

Internet Speed

Executive Summary

Internet speed is the measure of how fast data is transferred. More specifically, internet speed encompasses many metrics including bandwidth, latency, and jitter which describe the overall capacity and smoothness of data transmission. Different users may require different speeds depending on the application, so some aspects of speed may be more important than others for users with specific needs. Internet access technologies (fiber, cable, DSL, satellite, etc.) place different limitations on these performance metrics.

Highlights

- Internet speed is usually measured by bandwidth, the amount of data transmitted over time.
- Latency is another metric of speed, involving the amount of time for data to move between sender and receiver.
- Different internet technologies have different speed limitations.

Limitations

- Estimating average speed can be difficult depending on network conditions (congestion) and end-user technology.
- Some new technologies (5G and low-earth orbit satellites) are relatively untested.

Internet Speed Metrics

Internet speed, as viewed by the end user, depends on several factors, including bandwidth and latency.^{1,2} The most common description of internet speed is measured by **bandwidth**, which is the amount of data transmission over time, in megabits per second (Mbps). This is often advertised by internet service providers (ISPs), which list the maximum bandwidth possible. The Federal Communications Commission (FCC) currently sets the definition of high speed internet (broadband) based on bandwidth, with 25 Mbps download and 3 Mbps upload, although this may not be adequate for certain applications.³ This metric is especially relevant for large file downloads and video streaming. Another metric affecting speed is latency.² **Latency** refers to the fixed amount of time for data to move between sender and receiver, measured in milliseconds (ms). Latency is especially important for quick interactions, including video calls, online gaming, telemedicine, and online learning.² The FCC does not set any limits for latency currently.² Latency also changes over time, and this rate of change is referred to as **jitter**. High jitter can render applications like video calls difficult to use, even when the average latency is considered acceptable.⁴

Technological Capabilities

Some technologies offer faster speeds in terms of bandwidth and latency. The FCC Fixed Broadband tool can be used to compare advertised bandwidth rates in different locations.⁵

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Typically, internet delivered via fiber (fiber optic cables used to transmit light) has the highest bandwidth. Following fiber in bandwidth is cable modem (transmission over coaxial cables) and digital subscriber lines (transmission over traditional copper phone lines, also known as DSL).⁶ Satellite broadband has lower bandwidth and much slower latency than terrestrial technologies (fiber, cable, DSL).⁶ This latency limitation is due to the distance between the satellite and the ground. Satellite internet is also less reliable than terrestrial because it is impacted by weather conditions.⁶ Low-earth orbit satellites have been proposed to potentially increase bandwidth and somewhat reduce latency.⁷ 5G wireless networks have been proposed as an option to reach broadband speeds. Like the previous generation of cellular networks (4G), these operate on radio waves but use higher frequencies. While this allows greater bandwidth, the higher the frequency (especially for millimeter wave frequencies), the more limited range and trouble penetrating materials like glass or drywall. Because of these limitations, this technology is predicted to be mainly used in dense urban settings.^{8,9}

Actions of the user may also impact internet speeds. While ISPs advertise their maximum speeds (bandwidth), users may not always achieve these speeds. This can be due in part to technology at the user end, such as the type of router or number of users actively using the internet at the same time.¹ Connections may also vary based on congestion during peak hours, or in the case of DSL, distance to telephone company facilities.^{6,10}

References

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