Ground Based DVB-S2 Repeater for GEO

Wally Ritchie - WU1Y

Steve Conklin – AI4QR

Members Phase 4 Ground Team

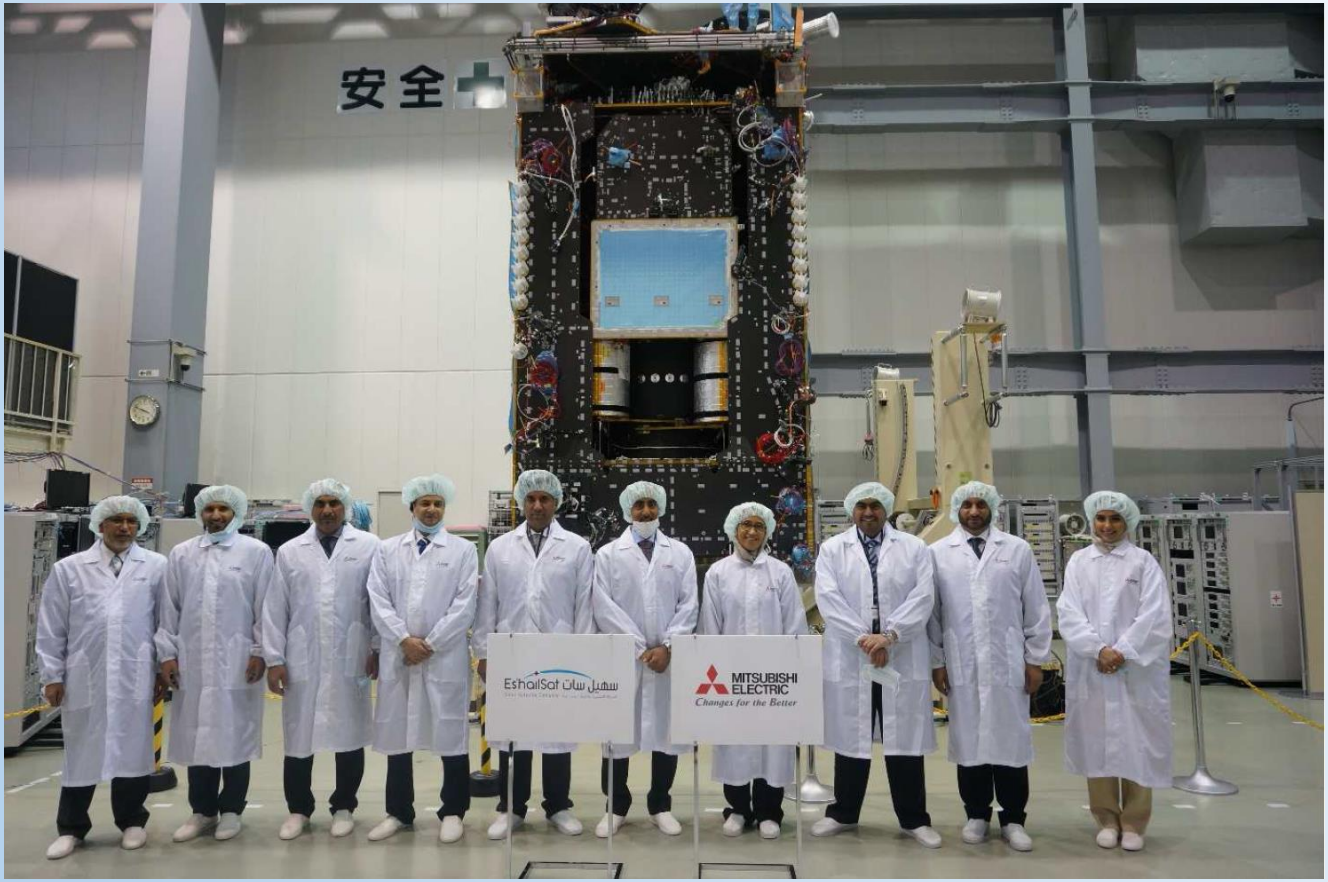
AMSAT PHASE 4 and 5

- PHASE 4 – Geosynchronous Satellites
  - Phase 4A – AMSAT-DL Rideshare on Es-hail-2 to launch scheduled for 2018
  - Phase 4B – Rideshare on Air Force WOFV (2019?)
  - Phase 4X - ???????
- PHASE 5 – Lunar Orbit and Beyond
  - Cube-Sat Challenge – RAGNAROK INDUSTRIES/AMSAT Team Winners will Launch on EM-1 (2019)

PHASE 4A: AMSAT-DL Es'hail 2

- Geostationary Orbit at 25.5˚E over Europe & Middle East
- Hosted Payload w/Qatar Satellite Company's Es-Hail 2
- Coverage – Europe, Africa, Middle-east, Thailand to Eastern tip of Brazil
- 2.4GHz Uplink – 10GHz Downlink
- Two Linear 140W Transponders:
  - 8 MHz for DVB Television and Data
  - 250 kHz for Traditional SSB, CW, etc.

Es'hail-2



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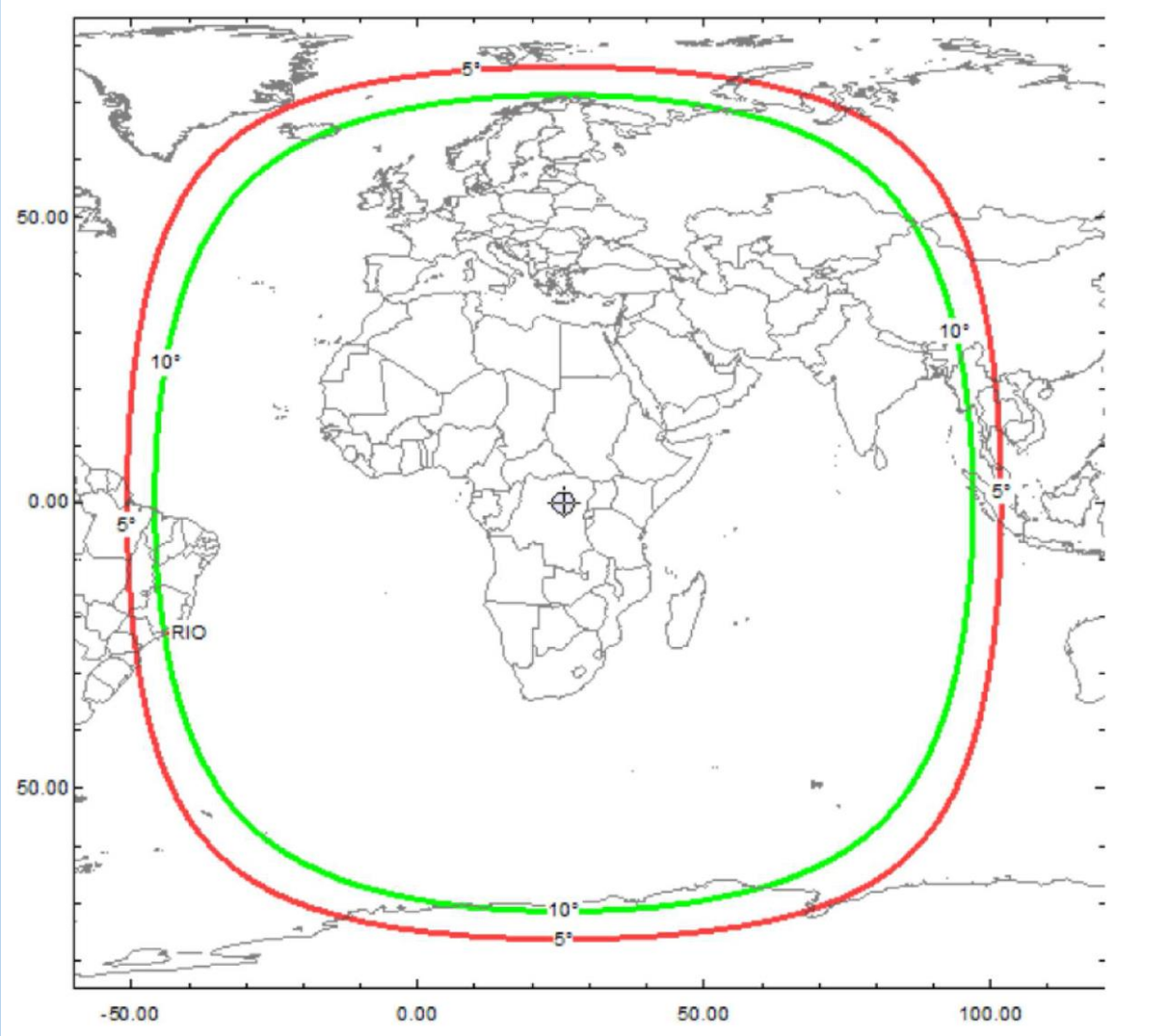
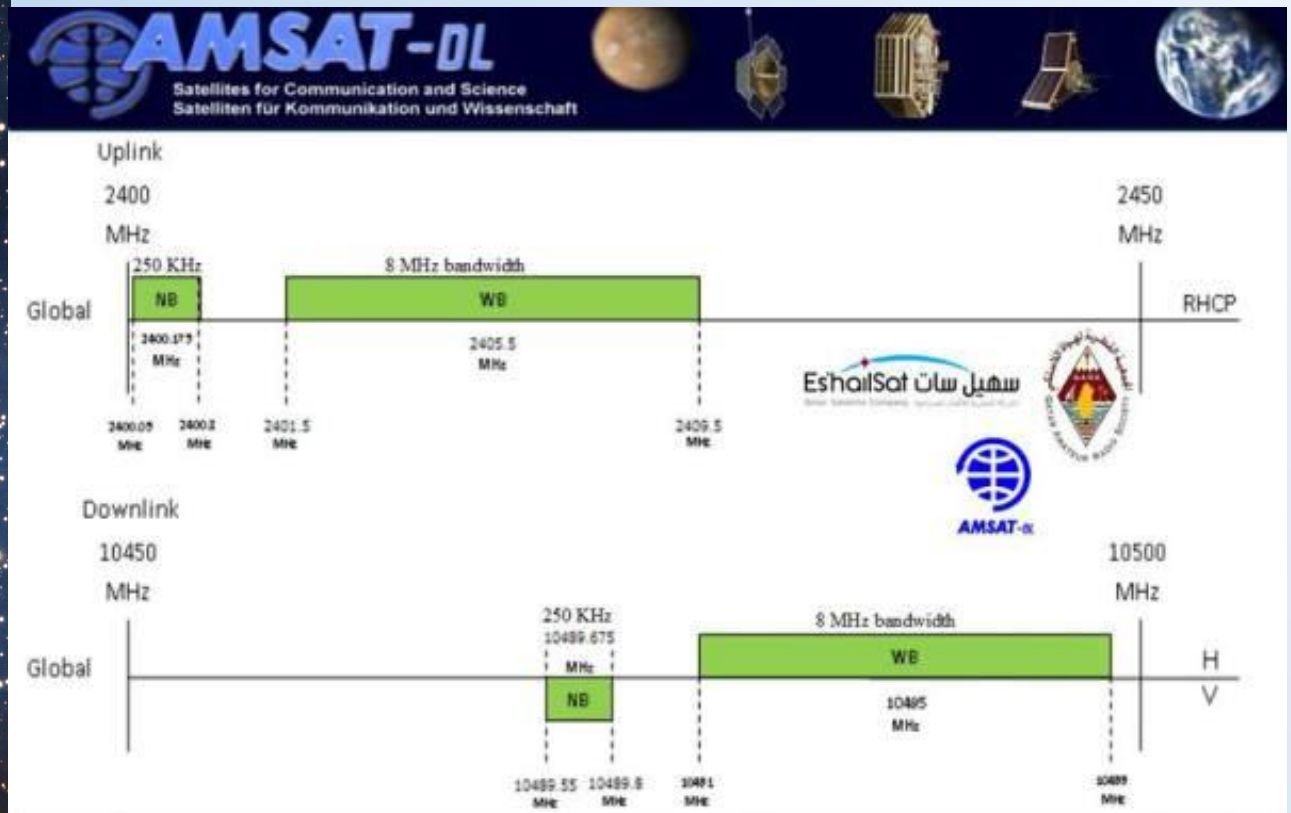
4A – Coverage Area



PHASE 4A Frequency Plan



Xpdr	U/L FREQUENCY (MHz)				D/L FREQUENCY (MHz)				LO	BW
No	Pol	Begin	Center	End	Pol	Begin	Center	End	(MHz)	(MHz)
NB	RHCP	2400.05	2400.175	2400.3	V	10489.55	10489.675	10489.8	8089.5	0.25
WB	RHCP	2401.5	2405.5	2409.5	H	10491	10495	10499	8089.5	8

PHASE 4B:

- Rideshare on USAF Wide Field of View (WFOV) Geosynchronous Satellite
- Partners
  - AMSAT, Millennium Space Systems, Virginia Tech
  - Rincon Research Corporation, ARRL, FEMA
- Geosynchronous Orbit over North America

USAF WFOV Satellite

PHASE 4B

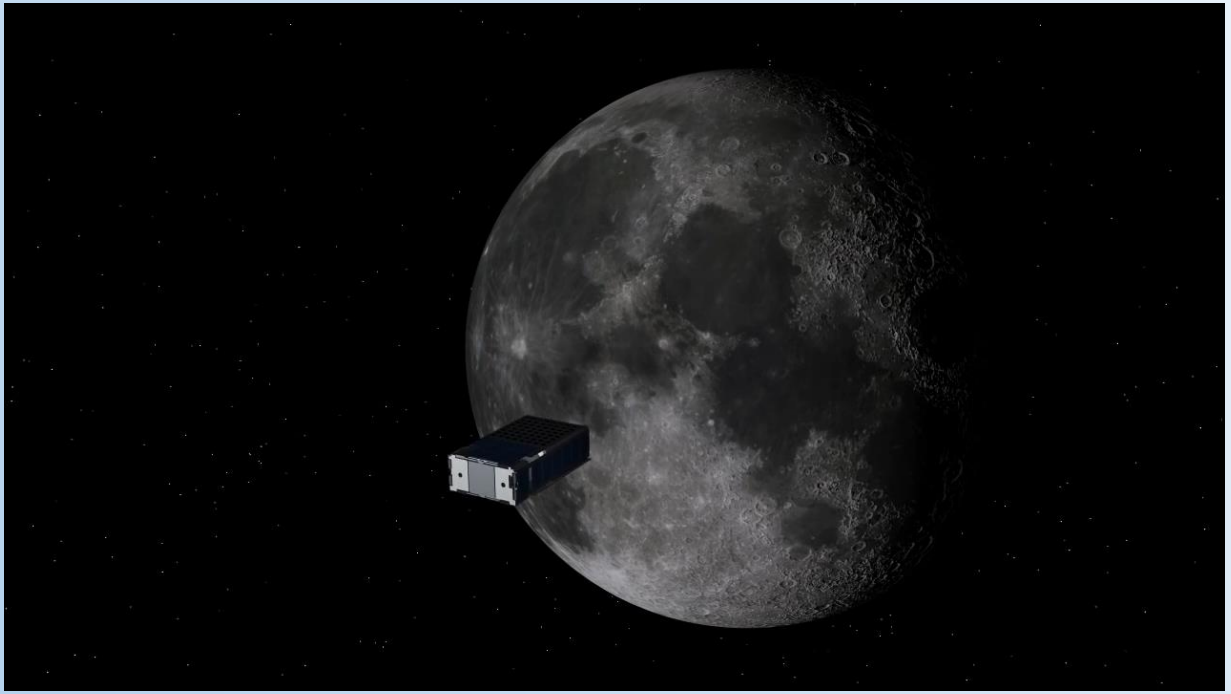
- Five and Dime (5GHz up 10Ghz down)
- Software Defined Radio
- ALL DIGITAL – No Analog Transponder
- Digital Regenerative Repeater
- Geosynchronous Orbit (Not Geostationary)
- Launch Date presently uncertain.

Phase 4B Downlink

- 10.450 GHz Carrier
- Single Downlink
- Saturated Power Amplifier (maximize DC efficiency)
- Up to 8+ Megasymbols per Second
- DVB-S2 Modulation
- ALL Stations synchronize to the downlink
- Stations Decode streams they want (including all)

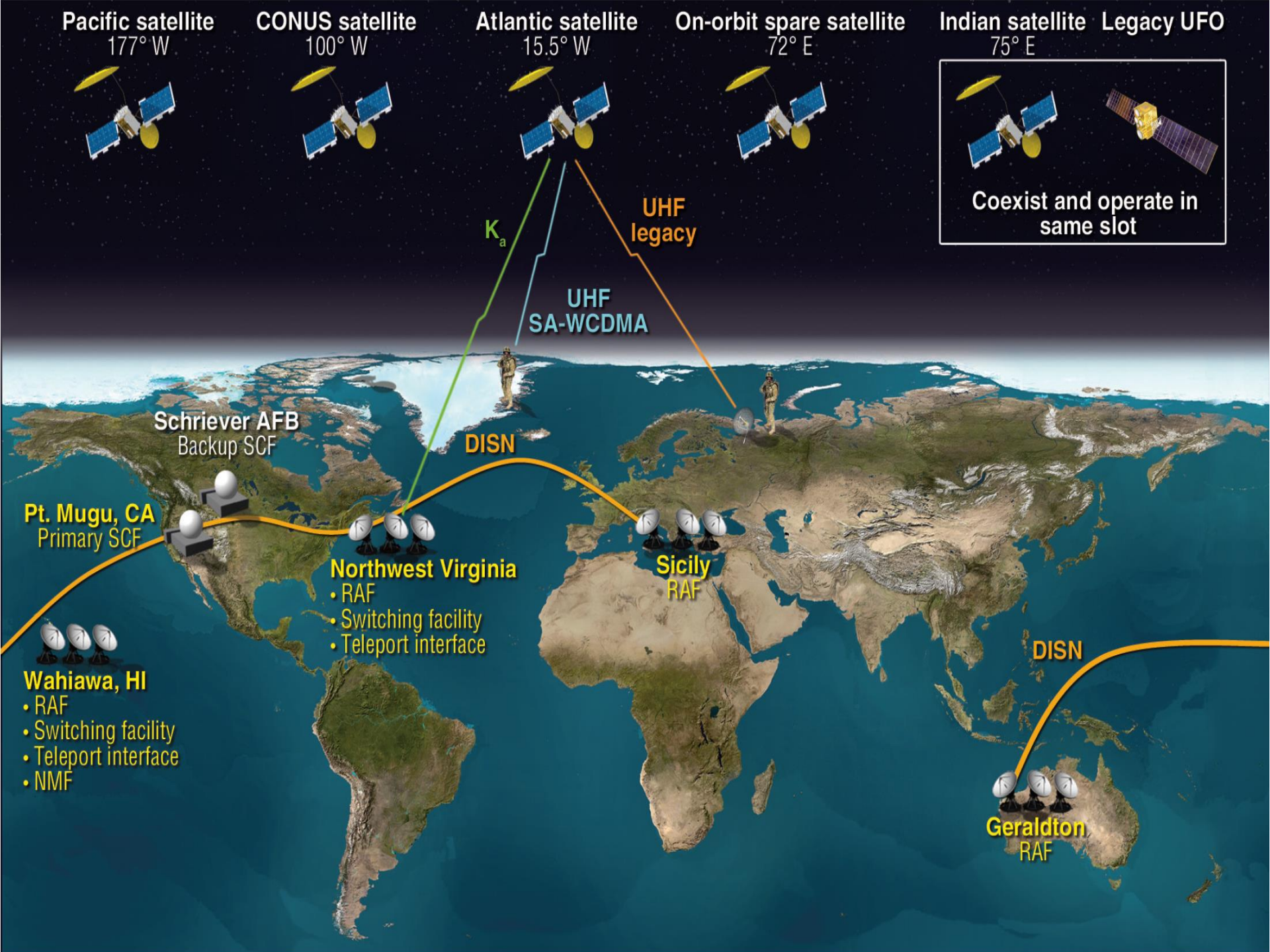
PHASE 5 – NASA CUBEQUEST CHALLENGE

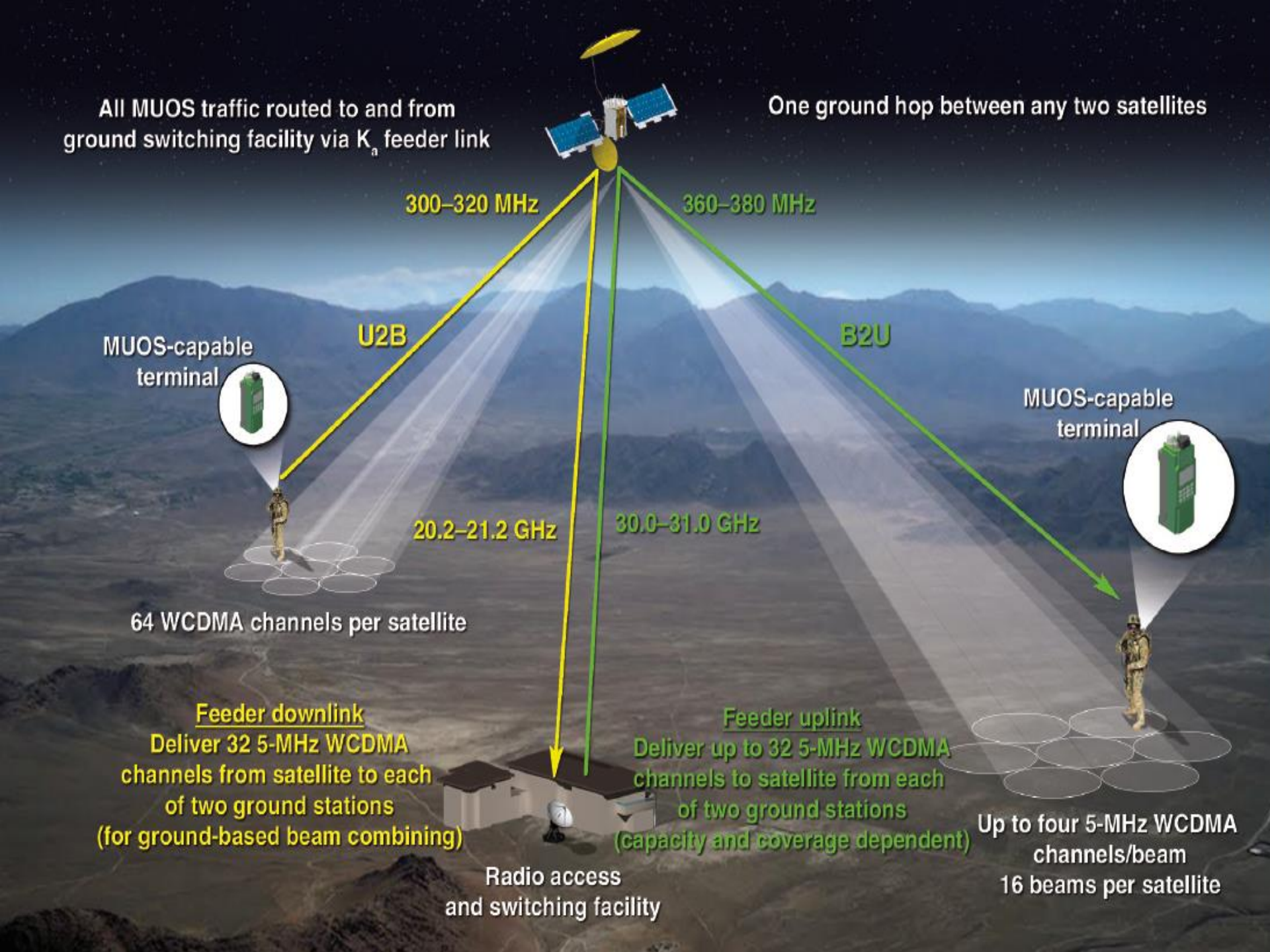
- RAGNAROK INDUSTRIES - HEIMDALLR

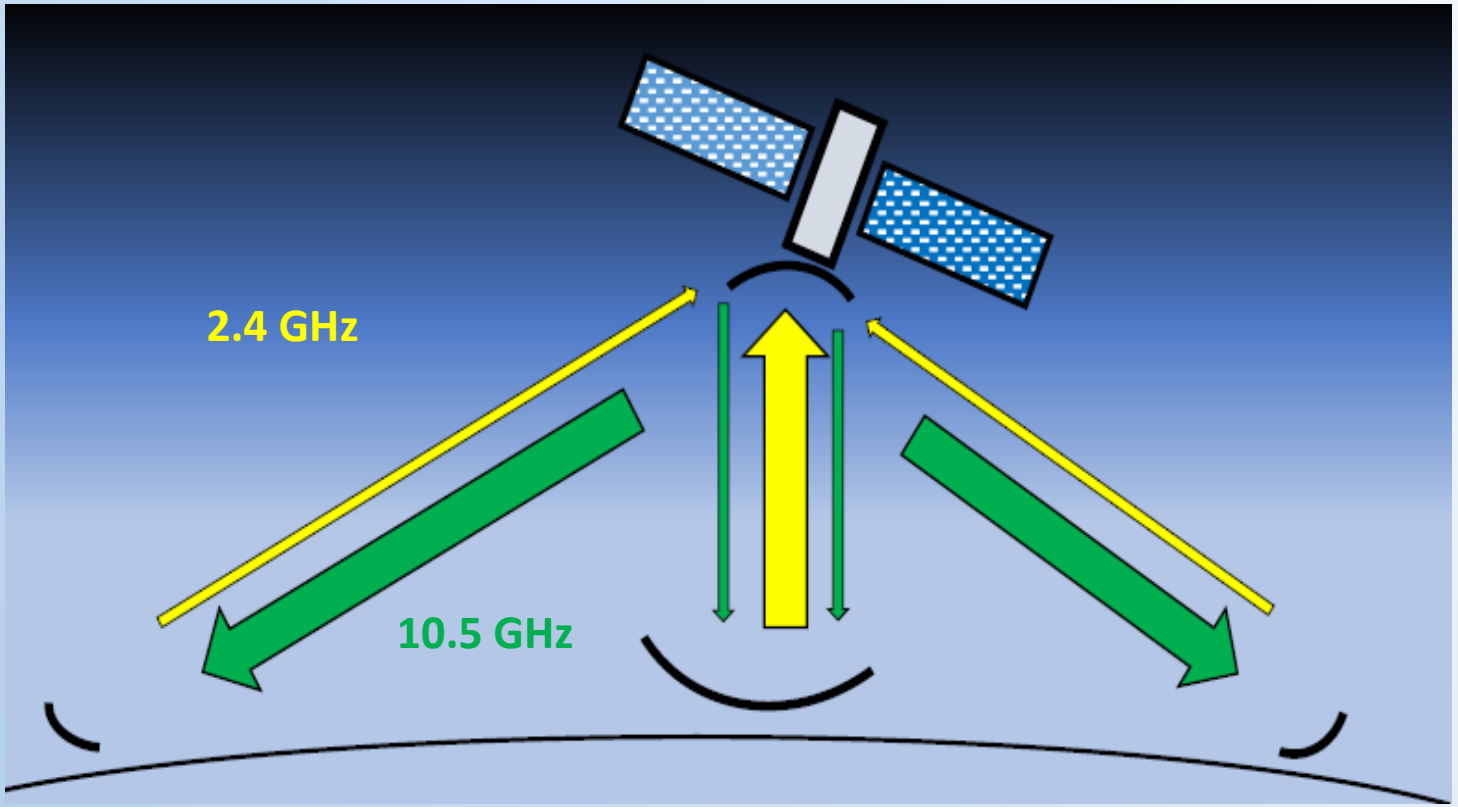


Phase 4B Uplink

- 5 GHz Band
- 10 MHz Receive Bandwidth at transponder
- Stations use 10kHz to 100kHz Bandwidth
- Modest Power Required 2W – 10W
- Modulation TBD
  - Pi/4 QPSK Likely


Pacific satellite
177° W
CONUS satellite
100° W
Atlantic satellite
15.5° W
On-orbit spare satellite
72° E
Indian satellite
75° E
Legacy UFO
Coexist and operate in same slot
Ka
UHF legacy
UHF SA-WCDMA
Schriever AFB
Backup SCF
DISN
Pt. Mugu, CA
Primary SCF
Northwest Virginia
• RAF
• Switching facility
• Teleport interface
Sicily
RAF
Wahiawa, HI
• RAF
• Switching facility
• Teleport interface
• NMF
DISN
Geraldton
RAF


All MUOS traffic routed to and from ground switching facility via K_a feeder link
One ground hop between any two satellites
300–320 MHz
360–380 MHz
U2B
B2U
MUOS-capable terminal
MUOS-capable terminal
20.2–21.2 GHz
30.0–31.0 GHz
64 WCDMA channels per satellite
Feeder downlink
Deliver 32 5-MHz WCDMA channels from satellite to each of two ground stations (for ground-based beam combining)
Feeder uplink
Deliver up to 32 5-MHz WCDMA channels to satellite from each of two ground stations (capacity and coverage dependent)
Radio access and switching facility
Up to four 5-MHz WCDMA channels/beam
16 beams per satellite



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Why DVB-S2

- DVB Standards are International, Free, and very widely used.
- DVB-S2 is the 2nd Generation Standard
- Generic Stream Encapsulation (GSE) used for the downlink data.

DVB-S2 Features

- Continuous Transmission of frames at symbol rate.
- Modulation and Coding (MODCOD) can vary with each frame.
- Very Powerful Forward Error Correction (FEC)

Repeater Mode Advantages

- Only DVB-S2 Receiver Required. (No need for existing transceiver and transverter)
- Simple Digital Transmitter on 2.4GHz uplink, 2W
- Digital Voice
- Expensive Equipment only at Central Station
- Coexistence with Analog Modes

Details in Paper

- Transmitter Performance
- Receiver Performance
- Path Losses
- C/N

Future

- Future GEO's will have onboard regenerative repeaters eliminating need for central ground station.
- Ground Repeater Software developed for Phase 4A will be useful for future satellites with onboard repeaters.
- 3 on-orbit satellites could eventually provide global coverage.

Get Involved

- PHASE 4 GROUND
  - Open to all AMSAT members worldwide
  - Active day by day through collaboration tools
  - Git repository
  - Satellite + Terrestrial Microwave

- ASCENT (Advanced Satellite Communications and Exploration of New Technology)
  - AMSAT-NA “Skunkworks”
  - ITAR due to US Export Regulations
  - Restricted to US Persons

More Information:

https://www.amsat.org

https://phase4ground.github.io/

https://www.amsat-dl.org/

https://amsat-uk.org/

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Questions and Discussion

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