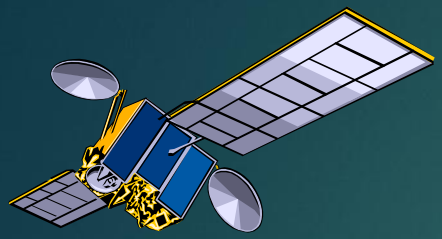
Satellite Spectrum Management Issues

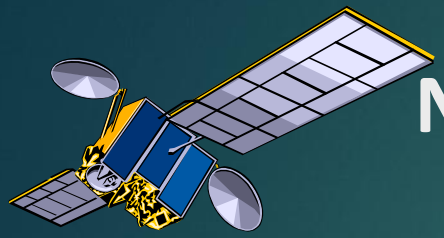
Jose Albuquerque
Chief, Satellite Division
FCC

May 15, 2018



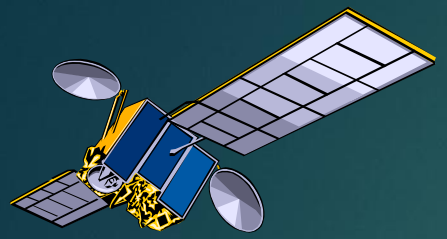
NGSO FSS Constellations

- During the last two years the FCC Satellite Division has devoted a significant amount of time to matters related to NGSO FSS systems
- This work proceeded along two parallel tracks
  - Consideration of several NGSO FSS constellations applying for an FCC license or for US market access
  - Streamlining the Commission's rules to facilitate the deployment of these NGSO FSS satellite systems



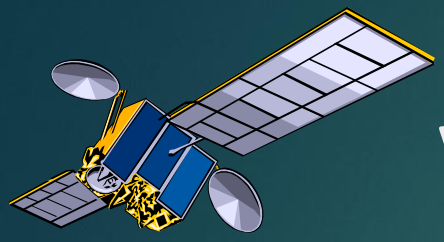
NGSO FSS Systems with Earth Stations Using Directional Antennas

- An application that comports with existing rules and is compatible with previous authorizations and applications is put on public notice and triggers a “processing round” (applications competing for the use of the same frequencies can be submitted until a specific date)
- An application from OneWeb for a NGSO satellite system using Ku/Ka band frequencies was filed in April 2016 and triggered a processing round for which 11 other applications were received (filing window closed November 15, 2016)
- An application from Boeing for a NGSO satellite system using V-band frequencies was filed in June 2016 and triggered a processing round for which 8 other applications were received (filing window closed March 1, 2017)



Ku/Ka-Band Processing Round

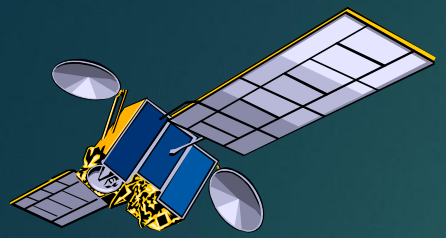
System (* RF Intersatellite Links)	# of Satellites (Orbit Altitude)	Downlink	Uplink	Licensing Administration
OneWeb	720 (1,200 km)	10.7-12.7 GHz; 17.8-18.6 GHz 18.8-19.3 GHz	14.0-14.5 GHz; 27.5-29.1 GHz 29.5-30.0 GHz	UK
O3b/SES	42 (8,062 km)	17.8-18.6 GHz; 18.8-20.2 GHz	27.5-30.0 GHz	UK
SpaceX	4425 (1,110-1,325 km)	10.7-12.7 GHz; 17.8-18.6 GHz 18.8-19.3 GHz; 19.7-20.2 GHz	12.75-13.25 GHz; 13.85-14.5 GHz 27.5-29.1 GHz; 29.5-30.0 GHz	US
Boeing	60 (Apogee 44,221 km; Perigee27,355 km)	17.8-20.2 GHz	27.6-30 GHz	US
Telesat Canada	117 (1,000-1,248 km)	17.8-18.6 GHz; 18.8-19.3 GHz 19.7-20.2 GHz	27.5-29.1 GHz; 29.5-30.0 GHz	Canada
LeoSat	78 (1,400 km)	17.8-18.6 GHz; 18.8-19.3 GHz 19.6-20.2 GHz	27.5-29.1 GHz; 29.5-30.0 GHz	Netherlands
Audacy Corporation*	3 (13,890 km)	19.7-20.2 GHz	29.5-30.0 GHz	US
Theia Holdings A Inc.*	112 (800 km)	10.7-12.2 GHz; 17.8 18.6 GHz; 18.8-19.3 GHz; 19.6-20.2 GHz	12.75-13.25 GHz; 14-14.5 GHz 27.5-30.0 GHz	US
Kepler Communications Inc.	140 (500-650 km)	10.7-12.7 GHz	14.0-14.5 GHz	Canada
ViaSat, Inc.*	24 (8,200 km)	17.8-18.6 GHz 18.8-19.3 GHz; 19.7-20.2 GHz	27.5-29.1 GHz; 29.5-30.0 GHz	Netherlands
Karousel LLC	12 (Apogee 44,002.3 km; Perigee 31,569.5 km)	10.7-12.7 GHz; 17.8-19.3 GHz 19.7-20.2 GHz	14.0-14.5 GHz; 27.5-29.1 GHz 29.5-30.0 GHz	US
Space Norway AS	2 (Apogee 43,509 km; Perigee 8,089 km)	10.7-12.7 GHz; 19.7-20.2 GHz	14-14.5 GHz; 29.5-3- GHz	Norway



V-Band Processing Round

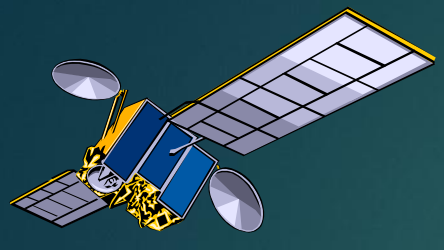
- Downlink Frequencies: 37.5-42 GHz
- Uplink Frequencies: 47.2-50.2 GHz; 50.4-51.4 GHz

System	# of Satellites (Orbit Altitude)	Licensing Administration
Boeing	2956 (970-1,082 km)	US
O3b/SES	16 of the 42 using Ku/Ka (8,062 km)	UK
SpaceX	Some of the 4425 using Ka (1,110-1,325 km) + 7,518 (1,100-1,325 km)	US
Boeing 2	132 (1,056 km) + 15 (Apogee 44,221 km; Perigee 27,355 km)	US
Telesat Canada	117 (follow-on to the 117 using Ka) (1,000-1,248 km)	Canada
ViaSat	24 (same using Ka) (8,200 km)	Netherlands
Audacy Corporation	3 (same using Ka) (13,890 km)	US
Theia Holdings A Inc.	112 (same using Ku/Ka) (800 km)	US
OneWeb	720 (same using Ku/Ka) (1,200 km) + 1280 (8,500 km)	UK



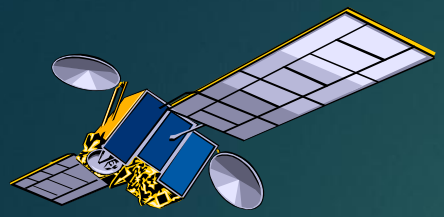
September 2017 NGSO FSS Report and Order (1)

- Changes to the Ka-band Plan to accommodate NGSO and GSO operations that have been authorized through waivers of the Plan
  - FSS secondary allocation in 17.8-18.3 GHz
  - GSO FSS primary designations: 19.3-19.4 GHz & 19.6-19.7 GHz
  - Secondary FSS designations: NGSO (18.3-18.6 GHz); GSO (18.8-19.3 GHz)
  - Removal of FS & MS allocations: 28.35-29.1 GHz; 29.25-29.5 GHz
- NGSO FSS Spectrum Sharing
  - Coordination among parties using overlapping spectrum to avoid unacceptable interference
  - Absent coordination, any commonly authorized frequency band will be divided among the affected satellite networks whenever $\Delta T/T$ in a link of any of these networks exceeds 6% ($\Delta T/T$ threshold substituted for the previously existing 10° avoidance angle threshold)
  - Comparison with ITU approach



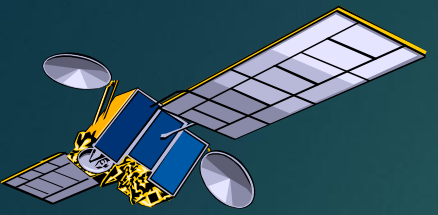
September 2017 NGSO FSS Report and Order (2)

- GSO-NGSO Sharing
  - ITU EPFD Limits have been incorporated by reference
  - New rule states that, unless otherwise provided, NGSO systems must not cause unacceptable interference to, or claim protection from, GSO FSS or GSO BSS networks
  - Sharing regime in 18.8-19.3 GHz and 28.6-29.1 GHz
  - Comparison with ITU approach
- Milestone and Geographic Coverage Rules
  - Relaxes the NGSO milestone rules (50% of the total number of satellites in 6 years; remaining in 9 years)
  - Removes international geographic coverage rules
- FNPRM invites comment on whether to remove the U.S. coverage requirement for NGSO FSS systems.



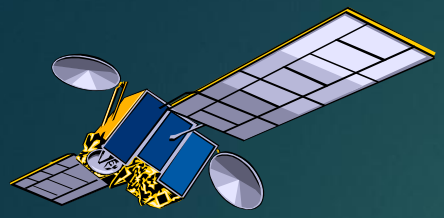
Sharing Between Satellite Systems and UMFUS in V-Band Downlinks: 37.5-42 GHz

- In the Memorandum Opinion and Order released in November 2017 in the Spectrum Frontiers proceeding, the Commission reserved the band 40-42 GHz (↓) for FSS use and declined to authorize fixed and mobile use in this band
  - This decision provides the opportunity for the deployment of FSS user terminals in these bands
- In the same Memorandum Opinion and Order the Commission also allowed limited deployment of individually licensed earth stations in the band 37.5-40 GHz
  - Up to three earth stations per county and up to fifteen per PEA (licensing area for UMFUS)
  - Earth station protection zones within a PEA encompass in the aggregate within a PEA up to:
    - 0.1% of the PEA population for any PEA with a population greater than 2,250,000
    - 2,250 for any PEA with population between 60,000 and 2,250,000
    - 3.75% of the PEA population for any Pea with fewer than 60,000 people
  - Protection zones do not intersect any major event venue, urban mass transit route, passenger railroad, cruise ship port, or specific types of roads
  - Applicant has completed coordination with the UMFUS licensees within the protection zone with respect to existing facilities constructed and in operation by the UMFUS licensee
  - Earth station may not be ubiquitously deployed and may not be used to serve individual consumers



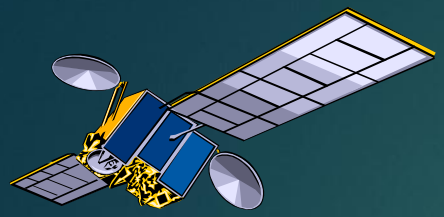
Sharing Between Satellite Systems and UMFUS in V-Band Uplinks: 47.2-50.2 GHz

- In the Memorandum Opinion and Order released in November 2017 in the Spectrum Frontiers proceeding, the Commission reserved the band 48.2-50.2 GHz (↑) for FSS use and declined to authorize fixed and mobile use in this band
  - This decision provides the opportunity for the deployment of FSS user terminals in these bands
- In the same Memorandum Opinion and Order, the Commission also allowed limited deployment of individually licensed earth stations in the band 47.2-48.2 GHz
  - Up to three earth stations per county and up to fifteen per PEA (licensing area for UMFUS)
  - The areas within a PEA in which the earth station generates a PFD at 10 meters above ground greater than or equal to -77 dBm/m^2/MHz encompass in the aggregate within a PEA up to:
    - 0.1% of the PEA population for any PEA with a population greater than 2,250,000
    - 2,250 for any PEA with population between 60,000 and 2,250,000
    - 3.75% of the PEA population for any Pea with fewer than 60,000 people
  - Protection zones do not intersect any major event venue, urban mass transit route, passenger railroad, cruise ship port, or specific types of roads
  - Applicant has completed coordination with the UMFUS licensees within the -77 dBm/m2/MHz PFD contour with respect to existing facilities constructed and in operation by the UMFUS licensee
- Use of the band 51.4-52.4 GHz is under consideration within Spectrum Frontiers



NPRM on Earth Stations in Motion (ESIMs) (May 2017)

- Proposes rules for the operation with a GSO space station of Earth Stations in Motion (ESIMs) in the following frequency bands:
  - 18.8-19.3 GHz (↓), 19.7-20.2 GHz (↓)
  - 28.35-28.6 GHz (↑), 29.25-30.0 GHz (↑)
- Such operations have been authorized in the past on a non-protected, non-interfering basis
- In addition, the NPRM proposes consolidation in a single section of Part 25, rules currently contained in separate sections addressing the operation of Earth Stations on Vessels (ESVs), Vehicle-Mounted Earth Stations (VMEs), and Earth Stations Aboard Aircraft (ESAAs)



NPRM on Small Sats (April 2018)

- NPRM seeks comment on a new application process for licensing small satellites.
  - As proposed, new procedures would shorten application processing times, involve lower application fee than existing fee for commercial applications, etc.
  - This would not replace the FCC's experimental or commercial authorization process – would be an alternative. Experimental licensing process will still be available for research-oriented missions.
- Small Satellite systems meeting certain characteristics would be eligible for streamlined processing. The proposed characteristics include:
  - 10 satellites or fewer under a single authorization
  - Mass of 180 kg or less
  - Total on-orbit lifetime of satellites of five years or less
  - Deployment at or below 400 km (below ISS) if the satellite lacks propulsion
  - Ability to share with current operations and not preclude future entrants seeking to use the authorized frequency band
  - Several additional characteristics associated with low risk from an orbital debris perspective.