

The State of US Broadband

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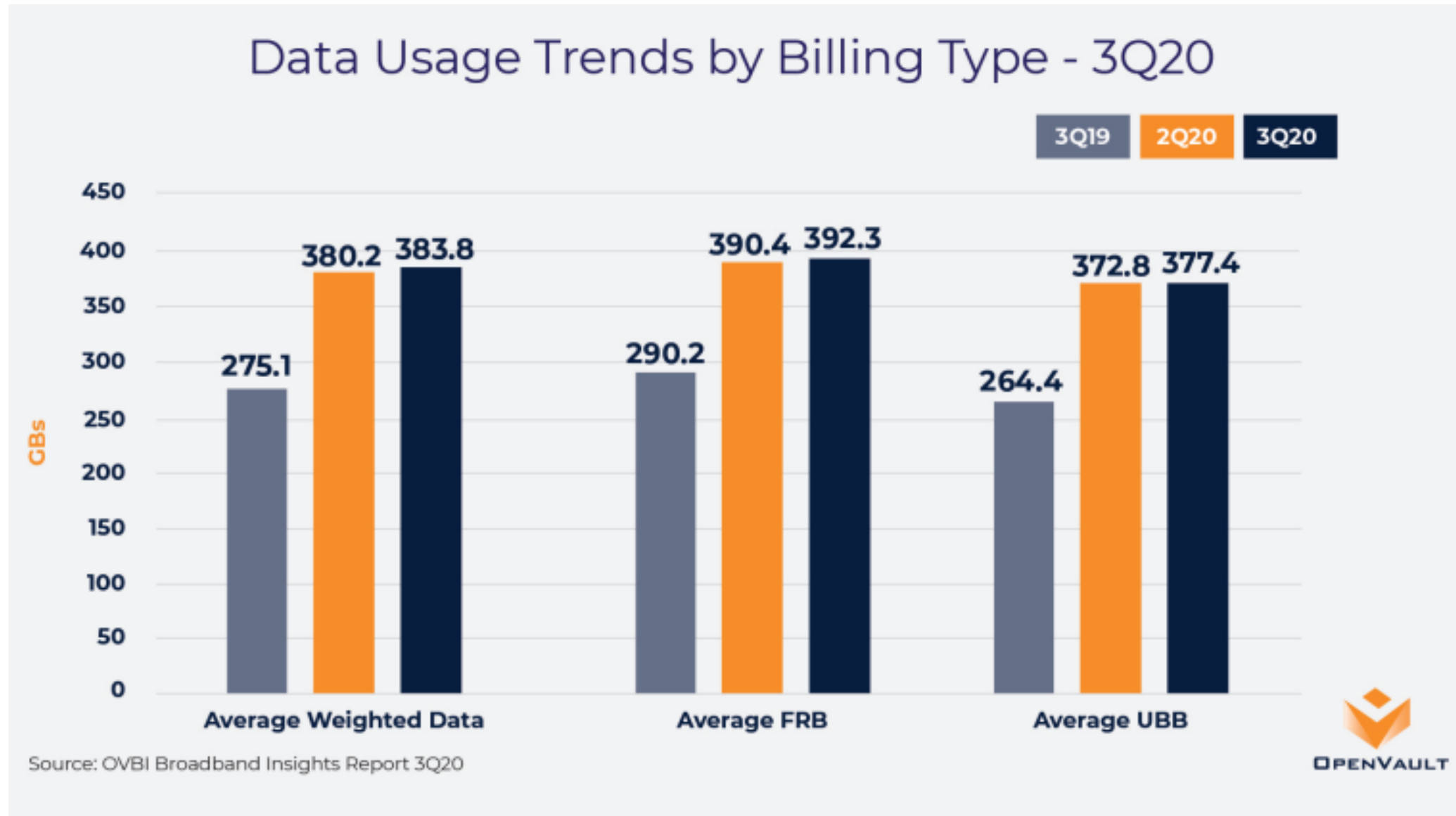


TFI Technology Conference
January 22, 2021

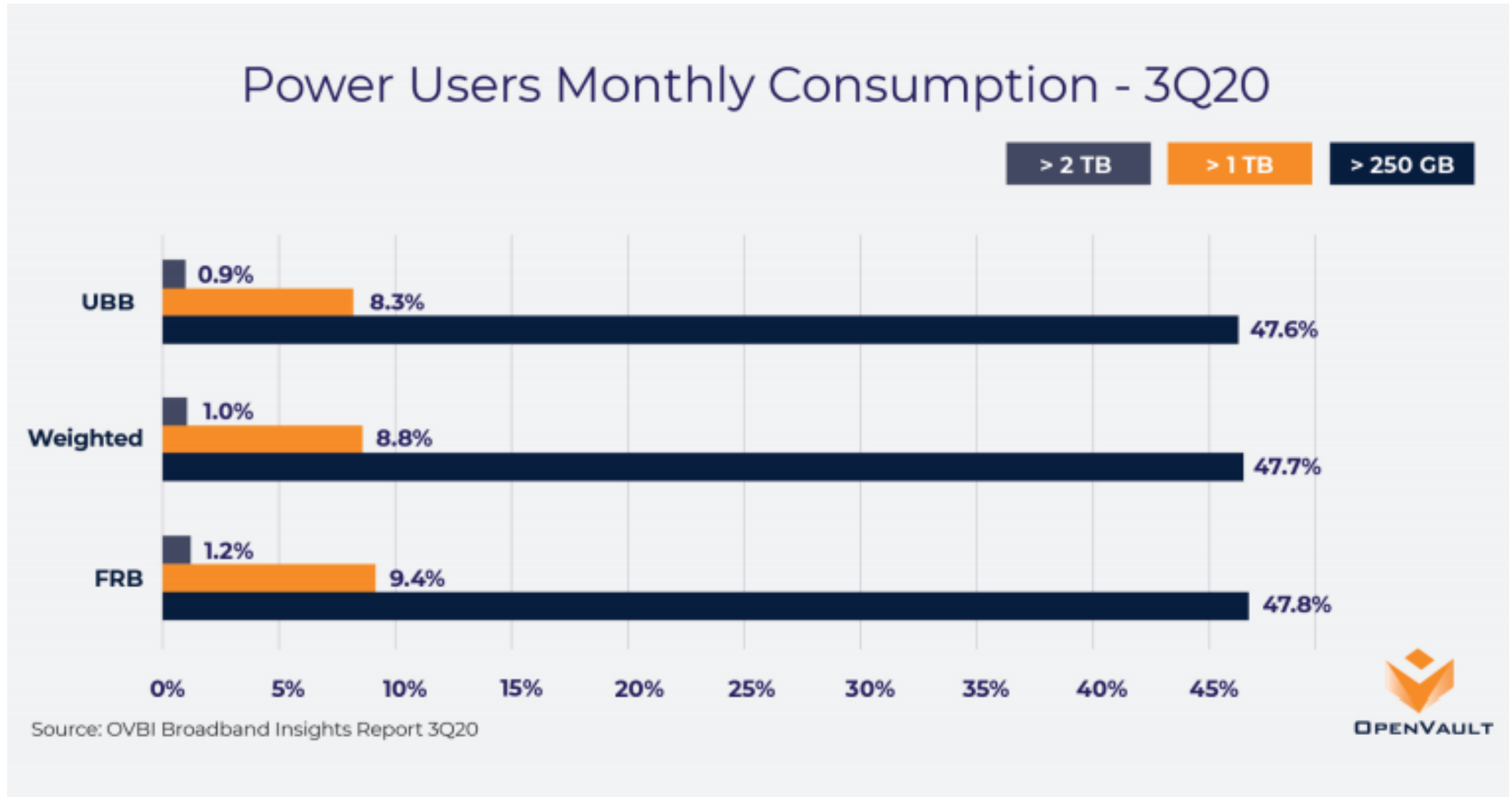
Topics and Trends

- Impact of the pandemic on broadband traffic and broadband speeds
- State of broadband competition
- The evolution of the cable access network (DOCSIS 4.0, '10G')
- Broadband drivers (rise of streaming services – SVoD, virtual MVPDs)
- Cable and 5G: Friend or foe?
- Keying on network and convergence
- Focus on rural America and the Rural Digital Opportunity Fund
- Emerging broadband alternatives (5G fixed wireless, LEO-based satellite services)

Impact of COVID-19 on Broadband

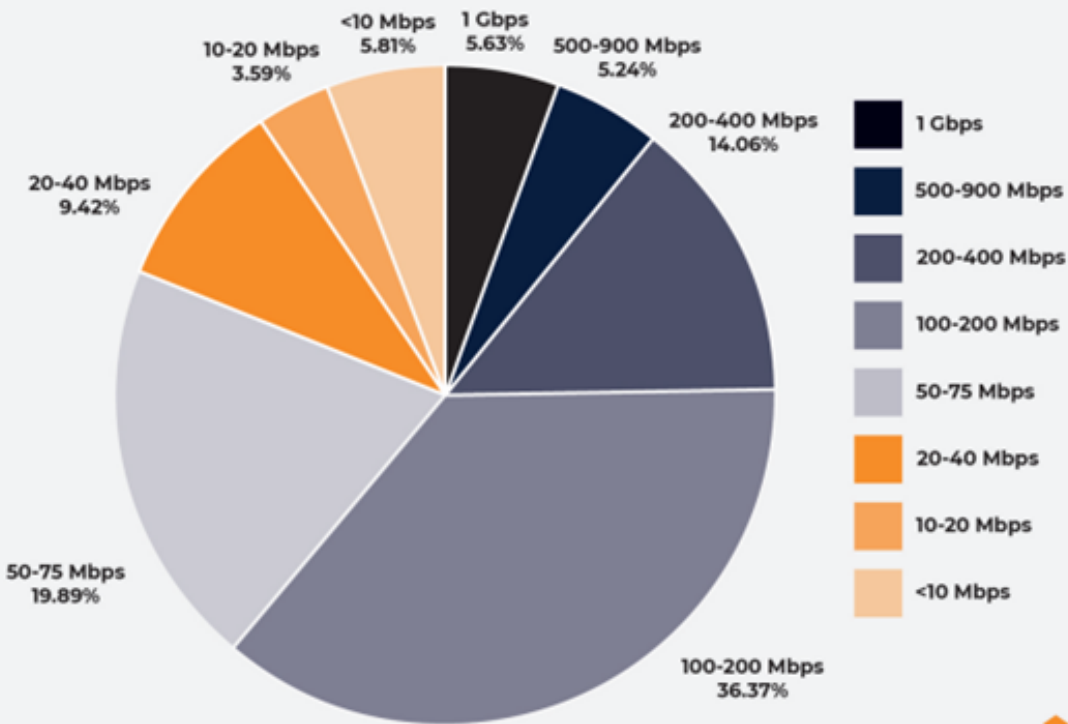


Impact of COVID-19 on Broadband



Impact of COVID-19 on Broadband

Provisioned Broadband Speeds - 3Q20



Source: OVBI Broadband Insights Report 3Q20



- Average data usage (down and up): 384 GB
- Average downstream usage: 359 GB
- Average upstream usage: 25 GB
- Average downstream speed: 169.8 Mbit/s
- Average upstream speed: 13.1 Mbit/s
- Average number of streaming services: 4*
- Average number of connected devices: 10.37**

*Deloitte Insights, Digital media trends survey

**Statista

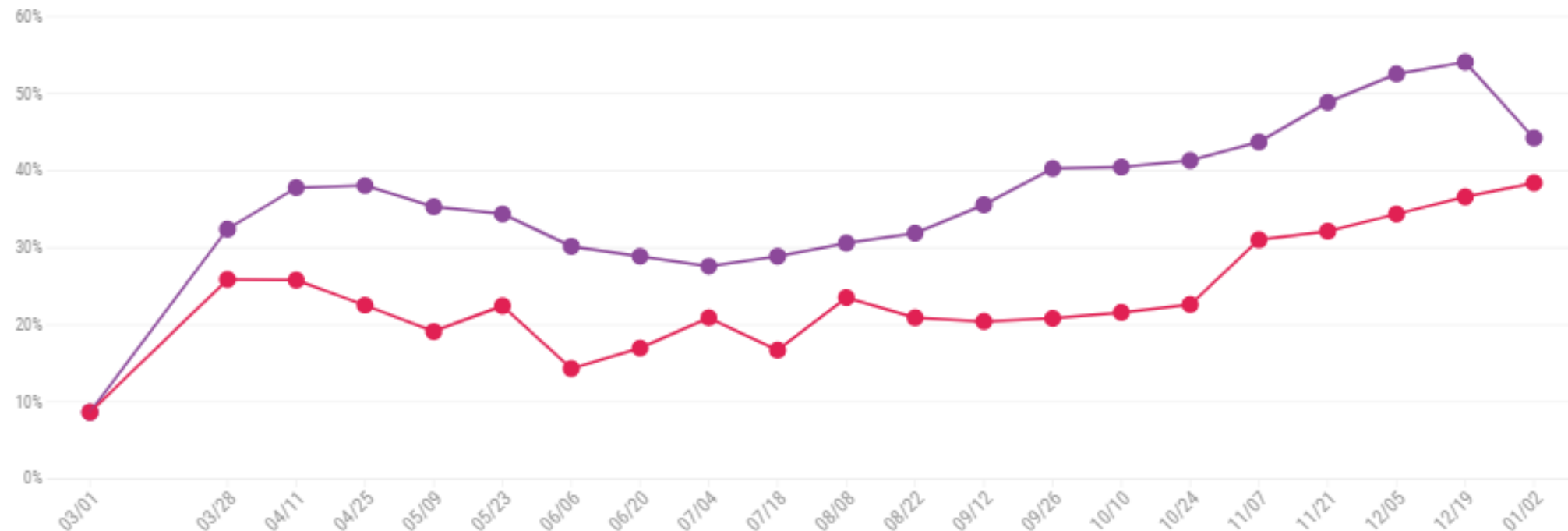
Impact of COVID-19 on Broadband – US Cable Networks

National Peak Internet Growth During COVID-19

Observed Increase in Peak Consumer Usage Since Early March 2020

Overall change in pre-COVID internet usage since 3/1/20

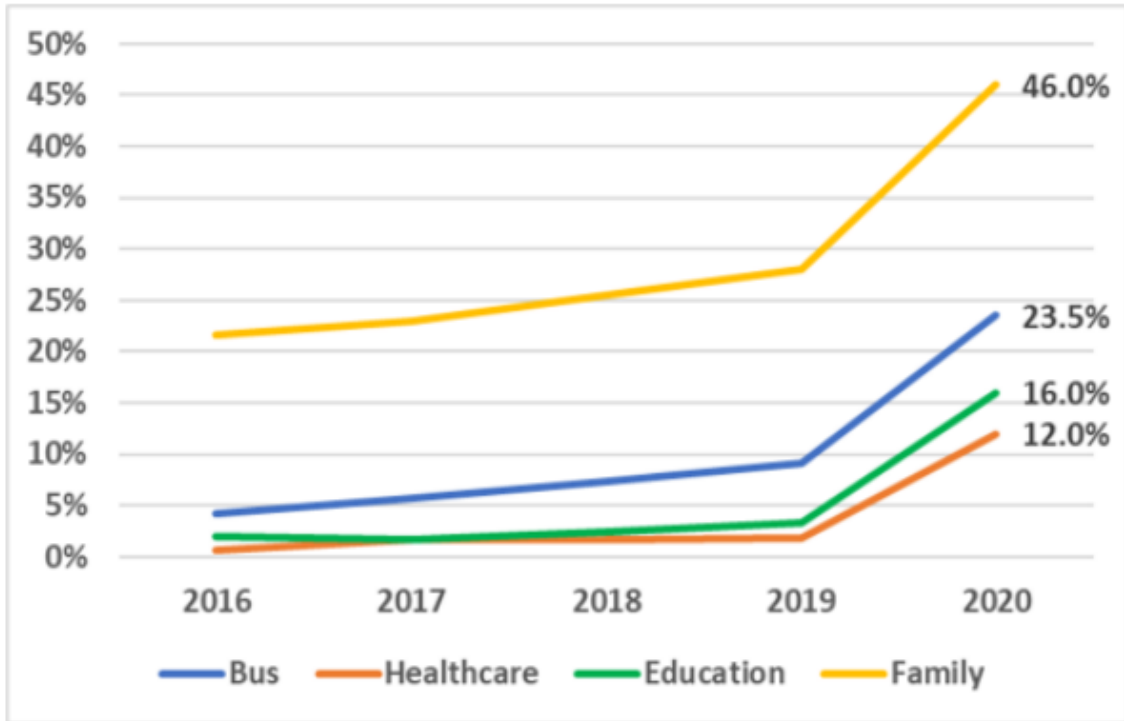
Upstream Downstream



Source: Data from NCTA member companies and others.

Impact of COVID-19 on Broadband

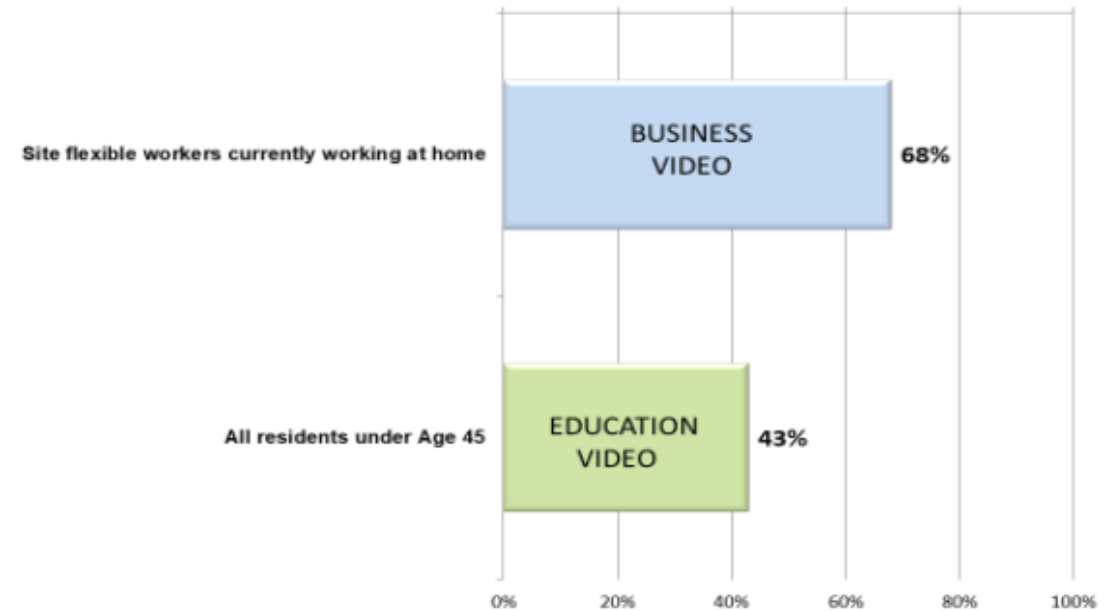
**Use Of Video Conferencing
Among Entire Sample**



RVA Market Research & Consulting, LLC

FBA Broadband Consumer Study April 2020

Video Conferencing Use Among Key Users

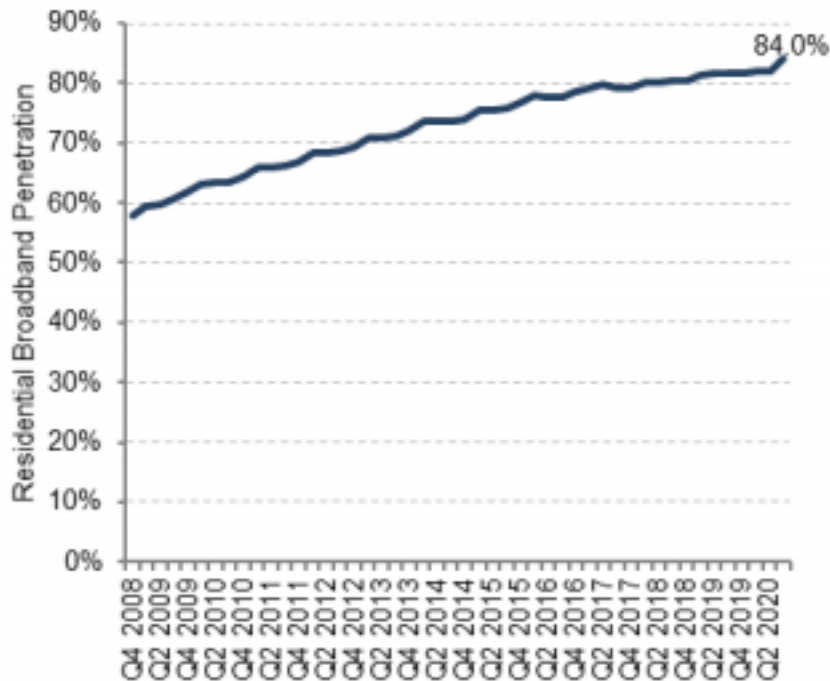


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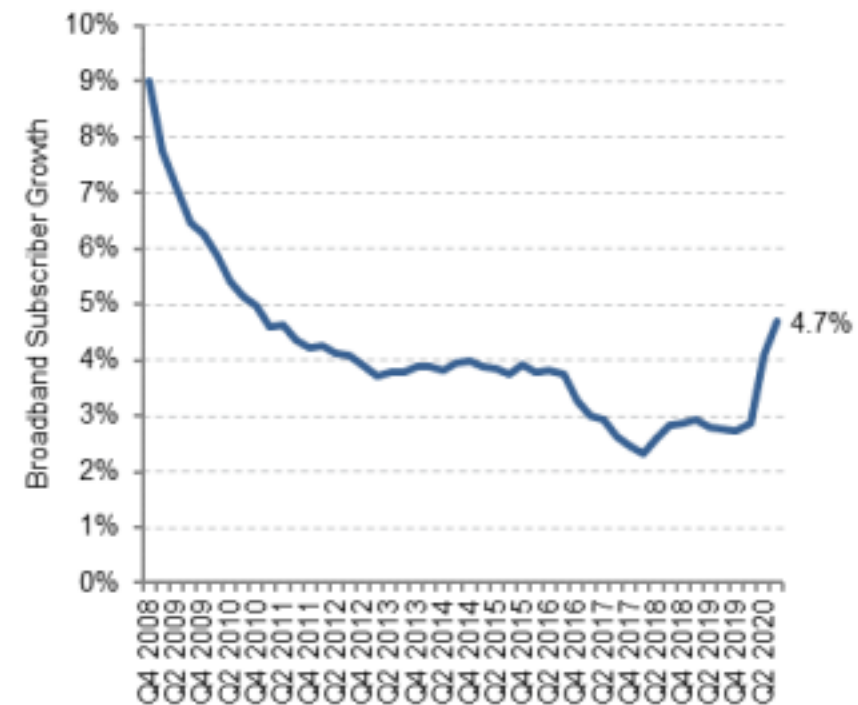
Impact of COVID-19 on Broadband – Subscriber Trends

Residential Broadband Penetration, Q4 2008 to Q3 2020



Source: U.S. Census Bureau CPS/HVS, Company reports, MoffettNathanson estimates and analysis

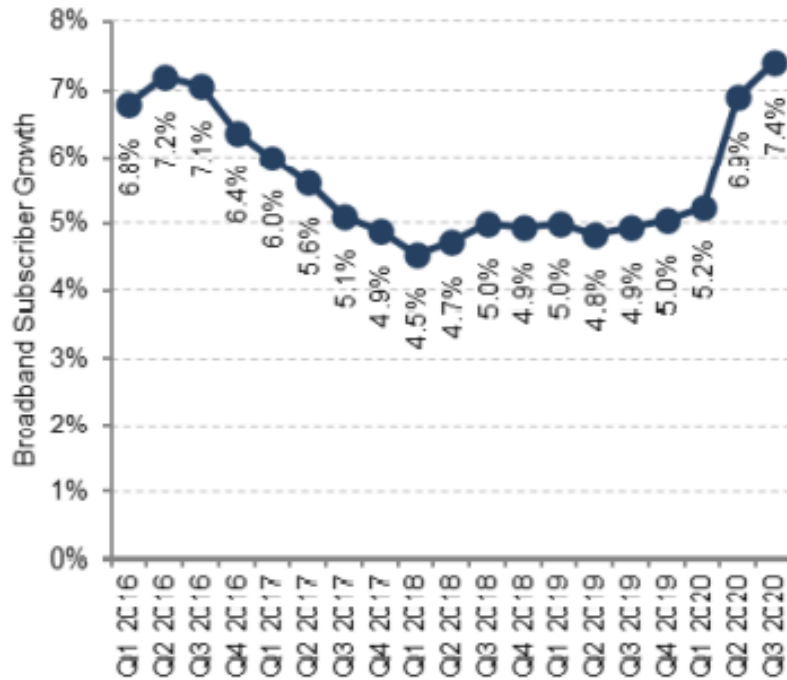
Total Broadband Subscriber Growth, Q4 2008 to Q3 2020



Source: Company reports, MoffettNathanson estimates and analysis

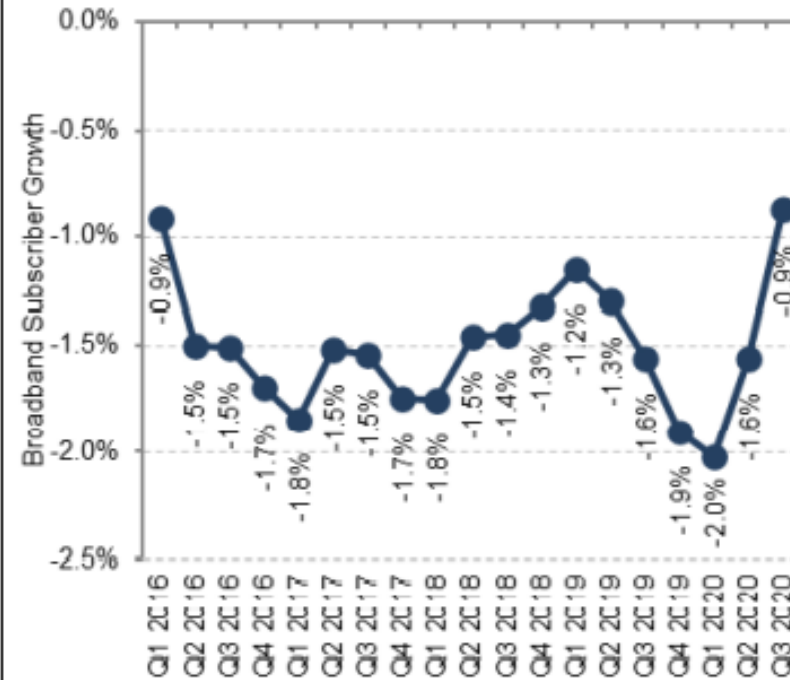
Impact of COVID-19 on Broadband – Subscriber Trends

Cable Broadband Subscriber Growth, YoY



Source: Company reports, MoffettNathanson estimates and analysis

TelCo Broadband Subscriber Growth (loss), YoY



Source: Company reports, MoffettNathanson estimates and analysis

Impact of COVID-19 on Broadband – Subscriber Trends

Q3 2020 snapshot*:

- US cable: 1.38 million subscriber adds – fueled by 4.7% year-on-year growth
- US telcos: 65,000 net sub loss – FTTP gains offsetting DSL erosion
- Satellite broadband: Flat growth, representing just 1.8 million subscribers, or less than 2% of the market
- Overall slowdown in rate of broadband subscriber growth anticipated for 2021

*MoffettNathanson

Impact of COVID-19 on Broadband – Operator Responses to Upstream Demand

- Boost existing capacity on the HFC network
- Pull fiber deeper and split nodes
- Employ new AI and machine learning techniques to boost efficiency of the network
- Employ upstream capacity upgrades
 - Mid-Split (5MHz-85MHz)
 - High-Split (5MHz-204MHz)
- Prep the plant for DOCSIS 4.0

Broadband Drivers



Online Gaming

Teleconferencing

AR/VR

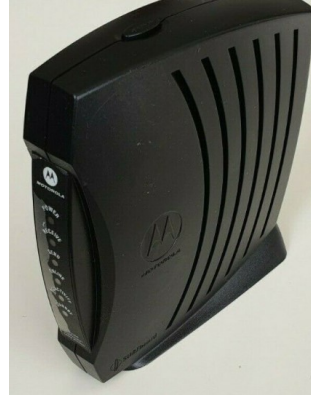
The Evolution of DOCSIS

DOCSIS 1.0



1996-2000

DOCSIS 1.1



2000-2001

DOCSIS 2.0



2002-2004

DOCSIS 3.0



2005-Present Day

DOCSIS 3.1



2012-Present Day

DOCSIS 4.0



2020 - ????

DOCSIS 4.0



- Multi-Gigabit speeds, support for symmetrical services:
 - 10 Gbit/s downstream and up to 6 Gbit/s upstream
- Support for lower-latency applications (online gaming, telemedicine, etc.)
- Enhanced security
- Two technological approaches:
 - Full Duplex DOCSIS (FDX)
 - Extended Spectrum DOCSIS (ESD)
- Specifications released by CableLabs in March 2020
- First prototype products could emerge in 2021, with certification testing to follow in 2022
- Work on 3GHz technology already underway (DOCSIS 4.1?)
- Ties into industry's broader, multi-access "10G" initiative

FDX

ESD

10G



- Access network agnostic: HFC, FTTP, wireless
 - Targeting symmetrical speeds of 10 Gbit/s
 - Enhanced security and lower latency
-
- 10G Smart Home demo in Ames, Iowa
 - Comcast tests symmetrical 1.25 Gbit/s on HFC

The Road to Converged Networks and Services



- Network agnostic future for networks and services
 - ‘Today’s cable operators are tomorrow’s mobile operators’ – John Chapman, Cisco
- Top US cable ops have launched mobile services
 - MVNO-based services (4.8M lines at end of Q3 2020)
 - Use of licensed spectrum on deck (CBRS, C-band auctions)
- ‘Cable’ fading from the industry lexicon
- ‘Connectivity’ and broadband now central to the cable strategy
- Comcast’s new ‘core tenets’ spell out direction of the company and – in some respects – the entire industry
 - Fast and reliable broadband
 - Offering content via aggregation
 - Using scale and reach of Comcast’s platform to succeed in streaming

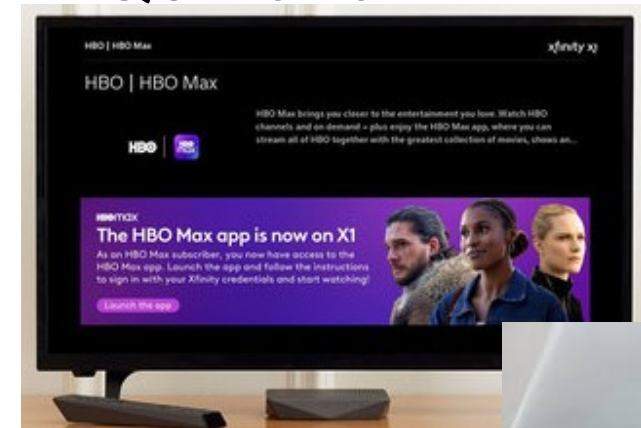


Broadband/Connectivity Focus Has Impacted Pay-TV

- Traditional pay-TV providers lost 1.45M subs in Q3 2020
- vMVPDs added 1.48M subs in Q3 2020
- Net gain of 30,000 in Q3

Operator responses to the trend:

- Build a next-gen platform for pay-TV and/or streaming
- Partner on a next-gen platform (X1 syndication, MobiTV, TiVo, Evolution Digital)
- Deemphasize or eliminate own pay-TV service and/or partner a vMVPD



5G – Friend or Foe?

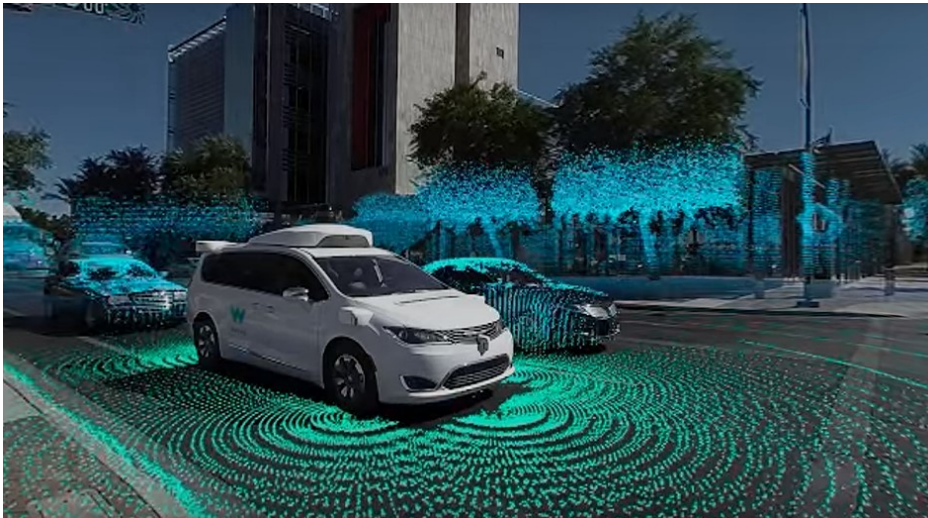
General Capabilities

- Faster speeds
- Super low-latency apps and services
- Spectrum agnostic
 - Low/mid/high spectrum bands
 - Licensed/unlicensed
- “Network slicing”



Applications & Services

- In-home broadband (as a fixed wireless service)
- The new mobility
- Automation: Factories, autonomous vehicles



5G – Friend or Foe?

Foe as fixed wireless evolves into a more viable home broadband competitor



- **Friend** as a potential revenue/business driver
 - Highly-distributed small cells feel a lot like HFC
 - 5G networks will need power and backhaul
 - 5G is mobile – mobile carriers are already besties in the “frenemy” category because of (lucrative) commercial backhaul agreements



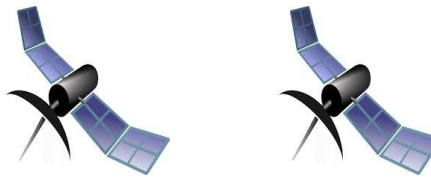
Satellite Broadband



Geostationary (GEO) orbit

- Orbit at ~22K miles
- Few satellites for broad coverage
- High latency (~600ms)
- Viasat: 603,000 subs
- HughesNet: 1.58M subs

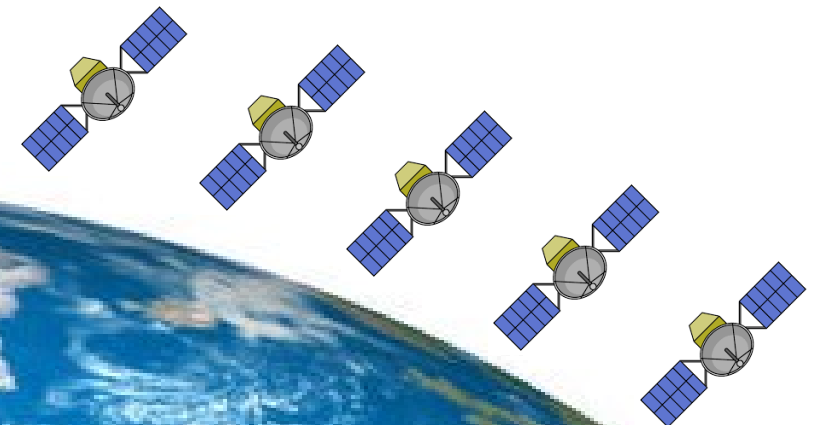
Medium-Earth orbit (MEO)



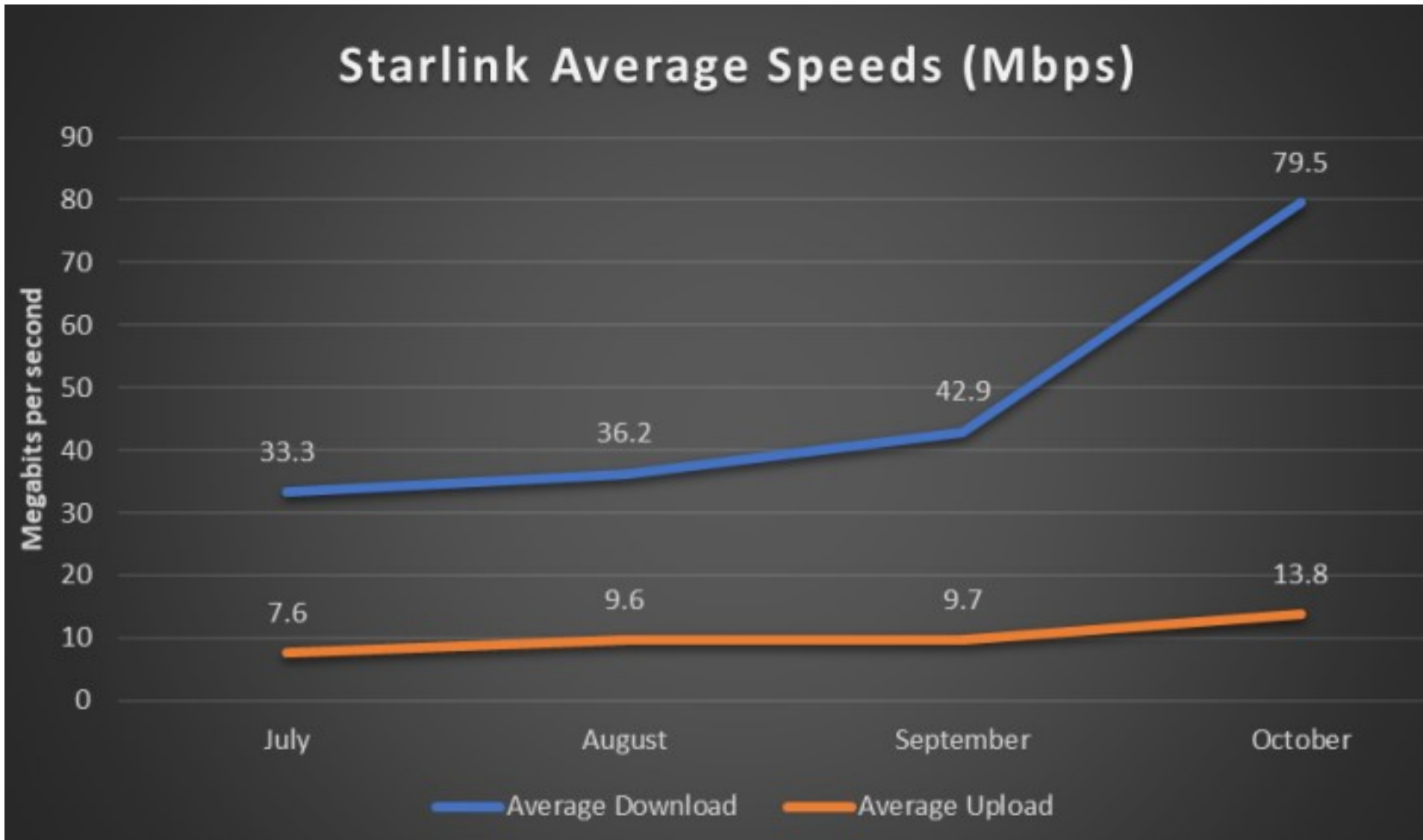
- Orbit at ~5K miles
- Dozens of satellites for coverage
- Lower latency (~120ms)
- SES O3b and O3b mPOWER

Low-Earth orbit (LEO)

- Orbit at ~300-350 miles
- Hundreds to thousands of satellites for coverage
- Low latency (~50ms)
- SpaceX (Starlink)
- Amazon (Kuiper)
- OneWeb

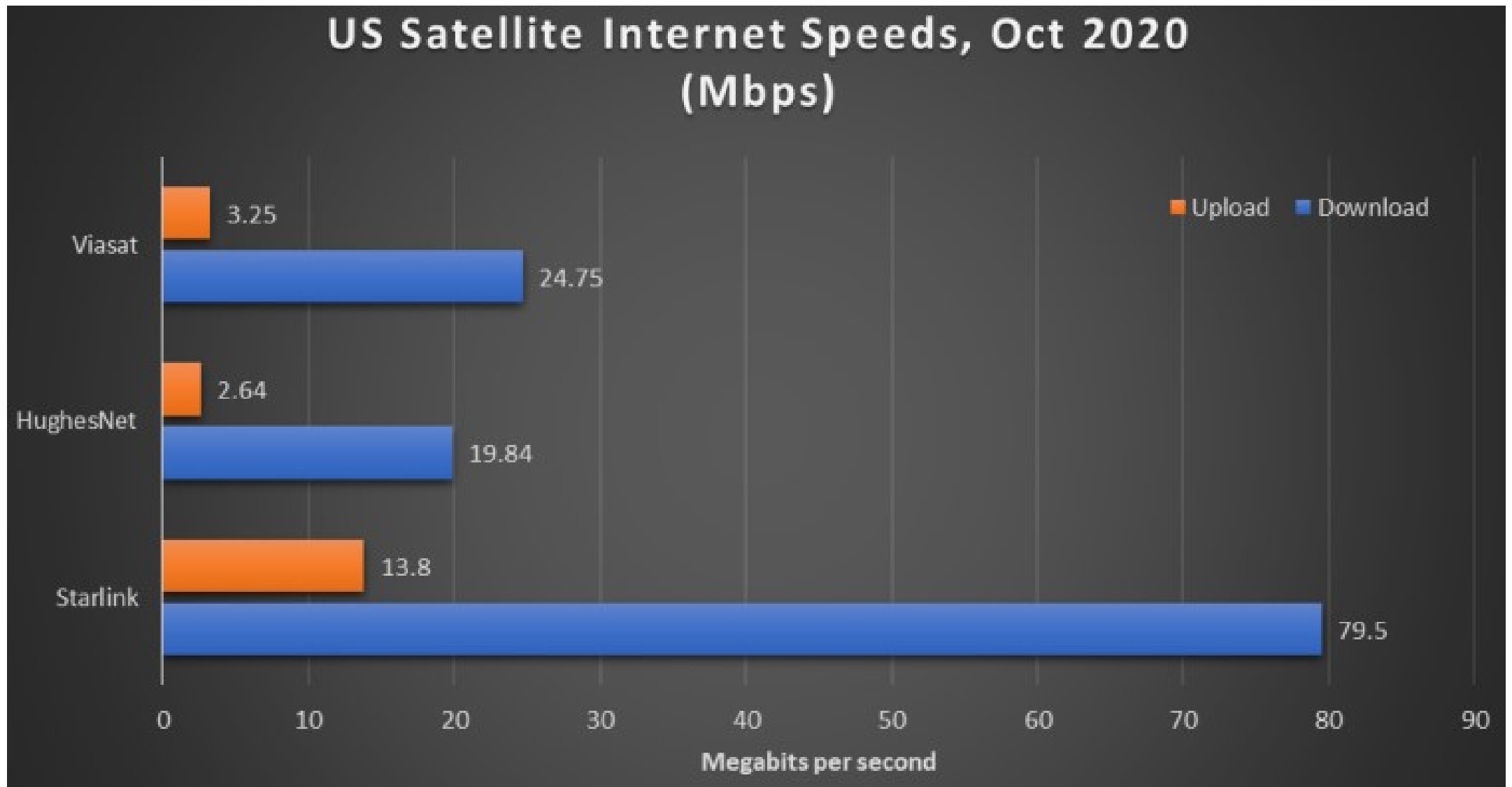


Starlink – Beta



Source: PCMag/Ookla

Starlink – Beta



Source: PCMag/Ookla

Fixed Wireless

- Small but growing segment
- Attention from big and small companies
- Millimeter wave – high speeds but faced with limitations
- Gathering attention from cable operators, notably Cable One/Sparklight



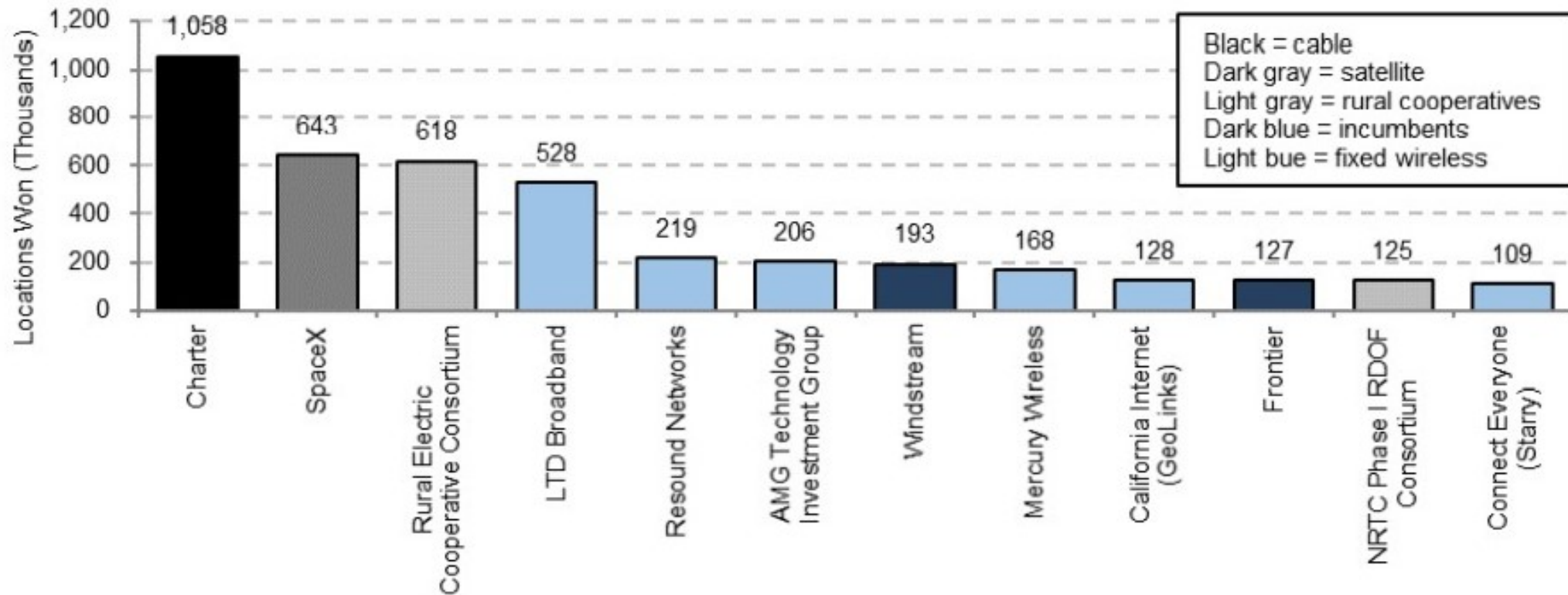


Fiber-to-the-Premises

- Telcos with VDSL shifting spend to GPON and more FTTP
 - Some projects have been accelerated
 - Not a wholesale shift, but more urgency is impact of the pandemic is prolonged
 - Rural Digital Opportunity Fund (RDOF) could accelerate some transitions among smaller operators.
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- XGS-PON becoming a factor in North American and Europe
 - Those without 2.5 GPON underway are likely skipping and going with XGS-PON and symmetrical 10-Gig
 - XGS-PON shipments up 210% from 2019 (67,000 ports) to 2020 (208,000 ports), according to Dell'Oro Group

Regional Wildcard – RDOF

Winners of Over 100K Locations (79% of Total Locations Awarded)



Source: FCC, MoffettNathanson estimates and analysis

Questions?



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