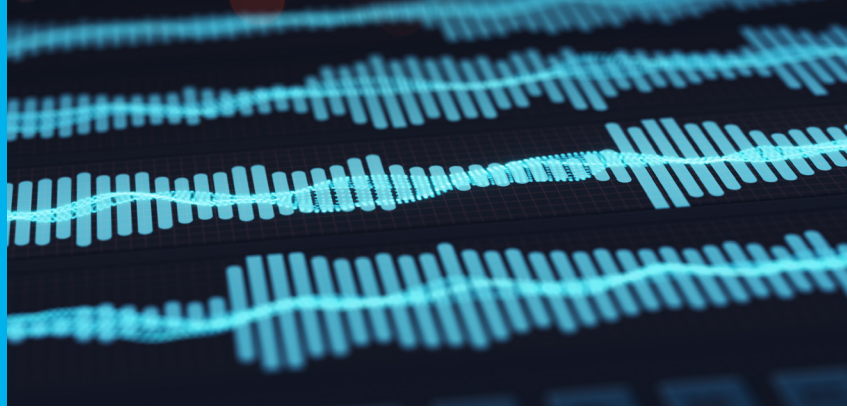
AT&T Policy Issues

Spectrum Bands



Until recently, mobile operators believed that 3 GHz was the upper limit of "usable" spectrum or frequencies for terrestrial mobile service necessary to provide commercial mobile broadband services.

Today, however, new use cases, such as providing HD video to customers, along with technology advancements, have expanded the potential frequencies for terrestrial mobile broadband use – well into the millimeter wave bands or those bands above 24 GHz.

Lower Frequencies:

- Have better propagation characteristics. Radio waves generally travel further the lower the frequency.
- Have better penetration. These radio waves can more easily pass through objects such as buildings and walls as well as through leaves and other foliage.
- Yet, lower frequencies - because radio waves travel further and through objects - can have less capacity given that it inhibits spectrum reuse.

Higher Frequencies:

- Allow for greater capacity by providing more contiguous bandwidth and generally have fewer incumbency issues.
- Support frequency reuse given that radio waves do not travel as far.
- Less propagation of higher frequencies, however, provides less coverage than lower band spectrum, requiring more infrastructure and increased deployment costs.

High-band – Above 6 GHz

Useful for very high-data-rate radio links traversing short paths. High-band frequencies have very high free-space loss. Foliage and buildings are nearly opaque to radio waves in this band. Due to advances in technology, these frequencies will be able to be used for mobile terrestrial service deploying extremely directional base station antennas and mobile stations with very high order beamforming as well as massive MIMO. In addition, due do the availability of broad swaths of spectrum, large contiguous blocks of spectrum can be obtained to increase capacity and throughput.

Mid-band – Between 1 – 6 GHz

Useful for reliable, higher data-rate radio links traveling medium length paths (up to 5 miles). Mid-band frequencies have moderate free-space as well as foliage and building penetration losses. In addition, mid-band spectrum allows for a higher degree of freedom for antenna directionality and spatial reuse, thus increasing capacity.

Low-band Frequencies – Below 1 GHz

Useful for highly reliable, relatively low-data-rate radio links traveling long paths (5 to 50 miles). Its key advantages are low free space, foliage and building penetration losses as well as invulnerability to rain. The key disadvantages are a shortage of available bandwidth and limited feasibility of new antenna designs such as directional antennas for beamforming or MIMO (multiple input multiple output) antennas.