Chapter Seven

Computers and Communications (C&C)

> Technology is rapidly reducing the communications barrier imposed by distance to a state of near irrelevance. Today, physical barriers matter far less than the logical barriers that separate sources and users of data.
>
> *Arno Penzias, Nobel Prize Winner and for 37 years Head of Research at Bell Labs (1933-)*

> Modern technologies are space collapsers, time shifters, and creative tools that extend our reach.
>
> *David Thornburg, founder and Director of Global Operations for the Thornburg Center*

LEARNING OUTCOMES

Until about 1995, electronic communications technology had only two applications in most elementary and secondary schools. It was used as an administrative tool in the form of the telephone, and it was used for educational programming through the medium of television. Today, however, triggered in large part by the explosive expansion of the World Wide Web, computers are enabling new uses of communications in schools. As more computers find their way onto teachers' desks, onto the students' desks, and into teachers' and students' homes, computer-based communications networks provide opportunities for electronic interaction, opening up pathways to knowledge and social interactions which are changing the way education is done.

This chapter will look at the nuts and bolts of computers and communications (C&C) in order to provide a context for its tidal wave of use in education. The next chapter—chapter 8—will then examine Distance Learning and, more specifically, the phenomenon of the Internet, of which the World Wide Web is an integral part. An inevitable by-product of the ubiquity of access to the web is a dramatic increase in online learning—learning that "happens," often spontaneously, as a result of children's immersion in the online world, whether at school or at home. Chapter 9 will go on to examine those online learning tools that are currently relevant within the context of K-12 education.

First we need to take a look at the scope of communications—what comes under the umbrella of communications and how communications affects K-12 education. It will be useful, too, for you to gain a basic understanding of networking technology—the electronic highways along which all the data flow. Finally, in this chapter, we will apply the lessons gained from the *TransParent*

School Model, which relies on already generally available communications technology (the telephone), as well as computer-based communication models.

Specifically this chapter will cover the following topics:

- The Scope of Communications
  - Computers and Communications (C&C)
  - Technology Transfer and the Challenge Posed by User Demand
  - Explosion in End-User Computing
  - The Expansion of C&C in Schools
  - A Vision for the Future
- Computer Networks
  - Computers
  - Communications Channels
  - Modems and Fax/Modems
  - Other Communications Hardware and Software
  - Different Kinds of Computer Networks: LANs, WLANs, WANs and MANs
  - Applications of Computer Networks
    - Telecommunications
    - Hardware Device and Software Sharing
  - The Case for Computer Networks
  - Implementing Computer Networks
  - Recommendations for Successful Introduction of Computer Networks in Schools
  - The Impact of Computer Networks in Education
- Home-School Communications
  - Schools Need Parents
  - Parents Need Help, Too!
  - The Schools Must Take Responsibility
  - The Importance of the Student-Parent-Teacher *Gestalt*
  - The *TransParent School* Model
  - Outcomes of the *TransParent School* Model
  - C& C Today - Extensions of the *TransParent School* Model
  - The Importance of Choice

THE SCOPE OF COMMUNICATIONS

Communication—the exchange of data within and between species—is nothing new. Amoebas do it, trees do it, cats and dogs do it, and so do we. Species survival depends on it. The human species, like most other species, uses language to communicate. Language involves verbal as well

as non-verbal cues. Humans have developed an incredible variety of spoken and written languages; we also smile, laugh, grimace, pout, cackle, and cajole.[1]

Over the years, we also have devised quite a range of technologies to communicate with people who are not close enough to see or hear our unamplified communication. We have used drums, we have yodelled, we have sent runners, we have made smoke signals, we have used flags, we have attached messages to arrows and used bows to fire them from point to point, we have used carrier pigeons, we have organized relays of ponies.

Once we discovered electricity and figured out how to use it for communication, we devised a system for sending coded messages across vast distances at close to the speed of light.

Enter Communications—with an 's'.

Communications is actually an abbreviation for Telecommunications. The prefix 'tele' means 'far distant' from the Greek. Communication (without the 's') refers to the act of communicating, whether near or far and no matter how it is done. Communication *includes* Communications (with the ‘s’). Communications refers to distance communication of data over electronic media. The data may be in verbal, written, coded, pictorial, audio or video form.

Computers and Communications (C&C)

Computers can be either standalone, that is to say unconnected to other computers, or networked. The problem with standalone computer systems is their isolation. Users of a standalone computer cannot take advantage of communications facilities such as electronic mail (e-mail), on-line chat, on-line data retrieval, and data sharing. Thus the writing is on the wall for computer systems that are unable to connect to a network. Today, any computer you buy has connectivity built in. You can still use the computer in standalone mode—you don’t *have* to be connected. Indeed, there will be times when you don’t *want* to be connected—either because you would have to pay a toll or because you simply don’t need to use any online services such as the web or e-mail. But for the most part, connectivity is becoming the norm.

One of the most important high tech trends in recent years has been the interlacing of computers with communications (C&C). In the 1960s, computer networks were built around mainframe and minicomputer hubs. In the 1970s, microcomputers arrived on the computing scene, and by the mid-1980s these desktop computers were being co-opted into service as communications tools. The 1990s saw the rise of the Internet. Leaps in satellite and telecommunication technologies have now made mobile computing, cellular phones and wireless networks almost as common as the home land-line telephone once was. Technology and communications businesses are actively seeking ways to continue and extend these growth trends. As we saw in Chapter 5, networked computer use in schools is becoming ubiquitous. Harnessing new, portable and relatively inexpensive technology resources for communication purposes is one of the tasks facing schools today.

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[1] The C& C versions of these gestures are the *smiley* (an icon) and the *emoticon* (a set of typed characters). Learn more at the Acronyms, Smileys and Emoticons Page (http://www.muller-godschalk.com/emoticon.html). Even more sophisticated are today’s talking, gesturing avatars. An *avatar* is a graphic representing an online users.

Technology Transfer and the Challenge Posed by User Demand

Technology transfer is the process whereby technology finds its way from the work bench of the inventor into the hands of the everyday user. With regard to computer technology, this transfer has accelerated rapidly as computers have become inextricably associated with communications systems. Birnbaum (1985) pointed out that computer technology, by 1985, had entered the third of the classic four phases of technological evolution[2].

- The electronic computer was "manufactured in quantity"—phase one.
- The computer had "become well known and commonplace"—phase two.
- But the computer was "used directly by only a rather small portion of the population"—phase three.

This was especially true in schools, where tight budgets severely restricted the spread of computer use in the classroom. The advance to the fourth and final "pervasive" stage, when "computer technology has become integral to daily life," is being effected now as the marriage between Computers and Communications (C&C) becomes standard at a price that is within the reach of all.

But, as the saying goes, "we ain't seen nothing yet!"

Significant changes are occurring in the science and engineering behind telecommunications. Originally, all voice communication was done by *analog* transmission, sound waves transmitted in their original form. Traditional copper wire telephone and cable lines transmit data in wave form at about 30,000 bits per second. Fiber optic[3] communications systems, which transmit data in the form of pulses of light, are capable of transmitting over 40 billion bits of data per second. That's equivalent to transmitting about a million pages of text a second (two thousand 500 page books per second!). And now the scientists have figured out a way of transmitting light at speeds faster than the speed of light! Yikes!

Why do we need to transmit data at such incredible speeds? Well, believe it or not, transmitting data electronically from one place to another is actually the bottleneck which slows down the work that computers do. If you have ever tried placing a telephone call on New Year's Eve, you'll know that it is possible for the telephone system to get overloaded even though the routing of calls is entirely computer-controlled.

Fiber optic and cellular technologies send and receive *digital* data, which you remember means bits and bytes. The development of *analog to digital* conversion devices means that more of our communication can be digital—which means more communications can be delivered at greater speeds, with little or no degradation of quality.

Communications companies and the manufacturers of communications hardware are continuing to design and implement data highways, transmitters and receivers that will be capable of high speed

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[2] This will make better sense, perhaps, if you remember that *the book* and the *ballpoint pen* were also technologies that transformed education.

[3] Fiber optics uses glass fiber tubes to carry pulses of light (lasers) from point to point. Each pulse of light represents one bit of data.

transmission of not only speech communication, but pictures and video as well. Currently, Internet communications based in Instant Messaging (IM) have made it possible for anyone with an inexpensive videocam[4] to have "real-time" voice and video conversations with anyone who has a compatible system and connection. Five years ago it would have seemed futuristic to imagine video telephones, but they too are now a reality.

Websites, e-mail, games and movies can now be viewed on a cell phone; text messages are fighting with voice messages for popularity. Phones not only view pictures, they take them and transmit them. Wired and wireless Internet connections (free or low cost) can be used with a special telephone or microphone, eliminating the need for a standard telephone connection. Moreover, a *symbiotic grid*[5] in many metropolitan areas makes access to the Internet free to anyone with the right hardware. More yikes!

Alert schools can take advantage of these technology transfers. The remainder of this chapter will explore ways in which new technologies, coupled with old technologies, can be used to meet essential communications needs.

Explosion in End-User Computing

The Internet is proving to be the wedge, what some like to call the “killer app,” that is opening up an explosion of data communications capability. At the same time, we are witnessing an explosion in end-user computing. In the bad old days, prior to the 1980s, computer use was controlled by information systems (IS) personnel. But today, relatively non-technical individuals with a modicum of training, teachers included, are taking advantage of the availability and ease of use of desktop, laptop and handheld computers to exercise personal control over the processing of "their" data and the transmission of their communications. Thanks to the graphical user interface (GUI), teachers, students and parents can interact with a computer with a minimum of technical preparation, in much the same way that the modern automobile is relatively simple to drive. The challenge is no longer: How do I use this machine? The challenge now is: How do I use this machine to improve the effectiveness of what I do? For the teacher, this means teaching, learning, and communicating.

The Expansion of C&C in Schools

In the so-called developed countries of the world, where expense is less of an issue, communications technology is now pervasive in schools. It is relatively inexpensive compared to just a few years ago. Thus, hard on the heels of the spread of C&C in homes and businesses, schools are in the midst of an explosion of networked computing that will further transform education.

The concepts that led to computer-integrated manufacturing (CIM) have been applied in forward-looking school districts where computer-integrated education is well established. In these schools, computers and related technologies are integrated into the classroom-based curriculum. C&C systems enable the students, the parents, and the teachers to form an electronic triangle with the

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[4] Video camera—the shorted form of the term is often applied to devices that are attached to, or included in, a laptop or desktop. It also, of course, also applies to handheld video movie cameras.

[5] Wireless access points aligned to form a "bubble" in which wireless access to the Internet is freely available.

interests of the students at its heart. Networked computer systems are linking students with other students. On-line databases, including the growing wealth of information available over the Internet, are giving students, whether they are at home or at school, access to a wide variety of resources for learning.

Computers are providing teachers access to a centralized database of student data—biographical, medical, academic, and behavioral. This is the kind of data to which teachers have always been entitled in the interests of best serving their students. But for all practical purposes, this information has not been readily available to them until now. School districts are taking advantage of the similar explosion of home Internet connections to also make this data available to parents – and students – 24/7.

Networked computers also are removing the concept of the closed classroom, opening up the students and teachers to the global community of their peers. For the time being, schools that have successfully integrated computer technology into day-to-day operations in and out of the classroom are still the exception in some areas; it will be some time yet before the school-teacher-parent triangle becomes truly and transparently digital. But the time is coming.

A measure of strength in schools is the extent to which all children, from the most gifted to those most in need, are given an equal opportunity to achieve. While money is not key to quality schooling, it is a factor, and there is currently too much disparity from one school district to another for true equality of educational opportunity to be guaranteed. To overcome this disparity, governments at local, state, and federal levels are teaming up with business and industry to help schools make the difficult transition to teaching and learning in a digital age—an age of information—and in the 21st Century—an age of information fluency[6].

Some states have passed so-called Robin Hood laws that call for higher taxes in the wealthier districts to help defray the costs for schools in areas where the tax base is low. Government also has decreed that communications companies must agree to produce educational programming and make it available free of charge to schools as a condition of gaining a Federal Communications Commission (FCC) license to do business. Further, we saw in Chapter 5 that the eRate initiative has promoted a significant upgrade of technological infrastructure (everything but hardware and software) in schools. Title I grants supplement state and local funding for educational materials, including software and Internet subscriptions, based upon the economic needs of the student population. Increasingly, industry and higher education are stepping forward to provide and promote communications partnerships with schools.

It remains up to the teachers and administrators to take advantage of these opportunities to promote the infusion of computer-based technologies in the schools. Those that do so will not be left behind in the 21st Century.

A Vision for the Future

"Ah, but a man's reach should exceed his grasp—or what's a heaven for." Robert Browning's words remind us that progress is something we humans strive after relentlessly. Progress does not

[6] The identification of 21st Century Information and Communications Technology Fluencies (or Literacies) is well under way. However, it will be the job of future teachers to both learn these skills and learn how to teach with them.

always bring beneficial effects, as the Arms Race sadly shows. But good progress is more likely to come about if we have a vision on which to focus our endeavors.

David Thornburg is founder and Director of Global Operations for the Thornburg Center and Senior Fellow of the Congressional Institute for the Future. Here is his vision for 21st century schools:

> The 21st century classroom will be wherever the learner is located—a room at a school, on the bus ride home, in the park, at a museum, or on the playground. Traditional tools (e.g., books, pens and paper,) will co-exist with the high-end tech tools of the telematic era that is still in its infancy…
>
> If our schools are equipped with the modern technologies of information and communication, they can serve as resources not just to our children, but to the community at large. This expanded role of schools as community access centers also fits with the reality that we have entered an era where lifelong learning is a necessity, not a luxury…Schools where young and old can learn, places where ideas can be shared, leverage points for economic development—all these and more become possible when we re-envision schools as active wired community access points to the entire planet. (Thornburg 2000)

This vision is already beginning to take shape. All over the United States are pockets of progress—sometimes the outcome of a few individuals' efforts, sometimes the outcome of a statewide mandate. It is time to examine more closely the technology involved, and how it can be used in schools.

COMPUTER NETWORKS

A computer network is comprised of a group of two or more computers connected electronically for the purpose of sending and receiving data. The following are the basic components of all computer networks.

Computers

The simplest of computers can be used to link users over local and wide area networks. The more powerful the computer, the more sophisticated the communications it can handle, but even older computers can act as serviceable "dumb" terminals to on-line databases, library card catalogs, e-mail systems, bulletin board systems (BBS), and the like. We will return to this idea shortly. Remember also that the definition of “computer” is changing as technology shrinks and the desire for portability increases.

Communications Channels

Shannon and Weaver (1949) formalized the terminology commonly used when describing communications systems. Fig. 7.1 (next page) illustrates the classic configuration of such a system, where a *sender* transmits a message over a *channel* or medium to a *receiver*.

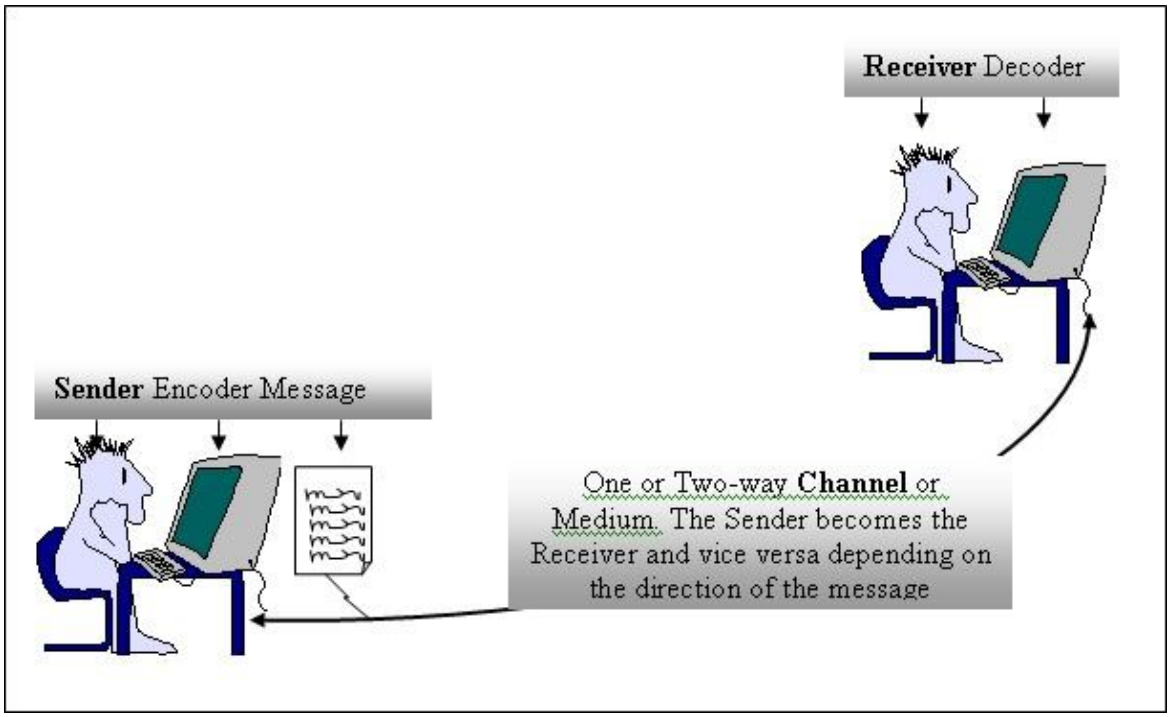

Fig. 7.1 The Shannon-Weaver model of a communications system

As you can see, the communications *channel*, also called a 'medium', is what connects one communications device with another. Typical media used today for channels include cable- or wire-based media (such as copper wire or optical fiber), and wireless media such as radio waves (cellular phones use a type of radio wave[7]). Advances in telecommunications technology are leading to faster and faster transmission speeds, or *data rates*, (measured in bits per second (bps)), making computer networks all the more viable for a multitude of applications both in and out of the classroom, such as those discussed later in this chapter.

The term *bandwidth* describes the difference between the highest and the lowest frequency in a channel. The greater the bandwidth, the more data can be sent in a given amount of time. The narrower the bandwidth, the lower the data rate. This translates to the speed at which the user can send and receive digital information. Think of bandwidth as though it were a pipe. A narrow pipe cannot channel fluid as fast as a wider pipe. Conversely, the wider the pipe, the faster the fluid can be poured along it. Electronic data, whether in the form of electro-magnetic waves or light waves, can be transmitted faster along broadband channels than along narrowband channels.

Modems and Fax/Modems

A modem is a simple device that connects computers to wide area networks, most often the telephone network. This is necessary because the telephone lines, for the most part, still transmit data in analog form. Remember that digital data is *discrete*, made up of separate electromagnetic pulses called bits (0 or 1). An analog signal is *continuous*, made up of electro-magnetic waves.

[7] The FCC assigns specific frequency ranges to the various use groups. Your cell phone shares its frequency range with garage door openers and wild life tracking collars.

The modem converts the computer's discrete digital data into the wave or analog form necessary for transmission over the telephone system and vice versa.

The word modem is a contraction of ***mod***ulator-***dem***odulator. The modulator component of a modem converts the data from digital to analog form; the demodulator converts the data from analog to digital form. Both components are necessary for two-way communication between computers that are connected by an analog transmission medium. Fig. 7.2 illustrates this process.

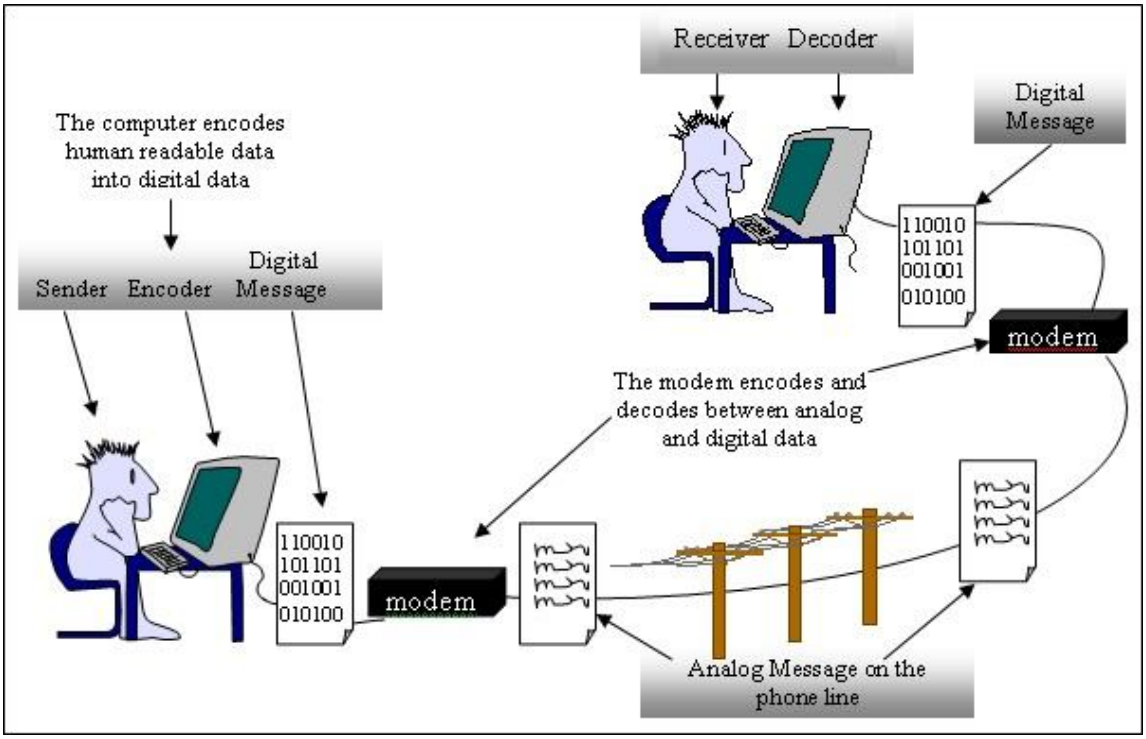

Fig. 7.2 The role of modems in communications systems

In a dial-up network connection, the speed of communications is, for the most part, determined by the speed of the modem connected to your computer.

The majority of modems are capable of transmitting data no faster than about 64 Kbps (kilobits per second), that is, 64 thousand bits per second (modems today are generally listed as 96 Kbps, but cannot actually achieve this speed due to the capabilities of the telephone lines). The data may be traveling over the telephone lines at close to the speed of light, but when they reach the bottleneck which is your modem, the whole transmission process grinds to a painfully slow pace.

Telecommunications companies are involved in an ongoing project to replace traditional analog electro-magnetic media (copper wire telephone lines, for example) by much faster and more reliable digital fiber-optic cable. DSL modems (Digital Subscriber Lines) and cable modems (which use coaxial cable TV lines) are digital devices; they provide significantly faster Internet connections by making use of otherwise unused copper wires or of fiber optic cable. Many schools use cable modem connections; others lease T1 lines from a telecommunications provider.

DSL and T1 lines have a capacity of around 1.5 Mbps (1500 Kbps). Cable modems have a possible capacity of 10 Mbps, but actual speeds are much slower[8].

The time is coming when "dial-up" modems will be obsolete—like typewriters—because there will be no need to convert data back and forth between analog and digital form. As wireless media are refined, and the "wireless grid" is expanded, wired network connections are also disappearing. For schools, as for the business and home user, this will bring about true portability of the "transmission/receiver" hardware—whether it be the computer or PDA or integrated cell phone.

Other Communications Hardware and Software

Telecommunications hardware for desktop computers takes the form of circuit boards or electronic components that are plugged into the logic board inside the computer. Like most of today's modern desktops, laptops often have a built-in analog modem. Additionally, connection to a wired or wireless network requires a NIC (Network Interface Card), which may be "integrated" (built-in) or a removable card about the size of a credit card[9] (this is often the case for laptops and handheld devices).

You will run across the term *Ethernet* often. This refers to the cable that connects computers inside of a network, using the NIC (which has a plug similar to, but larger than, a telephone connector plug). There are currently four speeds of Ethernet: 10Base-T (10 Mbps), 100Base-T or Fast Ethernet (100 Mbps), Gigabit Ethernet (1000 Mbps), and 10-Gigabit Ethernet (10,000 Mbps). The NIC card will determine the speed at which a computer will actually be able to send or receive data, no matter what the potential of the line. The line will determine how fast data moves between computers and inside of the school, no matter what the potential of the connection to the outside world (called "the backbone"). Needless to say, faster is better—and more expensive. It is not unusual for schools to have a mix of modems, 10Base-T and newer 100Base-T connections.

Wireless, *Wi-Fi*, connections use radio wave frequencies and require a "wireless card," which can be integrated, plugged into the motherboard, or a removable PC card, and an antenna (part of the card or, in the case of some laptops and handhelds, part of the hardware design). These connections today come in two speeds: 801.11b (11 Mbps) and 802.11g (54 Mbps). Actual connection speed will still depend upon the frequency available to the user and the distance from the wireless "access point[10]". Teachers should know that a "wired" connection is always significantly faster than a wireless connection. For this reason, some schools maintain "hardwired" labs for purposes of standardized testing and videoconferencing.

Current operating systems have the software necessary for networking built in. Modems and NIC cards are generally "plug and play"—meaning that the necessary software is already on your computer. The operating system (Windows, Linux, or Macintosh OS) will "see" the device and load whatever is necessary to use it effectively. This means that it takes very little work for a user

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[8] If you are using a modem, DSL, or cable modem connection, you can check its speed at Broadband Reports (http://speedtest.dslreports.com)

[9] These are referred to as PCMCIA or PC cards, or sometimes "ethernet cards"

[10] An *access point* is a device that makes it possible for a wired network to talk to wireless access cards. Apple's Airport is a common example in schools. One access point can connect to many computers.

to start connecting to a network. In order to connect to the Internet, or directly to other remote computers[11], you will need an "internet service provider"—an ISP. These are companies that provide access to the network that is the Internet. The cable companies and phone companies that provide schools and homes with modems are ISP's, along with a myriad of local and national companies. The Internet is not "free" to schools or individuals (except for those *symbiotic grids*)—accessing it requires the payment of a fee.

A *browser* (*Safari, Internet Explorer, Firefox*, for example) enables a computer or other device to "see" the content of a web page. Other software serves other purposes. An *ftp* program makes it possible for one computer to connect directly to files on another computer—you actually "see" the section of another hard drive to which you have access permission[12]. A *mail program* enables you to retrieve, send and manage e-mail. The telecommunications hardware and software together take care of hook ups and the other protocols[13] that maintain a trouble-free connection between one computer and another.

Some understanding of networks will be helpful for you, whether you are using a network at home or in school.

A computer network interface connects each computer to the communications channel (cable or wireless media) so that data transmission can take place. Every device (including printers, scanners, copy machines[14]) on the network has a unique address, called an *IP* (Internet Protocol) address. Without this address, digital data, traveling in *packets*, would not know where to go. Some devices on a network have *static* (permanent) addresses (printers, access points, copy machines, servers, routers, hubs, modems). Most computers and laptops will have *dynamic* IP addresses that are reassigned each time the computer is turned on. Some videoconferencing systems require that you find the IP address of the transmitting computer, but otherwise you don't need to know it, for each computer is also identified on the network by the "real name" of the user or the hard drive or the section of the web server, which could be a room name, a computer number, a URL (web address), or even your name.

Each network interface device also has a unique number, called a MAC (Media Access Control) address. This number is used to limit network use only to selected computers and devices. Even though you are not generally aware of it, when you use a networked computer, you can be clearly identified! You can also be blocked, which is why you need to know the vocabulary – so you can ask to be given access!

Different Kinds of Computer Networks: LANs, WLANs, WANs and *MANs*

Local Area Networks (LANs) connect computers over short distances—anywhere from a few feet to a kilometer or so. The simplest LAN is two computers connected by an Ethernet cable.

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[11] Many schools originally connected computers "peer-to-peer," or directly to each other in a sort of daisy chain, to form a network in a lab. This is still a sound way to transmit large files quickly. It is discussed in the next section.

[12] Some schools have "invisible ftp" to enable teachers to post to web sites. Apple's .iDisks are also .ftp enabled.

[13] Protocols are the rules of the road in communications systems, such as transmission speed and connection conventions (called *handshaking*).

[14] It is not necessary for these devices to be on a network. Often, they are connected directly to a computer. In this case, the network can be used to "share" access to the host computer, and thus to the printer or scanner.

This direct connection of two computers, even if accomplished over the Internet, is called a *peer-to-peer* (P2P) connection. Schools use P2P networks to share data and printers in basic computer labs and in offices.

Today, most LANs include one or more high-speed computers called *servers* which have large memories for storing and sharing networked software, data, and resources needed by all users (such as printer drivers, e-mail systems, databases and websites). Servers are generally accessible to all users on the network, but access privileges will vary depending upon the identity and role of the user (teachers will have different access privileges than students and administrators). Creating this system of privileges is an important job of the IT (Information Technology) staff.

Two or more LANs of the same type (say in different parts of a school or school district) can be connected using a hardware device called a *bridge*. School networks also often make use of *hub*, which interconnects all of the networked devices and connects directly to the "backbone," or use several *hubs* to form mini-LANs. A *switch* is a hub that detects the protocol of the *data packets* that flow through it and directs it to the correct device or port (think of it as a route) on the network. A *router* (sometimes called a *gateway*) is a device used to connect LANs of incompatible types (i.e. they use different communications protocols), most often to connect a school LAN to the Internet or to connect an older wired network to a newer wired network. This is pretty technical stuff, but you might like to know that most networks now use TCP/IP protocol.

Fig. 7.3 illustrates a typical LAN configuration in a school making the transition from wired to wireless. It might also illustrate the LAN in your students' homes.

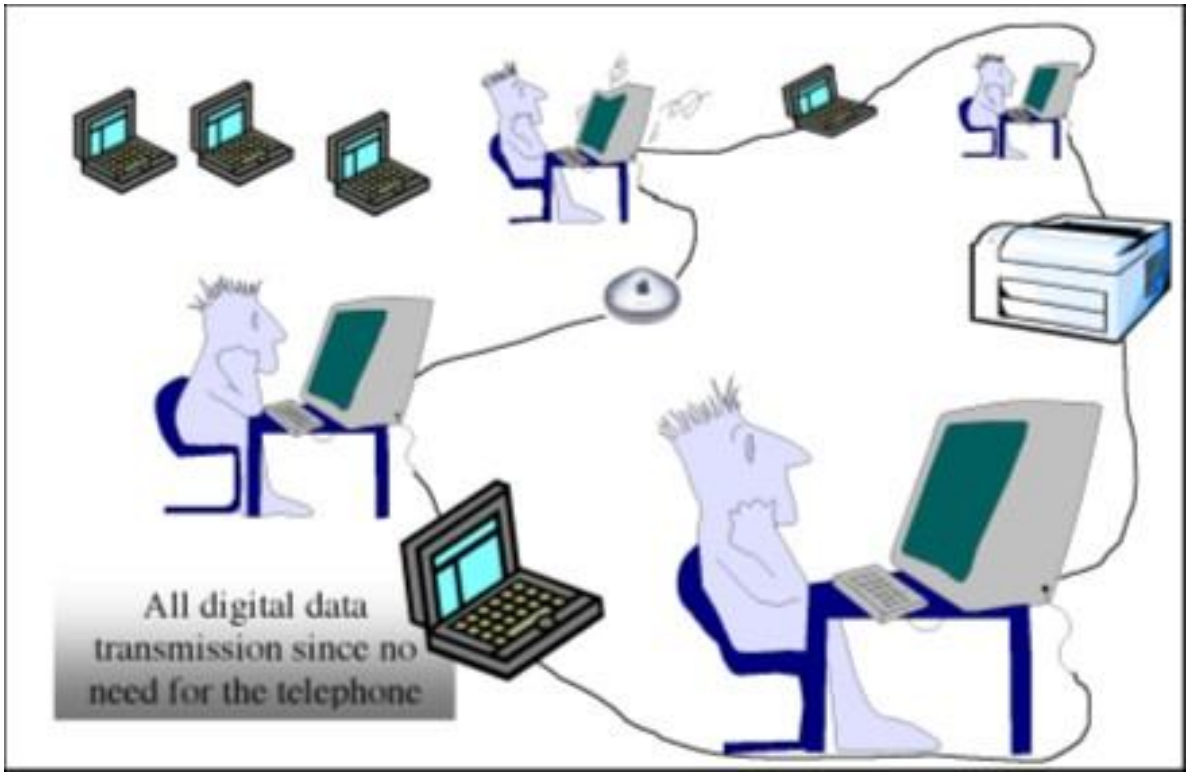

Fig. 7.3 A Local Area Network configuration

A wireless network, or WLAN, also contains *access points* (or base stations), devices that connect a wired LAN to one or more wireless devices. All of the devices above can be wireless as well as wired, but it is important to remember that all wireless networks at some point connect to cable!

An important piece of any LAN is the *firewall*, which may be hardware or software or both. As its name suggests, the purpose of the firewall is to secure a network by preventing unrestricted access by an outside user. Imagine the damage that could be done if an angry student decided to rewrite grade reports! When the firewall is "down" a network can be "hacked into."

Bluetooth is a new shortwave technology that uses radio waves to create a wireless LAN within a classroom, office (or home). Devices equipped with Bluetooth chips can speak to each other (voice and other digital data) no matter what their protocol. PDAs, computers, mobile phones, and various handheld controllers (like joysticks and adaptive devices) can be networked in this way. One use of Bluetooth is the remote control of a teacher's laptop when it is projected on a whiteboard. A Bluetooth-enabled pen can act exactly like a touchpad and cursor! This is technology finding its way into today's classrooms.

Lastly, *infrared* provides a simple network when used with some laptops, PDAs and infrared-enabled printers. Students can use infrared to "beam" data to another device or to a printer, without the need for wires or wireless access points. This technology is limited to short distances and a clear "line of sight."

"Artificial" networks for data transfer are also possible. The inexpensive device called a *key drive* or *USB flash drive* is portable memory. By plugging it into the USB port of one computer and then another (forever…), data can be quickly and inexpensively shared. Similar results can be obtained by using a CD ROM on which data has been stored. Teachers often find that these two devices are quicker and more convenient than sharing data over a network, especially large data files such as presentations, video and image libraries.

A Wide Area Network (WAN) establishes communications paths between computers that are scattered over areas that span anywhere from a kilometer to the area covered by the accessible universe (space stations, shuttles, and space probes have on-board computers for communications). Fig. 7.4 (next page) illustrates this concept. The Internet is a WAN. In addition to the devices we have already mentioned, a WANs now includes cellular devices that connect with Internet chips. This is a much slower connection than either wired or wireless (about 800 Kbps), but it is truly communication any time, anywhere.

A Metropolitan Area Network (MAN) is simply a smaller (city-based) example of a WAN. Fiber optic cables are being used to create MANs in large metropolitan areas where the underground infrastructure (subway systems) makes it easy to run the cable. These networks are the fastest, for the cable is necessary for 10-gigabite Ethernet. Wireless MANs are also being developed in urban areas—these are the *symbiotic grids* we mentioned earlier.

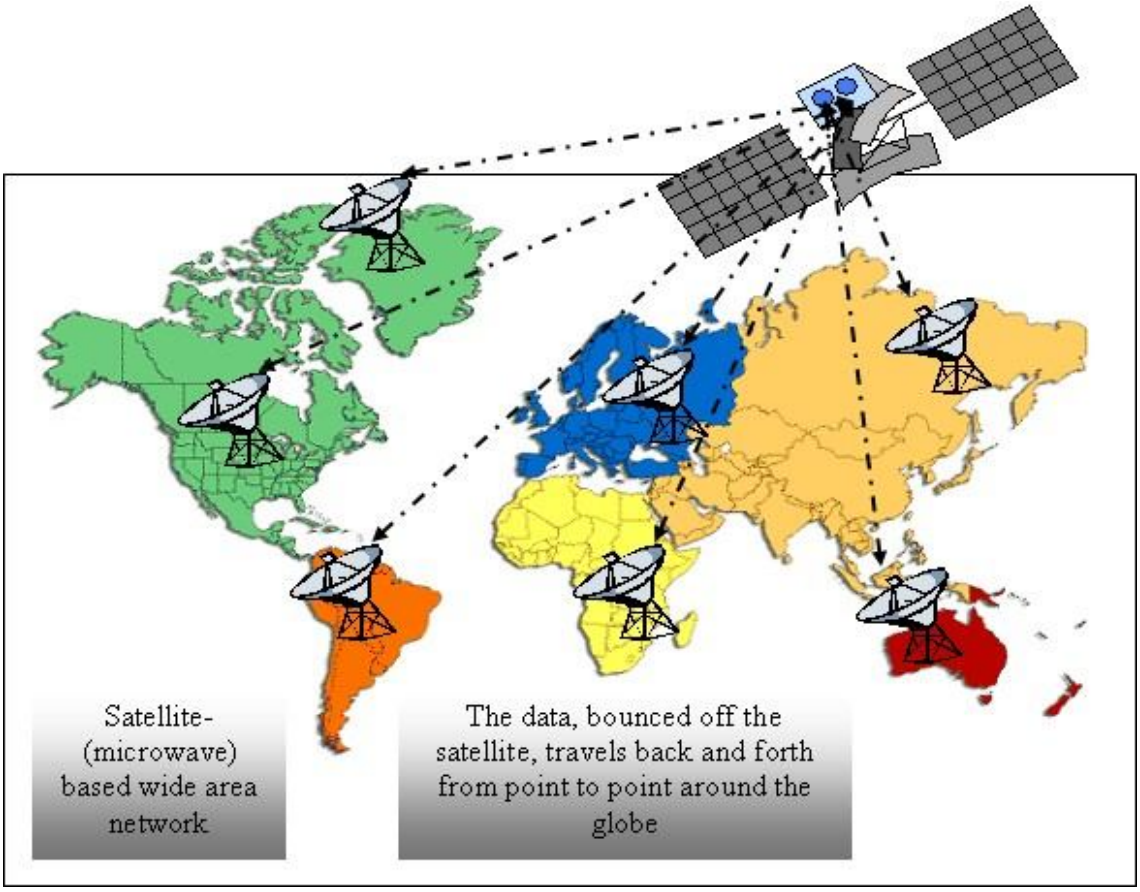

Fig. 7.4 Wide Area Network

Schools are exploring the uses of LANs and WANs for teaching and learning. Innovative communications applications are providing students with exciting collaborative and cross-cultural experiences. Of special interest are the wireless network options described that, because of technology advances, are becoming mainstream in schools. It can be safely predicted that, not too far down the road, ALL students and their teachers will each have a personal wireless portable computer (probably hand held like a cellular phone) that will be able to access all available online services anytime anywhere. This reality eventually and inevitably will transform the way education is done.

APPLICATIONS OF COMPUTER NETWORKS

Computer networks are commonly used for two kinds of operations: communications and the sharing of hardware and software. As you have seen, with the development of more powerful computer processors and the proliferation of cellular, microwave[15] and fiber-optic media,

[15] Cellular phones use microwaves, which are high-frequency radio waves, beaming a system from "cell" to cell. Other wireless signals, such as those used to connect buildings wirelessly, are "point to point."

networks are becoming more powerful—capable of handling larger volumes of data at higher speeds. As a result, using them frequently and integrally has becomes more viable for teachers and schools.

Telecommunications

This involves the transmission of data (text, still images, video, and audio) over short and long distances. Examples are:

Electronic mail (e-mail) For the most part, e-mail is used to exchange information between two or more individuals using computers. E-mail is essentially asynchronous, which you remember means that messages are read at some point in time after they have been sent. A *listserv* is a message system for a group of users who subscribe (generally for free) to receive e-mail messages sent by other members of the group. This is a wonderful way for teachers to stay up-to-date, to network, and to share concerns and successes. Listservs are gradually being replaced by *email subscription*, used commercially as well as educationally. Generally, users sign up for the subscription by adding an email address to a web form. Subscription messages are informational and generally 1-way. Many educational newsletters are now distributed this way. Most e-mail systems support the use of *attachments*, which are digital files literally connected to the message and downloaded when the message is opened. Webpage (HTML), audio and video mail (asynchronous transmission of digital video) are becoming more common due to the increases in upload and download speeds and to the greater memory and processing capacities of user computers. It is also now easy to use a cell phone to text a message to an e-mail account. As you can image, however, e-mail can be a huge bottleneck on a school network. Other ongoing problems with e-mail are *spam* (unsolicited "junk" e-mail that is often offensive in nature) and e-mail's propensity to spread computer *viruses* (often to the surprise of the sender). A good school network blocks spam and has virus detection and repair software installed on all computers. Make sure you have virus protection software such as Norton *Antivirus* installed on your computer, too.

Bulletin Board Systems (BBS) and **Forums** These are text-based system for sharing information stored on a central host server. Users access the system to share ideas, software, and data with other users. Most often, bulletin boards, or *forums*, are used to expand upon discussion topics. The resulting *threads* can be read from beginning to end, even though they were created by many writers over a long period of time. Some e-mail applications, notably *First Class*, make it possible for teachers to form *Conferences*, allowing them to share ideas and information within the school network. A *tag board* is a mini-bulletin board that can be added to a personal web page. It operates more like an old-fashioned message board: users add their messages to a continuous stream of posts.

Voice messaging Voice messaging is similar to e-mail in that it is asynchronous, but the medium of communication is voice rather than simple text. Users do not interact in real time; in other words they cannot respond in real time as on the telephone. The voice message is stored temporarily in an electronic "mail box," like e-mail. Schools use a computer system to manage voice mail, but to the teacher it appears like a home telephone.

File exchange This is the same concept as e-mail except that formal computer files, rather than informal mail, are transmitted from one computer to another. Exchange can be via attachments,

P2P connections (examples of this are the infamous *Napster* application for sharing music files directly off of a home computer), on a network or internet server (commonly found in schools), or through web-based file posting. The availability of "universal" file formats such as .rtf, .pdf, .jpg, .gif, .html, .swf and .mov make it possible for users to exchange files regardless of the computer platform on which they work. Types of files that can be exchanged for educational communication purposes are video files—a filmed lesson, presentation, or speech—and worksheets.

Local and remote on-line data retrieval This is the Internet, generally the World Wide Web. The Internet is, in a sense, a huge database, each web page, news group topic, stored file or e-mail message being a record in the database. Accessing, adding to and making sense of this database is becoming central to education.

Real time, interactive voice, and data interchange The computer can be used for interactive two-way communication. The simplest of these communications are through chat and IM, both of which often contain voice and video modes (see *video conferencing* below). It is now possible for many users to "share" a networked document or file, editing it in real time. The ability to create interactive databases, with real-time charting and graphing, has enabled webmasters and universities to make the exchange and analysis of numerical and text data a synchronous event (this has always been possible over a handheld, infrared network). Similarly, "realtime" whiteboards (like paint applications, complete with tools for drawing and typing) make it possible to remotely discuss and brainstorm in realtime.

Video conferencing Perhaps most exciting for children, video conferencing allows users to communicate over live video and voice communications systems from remote locations. People can "meet" electronically in real time, thus saving the time and expense of traveling to a central location. As previously discussed, inexpensive hardware and free software are making video conferencing much more available to the classroom teacher.

Social networking Can all of these modalities work together? You bet – and most students are doing so every day, whether the teacher likes it or not. Social networking refers to Internet spaces that make it possible for “members” (membership is generally free) to quickly and easily share any type of digital information, to communicate in real and asynchronous time, to gather a list of “friends” with whom all forms of communication are almost seamless. Teachers can use a site such as *Classroom 2.0* to network with like-minded educators. Students (and teachers too) are active in *Facebook*, *YouTube* and similar sites. Working professionals have accounts with *Linkedin* and *Xing*[16] . Social networking is now also specialized; many teachers use services like *Bloglines* to share interesting blogs or *Del.icio.us* to share

Hardware Device and Software Sharing

Networks enable users to benefit from sharing expensive, high-speed, high-quality, centrally-maintained devices such as printers, digital copiers, specialized cameras and microscopes—even telescopes and robot arms. Users also can share large capacity storage devices such as file servers for the mass storage of data and high-speed processors for data analysis. Finally, for special

[16] See a good listing at http://www.insidecrm.com/features/50-social-sites-012808/.

purpose applications, users can share processors (discussed later in the context of dumb terminals). This sharing of networked hardware and software creates a powerful learning environment.

Network versions of software, accessed from a central file server, offer several advantages over single (or local) software installations. First, they are usually a cost saving because a site license is less expensive than buying software one copy at a time. Second, since use of the networked versions is managed by a server, the school or institution is protected against software corruption, piracy and licensing violations. The school is able to log, or track, the use of its investment. Networked software also ensures that all users will have access to the same suite of applications. As changes are made to software and upgrades released by software developers, new versions that are centrally controlled can easily and consistently be made available to everyone in the school or school district.

The Case for Computer Networks

"Computers should be used to tie people together, not to separate them." This is the conclusion of Selfe (1992), who goes on to recommend computer networks to "help create communities among groups of students" where they can "share their writing electronically, conference with teachers via electronic mailboxes, and practice argumentation and written dialogue skills on electronic bulletin boards."

Selfe's vision for the teaching and learning of the English language is being realized across the broader academic curriculum by the growth of Internet access in schools. This is resulting in a greatly increased use of e-mail, chat and social networking among students, who are thus writing more than ever before[17]. This being the case, communications technologies should have a significantly beneficial effect on the ability of children to learn.

But computer networks in schools have more applications than simply improving communications skills. Selfe references Fersko-Weiss (1985) when he observes that "networks can expand students' perceptual boundaries, allowing them to tap into rich sources of library data and bibliographic information and become acquainted with the thinking of individuals from other countries or cultures." It is this global communication skill that is one of the core literacies identified for the 21st Century school[18].

Currid (1992) makes a compelling case for networked computing when she reminds us of the kind of anachronistic bureaucracy that still pertains in many professional environments today. She describes the traditional "16-step procedure" for transmitting a paper-based piece of information from one person to another within the same organization (say, from the principal to a teacher).

> The principal handwrites or dictates the memo and gives it to a secretary, who proofreads it and corrects it before either typing it or getting someone else to do it. Once the memo has been typed up, the secretary checks it over again before passing it back to the principal

[17] Interestingly, students do not consider these activities to be “writing for school,” even when they are writing in school.

[18] A list of 21st Century literacies can be found at http://www.noodletools.com/debbie/literacies/.

so she can check it over, too. Eventually it finds its way into the interoffice mail system and gets delivered.

Elapsed time: up to several days.

Alternatively, Currid observes, using networked computing, the same transaction goes like this:

Step 1: [Principal] drafts own document in a word processing program or the e-mail software.

Step 2: [Principal] sends electronic document to [teacher] and files a draft copy.

Step 3: [Teacher] gets message.

Elapsed time: 3 minutes to an hour.

The goal of every school district should be to put a computer on every teacher's desk (or in every teacher's hands in the form of a portable computer or networked handheld device) and to make a computer accessible to any student who needs it at any time. These computers should be connected to the rest of the world and supported by the media technologies, peripheral hardware and memberships that make collaboration and communication happen. If every teacher has a personal networked computer, and if every student has access to one, too, there is the potential for change in education equal to that produced by the printing press.

David Thornburg's vision of the future for education is closer to realization than most people are aware.

Implementing Computer Networks

The worst case scenario: putting obsolescent technology to work Many school districts have invested in computer technology which rapidly becomes obsolete. During the 1990s, millions of computer systems of all shapes and sizes were purchased for use in schools[19]. Many of these systems are now considered obsolete because they are not powerful enough to run much of the new software, they are limited to operating systems that are no longer supported by software developers, they lack CD or DVD drives (and thus cannot even access software installers), or because they can no longer even access the Internet. There is no greater frustration for the student and the teacher than this scenario.

Recycling to the rescue! Just about any computer can become a dumb terminal[20] on a network. Whether the computers are older Apple Macintoshes or PCs, as long as they have hard drives and some expansion capability, many older computers can be used for the purpose of simple e-mail. Older office machines are often sufficiently powerful to serve as e-mail servers.

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[19] It has been estimated that this totaled over $70 billion!

[20] You may recall that there are two types of network terminals: dumb terminals and smart terminals. A dumb terminal is one that does not have its own processor and therefore cannot perform as a stand-alone computer. A smart terminal is a general purpose computer with its own microprocessor which can also act as a node on a network.

It would, of course, still cost money to purchase basic networking software and hardware components[21] and to set up and maintain the network, but it would be money well spent in view of the extended lifespan given to what might otherwise be underutilized, antiquated systems. The amount of money would be a fraction of the cost of setting up every teacher and administrator with a new computer system.

Implementation of this idea would not preclude the necessity of purchasing up-to-date systems in the long run, because teachers will eventually want to use their computers for tasks other than e-mail. But as DeBalko (1992) observes, "e-mail alone, if used properly, can justify the cost of a LAN."

Thin-client technology provides another use of otherwise obsolete desktop computers. In this system, the local computer has only a "light" version of an operating system (a special system designed for this purpose), enabling it to connect to an application server that actually does the processing. The monitor displays activity that is taking place on the server, but the client user controls it. Thin-client solutions are highly cost-effective and can be used over a LAN or a WAN.

Some would argue that it is a waste of computing power to relegate a PC to the functionality of a dumb terminal, but this is better than not using the computer at all. Millions of computers are being discarded every day. Fortunately, there is an emerging recycling industry dedicated to repairing and reconfiguring such discarded systems so that they can be donated to grateful schools and charitable organizations.

A best-case scenario: Using current technology Money spent today on computer-based technology will buy considerably more than the same money spent during the early 1990s. This is because the computer industry is one of those rare industries where prices decrease even as the quality increases. For example, the price of secondary storage drives has fallen from about $10 per megabyte in the mid-1990s to a few cents per megabyte today. But not only has the price fallen dramatically; the drives are also much smaller (they can be put on your keychain), more reliable, data access is considerably faster, and the drives come pre-formatted and ready to go, with all the necessary disk management software on board.

This trend towards dramatic increases in value for money is likely to continue into the foreseeable future. Of course, the mere installation of computer networks will not transform the educational process. Teachers still must be trained and provided with on-going support—which must include *time* to integrate the technology into the curriculum. Nonetheless, it is useful to mention here *Metcalfe's Law*, first stated by Robert Metcalfe, inventor of Ethernet: *The usefulness of a network equals the square of the number of users.*

In other words: *More access = More users = More demand for improved access*—a never-ending cycle of demand if ever there was one!

[21] It should be noted here that a corollary to the speed of change is the speed with which old components disappear—necessary upgrades and software may not be readily available.

RECOMMENDATIONS FOR SUCCESSFUL INTRODUCTION OF COMPUTER NETWORKS IN SCHOOLS

There will be times when the funding is available and a school has the opportunity to build a quality network. To achieve this goal, a school must seek expert technical advice and probably a consultant. That said, we can also make these suggestions, which are rooted in the content of this text:

Make a plan—even if the implementation of the network is delayed, planning is the key to success in networking;

Include the entire school community in the planning—administrators, teachers, students, parents, alumnae, staff and the community at large—these are the people who will benefit from the network of the 21st Century school;

Be visionary—look as far into the future as possible when selecting protocols, systems and capabilities—remember Metcalfe!

Here are some other important recommendations:

All computers and production devices should be networked together The people that control the purse strings in schools should understand that it is a wasted opportunity when a computer stands alone, or when a printer serves only a small population, or when a video editing computer cannot save to a server, or when a kindergarten computer cannot speak to the fifth grade classroom. Even handheld devices (PDA's and calculators) should be viewed as potential network devices and, if necessary, outfitted for increased communication.

Every classroom should be wired for Internet communications In the next section of this chapter (Home-School Communications), and again in chapter 8, we will discuss valuable C&C applications as they apply to education and which become possible when classrooms are wired for Internet access.

Schools should take advantage of Cable in the Classroom (CIC) This is a free service provided by local cable operators and national cable programmers that makes commercial-free, copyright-cleared programming available to schools for use in the classroom. Schools which agree to use this service are wired for cable free of charge. In some locations, free cable modem service is also provided. Additional CIC materials include informational and news podcasts, lesson plans, and media literacy information. Access CIC at http://www.ciconline.org.

Teachers should have access to systems that will encourage them to use the computer as a tool These would include software tools such as the full range of productivity software discussed in Chapter 6; centralized on-line databases of student records; on-line school-wide calendars and announcements; networked support for curriculum planning; development and assessment; voice messaging for establishing and maintaining close contact with the students' families; e-mail systems; and support for creating their own web pages. Needless to say, it also means computers and other tools to access and use systems.

Teachers should have ready access to the voice messaging system It does little good to have a complex voice messaging system if teachers cannot get to a free telephone, and access their messages, during the school day.

Teachers should be expected to and trained to use the systems available to them Many school districts may hesitate to implement these recommendations because they are strapped for money. But money need not necessarily be a prohibiting factor, since billions of dollars every year are made available, by foundations and government agencies, to support technological innovation in education. Furthermore, free opportunities for schools to create many of these systems are made available by foundations and civic minded industries.

Of greater concern than money is the training and support that is necessary once all the teachers and classrooms are on-line.

The next section will examine what some schools are already achieving along the lines of educational C&C thanks to the support that they have received at the local, state and national levels.

THE IMPACT OF COMPUTER NETWORKS IN EDUCATION

The implementation of networking technology opens up the possibility of not only linking students and teachers within a school, but also linking a school to other schools, at all levels of the academic spectrum and all over the globe. Below are just four examples of the hundreds of ways in which schools are using computer and communications networks.

- Elementary-school students from five countries join in a virtual Learning Circle to share their knowledge and understanding of their community, history, government, and culture.
- PreK-5th grade students in Miami Country Day School are lucky to have the Abess Center for Environmental Studies (http://aces.miamicountryday.org) on their campus. Using its network resources, share their learning with students and scientists around the world.
- Middle and High School students worldwide undertake a historical and photographic study of the houses, buildings and monuments in their towns. Images, reflections and learning are shared on the project website.
- K-12 students around the world collect and analyze environmental data, using portable devices, and enter it into an interactive database. Their research and results are shared with active scientists as well as other students worldwide.

The benefits of networked computing in projects such as these are compelling. As time goes on electronic communication will replace much traditionally paper-borne interaction between teachers and administration, between one teacher and other teachers, between teachers and students, between students and students, between teachers and parents, and so on. But change will be slow, since it is not only a question of buying the equipment, installing it, and maintaining it on an on-going basis. Teachers and administrators must also change the way they think about education. "There's the rub," for that change inevitably involves both physical and cultural

adjustments at the individual and group levels. One group than can benefit immediately and markedly from 21st Century change is parents.

HOME-SCHOOL COMMUNICATIONS

Schools Need Parents

One of the greatest weaknesses of education, in modern times at least, has been the distancing of the home from the school. There has come about an almost complete dichotomy between what goes on at home and what goes on in school. The result is the loss of an opportunity to develop an essential partnership. The National PTA National Standards for Parent/Family Involvement Programs sets as standard #1 communication between home and school. The school's best ally in the task of nurturing a student's innate "urge to learn" is, first and foremost, the parents. *A Nation at Risk* (1984) paints a sobering picture when the report states that while parents do have "an undiminished concern for the well-being of their children," for the most part they are not culturally encouraged by the education system to intervene in their children's education. Unfortunately, this distancing has not improved in the last 25 years. Working parents, language differences, economic and cultural divisions, and a history of schools regarding parents as intruders and critics rather than partners have are built walls. Schools too often pay little more than lip service to the idea of involving parents in their children's education and parents have not, until recently, been active in seeking involvement.[22]

Eliminating this divide is one of the mandates of the NCLB legislation, which you will remember is also actively seeking to guarantee the education of all children, at all economic and academic levels, and speaking all languages. The government of the United States, then, recognizes that schools need parents.

The best schools educate the parents (and the community) as well, not in a patronizing way but out of a passion for the students' intellectual and personal welfare. The best schools listen to the parents and make them a part of their child's education. Returning to Thornburg's vision of the 21st Century School as a "common meeting ground," parent education and involvement are crucial elements in the future of education.

Parents Need Help, Too!

Now that a public school's "Report Card" is public information, parents have a chance to evaluate the educational outcomes of their school, or at least the results of standardized assessments. If parents are troubled about their child's education, what should they do? They should turn to the school. If they get the feeling that they are not welcome or that the school doesn't have an answer to whatever the problem might be, should they not seek a second opinion? Should they not take their child elsewhere? Maybe they should, and the NCLB allows them to do so without penalty after two years. But they don't really have a lot of options—other than very expensive ones. Few parents can afford to move to another school district, pay for transportation to another school, or

[22] Consistently, research has shown that fewer than 50% of parents visit the school during the school year.

seek out a private education for their child. It is for this reason that the NCLB has mandated that schools seek or create better communication channels.

This is necessary for all parents, but perhaps most true for parents of children with special needs. When it comes down to it, if parents of children with special needs are not an integral part of school life it is the larger society in general, and the schools in particular, that are to blame. The parents have no choice but to rely on the school's willingness to include them and educate them. All too often the parents are powerless because they simply don't know what to do and are left out in the cold.

Susan Isaacson is a special education teacher in Fairbanks, Alaska, certified to teach K-12 in special education with endorsements in the areas of the Learning Disabled (LD) and the Emotionally Disturbed. Susan has this to say about the need for schools to work with parents when children fail to achieve at the level of their abilities:

> If you have low achieving students who are definitely very capable, what is the primary problem? If we say that there is some type of traumatic situation that occurred, or that there is evidence of ADHD, then why do I not have my classroom overflowing with more students? For heaven's sake, there are many students who have incurred some type of extreme emotional trauma, but who do not require special education. There are also many who are very "busy" kids with attention problems, but who are not found to need special education. Why? It's easy. Most all of the children who end up in my classroom come from homes which are far from the ideal.
>
> Many [of the children] have been in one foster home after another. Some have not been removed from the home, but should be! If these children had been given a nurturing environment when they needed it, most likely they would not have fallen so far behind in their academics nor would they have begun to act out behaviorally. That's why I don't have half the school in my little classroom, because there are those good families out there and there are people who sell everything they have to get their child the help they need.
>
> I truly believe that half of my parents are in need of a good evaluation because they have never had their special needs (be they medical or psychological) addressed. So they are limping along, doing the best they can, not realizing they are many times adding to the problems with their own children.
>
> What may be part of the solution? I believe that if we are to continue to offer students special education, then we need to place a requirement on the parents/guardians. That requirement would be a simple parenting class, which could be listed as some type of special education course to support parents. This course could involve touching on subjects such as ADHD, along with the most current information, including pharmaceutical intervention/alternative medicine (and there is a place for both!). This course could involve such topics as mood swings and depression, which many fail to recognize in children. This course also could involve instruction in the necessary organization of home life when it comes to homework and preparation for a good school day (including preparing nutritious food on a shoestring budget).

> The course should be a mandatory requirement or no special education: how about it? I think we would see a lot of eyes opened. It has to be made clear that the only way to success for children is support from home, and that school and home must work hand-in-hand. We must empower our parents. But we must help them, too. Society must be willing to bear the cost of helping families with special needs. It's a matter of educating the leaders of our country so that we can get the funding to educate families such as these.

The Schools Must Take Responsibility

The responsibility for changing this state of affairs must lie with the schools. The parents are on the outside looking in. Culturally—traditionally—they are not supposed to interfere with what goes on in schools, and when they do they are regarded (respectfully, of course) like students with behavior problems, even when they are only trying to get help.

In their summary of the literature, Marshall and Rossett find that "the strongest predictor of academic achievement is the family's ability to create an encouraging home environment, to express high but realistic expectations for achievement and the future, and to become involved in their child's education." (Marshall 1997). Surely this is good for all parties involved—student, parent and teacher.

The importance of the Student-Parent-Teacher Gestalt

Wertheimer, the father of *Gestalt psychology*, argued that an organized whole is greater than the sum of its parts (Bigge, 1992). "For example," Wertheimer observed, "a triangle is greater than the sum of the three line segments that form it. This is because of its Gestalt." The triangle is an appropriate analogy for the argument we are trying to make, for it is the triangular relationship formed by the parents, the teacher/school, and the child that is greater than the sum of the three entities taken separately (Fig. 7.5).

Fig. 7.5 The student-parent-teacher Gestalt

You may have good parents, a good teacher, and a good child, but if they do not work together, the strength that could be derived from the Gestalt is lost. This perhaps explains why so many children, academically able or not, simply do not enjoy being at school, no matter how much "fun" they may be having, because they do not consider school to be integrated with the rest of their lives.

It seems reasonable to conclude that the more schools do to meld the triangular Gestalt formed by the child, the parent(s), and the teacher, the more committed the child will remain through the long process of formal education. And "if time and opportunity to communicate are the barriers [to making the Gestalt a reality], then telecommunications technology can come to the rescue" (Bauch, 1990).

The TransParent School Model

The original *TransParent School Model*, developed and formalized by Jerold Bauch at the Betty Phillips Center for Parenthood Education at Vanderbilt University, uses telecommunications technology to provide "voice-based information exchange between teachers and parents." The model, described in *The Parent Involvement REPORT* (1992a), is purposely simple, both technologically and methodologically, so as to make it as easy as possible to implement.

The components of the model are as follows:

- **Network infrastructure**: computer-based voice messaging system is installed at the school site.
- **Current information**: each day the teachers prepare a brief script, describing
  1. what their students learned during the day;
  2. specific homework/home learning assignments;
  3. parent education suggestions;
  4. any other school information.
- **Teacher-parent contact**: the teacher records the message in a voice mailbox. Some schools wire classrooms with phone jacks, others locate phones in faculty areas. Parents can use home or work or public phones to leave messages for teachers.
- **Anytime retrieval**: all parents can call and hear the message at any time.
- **School-wide information**: there are other voice mailboxes on the system, accessed with different phone numbers, which can contain messages about such items as the daily lunch menu, sports or performance event schedules, and so forth.

Outcomes of the TransParent School Model

The TransParent School Model has had several interesting outcomes, especially for those families where the parents have taken most advantage of the system.

- These parents are now more involved with their child's education.
- They notice that their child completes more homework assignments.

- They see an improvement in their child's skills.
- They observe an improvement in their child's grades.
- They feel better about the school.

C&C Today - Extensions of the TransParent School Model

New technologies and the faster networks that have been described in this chapter provide the school with new strategies for communicating with and involving parents. Here is a run-down of what is now possible:

- *E-mail*: Most schools make teacher and school e-mail addresses available to parents and encourage their use for day-to-day communication. Although certainly not all parents have access to an e-mail account, e-mail is the most common use of the Internet by adults today. Many schools give parents the choice of receiving announcements *in print* – e-mail is the default; parents can even sign up for accounts on the district e-mail server.
- *School websites*: 98% of the schools in the US now have websites. These serve many uses, but communication is perhaps the most important. In-house and externally housed sites can now be easily created with the equivalent of "digital templates" and secure digital databases—making it possible for teachers to post assignments and lesson plans, for schools to make student reports (grades, attendance, behavior) available online to parents, and for all announcements and other school information to be available "24/7." A good site will contain a "feedback form" to encourage parent response.
- *Other digital communication*: Parent bulletin boards and blogs can easily be implemented once a school has a website or has connected to a "school content provider[23]." These also can be used to provide homework help. Some schools are exploring the use of video conferencing and "streamed" (stored for viewing at home) videos to promote parent understanding and involvement in student learning. The web-based publishing of classroom notes, facilitated by applications such as Aquamind's *NoteShare*, make streamline communication about daily content. Many teachers are also using free blogging tools, such as *Edublogs.org*, to post class summaries, notes, and assignments.

The Importance of Choice

Choice is important, for although we would like to put it behind us, the *Digital Divide* still exists. Not all parents have home access to computers or to the Internet. We techies tend to forget that print is also a technology, one that reliably reaches the largest number of parents. For this reason, the best implementation of a *(New) TransParent School* Model includes parent choice and school follow-through that embraces:

- *voice messaging* in all of the languages (Spanish, Vietnamese, Arabic, Urdu, etc., as well as English) spoken in the community of parents;

[23] These are generally commercial concerns that host school web-based content, deliver lessons, and provide interaction and communication tools for subscribed members of the community.

- *person-to-person (face-to-face) communication*, especially *home visits*—this is "foot" technology, and, although beyond the scope of this book, has been proven to be highly successful;
- *print/mail options*—these include "backpacking" and postal mail and should also be multilingual;
- digital telecommunications.

It is most important that a school reach 100% of its parent community and that 100% of the parents respond in some way—daily would be ideal.

LOOKING BACK

Naisbitt (1982) describes his high tech/high touch formula as the balancing act between the introduction of new technology and "a counterbalancing human response." Naisbitt's intent is to show that the counterbalancing human response (the high touch) is often a reaction *against* increased implementation of new technology (high tech). But this is not necessarily the case. Often, a heightened human response is a *complement* to new technology. This especially can be true of C&C in schools. By putting parents, teachers, and students in touch with each other and with the local and global community, high tech C&C is extending the reach of education to the high touch benefit of all.

In this chapter, we have examined the impact of C&C in education, and the conclusion is inescapable that this technology is becoming an integral part of both educational administration and of the learning process itself. Today, at the beginning of the third millennium, close to 99% of personal computers are used for communications such as e-mail and Internet access. While this figure pertains to across the board PC use, schools, too, are experiencing the same evolution. As the new, connected systems are set up alongside the old, it has become necessary to integrate the older computers with the networked machines for the purposes of file sharing, communications, integrated learning, and so forth.

As Schmall (1992) pointed out, institutions that increase the quality of services such as networking "should not lose sight of what [these improved services] cause in terms of user's rising expectations." Once people get a taste for easy and well nigh instant access[24] to others in particular and to on-line services in general, they will quickly reach the point where they will be unable to do without such services.

The strains put on computer networks to meet these rising expectations can easily result in performance degradation when the system is pushed to its limits. This is a sufficiently common phenomenon for networks to have been have been facetiously nicknamed "notworks!" However, if the most common problems associated with networked computer systems arise from overuse, is this not compelling justification for their implementation in schools? Remember Metcalfe!

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[24] You know by now that "instant" or immediate communication is synchronous, but most of the communications solutions we have discussed are asynchronous. This means, in practice, that though parents may expect an immediate response—they may have to wait for a teacher to have a free moment!

LOOKING FORWARD

In the next chapter, we will examine the subject of computers and communications as the medium for distance learning and as the backbone of the Internet.

A key ingredient of our successful adaptation to an Information Age is our ability to access, process, transmit, and receive data to serve our information needs. Internet access is already ubiquitous in so-called developed countries in general and is rapidly becoming so in particular in schools. The information available on the 'Net is growing by leaps and bounds. On-line resources made available for teachers and students K-12 are already extensive, and growing day-by-day. The Internet thus warrants special attention, since it is a medium that is transforming education.

Along with the Internet, we should examine the concept of distance learning. As networked environments become the norm both in schools and at home, students will have opportunities to interact on-line with other students and with globally-located learning resources. More and more learning will take place in virtual learning environments where information in digital format will be discovered, accessed, processed and shared.