

Description of Tests Included in Report

The study developed 13 separate measurements that could be used to characterize various aspects of broadband performance to the consumer's home. This Report focuses on results from five of these tests for March 2011. The ISPs participating in the study agreed to base the Report on a full month of data, and following a prove-in period for the testing in February, participants in the study agreed to March as the test month, which afforded sufficient time for subsequent analysis of the data. Active data collection continued after March. Although each of the measurements taken over the course of the testing is useful for making determinations about the state of broadband performance in the U.S., this Report emphasizes two metrics that we believe are of particular interest to consumers: speed and latency.

Broadband throughput or speed, commonly expressed in Megabits/second or Mbps, is the primary performance characteristic advertised by ISPs. Broadband speed is the average rate at which information "packets" are delivered successfully over the communication channel. A higher speed implies a higher information delivery rate. A 10 Mbps service can, in theory, deliver ten times as much information as a 1 Mbps service in a given period of time.

The use of transient performance enhancements such as "PowerBoost," which are available as a part of many cable-based services, present a technical challenge when measuring speed. Services featuring burst techniques will deliver a far higher throughput for the earlier portion of a connection, although the duration of the speed burst may vary by ISP, service tier, and other factors. For example, a user who has purchased a 6 Mbps service tier might receive 18 Mbps for the first 10 megabytes³⁰ (MB) of a particular download. As supported by our test, this is of significant benefit to applications such as web browsing, which use relatively short-lived connections and transfer short bursts of data. But once the burst window lapses, throughput will return to the base rate, making the burst rate an inaccurate measure of performance for longer, sustained data transfers. In addition, other household broadband activities may decrease or eliminate the benefit of the speed burst. The speed test employed in this study isolated the effects of transient performance-enhancing services such as PowerBoost from the long-term sustained speed, and presents sustained and "boost" speed results separately.

Latency is another key factor in broadband performance. Latency is a measure of the time it takes for information to travel across a segment of a network and is commonly expressed in terms of milliseconds (ms). For practical reasons, latency measurements typically represent the round-trip latency, *i.e.*, from the consumer to the measurement point and back.³¹ The impact of latency is felt in a number of ways. For example, high round-trip latencies may compromise the quality of voice services in ways that are perceptible to consumers.³² Even lower latencies, which may not be directly noticeable by human perception, can still degrade network performance. Computer networks and applications are more sensitive to latency than humans. Latency affects the rate of information transmission for TCP protocol, which is commonly used to support Internet applications, and can therefore limit the maximum speed achievable for a broadband service regardless of the actual service speed. In the interactive

communications found in computing applications, latency is also additive, which means that the delay caused by the sum of a series of latencies adds to the time it takes to complete a computing process. Thus, latency can have a significant effect on the performance of applications running across a computer network. As service speeds increase, the impact of network latency can become more noticeable, and have a more significant impact on overall performance.

One of the key factors that affects all aspects of broadband performance is the time of day. At peak hours, designated for the purpose of this study as between 7:00 pm and 11:00 pm local time on weeknights, more people are attempting to use the Internet simultaneously, giving rise to a greater potential for congestion and degraded user performance. Unless otherwise noted, this Report concentrates on performance during peak hours as the period of highest interest to the consumer, while results for 24-hour averages and weekend performance are included in the Appendix.

This Report highlights the results of the following tests of broadband speed and latency, as measured on a national basis across DSL-, cable-, and fiber-to-the-home technologies:

- **Sustained download speed:** throughput in Mbps utilizing three concurrent TCP connections measured at the 25-30 second interval of a sustained transfer
- **Sustained upload speed:** throughput in Mbps utilizing three concurrent TCP connections measured at the 25-30 second interval of a sustained transfer
- **Burst download speed:** throughput in Mbps utilizing three concurrent TCP connections measured at the 0-5 second interval of a sustained transfer
- **Burst upload speed:** throughput in Mbps utilizing three concurrent TCP connections measured at the 0-5 second interval of a sustained transfer
- **UDP latency:** average round trip time for a series of randomly transmitted user datagram protocol (UDP) packets distributed over a long timeframe