Advanced Wireless Test Platforms Team Information Request Report

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Preface

This document is a compilation of self-reported information from Federal government agencies provided in response to an Advanced Wireless Test Platforms[1] (AWTP) Information Request by the AWTP Team co-chairs in April 2021. The AWTP Team focuses on providing a forum for interagency coordination on wireless test platforms and encourages public-private partnerships. This report complements the November 2020 Federal Mobility Group (FMG) report, *Framework to Conduct 5G Testing*. The FMG report compiled information about equipment (hardware and software) for existing testbeds through a survey and about visits to laboratories owned or operated by equipment vendors, mobile network operators, universities, and Federal agencies. At that time, early 2020, none of the Federal laboratories had 5G capability. The AWTP effort builds on that work but is focused on 5G and beyond infrastructure directly owned or operated by Federal Government agencies. In addition to updating the FMG study, this effort includes near-term plans, access, and data sharing elements to help facilitate coordination and collaboration.

[1] An advanced wireless test platform (AWTP) is an experimental platform that offers controlled and emulated conditions to prototype and test advanced wireless technologies and policies. For more information on the AWTP Team, go to https://www.nitrd.gov/coordination-areas/wsrd/awtp/

Executive Summary

The Wireless Spectrum Research and Development (WSRD) Interagency Working Group was formed in 2011 to coordinate Federal research and development (R&D) across Federal agencies and to inventory, coordinate, and make recommendations that promote efficient use of wireless spectrum through advanced technologies and systems. An advanced wireless test platform is an experimental platform that offers controlled and emulated conditions to prototype and test advanced wireless technologies and policies. The Advanced Wireless Test Platforms[2] (AWTP) Team, which reports to WSRD, was formed in 2020 in response to the Secure 5G and Beyond Act[3] of 2020. The AWTP Team helps to address research challenges and to provide opportunities for improving access to and coordination of wireless test platforms.

The AWTP Team conducted an Information Request in 2021 to gather information on Federal agencies' advanced wireless test platform capabilities (e.g., infrastructure, access, and expertise) to support interagency coordination and identify potential gaps. This effort supports national wireless communication priorities, including the *National Strategy to Secure 5G & Beyond Implementation Plan*[4] and the *Research and Development Priorities for American Leadership in Wireless Communication*.[5]

The Information Request was completed by nine Federal agencies that either have existing or planned AWTPs, or that need access to AWTPs. Twenty-two existing AWTPs responded or provided briefs on their capabilities. This report presents a summary of the Information Request responses, briefs, and AWTP Team meeting discussions; an analysis of trends in the data; and a description of potential gaps.[6] (See Appendix B for the complete text of the Information Request.)

Key takeaways are as follows:

1. There is significant progress toward aligning existing testbed capabilities to support national goals as 5G technologies mature and become more readily available.
2. The quantity of testbeds with either "real" or "emulated" components is evenly distributed. The number of testbeds available for internal (agency only) or external (other agency or non-federal) use is also nearly the same.
3. Significant trade-offs exist between operational response and flexibility when testbed equipment is tailored to a research area, application, or use case.
4. Potential gaps with respect to national priorities indicate an imbalance between agency interests and the capabilities of AWTPs and laboratories.

[2] For more information on the AWTP Team, go to https://www.nitrd.gov/coordination-areas/wsrd/awtp/

[3] https://www.congress.gov/116/plaws/publ129/PLAW-116publ129.pdf

[4] https://www.ntia.gov/files/ntia/publications/2021-1-12_115445_national_strategy_to_secure_5g_implementation_plan_and_annexes_a_f_final.pdf

[5] https://trumpwhitehouse.archives.gov/wp-content/uploads/2019/05/Research-and-Development-Priorities-for-American-Leadership-in-Wireless-Communications-Report-May-2019.pdf

[6] The completed Information Requests for each agency are located on the AWTP MAX page, which is available only to Federal government employees and contractors with a Federal government email address (or similar)

Federal Agencies Advanced Wireless Test Platforms Information Request

Purpose

An advanced wireless test platform is an experimental platform that offers controlled and emulated conditions to prototype and test advanced wireless technologies and policies. The Advanced Wireless Test Platforms (AWTP) Team[7] of the Wireless Spectrum Research and Development (WSRD) Interagency Working Group (IWG) conducted an Information Request in 2021 to gather information on Federal Agencies' advanced wireless test platform capabilities (e.g., infrastructure, access, and expertise) to support interagency coordination and identify potential gaps. This effort supports national wireless communication priorities resulting from the Secure 5G and Beyond Act[8] of 2020, including the *National Strategy to Secure 5G & Beyond Implementation Plan*[9] and the *Research and Development Priorities for American Leadership in Wireless Communication*.[10] The Information Request was completed by Federal Agencies that have existing or planned AWTPs, and Federal agencies that need access to AWTPs.

Background and Scope

The AWTP Team used the FMG report, *5G Framework to Conduct 5G Testing*,[11] as the basis for capturing the Federal AWTP capabilities landscape in 2021 and beyond. The term "5G" is used to specifically imply instantiations of 3GPP[12]-compliant 5G cellular network technology. The use of "Advanced Wireless" is purposefully broader, encompassing 5G and various beyond 5G (B5G), including technologies such as next-generation Wi-Fi (WiFi7) and new airborne networks [enabled by proliferated low earth orbit (LEOs) satellites, unmanned aerial vehicles (UAVs), and high-altitude platforms]. The Information Request was designed to elicit information about all such capabilities and includes Federal agencies that own or operate AWTP infrastructures as well as those agencies that are operationally impacted by related policy and technology considerations.

This report is intended to help facilitate conversations around use and development of AWTPs and raise awareness of potential gaps. Because the Information Request focus was limited to 5G and B5G, this report does not identify all wireless testbeds or capabilities. Findings, gaps, and suggestions made in this report are limited by the breadth of the community surveyed and the timeline required to produce this report.

[7] For more information on the AWTP Team, go to https://www.nitrd.gov/coordination-areas/wsrd/awtp/

[8] https://www.congress.gov/116/plaws/publ129/PLAW-116publ129.pdf

[9] https://www.ntia.gov/files/ntia/publications/2021-1-12_115445_national_strategy_to_secure_5g_implementation_plan_and_annexes_a_f_final.pdf

[10] https://trumpwhitehouse.archives.gov/wp-content/uploads/2019/05/Research-and-Development-Priorities-for-American-Leadership-in-Wireless-Communications-Report-May-2019.pdf

[11] https://www.cio.gov/assets/files/Framework-to-Conduct-5G-Testing-508.pdf

[12] Third Generation Partnership Project

Methodology for This Report

In January 2021, an Information Request was distributed through the AWTP Team. Team members served as the point of contact for gathering and submitting the information on behalf of their agency. The level of data requested was intended to provide an understanding of the types of network infrastructure available to facilitate increased collaboration and coordination, but not become a burdensome list of specific equipment and capabilities. To understand what elements of the national priorities are, or will be, supported, the request consisted of five overarching questions on current and planned capabilities, as well as a checklist of how these capabilities correspond with national priorities. (See Appendix B for the complete text of the Information Request.) All collected data was considered FOUO (CUI) to encourage effective sharing and was stored on the AWTP Government-Only web portal.[13] In July 2021, the AWTP examined the responses to identify the common elements, potential gaps, and key takeaways that are included in this report.

Intended Audience, Contributors, Distribution, and Updates

This report is available to the public as well as on MAX.gov. The intended audience includes the AWTP members (to support the Team's goals); WSRD members (to support strategic priorities and information requests regarding AWTPs); and other Federal agencies, universities, and private industries with an interest in AWTPs. Twenty-two AWTPs from among nine Federal Agencies responded to the Information Request, submitted written briefs on their capabilities, or gave presentations during AWTP meetings that provided additional detail on and insight into their current testbeds and plans.[14]

Related Groups and Databases

The General Services Administration (GSA) Federal Mobility Group (FMG)

The GSA FMG works to identify common wireless and mobility challenges, develop solutions, and share best practices. FMG looks at non-national security and mobility mission-related challenges that agencies face. It is currently focused on 5G, Internet of Things, artificial intelligence security and policy regulations, and other emerging technologies. In 2020, FMG undertook an evaluation of 5G testing approaches to understand available testing capabilities to avoid duplication, promote the use of shared testing resources, and define a framework for Federal 5G testing. The FMG and the AWTP Team held a joint workshop April 27–28, 2021, to advance the FMG work product, *5G Framework to Conduct 5G Testing*,[15] by exploring its applicability to specific 5G-inspired use cases.

IEEE[16] Future Networks

IEEE Future Networks is an IEEE-sponsored Future Directions initiative focused on next generation wireless technologies. Pertinent to this effort is the IEEE Future Networks Testbed Working Group,[17] which is part of a larger international effort aimed at road-mapping industry evolution through 5G and beyond in the *International Network Generations Roadmap*.[18] One of its key outcomes is an ongoing

[13] The completed Information Requests for each agency are located on the AWTP MAX page, which is available only to Federal government employees and contractors with a Federal government email address (or similar)

[14] The completed Information Requests for each agency are located on the AWTP MAX page, which is available only to Federal government employees and contractors with a Federal government email address (or similar)

[15] https://www.cio.gov/assets/files/Framework-to-Conduct-5G-Testing-508.pdf

[16] Any mention of commercial products within this document is for information purposes only; it does not imply recommendation or endorsement by the NITRD Program

[17] https://futurenetworks.ieee.org/

[18] https://futurenetworks.ieee.org/roadmap

Testbed Survey,[19] whose results have been curated and presented under broad categories, such as nature or type of testbed, primary use cases, protocol stacks, network configuration, industry vertical, and underlying technologies (radio, computer).

WSRD IWG

WSRD IWG created and maintains an online *Testbed Inventory*[20] that was launched and populated in 2013. Designed for the purposes of information exchange between government, academic, and industry researchers in need of spectrum testing facilities., groups are invited to contribute information on testing facilities that are available for use. WSRD is currently in the process of updating this database.

Updates/Continuity

Testbeds, technology, and infrastructure are constantly changing; this report and the summary document are only a snapshot in time. The AWTP Team may need to update the Information Request summary document on an annual basis, to be stored on the AWTP Team Government-Only web portal.[21] An update to this report may be issued as testing capability and alignment with national priorities change.

[19] https://futurenetworks.ieee.org/testbeds

[20] https://www.nitrd.gov/apps/ai-rd-testbed-inventory/

[21] The web portal is available only to Federal government employees and contractors with a Federal government email address (or similar)

Information Response Summary

The following chart summarizes at a high level the key elements of the testbeds included in the information request. The following descriptions and abbreviations are used:

- Type of testbed: Modeling and Simulation (M&S); Laboratory (Lab), Outdoor Range (Range)
- Equipment:
  - Operational (commercial grade or mission operational)
  - Emulated (hardware emulating a commercial/operational item)
  - Simulated (software simulated equipment or a model)
- Frequency Bands:
  - CBRS = Citizens Band Radio Service (3550–3700 MHz)
  - O-RAN = Open Radio Access Network
  - V2X = Vehicle to Everything (5850–5925 MHz)
- Who Can Use, Data Access:
  - Int = Internal (i.e., the testbed federal agency)
  - Ext = External (other federal agencies, academia, industry; CRADAs or other agreements may be needed)

Agency/Laboratory	State	Type[22]			Equipment[23]			Frequency[24]	Who Can Use[25]		Data Access		Notes
		M&S	Lab	Range	Op	Emul	Sim	Bands (GHz)	Int	Ext	Int	Ext	
DOD													
Hill Air Force Base	UT			X				3.1-3.45		X	X		
Marine Corps Logistics Base Albany	GA			X				CBRS, 37-40	X		X		Indoor/outdoor of warehouse
Naval Base Coronado	CA			X									In Deployment
Fort Hood	TX			X									Planned

[22] Modeling and Simulation (A software based, virtual testbed); Lab: Laboratory, which could be a room or anechoic chambers; Range: Outdoor environment

[23] Real; Emulated; Simulated

[24] Covered bands: <6=sub-6 GHz; 24=24 GHZ; 28=28 GHZ; 60=60GHZ; V2X=Device-to-device communications within an Intelligent Transportation Systems (ITS) cooperative and automated environment

[25] Internal; External

Agency/Laboratory	State	Type[22]			Equipment[23]			Frequency[24]	Who Can Use[25]		Data Access		Notes
		M&S	Lab	Range	Op	Emul	Sim	Bands (GHz)	Int	Ext	Int	Ext	
DOE													
INL	ID			X	X				X	X	X		Commercial core
Department of Transportation													
Turner-Fairbank Highway Research Center	VA			X				V2X	X				V2X
FDA													
Silver Spring	MD		X		X	X		<6	X		X	X	Medical devices

Abbreviations and acronyms used in this table (also included in Appendix A):

CBRS Citizens Broadband Radio Service **DOD** Department of Defense **GHz** gigahertz **M&S** modeling and simulation **V2X** vehicle to everything

Agency/Laboratory	State	Type			Equipment			Frequency	Who Can Use		Data Access		Notes
		M&S	Lab	Range	Op	Emul	Sim	Bands (GHz)	Int	Ext	Int	Ext	
NIST													
Public Safety Communication Innovation Laboratory	CO		X	X	X	X		<6, 24/28	X	X	X		
5G Coexistence Testbed	CO	X	X		X	X		<6, 24/28, O-RAN	X	X	X		Lab facilities designed for frequency coverage above 100 GHz
NBIT	CO		X		X	X		up to 80	X	X			Anechoic/reverb
Antenna Communication and Metrology Lab	CO		X			X	X	1-500	X	X			Pattern, 25µm res
Millimeter-Wave Channel Sounding and Modeling	VA	X	X	X				28, 60	X	X	X	X	Channel sounders
NTIA													
CRAIN	CO			X				RQZ	X		X		RQZ (Table Mountain)

Abbreviations and acronyms used in this table (also included in Appendix A):

DOE Department of Energy
FDA Food and Drug Administration
GHz gigahertz
INL Idaho National Laboratory
M&S modeling and simulation
NBIT NIST Broadband Interoperability Test Bed
NIST National Institute of Standards and Technology
O-RAN open radio access network
RQZ radio quiet zone
µm micrometer
V2X vehicle to everything

Agency/Laboratory	State	Type			Equipment			Frequency	Who Can Use		Data Access		Notes
		M&S	Lab	Range	Op	Emul	Sim	Bands (GHz)	Int	Ext	Int	Ext	
NSF													
AERPAW	NC			FY21	X	X			X	X			UAS
COSMOS	NY			X	X	X		<6, 28, 60	X	X	X	X	City-scale sandbox
POWDER	UT			FY22		X		SDR, MIMO	X	X	X	X	City-scale sandbox
Colosseum	MA		X			X		<6, O-RAN	X	X	X		
Millimeter-Wave Massive MIMO (M-Cube)	CA		FY			X		mmW, V2X		X		X	V2X
60 GHz Millimeter-Wave for Multi-GB Networking	VA		X			X		60	X		X		Networking
Scalable Millimeter-Wave SDR Network Testbed	PA		X			X		<6, 28					Flexible SDR
CI-New: Open Networked Airborne Computing			X	X		X			X		X		

Abbreviations and acronyms used in this table (also included in Appendix A):

AERPAW	Aerial Experimentation and Research Platform for Advanced Wireless	**CRAIN**	Communications Research and Innovation Network	**MIMO**	multiple-input, multiple-output	**O-RAN**	open radio access network	**SDR**	software-defined radio
CI	community infrastructure	**GB**	Gigabyte	**mmW**	millimeter wave	**POWDER**	Platform for Open Wireless Data-driven Experimental Research	**UAS**	unmanned airborne system(s)
COSMOS	Cloud Enhanced Open Software Defined	**GHz**	gigahertz	**NSF**	National Science Foundation			**V2X**	vehicle to everything
		M&S	modeling and simulation	**NTIA**	National Telecommunications and Information Administration				

Information Request Analysis

Trends

An analysis of the Information Request Summary data (please refer the table on pages 5–7), revealed the following trends:

- There is a balanced mix of laboratories and ranges; however, the Information Request did not capture many modeling and simulation testbeds.
- Approximately 60 percent of the testbeds reported provide both internal and external access to users. Of the internal testbeds, some of them (e.g., NTIA) were available through cooperative R&D or other agreements.
- Approximately 30 percent have external data access. All have internal data storage.
- Bands covered included <6 GHz, 28 GHz, and 60 GHz.
- Many testbeds use emulated systems. This is a combination of virtual communications network components with commercial off-the-shelf (COTS) systems or software-defined radio (SDR) emulators. Only INL had a full commercial network core and base stations.
- Real-time spectrum awareness capabilities are preferred.

Potential Gaps

The following potential gaps were identified from the information in the responses and from follow-on questions from AWTP Team members. The gaps indicate a lack of balance between agency interests and existing or future AWTP capabilities.

Operator Defined Open and Intelligent Radio Access Networks (O-RAN)

Five testbeds noted future plans for O-RAN: Colosseum and POWDER (NSF), INL (DOE), NBIT (NIST), CRAIN (NTIA), and Marine Core Logistics Base (DOD).

O-RAN is an open architecture approach with interoperable interfaces and RAN virtualization to decouple hardware and software that will enable multi-vendor networks. There are multiple O-RAN architectures, not just one. For example, the O-RAN alliance (https://www.o-ran.org/) is moving in one direction based on the seven two split, but there are other splits in play by other alliances such as the option six by the small cell forum. (However, all O-RAN approaches rely on interoperability between different vendor builds.)

While several of the testbeds noted inclusion of O-RAN, these testbeds are intended for application use and could provide options for manufacturers to develop and test new products in an operationally relevant environment. However, Federal testbeds will be needed to do the following:

- Broaden competition by providing sufficient access for small manufacturers.
- Test, evaluate, and understand the integration of O-RAN solutions and the intersection of O-RAN and other RANs.
- Develop standards and tools for measuring interoperability and optimal configuration.[26]
- Investigate potential vulnerabilities.

[26] It should be noted that, at this time, the O-RAN Alliance does not admit Federal Agencies and thus Federal AWTPs are unable to gain access to the requirements and standards.

Non-Terrestrial to Terrestrial Communication Systems

There are several commercial efforts to integrate non-terrestrial (airborne) network segments (e.g., UAVs, low earth orbit satellites, high altitude platforms) into a terrestrial 5G network. In addition, questions remain on the potential impact to various scientific instrumentation (e.g., radio astronomy, weather satellites, and other systems) as a result of new 5G deployments in or near bands allocated for such services (e.g., 24 GHz band). Federal testbeds are needed to provide unbiased data to understand these impacts and provide options or mitigations for manufacturers to develop and test new products in a non-interfering manner.

Millimeter-Wave Network Components

As networks migrate to GHz (and higher) frequency ranges, COTS equipment in this range is generally expensive and availability for testbeds is limited. While this limitation should change with evolving markets, obtaining early commercial prototypes for test and evaluation by testbeds will be revisited by AWTP in CY22.

White Space

White Space refers to the unused broadcasting frequencies in the wireless spectrum that television networks leave between channels for buffering purposes. White space in the wireless spectrum can be used to deliver widespread broadband internet. Research could support "Automated spectrum management tools and capabilities to improve efficiency, flexibility, and adaptiveness to take advantage of temporary spectrum allocations and unlicensed spectrum" (*referring to Element 2.3.5 of the Information Request Checklist in Appendix B, p. B-7*).

Other

The Information Request included a checklist that encompassed elements from the U.S. Government's *National Strategy to Secure 5G & Beyond Implementation Plan*[27] and the *Research and Development Priorities for American Leadership in Wireless Communications*.[28] For each element, agencies were asked to identify if their existing or planned testbed(s) supported these elements, and if the element aligned with their agency mission and operations (i.e., requirements necessitate access to testbeds that can support that element).

Out of 30 elements, 25 had three or more AWTPs identified that either existed or were planned to support those requirements. However, there were 5 elements that had two or fewer AWTPs identified but were noted as high interest or aligned with that agency's interest. Agencies are encouraged to consider adding an AWTP in these areas. These 5 elements are as follows:

- 2.1.6 Technologies and techniques to better control emissions, including out-of-band emissions.
- 2.1.9 Systems that incorporate multifunction and multi-mission capabilities to address and avoid frequency conflict.
- 2.2.5 Increase the speed of information sharing for faster collaboration between heterogeneous spectrum systems (e.g., wireless, radiolocation, radar, meteorological, and science systems), while maintaining privacy and security.
- 2.2.6 Improved sensing and monitoring systems for heterogeneous and adaptive wireless systems.

[27] https://www.ntia.gov/files/ntia/publications/2021-1-12_115445_national_strategy_to_secure_5g_implementation_plan_and_annexes_a_f_final.pdf

[28] https://trumpwhitehouse.archives.gov/wp-content/uploads/2019/05/Research-and-Development-Priorities-for-American-Leadership-in-Wireless-Communications-Report-May-2019.pdf

- 2.3.5 Automated spectrum management tools and capabilities to improve efficiency, flexibility, and adaptiveness to take advantage of temporary spectrum allocations and unlicensed spectrum.

Key Take-Aways

There is no one laboratory or outdoor range that can support the entire scope of research, development, and evaluation of wireless systems that is required by industry and the Federal Government. To accomplish the goals outlined in directives such as the *National Strategy to Secure 5G & Beyond Act Implementation Plan*,[29] and the *Research and Development Priorities for American Leadership in Wireless Communication*,[30] multiple capabilities are required, each with varying levels of technical detail based on intended use. Following are the key take-aways:

1. There is significant progress toward aligning existing testbed capabilities to support national goals as 5G technologies mature and become more readily available. The testbeds with "real" or "emulated" components are evenly distributed. The number of testbeds available for internal (agency only) or external (other agency or non-federal) use is also nearly the same.
2. Significant trade-offs exist between operational response and flexibility when testbed equipment is tailored to a research area, application, or use case.
3. Potential gaps with respect to national priorities indicate an imbalance between agency interests and the capabilities of AWTPs and laboratories. There were 30 elements of these plans related to testbeds captured in the Information Request questionnaire. Results show the following:
    a. There are three or more testbeds (existing or planned) in almost every element.
    b. There are five "light" elements. These are elements with large alignment or interest from the agencies but have two or fewer testbeds associated with that focus.

[29] https://www.ntia.gov/files/ntia/publications/2021-1-12_115445_national_strategy_to_secure_5g_implementation_plan_and_annexes_a_f_final.pdf

[30] https://trumpwhitehouse.archives.gov/wp-content/uploads/2019/05/Research-and-Development-Priorities-for-American-Leadership-in-Wireless-Communications-Report-May-2019.pdf

Next Steps

This report is intended to provide a snapshot overview of the existing and planned capabilities of AWTPs among Federal agencies, identify potential gaps in relation to the national priorities, and serve as a starting point to connect testbed operators and users (see Points of Contacts). To continue the goals of this report and those of the AWTP IWG, the following steps are planned:

- Continue monthly briefings on testbeds at AWTP IWG meetings.
- Elevate any relevant issues or significant gaps to WSRD for inclusion in the WSRD IWG activities and focus areas.
- Create an addendum to capture experiments being conducted at the testbeds.
- Update this report periodically and track progress on the potential gaps.

Points of Contact

For questions about the report, Information Requests, or points of contact for testbeds in this report, please contact the following at nco@nitrd.gov.

AWTP Co-Chairs

Melissa Midzor, Ph.D. (NIST)

Sumit Roy, Ph.D. (OUSD)

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About NITRD

The NITRD Program is the Nation's primary source of federally funded work on pioneering information technologies (IT) in computing, networking, and software. The NITRD Subcommittee of the National Science and Technology Council's Committee on Science and Technology Enterprise guides the multiagency NITRD Program in its work to provide the R&D foundations for ensuring continued U.S. technological leadership and for meeting the needs of the Nation for advanced IT. The National Coordination Office (NCO) supports the NITRD Subcommittee and the IWGs and Teams that report to it. The NITRD Subcommittee's Co-Chairs are Kamie Roberts, NCO Director, and Margaret Martonosi, Assistant Director of the NSF Directorate for Computer and Information Science and Engineering. More information about NITRD is available online at http://www.nitrd.gov/.

The AWTP Team reports to NITRD's Wireless Spectrum Research and Development IWG. More information is available online at https://www.nitrd.gov/coordination-areas/wsrd/.

Acknowledgments

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Appendix A. List of Abbreviations and Acronyms

Item	Spell-out
3GPP	Third Generation Partnership Project
AERPAW	Aerial Experimentation and Research Platform for Advanced Wireless
AWTP	Advanced Wireless Test Platforms
B5G	Beyond 5G
CA	California
CBRS	Citizens Broadband Radio Service
CI	community infrastructure
CO	Colorado
COSMOS	Cloud Enhanced Open Software Defined
COTS	commercial off-the-shelf
CRAIN	Communications Research and Innovation Network
DOD	Department of Defense
DOE	Department of Energy
FDA	Food and Drug Administration
FMG	Federal Mobility Group
FOUO (CUI)	For Official Use Only (Controlled Unclassified Information)
GA	Georgia
GB	Gigabyte
GHz	gigahertz
GSA	General Services Administration
ID	Idaho
IEEE	Institute of Electrical and Electronics Engineers
INL	Idaho National Laboratory
IWG	Interagency Working Group
LEO	low earth orbit
M&S	modeling and simulation
MA	Massachusetts
MD	Maryland
MIMO	multiple-input, multiple-output
mmW	millimeter wave
mm-Wave	millimeter wave
NBIT	NIST Broadband Interoperability Testbed
NC	North Carolina
NCO	National Coordination Office
NIST	National Institute of Standards and Technology
NSF	National Science Foundation
NTIA	National Telecommunications and Information Administration
NY	New York

Item	Spell-out
O-RAN	open radio access network
OUSD	Office of the Under Secretary of Defense
PA	Pennsylvania
POWDER	Platform for Open Wireless Data-driven Experimental Research
RAN	radio access network
RQZ	radio quiet zone
SDR	software-defined radio
TBD	to be determined
UAS	unmanned airborne system(s)
UAV	unmanned aerial vehicle
V2X	vehicle to everything
WSRD	Wireless Spectrum Research and Development

Appendix B. Federal Agencies Advanced Wireless Test Platforms Information Request

References

[1] *Secure 5G & Beyond Implementation Plan*
[2] *FMG Framework to Conduct 5G Testing*
[3] *Research and Development Priorities for American Leadership in Wireless Communications (2019 May WSRD Report)*

Objective

The purpose of this Information Request is to gather information on Federal agency current and planned Advanced Wireless Test Platform (AWTP) capabilities (e.g., current and planned infrastructure, expertise). A short-term goal is to facilitate execution of the Office of Science and Technology Policy (OSTP) "Secure 5G & Beyond Implementation Plan" [1]. This Information Request is meant for Federal Agencies that have existing or planned AWTPs, and for Federal Agencies that need access to AWTPs.

Background

The Wireless Spectrum Research and Development Interagency Working Group (WSRD-IWG) established an Advanced Wireless Test Platforms (AWTP) Team with the following charge.

Purpose and Scope of WSRD/AWTP Team

Provide a forum for interagency coordination on wireless test platforms to ensure access to a nationwide set of diverse testbeds;

Focus resources on technology enhancement and the development of solutions while reducing duplicative costs;

Encourage public-private partnerships; and identify gaps, priorities, and opportunities for interagency collaborations and investments.

Definition of AWTP: An experimental platform that offers controlled and emulated conditions to prototype and test advanced wireless technologies and policies.

The AWTP Team intends to use the FMG report [2] as the basis/starting point to more fully capture the Federal landscape vis-a-vis AWTP capabilities in 2021 and beyond. We use the short-hand '5G' to specifically imply instantiations of 3GPP compliant 5G cellular network technology. The term 'Advanced Wireless' is purposefully broader, encompassing 5G and various beyond 5G (B5G) technologies – including (not an exhaustive list) next-generation Wi-Fi (WiFi7), new airborne networks (enabled by proliferated LEOs, UAVs, High Altitude Platforms) etc. This Information Request is intended to elicit information about all such capabilities. As such, we would greatly appreciate your responses to the Questions below. As representatives of your respective agencies, we trust that you will consult as you see fit to provide the Information Requested. If your agency does not own/operate any AWTP infrastructure, but nonetheless is operationally impacted by ongoing relevant policy/technology considerations, please see Q4 and Q5.

The data will be collected by the AWTP co-chairs, and stored on the AWTP Government-Only web portal. All collected data will be considered FOUO (CUI) at the initial collection, to encourage the maximum sharing between government agencies.

When possible, a subset of the data will be posted on the public facing NITRD/AWTP webpage as appropriate, to encourage interaction between government and commercial testbed operators and users. However, any such data will be vetted and approved by the Government Agency that submitted the data before posting to the public page.

Please send your responses via email to the AWTP coordinator Mallory Hinks at hinks@nitrd.gov by 2/15/2021.

We sincerely appreciate your timely response.

Melissa Midzor, Sumit Roy (AWTP co-chairs)

Information Request: Questions

Q1: Please list your agency and your name/contact info. Please include all appropriate points of contact for various Advanced Wireless Test-bed sites and capabilities.

Q2: What EXISTING AWTP capabilities does your Agency currently own/operate? Please indicate, for example, if your agency owns/operates an LTE network and if that network is available to be used as a test bed. Please provide the following details:

- Location:
- Purpose:
- FY21 Technical Goals:
- Type: {Modeling and Simulations (M&S); Lab/Emulation; Range/Open-Air}
- Existing Infrastructure:
  - Facilities:
  - Equipment:
  - Focus areas of Projects/(Staff Expertise):
- Use Cases/Scenarios of interest:
- Data {How archived, availability}:
- Usage/Availability {Internal only; Internal and External; External only}:
- References/URLs:
- What elements of (OSTP) "Secure 5G & Beyond Implementation Plan" [1] and "Research and Development Priorities for American Leadership in Wireless Communications" [3] does your existing Testbed support? (*Please see checklist*)

Q3: What AWTP capabilities does your agency PLAN to establish or add? If your agency presently owns/operates LTE network infrastructure, for example, please describe any plans for evolution to 5G. Please provide the following details:

- Location:
- Purpose:
- Short and Long Term Technical Goals:
- Type: {Modeling and Simulations (M&S); Lab/Emulation; Range/Open-Air}
- Planned Infrastructure:
  - Facilities:
  - Equipment:
  - Focus areas of Projects/(Staff Expertise):
- Use Cases/Scenarios of interest:
- Data {How archived, availability}:
- Usage/Availability {Internal only; Internal and External; External only}:

- References/URLs:
- What elements of (OSTP) "Secure 5G & Beyond Implementation Plan" [1] and "Research and Development Priorities for American Leadership in Wireless Communications" [3] does your existing Testbed support? (*Please see checklist*)

Q4: Describe your agency's interest in AWTP more broadly. For example, how it might impact your operations and mission. Please provide responses to the following:

- What elements of (OSTP) "Secure 5G & Beyond Implementation Plan" [1] and "Research and Development Priorities for American Leadership in Wireless Communications" [3] aligns with your agency mission and operations? (*Please see checklist*)
- Could your agency provide subject matter expertise, use cases, coordination, access, services, and/or analyses in AWTP testing?
- What other agency AWTP capability has your agency considered using, or have supported, accessed, or reviewed? How did you engage with the other agency? [CRADA, added requirements to annual planning process, IAA, other].

Q5: In the event that your Agency does not own/operate or plan to acquire any AWTP testbeds – please describe your agency's interest in Advanced Wireless broadly from the perspective of how emerging 5G/Beyond 5G technology/policy may nonetheless impact your mission/operations/infrastructure & how WSRD/AWTP group may accommodate your interests.

- What form of coordination with or access to Advanced Wireless/5G network infrastructure operated by other agencies may be of interest (summarize type of access desired, what would be achieved etc.)

Checklist

- What elements of (OSTP) "Secure 5G & Beyond Implementation Plan" [1] and "Research and Development Priorities for American Leadership in Wireless Communications" [3] does your existing or planned Testbed support?
- What elements of (OSTP) "Secure 5G & Beyond Implementation Plan" [1] and "Research and Development Priorities for American Leadership in Wireless Communications" [3] aligns with your agency mission and operations? (i.e. will need/desire access to those testbeds)

		Existing	Planned	Aligns
1	**Secure 5G & Beyond Act Implementation Plan**			
1.1	**R&D: Research and Development to maintain U.S. leadership in 5G and beyond (Activity 1.1)**			
1.1.1	• Advanced communications and networking capabilities necessary to achieve security, resiliency, safety, privacy, capacity, coverage, and performance of 5G and beyond systems at an affordable cost;			
1.1.2	• Trusted end-to-end hardware, software, and network management ecosystem to reduce, manage, and mitigate security vulnerabilities;			
1.1.3	• Technical standards, strong intellectual property rights (IPR)			
1.1.4	• U.S. manufacturing of 5G and beyond systems.			
1b	**Security: Identify/develop/apply security principles for 5G infrastructure in the U.S (Activity 2.5)**			
1c	**Standards: Promote U.S. leadership in international standards development for 5G, including through private sector and international engagement (Activity 4.4)**			
1d	**Joint Testing (international): Joint testing environments with international partners (Activity 4.5)**			
2	**Research and Development Priorities for American Leadership in Wireless Communications**			
2.1	**PRIORITY 1: Pursue spectrum flexibility and agility to use multiple bands and new waveforms.**			
2.1.1	• Advanced antenna arrays and algorithms for all frequency bands of interest. (e.g., massive multiple-input multiple-output [MIMO] antennas, beam forming and steering, antenna nulling, and conformal arrays)			
2.1.2	• Advanced standards for receivers to incorporate new technologies that support new waveforms and multiple bands and reduce susceptibility to out-of-band emissions.			
2.1.3	• Exploiting available degrees of freedom (e.g., frequency, waveform, power, spatial orientation, location, and time) to create new spectrum access technologies.			

		Existing	Planned	Aligns
2.1.4	• Improving dynamic spectrum access for a larger class of wireless systems and frequencies, incorporating both local-to-the-radio and cognitive multidomain, network-centric dynamic spectrum access.			
2.1.5	• Evaluation of interference to Federal assets and protection of radio frequency emissions. Interference tolerance and flexible spectrum access of space-based systems.			
2.1.6	• Technologies and techniques to better control emissions, including out-of-band emissions.			
2.1.7	• (LT)* Advanced spectrum communication and radar technologies (beyond 5G)			
2.1.8	• (LT) Exploitation of degrees of freedom to create new spectrum technologies for flexible and dynamic spectrum access.			
2.1.9	• (LT) Systems that incorporate multifunction and multi-mission capabilities to address and avoid frequency conflict.			
2.2	**PRIORITY 2: Improve near real-time spectrum awareness.**			
2.2.1	• Systems and devices that actively monitor their spectrum environments (e.g., signal strength, interference, directional information, and noise floor) and support adapting operations, frequency bands, and delivery systems (satellite, terrestrial wireless, and WiFi) in near real-time.			
2.2.2	• Flexible and quantitative measures for defining and mitigating interference that incorporate new spectrum sharing technologies.			
2.2.3	• Securely share spectrum environment, system status, and network sensing information across heterogenous devices, systems, and bands.			
2.2.4	• Securely fuse crowd-sourced network sensing information with Federal sensing, monitoring, and enforcement systems, ensuring appropriate levels of privacy. (Identify and/or verify the pedigree and provenance of crowd-sourced data and correlate that to a level of trust.)			
2.2.5	• Increase the speed of information sharing for faster collaboration between heterogeneous spectrum systems (e.g., wireless, radiolocation, radar, meteorological, and science systems), while maintaining privacy and security.			
2.2.6	• Improved sensing and monitoring systems for heterogeneous and adaptive wireless systems.			
2.2.7	• Automated qualitative measurement and analysis of interference coupled with automated reporting of spectrum state information by cognitive wideband and multi-band systems.			

		Existing	Planned	Aligns
2.3	**PRIORITY 3: Increase spectrum efficiency and effectiveness through secure autonomous spectrum decision making**			
2.3.1	• Tools that perform autonomous spectrum decision making based on the current spectrum environment, operational risk assessment, risk management, and business management processes (e.g., cost benefit analysis, security, opportunity costs, national security, public safety, and national economic growth).			
2.3.2	• Tools that assess spectrum utilization technologies from the perspective of spectrum efficiency and mission effectiveness to support adaptive Federal and private spectrum allocations in place of static spectrum allocations and/or assignments to avoid degradation of systems or services.			
2.3.3	• Tools, processes, and procedures that foster closer collaboration and coordination within and between the government and industry on spectrum decision making.			
2.3.4	• (LT) Automation that supports agile, flexible, and adaptive spectrum sharing for all passive and active users. • Examples: – Automation that integrate mission requirements and operationally focused decision making into new spectrum technologies that improve sensor performance while mitigating interference. – Automation that supports dynamically assigning and allocating spectrum while minimizing human intervention or action.			
2.3.5	• (LT) Automated spectrum management tools and capabilities to improve efficiency, flexibility, and adaptiveness to take advantage of temporary spectrum allocations and unlicensed spectrum.			
2.3.6	• (LT) Secure autonomous, dynamic network configurations and operations. • Example: – Increased decentralized spectrum decision making and spectrum sharing between wireless systems in complex, heterogeneous, and congested or contested wireless environments.			
2.3.7	(LT) Better models for characterizing propagation in multiple potential operating conditions (e.g., frequency, waveform, location, modality and propagation environment).			

*Note: LT = long-term strategies proposed by WSRD