

JONES DAY

51 LOUISIANA AVENUE, N.W. • WASHINGTON, D.C. 20001.2113
TELEPHONE: +1.202.879.3939 • FACSIMILE: +1.202.626.1700

DIRECT NUMBER: (202) 879-3630
BOLCOTT@JONESDAY.COM

March 13, 2017

VIA ELECTRONIC FILING

Marlene H. Dortch
Secretary
Federal Communications Commission
445 12th Street S.W.
Washington D.C. 20554

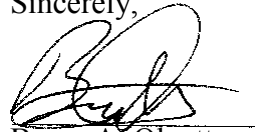
Re: Oral Ex Parte Notice
IBFS File Nos. SAT-LOA-20170301-00028

Dear Ms. Dortch:

On March 9, 2017, representatives of The Boeing Company (“Boeing”) met with staff of the Satellite Division of the FCC’s International Bureau to present and discuss Boeing’s recently filed application for authority to launch and operate a non-geostationary satellite orbit (“NGSO”) satellite system operating in the fixed-satellite service (“FSS”) in portions of the V-band. Participating in the meeting on behalf of the Satellite Division were Jose Albuquerque, Karl Kensinger, Kerry Murray, Stephen Duall, Diane Garfield, Merissa Velez, Jennifer Balatan and Chip Fleming. Participating on behalf of Boeing were Bruce Chelsey, Audrey Allison, Kim Kolb, and the undersigned. The discussion tracked closely with the attached presentation materials, which were distributed during the meeting.

Thank you for your attention to this matter. Please contact me if you have any questions.

Sincerely,



Bruce A. Olcott
Counsel to The Boeing Company

Attachment



Boeing V-band Constellation Overview FCC Application Summary

09 March 2017

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Broadband NGSO System Application Overview

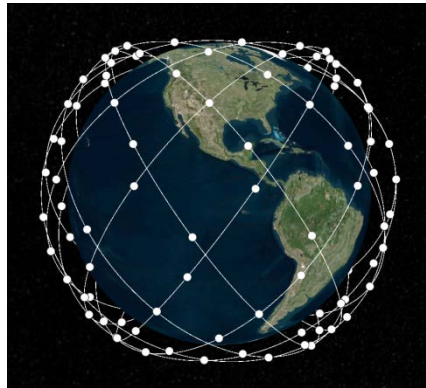
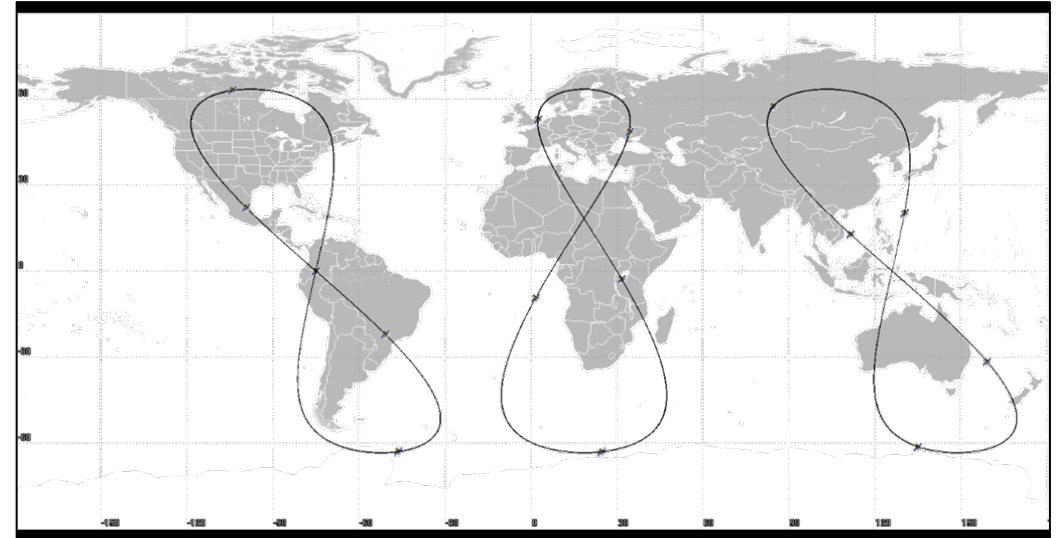
- **V-band Constellation System Description**
- **Inclined NGSO Constellation Summary**
- **LEO Constellation Summary**
- **Frequency Plan, Channels and Connectivity**
- **EIRP, EIRP Density and PFD Capabilities**
- **LEO to NGSO/GSO Crosslink Service Description**
- **Requested Waivers Summary**

Boeing V-band Constellation



Inclined NGSO (63.4°) Satellites

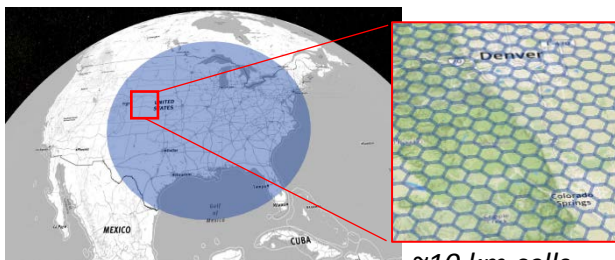
- Two-way broadband service and streaming media distribution to users
- 15 inclined NGSO (63.4°) satellites at GSO-like altitudes (27,200 – 44,000km)
- Global coverage via 3 nodes (Americas, Europe-Africa, Asia)
CONUS coverage >45 degrees elevation (25 degrees for AK, HI)
- High frequency re-use with satellite diversity
- Overlay on other terrestrial or other satellite broadband services



LEO Satellites

- Low-latency broadband service to smaller terminals via LEO Satellites
- 132 satellites at 1056 km (54-deg inclination)
- Flexible beamforming antennas enable very narrow/low side-lobe beams (~10km cells)
- Coverage of CONUS latitude regions above 25-deg elevation angles

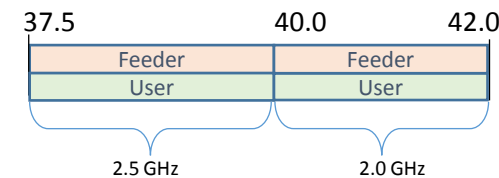
Peak data rates for **ALL** satellites exceed FCC's Broadband Goals (>25 Mbps Down / >3 Mbps Up)



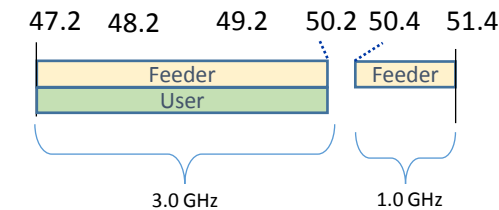
~10 km cells

Frequency Plan (all satellites)

Downlink (4.5 GHz total)



Uplink (4 GHz total)



Each Beam uses up to 4.5 GHz downlink bandwidth (dual-pol)

3 GHz uplink utilized for user service links (dual-pol)

4 GHz uplink bandwidth utilized for Feeder Links – dual pol

Gateways and user terminals share uplink and downlink bands

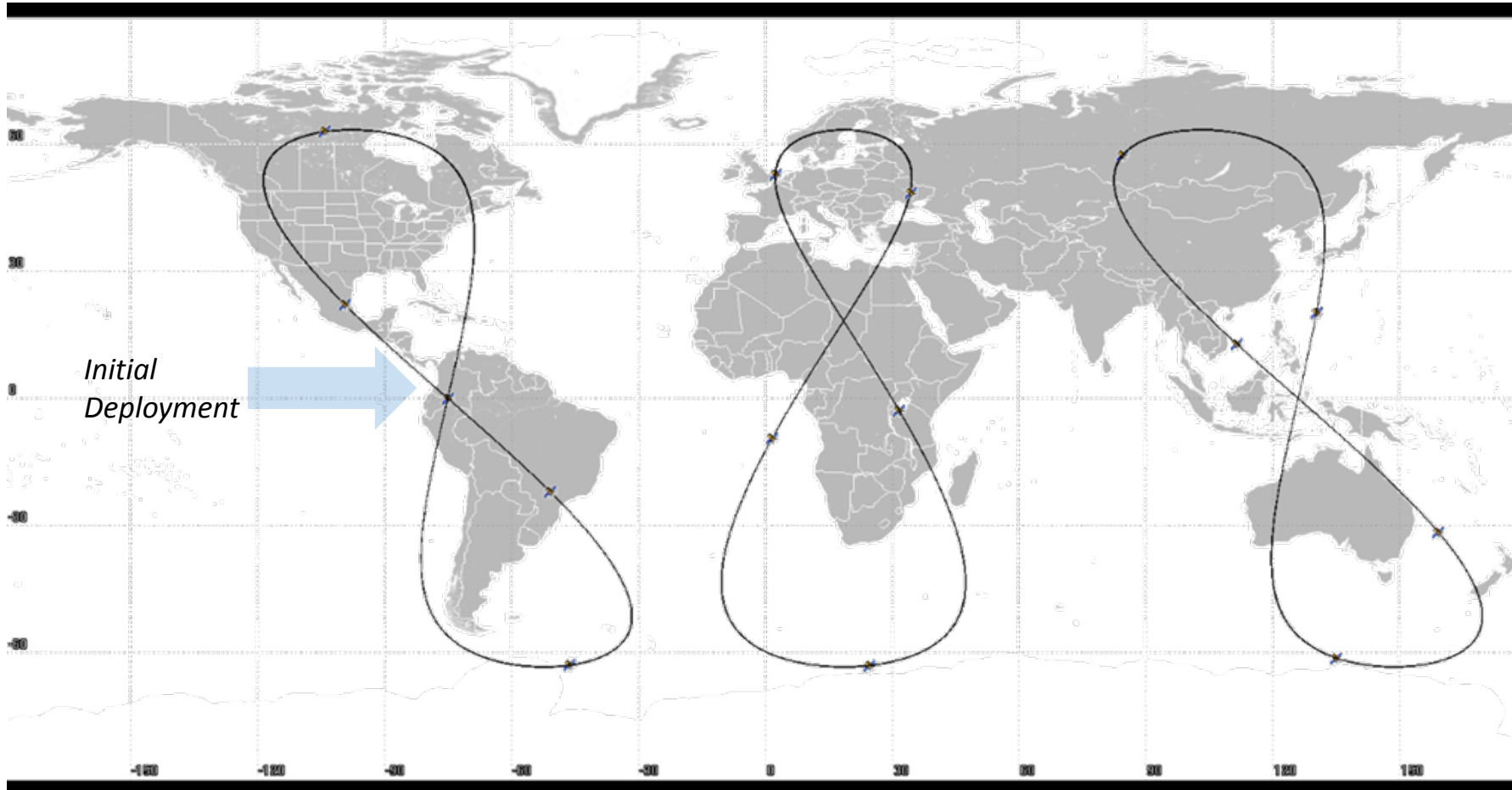
Compliant with FCC PFD regulations in each band (clear air and rain fade)

Integrated V-band Constellation with Broadband speeds and content/data distribution to fixed and mobile users

V-band Constellation 63.4° Inclined NGSO Orbit and Deployment Plan



Figure III-2 Inclined NGSO Satellite Tracks



15 total inclined near-GEO altitude NGSO satellites

Americas coverage with 5 satellites (Initial Deployment)

Worldwide coverage via 10 additional satellites

Orbital Parameters:

Inclination: 63.4-deg

Period: 86170.5 secs (geo-synchronous)

Americas and Asia Regions

Eccentricity: 0.2

Altitude: 27,354 to 44,221 km

Europe/Africa/Mideast Region:

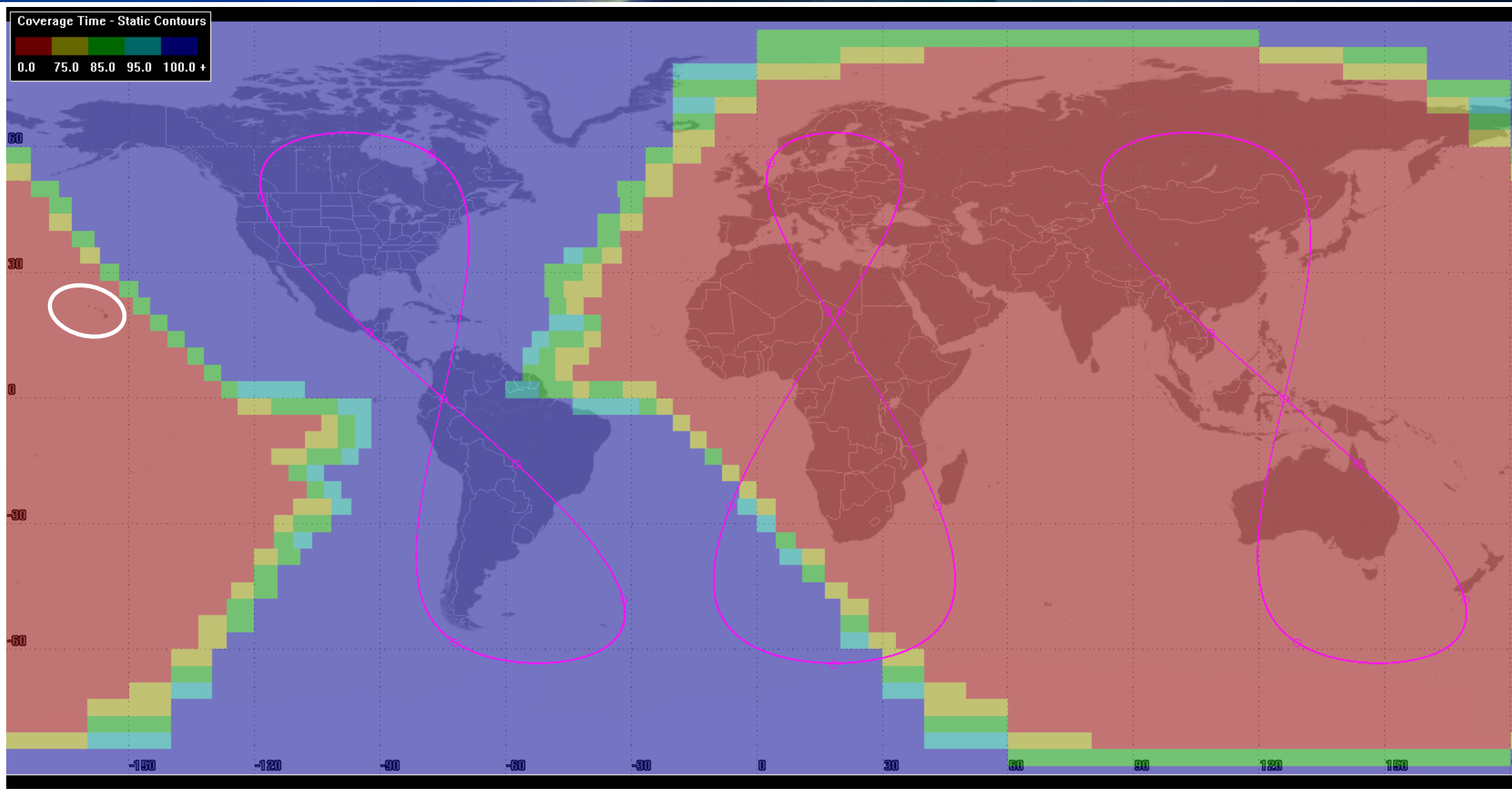
Eccentricity: 0.1

Altitude: 31,571 to 40,004 km

V-band Constellation – 63.4° Inclined NGSO



Americas coverage (Initial Deployment) - 45° elevation angle

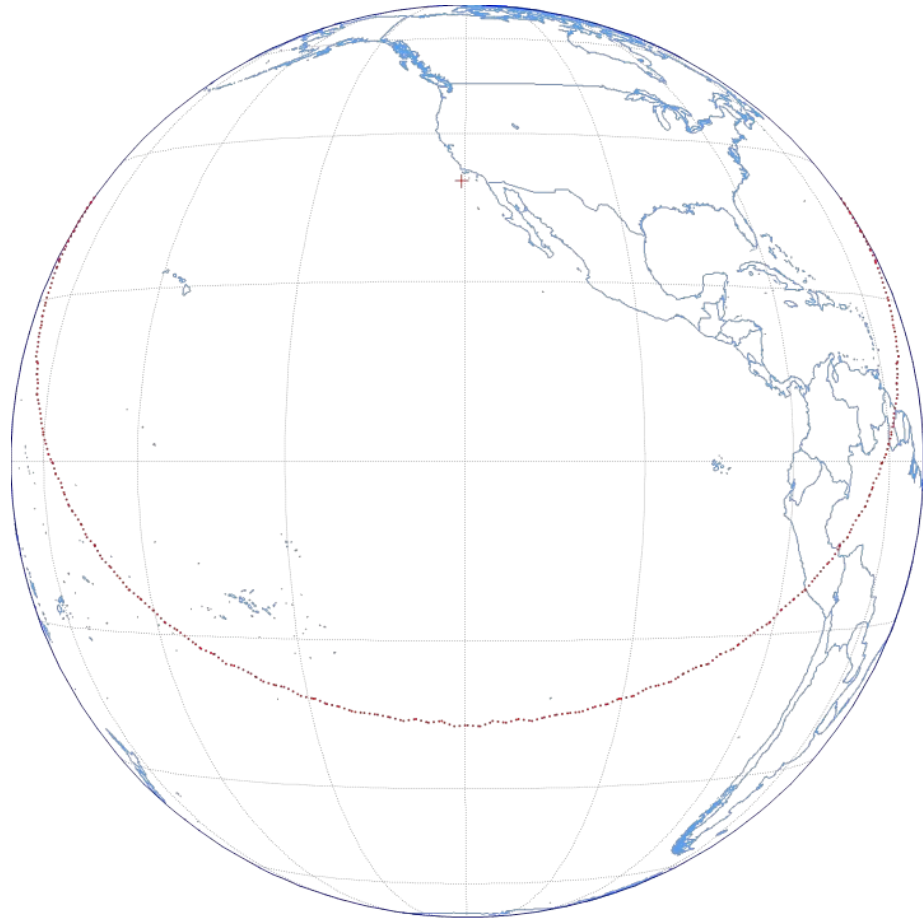


45-deg
elevation
angle coverage

V-band Constellation

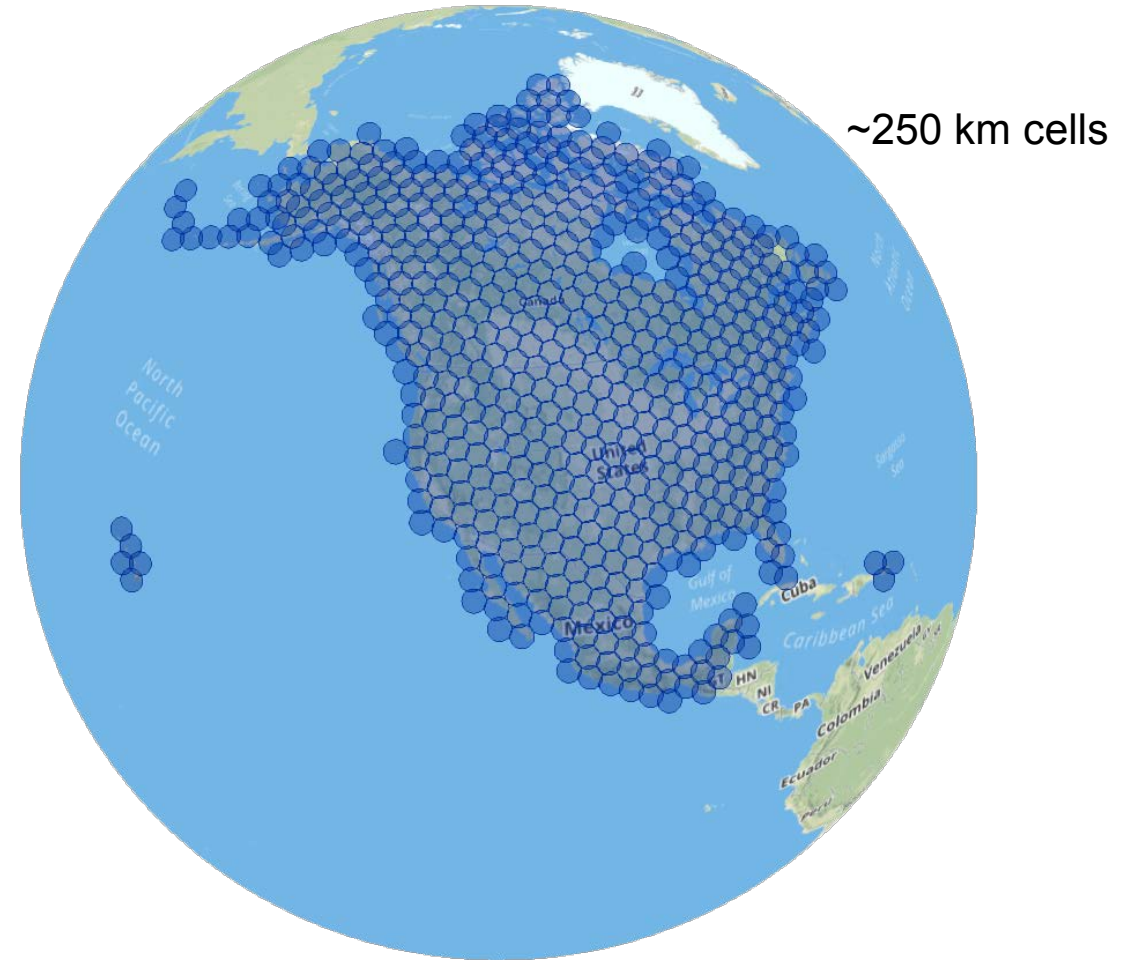
63.4-deg inclined NGSO Coverage Footprint and Beams

Figure III-7 Inclined NGSO Coverage Area Snapshot



Nominal operations at
25-degree minimum elevation angle

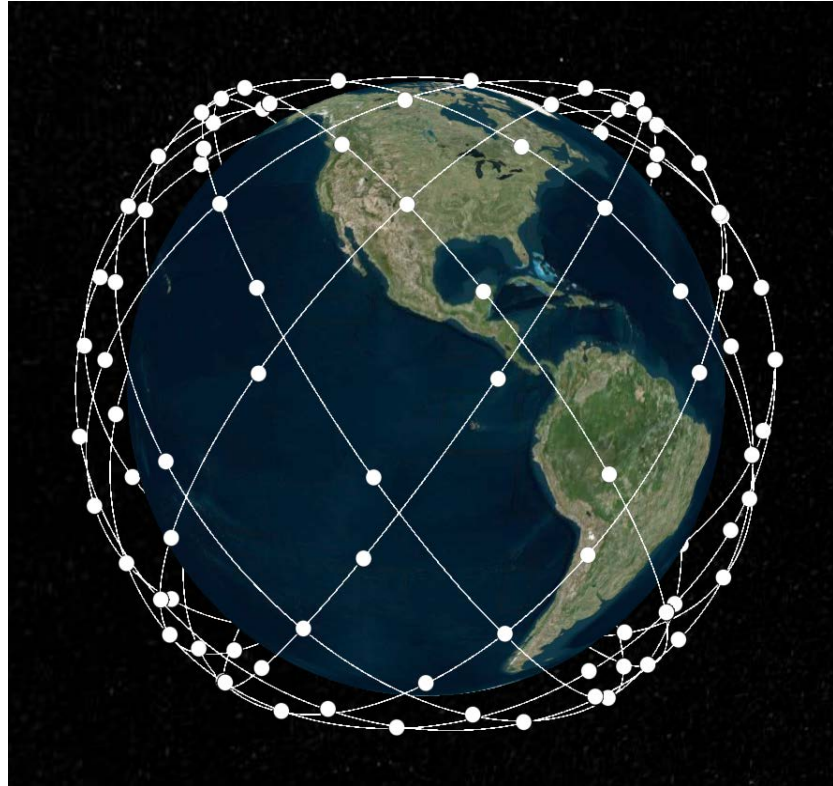
Figure III-6. Inclined NGSO Sample Cell Pattern



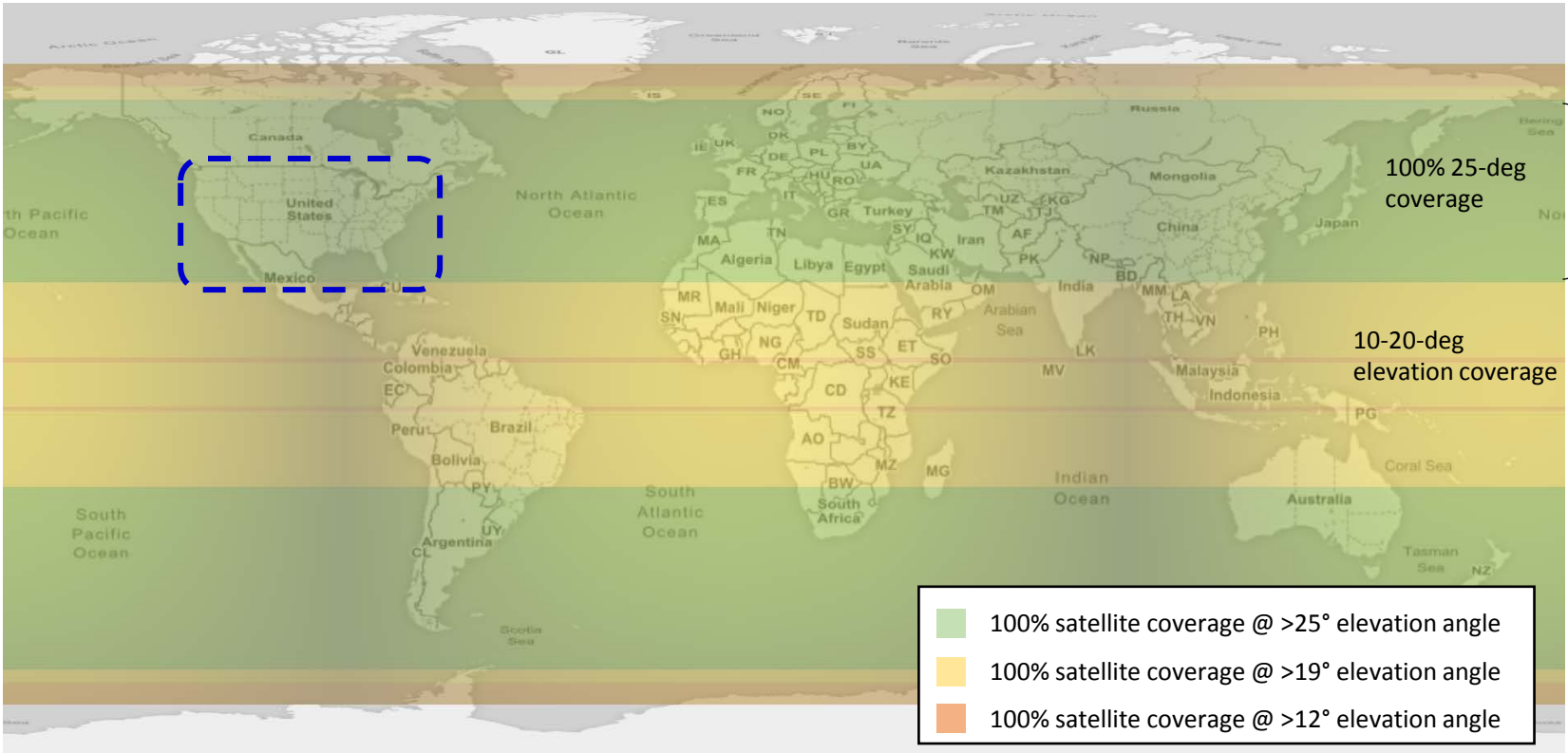
CONUS and Americas FOV supports
>45 degree elevation angles

V-band Constellation LEO Satellites Orbit, Coverage and Deployment

Low-latency broadband service via 132 LEO satellites



Orbital Parameters:
Inclination: 54 degrees
Altitude: 1,056 km
Number of planes: 11
Satellites per plane: 12



*100% service to CONUS
at >25 deg elevation
angles (22.5 to 60N latitudes)
Hawaii coverage at 19° elevation
Alaska coverage at 12° elevation*

*All LEO satellites fielded
by Final Deployment*

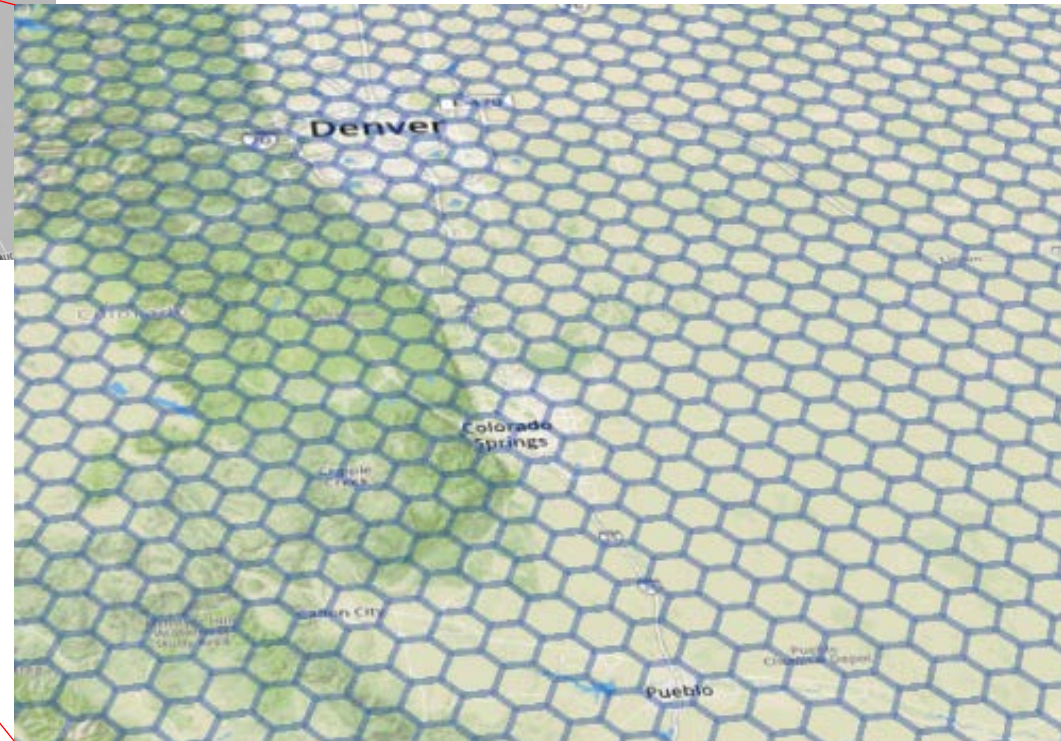
V-band Constellation LEO Satellite Coverage Footprint and Beams

Figure III-3 LEO Spacecraft Coverage Area Snapshot



Up to +/- 51° Field of View
25-degree elevation angle
3100 km footprint radius

Figure III-4. LEO Spacecraft Sample Cell Pattern



~10 km cells

Frequency Plan, Channels, and Connectivity

Uplink Bands

Figure III-10. Downlink Communications Frequency Plan



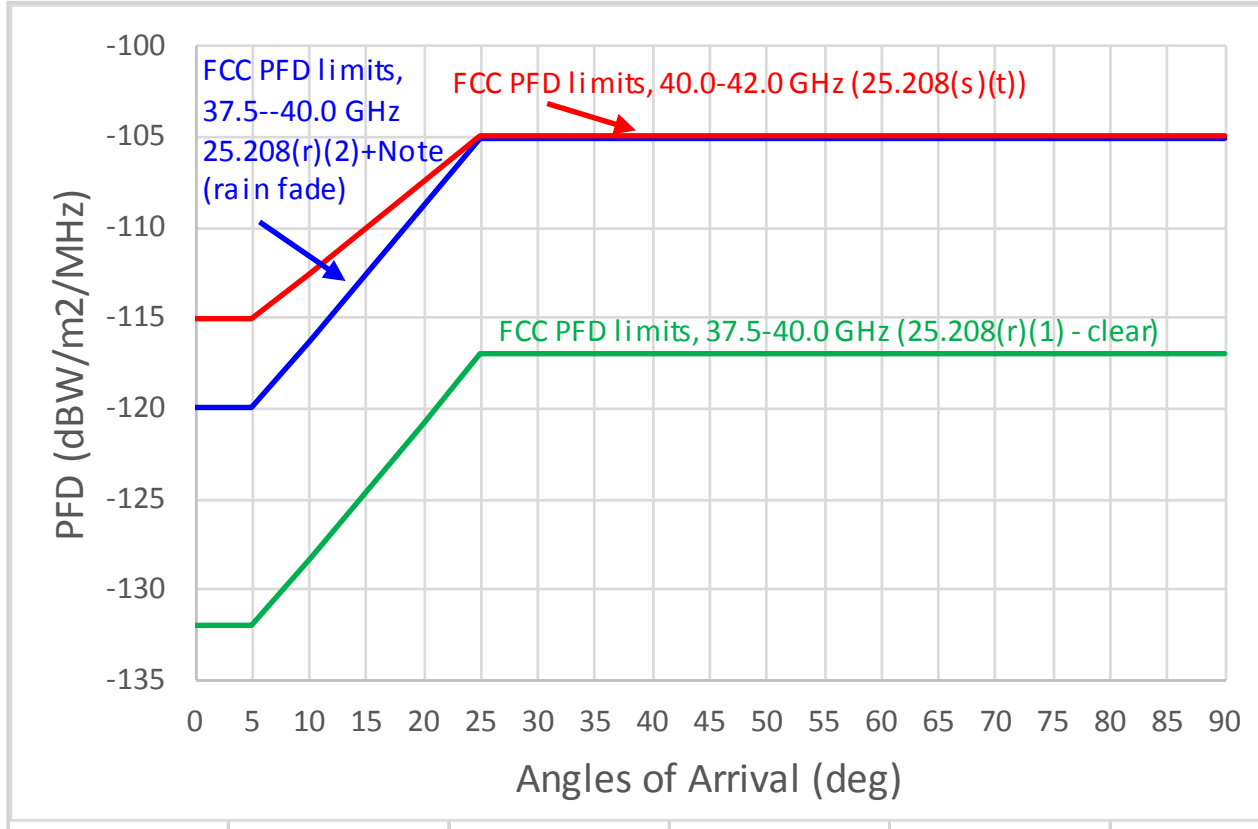
Figure III-8. Uplink Communications Frequency Plan



- *All satellites operate using up to 4.5 GHz of downlink spectrum*
 - *37.5-40.0 GHz band (dual CP) – 2.5 GHz*
 - *40.0-42.0 GHz band (dual CP) – 2.0 GHz*
- *Feeder link and User Service share entire 4.5 GHz of spectrum*
- *High frequency re-use factor for all satellites using narrow spot beam coverages*
- *EIRP of each beam controlled based on assigned bandwidth and propagation characteristics (slant range, rain fade) using downlink power control*

- *All satellites operate using up to 4 GHz of uplink spectrum*
 - *3 GHz of User Service Spectrum (dual CP)*
 - *4 GHz of Feeder link Spectrum (dual CP)*
- *Feeder link and User Service share lower 3 GHz spectrum*
- *High frequency re-use factor for all satellites using narrow spot beam coverages*
- *Satellites flexibly sub-channelize uplink spectrum and route sub-bands to downlink channels and beams*
 - *Routes uplink gateway spectrum from multiple GWs to downlink user beams and vice-versa for return link service(s)*

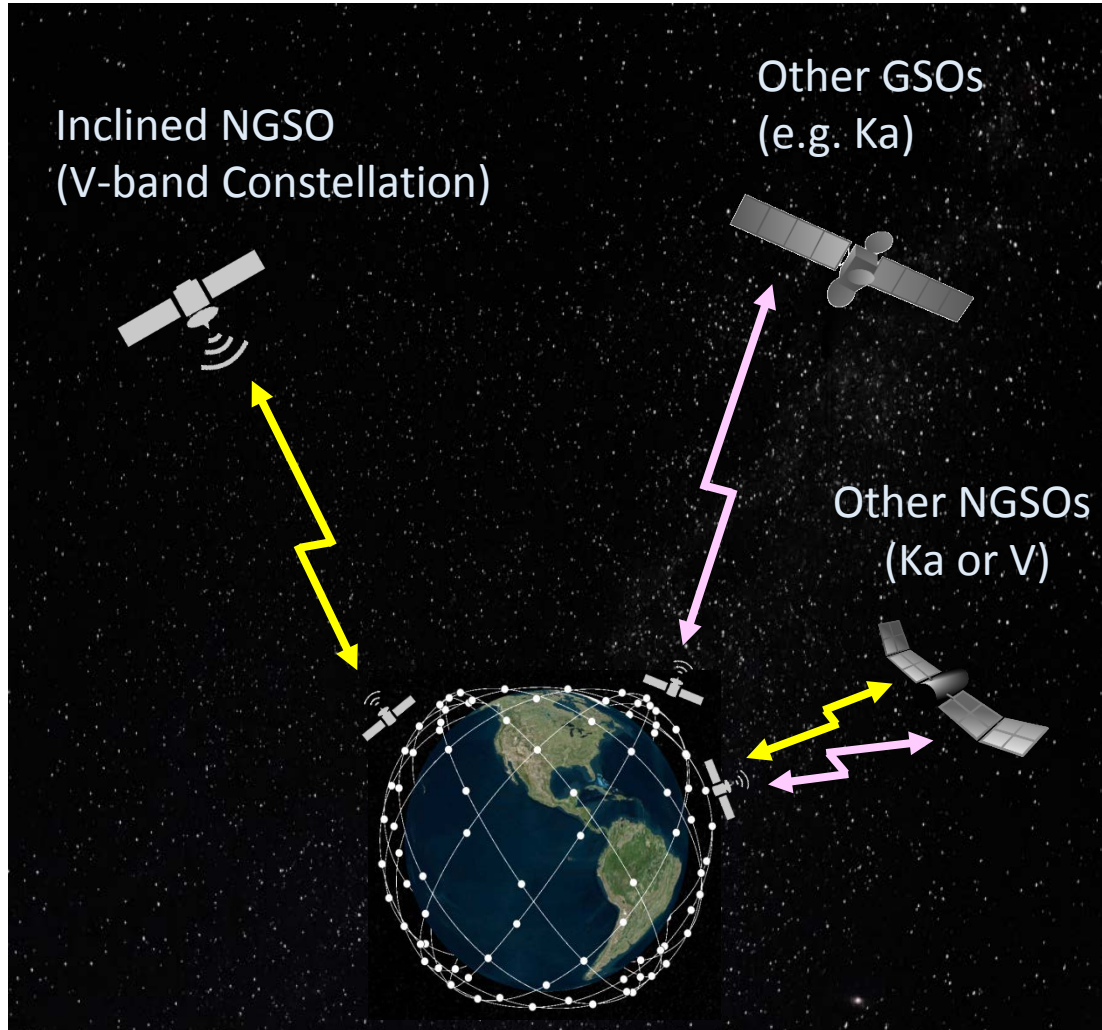
EIRP, EIRP Density and PFD Capabilities



- *V-band Constellation inclined NGSO and LEO satellite operation is fully compliant with current FCC regulations (no waiver requested)*
- *In 40.0-42.5 GHz band, satellites operate up to -105 dBW/m²/MHz in any conditions*
- *In 37.5-40.0 GHz band, satellites operate below -117 dBW/m²/MHz in clear air conditions*
- *Satellites will raise their EIRP and EIRP density in rain fade only and operate below the -105 dBW/m²/MHz maximum limit*
- *V-band Constellation will comply with outcome of Spectrum Frontiers FNPRM regarding additional clarifications of rain fade PFD operations (e.g. potential EPFD regulations)*

	Inclined NGSO	LEO
Altitude:	44,221 km	1,056 km
Slant range to 25-deg elevation:	47,572 km	1,979 km
Spot Beam Peak EIRP (in 2.5 GHz):	92.2 dBWi	65.9 dBWi
Spot Beam Peak EIRP density (in 2.5 GHz):	-1.8 dBWi/Hz	-28.1 dBWi/Hz

LEO to GSO/NGSO Crosslink Service



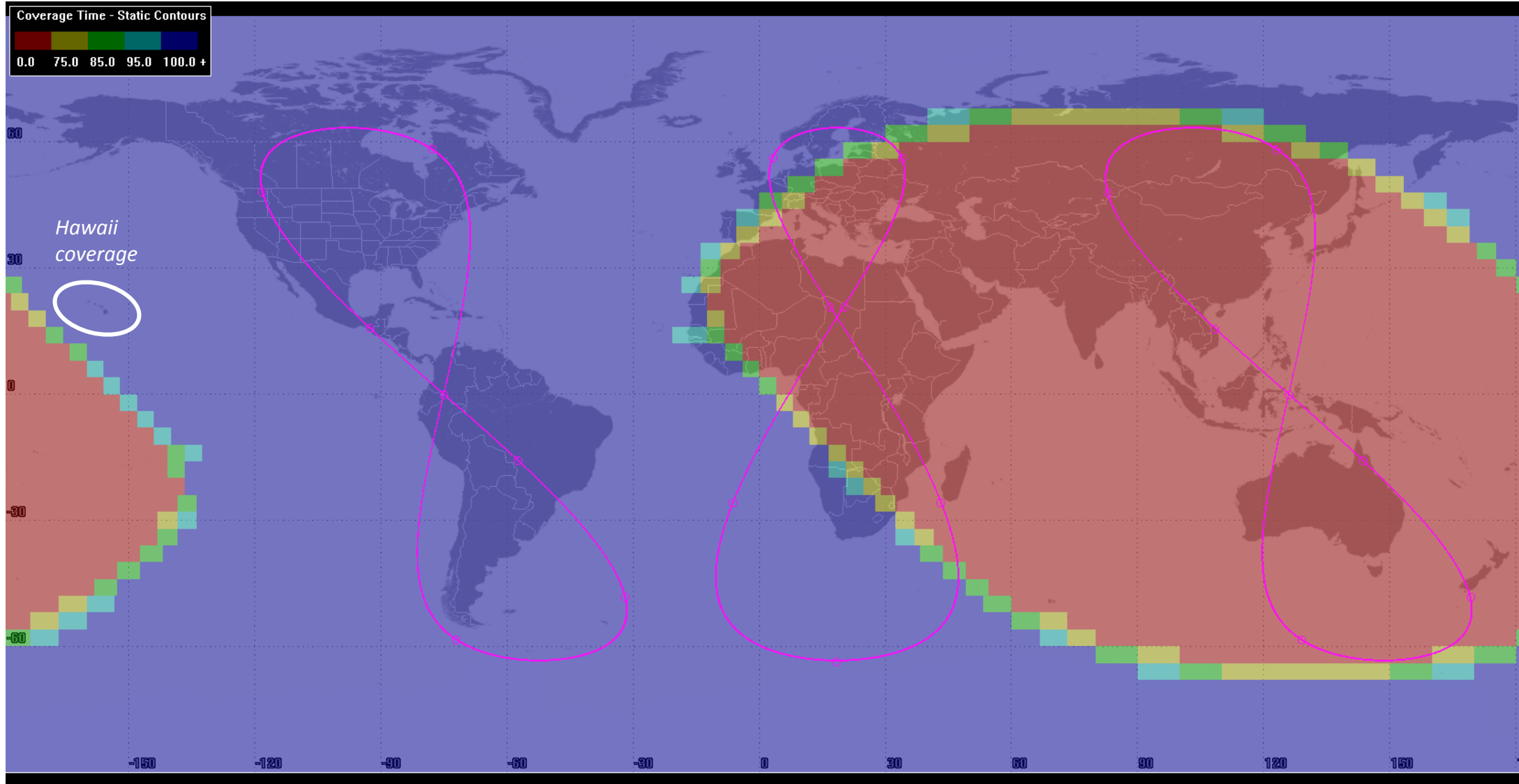
- *V-band Constellation LEO satellites designed to utilize inter-satellite links (ISL) to higher-altitude NGSO or GSO satellites*
- *Provides direct data connectivity to home region data processing centers for LEO satellites not in direct view of a system Gateway*
- *Improves constellation command/control robustness*
- *Includes V-band ISLs (LEO to inclined NGSO) and Ka-band ISLs (e.g. LEO to GSO Ka-band satellites)*
- *ISLs to other systems operate as a “user” of the targeted system on a non-interfering basis*

Ka ISL Characteristics		
Ka-band ISL	Rx: 17.8 – 19.3 GHz (dual CP)	Tx: 27.5 – 29.1 GHz (dual CP)
Frequency Bands	19.7 - 20.2 GHz (dual CP)	29.5 – 30.0 GHz (dual CP)
Maximum G/T	14.0 dB/K (1.7-deg beam)	
Maximum Transmit EIRP	61.0 dBWi (1.2-deg beam)	
V-band ISL Characteristics		
V-band ISL	Rx: 37.5 - 40.0 GHz (dual CP)	Tx: 47.2 – 50.2 GHz (dual CP)
Frequency Bands	40.0 - 42.0 GHz (dual CP)	50.4 – 51.4 GHz (dual CP)
Maximum G/T	18.5 dB/K (0.9-deg beam)	
Maximum Transmit EIRP	66.5 dBWi (0.7-deg beam)	
ISL Channels and FOV (both)		
Channel Bandwidths	Variable (125, 250, 500 or 1000 MHz)	
Field-of-View	Inclined NGSOs, Visible GSO arc, or other NGSO (MEOs)	

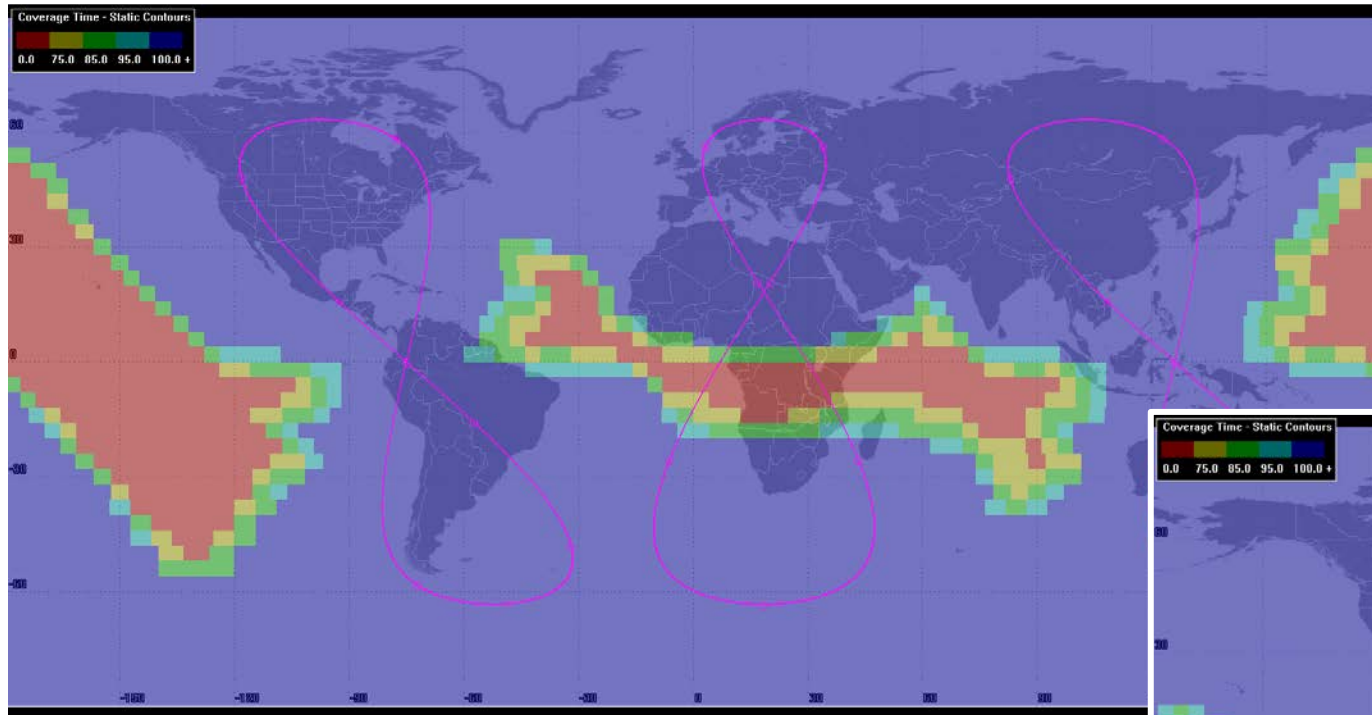
(from Tables III-3 and III-4 – Ka-band and V-band ISL Key Parameters)



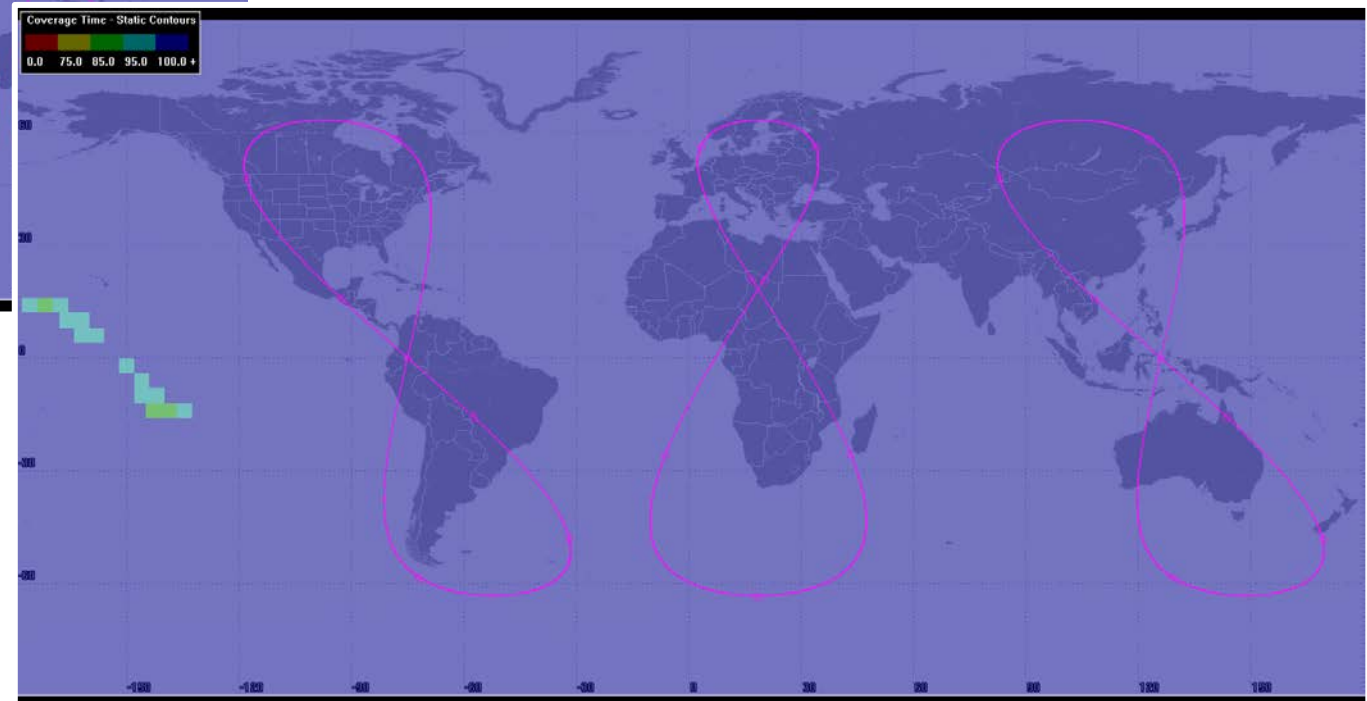
V-band Constellation – 63.4° Inclined NGSO Americas coverage (Initial Deployment) – 25° elevation angle



V-band Constellation – 63.4° Inclined NGSO Final Deployment Coverage (3 regions, 15 satellites)

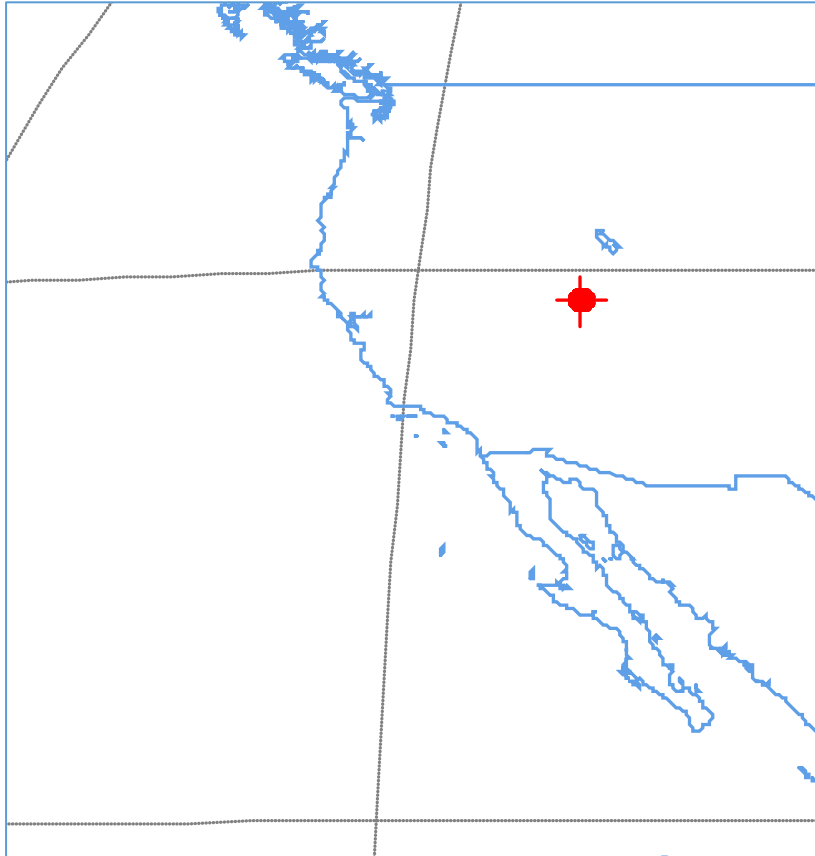


*45-deg
elevation
angle coverage*

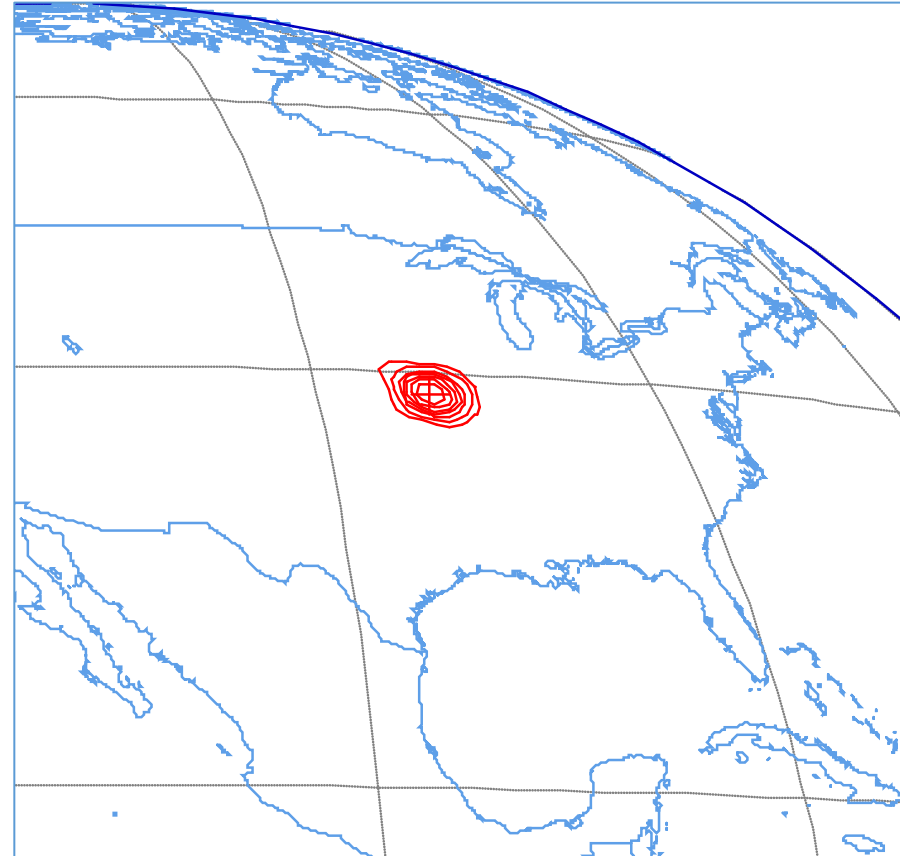


*25-deg
elevation
angle coverage*

Satellite Beam Patterns



LEO satellite beam pattern
(e.g. Schedule S LxL0,LxR0 .gxt files)



63.4-deg Inclined NGSO beam pattern
(e.g. GxL0, GxR0 .gxt files)

V-band Constellation supports cellular coverage and high frequency re-use from both Inclined NGSO and LEO satellites