



**KEYSIGHT
WORLD 2020**

Enabling Interoperability & Adherence to O-RAN Fronthaul Interface

Sr. Project Manager / Keysight Technologies

Brian Su



Why O-RAN is Happening Now?

CAPTURE GROWTH IN NEW 5G VERTICAL MARKETS CAPEX/OPEX CONTROL

Driving Forces



Objectives

- Network Densification
 - Scalability limitations of traditional architectures
 - Proprietary Networks dependence
 - Virtualization technology
- Increase Network Resource utilization (Slicing , Pooling)
 - Same cost reduction as data Centers
 - Power, Space Saving
 - Automation / orchestration

Expected Gains

Operational Efficiency

- Capex Reduction (HW optimization)
- Opex Reduction
- Revenue maximization

O-RAN Alliance Overview



MULTI-VENDOR, INTEROPERABLE, AUTONOMOUS, RAN

Members



20+ Operators
130+ Manufacturers and other entities



Operators



Equipment & SW



ChipSets



Mission

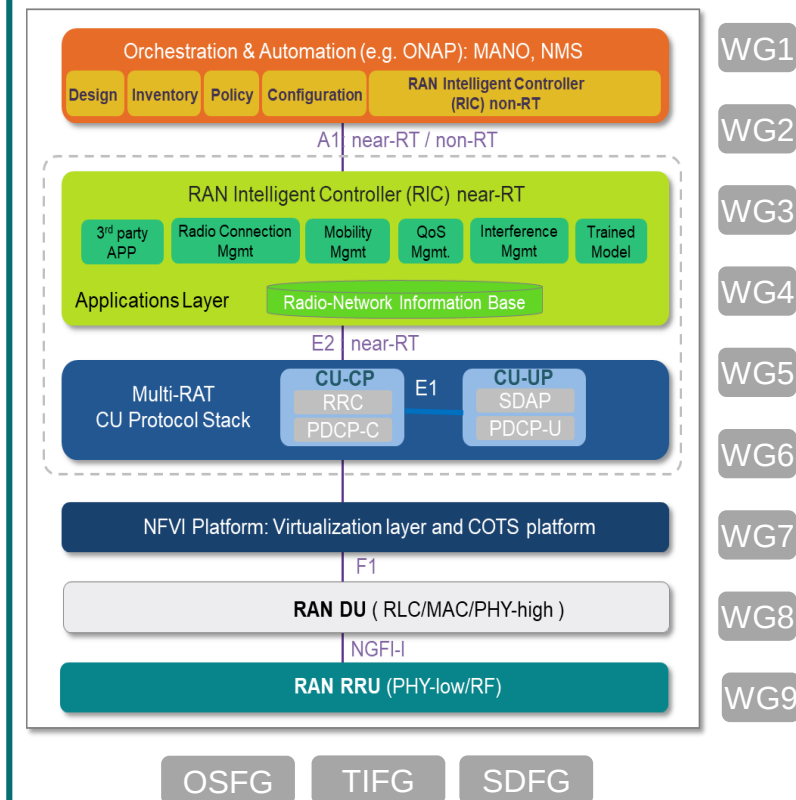
*Multi-vendor, Interoperable,
autonomous, RAN*

*Open, Standardized
interfaces*

*Global industry-wide vision,
commitment and leadership*

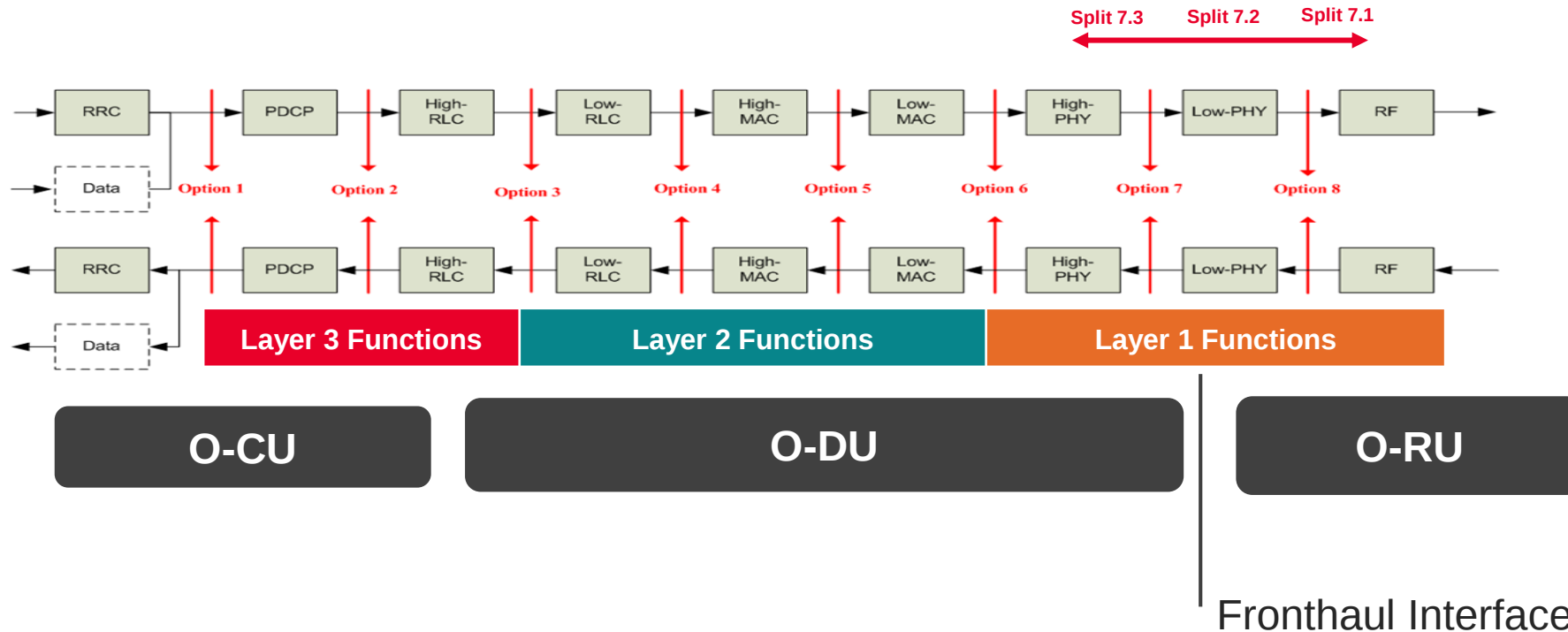
*Reference Design &
Whitebox*

New Architecture



gNB Disaggregation and O-RAN Splits

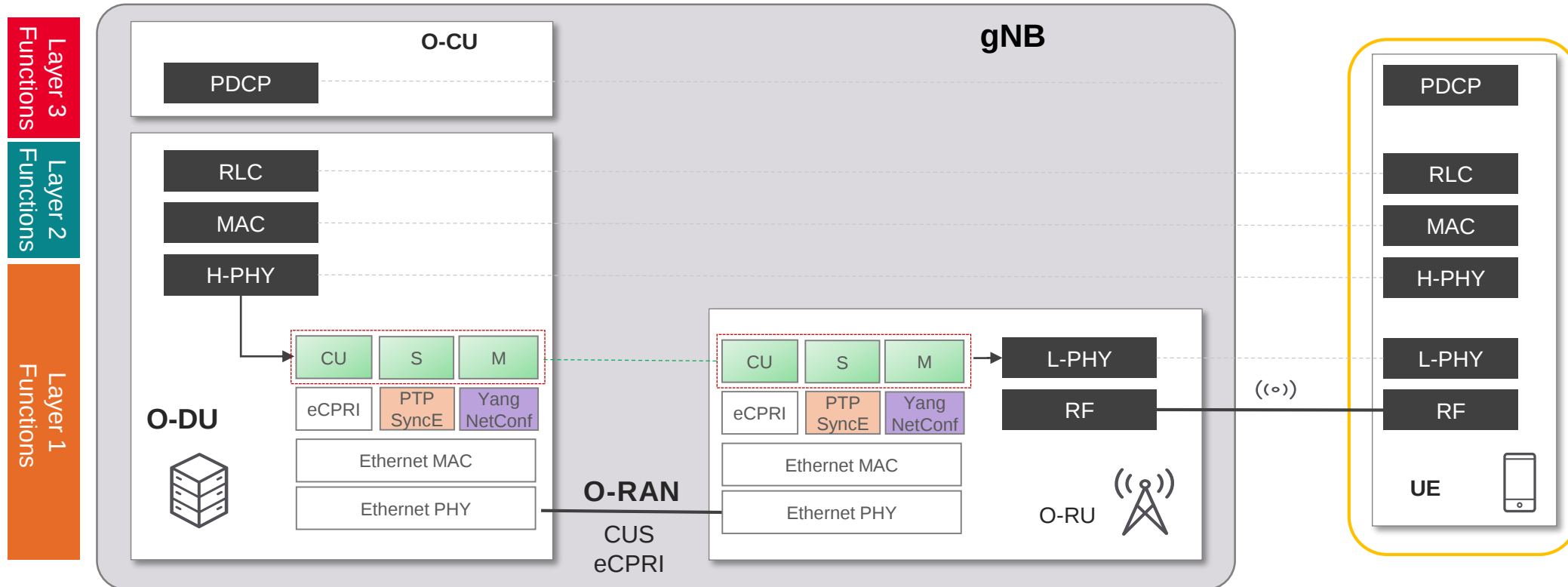
SPLITS



- *Split X.X* Functional Split Option X.X Define points where the RAN chain is split between elements
- *Split 7.2x* Functional Split Option 7.2("variable") O-RAN chosen option to separate O-DU and O-RU

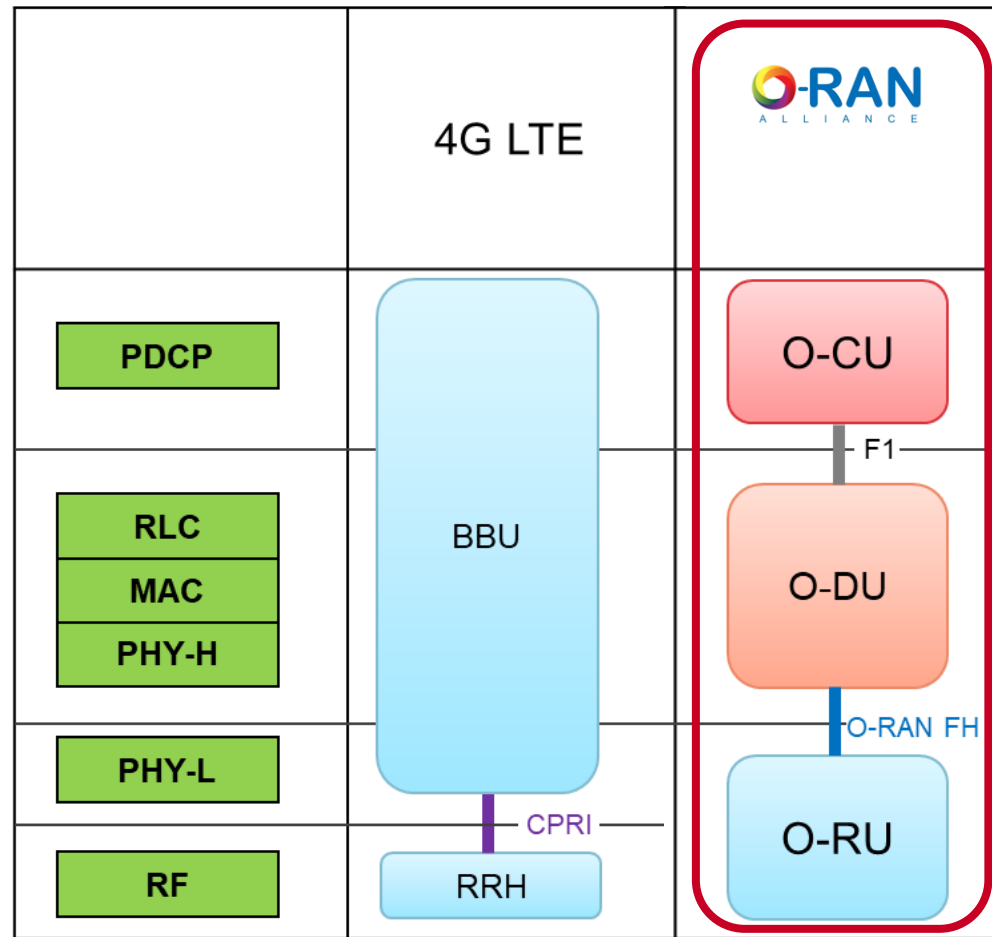
gNB Block Diagram and Protocols Mapping

O-RAN CUS-PLANE, M-PLANE



gNB Disaggregation . H-PHY/L-PHY

O-RAN TERMINOLOGY

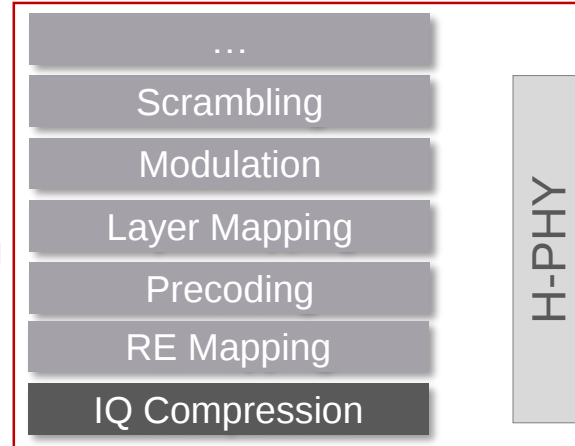


Single Vendor

Multiple Vendors

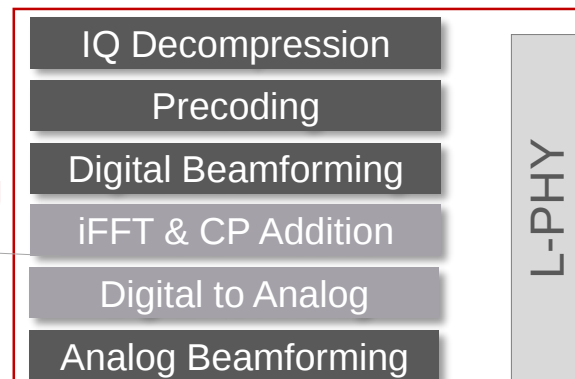
O-DU

Radio Functional Split



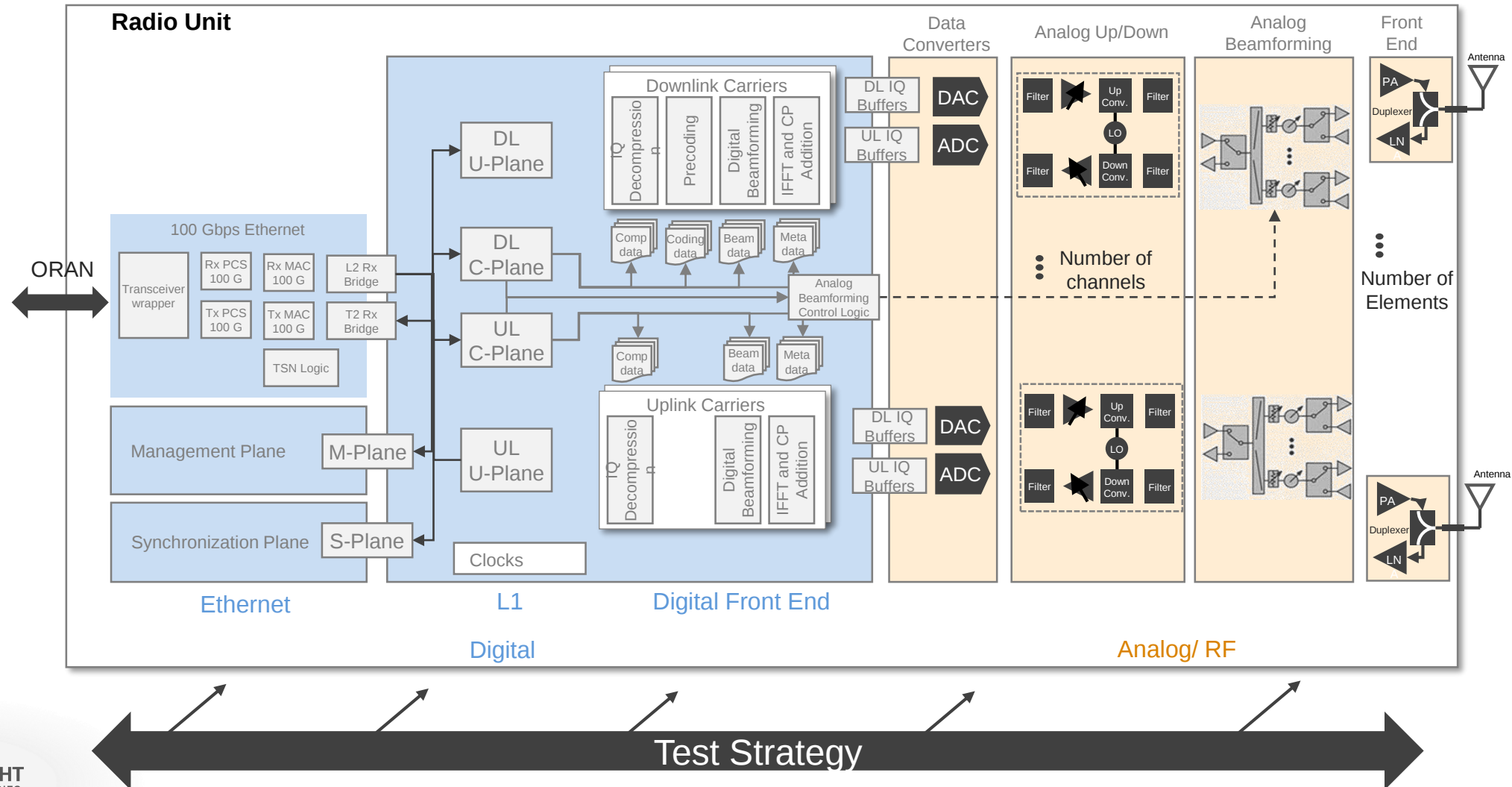
O-RAN Fronthaul

O-RU



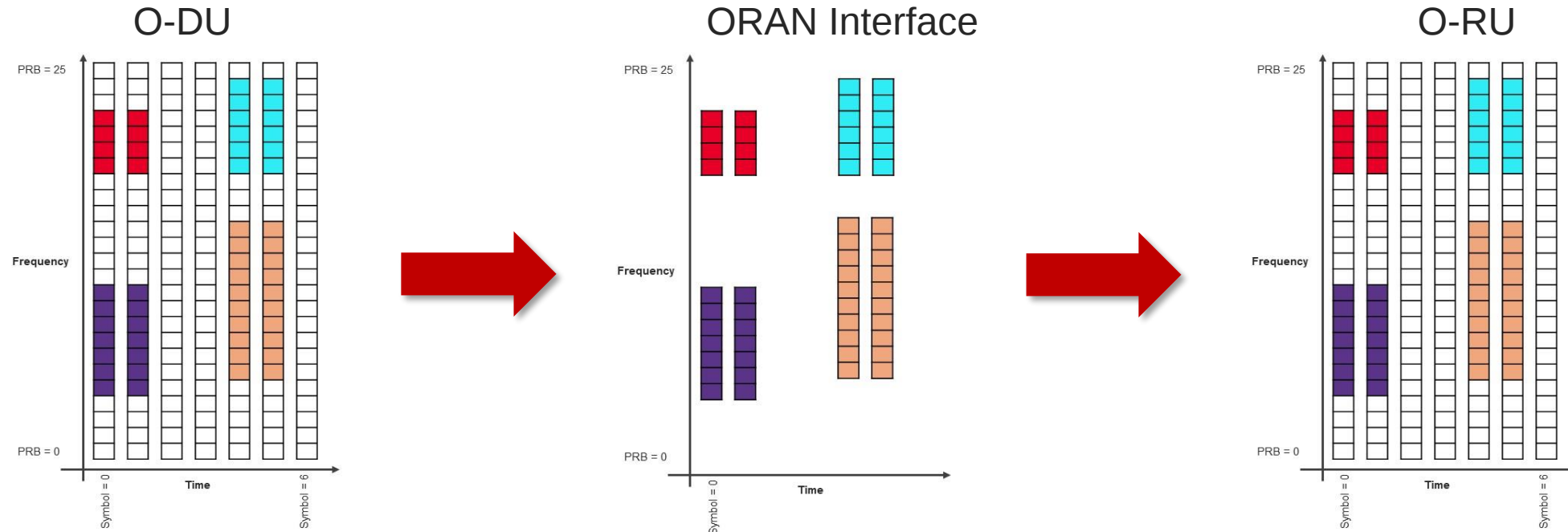
Radio Unit Block Diagram (O-RU)

FORMERLY CALLED REMOTE RADIO HEAD



O-DU to O-RU 7.2 Split Communication

OPTIMIZE FRONTHAUL BANDWIDTH



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

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

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

(7.2x Split View)

O-RAN Protocol Standards Mapping

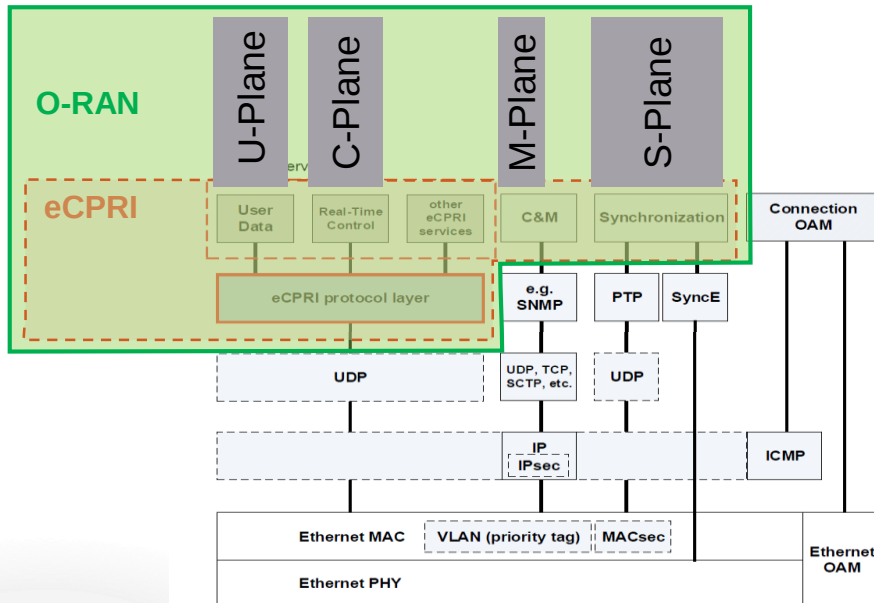
ECPRI/O-RAN STACK

O-RAN

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

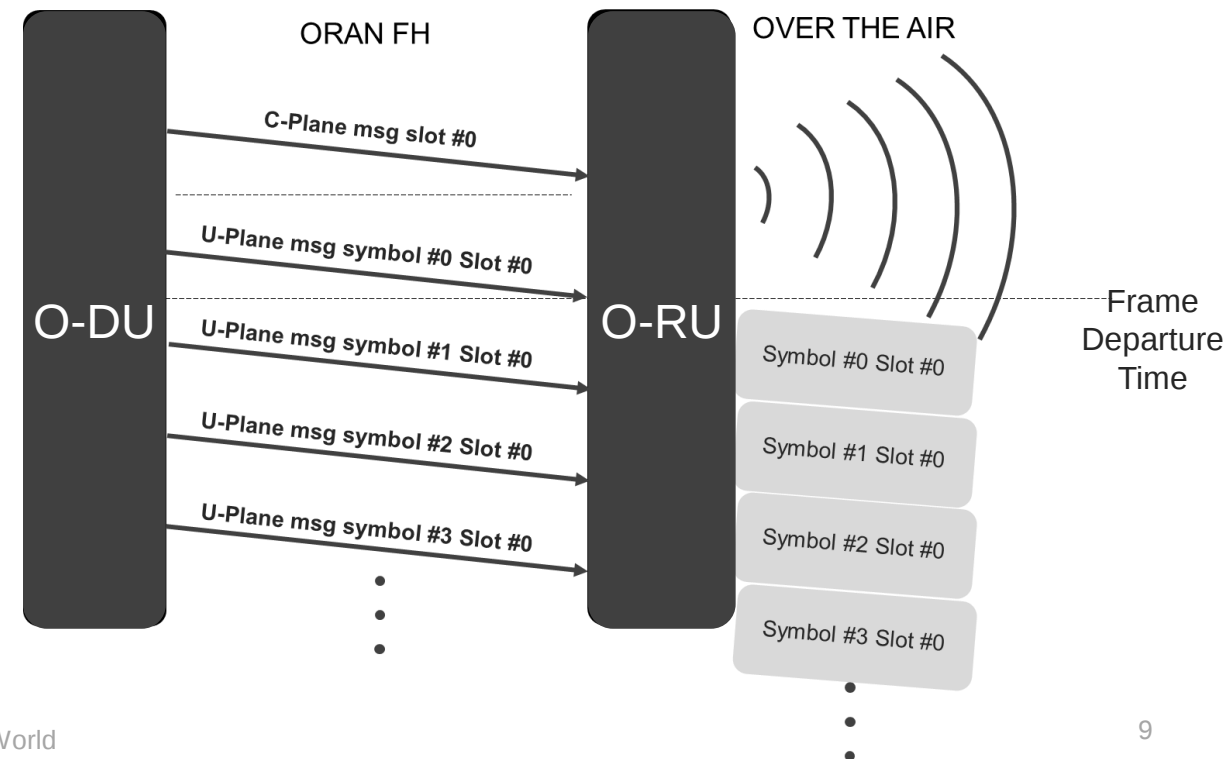
eCPRI

- Describes the mapping of split points inside the Physical Layer



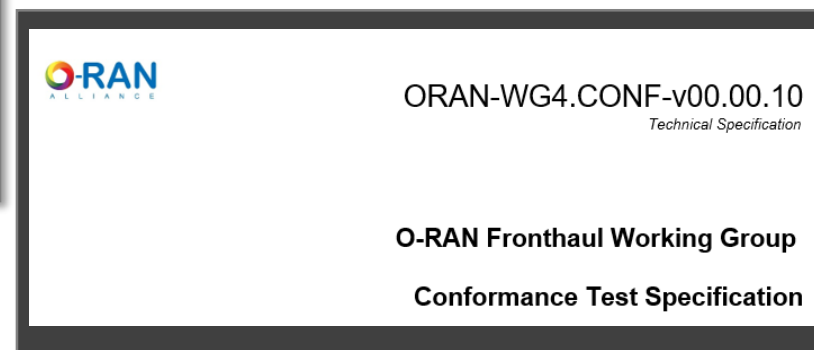
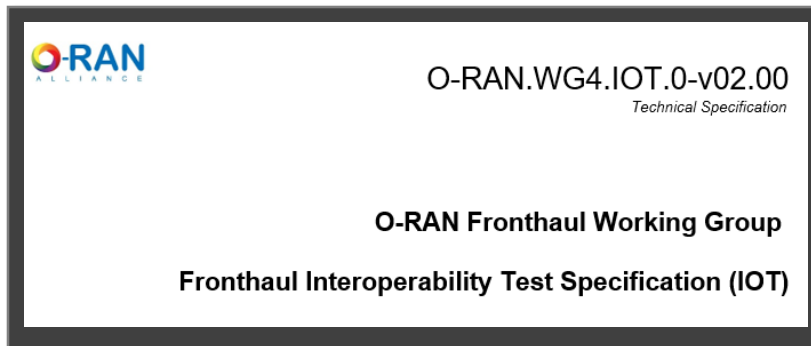
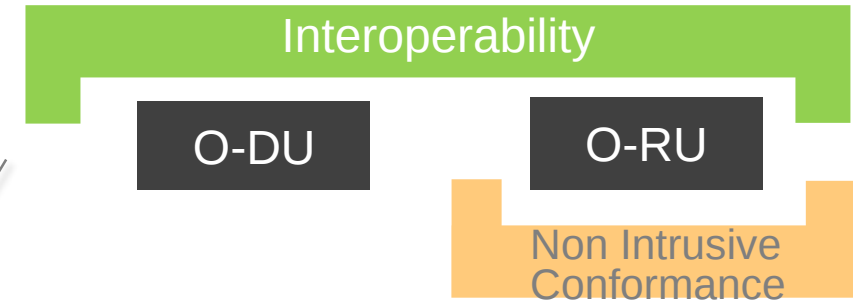
MESSAGE FLOWS

- 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

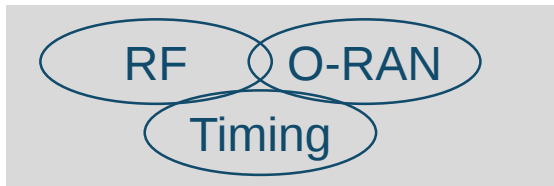
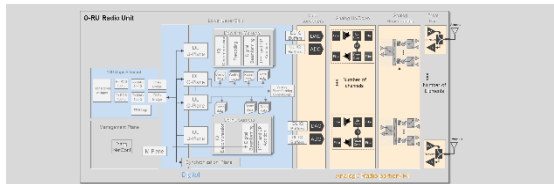
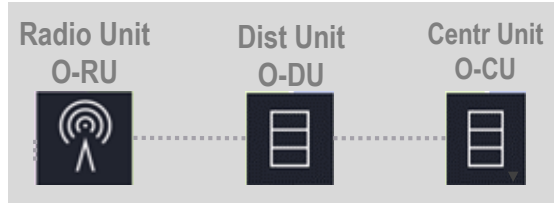


O-RAN Conformance & Interoperability

Agree that only RU can be tested for conformance , and use interoperability for DU test



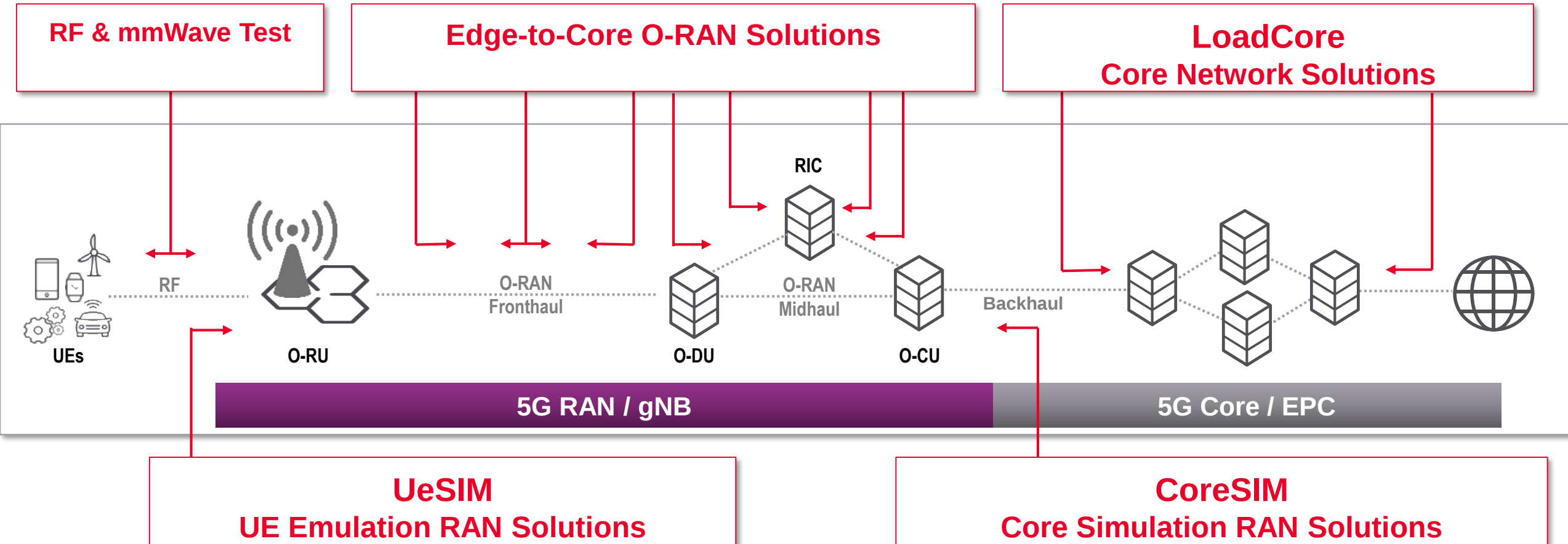
Migration Towards Open Fronthaul Interfaces



- gNB disaggregation drives emerging needs for **unit testing** in isolation, and **peer emulation** (DU, RU)
- Transformation towards Open Protocols require **conformance** and **interoperability** and performance test
- New **Function Splits** change 5G Radio Unit complexity and require new test capabilities
- Critical relationship between **RF, Timing, and Fronthaul Protocols**
- **FR1/FR2 3GPP** radio test requires O-RAN deterministic stimulus and analysis

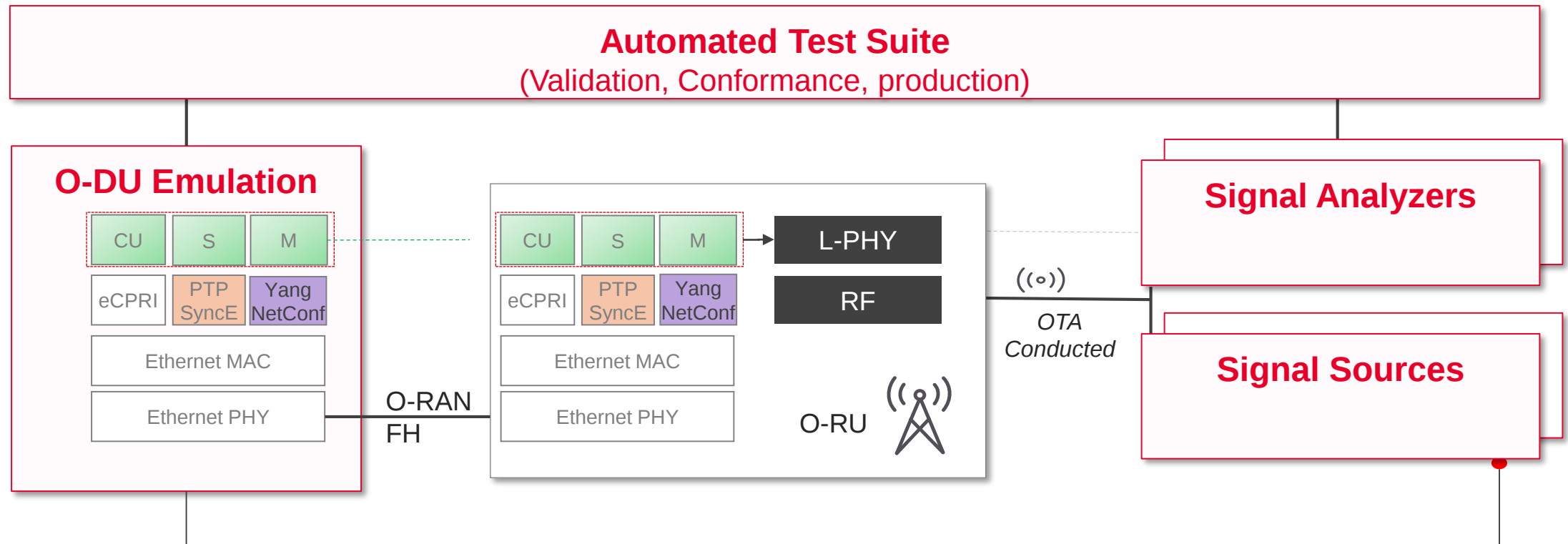
Keysight 5G Radio Access and Core Network Test Portfolio

ENABLING END TO END TESTING



O-RU Test Environment

O-RU TEST IN ISOLATION

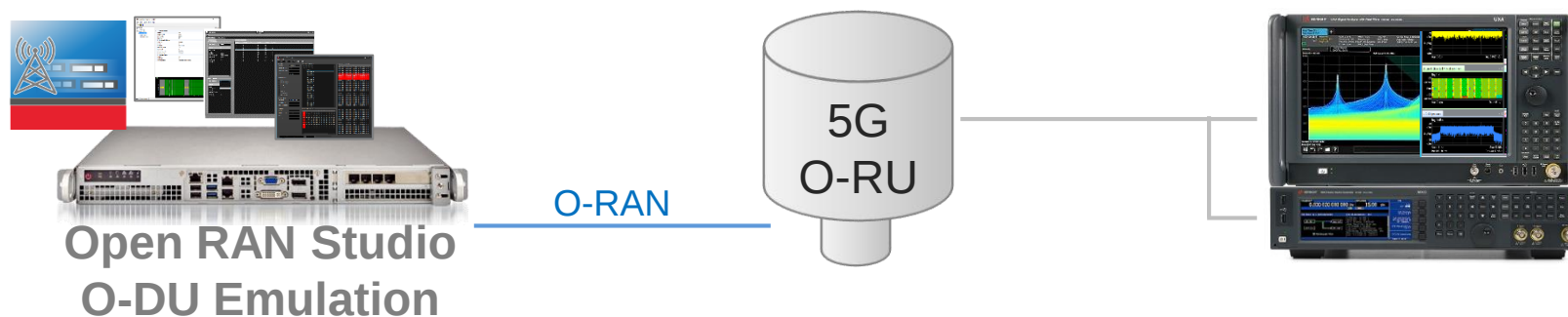


- *Deterministic test Vector generation*
- *Timing controlled stimulus*
- *Real-time analysis*
- *Integration with test framework*

Keysight Open RAN Studio Solution



COMPLETE O-DU EMULATION PLATFORM FOR O-RU (RADIO UNIT) TESTING



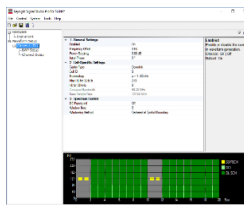
- Comprehensive** : O-RAN Stimulus and Analysis portfolio for uplink/downlink test
- Compliant** : O-RAN Standard CUS_plane (ORAN-WG4.CUS.0-v03.00)
- Configurable** : Maximize and optimize O-RAN test coverage
- Cross Domain** : for complete Radio RF / Protocol / Timing testing
- Integrated** : with RF / mmWave instrumentation and applications

Keysight Open RAN Studio

COMPREHENSIVE SOLUTION FOR O-RU (RADIO UNIT) TESTING

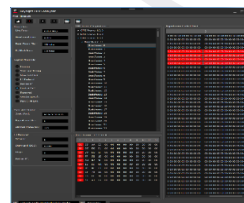
Signal Studio for 5G NR

Create 3GPP
compliant 5G NR
Waveforms



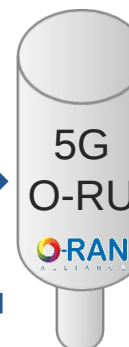
Open RAN Studio Builder

Construct O-RAN
compliant CUS
stimulus



Open RAN Studio Player

Ethernet

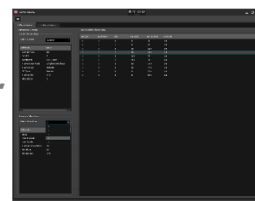


FR1
Radios



Open RAN Studio Explorer

O-RAN/eCPRI
Protocols Decode



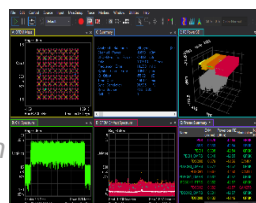
Open RAN Studio Capture

FR2
Radios



89600 VSA for 5G NR

5G NR Modulation
Measurements

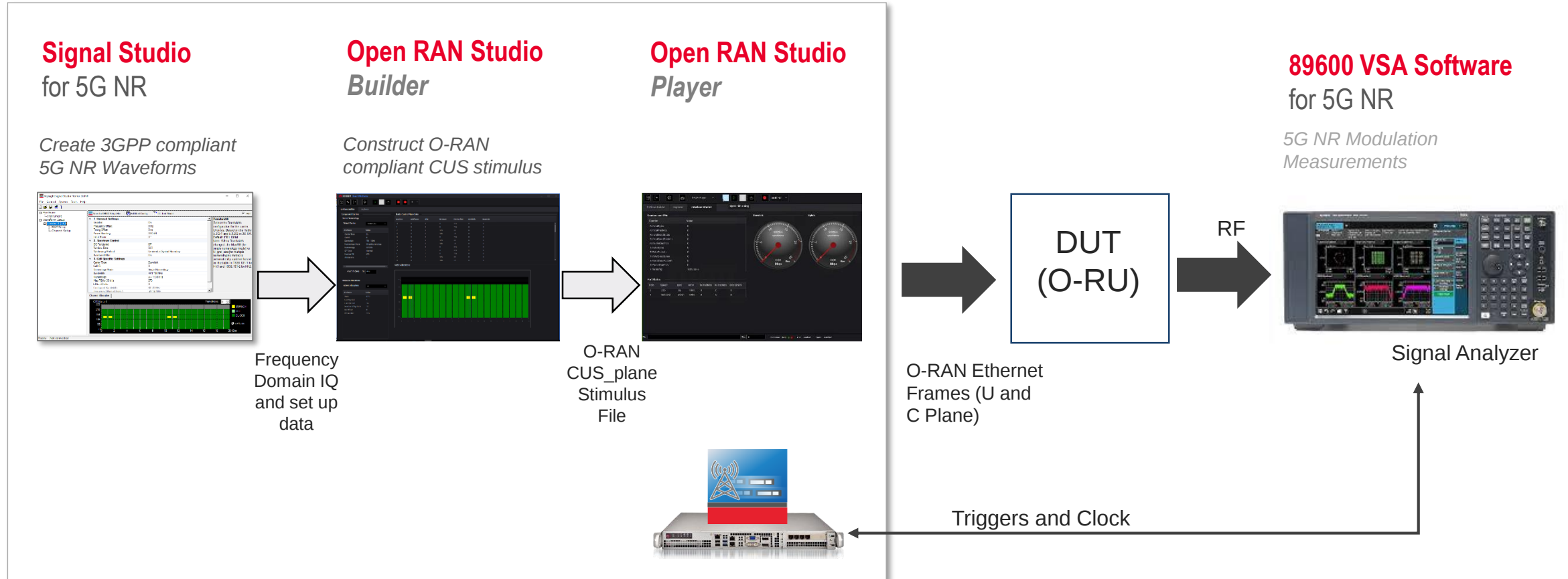


IQ Extractor



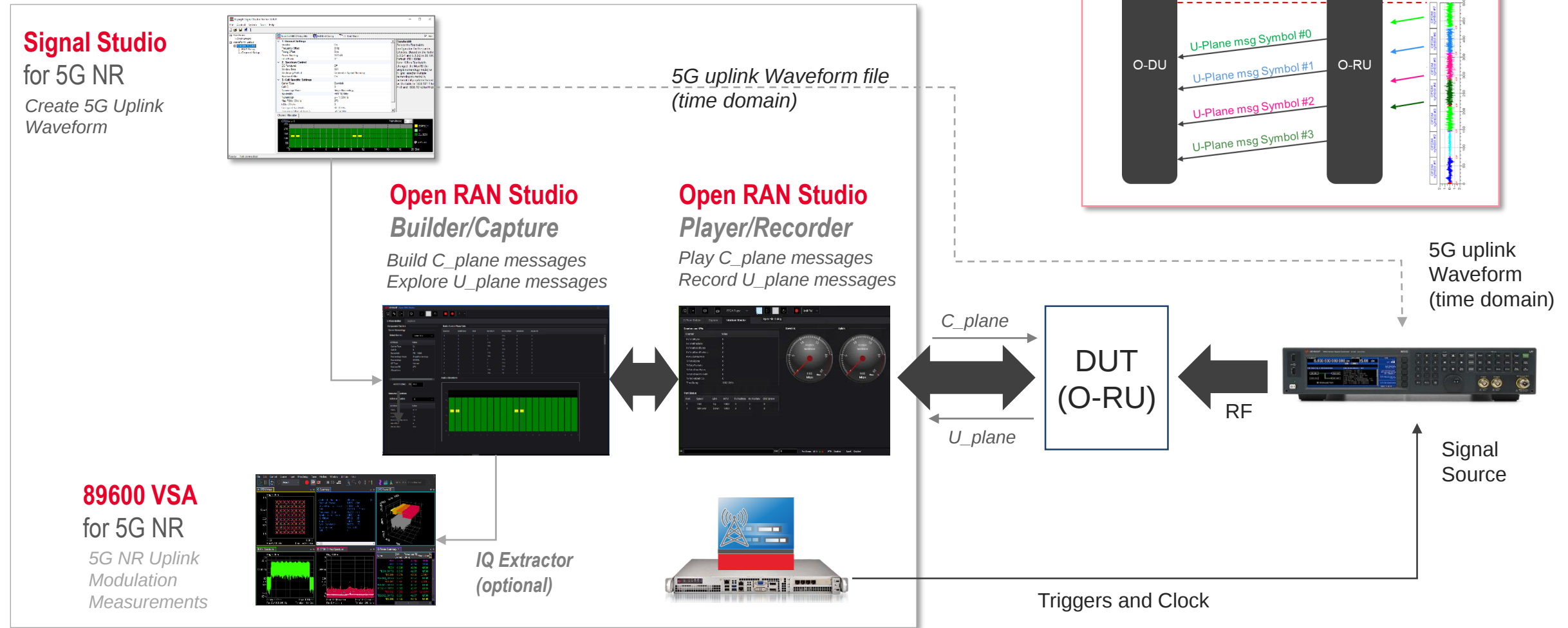
Down Link Test Flow

ALL CAPABILITIES PROVIDED IN A SINGLE INSTRUMENT



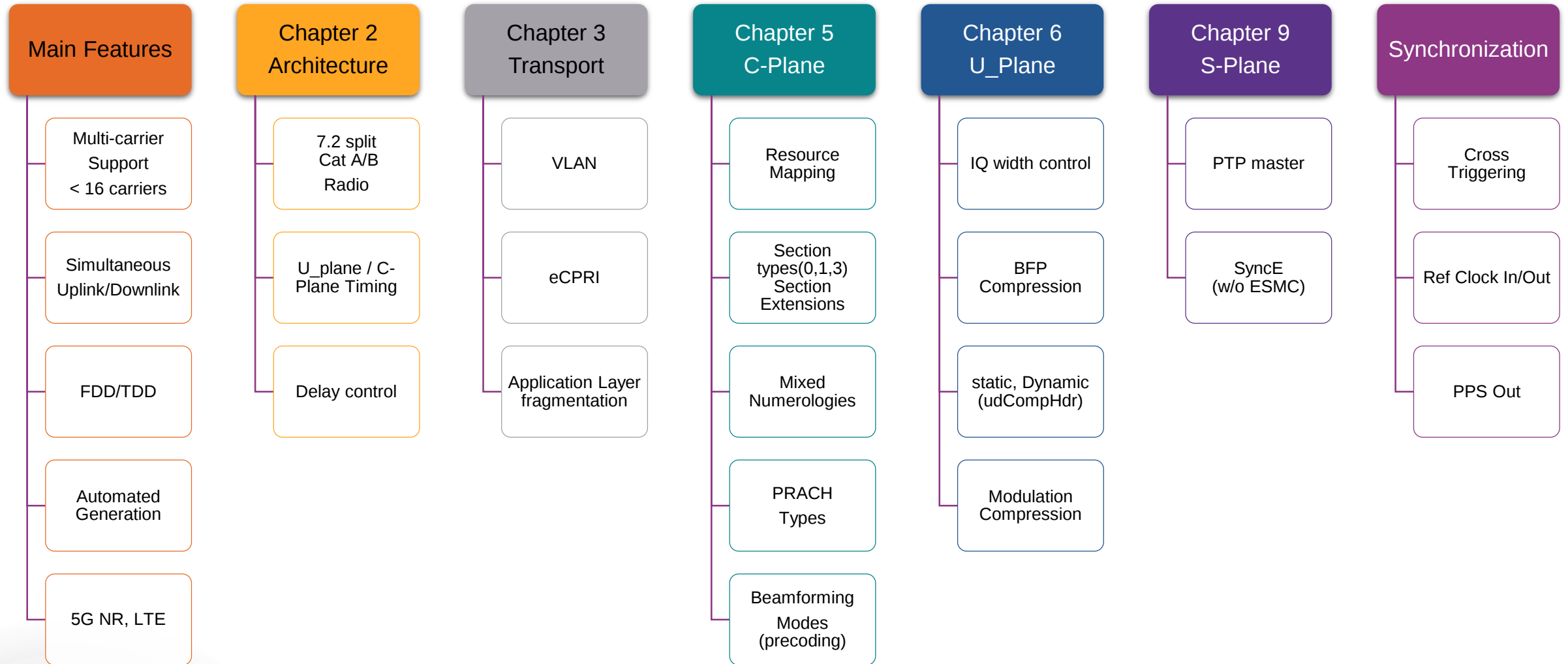
Up Link Test Flow

TIME ALIGNED TEST FLOW



O-RAN Fronthaul CUS Specification Support

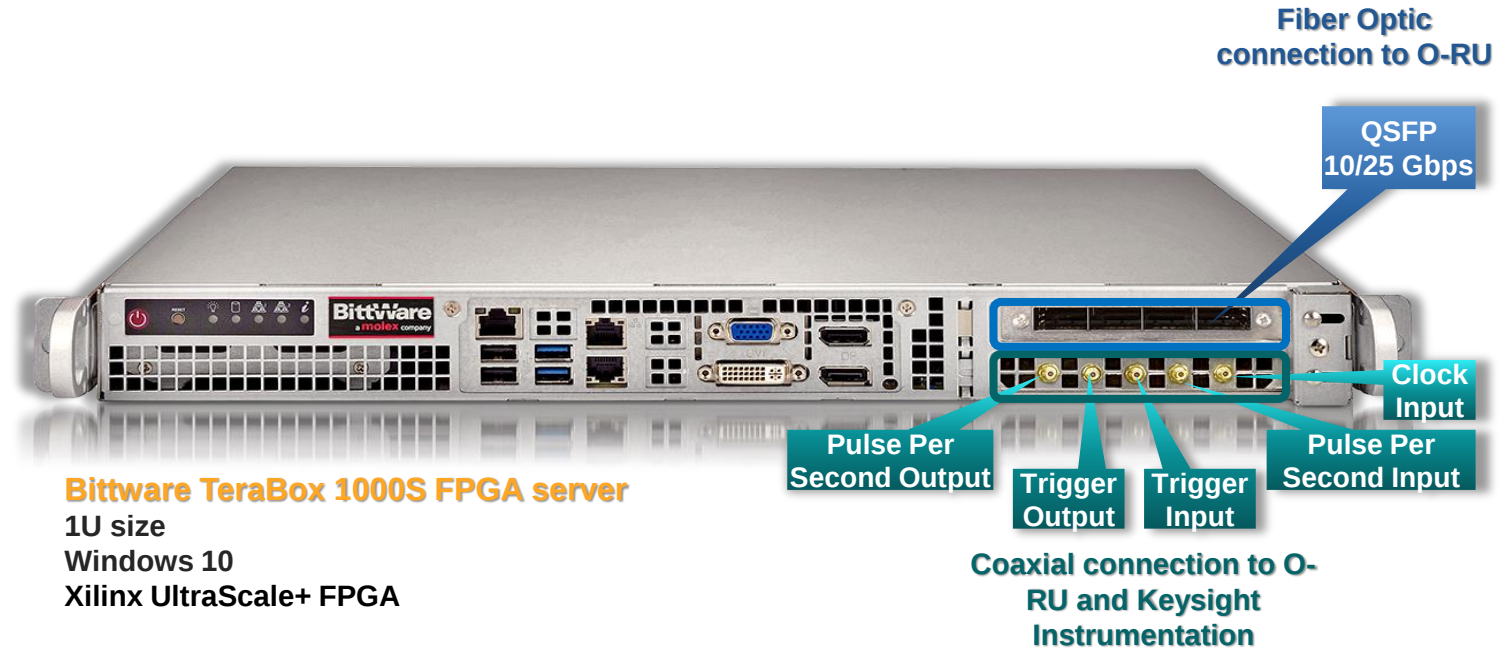
ACCELERATE AND MAXIMIZE O-RU TEST COVERAGE



Open RAN Studio Platform

HARDWARE

- O-DU functional Emulation
- Parametric Timing Control
- Real-time generation/analysis
- Enable clock and time alignment between DUT and test system
- API for test automation



Wireshark O-RAN Dissector

C-Plane_Plus_U-Plane_11_each.pcap

File Edit View Go Capture Analyze Statistics Telephony Wireless Tools Help

Apply a display filter ... <Ctrl-/>

No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000	Xerox_00:0d:00	SuperMic_2c:25:2a	O-RA...	74	C-Plane, Type: 1 (Most channels), Id: 0 (PRB: 0-4)
2	0.000005	Xerox_00:0d:00	SuperMic_2c:25:2a	O-RA...	74	C-Plane, Type: 1 (Most channels), Id: 5 (PRB: 25-2)
3	0.000007	Xerox_00:0d:00	SuperMic_2c:25:2a	O-RA...	74	C-Plane, Type: 1 (Most channels), Id: 10 (PRB: 50-
4	0.000008	Xerox_00:0d:00	SuperMic_2c:25:2a	O-RA...	74	C-Plane, Type: 1 (Most channels), Id: 15 (PRB: 75-
5	0.000009	Xerox_00:0d:00	SuperMic_2c:25:2a	O-RA...	74	C-Plane, Type: 1 (Most channels), Id: 20 (PRB: 100
6	0.000010	Xerox_00:0d:00	SuperMic_2c:25:2a	O-RA...	74	C-Plane, Type: 1 (Most channels), Id: 25 (PRB: 125
7	0.000011	Xerox_00:0d:00	SuperMic_2c:25:2a	O-RA...	74	C-Plane, Type: 1 (Most channels), Id: 30 (PRB: 150
8	0.000012	Xerox_00:0d:00	SuperMic_2c:25:2a	O-RA...	74	C-Plane, Type: 1 (Most channels), Id: 35 (PRB: 175
9	0.000013	Xerox_00:0d:00	SuperMic_2c:25:2a	O-RA...	74	C-Plane, Type: 1 (Most channels), Id: 40 (PRB: 200

> Frame 4: 74 bytes on wire (592 bits), 74 bytes captured (592 bits)

> Ethernet II, Src: Xerox_00:0d:00 (00:00:08:00:0d:00), Dst: SuperMic_2c:25:2a (ac:1f:6b:2c:25:2a)

> 802.1Q Virtual LAN, PRI: 0, DEI: 0, ID: 11

> eCPRI, Real-Time Control Data

> O-RAN Fronthaul CUS-C, Type: 1 (Most channels), Id: 15 (PRB: 75-79), Id: 16 (PRB: 80-84), Id: 17 (PRB: 85-89), Id: 18 (PRB: 90-94)

> ecprIRtcid (CU_Port_ID: 0, A_Cell_ID: 4, CC_ID: 5, RU_Port_ID: 7)

> ecprISeqid, SeqId: 0, SubSeqId: 3, E: 0

> C-Plane Section Type 1, Downlink, Frame: 10, Subframe: 1, Slot: 1, StartSymbol: 0

> Section, Id: 15 (PRB: 75-79), Symbols: 1, BeamId: 10939

0000 0000 1111 = Section ID: 15

.... 1... = RB Indicator: 1

.... ..00 0100 1011 = Starting PRB of Control Section: 75

.... 0000 0101 = Number of Contiguous PRBs per Control Section: 5

1111 1111 1111 = RE Mask: 0xffff

.... 0001 = Number of Symbols: 1

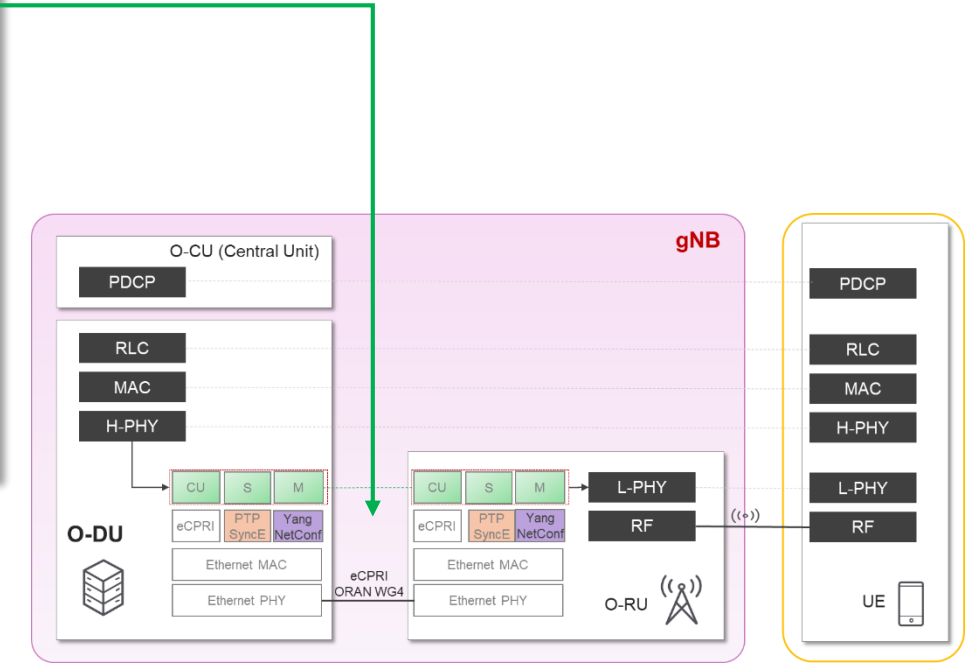
.010 1010 1011 1011 = Beam ID: 10939

> Section, Id: 16 (PRB: 80-84), Symbols: 1, BeamId: 10939

C-Plane_Plus_U-Plane_11_each.pcap

Packets: 22 · Displayed: 22 (100.0%)

Profile: Default



Summary

LEVERAGE FROM KEYSIGHT EXPERTISE TO ACCELERATE YOUR O-RAN DESIGNS

- Review Keysight's O-RAN Solution portfolio on www.Keysight.com/find/ORAN

DOWNLOAD FREE O-RAN WIRESHARK

- [https://connectlp.keysight.com/Keysight Open RAN Solutions](https://connectlp.keysight.com/Keysight%20Open%20RAN%20Solutions)

EVALUATE OPEN RAN STUDIO SOFTWARE

- www.Keysight.com/find/openranstudio





Thank You !



KEYSIGHT
WORLD 2020

