

Eye on the Sky: LEOs, 5G & The Industry Today

WILL SATELLITE AND WIRELESS MAKE MY FIBER OBSOLETE?



Larry Thompson, PE
CEO, Vantage Point Solutions
605-995-1740
Larry.Thompson@Vantagepnt.com

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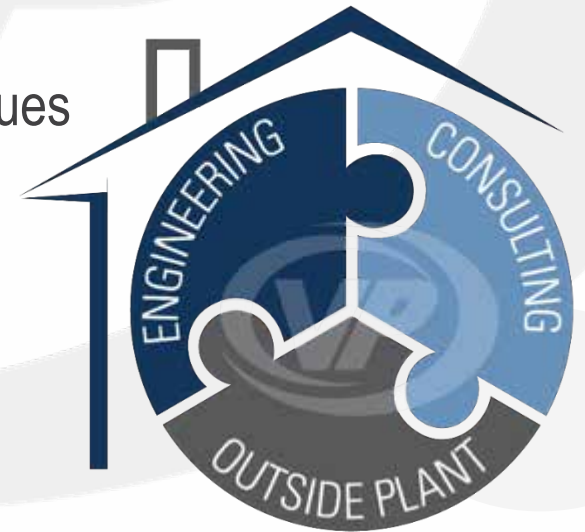


Larry Thompson

- VPS Founder & CEO
- Masters in EE
- 30+ Years in Telecom
 - » Landline/Fiber
 - » Wireless
 - » Satellite
- FCC Broadband Deployment Advisory Committee (BDAC)

VPS Engineering/Consulting

- 5 Offices Nationwide
- 450 Staff / 500+ Clients
- Professional Engineering
- Wireless & Wireline broadband
- Technical and Regulatory issues
- Cybersecurity
- Business Analysis



Ingredients for a Broadband Network

- Deploy Economically . . .
 - BEAD: \$4,058/passing (in theory); 30-50% penetration required
 - LEO: \$1.25/passing; 0.3% penetration required
- Meet Current Broadband Needs

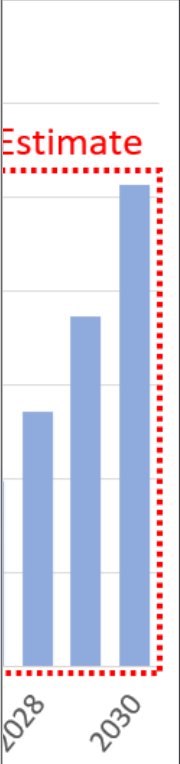
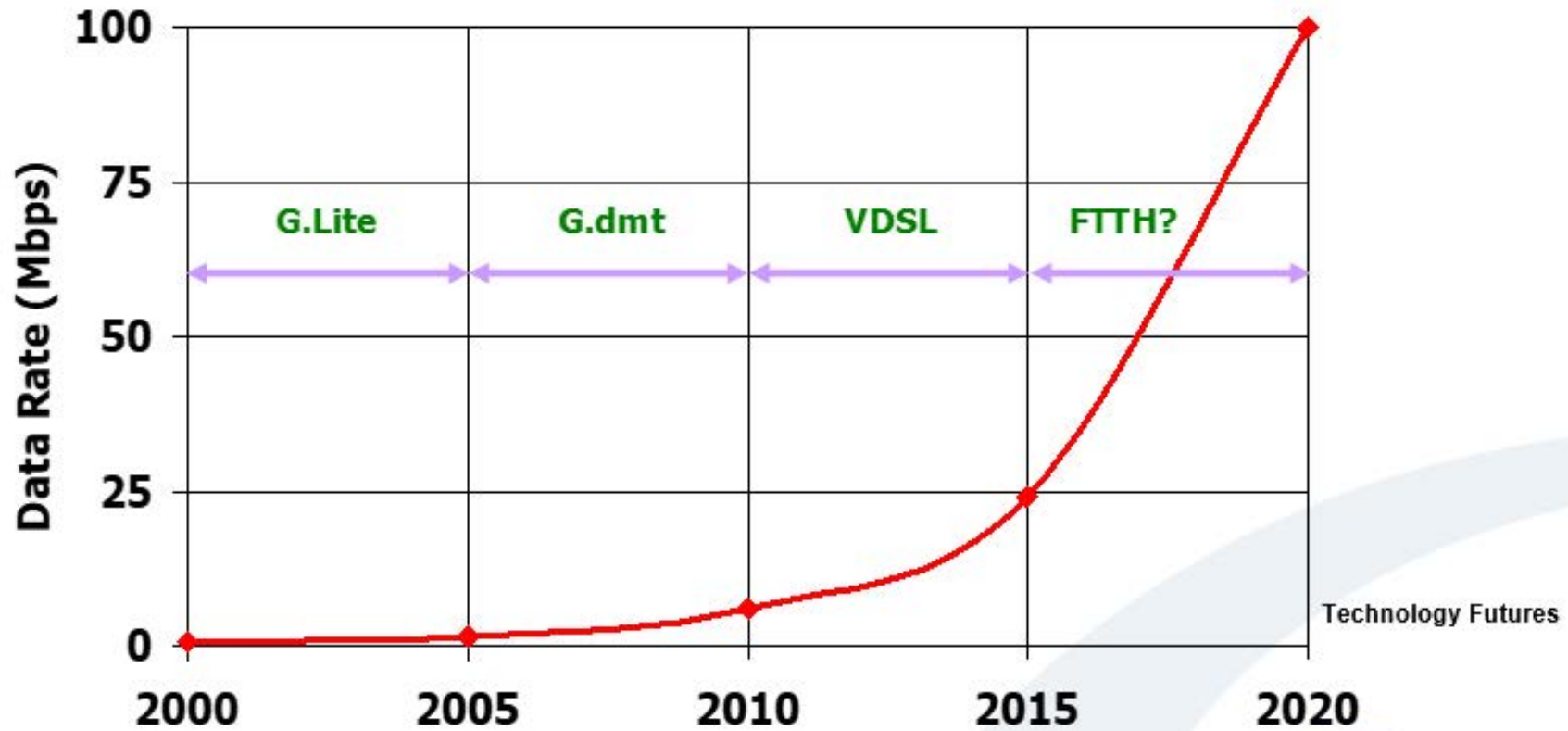
“. . . ensure that the network built by the project can easily **scale speeds over time** to ... meet the evolving connectivity needs of households and businesses”

Infrastructure Act § 60102(a)(1)(I)

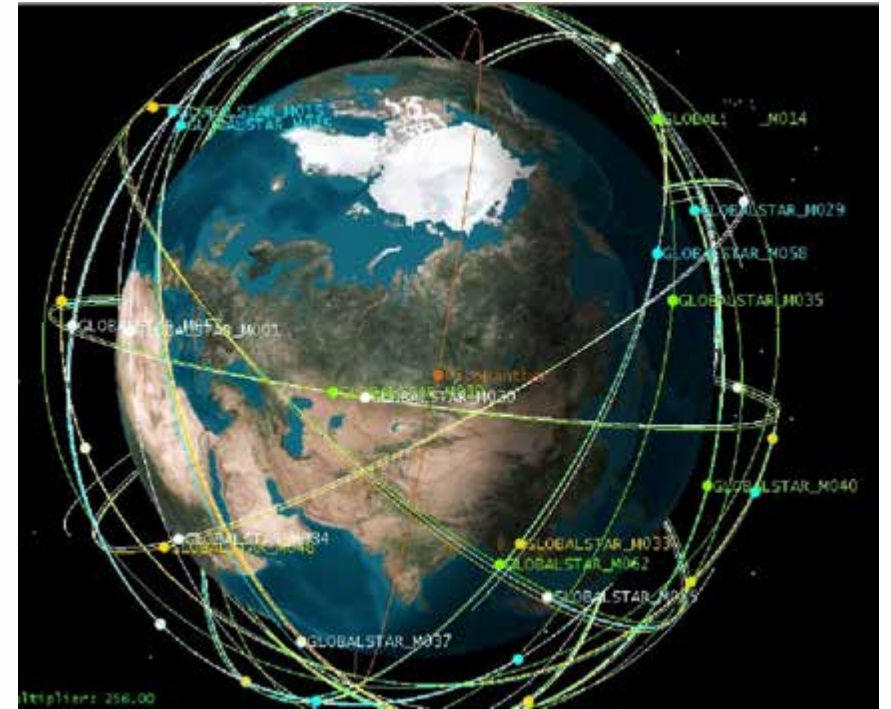
Data Bandwidth Demands

Cu

Speed (Mbps)



From Larry's Presentation
In 2002 . . .



Low Earth Orbiting (LEO) Satellites

Characteristics of **Great** Broadband

Characteristic	Consumer Demand	Applications Impacted
High Speed	<ul style="list-style-type: none"> Average Speeds > <u>300 Mbps Today</u> In metro areas, <u>1 Gbps is commonly available</u> 	eHealth, distance education, VPNs, interactive applications, gaming, Internet of Things
Low Latency	<ul style="list-style-type: none"> FCC standard of <u>100 ms or less</u> Terrestrial network latencies are typically 10-30 ms 	Interactive applications, distance education, video conferencing, Internet of Things
High Capacity	<ul style="list-style-type: none"> <u>>587 GB/mo (4Q22)</u> 	Video-based applications, eHealth, distance education, online backups, gaming
High Reliability	<ul style="list-style-type: none"> Customer health & security often rely on broadband 	Public safety, healthcare, and commerce
Economical and Scalable	<ul style="list-style-type: none"> Network must cost-effectively scale to meet increasing customer demand 	All applications

20



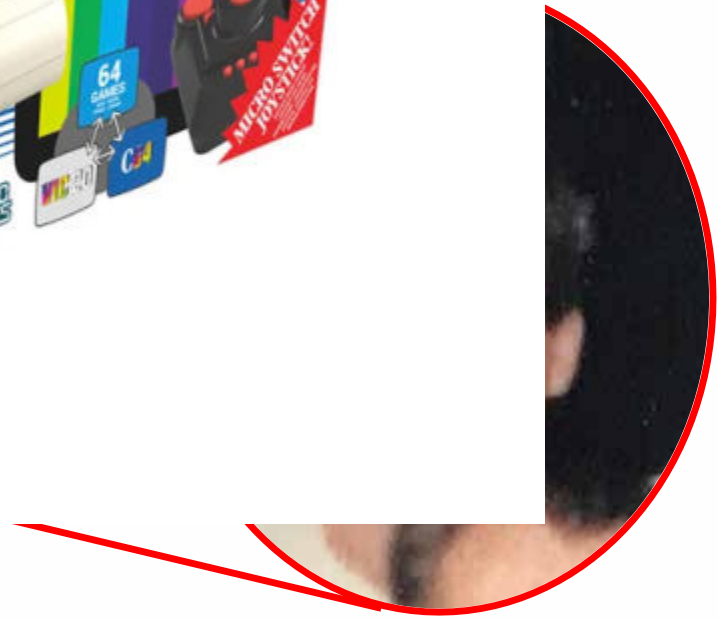
Geostationary Earth Orbit (GEO)

- Historically Used for Broadband



- Also, much more complex than GEO

The TDRSS Network . . .



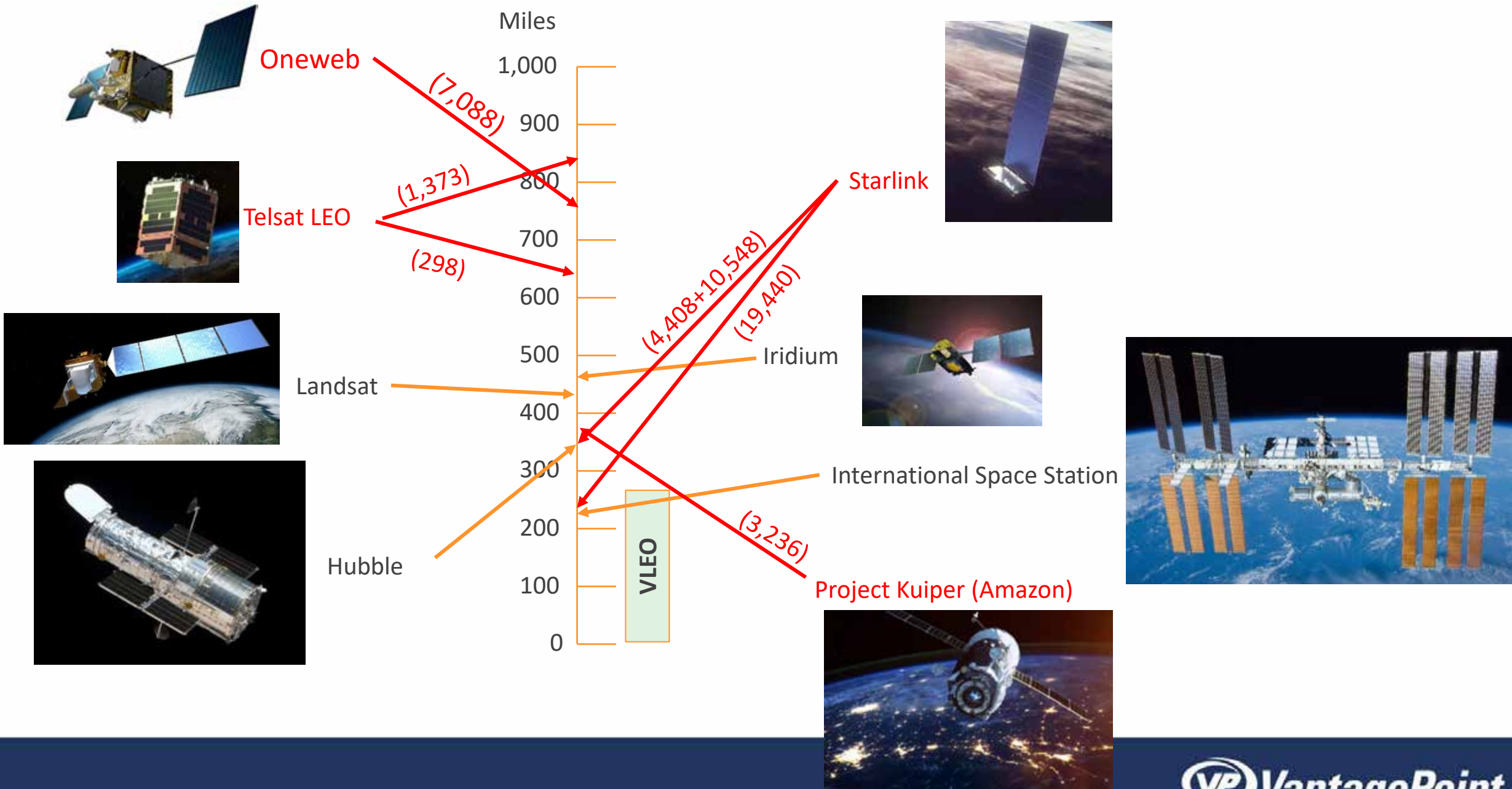
Key Players in LEOs

- Starlink / SpaceX
 - Significant head start
- OneWeb
 - Currently in 2nd place – Multi-national ownership
- Amazon Project Kuiper
 - Late to the game, but very aggressive plans
- Others: Telesat Lightspeed, Inmarsat Orchestra, China GW, etc.

Why Now?

Dramatic increases in:

- Manufacturing processes
- Computing power
- Antenna design/efficiency
- Broadband demand





Starlink



- 3,926 in Orbit as of Feb 2023
 - Gen 1: 1,467 – 673 lbs
 - Gen 1.5: 2,387 (with ISL) – 1 ton
 - Gen 2.0 Mini: 42 (dual solar array; E-Band backhaul) – 2 tons

- First 4,408 Must be Complete by March 2027



- Starshield: 7 Satellites to Date

SpaceX Value = \$137B

	Starlink (Space-X)
Satellites	Gen 1: 4,408 Gen 2: 30,000 (some VLEO)
Orbit	340-350 mi (210 miles for VLEO)
System Capacity (w/2,500 GW ant)	26.8 Tbps (19.7 Gbps/Sat)
Services	100-500 Mbps
Optical Backbone	Yes
Investment	\$20-30 Billion



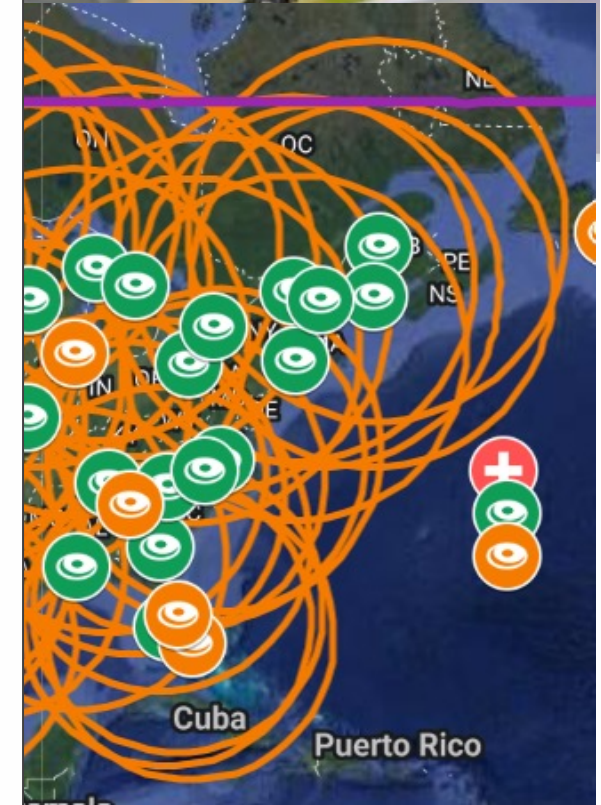
Starlink



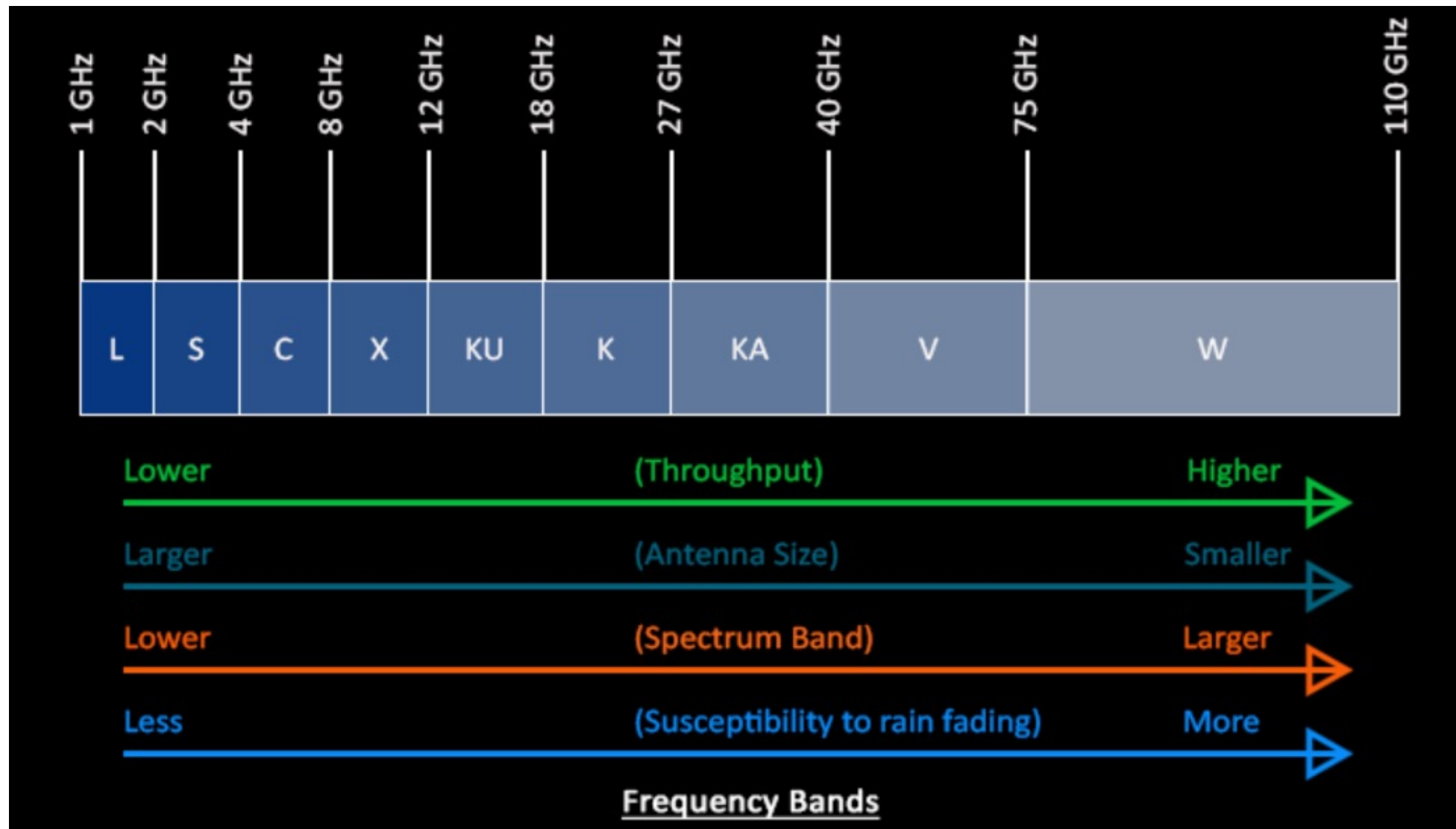
Photos of Butte, MT Gateway

Sighting

- Gen 2
 - E
- Gen 2
 - N
 - N
- >1M
- 47 Ga
 - 10

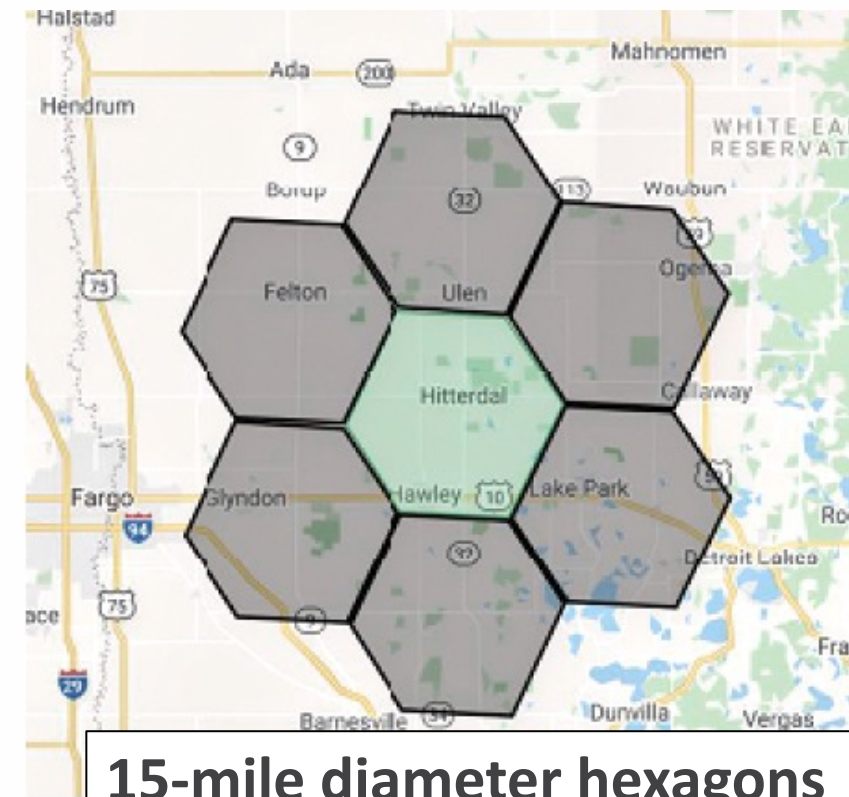


Satellite Spectrum



Starlink VLEO Satellites

- Starlink Gen 2: mmW VLEO Satellites
 - Likely 2-4 years away
- Capabilities
 - More satellites / Smaller beams
 - More than 10x capacity
- E-band will have more reliability/weather issues



15-mile diameter hexagons

**VLEO: 7.5 mile hexagons
(using 1.5 degree beam)**



Space is
the future

- 618 of
 - Have
- Turbule
 - Bar
 - Lots
 - Bha
- Focuse
- Orbit F
 - Deploying in Alaska Now

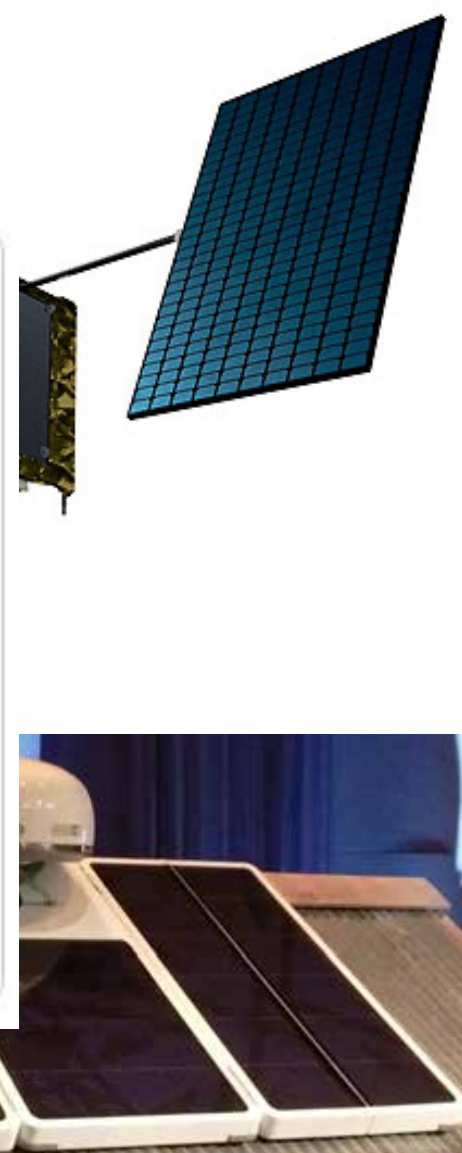


Boris Johnson  @BorisJohnson
United Kingdom government official

Fantastic news that we've secured satellite network [@OneWeb](#). This strategic investment will drive our space sector and put the UK at the forefront of space tech. A terrific boost to our advanced manufacturing, services and tech industries.

8:14 AM · Nov 20, 2020

 4.6K  2.5K  Share this Tweet





Project Kuiper

- Received FCC Approval Feb 8, 2023
- Constellation: 3,236 satellites (3 orbital shells)
 - User Terminals: 100 Mbps, 400 Mbps, 1 Gbps
- Contracted for 83 launches (Arianespace, Blue Origin, ULA)
 - 576 satellites needed for limited service – First launch early 2024
 - FCC requires 50% operational by July 30, 2026 – 100% by 2029



Filling the Sky

	Satellites
SpaceX	42,000
OneWeb	7,088
Kuiper	3,236
China GW	12,992
Telsat	298
Inmarsat	175
Total	65,798

Prior to 2018

- 8,950 Objects Had been launched into earth orbit
 - 1,950 were operational
- Within a Few Years . . .
 - Objects in space will increase by more than 30x



Can LEOs Solve the Digital Divide?

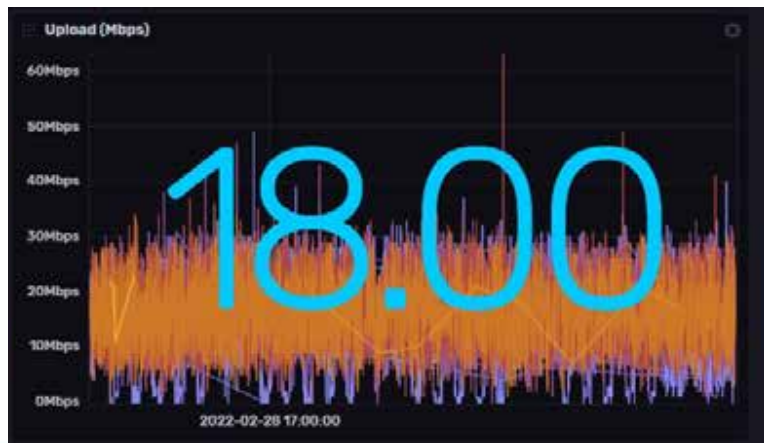
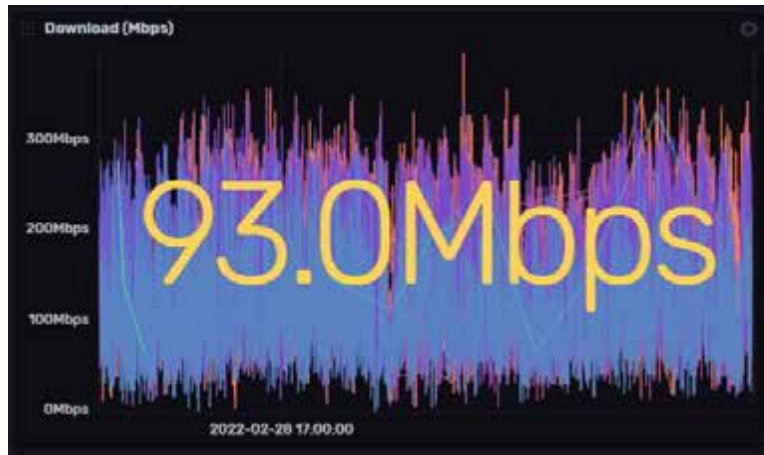
Will LEOs Solve the Rural Digital Divide?

- Is it a Threat to Rural Broadband Providers?
 - Answer: Yes (for locations without fiber)
- LEOs in Ku/Ka Bands
 - 100-500 Mbps possible
 - Possible customer congestion
- LEOs in E-Band (mmW)
 - 1 Gbps or more possible
 - Weather/reliability issues

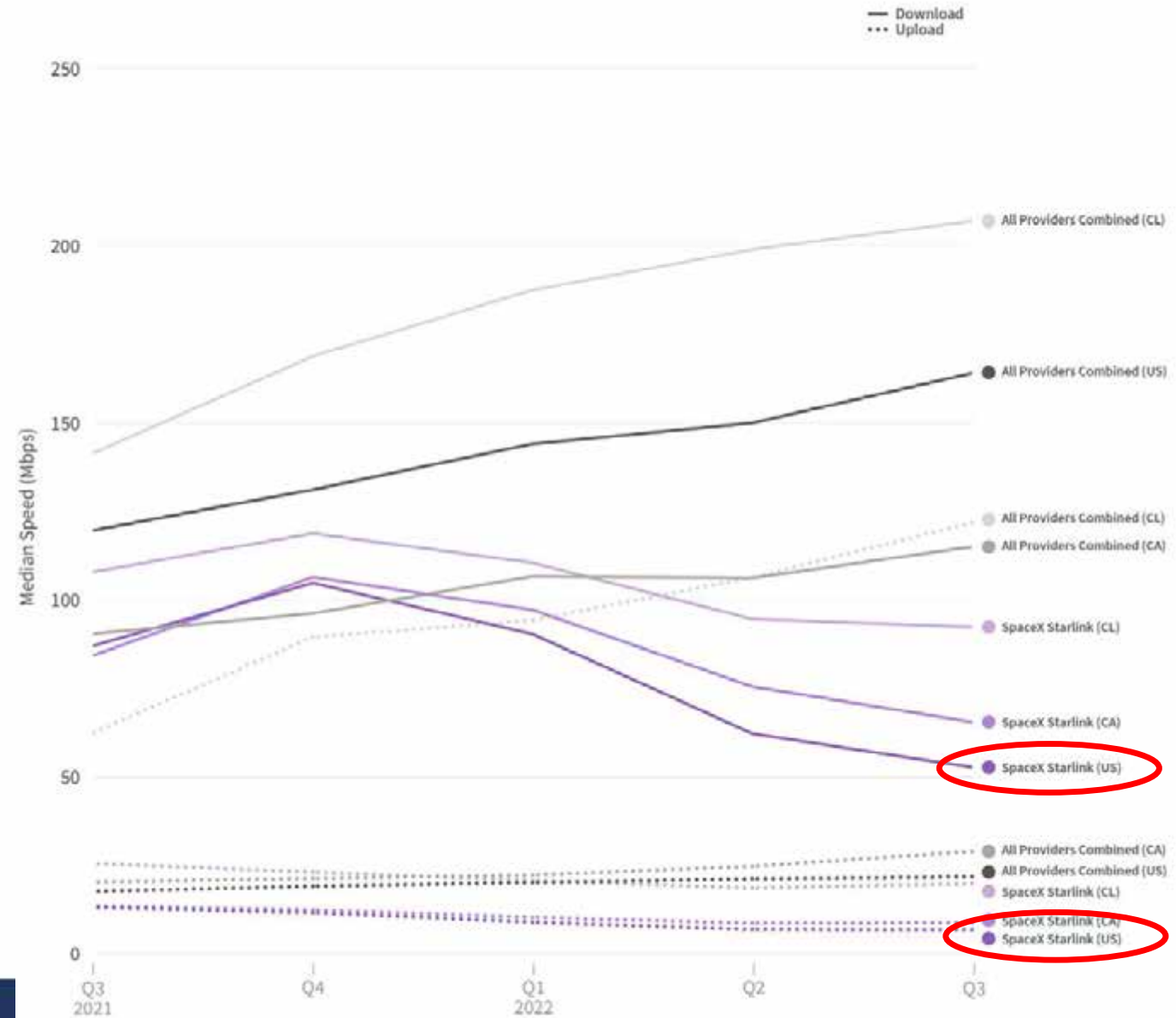
“I wanna be clear, it's not like Starlink is a huge threat to telcos. I want to be super clear. It is not.”

Elon Musk, March 9, 2020
Satellite 2020 Conference

Starlink Performance is Declining



Starlink Performance in Select North and South American Countries
Speedtest Intelligence® | Q3 2021 - Q3 2022



What do LEOs Need to

Successful?

- Need to Scale Bandwidth

Russia Announces Starlink Satellites, Moskva Was Attacked

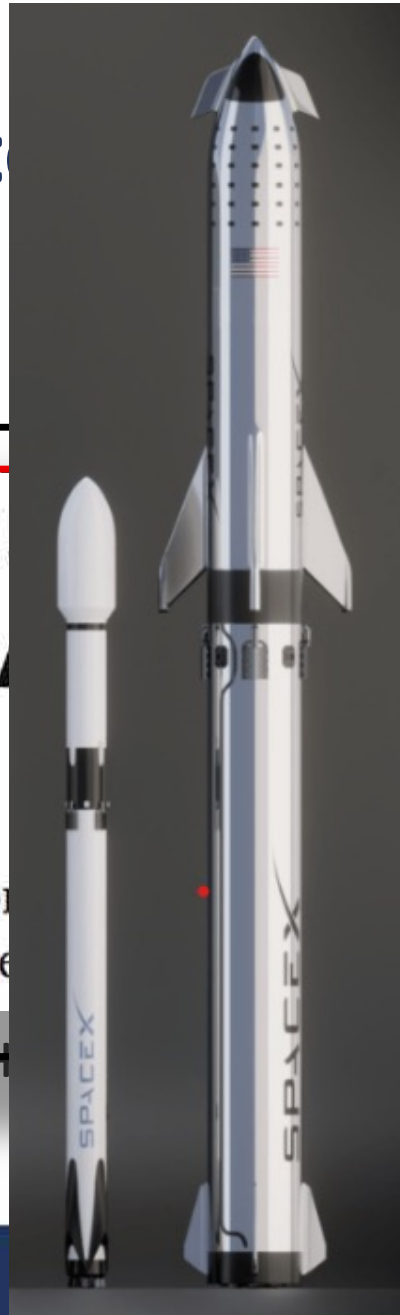
Space X's Starlink internet constellation satellite constellation was used to guide

- Better Economics - \$600 +
- Not Pick Fight with World

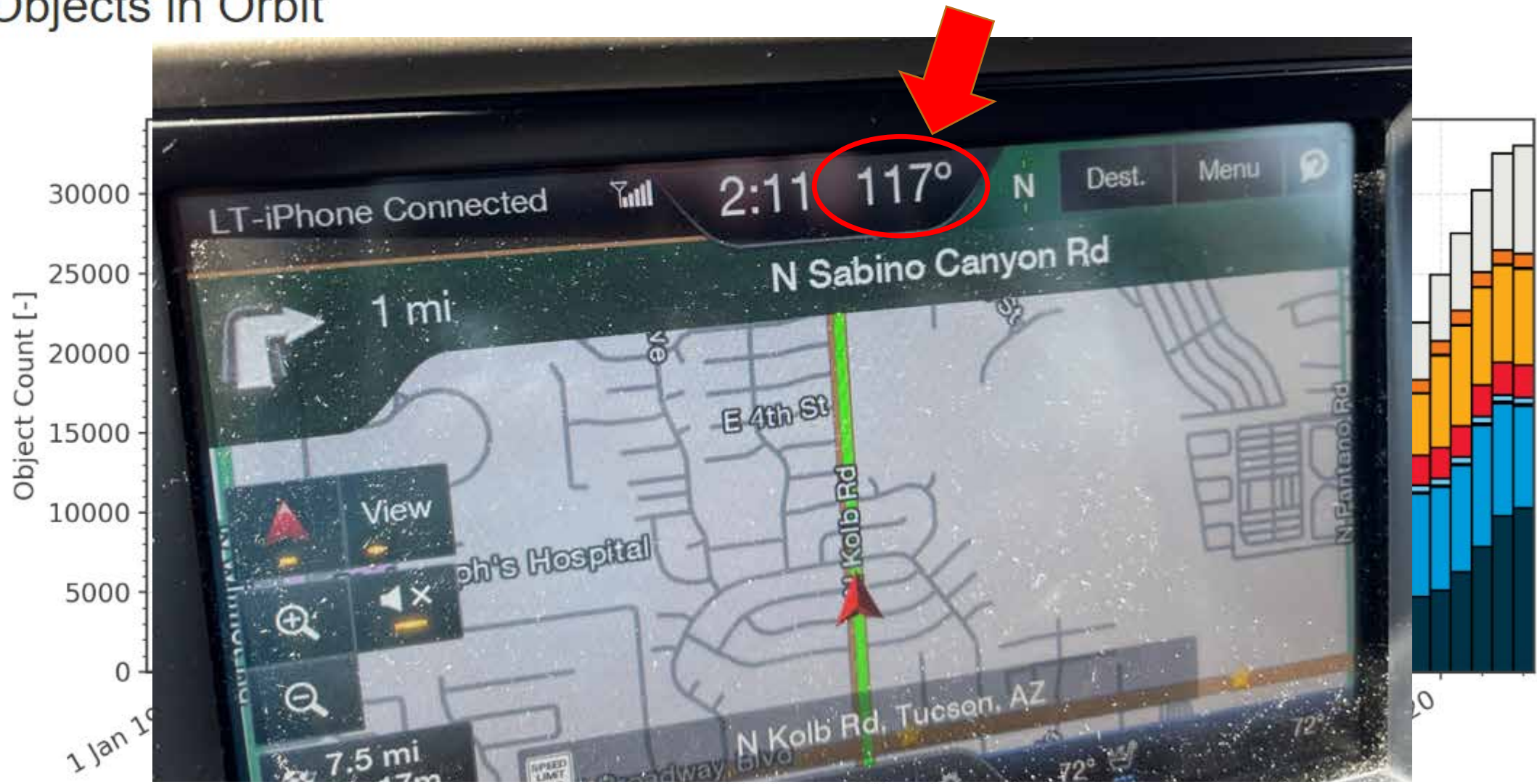
War On Elon Musk's Starlink Satellites, Moskva Was

Russia as it was reported that the Starlink satellite constellation was used to guide

too much



Objects in Orbit



Reference Epoch

Fixed & Mobile Wireless

WHAT IS THEIR FUTURE?

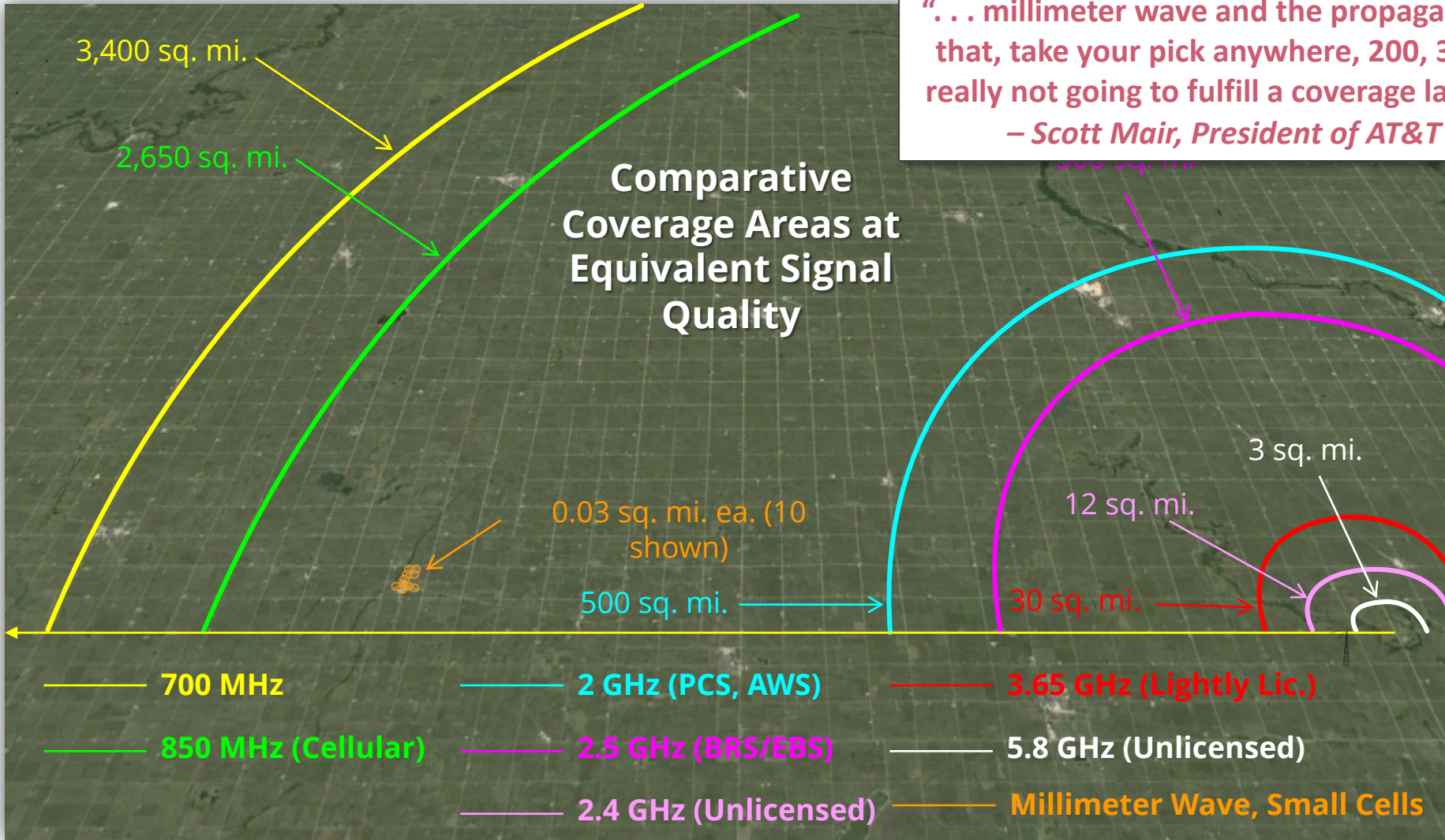


3GPP Forum LEO Activities

- Adapting 5G System to Support LEO
 - Phase 1: Connect 5G devices (sub-6 GHz)
 - Phase 2: VSAT and ESIM in Ku/Ka Bands
- Working on Using LEO for 5G Backhaul
- Tighter Integration Expected in 6G Wireless

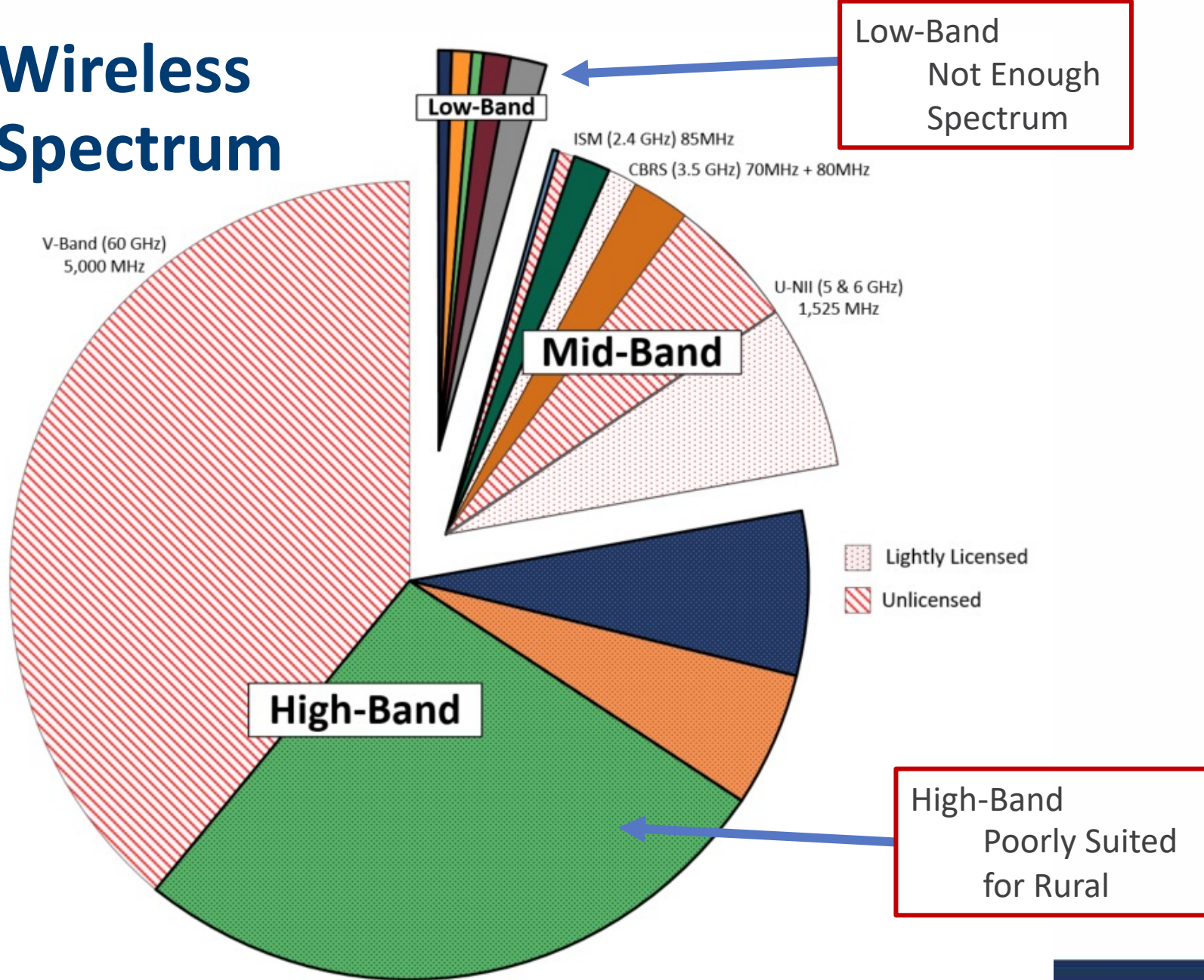
Will Fixed Wireless Solve the Digital Divide?

“... millimeter wave and the propagation properties of that, take your pick anywhere, 200, 300, 350 yards, is really not going to fulfill a coverage layer need for 5G.”
 – Scott Mair, President of AT&T Operations



YOUR MILEAGE MAY VARY! This is intended only to suggest relative ranges and coverage areas at FCC-authorized power levels among various single carrier frequencies, at a common Receive Signal Level (RSL) and noise floor throughout, which may be above or below the lowest RSL at which a particular technology can operate, assuming sufficient SINR. Actual range will vary depending upon the actual signal level and quality targeted as well as numerous other factors, including power level transmitted, elevation of transmitter and receiver antennas, directionality, gain and MIMO configuration of both the transmitting and receiving antennas, terrain, clutter, manmade interference and atmospheric and electromagnetic conditions, among others.

Wireless Spectrum



Low-Band
Not Enough
Spectrum

Gbps Possible,
But Not Very Far

Faster Speeds

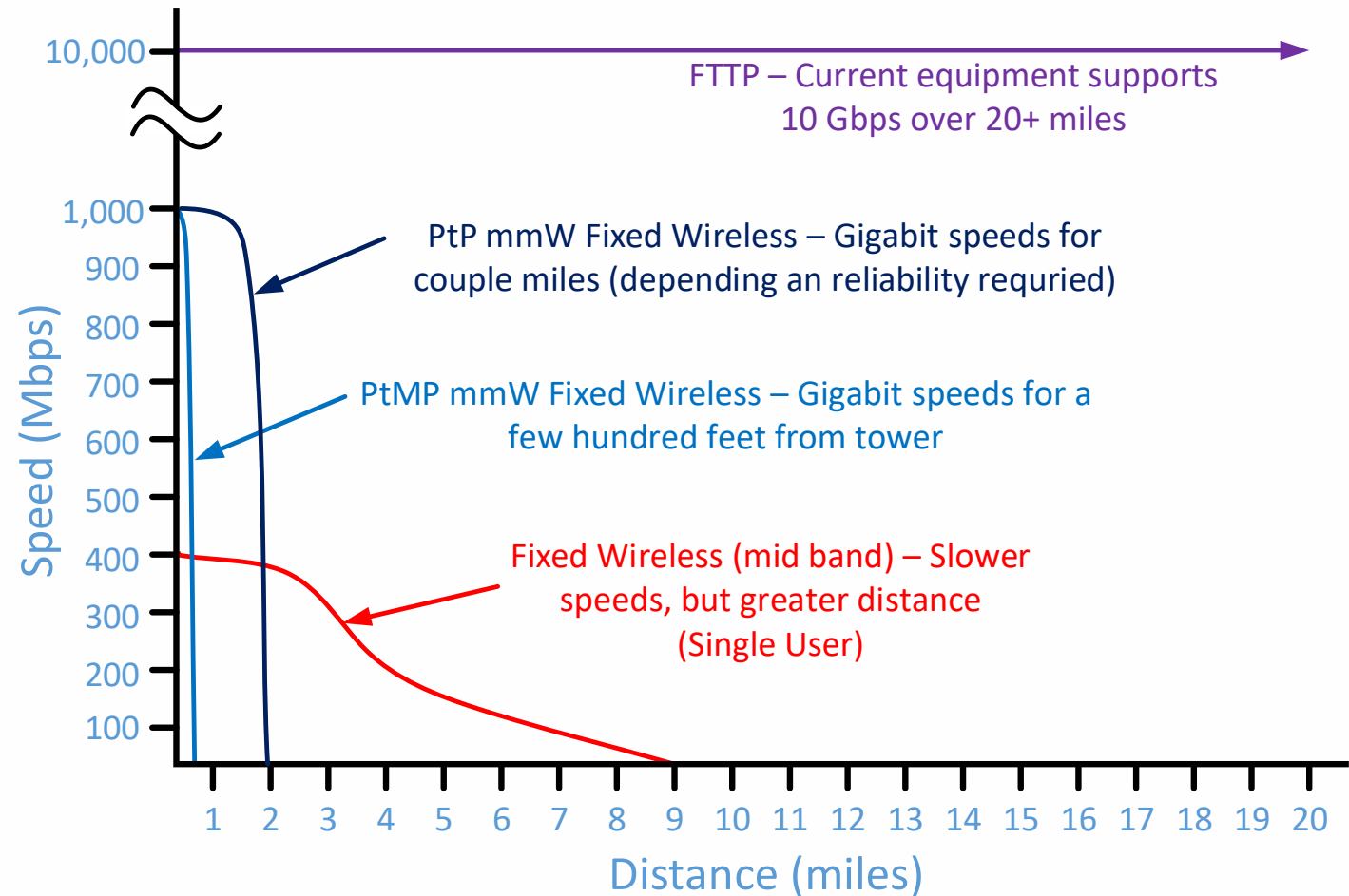
Greater Distance

High-Band
Poorly Suited
for Rural



Finding the Best Broadband

1. Must be Well-Suited for Rural Areas
2. Must Provide 100/20 Mbps (or more)
 - Low latency, reliable, good quality
3. Must be Scalable



How Many Locations does Licensed Wireless Eliminate for BEAD?

	No Wireless	With Licensed Wireless	Difference
Unserved (<25/3Mbps)	12.1M	7.8M	(4.3M)
Underserved (<100/20Mbps)	3.6M	6.0M	2.4M
Total	15.7M	13.8M	

- States with Biggest Impacts

- IL: 471K

- TX: 333K

- CA: 299K

- OH: 132K

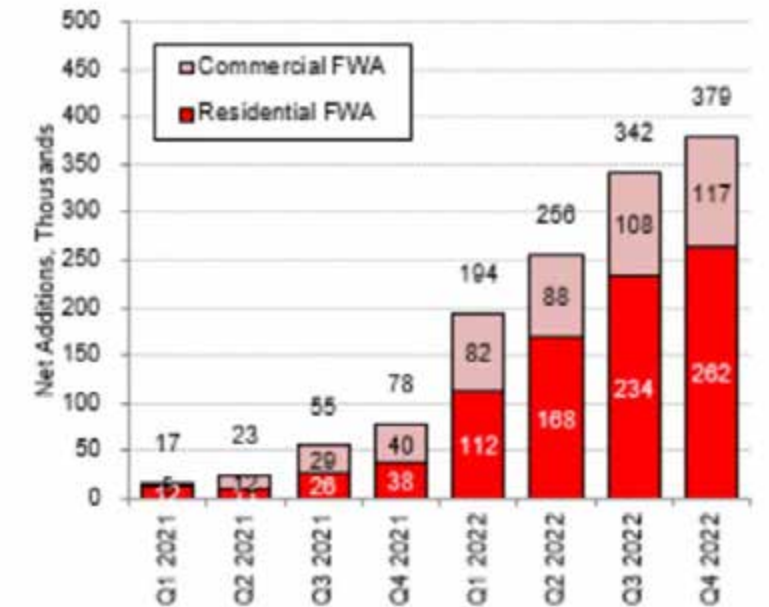
Unserved+Underserved

Slide About AT&T + T-Mobile Fixed Mobile Growth

- Verizon
 - 4Q22: 379K new FWA customers
 - 1.5M Total
- T-Mobile
 - 4Q22: 524K new FWA customers
 - 2.6M Total



Fixed Wireless Access: Net Additions



Source: Company reports, SVB MoffettNathanson estimates and analysis

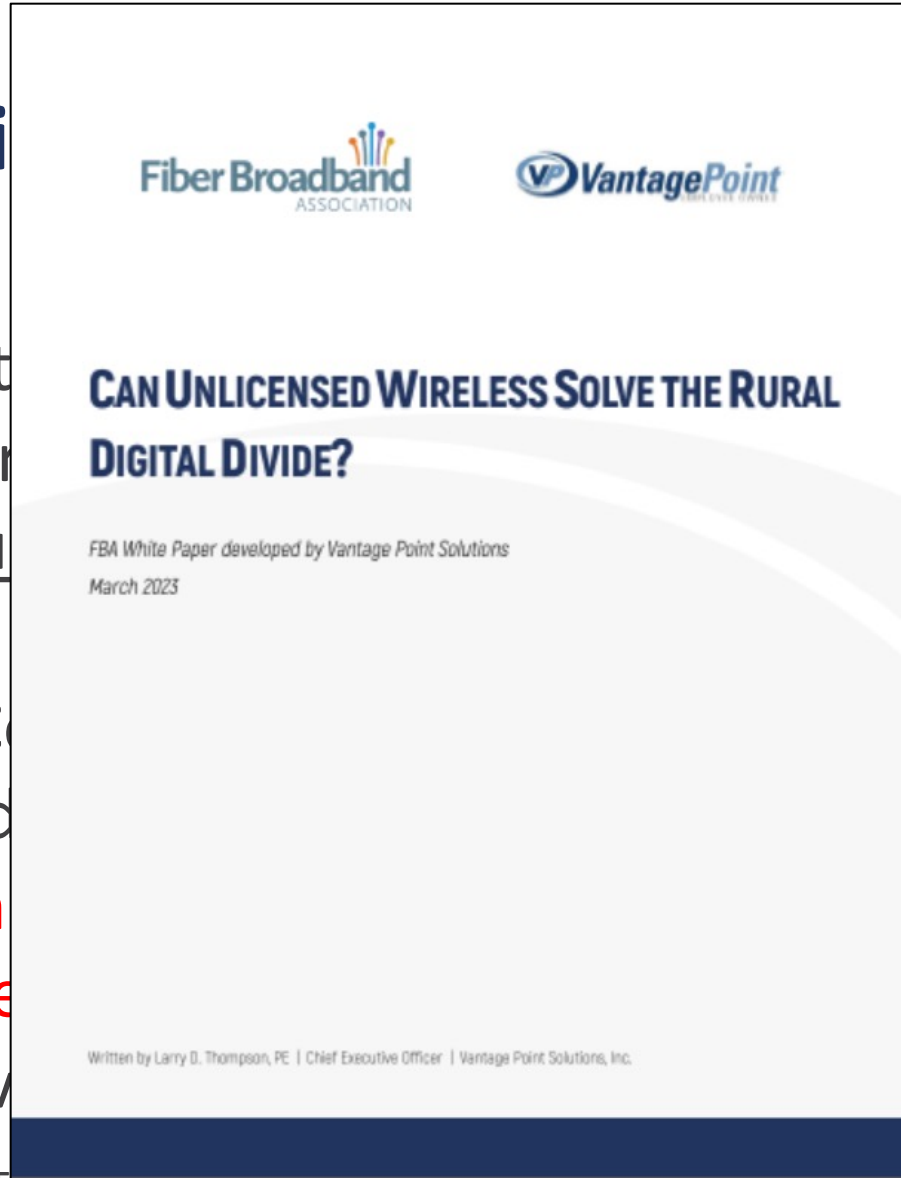
Broadband Requirements from Infrastructure Act

- Priority Broadband Project (Infrastructure Act)
 - “. . . provide broadband service that meets **speed, latency, reliability, consistency in quality of service**, and related criteria as the Assistant Secretary shall determine”
 - “. . . ensure that the network built by the project can easily **scale speeds over time** to ... meet the evolving connectivity needs of households and businesses”

Infrastructure Act § 60102(a)(1)(I)

NTIA NOFO: Unlicensed

“For the purposes of the Broadband Program, locations served by satellite, services using unlicensed spectrum, not specified by the Commission’s Broadband Maps, **do not meet the Reliable Broadband Service** and should be considered ‘unserved’.”



Considered

No Unlicensed Wireless	With Unlicensed Wireless	Difference
7.8M	6.2M	(1.7M)
6.0M	6.2M	0.2M
13.8M	12.4M	

FD Fund Distribution Losers
4K locations (\$900M loss)
-134K locations (\$400M loss)
8K locations (\$288M loss)

NTIA BEAD NOFO § IV (B) 4 (a)

Wireless Broadband Performance Can be Misleading (at least compared to landline)

1. Total Speed vs. Download Speed
2. Measuring Speed Under Unrealistic Conditions
 - Short Distance, Single Customer, Unrealistic Amounts of Spectrum
3. Confusing PtP with PtMP
4. Network Speed vs Customer Speed

Conclusions

- Satellite Broadband will Continue to Improve
 - New Spectrum & Technologies
- Satellite will continue to struggle to provide adequate broadband capacity as User Demand Grows
 - User demands often grow faster than technology advances
- Cannot Compete on Performance or Price with a FTTP Network
 - Fixed wireless and DSL at risk

Discussion

