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MBA: 1 Gigabit and Beyond

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Agenda

- Background and Overview
  - CableLabs
  - Cable Gigabit Service Availability
  - Enabling Technologies – DOCSIS, Fiber Deep, Distributed Access Architectures (DAA), and CPE
  - Consumer v. Testing Usage

- Testing of Gigabit Services
  - Continued Role of Active Speed Testing
    - Challenges and Potential Approaches
  - Related: Latency Measurement

65 Member MSOs Around the World

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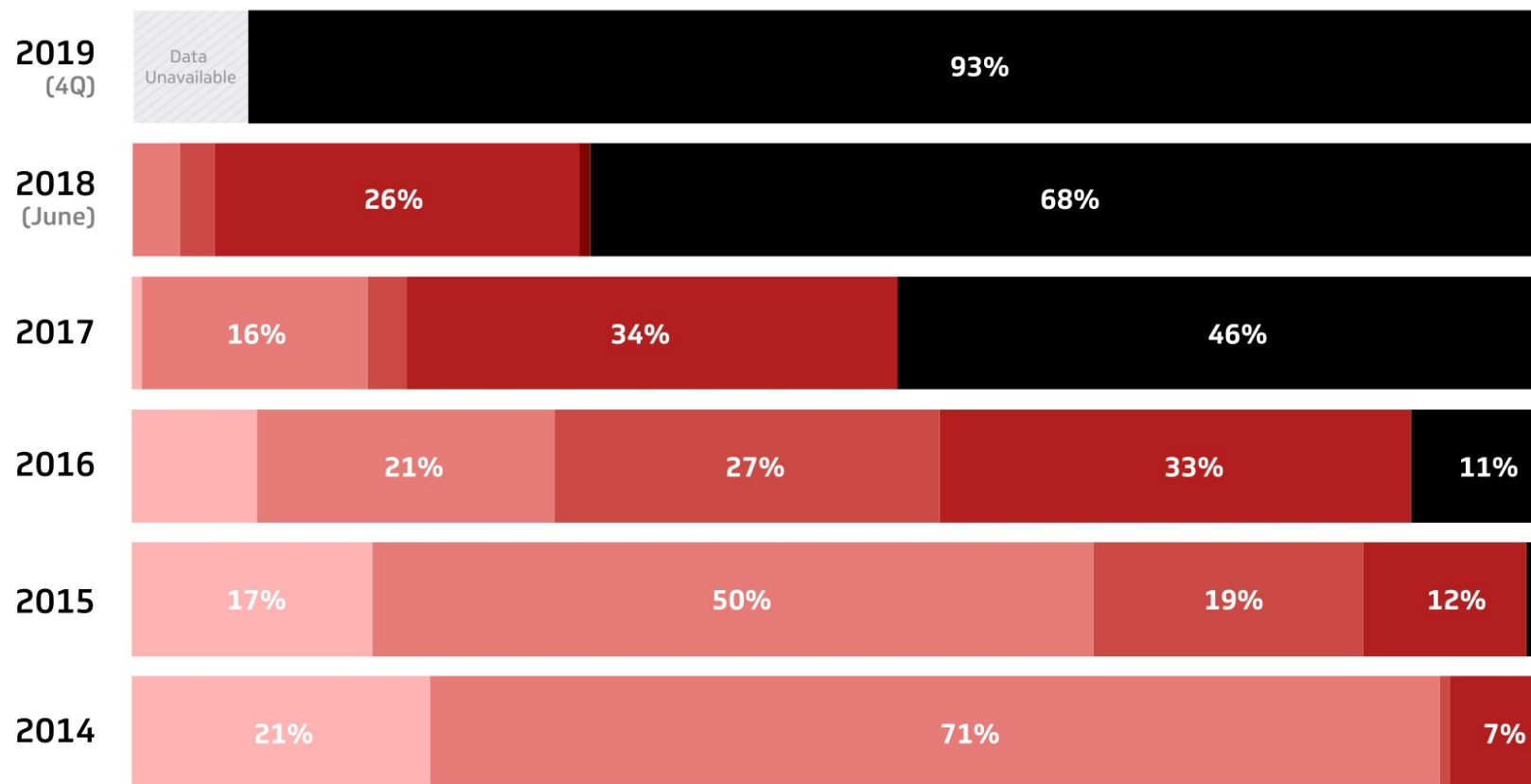# Cable Gigabit Now A Reality

DEC
2016
9%

CURRENT
80%

Availability to US Housing Units

Source: CableLabs

Progress in Available Speeds…

Cable Broadband Service: Max Available Download Speeds (Mbps)

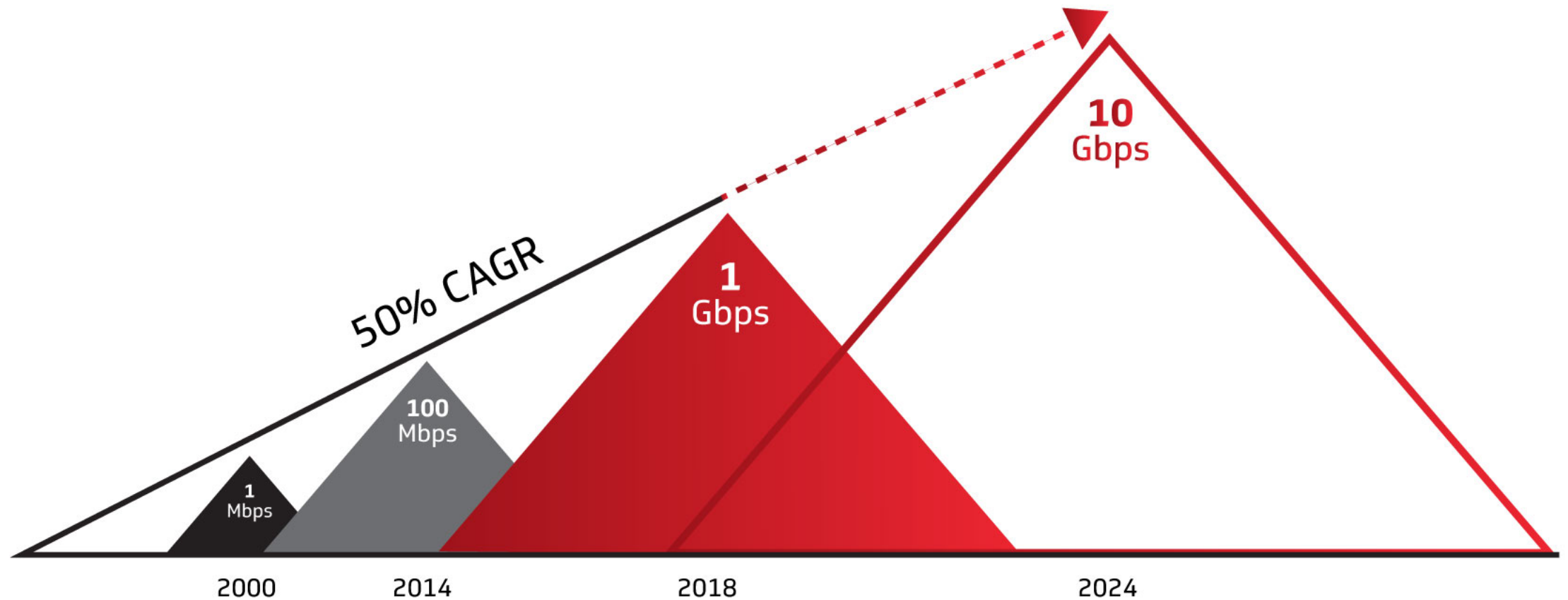Legend: <100 | 100-200 | 200-300 | 300-500 | 500-940 | 940+

2019 (4Q) — Data Unavailable — 93%

2018 (June) — 26% | 68%

2017 — 16% | 34% | 46%

2016 — 21% | 27% | 33% | 11%

2015 — 17% | 50% | 19% | 12%

2014 — 21% | 71% | 7%

0% — **Percentage of U.S. Cable Housing Units** — 100%

Source: CableLabs

10 Gigs on the Horizon

50% CAGR

1 Mbps	2000
100 Mbps	2014
1 Gbps	2018
10 Gbps	2024

Source: https://www.nngroup.com/articles/law-of-bandwidth/

Cable's Hybrid Fiber-Coax Networks

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1. Fiber

2. Coax

3. Wireless
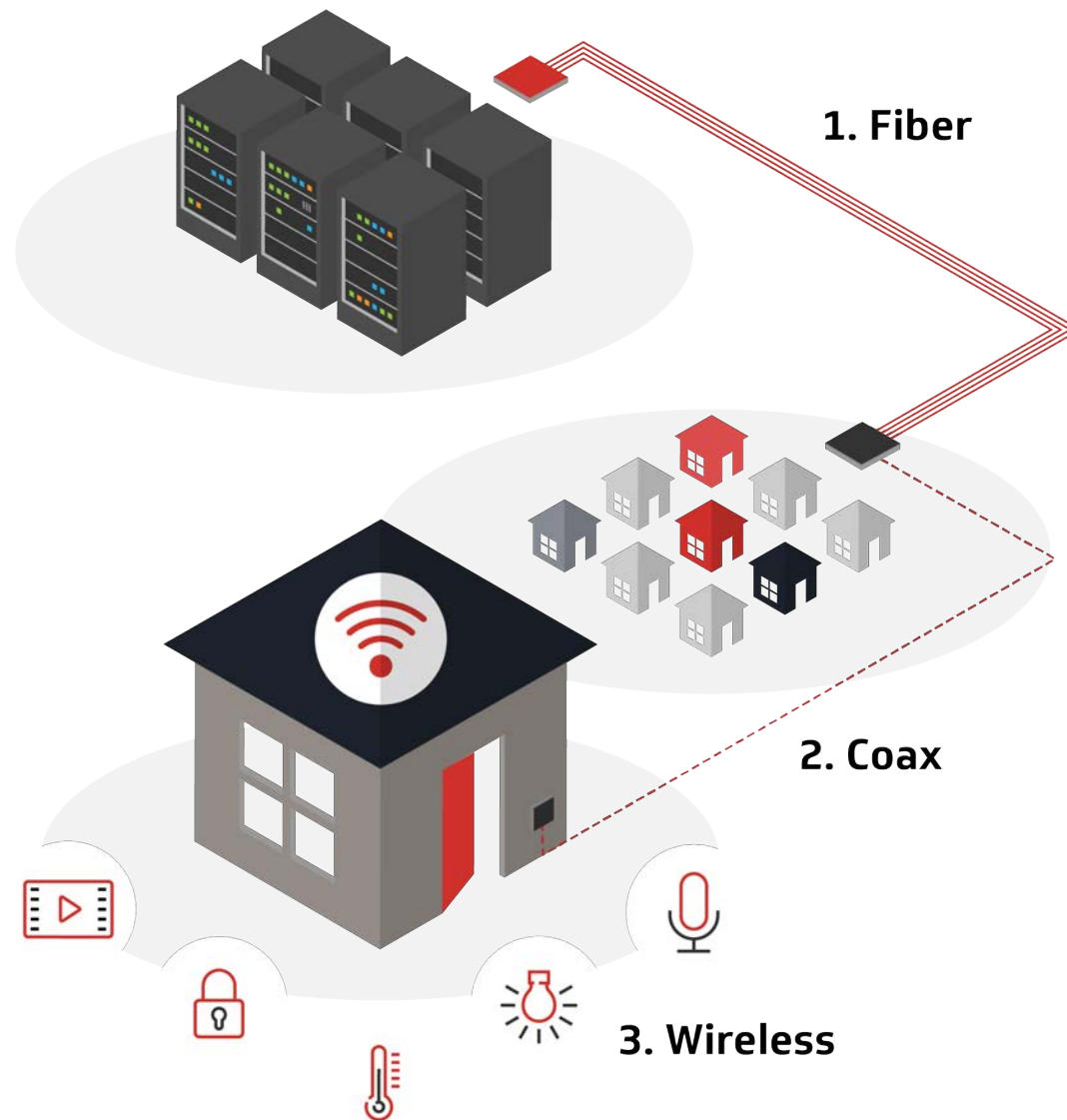
Enabling 1Gbps Services and Beyond

DOCSIS, Fiber Deep, Distributed Access Architectures (DAA), CPE

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.

Fiber Deep and Distributed Access Architecture (DAA)
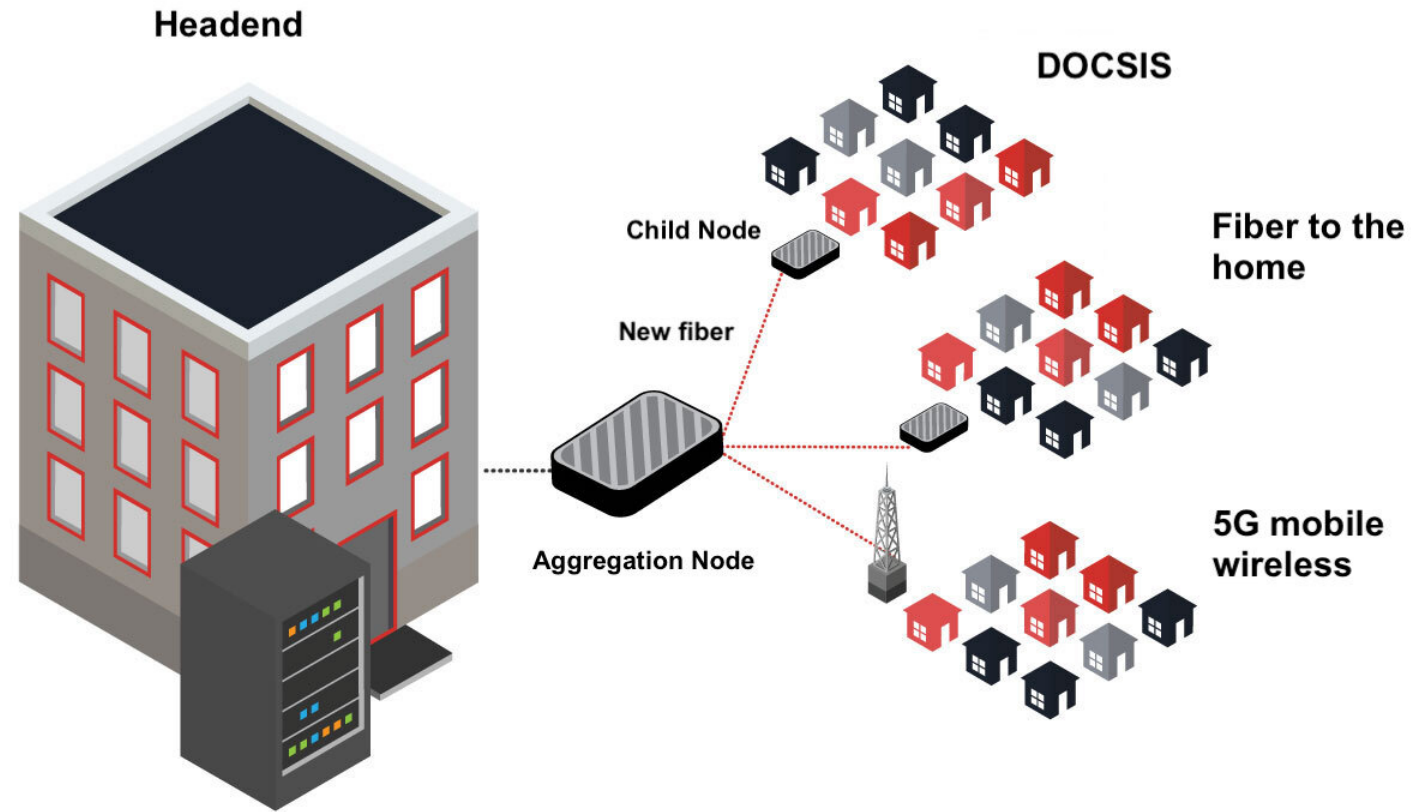
Increasing Capabilities of CPE (Modems & Gateways)

- Availability of 2.5 Gigabit Ethernet Ports:
  - Motorola
  - Netgear
  - Technicolor
- Wi-Fi 6 (802.11ax) becoming available in cable gateways
- Currently Available Downstream Capacity: 5 Gbps (DOCSIS 3.1)
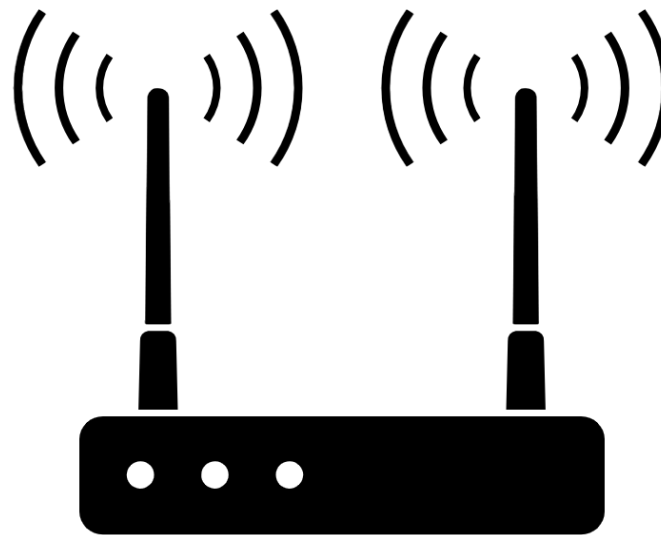
Consumer v. Testing Usage

Consumer Total Usage (Monthly – 1Q20)

- Monthly Usage
  - Average: 402.5 GB
  - Median: 233.6 GB

- Proportion of Avg. Weighted Subscribers
  - Usage of over 1,000 GB: 10%
  - Usage of over 2,000 GB: 1.2%

MBA Testing Total Usage (1Gbps tier) (Monthly)

- Total Usage (Current): 1,665 GB
  - 10-Second Download Tests: 20 per day
  - 10-Second Upload Tests: 20 per day
  - 20-Second Download Tests (Netflix, YouTube, Hulu): 18 per day

- Total Usage (Long Term): 556 GB
  - 10-Second Download Tests: 14 per day
  - 10-Second Upload Tests: 14 per day

Source: http://openvault.com/complimentary-report-Q120/

Testing of Gigabit Services

Observations, Considerations, and Recommendations

Continued Role for Active Speed Testing

- Observation: Remain focused on measuring the access link capacity rather than the end-to-end experience

- Considerations:
  - At higher speed tiers (particularly,1Gbps and beyond), active speed tests are not reflective of actual consumer usage
  - Seek to minimize network burden of active testing to avoid the potential of distorting network design and unnecessarily increasing the cost of broadband networks

- Recommendations:
  - Seek to minimize impact of external factors on the measurement of the access link capacity (e.g., using multiple test servers, moving test servers closer to the access link)
  - Optimize test plan to ensure statistically significant results while minimizing network burden

UDP- v. TCP-based Speed Tests

- Potential Benefits of UDP-based testing
  - More accurate measurement of the full capacity of the access link
  - Shorter duration tests to reach an accurate measurement – minimizing burden on the access network

- Potential Considerations
  - Perception of results – moving away from the predominant protocol currently used for Internet traffic (TCP)
  - Need to minimize potential impacts on other portions of the network, e.g., moving/using test servers closer to the access link, using multiple test servers
  - UDP-based testing will likely impair any other application running while the test is conducted – need to ensure link is idle prior to testing, even more so than with TCP-based tests
  - Multi-queue bottlenecks are becoming more common – need to ensure these can be accurately measured
  - Network security controls may see UDP-based tests as malicious activity and seek to block
  - Need further information on search algorithm and how it may be optimized to minimize the test duration while still providing accurate measurements

- Recommendation: Further information and evaluation needed

Related: Latency Measurement

- <u>Observation</u>:
    - Latency is becoming a more critical performance attribute to a wide range of applications
    - Will need to ensure validity of MBA latency measurements as latency becomes more critical
- <u>Consideration</u>:
    - <u>Minimize external variables</u>: Seek to minimize variation in testing results due to the relative geography of test servers, for example
    - <u>Idle and Under Typical Load</u>: Latency measurement of an idle link is not representative of the latency performance under typical load; measuring at idle and under typical load would help provide a more complete picture of latency performance
    - <u>Emerging Multi-Queue Approaches to Reducing Latency</u>
        - *Separating queue building and non-queue building traffic*: Low Latency DOCSIS (LLD) and other efforts seek to minimize latency for non-queue building traffic (e.g., latency-sensitive traffic)
        - *FQ (flow-queuing)*: Latency measurement traffic is queued separately from "load" traffic; latency under load measurements may not reflect performance of the other flows
- <u>Recommendation</u>: Explore how potential MBA changes to accommodate 1Gbps services and beyond may intersect and impact future needs for latency measurements

Questions?