/SGi
Real SIM's / SoftSIM Auth
Conformance & Load Testing

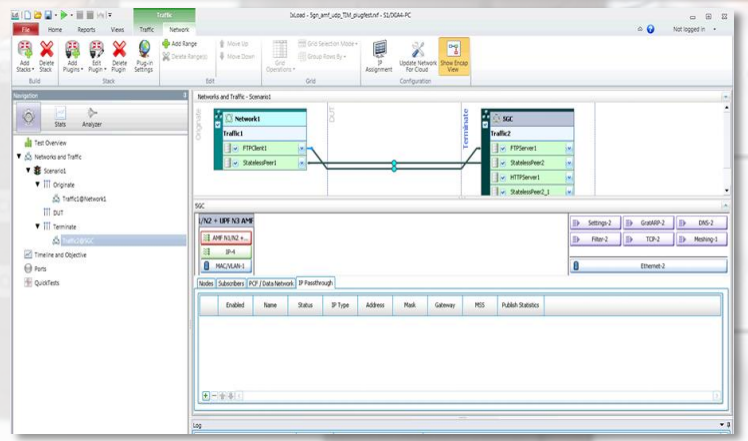
RuSIM General Features

- Allows sustained maximum thr.
- Mobility support
- Massive MIMO
- Massive #UE (up to 5000 per cell)
- FR1 & FR2 support
- 100 MHz carrier bandwidth
- 2x2 and 4x4 MIMO / 4xCC
- VoNR/VioNR
- DevOps/CI/CD frameworks

O-RAN Related Feat. Supp.

- M-Plane Client
- S-Plane with PTP client support
- Full C-plane and U-Plane Category A and B O-RU
- Beamforming support





KEYSIGHT TECHNOLOGIES

P8800S UeSIM + P8850S CoreSIM + Network Packet Broker

FOR E2E AND IOT TESTING IN CONNECTION

P8800S UeSIM

Vision Edge NPB *Monitoring*

P8850S CoreSIM

O-RU | O-RAN Fronthaul | O-DU O-CU

Multi UE Emulation	gNB	5G Next Gen Core	Internet

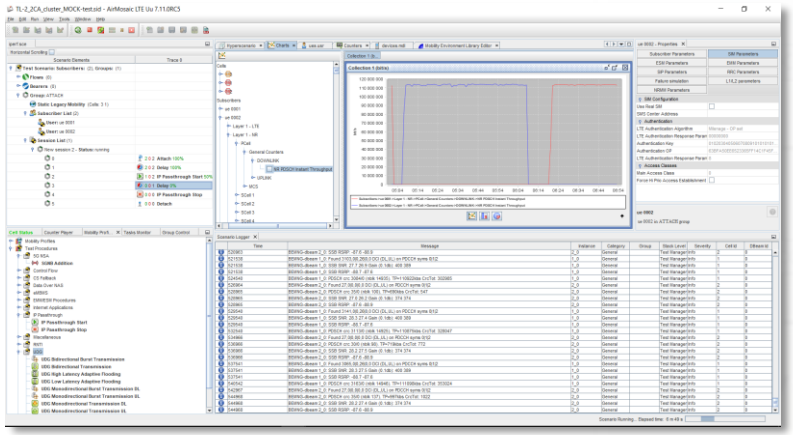
UeSIM Configuration
UeSIM 4 Layers – 5G SA Mode
FR1 Conducted Mode
AirMosaic GUI
Conformance & Load Testing

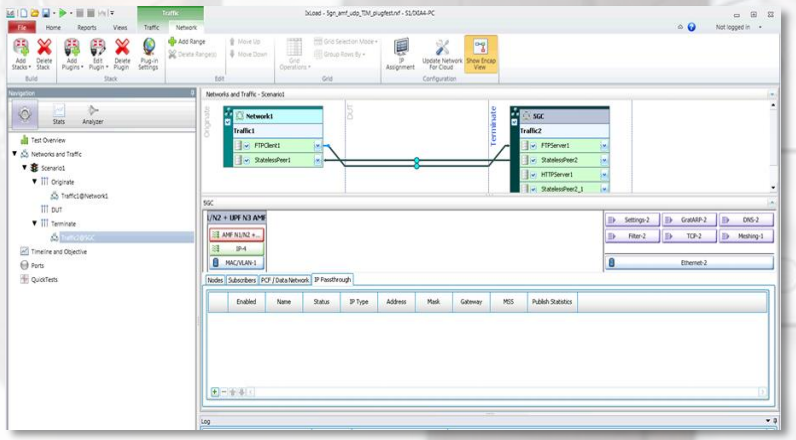
Network Packet Broker
2x 25 Gbps Monitoring
No limit on filter combinations on ingress, dynamic and egress stages

CoreSIM Configuration
Complete NGC Emulation
FTP/HTTP/SGi
Real SIM's / SoftSIM Auth
Conformance & Load Testing

UeSIM General Features

- Allows sustained maximum throughput
- Mobility support / Fast fading
- Massive MIMO, large number of layers (16/32/64)
- Massive #UE's (up to 5000 per cell)
- FR1 support; FR2: 24/26/28/39 GHz supported
- 100/200/400 MHz carrier bandwidths
- 2x2 and 4x4 MIMO / 4xCC and 8xCC (up to 800 MHz)
- VoNR/VioNR
- Dynamic Spectrum Sharing (DSS)
- Open interfaces for DevOps/CI/CD frameworks





KEYSIGHT TECHNOLOGIES

O-RAN Alliance Certification Process

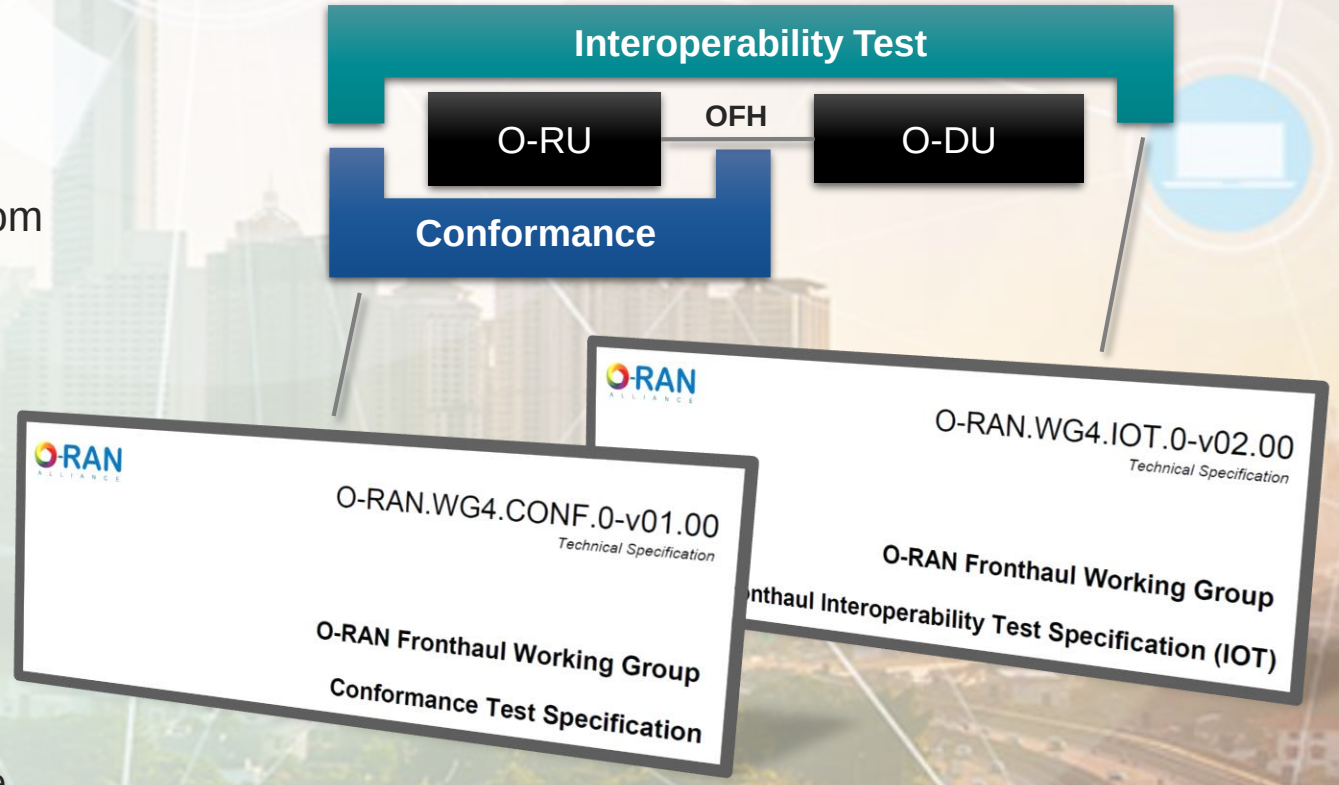
WILL BE FINALIZED BY TIFG SOON

✓ In Scope of Certification

- ***Conformance Test*** of individual subsystem or combinations of subsystems as well as relevant interfaces
- ***Interoperability Test*** of the underlying subsystem from one vendor with another vendor's subsystem
- ***End-to-end Assessment*** for system deployment blueprint based on Minimum Viable Plan initiative

x *Out of Scope*

- ***3GPP Functional and Performance Testing*** for the underlying components and interfaces.

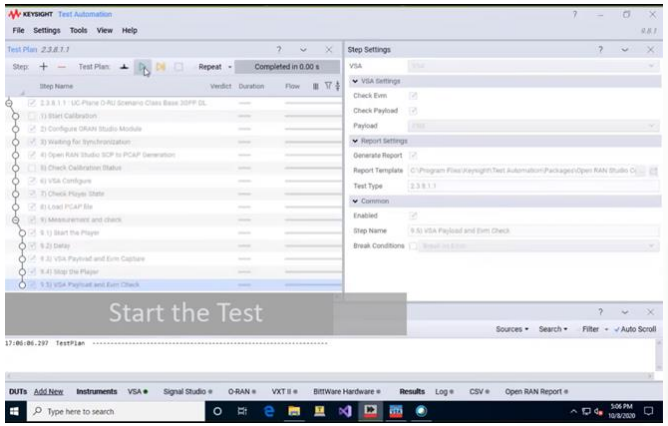


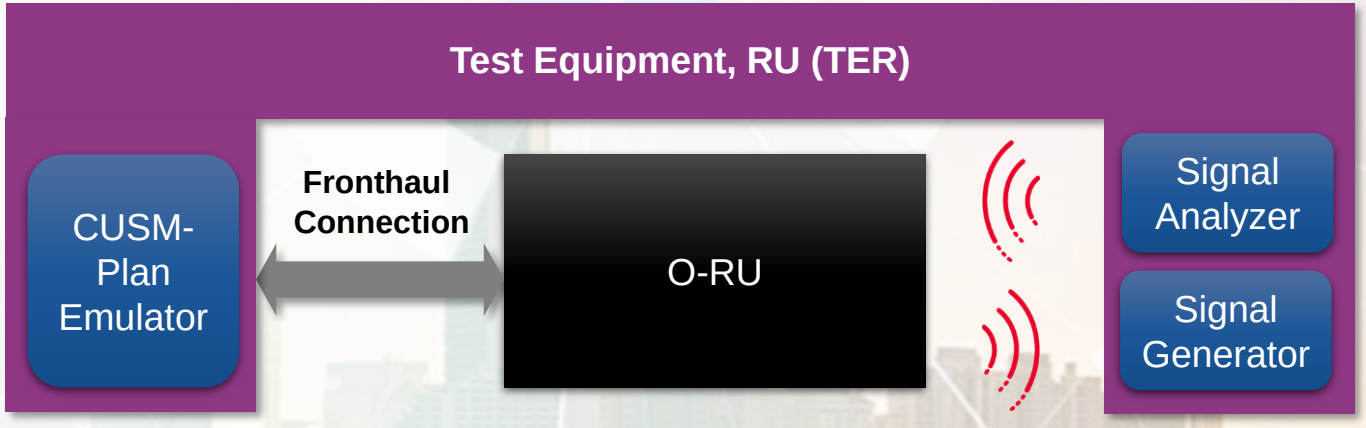
Note: Pre-requisite may be required like:

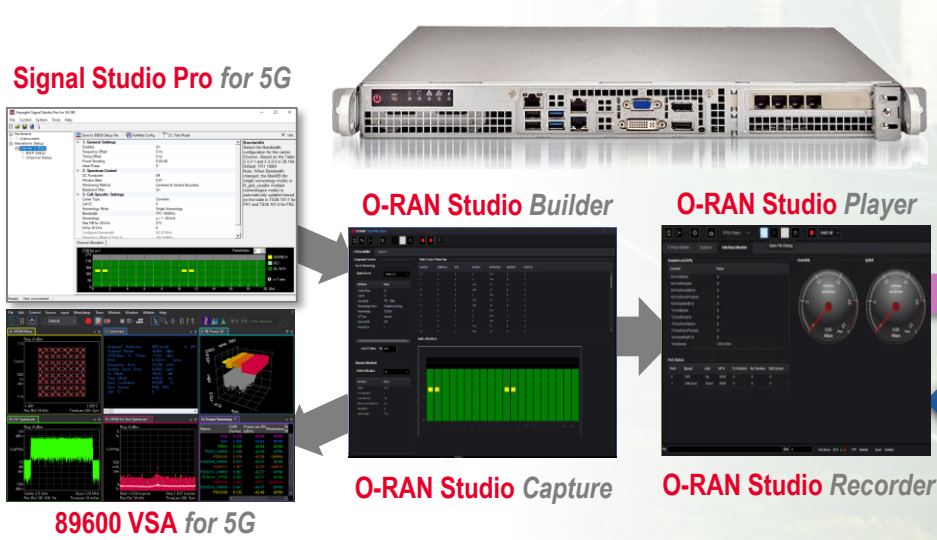
- 3GPP compliance validated by vendor, 3rd party, or the same certification entity as add-on service
- ……

Conformance Test Example

TEST CONFIGURATION: O-RU AS DUT







Estimated Timeline for O-RAN Certification

SOURCE: O-RAN ALLIANCE TIFG

Jan ‘20	Feb	Mar	April	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec ‘20 ~ Spring ‘21

Scope of Work and Milestone

Agree By TIFG

Proceed with task assignment

Final Review Voting

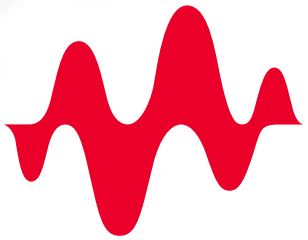
Publish

Certification Start

KEYSIGHT TECHNOLOGIES

Questions?

THANK YOU FOR LISTENING!



KEYSIGHT
TECHNOLOGIES