

# 5G Challenge

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*Prepared exclusively for the National Telecommunication Information Administration (NTIA)*

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# 1 INTRODUCTION

The National Telecommunication Information Administration (NTIA) intends to use a 5G challenge to aid development of the open 5G stack for Department of Defense (DoD) use. Existing 5G open stack efforts focus on different areas of the open stack and may not guarantee interoperability, a potential impairment to the overall 5G ecosystem.

When it is complete, the open 5G stack model will allow different vendors to interoperate using interface standards. Vendor-neutral interfaces and standards will aid established vendors and new groups to innovate at different layers of the overall 5G stack selectively. The use of well-defined standards will enable more vendors, smaller companies, and innovative upstart companies to participate in the NTIA 5G challenge and DoD 5G programs.

This report provides Booz Allen Hamilton’s response to the NTIA 5G challenge notice of inquiry, Docket No. 210105–0001, RIN 0660–XC049.<sup>1</sup> We provide an approach and details on actions that the U.S. Government could take to help further this 5G challenge in the following sections of this document.

## 2 APPROACH

We recommend NTIA build an approach that defines goals and definitions and then uses the 5G Challenge program to address identified gaps. This can be part of a roadmap that contains steps such as seen in Figure 1.



FIGURE 1. RECOMMENDED NTIA CHALLENGE APPROACH

- Define Open 5G Stack and Reference Architecture – The primary goal of this phase will involve aligning taxonomy and reference architectures to drive the challenge activities. This includes defining the “Open 5G Stack” and a more detailed description of “open” (e.g., extent of open standards, use of open source software). Defining a reference architecture will also provide a reference point for standards development and the types of challenges that will be defined in later phases.
- Define the Challenges and Success Criteria – Defining challenges that resonate with industry and help drive broader deployment of 5G technologies is critical. We recommend three categories of challenges: interoperability, security, and use cases. These types of challenges emphasize the need to encourage the development of open, secure, and hardened 5G networks. The use case challenges will help drive new, innovative uses and adoption of 5G technologies.
- Implement the Challenges – In implementing the challenges, NTIA and the DoD should seek ways to reduce barriers to entry for smaller, innovative companies while also incentivizing

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<sup>1</sup> References: <https://www.ntia.doc.gov/federal-register-notice/2021/5g-challenge-notice-inquiry>, <https://www.ntia.doc.gov/files/ntia/publications/fr-5g-challenge-noi-01112021.pdf>

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participation from across the 5G community. It should also consider partnering with industry and government test institutions (e.g., NIST, etc.) to host the challenges and leverage their expertise.

- Promulgate Results – NTIA and the DoD can use results to revise NTIA goals, influence upcoming DoD Other Transaction Authority (OTA) and project activities, and consider additional challenges to further the effort. The results can also help influence standards making efforts based on goals and the challenge findings.

The following sections of this paper detail this approach.

### 3 DEFINE OPEN 5G STACK AND REFERENCE ARCHITECTURE

We recommend NTIA establish and publish a taxonomy that will drive future challenge and standards development activities. Most importantly, we recommend that the Government focus on developing a NTIA-defined open 5G stack and a reference architecture describing the key components in 5G deployments. Table 1 explains specific recommended steps to do this.

TABLE 1. STEPS AND TASKS DEFINING OPEN 5G STACK

STEPS	TASKS
1. Form a Partnership with Carriers	<ul style="list-style-type: none"><li>• Partner with telecommunication carriers and commercial businesses when working to achieve the 5G open stack objectives.</li><li>• Work with carriers to influence vendors to implement open standard components, enabling the deployment of a multi-vendor, software-centric 5G infrastructure. Together through a partnership, the carriers and U.S. Government have the buying power to influence adoption by key Original Equipment Manufacturers (OEM).</li></ul>
2. Define the Open 5G Stack	<ul style="list-style-type: none"><li>• Seek ways to define the open 5G stack for its mission purposes and to create a common understanding across all the groups (e.g., 3GPP, O-RAN, NIST) currently developing it. This effort may involve referencing existing efforts and resolving differences in any existing definitions.</li></ul>
3. Develop a Reference Architecture	<ul style="list-style-type: none"><li>• Develop an Open 5G Reference Architecture that will drive interoperability, security efforts and ensure a common framework for all challenge efforts. While there are multiple reference architectures in existence, NTIA will want to determine a reference architecture most relevant to their needs.</li><li>• Investigate existing standards, identify gaps, and propose areas for new standards that are most critical (e.g., Radio Access Network (RAN) to mobile core standards gaps) to build out this reference architecture. Ideally, existing reference architecture concepts from carriers and others can be reused to the maximum extent possible to avoid recreating concepts.</li><li>• Participate in standard-setting groups to help influence and define each interface of the open 5G stack. This step should involve engaging with efforts at the National Institute of Standards and Technology (NIST) and the National Cybersecurity Center of Excellence (NCCOE).</li></ul>

## 4 DEFINE CHALLENGES AND SUCCESS CRITERIA

Based on the reference architecture and identified gaps, NTIA can begin to create challenges and other projects aimed at furthering the development of open 5G stack technologies by targeting those specific gaps and helping to build out a reference open 5G stack. The NTIA may benefit from creating multiple, smaller challenges where each challenge focuses on one or more specific NTIA goals. By offering multiple challenges, the Government encourages greater participation with a broader collection of companies and organizations while driving innovation and decoupling the success of any one challenge area with another.

After conducting this gap analysis, NTIA may identify multiple types of challenges as described in Table 2.

TABLE 2. 5G CHALLENGES

CHALLENGE CATEGORY	EXAMPLE CHALLENGES	SUCCESS CRITERIA	BENEFITS
<u>Interoperability</u> Showcase and prove ability for interoperable open 5G stack multi-vendor implementations	<ol style="list-style-type: none"> <li>1. RAN to core interoperability</li> <li>2. Multi-Access Edge Computing (MEC) to 5G interface interoperability</li> <li>3. Internet of Things (IOT) equipment interoperability</li> </ol>	<p>Adherence to reference architecture standards</p> <p>Successful test of a multi-vendor reference implementation</p> <p>Number of products with successful interoperability lab or exercise results</p>	<p>Accelerates adoption of key interoperability standards and drive multi-vendor solutions that avoid vendor lock-in</p> <p>Speed development by publishing products that met the requirements of the interoperability challenge</p>
<u>Use Case</u> Fund 5G-enabled applications to highlight new use cases, spur innovation, and increase usage of end user devices	<ol style="list-style-type: none"> <li>1. Smart bases, smart cities, smart ships, smart ports</li> <li>2. Battlefield internet technologies</li> <li>3. Connected logistics</li> </ol>	<p>Meet/exceed application and end user performance metrics</p> <p>Improvements over 4G or Wi-Fi</p>	<p>Drive broader adoption through identifying viable uses</p> <p>Lower costs through volume</p> <p>Reduce needed time to scale up the solutions</p>
<u>Security</u> Identify and address vulnerabilities including in multi-vendor solutions via a hackathon-like challenge	<ol style="list-style-type: none"> <li>1. Securing 5G RAN and core infrastructure that includes open source components</li> <li>2. Penetration testing of end user 5G devices</li> <li>3. Hardening of 5G multi-vendor infrastructure</li> </ol>	<p>Number of vendor solutions that conform to security architecture</p> <p>Penetration test vulnerabilities addressed</p>	<p>Establish reusable security approaches</p> <p>Enhance cybersecurity posture for wireless networks</p> <p>Drive definition of security standards to better harden 5G networks</p>

Across all challenges, NTIA may find that building the following structure will aid its overall goals:

- Challenges that focus on software will allow for more rapid innovation by applying software-defined system approaches. Meanwhile, the security focused challenges will directly influence

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the publishing of security implementation guidelines to enable the engineering and implementation of hardened infrastructures.

- Each challenge should be created to use open standards and open architectures where possible or available. In the technology industry, it is not uncommon for vendors to assert that some parts of a system are open or conform to standards, but the product is still heavily modified or contains proprietary extensions that hampers the spirit of open standards.
- Challenges should create software that can work on the open 5G stack. Vendors should be required to build to open standards, 3rd Generation Partnership Project (3GPP) standards, and other applicable standards to ensure interoperability. Well defined interfaces aid in the creation of software-defined solutions and will allow more companies, including small, fast-moving companies, to deliver software and services.

## 5 IMPLEMENT THE CHALLENGES

Once the challenges have been defined, it is critical that the Government find ways to encourage participation and effectively execute the challenges.

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### 5.1 Attract Participants and Define Incentives (Ref: NTIA Section II)

NTIA should consider ways to remove barriers to include groups such as non-traditional contractors, small businesses, research and development (R&D)-focused companies, or organizations (e.g., universities). This could be done by addressing the size and complexity of the challenges themselves; challenges could be structured into smaller, more manageable pieces rather than large complex programs. By publishing a reference architecture, challenges and projects can allow the industry to implement the architecture; smaller companies can innovate at specific levels of the architecture rather than implementing an entire 5G system. Well-defined interfaces and interoperability could be used to segment large programs and initiatives into smaller components to be competed for.

Once a reference architecture is created, companies can see where their expertise and capabilities fit within the framework of the overall 5G ecosystem. This will enable small, innovative, and more nimble companies to better contribute and participate. This approach will also allow NTIA to craft smaller, targeted challenges that can attract more companies and produce greater innovation.

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### 5.2 Release the Challenges

The Government should use contracting programs and outreach to include a diverse set of businesses (e.g., system integrators, technology OEMs, carriers, university labs, and start-up/non-traditional companies) to broaden the net of participation in these challenges, to include companies who do not traditionally support the Federal Government. Additionally, NTIA could consider offering a contract vehicle at the conclusion of the challenges to continue the efforts and attract industry participants.

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### 5.3 Establish Test Centers

NTIA should leverage industry test center facilities to help conduct these challenges. For example, the NTIA could leverage the Institute of Telecommunication Sciences (ITS) Center as one of the facilities to execute the challenges.

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Beyond the challenges, the test centers can be useful for longer term testing. A testing center that evaluates the products used by industry and government could help create a validated product list. Interoperability testing could be orchestrated to show conformance to the standard architecture and applicable interfaces. The Government could consider ways of mandating validation by the testing center before deploying products and demonstrating open standard compliance. To conduct this testing, the U.S. Government could seek ways of teaming with telecommunications carriers to garner market buying power behind conformance testing.

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## 5.4 Execution and Delivery of the Challenges

The Government should consider how the open 5G stack is delivered. An approach to this open stack needs to consider software supply chain security and development principles (e.g., DevSecOps, Continuous Integration (CI)/Continuous Delivery (CD) concepts) that may aid security and speed iteration. For these efforts, the Government can seek to reuse work done by others (e.g., secure supply chain working group related to 5G systems and software) to accelerate work. Security efforts can help verify the provenance and assurance levels of the software in-question and address open source software implementations.

Historical approaches for security can take months to get a system accredited. NTIA's challenges may seek to smooth the process or allow it to be conducted using new concepts or approaches for accreditation (e.g., the introduction of fast track ATO or continuous ATO in some federal agencies).

While this effort is focused on the DoD, the U.S. Government should also consider ways of broadening the scope of its efforts to leverage 5G at other federal agencies. For example, Department of Transportation (DoT), Department of Homeland Security (DHS), and others may have uses for 5G that could help to further open 5G stack development.

## 6 PROMULGATE RESULTS

NTIA should seek ways of applying the results of these challenges to further the open 5G stack, DoD missions, and other federal government objectives. To ensure follow-through and adoption of improved approaches after the challenge activities are complete, we recommend NTIA consider the following:

- Release the challenge results publicly where available and possible. This will help to garner feedback from public sector groups, contractors, and private businesses that work with 5G.
- Use the results of the challenge program to inform future Government projects (including with NIST, DHS), security requirements, solicitations, and NTIA challenge activities. For use cases, further spur adoption of 5G across many DoD and federal government users. Follow this up with broader use cases for future challenges. Work with DoD to drive adoption of the open 5G stack through dual use in both the federal government and in commercial business.
- Work with standards organizations such as Alliance for Telecommunications Industry Solutions (ATIS) to influence standards and other policies and specifications to aid open 5G stack interoperability.
- Consider using a model where new 5G features are procured as a service to iterate and build out functionality more rapidly. This could involve creating a development center around 5G engaging in activities such as connecting to drones, instrumenting smart bases, and aiding border security. Where possible, these developments could be done using O-RAN and open stack infrastructure to further NTIA's open stack goals.

- Ensure incentives are in place to encourage the presence of products that meet open 5G stack standards. Table 3 explains some incentives the U.S. Government could promote to help companies adopt the open 5G stack.

**TABLE 3. OPEN 5G STACK ADOPTION INCENTIVES (REF NTIA SECTION II)**

INCENTIVE	DETAILS
Lower Barriers to Entry	The use of a reference model, smaller procurements, and interoperability testing can lower the market barriers to entry. Otherwise, the market may become dominated by large, incumbent players. This approach and model will better encourage startup and small parties to participate in smaller-scale, niche areas of 5G development and drive innovation.
Approved Product List	The Government can create mandatory standards to promote the open 5G stack. Then Government buyers can be required to only purchase products that meet the standards. Incentive structures need to be in place so that these models are adopted. When the Federal government is the buyer of billions in products and services, it can help shift the market.
Innovation	Adopting the open stack will incentivize smaller companies since these companies will not have to recreate all elements of the stack themselves. Currently, experimenting at each layer of a 5G stack reference model is difficult. Well-defined interfaces between components (e.g., between RAN and core, between core and multi-access edge computing (MEC), between MEC and services) could make this easier for innovators and new companies to participate. The use of a reference model for coordination helps small players to innovate on only part of the stack at a time or with applications and services.
Lower Costs	Participating in open 5G stack development will reduce costs for creating a new capability. An innovator can leverage the aggregate investment in the space. If a developer does not use or reuse from the open stack, it will cost a lot more to create a capability.
Flexibility	Defining capabilities in software gives flexibility and can aid NTIA’s open 5G stack objectives. It can also help to disrupt the market in a way that is beneficial to the Government by including some new and innovative organizations.

## 7 CONCLUSION/SUMMARY

The recommended approach and steps in this response can help NTIA’s 5G Challenge program to further the open 5G stack. A structured approach will aid overall program organization and will help industry partners and companies participate. Coordinating this approach with telecommunication carriers can help ensure products in the market align to NTIA’s objectives. Where possible, challenge activities that focus on software, security, and services will allow for more rapid innovation by applying software-defined system approaches. NTIA can apply findings from the 5G Challenge program to propagate key practices and to consider additional future challenges that address new issues.

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