



Research on the Future of Learning and Business

■ Technology in 2002

Working papers and research notes of Internet Time Group.

Everything here is D-R-A-F-T, fodder for our understanding. This particular note is one of a series.

[eLearning Executive Summary](#) ■ [Research Notes & Working Papers](#) ■ [The Network Age](#) ■ [Business](#) ■ [People](#) ■ [Learning](#) ■ [Technology](#) ■ [Organizations](#) ■ [Knowledge Mangement](#) ■ [Decision-Making](#) ■ [Internet Time Machine](#) ■ 

BIG PICTURE

All of us will be connected to the net all of the time.

Broadband and fiber will put video on most desktops in the office and at home.

Bionic ID and virtual private networks will make the net secure.

Wireless connectivity will free us to work wherever we please.

Application software and files will migrate from the PC to the net.

“Thin client” devices and information appliances will replace PCs.

Software agents will continuously crawl the net, feeding information to our personal portals.

Bandwidth basics

What you really need to know is:

1. DSL will enable business and homes to connect to the Internet several hundred times faster than today's 56K modem, over telephone lines, at reasonable cost.
2. Optical fiber will boost the capacity of many Local Area Networks ten fold.
3. Wireless connections between satellite and mobile user will become commonplace but will be slower than wired connections. Wireless LAN connection will be commonplace.

4. The Internet backbone will not lack for capacity thanks to new innovations in optical technology.

Implications are:

1. Most people will be able to receive a video signal from the net, although not of the highest quality.
2. No one will have a sufficiently fast connection for virtual reality or verisimilitude.

There's a lot more where this comes from in this chapter's appendix.



Videophone.

Humans communicate with their eyes as well as their voices. By 2002, early adopters will use video phones. In time, we all will.

Cynics may point out that the phone company (there was only one Ma Bell at the time) introduced the PicturePhone at the 1964 New York World's Fair. The idea was on target but the necessary infrastructure was not there to support it. Broadband communication lays the foundation.

Y2K

By 2002, we'll have Y2K behind us, with no financial meltdown or panic in the streets. The few glitches that do arise will have made software developers more holistic and users, more cautious.

Looking back, we'll see more and more outsourcing of training. Patching up and testing systems before 2000 ate the capacity to support training initiatives in-house. Training and marketing departments were forced to bypass in-house LANs for support. They turned to programs delivered over the Internet. Frustrated by firewalls, many employees shifted training activities to their homes. As the frenzy of Y2K passed, many corporations found that outsourcing both development and delivery of training worked. Employees who had been too harried when trying to learn on the job found the barking dogs and shrieking children at home almost soothing in contract.

Cheap gear

During the Christmas 2002 shopping season, you'll be able to pick up an off-brand desktop computer at Costco or WalMart for \$150. A 1000 Mhz Dell notebook with wireless communications and built-in video will cost \$999 directly from the manufacturer. Information appliances from SONY, GE, Matsushita, and Braun are outselling PCs two to one. Cell phones with the integrated PalmPilot XXII cost but \$75.

Microsoft Office, recently renamed Microsoft Enterprise, rents for 10 cents per hour (and as low as 5 cents for corporate customers who pay in advance.) Philippe Kahn rents his simplified word processor/graphics suite for a penny an hour. The Open Standard Java suite is free, as long as you don't mind a stream of advertising.

Portable Desktop.

Think about working with your computer. Why is it easier for you to work with *this* computer than with Joe's?

You confused the computer with the interface, didn't you? For most of us, the computer is what appears on the screen. But your interface can appear wherever your software settings are running. By 2002, for most of us, our settings and software will run on the net. When we log in and identify ourselves, our interface greets us, customized the way we like it and giving access to our information and ways of doing things. No matter whether we jacked into the net from home, from the office, from a public terminal in the Red Carpet Club, or from the palm link rider we wear to meetings. (See "The Internet Becomes the Computer" below.)

Web Tone.

In 2002, most telecommunication will be broadband and digital. You will never hang up your phone. Old analog telephones use "circuit-switching." When I'm on the phone, I tie up a couple of copper wires; they're mine until I hang up and let the next guy use them. Digital communications networks use "packet-switching." My data uses up a tiny fraction of a line when it's moving. Otherwise, it uses no capacity at all! It costs nothing to stay on the line all the time.

"Web tone" is like "dial tone" in that it will seem quite natural for everyone to have it. But you won't really hear a tone unless your connection to the Internet is down due to malfunction. You're connected unless you hear otherwise.

The Role(s) of the Web.

We asked forty professionals and visionaries to think outside the box on the role of the Web in learning. We found not one "killer app," but many. The web has the potential to do all these things and more.



The web will fully automate the **desktop**, integrating all the communication and planning and writing tools I use in business. Users will attain "unconscious competence," using the Web as effortlessly as making a phone call today. I might tell a colleague anywhere, "Hey, take a look at this" and immediately, a video appears on both our desktops.



In the morning, when an employee comes in, she logs on to her personal page backed by her **personal learning server**. It serves up information harvested from the net, manages her learning, and is her electronic assistant. The Web becomes what Apple's Knowledge Navigator was supposed to be.



Our portable, personal computers will be **wired to our bodies** to monitor our health, "IP to the pancreas." The net will connect all people to all content all the time. Cheap flat panels will replace paper.



Today's software agents churn out more and more of the same. In the future, my agent will **shadow-dance** for me, exploring the paths I'd have taken in person. My bots will sniff out information and produce a custom-tailored daily feed. Intelligent pop-up's will replace training.



The Web will become a **village**. Senior managers (the village elders) will share their wisdom, values, and culture with newer members of their corporate tribes.



"Imagine that your entire working area -- **desk and walls** -- was capable of displaying digital images... Your desktop will have real piles of paper next to virtual piles. Your cubicle wall will turn into a Web windshield." David Weinberger. "Thank God for eyelids."



"The web will be a '**digital nervous system**.' If you think of the human body, what does our nervous system let us do? It lets us hear, see, take input. It lets us think and analyze and plan. It lets us make decisions and communicate and take action. Every company essentially has a nervous system: Companies take inputs, they think, they plan, they communicate, they take action." Bill Gates, Microsoft



The Web will flip from interactive to transactive. "Weblications" (Web applications). This new Web will run on **auto-pilot**, reducing Internet traffic, and freeing the Web from incessant intervention by pokey humans.



My heads-up display will warn me of things in advance, give me decision support, and find the needles in ever-larger haystacks. Our company, The Understanding Business, focuses on **getting rid of info-clutter**, eliminating redundant communication, and improving human performance. Five years out, the Web will perform many of these services, too.



The future Web is a **live-in movie**. In our virtual reality, we'll each become actors, directors, editors, and producers. It's the holodeck on the U.S.S. Enterprise. Is it simulation or the real thing? Is there a difference? "Be there now."



When I walk into any collaboration booth, it will recognize me and become my office. The giant, **wrap-around display** on the desk will show real-time images of co-workers and customers, virtual files, calendar, note pad, mailbox, imbedded phone, shared information space, and a picture of the kids. My workspace goes wherever I do. Bruce Tognazzini, Sun



The Web will offer the sensations of life. "**Real life** is just one more window." Sherry Turkle, *Life on the Screen*

Personal portals.

When you sign on to the net, your personal portal will greet you. You may choose one of the many default portals but more likely you'll assemble portal building blocks to tailor things to your particular needs and concerns. Your portal might include your picture-phone interface, to do list, incoming information organized by your bots, your scheduled events, a direct link to the corporate knowledgebase, your net-based software suite, your health monitor, your medical record, your learning record, and your collection of pointers to worthy destinations.

Bionic identification.

Computers, networks, and security systems will identify you by analyzing your unique thumbprint or eye's iris. Regulatory authorities and the College Board can stop worrying about who's really taking an exam. You won't need plastic to purchase things on credit or get money from the ATM. Touchpads will replace keys on the doors of private offices and restricted areas. You won't have to tell anyone your mother's maiden name or social security number if you don't want to. Passwords will be passé. The safety of information on the net will shift from iffy proposition to being the best way to do it. No one's going to hack your thumbprint.

Telepresence.

Is it live or is it Memorex? Given a choice, you won't fly to that meeting in Harrisburg when your avatar can go in your place. Our Neanderthal brains confuse media with reality. When we see a still photo of the person we're talking with on the phone, we feel more rapport. The postage-stamp sized, flickering video of low-bandwidth video conferencing brings even more immediacy. The full-motion video run on dedicated in-house systems fills the screen with clear, colorful images. At some

point, videoconferences will become so real that the effect is little different from all being in the same room together.

My avatar – a three-dimensional projection shadowing my gestures, voice, and bearing – could establish a sufficiently human presence to represent me. And on my end of the conference, my virtual reality gear would paint a scene every bit as compelling as being in the conference room physically. For that matter, you could attend the meeting from your mountain lodge, Sally will beam in from her apartment in Paris, and I'll join from my back deck. Forget Harrisburg. Let's meet in front of a roaring fire in a chalet in Davos.

Death of Distance

When I was in fifth grade, I read a science fiction story about a machine that could whisk people instantaneously to any location on earth. Want to go to India? Okay. Zot! You're there. "Beam me up, Scotty."

Reality is catching up with science fiction.



Bruce Togazzini tells us, "Human beings are designed to interact with each other. Not with computers, and not with some disembodied string of ASCII characters showing up on a screen. They crave warm human flesh and blood. If we are to have any semblance of the kind of multi-level communication through our computers that people need to thrive, we are going to have to go to high-bandwidth communication. Not ISDN, T1, or even T3. We are going to have to get serious about fiber, and we are going to

have to show actual-size, real-time images of each other face-to-face, coupled with high-quality audio and devices that allow us to see and experience touch, as well."

Firewalls Fall

A Virtual Private Network (VPN) lets a user log in to a corporate intranet securely. VPNs are replacing today's crazy-quilt of firewalls, centrally administered security policies, extranets, and intranets. Since VPNs carry encrypted data, they can transport data on shared lines instead of expensive dedicated lines.

Good riddance to firewalls. Leave the key in the gate and anyone on the net can walk right in. They block relationships with those outside the walls with good reason to get in (i.e., customers); they bottle up those within them with good reason to get out (i.e., learners). With VPNs, security levels can be set by user and by application. Customers will be able to transact directly with corporate extranets, a smoother and less costly way to do business than electronic data interchange (EDI).

Digital Video

Digital video will bring more than a clearer picture.

Unlike the analog video we're used to, viewers are in the driver's seat. Viewers

can speed it up or slow it down, start in the middle or review a section^[1]. Learning increases when the learner's in control. Fast-forwarding cuts time previously wasted on unnecessary or outright boring material. A simple index enables a learner to jump to the relevant sections of a video without having to wade through a presentation from beginning to end.

Packet-switched networks, either in-house LAN or outhouse cable, deliver digital video on demand. At home, the "500-channel future" will be replaced with an infinite-channel scenario. Connecting through the Internet, you can watch last week's ballgame whenever you feel like it. On the job, you can pull up the marketing director's presentation last June, a technical whiz's advice on repairing a fritzzy widget, or last month's video conference with the big client.

DVD

DVD (digital versatile disk) is an optical disk technology that will replace both CD-ROM and audio CDs by 2002. Think of it as CD on steroids.

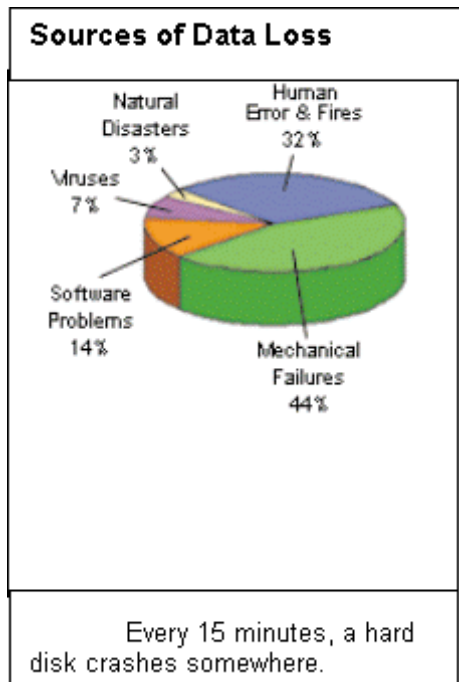
A digital versatile disk (DVD) holds 4.7 gigabytes of information on one of its two sides, or enough for a 133-minute movie. With two layers on each of its two sides, it will hold up to 17 gigabytes of video, audio, or other information. (Compare this to the current CD-ROM disk of the same physical size, holding 600 megabytes. A DVD holds 28 times as much!

DVD uses the MPEG-2 file and compression standard. MPEG-2 images have four times the resolution of MPEG-1 images and can be delivered at 60 interlaced fields per second where two fields constitute one image frame. (MPEG-1 can deliver 30 noninterlaced frames per second.) Audio quality on DVD is comparable to that of current audio compact disks.

Net Appliances.

Telecommuters and SOHO will connect to the net at 1.5 megabits/second via cable modems, DSL over phone lines, and satellite. Formerly sluggish web pages will snap on screen. With a fast-access connection, bringing up a Web page takes no longer than calling up a file from the local hard disk. The entire Internet becomes a peripheral to the PC, bonded as tightly as the PC and its local printer.

Already, connected users are running certain applications via the Internet. Professional "road warriors" maintain calendars, phone directories, and e-mailboxes on the net. This enables them to share their calendars with others and to check email from anywhere they log into the net. (At Internet conferences, message checkers line up behind banks of connected PCs as well as the telephones.) Quicken's TurboTax enables payers to calculate and submit tax returns over the net; unlike a tax



program you buy at the store, the on-line version is always up-to-date.

Consider back-up. Everyone knows it's important – all hard disks crash eventually. Most users don't back up religiously because it's a troublesome nuisance. Providers of on-line back-up rent you space on a system at their shop. Think of it as a remote hard drive attached to your computer. On-line back-up is as easy as copying a file to a local hard disk. It's so simple that users needn't even be aware when it's going on.

Traditional Back-up

Not current. Often deferred because it's a hassle.

Requires special hardware and media. Back-up media generally stored on site. Let's hope the house doesn't catch on fire.

Reading back-up requires physically inserting tapes, disks, whatever.

Half of all backups don't work.

On-line Back-up

Always current. Runs in the background whenever new files are created.

No additional hardware required.

Stored off site. The service provider even backs up your back-up.

Files can be retrieved from any port on the net.

Always readable – even the back-up is backed up.

Using Microsoft Word to jot down a memo is like using a jackhammer to perform surgery. Overkill. By 2002, many users will be running word processors, spreadsheets, graphics programs, and everything else Microsoft bundles into Office directly off the net. The availability of simple, easy-to-use, net-based software will severely eat into the bloatware market. You rent what you need when you need it. You'll choose the right tool for the job. Instead of a general-purpose word processor, you may select a memo processor, a report processor, a brainstorming processor, or a book processor. Apply this logic inside the firewall, centralize application programs on servers, and chop \$5,000 to \$10,000 TCO from every desktop. When you're running applications off a server, you no longer need an operating system designed to do everything locally. Chop it back. Close the Windows. The network has become the

computer.

@Backup.com is developing the back end for just such a portable environment. Their ideal customer:

SkyDesk™ Customer Profile

SkyDesk™ is the only "whole computing" solution for users away from their pc making it an ideal solution for the following kinds of customers:

Mobile Professionals

Consultants, engineers, attorneys, and sales professionals all need quick and simple access to their data files and applications wherever they are and whenever their customers or clients demand. SkyDesk™ helps these users effectively respond to these ever-changing demands without having to guess what customers will need from their computer next.

Small Business/Home Business Owners & Managers

The SOHO market is employing computer technology faster than ever and effectively using it to compete against the world's largest corporations. SkyDesk™ provides these users with a simple way for them to share information securely and access their data remotely without having to purchase extra notebook pc's.

Telecommuters & Home Users

Business users in companies both large and small may need to work from home periodically or just want to be able to complete a spreadsheet or document after dinner. SkyDesk™ provides these kinds of customers with complete access to all of their applications and data without having to install any new software on their home computers. Best of all, SkyDesk™ helps these users maintain a "safe" copy of their entire desktop should a child or other user corrupt their or disable their system.

Corporate Teams or Workgroups

Although SkyDesk™ is not intended to replace sophisticated corporate groupware installations, it is an ideal solution for small team computing, particularly where file and application sharing are a premium consideration. SkyDesk™ can be set up by any corporate user without IS support to provide file and application access to anyone in the team, making it well suited for today's fast-changing corporate environments.

More info: <http://skydesk.backup.com/>

Jini

Jini is Sun Microsystems' project to interconnect your television, thermostat, toaster, burglar alarm, answering machine, and all the other chips imbedded in your home and workplace. Sun calls this "spontaneous networking," because devices can start talking with one another without the software "drivers" and operating system that are required today. Jini is the next step after the Java programming language toward making a

network look like one large computer. Jini is expected to hit the market in late 1999.

Information appliance

"The PC is maturing from a universally adaptable, "one-size-fits-all" system into a wide range of targeted appliances designed to solve specific user applications," says Gordon Moore, Chairman Emeritus, Intel.

"MIT assistant professor Michael Hawley took turns pointing out the PC's many ills, all but relegating it to the trash-heap of digital history. "It's a product meant for office drudge work that fell off the back of a truck and landed in consumers' homes," said Hawley. "It's not fit for my mother to use. It's basically industrial waste."

An information appliance is a special-purpose computer. Because it has fewer options, it's cheaper and easier to use than a general-purpose PC. Today's PalmPilot, used mainly to keep track of appointments and check phone numbers, is a good example. It's not very hard to figure out how to use because there's not that much you can use it for. PalmPilots have, in fact, entered the consumer market. Yesterday at Fry's we noticed shoppers making the tough decision of which model to buy – the plain black plastic one or the model V in the sleek titanium case.

Imagine a portable, wireless, combination phone, pager, fax, personal organizer, e-mail agent, and web surfer that weighs less than a pound. Whoops. That's not a good example of what's to come; the Nokia 9000 wireless phone already does all that.

Why are information appliances crowding out PCs. Because dedicated tools work better than general-purpose ones. Consider the Swiss Army

Knife. It's a wonderful invention, but it doesn't pull corks as well as a real corkscrew, it doesn't drive screws as well as my ratchet screwdriver, and it doesn't slice bread as well as my serrated bread knife. The PC is the Swiss Army Knife; information appliances are the tools.

Consider an appliance that will find its way under many a Christmas tree in 2000, the Sony Playstation II. Engineered to perform highly specialized tasks, the Playstation delivers graphics that until now could be produced only by supercomputers. Sony and Toshiba have invested \$5 billion in the "Emotion Engine" chip that powers the Playstation at three times the speed of a Pentium III. The result? Graphics as good as Toy Story, but delivered in real time! Although Sony denies any intentions of competing with the general-purpose Wintel standard PC, analysts noted that the Playstation does come with slots for connecting modems, hard disks, and a new generation of digital video cameras. This machine heralds the merger of film, television and the video game businesses," said one Wall Street analyst. A Silicon Valley entrepreneur calls the Playstation II "the first credible alternative to the PC for reaching people on the Internet."^[2]

You can already buy a wireless web tablet, a handheld scanner, a combination phone/PIM/web surfer, a frame that rotates your digital [Photographs](#), a set-top box to capture your favorite t.v. shows, electronic books, and a cell phone the size of a wrist

watch.

No more monitors

The cathode-ray tube monitor, taking up a lot of real estate on the desk and sucking more amps than the rest of your computer put together, is going the way of the punched card.

In the office, thin, lightweight display film will be the rule. You'll have several: one will display your "dashboard," your control interface. Another will display live images of people you're communicating with. One 3x5 card displays will show a real-time sales chart, another a recent video snip of your daughter playing in the snow. At home, a 6'x4' flat panel in the living room will show any program you're willing to pay for. In your office, you'll have one of the old rigid flat panels, a corporate hand-me-down.

In addition to wall panels, we'll have flexible display films that look and feel like paper. Impregnated with "digital ink" to form high resolution images, content for these films will be downloaded from the net.

Uh-oh. We're ahead of ourselves. These displays won't be widely available until 2008. ^[3] By 2002, rigid flat panels will cost less than today's CRT monitors but the CRTs will still be emitting their radiation on a majority of the world's workers.

No more blurry LCD panel

By the time notebook computers morph into full-feature palmtops, and palmtops are shrinking into wrist-wraps, "i-glasses" will replace battery-hungry LCD panels. From the front rim of the glasses, an electron gun the size of a ladybug will beam signals directly to the retina, creating the illusion of a 20" screen floating a yard away from one's face. ("Is that trainee in deep concentration or watching Jerry Springer?")

Miniaturization

These days things are happening so fast one day's three-year forecast is tomorrow's technical news item. The day we were writing this, an article appeared in the San Francisco Chronicle describing the "World's Smallest Web Server." We went to the URL and found this message:



"Fifty years ago, a computer with less computational power than a modern pocket calculator filled a whole room, and ran programs consisting of only a few hundred instructions."

"In the intervening decades computer hardware has continued to shrink while computer software has continued to grow, so that today we can fit the extensive software needed to drive a World Wide Web server into a

computer the size of a box of matches."

"The web page you are reading is served to you by the computer in the photo."

The photo shows a circuit board the size of a matchbox, maybe 1.2" x 1.8."

Our brave prediction: By 2002, some things will be unbelievably small.



Speech recognition.

Computers are getting good at recognizing human voices. The Wildfire phone system takes messages, maintains a phone book, reads you faxes and email, and even recognizes the voices of frequent callers. A new palmtop records dictation and beams to your desktop computer, which converts words to text. By 2002, technology will have jumped the hurdles of misspelled words and the requirement to speak distinctly.

Superb speech recognition will enable us to issue verbal commands to any plugged-in device (“Hey, coffee pot, do your stuff!”) Voice commands will be the standard in mobile computing. But we’ll still have keyboards and visual pointers like the mouse. Microsoft Windows is confusing but just imagine trying to control your computer with the equivalent of voice mail. We can click an icon or enter a few words on a keyboard faster than we can say the words.

My Office in the Park

With network appliances at home, where we work, and in our pockets wherever we go, we’ll always be online to the Internet. Ponder the implications. Will you really need a permanent office? You’ll want a place to meet visitors and gossip with colleagues, but if you’re a knowledge worker, you’re not going to commute just to sit at a desk. Anywhere you work, your co-workers will be as close as if they were right down the hall. A Silicon Valley visionary^[4] expects innovative Internet services to be marketed with the slogan “anyone, anywhere, anytime: connected.”

Wireless.



Some of us have wireless cell phones, pagers, and modems. In 2002, carrying a wireless communication device will be as commonplace as wearing a wristwatch. Today it’s chic to whip out your StarTac or Nokia wireless phone. Last year in Milan, the most suave characters always seemed to be chattering into cell phones. “Pronto! Pronto!” When everyone has a wireless netphone, it will undoubtedly become hip to venture forth *unconnected*.

Wireless net connection will be commonplace in 2002. Mobile workers will be truly mobile. Office real estate will become cheap. A new LAN standard will turn wireless network adapters into commodities. *Wired* magazine will need a new name.

. Micropayments

Lots of people would be will to pay a nickel to read a good article, but in a world where credit cards and hard cash are the coin of the realm, it’s impossible to buy anything for a nickel. Enter micropayments, a structure to make it feasible to buy things of a tenth of a cent.

Several daring entrepreneurs have broken their picks trying to bring up micropayments but the consensus is that they were ahead of their time. E-commerce didn’t have much credibility until the Christmas buying binge of 1999 and clearly, it

takes lots of 1/10 cent transactions to turn a profit.

By 2002, micropayments will be a fact of life. Unimaginative learners will buy Stephen Covey at a penny a page.

Many more information appliances and gee-whiz gizmos

Craig McCaw's Teledesic is preparing 300 satellites to enable global Internet access

THE PACIFIC OCEAN, AUG. 31, 2002 - The last of 288 satellites went into orbit today, completing a constellation that, on Oct. 1, will begin providing the entire Earth with access to broadband communications. Teledesic Corp. Chairman Craig McCaw says his company expects to break even within two years on its \$12 billion investment in the global data communications network. Investor Bill Gates says Microsoft Corp. will shift all its internal communication needs to Teledesic, through AT&T Corp., its main service provider. Lead contractor Motorola Inc. followed suit, as did Boeing Co. and General Motors Corp.

<http://www.zdnet.com/intweek/printhigh/83198/beam.html>

In fact, as August 1998 draws to a close, the idea that, in the next four years, the Net will have established itself as the primary means of exchanging not just numerical data, text and Web graphics, but also sounds, sights and voice conversations themselves, is no longer some technology wonk's spirit-induced "vision." That public communications in the year 2002 will be synonymous with the Internet, at this juncture, seems more realistic than strained.

<http://www.zdnet.com/intweek/printhigh/83198/thenet.html>

with circuit switching, the pace of technological change is impressive. So called "stored program switches" - such as the Lucent Technologies Inc. 5ESS or the Northern Telecom Inc. DMS - double their performance for the same cost every 80 months, says Peter J. Sevcik, an associate at Northeast Consulting Resources Inc., located in Boston. More advanced ATM switches double performance in half that time.

IP routers, however, double performance every 20 months, and frame relay switches double every 10 months. When calculated in terms of the number of bits per second per dollar that can be moved, packet switches now beat circuit switches - and the gap will widen.

in the age of IP, the ability to write applications, utilities and other programs for communications networks is wide open. Anyone with a better idea can produce a product to improve communications performance.

"IP brings thousands of entrepreneurs supported by billions of dollars in the marketplace to bear on the problems of communications. It breaks it down, breaks communications down a piece at a time," says James Crowe, CEO of Level 3 Communications Inc.

With massive capacity, erstwhile sci-fi imaginings, such as video phones, go live

Don't look now, but they're coming back - video-on-demand and video phones; that is, the archetypes of neat, sure-fire innovation from years and decades gone by.

New long-haul telecommunications networks - combined with high-speed customer connections via television-cable, Digital Subscriber Line over ordinary phone lines, broadband fixed wireless systems and satellite - will support a dizzying array of communications, information and entertainment products for businesses and consumers. They will range from remote-control medicine and hyperfast and realistic games, to click-and-play teleconferencing and remote corporate training.

<http://www.zdnet.com/intweek/printhigh/83198/seeme.html>

With "click to call," users can talk with company representatives while they share Web page views. With broadband, this evolves to multimedia transactions. Now, an online shopping excursion can take you through a virtual-reality mall - or jungle or ballpark, for that matter - with video product demonstrations and narrated descriptions.

In financial services, call center operators will share application forms and scenario worksheets with customers, Analysys says. It notes banks and insurance companies could start giving away phone calls or dedicated terminals as come-ons.

Travel and entertainment sellers could add audio and streaming video to personal schedules and reservations on the Web, without big hardware investments. Distance learning, including corporate training, could involve group discussions and audio consultations with instructors as well as multimedia lectures. Design businesses could soup up three-dimensional images to be shared among professionals and with clients.

The next killer app?

Virtual private networks, which are corporate connections emulating private lines

By 2002, for instance, Internet audio could satisfy a stereophile. Applications and diversions could be stored on the network, with access in thousandths of a second, when the system gets as fast as a local disk. Knowledge management, or correlating and exploiting information from throughout a large corporation and from outside sources, would become immensely more powerful.

Multiple Phone Lines - Screaming Internet Speeds - One Connection

Every once in a while a technology comes along that breaks boundaries and changes the way you live. You get it - you bring it into your home - you use it - you can't remember what life was like without it. That's why Sprint is proud to announce Sprint ION, Integrated On-Demand Network - the future of telecommunications brought to you today.

Sprint ION stands for Integrated On-Demand Network. What it means is one connection for all of your telecommunications needs. What it means is doing more of what you like to do faster with simultaneous connections - talk on the phone, receive faxes and connect to the Internet at 100 times the speed of today's fastest modems all at the same time! No extra lines or extra wiring, just Sprint ION. Multiple phone lines will be a thing of the past, and applications such as high-speed on-line interactive services, video calling and telecommuting will be easier and more affordable. Other companies

couldn't dream of delivering all of this because they're running on an old, outdated network. But by combining the Sprint fully digital fiber-optic network and a number of recent technological advances into one package for your home, Sprint is delivering the total communications access other companies are only talking about - that is Sprint ION.

<http://www.sprint.com/ion/residential.html>

*, MARCH 15, 1999
Redmond Company Leads Convergence Revolution*

*Jesse Berst, Editorial Director
ZDNet AnchorDesk*

Convergence. The long-awaited marriage of television and the Internet. After years of false starts, the convergence market is poised to take off. Internet-enabled televisions (NetTVs) will be the surprise hit of the 1999 Christmas season, just as ecommerce was the surprise of 1998.

Maybe you knew that. Maybe you've been watching the slow progress of Microsoft's WebTV, which will garner its one-millionth customer this year. Maybe you even know that America Online is close to a monster announcement extending its AOL Anywhere initiative to television. But here are three things you probably didn't know:

When convergence arrives, the video may come through your phone line -- not your cable connection

The set-top boxes may run Windows -- but not the Windows CE flavor Microsoft is promoting

The change may be spearheaded by a company from Redmond -- but not the one chaired by Bill Gates

Redmond-based Stellar One, producer of a set-top box (SBT) called the Netris 3000. On the surface, Netris looks like all the other SBTs. But Netris crams in many different capabilities:

Surf the Internet over your TV (like Microsoft's WebTV)

View video-on-demand (like a better version of today's hotel-room systems)

Pause, rewind or fast-forward a program (like the digital VCRs from Replay and Tivo)

Watch "enhanced TV" -- TV with a wraparound Web page (like the new WebTV Plus)

Access email (like an Internet-equipped PC)

Shop from a video catalog (like a high-end custom kiosk)

Implement thin-client computing (like the ill-fated Network Computer concept)

Build new applications for it using familiar Windows APIs and tools (like an ordinary Win32 program)

Injectable Health Monitor What's going on in your body right now? If you have diabetes, you really need to know--in particular, you need to know your glucose levels. expect chip-run implants to monitor things such as metabolic waste products for kidney patients or oxygen levels for high-altitude mountaineers.

We mean ovens that know just how long to cook a casserole or bake a cake without being told; dryers that run only until the clothes are dry; washing machines that know how much hot water to use with a load of cotton sheets. We mean robotic vacuum cleaners guided by micropower-impulse radar that can clean your house while you watch Oprah.

Wearable Computer With chips turning up everywhere, computers will be everywhere as well. That's the idea behind Ubiquitous Computing, a.k.a. Ubicomp. The UbiComp paradigm includes the wearable computer--which encompasses CPU, hard drive, and power supply; input devices such as cameras, microphones, and other sensors; and special keyboards or handwriting tablets. The output is a tiny monitor mounted on a pair of glasses.

carry an entire reference library with you and provide easy access to the information there. You'll be able to carry your notes with you and pull them up for quick perusal. It will integrate CD player, fax machine, pager, and audio journal. It will sit and recognize the acquaintance you bump into at the grocery store and tell you his or her name. It will tell you how to fix the sink while you're fixing the sink.

Eventually, perhaps within a decade, they will weigh a lot less and become affordable. When that happens, wearable computers might become standard issue for stockbrokers, doctors, real estate agents, traveling salespeople, emergency service workers, lawyers--anyone who needs information on demand but can't be tied to a desk or even a laptop.

buy a digital camcorder that connects to your TV and the Internet--perhaps through a high-speed cable modem--so you can email your home movies to grandmother's house

The bionic eye that's coming in five years will be built with silicon, and it will merely restore sight to the blind.

The target market includes the 700,000 Americans afflicted each year by macular degeneration (the Western world's leading cause of blindness), as well as sufferers of retinitis pigmentosa (1.6 million victims worldwide). Both diseases involve the degeneration of cells that convert light to neural messages at the back of the retina. Solution: Place a chip in the back of the eye to mimic the lost cells.

instant voting

"invisible computing," when computers are as pervasive as electrical outlets or water spigots

the final bottleneck in computer usage is not dependent on where the compute processing is done, but where the cognitive processing is done. That is, the power of networked computing lies not in linking our computers together, but in linking us together.

Technologies that increase sustainability, autonomy and cohesion, such as: renewable energy technology, resource efficiency boosters, personal agents and other individual filtering technology, wireless communication, VCs with collaborative filtering, tech implants,...

Smartcards look intriguing; encrypted data couriering...

task/output based work bidding and exchange service

Source: IFTF

For example, the next big surprise will occur on the World Wide Web. At the moment, the Web is defined by people accessing information. Over the next two years, look for the Web's focus to shift away from this to a new model of people accessing other people in information-rich environments. In other words, the Web will go from being an information environment to an interpersonal environment in which information plays an important role supporting human interactions.

VLSI Video

Today, a videocam with all the attendant circuitry required to attach it to a computer costs approximately \$9 a unit in OEM (manufacturers' price to other manufacturers) quantities. Expect this to drop precipitously as the next generation packages everything on a single chip: the charge-coupled device (CCD), all the circuitry needed, and even the lens will be glued directly to the chip. Cheap video translates into cheap "eyes" that can be used for a myriad of applications, including surveillance, security, and even party games.

the advent of mass-customization. Ever since Stan Davis popularized this concept in the late 1980s, the philosopher's stone of manufacturing has been finding a means of combining the appeal of unique one-purchaser customization with the economies of scale associated with mass manufacturing. 6 The scale-change triggered by sensors and effectors could set the stage for this to become a reality across a broad segment of industries, from autos to consumer apparel.

*Very important - indexing within sound and video files. This can (sort of) be done by hand now, but when Steve Jobs gives a speech that's netcast in RealAudio it should be indexed and thus become searchable *within* the speech.*

Virtual Personalities, a software company based in Los Angeles, is working to put an animated face on the chatterbot technology to be integrated in

consumer electronics. For example, one company is using a Virtual Personalities chatterbot named Sylvie as an interface for a home automation system. You might tell Sylvie, which would appear on a central computer screen, to rewind the tape in your VCR or to alert you when a light bulb has burned out somewhere in the house.

"This will be one of the major computer interfaces of the near future," Dr. Mauldin said. "Very much like HAL, but if HAL didn't understand, he couldn't frown with a puzzled expression. The idea of this cold, logical, merciless computer is eerie and scary, but a computer with a face can have a look in its eyes showing it understands you." Even if it doesn't.

Dr. Wallace said the future of chatterbots would lie in personalization.

"In the future, lots of people will have their own chatterbots based on their own personalities," he said.

"Even while you're asleep, your chatterbot will talk to other chatterbots online and find people that share your interests so you can link up with them."

nyt 3/18/99

In the near future, chatterbots are expected to act as the voices of other Web-based intelligent agents, generally called bots, which gather data or perform other tasks automatically for users. Shopping bots, for example, like Excite's Jango (www.jango.com) and My Simon (www.mysimon.com), search offerings of online retailers to find the best prices for shoppers. But it's quite a leap to designing a bot that would predict your desires.

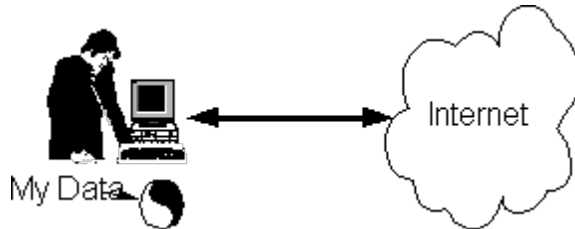
"Actually creating a computer program that understands what you mean is perhaps the most difficult nut to crack in computer science," said Andrew Leonard, author of "Bots: The Origin of New Species" (Hardwired, 1997). "But if we think of the chatterbot as a very good help system, that's certainly possible within a couple of years."

Bots

In 2002, **bots** (short for robot) or "intelligent agents"* will prepare the customized home page that welcomes you when you plug into your net -- your personal portal, if you will. Of course, your bot will gather news about your industry, your organization, and your profession. Your personal

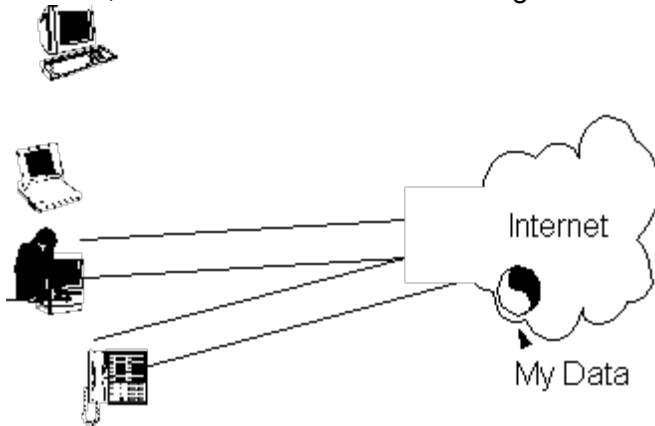
bot-spot will tell you of events that effect your customers. By name. The learning section of your bot-spot will give you new product information, government regulations, and competitive intelligence. Your bot will look at your learning inventory, development plan, team make-up, and learning style to arrive at your custom learning plans. Then it will deliver packets of information and guidance at optimal times throughout the day. Your robo-coach will suggest learning opportunities.

The Internet becomes the computer.



For most people in the late twentieth century, “my computer” has been the screen right in front of me and the Internet has been “out there” somewhere. The applications we use were right here with us. We’d swap files between laptop and our desktop computer but still feel an almost emotional attachment to “my” computer.

By 2002, reliable security and fast, cheap connections to the Internet will have freed up our thinking. The network will finally be the computer. “My interface” will replace “my computer” as the way we think of things. Our files – and much of our software – will reside on the net, not on the hard disk of our local machine. When we can access information from the net as rapidly as from a hard drive, there’s little to lose and lots to gain.



If you keep your information on the Internet, you can access it from wherever you are: your office, your customer’s office, your home, on the road, or from your pocket cell phone.

Using application software on the net (actually, renting applications for miniscule amounts) means no more upgrade headaches. Share your software with others and let a central site keep it working for everyone. This slashes TCO. Have the site do automatic backups. Big good-bye to bloatware. You’ll rent the right tool for the job, e.g. a slimmed-down

word processor for email and a heavy-duty publishing processor then you’re writing a book. Finally, your information will be more secure. Bio-identification insures that the only one to see your data; that’s many orders of magnitude safer than carrying a loaded corporate laptop that can disappear on the x-ray device at the airport.

Telecomputing's Wrong Turn By John C. Dvorak, PC, July 8, 1999

John and I agree on this one...

"The biggest buzz in the industry is over nouveau phones that act as little Web browsers, organizers, calendars and--uh--phones. Over the years, I've been promoting the be-all, end-all PDA that has phone functionality. These new phones are similar but wrongheaded.

The all-in-one device of the future should be computer-centric, not phone-centric. As a reminder, the all-purpose, futuristic PDA I've been talking about is a device about the size of a 3Com Palm III. It would house a complete computer system, TV, radio, phone, voice recorder with recognition, GPS, radio Internet connection, and LoJack device (since it would inevitably be lost or stolen).

The device would drop into a cradle that would be nothing more than a port replicator that hooks up to a keyboard and monitor for normal desktop use. All the functionality, including mass

storage, would be within the device. In portable mode, it would use a touch-sensitive screen and voice for command and control.

There's also no reason you couldn't plug in a pair of virtual-screen glasses, which Olympus and Sony are already showing behind closed doors. These glasses allow you to see a 60-inch virtual monitor. While you're looking at the virtual screen, the phone's screen can be used as a touch pad; you can scan through a complex database while on an airplane. It would be freaky to see a bunch of guys in business class wearing goggles, but expect it within the next decade. Moore's Law almost mandates such a thing to appear within the next 15 years.

Concepts

Collaborative filtering

Collaborative filtering is easiest to explain by way of example. Amazon notices that I have purchased books by Stan Davis and Daniel Goleman. Amazon's database notes that other people who bought books by Davis and Goleman also bought books by Charles Handy. Amazon tells me I may be interested in Handy's new book. The same technology could generate recommendations based on learning style, performance in various situations, or problem-solving approach.

Collaborative filtering is key to automating the display of knowledge respected by a community of practice. Pretend my practice is designing web sites. Collaborative filtering shows that my reference group of savvy designers read books by Edward Tufte, Donald Norman, and Paul Rand. Another example: I'm a new salesperson with Intel. Collaborative filtering can show me the learning activities of past sales newbies with backgrounds similar to mine who have been wildly successful. This might point me to the courses, learning experiences, product knowledge, mentor programs, customer challenges, and more.

Push & pull

Originally from marketing. You push consumers to products with advertising and sales pitches. You pull consumers to products with low prices and great functionality.

On your intranet, when the company sends everyone a memo describing a new healthcare option, that's push. (Think pushy.) When you download information on a new healthcare option from the company intranet, that's pull.

Brief History of Computing

	Batch	Time-Sharing	Desktop	Network
Decade	1960s	1970s	1980s	1990s
Technology	medium-scale integration	large-scale integration	very large scale	ultra large scale
Location	computer room	terminal room	desktop	mobile
Users	Experts	Specialists	Individuals	Groups
User Status	Subservience	Dependence	Independence	Freedom
Data	Alphanumeric	Text, vector	Fonts, graphs	Script, voice

Objective	Calculate	Access	Present	Communicate
User activity	Punch & try (submit)	Remember & type (interact)	See & point (drive)	Ask & tell (delegate)
Operation	Process	Edit	Layout	Orchestrate
Interconnect	Peripherals	Terminals	Desktops	Palmtops
Applications	Custom	Standard	Generic	Components
Languages	COBOL, FORTRAN	PL/1, BASIC	PASCL, C	Object oriented

Source: *Scientific American*, 9/91 (!)

Evolution of the web

1990-1993: The age of creation: When Tim Berners-Lee applied hypertext to the Internet and coined the term "World Wide Web," he envisioned a way for easy collaboration on projects. What he got was one of the signature innovations of our time, transferring the academic Internet into a medium that has changed how information is distributed.

1994-1995: The age of the Web: In the nine years since Berners-Lee developed the first Web browser and server while at CERN, the World Wide Web has evolved to the point of ubiquity. Information and publishing were the first driving forces on the Web, spurred in late 1993 by the release of Mosaic and its use of graphics.

1996-1998: The age of commerce: The general business community is now realizing the potential of the Web and searching for tools to rein in its power. Improved security has helped ease consumer fears about buying on the Web, while new technologies such as XML have smoothed the path for companies to do business over the Internet.

Mass customization.

My Levis, custom-made for me at no additional charge. Death of one-size-fits-all, mass-market products. Automation makes it possible to tailor products to an individual person or organization at no additional cost.

On the fly.

On the web, a page created on the spot. For example, a catalog which creates web pages from a database of product information when asked. Learning guru Elliott Masie predicts "On-The-Fly Content -- The technology delivered learning of tomorrow is going to be ASSEMBLED, not authored. It will be assembled from large reservoirs of content and presented to the learner according to a Learning Algorithm."

Open source.

Software maintained by hoards of volunteers and offered for free to all comers. Also, belief that a swarm of programmers working independently will produce better software in less time than a dedicated corporate team. Linux, a popular operating system, is open

source, as is the Netscape browser and the Apache web server. True believers are betting that Open Source will topple Microsoft; we're not holding our breath on that one. Nonetheless, the open source notion is intriguing. Might the future bring open source learning structures?

RAD

Rapid Application Development is a concept that products can be developed faster and of higher quality through:

- Gathering requirements using workshops or focus group
- Prototyping and early, reiterative user testing of designs
- The re-use of software components
- A rigidly paced schedule that defers design improvements to the next product version
- Less formality in reviews and other team communication

Training programs developed under rigorous, doctrinaire instructional design principles look great and would do the job well – if they didn't take such an ungodly amount of time to create. When a new product is being released in six weeks, and no one has had the opportunity to learn how it works, how to sell it, and so forth, RAD becomes *the* way to go.

TCO (total cost of ownership).

You see a spiffy new desktop computer selling for \$1,750 in an advertisement. The IT professional looks at the same machine and sees a price tag of \$10,000 upfront and \$5,000 a year. For every \$1 spent on hardware, the IT staff figures to spend \$5 or more on service, maintenance, help desk, upgrades, and problem-solving. The more varied the mix of hardware, the higher the bill for keeping it running.

I'm currently writing on a three-year old Gateway PC that cost \$4,000 when new. I got it for free when my company standardized on Dell computers. And this was a sound decision.

The company had accumulated a variety of computers over time. We had three vintages of Macintosh, three generations of PCs from six different manufacturers, a dozen incompatible notebook computers, and four LANs that didn't talk with one another. Something that should have been simple, for example, upgrading to a new version of Word, became a giant time-suck and disruption. IT staff had to personally visit most of the computers to install the software, trouble-shoot problems, and sometimes buy new hardware.

I'll admit that I like tinkering with computers, but I probably poured \$20,000 of time into messing with the innards and software of my computer(s).

TCO is why IT pros hate unauthorized software. Others see a freebie download from the net that lets them watch animations; IT sees twenty person-days of pleas for help, straightening out conflicts, and Excedrin headaches.

Scalability.

The program that scales can increase in size without boosting cost or degrading performance. For example, email scales. A spammer can send junk mail to 5 million users as easily as to 5. On-site training classes do not scale. An instructor can handle

twenty in a classroom but not two hundred.

Plug-in.

Chunk of software that adds capabilities to your browser. Examples: RealAudio for video and sound, Acrobat for reading files in Adobe's format, etc. To you, a nifty piece of software you can download off the net. To IT, a potential breach of network security by opening a hole in the firewall. Also, an addition to TCO.

FAQ

An FAQ (fak) is a list of "frequently asked questions" and their answers. Born on the Internet's USENET conferences, FAQs were developed to answer newcomer's questions. We expect FAQs to migrate into training – they're a rudimentary, poor man's knowledge base.



XML

XML (extensible **M**ark-up **L**anguage) is a way to flag the meaning of items in web pages and documents. Tags such as `<invoice_date>2/10/99</invoice_date>` enable computers to talk with one another directly without being held up by pesky, slow humans. By 2002, all the elements of training will have XML tags, paving the way for training modules to be interoperable.

Data mining

Data mining is the analysis of data for relationships that have not previously been discovered. This usually entails having computers root through mountains of data ("a data warehouse"). Data mining is primarily used to analyze and predict customer behavior, e.g. the people who bought massive quantities of Lady Godiva chocolate are dynamite prospects for diet books and exercycles six months later. In the future, data mining could predict likely learning needs for both employees and customers.

e-business

(AKA e-commerce, e-tailing) is the conduct of business on the Internet, not only buying and selling but also servicing customers and collaborating with business partners. In the future, training will appropriate many of the technologies developed for e-business: tracking systems, micropayments, feedback loops, secure web connections, and generally making web sites interesting and easy to complete transactions with.

Emoticon

Emoticon (also known as a "smiley"). On the net, a simple combination of characters used to show emotion. Looked at sideways, most smilies represent faces. ☺. ☹. ;-)
Emoticons arose because text alone communicates emotion poorly. On the net, otherwise civil people flame one another mercilessly, generally due to

misunderstandings. Training that doesn't connect emotionally often falls flat. In the short-term future, training will incorporate more sound and more faces – simply because it works better. Within a few years, as bandwidth makes high-quality video transmission a reality, coaches and guides will appear ever more lifelike. Some day it will be tough to tell if it's the instructor or it's Memorex.

IP Multicasting.

Multicasting enables a single server to send data simultaneously to millions of desktops with no delay. Heard of the "MBONE"? It's the Multicast Backbone, i.e. multicasting on the Internet. In 1993, a Rolling Stones concert was multicast to thousands. The magic comes from routers capturing the server's data stream and forwarding copies to individual users. It's as if you stuffed Christmas cards to your hundred French friends into a FedEx envelope for the trip to Paris. A friend there (the router) opens the package and distributes the cards locally. Only one charge for the transatlantic flight. Or, in the data space, only one set of packets traveling the length of the Internet, and thereby, less network traffic and snappier performance to all. Risk-averse IT managers have been slow to adopt multicasting because in the early days, one slip could shut down an entire network. Nonetheless, the technology holds promise for distribution of training events^[5].

Terminology

Network.

Communication, not computing, is the primary role of computers. Two or more computers linked together are called a network.

LAN.

"Local Area Network." An in-house network connecting PCs and/or peripheral devices such as printers or modems.

Web.

Narrowly defined, the web is the World-Wide Web, the visual side of the public Internet, a giant network outside the LAN. More broadly, in terms like "web-based learning", web can refer to a private intranet, the WWW, or any other network.



Internet.

The global network of networks connecting millions of users worldwide via many computer networks using a simple standard common addressing system and communications protocol called TCP/IP (Transmission Control Protocol/Internet Protocol).

Flowcharts represent the Internet as a cloud. Information goes into the cloud and comes out where you want it but you don't need to know what path it took to get there. (It hopped around among many computers.) Think of the cloud as a "black box."

Intranet.

An in-house network or web based on Internet standards. A “firewall” keeps out unauthorized users. Intranets are growing even faster than the Internet.

Extranet.

A password-protected part of an organization’s intranet that business partners are authorized to enter.

Sneakernet.

Jargon for no net at all. Information is transferred to a floppy which is walked to another computer.

Client/server.

A server is a program that awaits and fulfills requests from client programs in the same or other computers. A given application in a computer may function as a *client* with requests for services from other programs and a *server* of requests from other programs. Specific to the Web, a Web *server* is the computer program (housed in a computer) that serves requested HTML pages or files. A Web *client* is the requesting program associated with the user. A Web browser is a client that requests HTML files from Web servers.

Signal to noise ratio.

A measure of signal strength in relation to background noise. Figuratively, bloatware.

e-mail

(electronic mail). Purists argue about whether email’s hyphenated.) Email is the exchange of computer-stored messages by telecommunication. It’s also a frequently underutilized training tool. **List servers** are small programs (usually listserv or Majordomo) that accept subscriptions and redistribute subscriber messages, newsletters, or other announcements. We receive a digest of about a dozen e-mails a day from TR-DEV, the training and development list. It’s a steady stream of opinion, discovery, questions, discussion, and pleas for help. Professional groups, hobbyists, and others are learning and teaching one another all the time. The mail list directory site, www.listz.com (Listz, get it?), indexes more than 90,000 lists. Some lists have moderators who filter what appears on the list; others are wide-open, automatically posting anything e-mailed to them. In the future, we expect corporations to use in-house, confidential list servers to orient new hires, share information among remote offices, and swap competitive updates.

Streaming media.

Streaming video is a sequence of “moving images” that are sent in compressed form over the Internet and displayed by the viewer as they arrive. At slow transmission speeds, the effect is like looking at a slow-motion flipbook. Streaming media is streaming video with sound. With streaming

video or streaming media, a web user does not have to wait to download a large file before seeing the video or hearing the sound. Instead, the media is sent in a continuous stream and is played as it arrives. The user needs a *player*, which is a special program that uncompresses and sends video data to the display and audio data to speakers. Streaming media is progressing very rapidly. What sounded like a scratchy LP two years ago is now sometimes as pure as FM

Convergence with entertainment values: the celebrity presenter.

Appendix

What if Microsoft made cars?

A particular model year of car wouldn't be available until after that year instead of before it.

Every time they repainted the lines on the road, you'd have to buy a new car.

Occasionally your car would just die for no reason, and you'd have to restart it. For some strange reason, you'd just accept this.

You could only have one person in the car at a time, unless you bought a Car 95 or a Car NT. But then you'd have to buy more seats.

Sun Motorsystems would make a car that was powered by the sun, twice as reliable, and five times as fast - but it would only run on five percent of the roads.

The oil, engine, gas, and alternator warning lights would be replaced with a single "General Car Fault" warning light.

People would get excited about the "new" features in Microsoft cars, forgetting completely that they had been available in other cars for years.

We'd all have to switch to Microsoft gas.

The U.S. Government would be getting subsidies from an automaker, instead of giving them.

New seats would force everyone to have the same-size butt.

Source: Anonymous, off the Net

Bandwidth

"If you are amazed by the fast drop in the cost of computing power over the last decade, just wait

till you see what is happening to the cost of bandwidth." Andy Grove

Bandwidth, the speed of data flowing over networks, is as confusing and complex a topic as you'll ever find. Technological breakthroughs have blown out forecasts time and time again. You can't evaluate bandwidth without looking into the capacities of fiber, satellite, cable, LAN, local wireless, and other media. Bits per second is at best a rough measure, because compression, packet prioritization, and the introduction of new protocols make transmissions faster than they seem. This is a top-of-tree survey of bandwidth.

For planning, what you need to know is...

1. DSL will enable business and homes to connect to the Internet several hundred times faster than today's 56K modem, over telephone lines, at reasonable cost.
2. Optical fiber will boost the capacity of many Local Area Networks ten fold.
3. Wireless connections between satellite and mobile user will become commonplace but will be slower than wired connections. Wireless LAN connection will be commonplace.
4. The Internet backbone will not lack for capacity thanks to new innovations in optical technology.

Bandwidth is the capacity of a carrier of data. If the 1's and 0's of digital data were water, bandwidth would be the diameter of the pipe that carries them. Bandwidth is growing at least ten times faster than computer power. The world's digital carrying capacity doubles every four months.

Fiber optic cable transports data at the speed of light. Sixteen separate streams of data can ride along one fiber. Lucent just found a way to increase that to 80 streams of data by pouring data of different colors into the same pipe. By the end of 1999, an optical fiber will be able to transport 400 gigabits per second. (giga = billion. 400 gigabits = total capacity of the Internet worldwide). Strap eight of these strands together in a cable and bandwidth rises to 3.2 terabits/second (tera = trillion); this is equivalent to sending 90,000 encyclopedia volumes each second

So why are people complaining about bandwidth? Think of bandwidth as a bridge. Digital data is the automobiles, trucks, and motorcycles crossing it. Bandwidth results from the number of lanes. Road-hog analog voice signals turn the bridge into a one-lane span (called "narrowband"). Zippy digital signals speed across the same bridge in parallel, along many lanes (called "broadband"). A broadband bridge can have thousands of lanes.

Data may have to go over several bridges end-to-end to cross a channel. Naturally, traffic can't go any faster than permitted by the narrowest bridge. The **last mile** phenomenon illustrates this. A thousand-lane data bridge flows into the office of the local phone company but only a single-lane, unpaved bridge leads from the phone company to my house. The last bridge slows the data arriving at my house to a snail's pace, and the web becomes the agonizing "world-wide wait."

Sending text across the bridge doesn't require a very large vehicle. Your 28.8 Kbps modem at home spews text onto your screen much faster than you can read it. Graphics take longer. And carrying full-screen video requires a giant semi that may knock other vehicles off the side of the bridge. The floaters swim to shore and eventually get back on the bridge but it takes a while. Most IT professionals are very leery (read "over my dead body") of allowing anything on their networks that might compromise response time. ("Here's what you can do with your full-motion video.")

How to Market an Epidemic

by Rick Karlgaard^[6]

A guy with a drink at a lawn party last summer says to me: “Whoa@ You’ll never catch *me* typing out my credit card number onto a freaking Web page!” A few months slip by, and I bump into the guy again. It’s as if we were having the same cocktail chat, and the mint julep has never left his hand. But now he boasts, “Let me tell you about the Civil War bayonet I bought for a song on Ebay.”

That’s an attitude shift....

Soon! That’s what’s so puzzling – the speed at which dazzling opportunity comes over the horizon, trailed by its shadow, annihilation. What explains the “suddenness” of it all? Typically, here, we start by explaining Moore’s Law – a doubling of computer processing speed every 18 months or so --- which predicts a rapid, exponential rate of change. (Exponents are explosive. A bomb detonation is only an exponential gain in heat.) Then we move on to explain the even lustier gain path of digital bandwidth. We think it is expanding anywhere from two to ten times faster than Moore’s Law. Again, using the explosion metaphor: Moore’s Law is the atom bomb. Digital bandwidth is the hydrogen bomb.

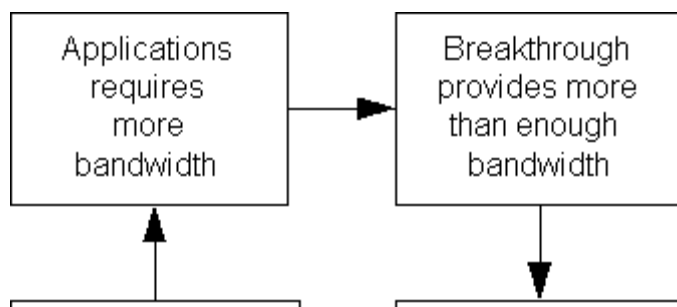
Crazy, but at least it’s all predictable. What’s crazier and apparently **unpredictable** is how consumers will adopt the products and services of the Digital Age. One minute, no sane person will hand out his credit card to a Web page; and then – blink! – he’s bidding for bayonets on Ebay.

Why Bandwidth Matters

Bandwidth is important to learning because it determines the responsiveness and fidelity of the transmitted images:

Bandwidth	Traffic over the bridge
28.8 Kbps	Web at home, slow graphics
56 Kbps	Good audio
128 Kbps	“ISDN” Typical desktop video conference
384 Kbps	Room-quality video
1-2 Mbps	VHS quality video & MPEG1 compression
4-6 Mbps	CD-quality video & MPEG2 compression
100 Mbps	Virtual reality

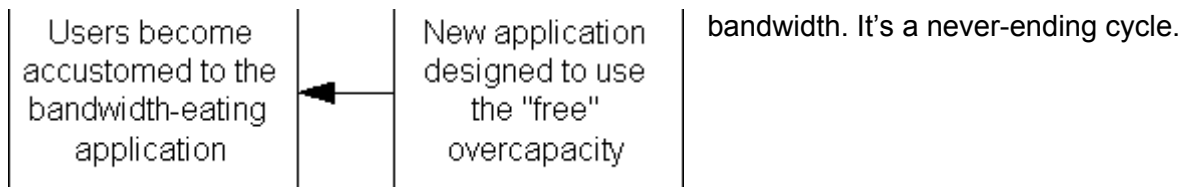
Bandwidth limits have been cited as the barrier to the development of truly interactive multimedia. Broadband will open the bandwidth floodgates, making high speed Internet, interactive TV, video on demand, and video conferencing, a reality.



Unlimited Bandwidth?

“We’ll have infinite bandwidth in a decade’s time,” said Bill Gates in late 1994.

Not everyone agrees. Some say bandwidth is something you’ll never have enough of because more bandwidth leads to cool new applications that require more



"Think of the capacity of fiber as if it were infinite. We don't know how many bits per second we can send down a fiber. Recent research says we're close to being able to deliver 1,000 billion bits per second. This means a fiber the size of a human hair can deliver every issue ever printed of the *Wall Street Journal* in less than a second. At that speed, a fiber can send a million channels of television concurrently -- roughly 200,000 times faster than the telephone line to your home."

-- Adapted from *Being Digital* by Nicholas Negroponte (1995)

Bandwidth to home and small business

Broadband is coming to homes and offices as we write, replacing graphics that crawl down the screen intolerably slowly with graphics that snap on screen instantaneously.

This is a messy story, because it takes years for infrastructural technologies to spread into every nook and cranny. In the past, households are about five years behind the pace set by corporations. Also, advances take place in the San Francisco area, Greater Boston, New York, Washington, Austin, and L.A. before reaching the rest of the nation. Here's what's happening on the coasts:

	bps	30k web page	1 mb video clip	50 mb x-ray
ADSL	7 m	.04 sec	1 sec.	1.2 min
DSL	1.5 m	< .2 sec.	~ 5 sec.	~ 5 min.
Cable	<= 1.5m	0.2 sec	~ 5 sec.	~ 5 min.
Satellite	400 k	1.4 sec.	~ 20 sec.	~ 20 min.
ISDN	128 k	~ 2 sec.	~ 1 min.	~ 55 min.
56K	56 k	~ 4.5 sec.	~2.5 min.	~ 2 hours
28.8	28.8 k	~ 9 sec.	~ 5 min.	~ 4 hrs.

Satellite peaks out at 400 kbps and only supplies data from the net. You need to have a regular ISP and modem connection to send data to the net.

Cable modems use your t.v. cable and promise breathtaking speed – as much as 10 mbps – but rarely do they deliver on the promise. Few users receive more that 1 mbps, and this can drop through the floor on a busy night. Your cable connection is shared with a number of your neighbors. If everyone logs on for the Victoria's Secret promo at the same time, no one's going to see it. Data you send out goes at 300 kbps. Typical fee is \$50/month. Of course, few businesses are wired for cable.

DSL (Digital Subscriber Line) is a dedicated packet-switching connection to the net over your phone line. Data arrives at a steady 1.5 mbps and you send data out at 256 kbps; this is 50% to 100% better than cable. Fees are all over the map. In California, \$40/month pays for both DSL and an Internet connection. Phone companies in other areas slow down DSL in order to sell a

degraded service at \$30-\$50/month and to charge \$100+ for full 1.5 mbps capability.

ADSL (Asynchronous Digital Subscriber Line) is up to five times faster than the DSL just mentioned. That's because the phone companies can save a trivial amount by installing something call G.Lite, which cuts DSL capability 80%. ADSL, which will probably arrive after much arm-twisting, achieves 7 mbps.

Corporate Bandwidth and Internet Backbone

Carrier	Speed in bps	Medium	Use
Telephone	14.4 to 56 k	Twisted pair	Home and small business access
ISDN ("BRI")	128 k	Twisted pair	"
Satellite	400 k	Airwaves	"
Frame relay	56 k to 1.5 m	Twisted pair or coaxial cable	Large company LAN to ISP ISP to Internet
T-1	1.5 m	"	"
T-2	6.33 m	"	"
Cable modem	512 k to 52 m	Coaxial cable	Home, business, school access
Ethernet	10 m	10BASE-T twisted pair; 10BASE-2 coax; 10BASE-F (fiber)	Most popular business Local Area Network (LAN)
T-3	45 m	Coax	ISP to Internet Smaller internal Internet links
Fast Ethernet	100 m	Twisted pair or coax	Workstations with 10 m Ethernet cards
FDDI	100 m	Optical fiber	Large, wide-range LAN
Gigabit Ethernet	1000 m	Optical fiber	Workstations with 10/100 m Ethernet cards
SciNet, OC48, OC-192, OC-256	2,000 m to 13,270 m	Optical fiber	Internet backbone

When considering network capacity, bear in mind that bandwidth is shared among active users. A 1 mbps video conference for 10 users requires 10 mbps.

The sky is filling up with satellites from Lockheed-Martin, Motorola, Hughes, and Teledesic (Craig McCaw and Bill Gates). These four will launch more than 400 satellites to create the equivalent of 2 million T-1 lines. By 2002, however, satellites will account for only 5% of business bandwidth. Experts agree that satellites will never compete economically with fiber at full capacity.

For distances in the five-mile range, organizations are connecting networks with 100 mbps microwave relays. (It's easier to put a dish on a roof than to dig a trench to hold a cable.)

Don't Believe What You Hear

When I bought my first PC in 1983, I bought a 300 bps modem for connecting to CompuServe. A few years later, I upgraded to 1200 bps for a mere \$400. I joined a conferencing system ("The WeLL") and upgraded to a blazing 9600 bps. When Mosaic brought graphics to the Web, I bought a 14.4 kbps modem (14,000 bps). Two years later I bought a 28.8 kbps modem, thinking it was the end of the line. The modem manufacturers said it would be impossible to squeeze more data over a phone line. Then they discovered superior compression algorithms, and I bought a 33 kbps modem card. I have a 56 kbps modem at the moment. I waited until prices dropped significantly; I paid \$120. Today on the radio, I heard a commercial for a 56 kbps modem for \$19! Pacific Bell is scheduled to drop by next week to install DSL service, the equivalent of a 1500 kbps modem.

[1] Tried out Eloquent, a digital presentation environment, to experience the potential of controlling a video's speed and place. Free demo CD at www.eloquent.com Personally, Jay finds 130% of normal about right for standard dialog, 90% for things he wants to listen to reverentially.


[2] New York Times, March 19, 1999, p. C4.

[3] Jay's wife reminds him that he's been saying flat panel television was right around the corner since 1969.

[4] Jakob Nielsen, usability fanatic.

[5] CIO magazine, October 1997.

[6] Digital rules, Technology and the New Economy, Forbes, April 5, 1999

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