

I. Challenge Structure & Goals

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?

A review of three past Challenge/technology competition examples that drove engagement provides some examples from which a 5G Challenge that would accelerate the development of the open 5G stack ecosystem in support of Department of Defense (DoD) missions can be structured. The three examples are:

1. OUSD(I): Defense Intelligence Information Enterprise (DI2E) PlugFest
2. Assistant Secretary of the Air Force for Acquisition: PlugFest Plus
3. European Space Agency/European Commission (ESA/EC) Technology Competitions: Copernicus Earth Observation Data and Galileo Global Navigation Satellite Systems (GNSS)

Each competition had a different way of competing, a certain type of technology infrastructure that had to be used/highlighted, and an incentive structure tailored to evoke engagement in a specific way. All required some institutional resources and promotion, but the return on investment in each case more than compensated. A prospective 5G Challenge could incorporate some elements of all three.

The Office of the Under Secretary of Defense for Intelligence (OUSD(I)) created the DI2E Plugfest and sponsored \$50K in prizes (1st - \$25K; 2nd - \$15K; 3rd - \$10K and an Honorable Mention list). This activity was not tied to a specific procurement or opportunity, and the competition focused on creative uses of community infrastructure and standards used in the Defense Common Ground System (DCGS), with a yearly theme or technology challenge. Bonus points were awarded for interoperability/integration between different vendor components to achieve more comprehensive Use Cases/problem set solutions aligned with the yearly technology challenge theme, and teams would spend significant resources on this activity.

The DI2E Plugfest would be the highlight of a yearly two-day conference, organized by the Association for Enterprise Information (AFEI) affiliate of the National Defense Industry Association (NDIA), would be held with competitors/vendors in an exhibit hall/room. A set of judges from sponsoring/collaborating agencies would observe a demonstration by each team over the course of the two days, with a known evaluation schedule and announce the winners at the end of the conference. The incentive to participate came primarily from the visibility achieved in finishing in the Top 3 or Honorable Mention. A DI2E community wiki site kept track of each year's results and conference presentations, leading to a catalogue of solution providers. Conference presentations by government stakeholders were like pre-industry day material that served to get organizations focused on the upcoming year and technically aligned.

The USAF PlugFest Plus effort was sponsored by the Assistant Secretary of the Air Force for Acquisition and grew out of the DI2E PlugFest community which sought to popularize a notion called "Evidence-based Acquisition". The competition was tied to specific procurements and Use Cases/problem sets of interest and started with an Industry Day conference. The idea was to have teams compete to solve a problem or core element of a larger problem in a technology competition that would determine contract awards.

Entries were judged by potential users with stakeholder evaluation of results to select one or more top entries to receive a contract award to further develop solutions. There would be a second judging of matured solutions by users to down-select one entry to go forward with a final contract award to finish any Minimum Viable Products (MVPs) and obtain required certifications to operate. The drawback was properly sizing and shaping the initial challenge to be something that competitors would invest in that solved enough of the problem and be significant enough to put in front of users. This is hard to do for some procurements, but not impossible.

The European Union wants to incentivize the use of their Earth observation data from the Copernicus program and the Galileo Global Navigation Satellite System (GNSS), and ESA/EC Technology Competitions for Copernicus (Earth Observation Data) and Galileo (GNSS) Masters fill this purpose. A yearly competition has been ongoing since 2004 for Galileo and 2011 for Copernicus, and the focus is to stimulate start-ups, small businesses, academia, and individual researchers/entrepreneurs and help bring products and services using Copernicus and Galileo to market.

Each competition features a variety of challenges that are sponsored by one or more organizations – both government organizations and private business (e.g., the European Commission or Airbus, etc.). Each competition challenge offers a €25K – €50K prize package that consists of a small cash award (€1K-€5K) and credit for resources that each competitor can choose based on their specific need. A competitor can choose from a menu of consulting services such as engineering or product design assistance, business development, marketing. Challenge winners are also typically offered entry into a business incubator program, as the goal is to generate viable businesses and solutions quickly. Each challenge has a panel of experts to judge entries, and a set of finalists is selected to give a presentation to the judges where winners and runners-up are selected. Each challenge winner then gives a final presentation where the overall competition winner is selected.

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 5G Challenge could be structured with goals and a purpose like the structure of the ESA technology competition challenges. This seems like the easiest starting point, and a provides a framework within which other elements could be incorporated. A set of government and industry challenges are conceived with corporate sponsorships of the in-kind services that make up the bulk of the prize packages. Experts are recruited to judge the challenges and judge for the overall challenge winner. The focus is on challenge participation by start-ups, small businesses, academia, and individual researchers/entrepreneurs. The challenges are sponsored by government and larger businesses that have an interest in the challenge focus areas.

Established small and mid-size businesses typically execute delivery of the in-kind services in the prize packages, frequently being fully or partially reimbursed by government and large business sponsors. Establish a relationship with, or start, a business incubator for challenge winners and runners-up. As community participation and open infrastructure matures consider executing a PlugFest Plus type competition for a contract award, perhaps in the second year. This effort built on the community esprit de corps established by the DI2E PlugFest in a fundamental way, and it must be cultivated. Establishing a community wiki, or similar, to support the community perhaps building off the 5G-to-XG.org site would help to focus communication and execution.

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 goal is to set the bar for participation low and allow less mature concepts and technologies to participate and gain visibility. For instance, a short business plan is part of the entry (in the ESA competitions the concept and associated business plan are more important than a working demonstration), but this competition should focus on working demonstrations with the business plan as a lesser component of the score. As an example, an End-to-End challenge involving the UE-RAN-Core Network could be one of the bigger challenges sponsored by the government. In conjunction with separate Radio Unit (RU) stack, a Distributed Unit (DU) stack, and Core Network challenges, topics such as the F1 standard definition and Open RAN Alliance 7.2X split could be explored experientially within the community. Additionally, Use Cases involving topics like ultra-reliable low-latency communication (URLLC) or network slicing could provide other avenues for Challenge focus areas.

The idea would be to get big telecommunications companies and DoD prime contractors to sponsor Use Case or technology component challenges that support open 5G systems. Have a yearly (online) kickoff event that outlines the challenges, along with a yearly challenge conference (online if required) where the winners and runners-up make presentations on the second day following a plenary day of government and industry leader presentations and panels, with an exhibit space for challenge participants and any organization that wants to staff an exhibit booth.

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 open 5G stack market will benefit due to the decreased “friction” and inefficiencies in the current telecommunications and associated information technologies (IT) ecosystem. Problems sets and Use Cases of interest are communicated more clearly to the pool of potential solution providers with a focus on the most creative and growing members of the community.

The government influences the Challenge focus areas in conjunction with industry and academia with a focus on solutions. The talent and ideas emerge from the Challenge winners and can be efficiently incubated into effective solution sets for the government and industry alike.

II. Incentives and Scope

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?

Such a structure provides incentives for all types of organizations associated with the 5G technology ecosystem to participate. The incentives for the challenge participants (start-ups, small businesses, academia, and individual researchers/entrepreneurs) are not just the currency value of the prize packages, but the business relationships established along the path from participant to winner. Getting a spot in a business incubator is unbelievably valuable by itself. Academia, government agencies, and small/mid-

sized/large businesses get recognition providing experts to judge the challenges, since everybody needs data points regarding expertise. Telecoms and big primes can source solutions, technologies, and people.

If the community evolves to the point where Evidence-based Acquisition can be applied to appropriately formulated challenge, a competition that determines a contract award can be very invigorating, exciting, and engaging for the community in the way only sports typically do. The selling point is that every proposal costs more money than people would like to admit, so get businesses to spend this money on a demonstration instead of an elaborate, complex proposal.

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, and security, in all its dimensions, would be a great Challenge focus area that recurs.

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?

Absolutely, and in some sense, this is what the Copernicus and Galileo challenges do, which is specifying certain technologies, services, and hardware to be used in the context of an individual challenge. This is the same with the DI2E PlugFest and the USAF PlugFest Plus approaches.

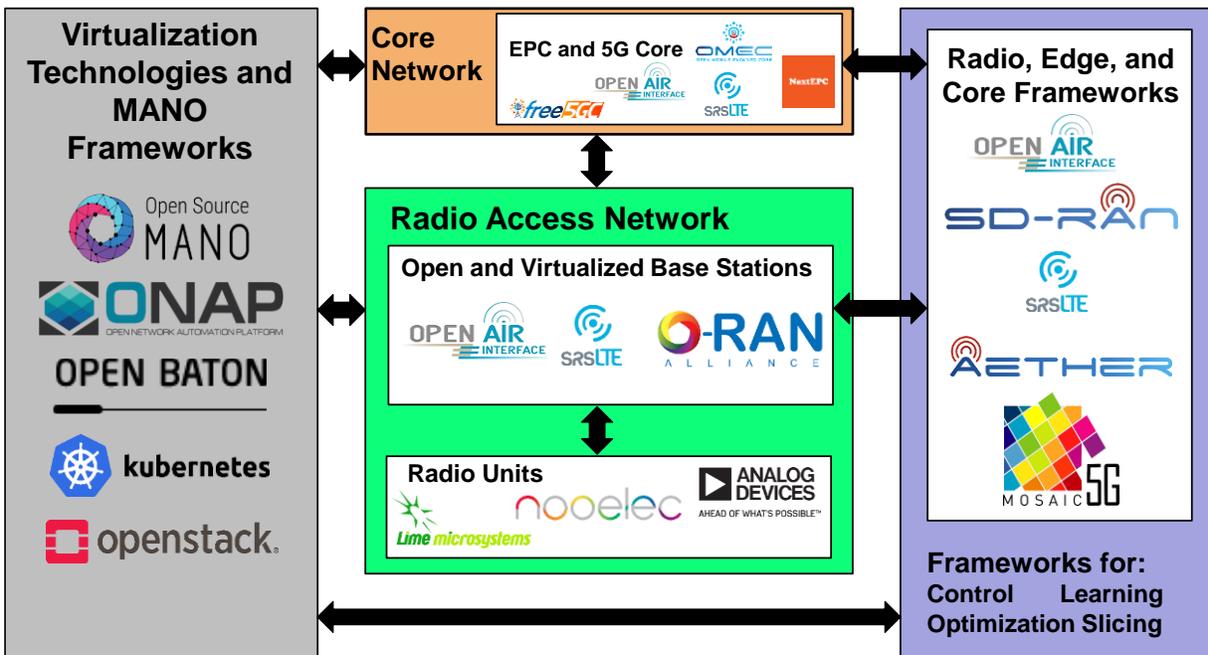
D. Many open 5G stack organizations have developed partial implementations for different aspects of an open 5G stack. What portions of the open 5G stack has your organization successfully developed with working code? What portions of the open 5G stack does your organization believe can be developed quickly (6 months or less)? What development support would best enable test and evaluation of the different elements of an open 5G stack?

Our organization creating end-to-end 5G infrastructures and is working at the physical layer and the firmware, drivers, and PHY layers that integrate new radio equipment into the 5G NR User Equipment (UE) and the radio access network (RAN) stacks. As such, we are experts with a wide variety of open 5G components.

Create an end-to-end testbed to support RF systems development including 3GPP version 15/16 compliant Radio Access Network (RAN) and User Equipment (UE) and support both Standalone (SA) and non-standalone (NSA) 5G Core Network implementations.

In the next 6 months we will be conducting a variety of UE-RAN-Core Network tests. This will give insight into completeness of standard implementations. We have installed and are different combinations:

- Free5GC (5G SA core) with various gNodeBs
- SRS's UEs with Open5GS NSA
- O-RAN Alliance with Free5GC SA
- O-RAN with Open5GS SA
- Maybe Open Air Interface's e/gNodeB with various NSA and SA cores



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?

All the above, plus security and end-to-end Use Cases and demonstrations.

III. Timeframe & Infrastructure

A. What software and hardware infrastructure will be needed to successfully execute this Challenge?

Minimal, unless a Challenge required community hardware or software.

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?

The limiting factor to organize and execute a 5G Challenge as outlined is the recruitment of the initial set of sponsors, and this could be done in four to five months.

- | | |
|---|--|
| 1. Initial organization: 4 months | 6. Finalist Presentation Judging Sessions: One month |
| 2. Challenge Kickoff Conference | 7. Challenge Winner and Runners-Up Notifications |
| 3. Challenge Team Activity: 4-5 months | 8. Challenge Winner Presentations to Determine Overall Winner: One month |
| 4. Challenge Team Judging Sessions: 3 months | 9. 5G Challenge Conference |
| 5. Announcement of individual Challenge Finalists | |