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Fixed Technologies Used to Deliver Broadband Service: A Primer and Considerations for Congress

Broadband—in general—refers to technologies that are capable of delivering high-speed internet service. Internet service providers (ISPs) use various technologies to deploy broadband infrastructure, and each technology has different speed and other performance characteristics. ISPs choose a certain broadband technology for a certain serviceable area based on various factors—for example, deployment cost and consumer demand in the area. Many consumers prefer fiber technology for their broadband service because of its reliability and high speed (e.g., most U.S. ISPs currently offer fiber-based residential internet service with up to 1 gigabit per second (Gbps) download speed). There is debate among Members of Congress on whether only fiber should be supported in federal efforts to close the digital divide, or whether other technologies should be included. The digital divide refers to the gap between those who have access to broadband services and those who do not.

This In Focus describes major fixed technologies capable of delivering broadband service and discusses selected considerations for Congress. Fixed internet service means service delivered through a stationary connection. Mobile technology (e.g., fifth-generation [5G] wireless technology) that is capable of delivering high-speed internet service is outside the scope of this In Focus.

Fixed Broadband Technologies

Fixed technologies that are capable of providing consumers with access to broadband include cable, digital subscriber line (DSL), fiber, satellite, and terrestrial fixed wireless. Some technologies provide consumers with a better-quality broadband connection than others, as measured by speed, latency (lag time), and reliability. **Table 1** provides a sampling of upload and download speed ranges of these technologies. **Table 2** provides the number of residential connections (ordered from most to fewest) by technology in the United States as of December 31, 2021.

Cable

Some cable service providers offer TV and broadband internet simultaneously through the same coaxial cables, with TV and internet provisioned on separate frequency channels.

Digital Subscriber Line

Broadband service provided through DSL—an older technology—transmits data over traditional copper-wire telephone lines.

Fiber

Broadband service provided through fiber transmits data via pulses of light. Fiber is hung (aerially) on poles or buried in the ground and can be connected directly to individual

residences (“fiber to the home”) or to a local platform that serves multiple customers (“fiber to the curb” or “fiber to the neighborhood”).

Satellite

Satellite broadband is provided by satellites either in geostationary or geosynchronous orbit (GEO) or in low Earth orbit (LEO). A satellite antenna (dish), modem, and direct line of sight are required for such service. LEO satellites for broadband—positioned at a lower altitude above the Earth than GEO satellites—are a newer satellite broadband technology.

Terrestrial Fixed Wireless

Using radio spectrum (licensed and/or unlicensed), broadband service through terrestrial fixed wireless technology transmits data between two fixed locations wirelessly but still relies on fiber or other physical cables for backhaul connection to the provider’s network.

Table 1. Sampling of Fixed Broadband Technology Speed Ranges (Upload and Download)

Technology	Upload	Download
Cable	10-500 Mbps	5-50 Mbps
Digital Subscriber Line	5-35 Mbps	1-10 Mbps
Fiber	250-1,000 Mbps	250-1,000 Mbps
Satellite (GEO)	25 Mbps	3 Mbps
Satellite (LEO)	25-220 Mbps	5-20 Mbps
Terrestrial Fixed Wireless	10-25 Mbps	1 Mbps

Source: CenturyLink, *Cable vs. DSL vs. Fiber Internet: Which is Best?*, October 6, 2021, at <https://discover.centurylink.com/cable-vs-dsl-vs-fiber-broadband-internet.html>; AT&T, *How Fast is AT&T Fixed Wireless Internet?*, at <https://www.att.com/internet/fixed-wireless/>; HughesNet, *What Comes in a HughesNet Plan?*, at <https://www.hughesnetinternet.net>; Starlink, *Starlink Specifications*, at <https://www.starlink.com/legal/documents/DOC-1400-28829-70>.

Note: Mbps = megabits per second.

Advertised Speeds and the National Broadband Map

The speeds provided in **Table 1** are ranges advertised by a sampling of service providers. Consumers may or may not experience these speeds—actual speeds may be higher or lower. The Federal Communications Commission (FCC) National Broadband Map provides information on broadband service availability by specific providers,

including the type of technology and speeds that are available. These data are submitted to the FCC by service providers twice a year. Per FCC rules, they may report the speeds they advertise, rather than actual speeds consumers are experiencing.

Residential Connections by Technology

According to the FCC *2022 Communications Marketplace Report*, broadband service provided through cable has the highest number of residential connections in the United States (see **Table 2**).

Table 2. Fixed Broadband Services in the United States by Technology (as of December 31, 2021)

Technology	Residential Connections
Cable	71.802 million
Fiber	24.165 million
Digital Subscriber Line	15.211 million
Terrestrial Fixed Wireless	2.672 million
Satellite	1.692 million

Source: Federal Communications Commission, *2022 Communications Marketplace Report*, December 30, 2022, p. 10, at <https://docs.fcc.gov/public/attachments/FCC-22-103A1.pdf>.

Notes: Residential connections are ordered from most to fewest. Data as of December 31, 2021 are the most recent data. The FCC publishes a Communications Marketplace Report every two years; the next version is anticipated in 2024.

Considerations for Congress

Issues that have, or may, come to the attention of the 118th Congress include the potential implications of raising the minimum broadband speed benchmark, as well as technological considerations by federal agencies for broadband projects using federal funding.

Minimum Broadband Speed Benchmark

As set by the FCC in 2015, to be considered broadband, an internet service should provide speeds of at least 25 Mbps for download and 3 Mbps for upload (25/3 Mbps). Some policymakers have considered raising the minimum broadband speed benchmark. For example, in March 2021, some Members of Congress sent a bipartisan letter to the FCC advocating for an increase to 100/100 Mbps. In July 2022, FCC Chairwoman Jessica Rosenworcel circulated a Notice of Inquiry to fellow FCC Commissioners that proposed increasing the minimum broadband speed benchmark to 100/20 Mbps. Raising the minimum broadband speed benchmark would raise the number of households considered unserved with broadband. Federal funds intended to provide service to areas currently without any broadband service might be redirected to areas that already meet the existing 25/3 Mbps benchmark to upgrade those areas to meet the new benchmark. Technologies such as DSL and GEO satellites that currently meet the 25/3 Mbps benchmark may not be able to deliver the speeds required by a higher benchmark.

Technological Considerations for Projects Using Federal Funding for Broadband Deployment

Some agency decisions about technology eligibility for federally funded broadband deployment projects have been a source of debate. For example, some Members of Congress have asked the National Telecommunications and Information Administration (NTIA) to revise the Notice of Funding Opportunity (NOFO) for the Broadband Equity, Access, and Deployment (BEAD) program, noting that “the BEAD’s rules violate the technology neutral spirit of the Infrastructure Investment and Jobs Act (P.L. 117-58).” Below are examples of technological decisions from the NTIA, the FCC, and the Department of the Treasury that Congress could weigh during future consideration of federal programs funding broadband.

In its NOFO for the \$42.45 billion BEAD program, NTIA defined reliable broadband service (i.e., technologies that are eligible for the program) as the following: fiber, cable, hybrid fiber-coaxial, digital subscriber line, and terrestrial fixed wireless utilizing licensed or a hybrid of licensed and unlicensed spectrum. This list does not include mobile, satellite, or fixed wireless over unlicensed spectrum. Separately, but also in the BEAD NOFO, NTIA prioritizes end-to-end fiber projects—states cannot choose to use other eligible technologies for broadband deployment unless they show why a fiber project is not viable for a particular location.

The Department of the Treasury, which administers the \$10 billion Capital Projects Fund (CPF) under the American Rescue Plan Act of 2021 (P.L. 117-2), also prioritizes fiber. According to the CPF Frequently Asked Questions, “CPF recipients are encouraged to prioritize investments in fiber-optic infrastructure where feasible, as such advanced technology better supports future needs.”

Although companies that use LEO satellite technology to provide broadband service were eligible to bid in the auction for Phase I of the FCC’s Rural Digital Opportunity Fund, the FCC reversed its decision on usage of LEO satellite technology for the program. Space Exploration Technologies Corporation (SpaceX) originally won more than \$885 million to deploy Starlink. However, after legal, technical, and policy debates, the FCC decided not to authorize support, stating that “Starlink’s technology has real promise ... but the question before us was whether to publicly subsidize its still developing technology for consumer broadband.”

Additional CRS Resources

CRS In Focus IF12429, *Broadband Equity, Access, and Deployment (BEAD) Program: Issues and Congressional Considerations*, by Ling Zhu.

CRS In Focus IF11875, *Raising the Minimum Fixed Broadband Speed Benchmark: Background and Selected Issues*, by Colby Leigh Rachfal.

CRS Report R47506, *The Persistent Digital Divide: Selected Broadband Deployment Issues and Policy Considerations*, by Colby Leigh Rachfal.

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