CableLabs®

Future of Connectivity

CableLabs

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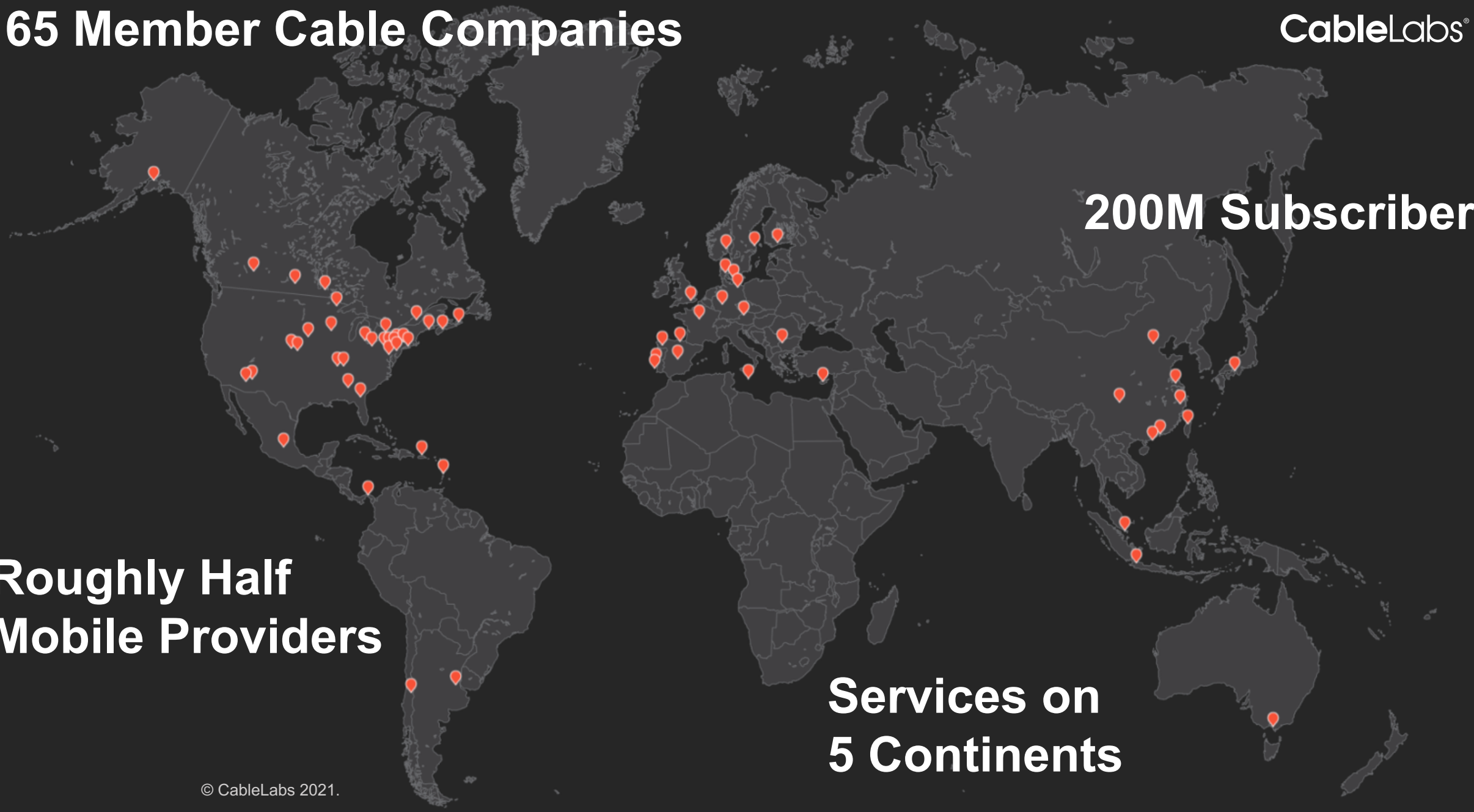
Cablelabs.com/nearfuture

65 Member Cable Companies

CableLabs®

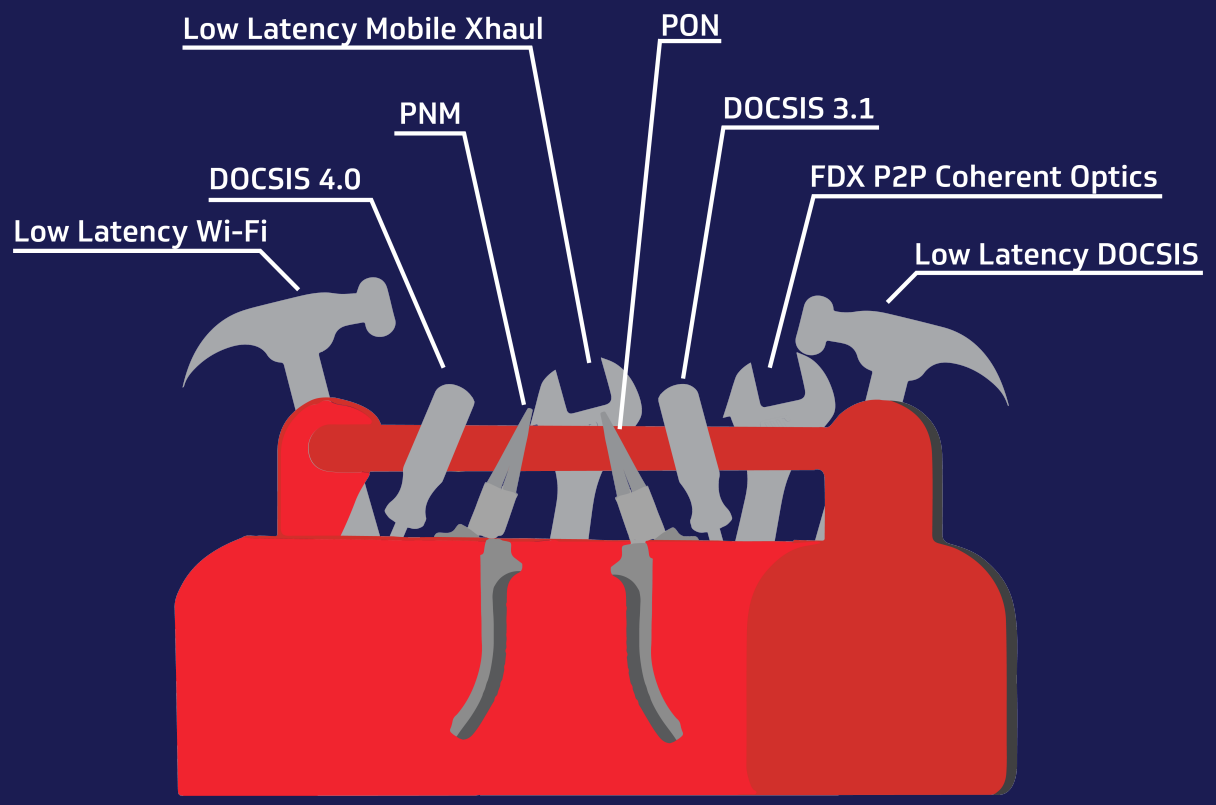


200M Subscribers

Roughly Half Mobile Providers

Services on 5 Continents

10G



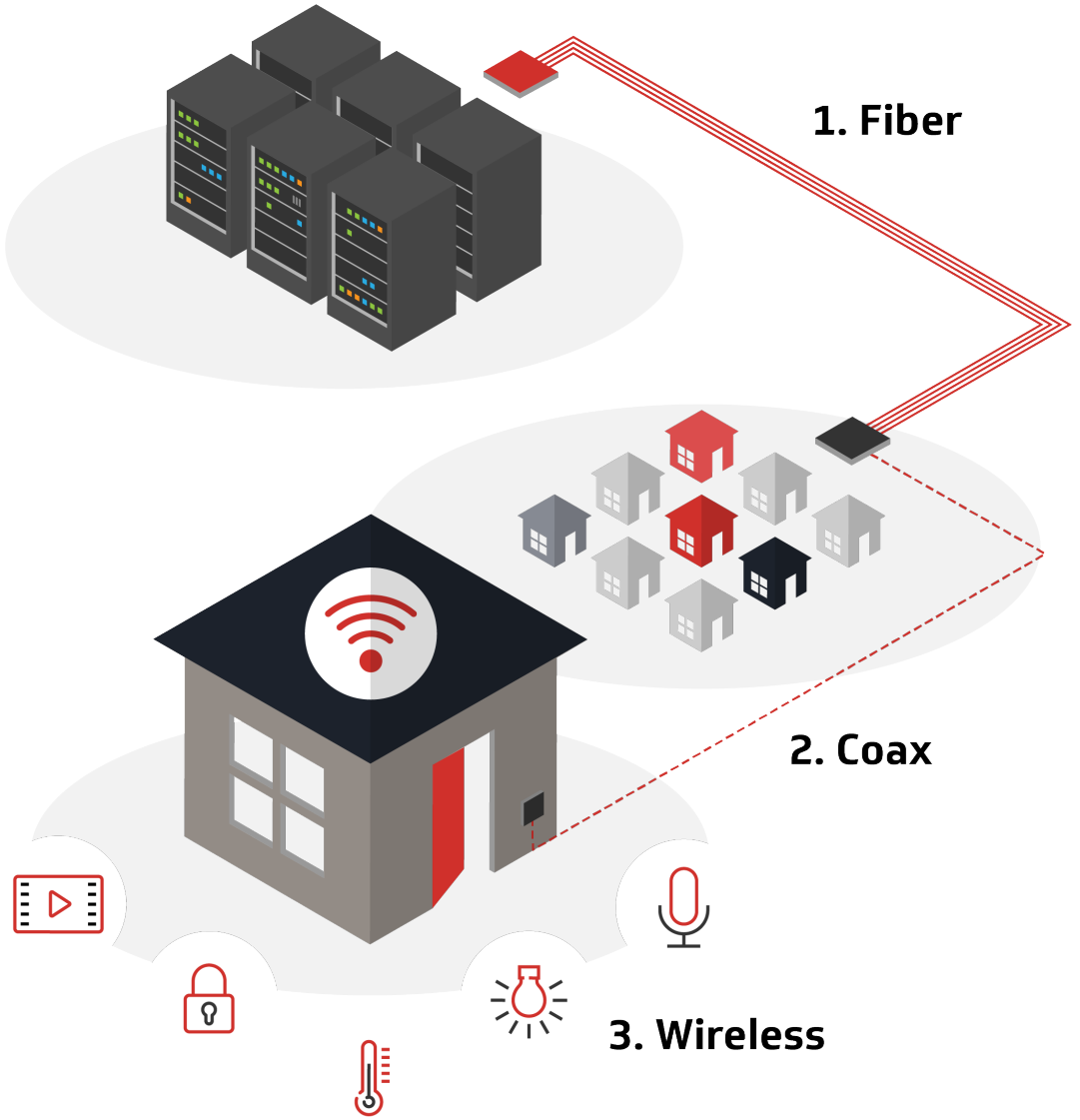
10x Speed

More Reliable

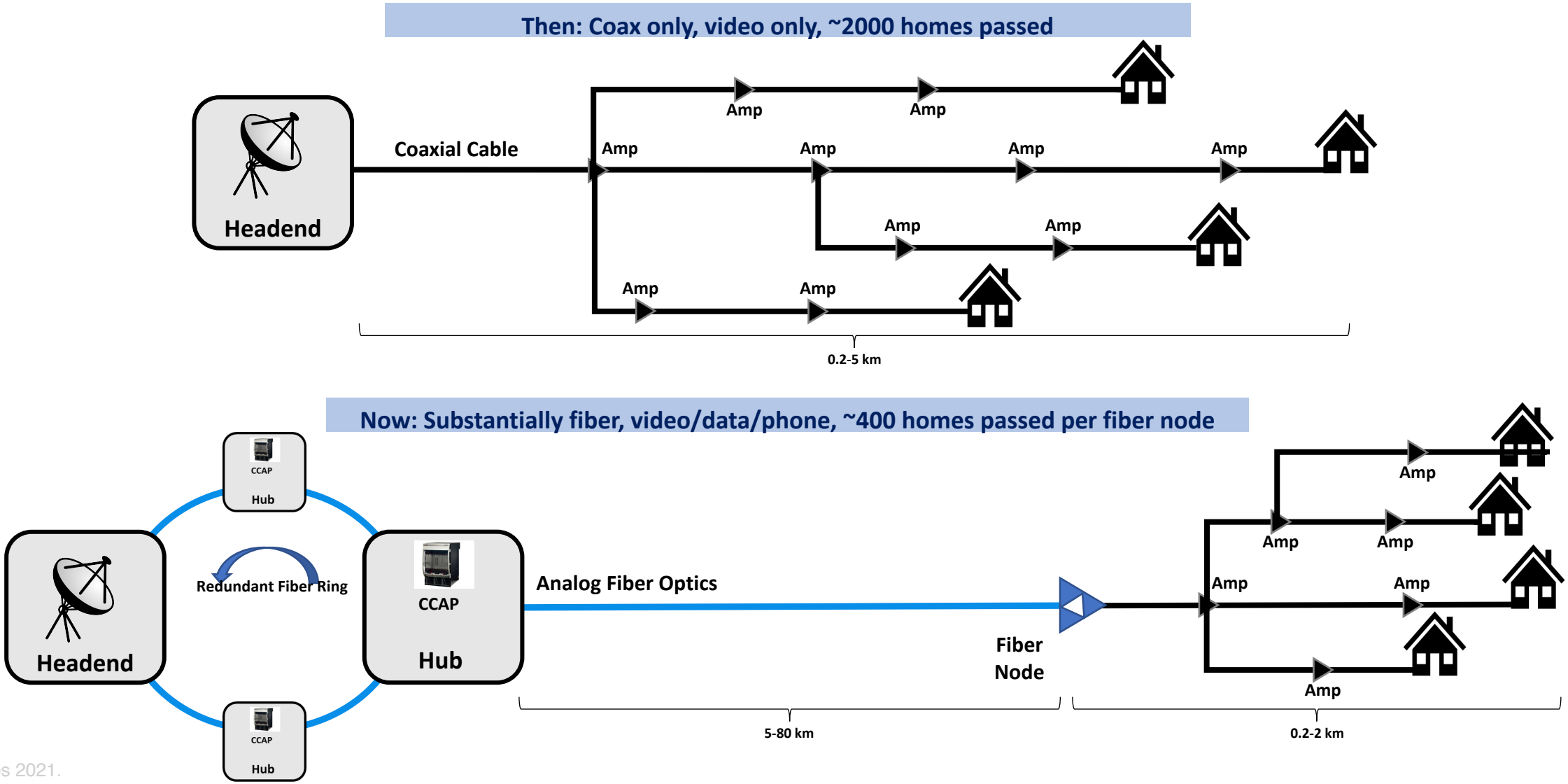
Better Security

Lower Latency

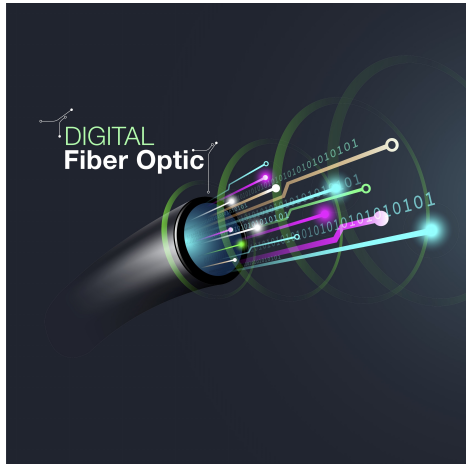
Cable's Hybrid Fiber-Coax Networks

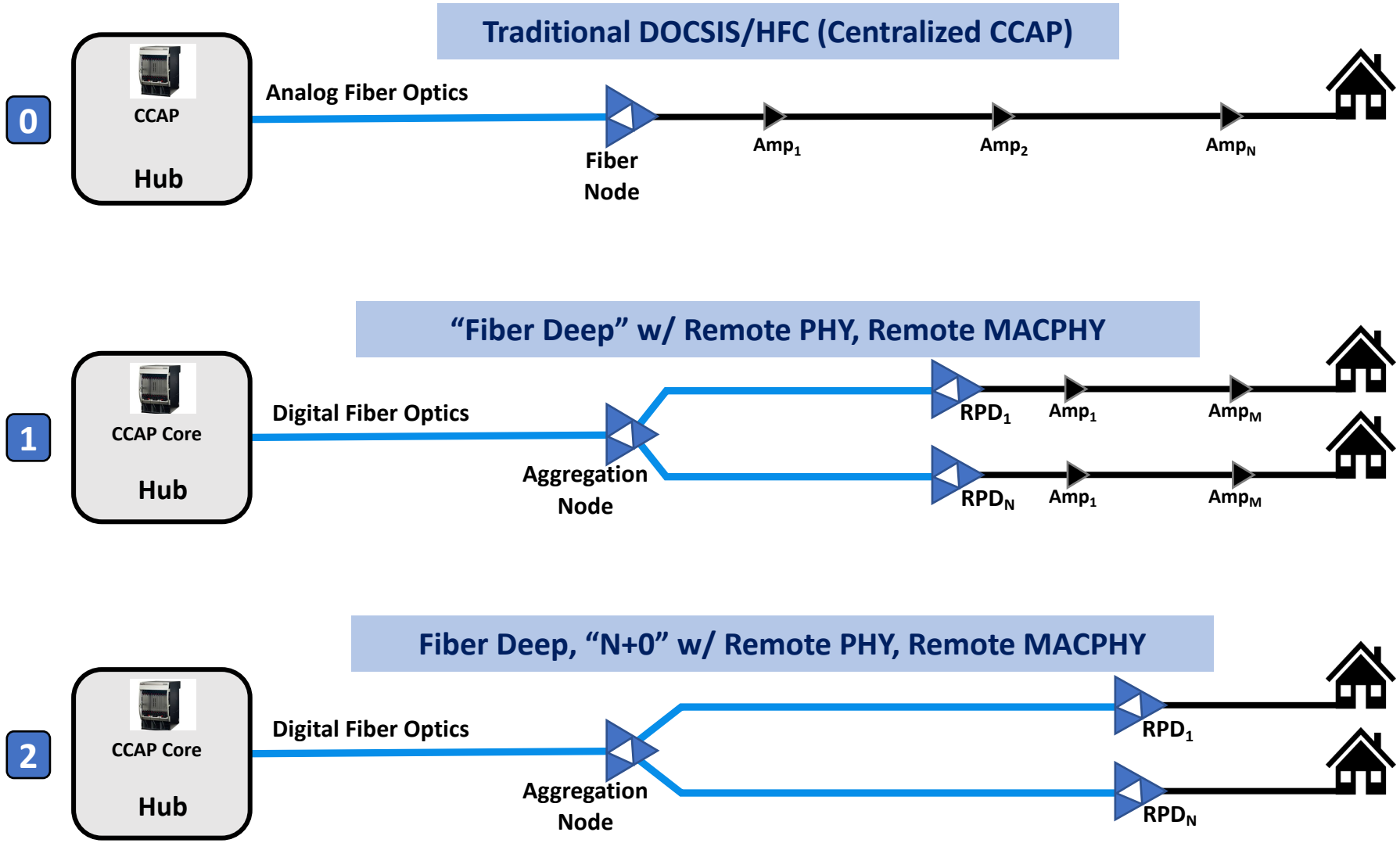


Cable Networks: Then and Now

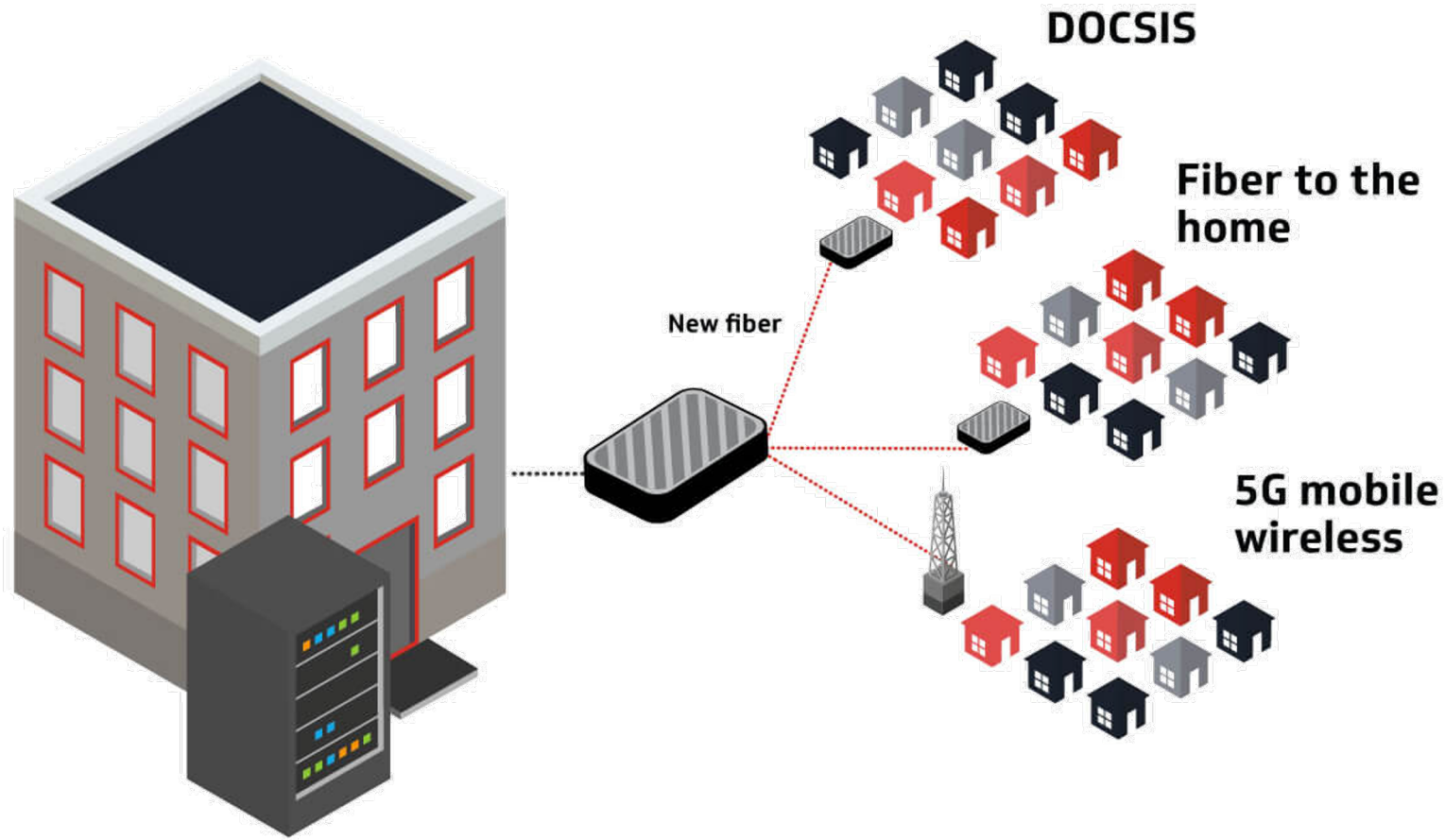


HFC Continuing Evolution – Fiber Deep



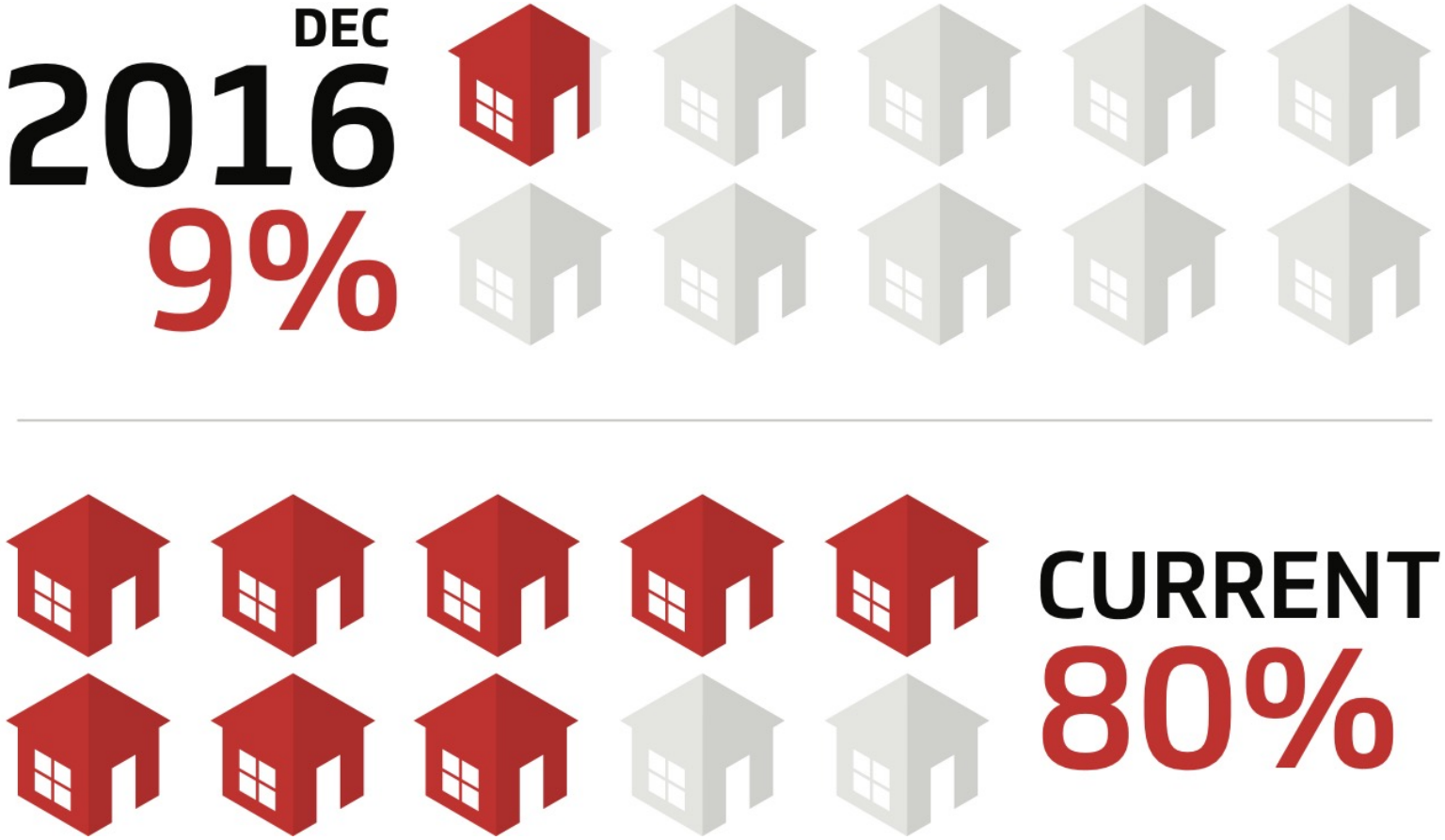


Convergence: Network and Services



Speed

Gigabit Broadband Now A Reality



Availability to US Housing Units

Source: CableLabs

Cable Broadband: Minnesota

- Cable Broadband: Available to **almost 2 million Minnesota Housing Units** (approx. 79% of Total Minnesota Housing Units)
- Cable *Gigabit* Broadband: Availability to **over 96%** of Minnesota housing units passed by cable broadband
- CableLabs Members Operating in Minnesota:
  - Cable One, Inc.
  - Charter Communications
  - Comcast Corporation
  - Mediacom Communications Corp.
  - Midcontinent Communications (Midco)
  - Schurz Communications
  - Sjoberg's Inc.
  - Telephone and Data Systems, Inc. (TDS)

Source: FCC 477 data (Dec. 2019)

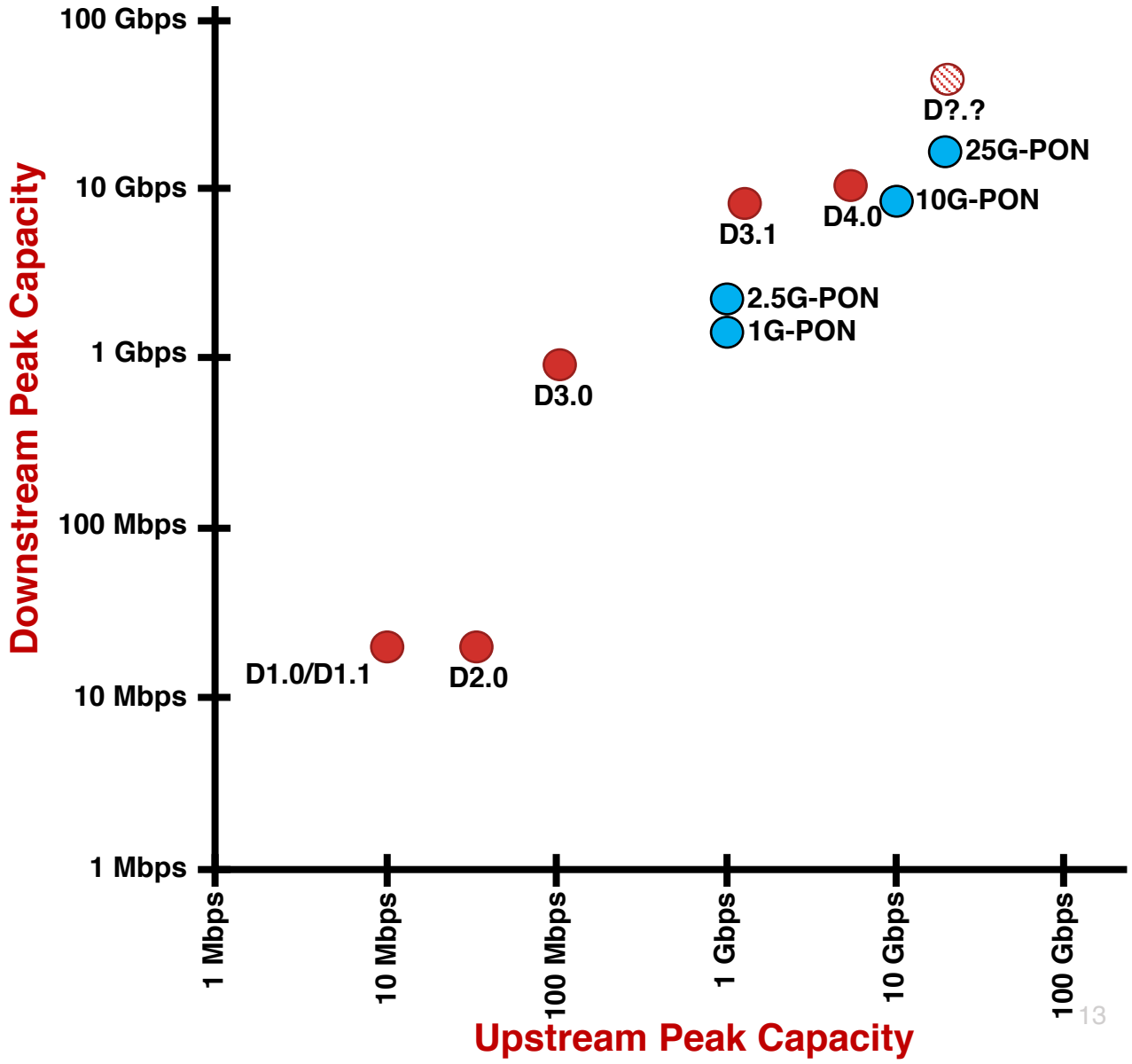
DOCSIS Evolution

	DOCSIS 1.0	DOCSIS 1.1	DOCSIS 2.0	DOCSIS 3.0	DOCSIS 3.1	DOCSIS 4.0
Highlights	Initial cable broadband technology, high-speed internet access	Added voice over IP service, gaming, streaming	Higher upstream speed, capacity for symmetric services	Greatly enhances capacity, channel bonding, IPv6	Capacity and efficiency progression, OFDM, wideband channel	Symmetrical streaming and increased upload speeds
Downstream Capacity	40 Mbps	40 Mbps	40 Mbps	1 Gbps	10 Gbps	10 Gbps
Upstream Capacity	10 Mbps	10 Mbps	30 Mbps	200 Mbps	1-2 Gbps	6 Gbps
First Specification Issue Date	1996	1999	2001	2006	2013	2019

*The DOCSIS Evolution table describes the maximum capabilities of the specifications.

Peak Network Capacity Comparisons

DOCSIS over Hybrid Fiber Coax keeps pace with fiber technologies

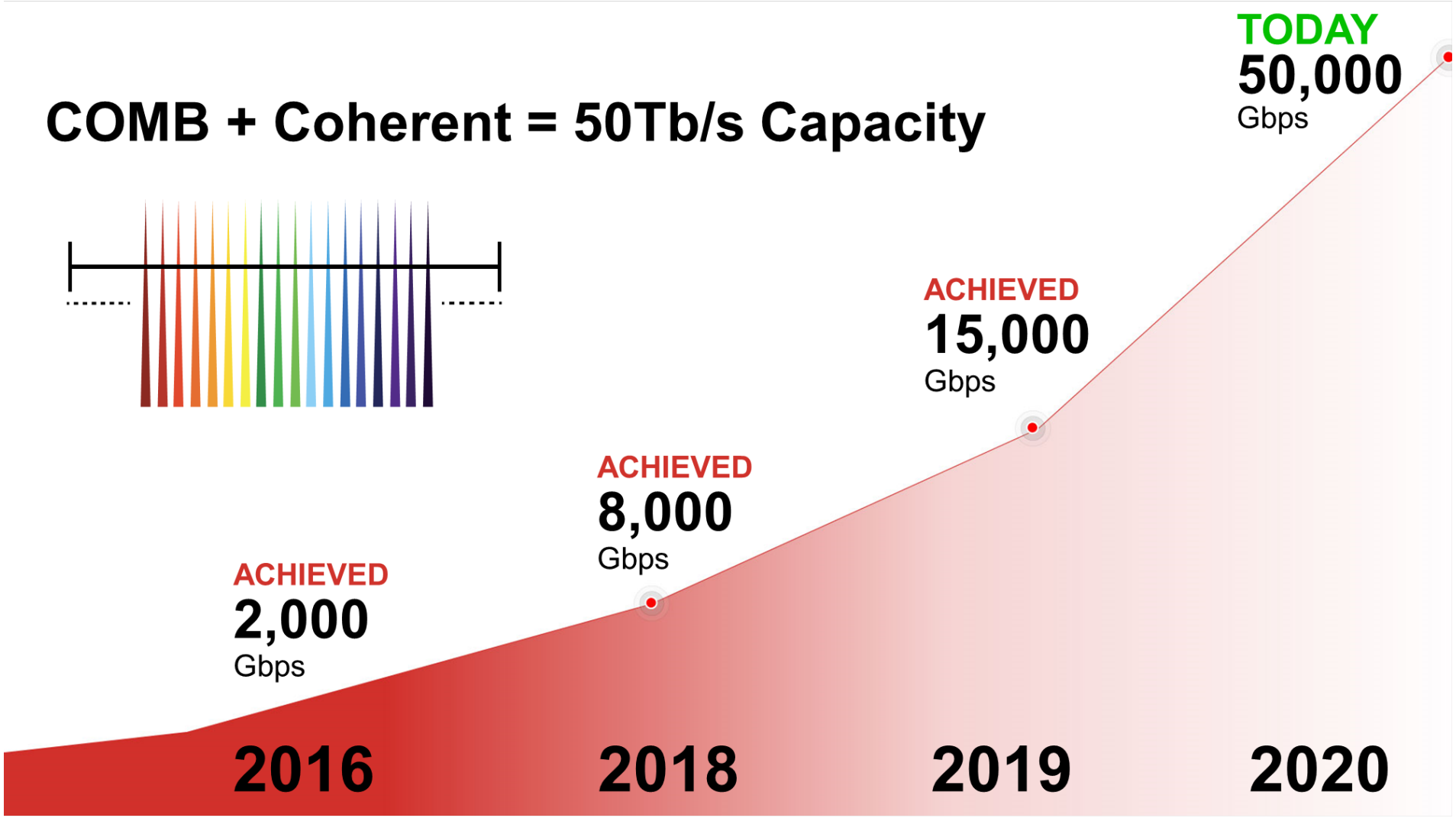


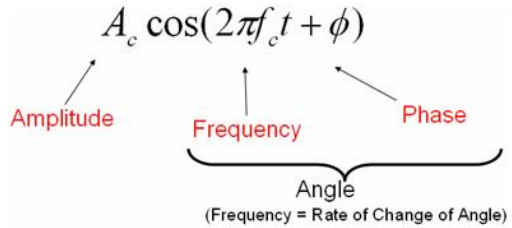
DOCSIS/HFC

Fiber to the Home/Passive Optical Networks (PON)

Coherent Optics

Optical Center of Excellence CableLabs





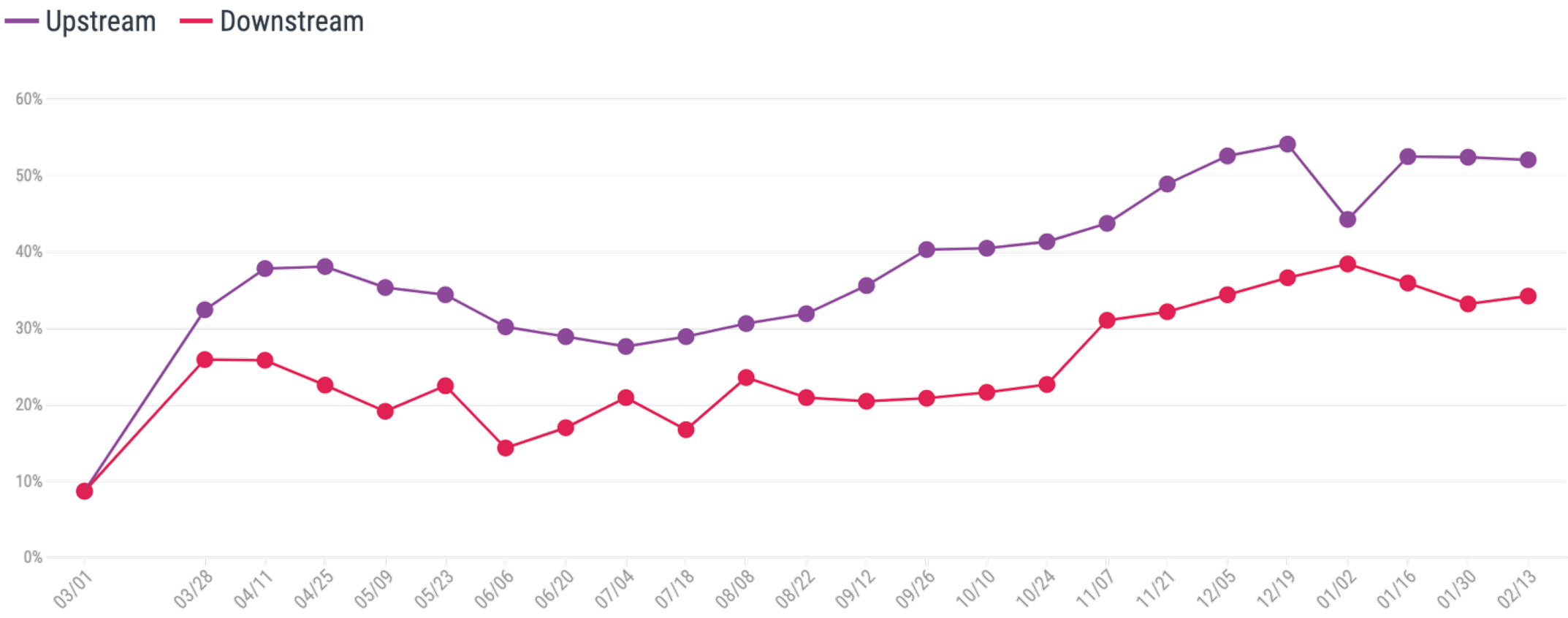
- Four dimensions:
  - Amplitude, frequency, phase, and polarization
- Significant increase in capacity per fiber
- Typically used in long haul and metro links – moving into access

Reliability

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



Source: https://www.ncta.com/COVIDdashboard

Covid-19: How Cable's Internet Networks Are Performing

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Select your state to display network information.

Minnesota

Downstream Growth (% of usage)

30.7% OVERALL SINCE 3/1/20

-3.6% WEEKLY 2/6–2/13/21

Upstream Growth (% of usage)

45.5% OVERALL SINCE 3/1/20

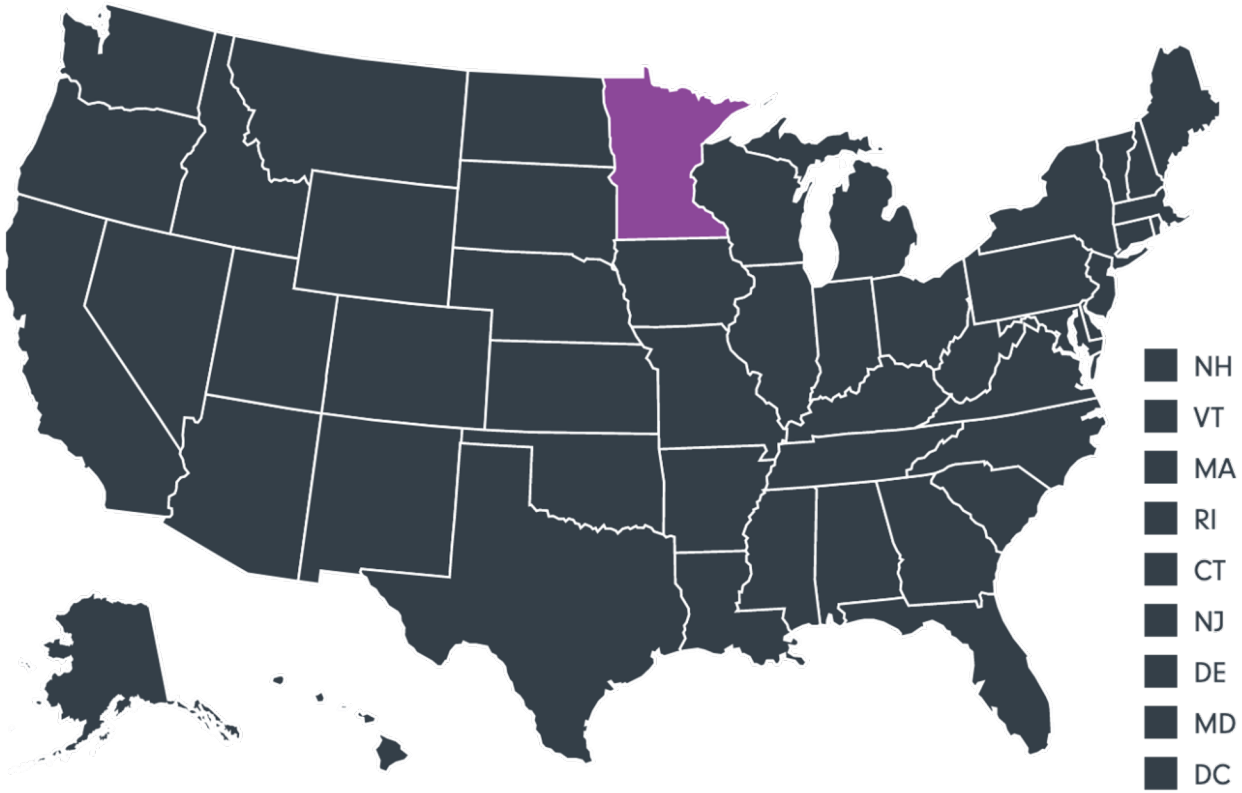
-1.8% WEEKLY 2/6–2/13/21

Network Performance (% of network)

98.9%	Normal Peak Usage
1.0%	Elevated Peak Usage
0.1%	Substantially Elevated Peak Usage
0.0%	Significantly Elevated Peak Usage

Internet Service Providers

CHARTER COMCAST MEDIACOM MIDCO SJOBERG'S



Source: https://www.ncta.com/COVIDdashboard

Security

Security Elements:

Device Identity

Onboarding/AAA

Confidentiality

Integrity

Availability

Lifecycle Management

Upgradeability
& Future Security

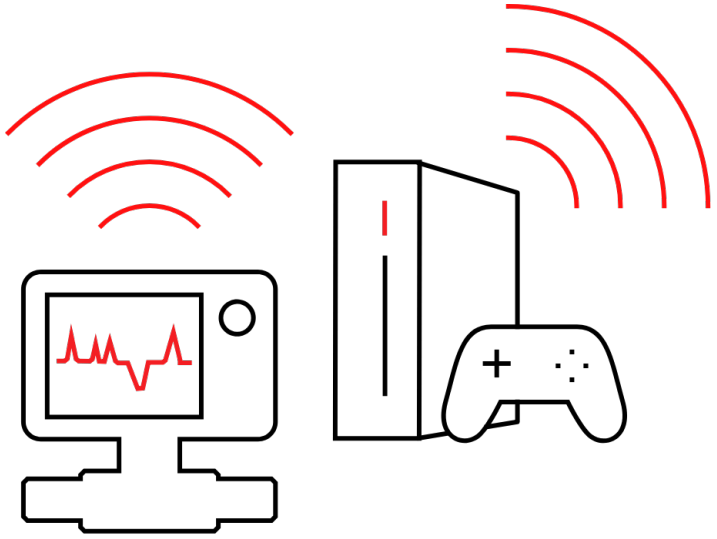
Assessment &
Conformance

Driving Increased Security:

- DOCSIS Public Key Infrastructure (PKI)
  - 20+ years
  - Largest PKI outside finance and DoD
  - Over 750,000,000 consumer device certificates under CableLabs management

- Mitigating Insecure IoT Devices
  - Wi-Fi Easy Connect
  - Micronets
  - Transparent Security

Low Latency



- DOCSIS 3.1 AQM: 10 milliseconds
- Low Latency DOCSIS: 1 millisecond latency for a range of applications
- Wi-Fi: Applying low latency technologies to the home network
- Improving UX: Video conferencing, gaming, web page loading will all benefit
- Enabling New Apps: Real-time cyber-physical systems, interactive immersive VR experiences

…Under A Conducive Policy Environment

- 10G will be the next leap forward in broadband connectivity
  - ➢ Faster speed, lower latency, better security, increased reliability

- The cable industry will further empower consumers and the digital economy via the 10G platform
- Requires a policy climate that fosters and incentivizes investment and innovation

The Future of Connectivity

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