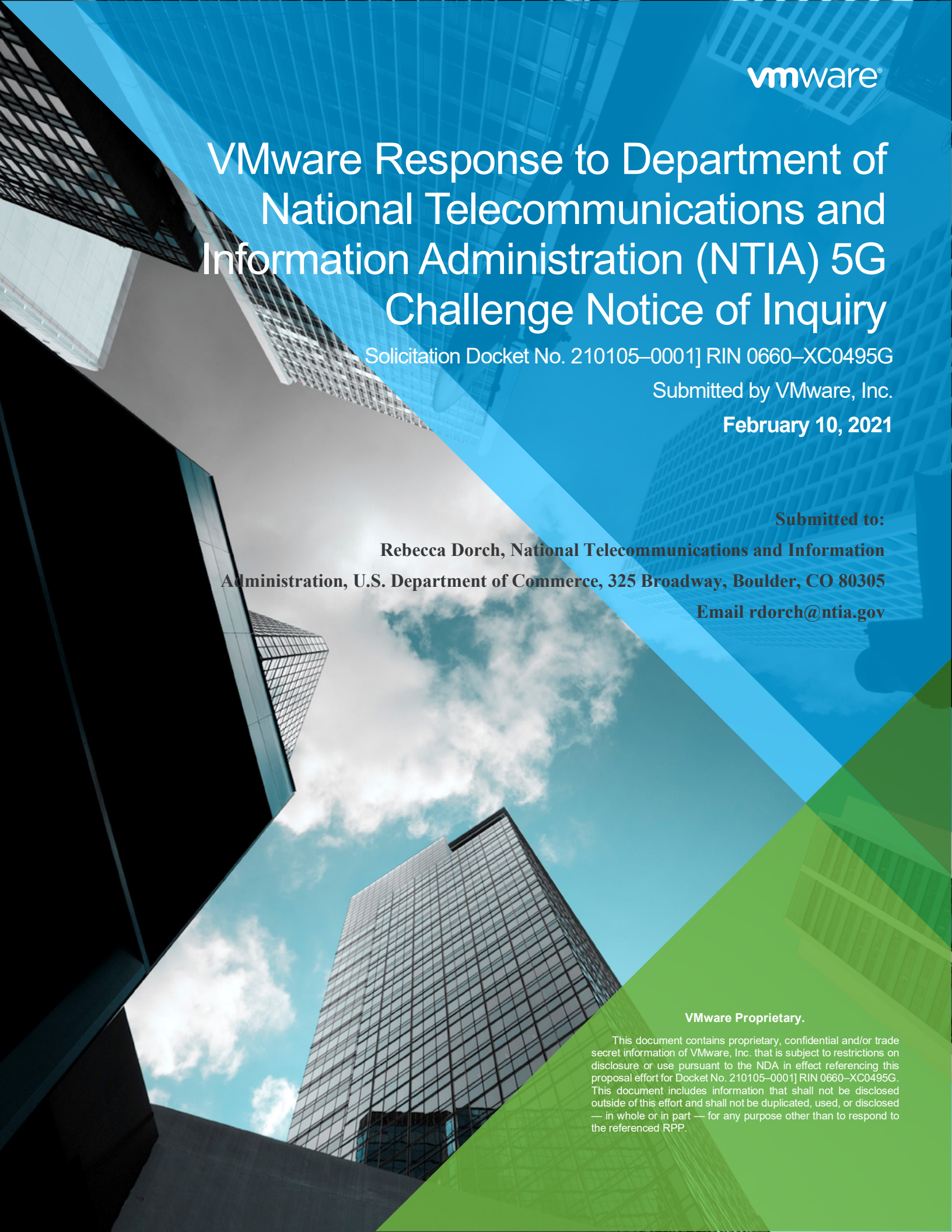

# VMware Response to Department of National Telecommunications and Information Administration (NTIA) 5G Challenge Notice of Inquiry

Solicitation Docket No. 210105–0001] RIN 0660–XC0495G

Submitted by VMware, Inc.

**February 10, 2021**

**Submitted to:**

**Rebecca Dorch, National Telecommunications and Information Administration, U.S. Department of Commerce, 325 Broadway, Boulder, CO 80305**

**Email rdorch@ntia.gov**

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February 10, 2021

To: Department of National Telecommunications and Information Administration (NTIA) 5G Challenge Notice of Inquiry

Attn: Ms. Rebecca Dorch

Via email: *5GChallengeNOI@ntia.gov*

Re: Docket No. 210105–0001] RIN 0660–XC0495G Solicitation

Dear Ms. Dorch,

VMware, Inc. is proud to present this Challenge Response illustrating our integrated, holistic, and proven approach to the Department of National Telecommunications and Information Administration (NTIA) 5G Challenge Notice of Inquiry. Our response is prepared in accordance with your instructions.

We look forward to discussing our solution with you further. Should you require additional information or clarification, please contact me via telephone at 703.638.2213 or via email at chrisa@vmware.com.

Sincerely,

//s//

Chris Armstrong, VMware, Inc., Sr. Capture Manager, DoD

# 1. VMware recommendations on open 5G stack ecosystem

VMware is pleased to submit to the National Telecommunications and Information Administration (NTIA) our comments and recommendations for the Department of Defense 5G Initiative, for the creation of a 5G Challenge that would accelerate the development of the open 5G stack ecosystem in support of Department of Defense missions.

National Telecommunications and Information Administration (NTIA) has solicited comments under three broad categories: (1) Challenge structure and goals; (2) incentives and scope; and (3) timeframe and infrastructure support. VMware is pleased to share its industry knowledge and expertise in all three categories. Our responses to each of the questions in the three categories is as provided in the table below.

## 1.1. I. Challenge Structure & Goals

| NTIA Question | VMware Response |
|---|---|
| A. How could a Challenge be structured such that it would take advantage of DoD's role as an early U.S. Government adopter of 5G technology to mature the open 5G stack ecosystem faster, encourage more participation in open 5G stack development including encouraging new participants, and identify any roadblocks to broader participation? | VMware recommends the challenge be structured in three phases:<br>**Phase-1**: A Definition phase, where the solution architecture components of the open 5G stack needed by DoD has to be clearly defined in collaboration with industry leaders. The real production deployable use cases from each of these categories (eMBB, uRLLC, MMTC) along with end-to-end low-level requirements (latency, data rate, density, throughput, performance KPI etc.) needs to be defined and agreed upon by the end of this phase. 3GPP standards have recommended adoption of virtualization for 5G networks as baseline.<br>**Phase-2**: A Selection phase to identify the right virtualized cloud infrastructure platform that can provide a carrier class foundation in terms of operational management, automation, reliability, resiliency, and security. A common platform infrastructure agnostic to application use case entities, is a cost effective and day-2 operationally stable recommended framework.<br>**Phase-3**: An integrated testing, validation phase that covers various network functions that form the solution on the common virtualized cloud infrastructure platform at the functional level and at the end-to-end solution level.<br><br>While an Open 5G ecosystem is a welcome sign, not all 5G ecosystem layers may be mature enough to meet the requirements. Flexibility and open mindset must exist in the ecosystem to allow for some proprietary components that provides open API and SDK to work along with less mature open community developed stacks. The correct definition of 'Open' in the context is key. DoD needs to define what 'Open' is in the context of interfaces, in the context of integration and in the context of validation. New participants may start with Open cloud native infrastructure and visionary ideas which needs consideration and acceptance. |

| NTIA Question | VMware Response |
|---|---|
| | Roadblocks could range from what incentives do the participants receive in terms of guaranteed contracts, would joint innovation IP be shared, how would a teaming agreement with DoD and or with integrators look like, would they be able to monetize on the joint innovation outside of DoD, outside of US etc. |
| B. How could a Challenge be structured to focus on the greatest impediments to the maturation of end-to-end open 5G stack development? | A recommended structure would be to focus on 5G core first, then focus on 5G RAN. With 4G, a virtualized core infrastructure for vEPC, vIMS, vSD-WAN has been proven in production globally. RAN virtualization is starting to be proven. Thus, a structure with Core first with Automation followed by 5G RAN based on open standards like O-RAN would be a recommended path for success. |
| C. What should be the goals of a Challenge focusing on maturation of the open 5G stack ecosystem? How could such a Challenge be structured to allow for the greatest levels of innovation? What metrics should be used in the assessment of proposals to ensure the best proposals are selected? | The first challenge is a clear definition of what is "open 5G stack ecosystem". This has to be defined without ambiguity. Does it mean open COTS Hardware for compute, ability to run virtual storage and virtual networking on any vendor storage/networking gear giving freedom of choice and COTS Software Defined Radio (SDR), providing DoD freedom of choice to pick the right vendor. Is the middleware layer based on community certified abstraction layer (e.g. Linux, Kubernetes, etc.)? Does this software have open API and SDK to support multi-vendor application software integration etc.? Questions like these and maturity of related open technology need to be answered. Not all components of the 5G ecosystem have maturity to the same level. Thus, a crawl, walk, run approach is recommended.<br><br>To allow for innovation, community-based specifications, and open sources like OpenStack, OSM, ONAP, ODL gained prominence as Telco's started to virtualize. Community level innovation has added value. However as real production environments started to scale, operational challenges forced operators to switch to more reliable solutions to ensure faster time-to-market with quality and reliability. An open 5G stack for a DoD type environment must be extremely reliable and secure. Thus structuring it such that there are innovation labs created to arrive at DoD specific solution for key areas (DSS, IWRP specific use cases for Spectrum Usage Measurement System (SUMS), Spectrum Access Management and Planning Tool (SAMPT) , Test Resource Management System (TRMS) , Spectrum Deconfliction Tools , Risk-Informed Spectrum Access (RISA)), creation of sandbox type environment, interoperability testing, plug fest, allowing a mix of open source with vendor-specific value-add enhancements to opensource would go a long way in creating a viable execution framework.<br><br>Proposal assessment based on technology, innovation, collaboration, commitment to standards, DoD specifications, |

| NTIA Question | VMware Response |
|---|---|
| | interoperability demonstration in real production deployment to date, day-2 operational excellence achieved, references, joint innovation projects currently in-progress could all be some measurements for selection |
| D. How will the open 5G stack market benefit from such a Challenge? How could a Challenge be structured to provide dual benefit to both the Government and the open 5G stack market? | The benefit to the market is by getting a "ready for open 5G stack" certification for their products. To achieve this, the government can create an established reference architecture first. Then define generic test cases that any vendor can execute in a cloud-based lab reliably. Any open 5G stack vendor can possibly self-certify initially for their product. Then they can prove viability in the government interoperability lab before they are officially certified. This certification process can benefit the Government by having an established criterion, which can be accepted by other agencies and subagencies, enhancing capability portability.<br>The benefit to the government will come only if they can first be willing to hire technologist and Architects who can oversee, guide, and establish standards, create guidelines and vendor agnostic certification program and process. The government should not charge vendors, maintain IP confidentiality, and build vendor trust to interoperate. Joint innovation, creation of new standards, advancement of lesson learned and its implementation beyond 5G to NextG will be of great reward to the Government. |

## 1.2. II. Incentives and Scope

| NTIA Questions | VMware Response |
|---|---|
| A. What are the incentives in open 5G stack ecosystem development that would maximize cooperation and collaboration, promote interoperability amongst varied open 5G stack components developed by different participants, and mature desired featured sets faster with greater stability? | 1. Forming groups and driving collaboration across like-minded participants will maximize collaboration and spur innovation. Examples of groups could be:<br>• Hardware and firmware (SmartNIC, accelerators, security hardening ....)<br>• Middleware, automation and orchestration (OS, virtualization stack, common messaging bus, virtual infrastructure manager, CaaS, PaSS, AI, ML, management...)<br>• Network functions (VNF, CNF, xNF, microservices, service-based architecture)<br>• Backend analytics, OSS, BSS I/F<br><br>2. Creation of DoD funded labs for functional level interoperability and solution level interoperability.<br><br>3. Joint collaboration and acceleration in standardization effort through GSMA, 3GPP, O-RAN, ETSI, ONF, MEF, use of 5G Open Innovation lab (OIL), NSF funded labs etc.. Joint contribution from open 5G participants to above effort may maximize cooperation.<br><br>4. Define outcome-based incentive to each participant<br>Please also refer response to Question 1D above. |
| B. Could a Challenge be designed that addresses the issues raised in previous questions and also includes test and evaluation of the security of the components? | Yes. Functional testing, performance testing, scale testing, stress testing, security testing at each of the above hierarchy levels and end-to-end security testing and certification are critical before production deployment. This will ensure building a DoD specific Reference architecture. |
| C. Could a Challenge be designed that would require participants to leverage software bill of materials design principles in the development of components for an open 5G stack? | Yes. A successful definition of the physical, logical architecture, interface schema, API, SDK, tools would go a long way in the participants to leverage cross product or open-source software. |
| D. Many open 5G stack organizations have developed partial implementations for different aspects of an open 5G stack. What portions of the open 5G stack has your organization successfully developed with working code? What portions of the open 5G stack does your organization believe can be developed quickly (6 months or less)? What development support would best enable test and | VMware is the Leader in virtualization with 20+ years' experience and 500M+ Enterprise customers. ***To-date, 100+ Telco 4G/5G production systems are running with 800Million+ mobile subscribers on VMware Telco platform globally.*** We are building 5G Core and 5G RAN Standalone and non-standalone architecture for major providers like DISH networks, Vodafone, Rogers etc. Our strength is in 5G infrastructure platform and automation with open interfaces, SDK and API. Our modular architecture platform is completely agnostic to any vendor compute, storage, and networking hardware; works across private infrastructure and most public clouds (Azure, Google, Amazon, Oracle to name a few). The platform is completely agnostic to any vendor solution (vIMS, vEPC, 5G MEC, 5G Pvt LTE, 5G RAN), even multiple vendors |

| NTIA Questions | VMware Response |
|---|---|
| evaluation of the different elements of an open 5G stack? | within a solution, and securely multi-tenanted is supported on the same virtualized infrastructure. Our technology includes multiple open-source projects (Kubernetes, OpenStack, Antrea, Open v-switch, Linux etc.). ***Our established reference architecture and Telco certification have been used and nearly 200 vendor network functions have been certified on the platform.*** We have a working 5G RAN solution using O-RAN guidelines with common automation and Orchestration today ready for testing and evaluation by DoD once the open 5G stack specifications and architecture is released.<br>https://telco.vmware.com/ |
| E. What 5G enabling features should be highlighted in the Challenge, such as software defined networking, network slicing, network function virtualization, radio access network intelligent controller, radio access network virtualization? | DoD should strongly consider avoiding siloed stack defined by a vendor. Building a flexible, scalable multi-vendor cloud infrastructure should be a day-0 priority. Virtual infrastructure has proven to scale, and function reliably for 20+ years in Enterprises. Almost all the 4G networks built from 2016, and 5G networks now being built, are virtualized and heading toward a pure cloud native containerized architecture.<br>SDN for transport with entities working as virtual functions and performing securely, providing performance matching or exceeding MPLS at a fraction of the cost paid for MPLS has been proven globally.<br>As you pool resources across compute, storage, networking and have a logical pool to slice and dice in a secure multi-tenant manner horizontally or vertically, network slicing will become important to offer specific services with defined QoS and SLA. To attempt this without virtualization as a baseline requirement creates Inability to achieve DoD 5G goals<br>Multiple silos that are going to be difficult to interoperate, leading to increased cost, increased time-to-market, lower reliability and service degradation<br>Inconsistent security boundaries |

## 1.3. III. Timeframe & Infrastructure

| NTIA Questions | VMware Response |
|---|---|
| A. What software and hardware infrastructure will be needed to successfully execute this Challenge? | COTS hardware with ability to hot add Smart NICs, GPU, virtual compute, storage, networking and management entities from any vendor of DoD choice that support virtualization. Software OS like Linux, Cloud native middleware like Kubernetes, Layer-2 and above software-based networking, Cloud based automation for highly distributed architectures like remote edges, nomadic entities, Ship-to-shore, airborne units.<br>Centralized Operational tools for capacity planning, root cause analysis, network insight tools to manage across legacy physical, new virtual infrastructure, Software defined networking and Radio network optimization tools to name a few. |
| B. What is a reasonable timeframe to structure such a Challenge? Should there be different phases for such a Challenge? If so, what are appropriate timelines for each suggested phase? | Ideally a 24-to-30-month time frame to achieve production mode would be a reasonable goal to establish. Multiple phases, which are well defined in scope with established outcomes, is essential. A first phase to have architecture finalized, requirements frozen, all hardware, networking stack, storage and virtual infrastructure built on a common platform architecture spanning 5G Core, RAN and edge for one site should be planned. Ability to adopt automation and orchestration layer built using open standards and specifications like SOL, TMF, O-RAN, security across the stack and validating it will help establish a strong foundation layer. This phase can last about 12 months. The platform is now ready to onboard any use case, from any multi-vendor solution in the second phase. This second phase can run concurrently with the first phase and thus achieve completion in an additional nine months. The final stage will involve more interoperability testing, certification, customization with orchestration, security, operational integration and knowledge transfer. The final phase can span from three to nine months based on level of end-to-end functionality, stress, performance, scalability, security testing needed to meet DoD specific needs. |

VMware will be glad to share any additional information the NTIA would need and collaborate on making the 5G Challenge a successful endeavor.