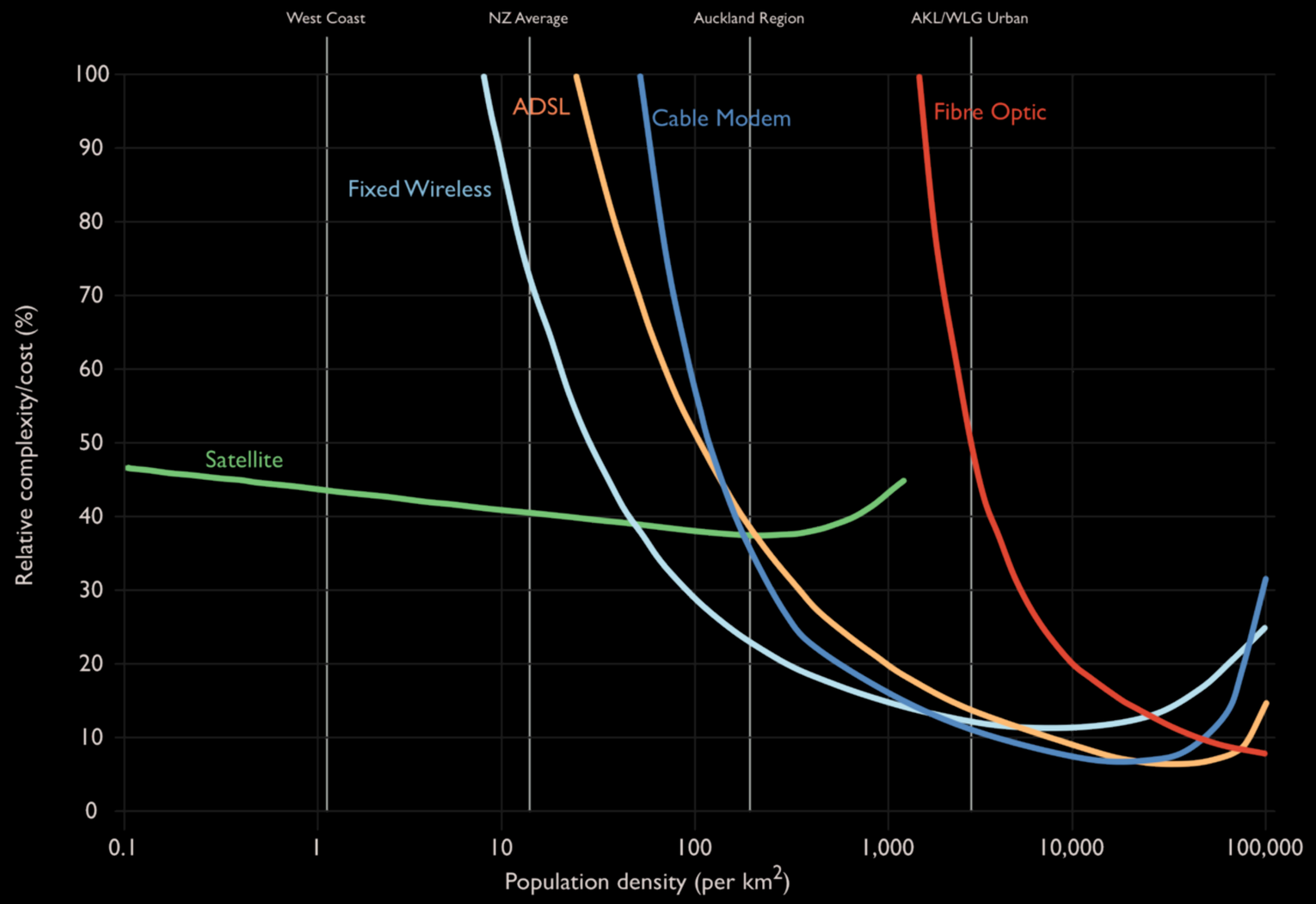
THE FUTURE IS

UP IN THE SKY

BROADBAND FROM THE SKY

- Why do we need it?
- What about distance and latency?
- Spectrum and rain fade?
- Speed? Architecture? Resilience?
- Why do we care?

WHY DO WE NEED SATELLITE? EASY.

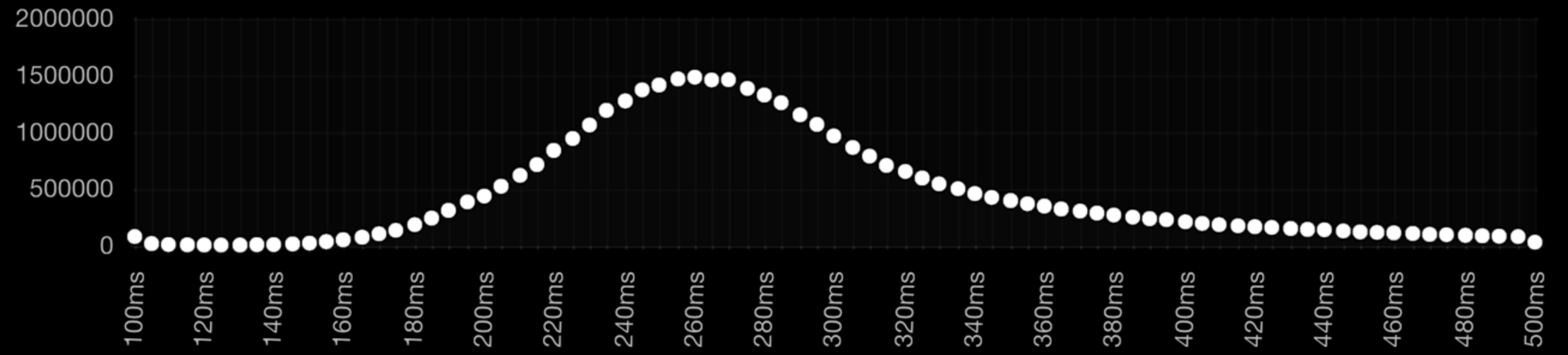


WHY DON'T WE WANT SATELLITE? EASY.

"People buy Horsepower, but drive torque."

"People buy Megabits, but surf latency."

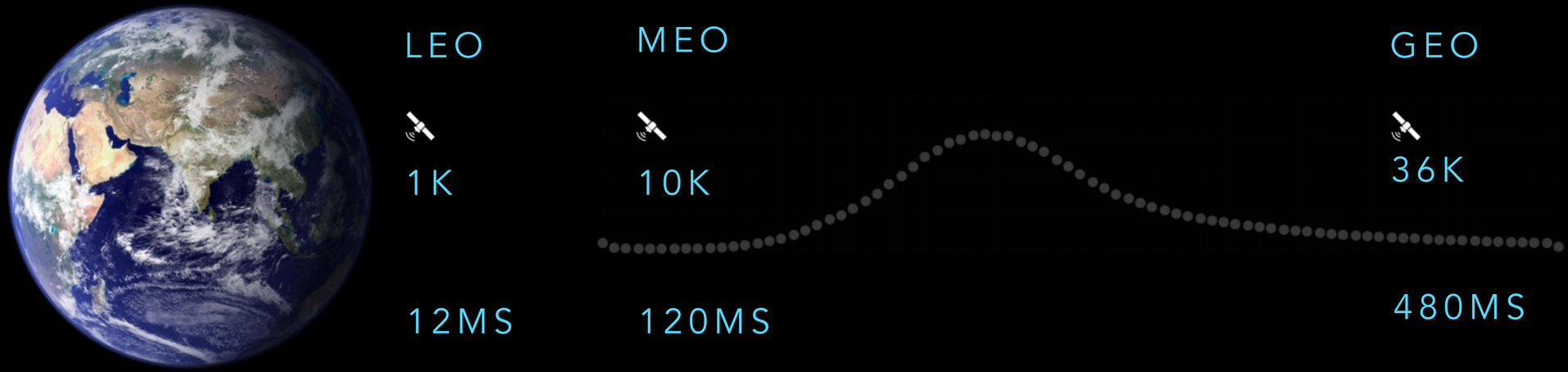
ALL HUMANS NOTICE LATENCY



http://www.humanbenchmark.com/tests/reactiontime/statistics

41 MILLION SAMPLES SAY AVERAGE REACTION TIME = 279 MS

LATENCY IS RELATED TO DISTANCE



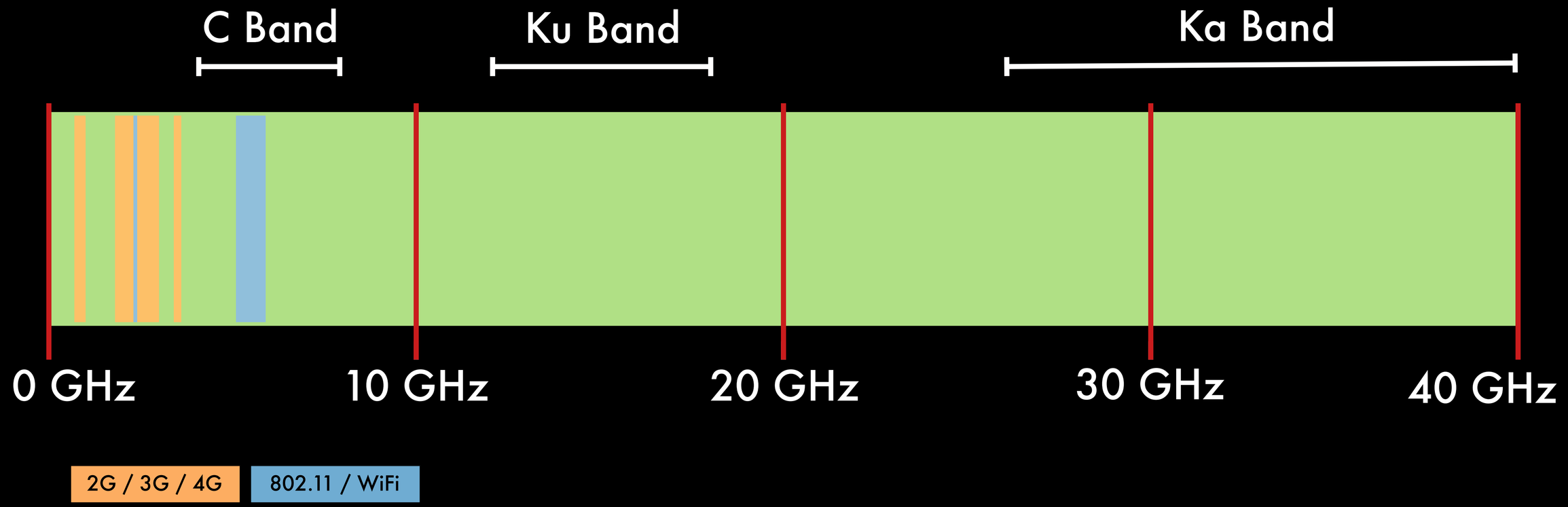
AT LEAST FOUR ONE-WAY TRIPS TO LOAD A WEB PAGE
IN ADDITION TO INTERNET LATENCY

SATELLITE IS SLOW
GAME OVER?

UP IN THE SKY = RADIO WAVES

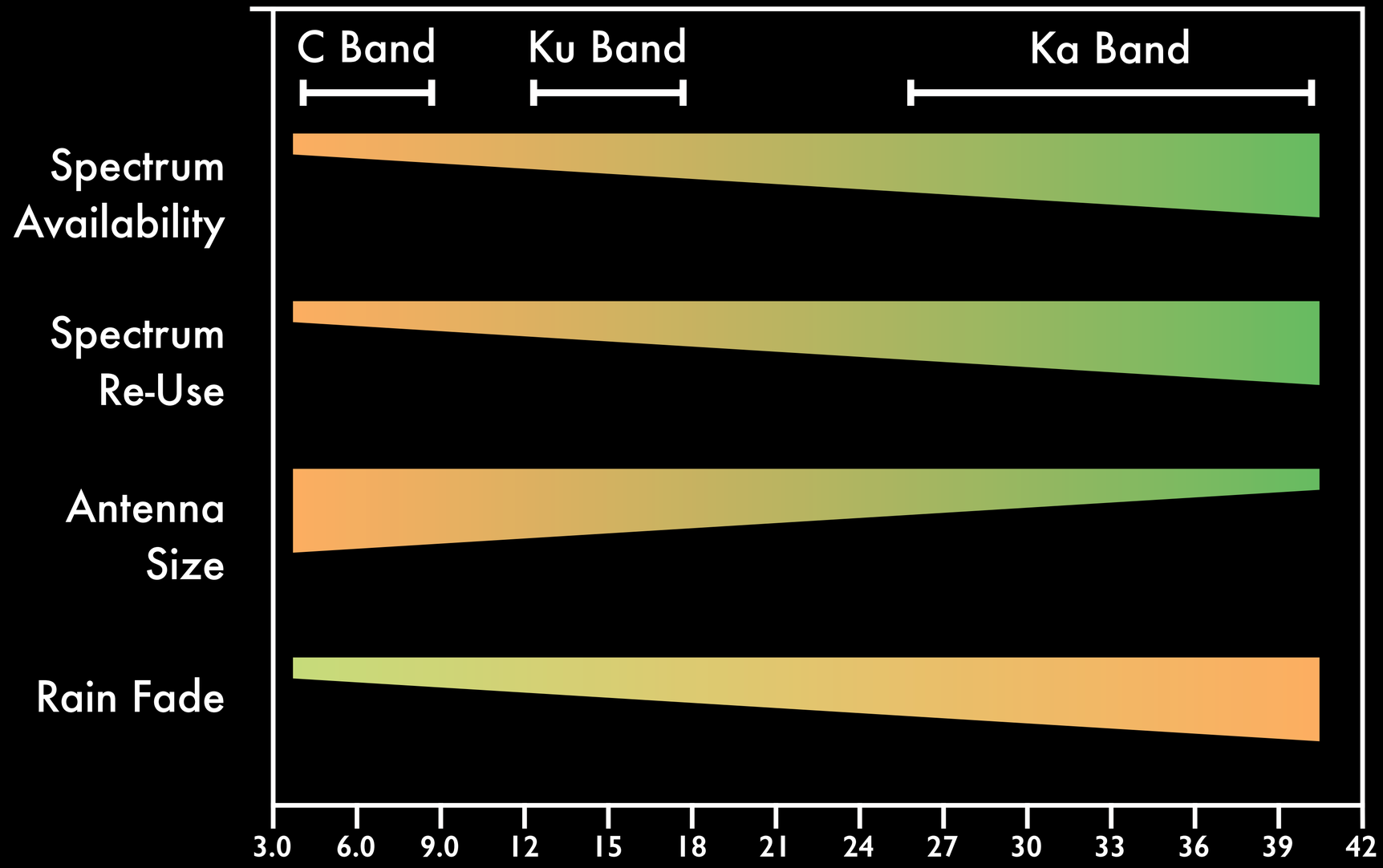
- Positive: Waves in air travel nearly speed of light
  - 40% faster than waves in fibre optic cables
- Negative: Things in the air can attenuate waves
  - Rain, snow, birds, swarms of locusts, x-men
- Neutral: Different frequencies = different properties
  - Bigger waves behave differently from smaller ones

BROADBAND SATELLITE SPECTRUM

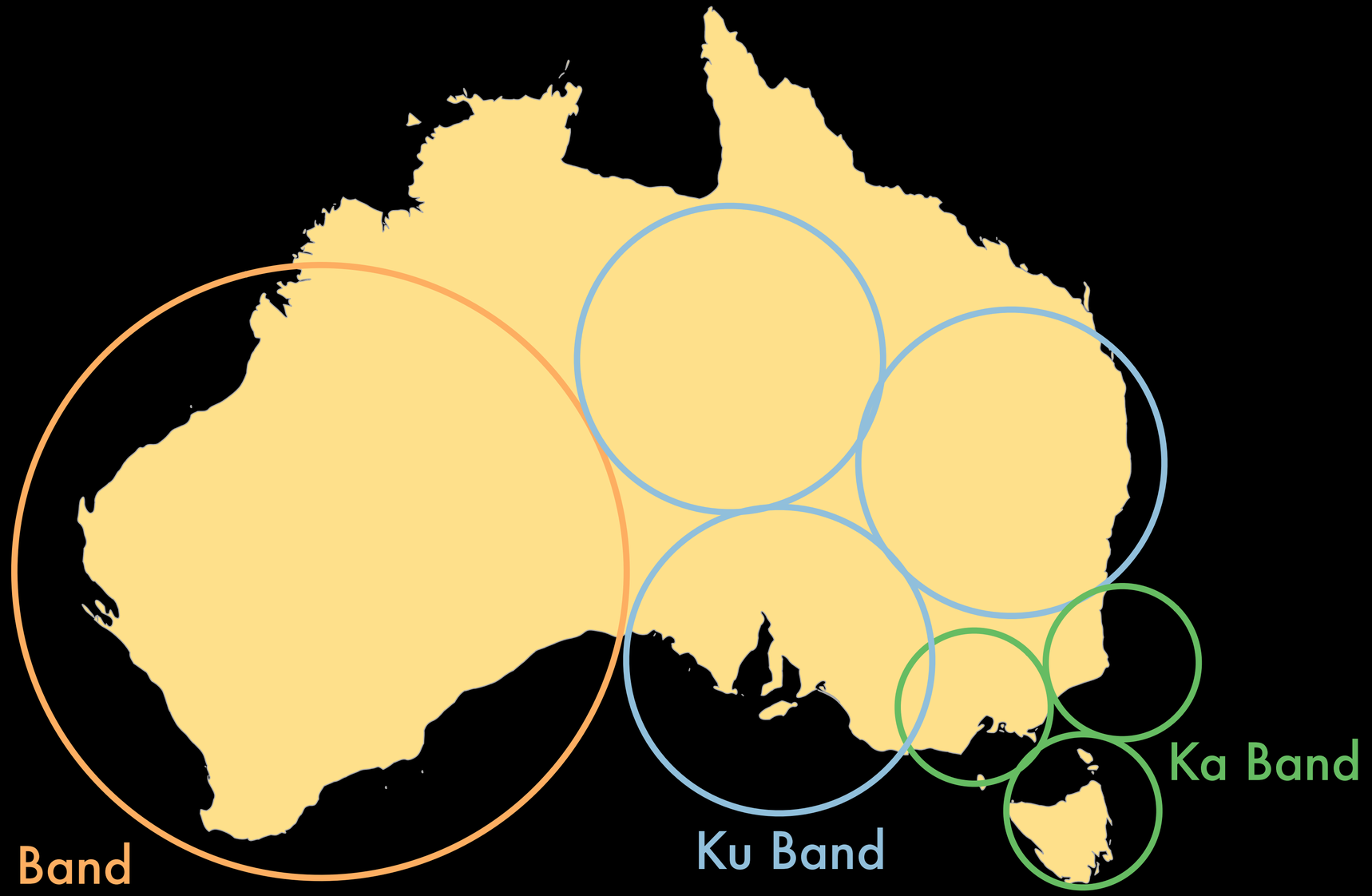


C Band — Ku Band — Ka Band

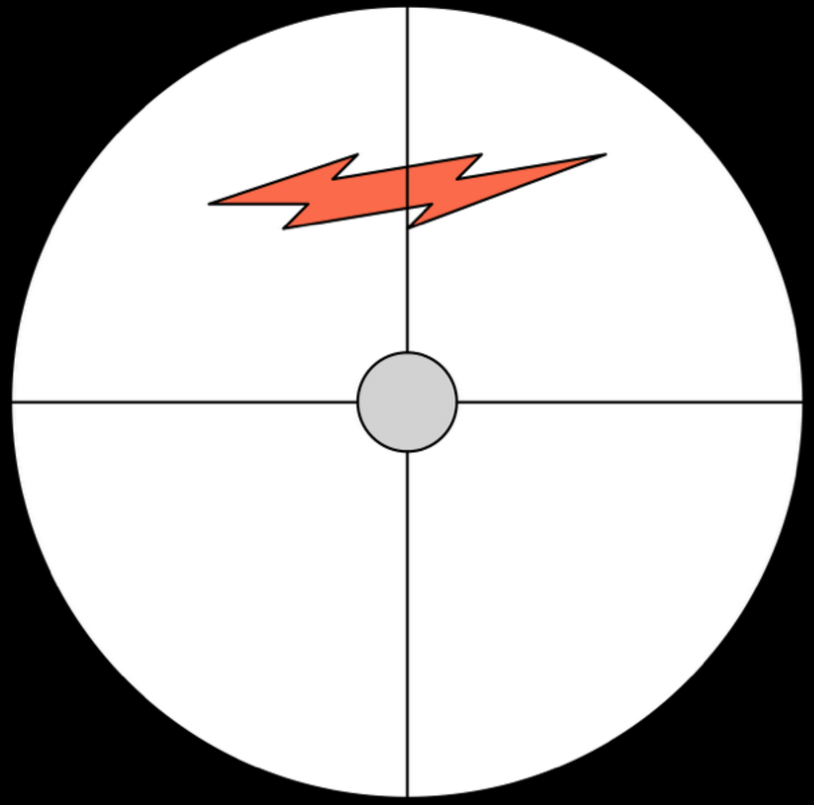
SATELLITE SPECTRUM PRIMER



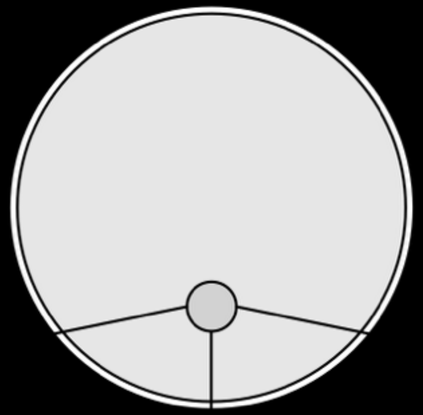
SATELLITE SPECTRUM REUSABILITY



HIGHER BANDS = SMALLER ANTENNAS



C Band 30 dBi



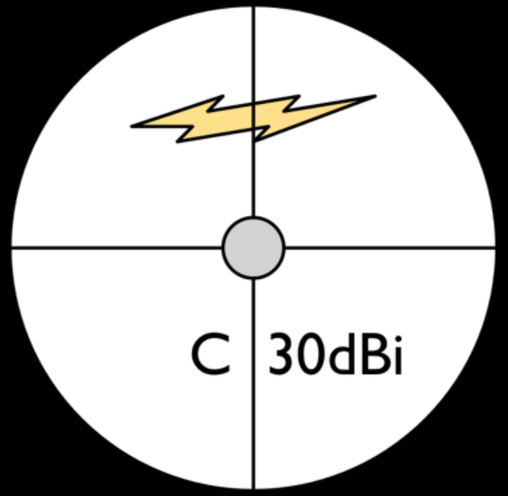
Ku Band 30 dBi

Ka Band 30 dBi

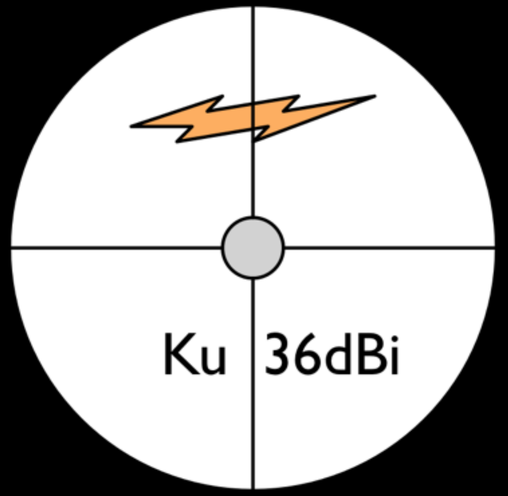
C BAND NEEDS 16X AREA OF KA BAND FOR THE SAME AMOUNT OF GAIN

HIGHER BANDS = MORE ANTENNA GAIN

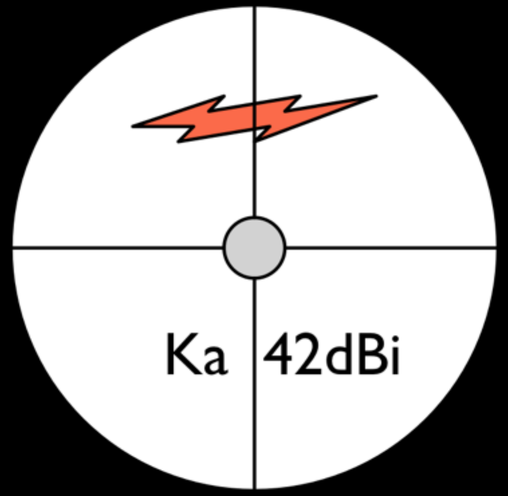
WITH A 1 WATT (30 dB)TRANSMITTER & A 1.2M DISH



1,000 WATTS EIRP



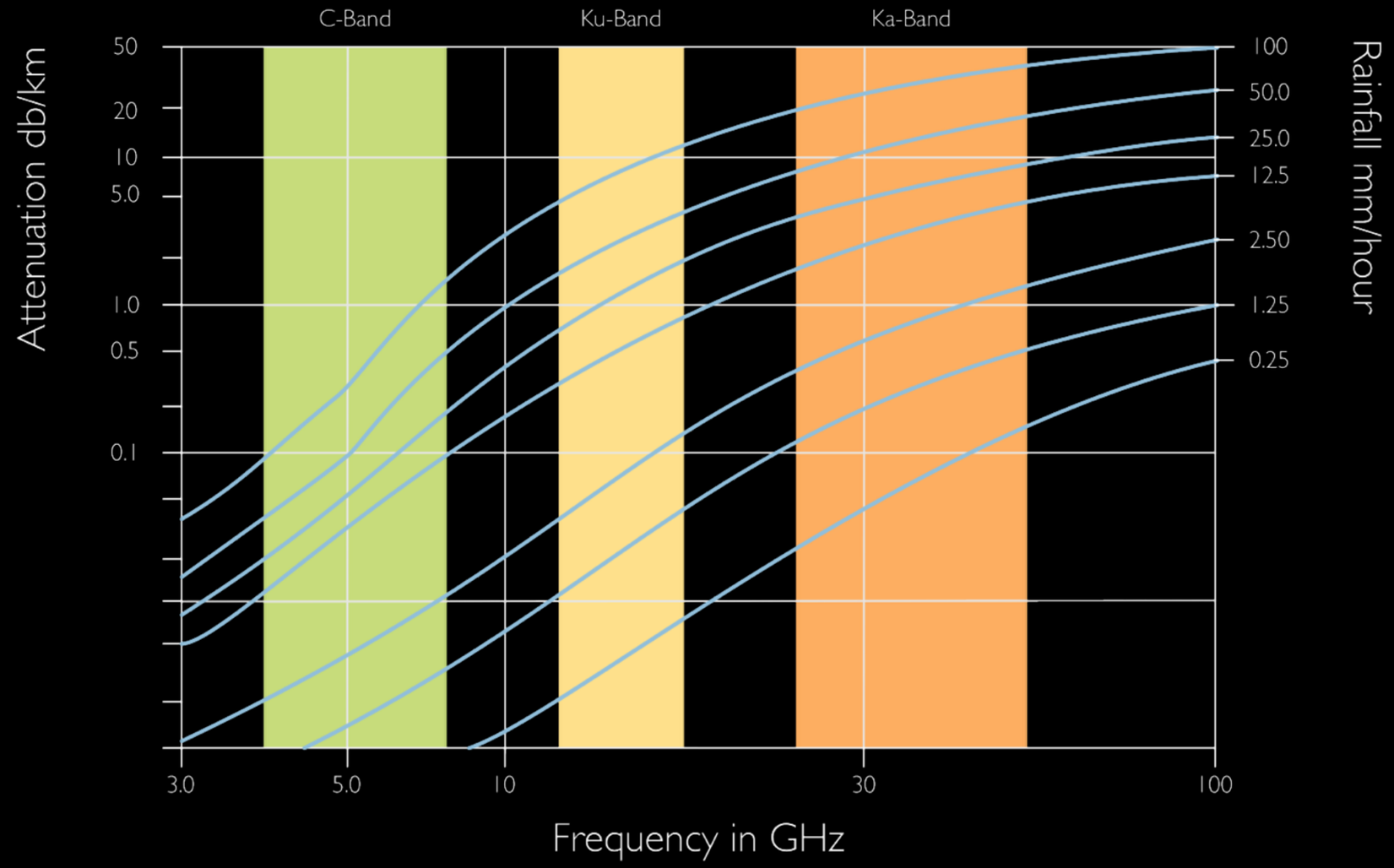
4,000 WATTS EIRP



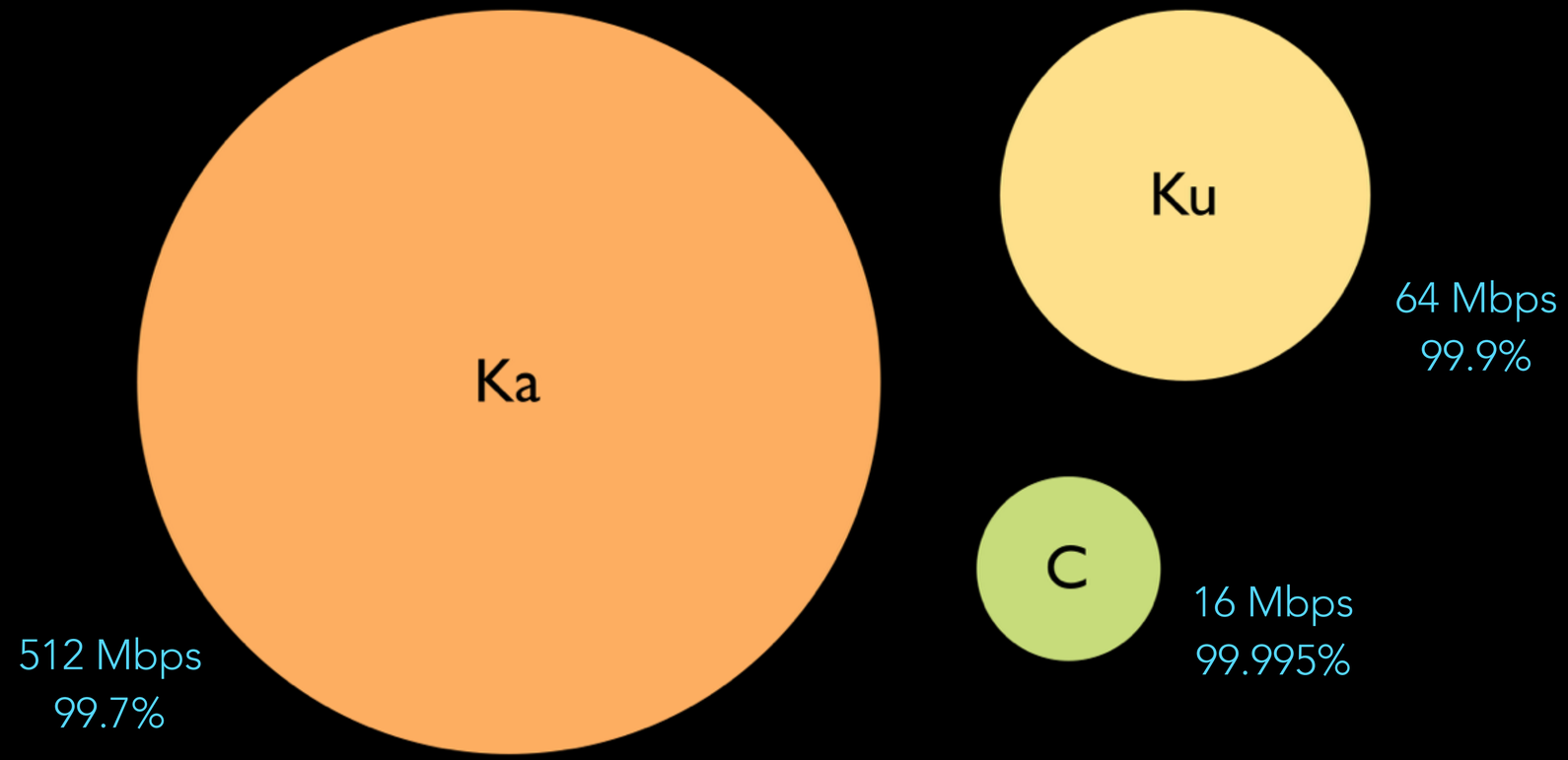
16,000 WATTS EIRP

HIGHER BAND = MORE RAIN FADE

HIGHER BAND = MORE RAIN FADE

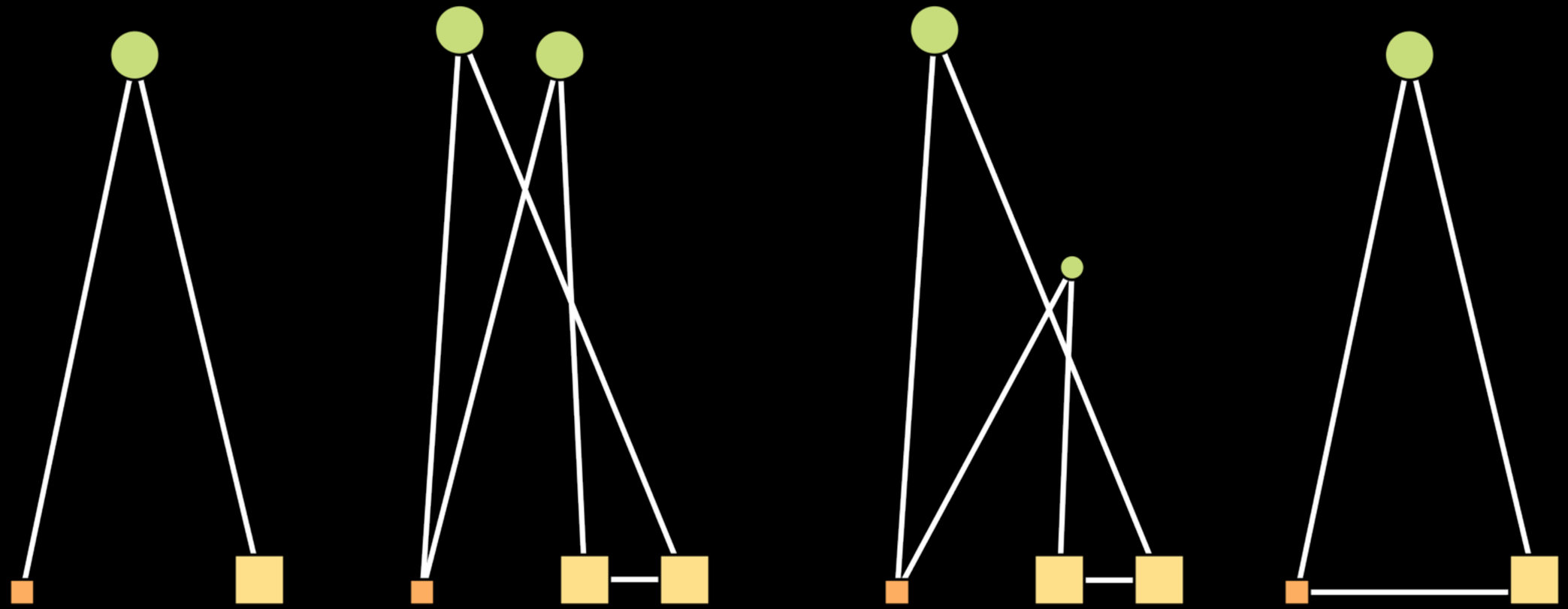


SATELLITE SPECTRUM STRAW MAN



ASSUME A 1.2M DISH ON THE GROUND

NETWORK ARCHITECTURE



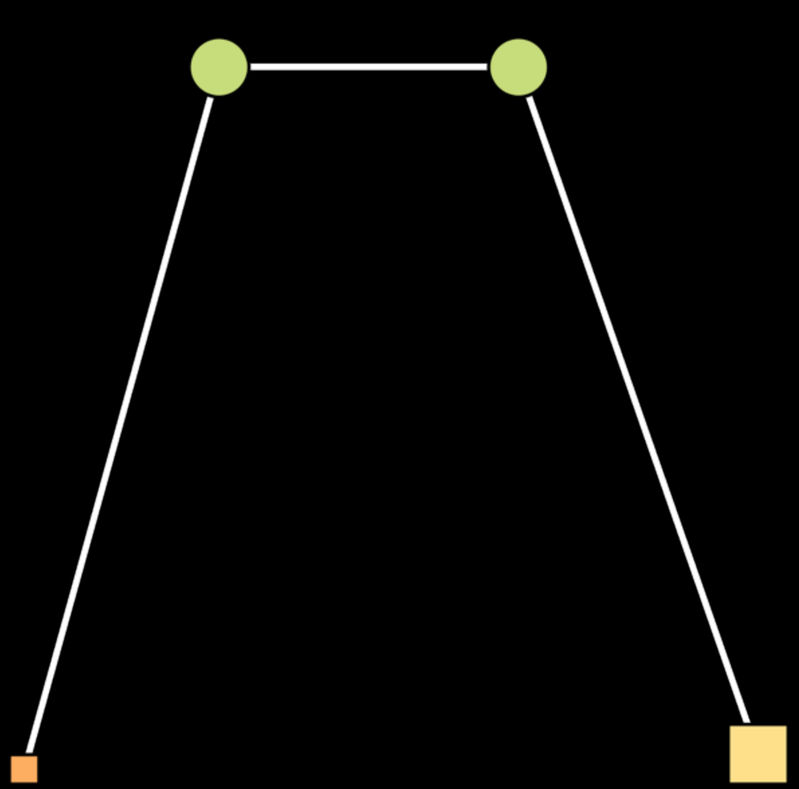
Up & Down

Redundant VSAT

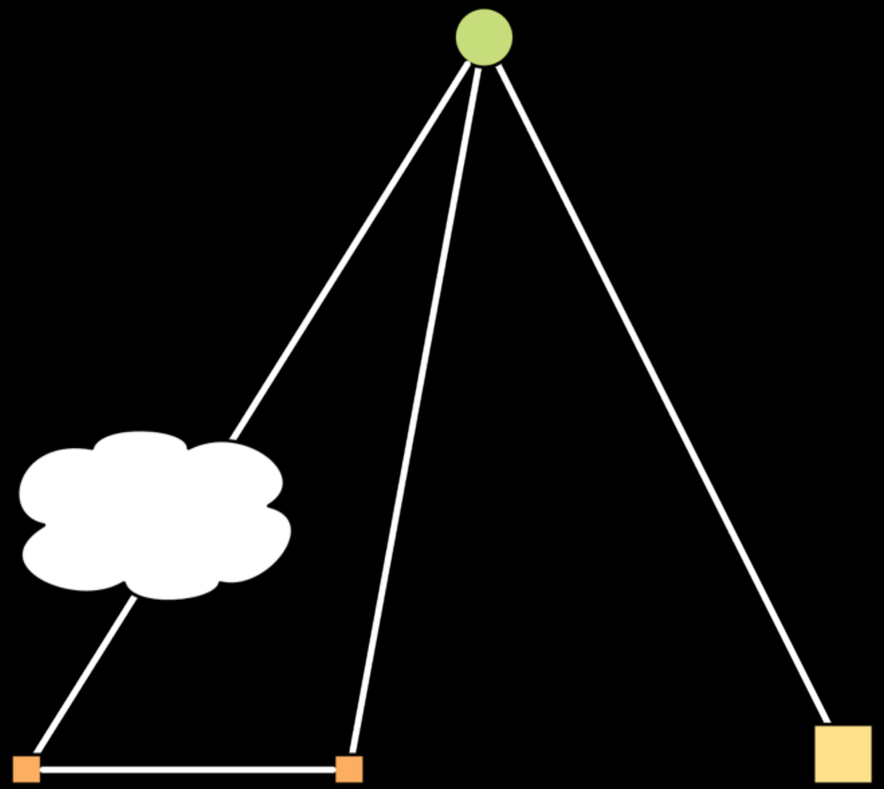
Multi-Modal

Multi-Modal

ADVANCED NETWORK ARCHITECTURE

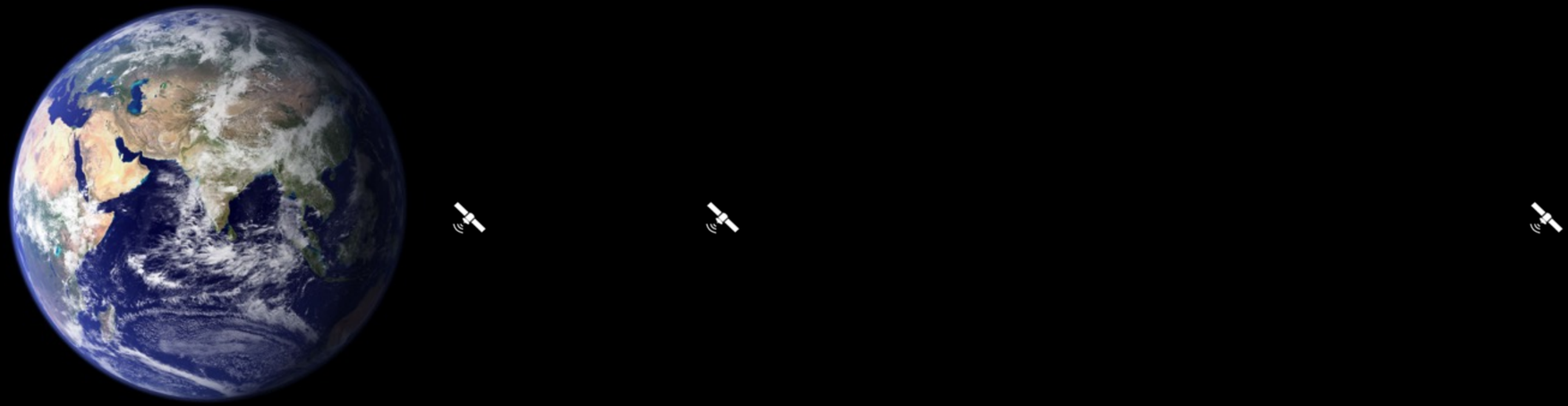


Sat X Link



Cloud Avoidance

ORBITS: LEO, MEO, & GEO



GEOSTATIONARY EARTH ORBIT

- Intelsat since 1965
- 400+ ms Latency
- 3 Satellites Needed
- +/- 82° Global Coverage
- Stationary receiver dishes
- Mass market satellite

Image ©NASA

FARMSIDE: OPTUS D2

- 2007-2022 (est.)
- Orbital “STAR-2” at 152° E
- GEO orbit, Ku band
- 56 MHz of Spectrum
- Up to 540 mbps downlink
- Up to 16/2 mbps to users

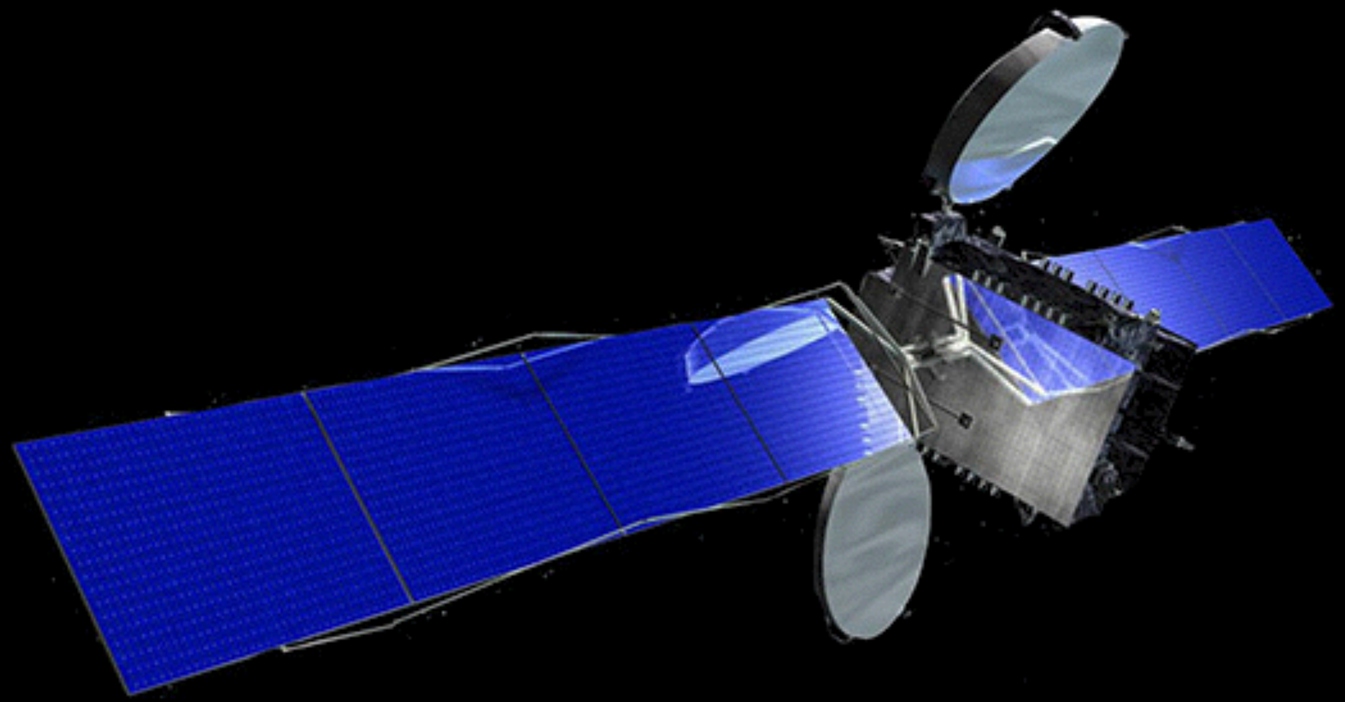


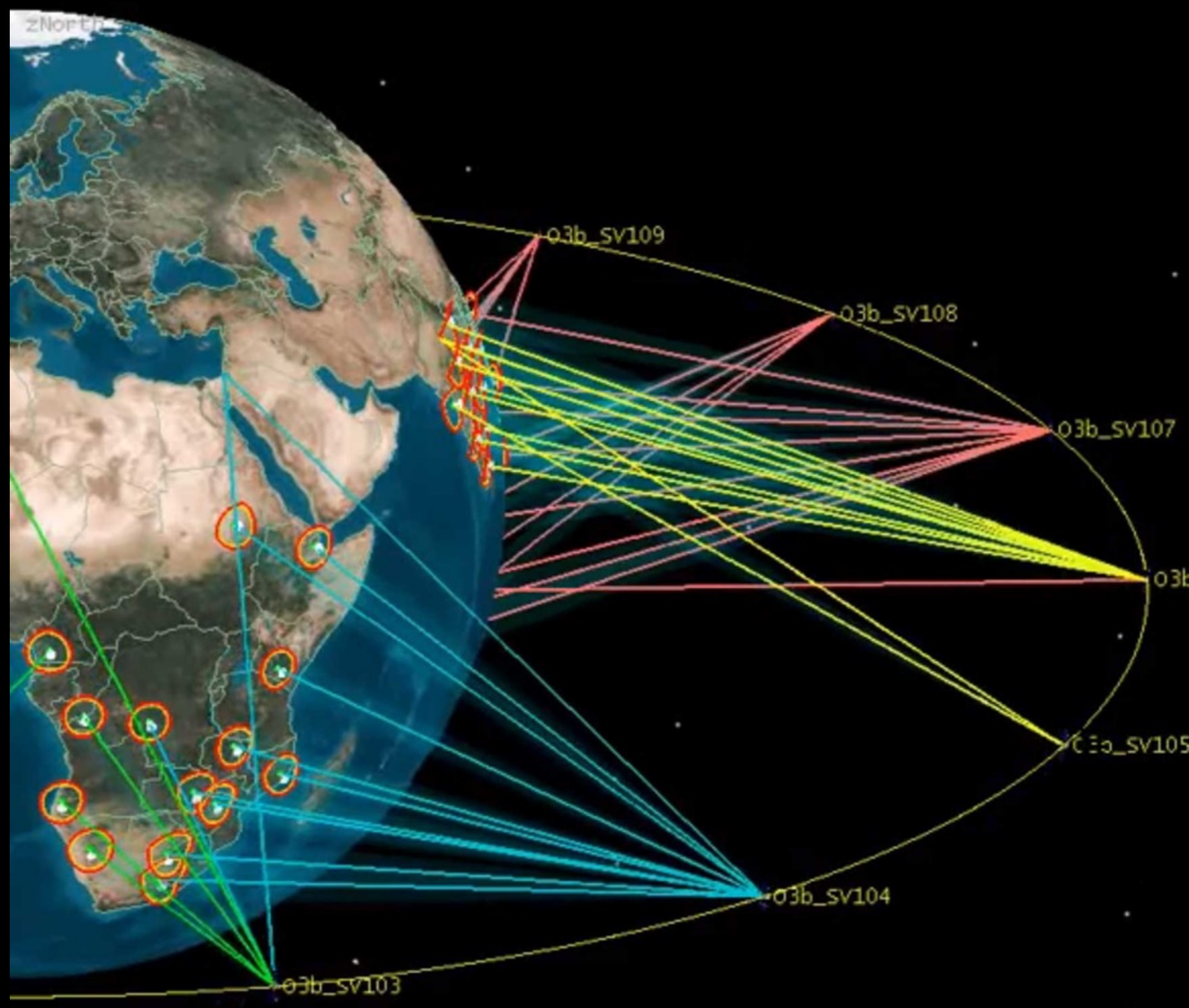
Image ©Optus

NBN CO SKY MUSTER

- 2016-2030 (est.)
- 2x SSL 1300
- GEO orbit, Ka band
- 67.5 gbps per satellite
- 25/5 mbps to users
- Ten Earth Stations

MEDIUM EARTH ORBIT

- Broadband since 2014
- +/-45° Global Coverage
- ~120 ms Latency
- 8+ Satellites Needed
- Receivers Must Track
- Important Niche



03B NETWORKS

- Live Since 2014
- MEO Orbit, Ka band
- 1.2gbps 700 km beams
- Up/down only (no sat-sat)
- 144 gbps online, 96 on order
- 2x Tracking antennas req
- Rain fade even w/ 4m dish

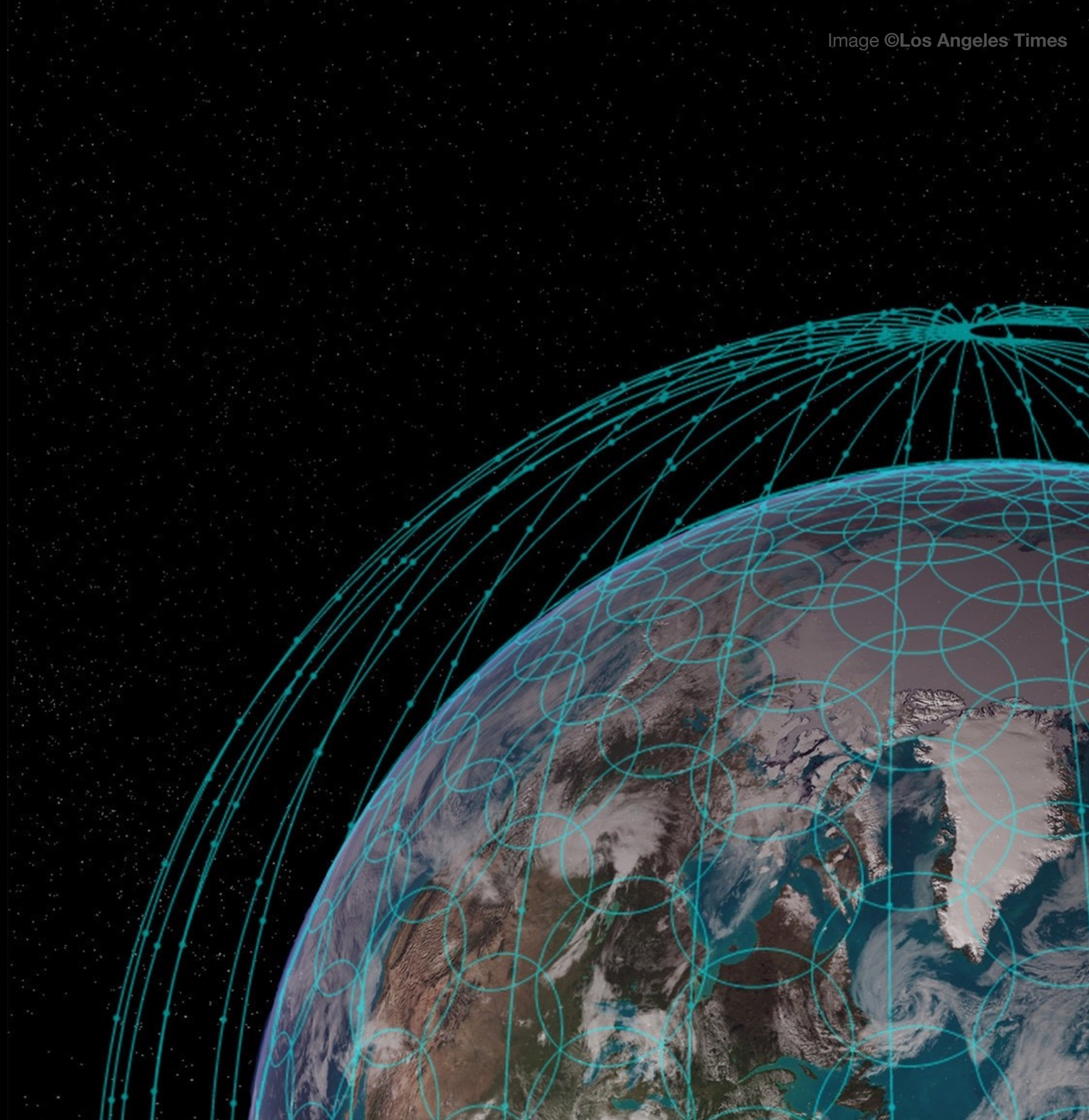
LASERLIGHT SPACECABLE

- Planned SD Optical Network
- Integrated with Terrestrial Networks
- Beams hop metro areas to avoid clouds
- Fastest intercontinental link
- 100 Gbps optical sat links
- 7.2 Tbps down, 12 satellites
- 19.2 Tbps sat x-link

Image ©ESA

LOW EARTH ORBIT

- Iridium, Globalstar, Orbcomm
- Global Coverage
- Imperceptible Latency
- 10s of satellites needed
- Today only narrow-band
- The Next Space Race



ONEWEB

- Consumer Focus from 2019
- Airbus, Boeing, Coca-Cola
- Qualcomm, Softbank, Virgin
- 700+ Ku Band LEO Satellites
- 20 orbital planes
- 6 gbps per sat, 4.2T network
- Intelsat Blended Offerings

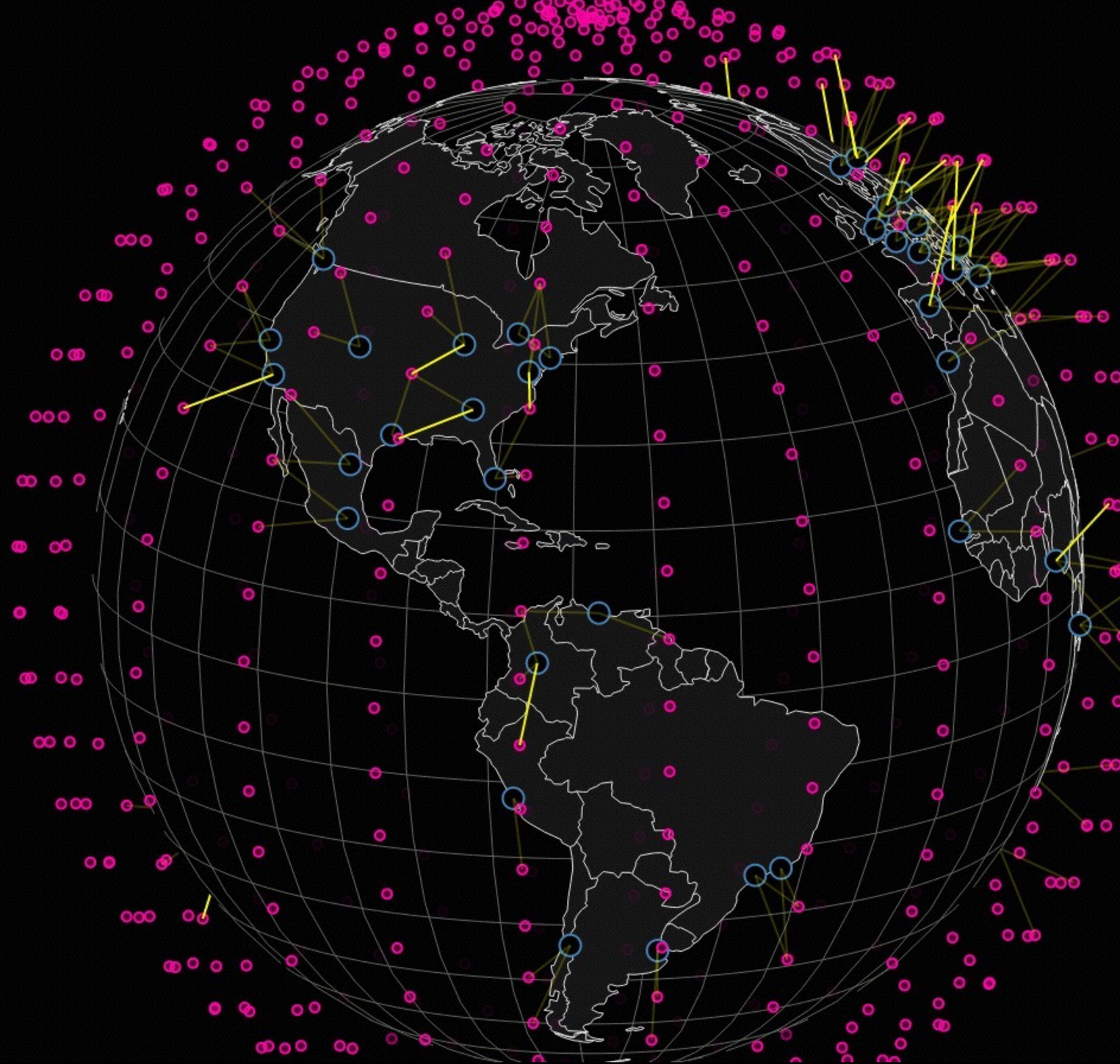
Image ©WSJ

LEOSAT

- Enterprise focus starting 2021
- Shares O3b & Iridium Next bus
- 78 LEO Satellites
- 6 orbital planes
- Optical cross connect
- 16 gbps per sat, 1.2T network

SPACEX GOOGLE

- Launching 2019-2024
- 4,425 LEO Satellites
- Optical cross connect
- 1gbps to end users
- 20 gbps per satellite
- 88.5T network



THE FUTURE IS

UP IN THE SKY

THANK YOU