

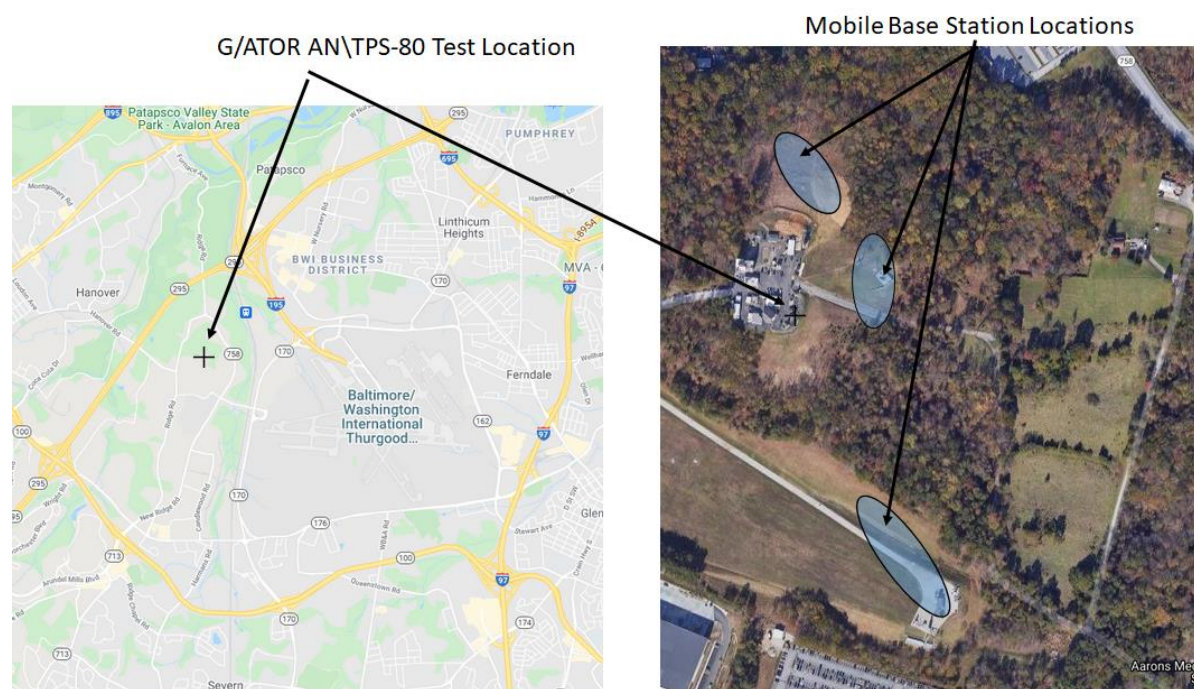
Description of System Purpose and Objective

The purpose of this experiment is to evaluate the levels of interference that may be observed from an AN/TPS-80 radar system to a local 5G network, and *vice versa*. This will be a field study of potential interference, magnitude, and resolution between AN/TPS-80 (G/ATOR) Primary Search Radar performance to and from anticipated local commercial cellular service. This will be accomplished by simulating the roll out of service by providers of 5G services using 5G NR FR1 sub 6 GHz band, including at least band N42 (3400-3550). The test hardware set-up is shown below in Figures 1 and 2. (The radar system will be operated pursuant to existing authority, so the authorization sought herein is solely for operation of the local 5G network simulation equipment.)

5G Equipment

- **Base Station Simulator:** 5G base station network emulator with 5G core stack from KeySight (www.keysight.com). **Model / Part Number:** UXM/E7515B. The UXM is coupled with third Party Power Amplifier, Low Noise Amplifier and Yagi Antenna.
- **Mobile Phone as Transmitter:** Commercial off-the-shelf mobile phone from any OEM e.g. Apple, Google, Samsung or Motorola etc. supporting 5G NR FR1 band inclusive at least band N42 (3400 – 3550), with maximum transmit power to network (uplink) 23 or 26 dbm (depending upon defined Handset Class n of 5).
- **Waveform Information:** Continuous Wave CP-OFDM (Cyclic Prefix – Orthogonal Frequency Division Multiplex) for Down Link (DL) & Up Link (UL). Also DFT-S-OFDM (Discrete Fourier Transform Spread OFDM) for UL.
- **Modulation Code / Signal:**
 - Network to Handset as downlink (DL): QAM (16/64/256), DL/QPSK
 - Handset to Network as Uplink (UL): QAM (16/64/256)
- **Antenna**
 - Orientation (Horizontal and Vertical position): 170 degree Arc around fixed point, from 350 deg to 160 deg referenced to true north; -10 deg ot + 30 deg in elevation relative to horizon
 - Antenna Polarization: Vertical

Field Test 5G Set Up at Northrop Grumman Ridge Road Test Facility



Operational Test Setup

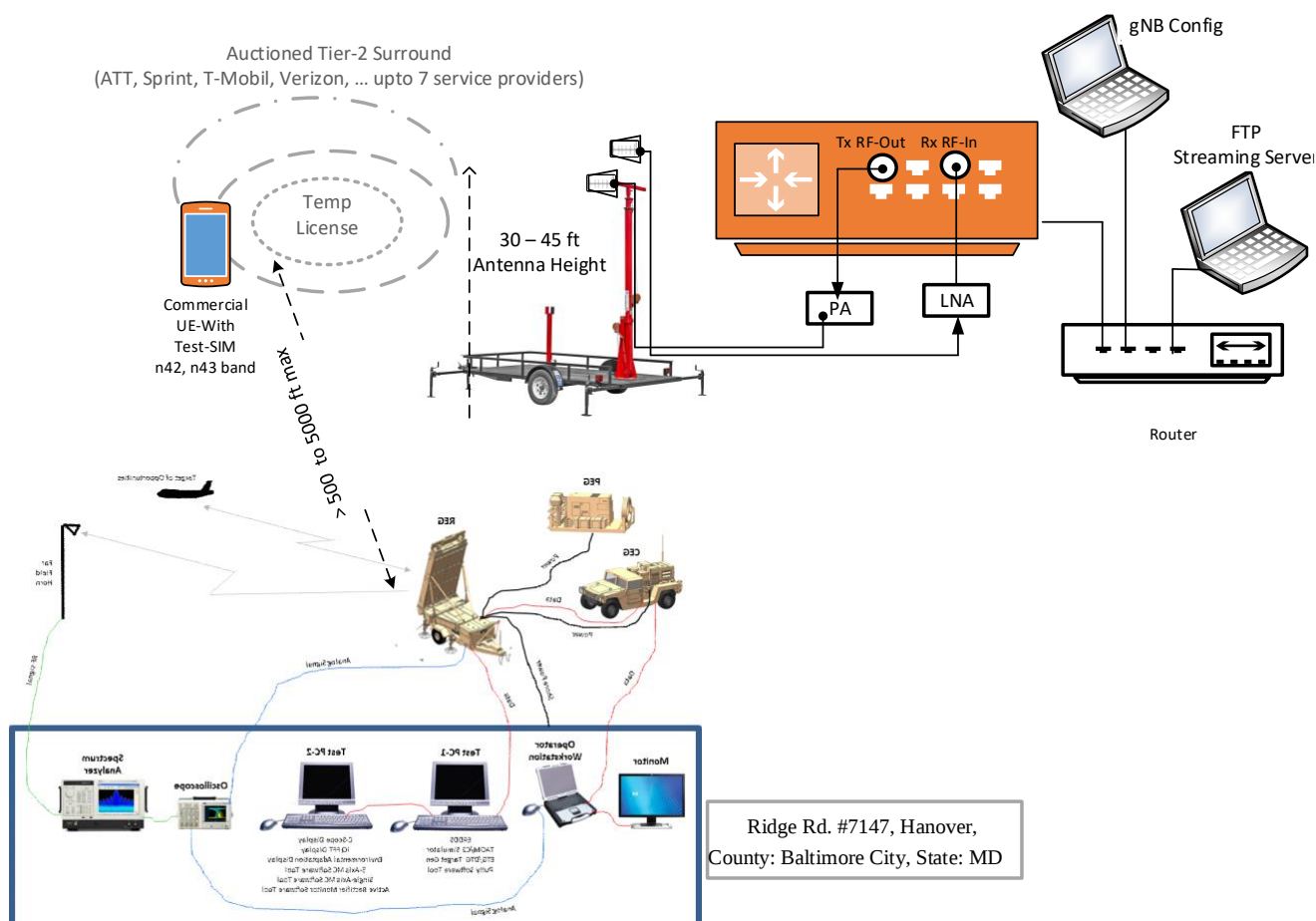


Figure 2: AN/TPS-80 and 5G Test Equipment Field Setup

Abbreviated Test Sequence

1. AN/TPS-80 is operational and is operated independent of experimental 5G Base Station representing potential 5G Service Providers.
2. 5G base station is operating independent of AN/TPS-80.
3. Distance between AN/TPS-80 and 5G Base Station is 100 to 300 meters.
4. 5G base station is configured and powered on, start broadcasting SIB messages.
5. Handset with special test SIM is powered on and camps on 5G-Network emulator.
6. Handset opens up browser and requests high definition video streaming.
7. FTP server start push-downlink (network to Handset) file that is converted to QAM over various resource blocks 5/10/15/20/.../100 MHz channels spread over 5G NR FR1 allocation: 3350 MHz to 3700 MHz as configured on the emulator.
8. The AN/TPS-80 open space has now 5G energy. Evaluations are made regarding impact to AN/TPS-80 High-Side-Tx (ground to air) and Low-Side-Rx (echo from target) performance.
9. The Key Performance Parameters of the AN/TPS-80 are monitored. Test records are archived for study.
10. As a derivative of 5G field set up, handset application Quality of Service (QoS) is observed. Any degradation is noted by CQI (channel quality indicator), the QAM is gradually decreased from 256/64/16 QAM or to QPSK modulated to mitigate any observed interference.

Equipment

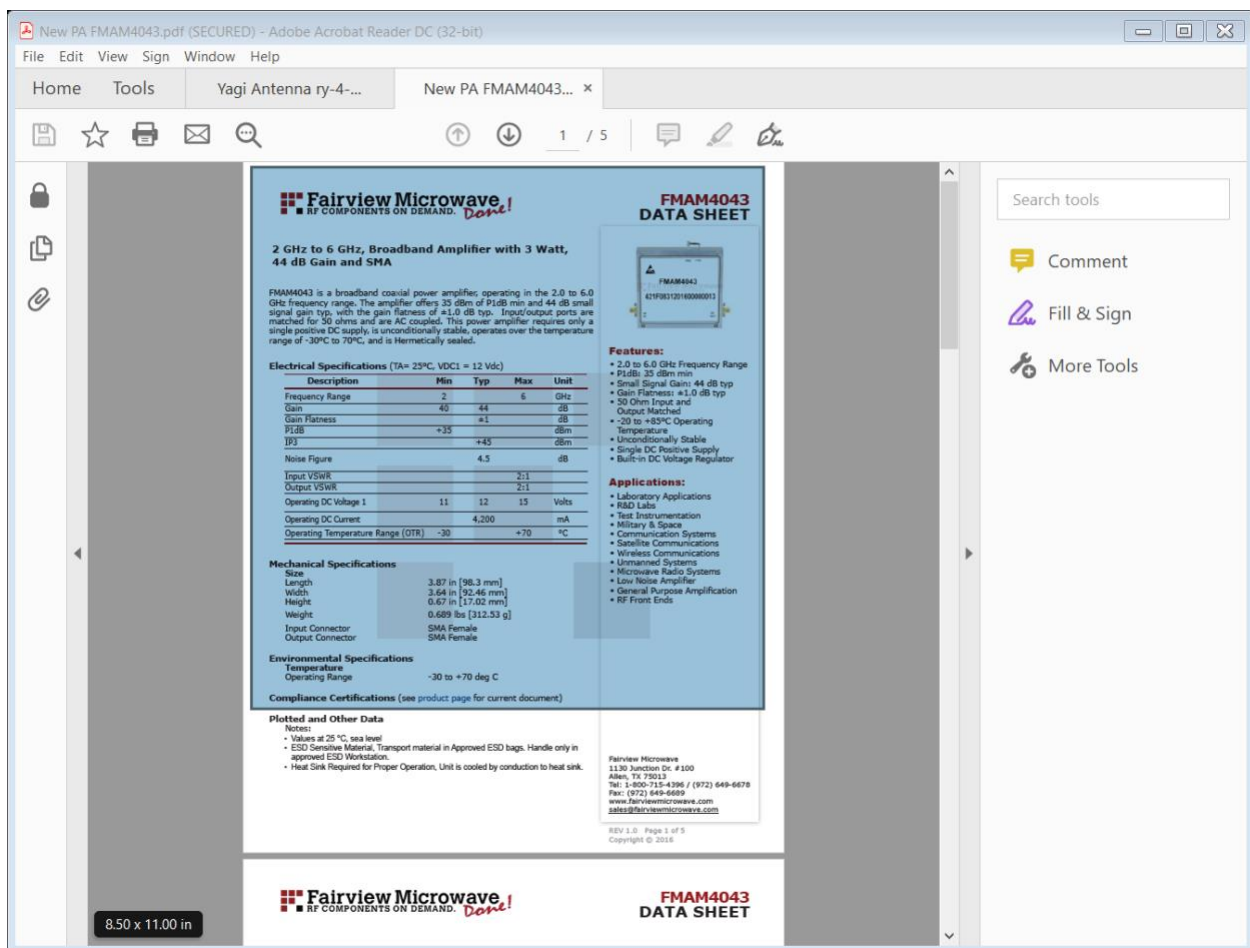


Figure 2A: Power Amplifier attached to gNB

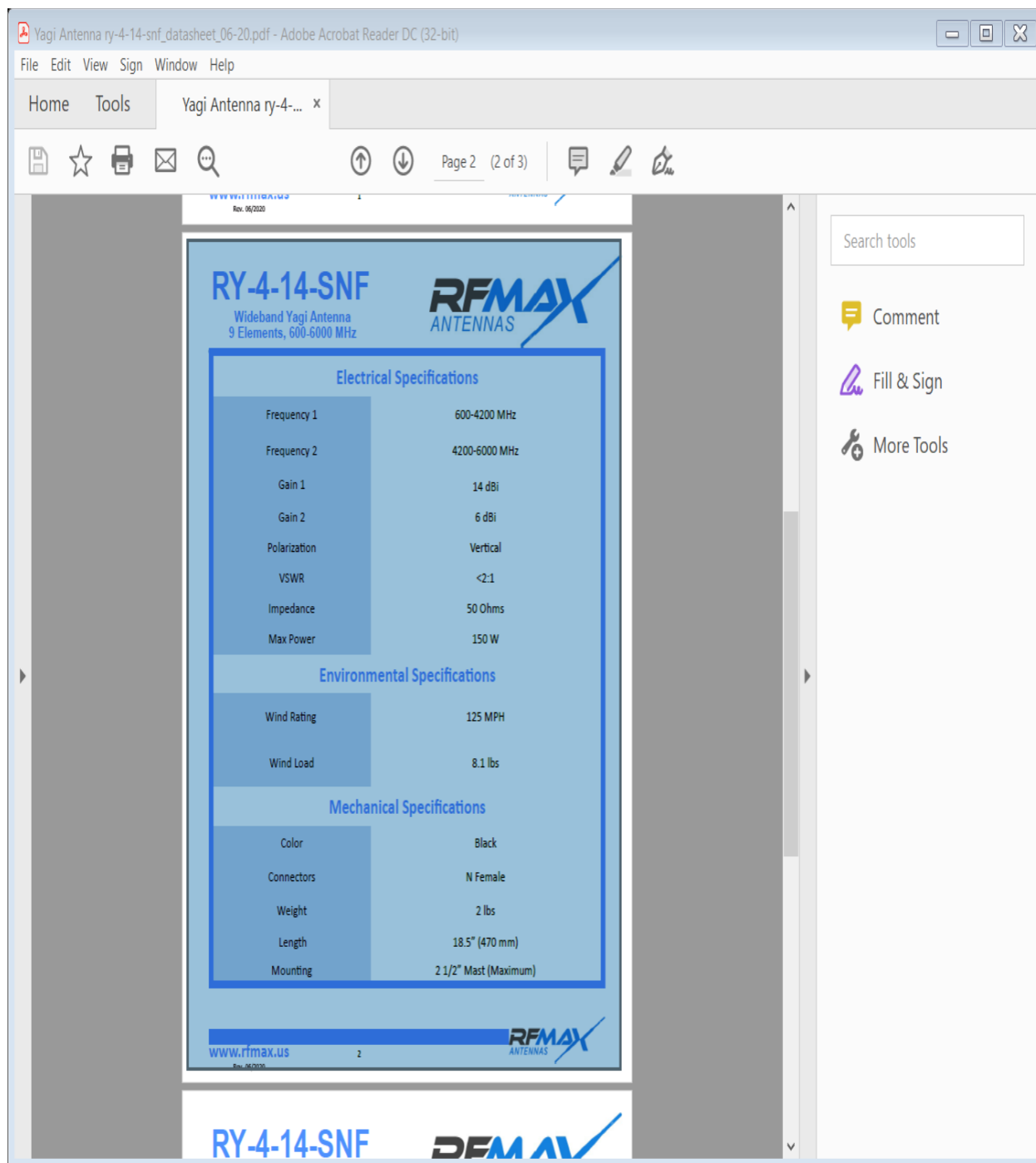


Figure 2B: Yagi antenna attached to PA to maintain link budget at cell edge < -90 dbm.

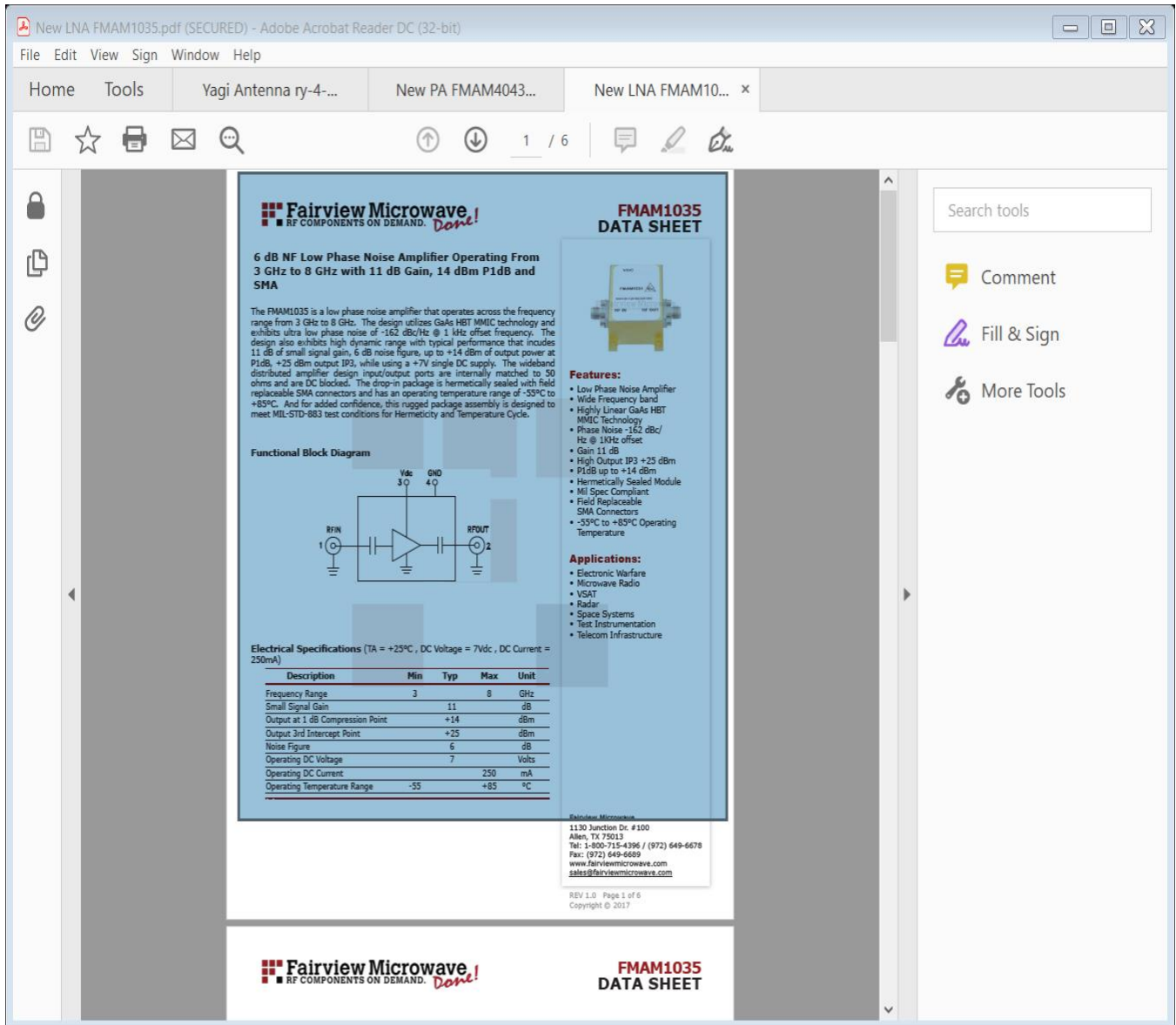


Figure 2C: Low Noise Amplifier attached to gNB to pick uplink from Remote Handset