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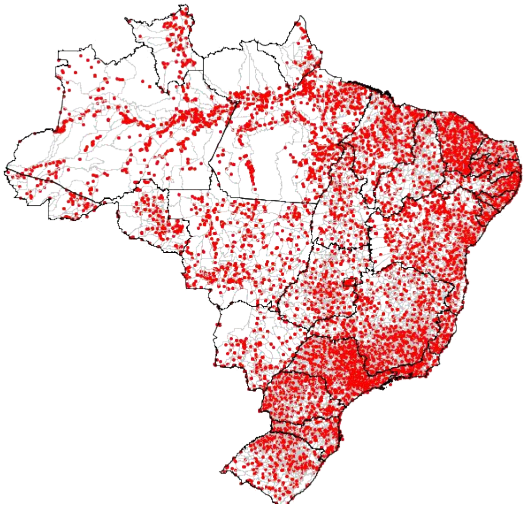
The Importance of the Global C-band Allocation for Satellite Communications Services

C-band satellite spectrum is an important and irreplaceable resource that is used globally by the satellite industry to provide critical services to major industries and applications, including aviation, maritime, peace keeping, disaster preparedness and response, television distribution, private and corporate networks, Internet access, distance education, telemedicine, network extension services., and feeder links for the mobile satellite service. C-band satellite services contributed significantly in recovery and relief operations for recent major disasters, such as the 2004 Asian tsunami and the 2010 Haiti earthquake.

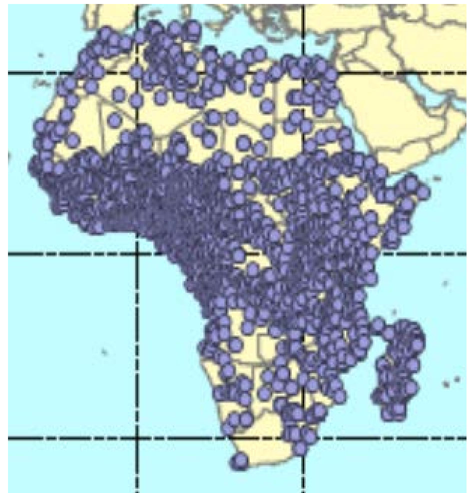
The specific C-band allocations of 3,400–4,200 MHz (space-to-Earth) and 5,725–6,725 MHz (Earth-to-space) are optimal for wide area satellite coverage of entire continents and are far less susceptible to signal interruptions from heavy rains as compared to other satellite spectrum allocations, making the C-band much better suited for ensuring high reliability in all areas. These attributes make C-band a highly economical choice, and in many respects, a unique choice for providing communications services that are ubiquitously available throughout the world.

The C-band frequencies are heavily used by the satellite industry. About 180 C-band satellites operate in geostationary orbit today, representing as much as $50 billion of in-orbit investment. Many of these satellites were launched in recent years and have expected operational lives of 15 years or more. Substantial additional investment has been made on the ground to communicate with, and receive services from, satellites using C-band.

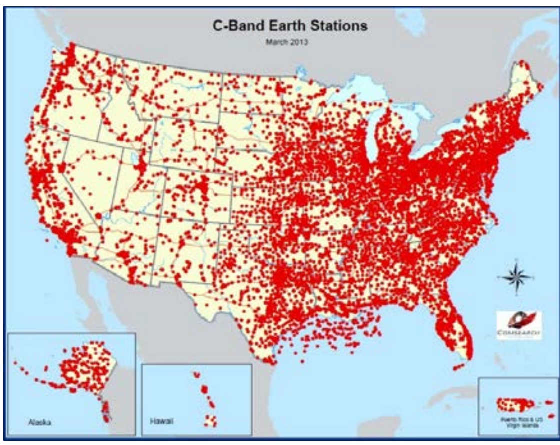
The figures below have been provided in various contributions to the International Telecommunication Union ("ITU") and identify C-band earth stations that are deployed in Brazil, Africa, Europe, and the United States. The Africa illustration includes only those earth stations communicating with C-band satellites operated by Intelsat and does not include countless additional earth stations operating with other satellite networks. Further, each of the figures does not include receive-only earth stations, which are often not formally registered with the ITU. Receive-only earth stations constitute the vast majority of C-band installations deployed around the world. Any disruption or degradation to the operation of these networks would result in serious harm to critical communications services.



C-band Earth Stations in Brazil



Intelsat C-band Earth Stations in Africa



C-band Earth Stations in the U.S.

C-Band Earth Stations in Europe

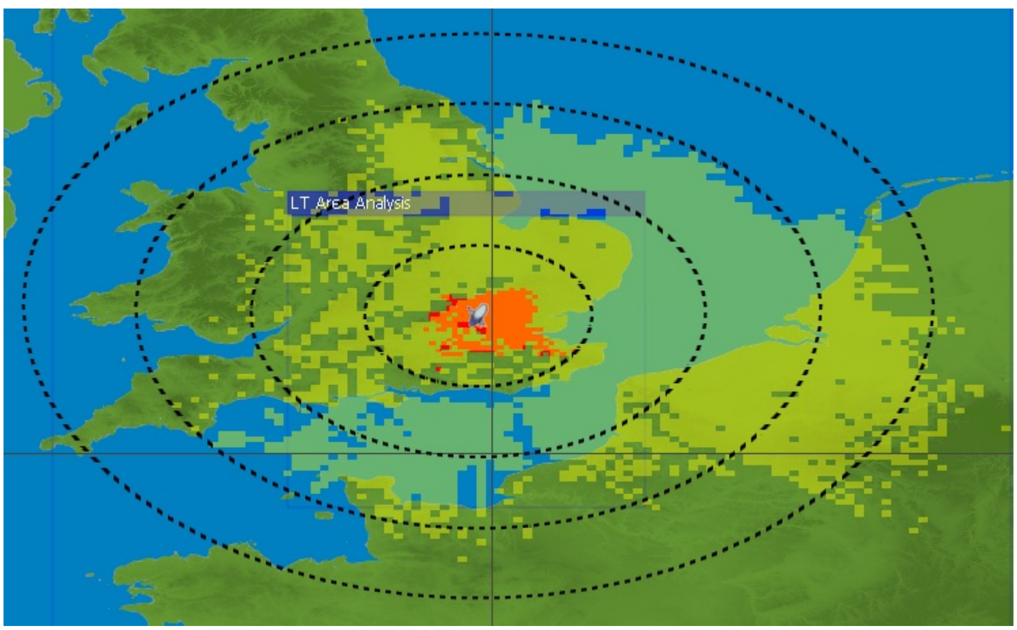
C-band satellite services cannot be replaced with satellite services using other spectrum bands. L-band satellite networks cannot provide the broadband capacity that is provided in C-band. Ku- and Ka-band satellite networks cannot provide sufficiently high reliability in tropical and high-rain regions as is provided in C-band, nor can they provide the large continental coverage within a single beam as is possible with C-band. Further, all of the other spectrum bands that are currently identified for satellite services are already very heavily used, and no additional capacity is available to accommodate the services that are provided today using C-band satellite networks.

C-band Satellite Networks Cannot Share with Terrestrial Mobile Systems

C-band satellite networks are designed to share spectrum efficiently with many other spectrum uses. For example, C-band satellite networks have long operated on a shared basis with fixed point-to-point microwave networks on a coordinated basis. C-band satellite networks also share with each other; nearly all of the approximately 180 C-band satellites in operation today use much of the same spectrum, employing precise orbital spacing and directional antennas to avoid interference into each other.

C-band satellite networks, however, cannot share spectrum with terrestrial mobile networks, such as Broadband Wireless Access ("BWA") and International Mobile Telecommunications ("IMT") because such services will cause harmful and unacceptable interference to C-band receivers when operated within a considerable distance of C-band earth stations. Eleven technical studies that have been considered at the ITU address this interference. These studies are summarized in ITU-R Report M.2109 and ITU-R Report [C-band Downlink][1]. The latter Report includes examples of real interference cases from BWA systems into C-band earth stations. ITU-R Report M.2109 concludes that the studies "all show that sharing between [IMT and C-band earth stations] is not feasible within the area delineated by the minimum required separation distances for each azimuth to protect that specific FSS earth station." ITU-R Report [C-band Downlink] further concludes that "[w]hen FSS earth stations are deployed in a typical ubiquitous manner or with no individual licensing, sharing between IMT-Advanced and FSS is not feasible in the same geographical area since no minimum separation distance can be guaranteed."

The technical studies further demonstrate that the geographic size of such interference protection zones are necessarily large, ranging from a radius of tens of kilometers to hundreds of kilometers depending on terrain, propagation conditions, and the amount of interference that an individual C-band satellite signal link can tolerate. The practical result is that terrestrial mobile networks cannot operate in the C-band anywhere in the world without causing substantial harmful interference to existing C-band earth stations in the same and adjacent countries. For purposes of illustration, the required separation zones are depicted below for a single existing earth station in the United Kingdom. The red and yellow shaded pixels areas are the locations for which an IMT base station is predicted to cause harmful interference to the earth station. The yellow shaded pixels are up to 450 km from the earth station, meaning that in in some cases the required separation distance is greater than this distance.



[1] See Draft New Report "Sharing studies between IMT-Advanced systems and geostationary satellite networks in the fixed-satellite service in the 3 400-4 200 MHz and 4 500-4 800 MHz frequency bands in the WRC study cycle leading to WRC-15"; Attachment 3 to document 4-5-6-7/584 (Annex 11).

Protection Zone Needed for a Single Earth Station in the UK
(Source ITU Attachment 3 to document 4-5-6-7/584 (Annex 11))
Note – the black dotted circles are radius of 100, 200, 300 and 400 kilometres

The protections zones for the above-identified earth station would prevent terrestrial mobile network operations in the C-band in most of the populated portions of the country. Ensuring equivalent protection for hundreds of thousands of other existing C-band earth stations would necessitate protection zones that would exclude BWA and IMT from most countries. These sharing difficulties present only one of the reasons why terrestrial mobile services would be better served by focusing on other spectrum bands instead of the C-band. Other important reasons are provided below.

Other Drawbacks of BWA/IMT Use of C-band

Sharing the C-band would not only be infeasible between terrestrial mobile services and C-band satellite networks, but it would also present other difficulties for terrestrial mobile network operators. The C-band spectrum propagation characteristics, although ideal for satellites, are not favorable for terrestrial mobile applications. The effective range of a macro-cell mobile base station in this band is about 2 kilometers in uncluttered conditions, far less than in lower spectrum bands, thus dramatically escalating terrestrial network construction costs. These higher frequencies also have very poor penetration of buildings, particularly modern “green” construction, resulting in very poor reception indoors.

Potentially as a result of these poor propagation characteristics, there is relatively limited availability of network and consumer equipment for mobile broadband systems in C-band. This probably reflects a lack of confidence of equipment manufacturers that there is a sizable market for C-band BWA and IMT systems. These technical factors and the lack of commercial success at C-band raise doubts as to whether C-band frequencies are suitable for meeting the spectrum requirements for terrestrial mobile systems. Fortunately, the actual spectrum capacity needs of terrestrial mobile networks can be satisfied adequately now and in the future using other available spectrum bands. An example comes from the “digital dividend” broadcasting spectrum released at around 700 MHz as a result of digitalization of broadcasting channels and the release of surplus spectrum. This area of the spectrum is regarded as “golden spectrum” for mobile purposes. This, together with unused IMT spectrum already allocated, may be sufficient for the future needs of IMT systems. The next Section is also highly relevant to these considerations

Actual BWA/IMT Spectrum Needs Are Highly Overestimated

The ITU published a report (ITU-R Report M.2290) indicating that, by 2020, terrestrial mobile services would need as much as 1,960 total megahertz of spectrum throughout the world. This estimate, however, is apparently based on the amount of terrestrial mobile spectrum that may be needed in the very most densely populated locations in the world, not everywhere else. In most locations, far less spectrum will be needed for terrestrial mobile services.

Further, when the assumptions employed in the report are scrutinized, it becomes clear that even the report’s estimates, even for the most densely populated locations, are substantially overestimated by least two orders of magnitude (a factor of 100 or more). The errors result from unrealistic assumptions for both the density of users in heavily populated locations and the data traffic consumed by those users. For example, the report contains entries that assume user densities in excess of 100,000 users per square kilometer, with some entries higher than 200,000 users per square kilometer. In reality, even in the most densely populated urban areas rarely exceed 30,000 inhabitants per square kilometer. Granted, certain instances exist for much higher densities for limited periods of time in discrete locations, such as sports venues and train stations. The geographic size of such locations, however, is relatively small (rarely as much as a square kilometer). For example, the overall population density of a sports stadium with 30,000 people in it will still likely be around 30,000 inhabitants per square kilometer, particularly given the corresponding low density of the surrounding parking lots during the event. Therefore, the overall spectrum requirements to serve such locations are manageable and can be addressed through micro-cells and other measures.

With respect to the report's assumptions about the amount of traffic consumed by each user, the unrealistic assumptions appear to be based on excessive expectations about the use of super-high-speed data services such as streaming high definition video. Granted super-high-speed data services are likely to be widely used by 2020, but the growth in such use appears primarily from consumer use of WiFi-enabled tablets and similar devices, which not do burden IMT networks. The ITU Report also assumes substantial use of high-speed data services in high-density mobile environments, such as in heavy commuter traffic and commuter trains stations. Certainly, many individuals in such high density situations may be streaming high definition video programming, but not most of them (and certainly not lone drivers in heavy commuter traffic). Countless others will use less data-intensive services such as making voice calls, texting, or viewing email.

The ITU Report's significant overestimations about traffic density levels, necessitate a conclusion that the report cannot be used to provide a reliable prediction of spectrum demand requirements for terrestrial mobile services. Instead, the actual need for additional spectrum to support terrestrial mobile services is far lower than has been predicted by the wireless industry and reported within the ITU. Any additional need that does exist in high density locations can be accommodated adequately using spectrum bands below C-band, which have the dual benefits of being better suited in terms of propagation characteristics for terrestrial mobile services, and also present much better opportunities for spectrum sharing with incumbent spectrum uses.