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# DISH NETWORK CORPORATION 5G BUILDOUT STATUS REPORT

American H Block Wireless L.L.C., DBSD Corporation, Gamma Acquisition L.L.C., and Manifest Wireless L.L.C., each a wholly-owned subsidiary of DISH Network Corporation (collectively, "DISH"), provide this 5G Buildout Status Report.[1] This report, submitted pursuant to the Wireless Telecommunications Bureau's ("Bureau") *Order of Modification and Extension of Time to Construct*, demonstrates that DISH has satisfied the June 14, 2022 AWS H Block, AWS-4, and Lower 700 MHz E Block deployment obligations set forth in the *Order*.[2] DISH is pleased to certify that, as of June 14, 2022, we offer 5G Broadband Service[3] to **72,769,696** people in the United States. This coverage equals approximately **22 percent** of the total U.S. population according to the 2020 U.S. Census with respect to DISH's AWS-4 and AWS H Block licenses; DISH covers more than 25 percent of the population in those markets where DISH holds a Lower 700 MHz E Block license.

| DISH Licenses | U.S. POPs (2020 Census) | DISH-Covered POPs | Percentage of POPs Covered |
|---|---|---|---|
| AWS-4 | 335,073,176 | 72,769,696 | 21.7% |
| AWS H Block | 335,073,176 | 72,769,696 | 21.7% |
| Lower 700 MHz E Block | 258,642,608 | 67,950,213 | 26.3% |

## I. Background/Summary

In 2019, DISH asked the Federal Communications Commission ("FCC" or "Commission") to extend the construction deadlines associated with its AWS-4, AWS H Block and Lower 700 MHz E Block licenses. This request was made, among other things, to facilitate and expedite DISH's entry into the wireless market as a nationwide facilities-based competitor with a "first-of-its-kind 5G network built from the ground up with an architecture that can take full advantage of expected 5G functionality."[4] As part of the extension request, and consistent with those plans, the Bureau imposed, and DISH accepted, several conditions on those licenses.[5]

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[1] DISH is requesting confidential treatment for the portions of this DISH Network Corporation 5G Buildout Status Report denoted in brackets below.

[2] *See* Applications of American H Block Wireless L.L.C., DBSD Corporation, Gamma Acquisition L.L.C., and Manifest Wireless L.L.C. for Extension of Time, *Order of Modification and Extension of Time to Construct*, WT Docket No. 18-197, 35 FCC Rcd 9580 (WTB 2020) (the "*Order*").

[3] "5G Broadband Service" is defined in the *Order* as a service that is "at least 3GPP Release 15 capable of providing Enhanced Mobile Broadband (eMBB) functionality." *Order*, 35 FCC Rcd at 9594, 9604.

[4] *Id.* at 9594.

[5] In granting the requested construction extensions, the Commission conditioned DISH's AWS-4, AWS-H Block and 700 MHz E Block licenses on the satisfaction of those commitments. *See id.* at 9585.

Among other things, DISH committed that, no later than June 14, 2022, it would offer 5G Broadband Service to at least 20 percent of the U.S. population and have deployed a core network for its AWS-4 licenses (Band-Specific Commitment #3), 700 MHz E Block licenses (Band-Specific Commitment #5), and AWS H Block licenses (Band-Specific Commitment #7).[6] DISH also committed to file a report within 30 days of the date of each commitment with information about the status of DISH's efforts to meet the terms of that commitment.

With this 5G Buildout Status Report, DISH reports on Band-Specific Commitments #3, #5, and #7, and affirms that it has satisfied all three commitments: as of June 14, 2022, DISH offered 5G Broadband Service to at least 20 percent of the U.S. population using its AWS-4 and AWS H Block licenses and the portion of the U.S. population covered by its Lower 700 MHz E Block licenses, and deployed a 5G core network.

DISH has achieved this milestone through deployment of a cloud-native, standalone 5G wireless network, consistent with Open Radio Access Network ("O-RAN") specifications and 3rd Generation Partnership Project ("3GPP") standards. This represents a significant industry first and DISH is the only operator anywhere in the world to deploy this type of wireless network. As DISH continues to deploy and increase coverage with this first-of-its-kind network, it will expand the availability of competitive services offered to both consumer and business customers, increasing competitive pressure on the incumbent carriers. This will benefit American consumers and promote U.S. technology leadership with the rest of the world.

The journey to June 2022 has not been easy, nor has it gone as expected. Even when DISH made these 5G commitments in 2019, we faced a challenging task: constructing a greenfield wireless network using new spectrum bands not widely deployed by incumbent carriers, utilizing a novel network architecture, and coordinating a complex technological vendor ecosystem. Our efforts were underway, but just beginning in earnest, when COVID-19 disrupted the American economy – and much of the world – in March 2020. Since 2019, DISH has overcome a number of ongoing challenges to reach its deployment goals, including:

- We battled supply chain shortages impacting availability and timely delivery of radios and other network equipment, and critical vendors faced their own pandemic-related delays and shortfalls that we were forced to navigate.
- DISH had to carry a greater than expected burden, as an industry technology leader, to ensure all of the O-RAN compliant systems deployed in our 5G network could interoperate, and our efforts paid off.
- Our transport suppliers and their vendors have been battling their own supply chain challenges, contributing to delays in delivering fiber transport connectivity to our 5G sites.
- We faced further challenges and delays in having power available at our 5G sites, due to utilities having to contend with their own supply chain and workforce issues.

[6] *See Order*, 35 FCC Rcd at 9599.

We were able to overcome these and other substantial obstacles through the collaboration, ingenuity, and hard work of our employees and network vendors, which include AWS, Cisco, CommScope, Dell, Fujitsu, Intel, JMA, Mavenir, Nokia, Oracle, Palo Alto, Qualcomm, Samsung and VMware and many other partners and suppliers. We are the only major network in the world built primarily with U.S.-based technology and software vendors.

DISH also grew its workforce as we expanded our wireless efforts, all while navigating the workplace safety protocols made necessary by COVID-19. Since launching our 5G buildout efforts nearly three years ago, DISH has grown its wireless workforce to nearly **[[ ]]** direct employees. In addition, we have relied upon more than **[[ ]]** to support our buildout. And, DISH has opened 39 offices to date across 28 states from coast to coast to provide in-market expertise in support of our network deployment.

## II. Core Network

Band-Specific Commitments #3, #5 and #7 require DISH to have deployed a core network no later than June 14, 2022 utilizing its AWS-4, AWS H Block and Lower 700 MHz E Block licenses. DISH has met these commitments. As of June 14, 2022, DISH has deployed a standalone 5G core network (the "DISH 5G core") supporting services utilizing AWS-4, AWS H Block and Lower 700 MHz E Block spectrum. DISH's 5G core supports 5G data, messaging, Voice over New Radio ("VoNR"), third party interconnection services, voice and data roaming, and applicable regulatory requirements. DISH's 5G core utilizes, among other things, cloud-native microservice-based containerized network functions ("CNFs"). The cloud-native architecture of DISH's 5G core gives the network a unique level of scalability and flexibility that will support growth and allow for real-time management of the dynamic traffic loads on our network.

### A. Core Deployment

DISH's 5G core is deployed with a tiered architecture, and the core elements are deployed in distributed National Data Centers ("NDCs"), Regional Data Centers ("RDCs"), and Breakout Edge Data Centers ("BEDCs") located throughout the U.S. BEDCs are deployed in AWS Local Zones ("LZs") that are connected with DISH's Passthrough Edge Data Centers ("PEDCs"), which serve as a connectivity aggregation point for all Local Data Centers ("LDCs") and cell sites in a particular geography. This layered structure is designed to ensure application resiliency and high availability. Availability Zones ("AZs") are interconnected with high-bandwidth and low-latency networking over redundant, dedicated fiber, which provides networking between AZs.

DISH's network architecture leverages the Amazon Virtual Private Cloud ("Amazon VPC") construct to represent NDCs/RDCs and/or BEDCs ("xDCs"), and to maintain logical separation and security in the networking environment. This virtual network is intended to resemble an on-premises network, but also contains the resources needed for data center functions and management. The VPCs hosting each of the xDCs are interconnected utilizing AWS Transit Gateway via the AWS global network. AWS Transit Gateway is used in AWS Regions to provide connectivity between VPCs deployed in the NDCs, RDCs, and BEDCs.

### B. Roaming

The DISH 5G core has been deployed with third party network interconnection that supports 4G and 5G roaming. The DISH 5G core supports 3GPP-compliant VoNR services on the DISH 5G network and supports Voice over LTE ("VoLTE") roaming through partner networks. DISH 5G customers receive 5G data services on the DISH 5G network and 4G/5G data services through DISH roaming partners. This solution provides DISH customers with nationwide 3GPP-compliant 4G and 5G services through a combination of the DISH 5G network and roaming partner networks.

## III. Band-Specific Commitments

Band-Specific Commitments #3, #5 and #7 also require DISH to "offer 5G Broadband Service to at least 20% of the U.S. population … no later than 6/14/2022"[7] with respect to its AWS-4, AWS H Block, and 700 MHz E Block licenses.[8] Because DISH's 700 MHz E Block licenses cover fewer people in the United States than its AWS-4 and H Block licenses, we report population coverage separately for each band:

| DISH Licenses | U.S. POPs (2020 Census) | DISH-Covered POPs | Percentage of POPs Covered |
|---|---|---|---|
| AWS-4 | 335,073,176 | 72,769,696 | 21.7% |
| AWS H Block | 335,073,176 | 72,769,696 | 21.7% |
| Lower 700 MHz E Block | 258,642,608 | 67,950,213 | 26.3% |

The service DISH is offering meets the definition of 5G Broadband Service included in the *Order*, which is "at least 3GPP Release 15 capable of providing Enhanced Mobile Broadband (eMBB) functionality."[9] DISH's 5G network offers 5G Broadband Service throughout a "5G Coverage Area," which the *Order* specifies is "that area included within the bounds of the polygon shapefile representing geographic coverage for 5G service with coverage based on DISH's ordinary course coverage analysis."[10] To demonstrate that DISH has met these requirements, this submission includes the following information:

- In **Attachment A**, a statement quantifying the U.S. Population covered by DISH's 5G Coverage Area as of June 14, 2022;[11]

[7] *Order*, 35 FCC Rcd at 9599.

[8] In the case of the 700 MHz E Block licenses, where DISH lacks a nationwide footprint, DISH's obligation is to cover 20% of the U.S. population "who are covered by DISH's Lower 700 MHz E Block Licenses." *Id.*

[9] *Id.* at 9604.

[10] *Id*.

[11] "U.S. Population" is defined in the *Order* as "the population of the United States (including the 50 states, Puerto Rico, and the U.S. territories) reported in either the 2010 U.S. Census (312,846,492) or the 2020 U.S. Census (which is expected to be reported in 2021). In its sole discretion, DISH may choose whether to utilize the 2010 or 2020

- In **Confidential Attachment B,** polygon shapefiles showing DISH's 5G Coverage Area as of June 14, 2022, which are being provided confidentially to the Commission as part of a separate submission; [12]

- In **Confidential Attachment C**, coverage maps illustrating DISH's 5G coverage as of June 14, 2022, which are being provided confidentially to the Commission as part of a separate submission;

- In **Confidential Attachment D**, a list of DISH 5G Sites (including information identifying individual sites, *e.g.*, latitude and longitude), spectrum deployed by band per sector, and antenna details, which is being provided confidentially to the Commission as part of a separate submission;[13]

- In **Attachment E**, an engineering statement and the link budgets used to confirm DISH's 5G Coverage Area as of June 14, 2022;

- In **Attachment F**, certifications from DISH engineering executives, Stephen Bye (Executive Vice President, Chief Commercial Officer) and Heather Campbell (Senior Vice President, National RF Engineering), that the representations in the DISH Network Corporation 5G Status Report, including the polygon shapefiles and Attachments A-E, are true and correct.

In the sections below, we also describe our user equipment and offerings, the 5G spectrum bands we have deployed, and the radio access network installed at our 5G Sites.

## IV. Network Deployment

### A. User Equipment and 5G Broadband Service

As of June 14, 2022, all of the DISH 5G Sites in Attachment D were offering 5G Broadband Service (*i.e*. transmitting and receiving signals compliant with 3GPP Release 15, capable of providing eMBB functionality) using DISH's AWS-4, AWS H Block, and 700 MHz E Block licenses.

In May 2022, DISH commercially launched Project Genesis, offering service in Las Vegas. By June 14, 2022, DISH had expanded service to more than 120 cities across the country. Project Genesis is available to anyone in a qualifying location. Consumers can visit https://launch.genesis5g.com/ to learn about current service areas and sign up with Project Genesis for unlimited data, voice and text.

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versions of the U.S. Census in calculating its compliance with its commitments, but DISH must apply the same population total and population distributions to all calculations uniformly." *Id*. at 9605.

[12] "5G Coverage Area" is defined in the *Order* as "that area included within the bounds of the polygon shapefile representing geographic coverage for 5G service with coverage based on DISH's ordinary course coverage analysis." *Id*. at 9604.

[13] "5G Sites" is defined in the *Order* as "macro sites on which 5G radios are deployed." *Id*.

DISH signs up new Project Genesis customers based on a serviceability address check against the DISH 5G Coverage Area. A potential subscriber must first qualify for DISH 5G service based on the address they provide. The address is assigned a latitude and longitude point coordinate using a third party geocoding service. This point is then mapped against the current DISH 5G Coverage Area. If the address point is within our service coverage, the customer proceeds with the enrollment process.

Through Project Genesis, DISH offers the Samsung Galaxy S22, a Netgear mobile hotspot, and the Motorola Edge+. All three devices support 3GPP Band n66, which includes DISH's upper AWS-4 (2180-2200 MHz), along with DISH's 600 MHz licenses (3GPP band n71). We anticipate that device vendors will begin making available user equipment **[[ ]]** that will support 3GPP Band n70 (1995-2020 MHz downlink) and Band n29 (722-728 MHz downlink) that can work on DISH's 5G network. When such devices become available and certified in the U.S., consumers will be able to purchase and use them on DISH's 5G network.

- **Samsung Galaxy S22:** Project Genesis voice and data services on the Samsung Galaxy S22 take advantage of DISH's 5G network, where available, while simultaneously connecting to a partner network. The Galaxy S22 switches between networks, providing DISH customers with voice and data services from multiple networks at any location (where coverage is available). This solution leverages eSIM and multi-SIM technologies.

- **Netgear:** The Netgear device provides Project Genesis customers with DISH 5G data where available, and on partner networks.

- **Motorola Edge+:** The Motorola Edge+, which supports VoNR, is currently available for purchase for customers in Las Vegas. Data services are available on DISH's 5G network, where available, and on partner networks.

DISH was the first provider to launch VoNR in the U.S. and we plan to expand VoNR functionality and the sale of VoNR devices to additional markets in the coming months as we optimize the VoNR experience. Launching a novel wireless voice technology has not been without its challenges. We have had to adapt outdated legacy technologies and practices for VoLTE into a new standalone 5G environment to facilitate compliance with important regulatory and legal requirements, including the location accuracy requirements for enhanced 911 and the Communications Assistance for Law Enforcement Act, among other things.

### B. Spectrum and 3GPP Band Support

As of June 14, 2022, each DISH 5G Site offered service using AWS-4, AWS H Block, and 700 MHz E Block spectrum licenses, consistent with DISH's commitments. DISH has also deployed its 600 MHz licensed spectrum at its 5G Sites. Each DISH 5G Site is capable of providing service over 3GPP Band n66 (2180-2200 MHz downlink), Band n29 (722-728 MHz downlink), and Band n70 (1995-2020 MHz downlink), and utilizes Band n71 for downlink and uplink. To provide enhanced quality of service, DISH is utilizing Carrier Aggregation ("CA") by combining frequencies in 3GPP Band n71 (600 MHz downlink) and 3GPP Band n66 (2180-

2200 MHz downlink). Additional CA combinations will be implemented following 3GPP standards as additional handsets and chipsets become available.

### C. 5G Sites Radio Access Network Technology

The DISH O-RAN network architecture consists of Radio Units ("RUs"), which are deployed on our 5G Sites, and Distributed Units ("DUs"), which control the RUs. The DU is located at or near the base of the 5G Site. The DUs interface with Centralized Units ("CUs"), which are hosted in the BEDC. These combined network elements provide a RAN solution that handles all radio level control and subscriber data traffic. This architecture is compliant with both 3GPP Release 15 and relevant O-RAN specifications.

#### i. Radio Units

DISH's 5G Sites are deployed with two types of Fujitsu 5G RUs: specifically the (i) Dual Band RU TA08025-B604/03 and the (ii) Tri Band RU TA08025-B605/02. Both of these RU models are O-RAN compliant and support the O-RAN 7.2x split.

Specifications for the two primary DISH-deployed RUs are as follows:

# DISH Dual-band RU Technical Specifications

| RU General Specification | |
|---|---|
| TRX Configuration & Part Number | TRX = 4T4R; Part Number = TA08025-B604/03 |
| Operating Frequency | n70 & n66 Frequencies (Dual-Band) |
| Instantaneous Bandwidth | n70: DL:25MHz, UL15MHz<br>n66: DL 90MHz, UL 70MHz |
| Operation Bandwidth | n70: DL:25MHz, UL15MHz<br>n66: DL 90MHz, UL 70MHz |
| CC BW | 5/10/15/20 MHz |
| Interface to DU | ORAN 7.2x / 10G optical IF |
| **TX Specification** | |
| Output Power per TX | n70: 20-40W per port<br>n66: 40-60W per port<br>**Total 80W per port** |
| ACLR | Compliant with 3GPP TS 38.104 |
| Transmitter Spurious Emissions | Compliant with 3GPP TS 38.104 |
| EVM | Compliant with 3GPP TS 38.104 |
| **RX Specification** | |
| Noise Figure | **[[ ]]** |
| Blocking Features | Compliant with 3GPP TS 38.104 |
| Receiver spurious emissions | Compliant with 3GPP TS 38.104 |
| **Mechanical Specification** | |
| Volume | 30 L |
| Dimension | W:400mm, H: 380mm, D: 200mm |
| Antenna Connector Type | 4.3-10 RF connector |
| External alarm port | 1 |
| Antenna Control Interface | AISG |
| Power Supply | DC -58~-36V |
| Power Consumption | Max: 1300W |
| Weight | 29 kg |
| **Environmental** | |
| Humidity (Absolute humidity) | 0.03 g/m3 ~ 30 g/m3 |
| Operating Temperature | -40°C ~ +55°C |
| IP Rating | IP65 |
| Cooling | Passive |
| **Mounting Options** | |
| Pole Kit | PCD4B780-0006-C001 |
| Wall Kit | PCD4B780-0005-C001 |

# DISH Triple-band RU Technical Specifications

| RU General Specification | |
|---|---|
| TRX Configuration & Part Number | TRX = 4T4R; Part Number = TA08025-B605/02 |
| Operating Frequency | n71 & n29 & n26 Frequencies (Triple-Band) |
| Instantaneous Bandwidth | n71: 35MHz<br>n29: 11MHz<br>n26: 7MHz |
| Operation Bandwidth | n71: 35MHz<br>n29: 10MHz<br>n26: 5MHz |
| CC BW | 5/10/20 MHz |
| Interface to DU | ORAN 7.2x / 10G optical IF |
| **TX Specification** | |
| Output Power per TX | n71: 30W per port<br>n29: 40W per port<br>n26: 10 W per port |
| ACLR | Compliant with 3GPP TS 38.104 |
| Transmitter Spurious Emissions | Compliant with 3GPP TS 38.104 |
| EVM | Compliant with 3GPP TS 38.104 |
| **RX Specification** | |
| Noise Figure | **[[ ]]** |
| Blocking Features | Compliant with 3GPP TS 38.104 |
| Receiver spurious emissions | Compliant with 3GPP TS 38.104 |
| **Mechanical Specification** | |
| Volume | 35 L |
| Dimension | W:400mm, H: 380mm, D: 230mm |
| Antenna Connector Type | 4.3-10 RF connector |
| External alarm port | 1 |
| Antenna Control Interface | AISG |
| Power Supply | DC -58~-36V |
| Power Consumption | Max: 1300W |
| Weight | 34 kg |
| **Environmental** | |
| Humidity (Absolute humidity) | 0.03 g/m3 ~ 30 g/m3 |
| Operating Temperature | -40°C ~ +55°C |
| IP Rating | IP65 |
| Cooling | Passive |
| **Mounting Options** | |
| Pole Kit | PCD4B780-0006-C001 |
| Wall Kit | PCD4B780-0005-C001 |

### ii. Antennas

Over 90 percent of our 5G Sites utilize either the (i) JMA Wireless NWAVTM X-Pol 8-Port Antenna (model number MX08FRO665-21), or the (ii) Commscope 8-port sector antenna (model number FFVV-65B-R2). The remaining sites utilize other antennas suitable for special cases, for example where there is less than normal usable vertical space on the tower.

### iii. Compliance with 3GPP Release 15 Standards

DISH's 5G network complies with the following 3GPP Release 15 standards consistent with the commitments adopted in the *Order*.[14]

| Standard | Description |
|---|---|
| 3GPP TS 38.300 | 5G; NR; Overall Description; Stage 2 |
| 3GPP TS 38.104 | 5G; NR; Base Station (BS) Radio Transmission and Reception |
| 3GPP TS 38.141-1 | 5G; NR; Base Station (BS) Conformance Testing Part 1 |
| 3GPP TS 38.321 | 5G; NR; Medium Access Control (MAC) Protocol Specification |
| 3GPP TS 38.322 | 5G; NR; Radio Link Control (RLC) Protocol Specification |
| 3GPP TS 38.323 | 5G; NR; Packet Data Convergence Protocol (PDCP) Specification |
| 3GPP TS 37.324 | Evolved Universal Terrestrial Radio Access (E-UTRA) and NR; Service Data Adaption Protocol (SDAP) Specification |
| 3GPP TS 38.331 | 5G; NR; Radio Resource Control (RRC) Protocol Specification |
| 3GPP TS 38.401 | 5G; NG-RAN; Architecture Description |
| 3GPP TS 38.420 | 5G; NG-RAN; Xn General Aspects and Principles |
| 3GPP TS 38.421 | 5G; NG-RAN; Xn Layer 1 |
| 3GPP TS 38.422 | 5G; NG-RAN; Xn Signaling Transport |
| 3GPP TS 38.423 | 5G; NG-RAN; Xn Application Protocol (XnAP) |
| 3GPP TS 38.424 | 5G; NG-RAN; Xn Data Transport |

[14] *See Order*, 35 FCC Rcd at 9594, 9604.

## V. CONCLUSION

As of June 14, 2022, DISH is offering 5G Broadband Service to at least 20 percent of the U.S. population using its AWS-4 and H Block licenses, and at least 20 percent of the U.S. population associated with its Lower 700 MHz E Block licenses, and has deployed a 5G core network, and thus DISH has satisfied Band-Specific Commitments #3, #5 and #7.

# ATTACHMENT A: STATEMENT OF POPULATION COVERED

The calculations described herein, made consistent with the requirements of the *Order*, demonstrate that as of June 14, 2022, DISH's 5G network covered 21.7 percent of the U.S. population.[15] For purposes of this report, DISH is relying on 2020 U.S. Census data, which reports the total U.S. Population as 335,073,176. This is the population number used to calculate coverage percentages for DISH's AWS-4 and AWS H Block licenses. DISH holds Lower 700 MHz E Block licenses in all but eight license areas. Therefore, for the E Block licenses, DISH uses 258,642,608 as the population denominator. The basis for DISH's population calculations are set forth below in Table 1 (basis for total U.S. population) and Table 2 (basis for population coverage of DISH's Lower 700 MHz E Block licenses).

DISH's signal coverage analysis was calculated using network design within the Planet (by Infovista) tool, version 7.6. DISH used the Planet P3M propagation model, which is a 3D model that supports the spectrum bands deployed by DISH.

DISH utilized three sets of detailed geodata to develop the network design within the Planet tool:

- 1 meter resolution data with 3D building polygons for Core Dense Urban areas with a Digital Surface Model
- 5 meter resolution with 2.5D clutter height per bin information for outer Dense Urban/Urban/Suburban areas
- 10 meter resolution data with average clutter height per market for remaining areas

To further improve the P3M propagation model's accuracy, DISH acquired Continuous Wave measurements (through drive testing) to fine-tune the propagation model parameters. This process included:

- Collecting required inputs (such as geodata and accurate transmitter locations) that were used to gather CW data
- Configuring the model (matching the frequency used when collecting the drive test data with the frequency in the propagation model)
- Tuning the propagation model
- Investigating discrepancies between the drive test data and the prediction layer (if any)
- Validating the propagation model parameters using standard industry practices

After the coverage analysis was completed, DISH utilized the FCC's "centroid" methodology[16] to calculate the resulting covered population. Following this methodology, all

[15] While the polygon shapefiles associated with this filing depict the lower-48 contiguous states, DISH used the entire U.S. population (including all 50 states, Puerto Rico, and the U.S. territories) in calculating the percentage of the U.S. population covered.

[16] *See, e.g.*, Public Notice, *FCC Releases Data on Mobile Broadband Deployment as of December 31, 2015 Collected Through FCC Form 477*, DA 16-1107, ¶ 12 (rel. Sept. 30, 2016).

geographic polygons with wireless coverage were overlaid onto the U.S. map of census blocks. Census blocks are the smallest unit of tabulation geography defined by the U.S Census Bureau. Each census block was marked as "covered" if the centroid of the census block (the calculated center point of the census block) was within the coverage polygon. If the centroid was covered, then all of the population associated with that census block was counted as covered and included in DISH's covered population calculation. If the centroid was not within the coverage polygon, then the population associated with that census block was not included in DISH's covered population calculation.

**Table 1: Total U.S. Population Calculation**

| U.S. State/Territory | 2020 U.S. Census POPs |
|---|---|
| United States (50 states) | 331,449,281 |
| Puerto Rico | 3,285,874 |
| U.S. Virgin Islands | 87,146 |
| American Samoa | 49,710 |
| Guam | 153,836 |
| Northern Mariana Islands | 47,329 |
| **Total** | **335,073,176** |

**Table 2: Lower 700 MHz E Block Total Population**

| Market No. | Market Name | 2020 U.S. POPs |
|---|---|---|
| *Total 2020 U.S. POPs* | | *335,073,176* |
| BEA003 | Boston-Worcester MA-NH-RI-VT | (8,815,492) |
| BEA010 | NYC-Long Is. NY-NJ-CT-PA-MA-VT | (28,020,320) |
| BEA012 | Phil.-Atl. City PA-NJ-DE-MD | (8,075,733) |
| BEA160 | LA-Riverside-Orange County CA-AZ | (20,684,708) |
| BEA163 | San Fran.-Oakland-San Jose CA | (10,583,440) |
| BEA173 | Guam-Northern Mariana Islands | (201,165) |

| Market No. | Market Name | 2020 U.S. POPs |
|---|---|---|
| BEA175 | American Samoa | (49,710) |
| BEA176 | Gulf of Mexico | 0 |
| | **TOTAL E Block POPs** | **258,642,608** |

# ATTACHMENT E: ENGINEERING STATEMENT AND LINK BUDGETS

This exhibit describes the engineering methodology and assumptions used to confirm that DISH's 5G Coverage Area is offering 5G Broadband Service to at least 20 percent of the U.S. population using its AWS-4 and H Block licenses, and at least 20 percent of the U.S. population associated with its Lower 700 MHz E Block licenses. DISH's predicted 5G coverage calculations are based on an indoor coverage environment and industry-standard practices. As shown in our band-specific link budgets, DISH assumed an appropriate signal loss for penetration of an exterior building wall, with the signal loss tailored to the propagation characteristics of each band.

Below, DISH provides four separate link budgets based on the following 3GPP bands: (i) Band n29 (for 722-728 MHz) (Table 1); (ii) Band n66 (for DISH's licensed 2180-2200 MHz) (Table 2); (iii) Band n70 (for DISH's licensed 1995-2020 MHz) (Table 3); and (iv) Band n71 (600 MHz) (Table 4).

The *Order* does not yet require DISH to make any buildout demonstrations for Band n71, because there is no 600 MHz buildout deadline due on June 14, 2022.[17] However, Band-Specific Commitments #3, #5, and #7 all cover downlink-only bands, requiring DISH to use uplink spectrum from another band. DISH is therefore providing a link budget for the Band n71 (600 MHz) spectrum it has paired with its downlink bands to offer 5G Broadband Service.

**Band n29 Link Budget**

3GPP Band n29 is an unpaired band within the lower 700 MHz band that is suited for Supplemental Downlink ("SDL"). DISH holds licenses in certain markets for 722-728 MHz, which is the Lower 700 MHz E Block.

When pairing 3GPP Band n29 downlink ("DL") with Band n71 uplink ("UL"), the Band n29 transmit power must be adjusted so that the Band n29 Maximum Allowable Path Loss ("MAPL") and the Band n71 MAPL are balanced.

[17] *See Order*, 35 FCC Rcd at 9595-96, 9599.

*Table 1. Band n29 Link Budget*

| NR Link Budget | | n29 4T | Comments |
|---|---|---|---|
| | | Downlink (5 MHz SDL) | |
| **General Parameters** | | | |
| Frequency | MHz | 723 | Operating Frequency (DISH owns n29, n71, n66, and n70 licenses) |
| Carrier Bandwidth | MHz | 5 | Block channel bandwidth (DISH owns 5, 10, 15, and 20 MHz channels) |
| Subcarrier Separation | kHz | 15 | Minimum Subcarrier spacing required in 5G |
| Total PRBs | Num | 25 | Total number of resource blocks (depending on the size of the channel) |
| Target BLER | % | [[ ]] | Number of erroneous blocks / the Total number of blocks received |
| Cell Edge Modulation Efficiency | bps/Hz | [[ ]] | Modulation efficiency at the cell edge |
| Cell Edge Target L2 Tput (est) | Mbps | [[ ]] | Targeted throughput at the cell edge |
| **Tx Parameters** | | | |
| Tx output power per path | dBm | 43 | Transmit power per transmit path (30 Watts Band n71, 40 Watts Band n66, 40 Watts Band n70, and 20 Watts Band n29) |
| Tx antenna gain | dBi | 14.8 | Antenna gain representative of a 6 foot dual band antenna (617-894 MHz) and (1695-2200 MHz) |
| No of Tx Antennas | Num | 4 | Number of Transmit Antennas |
| Combining gain | dB | 6 | Gain obtained by co-phasing signals and adding them up |
| Tx feeder + jumper (Other) losses | dB | 0.5 | RRUs are located close to the antenna, minimizing cable length |

| NR Link Budget | | n29 4T | Comments |
|---|---|---|---|
| | | Downlink (5 MHz SDL) | |
| **General Parameters** | | | |
| Total EiRP | dBm | [[ ]] | Effective Isotropic Radiated Power (EIRP) is the maximum power emitted by the antenna in the direction with highest antenna gain |
| **Rx Parameters** | | | |
| Thermal noise density | dBm/Hz | -174 | Standard noise power spectral density at room temperature |
| Number of PRBs Occupied | Num | 20 | Minimum information needed to radiate SSB block DL (20 PRBs). 20 PRBs is equivalent to [[ ]] Subcarriers. |
| Number of Subcarriers | Num | [[ ]] | One NR Resource Block contains 12 Subcarriers |
| EIRP per Subcarrier | dBm | [[ ]] | |
| Noise Bandwidth | Hz | 4,500,000 | Noise Bandwidth will define thermal noise floor (below) |
| Thermal noise power | dBm | [[ ]] | Noise created by temperature and its components thermal characteristics |
| Required MCS | Num | [[ ]] | Required Modulation Code Scheme |
| Required SINR | dB | [[ ]] | Required Signal to Noise Ratio |
| Rx noise figure | dB | 9 | Noise figure is a number by which the noise performance of a radio receiver is being presented |
| Thermal noise power per subcarrier | dBm | [[ ]] | |
| Rx noise floor (per antenna) | dBm | [[ ]] | Receiver noise floor = Thermal noise power + Receiver Noise Figure |
| Rx noise floor (Combined) | dBm | [[ ]] | |
| Rx sensitivity | dBm | [[ ]] | Minimum detectable signal strength level |

| NR Link Budget | | n29 4T | Comments |
|---|---|---|---|
| | | Downlink (5 MHz SDL) | |
| **General Parameters** | | | |
| Rx antenna gain | dBi | -4 | Performance parameter which combines the antenna's directivity and radiation efficiency |
| **System Margins** | | | |
| Number of RX Antennas | Num | 2 | Number of Receiving Antennas |
| Rx Combining and other losses | dB | 1 | Cable losses |
| Min Signal Reception Strength (Combined) | dBm | [[ ]] | |
| System MAPL | dB | [[ ]] | System Maximum Allowable Path loss |
| **Margins** | | | |
| Frequency Selective Gain | dB | 0 | Gain achieved based upon the scheduler being able to select the best conditions for a given user |
| TX Switch Diversity Gain | dB | 0 | Gain achieved by multiple antennas which uses equalization to obtain diversity gain against fading |
| Head and Body Loss | dB | [[ ]] | Loss created by keeping the device close to the body |
| Implementation & Temperature Loss | dB | 1 | |
| MAPL | dB | [[ ]] | |
| Limiting MAPL | dB | [[ ]] | |
| Suburban Slow Fade Margin | dB | [[ ]] | Based upon Slow Fade Margin (Shadowing Margin) for Suburban environment and [[ ]] cell area coverage probability |

| NR Link Budget | | n29 4T | Comments |
|---|---|---|---|
| | | Downlink (5 MHz SDL) | |
| **General Parameters** | | | |
| Suburban Fading Standard Deviation | dB | 6 | Suburban morphology |
| Indoor Suburban Loss | dB | 6 | Effect of signal loss when penetrating suburban structures |
| Interference Margin | dB | 3 | Loading Conditions |
| Best Server/Handover Gain | dB | [[ ]] | UE at cell edge can handover to neighboring cells with more favorable fade margin |
| Design MAPL with [[ ]] Area Probability | dB | [[ ]] | |
| RSRP | dBm | [[ ]] | Power level of the received pilot signal (Reference Signal) from the base station. Band n71 uplink limited. |

## Band n66 Link Budget

DISH's allocation of 3GPP Band n66 includes an unpaired DL component (2180 – 2200 MHz) of the band. This is currently utilized as the aggregated carrier to 3GPP Band n71 to enhance DL data services.

***Table 2. Band n66 Link Budget***

| NR Link Budget | | n66_4T | Comments |
|---|---|---|---|
| | | Downlink (20 MHz SDL) | |
| **General Parameters** | | | |
| Frequency | MHz | 2190 | Operating Frequency (DISH owns n29, n71, n66, and n70 licenses) |
| Carrier Bandwidth | MHz | 20 | Block channel bandwidth (DISH owns 5, 10, 15, and 20 MHz channels) |
| Subcarrier Separation | kHz | 15 | Minimum Subcarrier spacing required in 5G |
| Total PRBs | Num | 106 | Total number of resource blocks (depending on the size of the channel) |
| Target BLER | % | [[ ]] | Number of erroneous blocks / the Total number of blocks received |
| Cell Edge Modulation Efficiency | bps/Hz | [[ ]] | Modulation efficiency at the cell edge |
| Cell Edge Target L2 Tput (est) | Mbps | [[ ]] | Targeted throughput at the cell edge |
| **Tx Parameters** | | | |
| Tx output power per path | dBm | 46 | Transmit power per transmit path (30 Watts Band n71, 40 Watts Band n66, 40 Watts Band n70, and 20 Watts Band n29) |
| Tx antenna gain | dBi | 18.8 | Antenna gain representative of a 6 foot dual band antenna (617-894 MHz) and (1695-2200 MHz) |
| No of Tx Antennas | Num | 4 | Number of Transmit Antennas |
| Combining gain | dB | 6 | Gain obtained by co-phasing signals and adding them up |

| NR Link Budget | | n66_4T | Comments |
|---|---|---|---|
| | | Downlink (20 MHz SDL) | |
| **General Parameters** | | | |
| Tx feeder + jumper (Other) losses | dB | 0.5 | RRUs are located close to the antenna, minimizing cable length |
| Total EiRP | dBm | [[ ]] | Effective Isotropic Radiated Power (EIRP) is the maximum power emitted by the antenna in the direction with highest antenna gain |
| **Rx Parameters** | | | |
| Thermal noise density | dBm/Hz | -174 | Standard noise power spectral density at room temperature |
| Number of PRBs Occupied | Num | 20 | Minimum information needed to radiate SSB block DL (20 PRBs). 20 PRBs is equivalent to [[ ]] Subcarriers. |
| Number of Subcarriers | Num | [[ ]] | One NR Resource Block contains 12 Subcarriers |
| EIRP per Subcarrier | dBm | [[ ]] | |
| Noise Bandwidth | Hz | 19,080,000 | Noise Bandwidth will define thermal noise floor (below) |
| Thermal noise power | dBm | [[ ]] | Noise created by temperature and its components thermal characteristics |
| Required MCS | Num | [[ ]] | Required Modulation Code Scheme |
| Required SINR | dB | [[ ]] | Required Signal to Noise Ratio |
| Rx noise figure | dB | 7 | Noise figure is a number by which the noise performance of a radio receiver is being presented |
| Rx noise floor (per antenna) | dBm | [[ ]] | Receiver noise floor = Thermal noise power + Receiver Noise Figure |
| Rx noise floor (Combined) | dBm | [[ ]] | |
| Rx sensitivity | dBm | [[ ]] | Minimum detectable signal strength level |
| Rx antenna gain | dBi | -4 | Performance parameter which combines the antenna's directivity and radiation efficiency |
| **System Margins** | | | |

| NR Link Budget | | n66_4T | Comments |
|---|---|---|---|
| | | Downlink (20 MHz SDL) | |
| **General Parameters** | | | |
| Number of RX Antennas | Num | 4 | Number of Receiving Antennas |
| Rx Combining and other losses | dB | 1 | Cable losses |
| Min Signal Reception Strength (Combined) | dBm | [[ ]] | |
| System MAPL | dB | [[ ]] | System Maximum Allowable Path loss |
| **Margins** | | | |
| Frequency Selective Gain | dB | 0 | Gain achieved based upon the scheduler being able to select the best conditions for a given user |
| TX Switch Diversity Gain | dB | 0 | Gain achieved by multiple antennas which uses equalization to obtain diversity gain against fading |
| Head and Body Loss | dB | [[ ]] | Loss created by keeping device close to the body |
| Implementation & Temperature Loss | dB | 1 | |
| MAPL | dB | [[ ]] | |
| Limiting MAPL | dB | [[ ]] | |
| Suburban Slow Fade Margin | dB | [[ ]] | Based upon Slow Fade Margin (Shadowing Margin) for Suburban environment and [[ ]] cell area coverage probability |
| Suburban Fading Standard Deviation | dB | 6 | Suburban morphology |
| Indoor Suburban Loss | dB | 8 | Effect of signal loss when penetrating suburban structures |
| Interference Margin | dB | 3 | Loading Conditions |
| Best Server/Handover Gain | dB | [[ ]] | UE at cell edge can handover to neighboring cells with more favorable fade margin |
| Design MAPL with [[ ]] Area Probability | dB | [[ ]] | |

| NR Link Budget<br>General Parameters | | n66_4T<br>Downlink<br>(20 MHz SDL) | Comments |
|---|---|---|---|
| RSRP | dBm | [[ ]] | Power level of the received pilot signal (Reference Signal) from the base station. Band n71 uplink limited. |

## Band n70 Link Budget

3GPP Band n70 comprises lower AWS-4 spectrum (2000 MHz-2020 MHz) and AWS H Block downlink spectrum (1995 MHz-2000 MHz), and is also utilized as SDL.

***Table 3. Band n70 Link Budget***

| NR Link Budget | | n70_4T | Comments |
|---|---|---|---|
| | | Downlink (25 MHz SDL) | |
| **General Parameters** | | | |
| Frequency | MHz | 2007 | Operating Frequency (DISH owns n29, n71, n66, and n70 licenses) |
| Carrier Bandwidth | MHz | 25 | Block channel bandwidth (DISH owns 5, 10, 15, and 20 MHz channels) |
| Subcarrier Separation | kHz | 15 | Minimum Subcarrier spacing required in 5G |
| Total PRBs | Num | 106 | Total number of resource blocks (depending on the size of the channel) |
| Target BLER | % | [[ ]] | Number of erroneous blocks / the Total number of blocks received |
| Cell Edge Modulation Efficiency | bps/Hz | [[ ]] | Modulation efficiency at the cell edge |
| Cell Edge Target L2 Tput (est) | Mbps | [[ ]] | Targeted throughput at the cell edge |
| **Tx Parameters** | | | |
| Tx output power per path | dBm | 46 | Transmit power per transmit path (30 Watts Band n71, 40 Watts Band n66, 40 Watts Band n70, and 20 Watts Band n29) |
| Tx antenna gain | dBi | 18.8 | Antenna gain representative of a 6 foot dual band antenna (617-894 MHz) and (1695-2200 MHz) |
| No of Tx Antenna | Num | 4 | Number of Transmit Antennas |
| Combining gain | dB | 6 | Gain obtained by co-phasing signals and adding them up |

| NR Link Budget | | n70_4T | Comments |
|---|---|---|---|
| | | Downlink (25 MHz SDL) | |
| **General Parameters** | | | |
| Tx feeder + jumper (Other) losses | dB | 0.5 | RRUs are located close to the antenna, minimizing cable length |
| Total EiRP | dBm | [[ ]] | Effective Isotropic Radiated Power (EIRP) is the maximum power emitted by the antenna in the direction with highest antenna gain |
| **Rx Parameters** | | | |
| Thermal noise density | dBm/Hz | -174 | Standard noise power spectral density at room temperature |
| Number of PRBs Occupied | Num | 20 | Minimum information needed to radiate SSB block DL (20 PRBs). 20 PRBs is equivalent to [[ ]] Subcarriers |
| Number of Subcarriers | Num | [[ ]] | One NR Resource Block contains 12 Subcarriers |
| EIRP per Subcarrier | dBm | [[ ]] | |
| Noise Bandwidth | Hz | 19,080,000 | Noise Bandwidth will define thermal noise floor (below) |
| Thermal noise power | dBm | [[ ]] | Noise created by temperature and its components thermal characteristics |
| Required MCS | Num | [[ ]] | Required Modulation Code Scheme |
| Required SINR | dB | [[ ]] | Required Signal to Noise Ratio |
| Rx noise figure | dB | 7 | Noise figure is a number by which the noise performance of a radio receiver is being presented |
| Thermal noise power per subcarrier | dBm | [[ ]] | |
| Rx noise floor (per antenna) | dBm | [[ ]] | Receiver noise floor = Thermal noise power + Receiver Noise Figure |
| Rx noise floor (Combined) | dBm | [[ ]] | |

| NR Link Budget | | n70_4T | Comments |
|---|---|---|---|
| | | Downlink (25 MHz SDL) | |
| **General Parameters** | | | |
| Rx sensitivity | dBm | [[ ]] | Minimum detectable signal strength level |
| Rx antenna gain | dBi | -4 | Performance parameter which combines the antenna's directivity and radiation efficiency |
| **System Margins** | | | |
| Number of RX Antennas | Num | 4 | Number of Receiving Antennas |
| Rx Combining and other losses | dB | 1 | Cable losses |
| Min Signal Reception Strength (Combined) | dBm | [[ ]] | |
| System MAPL | dB | [[ ]] | System Maximum Allowable Path loss |
| **Margins** | | | |
| Frequency Selective Gain | dB | 0 | Gain achieved based upon the scheduler being able to select best conditions for a given user |
| TX Switch Diversity Gain | dB | 0 | Gain achieved by multiple antennas which uses equalization to obtain diversity gain against fading |
| Head and Body Loss | dB | [[ ]] | Loss created by keeping the device close to the body |
| Implementation & Temperature Loss | dB | 1 | |
| MAPL | dB | [[ ]] | |
| Limiting MAPL | dB | [[ ]] | |
| Suburban Slow Fade Margin | dB | [[ ]] | Based upon Slow Fade Margin for Suburban environment and [[ ]] cell area coverage probability |

| NR Link Budget<br>General Parameters | | n70_4T<br>Downlink<br>(25 MHz SDL) | Comments |
|---|---|---|---|
| Suburban Fading Standard Deviation | dB | 6 | Suburban morphology |
| Indoor Suburban Loss | dB | 8 | Effect of signal loss when penetrating suburban structures |
| Interference Margin | dB | 3 | Loading Conditions |
| Best Server/Handover Gain | dB | [[ ]] | UE at cell edge can handover to neighboring cells with more favorable fade margin |
| Design MAPL with [[ ]] Area Probability | dB | [[ ]] | |
| RSRP | dBm | [[ ]] | Power level of the received pilot signal (Reference Signal) from the base station. Band n71 uplink limited. |

## Band n71 Link Budget

***Table 4. Band n71 Link Budget***

| NR Link Budget | | n71 4T4R | | Comments |
|---|---|---|---|---|
| | | Downlink | Uplink | |
| **General Parameters** | | | | |
| Frequency | MHz | 637 | 683 | Operating Frequency (DISH owns n29, n71, n66, and n70 licenses) |
| Carrier Bandwidth | MHz | 10 | 10 | Block channel bandwidth (DISH owns 5, 10, 15, and 20 MHz channels) |
| Subcarrier Separation | kHz | 15 | 15 | Minimum Subcarrier spacing required in 5G |
| Total PRBs | Num | 52 | 52 | Total number of resource blocks (depending on the size of the channel) |
| Target BLER | % | [[ ]] | [[ ]] | Number of erroneous blocks / the Total number of blocks received |
| Cell Edge Modulation Efficiency | bps/Hz | [[ ]] | [[ ]] | Modulation efficiency at the cell edge |
| Cell Edge Target L2 Tput (est) | Mbps | [[ ]] | [[ ]] | Targeted throughput at the cell edge |
| **Tx Parameters** | | | | |
| Tx output power per path | dBm | 44.77 | 23 | Transmit power per transmit path (30 Watts Band n71, 40 Watts Band n66, 40 Watts Band n70, and 20 Watts Band n29) |
| Tx antenna gain | dBi | 13.6 | -4 | Antenna gain representative of a 6 foot dual band antenna (617-894 MHz) and (1695-2200 MHz) |
| No of Tx Antennas | Num | 4 | 1 | Number of Transmit Antennas |
| Combining gain | dB | 6 | 0 | Gain obtained by co-phasing signals and adding them up |
| Tx feeder + jumper (Other) losses | dB | 0.5 | 0 | RRUs are located close to the antenna, minimizing cable length |
| Total EiRP | dBm | [[ ]] | [[ ]] | Effective Isotropic Radiated Power (EIRP) is the maximum power emitted by the |

| NR Link Budget | | n71 4T4R | | Comments |
|---|---|---|---|---|
| | | Downlink | Uplink | |
| **General Parameters** | | | | |
| | | | | antenna in the direction with highest antenna gain |
| **Rx Parameters** | | | | |
| Thermal noise density | dBm/Hz | -174 | -174 | Standard noise power spectral density at room temperature |
| Number of PRBs Occupied | Num | 20 | 2 | Minimum information needed to radiate SSB block DL (20 PRBs). 20 PRBs is equivalent to [[ ]] Subcarriers. |
| Number of Subcarriers | Num | [[ ]] | [[ ]] | One NR Resource Block contains 12 Subcarriers |
| EIRP per Subcarrier | dBm | [[ ]] | [[ ]] | |
| Noise Bandwidth | Hz | 9,360,000 | 360,000 | Noise Bandwidth will define thermal noise floor (below) |
| Thermal noise power | dBm | [[ ]] | [[ ]] | Noise created by temperature and its components thermal characteristics |
| Required MCS | Num | [[ ]] | [[ ]] | Required Modulation Code Scheme |
| Required SINR | dB | [[ ]] | [[ ]] | Required Signal to Noise Ratio |
| Rx noise figure | dB | 9 | 2.5 | Noise figure is a number by which the noise performance of a radio receiver is being presented |
| Thermal noise power per subcarrier | dBm | [[ ]] | [[ ]] | |
| Rx noise floor (per antenna) | dBm | [[ ]] | | Receiver noise floor is calculated like this = Thermal noise power + Receiver Noise Figure |
| Rx noise floor (Combined) | dBm | [[ ]] | [[ ]] | |
| Rx sensitivity | dBm | [[ ]] | [[ ]] | Minimum detectable signal strength level |

| NR Link Budget | | n71 4T4R | | Comments |
|---|---|---|---|---|
| | | Downlink | Uplink | |
| **General Parameters** | | | | |
| Rx antenna gain | dBi | -4 | 13.6 | Performance parameter which combines the antenna's directivity and radiation efficiency |
| **System Margins** | | | | |
| Number of RX Antennas | Num | 2 | 4 | Number of Receiving Antenna |
| Rx Combining and other losses | dB | 1 | 0.5 | Cable losses |
| Min Signal Reception Strength (Combined) | dBm | [[ ]] | [[ ]] | |
| System MAPL | dB | [[ ]] | [[ ]] | System Maximum Allowable Path loss |
| **Margins** | | | | |
| Frequency Selective Gain | dB | 0 | 0 | Gain achieved based upon the scheduler being able to select best conditions for a given user |
| TX Switch Diversity Gain | dB | 0 | 1.5 | Gain achieved by multiple antennas which uses equalization to obtain diversity gain against fading |
| Head and Body Loss | dB | [[ ]] | [[ ]] | Loss created by keeping the device close to the body |
| Implementation & Temperature Loss | dB | 1 | 1 | |
| MAPL | dB | [[ ]] | [[ ]] | |
| Limiting MAPL | dB | [[ ]] | | |
| Suburban Slow Fade Margin | dB | | [[ ]] | Based upon Slow Fade Margin (Shadowing Margin) for Suburban environment and [[ ]] cell area coverage probability |
| Suburban Fading Standard Deviation | dB | | 6 | Suburban morphology |

| NR Link Budget | | n71 4T4R | | Comments |
|---|---|---|---|---|
| | | Downlink | Uplink | |
| **General Parameters** | | | | |
| Indoor Suburban Loss | dB | | 6 | Effect of signal loss when penetrating suburban structures |
| Interference Margin | dB | | 3 | Loading Conditions |
| Best Server/Handover Gain | dB | | [[ ]] | UE at cell edge can handover to neighboring cells with more favorable fade margin |
| Design MAPL with [[ ]] Area Probability | dB | | [[ ]] | |
| RSRP | dBm | | [[ ]] | Power level of the received pilot signal (Reference Signal) from the base station. Limiting factor for coverage. |

# ATTACHMENT E: ENGINEER CERTIFICATIONS

**DECLARATION OF STEPHEN BYE**

I, Stephen Bye, am an engineering executive employed by DISH Network Corporation ("DISH"). I have reviewed and helped prepare the foregoing **DISH NETWORK CORPORATION 5G BUILDOUT STATUS REPORT** and certify as follows:

1. I am Executive Vice President and Chief Commercial Officer for DISH. In this role, I am responsible for, among other things, DISH's wireless wholesale and enterprise services, business development, product management, service integration and partner management.

2. I hold a Bachelor of Engineering degree, with honors, in electrical engineering from the University of Tasmania and a Bachelor of Science degree, with honors, in banking and finance from the London School of Economics. I am a Chartered Engineer, a Senior Member of IEEE, and a Fellow of the Institute of Engineering and Technology.

3. Before joining DISH, I spent three decades in the wireless, cable and wireline industries in the U.S. and several other countries. I was previously the CEO of Connectivity Wireless, a provider of carrier-grade, in-building neutral host wireless solutions. Before that, I served as the President of C Spire, where I was responsible for the day-to-day operations of the company. I also served as the Chief Technology Officer of Sprint during the transition to an LTE-based network.

4. I hereby certify that the representations in the **DISH NETWORK CORPORATION 5G BUILDOUT STATUS REPORT,** including the polygon shapefiles and Attachments A-E, are true and correct to the best of my information, knowledge and belief. My certification is based upon my personal knowledge and information provided to me.

Date: 07/14/2022

Engineering Council

STEPHEN J BYE
BE BSc CEng FIET
Chartered Engineer
Registrant 552432 of the Engineering Council

**DECLARATION OF HEATHER CAMPBELL**

I, Heather Campbell, am an engineering executive employed by DISH Network Corporation ("DISH"). I have reviewed and helped prepare the foregoing **DISH NETWORK CORPORATION 5G BUILDOUT STATUS REPORT** and certify as follows:

1. I am Senior Vice President of National Radio Frequency Engineering for DISH. In this role, I lead the national radio frequency (RF) engineering and planning, regulatory services, and spectrum coordination teams.

2. I have a Bachelor of Science in Electrical Engineering and a Bachelor of Science in Computer Engineering, both with honors, from North Carolina State University. I also hold a Professional Engineer license and am licensed in seven states.

3. Before joining DISH, I had a 19-year career with Sprint-Nextel, where I led a variety of initiatives, including long-term network strategy planning, spectrum harvesting, radio access network (RAN) transition and RF engineering. Most recently, I served as Vice President, Access Networks for Rogers Communications, where I helped launch Canada's first and largest 5G network and led their national network engineering, planning and design efforts.

4. I hereby certify that the representations in the **DISH NETWORK CORPORATION 5G BUILDOUT STATUS REPORT,** including the polygon shapefiles and Attachments A-E, are true and correct to the best of my information, knowledge and belief. My certification is based upon my personal knowledge and information provided to me.

Heather Campbell

Date: 7/14/22