

5G Challenge 2023 Test Plan Overview

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1 Version History

Version	Date	Author(s)	Notes
1.0	Feb 1, 2023	Multiple	Initial Release

2 List of Figures

Figure 1 - 2023 5G Challenge Flowchart..... **Error! Bookmark not defined.**

Figure 2 - 5G Challenge Reference Architecture 9

3 Acronyms

3GPP	3rd Generation Partnership Project
5GC	5G Core
APN	Access Point Name
BLER	Block Error Rate
CA	Carrier Aggregation
CC	Component Carrier
COTS	Commercial Off-the-Shelf
CP	Control Plane
CQI	Channel Quality Indicator
CU	Central Unit
DL	Downlink
DLM	Delay Management
DNN	Data Network Name
DRB	Data Radio Bearer
DU	Distributed Unit
DUT	Device Under Test
E2E	End-to-End
eCPRI	Enhanced Common Public Radio Interface
EMS	Element Management System
FDD	Frequency Division Duplex
FR1	Frequency Range 1 in 3GPP
FTP	File Transfer Protocol
gNB	gNodeB
IE	Information Elements
ICMP	Internet Control Message Protocol
IOT	Interoperability Testing
IP	Internet Protocol
KPI	Key Performance Indicators
M-Plane	Management Plane of the O-RAN Fronthaul interface
MAC	Media Access Control
MCC	Mobile Country Code

MCS	Modulation Coding Scheme
MIB	Master Information Block
MIMO	Multiple Input Multiple Output
MNC	Mobile Network Code
MO	Mobile Originating
MTU	Maximum Transmission Unit
NAS	Non Access Stratum
NGAP	NG Application Protocol
NR	New Radio
OAM	Operation and Management
ORAN	Open Radio Access Network
OTA	Over-the-Air
PCI	Physical Cell ID
PDU	Packet Data Unit
PLMN ID	Public Land Mobile Network Identity
PTP	Precision Time Protocol
RA	Resource Allocation
RAN	Radio Access Network
RB	Resource Block
RF	Radio Frequency
RLF	Radio Link Failure
RoE	Radio Over Ethernet
RRC	Radio Resource Control
RSRP	Reference Signal Received Power
RTP	Real-time Transport Protocol
RU	Radio Unit
S-Plane	Synchronization Plane of the O-RAN Fronthaul interface
SA	Standalone Architecture
SCTP	Stream Control Transmission Protocol
SFP	Small form-factor pluggable
SIB	System Information Block
SMA	SubMiniature version A
SSB	Synchronization Signal Block

SUT	System Under Test
TAI	Tracking Area Identifier
TCP	Transmission Control Protocol
TDD	Time Division Duplex
TNL	Transport Network Layer
UC-Plane	User and Control Plane of the O-RAN Fronthaul interface
UDP	User Datagram Protocol
UE	User Equipment
UL	Uplink
UP	User Plane
UUT	Unit Under Test
vRAN	Virtualized Radio Access Network

4 Introduction

This document contains an overview of the 2023 5G Challenge test plans. This document is subject to change and may be superseded by later versions. The detailed test plans will be released when lab testing begins. The detailed test plans will identify mandatory tests, optional tests, and the points awarded for passing each test.

The 5G Challenge consists of a Preliminary Event in 2022 and the 2023 5G Challenge. The Preliminary Event focused on basic functionality for individual supplier 5G RAN components utilizing open interfaces and interoperable subsystems. The Preliminary Event was conducted at the CableLabs host lab in Louisville, CO.

In the 2023 5G Challenge, also conducted at the CableLabs host lab in Louisville, CO, participating contestants will have the opportunity to integrate and test their subsystems in the host lab leading up to the prize challenge. The 2023 5G Challenge will focus on CU+DU and RU subsystem integration with an emphasis on end-to-end performance and mobility testing.

The 2023 5G Challenge consists of four stages as shown in the diagram below (Figure 1):

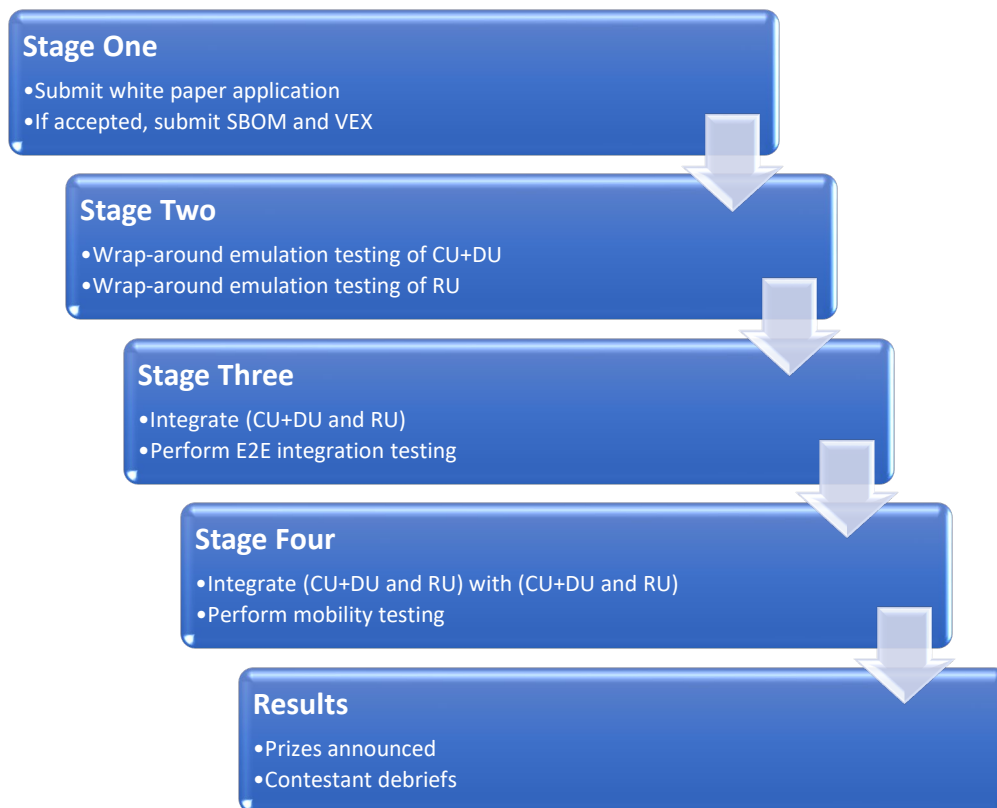


Figure 1 - 2023 5G Challenge Flowchart

The diagram below (Figure 2) shows the 2023 5G Challenge reference architecture and the specific interfaces that would be tested for the contestant sub-system under test.

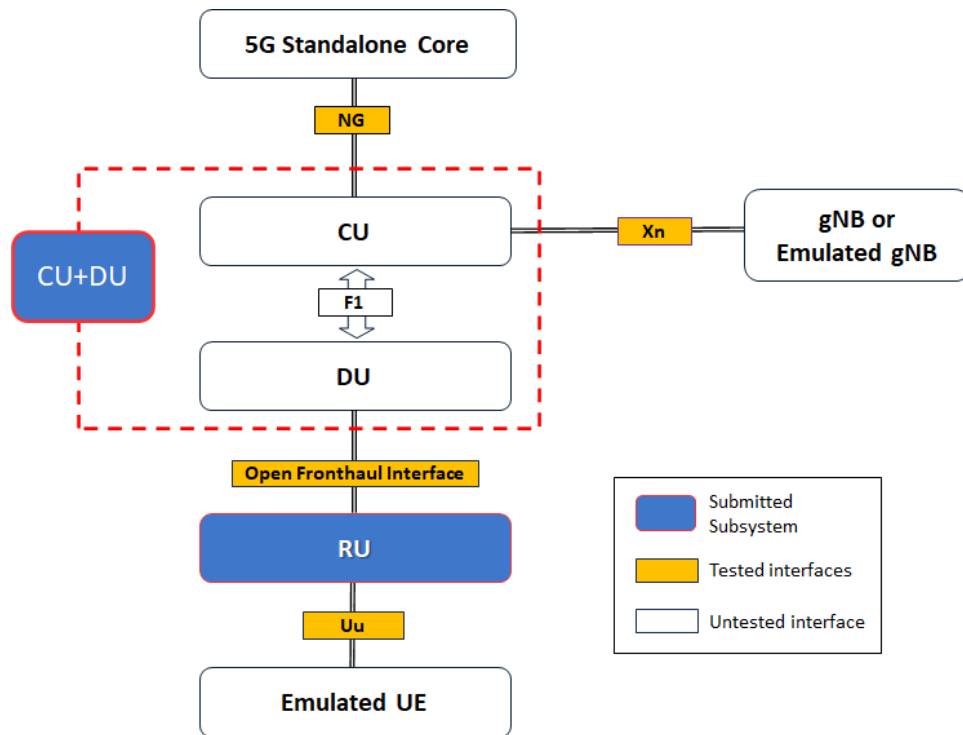


Figure 2 - 5G Challenge Reference Architecture

This document provides an overview of the test categories, test description and relative reference documents for each of the four Stages in the 2023 5G Challenge. Further details will be included in the Test Plan for each of the Stages and subsystems under test.

5 Stage Two – Wrap-around Emulation Testing

5.1 Radio Unit (RU)

5.1.1 Summary

The Radio Unit (RU) test procedures within Stage Two may include the following testing categories:

- **Integration** – The objective is for the RU to demonstrate successful integration into the test environment.
- **Conformance** – The objective is for the RU to perform O-RAN Work Group (WG) 4 conformance and basic functionality tests. It also includes essential M-Plane procedures and S-Plane functionality that are required for the integration with the combined CU+DU in Stage Three.

For each of the above test categories, test environment, equipment, lab setup and test procedures have been defined together with their associated success criteria.

5.1.2 Test Matrix

The test categories and the associated specifications expected for Stage Two RU testing are provided in Table 1 below.

Test Category	Test Category Description	Reference Specs
Integration	S-Plane, M-Plane & UC-Plane integration with the RU Wraparound Tester	O-RAN.WG4.CONF.0-v05.00; Conformance Test Specification
Conformance	<p>M-Plane</p> <ul style="list-style-type: none"> -Transport and Handshake -Manage Alarm Requests -Connection Supervision -Retrieval of RU's Information - Elements -Fault Management -RU Software Update -RU Software Activation -Access Control <p>RU Configurability</p> <ul style="list-style-type: none"> -Log Management <p>UC-Plane</p> <ul style="list-style-type: none"> -NR Generic -Beamforming -Compression -Delay Management <p>S-Plane</p> <ul style="list-style-type: none"> -ITU-T G.8275.1 (LLS- C1/C2/C3) 	<p>ORAN-WG4.CUS.0-v05.00; Control, User, and Synchronization Plane Specification</p> <p>O-RAN.WG4.MP.0-v05.00; Management Plane Specification</p>

Table 1 - Overview of Stage Two RU Test Category and Description

The test procedures are black box tests designed to evaluate basic pass/fail criteria for the 5G vendor products. These test categories and descriptions are subject to change during the contest as additional information and criteria are identified.

5.2 Combined Central and Distributed Units (CU+DU)

5.2.1 Summary

The Combined Central Unit (CU) + Distributed Unit (DU) test procedures within Stage Two may include the following testing categories:

- **Integration** – The objective is for the CU+DU to demonstrate successful integration into the test environment.
- **Functionality** – The objective is for the CU+DU to perform O-RAN ALLIANCE conformance and basic functionality tests. It also includes essential M-Plane procedures and S-Plane functionality that are required for Level 2 testing.
- **Interoperability** – The objective is to demonstrate CU+DU fronthaul interface interoperability between the contestant’s DU and a reference RU, using Radio Layer

and Core Network interfaces emulation. This includes mobility with Xn handover messaging across the CU plane with a CU emulator.

For each of the above test categories, test environment, equipment, lab setup and test procedures have been defined together with their associated success criteria.

5.2.2 Test Matrix

The test categories and the associated specifications expected for Stage Two CU+DU testing is provided in Table 2 below.

Test Category	Test Category Description	Reference Specs
Operations / Integration	<p><i>DU FH Interface:</i> S-Plane, M-Plane, UC-Plane integration.</p> <p>CU: NG Interface Integration</p>	<p>3GPP TS 23.502 V15.6, 5G; System architecture for the 5G System</p> <p>3GPP TS 38.413 V15.6, NG-RAN; NG Application Protocol</p> <p>3GPP TS 38.423 V15.6, NG-RAN; Xn Application Protocol</p>
Functional / Protocol Conformance	<p><i>DU (UC-Plane Scenario Class):</i> NR testing Generic (includes base Cat-A RU), Compression (CMP includes Static format fixed-point uncompressed), Delay Management (DLM includes Delay-Management on-time arrival, early, and late arrival).</p> <p><i>CU+DU:</i> Include PDU Session Management procedures, UE Context Management procedures (includes UE Context Setup, Modification and Release).</p>	<p>O-RAN ALLIANCE Working Group 4 (Open Fronthaul Interfaces WG)</p> <p>ORAN-WG4.CUS; Control, User and Synchronization Plane Specification</p> <p>O-RAN.WG4.MP; Management Plane Specification</p> <p>O-RAN Open F1/W1/E1/X2/Xn Interfaces Working Group</p> <p>O-RAN.WG5.U; NR U-plane profile</p>
Interoperability	<p>Interface Management Procedures with focus on NG Setup, Xn setup, RAN/AMF Configuration update, NG reset, and reset (including Partial reset for CU initiated, DU initiated scenarios).</p>	<p>O-RAN.WG5.C; NR C-plane profile (NR Standalone)</p> <p>O-RAN.WG5.Transport Transport Specification</p>

Table 2 - Overview of Stage Two CU+DU Test Category and Description

The test procedures are black box tests designed to evaluate basic pass/fail criteria for the 5G vendor products. These test categories and descriptions are subject to change during the contest as additional information and criteria are identified.

6 Stage Three - End-to End Integration Testing

6.1 Summary

End-to-End (E2E) Integration test procedures in Stage Three may include the following testing categories:

- **Integration** – These test cases verify the basic connectivity of the end-to-end setup which are pre-requisite for running any further functional, performance and stress test cases. The test cases validate the ability of contestant individual subsystems (CU+DU and RU) to successfully integrate with the E2E setup which consists of a UE emulator, non-emulated 5G SA core, and two contestant subsystems (CU+DU and RU).
- **Functional** – These test cases verify the contestant subsystem's compliance to O-RAN ALLIANCE and 3GPP specifications with regards to protocol conformance and baseline functionality to build a working setup of E2E 5G network for establishing a successful data session.
- **Performance** – These test cases verify contestant (CU+DU and RU) subsystem performance (e.g., latency, jitter, and throughput) for different traffic types (i.e., TPC, UDP, RTP, etc.) for optimal RF and sub-optimal conditions for a single UE.
- **Stress, Reliability, Stability** – These test cases verify contestant (CU+DU and RU) subsystem performance (e.g., latency, jitter, and throughput) for different traffic types (e.g., TPC, UDP, RTP), reliability and stability conditions using pre-defined traffic models for multiple UEs at varying RF conditions.

The test procedures follow pass/fail criteria and are intended to be standalone procedures, not dependent upon any other test cases. The focus of this document is to harmonize the end-to-end test specification, conditions, methodologies, and procedures. The test configuration (parameters) recorded in the test report enable the tests to be performed in stable and repeatable conditions on stable and consistent test setups.

For each of the above test categories, test environment, equipment, lab setup, and test procedures have been defined together with their associated success criteria.

6.2 Test Matrix

The test categories and the associated specifications expected for Stage Three end to end testing are listed in Table 3 below:

Test Category	Test Category Description	Reference Specs
Integration/ Operations	Includes Interface Management Procedures (e.g., M-Plane, S-Plane, UC-Plane, etc.)	3GPP TS 23.502 V15.6, 5G; System architecture for the 5G System
Functional / Protocol Conformance	Includes System Procedures, Session Management Procedures and RRC Procedures	3GPP TS 38.413 V15.6, NG-RAN; NG Application Protocol
Performance	Includes single UE performance at optimal RF conditions and poor RF conditions for different traffic types (e.g., TCP, UDP, FTP, RTP, ICMP)	3GPP TS 38.423 V15.6, NG-RAN; Xn Application Protocol
Stress, Reliability and Stability	Includes multiple UE performance at varying RF conditions for different traffic types (e.g., TCP, UDP, FTP, RTP, ICMP), loading test cases (e.g., simultaneous and staggered registrations) and stability test cases (e.g., long term stability testing with pre-designed traffic model)	O-RAN.WG4.CONF.0-v05.00; Conformance Test Specification ORAN-WG4.CUS.0-v05.00; Control, User, and Synchronization Plane Specification O-RAN.WG4.MP.0-v05.00; Management Plane Specification O-RAN.TIFG.E2E-Test.0-v04.00.docx O-RAN.WG4.IOT.0-v05.00

Table 3 - Overview of Stage Three E2E Integration Testing Category and Description

These test categories and descriptions are subject to change during the contest as additional information and criteria are identified.

7 Stage Four – Mobility Testing

7.1 Summary

A summary of Stage Four Mobility test categories, description and reference specifications is provided in Table 4 below.

- **Integration** – The objective is to integrate two standalone contestant subsystems (CU+DU and RU) and demonstrate successful integration into the test environment in preparation for mobility handover.
- **Mobility** – The objective is for two standalone contestant E2E subsystems (CU+DU and RU) to perform mobility tests that include connected mode handovers and idle mode mobility.

7.2 Test Matrix

The test categories and the associated specifications expected Stage Four Mobility testing is provided in Table 4 below.

Test Category	Test Category Description	Reference Specs
Integration	NG and Xn setup	3GPP TS 23.502 V15.6, 5G; System architecture for the 5G System
Mobility	Includes connected mode handovers and idle mode mobility	3GPP TS 38.413 V15.6, NG-RAN; NG Application Protocol 3GPP TS 38.423 V15.6, NG-RAN; Xn Application Protocol 3GPP TS 38 401 - V15.3.0 - 5G; NG-RAN; Architecture description O-RAN.TIFG.E2E-Test.0-v04.00.docx O-RAN.WG4.IOT.0-v05.00 O-RAN.WG5 Interoperability Test Specification (IOT) 5.0

Table 4 - Overview of Stage Four Mobility Test Category and Description

The test procedures are black box tests designed to evaluate basic pass/fail criteria for the 5G vendor products. These test procedures are subject to change during the contest as additional information and criteria are identified.