

SPECIFICATION

5G RF Channel Emulator

1 Background

Cellular communication networks are rapidly evolving from 4G to 5G as commercial wireless network carriers accelerate their network upgrades worldwide. 5G cellular communication networks and ancillary networking technologies are expected to become a significant testing and verification challenge for the US Navy Electronic Warfare and Cyber Operations research communities.

1.1 Scope

To enable Over the Air (OTA) testing in laboratory environment we plan on upgrading an existing Keysight F8800ARF1 PROPSIM 24 Channel RF propagation channel emulator to 64 Channels with support for the FR1 (Sub-6GHz) 5G frequency band and optionally the FR2 n260 (39 GHz) band. The 5G radio channel is complex, has highly dynamic fading, uses 3D beamforming, and has a highly blocking channel due to Massive MIMO and MMW hybrid beamforming with wide signal bandwidth. This upgrade will allow the RF channel emulator to emulate all of the 5G channel propagation properties, phased array beamforming and real-life deployment scenarios where a 5G cell phone can be moving. It will allow for focused protocol testing prior to real OTA testing, it will save time in research and development of the 5G technologies.

2 Requirements

To cover the scope of this SOW, the requirements have been broken into three separate phases:

1. Basic Award: Upgrade the F8800ARF1 Propsim 24 Channel Emulator to support 64 channels in the 5G FR1 Band: 450 MHz – 6 GHz
2. Option 1: Add the capability to auto-calibrate amplitude and phase for each test setup
3. Option 2: Add 8 additional channels in the 5G FR2 Band: 39 GHz.

At the time of award, a decision will be made as to which of the two optional requirements will be made (none, either one, or both).

2.1 Basic Award: Upgrade the F8800ARF1 Propsim 24 Channel Emulator to support 64 channels in the 5G FR1 Band: 450 MHz – 6 GHz.

The RF channel emulator will support characterization of end-to-end system performance of the latest 4G and 5G base stations and mobile devices by emulating real-world RF environments. The emulator shall meet the following minimum requirements:

Emulation Channels: 64 Bi-directional Ports

Frequency Range: 5G FR1 – 450 MHz – 6 GHz

Instantaneous signal Bandwidth: 160 MHz

- 5G NR Carrier Aggregation Support: ≤ 1200 MHz
- Supported Network Topologies: MIMO, Mesh, and MANET
- Supported MIMO configurations: up to 8x8 bi-directional MIMO channels
- Supported Propagation Channel Models: 3GPP 5G NR TDL Channel Models
- Supported MIMO fading channels: up to 1024 digital channels

- Supported Standard fading profiles: Constant, Rayleigh, Rice, Nakagami, Lognormal, Suzuki, Pure Doppler, flat, rounded, Gaussian, Jakes, Butterworth, and user-defined
- Supported Delay profiles: Constant, sliding delay, 3GPP birth-death, 3GPP sliding delay group, user-defined, and ray-tracing applications
- Ability to introduce White Gaussian Noise as an interference source into each fading channel
- Ability to introduce upto 100 dB of dynamic pathloss/shadowing in each TRX channel independently
- Ability to introduce upto 60 dB dynamic pathloss/shadowing in each digital fading channel independently

2.2 Option 1: Phase and amplitude auto-calibration

Calibrating bi-directional channels is a time-consuming manual process. The vendor shall propose a way to automatically calibrate each channel in both amplitude and phase for each test setup. Having a standard way to calibrate is essential for testing beam forming and beam steering.

2.3 Option 2: Add 8 5G NR FR2 Channels in the n260 (39 GHz) band

The RF channel emulator will support characterization of end-to-end system performance of the latest 4G and 5G base stations and mobile devices by emulating real-world RF environments to include characterizing antennas and beamforming in the 5G NR FR2 band. The emulator shall meet the following additional minimum requirements:

Shall provide Eight bi-directional 5G NR FR2 Channel Emulation ports in the n260(39 GHz) band

Shall provide support for beamforming testing that includes two angles of arrival (AOA)

Shall include 5G Geometric Channel Modeling (GCM) support for 3D antenna models, 3D spatial scenarios and dynamic movement scenarios

Shall provide 5G GCM 3D models for OTA testing support

Shall provide 5G GCM 3D models for multi-beam antennas

2.4 Setup, Training, Documentation, and Warranty

2.4.1 The Contractor shall provide on-site training for the RF channel emulator to include initial system set up, configuration, and maintenance of the system, as well as the completion of operation tasks.

2.4.2 The Contractor shall provide complete documentation of the system and subsystems to include a paper and electronic copy of system level documentation, and electronic copy of user and maintenance manuals for all components.

2.4.3 The Contractor shall warranty the complete system, to include any options exercised, for at least one year. This warranty support shall include the rights to and installation of any software updates that are released during the warranty period.

2.4.4 The Government shall have unlimited usage rights during and at the completion of the warranty period for the permanent use of the RF channel simulator to include any hardware or software upgrades that were delivered during the

warranty period.

2.5 Deliverables

2.5.1 Basic Award – Upgrade to 64 Channels

- F8800U-R60 RF Opt. 6 GHz Channel Unit(CU); Qty: 5
 - F8800U-016 Signal BW 160 MHz 8 TRX ports per CU; Qty: 5
 - F8800ARF1 (SOLN) Channel Unit, 8 TRX ports; Qty: 5
 - o R-47-012-C One year maintenance repair and standard calibration; Qty: 5
 - F8800ASTU (SOLN) Upgrades PROPSIM F64 Standard Tools support; Qty: 1
 - o R-45N-099-A Node-locked license; Qty:1
 - o R-46N-001-L 12 months upgrades and support; Qty:1
 - F8800ASHU (SOLN) Upgrade PROPSIM F64 Shadowing support; QTY: 1
 - o R-45N-099-A Node-locked license; Qty: 1
 - o R-46N-001-L 12 months upgrades and support; Qty: 1
 - F8800AAWU (SOLN) Upgrade PROPSIM F64 AWGN license; Qty: 1
 - o R-45N-099-A Node-locked license
 - o R-46N-001-L 12 months upgrades and support; Qty: 1
 - F8800UM16 (SOLN) Upgrades 1 to 16 MIMO CH; Qty:1
 - o R-45N-099-A Node-locked license
 - o R-46N-001-L 12 months upgrades and support
- PS-XSUP-AESN1 AEO Solution Support Days to be delivered over 12 months from order; Qty: 5

2.5.2 Option 1 – Add Auto Calibration

- F8800C08A Integrated lab setup calibration license for eight (8) Channel Units

2.5.3 Option 2 – Add 8 5G NR FR2 Channels

- E7770A Common Interface Unit; Qty: 1
 - o Hardware Support plan, 1 year; Qty: 1
- M1740A mmWave Transceiver for 5G, RF cable N-SMA 4 m, RF cable TNC-SMA 4m; Qty:4
- F8800AUD1 (SOLN) Remote Radio Head driver; Qty: 4
 - o R-46N-001-L 12 months upgrades and support, node-locked; Qty: 4
 - o R-45N-099-A Node-locked license; Qty: 4
- PS-XSUP-AESN1 AEO Solution Support Days to be delivered over 12 months from order; Qty: 3
- F9860A008 (SOLN) PROPSIM GCM 5G mmWave OTA probe mapping option; Qty: 1
 - o R-46N-001-L 12 months upgrades and support, node-locked; Qty:1
 - o R-45N-99-A Node-locked license; Qty: 1
- F9860A006 (SOLN) PROPSIM GCM 5G multi-beam modeling; Qty: 1
 - o R-46N-001-L 12 months upgrades and support, node-locked; Qty:1
 - o R-45N-99-A Node-locked license; Qty: 1

2.6 Delivery Date and Address

The upgraded 5G RF channel emulator shall be delivered to the following address no later than 120 days from the award.

- a. The contractor shall deliver supplies, all transportation charges paid, in accordance with FAR 52.247-34, FoB Destination (NOV 1991)
- b. Inspection and acceptance will be accomplished by the Authorized Government Representative (AGR) designated below.
- c. Final Inspection and acceptance of all items delivered will be performed at the Delivery Address as follows:

Naval Research Laboratory
4555 Overlook Ave., SW
Washington, DC 20375