

What is Broadband?

Desirable broadband characteristics are affordable, high-speed, always connected, access that can support common Internet and Intranet applications. Let us consider each of these characteristics.

Affordable

The cost for residential Internet access today generally ranges from \$30 to \$50 per month. Additional services delivered over a broadband connection, such as telephone calls, music, and video may cost more. Costs for businesses are usually much higher, which discourages use for small and medium businesses. For example, the cost for 1.5 Mbps T1 line Internet access may be \$1000 to \$2000 per month, which is usually prohibitive. Business DSL and cable services may be more reasonable. Many communities are setting up non-profit organizations to deliver 10/100/1000 Mbps Ethernet access to every premise for \$30-\$40 per month.

High Speed

Important issues are the speed, throughput, and quality-of-service (QoS), both upstream and downstream, which are needed to support desired applications. Most local area networks (LANs) today provide end-user access at bi-directional, symmetrical speeds of 10/100 Mbps. These same speeds are desirable for residential and small business access, but generally require fiber to the premise solutions (FTTP). Fiber can also support higher speeds, such as Gigabit Ethernet and 10 Gbps Ethernet.

Residential cable TV modems, ADSL (Asymmetrical Digital Subscriber Line), and satellite have generally been too slow in the upstream directions to support much more than text email (64-128 kbps). Speeds and performance vary greatly among different service providers and, in the case of ADSL, are dependent on telephone cable distance. Cable TV and DSL services are generally much better than dial-up, especially in the downstream direction where T1 like speeds are possible. Newer versions of cable, DSL, and satellite are being deployed that can offer better performance, but far less than the performance possible over fiber.

In the wireless-LAN arena, 802.11a/b/g products can support 5 Mbps to 25 Mbps throughput per access point, which is divided among the number of simultaneous users. Generally, wireless-LANs have not been suitable for video applications, although the technology continues to improve. Also, quality-of-service capabilities have been in development to support voice and video applications. Nonetheless, the technology is very useful for portable, hot-spot, alternate route, and hard-to-reach locations, depending on the applications. The speeds decrease at longer distances.

Always Connected

Dedicated, always on, connections are needed that are always available and ready for sending and receiving data. Dial-up connections are typically inconvenient and slow, which discourages use. Also, dial-up may not be readily available if the line is in use for other purposes.

Access

Access refers to an organization's, or end-user's, communications connection from wherever they are located to the service provider's core network. It may be referred to as local, metro, last mile, first mile, and last 100-foot access. It is usually provisioned over fiber, twisted-pair, or coax cables, as well as wireless (radio frequency and laser light). For end users, the most common type of broadband access interface connection is Ethernet. Computers that are connected via Ethernet use a standard set of communication protocols called TCP/IP to communicate over the Internet.

Applications

Applications determine what speed and capacity broadband needs to support. If a broadband network does not support the desired applications as they evolve during the life of the infrastructure, then the infrastructure will need to be replaced. It could be several times more costly to deploy technologies with a short life-cycle, than to put in a longer-term solution.

Common applications include:

- e-Mail, with attachments
- Web browsing, with downloads which can be large
- Web discussion forums
- Internet messaging and chat
- Telephony and Voice over IP
- Teleworking from home, with file transfers in both directions
- Banking
- Web site for marketing/advertising/publishing/collaboration
- Placing orders
- Making payments
- Receiving orders and payments from customers
- Interactive customer and/or employee services
- Call centers
- Education and training
- Audio streaming and audio on demand
- Video streaming and video on demand
- Videoconferencing
- File sharing and/or transfer of large files
- Network storage and backup
- Monitor and control for security, environmental control, alarms, etc.
- Health monitoring and pervasive computing
- Networking wireless access points
- Networking between organization, partner, and home-office sites
- Disaster avoidance and recovery

Most common applications are horizontally applicable across all sectors, including government, education, healthcare, business, homes, etc. Basic network needs and the

infrastructure to support them are similar for all. Individuals on the underserved side of the digital divide that have not had the opportunity to learn and use Information Technology may not realize the value, but many can learn if affordable broadband is available.

Asymmetrical services that severely restrict upstream traffic, such as many of today's ADSL and Cable TV modem services that inhibit small businesses and the masses of people from being producers of content and services. This is *not* good for economic development, e-business, distance learning, telemedicine, teleworking, and other sector applications. High-speed broadband access should be symmetrical, or provide bi-directional, dynamic, allocation of bandwidth. Products are available that provide the needed functionality. Communities should not support service providers that do not provide the needed services.

To support minimal 2-way video, audio, and file transfer at least 512-768 kbps are needed with QoS, but 1-2 Mbps is more satisfactory. High resolution digital video needs throughputs of 10-20 Mbps per channel. To interconnect government, school, large/medium business, and other sites, 10, 100, and 1000 Mbps links may be needed. Higher speed 10 Gbps links, or channels, are needed for advanced backbones, education/research, telemedicine, network storage, and other applications. These speeds and capacities are all possible today using IP over Ethernet over Optical technologies.