

Enabling Direct-to-Handset Satellite Connectivity: Highlights from the Proposed FCC Regulations

Overview. Direct-to-handset satellite services proposed by the likes of Lynk Global, AST SpaceMobile and SpaceX are bold commercial endeavors that lack the appropriate regulatory framework for sharing spectrum between mobile network operators and satellite service providers. The FCC has recently proposed a framework that governs the use of mobile spectrum by satellite operators, which it calls Supplementary Coverage from Space (SCS). Here, we distill the key elements of the FCC's Notice of Proposed Rule Making of March 16, 2023 and project the highlights onto a global scale since low-earth orbit (LEO) constellations are global commercial projects that cannot survive by relying on revenue from a single market/country.

Spectrum for Coverage from Space. The FCC targets sub-3 GHz frequency division duplexed spectrum (part of 5G NR FR1 bands), leaving aside spectrum in 5G NR FR2 bands, primarily millimetre-wave, for future consideration. SCS services would be approved for these bands:

- 600 MHz: 614-652 MHz and 663-698 MHz;
- 700 MHz: 698-758 MHz, 775 MHz-788 MHz, and 805-806 MHz; this excludes portions of the 700 MHz bands allocated for public safety (758-775 MHz and 788-805 MHz);
- 800 MHz: 824-849 MHz and 869-894 MHz;
- Broadband PCS: 1850-1915 MHz and 1930-1995 MHz; and
- WCS: 2305-2320 MHz and 2345-2360 MHz.

The FCC will authorize mobile-satellite service (space-to-Earth and Earth-to-space) in these bands and will modify the US frequency allocation tables to add SCS as coprimary allocation.

Competing Models for Direct-to-Handset Satellite Connectivity

There are broadly two competing spectrum models for mobile devices to connect with satellites.

The first access model uses spectrum assigned to the terrestrial service provider. We differentiate two sub classes of this access mode: 1. Spectrum slice where the terrestrial service provider dedicates a spectrum band exclusively for satellite services; and 2. Spectrum in-fill where the terrestrial operator uses the same band for both terrestrial and satellite services. In the latter case, it is necessary to have active interference management to protect terrestrial services. Examples of this access technique includes SpaceX and Lynk (spectrum slice) and AST SpaceMobile (spectrum in-fill)

The second access mode uses spectrum designated for satellites. We call this model over-the-top, since it is not dependent on the terrestrial service provider spectrum. This access mode requires phones that support additional spectrum bands and waveforms. As a result, phones supporting this mode will be a little more expensive. Examples of this service includes Globalstar for Apple iPhones and Iridium which is collaborating with Qualcomm for the Android ecosystem.

The FCC framework addresses the first access mode where satellites are using terrestrial spectrum.

All these bands are available for flexible use, i.e. the FCC does not prescribe the specific application or use case.

For all bands, except the 800 MHz band, the proposal is relatively straight forward. The 800 MHz "Cellular Band." was the first band to be allocated to mobile communications in the 1980s. It has legacy licensing rules that might complicate the provision of SCS: a licensed area is the composite of service areas where service can be provided (known as Cellular Geographic Service Area - CGSA). An unserved area beyond the 800 MHz cellular licensee's coverage remains unlicensed in the FCC's spectrum inventory. This is exactly where satellite services are needed. Under the proposed rules, the Cellular Band licensee is required to expand the CGSA to include adjacent unserved areas.

Addressable Coverage Area: To eliminate the potential for interference between satellite and terrestrial mobile networks, the FCC will require the terrestrial spectrum licensee to hold all co-channel licenses in a Geographically Independent Area (GIA). Six areas are defined: The continental US, Alaska, Hawaii, American Samoa, Puerto Rico & Virgin Islands, and Guam.

Note that these areas are geographically independent with significant separation between them. The terrestrial service provider will need to have a spectrum license over an entire GIA to enable SCS services. For example, T-Mobile will allocate a slice of its PCS band spectrum to SpaceX for service over the continental US. Further collaboration or steps are required to limit interference with terrestrial networks in Canada and Mexico.

The continental US is a large area which makes it easier to design satellite antenna systems that prevent spillover satellite coverage into co-channel frequency bands allocated to geographically adjacent licensees. This is not the case for many parts of world where national boundaries lead to

Overview of Direct-to-Satellite Market Activities

A number of companies are vying for part of the DTH market. The ones that will use MNO spectrum include:

- Lynk Global has launched three satellites and received FCC authorization to deploy 10 satellites. It has announced multiple service provider agreements claiming 25. Lynk's initial service will focus on SMS services.
- AST SpaceMobile plans a 243 satellite constellation. It launched its latest test satellite in November 2022. Codenamed Bluewalker 3, it features a 64.4 m² antenna. AST is collaborating with AT&T, Vodafone and Rakuten among other operators.
- SpaceX announced that it will provide DTH services over T-Mobile PCS G spectrum in August 2022. This will be over some of Starlink Gen 2 satellites.

Two other competing services use "overthe-top" spectrum; i.e. spectrum that the MNOs do not control.

- Globalstar uses its X and L-band spectrum to enable Apple iPhone Emergency SoS service. Globalstar uses its existing bent-pipe satellite architecture.
- Iridium uses its L-band spectrum to enable the Android phone ecosystem offer competing feature to Apple's emergency SoS.

There are two noteworthy aspects to mention:

- Lacuna Space is an example of a company using 900 MHz unlicensed band spectrum to provide IoT connectivity from satellites (LoRaWAN protocol in this case).
- 2. Bullitt developed a service that uses a Motorola Defy dongle to connect with phones over Bluetooth and with GEO satellite over NB-IoT connectivity.

small coverage areas that consequently raise the complexity of satellite antennas to prevent co-channel interference. In such markets, collaboration between multiple national regulators would be necessary. This could complicate market access for the satellite service providers.

Devices. Devices play an important role in defining the service and potential business opportunity. For this initial set of regulations, the FCC does not authorize a satellite service to satellite-only devices using terrestrial spectrum. The mobile network operator is required to acquire a blanket earth station license for its subscribers' terrestrial devices that will use the SCS service. This includes handset and IoT devices, but excludes user terminals used for fixed wireless access such as the ones for SpaceX Starlink and AWS Kuiper. This of course limits, for the time being, the addressable market for the direct-tohandset satellite constellations. [As a side note, SpaceX started providing consumer fixed wireless access connectivity, and later entered into enterprise FWA services to be followed by mobile satellite services as in connectivity to planes and ships.]

Emergency Services/911 Calling. Mobile network operators are required to support basic and Enhanced 911 (E911), outdoor and indoor location accuracy, and text-to-911. On the other hand, mobile satellite services are exempt from supporting emergency/911 calling; but are required to provide emergency call center service. Emergency services are a critical element of the DTH satellite service model as evident in Apple positioning of the recently introduced iPhone 14 Emergency SoS service. Regulations for emergency services/911 calling are pending the consequent deliberations. Wireless Emergency Alerts is a similar feature that is also pending.

Spectrum Lease Arrangement. The satellite operator is required to lease the spectrum from the MNO (under part 1 of FCC rules). This enables the satellite operator to provide SCS service with authorization under part 25 of FCC rules. The guestion centers on who has effective control of the spectrum license: the satellite operator or the MNO? In answering this question, there are two main models: 1. The licensee retains both de facto and de jure control; and 2. The licensee retains de jure control while de facto control lies with the lessee (the satellite operator). The former is referred to as spectrum manager lease arrangement and does not generally require prior FCC approval, but the licensee (lessor) must notify the FCC ahead of commencing operations. The latter is called de facto spectrum lease arrangement which requires FCC approval prior to the spectrum leasing agreement takes effect.

Since DTH service is new and was not envisioned when the rules for spectrum leasing were defined, it raises certain questions on the lease arrangement, for instance: how to harmonize the term of the lease with the term of the license, and who is ultimately responsible for meeting interference requirements. Many other questions branch out of the lease arrangement that will have to be answered.

Key Takeaways

- The FCC Supplementary Coverage from Space is the first framework for regulating direct-tohandset satellite services allowing satellite operators to communicate with mobile devices over MNO spectrum.
- The current focus is on sub 3 GHz mobile spectrum, which excludes millimeter wave spectrum. The MNO has to own the all co-channel licenses over a Geographically Independent area, of which there are 6 with the continental US being the most prominent.
- The size and location of the service areas impacts the design and complexity of the satellite antennas and impacts the financial viability of the venture as well since DTH satellite constellations need to have a global revenue stream for commercial profitability.
- The SCS framework excludes satellite-only devices; in other words, it is a service for cellular mobility and IoT, but not for fixed wireless access.
- Satellite operator will have to lease the spectrum from the MNO and operate under FCC part 25 rules. The full lease arrangements as well as many important questions, such as interference management and emergency calling, are yet to be defined.

About Xona Partners

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