An Interview with

Gordon Bell

Gordon Bell has been a major computer industry pundit since the 1960s. Known for his role as project leader for the VAX, Digital Equipment Corporation's famous minicomputer, his wide expertise has influenced the design of many other products at Digital, Encore, Ardent, and a score of other companies. He recently became a Senior Researcher at Microsoft Corporation. Bell has also been a Professor of Computer Science and Electrical Engineering at Carnegie-Mellon University and influenced technology policy as the first Assistant Director of the National Science Foundation's Computing Directorate. He led the National Research and Education Network panel that became the NII/GII, and was an author of the original High Performance Computer and Communications Initiative. Recognized for his contributions by the many honors he has received, Bell is an ACM Fellow and was awarded the 1991 National Medal of Technology "for his continuing intellectual and industrial achievements in the field of computer design; and for his leading role in establishing . . . computers that serve as a significant tool for engineering, science, and industry." In his book, High Tech Ventures: *The Guide to Entrepreneurial Success* (Addison-Wesley) 1991, Bell describes the Bell-Mason Diagnostic for analyzing new ventures, an expert system for venture development to startups, entrepreneurial ventures, investors, and governments. Bell sits on the boards and technical advisory boards of Ambit Design, Cirrus Logic Inc., Disk Excellaration Systems Inc., Fakespace Inc., University Video Communications, and CSC's Vanguard Group Computer Science Corporation. **Now that he is with Microsoft Research, Bell hopes to pave the way for telepresence by "colliding telephones with computers," developing "instruments" that he believes will become the next platform to change our lives. Below, he describes the evolution of the Internet, why telecommunications companies have to withhold bandwidth, and the requirements and challenges that must be met for us to be telepresent.**

Karen Frenkel: You're in a position of a rare few in our industry because you were involved in the Internet in the earliest days. Let's talk about the vision back then and how much of what we have today was anticipated.

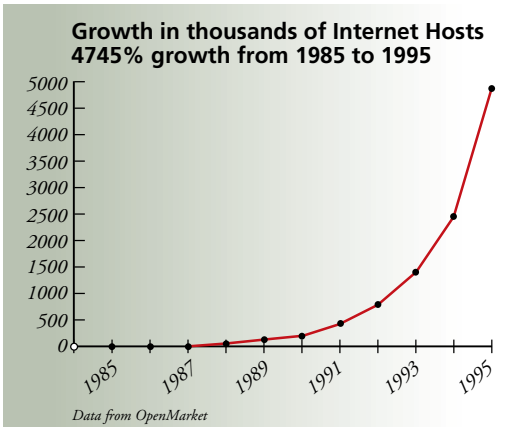
Gordon Bell: If you go back to the very beginning of ARPAnet, the goal was to have researchers share machines. Unfortunately, the users of those machines didn't want that to happen at all. Sharing was top-down from ARPA. ARPA also wanted people to be able to collaborate and exchange software. Sharing was achieved using file transfers, but the killer apps turned out to be email and then bulletin boards. Chat groups and computer conferencing, that is, just synchronous email, came into being when more people were online.

A theme that those of us who have a vision or create technology should always observe is that how something finally gets used has little bearing on what we anticipated when we began. This is the serendipity that we hope for when funding research! Let me claim that the Net's apps have been constant from '72 until '90 even though use has doubled every year.

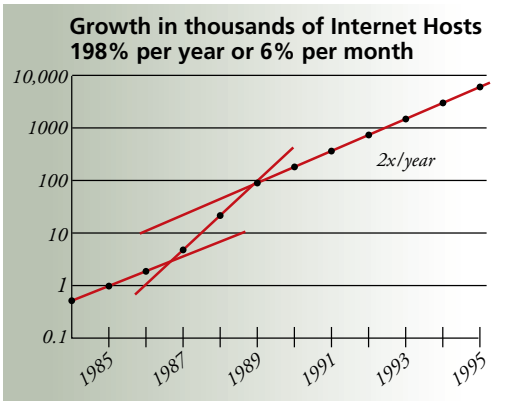
Can I just stop you for one second? You were saying there was reluctance to share computers back then. Now that seems to be all everyone wants to do. Why was there reluctance and what happened in 1990? With ARPAnet people were using timesharing computers and they were all overloaded. The last thing anyone wanted was another user on their system. With distributed computing everyone had access. Now the challenge is to get them tied together and sharing again.

The big transition in network apps occurred when the NSF Backbone came into existence to increase bandwidth. This came with our National Research and Education Network (NREN) plan that is now called NII and GII [National and Global Information Infrastructure, respectively].

In 1992 the perception was that the 20-year-old Internet had just been born. The rate of change of number of users has not changed at all. It's just when it went from 2 million to 4, 8, and 16 million that people begin to notice the phenomenon. These are the same people that believe that two Steve's "invented" the PC when in fact the PC had been around for over a decade.



Here's the gee-whiz growth of hosts graph. That's 4.8 million hosts in January 1995.



If you plot it on a semi-log graph, that's a 100% per year growth. I don't understand the '86 to '88 shift, but that was when NSF got serious about networking. I was there. That's not Internet as we know it today. It was email and file transport.

Yes, that's your point about how when we get to the millions everyone tends to notice. So you thought of that, I guess, because once there was more bandwidth available, then we saw a change in the use from ARPAnet. That's right. It was one of the best technological plans I've ever lead. It was done as head of a federal, interagency task force that was responding to the Gore Bill to propose an information superhighway to look at linking the research and education communities, including linking high schools to supercomputers.

The 1987 plan had four phases. Phase Zero was to make the current NSFNet, ARPAnet and other nets work and interoperate. They were all overloaded and the operations were really poor—the service was lousy. We were connected using 56 kilobit per second backbone links. Phase One was to get T1 for the backbone. Phase Two kicked in the late 1980s with 45 megabits per second. And Phase Three was to go for fiber—providing gigabit links. There was no research involved through Phase Two. Phase Three research was to deal with higher speeds that created the Bay Area Gigabit Network and other test beds.

But in reality what's created the 1995 Internet craze—what I call Internet 2.0—was the World Wide Web and Mosaic viewers. That's again where serendipity comes in. It occurred because there's been the factor of three-plus orders of magnitude increase in bandwidth, going from Phase Zero 56 kilobits to 45 and 155 megabits per second links.

Can you talk about the interesting statement you made in your Internet World '95 speech about selling this in Washington using supercomputers and supercomputer centers? When I went to NSF to start up the Computing Directorate, networking was under the Supercomputing Center Division. The first thing I did was to hire Steve Wolfe to head a new division on networking and remove it from the supercomputing division. We phased in the NREN plan in broad terms, including talking about supercomputers. But most of us thought the supercomputer connection was a stupid, bogus idea.

Why was it a stupid, bogus idea? Because there were hardly any users of the "timesharing" Supercomputer Centers. Only a small number, about 9,000 scientists I believe, were using the centers and the only support they had from the scientific community came because they were "free" since the money for them came from someone else's budget. What all the scientists, engineers and educators wanted was their own computers and a reliable and fast network, not linking to a timesharing system. They wanted communication among themselves. They couldn't have cared less about dialing into a timesharing system.

But this was 1987, so they already had email. But they wanted more capacity and reliability because at the time, email was croaking. It was taking days to get mail through the system and not everyone could access it.

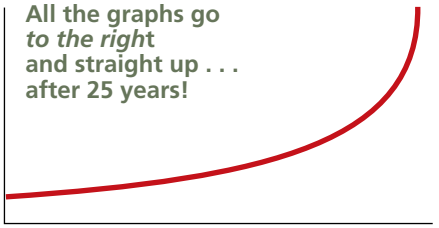
It was croaking even for just 9,000 supercomputer users and the rest of the computer world? Well, no. You had many academics on the system, industrial researchers wanted to be connected, and the 56 kilobit links were just not enough. When you remote anything, response time becomes a network and bandwidth question as much as a human interface question. That's why I spend much of my time worrying about the network.

I see the network as the critical limiter for ubiquitous computing—whether it's a cost issue, a bandwidth issue, a symmetry issue, a Washington-is-doing-it-wrong issue, or the telcos-have-a-damn-monopoly-on-the-last-mile issue and aren't-doing-it-at-all issue. You might note a minimum of 30 years of hostility in my voice when I talk about networking. Every bit per second and every link along the way has been a fight.

To get more bandwidth. To get more bandwidth at a reasonable or any price, to get less restrictions, to get openness, to get it to work. The only reason we've got networks today is because a separate datacom industry developed them using the installed "communications" wires and fibers to lay protocols over. Networking occurred in spite of telecommunications, not because of it.

Now, when you say in spite of telecommunications, do you mean the long distance carriers? Long distance carriers, regional operating companies and PTTs. These organizations have stood in the way of data communications for three decades and remain firmly entrenched in the past.

Why isn't this need obvious to them? How could we make them see that they could make money? The telecom companies have operated



So the growth rate is constant and hasn't changed for 25 years. If you double every year for 22 years, you end up with 4 million. We tend to notice things when they get to be in the millions.

with regulatory agencies for so long that they only understand how to negotiate tariffs with governments. And in the world market you have the same problem. All the foreign telcos know how to do is be state suppliers. They don't respond to carrots. When they do take a risk such as ISDN, it's a screw-up. They respond to the threat of competition by lobbying or buying a competitor. There's competition in long distance communications, but there's no alternative for the last mile. We need competition for connecting homes and small offices. In large cities there are a few alternatives. Some cities or towns could put in their own plants similar to what Palo Alto did.

You mean from the curb to the home? Connecting phones to the 20,000 or so central offices. The wiring could support reasonable symmetrical bandwidth so that we could have higher speeds. But they would have to become more aggressive about providing this service. They would have to bet on Internet or on video telephony or data-communications. This connection is our biggest limiter today and for the foreseeable future.

Today, the threat to telephony and our alternative for high speed data is cable. Of course, reliability of service is cable's key issue, so in a sense their threat is limited. But for connecting to the Internet, we can probably live with cable reliability. Cable represents a medium for delivering one-way, high-speed data to our desktops.

What bandwidth do you need? In 1965, when we were first timesharing, terminals were at 100 bits per second. We've grown a factor of 288 in bandwidth over 30 years. But ARPAnet went from 56 kilobits to 155 megabits, which is a 3,000 gain in about 20 years. So the discrepancy between what can be and what's actually delivered is great.

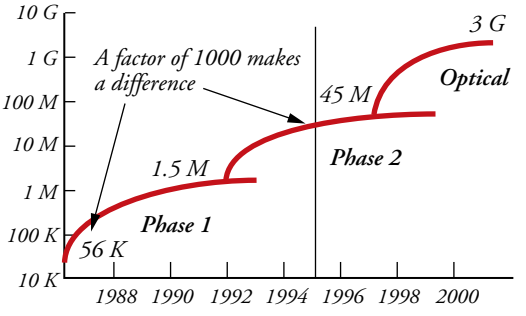
And now the phone companies have invested in ISDN, which is really too little too late. It's only 128 kilobits or less, finicky, hard to install, sales and service folks don't understand it, and its expensive. They could give us T1 for the same price and installation pain because its all labor and overhead. Furthermore, it gets in the way of putting in a decent system. Can I urge everyone just to say no to ISDN! I'm ready to take mine out.

I'm advocating that telcos deliver five to 10 megabits per second to our homes and shoot to make it symmetrical. That is, I've got to be able to send back those speeds as well as receive them. However, for now, my next step is going to be to connect to a cable service to get 10 Mbits per second from the Internet and I'd like a separate T1 line for the reverse channel.

But I thought you said 25 Mbits per second in your talk. That's what I *want.* I believe the technology exists to send and receive 25 Mbps on a 4 wire (2 pair) service at distances up to 20 thousand feet. Five to 10 Mbps is the minimum, although this only gets one channel of high-quality video.

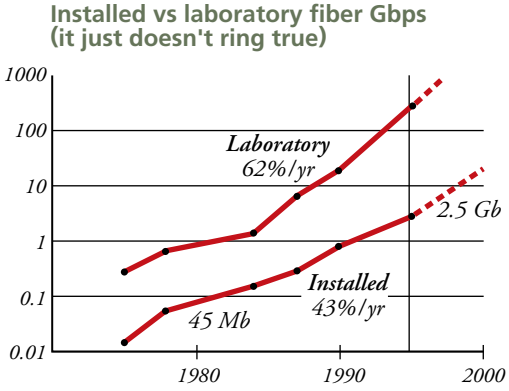
Fortunately, swirling around are other providers—cable, broadcast and satellite as I've sketched out in a figure I called "The Colliding Worlds of Television, Communications, Data-Communication, and the Internet." At least four guys are trying to provide video or television, and since the cable guys are threat-

FCCSET NREN Plan 11/1987



This is my proposal at a meeting in February 1987 where we planned the NREN (National Research and Education Network). The proposal was to start with 56 kilobits per second and get what we had working, get to T1 quickly (late 80's), and then go to T3 (45 megabits) in the 1993 timeframe.

The factor of 1000 really makes a difference. With a very fat pipe you get, not the ability to send pictures or video to the desktop, but rather the ability for a lot of people to send a lot of small messages and get them instantaneously. This is what makes Internet 2.0 work in 1995.



Demonstrated, laboratory communication data rates are growing at 62% per year — just like Moore's Law for semiconductors or magnetic disk density. But installed capacity is only doubling every two years (why the discrepancy? . . . it's not changing prices or introducing services to soak up capacity). But more importantly, as subscribers, have we gotten any more bits from plain old telephone service in decades?

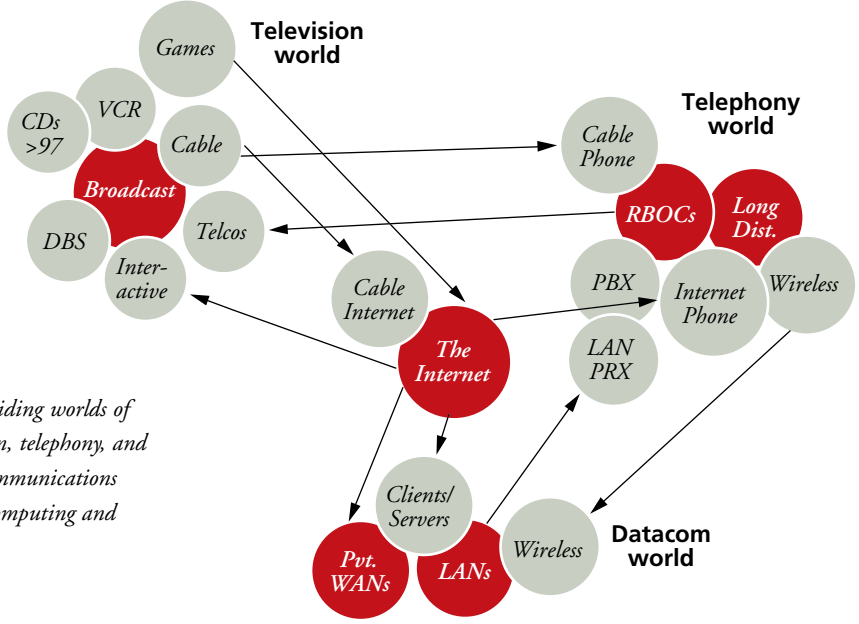
ened by the telcos, they want to enter into the lucrative phone business. But an even greater threat to the telcos core business is the Internet and its ability to carry worldwide long distance phone, email, and video conversations.

You mean you could carry voice via the Internet? Today, Internet is being used for long distance phone calls using only 14.4 Kbps local connections. A new service, called RealAudio is providing Internet audio pages.

How? If it takes so much time to load real-time audio? This runs continuously. It isn't loaded before it's played back. This is lower quality audio at 14.4 kilobits per second.

It's AM radio quality. Yes. These apps, including video-telephony, are enabled by today's Internet 2.0 and just POTS (Plain Old Telephone Service). Now Internet 3.0 is where we solve the last-mile problem, where we've got symmetry to the home and adequate bandwidth so that we can do complete video telephony. However, for the near term I think when you're home, we're stuck with POTS and compression to give say 50 Kbps and then you use Internet down-line loads from cable TV at Mbps speeds. This costs nothing except a cheap modem that attaches to cable. Let's help ISDN die so we can make the investment in Internet 3.0. That's what I want.

Can you do *anything* very exciting with just POTS? We have to since POTS is the only ubiquitous service. I'm involved in a project that I think will change how we all interact. It's the ability to put a videophone in every



The colliding worlds of television, telephony, and data-communications a.k.a. computing and Internet

Internet 3.0

Universal digital dial tone
Scaleable symmetrical service: 25 Mbps -- not 0.0144 or .128 Mbps
Fungible bits:
- *datacom, images, and video-like*
- *RealAudio™*
- *2d and 3d video,*
- *phone?*

Costs of telephone and cable

PC running Windows PC. My goal is to have Microsoft ship a "free" POTS-based videophone with every copy of Windows within a year or two. I really need this in order to work on the telepresence that we first wanted to talk about today.

And will Microsoft deliver it? When will it be ready? I don't know. But I want them to. A product should be released by the end of the year. Furthermore, other companies also need to be shipping videophone-only versions. This is the big enabler for telepresence because everyone can have one.

Is this a software product? It's software, but for the best quality you really need about 200 million operations per second. That's well over a Pentium or P6 and takes a chip that would ultimately go on the mother board.

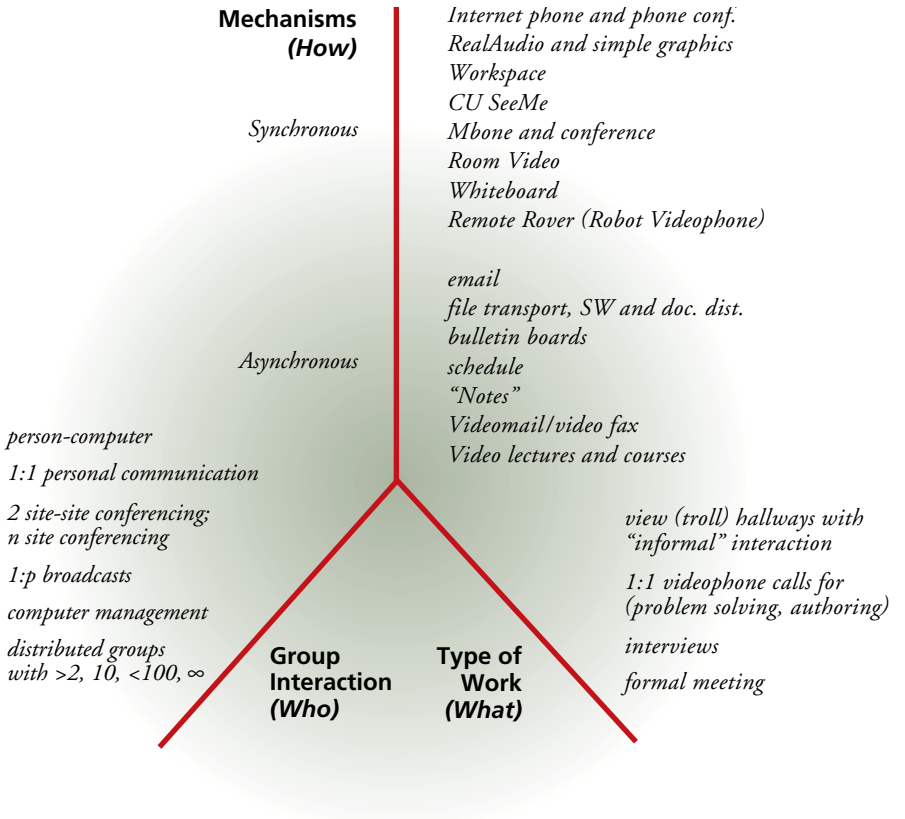
Who's doing the chip? A company that I know, but can't disclose. There are probably several companies.

When can you talk about it? It will be out by the end of the year. But the breakthrough is that we are going to be able to have a nice videophone using just POTS. The quality is better than the videophones or picture phones that we see today using ISDN.

Who do you think wants this? Well, first and foremost, I'm a technologist who uses business insight. I trust my intuition since I've been right before, even though the world doesn't always get there as fast as I'd like. I want this and I want this now. And from the little market research I've done, there are others like me who prefer to have face-to-face conversations or face-to-face collaboration. And that drives me into what I want to work on—-telepresence.

The greatest inhibitor to telepresence is the fact that we don't *all* have the ability to "see" each other. The only way to achieve ubiquitous telepresence is to provide it to everyone at very low cost. This means it can't use ISDN, due to its cost and nonuniform access. The same chip can be put in a telephone—let's call it a telephone-like device—a low cost videophone. Just like the PC and Internet brought the power of the mainframe and the network cost-effectively

The Who, What, and How of Telepresence



to the masses, so should telepresence products deliver interactive communications.

Would you please define telepresence? What does it mean to you? How would it be different from CUSeeMe with good audio? Telepresence is "being there without having to" or "being there while being here." I want to explore various apps and especially focus on business. I want to virtually be at Microsoft in Redmond or San Francisco while physically staying at home in Silicon Valley!

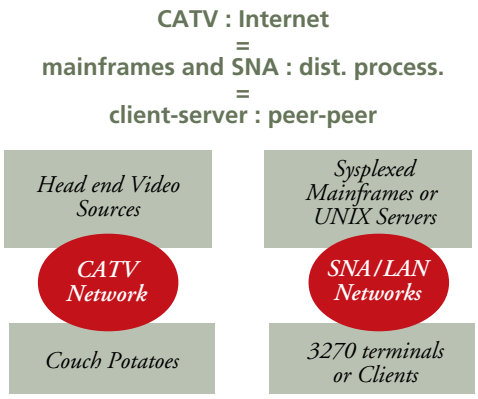
I think of a new world like telepresence as having various dimensions. The three key dimensions depicting Telepresence for Business is given in my figure.

The three dimensions are: (1) the mechanism—how is telepresence accomplished; (2) the application—what is achieved using telepresence; and, (3) the group structure—who is using telepresence. The first is based on technology and the other two are social. We engineers tend to concentrate on the mechanism. That is, what are we providing from a pure channel standpoint? And what should go from text to video to graphics, white boards to sketch on, and the control of shared programs and data.

Then the second dimension is what are we going to do with telepresence? Are we simply communicating, are we doing inter-views, or are we creating a "virtual hallway" to stroll down, in order to accomplish "management by walking around"? Are we attempting to design something, or solve a problem? Or, are we conducting a formal meeting run by Robert's Rules of Order? These ques-tions are answered only when we have enough real telepresence users. Research on collaboration doesn't mean anything unless you've got enough instruments deployed in real-world situations.

The critical social dimension is the structure of who's communicating, who's collaborating, who's being teleported, and how is the teleporting occurring? This begins with simple one-to-one interaction, goes through highly distributed groups, and finally mob scenes with an unlimited number.

Two-site conferencing, including person-to-person and video conferencing, provided by AT&T's Picturephone Meeting Service (PMS), in 1978, is the most common. PictureTel and others evolved this into an industry. When AT&T started, they began with a dozen different Picturephone sites. I was one of the first users when DEC was doing the Ethernet deal with Intel and Xerox. We needed to meet, but didn't have the time to travel so we spent a couple of hours meeting via Picturephone and agreed to go ahead with the deal even though it was our first meeting together.



As I look at it, cable is to Internet as mainframes/SNA are to distributed processing. As client/server is to true peer- to-peer. 3270 terminals are the couch potatoes of the office world, unable to interact with the host.

At that point, I got very intrigued with teleconferencing and convinced DEC to install several sites. Each room cost over a quarter of a million dollars because we focused on the quality of service. The audio was very good, the pictures were good, it had lots of cameras and ways to transmit information—it was a high-cost solution. Today, companies sell $50,000 products.

So since AT&T was doing this fairly early on, then does that mean you don't include them with the telcos you find so backwards and were flaming about? That was just a service they introduced that no doubt lost money. It wasn't a computer service at all. It was an experiment to try and sell bandwidth. It enabled and encouraged others to start successful businesses and AT&T could have been the pio-neer in selling videophones for conferencing. They could have leased videophones!

So they were on the right track. They worry about selling bandwidth or offering a service to sell bandwidth, not necessarily making the right choice for the right thing to happen or being creative with a new venture.

Internet affects $240 B industries

Media	*Who*	*When*	*Industry*	*Size*
Text/www	*CERN*	*'89*		*--*
Graphics	*NCSA*	*3/93*	*print media*	*153**
Audio	*SoundM*	*3/93*		
Telephony	*>3 cos*	*3/95*	*long distance*	*65*
Contin.	*Prog.Net*	*4/95*	*radio, record*	*21*
Video	*Qtime*	*3/93*		
	CU-SeeMe	*10/93*	*teleph. video cnf*	*91*
	Mbone	*7/92*	*tv, cable, film*	*78**
3D and animation...		*3/95*		*--*

** book 24, newspaper 48, magazine 21, printing 60; tv 28, cable 21, filmed entertainment 29*
***from Technologic partners 4/10/95*

This is an important table because it shows that about a quarter trillion dollars of industries are affected by Internet. As Internet can begin to deliver more complex media, it can compete with other industries. With just graphics, the entire book, newspaper, magazine, and printing industries are affected. When video becomes available, everything from TV to videophones will change.

Why do you suppose that they don't make the "right choice"? I believe the fundamental problem with telecommunications is their preoccupation, concern, and regulation that breaks bandwidth up into 64 Kbps voice-grade line chunks for tariffs. This whole industry sits around trying to maintain the cost and pricing structure based on voice grade lines. That's what screws everything up. Pacific Bell could offer me a T1 at the same cost as my two POTS lines. But the minute they do that, they're scared that I'll take the bandwidth, slice it up into 64 kilobit chunks, use it to get myself 24 phone lines or sell it to my friends for voice and undercut their market. And, of course, there will be people who will. I won't, but there's a big business for small companies who slice up T1 and ship it across the country and unslice it at the other end. Large companies do that with their own networks. This is occurring with the Internet Phone today.

We've got a dichotomy between datacom running at the megabit level, telecom for voice, which is priced and runs at 64 kilobits, and the Internet, which is POTS limited, at least for home users. The Internet is ready to wreak havoc with the telecom industry because the PC will dominate as the telecom switch for POTS. As a by-product, I think we'll see a new "instrument" that I call the "telecomputer"—a PC-plus-phone, but aimed at Internet access. At this point, the Internet replaces the telephone network.

What exactly is the telecomputer? Mainframes dominated the generation of computing in 1960. Minis came in '70. PCs and workstations came in the '80s. Now, the Internet is the new infrastructure of the '90s. I see the ubiquity of the Internet as the catalyst for the telecom-puter—the next dominant platform and a significant instrument to change our lives.

The telecomputer is an Internet browser, probably a PC without storage, and is externally maintained via the Net. It has a cam-era and optional printer. So it has a limited and well-defined state and it doesn't require a network or system support organization that characterizes us as PC or workstation users. Disks filled with arbitrary programs and files are where all the direct and indirect user costs are.

Incidentally, AT&T announced a $300 Internet "instrument" but I have no confidence in their ability to manufacture it. Their technology seems to be totally in their minds and ads.

Will the telecomputer will be available in the late '90s? Perhaps, but that's a little soon. By 2002 is better. It's because of Internet and the datacom/telecom collision. This will remove the two barriers that hinder telepresence. One is bandwidth and the second is the ubiquity of a low cost instrument. I'm assuming time will solve both problems. Metcalfe's law governs when and whether the telecomputer, videophone, and telepresence exist.

What is the ubiquity issue and what's Metcalfe's Law? It's having enough deployed instruments so that everyone is communicating via the instrument with one another. We saw how faxes became important after "everyone" got them. Metcalfe's law is simply that the value (number of possible conversations)

So who does it affect?

communication: *snail mail, radio…video substitution*
telestuff: *medicine, science, government, work*
content: *accessing Intellectual Property, dbases reports and papers, SW, backup, …*
catalogues: *order goods and services*
recreation: *games, groups, mousing around, up and down the trees*
computing and content: *education*

Most of this is obvious. As an avid catalog shopper, I see Internet as the ultimate catalog. And games and education will change dramatically. What about CDs? You might ask, which CDs can I get rid of personally, in favor of network access?

Which magazines and reports would you rather get electronically? Perhaps reference materials, like Consumer Reports.

Which do you not need on-hand at all? I can see the end of some news type magazines that I just want to browse.

of a network increases as the square of the number of nodes.

Having the videophone in the computer is the enabler. This could get us almost 100 million instruments almost instantaneously! But on the other hand, it's too expensive and the computer is too hard to use and maintain compared to the telephone.

If I want to fire up a phone on a computer, it's a lot more painful than just dialing. And you've got to deal with software, different versions and other maintenance issues. Ultimately, we need the telecomputer to replace the telephone. However, it probably won't *replace* the telephone or computer, but it will replace some of their uses since it will become our primary communications instrument.

I suggested this recently to several people and got a reaction from friends at Intel that the computer would never cost less than $1500. Counter to what they believe, a $1500 device is too expensive for ubiquity and worse yet, the programmability of the computer is why it's so expensive to use and maintain. I'm not going to install many more "programmable" computers in my house, even though I can afford it. I did, however, finish installing Ethernet ports by every phone as a prelude to replacing phones with the "telecomputer."

I have a relatively small house and about a half-dozen rooms with phones. If all these had computers, I wouldn't get a thing done. I would just be maintaining the machines and worse yet, a system manager would have to live in my garage or I would have to build an addition. So what we need is the non-programmable telecomputer.

However, the "home LAN" is a great new product and service opportunity. It's clear that everyone will need this. The need is to be able to use existing telephone wiring and enable it to act as a LAN because wiring an existing house with Ethernet or ATM is an expensive task.

Can you elaborate on the reference you just made to Intel and the $1500 PC? They think that PCs are going to remain fixed at the $1500 price level for the next decade. More importantly, they believe that the PC will have increasing functionality for the next decade. And to some extent, they're right. But in the meantime, another device with lesser or fixed functionality is going to emerge and take a significant part of the PC's marketshare. Today's PC industry talks like the mainframe guys used to. And, meanwhile, the telecomputer will come in and wipe them out.

Now, is this device what you're going to be working on at Microsoft research? What's Microsoft's role? What I hope to work on will build on this technology and enable the need for more telepresence. Again, what are the inhibitors to telepresence? Bandwidth, cost, and then the question is, is there a need for it? As a good technologist, I assume the usual: we will build it and they will come. Less than half the time that's true. In this instance, I think I can clearly see products and needs.

Microsoft has a history of putting software on the dominant platforms. They were right

What info comes via the post office that could come Internetted?

catalogues, direct mail, letters to buy things
periodicals, newspapers, newsletters, magazines
personal purchases including goods
personal bills
personal finances: reports, transactions
personal and formal letters

The NY Times Fax service in PDF format is really impressive and gives us a glimpse of what could come.

Bills are another favorite item for electronic delivery. I've invented BillFree which I've asked to trademark. I'm assuming CheckFree is going to buy it some day. It's the converse of CheckFree for bills.

And faxes are disappearing (thank god). We owe it to the world to get rid of faxes.

Finally, personal letters, which are making something of a comeback. In a lot of cases, Internet brings people closer together because they're on-line already and it's easy and natural.

about the PC and they were right about building NT to deal with corporate computing. I hope they'll be equally aggressive about the Internet and the telecomputer. I'm a new employee and don't understand their commitment to these products. However, I know that TAPI (telephony applications programming interface) is the foundation for the telecomputer.

What about the cost issue? Technology and time solve this. I'm predicating that putting videophones in every computer will create the market for such applications.

Now, let's go back to telepresence because, in the long run, telepresence will develop because we've experimented on our mainframes. Today, our mainframes are our PCs and they're as complicated as any mainframe. We've all become system managers since we spend an enormous amount of time maintaining software to keep PCs running and all of that. PCs are truly mainframes that you baby-sit, back up and maintain. I'm willing to have one that never fails, in my house, but all the others should be slaved to it and can't have much state.

Do you want to tell us more about how? I'm forming an opinion right now. My desire is that all the computer engineers in the world to take an oath that reliability is their number one goal—"Our goal is to build computers that always work, never fail, and never have to be rebooted. Performance should be goal number two, that is, the user shouldn't wait. That ties in with having a simple, consistent, no overhead and no metaphors please, interface. A garbage can or recycle bin is ok. Just the thing that *interactions* magazine concentrates on is what I would eliminate.

Then, if there are any computer resources left, the engineers can start working on brand new functions—and hopefully not ways of doing the same function just differently. If we ever get to the point of using speech, then that will cause the interface to change. But today, a different way of doing something or a bizarre feature is goal number one—which creates an increas~ingly complex interface, performance is number five, and reliability is number 10, and consistency is 11. No, actually, that's not true. To the desktop industry, including its buyers, purchase price appears to be number one. That's what they design for.

How do you feel about Bob? I don't know it, I hope it adds user value. But if it won't do anything new for any of us, increases complexity by being on top of an already too complex environment, and gets in the way of apps, I doubt if I'll like it. I sure feel that way about General Magic's cute mac redo. Just like a two-year-old, I want to get to my app ASAP.

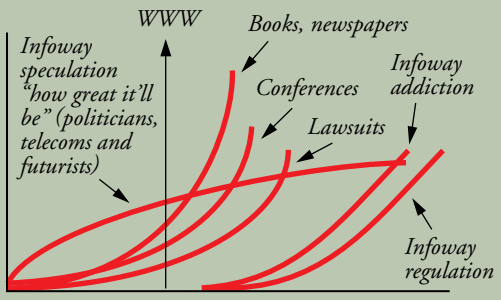
Unfortunately, the real cost of a computer is a user's time, including the time to learn, install, maintain, relearn, and attend to its flaws. The hardware/software cost has remained constant or even increased over the last ten years. Hardware now costs nothing and software costs a lot. But the cost that's increased is that users are now the system managers, and that's costing a minimum of $50 billion a year to the 50 or 100 million computer users in lost time.

Let's get back to what you're going to do at Microsoft. Engineering telepresence on PCs is a good platform for experiments and provides a base for useful products, but I think by 2002 there will be other devices better targeted for this. Recall the mechanism dimension in the first figure, which is going from audio, graphics, white boards, and control.I gave a talk to the financial community about computing, and there were 200 people online. I had pre-faxed them overheads and then presented via a phone conference. That worked really well. Better yet, all of us could hold many of our small technical conferences this way using the Mbone [the Internet multicast backbone, that is, the Internet's broadcast-like system] and even get embryonic video conferencing to boot.

Within three years, I expect to be able to do that same thing only better, with a telepresence conference system. My slides are online, and there's video and audio of me, they see my overheads, and I see them. And this is all done using existing POTS conference facilities or Mbone!

Is that what you're going to start to do at Microsoft? No, no. This is just a capability of telepresence. I'll find all sorts of projects. For

Growth in hype vs reality

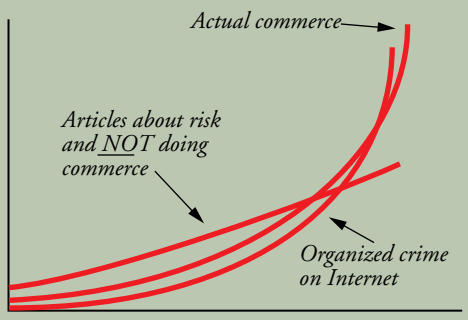


Where did I get the data for this graph? I made it all up. This one shows the growth in hype vs reality. The first curve shows the rise of speculation on how great it'll be — politicians, telecom presents and futurists all making statements about cyberspace. Then we had an impulse, a function that is infinitely high and takes zero time. The impulse was the World Wide Web with hyperlinks followed by the Mosaic viewers.

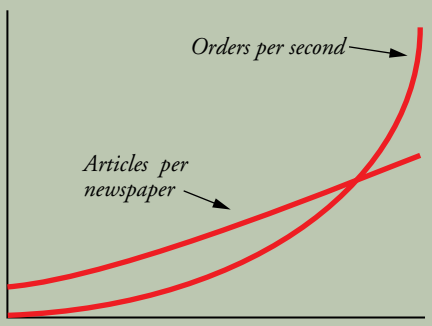
Conferences about Internet follows along with growth in browswers. And then there will be lawsuits. Since we are all spending hours and hours browsing there will be Infoway addiction. And that's followed by Infoway regulations.

Articles about security, privacy, and fraud vs commerce ($M)

This graph shows articles about security, privacy, and fraud vs actual commerce. We continue to see articles about how you shouldn't use your credit card on Internet. Commerce is taking off and none of us worry about sending credit card numbers. With encoded browsers, it's much safer. Finally, we'll see organized crime.



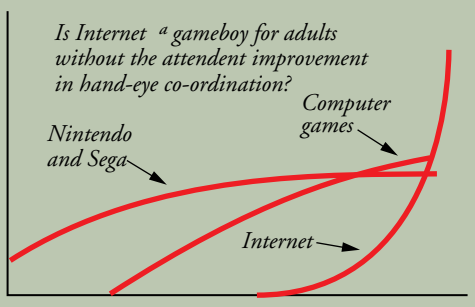
Articles per newspaper vs orders per second sent via Internet



Here we are with articles per newspaper vs orders per second. It's crossed over with more orders. This is major, since every newspaper has an article or two on why you shouldn't order and why you shouldn't advertise. They want to keep their subscribers. They are also working on putting their newspapers on the net.

Gamer-age years hours of play vs time for various machines

This is my last graph. This is the evolution of gamer age years, hours of play vs time for various machines. That is, if you're 24 years old then you get counted as two times a 12-year-old. An hour of my time counts a lot. Nintendo and Sega are 12-year-old boy's machines. I can't play them well. Computer games may be for girls because they're head games, and the Nintendos are hand/eye coordination and shooting. And then Internet is the final and ultimate game. It's gonna cross over.



now, the first thing I want to accomplish is to get video telephony in all of the operating systems as a data type, therefore into all the products, and especially TAPI, so that we can use it as a building block for doing many apps. That's not the end, but a building block. Just like the telephone isn't the end of the world, it's the beginning, a building block. There's a parallel with the telephone.

When the telephone was invented, it began with a single one-to-one conversation. Now, look at all the applications it can do—commerce, social interaction, shopping, ordering tickets, sex and everything else we talk about but don't understand. Telepresence won't be any different, to users it will just be more enriching to have pictures and video combined with audio. Recall that about half the population is visually oriented and the other half verbal.

How will we interact with it? What do you think the user interface is going to be to interact with our telecomputer? It must be as uncomplicated as a simple telephone—anyone from five to ninety-five can use it. Note that I said a "simple telephone"—the telecomputer can't be as complicated as the new feature-rich telephones, where you look at every but-ton, recognize none of the words, and you can't even get a dial tone or make a phone call without a user manual or telephony course.

Gordon Bell
Microsoft, Inc.
gbell@microsoft.com

Well, when I turn on my PC, what am I going to do? Am I going to click an icon on the TV-telephone part of my PC? First, you don't turn on this gadget—it's on all the time. It's just there and it's as simple as touching a point on the screen (with a finger, not a mouse, and eventually with your voice).

Am I going to touch that point and then get a dial tone? Sure. But you'd also better be able to speak to it soon, too.

So it's as simple as picking up the receiver. Yes, it's got to be that simple. You can't spend any more time than you're doing now. It can't be any more difficult or frustrating than a simple phone.

So is that hard to do? Yes, engineering simplicity is always hard—it's an art. Why? Because most engineers would rather create a multitude of irrelevant options—building Cadillacs when only Volkswagens are needed.

But why can't I click on an icon to my modem, which is now a 28 Kbit modem? Just the issue of sending email to me has been difficult when I'm home. Or if you're not on a good corporate LAN system, then you must go through the pain of a dial. Clicking on an icon, having it dial, watching it log on, is not acceptable from a 40-seconds-of-lost-time standpoint. It must be instantaneous. Today, I can physically find a number and have a dialer act faster than I can find it on a computer and have a computer dial a modem.

So now that Microsoft is going to be able to have you click on an icon to get into MSN, you would still have to hang around and wait, and do "are you there," and do that whole thing—Hopefully, that's better than making an Internet interconnection today. It's not the clicking of the icon, it's waiting for the service that is the issue. The modem dialing and handshaking is where most of the time goes. I should wait no longer than I wait for a phone call completion.

Is your Microsoft group going to look like a university research group? No. I believe universities should do the research and we should support them. I want to look at their work and bring it into Microsoft as a prelude to products. The place we're probably going to collaborate with more than anybody else is Berkeley. Berkeley's got a multimedia research institute that's headed by Larry Rowe. So I expect great ideas, prototypes and students. Berkeley has a fine record of this. We officially report to Rick Rashid's office, the Vice President for Research.

And how many people have you chosen? It will be a small group, probably not more than half a dozen. The group is remote and one of the nice experiments is going to be to see whether or not we can work in the remote fashion. First, Microsoft in Redmond must

Karen A. Frenkel is a science and technology journalist and producer. She has just completed a documentary, Minerva's Machine: Women and Computing, which will premiere on San Jose's PBS station, KTEH - Channel 54 on October 23, 10 pm PST.
frenkel@acm.org

have the hottest, most advanced development and engineering groups focused in the telepresence area. So my initial task in starting a telepresence lab is to help build those groups. Because I feel so strongly that this is an important area, I don't want to leave it to just research, because at times research is so unpredictable. That's why I'm concentrating on seeing that there will be a videophone channel in the PC . . . this will stimulate more technology than any research activity could.

How is this research going to be funded and to what level? It comes out of the Microsoft research budget.

What's the budget? I have no idea.

I understand that there will also be parallel processing research. I work with Jim Gray and he's focused on scaleable computing which I'm interested in too. The idea is to build very large systems with hundreds of PCs. The PCs will be quad processors that are the most cost-effective platform on the market. This structure is the root of "upsizing," which has been dominating the last several years of mainframe/mini downsizing trends. Also, Jim's lab will be a test site for the telepresence work.

So what's the first problem you're going to tackle? Right now I want to have videophones all around my home and the San Francisco lab that link to San Francisco and Redmond. Jim Gray is our "user." The first projects are tools for doing video and there are a number of products we can begin to use.

Like what? Intel's Pro-Share, CUSeeMe, and Vivo.

So you want to improve on those? Yes, and use them as components for telepresence systems. Within a few years, the platform will be combined with a robot and used to roam and attend meetings in another space, instead of being constrained to just exist in cyberspace. Once you've opened your mind to the possibilities of telepresence, it's hard to go back to just the simple telephone.