

5G CHALLENGE

Official Rules

5G Challenge Preliminary Event: RAN Subsystem Interoperability

Version 1.2

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Document History

Version	Date	Changes
1.0	4/6/2022	Initial Release
1.1	7/15/2022	Clarification of Stage Two lab time schedule; Update on host lab system; Correction to Technical Paper submission deadlines
1.2	8/9/2022	Stage Three contestant selection and prize changes in the case of critical contestant pairing limitations; Stage Two security evaluation change

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1 Introduction

1.1 5G Challenge Vision

To accelerate adoption of 5G open interfaces, interoperable subsystems, and multi-vendor solutions by fostering a large, vibrant, and growing vendor community dedicated to advancing 5G interoperability towards true plug-and-play operation.

Today, mobile wireless networks are assembled by mobile network operators and composed of many proprietary solutions. Each discrete element typically has custom, closed-source software and hardware. Changes to any single element require complex and meticulous verification of the entire network. This industry dynamic increases costs, slows innovation, and reduces competition. Security issues are often difficult to detect and fix.

In response, the National Telecommunications and Information Administration's Institute for Telecommunication Sciences (NTIA/ITS), in collaboration with Department of Defense's Office of the Under Secretary of Defense for Research and Engineering (OUSD(R&E)) is carrying out the 5G Challenge to accelerate the adoption of:

- Open interfaces
- Interoperable subsystems
- Modular, multi-vendor solutions

In the envisioned future 5G market, open interfaces reflect clear-cut requirements, enabling true plug-and-play operation. Modular 5G elements let network operators quickly and easily reconfigure, update, or replace subsystems as needed. External scrutiny of open interfaces allows vulnerabilities to be identified and patched. Attracted by this open, modular, interoperable environment, new suppliers can more easily emerge. A diversified marketplace delivers targeted innovation and drives down costs. International allies and partners can establish secure, trusted supply chains. Beneficiaries of this future 5G market include DoD, international allies and partners, network operators, businesses, and consumers.

To realize this vision, the 5G Challenge will:

- Utilize existing open interface standards
- Leverage industry trends toward virtualization, softwarization, and cloud systems
- Encourage modular product development
- Demonstrate multi-vendor interoperability
- Reduce barriers to entry for new solutions providers

This public prize challenge approach will support the growth of a large, vibrant community working on 5G multi-vendor interoperability. This approach is a powerful catalyst for creating diverse solutions, attracting non-traditional performers, and sparking new innovations. The 5G

Challenge envisions a world where flexible 5G technologies create new supplier opportunities and enhance network security. Streamlining integration enables continuous development, integration, and testing.

1.2 Reasons to Compete

The 5G Challenge Preliminary Event provides contestants with an:

- Opportunity to showcase 5G RAN subsystems to the broader U.S. government market, including DoD and NTIA, for 5G innovation opportunities
- Opportunity to win part of the \$3,000,000 Preliminary Event cash prize pool
- Early exposure to DoD and NTIA/ITS in the Preliminary Event in 2022 in anticipation of a much larger prize pool in the Final Event in 2023
- Opportunity to showcase how a single supplier RAN component integrates into an independent host lab environment, in an open innovation prize competition
- Advanced-level competition for high-scoring contestants to integrate with fellow contestants and the host lab to test interoperability with different RAN component configurations
- Opportunity to use a host lab and work with knowledgeable engineers, who have extensive knowledge and expertise working with multiple suppliers to achieve integration and interoperability

2 Background and Goals

2.1 Program Structure

The 5G Challenge consists of a Preliminary Event in 2022 and a Final Event currently planned for 2023. This document describes the 5G Challenge Preliminary Event: RAN Subsystem Interoperability. The rules, location, and details of the Final Event will be released later. Contestants, while encouraged to do so, do not need to participate in the Preliminary Event to compete in the Final Event.

The Preliminary Event focuses on basic functionality for individual supplier 5G RAN components utilizing open interfaces and interoperable subsystems. The Preliminary Event will be conducted at the CableLabs host lab in Louisville, CO. In the Preliminary Event, participating contestants will have the opportunity to integrate and test their subsystems with the host lab leading up to the prize challenge. Top performing contestants will earn cash prizes for their efforts as detailed in the following sections.

All official 5G Challenge documents are posted on the 5G Challenge webpage at <https://www.challenge.gov/?challenge=5g-challenge-2022> (“Challenge.gov”).

2.2 Desired Capabilities

The objective of the Preliminary Event is to demonstrate individual contestants’ 5G RAN subsystems that utilize open interfaces and operate as part of an emulated and end-to-end standalone (SA) 5G system in the CableLabs host lab. The host lab will provide a 5G emulator

and an SA 5G baseline system into which competing contestants will integrate their subsystems. “Plug-and-play” performance will be evaluated using a standard corpus of performance metrics. The host lab will be made available to all participating contestants for preparation prior to integration, testing, and interoperability performance evaluation.

An SA 5G system consists of a 5G Core with a 5G Radio Access Network (RAN), as defined by 3GPP. 3GPP also defines a non-standalone (NSA) 5G system as a 4G core with eNB, ng-eNB and gNB RAN elements. The 5G Challenge is focused on testing 5G SA configurations. NSA 5G and backward compatibility with other legacy systems is outside the scope of the 5G Challenge.

2.3 Contest Overview

Participation in the Preliminary Event will be a multi-stage process, which is summarized here and further defined in Section 3.

The 5G Challenge Preliminary Event consists of three stages:

- Stage One: Application
- Stage Two: Emulated Integration
- Stage Three: Network Integration

During Stage One, interested contestants will apply for participation in the 5G Challenge Preliminary Event by submitting a white paper. The white paper will include Contestant documentation on 3GPP and O-RAN Alliance specification compliance and subsystem test reports. The most qualified contestants will be accepted from the application pool based on criteria detailed in Section 3.1.3.

During Stage Two, the selected contestants’ subsystem(s) will be evaluated in the host lab’s wrap-around emulator. The Contestants are expected to provide appropriate technical expertise and resources to ensure interoperability with the emulator. If the subsystem’s interface does not interoperate with the host lab’s emulator, the host lab will make available technical expertise during the contestants’ allotted lab time to work with the contestants to fault isolate and try to achieve interoperation. Each contestant whose subsystem(s) achieves a basic level of functional performance will qualify for an Emulated Integration prize of \$150,000. Of the contestants who qualify for an Emulated Integration prize, the contestant with the best Software Bill of Materials (SBOM) will also receive a \$200,000 prize. The functional performance will be defined in the testing procedures, which the host lab will release only to Stage Two and Stage Three contestants at least one week prior to beginning their integration process.

Top performers from Stage Two will be selected for participation in Stage Three. The goal of Stage Three is to establish a data session with an emulated user equipment (UE) and then to characterize the performance of the integrated system. Stage Three will include two test windows. During each test window, contestants will be divided into pairs of two contestant

subsystems. Each contestant pair will simultaneously integrate their subsystems into the host lab system.

Each contestant in the contestant pair will receive the same performance score for their integrated system. For each test window, the contestant pair with the highest overall score will win a Network Integration Prize of \$250,000 for each contestant, for a total of up to \$500,000 for each test window. Up to four Stage Three prizes of \$250,000 each will be awarded in Stage Three.

During Stage Three integration, each contestant will provide one RAN subsystem (Radio Unit (RU), Central Unit (CU), or Distributed Unit (DU)) and the host lab will provide the rest of the 5G system. Only one UE emulator is available in the host lab. Since the one UE emulator is a shared resource among all contestant pairs, an identical actual UE will be provided for over-the-air testing, for use when the emulated UE is not available. See Section 3 for more details.

2.4 Host Lab Capabilities and Configurations

CableLabs, the host lab for the 5G Challenge Preliminary Event, is a not-for-profit innovation and R&D lab that has global impact through its 63 member companies serving more than 150 million households and mobile users worldwide with its state-of-the-art research facility and collaborative ecosystem. The 5G Challenge builds on CableLabs' experience as an independent arbitrator and host of industry interoperability events.

During Stage Two, the host lab will provide an emulated Viavi 5G test system.

During Stage Three, the host lab will provide two (2) SA 5G cores:

- Primary: MAVENIR™ core running on Intel COTS servers
- Secondary: open5Gs (<https://open5gs.org/>, <https://github.com/open5gs/open5gs>)

For Stage Three, the host lab will also provide two (2) virtualized Radio Access Networks (vRAN):

- Primary: MAVENIR CU, DU, and RU
- Secondary: Accelleran™ CU, Benetel™ RU, Phluido™/EffNet™ DU

For more information on the host lab's 5G systems see the "Host Lab Specification" document, published separately. Note that references to the "host lab system" throughout this document may refer to multiple host lab system configurations.

The host lab will verify interoperability and measure performance metrics of submitted designs. The host lab can emulate up to 128 UEs and 128 connections across a 10Gb/s interface. The 5G core can support up to 10,000 subscribers and connections.

2.5 Interfaces and Subsystems Under Test

The 5G Challenge Preliminary Event will evaluate the 5G SA subsystems via the interfaces depicted in Figure 1. NSA 5G systems will not be evaluated. The 5G Challenge uses both the SA core and 5G RAN configuration (SA Option 2), but only 5G RAN subsystems will be evaluated.

The 5G Challenge Preliminary Event will evaluate the following interfaces:

- 3GPP interface **F1-c**—Control plane for midhaul interface between CU and DU functions
- 3GPP interface **F1-u**—User plane for midhaul interface between CU and DU functions
- 3GPP interface **NG (N1/N2/N3)**—RAN interface to 5G Core. N1 is a transparent interface between the UE and the 5G Core. NG control plane is also known as N2. NG user plane is also known as N3
- O-RAN Alliance interface **Open Fronthaul (DU to RU)**—Includes Control, User, Synchronization (CUS) Plane and Management Plane protocols. Based on lower layer functional split “7-2x” and leverages eCPRI protocols

Challenge contestants may submit hardware and/or software solutions for any or all of the following subsystems which must be compliant with the 3GPP Release 15 Standard and also be compliant with O-RAN Alliance technical specifications mandatory for the Open Fronthaul 7-2x split interface (Reference Documents [13] and [14]):

- Distributed Unit (DU)
- Central Unit (CU)—only testing support to single DU
- Radio Unit (RU)—must have the ability to operate with cabled air interface emulation supporting up to 4x4 MIMO (FR1 only)

For each subsystem submitted, the following interfaces must be available for testing and evaluation.

Table 1: Required interfaces for subsystems submitted

Subsystem	F1-c	F1-u	NG	Open Fronthaul
CU	X	X	X	
DU	X	X		X
RU				X

Each subsystem will be allotted an equal amount of time in the host lab. Any contestant who has multiple subsystems accepted for Stage Two, will receive equal time in the lab for each subsystem.

Subsystems must be capable of operating with a 5G baseline system that adheres to 3GPP specifications in Release 15 (or later) for the F1 and NG interfaces; or in the case of the Open Front Haul interface, the product must follow O-RAN Alliance technical specifications mandatory for the Open Fronthaul 7-2x split interface (Reference Documents [13] and [14]). If

the contestant is submitting an O-DU and/or an O-RU, the technical approach should state which Open Front Haul (OFH) synchronization configuration(s) the contestant’s entry supports and why those configurations were chosen. These synchronization configurations are defined by the Open RAN Alliance CUS Working Group 4 as the LLS-C1, LLS-C2, LLS-C3, and LLS-C4 options. CableLabs can support all four of these configurations but can only test LLS-C1, LLS-C2, and LLS-C3. Contestants may bring their own synchronization configuration.

The host lab can support the following entry tracks (regardless of track chosen, the host lab will provide remote access to the contestant’s subsystem):

- **TRACK 1:** Cluster delivery and local host lab installation — contestant subsystem hardware/software servers are staged, pre-tested and pre-configured and delivered to host lab for integration and test.
- **TRACK 2:** Remote install onto host lab cluster — delivery of contestant subsystem is remotely uploaded and installed into host lab cluster for integration and test.
- **TRACK 3:** Remote contestant lab — contestant subsystem is located remotely in contestant lab and accesses host lab for integration and test. This Track is only available to CU subsystem submissions. Contestants who choose Track 3 may experience some latency issues which might negatively impact scoring.

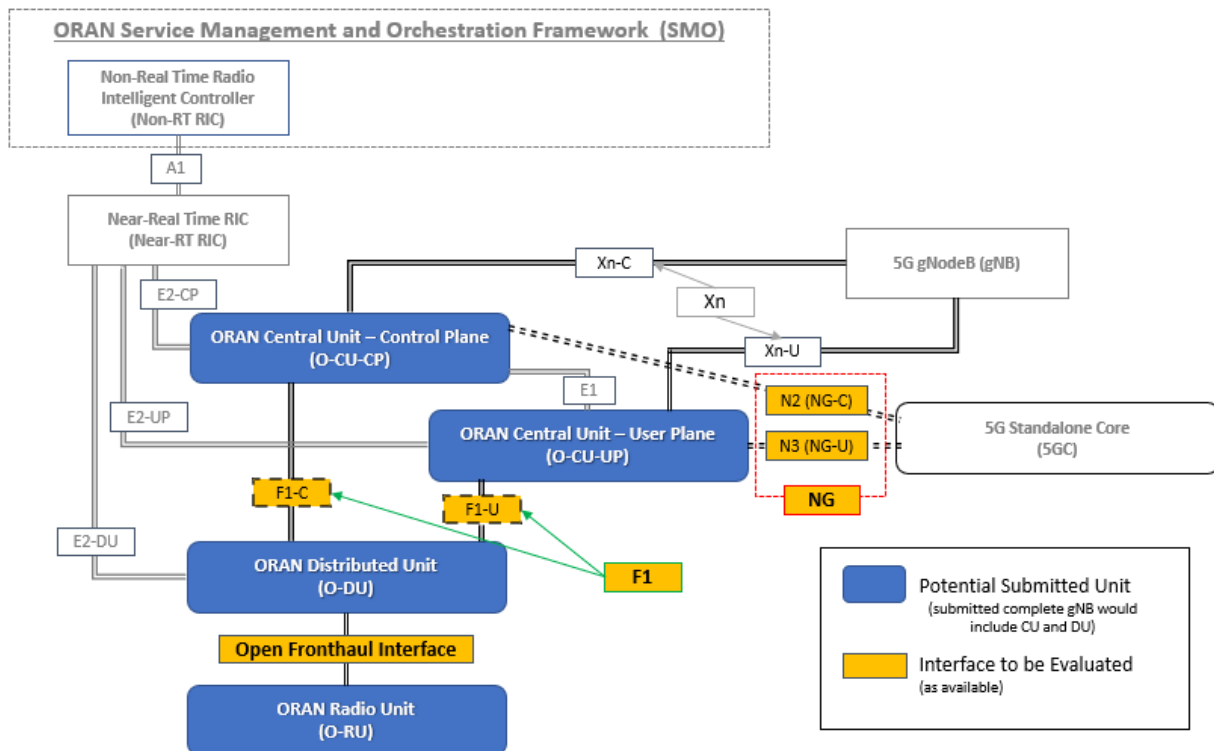


Figure 1: 5G RAN Reference Architecture

Note: CU subsystems submitted to the challenge must contain both the CU-CP and CU-UP.

The host lab will take reasonable precautions to protect software between contestants. Contestants can run in a shared environment on Openshift 4.8 CaaS. By default, the host lab would limit all contestants to a dedicated namespace with RBAC controls only allowing them access to that namespace. Once the contestants testing is completed, all contents in the namespace will be deleted. Networking connections between the systems will be limited to only ports and protocols needed for operation.

Contestants may also provide their own hardware and CaaS, for which they would be responsible for all system security and access. Networking connections between the systems would be limited to only ports and protocols needed for operation.

2.6 Scope and Precedence

This document defines the rules for 5G Challenge Preliminary Event: RAN Subsystem Interoperability. The rules outlined herein apply to all contestants in the Preliminary Event. The intent of this document is to inform contestants as they prepare their subsystems for the 5G Challenge. Further documents are planned for publication that will provide details about additional resources that will be provided to the contestants to aid their solution development and testing.

NTIA/ITS may release additional documents with rules updates, procedures, and other information for contestants as needed. These additional documents carry the full authority of the rules in this document.

Additional “5G Challenge Preliminary Event: RAN Subsystem Interoperability” documents intended to be released include the following:

- Host Lab Specification
- Scoring Guide and Metrics
- Participation Agreement
- Technical Paper Guidelines
- Frequently Asked Questions (FAQ)

All of the above documents will be published on the 5G Challenge webpage at Challenge.gov. All 5G Challenge documents including this rules document should be considered living documents, subject to updates and clarification throughout the 5G Challenge program. NTIA/ITS has the authority to modify and interpret the rules at any time.

The host lab will release testing procedures to only Stage Two and Stage Three contestants at least one week prior to beginning their integration process with the host lab.

3 How to Compete

The 5G Challenge Preliminary Event consists of multiple stages during which contestants are evaluated and prizes are awarded, as shown in Figure 2: Preliminary Event Flowchart. Specific dates for major Preliminary Event milestones are provided in Table 2: Preliminary Event Important Dates. The 5G Challenge Organizers reserve the right to make scheduling changes due to unforeseen events.

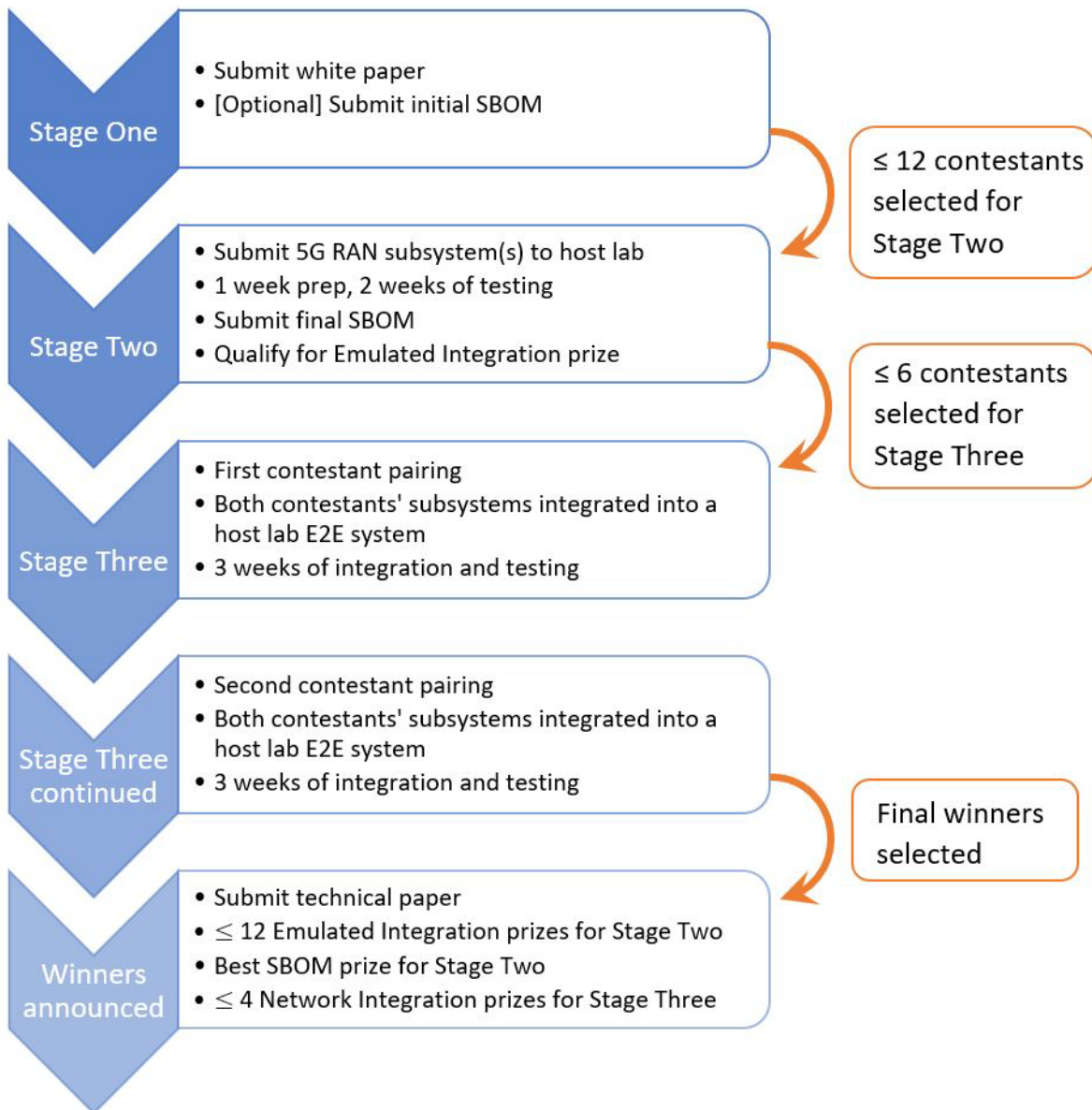


Figure 2: Preliminary Event flowchart

Table 2: Preliminary Event important dates

Stage	Event	Date
Stage One	Early-bird white papers due	April 20, 2022
	Early-bird Stage Two contestants announced	April 26, 2022
	Final white papers due	May 5, 2022
	Remaining Stage Two contestants announced	May 19, 2022
Stage Two	Emulated Integration testing	May 3 – August 5, 2022
	Judge panel evaluates results	August 8-10, 2022
	Stage Two winners and Stage Three contestants announced	August 11, 2022
	Stage Two technical papers due (for Stage Two winners not selected for Stage Three)	September 1, 2022
	SBOM due	September 1, 2022
Stage Three	Network Integration testing – Test Window 1	August 18 – September 8, 2022
	Network Integration testing – Test Window 2	September 9-29, 2022
	Closing Ceremony	September 30, 2022
	Judge panel evaluates results	October 3-5, 2022
	Stage Three and SBOM winners announced	October 6, 2022
	Stage Three technical papers due	October 27, 2022

3.1 Stage One: Application

To apply to the 5G Challenge Preliminary Event, contestants must:

- Already have a functioning version of one or more subsystems that exercise the interfaces and subsystems described in Section 2.5
- Meet the Eligibility requirements detailed in Section 3.1.2
- Submit a white paper, as described in Section 3.1.3
- [Optional for Stage One] Submit a software bill of materials, as described in 3.1.4

After all applications are reviewed, the Stage Two field of Preliminary Event contestants will be announced. NTIA/ITS will select up to 12 applications (up to 6 CUs, 3 DUs, and 3 RUs) that meet the minimum criteria and best demonstrate a viable solution, to compete in Stage Two. See Section 4.1 for the application evaluation methods.

Per the schedule in Table 2, up to four contestant submissions (up to 2 CUs, 1 DU, and 1 RU) from contestants who submit their white papers by the early-bird deadline will be selected for Stage Two and will be the first contestants to begin testing. Any contestant white papers not selected during the early-bird submission will be re-evaluated along with the rest of the white papers submitted by the final deadline. If contestants whose papers were not selected during the early-bird process want to make changes to their early-bird white papers, they must re-

submit a revised version by the final white paper due date. No white paper feedback will be provided to contestants during Stage One.

The remaining contestants will be selected from the final white paper submission until up to 12 contestants have been selected (comprising subsystems for up to 6 CUs, 3 DUs, and 3 RUs). Preference will be given to selecting 12 unique contestants; however, if there are not 12 unique contestants, some contestants may have more than one subsystem accepted in Stage Two. Refer to the “Scoring Guide and Metrics” document, published separately.

Contestants that submit multiple subsystems to the 5G Challenge shall consolidate their subsystem descriptions into a single white paper entry.

3.1.1 Fee

There is no fee for entry.

3.1.2 Eligibility

The 5G Challenge is interested in stimulating broad participation and encouraging new entrants to the market. The 5G Challenge, authorized under Section 105 of the America COMPETES Reauthorization Act of 2010 (Pub. L. No. 111-358), as amended by Section 401 of the American Innovation and Competitiveness Act of 2016 (Pub. L. No. 114-329) and codified in [15 U.S.C. § 3719](#) (hereinafter “America COMPETES Act”), is open to all individuals, nationalities, ages, academic institutions, and business interests, subject to the caveats below:

- An entrant may be an individual, a group of individuals, or a contestant representing a business or academic institution.
- At the time the application is submitted, the respective individual applicant, or in the case of a team submission, the Contestant Leader, must be at least age 18 and a U.S. citizen or permanent resident of the United States or its territories. In the case of an entity applicant, the entity must be incorporated in and maintain a primary place of business in the United States or its territories.
- Each entrant must provide a current U.S. taxpayer identification number (TIN) to validate eligibility (e.g., social security number, employer identification number).
- Entrants may enter under an official affiliation (e.g., a university or corporation). Entrants may also have an official set of sponsors. Affiliations and sponsors must be disclosed in the white paper.
- Each contestant team must identify a single individual as the Contestant Leader. This individual must meet all eligibility requirements and will serve as the official administrative point of contact for communications with the 5G Challenge team.
- Contestants are to be wholly separate entities that do not share members/affiliations or sponsorship (financial interests) with other contestants. Individuals cannot be members of multiple contestant teams. Contestants may have one or more sponsors. Contestants may not collaborate or share their technical approaches and solutions with other contestants,

with the exception of the Stage Three pairing. Contestants who do not comply with these guidelines will be subject to disqualification.

- Ownership/Control: 5G Challenge entrants shall not be majority-owned or controlled by a foreign state
- Federal Acquisition Regulations (FAR): FAR compliant accounting systems are not required.
- Non-Commercial Entities: Academic participation is permitted, provided a path to market for the resulting product is clearly defined.

The following individuals and organizations are not eligible to participate in 5G Challenge events:

- Companies that are suspended, debarred, or otherwise excluded from contracting with the U.S. Government cannot participate.
- Foreign Individuals/Entities: Individuals who are non-U.S. citizens or permanent residents and entities that are not incorporated and maintain a primary place of business in the United States cannot participate.
- Official Government entities (from the U.S. or any other country) are not eligible to participate as entrants, sponsors, or official affiliates.
- Government employees and/or Government contractors (from the U.S. or any other country) acting within the scope of their employment or contract, as applicable, are not eligible to participate as entrants or contestant members.
- Persons or entities that received funds for supporting or advising the 5G Challenge are not eligible to participate.

Government military members or civilian employees may be eligible to participate if they do so in their personal capacity and if the work performed for the contest is NOT related to their official government duties. Government military members or employees should consult their supervisors and designated agency ethics officials before participating in the contest.

An individual or entity shall not be deemed ineligible under these rules because the individual or entity used Federal facilities or consulted with Federal employees during the 5G Challenge. Facilities and employees are made available to all individuals and entities participating in the 5G Challenge on an equitable basis.

3.1.3 White Papers

Entry into the 5G Challenge requires submittal and acceptance of a white paper in accordance with the instruction outlined herein, as well as proof of eligibility (submitted separately). The white papers must include the following sections (this includes information in addition to the evaluation criteria; see Section 4 for evaluation criteria):

1. **Subsystem(s):** a list of subsystems to be submitted for testing, including any specifications that may impact the host lab (e.g., computer hardware, operating system, and orchestration).

2. **Technical Approach:** An overview of the applicant's technical approach with sufficient detail to assess viability.
3. **Experience Integrating with Host Lab Systems:** Experience, if any, integrating with subsystems in the host lab system (Mavenir, Acceleran, Benetel, Phluido/EffNet, open5Gs)
4. **Prior Integration Partners:** Identify vendors that the applicant has interoperated with prior to the contest.
5. **Summary of Prior Integration Tests:** Provide RAN subsystem test summary, either from independent testing or during a plugfest which demonstrates submitted subsystems are already functional.
6. **Security Plan:** Describe the security plan, including implementation of 3GPP security procedures, known critical software vulnerabilities, and mitigation plan.
7. **Compliance:** Identify compliance to the 3GPP Release 15 Standard and O-RAN Alliance technical specifications mandatory for the open fronthaul 7-2x split/eCPRI (Reference Documents [13] and [14]).
8. **Staffing and Management Plan:** Summarize experience in mobile telecommunications and 5G (e.g., provide resume or history of related projects), staffing to support 5G Challenge lab work, and commitment to the 5G Challenge (e.g., statement of organizational support).
9. **Path to Market:** Intended path to market, including timeline(s).

Proof of Eligibility: A statement of eligibility that satisfies the requirements in Section 3.1.2. This information must be sent separately from the white paper, via secure email, and will not be counted towards the white paper page limit. Upon receipt of a contestant white paper, NTIA/ITS will send the contestant a link to a secure file collaboration site where the contestant must submit their Proof of Eligibility for evaluation by the 5G Challenge organizers.

White papers shall be no more than 10 pages in length, with standard 1" margins and font 10 points or larger. White papers shall be submitted in .docx or .pdf format.

NTIA/ITS will acknowledge receipt of white papers via e-mail. White papers received after the deadline specified herein will be disposed of in a secure manner. Incomplete applications will not be accepted. Applications may be withdrawn at any time by sending a communication to the 5G Challenge organizers via Challenge.gov.

White Papers will not be published externally. The contestant names and subsystems of accepted contestants may be published, as described in Section 6. The names and subsystems of white papers that were not accepted into the contest will not be published externally.

Applicants are required to disclose any prior experience interoperating with vendors of the host lab system (Mavenir, Acceleran, Benetel, Phluido/EffNet, open5Gs). To the extent possible, selected contestants for Stage Two and Stage Three will be assigned to integrate with a host lab system that they have not previously interoperated with. This information will not be used to score the application.

The other white paper information collected by NTIA/ITS will be treated as confidential, used for the sole purpose of administering the 5G Challenge, and to the extent permitted by Federal law, will not be distributed to parties outside of the 5G Challenge nor released for any other purpose except as noted in this document.

3.1.4 Software Bill of Materials (SBOM)

Applicants are encouraged, but are not required, to submit an initial SBOM with their application, so judges can start determination of secure software implementation. The number of SBOM pages submitted is not included in the maximum number of pages for the white paper. An SBOM is a nested inventory for software—a list of ingredients that make up software components. The SBOM is optional during Stage One but will impact the evaluation score. The SBOM will become mandatory during Stage Two.

For guidance on writing an SBOM, see the following website: <https://www.ntia.gov/SBOM>. This website includes:

- Acceptable SBOM formats — SPDX, CycloneDX, and SWID
- How to generate an SBOM and SBOM examples
- Available tools for generating and verifying an SBOM

Vulnerability Exploitability eXchange (VEX) is a machine-readable companion to an SBOM which communicates the current status of vulnerabilities in software components itemized in an SBOM. The following websites contain additional information:

- https://www.ntia.doc.gov/files/ntia/publications/sharing_and_exchanging_sboms.pdf
- <https://www.cisa.gov/known-exploited-vulnerabilities-catalog>
- <https://blog.adolus.com/what-is-vex-and-what-does-it-have-to-do-with-sboms>

3.2 Stage Two: Emulated Integration

The contestants selected for Stage Two will submit their subsystems for integration.

During Stage Two, the subsystem will be tested in an emulated environment based on test equipment.

Each Stage Two contestant is eligible for an Emulated Integration Prize; see Section 5 for details.

3.2.1 Subsystem Submission

Contestants will submit their 5G subsystems directly to the host lab. The host lab will contact contestants with coordination details.

3.2.2 Emulated Integration Schedule

Stage Two provides for contestant subsystems to be installed and integrated with the host lab's 5G emulated system. Each Stage Two contestant within each subsystem category (i.e., CU, DU

or RU) will be offered an equal amount of installation and integration time “in the lab” with the host. Contestants can do this work remotely or in-person at the lab (subject to COVID-19 health and safety protocols).

There is one week between the early contestants being announced and when testing starts in the lab; this is to provide a buffer to allow contestants the opportunity to travel to the host lab and ship their equipment. It may be possible to start sooner, depending on host lab and contestant readiness.

The lab time assignment schedule for each contestant will be released after the Stage Two contestants are announced (one set after the early bird submissions are announced and one set after the final papers are announced). “Lab time” refers to regular business hours and days, excluding Federal holidays.

Table 3: Stage Two subsystem testing schedule

May 3–August 5 (each week is 5 working days, excludes 3 Federal holidays)												
Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10	Week 11	Week 12	Week 13
Prep	CU 1 test			Prep	CU 3 test			Prep	CU 5 test			
		Prep	CU 2 test			Prep	CU 4 test			Prep	CU 6 test	
Prep	DU 1 test			Prep	DU 2 test			Prep	DU 3 test			
		Prep	RU 1 test			Prep	RU 2 test			Prep	RU 3 test	

For Stage Two testing, the wrap-around emulator can simultaneously test both a CU and either a DU or an RU. Therefore, the schedule in Table 3 shows a continuous testing of CU subsystems whereas DU and RU subsystem testing alternates. Note: either the DU 1 or RU 1 may be selected to be tested first; the schedule shown in Table 3 is just an illustration if the DU 1 were to start first.

Each contestant subsystem that is selected for Stage Two will get one week (5 business days) of preparation plus two weeks (10 business days) of host lab time. If fewer than two contestants have qualified for each subsystem category in Stage Three, then the 5G Challenge Organizers reserve the right to apportion any available remaining lab time among the contestants in that subsystem category that have not yet qualified, on an equal basis. CableLabs engineers will be available for consultation to contestants during the three weeks of their lab time, as time allows, and shared with other contestants also in the lab. Business day means 8 hours of lab time.

3.2.3 Stage Two SBOM Submission

Each Stage Two contestant must submit a final SBOM, due by September 1, 2022.

3.2.4 Emulated Integration and Testing

During the integration stage, contestant subsystems will be tested in an emulated environment. Contestants are permitted and encouraged to modify their code for functionality and performance during this integration period, but are reminded that code modifications must be made within the allotted emulated integration test period.

To pass Stage Two Emulated Integration, contestants must integrate at least one subsystem into the host lab’s emulated environment.

3.3 Stage Three: Network Integration

Stage Three consists of performance evaluations conducted by the host lab for each contestant. Up to six (6) Stage Two contestants will move on to Stage Three. If contestants had more than one subsystem in Stage Two, the 5G Challenge Team will select only one subsystem to move forward to Stage Three for each selected contestant. See the “Scoring Guide” document for exceptions.

3.3.1 Subsystem Submission

Contestants must submit a “statement of compliance” with the host lab prior to entering Stage Three (e.g., explaining contestant capabilities and functionality). CableLabs will provide contestants with a template prior to Stage Three. Contestants will submit their 5G subsystems directly to the host lab. The host lab will contact contestants with coordination details.

3.3.2 Network Integration Contestant Pairing and Schedule

For Stage Three testing, each subsystem will be tested in two different combinations of systems (in two three-week test windows, a “week” being no greater than 40 hours of lab time) as shown in Table 4. Ideally, there will be a total of 2 RU contestants, 2 DU contestants, and 2 CU contestants so that two contestants and one host lab RAN subsystem can comprise three different system combinations for each test window. The 5G Challenge will prioritize pairing contestants and host lab subsystem vendors who have not previously integrated prior to the contest. If possible, the host lab core and RAN equipment will not be the same vendor as the contestant. If an odd number of contestant subsystems are selected for Stage Three, then one of the contestant pairings will contain a single contestant.

Table 4: Stage Three subsystem pairing testing schedule

August 18–September 29 (each week is 5 working days, excludes 1 Federal holiday)					
Test Window 1			Test Window 2		
Week 1	Week 2	Week 3	Week 4	Week 5	Week 6
Contestant Pairing 1			Contestant Pairing 4		
Contestant Pairing 2			Contestant Pairing 5		
Contestant Pairing 3			Contestant Pairing 6		

If the selection process in Section 4 of the “Scoring Guide and Metrics” document produces only one possible Stage Three contestant pairing, then the 5G Challenge Organizers reserve the right to alter the Stage Three scheduling accordingly (*e.g.*, changing from two testing windows to one testing window). In this event, the Stage Three testing may occur in one five (5) week window. The prize structure may also be modified accordingly.

Up to four (4) Network Integration prizes will be awarded in Stage Three; see Section 5.1 for details.

Stage Three provides performance evaluations for two sets of systems integrated with contestants’ RAN subsystems, host lab RAN subsystem, host lab emulated UE, and host lab 5G core. The sets of integrated systems for the two sets of systems will be released when the Stage Three contestants are announced. Contestants are allowed to be present (subject to COVID-19 health and safety protocols). All contestant pairs will be evaluated in parallel.

Subsystems will be evaluated according to the metrics specified in the “Scoring Guide and Metrics” document, published separately.

3.4 Technical Papers

All Stage Two Emulated Integration, Stage Two Best SBOM, and Stage Three Network Integration prize recipients must submit a Technical Summary Paper to NTIA/ITS on the applicable dates specified in Table 2 of these Official Rules to be eligible for prize payments. The winners will not receive their prize payment until after the 5G Challenge has reviewed the technical papers and finds them acceptable.

This Technical Summary Paper shall describe the technical details of the contestant’s system, a list of any known critical vulnerabilities in the software implementation along with mitigation plan, performance, and lessons learned. The Technical Summary Papers will be evaluated and approved according to the Preliminary Event Technical Summary Paper Guidelines. NTIA/ITS will review each technical summary paper and communicate acceptance of papers to each contestant.

To the extent permitted by law, NTIA/ITS will not disclose the technical papers outside the U.S. Government, including U.S. Government contractors. See Section 6 for more information.

4 Evaluation Criteria

4.1 Evaluation Criteria for Stage One: Application

White Papers will be evaluated across the following criteria.

4.1.1 Eligibility

All applications will be assessed to determine eligibility per the requirements in Section 3.1.2.

4.1.2 Technical Approach

The technical approach each contestant follows in developing their 5G product must be clearly stated in the white paper for fair and thorough evaluation by ITS and the host lab. For more details on the host lab, refer to the “Host Lab Specification” document, published separately.

4.1.3 Technical and Business Readiness

Functionality demonstrated during prior tests (e.g., RAN test summary, independent testing, or plugfests) must be described. The white paper should identify the target users and define the timeline to market, including when their product will reach “general availability” (if it is not already available).

4.1.4 Security Plan

Contestants will be evaluated on their implementation of the 3GPP security procedures, SBOM, and their approach to overall secure software implementation. Any known critical vulnerabilities present in the product should be identified and have a mitigation plan.

4.1.5 Staffing and Management Plan

Contestants must demonstrate that they have sufficient staffing to support the work required by the timeline, including lab and design support (e.g., statement of organizational support). Contestants must demonstrate that the staff/management have sufficient experience in mobile telecom and 5G (e.g., provide resume or history of related projects). The white paper should address corporate commitment to supporting the submission.

4.2 Evaluation Criteria for Stage Two: Emulated Integration

The evaluation elements for the fully emulated environment are described in the “Scoring Guide and Metrics” document, published separately.

4.3 Evaluation Criteria for Stage Three: Network Integration

The evaluation criteria for the actual 5G operating environment are described in the “Scoring Guide and Metrics” document, published separately.

5 Prizes

5.1 Prizes

Stage Two Emulated Integration Prizes: NTIA/ITS will award prizes of \$150,000 each to up to twelve (12) contestants who meet the minimum performance threshold during Stage Two. Contestants that submit multiple subsystems will qualify for multiple Emulated Integration Prizes for any of their subsystems that meet the minimum performance threshold during Stage Two.

Only contestants who qualify for a Stage Two Emulated Integration Prize will be considered for the best SBOM prize; one qualified contestant will be selected to receive a \$200,000 prize for the best SBOM.

Stage Three Network Integration Prizes: Up to four (4) additional prizes of \$250,000 each will be awarded during Stage Three. During each Test Window, the contestant pair that receives the highest score will win, and each contestant in that contestant pair will be awarded a Network Integration Prize of \$250,000. If the contestant pair contains a single contestant, then that contestant will be awarded a Network Integration Prize of \$250,000 and the remaining prize will not be awarded. A contestant could potentially win two Network Integration prizes if they win both the first window and the second window of pairings in Stage Three.

If the selection process in Section 4 of the “Scoring Guide and Metrics” document produces only one possible Stage Three contestant pairing, then the 5G Challenge Organizers reserve the right to alter the Stage Three prize structure accordingly. For example, if the judge panel selects only one contestant pairing of three contestant subsystems for Stage Three, the Stage Three prizes will be awarded as a threshold prize with each qualified contestant winning a Network Integration Prize of \$250,000. For more information see the “Scoring Guide and Metrics” document, published separately.

To receive a cash prize, winning contestants must submit an acceptable technical paper by the deadline in Table 2. Prizes will be awarded following review and acceptance of technical papers.

5.2 Closing Ceremony

NTIA/ITS will host a Closing Ceremony at the host lab facility in Louisville, Colorado, at the conclusion of Stage Three. The Closing Ceremony may be broadcast remotely due to COVID-19 concerns. The Closing Ceremony will include:

- Keynote address(es) by the 5G Challenge team
- Initial interoperability and evaluation results from Stage Two and Stage Three

The winners will not receive prize awards until contestants submit their final technical paper and it is reviewed and accepted by the 5G Challenge team.

Attendance at the Closing Ceremony is by invitation only and on a limited basis due to ongoing health, travel, and safety restrictions. Anticipated attendees include contestant teams, challenge staff and contractors, and public officials. NTIA/ITS will extend Closing Ceremony invitations at a date to be determined.

5.3 Payment Mechanics

Prizes awarded under the 5G Challenge will be paid by electronic funds transfer to the bank account specified by the Contestant Leader of the contestants determined by NTIA/ITS to be the winners of each prize event. If the winner is a team, it is the responsibility of the Contestant Leader, not NTIA/ITS, to determine the subsequent division of any prize money.

All prizes awarded are subject to tax liabilities. NTIA/ITS will comply with the Internal Revenue Service withholding and reporting requirements, where applicable. NTIA/ITS will not provide

tax advice to challenge winners. Winners are encouraged to seek independent advice to ensure that the prize money is handled properly and reported accurately for tax purposes.

6 Publications

6.1 Information Published Externally

Data from Preliminary Event testing and SBOM evaluations will be compiled by NTIA/ITS and the results presented to all contestants at a Preliminary Event Closing Ceremony. This information may also be published or presented in other venues.

The identities of all Stage Two and Stage Three prize winners and the name of their winning subsystems will be published externally. If multiple subsystems are submitted, only the name of subsystems that win prizes will be published externally. If a contestant withdraws or is disqualified, their anonymized performance results (if any) may be included in publications. Publications that pre-date the contestant's withdrawal will not be modified.

The following information will only be published as anonymized summarizes:

- Information on subsystems that did not meet the prize threshold
- Evaluation results from Stages One, Two, and Three
- Subsystem interoperability summary
- Known critical vulnerabilities identified with a mitigation plan
- SBOM
- The number of white papers that were rejected due to selection criteria

Other information, if any, will only be published in anonymized form (i.e., without naming specific contestants), such as the following:

- Problems associated with the third-party components (e.g., operating systems, hardware, standards, test suites, or pandemic restrictions)
- Observed advantages and disadvantages of development strategies (e.g., tailored hardware vs COTS hardware, whether the subsystem included virtualization and a container orchestration platform, or which interface options were selected)
- Lessons learned about the evaluation process
- Lessons learned on interoperability failures, integration, and system configuration

6.2 Information for Internal Use Only

Each contestant will be provided with details of their system's evaluation. This report may include measurements that are not listed in the "Scoring Guide and Metrics" document (e.g., speed tests, integration effort).

To the extent permitted by Federal law, the following information will be held confidential. This information may be distributed internally by NTIA, DoD, and the host lab. This information will

not be published externally but may be used for other purposes (e.g., to design the 5G Challenge Final Event, for CableLabs internal research purposes, or to guide Federal research).

- The identities of contestants who do not win prizes, withdraw, or are disqualified
- Details of the effort required to integrate with the host lab system during Stage Two (e.g., effort required for a specific contestant's subsystem, comparisons between contestants)
- Performance test data
- Technical reports submitted by prize recipients (see Section 3.4)

Except for contestant names and subsystems (whose potential use in publications is described above), the white paper will be treated as confidential, used for the sole purpose of administering the 5G Challenge, and will not be distributed to parties outside of the 5G Challenge nor released for any other purpose except as noted in this document, to the extent permitted by Federal law.

7 Legal

Nothing in these rules, including information on the 5G Challenge website and communications by NTIA/ITS, DoD and the 5G Challenge organizers, may be interpreted as authorizing the incurrence of any costs, modifying the statement of work, or authorizing work outside the terms and conditions of any existing agreements or contracts with the U.S. Government.

7.1 Event Participation Agreement

Participation in the 5G Challenge Preliminary Event will be governed by the 5G Challenge Preliminary Event Participation Agreement. This Agreement will define the boundaries of the contest within the event as well as assign IP rights to data transmitted during the event to NTIA/ITS. Acceptance of the Event Participation Agreement is mandatory for participation in this prize event.

Each individual (whether participating singly or in a group) and entity participating in this contest must comply with all terms and conditions of these rules, and participation in this contest constitutes each contestant's full and unconditional agreement to abide by these rules.

7.2 Communications

The official communication channel between 5G Challenge organizers and participating contestants is via Challenge.gov. Any questions, such as rules clarifications, questions about proprietary/sensitive matters, or the logistics of the 5G Challenge events, should be formally submitted to NTIA/ITS via Challenge.gov. Upon receiving any generally applicable questions, the 5G Challenge organizers will disseminate an appropriate response to all contestants via a FAQ process, published on Challenge.gov, to ensure that answers do not give any contestant an unfair advantage. In doing so, 5G Challenge organizers may rephrase questions to anonymize the submitting contestant or make them more generally applicable to all contestants.

7.3 Publicity

All contestants that participate in the 5G Challenge contest may be listed on the 5G Challenge website to enable the challenge to be tracked by interested members of the public. Public information may include performance results from 5G Challenge events and general information updates. The names and photographs of the 5G Challenge contestants may be posted on the 5G Challenge website; featured on the NTIA/ITS and OUSD (R&E) websites, newsletters, social media, or other outreach materials; and released to the media.

During the 5G Challenge Preliminary Event, equipment may be used to photograph, record video and sound, and film footage in connection with the production of documentary content by third-party producer(s). Your presence (physically or virtually) at the event is an acknowledgment that you have been informed that you may be photographed, video recorded, and filmed; and, that you grant permission for your likeness and voice to be used without compensation, credit, or other consideration in any media now known or hereafter devised, in perpetuity and throughout the universe, to include the advertising and publicity thereof. If you do not wish to be subject to the foregoing, please do not attend this event.

The appearance and reference to any person, name, place, film, artwork, or any other images that are used in connection with the 5G Challenge does not constitute or imply endorsement by the U.S. Government, NTIA/ITS, or the Department of Defense.

7.4 Disqualification

NTIA/ITS reserves the right to disqualify a contestant whose actions are deemed to violate the spirit of the competition for any reason, including but not limited to, the violation of laws or regulations during participation in the 5G Challenge. In addition, NTIA/ITS may disqualify any contestant who does not meet the eligibility requirements specified herein or fails to comply with the Preliminary Event Participation Agreement.

Examples of disqualifying behavior include but are not limited to: a) using source code from restricted entity sources; b) using malicious or security-compromised software/hardware; and c) not adhering to basic security expectations of any software or hardware integration process.

7.5 Withdrawal

Contestants can withdraw from the competition by contacting NTIA/ITS in writing. The contestant will no longer be eligible for prizes. See also Section 6.

7.6 Intellectual Property

The U.S. Government (DoD and NTIA/ITS) claims no rights to software or hardware developed by 5G Challenge contestants as a result of participation in the 5G Challenge.

All technical papers and provided supporting materials as outlined above shall be delivered to NTIA/ITS with Government Purpose Rights as defined in 48 CFR § 252.227-7013 – Rights in technical data – Noncommercial items. NTIA/ITS will only use the materials submitted by

contestants for official government purposes. Unless required by law, NTIA/ITS does not intend to disclose technical papers outside the Government, with the following exception: technical papers may be handled by 5G Challenge support contractors for administrative purposes and/or to assist with technical evaluation. All NTIA/ITS support contractors performing this role are bound by non-disclosure agreements.

The host lab will maintain confidentiality of information disclosed by the contestants to the extent permitted by Federal law. The host lab will disclose test results to the contestants and to 5G Challenge organizers or as required by law. The host lab will make an effort to keep the contestants' systems confidential from other contestants through best practices such as limited access to namespaces on shared systems and limited networking functions. The contestants will be responsible for securing access to their own hardware, software, and systems.

7.7 Rule Modifications

This version of the rules is subject to change and may be superseded by later versions. NTIA/ITS has the authority to modify and interpret the rules at any time. NTIA/ITS will post any modifications to the rules on the 5G Challenge website and via direct communication with contestants on Challenge.gov. Interested parties are encouraged to monitor the 5G Challenge website for the latest information.

7.8 Contest Subject to Applicable Law

This prize contest is authorized under the America COMPETES Act, 15 U.S.C. § 3719, which authorizes Federal agencies to award prizes competitively to stimulate innovation that has the potential to advance the mission of the respective agency. For more information, see https://www.govregs.com/uscode/title15_chapter63_section3719.

All contests are subject to all applicable Federal laws and regulations. Participation constitutes each Contestant's full and unconditional agreement to these official rules and administrative decisions, which are final and binding in all matters related to the contest. Eligibility for a prize award is contingent upon fulfilling all requirements set forth herein. This notice is not an obligation of funds; the final award of prizes is contingent upon the availability of appropriations.

Participation is subject to all U.S. Federal, state, and local laws, and regulations. Contestants are responsible for checking applicable laws and regulations in their jurisdiction(s) before participating in the prize contest to ensure that their participation is legal. NTIA/ITS shall not, by virtue of conducting this prize contest, be responsible for compliance by contestants in the prize contest with Federal Law including licensing, export control, and nonproliferation laws, and related regulations. Individuals entering on behalf of or representing a company, institution, or other legal entity are responsible for confirming that their entry does not violate any policies of that company, institution, or legal entity.

7.9 Liability

By submitting their application and acceptance to the 5G Challenge contest, all contestants agree to assume any and all risks and waive claims against the Federal Government and its related entities, except in the case of willful misconduct, for any injury, death, damage, or loss of property, revenue, or profits, whether direct, indirect, or consequential, arising from participation in this prize contest, whether the injury, death, damage, or loss arises through negligence or otherwise.

Insurance: Contestants are not required to obtain liability insurance for this contest.

Indemnification: Contestants agree to indemnify the Federal Government and CableLabs against third party claims for damages arising from or related to contest activities.

By registering and/or participating in the 5G Challenge, each individual (whether competing singly or in a group) or entity agrees to indemnify the U.S. Government and CableLabs from any and all liability and costs arising from or related to the contestant's participation in the contest.

7.10 Verification of Winners

Contestants must comply with all terms and conditions of the 5G Challenge Rules. Winning a prize is contingent upon fulfilling all requirements contained herein. Winners from the 5G Challenge Preliminary Event will be notified by email after the conclusion of the event. Each winner of monetary or non-monetary awards will be required to sign and return the Payment Information Form to claim their prize.

In the sole discretion of the NTIA/ITS, a potential winner will be deemed ineligible to win if: (i) the entrant cannot be contacted within 90 days; (ii) the entrant fails to sign and return the Payment Information Form within the required time period; (iii) the prize or prize notification is returned as undeliverable; or (iv) the submission or entrant is disqualified for any other reason. In the event of a disqualification of a winner, NTIA/ITS in their sole discretion may award the applicable prize to an alternate winner, when applicable.

7.11 Resolution of Disputes

NTIA/ITS reserves the right to disqualify an individual or contestant whose actions are deemed to violate the spirit of the competition for any reason, including, but not limited to, the violation of laws or regulations during participation in the 5G Challenge. NTIA/ITS does not authorize or consent to contestants infringing on any U.S. patent or copyright while participating in the 5G Challenge.

NTIA/ITS is the final decision authority for all matters concerning the 5G Challenge. NTIA/ITS reserves the right, in its sole discretion, to (a) cancel, suspend, or modify the contest without notice, and/or (b) not award any prizes if no entries are deemed worthy. Decisions by NTIA/ITS are final and binding in all matters related to the contest.

8 References

- [1] [3GPP TS 33.501, Security architecture and procedures for 5G System](#)
- [2] [3GPP TS 38.410, NG-RAN; NG general aspects and principles](#)
- [3] [3GPP TS 38.411, NG-RAN; NG layer 1](#)
- [4] [3GPP TS 38.412, NG-RAN; NG signaling transport](#)
- [5] [3GPP TS 38.413, NG-RAN; NG Application Protocol \(NGAP\)](#)
- [6] [3GPP TS 38.414, NG-RAN; NG data transport](#)
- [7] [3GPP TS 38.470, NG-RAN; F1 general aspects and principles](#)
- [8] [3GPP TS 38.471, NG-RAN; F1 layer 1](#)
- [9] [3GPP TS 38.472, NG-RAN; F1 signaling transport](#)
- [10] [3GPP TS 38.473, NG-RAN; F1 Application Protocol \(F1AP\)](#)
- [11] [3GPP TS 38.474, NG-RAN; F1 data transport](#)
- [12] [3GPP TS 38.425, NG-RAN; NR user plane protocol](#)
- [13] O-RAN-WG4.CUS.0-v05.00, *Control, User and Synchronization Plane Specification*
- [14] O-RAN.WG4.MP.0-v05.00, *Management Plane Specification*
- [15] O-RAN.WG4.CONF.0-v03.00, *Conformance Test Specification*
- [16] O-RAN.WG4.IOT.0-v05.00, *Fronthaul Interoperability Test Specification (IOT)*
- [17] O-RAN.WG5.U.0-v03.00, *NR U-plane profile*
- [18] O-RAN.WG5.C.1-v03.00, *NR C-plane profile (NR Standalone)*
- [19] O-RAN.WG5.Transport.0-v1.00, *Transport Specification*

Note: the O-RAN documents referenced in [13]-[19] are only available upon registration and agreement to the O-RAN ALLIANCE Adopter License.