Small Cells Sharing with the Fixed Satellite Service in 3550-3650 MHz

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SIA MEMBER COMPANIES

Overview

- C-band services continue to be important to the satellite industry, and must remain viable
- Small Cells proposal in 3.5 GHz raises many difficult policy and technical questions
  - Protection of existing and future C-band services is essential
  - Unclear wireless demand for 3.5 GHz
  - Spectrum sharing is challenging due to the significant separation distances needed
  - Enforcement mechanisms are unproven and tiered sharing framework is contested.
- Much more thought required before the domestic 3.5 GHz proposal can proceed
- The domestic 3.5 GHz proposal should not dictate the U.S. position at WRC-15 for the entire C-band

Satellite Investment in C-band

- Satellite companies have made – and are continuing to make – extensive investments in C-band satellites
  - Around 169 C-band satellites in geostationary orbit today, representing investments of $42-51 billion
  - At least 69 of these operate in parts or all of the 3400-3700 MHz band, including 15 U.S.-licensed satellites
  - At least 35 satellites with C-band payloads are under construction and are scheduled to be launched in 2012-2015, representing $9-10 billion in investment

- The 3700-4200 MHz band (standard C-band) is heavily used in the United States and worldwide:
  - Media distribution to all 110 million U.S. TV households and around the world
  - Hundreds of well-known content brands, including CNN, Disney/ESPN, HBO/Turner, Fox, Viacom
  - U.S. government networks for the State Department and U.S. military

- The 3600-3700 MHz band (extended C-band) is less used in the U.S., but is extensively used outside the United States:
  - In the U.S., the band is used to receive international satellite services
  - Worldwide, the band is also used for TT&C and feeder links for Inmarsat's mobile-satellite service system, which is used to support public safety and disaster relief missions
  - In North America, Mexico is building extended-C-band-only satellites, which are being manufactured by Orbital Sciences Corporation, a U.S. satellite manufacturer

Policy Issues

Protection of C-band FSS is Essential

- Any FCC action to approve small cells deployments in the 3550-3650 MHz band must:
  - Protect existing FSS earth stations from in-band and out-of-band interference
  - Enable additional FSS earth stations to be deployed and protected from interference
- However, the record raises significant questions regarding whether small cells would be compatible with FSS operations or meet the needs of the wireless industry
- Given these unresolved issues, the small cells proposal in 3.5 GHz should not dictate the U.S. position on the entire C-band at WRC-15

Unclear Wireless Demand in 3.5 GHz

- The Commission's proposal to allow shared use of the 3.5 GHz band for small cells does not respond to concrete demand
  - Small cell configurations are possible today in existing mobile spectrum
  - Wireless industry members have indicated that additional licensed spectrum for mobile broadband is their priority, and they recognize that the 3.5 GHz band is generally unsuited for this purpose
  - The 3.5 GHz band could be used for backhaul, as suggested by some commenters, under SIA's original suggestion to share the band with point-to-point microwave on a coordinated basis

Spectrum Sharing is Challenging

- Protecting C-band satellite services from interference presents substantial practical challenges
  - significant separation distances will be required between small cells and earth station sites
    - a minimum of 11.4 km and up to 487.0 km for in-band interference protection
    - up to 36.6 km for out-of-band interference protection
    - up to 8.91 km for LNA/LNB overdrive interference protection
  - adjacent band effects must be considered and addressed
- The FCC should lift the freeze to allow new earth stations to be introduced pending resolution of these issues
- Given questions about whether sharing is possible, small cells should not be allowed in the 3650-3700 MHz band

Enforcement Methods are Unproven

- The feasibility of proposed methods for enforcing separation distances (Spectrum Access database, spectrum sensing) is unproven
  - Commission experience with database method such as Television White Spaces (or TVWS) is limited (first commercial deployment in April 2013)
  - Spectrum sensing is impractical for protecting satellite receivers because the transmissions originate in space
  - Unknown number of unregistered earth stations that would need to be protected.
- Every aspect of the Commission's tiered sharing approach is a point of contention
  - should there even be priority access?
  - who should have priority access?
  - how would the tiered access framework work?
  - which devices should have geolocation?

Technical Analysis

SIA Technical Analysis

- FSS characteristics – reflect existing operations of U.S. earth stations receiving FSS transmissions in the 3.5 GHz band
  - Elevation angles of 5 and 30 degrees are typical for inter-continental services in this band
  - 2.4 meter antenna with ITU antenna reference pattern
- Small cell characteristics – power levels derived from NPRM and comments filed by Google, Motorola, Qualcomm, Redline, and WISPA
  - EIRP density of -10, 0 and 13 dBW/MHz
  - Interfering small cell carrier overlapped completely with FSS carrier
- Interference criteria – defined by ITU-R Recommendations S.1432-1 and SF.1006
  - Short term I/N of -1.3 dB
  - Long term I/N of -10 dB

Operational Scenarios Considered

- Simulations considered two FSS earth station locations with different terrain characteristics – Florida (flat terrain) and Maryland (hilly terrain)
  - For each location, the simulation considered earth station elevation angles of 5 and 30 degrees
- Results for three potential sources of interference:
  - in-band interference
  - out-of-band interference
  - amplifier overdrive

Single-entry In-band Interference

Location	FSS antenna Elevation	Interference Mode	Small Cell EIRP density		
			-10 dBW/MHz	-0 dBW/MHz	13 dBW/MHz
Florida	5 degrees	Long-term	31.2 km	43.4 km	63.5 km
		Short-term	363.7 km	425.3 km	487.0 km
	30 degrees	Long-term	11.4 km	21.1 km	35.6 km
		Short-term	91.2 km	238.1 km	410.0 km
Maryland	5 degrees	Long-term	60.1 km	98.7 km	107.4 km
		Short-term	72.3 km	141.9 km	252.5 km
	30 degrees	Long-term	64.9 km	98.7 km	107.4 km
		Short-term	72.3 km	141.9 km	252.5 km

- To mitigate long-term interference: separation distance of up to 107.4 km required
- To mitigate short-term interference: separation distance of up to 487.0 km required
- Separation distances for Maryland can be larger than those for Florida due to ground elevation and line of sight difference

Single-entry Out-of-band Interference

Location	FSS antenna Elevation	Out-of-band mask	Small cell EIRP density		
			-10 dBW/MHz	0 dBW/MHz	13 dBW/MHz
Florida	5 degrees	43 + 10 log (P)	8.9 km	8.9 km	8.9 km
		45	3.8 km	7.8 km	18.9 km
	30 degrees	43 + 10 log (P)	2.4 km	2.4 km	2.4 km
		45	-	1.9 km	4.8 km
Maryland	5 degrees	43 + 10 log (P)	4.1 km	4.1 km	4.1 km
		45	1.0 km	3.1 km	36.6 km
	30 degrees	43 + 10 log (P)	4.1 km	4.1 km	4.1 km
		45	0.9 km	3.1 km	15.5 km

- For the Maryland (hilly terrain) scenario, interference threshold is exceeded within a maximum distance of 36.6 km

Single-entry Amplifier Overdrive

Max interference	dBW	-95					
Earth station elevation angle	°	5			30		
Earth station antenna gain towards horizon	dBi	14.5			-4.9		
Small Cell EIRP Density	dBW/MHz	-10	0	13	-10	0	13
Required loss	dB	99.5	109.5	122.5	80.1	90.1	103.1
Frequency	MHz	3600					
Distance	km	0.63	2.00	8.91	0.07	0.21	0.95

- To mitigate interference: separation distance of up to 8.91 km required

Other Technical Studies in the Record

- Two other technical studies analyze in-band and out-of band protection requirements for FSS earth stations in detail
  - Alion Report (submitted April 5, 2013)
  - Comsearch Report (submitted May 8, 2013)
- Those studies reach conclusions that are in line with SIA's analysis, albeit using somewhat different assumptions.
  - There remains considerable variation in proposed small cell parameters in the record.

For more information, please contact:

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