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Contents

1. 5G OPEN INNOVATION LAB - OVERVIEW	3
1.1. PROPOSAL BACKGROUND & CONTEXT	3
1.2. WHERE WE ARE TODAY	4
1.3. 5G FIELD LABS	4
2. CHALLENGE STRUCTURE AND GOALS	5
2.1. HOW DO WE STRUCTURE THIS CHALLENGE TO ENCOURAGE MORE PARTICIPATION?	5
2.2. HOW DO WE STRUCTURE THIS CHALLENGE TO OVERCOME THE GREATEST IMPEDIMENTS?	5
2.3. WHAT SHOULD THE GOALS AND METRICS BE TO ALLOW FOR THE GREATEST LEVEL OF INNOVATION?	5
2.4. HOW WILL THE OPEN 5G STACK ECOSYSTEM BENEFIT FROM THIS CHALLENGE?	6
3. INCENTIVES AND SCOPE	6
3.1. WHAT ARE THE INCENTIVES THAT WOULD MAXIMIZE PARTICIPATION?	6
3.2. COULD A CHALLENGE BE DESIGNED TO ALSO ADDRESS THE SECURITY OF THE COMPONENTS?	6
3.3. SUGGESTED INDUSTRY EXPERT TARGETS FOR EXPLORATION ZONE WORKING GROUPS	6
4. TIMEFRAME AND INFRASTRUCTURE	7
4.1. FUNCTIONAL AND TECHNOLOGY IMPERATIVES	7
5. SOURCES AND OTHER INFORMATION	7

1. 5G Open Innovation Lab - Overview

1.1. PROPOSAL BACKGROUND & CONTEXT

Platforms (IT infrastructure) are built to support applications. This is the case today with device operating systems running software applications or complex multi-tenant cloud computing infrastructure designed to run millions of globally distributed applications. Fifth generation (5G) wireless standards for Communication Service Providers (CSPs) promises a vastly more connected world, powered by distributed computing systems (mobile edge computing) and robust connectivity. To meet the needs standards like 3GPP2 are mandating Virtualization as a baseline. CSP adoption of 5G standards will transition their current platforms built as vendor specific silos for monolithic environments to a vendor agnostic distributed cloud-based infrastructure. Therefore, seeing 5G networks as a connectivity layer undermines its true potential as a distributed cloud powering connectivity and computing on the edge. We see this as strategic opportunity for the DOD and its forthcoming 5G Challenge.

The ethos of the 5G Open Innovation Lab was to create a partnership of leading technology and connectivity platforms focused on harnessing the innovation of application developers (startups). **We are focused on building an application based ecosystem for 5G where most of the innovation, and value, will be built.** Applications generate user value and pull through platforms; it is not often the other way around.

Nokia's Bell Labs correctly predicted a fourfold increase in data creation between 2015 and 2020¹, predating the roll-out of 5G networking infrastructure. Similarly, the GSMA predicts that the number of unique mobile subscribers will grow from 5 billion in 2017 to 5.7 billion by the end of 2020².



Billions of newly connected devices for enterprises are essential to supporting use cases such as IoT, automation, robotics, and autonomous systems. Application developers will gravitate to these opportunities differentiating the United States well through its powerful software ecosystem.

4G and 5G core networks that are fully virtualized on Telco carrier grade platforms [8] like that of VMware are globally deployed in production. Pushing computing closer to users (aka edge computing) is already gathering investments from public cloud providers such as Microsoft's Azure, Amazon's AWS, and Google's Cloud Platform. In addition, the Hybrid cloud model of seamlessly secure cloud connectivity across private and public cloud is very important for the DOD and also proven by technical platform leaders such as the Founding Partners of our 5G Open Innovation Lab. Similarly, enterprises are considering their own private LTE/5G. Microsoft's recent \$2 billion acquisitions of Affirmed and MetaSwitch hint of opportunities to come through their Azure for Operators approach. Future private LTE/5G networks are positioned to support connectivity needs and edge computing as well. **Given that application developers have been focused on cloud native for several years, the industry is in its early days with respects to edge native application models. We see this an opportunity and one that the DOD can influence through its proposed 5G Challenge.** The DOD itself would benefit from seamless deployment of private LTE/5G networks, seamless secure SD-WAN transport connectivity all offered as virtual network functions or container network functions with integrated virtual computing, virtual storage, virtual networking from Layer-2 and above on site capable of securely handling application demands on from secure public, private, and hybrid cloud environments.

We believe that the future of 5G and Edge computing will be shaped by Government entities, cloud platform service providers, hardware providers, and CSPs working together with application developers, not in silo's. In 2018 we launched

the 5G Open Innovation Lab to develop a much-needed application developer ecosystem focused on harnessing future 5G connectivity and edge computing to address current and future enterprise use case demands.

1.2. WHERE WE ARE TODAY

The 5G Open Innovation Lab and its partners (Microsoft, T-Mobile, Intel, F5 Networks, Dell Technologies, VMware, and Amdocs) form the foundation of our program. We have created a public-private partnership in the State of Washington (see list below) to develop new application driven 5G and Edge computing use cases. Currently our public partnerships include:

1. University of Washington
2. Washington State University
3. Snohomish County
4. City of Bellevue
5. Pacific Northwest National Lab

To bring the products and business models into the light, we launched our Field Labs that test and validate 5G and edge powered use cases within an operating commercial setting. This approach allows us to work hand in hand with industrial customers to understand their challenges while matching them with relevant technology. In addition, the Field Labs support ongoing experimentation of new technology from Startups and our Partners in support of our applied innovation agenda. As of today, 32 companies have joined our program ranging from early stage seed funding to Series B. Combined all companies have raised close to \$200M in funding prior to and post-graduation of the program.



1.3. 5G FIELD LABS

Since the initiation of the Lab, we have always believed that collaboration in the context of industry is the best approach to applying innovative technology at scale. In collaboration with our partners, we were able to realize this vision through the launch of our Field Labs. Snohomish County allocated CARES funding to invest in building two standalone 5G testbeds (aka Field Labs)³. Unlike other testbeds we have seen, these are fully standalone 5G CBRS networks with both dedicated EPCs and edge computing nodes. The application builders we work with, through our Lab program, can now build edge applications supported by 5G connectivity. Together with industry, platform & public partners, and application builders, we are enabling innovation in a new way. A unique aspect of our Field Lab approach is in unifying the best in breed platform providers with public research and application developers. Our Field Labs embody the technical diversity often found in thriving ecosystems and taps into the innovative application developers that have historically differentiated the United States globally.

2. CHALLENGE STRUCTURE AND GOALS

2.1. *How do we structure this Challenge to encourage more participation?*

Our recommendation is to shift the challenge from being connectivity focused to application focused – with connectivity and edge computing as an enabling technology. As we have shared earlier there is a robust ecosystem of supply side endeavors already in play. However, we see a lack of investment focused on cultivating the application developer engagement where much of the value will be created. User adoption of applications generate demand for infrastructure innovation similar to how the cloud computing sector operates today. Revenue, and profits, generated from cloud consuming applications drives infrastructure efficiency and innovation. We believe the world is over indexing on 5G connectivity when we should be cultivating an application ecosystem of developers who will use these platforms for creating revenue generating value. With the strong trend towards cloud native applications, the need for continuous integration (CI), Continuous Deployment (CD) type environment, precious placement of applications at the right edge and its management becomes critical. Thus the need for an overall vendor agnostic Automation and Orchestration system plays a very important role and must be a baseline part of the architecture structure.

Harnessing the immense DOD clout into applied innovation encourages the growth of application developer ecosystem. This focus and investment will create positive spill over benefit in the private sector given the scale and influence of DOD operations. Thriving application ecosystems are the investment vehicle underpinning infrastructure platforms. The transition from 3G to 4G developed a thriving application ecosystem where over the top (OTT) application developers benefited mostly from the investments made by CSPs. In parallel these application builders fueled the emergence of the cloud computing industry into what it is today. Unfortunately, CSPs were unable to tap into the value created from applications and have struggled to differentiate beyond connectivity services. 5G is an important pivot point for the industry into edge computing directly engaging application developers' hand in hand with the public cloud industry. From our perspective, CSPs need to branch out beyond connectivity into the cloud not just for engaging application developers, but to also generate new profitability which in turn will create self-sustaining infrastructure innovation. Engaging the private sector through this approach will drive infrastructure and application innovation benefiting the US economy and in creating innovations of benefit to the DOD. There is an important flywheel initiated by demand created through applications. It is challenging to invest in new platform capabilities when return on investments are limited to just device connectivity (ARPU) certainly in a saturated market like the United States.

From a 5G Open Innovation Lab perspective, we would be honored to help the DODs 5G Challenge. Our unique platform of private and public partnerships is already focused on accelerating 5G business solutions and developing a relevant 5G and edge developer ecosystem backed by our Founding and Corporate Partners. We are focused on building a robust, innovative, application ecosystem where developers can build for what we see as immense 5G and edge platform potential.

2.2. *How do we structure this Challenge to overcome the greatest impediments?*

Being connectivity and edge computing focused encourages important industry collaboration. Developing an engaged, cross-industry ecosystem, we share knowledge, collaborate to solve problems and identify solutions that work for the industry, not just for infrastructure or one Company in particular. **It is therefore our recommendation that the DOD consider developing a similar ecosystem of proven Platform providers, Industry leaders, and startups** to address application development potential and to deal with impediments known today and in future.

2.3. *What should the goals and metrics be to allow for the greatest level of innovation?*

We believe in developing an open 5G platform and fully support the O-RAN Alliance and other consortiums⁴. However, no one company can do this alone which is why the 5G Open Innovation Lab focuses on applied innovation supported by private and public partnerships. We propose the following goals and metrics for DOD consideration:

Program Goals	Success Metrics
Bring US Industry leaders together to build consensus across a common open Stack vision	10+ US-based Industry Leaders to help guide the Program and run POCs with the Startups
Develop a startup program that cultivates talented companies solving challenging problems	20+ startups through the program per year during a 3-year program
Identify DOD challenges, and invest in, solving these challenges through our proposed program.	Scalable use cases that have applicability to the DOD and private industry. Profitability drives supply side innovation.
Validate startups that can solve DOD and Industry challenges, advancing product readiness	Transition 7+ companies / year into an advanced state of readiness (funding / POC at Field Lab)

2.4. How will the open 5G stack ecosystem benefit from this Challenge?

Since 2000, Microsoft, Amazon, and Google have invested over \$347 billion of CAPEX⁵ into their public cloud services. In 2020 over \$257B of revenue was generated through public cloud services⁶ according to industry research firm Gartner. CSP have started to build their own 5G private clouds and they also need to protect their 4G investments. **By enabling application driven innovation allowing for an open 5G hybrid architecture we strongly believe that this will lead to self-sustaining infrastructure investment and innovation not too dissimilar from investments into the public cloud.** 5G gives CSPs a unique opportunity to tap into the application developer ecosystem for the first time. If US-based CSPs are able to monetize and profit from the application platform services (the edge and connectivity) they will enjoy a global competitive advantage well into the future. The DOD has the means and influence necessary for initiating the convergence of connectivity and computing on the edge. In return, the DOD can reap the benefits of private investments and ecosystem engagements in support of their near and long terms priorities.

3. INCENTIVES AND SCOPE

3.1. What are the incentives that would maximize participation?

We have found that by giving the ecosystem a Common modular platform to collaborate, engage in joint proofs of concepts, and co-develop with platform providers we were able to encourage strong participation. In 2020, the DOD launched 5 of its own test beds⁷ to promote 5G technology development in support of key DOD priorities. By being an early adopter this will surely spur industry solutions to key DOD priority areas, discover new use cases, accelerate innovation and solve key challenges by creating a collaborative ecosystem and expanding industry involvement. **We recommend broadening the ecosystem to include 3 key groups: Platform Companies (Microsoft, Dell, VMWare, Intel, TMobile), Industry leaders (CNH, GM, Boeing, Lockheed, etc.) and startups.**

3.2. Could a Challenge be designed to also address the security of the components?

Yes, intrinsic security at component level and cross cloud security is imperative for the DOD and private enterprise ecosystem. **Our Corporate Partners take security very seriously and so do we. We envision providing East-West and North-south Security, all through software entities and running security tests and hackathons against our own Network and the platforms our startups are deploying.** What makes this unique is that we have some of the greatest programming minds working together – startups, developers and Corporate leaders to come up with new solutions. We recommend replicating this approach to addressing DOD security challenges of today and the future.

3.3. Suggested Industry Expert Targets for Exploration Zone Working Groups

In much the same way has built its own 5G testbeds, the 5G Open Innovation Lab has engaged Public and Private entities to develop a Private 5G Field Labs that enables our Corporate and startup partners to test solutions initially for the Agriculture Industry. More broadly, our current focus is on several high-growth market areas, including:

1. Manufacturing (discrete and process)
2. Transportation & logistics
3. Energy (inclusive of oil/gas, and utilities)
4. Healthcare
5. Education

And so, we recommend expanding the work already being done at Military Bases across the US to include collaboration alongside our platform and startup partners. This will provide the 3rd leg of the stool and expose the DOD, Platform companies and Industry leaders to early innovation on these 5G Networks. This will accelerate solution development and thus provide more incentive for the supply side companies to build a 5G network that benefits the entire Country.

4. TIMEFRAME AND INFRASTRUCTURE

4.1. Functional and technology imperatives

We believe that timing is of the essence here. The 5G Open Innovation Lab setup a Private 5G Network in partnership with the Snohomish County Government in 42 days³. This Network allows us to bring our Partners and startups together to envision, test and validate new solutions.

5G networks are being deployed and new technologies and business solutions are being created as access to this broadband network is available. At a Geo-Political level, it is NOT which Country can deploy 5G networks the fastest that will see the greatest benefit – it is the Country who can develop demand-side solutions. Applications make the iPhone great, the iPhone without applications is simply another phone. **By bringing together all players within the business innovation ecosystem (Platform players, Industry and startups), you can accelerate innovation to solve some of our most pressing challenges. And the 5G Open Innovation Lab would be honored to assist you in setting up and managing this ecosystem.**

5. SOURCES AND OTHER INFORMATION

¹ <https://www.nokia.com/blog/mobile-data-growth-and-5g-are-we-getting-numbers-right/>

² <https://www.gsma.com/newsroom/press-release/number-of-global-mobile-subscribers-to-surpass-five-billion-this-year/>

³ <https://5goilab.com/field-labs/>

⁴ **Open Standards:** Emerging open standards is generating community interest as seen by communities such as the Open RAN (O-RAN) Alliance, Linux Foundation Edge and Networking. We have done some exploratory work in the Lab to focus on research using open source software and systems to understand and work toward opportunities in spectrum aggregation, orbital/terrestrial (C-BAND) spectrum repurposing, and other open system explorations. Along with these network and spectrum considerations, we will drive a solution focus by ensuring that other elements to modern cloud services delivery are also incorporated into our investigations. We aim to develop a deep understanding of the requirements driven to the network by modern sensor and data collection methodologies like visual and AR cognitive services, edge located ML, network data transfer, hardware appliances at the edge, etc. These perspectives are critical to realizing innovative use cases exploiting the potential of 5G connected and edge native intelligent applications influencing Industry 4.0 transformations.

⁵ <https://www.platformonomics.com/2020/02/follow-the-capex-cloud-table-stakes-2019-edition/>

⁶ <https://www.gartner.com/en/newsroom/press-releases/2020-11-17-gartner-forecasts-worldwide-public-cloud-end-user-spending-to-grow-18-percent-in>

⁷ <https://www.defense.gov/Newsroom/Releases/Release/Article/2376743/DOD-announces-600-million-for-5g-experimentation-and-testing-at-five>

⁸ <https://telco.vmware.com/>