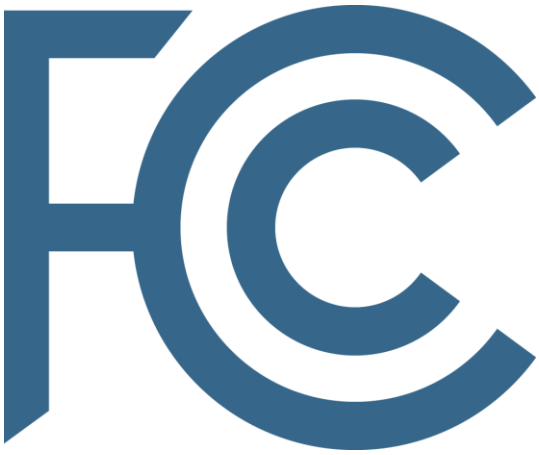
2015

Measuring Broadband America Fixed Broadband Report

A Report on Consumer Fixed Broadband Performance in the United States



FCC's Office of Engineering and Technology

and

Consumer and Governmental Affairs Bureau

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1. Executive Summary

The 2015 Measuring Broadband America Fixed Broadband Report ("2015 Report") contains the most recent data collected from fixed Internet Service Providers (ISPs) as part of the Federal Communication Commission's (FCC) Measuring Broadband America program. This program is an ongoing, rigorous, nationwide study of consumer broadband performance in the United States. We measure the network performance delivered on selected service tiers to a representative sample set of the population. The thousands of volunteer sample panelists are drawn from subscribers of Internet Service Providers (ISPs) serving over 80% of the residential marketplace.

The initial Measuring Broadband America Fixed Broadband Report was published in August 2011, and presented the first broad-scale study of directly measured consumer broadband performance throughout the United States. Including the 2015 Report, five reports have now been issued.[1] These annual reports provide a performance benchmark for fixed broadband Internet access services in the United States, and track progress towards the Commission's continuing goal of improving the speeds and quality of broadband access commonly available to the American public.

In order to better inform consumers about the potential variability of their broadband service performance, the 2015 Report expands our prior analysis of the consistency of service delivered to the consumer. The 2015 Report also introduces multi-year and regional views of performance. These new regional statistics help show how performance measured in this study varies across the US and what portion of the program's sample panelists within the United States are reaching the FCC's new 25 Mbps definition of broadband service. These new charts inform consumers about the consistency in performance of broadband services and show high level performance trends for technologies, service tiers, and geographic areas.

We continue to see significant growth in broadband speeds and in the uptake of these higher speeds by consumers, though results are not uniform across technologies. Spurred by the deployment of enabling technologies such as DOCSIS 3, the maximum advertised download speeds among the most popular service tiers offered by ISPs using cable technologies has increased from 12-30 Mbps in March 2011 to 50-105 Mbps in September 2014. In contrast, the maximum advertised download speeds that SamKnows tested among the most popular service tiers offered by ISPs using DSL technology has remained generally unchanged since 2011. There is a growing disparity in most download speeds tested between many DSL-based broadband services and most cable-based broadband services[2].

As in our most recent reports, we find that the actual speeds experienced by most ISPs' subscribers are close to or exceed the advertised speeds. All ISPs using cable, fiber or satellite technologies advertise speeds for services that on average are close to or below the actual speeds experienced by their

[1] The 2011 report was based on measurements taken in March 2011, the 2012 report on measurements taken in April 2012, and the 2013 through 2015 reports on measurements taken in September of the previous year.

[2] It is important to note some limitations on the results contained in this Report. Generally, only the most popular service tiers among an ISP's offerings were tested, even though some service providers may offer other tiers not represented by volunteers contributing data to the program. We note that a particular ISP may offer faster speed tiers either throughout their territory or in specific portions of their territory that are not as popular as the speed tiers we tested.

subscribers. However, some ISPs using DSL technologies continue to advertise "up-to" speeds that on average exceed the actual speeds experienced by their subscribers.

Actual speeds experienced by consumers may vary based on location and may vary during each day. Starting in this report, we now illustrate, for each ISP, the percentage of participating consumers who experienced an actual monthly average download speed that was greater than 95%, between 80% and 95%, and less than 80% of the advertised download speed. Even though the actual download speeds experienced by most ISPs' subscribers are close to or exceed the advertised download speeds, for each ISP there are some panelists for whom actual download speed falls significantly short of the advertised download speed. Relatively few subscribers to cable, fiber, or satellite broadband service experience such shortfalls.

Consistency of speed may be more important to customers who are heavy users of applications that are both high bandwidth and sensitive to variations in actual speed, such as streaming video.[3] In this Report, we continue to present statistics on the minimum actual speed that was experienced by at least 80% of panelists during at least 80% of the peak usage period.

Although actual download and upload speeds remain the network performance metric of greatest interest to the consumer, we spotlight two other key network performance metrics in this report: latency and packet loss.

Latency may affect the perceived quality of highly interactive applications such as phone calls over the Internet, video chat, or online multiplayer games. The higher latencies of satellite-based broadband services may negatively affect the perceived quality of such highly interactive applications. However, the differences in average latencies among terrestrial-based broadband services are small, and are unlikely to affect the perceived quality of such highly interactive applications. Furthermore, differences in average latencies across all technologies are unlikely to affect less interactive applications such as web browsing and video streaming.

Packet loss may affect the perceived quality of applications that do not request retransmission of lost packets, such as phone calls over the Internet, video chat, some online multiplayer games, and some video streaming. However, packet losses of a few tenths of a percent are sufficiently small so that they are unlikely to significantly affect the perceived quality of most such applications. Packet losses closer to one percent may affect the perceived quality of some such applications, depending on how the application responds to the packet loss. Packet loss is unlikely to directly affect the perceived quality of applications that do request retransmission of lost packets, such as web browsing and email.

The Internet is continuing to evolve along multiple dimensions: architecture, performance, and services. We will continue to evolve our measurement methodologies to help consumers understand the performance characteristics of their broadband Internet access service, and to thus make informed choices about their use of such services.

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[3] Video traffic currently comprises over 60% of Internet traffic, and some expect it to grow to 80% by 2019. See "Cisco Visual Networking Index: Forecast and Methodology, 2014-2019 White Paper", May 27th, 2015 at http://www.cisco.com/c/en/us/solutions/collateral/service-provider/ip-ngn-ip-next-generation-network/white_paper_c11-481360.html, last accessed on 10/6/2015

2. Summary of Key Findings

A. Most popular advertised service tiers

As explained in more detail in the section on Methodology below, these reports focus on the most popular service tiers offered by each participating ISP, as shown in Table 1, which together constitute the majority of the broadband plans subscribed to by their consumers. Some participating ISPs also offer faster service tiers than shown here, but if their number of subscribers is small, they are not analyzed herein.[4]

Table 1: The most popular advertised service tiers

Tech-nology	Company	Speed Tiers (Download)							Speed Tiers (Upload)				
DSL	AT&T-DSL	3	6						0.384	0.512			
	AT&T-Uverse	6	12	18	24				1	1.5	3		
	CenturyLink	1.5	3	7	10	12	20	40	0.256	0.64	0.768	0.896	5
	Frontier DSL	1	3	6					0.384	0.768			
	Verizon	0.5 - 1.0	1.1 - 3.0						0.384	0.384 - 0.768			
	Windstream	3	6	12					0.768				
Cable	Cablevision	15	50	101					5	25	35		
	Charter	15	30	60	100				3	4			
	Comcast	3	25	50	105				0.768	5	10		
	Cox	5	25	50	100				1	5	10		
	Mediacom	15	50						1	5			
	TWC	15	20	30	50	100			1	2	5		
Fiber	Frontier Fiber	25							10	25			
	Verizon Fiber	15	25	35	50	75			15	25	35	50	75
Satellite	Hughes	5	10						1				
	Viasat/Exede	12							3				

Chart 1 (below) displays the maximum advertised download speeds among the most popular service tiers for each participating ISP, during the years 2011-2014, grouped by the access technology used to offer the broadband Internet access service (DSL, cable, fiber and satellite). Between September 2013 and September 2014, we observe a 105% increase in the maximum advertised download speeds among the most popular service tiers across participating ISPs weighted by the number of participants using a given ISP; this increase is not uniform across access technologies.

[4] Starting in this report, we now breakout AT&T's U-Verse service from their other DSL services per their request (see Appendix A).

Starting in this report, Verizon now advertises a speed range for each tier of their DSL broadband service, rather than an "up-to" speed. This range is illustrated in charts as a shaded region indicating the advertised range.

Chart 1 shows that when DSL is used to provide broadband service, the maximum advertised download speeds among the most popular service tiers has remained generally unchanged since 2011.[5] In contrast, when cable is used to provide broadband service, the maximum advertised download speeds among the most popular service tiers has increased from 12-30 Mbps in March 2011 to 50 - 105 Mbps in September 2014.[6] In particular, most cable broadband ISPs now offer a 50 Mbps or 100 Mbps download speed tier, taking advantage of the increase in download speeds made possible by the transition from DOCSIS 2 to DOCSIS 3 technology.[7]

[5] In 2014, the acquisition of Qwest by CenturyLink resulted in CenturyLink offering a 40Mbps DSL-based broadband service subscribed to by a substantial number of its subscribers.

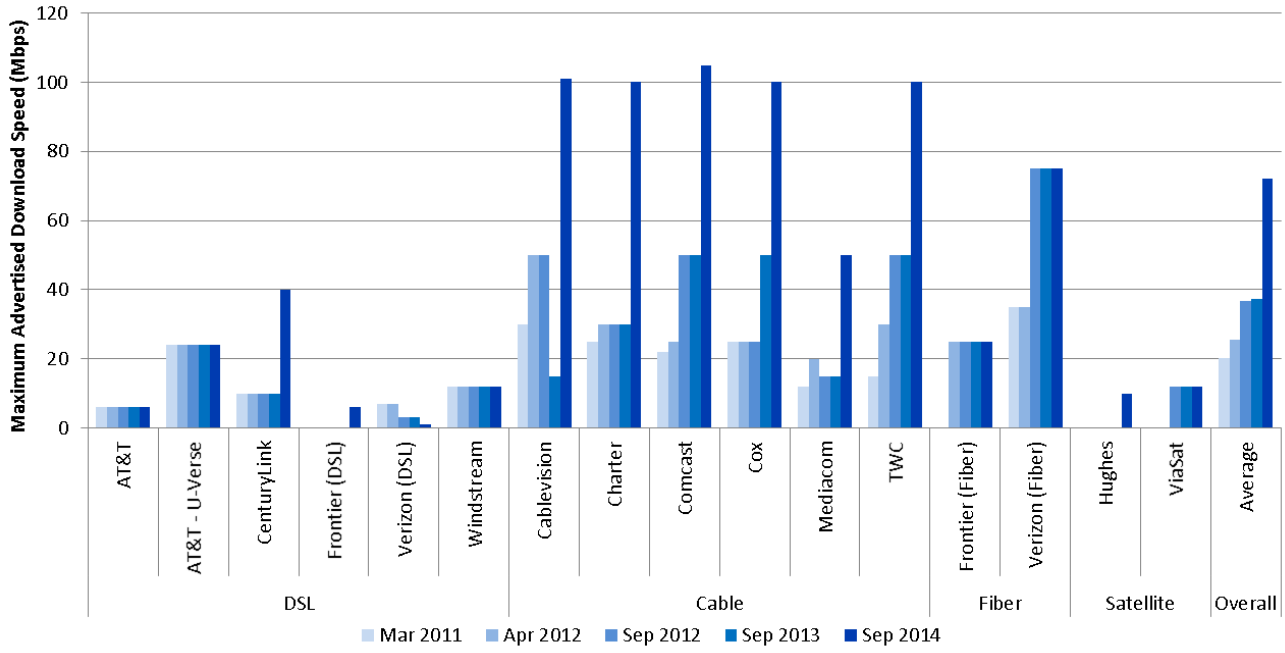
The September 2012 decline in Verizon's maximum advertised DSL speed included in our survey largely derives from customer transitions from DSL to Verizon FIOS (fiber) service as well as Verizon's sale of service territories to other carriers.

Frontier acquired a number of service territories from other ISPs in 2011 and again in November 2014. Consequently, in this Report we omit metrics for Frontier (DSL) for prior years as they as are not comparable.

[6] The temporary drop in 2013 in Cablevision's maximum advertised download speed is due to the exclusion of the 50 Mbps tier (by Cablevision's request), which was replaced in 2014 by a 101 Mbps tier.

[7] However, subscribers of 50Mbps or 100Mbps download speed tiers offered by cable broadband ISPs will only experience actual download speeds close to the advertised rates if they are using a DOCSIS 3 cable modem.

Chart 1: Maximum advertised download speed among the most popular service tiers



Among participating broadband ISPs, only Frontier and Verizon use fiber as the access technology for a substantial number of their customers. While the maximum download speed measured by SamKnows for Frontier's Fiber product F has remained 25 Mbps throughout the course of these Reports, the maximum popular download speed included in our survey for Verizon has more than doubled from 35 Mbps to 75 Mbps in 2012 and has remained at that speed in subsequent years.

We report results for ViaSat (Exede) starting September 2012 and for Hughes starting September 2014, representing when each began its respective participation in the program.

The maximum advertised download speed among the most popular service tiers, averaged across all participating ISPs (weighted by the number of panelists) increased from 37.2 Mbps in September 2013 to 72.0 Mbps in September 2014, an increase of 94%. However as noted, this increase in advertised download speed is not uniform across access technologies.

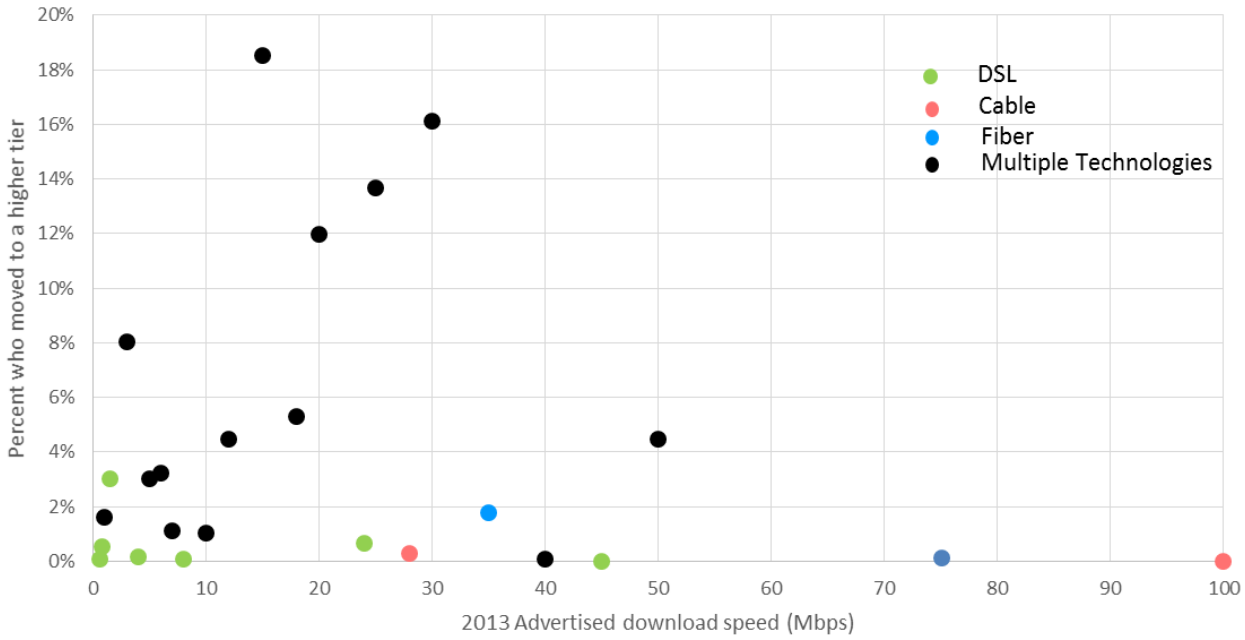
Chart 2 charts the migration of panelists to a higher tier based on their access technology[8]. Specifically, the horizontal axis of Chart 2 partitions the September 2013 panelists by the advertised download speed of the service tier to which they are subscribed. For each such set of panelists who also participated in

[8] Where several technologies are plotted at the same point in the chart, this is identified as "Multiple Technologies".

the September 2014 collection of data[9], the vertical axis of Chart 2 displays the percentage of panelists that migrated by September 2014 to a service tier with a higher advertised download speed. There are two ways that such a migration can occur: (1) if a panelist changed their broadband plan during the intervening year to a service tier with a higher advertised download speed, or (2) if a panelist did not change their broadband plan but the panelist's ISP increased the advertised download speed of the panelist's subscribed plan.[10]

Chart 2 shows that among panelists subscribed in September 2013 to service tiers with advertised download speeds less than 15 Mbps, only a few percent migrated within the following year to a service tier with a higher advertised download speed. In contrast, among panelists subscribed in September 2013 to service tiers with advertised download speeds between 15 Mbps and 30 Mbps, there was a much higher rate of migration within the following year to a service tier with a higher advertised download speed. This observation is consistent with the observations above regarding the maximum advertised download speeds of each access technology. Generally, speed tiers at 15 Mbps and below are dominated by DSL, while speed tiers above 15 Mbps are dominated by cable and fiber.

Chart 2: Consumer migration to higher advertised download speeds



[9] Of the 4,980 panelists who participated in the September 2013 collection of data, 4,014 panelists continued to participate in the September 2014 collection of data.

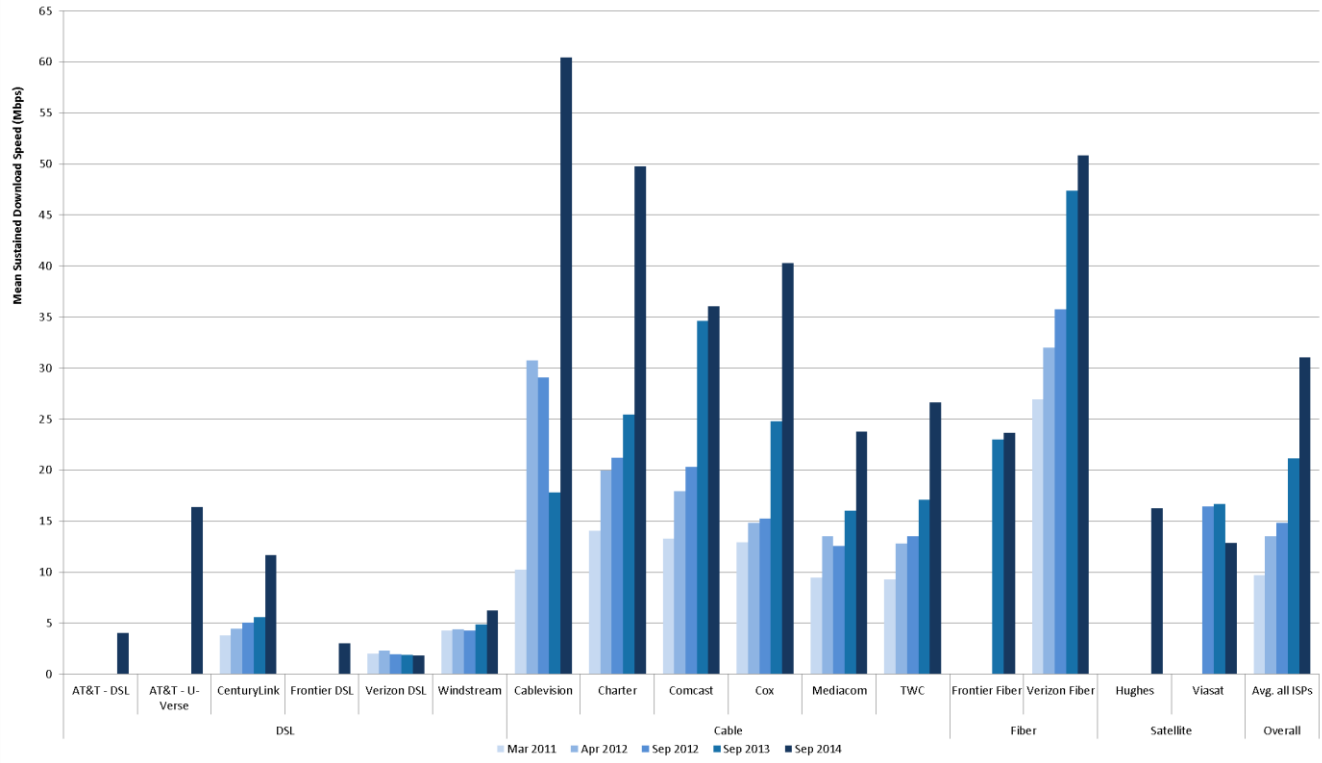
[10] We do not attempt here to distinguish between these two cases.

B. Actual download speeds

Advertised download speeds may differ from that actually experienced by subscribers; this can be the case for several reasons. First, each ISP chooses what speed to advertise, and their decisions may vary. Second, speeds experienced by different consumers subscribed to the same ISP and the same service tier may vary across a geographical region based on the subscriber's location. Third, speeds experienced by a particular consumer will vary during the day based on variations in the aggregate Internet usage by all subscribers to that consumer's ISP. We examine each of these factors in turn. Unless stated otherwise, all actual speeds are measured only during peak usage periods.

Chart 3 shows the actual download speeds experienced by each participating ISP's subscribers -- averaged across all analyzed speed tiers, geography, and time -- from 2011 to 2014. The actual download speed, averaged across all participating ISPs, has tripled during this period, from approximately 10 Mbps in March 2011, to approximately 15 Mbps in September 2012, to nearly 31 Mbps in September 2014.

Chart 3: Actual download speeds by ISP, 2011 to 2014



However, as we observed above when examining advertised download speeds, the increase in actual download speeds is not uniform across access technologies. For subscribers to DSL-based broadband service, the increase in actual download speeds has varied among ISPs. For subscribers to each of the participating cable broadband services, there have been fairly steady and substantial increases in actual

download speeds.[11] We find that, over the course of our reports, the average annual increase in actual download speeds by technology has been 28.2% for DSL[12], 61.2% for cable, and 19.2% for fiber[13].

Chart 4 shows the ratio in September 2014 of the actual speeds experienced by an ISP's subscribers (averaged across both geography and time) to that ISP's advertised speeds.[14] The ratios for downloads and uploads are both illustrated. The ratio in September 2014 of the actual download speeds to advertised download speeds, averaged across all panelists, was 105.6%, an increase from the 101.6% reported last year for September 2013.[15] For uploads, the similar ratio increased to 113.2% compared to the previous year's 109.1%.

The actual speeds experienced by most ISPs' subscribers (when averaged across both geography and time) are close to or exceed the advertised speeds. However, some DSL broadband ISPs continue to advertise "up-to" speeds that on average exceed the actual speeds experienced by their subscribers.

[11] It should be noted that the temporary drop in 2013 in Cablevision's actual download speed was the result of the exclusion of its 50 Mbps tier (at the request of Cablevision) since it was transitioning this tier to the 101 Mbps tier.

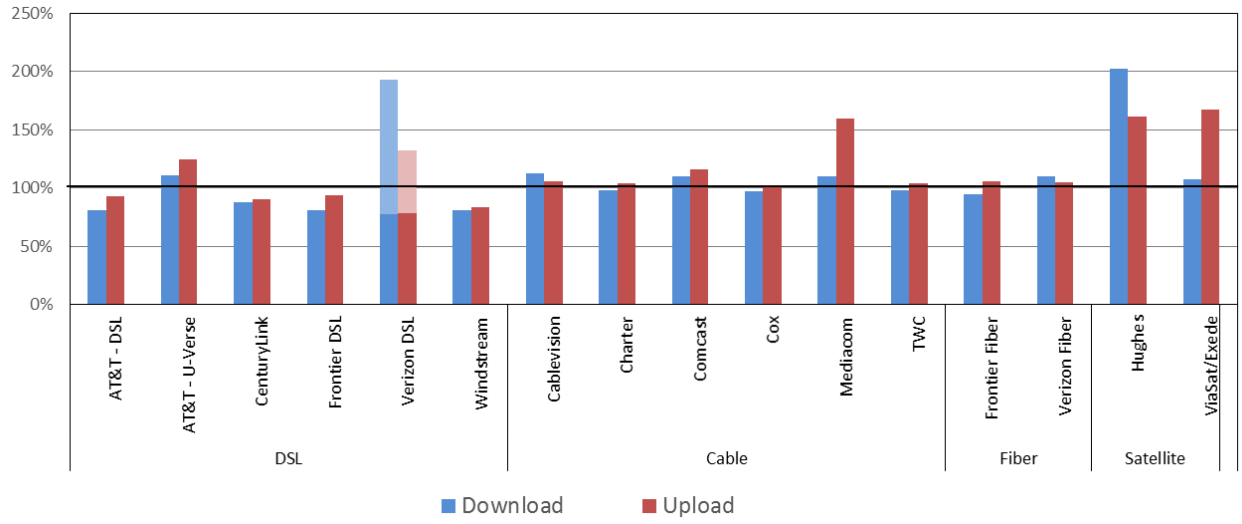
[12] These increases are calculated as weighted averages based on the number of participants. We did not include AT&T (DSL), Frontier (DSL), and CenturyLink in the calculated average for DSL for reasons explained in footnotes above.

[13] We are comparing growth in actual consumer download speeds as opposed to the maximum speed tier offered by an ISP in our survey.

[14] Because Verizon now advertises a range of download speeds for their DSL products, this chart shows the ratio of actual to advertised speed for Verizon (DSL) as a range with the lower end of the shaded bar corresponding to upper end of the advertised speed range and the upper end of the shaded bar corresponding to the lower end of the advertised speed range.

[15] For this calculation and other averages across all participating ISPs, we use the midpoint of Verizon DSL's advertised speed range.

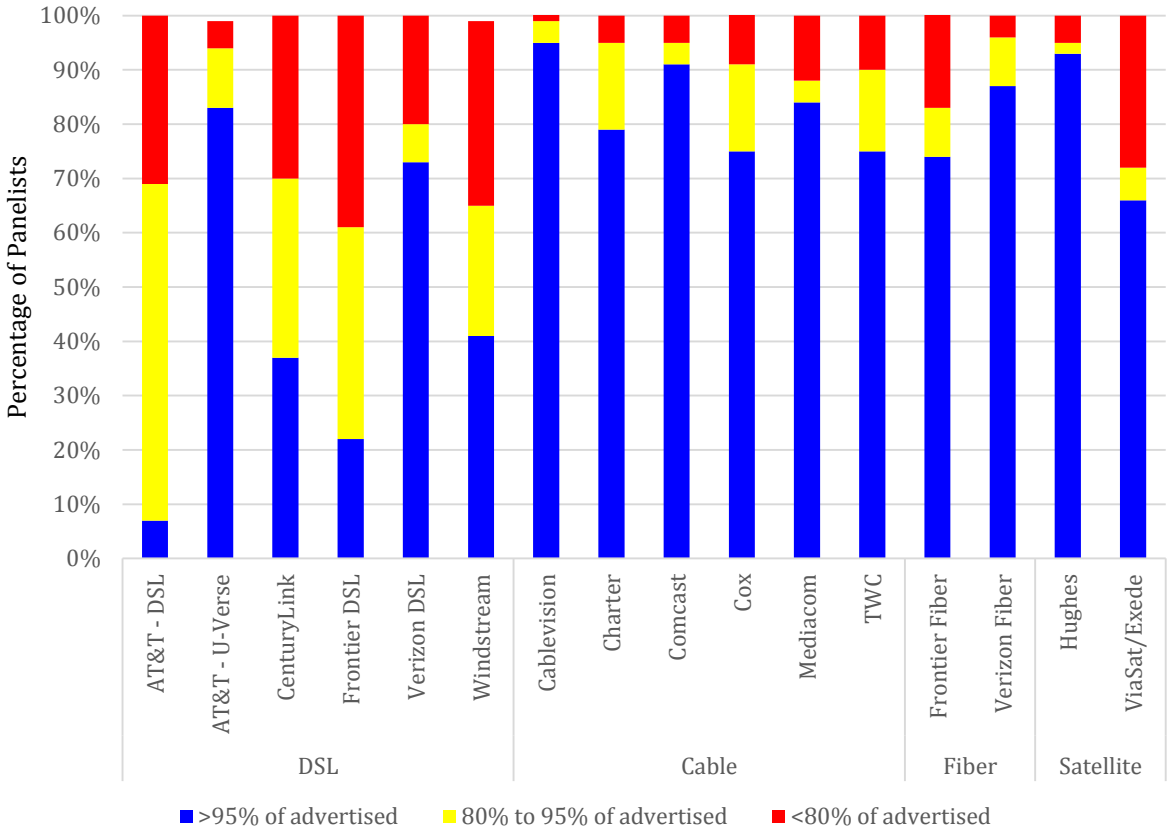
Chart 4: The ratio of actual speed to advertised speed



C. Variations in speeds

As noted above, actual speeds experienced by consumers may vary based on location and may vary during each day. Chart 5 shows, for each ISP, the percentage of consumers (across the ISP's service territory) who experienced an actual download speed (averaged over the peak usage period during our measurement period) that was (a) greater than 95%, (b) between 80% and 95%, and (c) less than 80% of the advertised download speed.

Chart 5: The percentage of consumers whose actual download speed was (a) greater than 95%, (b) between 80% and 95%, and (c) less than 80% of the advertised download speed



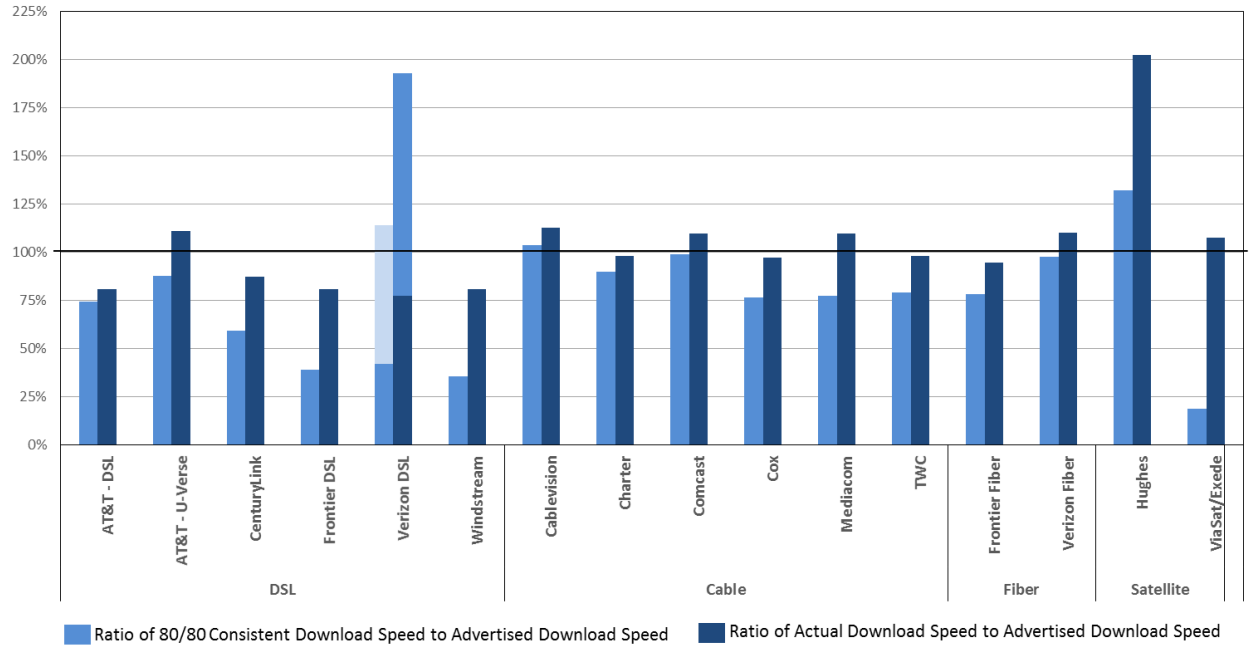
Even though the actual download speeds experienced by most ISPs' subscribers (when averaged across both geography and time) are close to or exceed the advertised download speeds, for each ISP there are some panelists for whom actual download speed falls significantly short of the advertised download speed. Relatively few subscribers to cable, fiber, or satellite broadband service experience such shortfalls. The best performing ISPs, when measured by this metric, are Cablevision, Comcast, and Hughes; fewer than 10% of each their panelists were unable to attain an actual average download speed of at least 95% of the advertised download speed. In contrast, many subscribers to some ISPs' DSL broadband service experience actual download speeds that fall substantially short of advertised download speeds.

In addition to variation based on a subscriber's location, speeds experienced by a particular consumer will vary during the day based on variations in aggregate usage by all subscribers to that consumer's ISP. For purposes of discussion, we use the term "80/80 consistent speed" to refer to the minimum actual speed that was experienced by at least 80% of panelists during at least 80% of the peak usage period.

Consistency of speed may be more important to customers who are heavy users of applications that are both high bandwidth and sensitive to variations in actual speed.[16]

Chart 6 illustrates, for each ISP, the ratio of 80/80 consistent download speed to advertised download speed, and for reference the ratio of actual download speed to advertised download speed shown previously in Chart 4. The ratio of 80/80 consistent download speed to advertised download speed is less than the ratio of actual download speed to advertised download speed for all participating ISPs, due to fluctuations in Internet usage that occasionally result in short periods of time when actual download speeds are lower than the overall average. When the difference between the two ratios is small, the actual download speed is fairly insensitive to both geography and time. When the difference between the two ratios is large, there is a greater variability in actual download speed, either based on location or variations during the peak usage period.

Chart 6: The ratio of 80/80 consistent download speed to advertised download speed.



Customers of Cablevision, Comcast, or Verizon Fiber (FiOS) experienced actual download speeds that are very consistent; over 80% of their customers experienced actual download speeds at or above advertised download speeds during at least 80% of the peak usage period. Hughes customers, in contrast, experienced actual download speeds that are highly variable; however, since Hughes advertises conservative download speeds, over 80% of Hughes customers also experienced actual download speeds at or above advertised download speeds during at least 80% of the peak usage period.

16. Some video streaming and some cloud-based applications fit into this category, see e.g. *Cisco Global Cloud Index: Forecast and Methodology 2013–2018 White Paper*, available at http://www.cisco.com/c/en/us/solutions/collateral/service-provider/global-cloud-index-gci/Cloud_Index_White_Paper.html.

In contrast, there are a few ISPs who offer service for which consistent download speed falls substantially short of their advertised download speed, even though the actual download speed (averaged over geography and time) may meet or exceed the advertised download speed. Finally, as we observed above, some DSL broadband ISPs' actual download speed falls substantially short of their advertised download speed; the gap between their consistent download speed and advertised download speed is even greater.

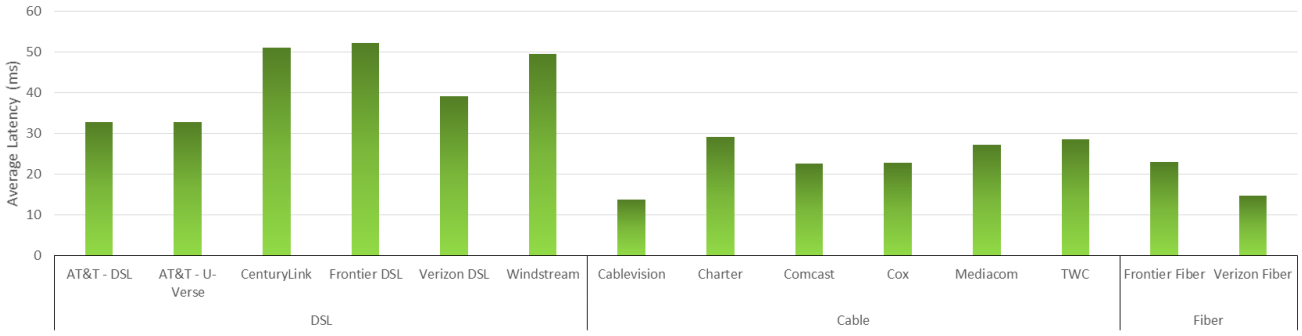
D. Latency

Latency is the time it takes for a data packet to travel from one point to another in a network. It increases with distance of the route between the source and destination and with any congestion on the route, and decreases as actual speed increases. The Measuring Broadband America program measures latency by measuring the round-trip time from the consumer's home to the closest measurement server and back.

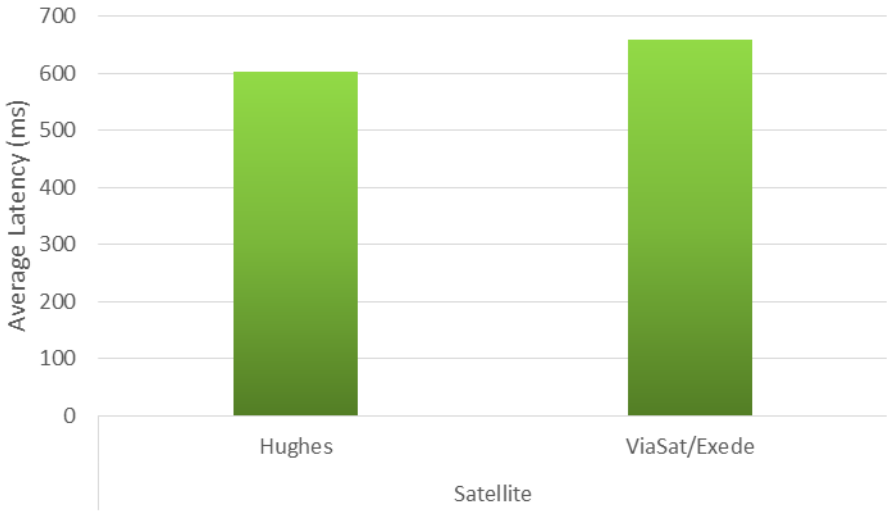
Chart 7 shows the average latency for each participating ISP. The data suggest that average latency is strongly influenced by the technology used by the ISP. In particular, satellite-based broadband service transmits packets to and from the consumer through a satellite. As a consequence, the distances of the paths used by satellite-based broadband services are much higher than those used by terrestrial technologies (DSL, cable, and fiber), and the average latencies of satellite-based broadband services (which range from 603 ms to 659 ms) are much higher than those for terrestrial-based broadband services (which range from 14 ms to 52 ms).

Chart 7: Latency by ISP

(a) Terrestrial ISPs



(b) Satellite ISPs



Latency may directly affect the perceived quality of highly interactive applications such as phone calls over the Internet, video chat, or online multiplayer games. The higher latencies of satellite-based broadband services may negatively affect the perceived quality of such highly interactive applications. However, the differences in average latencies among terrestrial-based broadband services are small, and are unlikely to affect the perceived quality of such highly interactive applications.

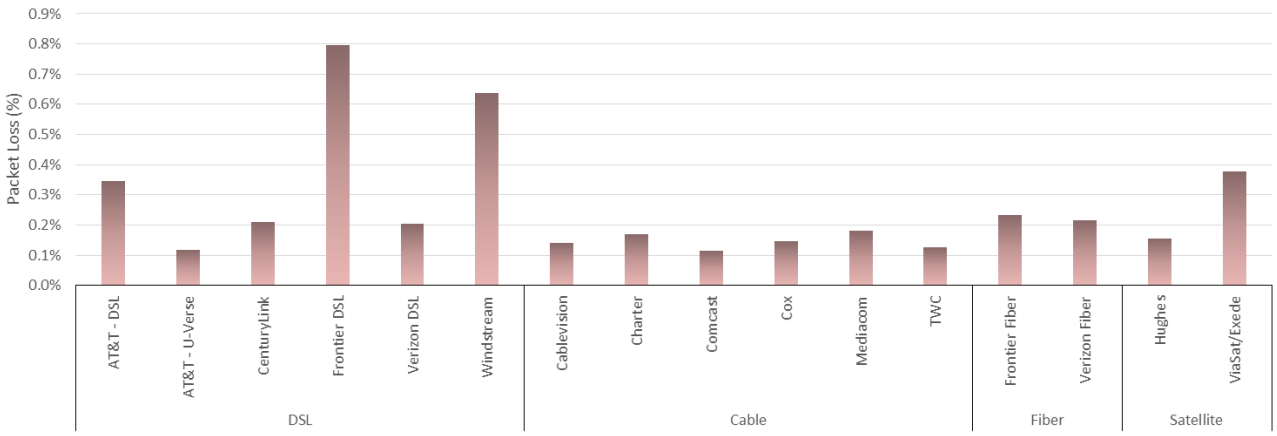
These differences in average latencies are unlikely to affect less interactive applications such as web browsing and video streaming, except for creating indirect effects on actual speed. Latency may indirectly affect the actual speed of the service due to its impact on Transmission Control Protocol (TCP), the software protocol commonly used to control the transport of information on the Internet. However, this effect may be more directly observed by considering the actual speed observed by consumers of a particular ISP at a particular service tier.

E. Packet loss

Packet loss is the percentage of packets that are sent by the source but not received by the destination. The most common reason that a packet is not received is that it encountered congestion along the route. A small amount of packet loss is expected, and indeed some Internet protocols use the packet loss to understand Internet congestion and to adjust the sending rate accordingly. The Measuring Broadband America program denotes a packet as lost if the latency exceeds 3 seconds or if the packet is never received.

Chart 8 shows the average packet loss for each participating ISP, grouped by technology.

Chart 8: Packet loss by ISP



Packet loss may directly affect the perceived quality of applications that do not request retransmission of lost packets, such as phone calls over the Internet, video chat, some online multiplayer games, and some video streaming. However, packet losses of a few tenths of a percent are sufficiently small so that they are unlikely to significantly affect the perceived quality of most such applications. Packet losses closer to one percent may affect the perceived quality of some such applications, depending on how the application responds to the packet loss.

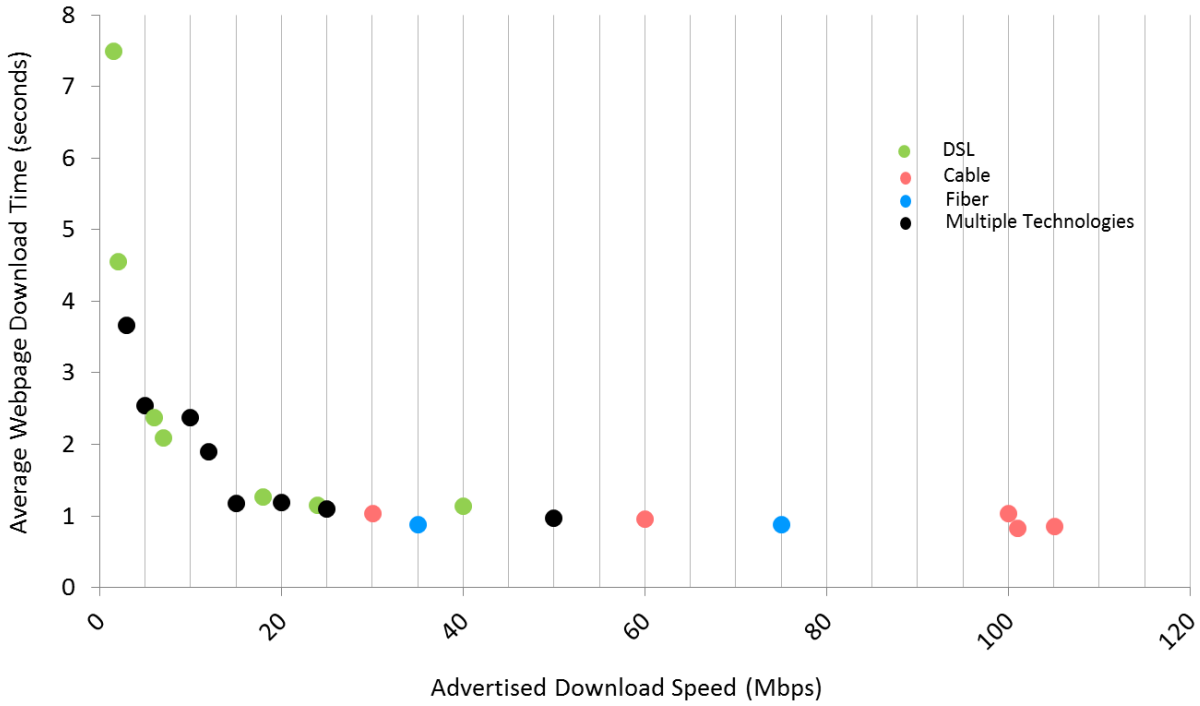
Packet loss is unlikely to directly affect the perceived quality of applications that do request retransmission of lost packets, such as web browsing and email, except for creating indirect effects on actual speed. Packet loss may indirectly affect the actual speed of the service due to its impact on TCP. However, this effect may be more directly observed by considering the actual speed observed by consumers of a particular ISP at a particular service tier.

F. Web Browsing Performance

The Measuring Broadband America program also conducts a specific test to gauge web browsing performance.

The web browsing test accesses 9 popular websites that include text and images, but not streaming video. The time required to download a webpage depends on many factors, including a consumer's actual download speed within an ISP's network, the web server's speed, congestion in other networks outside the consumer's ISP's network (if any), and the time required to identify the location of the webserver. Of all of these factors, only the actual download speed within an ISP's network is within the control of the consumer's ISP. Chart 9 displays the average webpage download time by the advertised download speed. Users subscribing to a service tier with a 1.5 Mbps download speed on average wait for approximately 7.5 seconds for a webpage containing text and images; users subscribing to a service tier with a 5 Mbps download speed on average wait only approximately 2.5 seconds; and users subscribing to a service tier with a 25 Mbps download speed on average wait on only approximately 1 second. Subscribers to service tiers with an advertised download speed exceeding 25 Mbps on average do not experience significantly reduced webpage download time. These download times assume that a single user is using the Internet connection at the time at which the webpage is downloaded, and does not account for more typical scenarios where multiple users within a household are simultaneously using the Internet connection for multiple uses, such as real-time gaming or video streaming.

Chart 9: Average webpage download time, by advertised download speed



3. Methodology

A. Participants

Thirteen ISPs participated in the Fixed Measuring Broadband America program in September 2014.[17] They are:

- AT&T
- Cablevision Systems Corporation
- CenturyLink
- Charter Communications
- Comcast
- Cox Communications
- Frontier Communications Company
- Hughes Network Systems
- Mediacom Communications Corporation
- Time Warner Cable
- Verizon
- ViaSat
- Windstream Communications

The methodologies and assumptions underlying the measurements described in this Report are reviewed at meetings that are open to all interested parties, and documented in public *ex parte* letters filed in the GN Docket No. 12-264. Participation in this effort is open and voluntary. In 2014-2015, participants at these meetings (collectively and informally referred to as "the broadband collaborative"), included all thirteen participating ISPs and the following additional organizations:

- Adtran
- Corning
- Fiber to the Home Council
- Georgia Institute of Technology
- Genband
- Intel
- Internet Society
- JDSU
- Level 3 Communications ("Level 3")
- Massachusetts Institute of Technology ("MIT")
- M-Lab
- Motorola
- National Cable & Telecommunications Association ("NCTA")
- New America Foundation
- Practicum Team, NCSU, Institute for Advanced Analytics

[17] The 2014 Report also included Insight Communications, which is now merged with Time Warner Cable, and Qwest Communications, which is now merged with CenturyLink. Hughes Network Systems joined the program in 2014. ViaSat operates under the brand name Exede Internet.

- United States Telecom Association ("US Telecom")

Participants have contributed importantly to the integrity of this program. Initial proposals for test metrics and testing platforms were discussed and critiqued within the broadband collaborative. M-Lab and Level 3 contributed their core network testing infrastructure, and both parties continue to provide invaluable assistance in helping to define and implement the FCC testing platform. Policy decisions regarding our program involving such things as test periods, mitigation of operational issues, terms of use notifications to panelists, etc. are discussed at these meetings prior to adoption. Participation in these discussions from diverse groups representing academia, consumer equipment vendors, telecommunications vendors, network service providers, consumer policy advocates as well as our contractor for this project, SamKnows, provide valuable feedback for FCC decisions on the deployment and ongoing management of this program. We wish to thank the participants for their contributions to this program.

B. Measurement process

The measurements that provide the underlying data in this Report rely both on measurement clients and measurement servers. The measurement clients reside in the homes of 5,583 panelists who receive service by the 13 participating ISPs. The participating ISPs collectively account for over 80% of U.S. residential broadband Internet connections. The panelists closely match the overall state and region statistics of Internet access connections in the United States as reflected in the Commission's Form 477 data.[18]

The measurement servers are hosted by M-Lab and Level 3 Communications, and are located in 9 cities across the United States near a point of interconnection between the ISP's network and the network on which the measurement server resides.[19]

The measurement clients collect data throughout the year, and this data is available as described below. However, only data collected from September 1, 2014 to September 16, 2014 and from September 27, 2014 to October 11, 2014 (referred to throughout this report as the "September 2014" reporting period) are used to generate the charts in this Report.[20]

One of the key factors affecting all aspects of broadband performance is the time of day. At peak hours more people are attempting to use their broadband Internet connections, giving rise to a greater

[18] The Form 477 results can be obtained from: http://www.fcc.gov/encyclopedia/form-477-filers-state-0.

[19] For this report, the measurements for the 100-105 Mbps download service tiers exclude measurements using the M-Lab measurement servers, due to a problem with the architecture of those servers that affected the higher speed tiers.

[20] The period from September 17, 2014 to September 26, 2014 was omitted due to unusually high Internet traffic created by what we believe to be downloads of Apple's iOS 8 operating system, per the FCC policy concerning the collection period for fixed-line MBA data (See the August 19, 2013 ex-parte letter for the meeting held August 7, 2013, http://apps.fcc.gov/ecfs/document/view?id=7520939594, and http://www.fcc.gov/encyclopedia/measuring-broadband-america-measuring-fixed-broadband.)

potential for congestion and degraded user performance. Unless otherwise stated, this Report focuses on performance during peak usage period, which is defined as weeknights between 7:00 PM to 11:00 PM local time. Focusing on peak usage period provides the most useful information because it demonstrates the performance users can expect when the Internet in their local area is experiencing highest demand from users.

Although the Report generally focuses on each participating ISP's entire service territory, in this Report we also briefly analyze network performance in each of the four census regions of the United States.[21]

Our methodology focuses on performance within each participating ISP's network. The metrics discussed in this Report are derived from traffic flowing between a measurement client (located within the modem or router within a panelist's home) and a measurement server. For each panelist, the tests use the measurement server for which the latency between the measurement client and server is the lowest. As a result, the metrics measure congestion (if any) within each ISP's network, as well as congestion (if any) at a point of interconnection between the ISP's network and the network on which the measurement server resides; however, since each panelist's tests rely on a single measurement server, the metrics will only measure congestion (if any) at a single point of interconnection.

However, the performance that a consumer may experience may differ for at least three reasons. First, a consumer may be communicating with a point on the Internet that is outside the network of the consumer's ISP. There may be congestion in a portion of the Internet along the route that is outside the network of the consumer's ISP; the effects of this congestion on the user experience is not reflected in the data set forth in this Report. Second, a consumer's home network may be the bottleneck, rather than the ISP's network. This may occur, for instance, if the home network's maximum transmission rate is lower than the advertised speed of the selected service tier; if a device is communicating with a Wi-Fi home router at a reduced speed due to walls or obstructions in between the device and the router; if multiple users within the home are currently sharing the total actual speed available; or if there is congestion within the home network due to transfers of data within the home. Third, consumers typically view performance through the lens of a set of applications that they utilize. The performance as seen through a particular application depends on both the network performance and on the application performance. While network performance is considered in this Report, application performance is generally not. For instance, if a consumer is web-browsing, the delay from a request for a webpage to the display of that webpage includes network latency (considered in this Report), the time it takes for the webserver to respond to the request, and the time it takes for the browser to render that webpage. The latter two components of the total delay are only considered in the Web Browsing test. For other commonly used applications, this Report does not consider components of the application performance that are outside the control of the ISP.

C. Measurement tests and performance metrics

This Report is based on the following measurement tests:

- Download speed: Measures the download speed over a 5 second time interval, every 2 hours; the results are then averaged to determine the "actual download speed" for each panelist.

[21] While the program's methodology is not designed to produce an analysis at the state level in general, in the Appendix we provide statistics for those states for which we have statistically significant data.

- Upload speed: Measures the upload speed over a 5 second time interval, every 2 hours; the results are then averaged to determine the "actual upload speed" for each panelist.
- Latency and packet loss: Measures the round-trip times for packets sent at randomly distributed times. Times less than 3 seconds are averaged to determine "average latency". Acknowledgements not received or received with a round-trip time greater than 3 seconds determine "packet loss".
- Web browsing: Measures the total time to request and receive webpages (including the text and images on each webpage) from 9 popular websites, every hour. The measurement includes the time required to translate the webpage name into the webserver's IP address.

The Measuring Broadband America program also runs three tests that are not used in this Report, but for which data is available as described in section 2.D.

This Report focuses on three performance metrics that are of particular relevance to consumers of broadband Internet access service: speed, latency, and packet loss. Download and upload speeds are the primary network performance characteristic advertised by ISPs. Actual download speed is the average rate at which information can be downloaded by the consumer. Higher speeds indicate a higher delivery rate. However, as discussed above, the performance observed by a user in any given circumstance depends not only on the actual speed of the ISP's network, but also on the speed of other parts of the Internet and on the speed of the application itself.[22]

Latency is the time it takes for a data packet to travel from one point to another in a network. It increases with distance of the route or path between the source and destination and with any congestion on the route. The Measuring Broadband America program measures the round-trip time between the consumer's home and the closest measurement server. Latency may directly affect the perceived quality of highly interactive applications, such as real-time two-way voice applications,[23] video chat, or interactive games. Latency may also indirectly affect actual speed. Some applications consist of a sequence of network tasks, so the effect of network latencies may accumulate.

Packet loss is the percentage of packets that are sent by the source but not received by the destination. The most common reason for packet loss is that the packet encountered congestion along the route. A small amount of packet loss is expected, and indeed some Internet protocols use packet loss to understand network congestion, and adjust the sending rate accordingly. The Measuring Broadband America program denotes a packet as lost if the latency exceeds 3 seconds or if the packet is never received.

[22] Performance observed by a user may also depend on other factors, including the capabilities of their device and the performance of network devices within their home.

[23] See International Telecommunication Union (ITU), Series G: Transmission Systems and Media, Digital Systems and Networks; International Telephone Connections and Circuits—General Recommendations on the Transmission Quality for an Entire International Telephone Connection, G.114 (May 2003).

The Technical Appendix for the 2015 Report provides specific information regarding the process by which measurements were made and describes each test that was performed.

D. Availability of Data

The Validated Data Set[24] on which this Report was based, as well as the full results of all tests, are available at http://www.fcc.gov/measuring-broadband-america.

In addition to the Validated Data Set for the September 2014 reference month, in the interest of transparency and to support additional research, raw data for the reference month as well as other months is available at the same website. Previous reports of the Measuring Broadband America program, as well as the data used to produce them, are also available at the same website.

Both the Commission and SamKnows, the Commission's contractor for this program, recognize that, while the methodology descriptions included in this document provide an overview of the project as a whole, there will be a number of interested parties – ranging from recognized experts to members of the general public – who would be willing to contribute to the project by reviewing the actual software used in the testing. SamKnows welcomes review of its software and technical platform, consistent with the Commission's goals of openness and transparency for this program.[25]

[24] The September 2014 data set was validated to remove anomalies that would have produced errors in the Report. This data validation process is described in the Technical Appendix.

[25] The software that was used for the testing will be made available for academic and other researchers for non-commercial purposes. To apply for non-commercial review of the code, interested parties may contact SamKnows directly at team@samknows.com, with the subject heading "Academic Code Review."

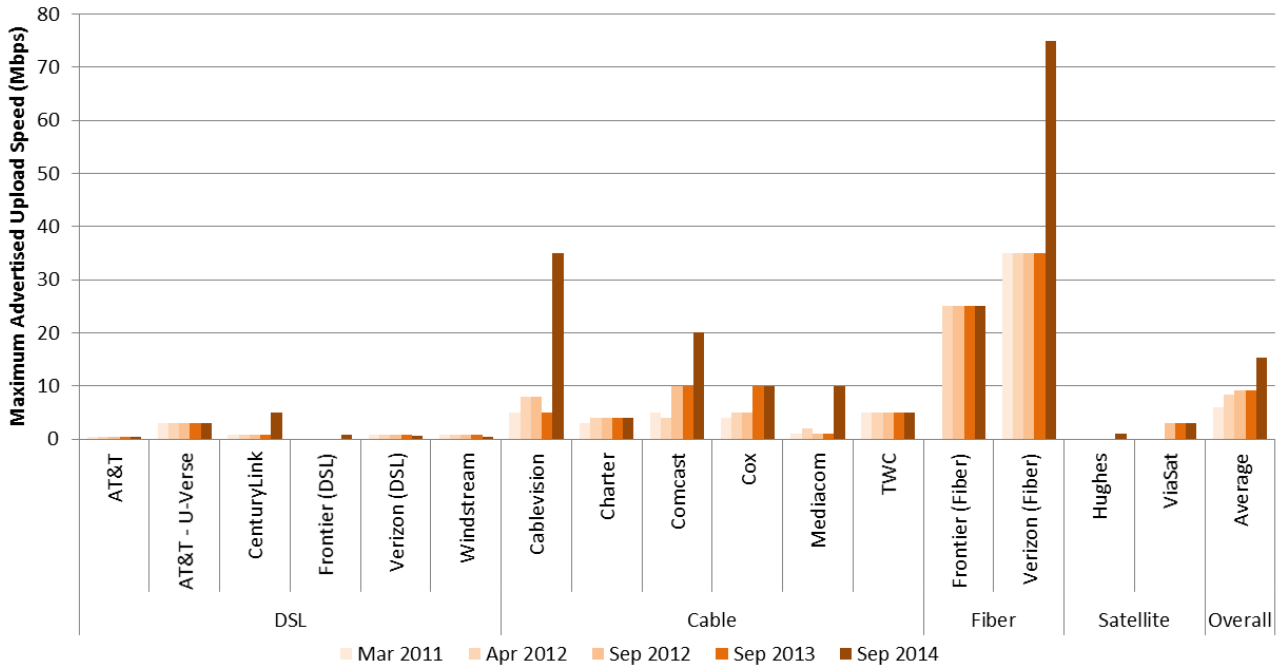
4. Test Results

A. Most popular advertised service tiers

ISPs often increase the advertised upload speeds at the same time that they increase the advertised download speeds. Between September 2013 and September 2014, several ISPs increased the maximum advertised download speeds among the most popular service tiers. Concurrently, these providers also increased the corresponding upload speeds: Cablevision from 5 Mbps to 35 Mbps, CenturyLink from 768 kbps to 5 Mbps, Comcast from 10 Mbps to 20 Mbps and Verizon (fiber) from 35 Mbps to 75 Mbps.

Chart 1 (in section 2.A) above displayed the maximum advertised download speeds among the most popular service tiers for each participating ISP, during the years 2011-2014, grouped by the access technology used to offer the broadband Internet access service (DSL, cable, fiber and satellite). Chart 10 below displays the corresponding maximum advertised upload speeds. In particular, when DSL is used to provide broadband service, the maximum advertised upload speeds among the most popular service tiers has remained generally unchanged since 2011. In contrast, among cable-based broadband providers, the maximum advertised upload speeds among the most popular service tiers increased from 1-5 Mbps in March 2011 to 4-35 Mbps in September 2014.

Chart 10: Maximum advertised upload speed among the most popular service tiers

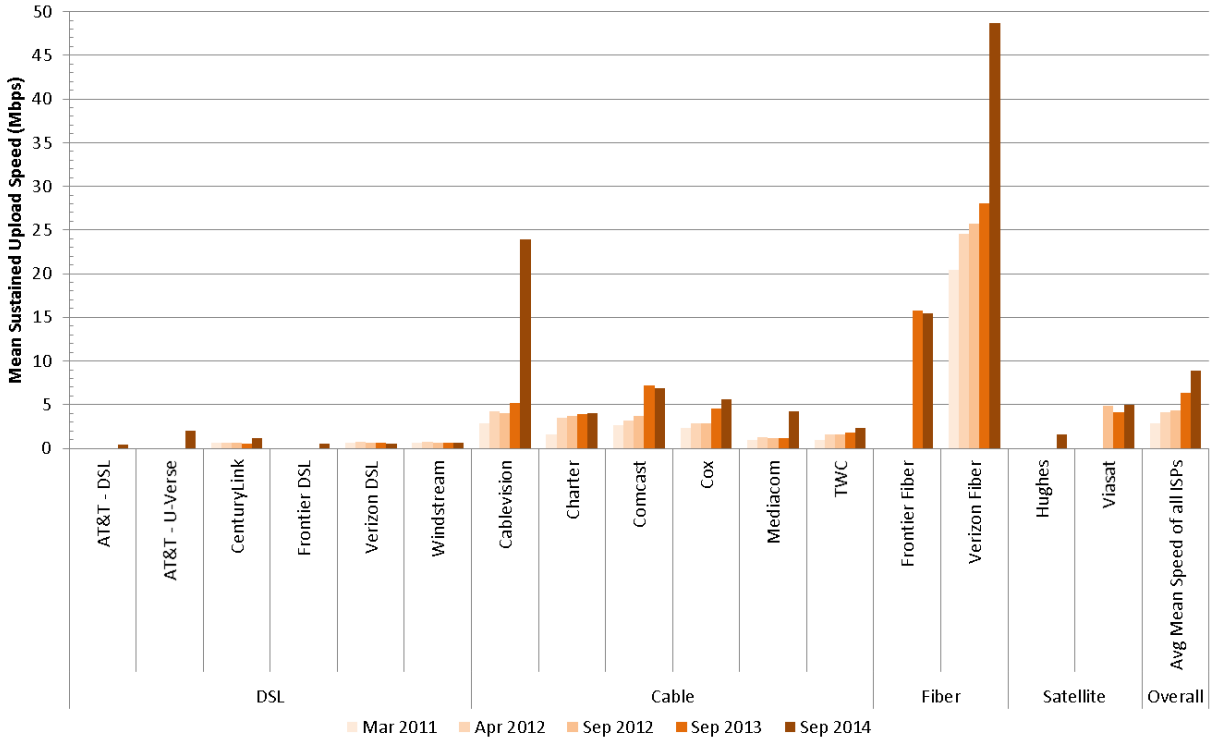


B. Actual speeds

Chart 3 showed the actual download speeds experienced by each ISP's participating subscribers, averaged across both geography and time, from 2011 to 2014. Chart 11 below shows the corresponding actual upload speeds.

The actual upload speed, averaged across all participating ISPs, has tripled during this period, from approximately 3 Mbps in March 2011 to approximately 9 Mbps in September 2014.

Chart 11: Actual upload speeds by ISP, 2011 to 2014



However, the increases in actual download and upload speeds are not uniform across access technologies. Charts 12.1 and 12.2 show the actual download and upload speeds by technology, from 2011 to 2014. For subscribers to DSL broadband service, the increase in actual speeds has depended on the ISP. For subscribers to any participating cable broadband service, there have been fairly steady and substantial increases in actual upload speeds. We find that over the course of our reports, the annual average increase in upload speeds by technology has been 77.4% for cable, 27.7% for fiber and 12.5% for DSL.

Chart 12.1: Actual download speeds by technology, 2011 to 2014

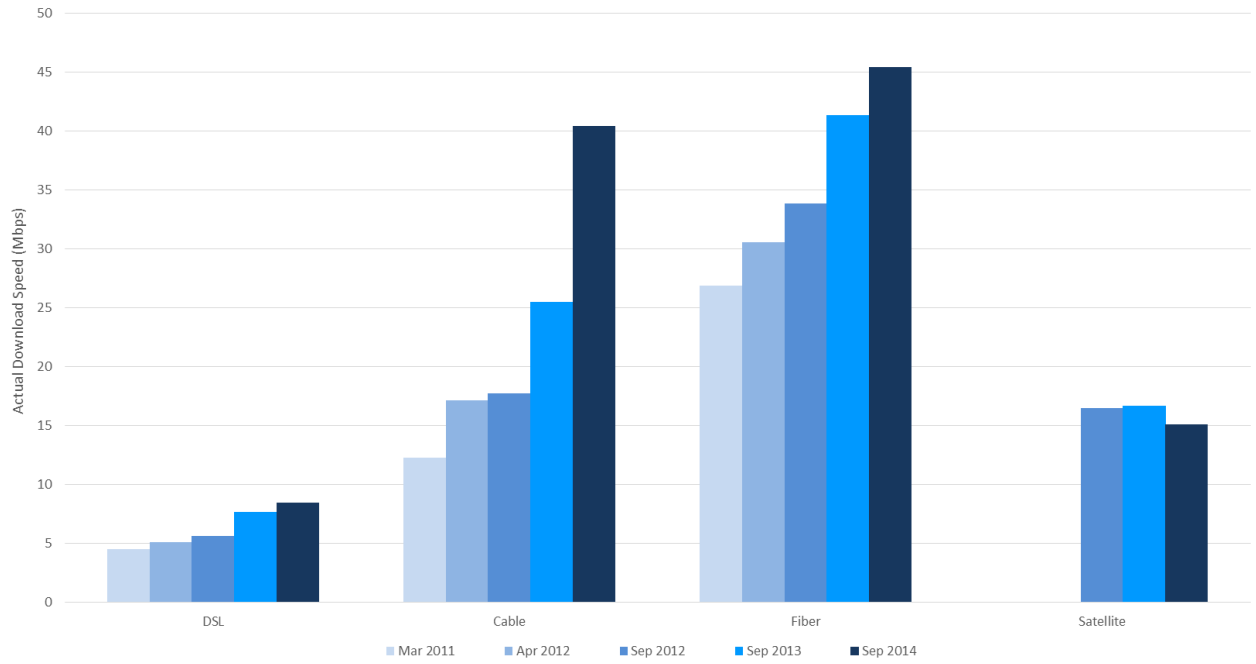


Chart 12.2: Actual upload speeds by technology, 2011 to 2014

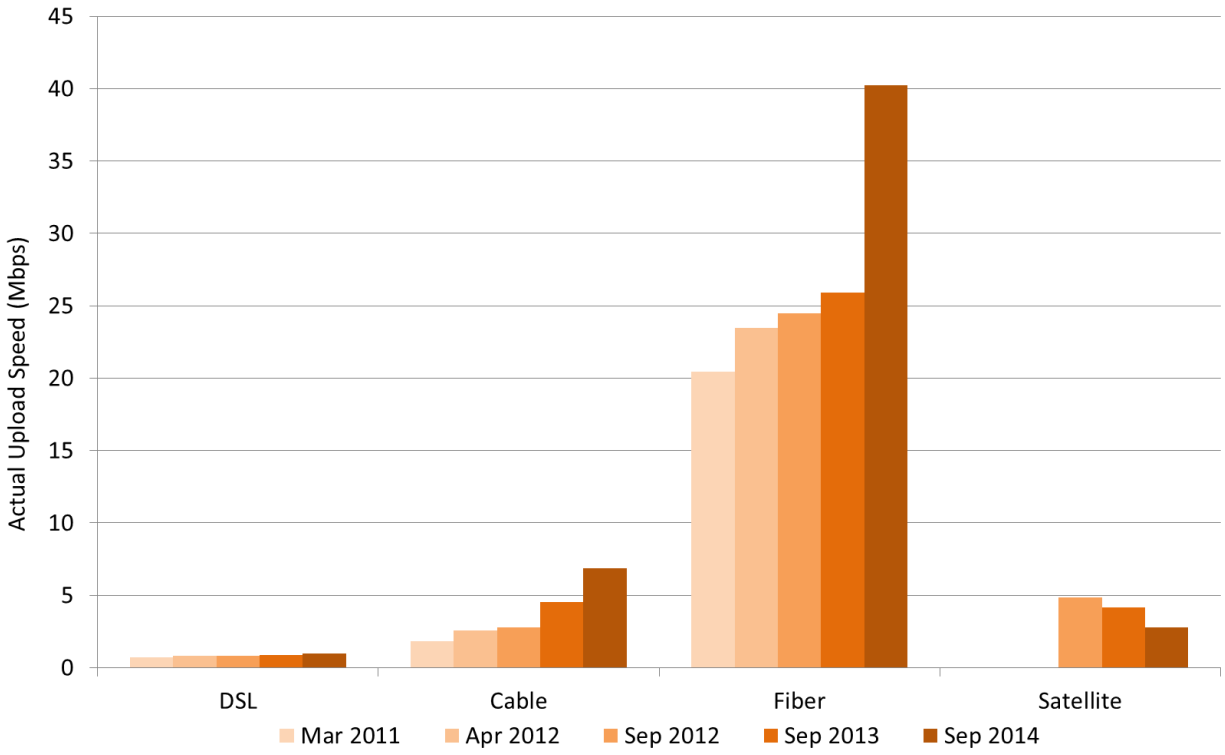


Chart 4 (in section 2.B) showed the ratio in September 2014 of the actual speeds experienced by each ISP's subscribers (averaged across both geography and time) to advertised speeds. Charts 13.1 and 13.2

below show the same ratio for each ISP from 2011 to 2014. The actual speeds experienced by most ISPs' subscribers (when averaged across both geography and time) have been close to, or have exceeded, the advertised speeds during most of this time period. However, as noted above, some DSL broadband ISPs continue to advertise "up-to" speeds that on average exceed the actual speeds experienced by their subscribers.

Chart 13.1: The ratio of actual download speed to advertised download speed, 2011 to 2014

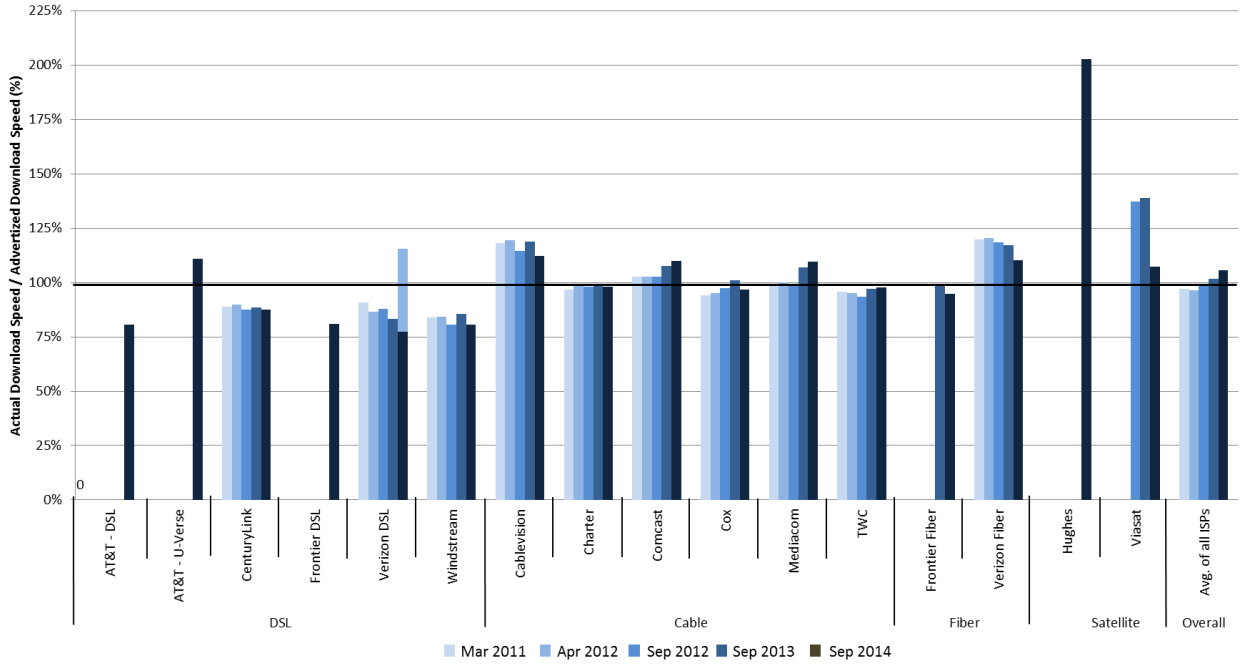
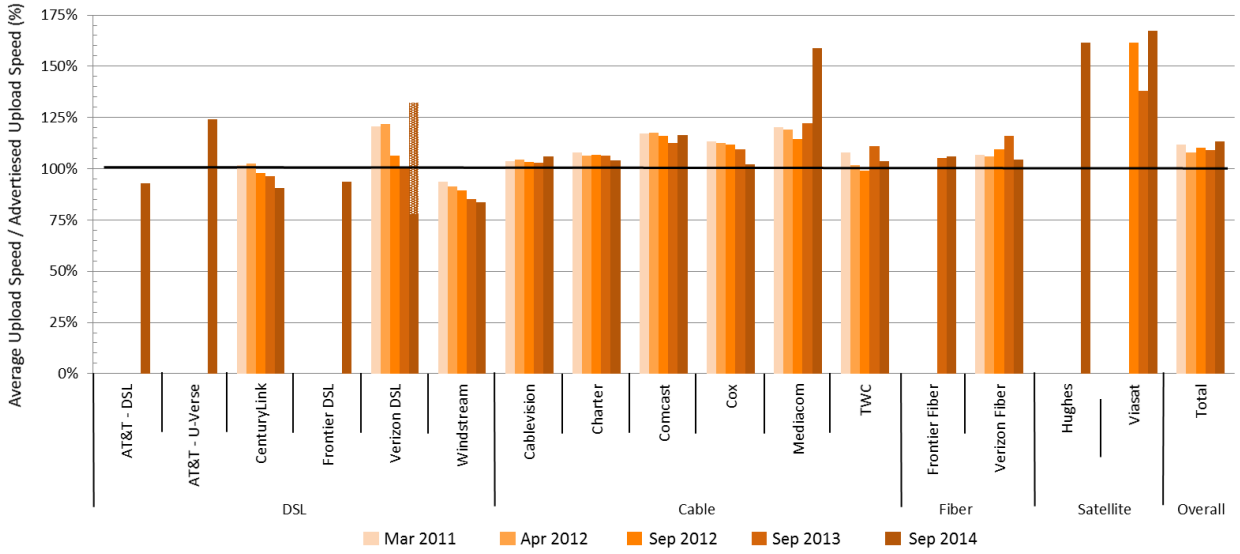


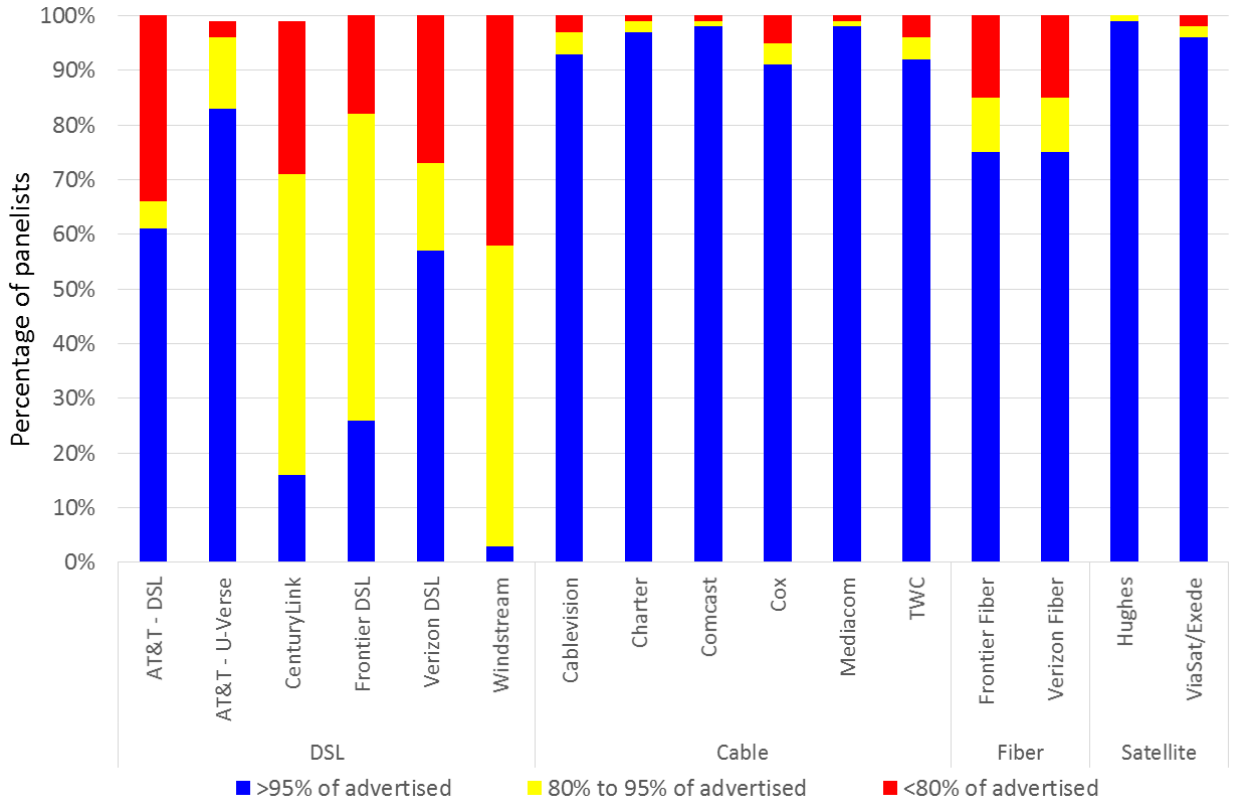
Chart 13.2: The ratio of actual upload speed to advertised upload speed, 2011 to 2014



C. Variations in speeds

As noted above, actual speeds experienced by consumers may vary based on location and time of day. Chart 5 (in section 2.C) showed, for each ISP, the percentage of consumers (across the ISP's service territory) who experienced an actual download speed (averaged over the peak usage period) that was (a) greater than 95%, (b) between 80% and 95%, and (c) less than 80% of the advertised download speed. Chart 14 below shows the corresponding percentage of consumers whose actual upload speed fell in each range.

Chart 14: The percentage of consumers whose actual upload speed was (a) greater than 95%, (b) between 80% and 95%, and (c) less than 80% of the advertised upload speed



Even though the actual upload speeds experienced by most ISP's subscribers (when averaged across both geography and time) are close to or exceed the advertised upload speeds, for each ISP there are some subscribers whose actual upload speed falls significantly short of the advertised upload speed. Relatively few subscribers to cable, fiber, or satellite broadband service experience such shortfalls. However, the data suggest that many of the subscribers of some ISP's DSL broadband service often experience actual upload speeds that fall substantially short of advertised upload speeds.

We can learn more about the variation in network performance by separately examining variation across geography and time. We start by examining the variation across geography within each participating ISP's service territory. For each ISP, we first calculate the ratio of the actual download speed (averaged over the peak usage period) to the advertised download speed for each panelist subscribing to that ISP. We then examine the distribution of this ratio across the ISP's service territory.

Charts 15.1 and 15.2 show the complementary cumulative distribution of the ratio of actual download speed (averaged over the peak usage period) to advertised download speed for each participating ISP. For each ratio of actual to advertised download speed on the horizontal axis, the curves show the percentage of panelists subscribing to each ISP that experienced at least this ratio[26]. For example, the Cox curve in Chart 15.1 shows that 90% of Cox subscribers experienced an actual download speed exceeding 80% of the advertised download speed, while 70% experienced an actual download speed exceeding 96% of the advertised download speed and 50% experienced an actual download speed exceeding 101% of the advertised download speed. Curves that fall steeply around near 100% of the advertised download speed, like that of Cox, indicate that a high percentage of subscribers experience a ratio near 100%. In contrast, curves that fall slowly, like that of Frontier DSL's download ratio, indicate that there is a wider range of performance within the service territory.

[26] In prior Reports, for each ratio of actual to advertised download speed on the horizontal axis, the CDF curves showed the percentage of measurements (not panelists subscribing to each ISP) that experienced at least this ratio. The methodology used in this Report, by panelists subscribing to each ISP, more accurately illustrated performance from the point of view of the consumer.

Chart 15.1: Complementary cumulative distribution of the ratio of actual download speed to advertised download speed

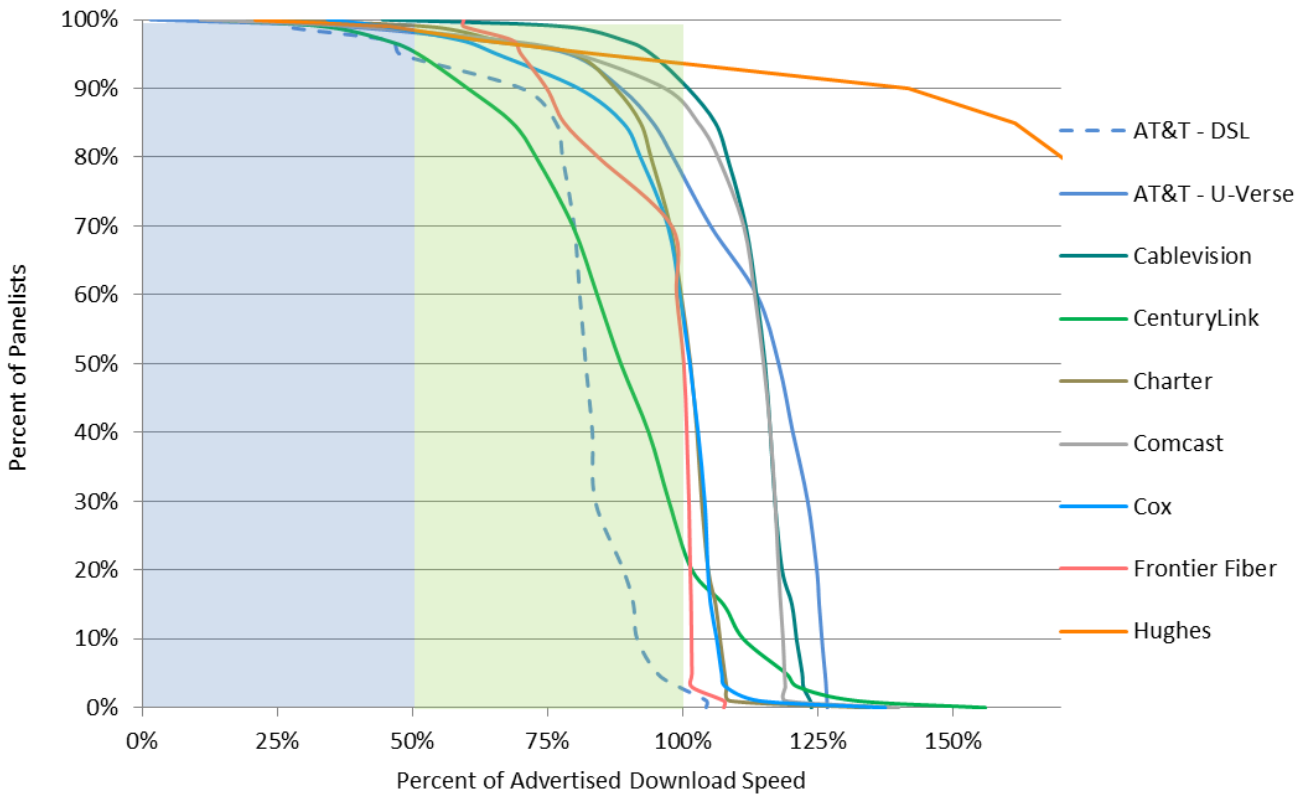
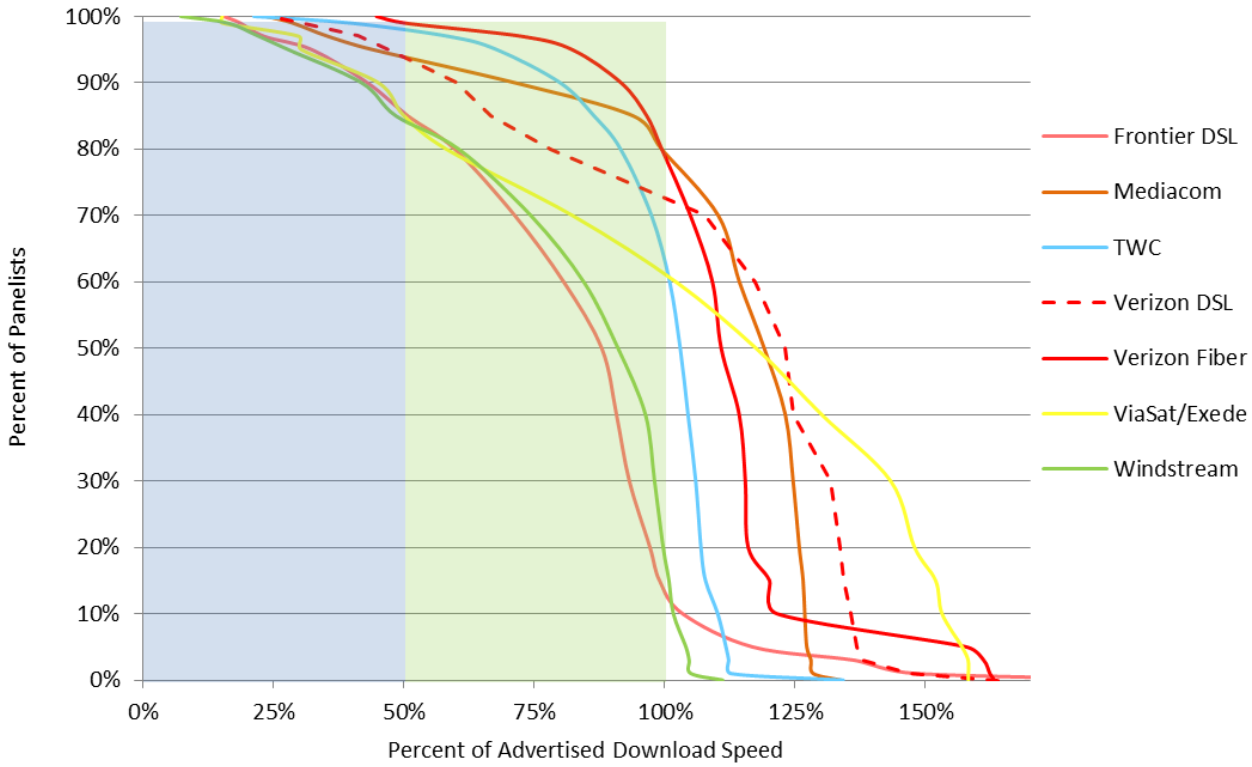


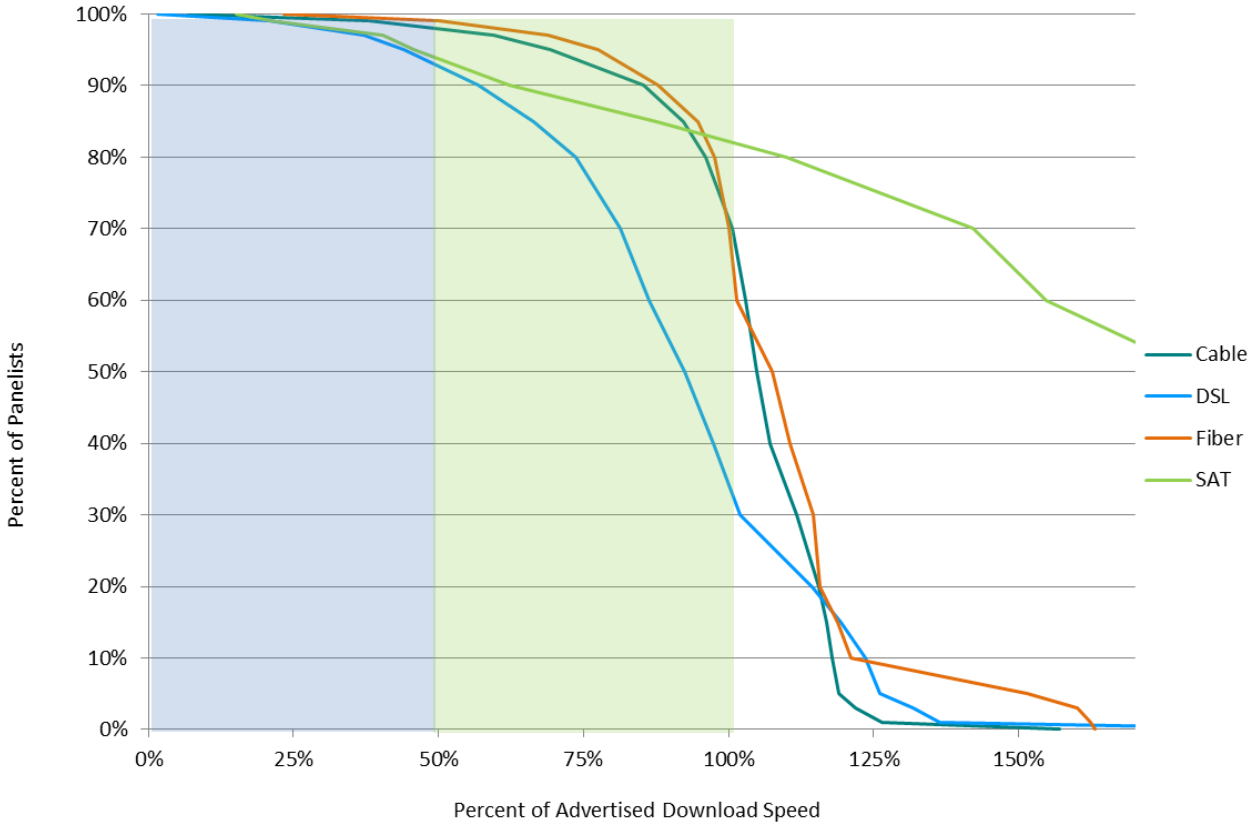
Chart 15.2: Complementary cumulative distribution of the ratio of actual download speed to advertised download speed (continued)



The curves for cable-based broadband and fiber-based broadband are steeper than those for DSL-based broadband and satellite-based broadband. This can be more clearly seen in Chart 15.3, which plots aggregate curves for each technology. Approximately 70% of subscribers to fiber- and cable-based technologies experience actual download speeds exceeding the advertised download speed. In contrast, only approximately 35% of subscribers to DSL-based broadband experience actual download speeds exceeding the advertised download speed.[27] Over 80% of subscribers to satellite-based broadband experience actual download speeds exceeding the advertised download speed.

[27] It is a property of DSL technology that actual speeds will vary widely within a geographic region. Thus the complementary cumulative distribution function will fall slowly, unless the broadband ISP's advertised rate depends on the subscriber's location.

Chart 15.3: Complementary cumulative distribution of the ratio of actual download speed to advertised download speed, by technology



Charts 15.4-15.6 show the complementary cumulative distribution of the ratio of actual upload speed (averaged over the peak usage period) to advertised upload speed for each participating ISP (charts 15.4 and 15.5) and by access technology (chart 15.6).

Chart 15.4: Complementary cumulative distribution of the ratio of actual upload speed to advertised upload speed

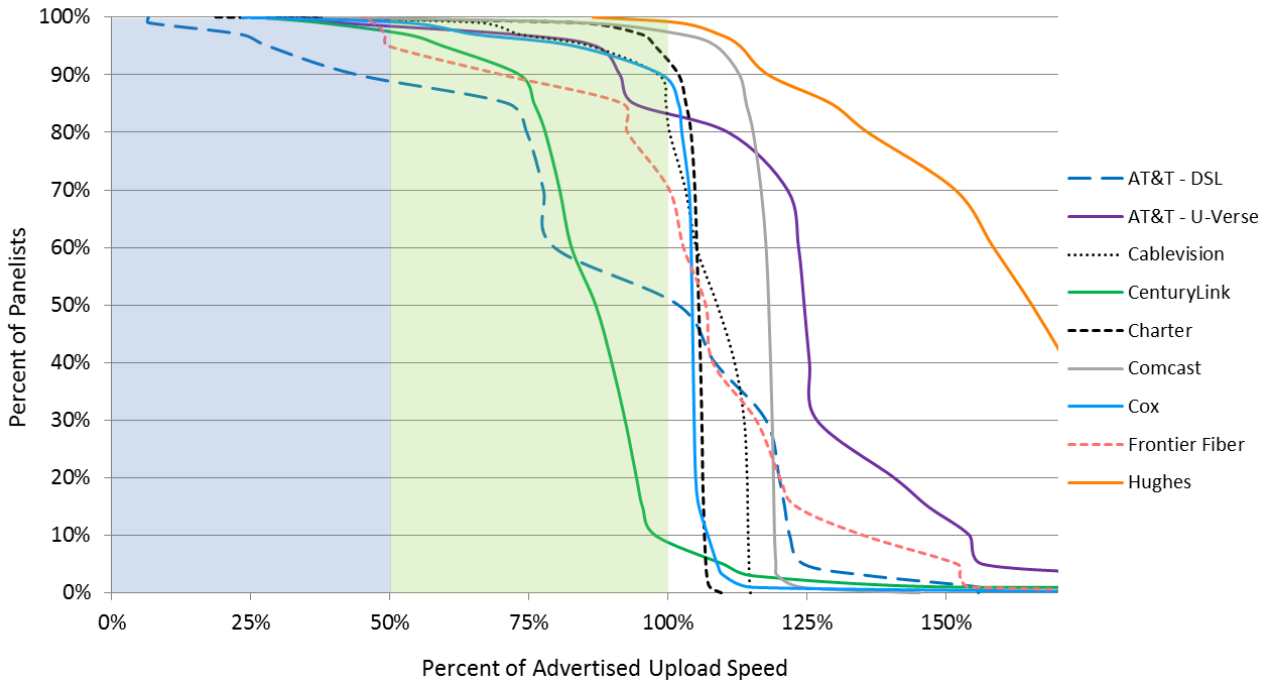


Chart 15.5: Complementary cumulative distribution of the ratio of actual upload speed to advertised upload speed (continued)

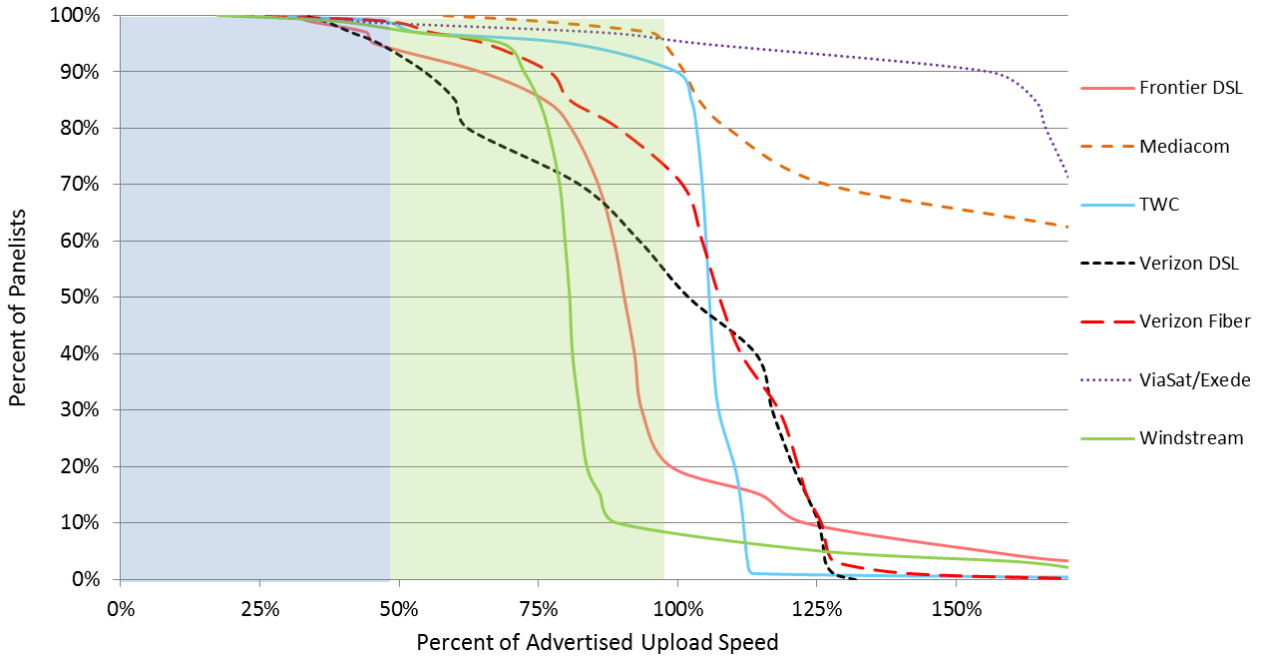
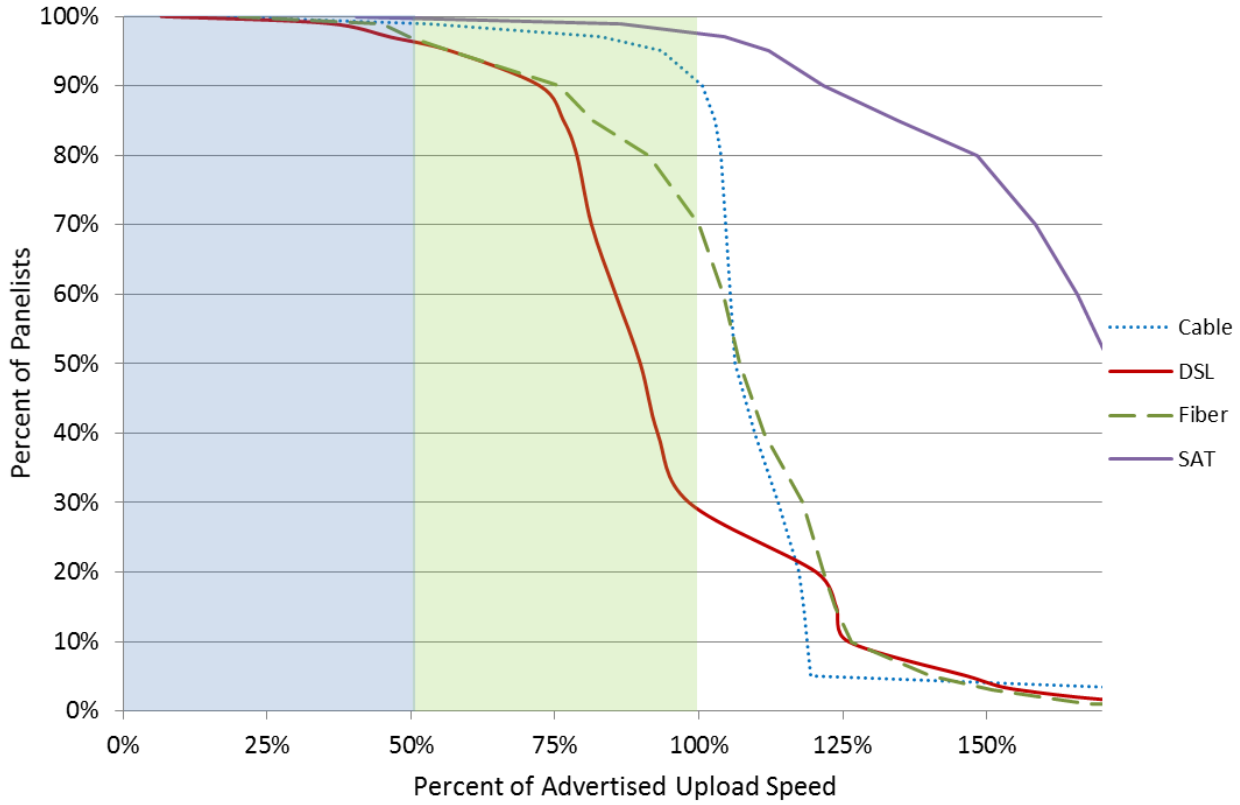


Chart 15.6: Complementary cumulative distribution of the ratio of actual upload speed to advertised upload speed, by technology



All actual speeds discussed above are measured only during peak usage periods, which for purposes of this Report are defined as weekdays between 7:00 pm and 11:00 pm local time. In contrast, Charts 16.1 and 16.2 compare the ratio of actual speed to advertised speed during peak and off-peak times.

Chart 16.1: The ratio of actual download speed to advertised download speed, peak versus off-peak

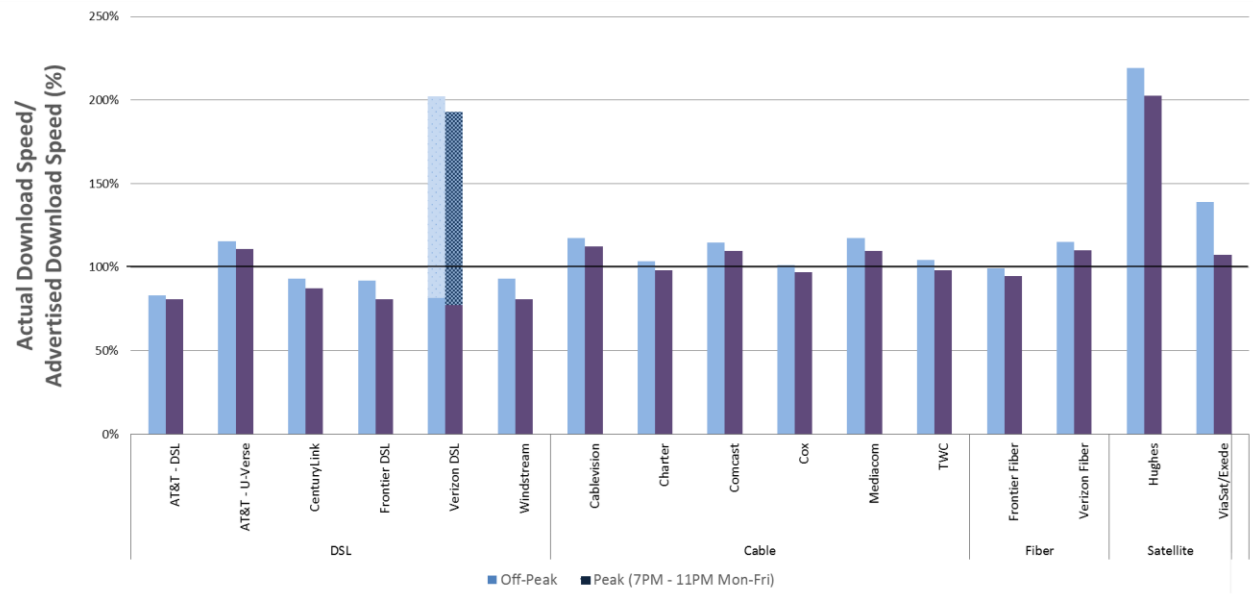
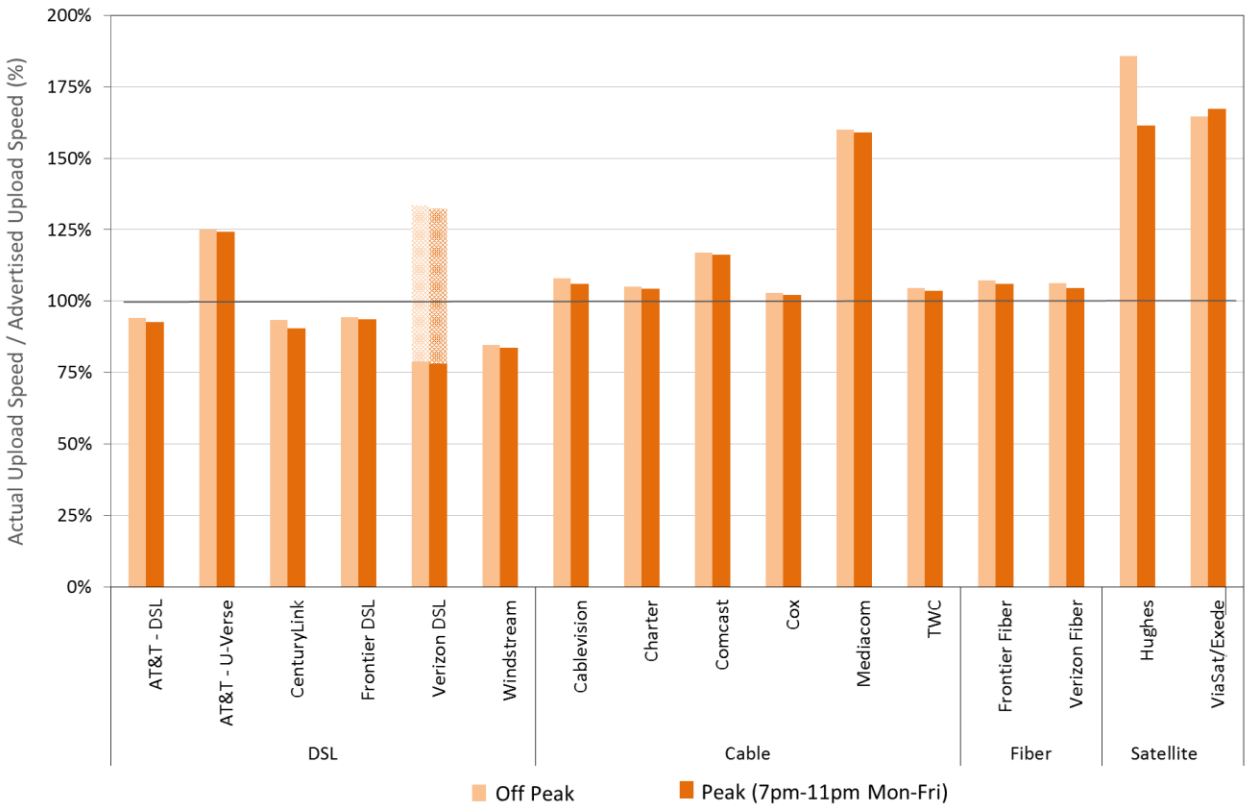


Chart 16.2: The ratio of actual upload speed to advertised upload speed, peak versus off-peak



Charts 17.1 and 17.2 show the download ratio in each 2 hour time block during weekdays for each ISP. The ratio is lowest during the busiest 2 hour time block (8:00 pm – 10:00 pm).

Chart 17.1: The ratio of actual download speed to advertised download speed, M-F 2 hour time blocks, terrestrial ISPs

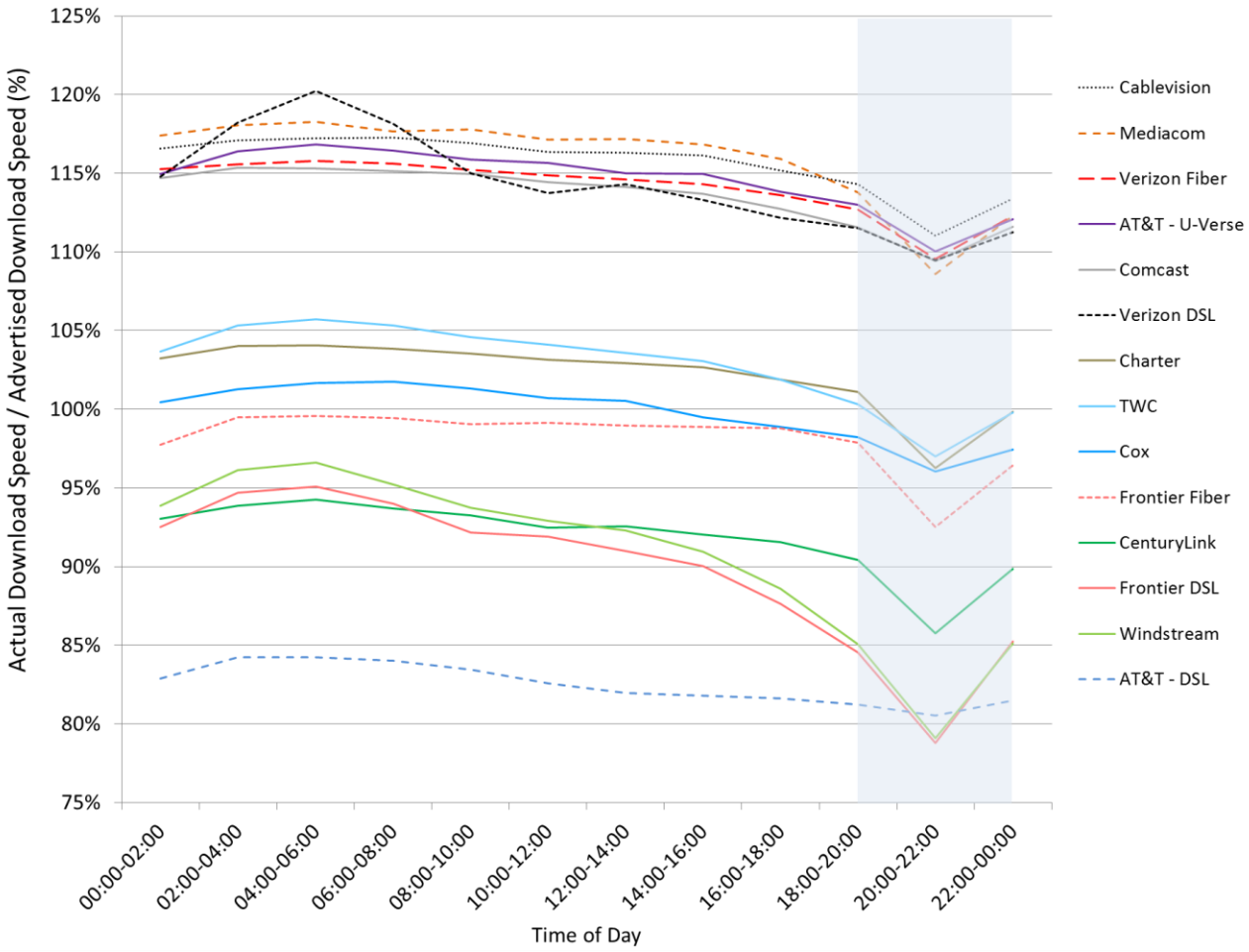


Chart 17.2: The ratio of actual download speed to advertised download speed, M-F 2 hour time blocks, satellite ISPs

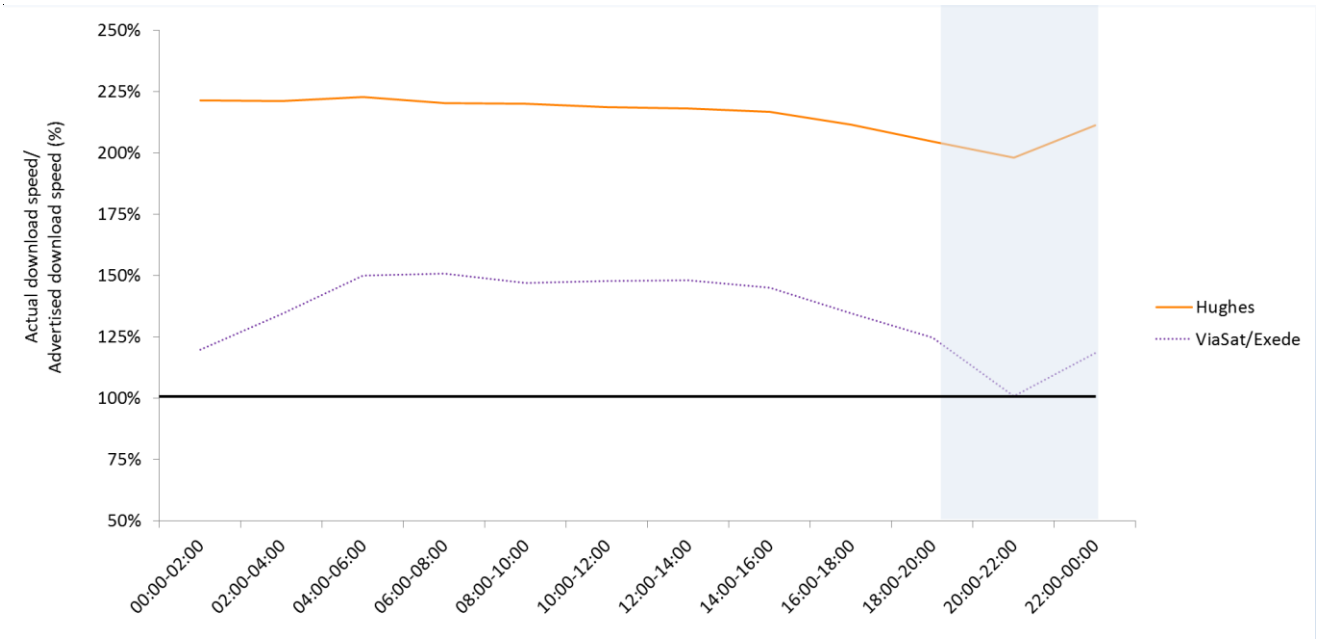
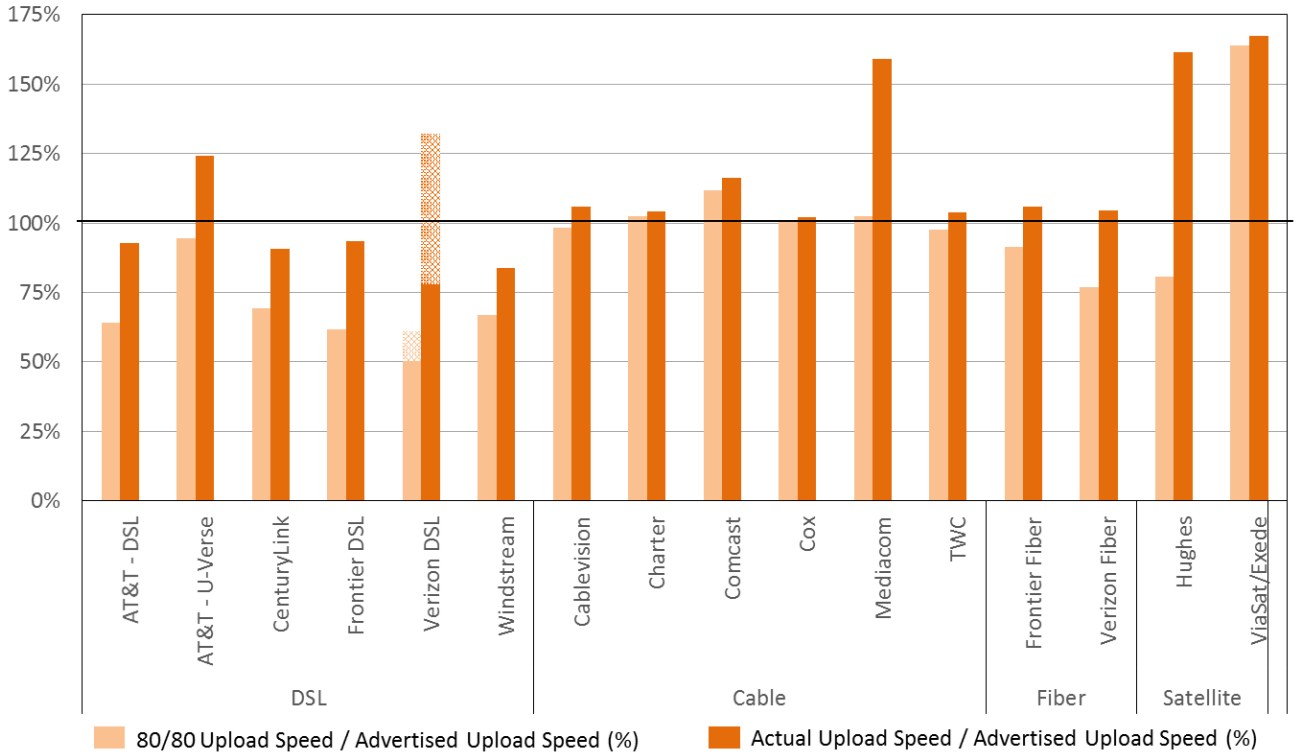


Chart 6 (in section 2.C) Illustrated, for each ISP, the ratio of actual download speed that was experienced by at least 80% of panelists for at least 80% of the peak usage period ("80/80 consistent download speed") to advertised download speed, and for reference the ratio of actual download speed to advertised download speed shown previously in Chart 4. We expand on the theme of consistent speed in the following charts.

Chart 18.1 illustrates information for 80/80 consistent upload speed.

Chart 18.1: The ratio of 80/80 consistent upload speed to advertised upload speed.



Charts 18.2 and 18.3 illustrate similar consistency metrics for 70/70 consistent speeds, i.e., the actual speed experienced by at least 70% of panelists during at least 70% of the peak usage period. The ratios for 70/70 consistent speeds are higher than the corresponding ratios for 80/80 consistent speeds. In fact, for many ISPs, the 70/70 consistent download speed is close to or higher than the advertised download speed.

Chart 18.2: The ratio of 70/70 consistent download speed to advertised download speed.

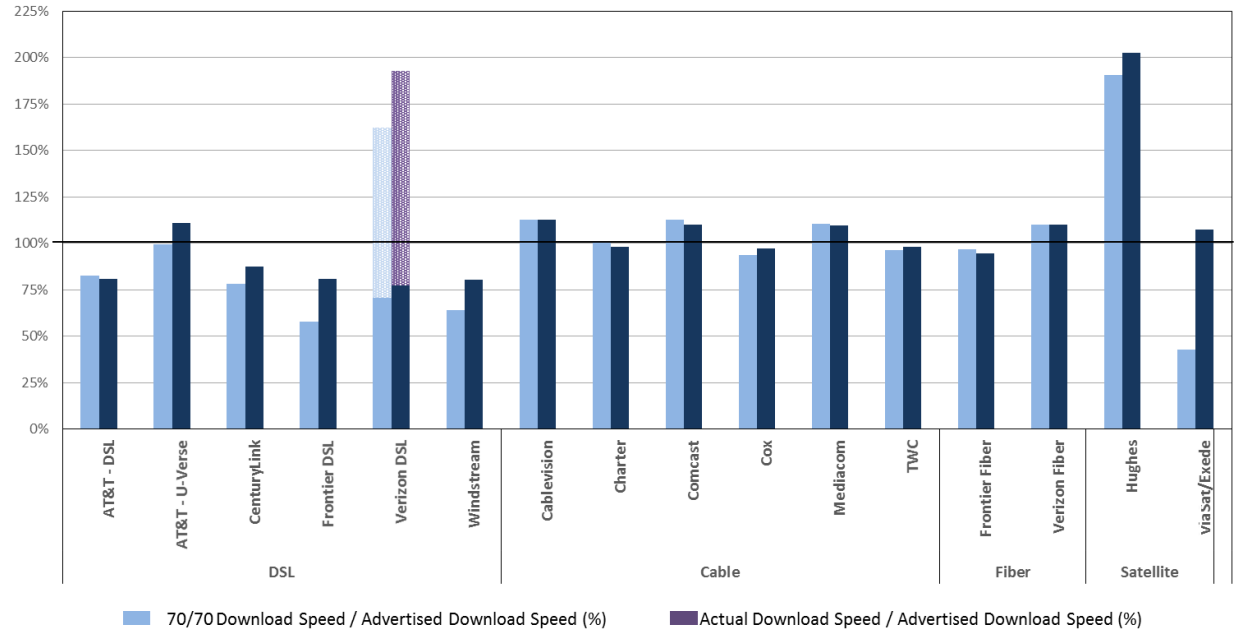


Chart 18.3: The ratio of 70/70 consistent upload speed to advertised upload speed.

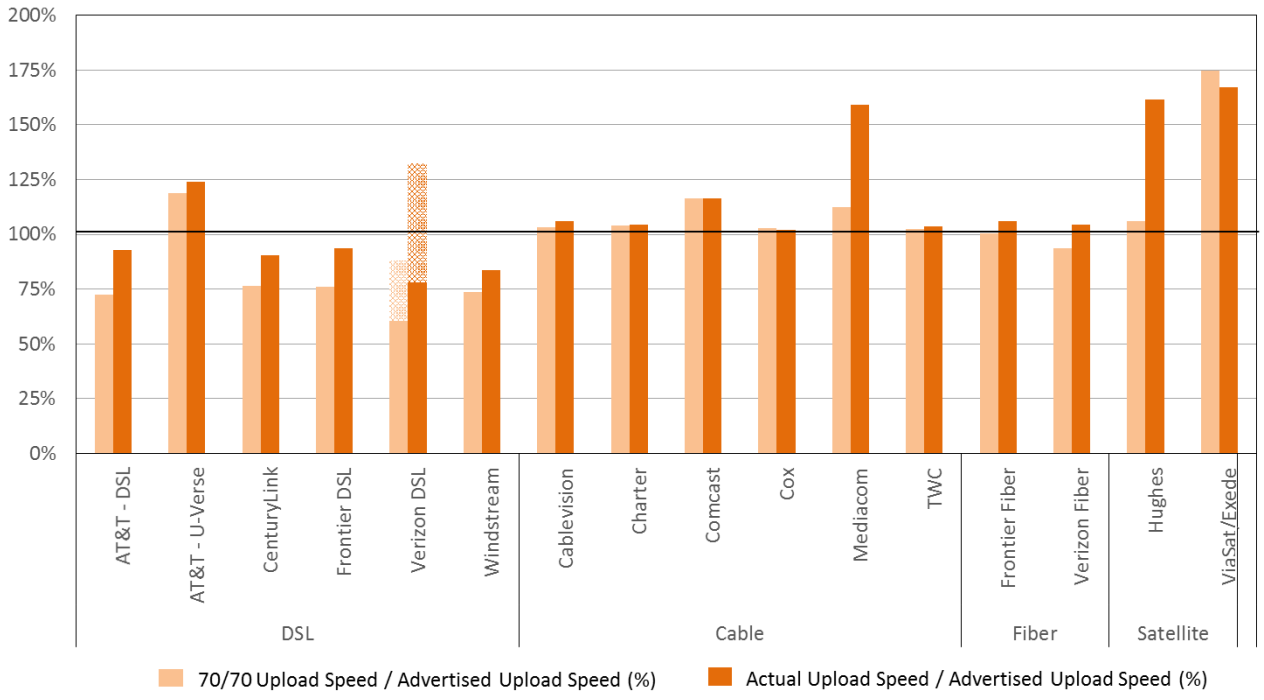
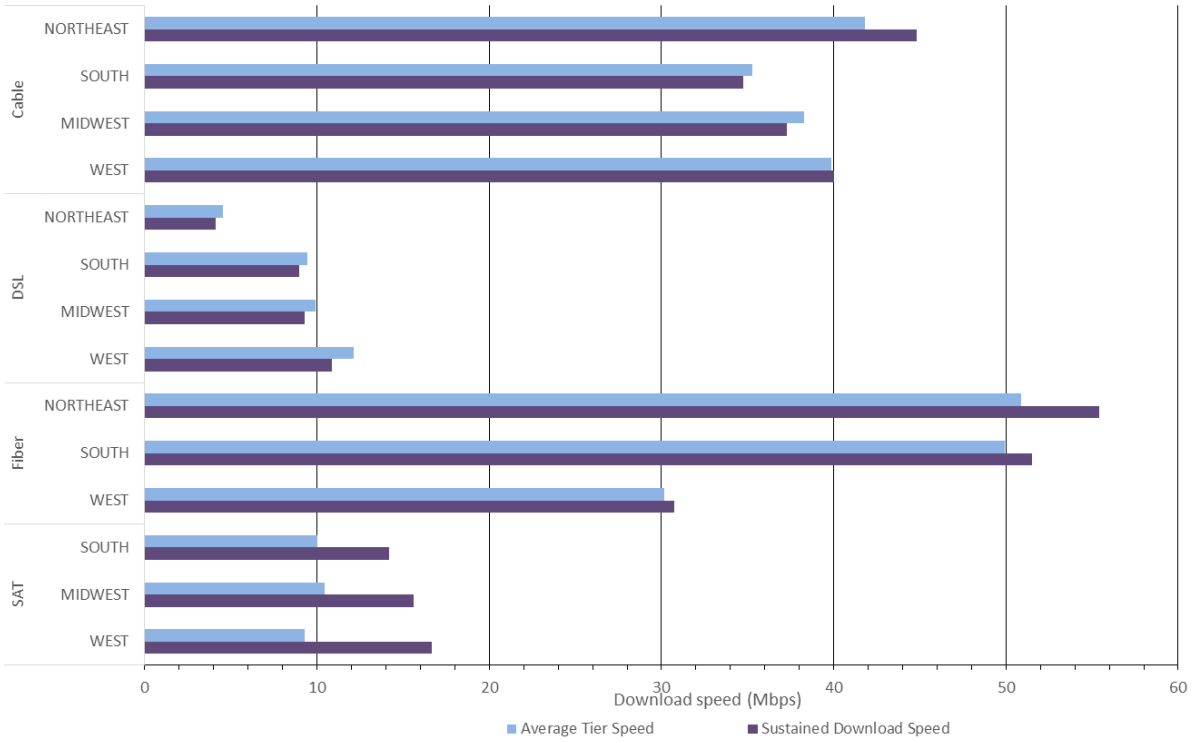


Chart 19 shows the variations among the four U.S. census regions (Northeast, South, Midwest, and West) in the advertised download speed and actual download speed, averaged across all panelists in

each region.[28] While no single technology was the fastest in all regions, for cable- and fiber- based broadband, both the average advertised download speed and the average actual download speed among the most popular service tiers exceeded 25 Mbps in each region.

Chart 19: Advertised download speed and actual download speed, by region and by technology

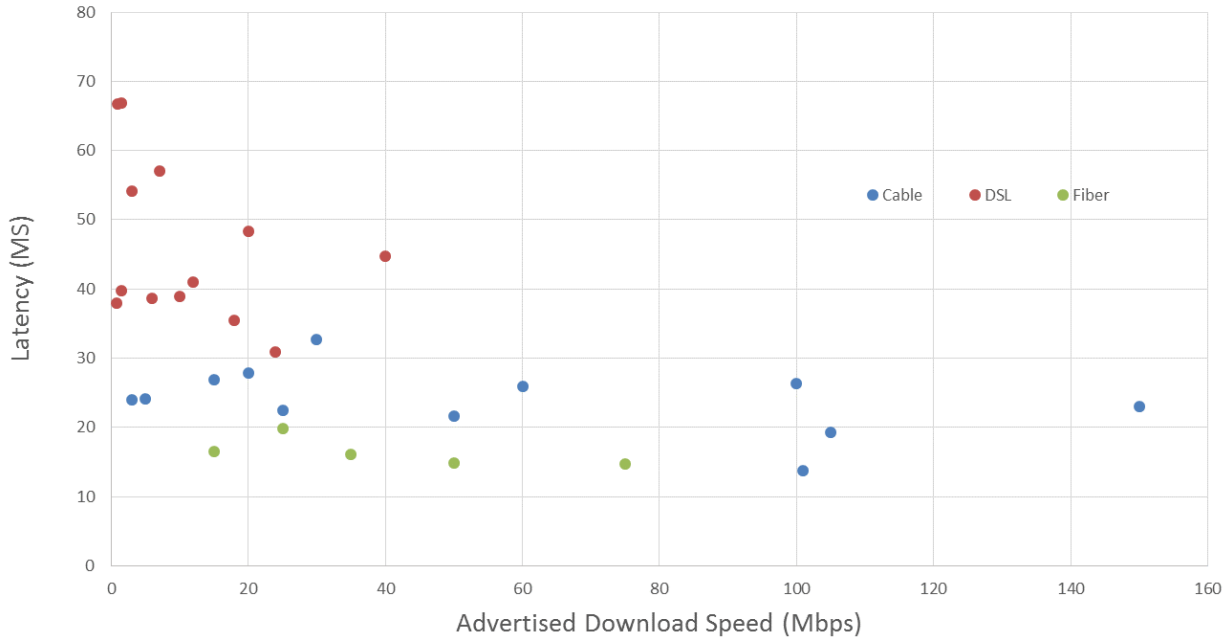


D. Latency

Chart 7 (in section 2.D) illustrates the average latency for each participating ISP. We observed that average latency depends primarily on the technology used by the ISP. Chart 20 below shows the average latency, by technology and by advertised download speed. For a given technology, latency varies little with advertised download speed.

[28] This chart represents an unweighted average of advertised and actual speeds across all panelists in each region. As such, it should not be used to compare the performance of broadband providers. Results for technologies in some regions are excluded when there were not enough panelists to ensure statistically valid metrics.

Chart 20: Latency, by technology and by advertised download speed



5. Additional test results

A. Actual speed, by service tier

As shown in Charts 21.1-21.6, peak usage period performance varied by service tier among ISPs included in this study during the September 2014 test period. On average, during peak periods, the ratio of actual download speed to advertised download speed for all ISPs are 74% or better, and 90% or better for the majority of ISPs. However, the ratio of actual download speed to advertised download speed varies among service tiers.

Chart 21.1: The ratio of actual download speed to advertised download speed, by ISP (1-5 Mbps)

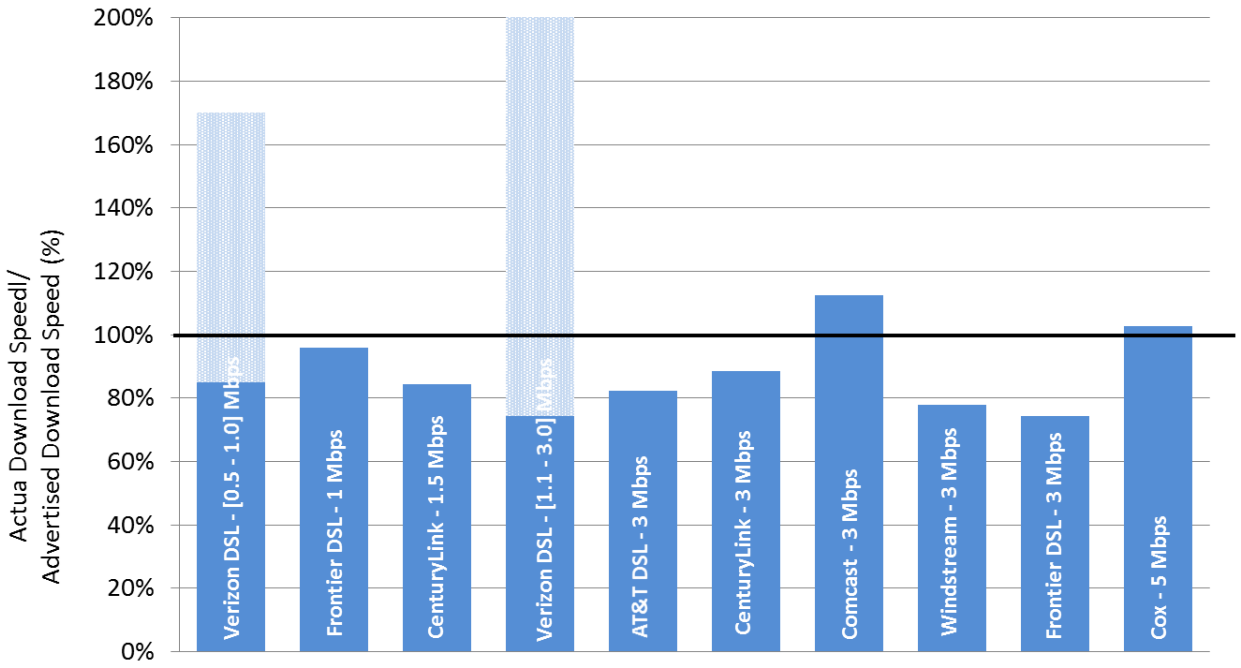


Chart 21.2: The ratio of actual download speed to advertised download speed, by ISP (6-10 Mbps)

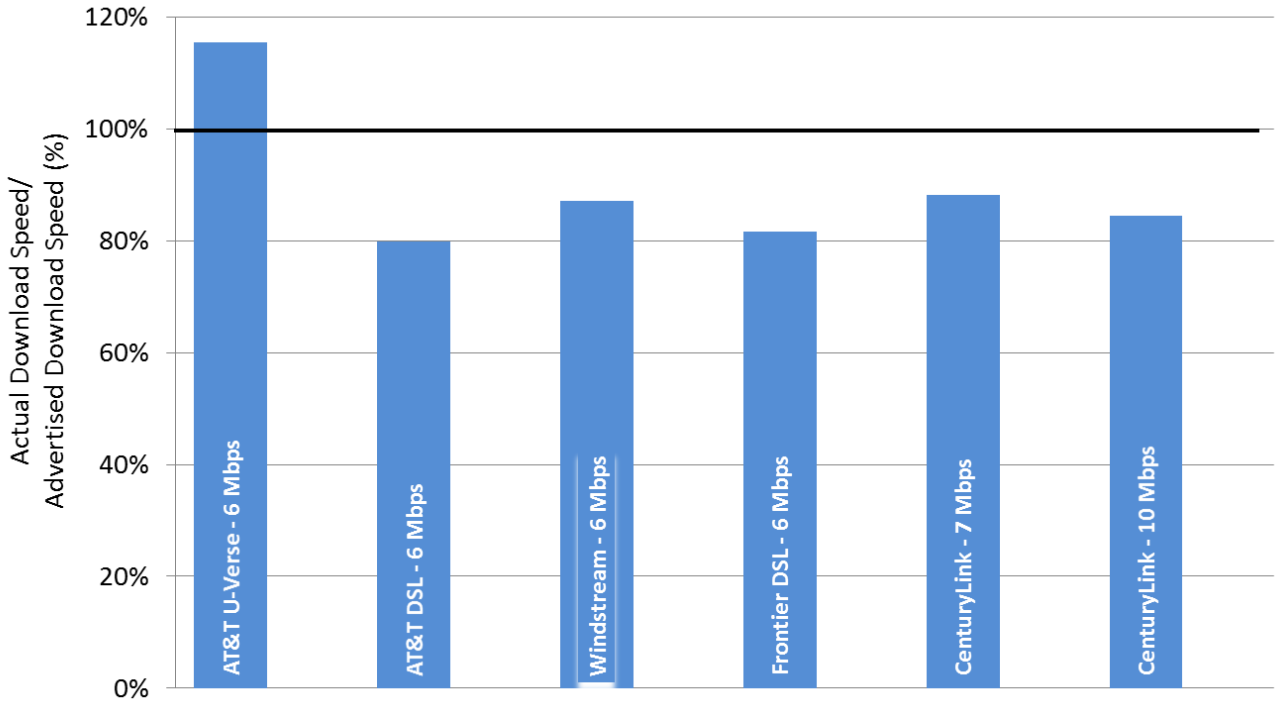


Chart 21.3: The ratio of actual download speed to advertised download speed, by ISP (12-15 Mbps)

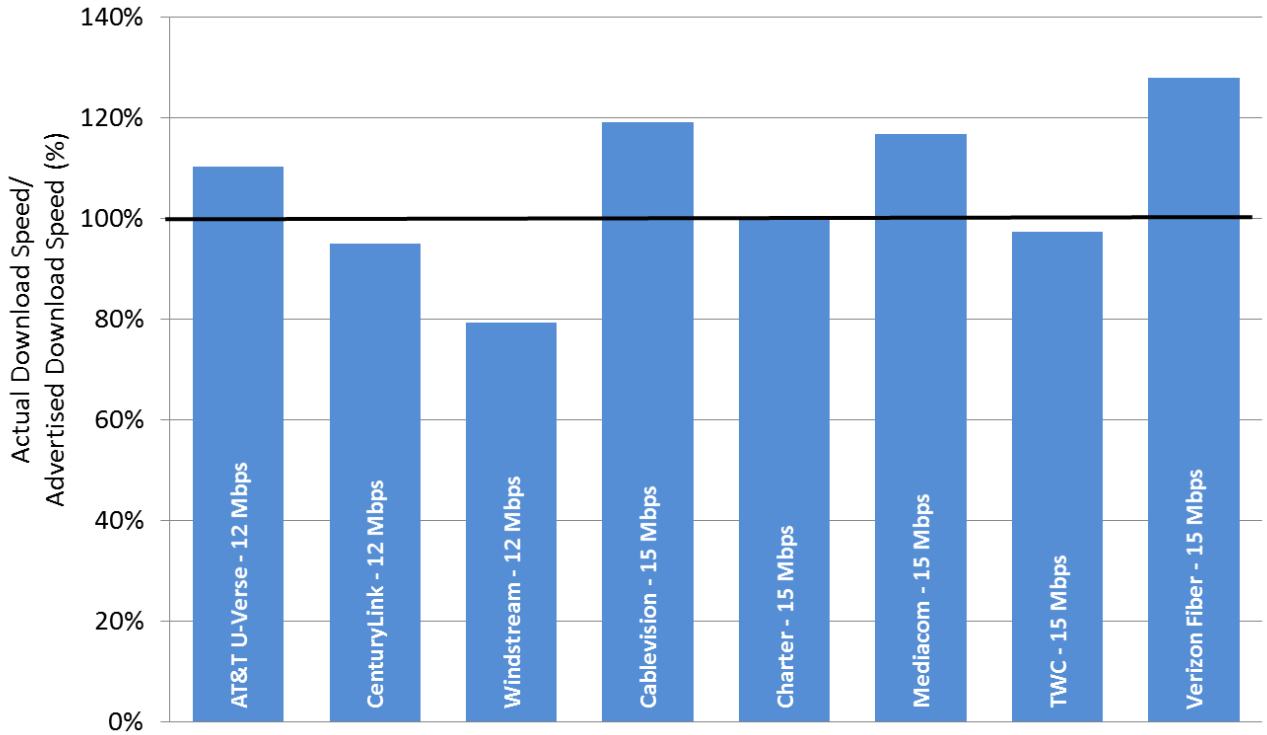


Chart 21.4: The ratio of actual download speed to advertised download speed, by ISP (18-25 Mbps)

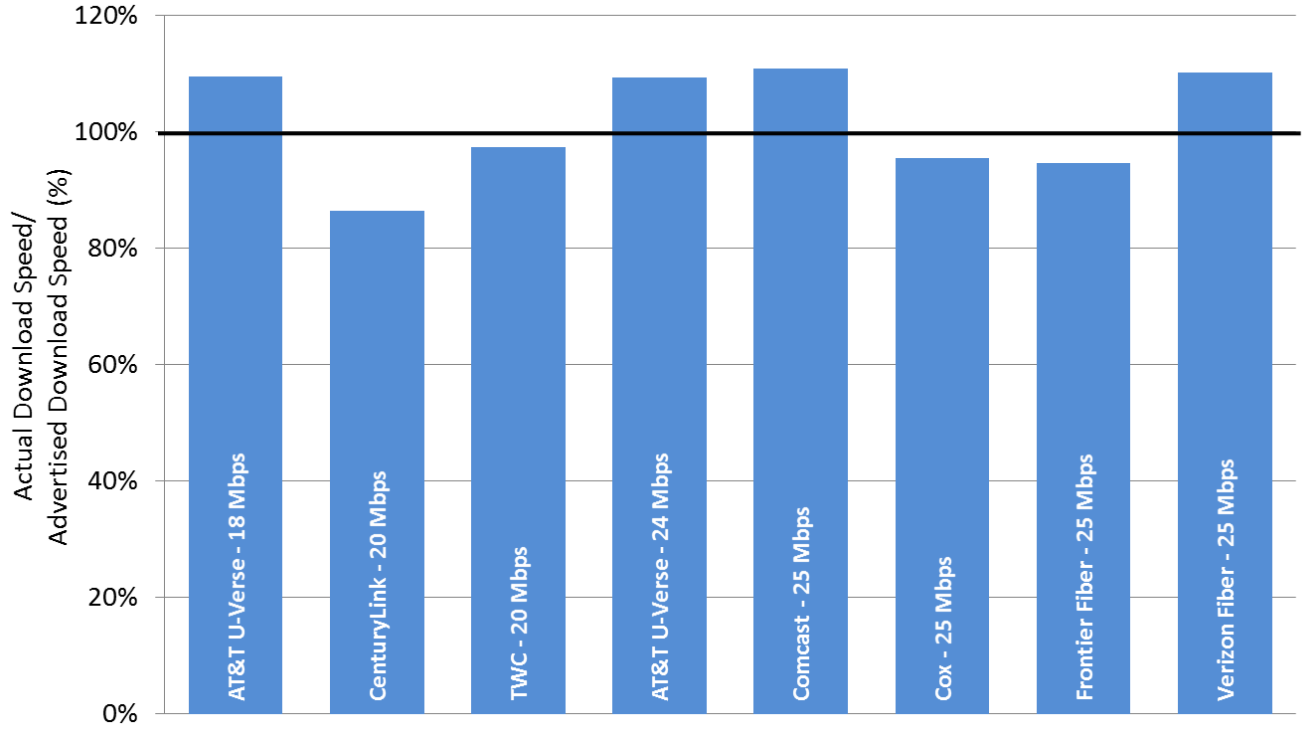


Chart 21.5: The ratio of actual download speed to advertised download speed, by ISP (30-50 Mbps)

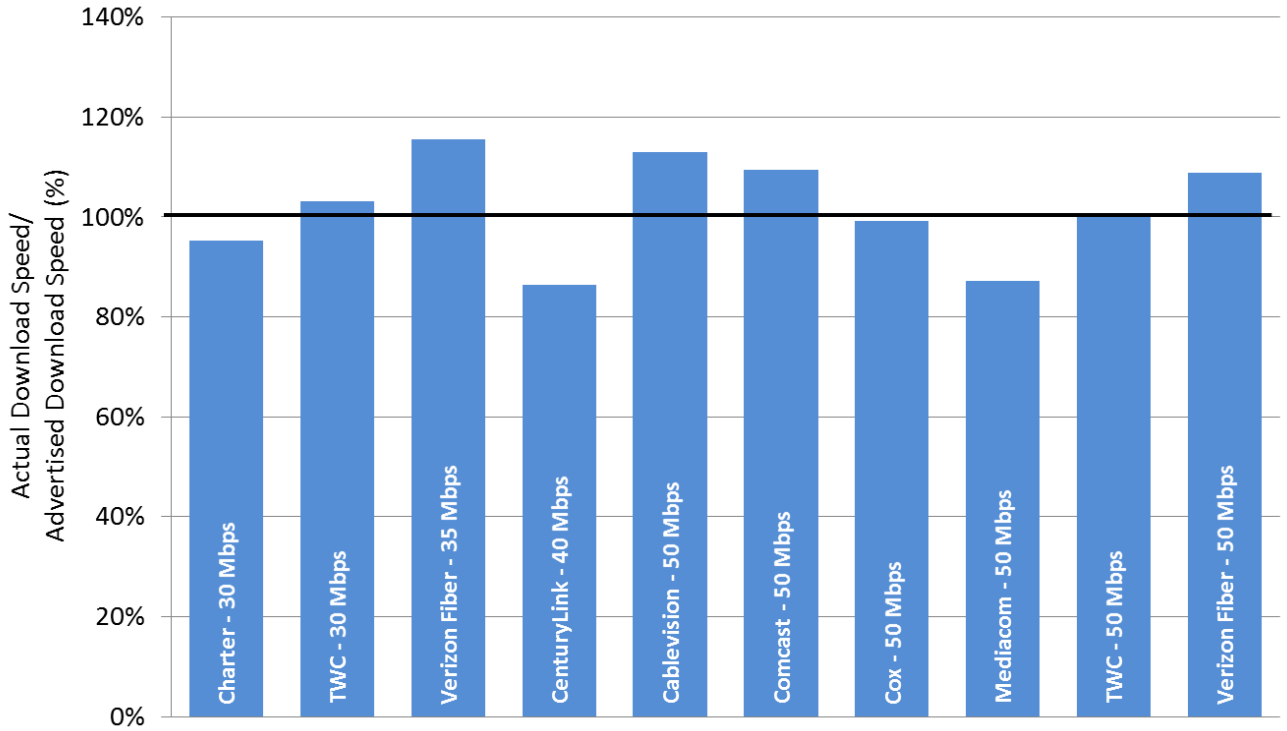
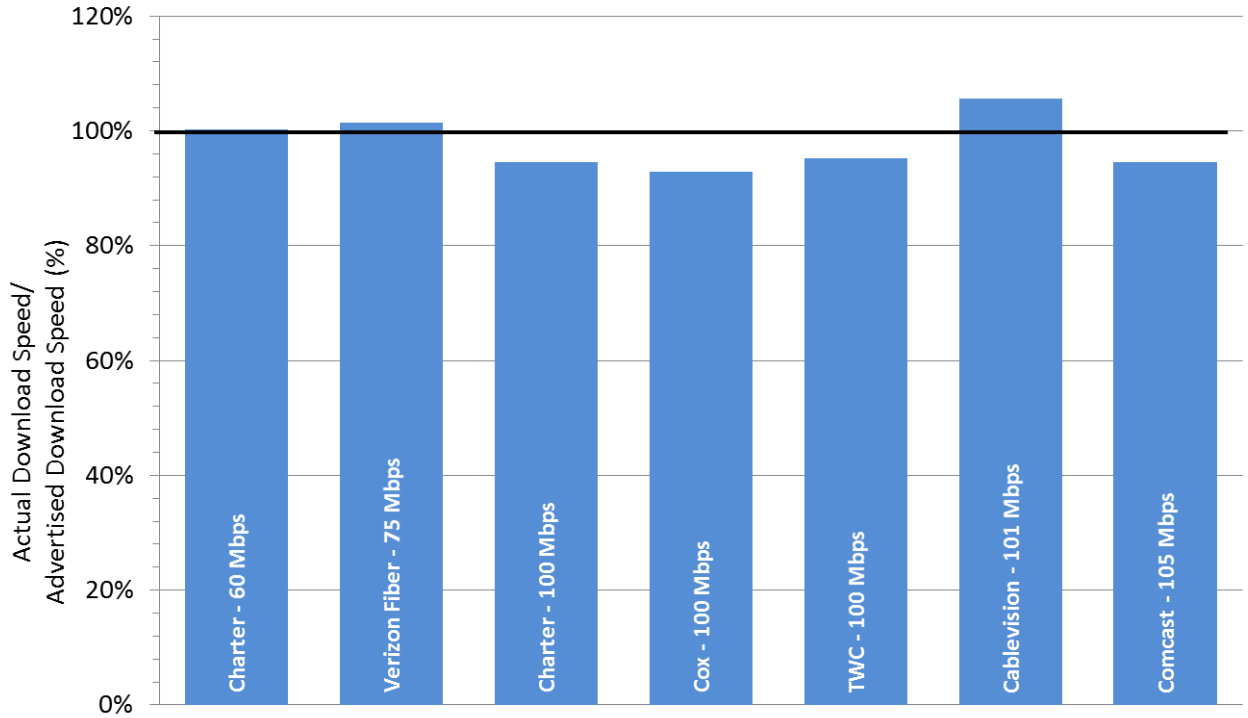


Chart 21.6: The ratio of actual download speed to advertised download speed, by ISP (60-105 Mbps)



Charts 22.1 –22.5 depict the ratio of actual upload speeds to advertised upload speeds for each ISP by service tier.

Chart 22.1: The ratio of actual upload speed to advertised upload speed, by ISP (0.256-0.64 Mbps)

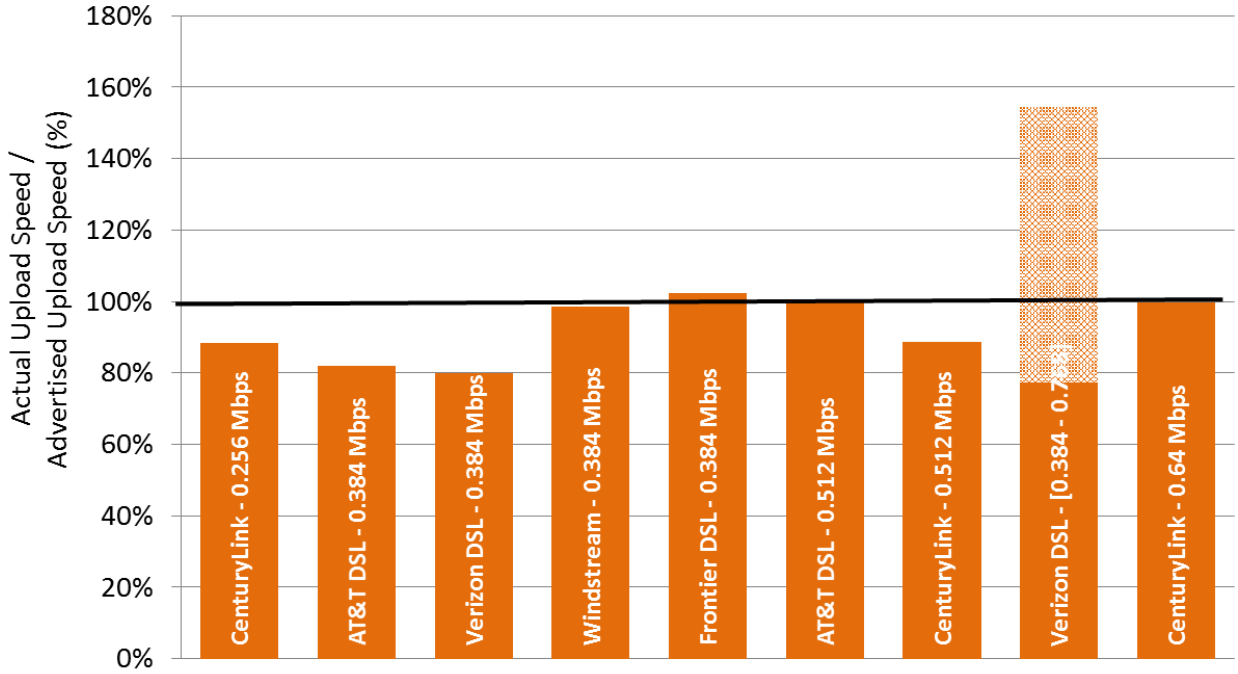


Chart 22.2: The ratio of actual upload speed to advertised upload speed, by ISP (0.768-1.5 Mbps)

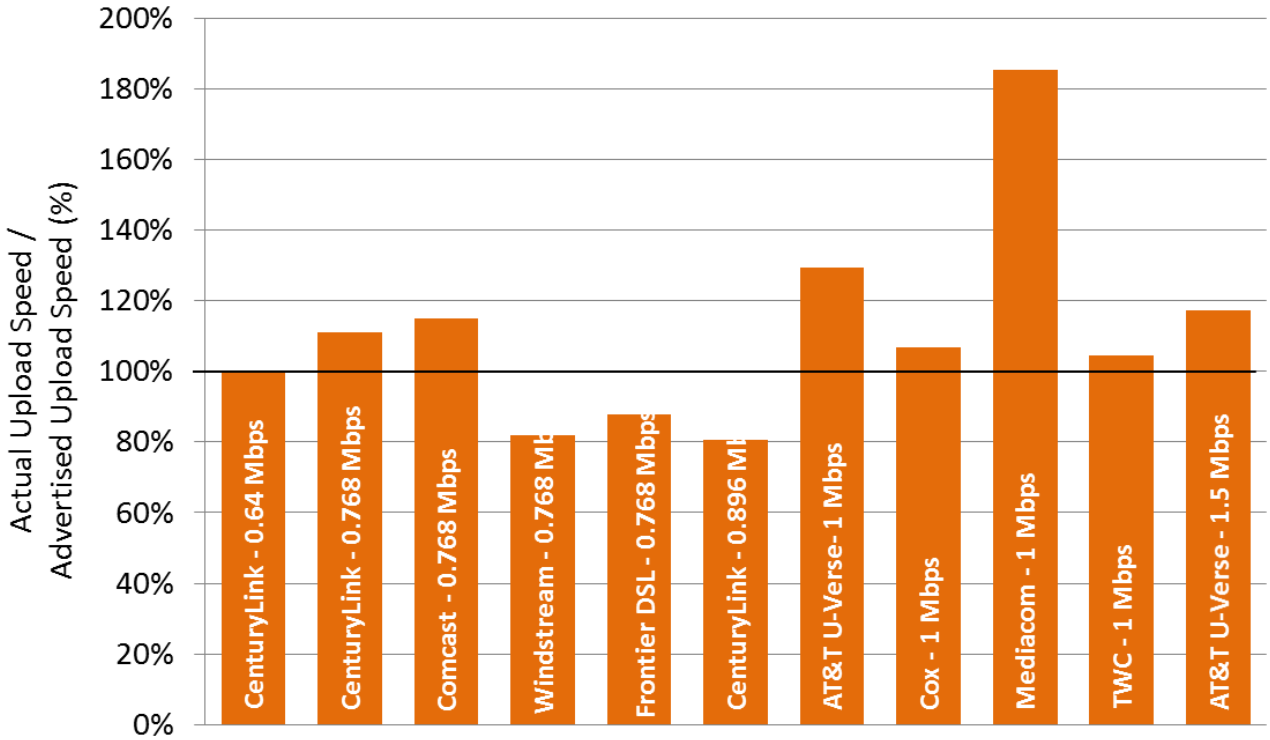


Chart 22.3: The ratio of actual upload speed to advertised upload speed, by ISP (2-5 Mbps)

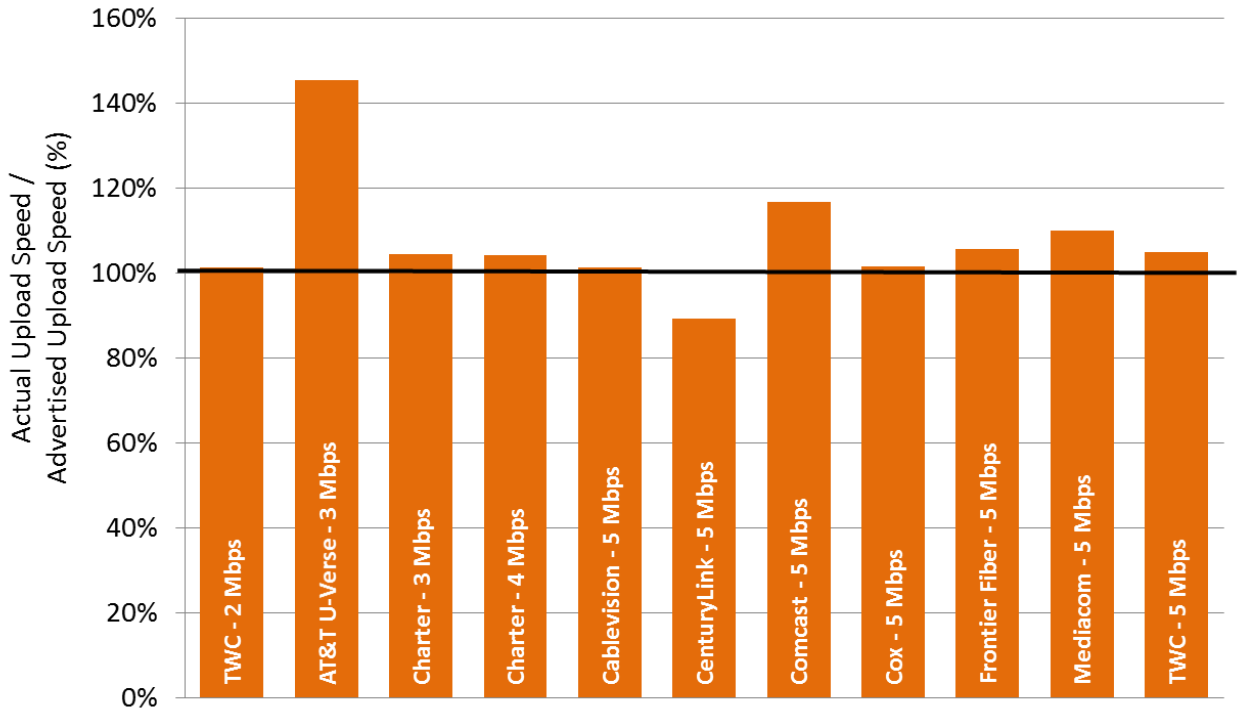


Chart 22.4: The ratio of actual upload speed to advertised upload speed, by ISP (10-25 Mbps)

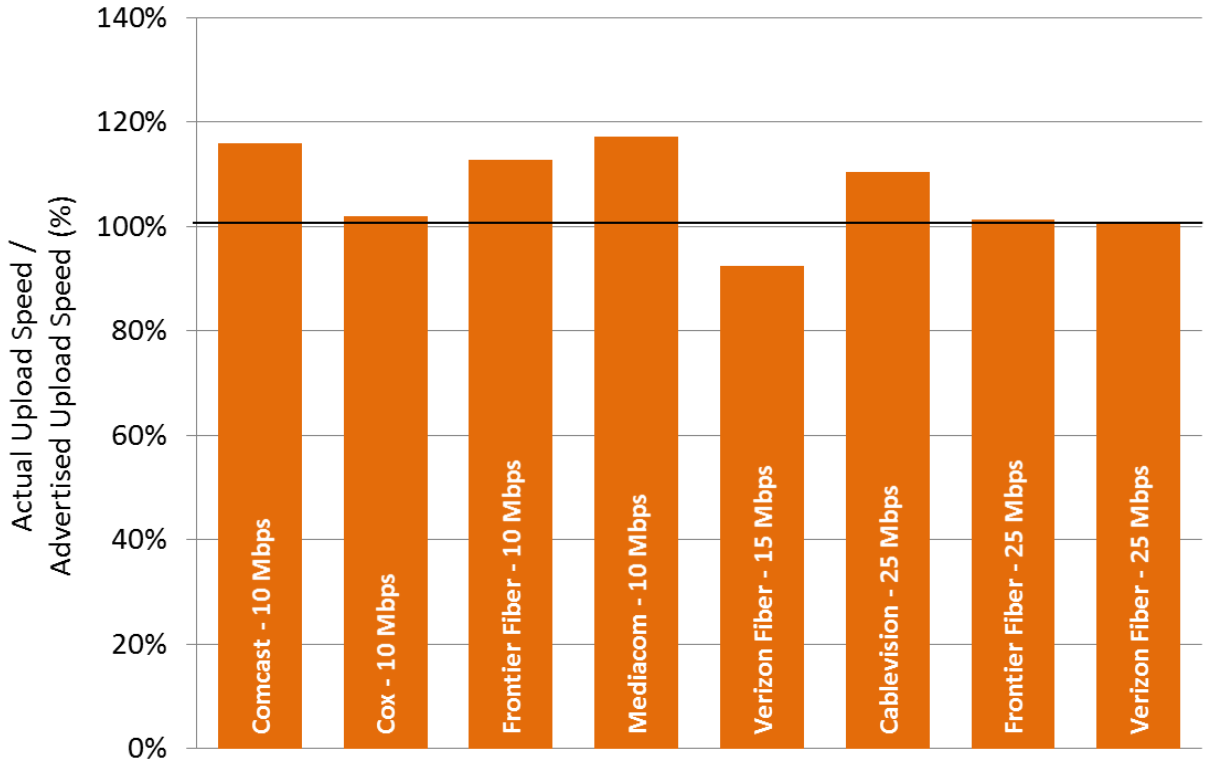


Chart 22.5: The ratio of actual upload speed to advertised upload speed, by ISP (35-75 Mbps)

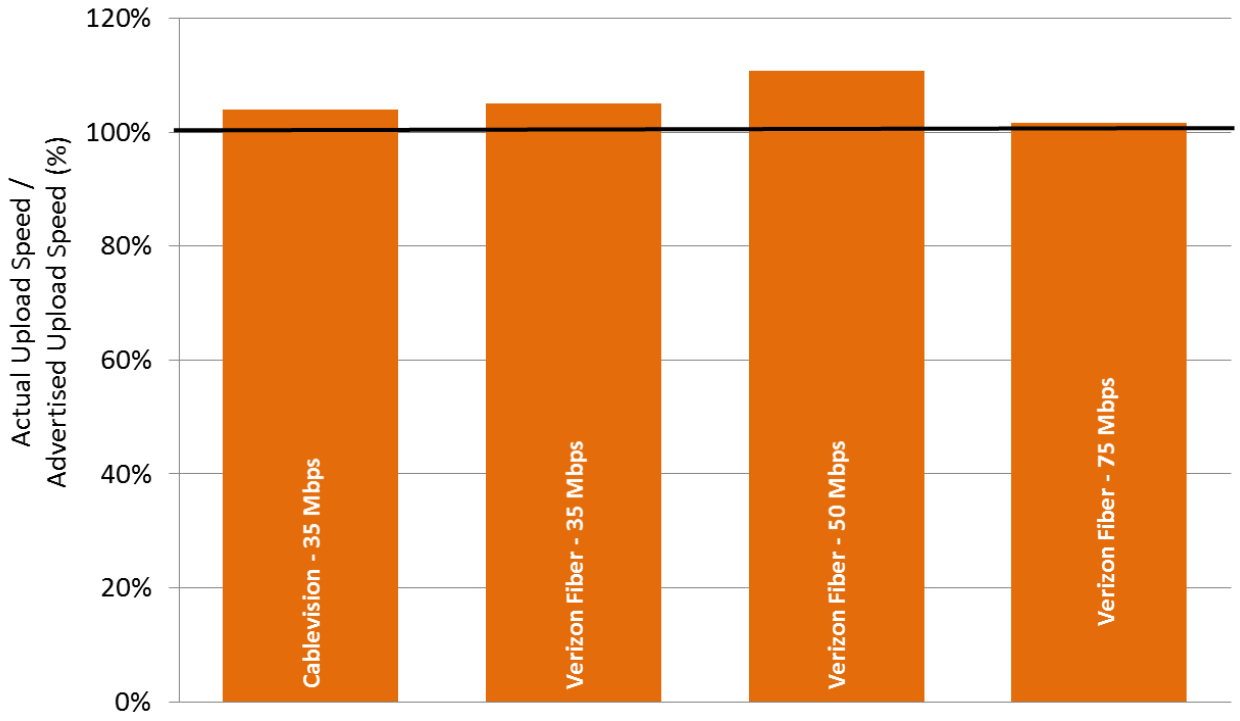


Table 2 lists the advertised download speed tiers included in this study, and compares this with the average of an ISP's actual download speed results from September 2014. As before, we note that the actual download speeds listed here are based on national averages, and may not represent the performance experienced by any particular consumer at any given time or place.

Table 2: Peak Period Actual Download Speed, by ISP

Actual Download Speed (Mbps)	Advertised Download Speed (Mbps)	ISP	Actual Speed / Advertised Speed
0.85	0.5 - 1	Verizon DSL	85% - 170%
0.96	1	Frontier DSL	95.9%
1.3	1.5	CenturyLink	84.5%
2.2	1.1 - 3	Verizon DSL	74.2% - 202.4%
2.5	3	AT&T DSL	82.4%
2.7	3	CenturyLink	88.4%
3.4	3	Comcast	112.4%

2.3	3	Windstream	78%
2.2	3	Frontier DSL	74.2%
5.1	5	Cox	102.8%
6.9	6	AT&T U-Verse	115.5%
4.8	6	AT&T DSL	79.9%
5.2	6	Windstream	87.2%
4.9	6	Frontier DSL	81.6%
6.2	7	CenturyLink	88.2%
8.4	10	CenturyLink	84.4%
13.2	12	AT&T U-Verse	110.2%
11.4	12	CenturyLink	95%
9.5	12	Windstream	79.3%
17.9	15	Cablevision	119%
15.1	15	Charter	100.3%
17.5	15	Mediacom	116.7%
14.6	15	TWC	97.4%
19.2	15	Verizon Fiber	127.9%
19.7	18	AT&T U-Verse	109.5%
17.3	20	CenturyLink	86.4%
19.5	20	TWC	97.3%
26.2	24	AT&T U-Verse	109.3%
27.7	25	Comcast	110.9%
23.9	25	Cox	95.5%
23.7	25	Frontier Fiber	94.6%

27.6	25	Verizon Fiber	110.2%
28.6	30	Charter	95.2%
30.9	30	TWC	103.1%
40.4	35	Verizon Fiber	115.5%
34.6	40	CenturyLink	86.5%
56.5	50	Cablevision	113%
54.7	50	Comcast	109.4%
49.6	50	Cox	99.1%
43.6	50	Mediacom	87.1%
50.0	50	TWC	100%
54.4	50	Verizon Fiber	108.9%
60.2	60	Charter	100.3%
76.1	75	Verizon Fiber	101.4%
94.6	100	Charter	94.6%
92.8	100	Cox	92.8%
95.3	100	TWC	95.3%
106.8	101	Cablevision	105.7%
99.4	105	Comcast	94.6%

B. Variations in speed

In Section 3.C, we presented speed consistency metrics for each ISP based on test results averaged across all service tiers. In the present section, we provide the detailed results for each individual speed tier of each ISP.

Chart 23.1: The percentage of consumers whose actual download speed was (a) greater than 95%, (b) between 80% and 95%, and (c) less than 80% of the advertised download speed, by speed tier

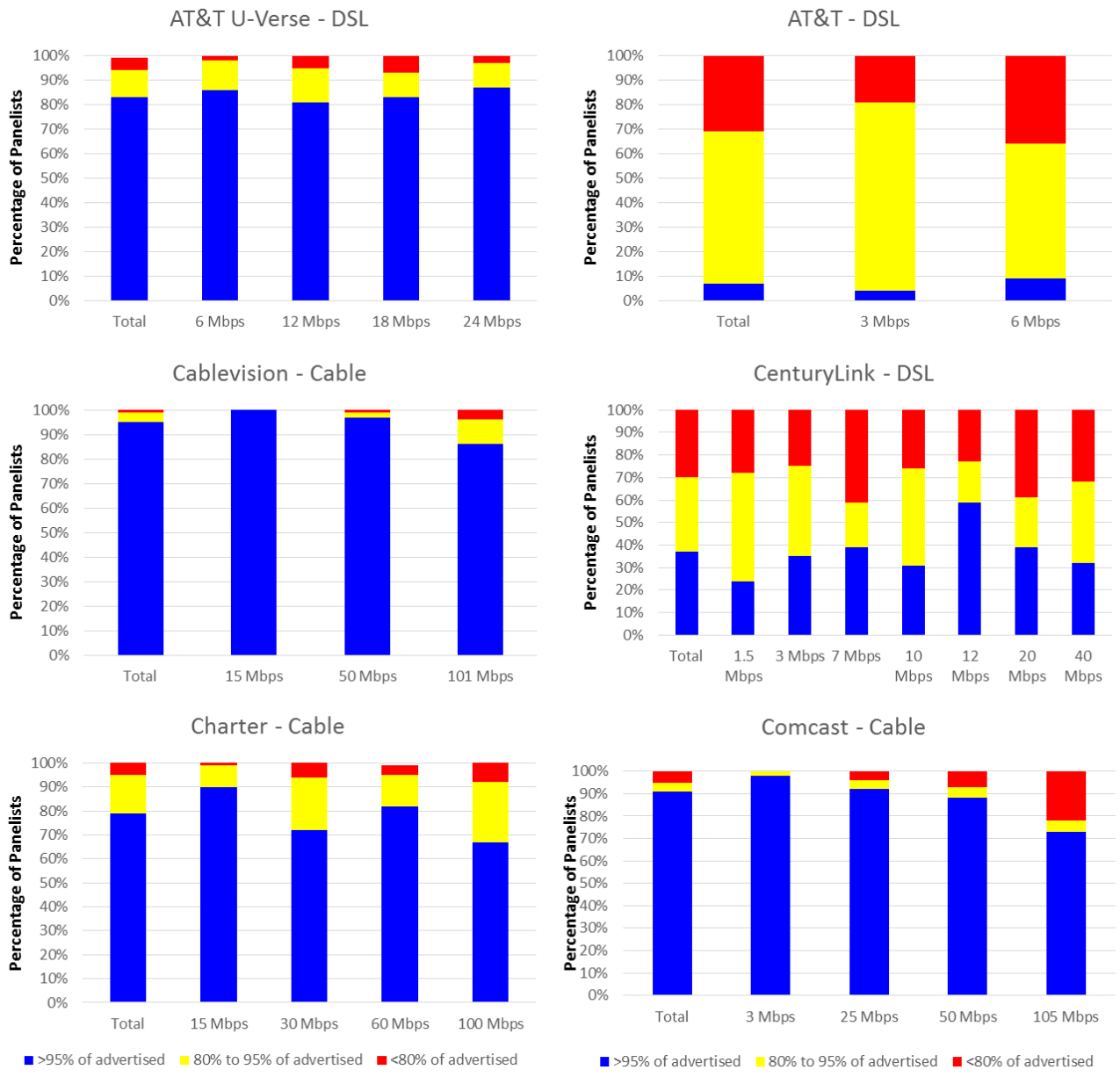


Chart 23.2: The percentage of consumers whose actual download speed was (a) greater than 95%, (b) between 80% and 95%, and (c) less than 80% of the advertised download speed (continued).

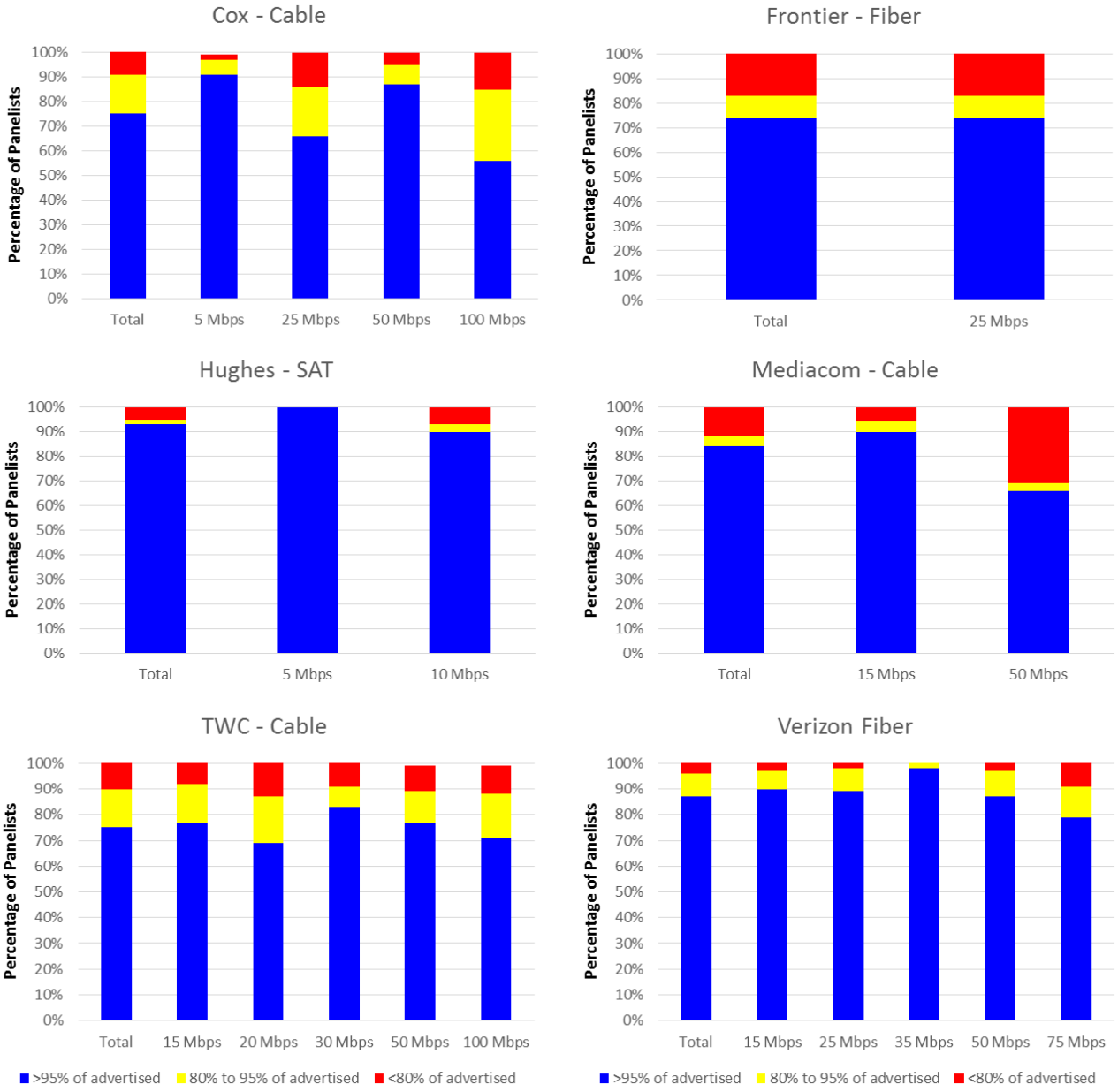


Chart 23.3: The percentage of consumers whose actual download speed was (a) greater than 95%, (b) between 80% and 95%, and (c) less than 80% of the advertised download speed (continued).

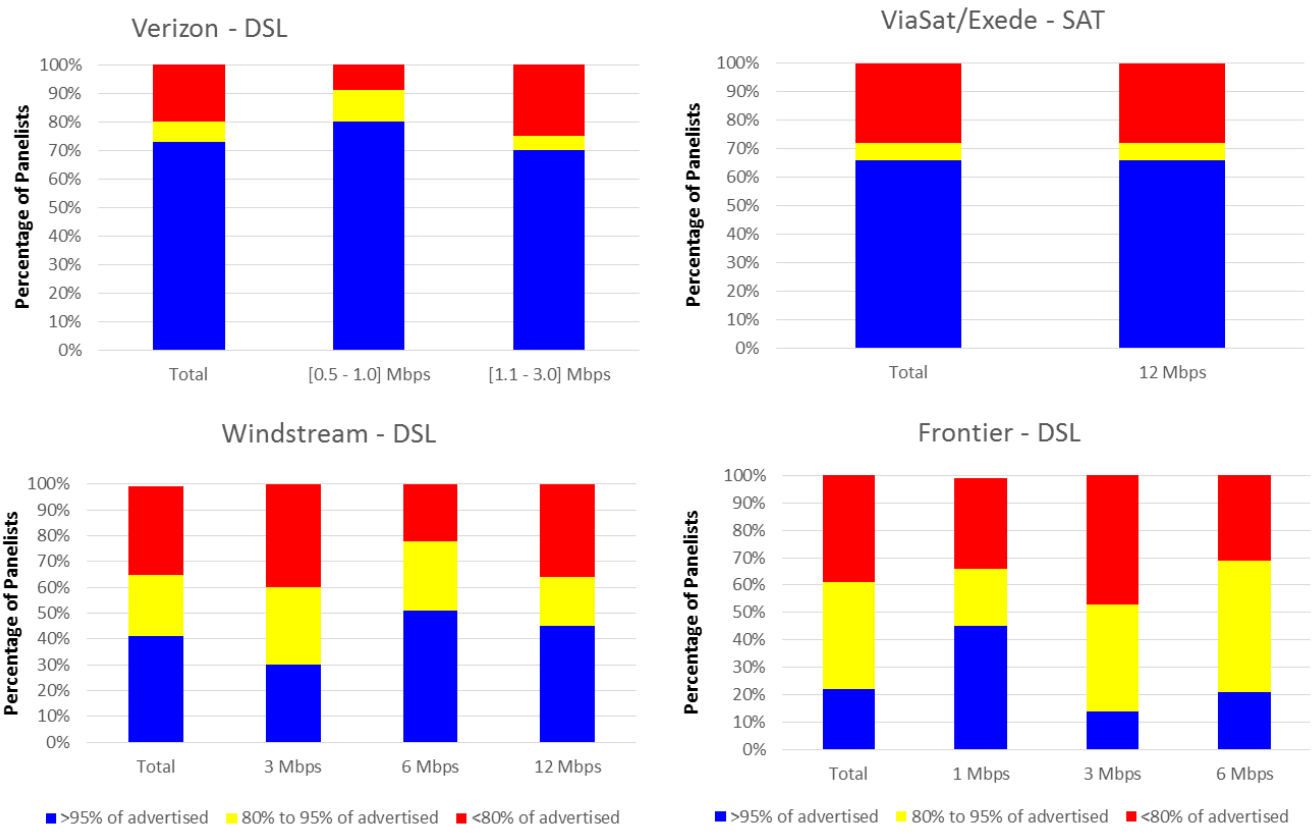


Chart 24.1: The percentage of consumers whose actual upload speed was (a) greater than 95%, (b) between 80% and 95%, and (c) less than 80% of the advertised upload speed.

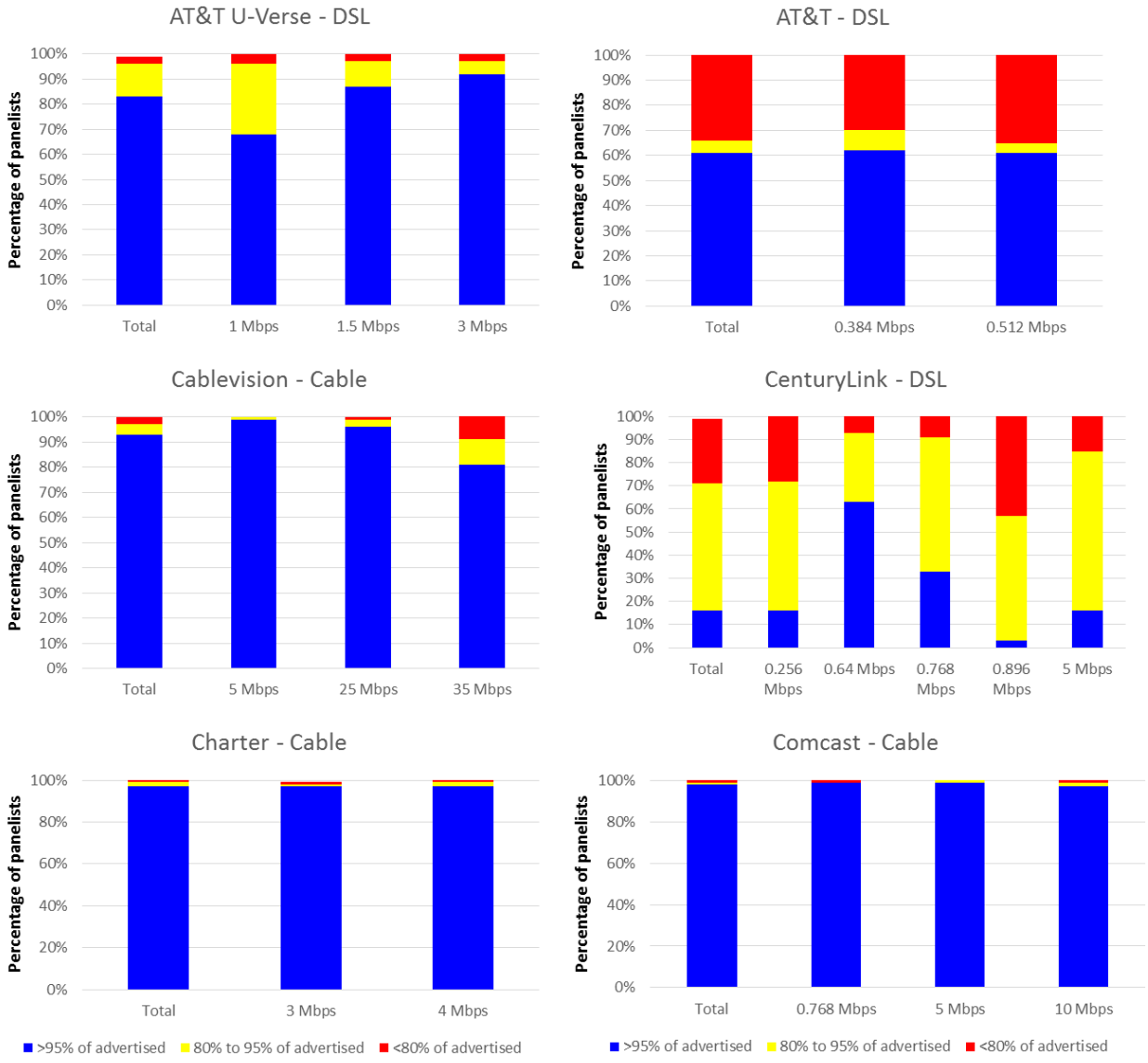


Chart 24.2: The percentage of consumers whose actual upload speed was (a) greater than 95%, (b) between 80% and 95%, and (c) less than 80% of the advertised upload speed (continued).

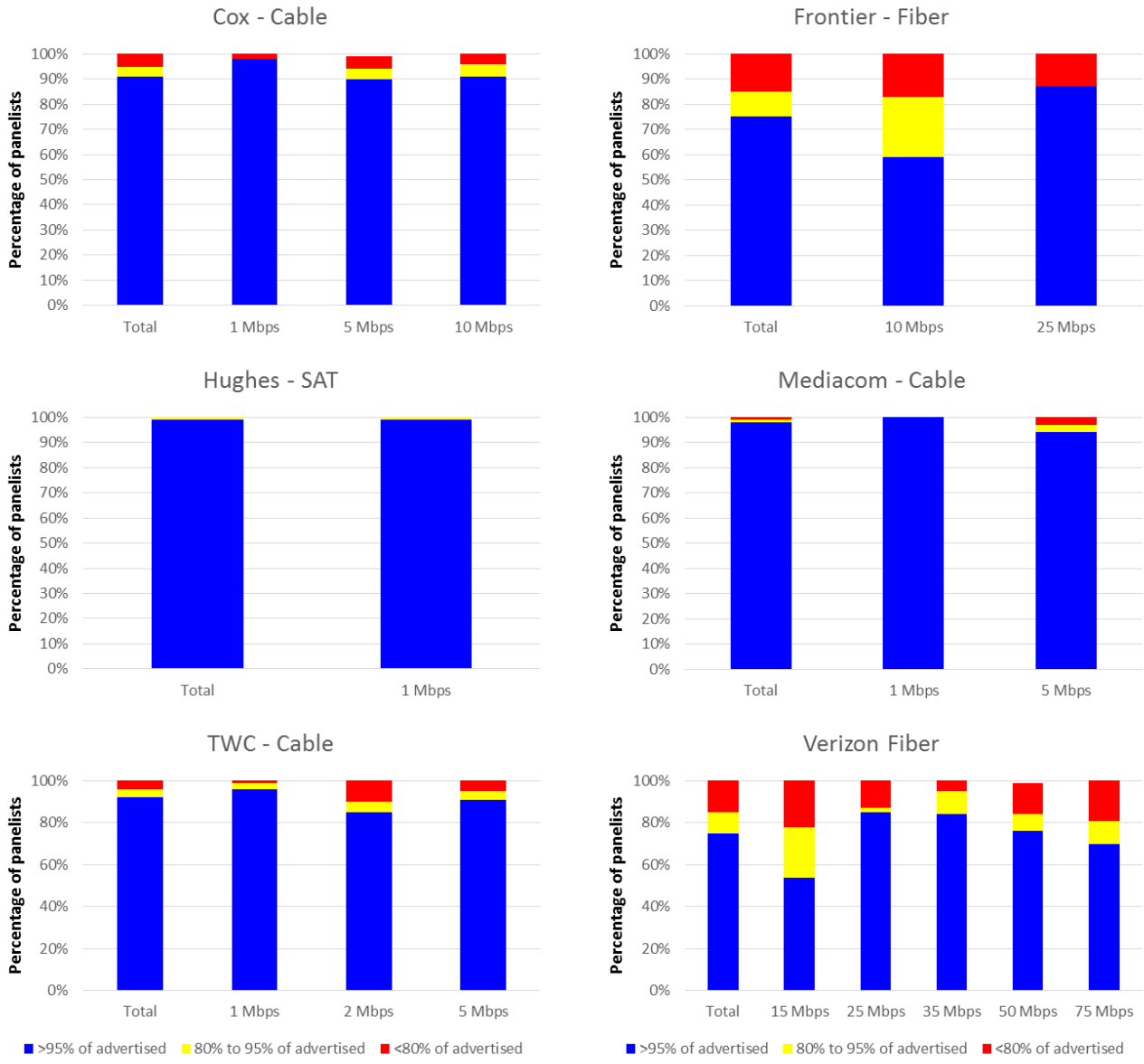
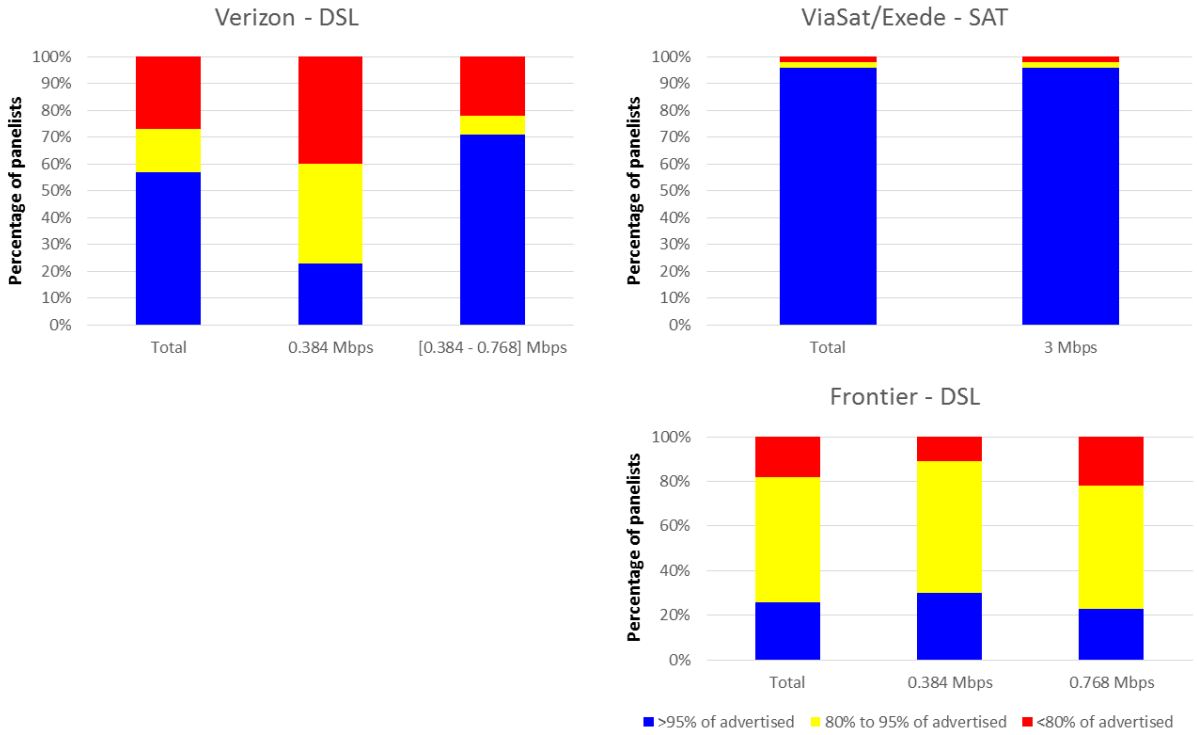


Chart 24.3: The percentage of consumers whose actual upload speed was (a) greater than 95%, (b) between 80% and 95%, and (c) less than 80% of the advertised upload speed (continued).



In Section 3.C, we presented complementary cumulative distributions for each ISP based on test results averaged across all service tiers. In the present section we provide tables showing selected points on these distributions by each individual ISP and technology.

Table 3: Complementary cumulative distribution of the ratio of actual download speed to advertised download speed, by technology, by ISP

ISP	20%	50%	70%	80%	90%	95%
AT&T (U-verse)	125%	118%	105%	98%	89%	79%
AT&T (DSL)	89%	82%	80%	78%	70%	48%
Cablevision	118%	115%	112%	108%	101%	94%
CenturyLink	102%	89%	80%	73%	60%	51%
Charter	105%	101%	98%	94%	88%	80%
Comcast	118%	115%	111%	107%	97%	80%
Cox	105%	101%	97%	92%	81%	66%

Frontier Fiber	101%	100%	98%	84%	75%	70%
Frontier DSL	97%	88%	71%	60%	43%	32%
Hughes	268%	203%	187%	170%	142%	83%
Mediacom	126%	119%	110%	99%	71%	44%
TWC	107%	103%	97%	92%	80%	68%
Verizon Fiber	116%	111%	105%	99%	92%	82%
Verizon DSL (Mid-Range)	134%	123%	108%	78%	60%	47%
ViaSat/Exede	148%	118%	82%	58%	45%	30%
Windstream	100%	91%	74%	61%	42%	28%

Table 4: Complementary cumulative distribution of the ratio of actual upload speed to advertised upload speed, by technology, by ISP

ISP	20%	50%	70%	80%	90%	95%
AT&T (U-verse)	141%	124%	121%	111%	91%	87%
AT&T (DSL)	120%	102%	78%	75%	44%	28%
Cablevision	114%	109%	103%	100%	98%	86%
CenturyLink	94%	87%	81%	78%	73%	60%
Charter	106%	105%	105%	104%	102%	98%
Comcast	119%	118%	117%	115%	113%	109%
Cox	105%	104%	103%	98%	99%	83%
Frontier Fiber	120%	107%	100%	93%	70%	49%
Frontier DSL	99%	90%	86%	81%	64%	45%
Hughes	182%	165%	152%	136%	118%	113%
Mediacom	188%	185%	116%	109%	101%	98%

TWC	110%	106%	104%	103%	100%	81%
Verizon Fiber	122%	107%	101%	89%	77%	65%
Verizon DSL (Mid-Range)	121%	102%	83%	62%	55%	47%
ViaSat/Exede	178%	176%	171%	166%	156%	104%
Windstream	84%	81%	79%	77%	72%	69%

As discussed in prior Reports, some cable ISPs offer "burst speed" techniques which temporarily allocate more bandwidth to a consumer's service. The effect is temporary—typically lasting less than 15 to 20 seconds—and may be reduced by other broadband activities occurring within the consumer household.[29] Burst speed is not equivalent to actual speed, and may be more useful with certain applications than with others. For example, large file transfers, video streaming, and video chat require the transfer of large amounts of information over sustained periods of time. However, other activities require the transfer of moderate amounts of information in a short interval of time, and may benefit from burst speed techniques.

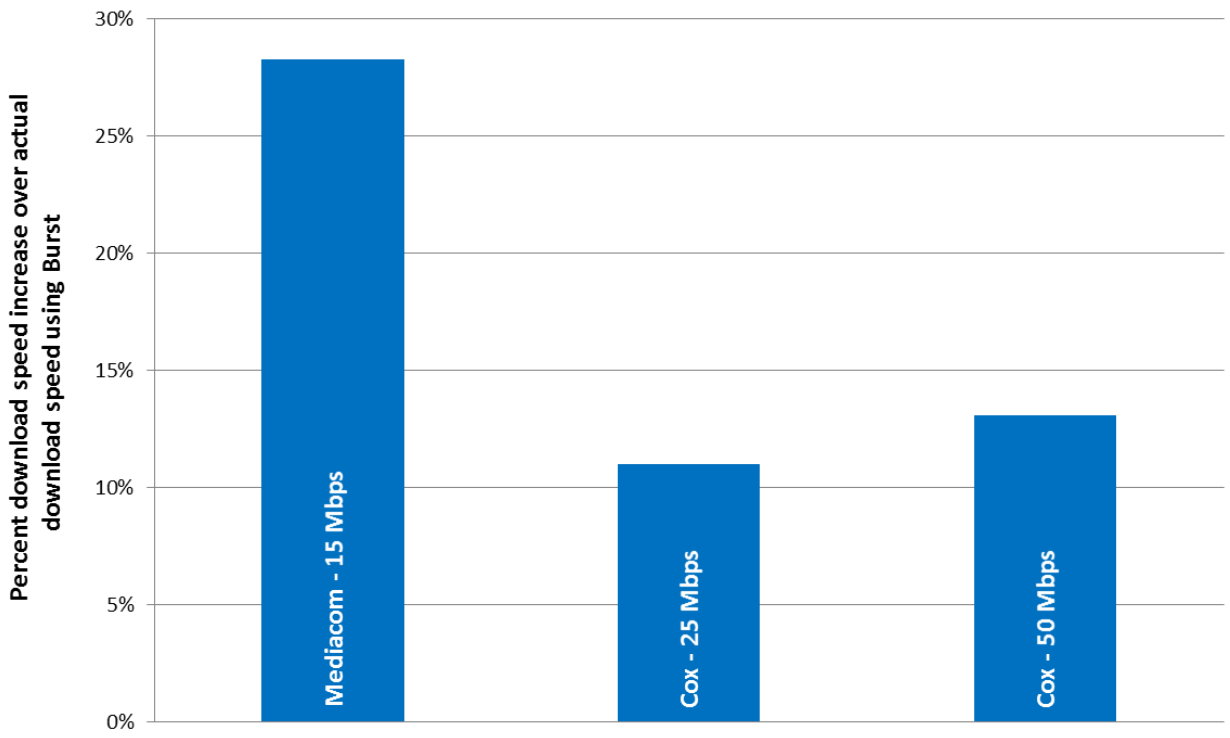
Comparing burst download speeds to actual download speeds demonstrates the effect that burst services can have on data throughput. To test for the possible effect of burst technology, we compare the average download speed in the first five seconds of a speed test to the average download speed in the last five seconds of a total 30 second test. Large differences may indicate the use of burst technology, while smaller differences are likely the effect of variable packet performance.

We have tracked this metric from the inception of these reports. As broadband speeds have increased, the measurable impact of using this burst technique has diminished. Correspondingly, only two ISPs (Cox and Mediacom) use this technique now. This year, therefore, we have restricted the results to only those two participating ISPs that have affirmed that they are using burst technology. Chart 25 shows burst download speed results.[30] Mediacom's 15 Mbps advertised download speed tier showed a 28% increase from actual download speed to burst download speed, and Cox's 25 Mbps and 50 Mbps advertised download speed tiers showed 11%-13% increases from actual download speed to burst download speed. Other tiers offered by these broadband providers showed less than a 10% increase.

[29] For example, downloading a large file while browsing the web would limit the effectiveness of burst technology.

[30] The FCC does not have detailed information on which speed tiers employ burst speed technology. This chart shows the percent difference between the actual speed and burst speed tests. Large differences in these speeds can be inferred as the result of burst speed technology being employed.

Chart 25: Peak Period Burst Download Speeds as a Percentage Increase over Actual Download Speeds, by ISP (where tiers showed a greater than 10% Increase)



The use of burst speed techniques on uploads is even less prevalent.

C. Web browsing performance, by service tier

In the present section we provide the detailed results of the webpage download time for each individual speed tier of each ISP.

Chart 26.1: Average webpage download time, by ISP (1-3 Mbps)

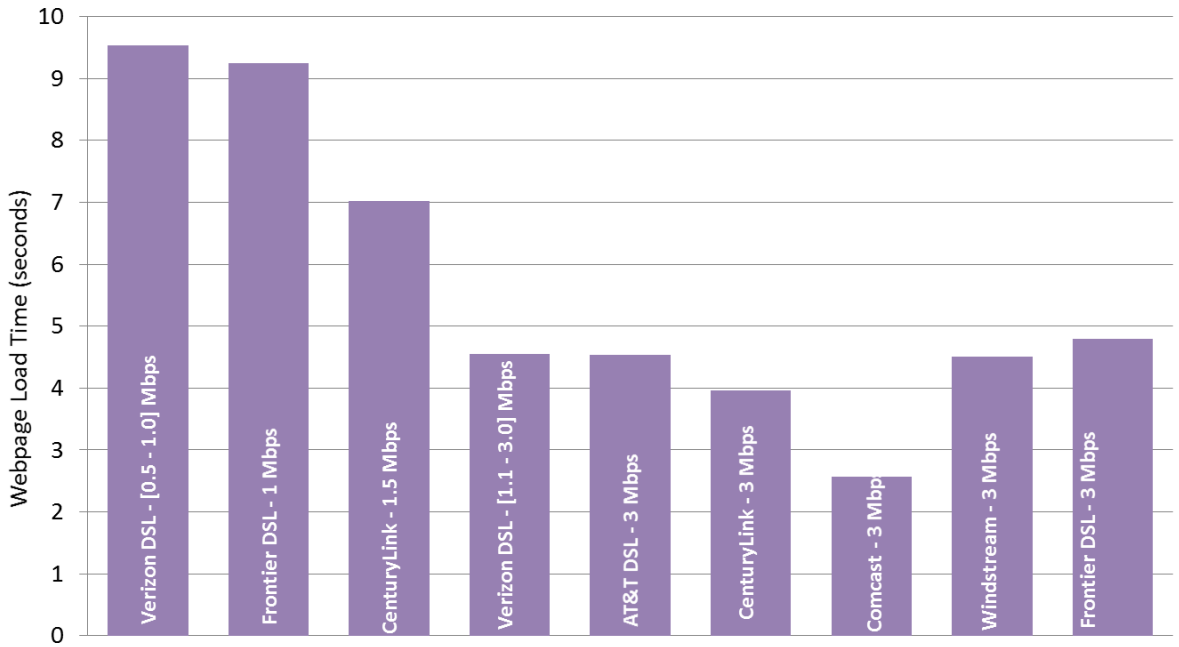


Chart 26.2: Average webpage download time, by ISP (5-10 Mbps)

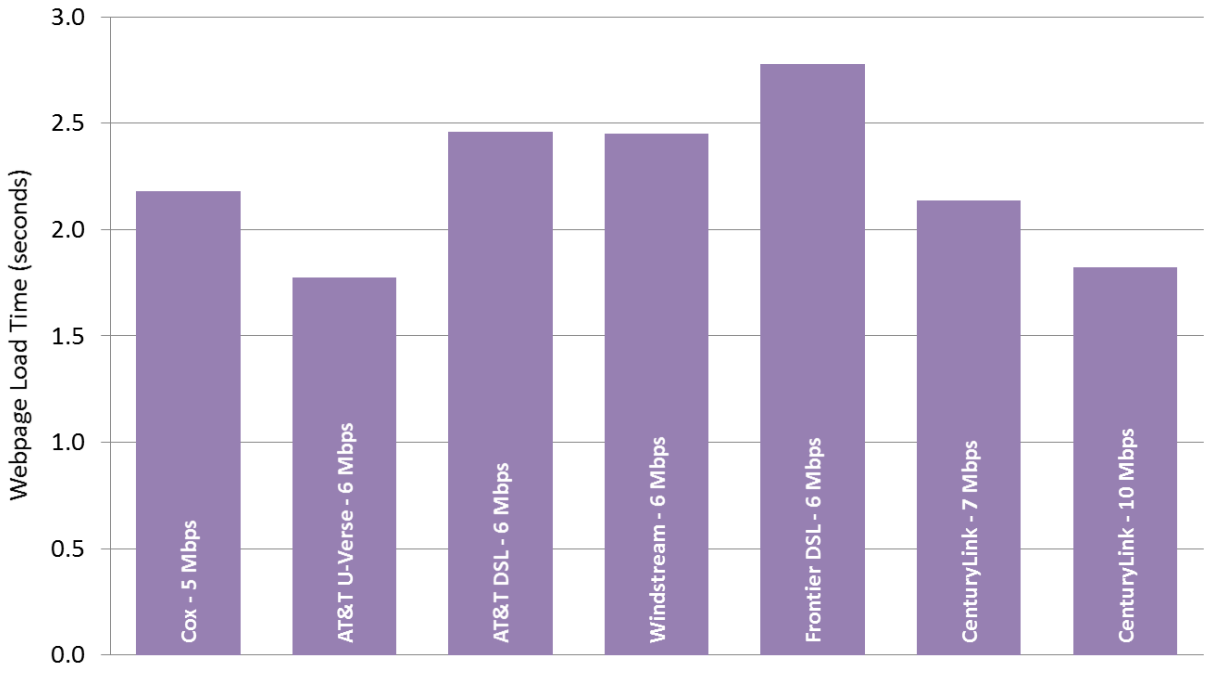


Chart 26.3: Average webpage download time, by ISP (12-15 Mbps)

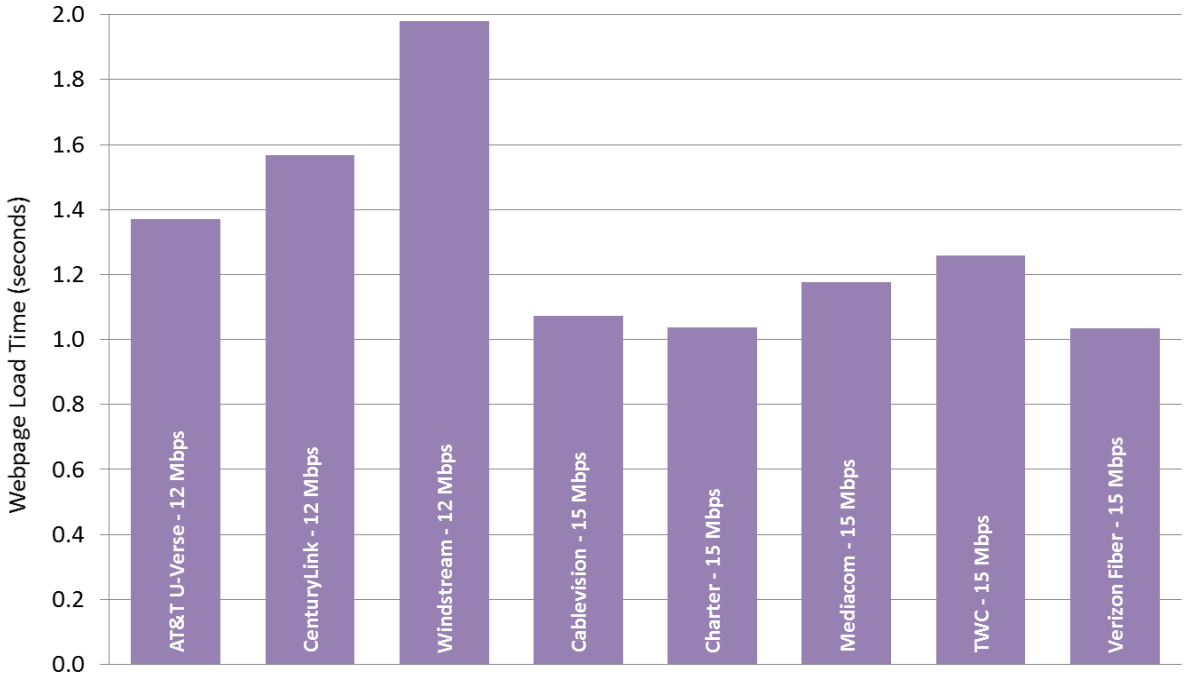


Chart 26.4: Average webpage download time, by ISP (18-25 Mbps)

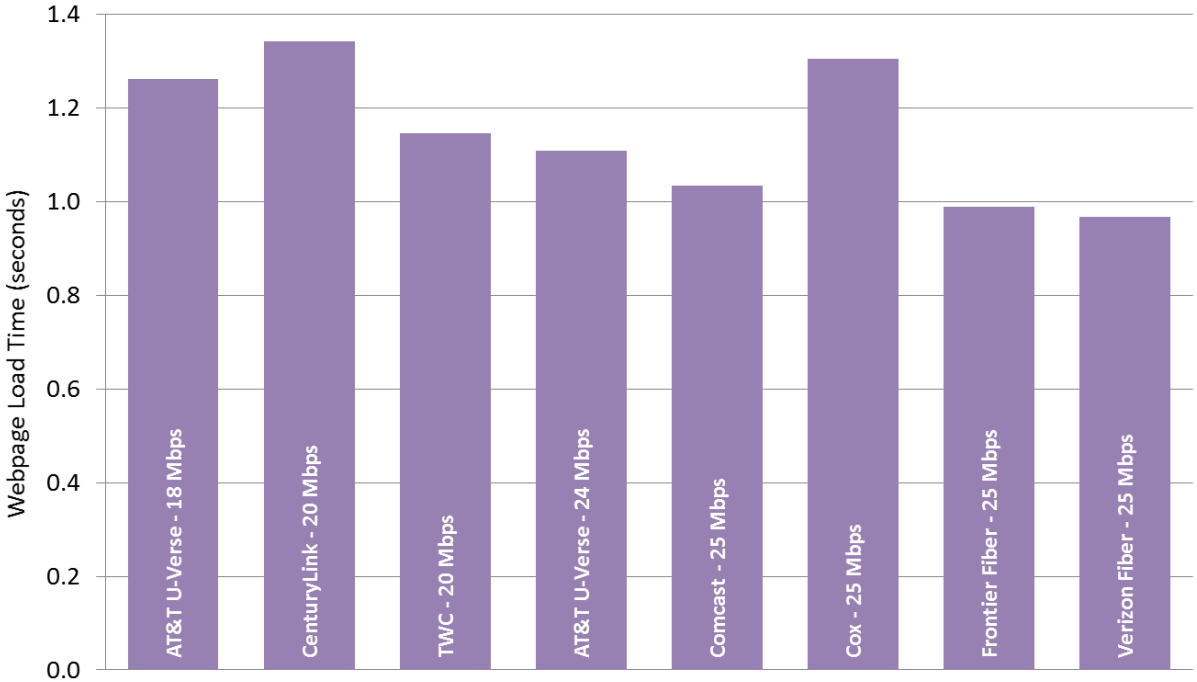


Chart 26.5: Average webpage download time, by ISP (30-50 Mbps)

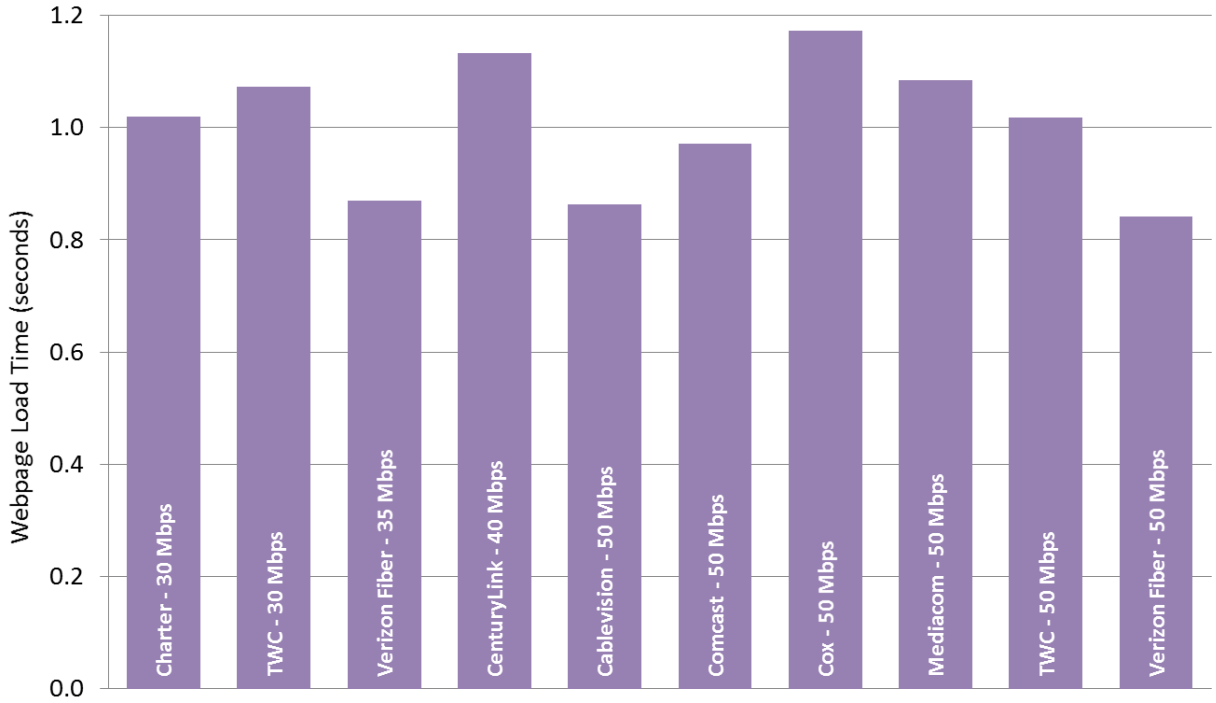
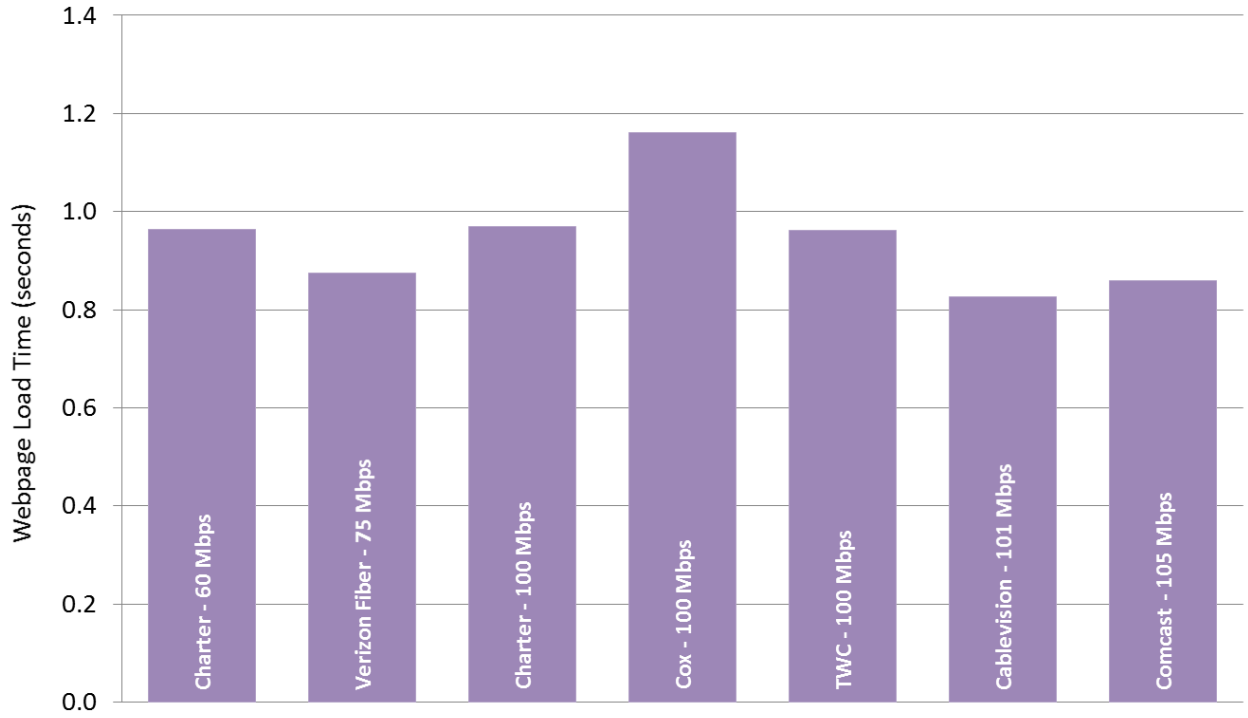


Chart 26.6: Average webpage download time, by ISP (60-105 Mbps)



D. Methodology and Sampling Plan for Statewide Statistics

The program's methodology and sampling plan is designed to measure ISP performance by census region in order to provide statistics at a national level. While the sampling plan was not designed to provide first order inferences by region or state geography, in some cases the subscriber counts and data do support some aggregated statistics by technology and region, and statistics by state. In order to calculate statistics for the more specific levels of regional and state geography, measurements must be aggregated across ISPs and technologies to ensure an adequate number of measurements are available. Table 5 displays the aggregate performance of all ISPs and technologies across all speed tiers in 2013 and 2014. However, as Table 6 indicates, some states do not have a sufficient number of samples and are excluded. For states with sufficient number of aggregated samples, Table 5 shows the Average Download Speed (the average of all actual download speeds) and the Average Tier Speed (the average of all advertised download speeds). The Total Sample Count shows the total number of subscribers for the State, and the cable, DSL, fiber, and satellite columns show the number of subscribers for a given technology, respectively.

Table 5: Statewide Download Speed with Sample Size by Technology

State	Average Download Speed (Mbps)	Average Tier Speed (Mbps)	Sample Size				
			TOTAL	Subdivided by Technology			
				Cable	DSL	Fiber	Satellite
AL	29.97	29.34	51	26	18	0	7
AR	14.23	14.5	39	9	25	0	5
AZ	37.66	40.03	218	161	54	0	3
CA	31.3	30.31	489	303	119	52	15
CO	22.79	22.64	117	39	71	0	7
CT	46.94	44.12	65	63	0	1	1
FL	26.9	27.85	173	81	69	18	5
GA	25.32	25.9	155	78	74	0	3
IA	29.26	33.57	172	128	44	0	0
ID	13.87	14.35	29	6	23	0	0
IL	25.99	25.21	185	107	71	0	7
IN	21.54	22.4	88	50	27	7	4
KS	36.83	40.09	33	23	9	0	1

KY	16.09	17.65	106	63	38	1	4
LA	32.52	30.96	41	30	4	0	7
MA	35.49	32.03	95	45	12	36	2
MD	39.01	36.67	81	19	6	55	1
MI	35.35	33.79	149	101	36	0	12
MN	23.29	23.85	136	73	63	0	0
MO	38.79	39.55	119	61	50	0	8
NC	21.43	21.17	190	118	68	0	4
NE	25.08	27.12	49	26	23	0	0
NJ	57.03	52.04	213	152	12	48	1
NM	21.08	22	52	20	32	0	0
NV	35.45	35.31	47	28	19	0	0
NY	41.31	38.71	380	280	35	57	8
OH	14.22	14.68	224	125	97	0	2
OK	31.75	31.98	62	40	17	0	5
OR	26.29	26.03	161	50	28	80	3
PA	25.9	24.88	167	49	65	52	1
SC	31.29	30.65	72	49	19	0	4
TN	26.08	25.76	70	57	11	0	2
TX	29.62	27.73	203	84	84	30	5
UT	28.53	29.07	40	23	17	0	0
VA	37.08	37.40	210	74	32	97	7
WA	25.26	24.8	181	84	51	43	3
WI	28.83	28.3	164	110	47	0	7

Table 6: States with Low Sample Counts

2013	Count	2014	Count
DC	7	DC	13
DE	9	DE	9
HI	10	HI	11
LA	17		
ME	8	ME	13
MS	7	MS	12
MT	3	MT	2
ND	2	ND	1
NH	13		
RI	7	RI	9
SD	2	SD	3
VT	1	VT	6
WV	9	WV	16
WY	1	WY	1

* LA and NH had sufficient samples for 2014.

In order to provide statistical background for the availability of technologies by state, Table 7 reproduces Form 477 statistics on the availability of particular broadband speeds for states, regions and technologies published in Table 16 of the October 2014 Internet Access Services Report.[31]

[31]. Industry Analysis and Technology Division Wireline Competition Bureau, Internet Access Services: Status as of December 31, 2013, Report (rel. Oct. 2014), https://www.fcc.gov/document/fcc-releases-new-data-internet-access-services-2 (Internet Access Report). Table 8 reproduces only the information for States and technologies included in Table 6 from Internet Access Report for connections by technology by state as of December 31, 2013 for connections over 200 kbps in at least one direction, in thousands. Data for satellite connections was withheld in the Internet Access Report to maintain firm confidentiality.

Table 7: Form 477 Statistics for Connections by Technology by State as of December 31, 2013 for States in Table B.4

State	ADSL Percent of Total	SDSL Percent of Total	Cable Modem Percent of Total	Fiber Percent of Total	ADSL Connections	SDSL Connections	Cable Modem Connections	Fiber Connections	Total Connections
AL	13.78%	0.10%	16.95%	0.29%	527	4	648	11	3823
AR	14.97%	*	13.86%	0.47%	350	*	324	11	2338
AZ	11.52%	*	22.24%	0.11%	649	*	1253	6	5634
CA	10.85%	0.03%	14.80%	2.14%	4205	11	5735	830	38742
CO	*	*	18.47%	0.14%	*	*	952	7	5154
CT	*	0.03%	21.71%	0.17%	*	1	783	6	3606
FL	10.14%	0.01%	21.36%	2.47%	1928	1	4060	469	19009
GA	13.80%	0.02%	16.03%	0.49%	1223	2	1420	43	8860
IA	16.29%	0.04%	17.43%	2.62%	386	1	413	62	2369
ID	16.33%	*	12.53%	0.30%	219	*	168	4	1341
IL	12.30%	0.05%	17.95%	0.22%	1470	6	2145	26	11952
IN	13.95%	0.02%	17.00%	1.77%	747	1	910	95	5354
KS	11.77%	0.04%	19.31%	2.84%	286	1	469	69	2429
KY	13.99%	0.06%	17.54%	0.83%	508	2	637	30	3631

MA	*	0.01%	23.36%	*	*	1	1568	*	6711
MD	*	0.03%	15.90%	*	*	2	912	*	5737
MI	10.27%	0.07%	20.84%	0.15%	904	6	1835	13	8805
MN	12.87%	0.29%	18.65%	1.00%	631	14	914	49	4902
MO	16.43%	*	14.04%	0.68%	850	*	726	35	5172
NC	12.83%	*	22.60%	0.56%	1071	*	1886	47	8346
NE	11.33%	*	21.59%	1.00%	181	*	345	16	1598
NJ	3.34%	0.01%	20.37%	*	310	1	1890	*	9279

Note: Data unavailable from the Internet Access Report or unable to be calculated is denoted by *.

Appendix A: AT&T Separation of IP-based U-verse from ATM-based DSL

The FCC received the following request from AT&T to separate out IP-based U-verse services from ATM-based DSL services for the 2015 Measure Broadband Report (see attachment below). This was agreed to by the FCC and the current Report differentiates between these services.

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at&t	**James K. Smith** Assistant Vice President Federal Regulatory	AT&T Services, Inc. 1120 20th Street, NW Suite 1000 Washington, D.C. 20036	T: 202 457 3010 F: 202 457 3070

February 20, 2015

Mr. Walter Johnston
Chief, Electromagnetic Compatibility Division
Federal Communications Commission
445 12th Street, SW
Washington, DC 20554

Re: *Measuring Broadband America Program*; GN Docket 12-264

Dear Mr. Johnston:

On August 18, 2014 and February 13, 2015, discussions were had with FCC Staff and representatives of SamKnows concerning AT&T's desire to separately Report IP-based U-verse broadband results for the Measuring Broadband America (MBA) 2014 test period. Initially, AT&T offered broadband Internet access services over ATM-based DSL. Since the publication of the Commission's first MBA Report, AT&T has invested significantly in its IP-based U-verse broadband platform. As a result of this investment in IP technology, combined with an aggressive effort to migrate legacy ATM-based Internet customers to AT&T's more robust IP-based U-verse technology, AT&T now has more than 12M IP-based U-verse high speed Internet customers. Furthermore, 62% of U-verse broadband customers have plans delivering up to 12 Mbps or higher as of September 2014.

In light of this technology evolution and continuing efforts to migrate legacy ATM-based DSL broadband customers to the more advanced IP-based U-verse technology, AT&T believes that it is now appropriate for the Commission to separately Report MBA test results for AT&T's IP-

based U-verse subscribers. Accordingly, AT&T hereby requests that the Commission's MBA Report for the 2014 test period, and any subsequent years, Report separately the results for AT&T's IP-based U-verse broadband subscribers as distinct from its legacy ATM-based DSL broadband subscribers.

Sincerely,

/s/ James K. Smith

James K. Smith

CC: Rajender Razdan