GILDER TECHNOLOGY REPORT

TELECOSM SUPPLEMENT

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On the Verge of Opportunity

The Telecosm has been hard hit this year. In his keynote address to the 2001 Telecosm conference delivered November 5th, George Gilder identified the problem, the culprits, the solution, and the opportunity. Herewith, the edited version of George's remarks kicking off what he later proclaimed "the best Telecosm ever!"

I always tell people, "Don't solve problems." When you solve problems, you end up feeding your failures, starving your strengths, and achieving costly convalescence. And costly convalescence in a competitive global economy puts you out of business.

This insight is essentially Peter Drucker's. But what could he mean really? Human beings as a species solve problems. That's what we do when we get up in the morning, we face problems and solve them. But Drucker's key theme is: look beyond the set of problems to the transforming facts on the horizon.

However, as I said, we all have to solve problems first, and recently I've been a problem-solver. Bret Swanson and I went to Washington ten days ago, to try to persuade them of what I believe is the fundamental problem of this economy at the moment. That problem is deflation. It's not an unsolvable crisis or predicament. What makes it serious is that virtually all economists in the world fail to understand it. Virtually all central bankers still fear inflation above all.

In Europe, the central bankers still live in a world that is overshadowed by the memory of Weimar. In Japan, which has not had any serious inflation since the Second World War, the central bank last week warned again about the danger of inflation if it eased monetary policy. And in the United States a couple weeks ago, Milton Friedman, our leading monetarist expert, warned against inflation in the pages of the *Wall Street Journal* on the basis of his analysis of the loose monetary policy signaled by reduced interest rates by the Fed and increasing monetary aggregates.

So somehow what is a simple problem to address, deflation, has been transformed into a grievous problem by the general failure of politicians and economists to recognize what's going on. I talked to Dick Cheney, Michael Powell, and others in Washington, and they all have a different explanation for our economic problems in each case: "Telco's over-expanded their investments." "The banks in Japan made an array of terrible loans." "The Argentinians are corrupt." "The Turks are in chaos." There are special reasons for each of these cases, but I think the heart of it is a systemic problem, and that systemic problem is deflation.

A general decline in prices is one way to recognize deflation, and declining prices are manifest. But, more significantly, the price of gold, which is the most important monetary measure, is down 40 percent since 1996. Steel is down 42 percent. Grains are down 40 percent. All the commodity indexes are at a 15-year low.

Deflation punishes anybody with debt. And it so happens that our Telecosm is always dependent on debt. It's making long-term commitments, long-term engagements, and building a large infrastructure that lasts a long time. Those kinds of investments are typically supported by debt.

The existing infrastructure was backed by some $200 to $300 billion of junk bonds, high-yield securities issued during the late '70s and through the '80s, when MCI's first big fiber network was financed, along with Sprint and TCI's cable network, McCaw's digital cell phone network, and many of the content players that complemented the deployments of these net-

works (News Corp, Time Warner and Liberty Media). All of these were financed with huge amounts of debt. But today, because of very tight monetary policy, such debt becomes a vice that is destroying the financial viability of Telecosm players such as Global Crossing and Metromedial Fiber.

In response to this a lot of them are resorting to barter. They are so afraid of monetary transactions, that Qwest and Global Crossing and all these companies have been making "swaps," which distresses Wall Street. The Street thinks there must be some kind of deception underway when these companies swap capacity rather than buy and sell capacity. This is again an expression of the lack of liquidity in the global economy, and it's very dangerous for an industry which is building the future.

Now, of course, there have also been bad business plans. The numerous and detailed diagnoses that have been offered by economists and financial analysts are true. Many companies did make errors. There were excesses. But these excesses should not have resulted in the kind of carnage we see today.

Today, in a deflation, money is increasing in value, and there is a scarcity of it relative to the opportunities and the transactional needs. As a result people move their wealth from long-term investments into liquid categories that are measured as an expansion of the money supply. You go to a conference of venture capitalists and they all say they're holding more and more of their funds in cash. Venture capitalists are the most visionary long-term investors in the economy and they are in cash. Everybody clutches cash and so all the monetary supply numbers expand and the velocity of money (measured by the number of transactions) collapses.

Money is increasing in value and there is a scarcity of it

There's been some talk about deflation for the first time in the press. In general there's beginning to be some recognition that the environment we have does not portend any inflationary danger at all and that zero interest rates adjusted for expected deflation may be very high, double digit or higher. Indeed, you just have to listen to the radio to know that interest rates in the auto business are zero or below, and the concessions on financing that the auto companies have made result in about a $16 billion reduction in revenues, which is twice their total pre-tax earnings.

So we have this deflationary situation in which deflation mimics inflation, and the monetary authorities fail to recognize it. That is the basic source of the plight of our industry.

But I'm a cornucopian economist, so I don't solve problems for long. The real facts that have emerged in the last year or so beyond all the clutter of noise, is a fundamental new abundance which implies huge prospects for increased wealth over the next decade. That cornucopian opportunity is bandwidth.

The way you identify the key abundance is by the plummeting price of a central factor of production. During the Industrial Era it was kilowatt hours that manifested this plummeting price. Companies, countries, and individuals that exploit the resource that is plummeting in price gain market share against all other countries, companies, and individuals, and end up defining the age: the age of steam, the age of coal, the age of information. And so on.

Once a key resource reaches some fundamental level where its decline in price diminishes, it doesn't become less important; it becomes a crucial, pervasive force throughout the economy. So power clearly does not become less important as its price declines; it merely no longer defines the crucial opportunities of an era.

We've just been through the computer age. The computer age was based on the plummeting price of transistors. The price of a transistor over a thirty-year period dropped from seven dollars, with support circuitry, down to about a millionth of a cent next year with the launch of gigabyte DRAM. This is the Moore's law cliff of cost, and it has essentially fueled the personal computer revolution.

Now transistors still are an abundance and they still are absolutely central to the new economy, but notice people now depict transistors in different ways. There is increasing emphasis on analog devices, on transistors made of compound semiconductors of various kinds—heterojunctions. The DRAM/CMOS device is no longer the canonical transistor. Having reached the level of about a millionth of a cent, transistors will tend to drift upward in price.

Not only have transistors been abundant during the computer era, silicon area has been abundant also. You can always waste silicon. You can always plug in another daughtercard into the motherboard, always add more chips, and more devices. Silicon area has doubled every five years throughout the computer era. But it is no longer an uncomplicated abundance of the sort that launches and identifies new ages in technology. With the modal personal computer now a digital cell phone, silicon area has become increasingly scarce. Mobile devices mandate this.

I just returned from the CDMA World Conference where everybody was ecstatically celebrating the breakout of Sprint PCS which added 1.2 million mobile customers last quarter and increased its revenues 55 percent over last year. Sprint's CDMA advantage is now dramatically manifest. The Koreans have added a million 3G customers. Everybody was talking last year about how the Europeans were ahead of us in cell phones. Well, it now turns out that 3G, the real 3G, is

CDMA 2000, and a million of them have now been sold in Korea.

Korea is really the center of cell phone and (surprisingly) DSL advances. Samsung is bringing a wide range of new wireless devices launched in Korea to the U.S. market. Sprint PCS is deploying CDMA2000 during the next quarter. CDMA2000 will be increasingly rolling out over the next year with Verizon and other companies. This trend is even accelerated by the events of September 11, which brought new recognitions of the value of wireless communications in a crisis.

There's been a reversal of the configuration of abundances and scarcities that sustained the computer era. Now we're moving into an era that is marked by the technologies that waste bandwidth.

On the surface it looks as if telecom capital spending has dropped 16 to 20 percent this year, and is projected to drop 40 percent the year after. This essentially represents the removal of a $35 billion bulge of spending in 1999 and 2000. That spending was absolutely necessary. In order to sustain Internet traffic in the year 2000, if they'd used the old SONET gear of 1995, it would have cost $8.7 *trillion*. In other words, all private GDP of America would have had to have been expended to enable the Internet performance that was maintained in the year 2000. With the continued acceleration in 2001, you can see upward of $20 *trillion* would have been required to use the old equipment.

The impact of optics and the expansion of optics on the viability of the Internet is immense. This represents a huge achievement by the industry and I think it is only the beginning. We're just at the beginning of this optical revolution.

Terry Turpin of Essex describes a law that resemble's Carver Mead's insight from the 1960's, that as transistors get smaller and are moved closer together they run cooler, faster, better, cheaper—all their various parameters improve. Terry Turpin has identified a similar effect when more lambdas are incorporated on a single fiber thread, and he's already demonstrated lambdas 50 *megahertz* apart. Now the typical in the industry is putting lambdas 100 *gigahertz* apart and maybe moving down to 50 GHz. But he's demonstrated that it's possible to put lambdas almost in unlimited numbers on individual fiber threads.

There's no boundary to the increase in circuits that can be placed on a single fiber. And of course no one uses a single fiber, people deploy fiber cables—the new Pirelli cable has 1128 fibers in it, and it's possible now in a single fiber cable to put as much capacity— many bits per second—as the entire Internet ran in a *month* at the beginning of the year 2000.

Now, some people believe that this kind of bandwidth is a menace, that it portends a disastrous collapse of prices which jeopardizes the future of the industry. I believe that resembles the misconception that led people in 1985, including Gordon Moore himself, to speculate on what we could possibly do with the millions of transistors on a single chip. Gordon said none of us have the slightest idea, beyond just increasing computer memories, what to do with so many transistors.

When you have an abundant resource, you need to waste it in order to supply those essential elements that complete a system. And it's supplying those essential elements to complete a system that produces profits and opportunities. When you have an abundance of bandwidth, the scarce resource is connectivity and you have to focus on connectivity. The way you achieve connectivity is through the deployment of more and more lambda circuits. You waste lambda circuits.

It's connectivity that people will pay for

The companies that will prevail are those who are willing to deploy lots of lambdas to maximize the number of circuits that can be used to supply connectivity across the network. It's connectivity that people will pay for. I believe that the opportunities for selling connectivity through the industry are getting better and better.

The evidence for this is measured by elasticity. The price elasticity of demand for a product is really what allows it to continue an ascent with plummeting prices and expanding uses, as the Moore's law experience suggests. And what really made Moore's law successful was that you could manufacture these transistors in batch mode.

The first big success in semiconductors, one of the big successes that made semiconductors dominant was the 1211 transistor sold by Fairchild to service the tuner in UHF television sets, and it was the first big consumer breakthrough for Fairchild and for the semiconductor industry. Its total market was all the television sets, which, if you assume a global market, you can assume possible billions of transistors sold to the television market. And what made Moore's law dominant was that today you put billions of transistors in *each and every* television set.

This kind of prediction would have seemed totally fatuous and quixotic back in those years if you didn't have the insight of the possibility of putting billions of transistors not in discrete applications, like one in every television set in the world, which would have seemed ambitious, but rather billions in every television set in the world.

If you look at the drop in the cost of bandwidth since 1996, a DSO-mile-month, which is the usual way it's sold, went from close to 10 cents in 1996 to .005 cents in 2001. That's about a 500 percent drop in price over a five-year period. Meanwhile, there was a near

300-fold (30,000 percent) increase in Internet traffic. That suggests an elasticity of approximately 6.

In other words, for every 10 percent drop in price you get a 60 percent increase in unit volumes of bandwidth. So all the various estimates of the elasticity of demand for bandwidth hover between 4 and 6, and this is a huge elasticity that exceeds that even for DRAMs, which was the most elastic use of transistors in the semiconductor era. It's only the analysts who focus solely on long distance prices who have failed to recognize this gain.

We see greater opportunities than ever before

The source of the advance is measured in lambda-bit-miles over the last 5 years. In 1995, a state-of-the-art Ciena WDM system had four lambdas carrying 622 megabits a second 300 miles. This year Broadwing has deployed a Corvis system of 160 lambdas, each carrying 10 gigabits per second over 3,000 miles. So you get another 6,000 factor there that is double the traffic factor over this same period of time. With these elasticities, it means that as the price goes down, usage goes up, and a new possibility—creative waste of the abundant resource—emerges on the edge to further fuel the markets.

Thus, what Gordon Moore failed to identify is the possibility of designers outside of Intel Corporation conceiving of a huge array of new products that could use transistors. Similarly, people in the telecom industry are probably not best poised to identify the huge numbers of new applications that will emerge for bandwidth as the canonical factor of production plunges over its historic cliff of cost.

Back in 1996 the real fear, one of the most acute fears, was quite different. And it gives you an insight into the prospects for the next decade. In 1996 Bob Metcalfe foresaw another kind of catastrophe. He compared the traffic on the Internet, which was then 15 terabytes per month, with the traffic and the capacity of the Ethernets in corporations all around the world, which was exabytes a month. An exabyte is 10^{18}, and it's a huge number, best measured in LOCs—which are Libraries of Congress—the digital contents of the Library of Congress. An exabyte is about 15 LOCs or 50 times the contents of the Library of Congress, and those 15 exabytes add up to over 20 trillion books, 20 trillion big books, which if stacked would reach 200 million miles beyond the sun.

This was Metcalfe's fear really, that all these books would tumble out onto the Internet and destroy it because the Internet just did not have the capacity to accommodate this huge amount of potential traffic pent up in local area networks.

Because of this phenomenal achievement of deploying capacity, we're now worried about a glut of bandwidth rather than a glut of potential traffic. But today, the overhang from the corporate sector and the residences over the Internet has increased vastly. When Bob Metcalfe was writing, 95 percent of all storage was analog. It was videocassettes and records and tapes of all kinds, and analog microfiche. And, of course, photographs were all analog. Today, close to 90 percent of all storage is digital and Net ready. The amount of digital storage has increased a hundred thousand fold since 1995. So the availability of bits to flood the Internet, these potential exafloods, have expanded about a hundred thousand fold since 1995.

Looking beyond the problems to the opportunities, we see greater opportunities than ever before. The terrible international crisis we face has woken us up and made possible new policy initiatives that can unleash this fabulous potential of the telecosmic economy. Surely, there's been a delay of deployments of some technologies, but wireless has actually taken the initiative away from optics lately, over the last year or so, and wireless is the chief source of mobile connectivity that can pour huge new floods of bytes into the Telecosm.

George Gilder
November 5, 2001

"The best Telecosm ever," George Gilder concluded, after the Technologies of Freedom discussion wound down the fifth annual confab. The best ever? This year? How can that be?

If you heard Carver Mead explain how neural networks will keep us safe, or George Gilder tell us how deflation can be overcome, or Eric Schmidt hold forth on data mining, or Peter Huber describe the ultimate "killer app," you would understand.

Impinj showed off its brand new "self-adaptive silicon," promising to transform analog-intense communications chips like cell phones and high-speed network nodes. Terry Turpin of Essex wowed Qualcomm's Klein Gilhousen with his explanation of OPERA, an optical processor Turpin says could boost CDMA cell capacities by 400 percent. Narad and Soma begin lighting up the multi-megabit residential last mile at year-end. And NP Photonics is well on its way to reducing the size and cost of the EDFA by an order of magnitude. Amplifiers everywhere!

The Telecosm is down, down, down, but it is not anywhere close to being out. It's not too late to HEAR "The best Telecosm ever!" Just use the convenient order coupon enclosed with this issue or call us on 1-800-720-1112.