PRESTOWITZ: Good afternoon. Welcome to this forum jointly sponsored by the Economic Strategy Institute (ESI) and the Potomac Institute for Policy Studies. I’m Clyde Prestowitz, President of the Economic Strategy Institute. I want to congratulate you and thank all of you for attending today. This is clearly the hard core audience which neither wind, nor rain, nor dark of afternoon could deter.

We are particularly pleased to take part in this forum because, as the end of this century approaches, it is clear that history will recognize technology as the driving force of our time. It is technology that is accelerating globalization. Technology is having profound and, as yet not fully understood, political, social, and economic implications.

I just returned from New Zealand where I attended the APEC Leaders Meeting. I had the chance to meet with a number of business and government leaders from the various Asian Pacific countries, and I was struck by the phenomenon that every other country in the world is asking the same question: how can we raise venture capital and boost technology? How can we support start up companies and build our Silicon Valleys?

One thing that differentiates the American economy from virtually all other economies is the extent and the role of venture capital and entrepreneurship, and how these dynamic forces have joined with government to spearhead fundamental research and development.

That is the focus of this panel. So, it’s my pleasure to welcome you to the Economic Strategy Institute, and I would like to turn the microphone over to Mike Swetnam, President of the Potomac Institute for Policy Studies to add his comments.

SWETNAM: I’m Michael Swetnam, President of the Potomac Institute for Policy Studies. We’re a not-for-profit technology and technology policy institute in Virginia. It’s our distinct privilege to be jointly hosting this event with the Economic Strategy Institute. This is the second major event that we’ve undertaken with ESI. We jointly published a report on ship building last year, and it is only natural that our two organizations come together to talk about issues such as where the information technology revolution is going and, hopefully, to epitomize the relationship between economics and technology as it evolves in the world today.

The relationship between venture capital economics and technology and the success that the United States and the U.S. business community has had in leveraging our technical achievements is obvious to everyone today. I know that some of our panelists are going to tell us an awful lot more about the kinds of things that you can expect to see tomorrow or the day after tomorrow.

As this revolution unfolds, it’s very important to understand the issues, the trends, the investment by government and industry that’s helped fuel the revolution, and what we might do in terms of policy to enable it to spread around the world and to continue to empower the economy of this country.

I’m really pleased to see that most of the chairs in the room are filled. Hopefully, with the kind of technology that we’re investing in, this kind of forum will be possible in your living room in a year or two, so that we won’t have to worry about storms other than what they do to the local power grid.

Thank you all for coming. Please interact as the panel session goes on. As you have the opportunity to provide feedback to Clyde at ESI or to myself at the Potomac Institute on this session, please let us know what you think we could have done to make it more useful to you and please give us suggestions on where we should go in our
Today, our panelists are really directly involved in this. We hope to gain a better understanding of the strategies and the challenges and the issues that can maintain this dynamism in the Internet, and I think these people will help us today understand that better.

As moderator, I will briefly introduce the speakers and ask them to speak for about 15 to 20 minutes. Dr. Allan Mendelowitz from the ESI is going to act as the discussant. Then, time allowing, we will open up for discussion from the audience.

Without further ado, our first speaker is Dr. Bill Mularie. He's Director of DARPA's Information Systems Office, where he oversees all information systems research and development for that agency. He has spent 30 plus years in the private sector.

MULARIE: I've spent 32 years in commercial industry, everything from venture capital start-ups to working for Fortune 100 corporations, and I've spent a very enlightening two and a half years in the Department of Defense information technology community. I'll leave you with some thoughts today.

I'd like to talk about some very important things. Programmatically, they sort of fall in four areas. One is my claim that the world economy now is really a hostage to information technology and to those of us who are the voodoo of IT. Secondly, there is really a paradox in this whole issue of computerization. It has implications with respect to commercial companies, but it has particular implications in the military that I want to discuss. Then I want to talk about disenfranchisement in this information age. Lastly, the killer app. I revealed this killer app 10 years ago in an Annenberg school panel I was on. Very few people are practicing it, but it is absolutely where we have to be to really see the benefits of information technology.

Let's talk about the hostages in this world economy. If you're sitting in a CEO's chair of a corporation, you're looking at your asset base, you're reading your balance sheet, and you're looking at the financial metrics by which the street looks at you. What do these financial parameters mean now if you're a dependent, which we are upon information technologies globalization? You look at return on capital; you look at your hard asset base. But then you look out the window, and you see these young people walking out the door with what you call intellectual capital.

Fundamentally, the worth of your corporation decreases after 5:00 and increases if they walk in the door at eight or nine o'clock. Drucker calls these people knowledge workers, and we treat knowledge workers in a different way. They can walk next door and probably double their salary. We treat them in a different way because they fundamentally know more about the inner workings of the business than we do.

Now Frederick Taylor would turn over in his grave, if you remember scientific management. The job of management was to create a productive atmosphere. You would teach your poor workers, who were sort of unmotivated in the first case and somewhat on the order of chimpanzees with respect to IQ. Your job as management was to firmly lay down a process so that these workers
could feel more productive, feel good about themselves in the corporation, which would benefit the win, win situation. But what a change.

I want to say that the serious thing here is that the manufacturing base is absolutely critical to the health of our economy. We got carried away about the new economy where the shareholder stock worth of a corporation is so many multiples of revenues rather than something that drops under the bottom line that we used to look at. I think that it probably won’t be with us in the long term.

Now, the paradox. I’ve been thinking about this for a while. It particularly has ramifications in the DoD. The paradox goes sort of like the following. If we all understand it, computerization amplifies human capabilities, and that’s why we do it, it’s a tremendous advantage. The second part of this paradox is that this amplification of human capabilities is gained, increasingly, at the price of increasing complexity in the environment. In many cases, the human being no longer communicates in a very easy way in this environment. So what do we do? We try to deal with this increased complexity with more computerization. Another layer of computerization upon this so the human can get back into the environment.

Let me give you a military example where this works very, very well: the F-117. If you’ve seen the aerodynamic surfaces of the F-117, this thing shouldn’t fly. It’s a rock, right? We do this to reduce the cross-section of this thing. If you put a pilot in the cockpit of the F-117 with his normal sort of flight skills and linear controls, of course he can’t fly this thing. What flies it? What flies it is fundamentally an open loop control system that understands the non-linearity in how you have to treat the control surfaces to make this thing fly. What they put in the pilot’s hand is something he is familiar with, a stick. What the computer does is translate what the control surfaces need to fly, to what the pilot is used to in terms of some linear controls.

What we’re saying is that computerization allows this plane to fly. What we’ve done is put another level of computerization on top of this to allow the human to get back into the environment and thinks he’s familiar with linear control.

The problem in corporate America and in the military is that this level of computerization has only reached the operational level. Whether it’s the financial system in the corporation, a financial officer, a pilot, it has not reached the executive management level. That was one of Drucker’s points in his book Management Challenges for the 21st Century.

This has ramifications with respect to the military and, I suspect, on the corporate side. So let me take the rest of my time to pursue that. That is really the essence I think of where we have to go in this computerization.

In the military I talked to several admirals and I said, sir, how do you get your information? How do you know that this X-10,000 man army you’re running, or this navy, or control of the Pacific, how do you know what’s going on on a daily basis? He says, I don’t, I don’t know what’s going. Well, how do you get your information? Well, I ask my executive officer, I say, how are we doing here? Either that day or three days later, I get a PowerPoint four-slide briefing that tells me how we were doing three days ago.

How do you run a military like that? How do you run a corporation like that? One of the problems that we have in this computerization is that we haven’t been able, from our information systems, to abstract the information so that all levels of an organization can fundamentally work off this information.

The legitimate question from a CEO is, how are we doing? The legitimate question from a manufacturing person is, how many pairs of these did we put out today? You ought to be able to access that in real time situations. We don’t view that as important.

The target of interface. My dear mother who’s 85 years old, gave me a call one day and said, Bill, you spend a lot of money on education, explain this to me: why do I have to press Control-Alternate-Delete on this system to get into it? I don’t know, mother. The arcade interfaces that we generate and are happy with are dismal. The web browser doesn’t tell you what you want to know, it tells you what you don’t know. 24,000 hits; how are you ever going to find what you really want to find? So not only is the ability of our information system to abstract information important, but, fundamentally, we have to do something about the arcade interfaces.

Alan Turing, the father of computerization, was able to read at sight 32 byte code, I can’t do that. I need some higher level of understanding of abstraction.

The thesis I have is that we’re really doing a poor job with respect to the infringement of our executive structuring in the computer age. We have left this computer information revolution at a particular level that is really not appropriate, the expert level.

I remember looking at a military demonstration during my first month in the government. They were supposed to display the latest in information technology, and they were using overhead material and all sorts of things. At the workstation, where they were using wonderful things and pull down menus, where the experts are, right? The guys who know the voodoo. Standing in the back, were the commanding control structures with absolutely blank looks, totally disenfranchised. We’ve got to do something about that.

The killer apps really fall from these two things. The first is obvious. It’s the cognitive filters, the interfaces so that we’re looking, pointing and clicking and getting rid of keyboards. People are working on this, and I think we will see some advance. The second, I think, is probably less obvious and that’s abstraction from common information systems. Let me give you an example why this is critical to the military.

At DARPA, we sent into Kosovo some experimental work on a UAV (Unmanned Aerial Vehicle), fundamentally a surveillance vehicle but we used it in the targeting mode so that we could look at movers on the ground and get targeting coordinates. Our technology worked well. We could get targeting coordinates from our video in about 20 seconds. It took three hours for the weapons cycle. That’s
because in the decision cycle, we had to be careful what we were hitting there were sneakernets.

The military commanders on the top got their information from a guy generating PowerPoint slides. They said, sir, we have a target here on our next slide, so you get a three-hour target. We have to allow from the same system obstruction in these levels.

The killer app for me is to really deliver these two things. I only know one company, which happens to be in the San Francisco Bay area, which is working on these two issues. The people there are doing some absolutely amazing things.

However, the President is a landscape architect, the Vice President is a musician. We need people who can provide cognitive filters that are not in the computer when we’re doing the high level of code. We need people that have a broader, different view of information systems. Where does this lead in terms of market for the killer app? Again, I gave you the example of my mother trying to fight through to send me e-mail by going through these arcade interfaces.

The disenfranchised are not only executives and CEO’s and military commanders but also our parents, at least my parents. Smart people, but the interfaces we’re building aren’t appropriate.

The driving force in it, and I said this ten years ago at the Annenberg school, was when everyone was buying up these huge archives of “I Love Lucy” and saying that the entertainment was going to really be the driving force in this digital revolution, and I said no, it’s interpersonal communication. I mean that’s where it is.

What was the single application that made the Internet grow explanatively? E-mail. Suddenly it was no longer scientists talking to scientists, it was something where you could really talk interpersonally. We’re herd animals; that’s what we want to do.

Thank you.

CIMENT: Thank you Bill for a very stimulating vision.

Our next speaker is Gary Smaby, and while he’s hooking up let me say a few words about him. Gary’s experience in the IT industry began as an entrepreneur. He founded several start-ups and then migrated to Wall Street where he held positions as Managing Director of Technology Research for Piper Jaffray and Managing Director at Needham and Company. Gary continues to play a role as a venture strategist to senior corporate executives and entrepreneurs. He’s on retainer at some of the biggest companies in the IT domain.

Last year the Smaby Group formed a seed-stage venture called Square One Ventures. As its managing director, Gary serves as an advisor, investor, and board member to several start-ups. He’s a well-known influential figure as an IT industry watcher, appears on TV, and is a frequent speaker at major conferences and forums.

SMABY: Thank you Mel. If you don’t mind I’m just going to do it from right here, I’m tethered to my computing devices and, in a few years, that won’t be the case.

I’m going to review some recent experiences I’ve had being on the digital frontier funding primarily Internet based start-ups and talk a little bit about what I’ve learned. I started my first start up company almost 30 years ago as a 20’s entrepreneur, and I thought I’d learned a lot of lessons during the course of that last 30 years. I’ve discovered a few things; in particular, there are “knowns” – lots of things that I thought were truths that are no longer truths in this new web world.

The first one is there are no maps. (Fig. GS-1) If you’re trying to start an Internet venture, do not go out to the business library and check out books on start-ups because it will do you no good. The rules have changed; the old maps won’t get you to where you want to go.

No speed limits. (Fig. GS-2) It’s incredible to me how quickly ventures are getting started, funded and exited from – that’s a venture term. Venture capitalists look for exit strategies, which means: how do we get our money back plus a 10x return or more?

The time to exit has been incredibly fast in the last couple of years. And that’s one reason more venture money is available. I think it was $6 billion a couple of years ago; today $30 billion is going into venture capital. The returns are coming in much quicker, and they are much more significant than they have been historically.

Venture capital returns historically run between 25 and 35 percent per year on a compounded annual basis. Typically a venture capital firm invests a dollar and five to seven years later gets their return.
Here’s another example of a typical VC experience: if we get a thousand inquiries over the course of a year, we might look at a hundred of those. Of the hundred, we might decide to do due diligence on, and actually make an investment in, ten. Of the ten investments, we would expect seven of those ten to break even or go belly up. We would expect to get two to five times our money on two investments, and we would expect to get a 10x return on one. So out of a thousand deals that came through the pipeline, we have one deal at the end that essentially pays for the whole process of reviewing and investing in companies.

If you run the numbers on those ten investments and seven of them are not successful or break even, you’ll see that compound and the rate of return is something in the 25-35% range.

Well, those rules have been broken consistently in the last several years as primarily Silicon Valley-based companies have been pouring money into Internet start-ups. Companies are going public quickly. Some of those venture firms are able to exit their investments early and are locking in returns that are unquotable.

So speed is an incredibly important component. Velocity, time to market, time to investment, time to first place. All of those things are what are really pacing the market today.

Number three, no experts. (Fig. GS-3) There isn’t anybody that can tell you what’s going to happen. There are a number of people who can speculate on what might happen, that can use their past experience to give you some perspective, but forget about going to a market research firm and asking them: what the market’s going to be like if you’re in this Internet space? No one knows.

I hate to say it but technology is five percent of the overall solution today in the Internet. It’s the people who bring their energies and talents to exploit the available technologies.

You can’t do it with just one idea. (Fig. GS-4) I mean, I can’t say that you can’t do it. But it’s difficult to come in with a product idea. You have to have a business model that can evolve and adjust and adapt.

You don’t want to have a firm business plan because you can guarantee that you’re going to throw that business plan out in a month to six weeks because the market is going to adjust underneath you. New competitors are going to emerge. You’re going to have to adapt to what those new competitive models are.

What you think you are when you start your business is not likely what you are going to be six months from now or a year from now. You have to go in with an understanding that you’ve got a team of very smart energetic individuals who can adapt to the market. You’ve got good partners, you’ve got good investors, and they’re going to help you understand how the landscape is changing so that you can make your business model successful.

No one-man bands. (Fig. GS-5) What that means is that no one individual is likely to make the company successful. It’s teams of people that make companies successful.

The first thing I ask a young entrepreneur walking in the door is: who are you going to do this with? In many cases, they don’t have anybody yet that they’re going to do
it with; it’s their idea and they want to drive. I say, well, you’re not going to be able to make it go fast enough. You have to find someone else with whom you think you might be competitive, with whom you think you might have a sympathetic idea, a synergistic idea. Find a team of people. Someone who knows technology, someone who knows marketing, someone who knows finance, and get the company up and running.

Some of you may have read an article, I think it was in the New York Times a couple of weeks ago, about a company in the Valley called Opinions that got started and funded in record time – it was ten days or something like that. These were all people who left big stock options on the table at other companies. They had been successful by anybody’s terms and they could have stayed at those companies and reaped the benefits, but they decided to go for the next company, the next new idea, the next killer app.

That is a great signal to a venture capitalist. If you get people who are willing to leave a going company and walk across the street and form a new business with a new group of likewise energized individuals, those companies will get funded because they are what we call in the business repeaters.

Again, back to the time. You don’t have any time to be confident that all the decisions that you’re going to make are going to be the right decisions. (Fig. GS-6) As I think about the community that many of you are in, and if I’m assuming correctly that many of you are involved in government or government-related activities, this is something that’s going to feel uncomfortable to you. To make decisions without having all the evidence in, without having the reports written, without having the research done, having to make gut level decisions about what direction to make based on limited input from a small handful of smart advisors.

That’s typically what happens here because you make decisions, you make big decisions, you’re spending. I can give you several examples of companies that I’ve been involved with that have grown so fast that they can’t afford to make more than a couple of mistakes or they’re out of it. They have to pick a track and get the best advice that they can and go off and run.

If you go off and run and you don’t make it, well, no excuses. (Fig. GS-7) I mean, you’re going to find out very quickly in this new Internet game whether you’re successful or not.

You’ll either be the hot story and venture capitalists will be falling over you trying to put in money at what will be very uncomfortable valuations for them, or you’ll be sitting out there with no one, no dance partner at all. There’s not a lot in between, you’re either a hot deal or you’re not.

There is so much money. Many people say that there’s no venture capital around, but there is so much money out there that it just keeps chasing the best deals. Because there’s so much money, and actually the number of venture partners hasn’t increased all that much in the last years, what’s happened is that the venture partners have to spend more money each year. They have to place bigger and bigger bets.

They’ve got to. Instead of placing hundred thousand or million dollar early stage bets, they’ve got to be able to deploy five million, seven million dollars. It’s big money against big ideas.

That’s why a lot of small start-ups, technology risk start-ups, are claiming to have a lot of trouble getting funding these days. It’s because their model doesn’t fit the kind of model that venture capitalists are looking for.

Remember I said that the bogey is ten times your money. So if you’re putting in $5 million, you’re expecting to get a $50 million return on that investment, getting $50 million back in a short period of time.

The venture business model has to be the kind of model that allows that to happen. Many of the riskier technology start-ups can’t give you that kind of return because the markets are niches, they’re too small. You can’t confidently believe that you’re going to get that much money back. Because if you’re only going to own 20, 30, 40% of the company as a venture capitalist, you’d have to get your $50 million times some other multiple depending upon how much other money is invested in that company.

It’s really the business model more than anything that I think is driving the decision the venture capitalists are making on which companies get the money and which ones don’t.

Those are my seven “knowns” as of today. If you keep this presentation, I reserve the right that next week or two
weeks from now I'll change some of those "knowns." With
that, I’ll pass it over to Mel, and he can introduce Steve.

CIMENT: Thank you Gary for that very interesting
talk.

While Steve is setting up, let me say a few words about
him. Steve is currently an advisor at CenterPoint Ventures
in Dallas, Texas. He’s also a Visiting Professor of
Management at Rice University. Prior to his relationship
with CenterPoint, he was the Chief Technology Officer of
Hewlett Packard, Convex Division.

He worked for Convex Computer, acquired by HP, and
was the chief designer of the Convex C series as well as the
Exemplar Scalable Parallel Processor, a high performance
system for technical and commercial applications.

Steve holds 33 patents in various areas of computer
design and is featured prominently in Tracy Kidder’s
Pulitzer Prize winning book, The Soul of a New Machine, a
very interesting read, even after all these years. He’s
currently a member of the President’s Information
Technology Advisory Committee.

WALLACH: Thank you Mel. This presentation will
be a little bit more technical, but I’m going to put a business
spin on it also. What I’m really going to do is talk about
optics. The funds I work with have only a billion dollars of
funds, we’re obviously into the Internet, but we like to fund
the plumbing as opposed to the dot-com companies.

That is all this six billion dollars a quarter, all these
companies have to buy routers and all this other stuff, so we
can make a profit on this and not worry about other things.
We can do more of the plumbing. Since we’re engineers by
background, all of us, it’s a lot easier to do this.

The other thing is we tend to put companies together.
Rather than waiting for someone to show up, we go out and
look at the technologies, look at people, and say, hey, how’d
you like to help start a company? We’ll help you put it
together. We’re very proactive in that.

Now, I put this thing out called Silicon Culture; we’ve
heard various people talk about it. (Fig. SW-1) Like Gary
said, that’s about the right ratio: a thousand business plans, a
hundred you look out, ten you fund, etc.

Our term for the seven that don’t make it is “among the
living dead.” That is, they’re kind of there, but they’re not
there. The other metaphor we use is “the jockey and the
horse.” When people come up, the jockey are the people
and the horse is the idea. Depending, for those who have
ever been to a track, you know, sometimes you bet on the
horse, sometimes you bet on the jockey. But if you could
you find the best horse and the best jockey, that’s the best
combination. You want the best idea and the best people.

So, why is this all happening? One is capital formation.
That’s the name of the game. Everyone’s trying to make
money. You need tax laws that favor capital gains. If
you’re in a country like, for example, France where tax laws
don’t favor you, you don’t see too many start-up because
there’s no advantage. It’s literally that simple. What
happens is the French will come to the United States to start
a company as opposed to staying in France. There are no
borders with respect to technology.

You want a culture that promotes risk/reward, not a job
for life. If you fail, then you start another one or you give
up and go work for a big company. You know, it’s not a big
deal if you fail, it’s not a black mark against you. You have
to have a culture that promotes that.

Quick decision making is the opposite of consensus. If
you can’t make a decision in 15 minutes or less in the
hallway, you loose. The days of, let’s plan a meeting in
three weeks to discuss this, they’re gone. From my
perspective, because I was an entrepreneur and I helped start
half a dozen companies, I don’t care, you want to make a
decision in five minutes, make a decision in five minutes.
My view is no decision is the wrong decision. That’s very,
very important.

Exit strategy. We heard Gary. Ten years ago it was
going public; today you may actually structure your
company to be bought out by Cisco, Yahoo, or whomever,
and almost every major company has a venture capital
subsidiary. Intel is one of the best examples of this.
Venture capital subsidiaries of major companies invest for
many reasons: to make money, to gain access to and
promote technologies that benefit their core businesses, etc.
That is, if they can’t hire the people, they’ll buy the
company. At different times, companies have approached
to buy maybe half of our investments. In some sense, that’s
actually more liquid. Because if I had a million dollars of
Intel stock, that’s cash as opposed to a million dollars of a
company that could go up or down 20% in a day.

This is very important, and on PITAC we talk about
this, and of course the best example is Internet and TC/PIP.
That started off 30 years ago; last week there was an
announcement that the first in the series of e-mail was 30
years ago at UCLA. We have to recognize that, in essence,
the government is the venture capitalist of first resort.
Depending on what technology is developed, the
government has to promote that technology transfer to
industry. The government doesn’t see a return in the sense
of an internal rate of return. I’m not an economist, but if
you look at what’s happening with the capital gains and us
getting the budget, at least what I hear on TV, a lot of the
reason for that is because of the growth of the economy and
capital gains generating it. The person who was just put on the vice chair of the Fed is an information technology person as much as he’s an economist. I think that’s a good indication that we’re in a whole different business model. That’s my little on Silicon Culture.

Okay. Now let’s talk about optics. (Fig. SW-2) I don’t expect you all to understand this, though to some people, I’ll give a test afterwards. But basically what this says, if I solve these equations, I can’t make electrons go any faster, I have to go to optics.

**ELECTRICAL PROPAGATION DELAY**

- **Lossless Line**
  
  \[ \text{Time} = \sqrt{LC} \]

- **Lossly Line**
  
  \[ \text{Time} = \frac{L}{\sqrt{\varepsilon_r/C_o}} \]
  
  \[ \varepsilon_r = \text{Dielectric Constant} \]
  
  \[ C_o = \text{Speed of Light} \]

**SW-2**

Today you hear various terms: photonics, WDM, etc. (Fig. SW-3) Wave division multiplexing (WDM) basically means, how do I put multiple channels on the same fiber? Things like the radio in your car. That is, if you go to stations 93.1, 93.3, 93.5. It’s multiple channels on the same band.

**OPHTICAL TECHNOLOGY**

- **EXPLOITS**
  
  - Bandwidth of silica fiber
  - High-gain wideband optical amplifiers

**SW-4**

That resulted in a single fiber going from one channel to potentially terahertz. We’re now beyond gigahertz. Just like the supercomputer people talk about petaflops and teraflops, we’re now basically bringing the same thing into telecommunications.

The reason we need this is that the Internet demands the data. (Fig. SW-5) Internet data, not voice, is doubling every six to nine months, conservatively. If it’s every six months, you know, we could all go one, two, four, eight, sixteen and take it out and go, gee wiz, we’ll need 64 times or 128 times, that’s daunting.

**IMPACT of INTERNET**

- Demand for data transmission doubling every 6 to 9 months
- Accelerating the convergence of data and voice
- Easier to expand what is in the ground to get the extra bandwidth
- Accelerates demand for AON

We literally don’t have the cost effective technology to do it today. Yet with all these dot-coms and e-mail, we have to do it. If we don’t, it will be just like a highway, you know, if you have a three-lane highway and you want to put four lanes worth of traffic, it gets backed up.

There’s a lot of money to be made and a lot of research to be done to figure out how to meet these requirements. This is called All Optical Network.
This is one view, I’ll just skip this, is you always hear about the Internet cloud. (Fig. SW-6) The Internet cloud is becoming actually optical cloud called All Optical Network.

**WDM ARCHITECTURE**

What’s happening is that, out of this network, eventually it gets down to you at the desk, perhaps by Ethernet, FDDI, ATM, or perhaps it goes to a company where there may be a 10 gigabit terminal. (Fig. SW-7) This is beginning to go worldwide. The other benefit of optics and the Internet is we don’t differentiate between sending an e-mail across town or sending an e-mail to Tokyo or sending an e-mail to Frankfurt.

**CURRENT MCI NETWORK**

With optics, we can go worldwide effectively at the speed of light. In fact, we’re getting to the point for some companies. Even though I’m not supposed to do this, I did an engineering design. For the first time in my life, the speed of light was a limiting factor in the design.

I had to work out the propagation delay on the fiber, and I go, I don’t believe this, I cannot go any faster because it was an equation that involved the speed of light. Literally, we are not pushing the forefronts of a lot of this technology.

Just to give you an idea (this is from the web), this is the MCI network; it’s 25,000 miles of fiber. (Fig. SW-8) This is in the United States. MCI is now replicating this in Europe and the Far East. This was for voice.

**CURRENT UUNET NETWORK**

For data, it’s UUNET. (Fig. SW-9) As someone said in tongue and cheek, it’s sort of all the major hubs of where there were NFL teams. I say tongue and cheek, that’s Bill Gate’s house up here.

**WDM ARCHITECTURE**

But as a result of all this optics worldwide, depending on who you speak to, it costs a hundred thousand dollars per mile to install it. It’s not the fiber, it’s the easements and the legal issues. The actual material and bearing are about five percent of the overall cost. When they dig the trench, they bury 50, 100 fibers, as many as they can. Because once it’s buried, you don’t want to have to uncover it again.

But now there are constraints. (Fig. SW-10) I call this L’Hospital’s Rule, something I learned in calculus. Profit is a function of the differential of market size over investment. The market size, people would like it to approach infinity, but unfortunately, sometimes it approaches zero. The investment, while you’d like it to be a constant, sometimes approaches infinity. So, as a result, you’re either a success or a failure.

One thing you have to realize, at least from the investment perspective, is when to cut your losses. When you’re a venture capitalist, that’s real easy, you go: I’m not putting any more money into it, next. What you do is look for the one or two firms that will return not 10:1 but 50:1. Because the firm that returns 50:1 covers a lot of mistakes. You look for the big bang.
Okay. I’ll talk about some optical technologies and end with what I think is happening. Most of the optics, a lot of the switching today, is mechanical in nature; literally a mirror rotating fast. (Figs. SW-11, SW-12) But that’s not fast enough. These things go forward, and there are a lot of reliability issues.

CONSTRAINTS

- Cost of Investment - I (billions)
- Size of Market - M (millions)
- L’Hospital’s Rule of Profit
  - Profit = dM/dl
    - I, investment, sometimes approaches infinity
    - M, market, approaches K (sometimes 0)
  - result is \{ 1 (success) | 0 (failure)\}

Optical Switching Technologies

- Mechanical
- MEMS, LCD, BEAM BOX
- SOLID STATE
  - Lithium Niobate
  - SOA
  - AOM
  - EAM
  - Silicon

Mid-Range Switching

- LCD - liquid crystal
  - microsecond to millisecond switching
  - low dB loss and cross talk
  - amenable to higher levels of integration
  - Chorum Technology - Richardson
  - www.chorumtech.com

You know it’s interesting, when a computer fails it doesn’t make the press. Remember about a month ago, MCI had a failure in their software, and for about two weeks, the Chicago Board of Trade could not trade, etc. Then at the very end, MCI said, okay, we’re going to give all customers two weeks of free service. Or a year ago when it happened to AT&T, Armstrong, the President, was on CNN apologizing. I don’t know if he did this afterwards, but I know if I was Armstrong, when I got into my office afterwards, I would look at, let’s say my 10 departments, and I say, we’re going to fix this and if it happens again, you 10 are not here.

The Chairman of AT&T does not want to be on CNN apologizing for a problem in the network. It doesn’t just work, it has to work. You know, the rule is four hours of down time in 25 years. There’s an incredible amount of reliability and redundancy put in because it’s a utility, that’s the key. It’s just like electricity, you expect it to work all the time.

We have technologies, we have liquid crystal that is a mid-range, and we actually started a company. (Fig. SW-13) We found these two people at the University of Colorado. What I mean by proactive; we liked their technology, and we said: move near us in Dallas because Dallas is a major telecommunications hub. We put a team around them. Now they’re shipping product. Rather than waiting we approached them, this is an example.

MEMS, there’s a lot of DARPA money going into that. It’s Micro Electronic Mechanical Systems, and I’ll show you a picture of it. (Figs. SW-14, SW-15) This actually is from TI. Literally, mirrors made out of semi-conductors that flip back and forth. There’s a company in San Diego we also fund, actually Sevin Rosen funded it, where the President came from DARPA. This is what I mean by the government should promote technology transfer. You shouldn’t just slap someone’s hand. I mean subject to contracts and things like that. That’s the best way to move technology. Because what we have in the United States is the best technology transfer mechanism in the world.

That’s the way we have to view it. Eighteen years ago when MCC started in Austin, Bobby Inman was its first president. He was at an AEA conference and someone asked him that; either you’re going to put all this money in, but more than likely the venture capitalist will take the technology to the market. Technology won’t go back to
IBM. His answer was: if that gets it into the market place faster than anything else, then I’m doing the right thing. Because his view was to make the U.S. more competitive and not to enrich the people who funded MCC.

**Mid-Range Switching**

- MEMS (micro electronic mechanical systems)
  - micro-miniature mirrors.
  - Optically transparent
  - amenable to higher levels of integration
  - millisecond or less switching times

**Optical Switching**

- Optical Switch - Richardson
- Frustrated Total Internal Reflection
- 2 microsecond switching time
- www.opticalsswitch.com

**Solid State**

- Lithium Niobate
  - been around for a long time
  - nanosecond level of switching
  - expensive material
  - was part of original MONET project definition

There’s something called lithium niobate that’s been very heavily funded by the government as part of the Monet project. (Fig. SW-18) It’s been around a long time.

**Semiconductor Optical Amp**

- Not widely used
- Potential Noise problems
- Problems switching DWDM signals

Okay. I’ll skip some of these. (Fig. SW-16) Here’s another Dallas firm who’s trying to do something. (Fig. SW-17) The key is what the world really needs is solid state optics. The reason computers are cheap is because we’ve gone to solid state. That’s the key here.
What's really needed is more of a semiconductor silicon or other technology. This is a company, Bookham, that is in the UK. (Fig. SW-22) There’s a project funded by the government called HTMT, working with Princeton. It’s not totally proven yet, but this is the type of thing that we have to begin funding. We have to break away and develop whole new technologies.

Now we have recognize that to really go all-optical, we need a technology that permits optical components to be fabricated using semiconductor-type technologies. (Fig. SW-24) Otherwise it can’t be cost effective.

I don’t care what it is. I have no particular prejudice as long as it uses semiconductors, because that means I can make it cheaply. (Fig. SW-25) If you go back in the computer industries in the 50s and 60s, that is the state of the optical component technology today. It’s hybrid oriented, you know, it’s first, second generation. There are a lot of electrical-optical conversions, we cannot stay in just the optical domain. Simplistically, we need, as I called it, the moral equivalent of DTL logic. That’s the way the computer industry started, what led to hundreds of billions of dollars, and the reason why this is the same performance of a supercomputer of 20 years ago.

This was from an IEEE magazine; they called it the Ultimate Network Switch. (Fig. SW-26) We’re going to need things like this if the Internet will continue to double every six months. Because if we don’t, you’ll have your DSL in your home, or your cable modem. The good news is when it works, it will work at a megabit a second, but if it’s 3:00 PM or another time, and you log on, it’s going to
dribble down because the backbone itself won’t be able to deal with it.

**Wishful Thinking**

- In essence what existed in the computer industry in the 50’s and early 60’s is the state of the optical component industry today.
- Thus, lots of O-E-O types of design
- Simplistically we need the moral equivalent of DTL logic (Diode Transistor Logic)

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**The Ultimate Network Switch?**

There’s this firm called PointCast, some of you may have heard of, and their biggest demand was the day that the Monica Lewinsky story hit. The biggest demands are, let’s say, the unusual news events. On that day PointCast had its largest demand; that is they transmitted one terabyte of data when the Lewinsky story hit. So of course the geeks immediately established a metric called one Lewinsky. From their perspective, bandwidth is measured in Lewinskys. If it’s a slow day, it’s a 0.1 Lewinsky and maybe now, because of the hurricane, they’re up to 1 Lewinsky again. Obviously, I don’t think we want that necessarily. That’s not perhaps appropriate to last forever, but in geekdom, you know, things like that happen. Thank you.

**CIMENT:** Thank you Steve for the very illuminating thoughts.

Allan, you have a hard job here. I think we need three discussions for some of this. We went from cognitive filters to no rules and no knowns to optics. These have been very stimulating presentations, and Allan is going to kick off the discussion.

**MENDELOWITZ:** I have to say I have an absolutely impossible charge. I was sitting there frantically trying to figure out how to follow a presentation like that. I feel a little bit like the thirsty boy on a hot summer day who wanted a drink of water, went up to a fire hydrant, turned it on, and tried to take a drink.

This has been a really interesting seminar because it was an incredibly rich mix of business concerns, investment concerns, venture capital concerns, and technology issues. I think that it is emblematic of what’s going on in the world today. The dividing line between technology, business, and venture capital has changed dramatically in recent years. Everything is now thrown into the pot and stirred into an unprecedentedly dynamic brew.

If you look back, what was the old world? The old world was the world that existed from the 1950s to the 1980s. What was the premier technology company in that period? I know you all know.

Somebody came up with the right answer. Somebody always says IBM. Mel, you’re the first person who hasn’t said IBM. Almost everyone always says IBM. However, if you look back at the business activity of IBM during that period, we see that IBM was never a technology-driven company. IBM was a revenue-driven company. You know that ad for wine, “we sell no wine before its time.” IBM’s motto was, we introduce no new technology before its time. IBM never ate its young; it never cannibalized its existing product line. If there was revenue to be squeezed out of existing technology, it squeezed it out. However, in today’s world, no one controls the pace of technological change.

The pace of technological change is unbelievably torrid, and it’s popping up all over. It’s driven by bright people with good ideas, who make quick decisions, who have the ability to execute and can access the needed venture capital, and put it together in a matter of months rather than years. I think that that’s what is making this so interesting.

From the perspective of the consumer, all of this is not directly irrelevant. From the perspective of the consumer, there is a veil between the consumer and what is taking place behind the consumer market place. What the consumer wants to know is, what can you do for him or her and how cheaply can you do it? The American market has been transformed by the unprecedented level of competition, and the U.S. market has become so competitive because of several key changes that have taken place in the past couple of decades. One is certainly the dramatic pace of technological change. The second is the internationalization of the American economy. The third is the rapid pace and breadth of deregulation that took place in this economy over the past 20 years. Not the least of which, it took place in telecommunications.

The American consumer has been spoiled by competition. The motto of the American consumer today is summed up in three words: perfect, now, and free. American consumers expect to get a product that is perfect, they expect to get it immediately, and they expect to get it for free.

Let’s look at how things have changed. How many of you have ever bought anything from a catalog? Americans are catalog shoppers, right? You get a catalog in the mail from some place in Maine, you see a jacket you like, and you order it. When do you expect it to arrive? It used to be...
six weeks of so. Now, shift to the Internet world. You get
on the Internet, you go to the same company’s website, you
click to purchase the same jacket, and when do you expect it
to arrive? You expect to arrive tomorrow, and you expect to
get it at a rock bottom price.

I assume that all of you have your “Freeway” cards.
You know what the “Freeway” card is? It provides free
long distance calling. It is unlimited free long distance
calling brought to you the same way that you get free over-
the-air television and free over-the-air radio, advertisers pay
for it. You call an 800 number, key in your special ID, type
in the number that you want to call, and then, instead of
having your call go through immediately, you hear an
advertisement. How much free airtime you get is a function
of your willingness to listen to these ads. I learned that for
about four or five minutes of ads, you get a half-hour of free
long distance calling.

This is a whole new world, and the new world revolves
around unbelievable competition and technological change;
perfect, now, free. All the things that we’re talking about
here are the things that make the new economy go. The
result is that we have a new economy that, in fact, is
undergoing changes every bit as dramatic as the industrial
revolution. These changes are taking place because of all of
the interfaces, the interconnections, the information
exchanges, and the roles of the different players in making it
happen, some of whom we have heard from today.

I would say that as difficult the charge was to come up
with comments that span the range of topics covered: venture capital, technological change, and business
transformation, the seminar provided an authentic window
on what is going on in the U.S. economy.

It offered valuable insight into the underpinnings of
what’s going on and why we’re undergoing so much
dramatic change in this economy: why productivity is
rising; why prices are stable; why unemployment is falling;
and why the economic future is going to be so very different
from the economic past.

All the economic models we have out there with
structural equations and coefficients based upon historical
data, are going to give severely impaired insight into the
future. What we must appreciate is that insight into the
future cannot rely on the way things were done in the past.
If you are going to succeed in the new economy, it will be
because you go forward with a new and better idea and not
because you develop a business plan that relies on obsolete
from a book on how it was done in the past.

With that, we should throw it open to discussion. Mel,
I’m sure that you’ll do a wonderful job entertaining
questions from the audience.

CIMENT:

Thank you, Allan. We will entertain questions from the
audience.

Note: Due to technical difficulties, most of the questions
during the Q&A session were inaudible. Here we have
attempted to present some of the major topics addressed in
the Q&A session.

Q&A session

There was some additional discussion of how the VC
system operates. It was mentioned that decisions are made
in 15 minutes on gut feelings and that business plans are
generally given as PowerPoint presentations, not on paper.
Questions asked by venture capitalists include: what’s the
market?, what’s your intellectual property?, and what’s your
competitive advantage? One panelist addressed the fact that
spreadsheets showing lots of numbers (that are essentially
random) will not help a firm’s proposal.

One question addressed how the VC system supports
companies that wish to stay small. It was mentioned that VC
funds are generally not interested unless they can invest at
least $3 million in a company, since it takes the same
amount of time to invest $3 million or $0.5 million. The role
of business angels in the VC market was briefly discussed,
and it was brought up that web-based businesses (as
opposed to technology-based businesses) don’t require a lot
of money.

The issue of corporate VC came up, and it was
mentioned that Intel’s business development unit is, in
essence, the largest VC firm in the world. One large
difference between the view of VC firms and corporate VC
units is that corporations are looking not only for financial
return but also for technologies that will help the company
in the future.

Technologies for the telecommunications last mile were
discussed, and it was suggested that the ‘last mile’ issue was
primarily a business, not a technology, issue. Difficulties
faced by government and the military related to rapid
technological changes in telecommunications were
addressed; policies were seen as too slow to keep up with
the pace of technological change, and military technologies
were seen as the weak link in the system.

Several other issues were raised, including why
companies don’t spend as much on basic research as they
used to, the importance of NSF funding as a way of training
people, the importance of a cultural infrastructure (such as
the one found in Silicon Valley), and the importance of
other aspects of the national innovation system on IT
innovation. It was asked why VC and entrepreneurship are
not as present outside of the U.S. and, within the U.S.,
outside of Silicon Valley. Responses addressed the fact that
Silicon Valley is a self-sufficient cluster that has everything
it needs: intellectual property lawyers, people and
businesses who understand risks, rental agents, etc. While
aspects of national innovation systems were not discussed in
depth, tax laws and culture (e.g., lifetime employment in
Japan) were mentioned.