GILDER TECHNOLOGY REPORT

Published jointly by Gilder Publishing and Forbes Magazine www.gildertech.com April 2000/Vol. V No.4

Avanex Rocks the Telecosm

I saw nothing at any of my companies to justify a collapse of values. JDSU and Sun struggle with too much demand. The Telecosm is bursting at the seams.

If you are looking for ways to triumph in a troubled market—as Telecosm companies tumble over the precipice of prices—don wings of light. That was the conclusion I reached on a pell-mell romp around the Telecosm over the last month. I have been investigating firms as various as **Vignette Software** (VIGN), **Exodus** (EXDS), **Sun Microsystems** (SUNW), **Allied Riser** (ARCC), **Terayon** (TERN), **SDL** (SDLI), **Agilent** (A), **TeraBeam**, **MMC** (MMCN), and **Blaze** (BLZE). I got sick in St. Louis, collided with a Ford Ranger in Oakland, saw my name in lights in Orinda, endured seven counts of epidermal surgery in San Francisco, and checked in with the savvy folks at **W. R. Hambrecht & Co.** to find a way for subscribers to partake of telecosmic IPOs as an "affinity group." This is the company of Bill Hambrecht, formerly a venture titan at **Hambrecht & Quist**, now set on transforming the world of technology IPOs. You might want to help him. I do.

Things were hopping at all the companies I encountered. Although my good partners at Forbes ambushed me on TeraBeam, I found it exhilarating to face friendly fire and be missed entirely. With the transformation of chief rival **Lucent** (LU) Optic Air into a passionate collaborator, TeraBeam has emerged as an even more devastating player than I had thought. Its initial manufacturing ally—the infamous "mystery company"—got rolled over by an offer from Lucent 15 times better financially and hugely superior in every other way.

Before visiting the company, Lucent was bent on competing with TeraBeam. A week after, Lucent actually wired $400 million to TeraBeam's bank. Blown off the list are **Teligent** (TGNT), **Nextlink** (NXLK), and all other ghosts of microwave multipoint radios. But the source of TeraBeam's crucial 5-watt Erbium Doped Fiber Amplifiers (EDFAs), **IPG Photonics** of Sturbridge, Mass. (watch this space for the IPO plans), seems more attractive than ever. And **Meade Instruments Corporation** (MEAD)—discovered in a European patent search by members of our own Forum at www.gildertech.com—is indeed assured of an expanding market for its telescope lenses. TeraBeam is rumored to have two IPOs planned later this year—one by the manufacturing arm 30 percent owned by Lucent and the other by the service company, TeraBeam proper, rolling out in some 100 cities around the globe.

Apart from the sad fate of TeraBeam's competitors, I saw nothing at any of my companies to justify a collapse of their values. **Mirror Image** (XLA) might have been treated like trash in the market crash,

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but Exodus, the data warehouse leader, has recently invested $600 million in the company and is deploying its technology. Optic companies, such as **JDS Uniphase** (JDSU), chip companies such as **TI** (TXN) and **Atmel** (ATML), server paragon Sun Microsystems, and semiconductor equipment firms such as **Applied Materials** (AMAT) are struggling desperately with too much demand. MMC is doing 10 gigabits per second on a single chip and Blaze is reducing gigabit Ethernet to cheap silicon. The Telecosm is bursting at the seams.

The key problem, as Brian Wesbury shows in his research report, is that Alan Greenspan inverted the yield curve, creating the largest negative spread in real interest rates between 2-year and 10-year Treasuries since 1981. Triggered by this event and by unexpectedly large capital gains tax bills due on April 17, the Wall Street slide was mostly unrelated to anything happening at our companies. Yes, I know what happened in 1982 (unlike today, a time of runaway inflation). I also know what happened between 1983 and 2000. It did not pay to lose your head and rush for cover in 1981.

The Avanex PowerMux is the single most promising new product in the industry.

Bouncing from booming computer company to overbooked chip vendor, I felt like a pinball, as everywhere I landed lights went off and bells rang. But of all the companies I saw, my most inspiring and edifying time was spent at **Avanex** (AVNX) in Fremont, California. However hard it may be to focus in the midst of downward flight, I suggest that you steer your parachute toward its polychrome photonic trampoline, deployed in two buildings with close to 150,000 square feet of manufacturing space at Encyclopedia Circle.

The Avanex abundance

The name Avanex will be familiar to most of you. Some of you who bought its shares in the aftermath of its $14 billion IPO may be ruing the ruinous day you learned it. But you can be assured that in those buildings, replete with some 450 animated Asian workers, you can find some of the most creative minds in all optics and the single most promising new product in the industry, the Avanex PowerMux or symmetrical multiplexer-demultiplexer.

This device performs the vital function of taking bit streams from many wavelength sources, combining these wavelengths at one end, and sending them simultaneously down a single fiber. At the other end, it takes these same wavelengths and separates them, along with their bit streams, so they can be sent to their destinations. Unlike most mux-demux devices, the Avanex processor is scalable and adaptable. It can handle virtually any bitrate, any number of wavelengths, and any spacing between wavelengths. In other words, unlike the products of its competitors, it is not restricted to a fixed set of capabilities that maximize only the gross capacity of the fiber. Instead, PowerMux maximizes the flexibility and adaptability of the network. The principle behind the PowerMux could recreate today's network, consummating the silent revolution launched by WDM, reversing the thirty year progress of packet switching, restoring the elegant luxury of circuits, but now enriched many million-fold by the power of light.

The key to every new economic era is a canonical abundance. Companies prevail by wasting it. During the transistor age, companies that husbanded transistors—designing them carefully and implanting each one at the optimal spot on the microchip—lost out to companies that wasted transistors. Rather than honing single transistors to run ever faster, the winners accelerated chip design to launch new products ever faster, and squandered transistors as if there were no tomorrow.

Tomorrow is now here for semiconductors, with the exacting new demands of copper interconnects, fluoride silicate glass insulation, system-on-a-chip design methods, and other exquisitely challenging new technologies. The transformation of wafer fabrication makes key players of semiconductor capital equipment companies such as Applied Materials. In a world of handheld teleputers, the focus is on combining many elements of intellectual property and different signal forms on a low-powered single chip system. What was abundant before—power and silicon area—is scarce today. From **National Semiconductor** (NSM) and **Xilinx** (XLNX) to the newly modish **Transmeta**, nearly all the leading chip firms are economizing on power and silicon rather than wasting them as before.

Today the ascendant technology is optics and the canonical abundance is bandwidth. Companies focused on jamming more and more information packets down a single-lane bit-stream—as if there were no bandwidth to spare—will lose to companies that waste bandwidth in order to build capacious multilane highways with each lane running well below capacity.

For lanes, think wavelengths or lambdas. The networks of the future will rarely need lightpaths that can bear the Net traffic of entire cities on a single beam. What the new networks will soon require is millions of addressable colors of infrared light. Each one will constitute a potential circuit connection between one terminal and another, just as your telephone creates a circuit connection between one user and another.

This mandate is difficult for most experts in the industry to grasp because it seems to reverse every important advance in networking over the past three decades. The leaders of telephony came of age years ago in an environment of bandwidth abundance, at least when measured against the modest demands of voice. They wasted bandwidth as a matter of course. Most of the capacity of a telephone network lay fallow more than 95 percent of the time as people used their phones an average of 20 minutes a day. In a world of bandwidth abundance, circuit switching—connecting the two parties over a line devoted entirely to their call—made sense.

Only connect

As the Internet rose and data became dominant, however, computers remained on line for many hours at a time. Even as absolute bandwidth soared, it grew more scarce relative to demand and the phone companies were beset with complaints of bandwidth bottlenecks. Changing their entire approach to network economics, the masters of telecom in the 1990s had to learn how to economize on bandwidth. From Bell Labs, they learned the secrets of statistical multiplexing, combining many calls onto a single long-distance connection. Then from the Internet, they laboriously learned the rules of packet switching, cutting up every message into many packets each bearing a separate address. While a circuit switched phone network sets up the call in hundreds of milliseconds, a packet switched network functions like a multi-megahertz post office. The envelopes are switched not in minutes or even milliseconds but in microseconds.

Finally, telephone and data network engineers have definitively learned the superiority of packet switching. Vinton Cerf of **MCI WorldCom** (WCOM), the co-inventor of the Internet Packet protocol, TCP-IP, gives out an off-color T-shirt emblazoned triumphally: *IP on everything.* But if Cerf's company is to stay in the Telecosm, it will have to learn to restrict its IP processing to the appropriate places—on the edges of the network.

The new optics is turning the entire world of networks upside down once again. Wavelength division multiplexing, which sends many colors of light down a single fiber thread, is ushering in a tide of fabulous bandwidth abundance. Back to the drawing board one more time folks. In a world of bandwidth abundance, bandwidth-wasting circuits become ideal once again. Rather than economizing on bandwidth by chopping everything into packets and multiplexing them into time slots, the mandate is to waste bandwidth. As in the old telephone system, the best approach is circuits. In this case, the system software sets up wavelength circuits between terminals at the edge of the fiber network. At first these terminals will be giant Juniper or Cisco routers in Internet hubs and data warehouses, where the wavelengths are finally converted back into packets or launched into the fiber "cloud." But the reach of wavelength circuits will steadily expand into metropolitan networks, across corporate campuses, and finally into enterprises and even neighborhoods. Many of the giant routers will go away.

Nortel's stunt

This regime of bandwidth abundance favors companies that multiply the scarce resource—lambdas (wavelengths)—and squander the abundant resource, bandwidth. The principal company pioneering and enabling this new regime is Avanex. We greatly admire **Nortel** (NT), but their announcement of a system with 80 wavelengths each bearing 80 gigabits of information is a stunt rather than a product. If you send 6.4 terabits down single thread in a second—roughly as much as the total average traffic of the world's telecom infrastructure—you have accomplished nothing unless you can distribute the bits to the right addresses at that speed. You are in the position of a pitcher who can only throw the ball a thousand miles an hour. Amazing as a stunt but hard on catchers. The optical all-stars will have to mix (or mux) their pitches. They will need Avanex's PowerMux, which promises to deliver "any number of wavelengths, at any spacing, at any bitrate."

At the helm of Avanex is a 38 year old with more than 36 optical patents named Simon Cao, one of the leading figures in the history of optics. Having smoothly disbanded the company's distracting software arm, Walter Alessandrini is a capable and decisive CEO. But it is Cao who creates and manages the technology.

In 1993 at **E-Tek Dynamics** (ETEK) (now merging with JDS Uniphase), Cao helped develop the first WDM system, a 2-channel affair based on a thin film filter he engineered. Working with Pirelli of Italy, he then proceeded to create the key components for a 4-channel system based on the first EDFAs. An amplifier that rendered WDM efficient by boosting all the wavelengths at once, the EDFA was enabled by Cao's ingenious isolators. These devices combine polarization effects with filters to keep the light going in one direction rather than being partly reflected. In 1996, still at E-Tek, Cao contributed crucial components to Alcatel's 32-wavelength system.

In 1997, Cao left E-Tek to help found Avanex and launch his new inventions, led by the PowerMux. Until the Avanex device, optical suppliers such as Lucent and JDS Uniphase created multiplexing gear using devices called gratings that operate in the spacial domain. The new director of Research and Development at Avanex is Giovanni Barbarossa, who worked on these gratings at Lucent and came to see their limitations. These have to manipulate wavelengths differing by billionths of a meter (nanometers) in size. By contrast, the PowerMux operates in the frequency domain. It manipulates colors of infrared light billions of cycles a second apart. For example, a wavelength of 1550 nanometers (1.55 thousandths of a millimeter), typical in WDM systems, travels through a point in space at a frequency of approximately 194,000 gigahertz or 194,000 billion cycles per second. For longer wavelengths, the frequency decreases since the number of cycles that can pass through a point every second at the constant speed of light will decrease. Shorter wavelengths have higher frequencies. At 1550 nanometers, a mere 1 nanometer change in wavelength results in a change in frequency of 133 gigahertz—133 billion cycles per second. Clearly, it is easier to separate frequencies billions of cycles a second apart than their corresponding wavelengths only small fractions of nanometers apart.

Cao's paradigmatic dream is a network of optical highways that does not have to be switched at all.

Avanex's 800 lambdas

Once a particular spacing is set, the PowerMux is a periodic processor that automatically sets up the channels at the correct gigahertz spacing. The tighter the spacing, the more wavelengths you can fit on a fiber. At OFC Avanex demonstrated 800 channels spaced 12.5 gigahertz, or only 0.1 nanometer, apart. This was accomplished in the frequency domain. Barbarossa doubts that other companies can achieve such spacing as reliably and robustly in the nanometer domain of wavelengths.

What gives Avanex a decisive edge over its rivals is its

THE OTHER SIDE OF LUCENT

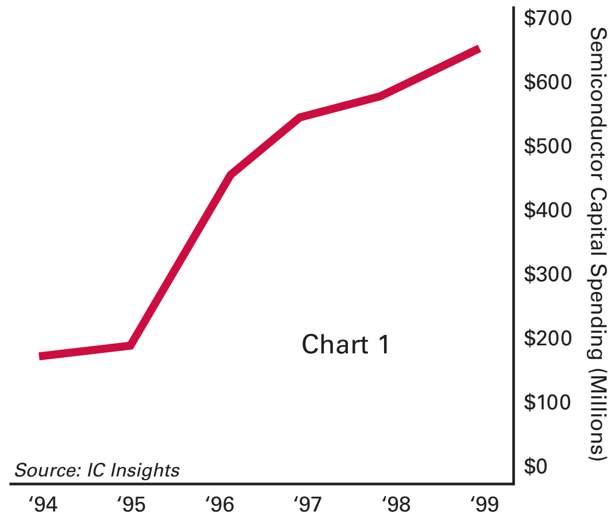
Most GTR readers probably know Lucent is the world leader in fiber optics equipment sales. But LU is also a leader in communications chips, one of the leading suppliers of semi-conductors to the Telecosm. In fact, Lucent's $3.275 billion in semiconductor revenues for 1999 topped by 85 percent its estimated $1.76 billion in fiber optics equipment sales.

Crucial has been Lucent's combination of aggressive capital spending and technology focus. Lucent more than doubled semiconductor capital spending even during the 1996 downturn and has continued since (Chart 1).

But Lucent has also focused on key technologies for the Telecosm, last year placing second only to consummately focused TI in Digital Signal Processors (DSPs) with 26 percent market share, double 3rd place Motorola. In ASICs (application specific integrated circuits) LU was number two to IBM, counting both merchant and captive sales (Charts 2 & 3).

Intel dominates North American chip sales, but is struggling with communications devices. Thus Telecosm companies take 10 of the top 14 spots with a combined $24 billion in sales nearly equal to Intel's $25 billion (Chart 4).

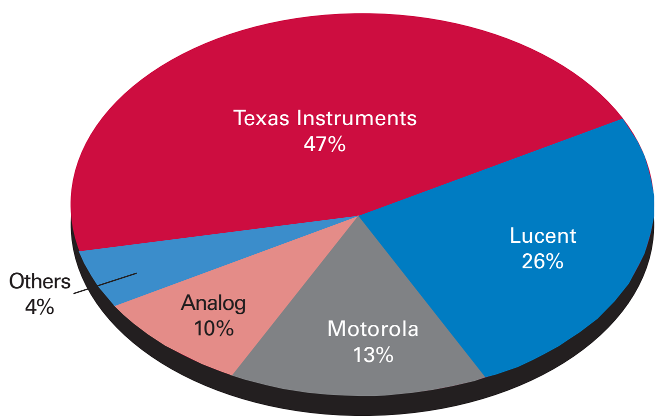
LUCENT BOOSTED SEMI CAPITAL SPENDING EVEN IN '96/'98 MARKET DOWNTURN



THE AVIS OF COMMUNICATIONS CHIPS

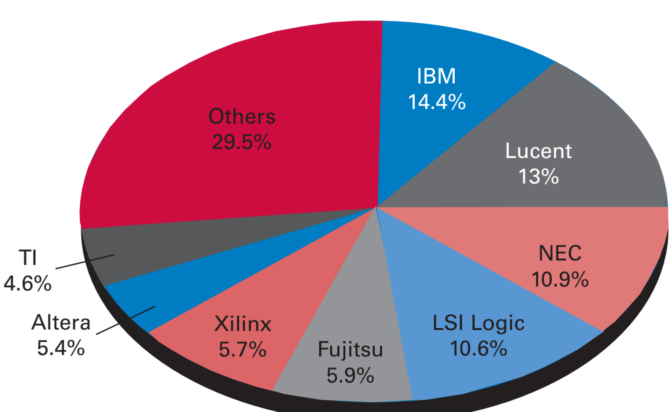
1999 DSP Market Share

Chart 2



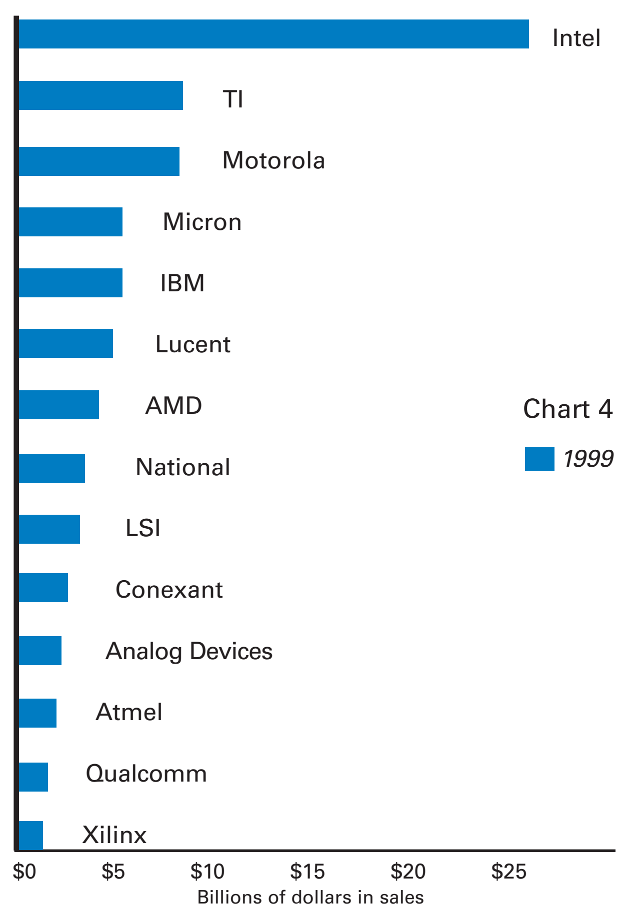
1999 ASIC Market Share

Chart 3



Source: IC Insights

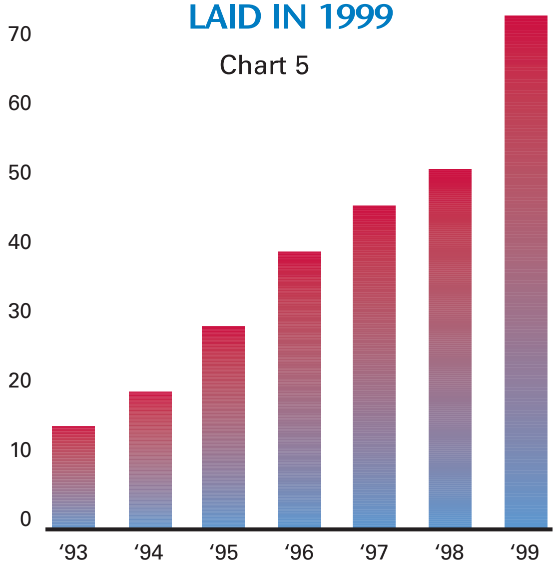
TEN OF THE TOP 14 AMERICAN CHIP MAKERS ARE TELECOSM COMPANIES



Source: IC Insights

HOW BIG WILL THE TELECOSM BE?

70 MILLION KM OF FIBER LAID IN 1999



Source: Corning

How big are the markets for the PowerMux, optical cross connect, and all the other crucial drivers of the all-optical network? We don't do projections, but 1999 saw the most dramatic build out of the Telecosm yet. Worldwide deployment of fiber surged 42 percent, with more than 70 million kilometers of new fiber laid (Chart 5).

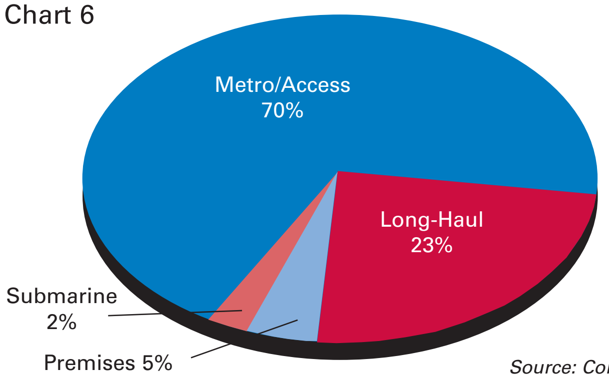
Long-haul, point-to-point links dominated early fiber installations. But 70 percent now goes to metro and access networks (Chart 6). That figure will continue to grow, changing the mix of component sales. Happily for JDSU and SDL, and increasingly Corning and IPG, the amplifier market will continue to explode. Sales of dispersion compensators, already surprisingly strong, should accelerate as Avanex raises the standard and lambdas per fiber proliferate. But growth in the metro space will boost terminators and off and on ramps: transmitters/receivers, add-drops, and the mux-demuxes themselves (Charts 7 & 8).

The JDSU/E-Tek combination will account for nearly a third of the mux-demux market (Chart 9). But expect that market to re-arrange itself dramatically around the PowerMux and Simon Cao's plethora of patents.

-Ken Ehrhart

MOST FIBER NOW GOES TO METRO NETWORKS

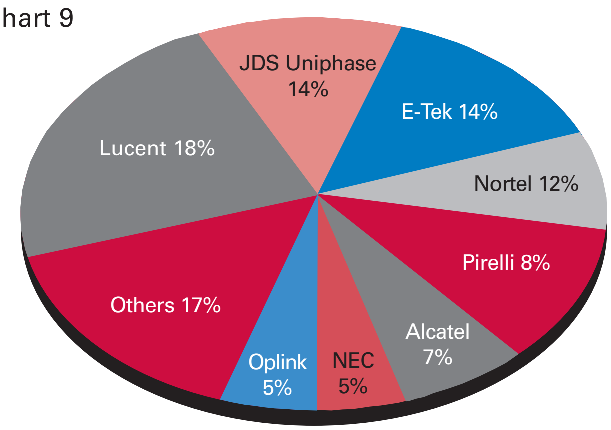
Chart 6



Source: Corning

JDSU/E-TEK COMBO LEADS MULTIPLEXOR MARKET - *FOR NOW*

Chart 9



Source: Erica Henkel, Frost & Sullivan

LONG HAUL AND METRO NETS DEMAND DIFFERENT COMPONENT MIX

Chart 7

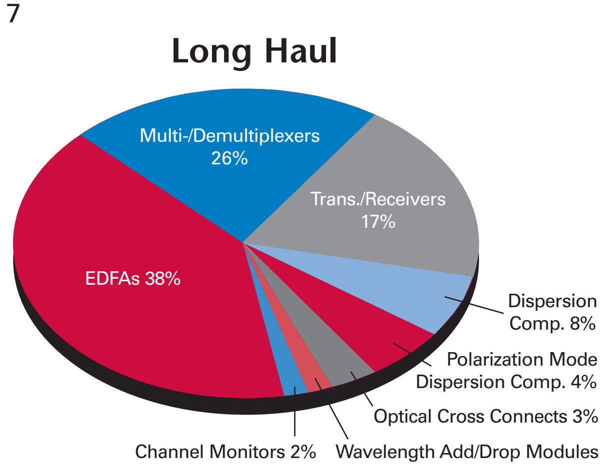
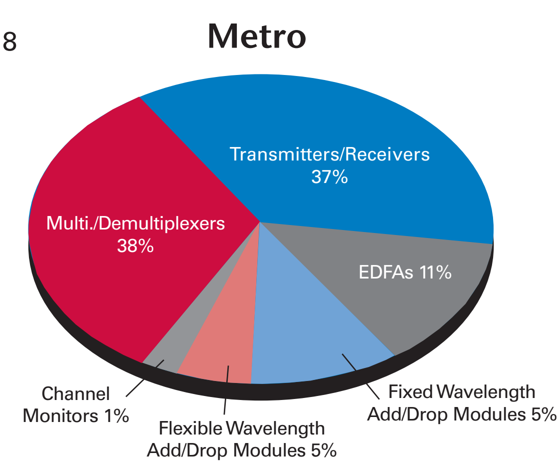


Chart 8



Source: Corning

ability to cascade its PowerMuxes in a tree and branch topology. Depending on the number of devices in the hierarchy, a particular set of wavelengths can be reduced to any arbitrary mix of spacing parameters. Within the optical power budget, this capability allows a particular set of lambdas to carry a variety of bit streams. One wavelength can bear a SONET OC-192, 10 gigabit a second stream, while another wavelength on the same fiber can carry a T-1 bitstream of 1.544 megabits a second. Opening up is a vista of truly adaptable circuit switched wavelength networks.

Using a multiple set of tiny mirrors with variable refractive indices and reflectivities in a package several cubic inches in size, the PowerMux controls the interference patterns of separate light beams. Light normally takes the form of linear sine waves. When the waves exactly coincide, the interference is *constructive*, or additive. When the peak of one wave coincides with the trough of another, the interference is *destructive*, or subtractive. By manipulating the distances between the mirrors, the PowerMux controls the patterns of the emerging light beams, creating areas of constructive and destructive interference that enable the muxing and demuxing of wavelengths as desired.

The AT&T network is about to be impaled on the cruelest dilemma facing wireless carriers today.

Better still, the PowerMux is a nonlinear interferometer—that is, it is not restricted to simple sine waves that tend to mush together (dispersion) as they flow down the fiber. Instead, the nonlinear properties of the device enable the engineer to form interference patterns that create crisp, "square" waves of light. As the word implies, "square" waves are more distinct and separate than sine waves. The bits are more readable, more robust, and more resistant to dispersion (they hold their shape longer before they mush together).

Nonlinearities are the basis also of the PowerShaper line of Avanex products that compensate for dispersion by reconstructing the "square" wave pattern at each end. Tested by **AT&T** (T), the Avanex PowerShaper compensated for dispersion over a 30 percent longer distance, and with a three orders of magnitude bit error rate improvement, compared to dispersion compensating fiber.

The PowerMux paradigm

The PowerMux mirrors' distances and reflectivities can be changed in minutes to accommodate or tune to different sets of wavelengths. This tuning speed, though slow in the world of circuit switches, is still a vast improvement over nontunable fiber Bragg gratings. And Simon Cao envisages a time when the PowerMux can be dynamically tuned in thousandths of a second, or milliseconds. Experts from the packet switching world—where millions of packets must be processed in a single second—will disdain any device that switches "only" in milliseconds. But millisecond switching is fine for setting up new circuits in an all-optical network based on lambdas.

This is Simon Cao's paradigmatic dream, a network of optical highways that does not have to be switched at all in the usual sense. Wasting bandwidth as a replacement for switching, he foresees networks in which PowerMuxes sort and shape millions of lambdas through the network. Meanwhile tunable lasers and photodetectors do the work of creating the wavelength "phone numbers." In essence, it is a return to the old topology of telco circuits. But in Cao's world, each of the wavelengths can carry the multigigabit per second streams associated with high resolution images like those now seen in digital HDTV. Circuit-based video teleconferencing can become virtually as vivid as being there.

Already joining in Cao's vision is MCI WorldCom, which has begun ordering PowerMuxes for long-haul applications. Lined up right behind MCI WorldCom are Nortel and **Qtera**, **Corning** (GLW), **Sycamore** (SCMR), **Siemens**, **Sumitomo**, and **Fujitsu**, all in various stages of ordering the PowerMux.

Like most leading edge technology players, Avanex is far from riskless. (Someone from Lucent might inadvertently drop a giant SONET add-drop multiplexer on Simon Cao's head.) Avanex is depending on a Chinese company to manufacture crucial subcomponents at a time when relations with China are fraught with political dangers. Its current manufacturing processes, like most in the world of optics, are labor intensive. At some point, all these optical companies may face disruption from below by companies such as **Bookham** (BKHM) that now make relatively primitive but functional devices on silicon wafers and benefit from the advances of the semiconductor industry. Barbarossa is correct that such devices are today neither tunable nor adaptable and thus are far inferior to Avanex's. But silicon optical waveguides may find a niche in coarse WDM products for the cable industry or enterprise networks. Clayton Christensen shows how an apparently innocuous disruption from below can ultimately usurp key markets.

In response to this kind of manufacturing challenge, Cao has mandated Barbarossa to research new ways of mass manufacturing PowerMuxes. Under Cao's technical leadership, Avanex plans to be ready for rapid change. So far in his career, Cao has been able to meet every challenge of WDM with new creativity and insight. I would bet on him for the future.

This way to the Egress

If the AT&T Wireless IPO (Irredeemably Pathetic Offering) succeeds on the scale T is predicting it will be an even more amazingly Barnumesque feat than Craig McCaw's unloading it on AT&T the first time. Inferior by far even to GSM, the European TDMA standard, AT&T's American TDMA network has no future at all. Literally. Incapable of carrying bursty Internet data at any reasonable speed, TDMA will likely never evolve into a 3G standard.

Currently U.S. TDMA carriers can offer data only on a separate Cellular Digital Packet Data (CDPD) network operating at a humble 19.2 Kbps. GSM networks now poking along at only 9.2 Kbps for data have a relatively easy and inexpensive upgrade to a "Generation 2.5" system known as GPRS, which will eventually offer data at up to 57.6 Kbps. That's paltry compared to **Qualcomm**'s (QCOM) G2.5 entry, the CDMA2000 system offering nearly triple the data rate and, unlike GPRS, allowing voice and data to use the same channels. Far from leeching voice to support data, CDMA2000 actually doubles the voice capacity of existing CDMA networks.

AT&T, however, does not even have GPRS to fall back on, since that is a GSM-only upgrade. For robust data, AT&T must wait—possibly forever—for EDGE, slated to trail CDMA2000 by at least a year, and featuring a data rate of only 384 Kbps, one sixth Qualcomm's coming HDR (High Data Rate) system. Worse yet, EDGE is not an extension of American TDMA but a separate network overlay requiring its own dedicated spectrum.

Already some three times less spectrally efficient than CDMA for voice, the AT&T network is thus about to be impaled on the cruelest dilemma facing wireless carriers today. Wireless customers increasingly will expect robust data capacity. But at a time when most wireless networks can sell all the voice minutes they can supply, dedicating channels to data is a painful and costly exercise.

CDMA2000 turns that dilemma into an opportunity as early as the end of this year, offering data while doubling voice capacity without hogging dedicated spectrum. HDR will require a dedicated channel. But at 2.4 Mbps, six times as fast as EDGE, the trade off is easier to justify.

If EDGE ever emerges from vapor, AT&T's only robust data option will require it to permanently trim voice capacity from an already inefficient system, while **Sprint PCS** (PCS) and **Bell Atlantic** (BEL)/**Vodaphone** (VOD) double voice capacity and add data for one-third the investment.

The data dilemma dooms American TDMA networks. The Bell Atlantic/Vodaphone partnership (inexplicably renamed Verizon) abruptly thrusts AT&T into a distant second place in wireless market share. T's only remaining advantages are cash, bulk, and an increasingly compromised brand. In thrall to a bankrupt technology, all three will waste away.

Departing comrades

At the GTR we deal in technology paradigms: deep rules that operate at the nexus of technology and economics and dictate which technologies and companies will succeed in the marketplace over the long term.

The Telecosm Table on our back page is first and foremost a list of those "ascendant technologies" that will triumph because they express the dominant paradigms of the current era. The companies listed in the next column over are those which best represent these technologies. They are not necessarily the only companies that do so. Faced with a choice, we look for superior execution, focus, and a grasp of the ruling paradigm suggesting management will stay on course.

Clearly such specific criteria bar from the table large numbers of outstanding companies bearing good prospects for investors. By the same token, the removal of a company from the list does not necessarily signify the collapse of its prospects. It is often not a "sell signal" any more than continuing a company on the list is a recommendation to buy at the current price.

The Telecosm Table is not a model portfolio in the ordinary sense. One reason is that if it were, we would be forced to remove paradigmatic companies whenever they appeared to be fully priced. That is not what we do. Qualcomm will stay on the list as long as CDMA is not superceded as the ascendant wireless technology and Qualcomm remains the world's premier CDMA company. To take it off in January because the share price seemed excessive and put it back on in April because the market had a migraine would undermine the purpose of the list and this letter, which is to provide long-term strategic insights for technology investors capable of making their own decisions about price and timing. We ourselves don't do price and timing, leaving that to higher level thinkers. We prefer the easy stuff like the physics of WDM. We do hear it is generally better to buy low and sell high.

Of the three companies we remove from the list this issue, **Intentia**, Teligent and Nextlink, Nextlink is the supreme example of a company whose prospects are bright. We placed Nextlink on the list when it became the largest holder of LMDS spectrum licenses. With TeraBeam on the move, LMDS has lost its ascendancy, and the specific rationale for keeping Nextlink has evaporated.

LMDS has lost its ascendancy. Teligent's happiest fate would be to acquire Greg Amadon for an owner.

While TeraBeam competes with Nextlink and Teligent in the service arena, however, the manufacturing venture with Lucent eventually may sell TeraBeam boxes to all comers. Nextlink owns rights to 25 percent of the **Level 3** (LVLT) national network and has downtown fiber connections to 1320 buildings in 49 cities. Above all Nextlink has Craig McCaw whose entrepreneurial panache has made him a giant of the Telecosm, despite his occasional bent for backward technologies, such as AT&T's TDMA wireless.

Teligent departs for the same reason as Nextlink. Like Nextlink it has more arrows in its quiver than just LMDS. Its happiest fate would be to acquire Greg Amadon as an owner.

Intentia is on the list for its leadership in applying Java to the challenge of Net-based enterprise software. But Java's success is now so widespread that it seems misleading to designate any single practitioner as paradigmatic. Moreover, Intentia's Java rollout is still six months hence. Thinly traded, still chiefly a European company in part because of American growth slower than we expected, it is also difficult to track from the U.S. Keeping it on the list is no longer a service to our readers. The Java paradigm is more than adequately represented by its inventors, our friends at Sun. One of our earliest ascendant companies, Sun, on our recent visit, seemed more resplendent than ever, with a 35 percent rise in year-to-year revenues, a 48 percent jump in earnings, nearly two million Java developers, and Scott McNealy close to geosynchronous orbit.

- George Gilder
April 20, 2000

TELECOSM TECHNOLOGIES

ASCENDANT TECHNOLOGY	COMPANY (SYMBOL)	REFERENCE DATE	/ PRICE	MAR-'00: MONTH END	52 WEEK RANGE	MARKET CAP
WINGS OF LIGHT						
Wireless, Fiber Optic Telecom Chips, Equipment, Systems	Lucent (LU)	11/7/96	11 25/32	62	49 13/16 - 84 3/16	163.7B
Wave Division Multiplexing (WDM) Systems, Components	Ciena (CIEN)	10/9/98	8 9/16	126 1/8	16 5/8 - 189	17.7B
Wireless, Fiber Optic, Cable Equipment, Systems	Nortel (NT)	11/3/97	23	126	31 5/8 - 144 3/16	171.6B
Optical Fiber, Photonic Components	Corning (GLW)	5/1/98	40 15/16	194	47 11/16 - 226 7/16	53.5B
Wave Division Multiplexing (WDM) Components	JDS Uniphase (JDSU)	6/27/97	3 5/8†	120 9/16	12 13/16 - 153 3/8	85.9B
Adaptive Photonic Processors	Avanex (AVNX)	3/31/00	151 3/4	151 3/4	47 3/8 - 273 1/2	9.5B
THE LONGEST MILE						
Cable Modem Chipsets	Broadcom (BRCM)	4/17/98	6 *	242 7/8	29 - 253	51.9B
S-CDMA Cable Modems	Terayon (TERN)	12/3/98	31 5/8	205	26 15/16 - 285 1/8	4.5B
Linear CDMA Power Amplifiers, Cable Modems	Conexant (CNXT)	3/31/99	13 27/32	71	12 5/8 - 90 3/8	14.4B
THE TETHERLESS TELECOSM						
Satellite Technology	Loral (LOR)	7/30/99	18 7/8	10 3/16	9 7/8 - 25 3/4	2.5B
Low Earth Orbit Satellite (LEOS) Wireless Transmission	Globalstar (GSTRF)	8/29/96	11 7/8	13 7/8	12 13/16 - 53 3/4	1.3B
Code Division Multiple Access (CDMA) Chips, Phones	Qualcomm (QCOM)	7/19/96	4 3/4	149 5/16	15 3/8 - 200	105.7B
Nationwide CDMA Wireless Network	Sprint (PCS)	12/3/98	7 3/16	65 1/2	20 3/4 - 66 13/16	59.9B
CDMA Handsets and Broadband Innovations	Motorola (MOT)	2/29/00	172	144	73 3/4 - 184 5/8	103.3B
THE GLOBAL NETWORK						
Broadband Fiber Network	Level 3 (LVLT)	4/3/98	31 1/4	105 3/4	45 1/4 - 132 1/4	38.3B
Broadband Fiber Network	Metromedia (MFNX)	9/30/99	24 1/2	96 3/4	21 1/8 - 103 3/4	26.1B
Submarine Fiber Optic Network	Global Crossing (GBLX)	10/30/98	14 13/16	40 15/16	20 1/4 - 64 1/4	32.8B
Broadband Fiber Network	Northeast Optic (NOPT)	6/30/99	15 1/16	84 9/16	13 1/2 - 159	1.4B
Telecommunications Networks, Internet Access	MCI Worldcom (WCOM)	8/29/97	19 61/64	45 5/16	40 5/8 - 64 1/2	129.4B
CACHE AND CARRY						
Directory, Network Storage	Novell (NOVL)	11/30/99	19 1/2	28 5/8	16 1/16 - 44 9/16	9.4B
Java Programming Language, Internet Servers	Sun Microsystems (SUNW)	8/13/96	13 3/4	93 45/64	24 7/8 - 106 3/4	163.7B
Network Storage and Caching Solutions	Mirror Image (XLA)	1/31/00	58†	162	1 3/16 - 225	8.6B
THE MICROCOSM						
Analog, Digital, and Mixed Signal Processors	Analog Devices (ADI)	7/31/97	11 3/16†	80 1/2	15 15/16 - 94 11/16	28.5B
Silicon Germanium (SiGe) Based Photonic Devices	Applied Micro Circuits (AMCC)	7/31/98	5 43/64†	150 1/16	10 1/4 - 158 7/8	17.8B
Programming Logic, SiGe, Single-Chip Systems	Atmel (ATML)	4/3/98	8 27/32	51 5/8	8 1/2 - 61 3/8	11.4B
Digital Video Codes	C-Cube (CUBE)	4/25/97	23	72 13/16	18 1/2 - 106 1/4	3.0B
Single-Chip ASIC Systems, CDMA Chip Sets	LSI Logic (LSI)	7/31/97	31 1/2	72 3/4	15 3/8 - 90 3/8	22.0B
Single-Chip Systems, Silicon Germanium (SiGe) Chips	National Semiconductor (NSM)	7/31/97	31 1/2	60 3/4	8 7/8 - 85 15/16	10.5B
Analog, Digital, and Mixed Signal Processors, Micromirrors	Texas Instruments (TXN)	11/7/96	11 7/8	160	49 1/2 - 199 9/16	130.1B
Field Programmable Gate Arrays (FPGAs)	Xilinx (XLNX)	10/25/96	8 7/32	82 13/16	19 1/2 - 88 7/16	26.6B

Added to the Table: Avanex **Removed from the Table: Intentia, Nextlink, & Teligent**

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† SPLIT ADJUSTED THIS ISSUE

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Gilder Technology Report
Published by Gilder Publishing and Forbes Inc.
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TELECOSM TECHNOLOGIES

ASCENDANT TECHNOLOGY	COMPANY (SYMBOL)	REFERENCE DATE	/ PRICE	MAR-'00: MONTH END	52 WEEK RANGE	MARKET CAP
WINGS OF LIGHT						
Wireless, Fiber Optic Telecom Chips, Equipment, Systems	Lucent (LU)	11/7/96	11 25/32	62	49 13/16 - 84 3/16	163.7B
Wave Division Multiplexing (WDM) Systems, Components	Ciena (CIEN)	10/9/98	8 9/16	126 1/8	16 5/8 - 189	17.7B
Wireless, Fiber Optic, Cable Equipment, Systems	Nortel (NT)	11/3/97	23	126	31 5/8 - 144 3/16	171.6B
Optical Fiber, Photonic Components	Corning (GLW)	5/1/98	40 15/16	194	47 11/16 - 226 7/16	53.5B
Wave Division Multiplexing (WDM) Components	JDS Uniphase (JDSU)	6/27/97	3 5/8†	120 9/16	12 13/16 - 153 3/8	85.9B
Adaptive Photonic Processors	Avanex (AVNX)	3/31/00	151 3/4	151 3/4	47 3/8 - 273 1/2	9.5B
THE LONGEST MILE						
Cable Modem Chipsets	Broadcom (BRCM)	4/17/98	6 *	242 7/8	29 - 253	51.9B
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