3400-3550 MHz Experimental License Application for 5G Development Work

1 Introduction

Qualcomm's technologies powered the smartphone revolution and connected billions of people. We pioneered 3G and 4G – and now we are leading the way to 5G and a new era of intelligent, connected devices. Our products are revolutionizing industries, including automotive, computing, IoT, healthcare and data center, and are allowing millions of devices to connect with each other in ways never before imagined. Qualcomm Incorporated includes our licensing business, QTL, and the vast majority of our patent portfolio. Qualcomm Technologies, Inc., a subsidiary of Qualcomm Incorporated, operates, along with its subsidiaries, all of our engineering, research and development functions, and all of our products and services businesses, including, our QCT semiconductor business. For more information, visit Qualcomm's website, OnQ blog, Twitter and Facebook pages.

This experimental license request is in support of a small 5G R&D development and demonstration network contained planned for operation within a 0.5-mile radius of Qualcomm's campus in Sorrento Valley area of San Diego, California. The R&D network will utilize a 100 MHz transmission bandwidth within the frequency range of 3.4-3.55 GHz.

The requested frequency range of 3.4-3.55 GHz is for technology development purposes only and not targeted for future wireless communication deployment in the United States.

2 Experiment Description

The network supported by this experimental license is critical for Qualcomm to develop, validate, and then demonstrate 5G technology wireless communications systems.

Qualcomm designed the network to generate the smallest amount of RF interference to incumbents in the requested frequency range while also providing the RF coverage area required for engineering development and showcasing advanced wireless technology for indoor, outdoor, static and mobility user environments. The network is required to support both conventional passive antennas configurations as well as advanced beam forming technologies that will be utilized by 5G networks.

Deliberate placement and positioning of directional antennas limit the usable engineering RF test coverage area to a 0.5-mile radius with a goal of also limiting the network RF footprint to below the thermal noise floor off the coast of San Diego. Although the EIRP for the fixes sites has been reduced below target EIRP values proposed by 5G network operators, Qualcomm anticipates the carefully designed network will still provide the required engineering value need for the technology development goals.

The network utilizes four fixed sectors to provide the RF coverage area to a maximum of 30 mobile devices anywhere within the 0.5-mile coverage area. Three of the locations utilize one directional antenna while the third site has two directional antennas. The mobile devices can be used in static locations, in vehicles, or in human mobility scenarios. Most mobile testing occurs at ground level but some mobiles may on occasion be located inside buildings exceeding one story.

The intent is to operate the networks 24 hours per day, 7 days per week.

3 Transmitter Information

The test network utilizes a single TDD 100 MHz channel bandwidth transmitted in the range of 3.4-3.550 GHz at a fixed center frequency. The license requests a frequency range wider than a 100 MHz frequency span to provide center frequency flexibility if needed to address technical or interference challenges that may occur during testing. Both fixed and mobile transmitters use OFDM modulation with a FCC emission designator of 100M00W7W.

Table 1 describes the technical parameters of the four fixed sites required for the network that are located on three different buildings. Building "AY" has two directional antennas while the other three sites have only one directional antenna. The EIRP in Table 1 represents the highest EIRP MIMO beamforming operation mode of operation resulting from the achieved beamforming array gain. The EIRP is lower when operating in a non-beamforming mode.

The directional fixed site antennas planned for use have not been selected but are planned to follow the antenna pattern shown in Figure 1 when operating in a beamform configuration. In the beamforming mode, the 3dB beamwidth is anticipated to be approximately 8° in elevation and approximately 2° in azimuth while tracking a target receiver. Without beamforming, the 3dB beamwidth is approximately 8° in elevation and approximately 74° in azimuth. In both cases, the front to back lobe ration is expected to exceed 20dB. Mobile devices use omni directional antennas.

Figures 2 shows the test network area location in San Diego and Figure 3 provides a visual of the resulting RF coverage area required for the engineering activities.

Table 1 Transmitter Information in the frequency range of 3.4-3.550 GHz

Site Name	Longitude Latitude	Ant. Height [m] AGL	Ant. Height (m) AMSL	Azimuth [°]	Total Tilt [°]	EIRP / 100 MHz [dBm]	EIRP / 100 MHz [W]	ERP / 100 MHz [W]	EIRP / 1 Hz [dBm]
Bldg_N	32 53 46 N 117 11 43 W	53	148	35	8	65	3162	1919	-15
Bldg_AY_1	32 54 6 N / 117 11 35 W	26	123	285	4	65	3162	1919	-15
Bldg AY_2	32 54 6 N / 117 11 34 W	26	123	120	0	65	3162	1919	-15
Q_Parking	32 54 11 N / 117 11 58 W	17	124	60	0	65	3162	1919	-15
Mobile Devices	0.5-mile radius	Varies	Varies	Omni	Omni	26	0.40	0.24	-54

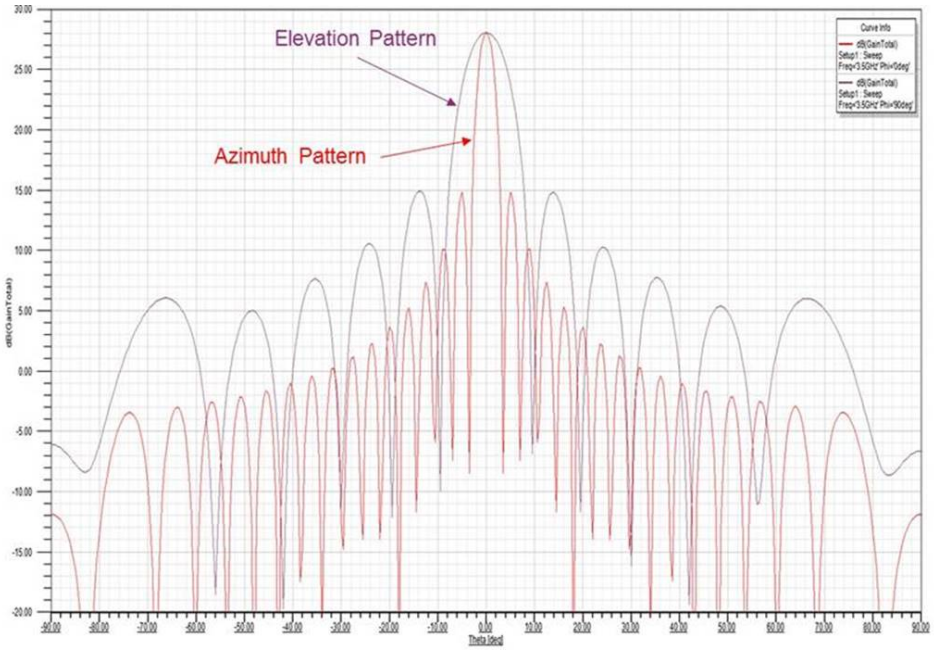
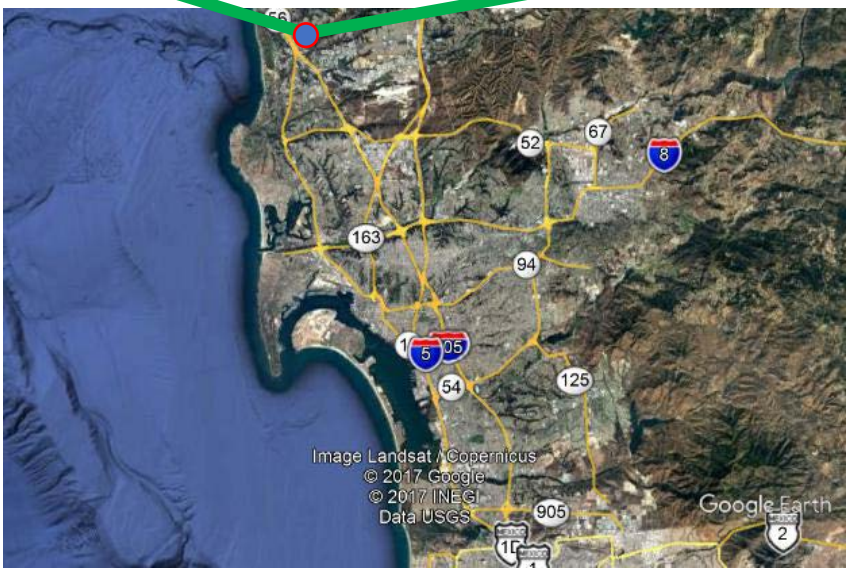


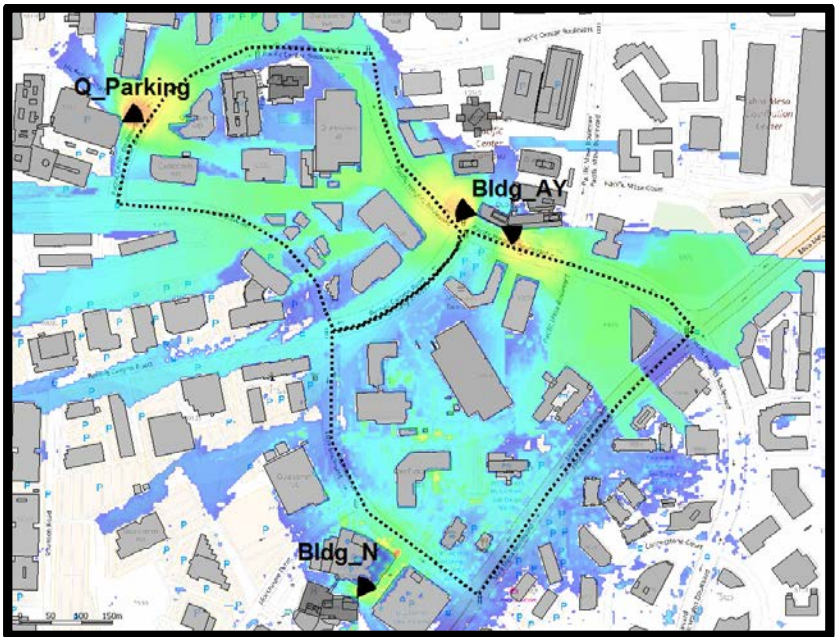
Figure 1 Anticipated Beamforming Antenna Pattern

Zoom showing Sorrento Valley and fixed site



San Diego Area

Figure 2 Test Network Area in San Diego



Site locations depict the directional antenna azimuths

Figure 3 Intended Test Coverage Area

4 Interference Coordination

Immediate requests for Qualcomm to stop transmission should be emailed to 3.4GHz.OTA.shutdown@qualcomm.com. Alternatively, a shutdown requested can be submitted through John Forrester who can be contacted at 858-845-7428 or jforrest@qti.qualcomm.com