

Measuring Broadband America

**A Report on Consumer Wireline Broadband
Performance in the U.S.**

**FCC's Office of Engineering and Technology and
Consumer and Governmental Affairs Bureau**

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Executive Summary

To make informed choices about purchasing and using broadband, consumers need to have access to basic information about broadband performance. Will a particular offering allow me to browse the web quickly and easily? Will it enable me to use new applications that help me maintain my health, search for a job, or take courses online? What should I look for in a provider if I want to watch high definition online video or play online video games? Does a given speed tier have sufficient upload capacity to enable video conferencing? Will a higher speed, higher priced service improve my Internet experience? Can I get by with a lower priced service? And does the speed a provider advertises match the actual speed I will receive at my home? To help answer these questions, this Report presents the results of the first rigorous, nationwide study of actual home broadband performance in the United States.

Currently, information that would allow consumers to answer these questions is not readily available in a consistent and easily understandable form, and studies show that consumers' awareness of their broadband service and its characteristics is limited. A recent FCC survey found that 80 percent of consumers did not know what speed they purchased from their Internet Service Provider (ISP),¹ and during the course of the study outlined below, we found that a more modest but still sizable 49 percent of consumer volunteers inaccurately reported the advertised broadband speed they believed they had purchased from their ISP. Another study conducted in 2010 found that 13 percent of consumers who have broadband in the home do not know whether they purchased a basic or premium service.²

This lack of consumer awareness of basic elements of broadband performance led to the recommendation in the National Broadband Plan (NBP), released last year, that the Commission undertake several initiatives to help improve the availability of information for consumers.³

As part of the NBP, in March of 2010 the FCC made available a consumer-initiated online test of broadband speed.⁴ The purpose of the Consumer Broadband Test is to give consumers additional information about the quality of their broadband connections across their chosen ISPs' networks and to increase awareness about the importance of broadband quality in accessing content and services over the Internet. The Consumer Broadband Test has gathered data about how well the Internet is functioning, both generally and for specific ISPs at specific times. But the results of the software-based Consumer Broadband Test do not always capture the baseline connection quality provided by the consumer's broadband service: the core connectivity between an ISP and its subscribers, rather than between the rest of the Internet and those subscribers. For instance, results of software-based tests can vary depending on the end user's computer, the type of connection between the end user's computer and the ISP's network (*e.g.*, the use of an in-home WiFi router may affect test results), the number of end user devices connected to a broadband service, and the physical distance of the end user from the testing server. Additionally, there is no standard testing methodology for software-based broadband performance tests, and the Consumer Broadband Test therefore uses two

alternative testing methodologies, which also affects the results.⁵ In order to assess the speed claims made by ISPs, and to see how particular activities – such as browsing the web or watching streaming video – are impacted by different speeds, we decided to complement the more general Consumer Broadband Test with more consistent tests of the speed of broadband delivered to American homes.

The Commission has opened a public inquiry into the availability of information regarding broadband performance. Specifically, the Commission has issued a Notice of Inquiry on the topic of general consumer information and disclosure requirements,⁶ which sought comment on the types of information that consumers need to make informed choices. In April 2011, the Commission also issued a Public Notice seeking input on the particular types of information that are most useful to consumers in assessing which broadband services to purchase, and in particular which technical parameters have the most significant effects on common consumer uses for broadband.⁷

This Report responds to another NBP recommendation: that the Commission obtain and publicly release detailed and accurate measurements of consumer broadband performance on a national level.⁸ Such measurements can help inform consumers and create a mechanism for checking ISP broadband performance claims and for comparing ISPs in meaningful ways.

This Report presents results of the first nationwide performance study of residential wireline (or “fixed,” as opposed to mobile) broadband service in the United States using measurement technology deployed in the consumer’s home, focusing on three technologies—digital subscriber line (DSL), cable, and fiber-to-the-home.⁹ The study examined service offerings from 13 of the largest broadband providers¹⁰—which collectively account for approximately 86 percent of all U.S. wireline broadband connections—using automated, direct measurements of broadband performance delivered to the homes of thousands of volunteer broadband subscribers during March 2011.¹¹ This Report focuses on major findings of this study, while a separate Appendix provides a detailed description of the process by which the measurements were made and describes each test that was performed. In addition, the Commission is making available the following resources: electronic copies of the charts included in the Report; data sets for each of the charts in the Report; resources regarding the underlying methodology by which the data was collected and calculated; tabular results for each test performed and data sets for recorded data for March 2011; and the complete raw bulk data set for all tests run during the testing period.¹²

The results contained in this Report will enable consumers to compare the actual performance of different broadband offerings with a new level of detail and accuracy. In addition, the methodology developed in this study can serve as a tool to help broadband providers, including those that did not participate in this process, measure and disclose accurate information regarding the performance of their broadband services. The Appendix and the complete raw bulk data set will be useful to the research community in examining performance characteristics of broadband services in the United States, and in encouraging the development of new broadband performance testing methodologies in the future. We hope that

independent investigation of this data set will provide additional insights into consumer broadband services.

Unless explicitly stated otherwise, all of the findings in this Report reflect performance during the peak consumer usage hours of weekdays from 7:00 pm - 11:00 pm local time. We focus on this period of time since it is during such “busy periods” that consumer usage of broadband services is greatest and it is also during this period that the greatest performance degradation occurs.

Throughout this Report we use the term “advertised speed” to refer to the speed ISPs use to advertise and market a particular broadband service, *e.g.*, “1.5 Mbps¹³ DSL” versus “7 Mbps DSL.” Generally ISPs do not expressly guarantee advertised speeds, but rather may describe an advertised speed as an “up to” speed, suggesting that consumers can expect to experience performance up to the advertised speed, with actual performance varying based upon network conditions and other factors.

We also use the term “sustained speed” throughout this Report. Broadband Internet access service is “bursty” in nature. On a short time scale, broadband speeds or information rates may vary widely, at times approaching or even exceeding advertised speeds and at other times—due to network congestion—slowing to rates which may be well below advertised speeds. In this Report, to provide an estimate of long-term average broadband performance, we define sustained speed as speed averaged over a period of several seconds (note that sustained speed does *not* necessarily mean that actual speed stays above the sustained speed average for the entire period).¹⁴

Based on the foregoing, the major findings of this study include the following:

- Actual versus advertised speeds. For most participating broadband providers, actual download speeds are substantially closer to advertised speeds than was found in data from early 2009 and discussed in a subsequent FCC white paper, though performance can vary significantly by technology and specific provider.¹⁵
- Sustained download speeds. The average¹⁶ actual sustained download speed during the peak period was calculated as a percentage of the ISP’s advertised speed. This calculation was done for different speed tiers offered by each ISP.
 - *Results by technology:*
 - On average, during peak periods DSL-based services delivered download speeds that were 82 percent of advertised speeds, cable-based services delivered 93 percent of advertised speeds, and fiber-to-the-home services delivered 114 percent of advertised speeds.¹⁷
 - Peak period speeds decreased from 24-hour average speeds¹⁸ by .4 percent for fiber-to-the-home services, 5.5 percent for DSL-based services, and 7.3 percent for cable-based services.

- *Results by ISP.* Peak period download speeds varied from a high of 114 percent of advertised speed to a low of 54 percent of advertised speed.
 - Only three ISPs had speed decreases of 10 percent or greater during the peak period (as compared to 24-hour average speeds).
- Sustained upload speeds. Peak period performance results for upload speeds were similar to or better than those for download speeds.
 - Upload speeds were not significantly affected during peak periods, showing an average decrease of only 0.7 percent from the 24-hour average speed.
 - *Results by technology:* On average, DSL-based services delivered 95 percent of advertised upload speeds, cable-based services delivered 108 percent, and fiber-to-the-home services delivered 112 percent.
 - *Results by ISP:* Upload speeds among ISPs ranged from a low of 85 percent of advertised speed to a high of 125 percent of advertised speed.
- Latency. Latency is the time it takes for a packet of data to travel from one designated point to another in a network. Since many communication protocols depend upon an acknowledgement that packets were received successfully, or otherwise involve transmission of data packets back and forth along a path in the network, latency is often measured by round-trip time. Round-trip time is the time it takes a packet to travel from one end point to another, and for an acknowledgement of successful transit to be received back. In our tests, latency is defined as the round-trip time from the consumer's home to the closest¹⁹ server used for speed measurement within the provider's network.
 - During peak periods, latency increased across all technologies by 6.5 percent, which represents a modest drop in performance.
 - *Results by technology.*
 - Latency was lowest in fiber-to-the-home services, and this finding was true across all fiber-to-the-home speed tiers.
 - Fiber-to-the-home services provided 17 milliseconds (ms) round-trip latency on average, while cable-based services averaged 28 ms, and DSL-based services averaged 44 ms.
 - *Results by ISP.* The highest average round-trip latency among ISPs was 75 ms, while the lowest average latency was 14 ms.

- Effect of burst speed techniques. Some cable-based services offer burst speed techniques, marketed under names such as “PowerBoost,” which temporarily allocate more bandwidth to a consumer’s service. The effect of PowerBoost is temporary—it usually lasts less than 15 to 20 seconds—and may be reduced by other broadband activities occurring within the consumer household.²⁰ Burst speed is not equivalent to sustained speed. Sustained speed is a measure of long-term performance. Activities such as large file transfers, video streaming, and video chat require the transfer of large amounts of information over long periods of time. Sustained speed is a better measure of how well such activities may be supported. However, other activities such as web browsing or gaming often require the transfer of moderate amounts of information in a short interval of time. For example, a transfer of a web page typically begins with a consumer clicking on the page reference and ceases when the page is fully downloaded. Such services may benefit from burst speed techniques, which for a period of seconds will increase the transfer speed. The actual effect of burst speed depends on a number of factors explained more fully below.
 - Burst speed techniques increased short-term download performance by as much as 52 percent during peak periods for some offerings, and as little as 6 percent for other offerings.
- Web Browsing, Voice over Internet Protocol (VoIP), and Streaming Video
 - *Web browsing.* In specific tests designed to mimic basic web browsing—accessing a series of web pages, but not streaming video or using video chat sites or applications—performance increased with higher speeds, but only up to about 10 Mbps. Latency and other factors limited performance at the highest speed tiers. For these high speed tiers, consumers are unlikely to experience much if any improvement in basic web browsing from increased speed—*i.e.*, moving from a 10 Mbps broadband offering to a 25 Mbps offering.
 - *VoIP.* VoIP services, which can be used with a data rate as low as 100 kilobits per second (kbps) but require relatively low latency, were adequately supported by all of the service tiers discussed in this Report. However, VoIP quality may suffer during times when household bandwidth is shared by other services. The VoIP measurements utilized for this Report were not designed to detect such effects.
 - *Streaming Video.* Test results suggest that video streaming should work well across all technologies tested, provided that the consumer has selected a broadband service tier that matches the quality of streaming video desired. For example, standard video is currently commonly transmitted at speeds below 1 Mbps, while high quality streamed video might require 2 Mbps or more. Consumers should understand the requirements of the streaming video they want to use and ensure that

their chosen broadband service tier will meet those requirements, including when multiple members of a household simultaneously want to watch streaming video on separate devices.

This Report and the accompanying data sets provide a useful foundation for a more comprehensive and ongoing assessment of broadband speeds and reliability, and are a key step in our continuing effort to improve the availability of information regarding broadband performance in the U.S. We hope that broadband providers will adapt the methodology used in this project to develop their own broadband performance testing programs, to incorporate accurate performance measurement tools into their networks, and to improve their ongoing disclosures to consumers. In addition, the FCC plans to continue to study and acquire data on actual mobile broadband performance, which will help consumers, the FCC, and mobile broadband providers better understand actual performance, as the data from this project has done for fixed broadband.

This Report and associated supporting material can be found online as listed below:

Online Resources

- Report and Appendix: <http://www.fcc.gov/measuring-broadband-america>
- Electronic copies of charts included in Report: <http://www.fcc.gov/measuring-broadband-america/charts>
- Data sets for each of the charts in the Report: <http://www.fcc.gov/validated-march-data-2011>
- Resources regarding the underlying methodology by which the data was collected and calculated: <http://www.fcc.gov/measuring-broadband-america/methodology>
- Tabular results for each test performed and data sets for recorded data for March 2011: <http://data.fcc.gov/download/measuring-broadband-america/statistical-averages-2011.xls>
- Complete raw bulk data for all tests run during the testing period: <http://www.fcc.gov/measuring-broadband-america/raw-bulk-data-2011>