



The Future of Satellite Connectivity: Various Approaches to Direct-to-Device Services



Exploring the transformative impact of satellite direct-to-device connectivity, shaping the future of ubiquitous mobile communication.

Global Challenges | Satellite Answers



Introduction

The advent of satellite direct-to-device connectivity heralds an exciting era for the satellite industry, introducing novel services that offer consumers ubiquitous connectivity benefits using their own mobile devices. This paper examines two variants of satellite direct-to-device (D2D) applications, focusing on their significance within the satellite communication market.

To understand these variants, we first need to define Non-Terrestrial Networks (NTN). NTN encompasses various satellite services and their applications, as well as technology and waveforms defined by 3rd Generation Partnership Project (3GPP). The 3GPP standardization effort aims to achieve economies of scale across sectors, use-cases (e.g., Internet of Things (IoT), data, voice, emergency services, ESIMs¹, backhaul, and many more). D2D is a sub-category of NTN related to the direct connection to mass market user equipment.

The first variant utilizes spectrum already allocated to the Mobile Satellite Service (MSS) and generally leverages 3GPP NTN standard specifications enabling features to be implemented in both the Radio Access Network (RAN) and User Equipment (UE), ensuring compatibility and multi-vendor interoperability, and eventually integration across terrestrial and non-terrestrial radio interface. For purposes of this paper, this variant is referred to as “D2D in MSS bands.”

The second variant aims at addressing already commercialised mobile handsets (i.e., UE pre 3GPP Release -17 specifications) by utilizing spectrum allocated to the Mobile Service (MS). This approach requires careful considerations to ensure that the D2D service is compatible with the terrestrial mobile service. This second variant is referred to as “D2D in MS bands” in this paper.

Despite technical and regulatory challenges both D2D in MSS bands and D2D in MS bands offer opportunities to provide consumers connectivity across urban, suburban, rural and other areas under-served by terrestrial networks such as maritime, aeronautical, desert, archipelagic and mountainous regions.

D2D in MSS Bands

The first variation of satellite D2D uses spectrum already allocated to the MSS, where MSS operators can provide services directly into mass market devices, integrating MSS capabilities directly into those. This integration offers a quasi-seamless transition between terrestrial and satellite networks for voice, data, and messaging services, providing connectivity regardless of location, whether near terrestrial base stations or in areas with limited or no terrestrial coverage.

D2D in MSS bands is primarily focused on 3GPP specifications for which full NTN connectivity specification was published in 2022 with Release 17. Implementing D2D in MSS bands entails mobile chipset vendors supporting relevant MSS frequencies and 3GPP Release 17 and later NTN air interfaces. It can also support various applications from broadband to IoT and offers services like high-quality voice, rich messaging, videos and more. Supported devices, include smartphones, wearables, IoT devices and more.

When deploying D2D in MSS bands, devices that incorporate the NTN frequencies gain terrestrial and satellite connectivity access with interference and/or compatibility issues already having been studied and addressed. This is because the spectrum utilized by both the terrestrial service and the satellite component already have their own separate allocations, thus possibly mitigating the need for additional interference analysis or operational limitations. MSS already authorized in various countries would not require additional regulatory frameworks when deploying D2D using the same MSS bands to protect other radio spectrum uses.

1. Earth Stations in Motion.

Regulatory bodies play a critical role in expanding access to MSS spectrum for the future development of direct satellite connectivity to end-user devices. To meet the growing demand for this service, regulators must preserve existing MSS spectrum allocations and make additional MSS spectrum available to accommodate anticipated consumer device uses. Two agenda items (AI), 1.12 and 1.14, will consider additional MSS spectrum at the next World Radiocommunication Conference in 2027 (WRC-27).

D2D in MS Bands

The second variant of satellite D2D enables satellites to connect directly to existing mobile handsets using terrestrial Mobile spectrum to serve as a complementary solution to terrestrial mobile coverage, especially in areas where such coverage is unavailable or lacking. This variant allows satellite networks/systems to utilize bands allocated to MS and identified for International Mobile Telecommunications (IMT), which are frequency bands used by MNOs to transmit signals between existing mobile handsets and base stations. Using MS bands would leverage existing mobile handsets and their associated chipsets.

D2D in MS bands requires that satellite operators and MNOs establish partnerships or enter into an agreement for access to shared spectrum beyond the MNO's coverage area. This variant of D2D requires addressing interference management, potentially requiring exclusion zones and/or power limitations on operations to mitigate interference. Developing specific regulatory frameworks is also necessary to permit satellite use in bands allocated to MS.

D2D in MS bands in the International Telecommunications Union (ITU) Radio Regulations (RR) is currently a non-conforming use² of spectrum due to the absence of a regulatory framework that allows for satellite use of bands allocated to MS. Domestic regulation may need to be modified to accommodate D2D in MS bands. On an international level, WRC-27 AI 1.13 will study the technical, operational and regulatory aspects of D2D in MS bands between 698 MHz to 2.7 GHz. Additionally, some administrations have taken steps to create a regulatory framework for D2D in MS spectrum in an effort to formalize this variant.³

Conclusion

In conclusion, satellite D2D service presents both promising opportunities alongside some challenges. Exploring the two variants, D2D in MSS bands and D2D in MS bands, underscores the innovative landscape of satellite communications.

Satellite D2D in MSS bands leverages existing allocations and standardized protocols and frameworks, capitalizing on 3GPP NTN specifications for seamless terrestrial and satellite connectivity networks across various applications, with no additional changes to ITU Radio Regulations. This variant necessitates increased collaboration with mobile chipset vendors to support relevant MSS frequencies in their user equipment.

On the other hand, D2D in MS bands provide a solution to complement mobile coverage, addressing gaps in connectivity where traditional networks fall short, potentially using off-the-shelf mobile handsets. However, the technical and regulatory challenges of this variant are under study.

The forthcoming WRC-27 holds pivotal significance for the future of satellite D2D services as it will address potential new MSS allocations in Agenda Items 1.12, 1.13 and 1.14, as well as paving ways to accommodate future NTN development and innovations in other frequency bands. Collaboration between satellite operators, MNOs, and regulatory bodies is indispensable to realize the full potential of satellite D2D connectivity and usher in a new era of ubiquitous and seamless communications.

2. Deploying D2D services in bands not allocated to satellite service may require invocation of ITU RR No. 4.4 by the filing administration.

3. The Federal Communications Commission in the United States adopted a regulatory framework for Supplemental Coverage from Space ("SCS") to allow for D2D in MS spectrum.

