Report on U.S. Resources and Capabilities for Accelerating Open RAN Executive Summary

Open Radio Access Network Advisory Group

National Spectrum Consortium

February 2023

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INTRODUCTION AND RECOMMENDATIONS TO ACCELERATE OPEN RAN DEVELOPMENT IN THE U.S.

On July 12, 2022, the Office of the Undersecretary of Defense for Research and Engineering (OUSD (R&E)) and the National Spectrum Consortium (NSC) co-hosted a full-day event focused on producing concrete recommendations for accelerating the development and deployment of Open Radio Access Networks (Open RAN) in the United States. Attendees included approximately 200 members of the NSC, along with federal government representatives from the White House, Department of Defense (DOD), and National Telecommunications and Information Administration (NTIA).

Open RAN systems have the potential to bolster U.S. leadership in wireless networking technology, a key component of nearly every new modern infrastructure, security, and defense system under development today. Truly open, interoperable wireless networking systems will increase the pace of technology development, lower the costs of complex infrastructure systems, and provide flexibility to both government and commercial network operators.

At the July event, NSC members provided input on the challenges and opportunities for Open RAN. This led to robust discussion and a broad list of recommendations for the federal government. It also drove near-term actions in support of some of these recommendations as described further below.

Recommendations from NSC members spanned both technology and policy domains. They included but were not limited to:

- Creating a roadmap and timeline for specific Open RAN performance features required by government and industry network operators
- Ensuring tighter federal agency coordination on Open RAN Issues
- Enabling greater participation and coordination in standards-making efforts by smaller and non-traditional wireless innovators
- Hosting industry- and government-sponsored security and penetration testing challenges
- Creating a framework to provide interoperability certification of Open RAN components
- Developing Open RAN reference architectures
- Leveraging research facilities with Open RAN capabilities to support end-to-end network testing with Open RAN interfaces, and to lower the barrier to entry for new technology players to participate in Open RAN development

While many of the recommendations generated at the July event require continued strategic planning and additional stakeholders to implement, NSC leadership undertook initial follow-up tasks in the months after the event to advance some of these goals. These included creating an NSC Open RAN Advisory Group and developing two new reports with crucial data from across the wireless ecosystem. These reports on U.S. Resources and Capabilities for Accelerating Open RAN and Open RAN Use Cases follow below.

EXECUTIVE SUMMARY

The United States federal government and commercial wireless industry have prioritized the development and deployment of Open RAN. These networks have the potential to bolster U.S. leadership in wireless technology, a key component of nearly every new modern infrastructure, security, and defense system under development today.

Given the urgency and sizeable investment behind Open RAN, the National Spectrum Consortium (NSC) – working with its partners in the Department of Defense (DOD) – established an Open RAN Advisory Group to provide recommendations on programs and policies that might accelerate the development of a robust, U.S.-based wireless networking ecosystem.

Despite a number of successful ongoing Open RAN deployments worldwide, the Open RAN ecosystem is still under development. To unlock the full potential of Open RAN for 5G, Beyond 5G, and 6G, additional resources are needed to make it easier for more players (e.g., equipment suppliers, network integrators) to participate in both basic and applied research and development, and to deliver innovations that meet the greatest challenges of next-generation wireless connectivity.

In this report, the Advisory Group seeks to outline, according to NSC members, current requirements for Open RAN test and integration facilities to grow and scale the ecosystem in the U.S. In addition, the Advisory Group undertook an effort to catalog currently existing domestic resources available for accelerating Open RAN development. **Open RAN technology is not the same as 5G technology, and it has specific requirements for ensuring interoperability with both new and existing network systems (greenfield and brownfield network deployments respectively).**

Today in the US, numerous labs and testbeds support wireless testing and research. However, network operators and the research and development community (industry-, university-, and government-led) are vocal about their concern that few of these facilities – outside of closed vendor and Mobile Network Operator (MNO) labs – can perform end-to-end Open RAN testing to ensure interoperability and performance. Further, they note that most Open RAN test and development platforms today are not accessible to non-traditional telecom technology providers, and those that are broadly available, are under-resourced.

In this report, we present the results of a study by the NSC Advisory Group on facilities across the U.S. with the ability to deliver some of the testing, development, and prototyping resources needed for Open RAN. The process of our study involved several steps:

1. Gathering input from the government, industry, and academic wireless communities on the types of resources needed for accelerating Open RAN development and deployment
2. Identifying the Open RAN capabilities at existing research facilities in the US through surveys and interviews
3. Analyzing and articulating the gaps between what is needed and what existing facilities can provide to accelerate Open RAN efforts

Our findings suggest there is a solid foundation for continued Open RAN development, and for facilitating Open RAN technologies so they can be adopted into commercial networks. **However, as many have stated, not everything needed to accelerate Open RAN is available today, and of those resources**

that are available, many are not accessible to smaller technology companies and the broader research and innovation community.

If the federal government truly has the goals of "supporting a more competitive and diverse telecommunications supply chain…[and]…fostering competition," then we must address known technical and accessibility gaps in the development of open networking technologies as quickly as possible. Only by solving these resource challenges can we take full advantage of Open RAN to diversify the telecom supply chain and expand our telecom innovation ecosystem.

TYPES OF OPEN RAN TESTING AND DEVELOPMENT NEEDED

There are two major categories of Open RAN research and testing support needed by the wireless community: Category A – Open RAN interoperability and performance parity testing to speed commercial deployments; and Category B – advanced Open RAN research and development to accelerate innovation and significantly expand the telecom supplier ecosystem. (See chart below)

In both cases, many facilities have a subset of what is needed, but not everything that is required end to end. Furthermore, no facility listed has the necessary volume and diversity of solutions to support wide-scale testing and experimentation.

In Category A, for example, there are no facilities currently offering Open RAN certification. This is partly because while there is a formalized test specification for the open fronthaul interface today, specifications and standards for additional Open RAN components still need to be established. It is also partly because all of the facilities cited need more Open RAN-specific testing expertise and Open RAN-specific testing equipment. In Category B, different types of research are supported at different facilities, and at different levels of comprehensiveness and accessibility.

Research Facilities Listed by R&D Category – Varying Capabilities Available; Varying Levels of Access Offered to External Users

<table>
<tr><th>CATEGORY A
Open RAN interoperability and performance parity testing</th><th>CATEGORY B
Advanced Open RAN research and development</th></tr>
<tr><td>Supports Open RAN interop and performance testing:
CableLabs/Kyrio – OTIC
COSMOS, NSF PAWR Testbed – sponsored as an OTIC by AT&T and DISH
TIP Menlo Park</td><td rowspan="3">AERPAW, NSF PAWR testbed
Booz Allen
CableLabs/Kyrio – OTIC
COSMOS, NSF PAWR testbed – sponsored as an OTIC by AT&T and DISH
Idaho National Lab (INL)
LinQuest Lab
MITRE (w/UMD ARLIS and Northeastern University, security focus)
NIST Communications Technology Lab (CTL)
Northeastern University
Pacific Northwest National Lab (PNNL)
POWDER, NSF PAWR testbed
Texas A&M testbed
TIP Menlo Park
Virginia Tech CCI xG testbed
*ARA, NSF PAWR testbed, scheduled to launch in spring of 2023</td></tr>
<tr><td>Supports network interop and performance testing and could extend into specific Open RAN compliance:
UNH IOL
Booz Allen
LinQuest Lab
MITRE (w/UMD ARLIS and Northeastern University, security focus)
Texas A&M</td></tr>
<tr><td>Specializes in Open RAN and could extend into Open RAN interop and performance testing:
POWDER, NSF PAWR Testbed
Virginia Tech CCI xG testbed</td></tr>
<tr><td colspan="2">Operator research facilities – AT&T, DISH, T-Mobile, Verizon
Wireless operators drive a significant amount of Open RAN development activities, and their various facilities can and are used to support both testing and research efforts. Outside of DISH, however, no wireless operator is currently establishing a formal policy or process for onboarding and supporting external users at their lab and testbed sites – and DISH is still in the planning phase. Operators more often partner with outside test facilities for broad testing and research activities, as evidenced by AT&T's and Verizon's use of partner labs to host Open RAN Plugfests and POC fests.</td></tr>
</table>

For interoperability and performance testing, the wireless community needs facilities with a wide mix of commercial equipment (traditional RAN and Open RAN) and software available **on demand**. It is not enough for labs to work with partners to set up the configuration of hardware and software needed just for a one-time, pre-planned plugfest. These components must be acquired, installed, and maintained for ongoing usage.

For advanced feature research and development, the wireless community needs facilities with at-scale *open architectures* available **on demand**. This includes research facilities with end-to-end test environments, but with open, programmable versions of the necessary network components (often open source) rather than traditionally closed commercial systems.

Additional challenges to Open RAN development include limited human resources and the inherent high cost of test equipment and test environments for new, small U.S. companies entering the Open RAN marketplace. If the goal is to enable small-to-medium-sized companies and academic innovators to demonstrate new Open RAN technology and concepts at scale, then issues of staffing support and resource accessibility must be addressed.

Availability of Open RAN Testing and Development Capabilities

Capabilities Needed for Open RAN Testing and Development	**Availability/Status**
Multiple and diverse range of commercial mobile cores, gNodeBs, CUs (hardware and software), DUs (hardware and software)	Does not exist at volume outside of internal company facilities
Multiple and diverse range of new commercial open RUs and programmable reference RUs	Does not exist at volume outside of internal company facilities
Open source mobile cores, CUs, DUs	Open source CUs, DUs still in development
SDRs with RF frontends supporting a range of frequency bands	Exists in a few places, outdoor deployment extremely limited
Programmable massive MIMO arrays	Extremely limited
Commercial and open source near-real-time RIC implementations	Limited availability
Access to non-real-time RIC platforms within SMO	Limited availability

UE devices – both commercial mobile devices with SIM cards and programmable modules supporting a range of frequency bands	Most facilities do not have diversity and volume
Open source mobility stacks that have been configured to work with software defined radios for over-the-air cellular research use	Limited proven deployments outside of a controlled lab
Massive computing power including edge compute capacity	Available in several places
Backhaul connectivity	Available in several places
Physical network components such as enclosures, cables, and mounting equipment	Available, but more always needed
Volume of test equipment to support Open RAN-specific testing	Does not exist at volume outside of internal company facilities
Simulation capabilities	Some availability
Channel emulation capabilities	Limited availability
Access to spectrum across a wide range of frequency bands	Does not exist outside of carriers
Physical space – indoors and outdoors	Available in several places
Significant number of expert personnel – advanced wireless technology, Open RAN conformance, operational support	Additional expert personnel needed nearly everywhere
Formal operational processes and other resources for on-boarding and supporting a broad pool of external users	Limited to a few facilities