Bandwidth Primer

The basic conditions and terms used to describe information exchange over networks.

385 Jordan Road • Troy, NY 12180 • Phone 518.286.7000 • 518.286.2439 • www.learnlinc.com

Table of Contents

TABLE OF CONTENTS....2

WHY BE CONCERNED ABOUT BANDWIDTH? 3

THE COMPUTER 3

THE LAN (LOCAL AREA NETWORK)....4

WHEN THE LAN IS NOT ENOUGH...YOU NEED A WAN 5

CONNECTIVITY OPTIONS FOR A WAN, A PRIVATE INTRANET, OR THE PUBLIC INTERNET....6

THE INSIDE OUT 7

UNICASTING VS. MULTICASTING 7

Unicasting....8
Multicasting....8

BANDWIDTH AND ONLINE LEARNING....9

ABOUT LEARNLINC CORPORATION 10

A Primer on Bandwidth

Bandwidth *refers to the amount of information that can be transmitted over a network in a given amount of time, usually expressed in kilobits (thousands of bits) per second or Kbps. It is often confused with speed. Speed is the time it takes for one piece of information to get from point A to point B. Think of two conveyor belts of different widths, both moving at identical speeds. Two boxes, one placed on each conveyor belt will both reach the end at the same time, but the wider conveyor belt can carry more boxes than the narrow one. Thus, a network with more bandwidth can carry more information per second than one with less bandwidth.*

Why be concerned about bandwidth?

The desktop computer world began with just that – a computer sitting on a desktop, accessible by one person, unconnected to other computers. That world has now evolved to include local area networks, wide area networks, intranets, and the ubiquitous World Wide Web. Information now travels between computers down the hall, throughout the organization and around the world at network speed. Unfortunately the amount of information transmitted is subject to many limitations. This whitepaper attempts to explain the conditions and terms being used today to describe the limits on electronic information exchange – a matter of bandwidth.

You may think that this information is none of your concern, but if you are involved in any way with the operation, evaluation, and selection of information technology, your ability to understand and communicate requires a basic knowledge of bandwidth issues.

The Computer

You are probably familiar with the World Wide Web or Internet connections at home. Your computer is connected through a **Modem**, which allows you to dial-up to an **ISP** (**Internet Service Provider)**. Computer modems provide bandwidth between 14.4, 28.8, and 56 Kbps. These rates represent maximum limits. The actual rate may be much less than the stated bandwidth. The amount of time you have to wait for a screen to display or for a file to download is a function of the modem speed, the current amount of traffic on the Internet, and the capabilities of the site that you are accessing. It is not uncommon for a 56 Kbps modem to connect at only 28 Kbps.

In some areas, cable companies offer **Cable Modems** and telephone companies offer **DSL (Digital Subscriber Line)** service providing bandwidth up to 7 Mbps (million or megabits per second), depending on the same factors affecting standard modems. In either case, the higher bandwidth rates refer to your connection to your ISP, and while actual bandwidth rates can be much higher than standard modems, performance varies with conditions on the Internet at any given point in time. **The public Internet provides no guaranteed bandwidth rate.**

The following chart illustrates the time needed to download a 1-Megabit still picture at various bandwidth rates:

Modem connecting at 28.8 Kbps	36 seconds
Modem connecting at 56 Kbps	14 seconds
Cable Modem connecting at 1.2 Mbps	.7 seconds

The LAN (Local Area Network)

A **LAN** is a group of computers connected together to share files such as Word documents, hardware peripherals such as printers, software applications such as databases or email. A LAN is usually set up for a single location such as a company headquarters, branch office, or University campus. LANs are often connected to the public Internet to provide Internet access or email.

LAN Components

- Workstations (computers)
- Network cards
- Cables
- Hub
- Server
- Rules for communicating (protocols)

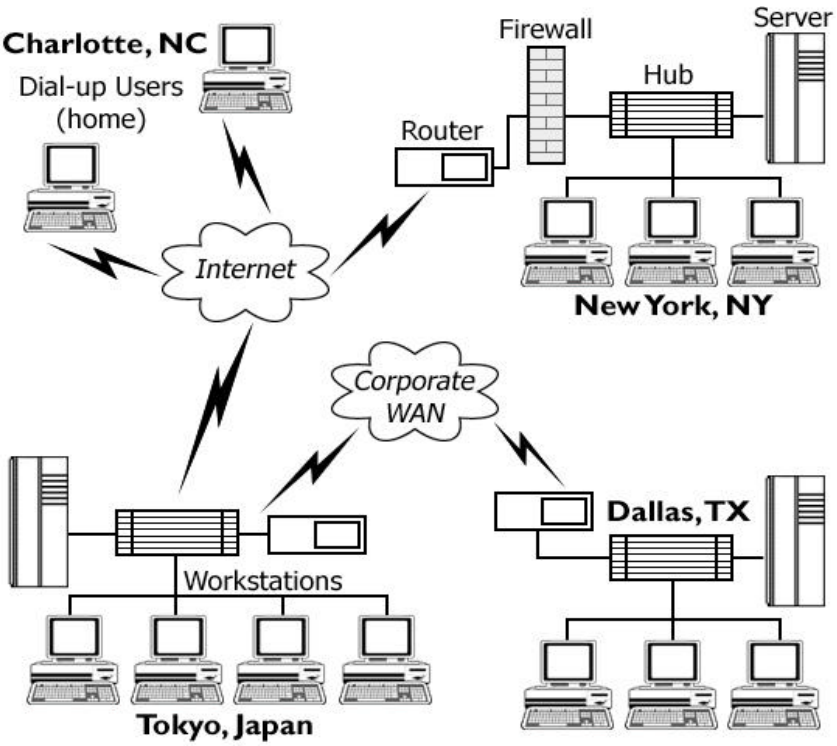
All computers on the LAN are connected via network wires from their network cards to a network hub that connects them all to a server. Protocols are the rules that the network cards use to keep track of the information on the LAN. Information usually travels around a LAN at a rate of 10 to 100 Mbps. The effective information transfer rate depends on the amount of traffic on the LAN at any given time. This is considered to be a high bandwidth environment for desktop computers.

When the LAN is not enough...you need a WAN (Wide Area Network)

A **WAN** is made up of one or more LANs that connect computer locations via telecommunications links. Corporate LANs are sometimes connected together over a variety of different kinds of communications lines to create a private network similar to the **Public Internet** – this is called a **Private Intranet** or a **LAN/WAN.**

Routers are special network devices used to connect one recognized computer network to another. Routers work like a postal worker; they examine the To addresses of network messages they are given and use part of the address like a zip code to figure out which computer network to send it to. Once a router has figured out which network the message should go to, it sends the message to another router, which repeats the process until the last router in the chain sends it directly to the computer listed in the destination address.

This diagram illustrates a typical situation in which private computers and LANs are connected by the public Internet or private WANs or intranets:



Connectivity Options for a WAN, a Private Intranet, or the Public Internet

ISDN

ISDN (Integrated Services Digital Network) is a digital telephone line that can be used like a regular telephone line. ISDN users dial up the other ISDN locations and pay for just the time connected. ISDN bandwidth is guaranteed and varies from 56 to 128 Kbps.

T-1

T-1 is a type of high-speed digital connection that requires a two-pair (four-wire) connection between the Telephone Company Central Office and the customer premises. T-1 lines are always connected and operate at 1.54 Mbps (or 1540 Kbps, more than ten times ISDN). Fractional T-1 service is also available, which provides less bandwidth over the same connection.

Frame Relay

Frame Relay connections are designed to take advantage of the fact the most information requires a low rate of transmission, requiring short "bursts" of data infrequently. Bandwidth on a frame relay connection may be set at any level based on the price.

The Public Internet and Private Intranet

The public Internet and private intranets use the same technology to connect computers. ISDN, T-1 lines, and routers are all used to operate Internet/intranets. Just like the protocols used to direct data in a LAN, a protocol called TCP/IP (Transmission Control Protocol/Internet Protocol) is used to direct information on the Internet/intranets.

When you send an e-mail, TCP/IP breaks the message into "packets." Each packet is packaged with surrounding information such as the source, destination, etc. All packets are broadcast onto the network. When received, the packets are collected, put back in order, and the message is rebuilt. TCP/IP works the same for e-mail, file transfers, audio, and video, and other data.

Because private intranets use higher bandwidth connections in a controlled environment, there are differences in the performance of intranets versus the public Internet:

Intranet:
- Private
- Operated by provider
- More dependable
- More secure
- Usually some guarantee of service

Internet:
- Public
- No one controls it
- Less dependable
- Less secure
- No guarantees

The Inside Out

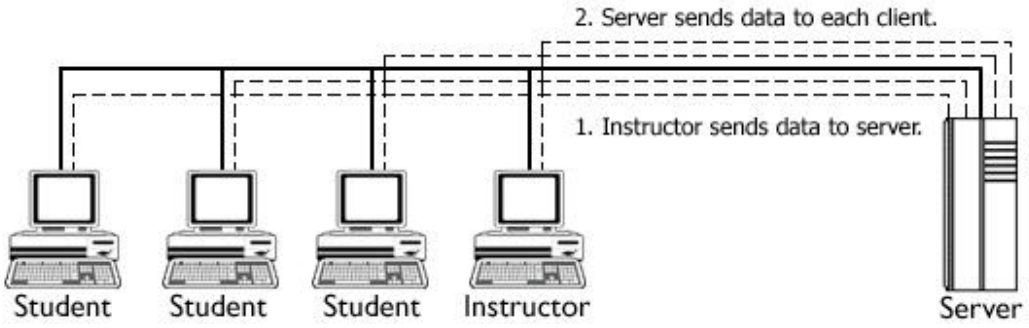
Most organizations want to limit access to their internal information by the world outside so they stay behind a Firewall. It's the firewall that keeps email addresses private and keeps outsides from accessing a private database inside an organization. Generally, firewalls inspect information packets to verify that they are allowed in or out. A Proxy Server may also be used to store information until an internal network requests it. The configuration of firewalls and proxy servers by different organizations can determine whether employees can access certain information services.

Unicasting vs. Multicasting

Unicasting

There are two different methods for distributing information using TCP/IP on networks. Unicasting works by sending packets of information (such as audio) to every computer that is participating in an IP audio conferencing session. Thus, the bandwidth requires is a multiple of the number of participants. The diagram below illustrates a unicasting scenario:

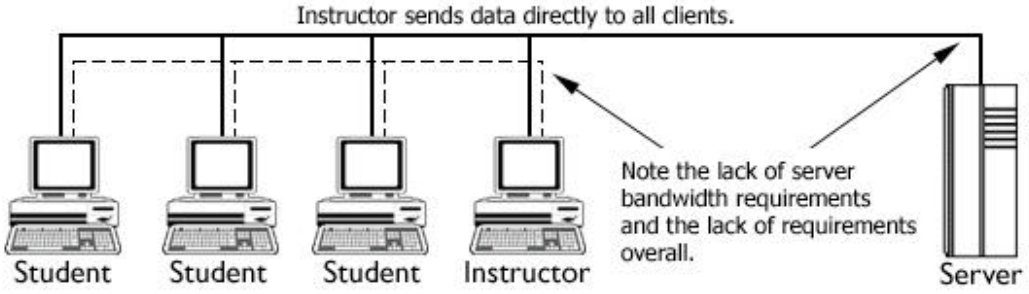
Unicasting



Multicasting

Multicasting works by sending one set of packets which are replicated for each participating computer. The bandwidth required is not dependent on the number of participants, but rather remains constant regardless of the number. Multicasting requires the use of routers on the network and is not widely supported in the public Internet. The diagram below illustrates a multicasting scenario:

Multicasting



Bandwidth and Online Learning

At LearnLinc Corporation, we believe that online learning solutions should be flexible enough to serve different learners under different conditions as corporations and universities grow and expand their learning requirements. That is why we offer communications options such as audio and video conferencing using technologies such as multicasting. The LearnLinc live, virtual classroom is designed with comprehensive learning tools to deliver highly effective interactive training under widely varying bandwidth conditions.

If you are evaluating online learning solutions such as the LearnLinc virtual classroom, we suggest that you gather the following information before you talk to online learning vendors.

- Modem speed and actual connection rate for remote students dialing the public Internet or Corporate Remote Access Server
- Bandwidth available from the LAN to the public Internet (corporate Internet connection)
- Bandwidth available on the LAN and/or WAN (or intranet)
- The availability of multicasting on the WAN.

The more information you have at hand when you discuss the various options for online learning, the easier it is to customize the technology and learning options for your specific environment.

We hope that this primer will help you to evaluate information technology options more intelligently. If you are evaluating online learning technologies, we hope you will appreciate the advantages that LearnLinc live Internet learning software can offer in the real world where bandwidth limitations are a fact of life.

About LearnLinc Corporation

LearnLinc Corporation is the leader in live Internet IT training. Organizations rely on LearnLinc Corp.'s innovative software to create the most effective virtual learning environments. LearnLinc Corp. continues to define the market it pioneered with new solutions such as the LearnLinc Application Hosting, which expands the power of live Internet learning to all organizations. The company leverages its education expertise to create virtual classrooms that foster the highest-caliber teaching and learning. Companies worldwide turn to us for maximum employee effectiveness and business-critical IT training success.

LearnLinc Corp. customers range from mid-size companies to Global 2000 leaders, including Aetna US Health Care, Lucent Technologies, Chrysler Financial, Computer Associates, and MCI WorldCom. Satisfied customers such as Aetna and MCI have published results showing millions of dollars in savings using LearnLinc versus traditional classroom instruction. Major strategic partners and resellers include IT training leaders ExecuTrain and New Horizons, and learning technology leaders such as Intel and Asymetrix. Major investors in LearnLinc Corporation include Intel Corporation, GeoCapital Partners, and Exponential Business Development Company.

LearnLinc Corporation
385 Jordan Road
Troy, NY 12180
Ph: (518) 286-7000
Fx: (518) 286-2439

www.learnlinc.com
info@learnlinc.com

