GILDER
TECHNOLOGY
REPORT

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Life After Television

Terayon enjoys a six-month lead on chip competitors Broadcom and TI and has even more of a jump on its chief head-end competitor Cisco. It also trades at a radically lower multiple than its semiconductor peers.

Inside:

From the National Association of Broadcasters in Washington to a conference of NewsCorp on Heyman Island in Australia, they laughed when I waved my arms and recited the theme of a chapter of my 1989 book *Microcosm*, predicting "The Death of Television." They yawned when I parlayed it into a book the next year called *Life After Television*. Those were the days when the broadcasters ruled the air and imagined that the fumes of their programming and advertising smelled like roses along the road to the future rather than the fragrant residue of horses and buggies.

Television, so I said, was a top-down, lowest-common-denominator broadcast system attempting to extend a paradigm of dumb-terminals or boob tubes into a world of ever-smarter computers. It would die. They took me aside and confided in a whisper that "of course it was a boob tube—because the people are boobs." The broadcast execs knew it—"from market surveys."

I continued year after year to make my case. Advances in digital processing power—the already familiar Moore's law—would converge with a newer, less heralded, but even more heroic expansion of fiber optic networks to yield a "worldwide web of glass and light" with smart terminals at the edge. With vast gains in the viewer's control over both timing and content, the longstanding top-down, master-slave, couch-potato culture would give way to a world of pullulating variety, choice, and intelligent interactivity.

As I have been saying for more than a decade, this vision is coming true, "any day now." In 2002, at last, you can watch it unfold. Driven by chips and optics, the Internet has already displaced television as our chief *information* medium. Now yet another technology—one that I utterly failed to foresee in the 1980s—is spurring the disruption of television as an *entertainment* medium. With the slower-than-expected roll-out of last-mile broadband connections, hard-disk data is emerging as the real TV killer. With the cost per megabyte of storage dropping a thousandfold since the mid-1990s—from a dollar a megabyte to a dollar a gigabyte—low-cost hard-drives now enable consumer-class devices such as **TiVo** (TIVO) or ReplayTV that can store, shift, and de-louse weeks-worth of video. TiVo's mid-market digital video recorder (DVR) handles 30 hours of video on a 30 gigabyte drive, while **SonicBlue**'s (SBLU) newest ReplayTV box harbors up to 320 hours worth on a 320 GB drive.

The huge bandwidth advantages of cable and satellite have been slowly transforming broadcast television for three decades. But while they greatly expanded choices, they did not address even more important issues: *flexibility* and *time*. Given that the customer's time is the ultimate scarcity in today's world, real choice isn't just choosing *what* to watch, but *when* to watch.

Video-on-demand offerings from the cable companies—**Comcast** (CMCSK), **Cox** (COX), **Charter** (CHTR), **Cablevision** (CVC)—only minimally fulfill this concept of choice. You can select a limited assortment of movie titles usually rotated weekly and played at pre-set times. Two years ago TiVo broke through the boundaries of both content and time by wasting cheap digital storage. Record anything (or everything), and watch it at any time, with no commercials and no clumsy VCR tapes.

Now SonicBlue's ReplayTV is taking the concept one step further by enabling users with broadband connections to share video over the Internet. This move sparked a lawsuit from Hollywood and a court order that SonicBlue must keep detailed records of each

customer's viewing, storing, and sharing habits. Fortunately, the mandate was just overturned on appeal, but SonicBlue, and Napster before it, have jolted Hollywood and Madison Avenue. The Motion Picture Association of America has even put out a white paper suggesting a law requiring all the world's analog-to-digital converters (present in virtually every digital device that links to the real world) be equipped with a special "cop chip" to police everything you watch, read, and hear.

The guts of TiVo's and SonicBlue's products are already contained in other common household appliances

Like the **Xerox** (XRX) machine, the VCR, and Napster, the threat of hard-drives and software has blinded the content world to how these inventions could expand its markets. It continues the fight to crack down on its best customers.

It's easy to see why. Seventy percent of digital video recorder (DVR) users report they use their machines to skip commercials, which today consume more than one-quarter of all airtime. Forrester Research predicts 58 million DVRs will be in American homes by 2005. That means traditional advertisers will reach some 40 million fewer households within three years. Moreover, these early DVR adopters surely comprise the most-sought-after advertising demographic. I said it twelve years ago: The current broadcast advertising model is dead.

Though DVRs are sure to be popular—close to a million were sold through May—TiVo's and SonicBlue's prospects are uncertain. The guts of their products are already contained in other common household appliances.

The PC already has a hard-drive. Today a stand-alone 120 gigabyte drive capable of storing some 120 hours of video costs $109. With a little software, the PC can easily double as a digital video recorder. **Sony**'s (SNE) latest Vaio desktop does just that. Sony is also the first company to integrate DVR functionality into a cable set-top box, which will soon be available to Cablevision customers, and **Motorola** (MOT) and **Scientific-Atlanta** (SFA) are right behind. Although TiVo has achieved 45 percent of its sales (200 thousand units) through its partnership with DirecTV, it's doubtful satellite subscribers will continue to want or need two distinct boxes. Satellite set-top boxes, which unlike cable boxes have the advantage of being all-digital, are already swallowing TiVo's DVR capabilities. Unless TiVo and SonicBlue can master a software licensing model, it is unlikely they will succeed as companies. Not with PC makers like Sony and **Dell** (DELL), set-top box kings Scientific Atlanta and Motorola—and **Microsoft** (MSFT) (can Bill Gates's X-Box be far behind?)—squeezing them in the hardware arena.

Regardless, TiVo and SonicBlue give us a glimpse of life after television. And none too soon….

Light traffic

Imagine that between now and December, carriers needed to install and light the equivalent of 14,840 **Corvis** (CORV) 160 lambda WDM systems to accommodate seismic traffic growth over backbone links.

During the headiest days of network expansion—the late 1990s—so bizarre a prediction would have invited derision. Yet, at that very time, many in the industry were unwittingly scripting such an Internet flood for the second half of 2002. The advent of browsers and the World Wide Web propelled Internet traffic to a doubling every three to four months, for 100 times growth from December 1994 to December 1996. Had the trend continued, even at a declining rate as assumed by us and other observers, the 1.5 petabytes (a thousand trillion bytes) that crossed U.S. Internet backbones during December 1996 would have swollen to massive dimensions. The mid-1990s trend would have brought traffic to between 300,000 and 474,342 petabytes this month and a million to 1.5 million petabytes by December. Multiply these aggregate monthly values by 8 to get traffic in bits and divide by 2.6 million seconds per month for bit rate, and we would project a data deluge of 1,464 Tbps (terabits or trillions of bits per second) today and 4,630 Tbps by year's end.

That's the *average* bit rate, based on uniform data flows. But in datacom, sudden traffic bursts can swell to six times the average bit rate. Accommodating rush hour, when peak bit rates exceed 80 percent of lit capacity and performance sharply degrades, capacity must be 25 percent above the 6-times peak rate. By December, with 4,630 Tbps average traffic, we'd require 3,472,500 lambdas or 21,703 Corvis systems, an increase of 14,840 systems in just six months.

Forget it. As reported in last month's GTR, since that surge ended in December 1996, Internet backbone traffic has been approximately doubling annually. Of the reputable studies confirming this trend, **RHK** gives us the highest estimate of U.S. monthly backbone traffic—100 petabytes last December. (On the low end, Larry Roberts of **Caspian Networks** estimates 50 petabytes.) Running with RHK for the moment and assuming traffic growth holds, we should reach 141 petabytes this month and 200 petabytes by December.

Repeating the calculations performed on the previous example, including an accounting for 6:1 traffic spikes and the necessary 25 percent overbuild to maintain minimally-acceptable quality of service, we discover that 3.3 Tbps of bandwidth could carry this month's core Internet traffic. That's equal to 330 lambdas, each 10 gigabits per second—three Corvis systems (two fully-lit systems plus 10 lambdas). By December, assuming 200 petabytes of traffic, we could do it with 460 lambdas, still handled by three Corvis systems. If traffic continues to double annually, by December 2003, six systems (900 lambdas) suffice, an increase of three systems over the year. By December 2004, we're up to 1,800 lambdas or twelve systems, an increase of six. Or, if Roberts is right—he estimates half the traffic of RHK—the bandwidth in a mere six Corvis systems could transport all core Internet bits by December 2004. Since the average connection length in North America is

about 2,300 kilometers or half the cross-continent distance, perhaps we will need to light only three fibers per link instead of six, based on Roberts's figures.

Actually, it's not *quite* so bad for equipment manufacturers and their components suppliers. We have been examining backbone traffic in the U.S. only. More than half of Internet traffic originates abroad. China is coming on strong; they will need lambdas too. Back in this country, most of the traffic keeps to metropolitan areas, which require their own networks in addition to the Corvis backbone links. Furthermore, even after the carrier carnage, more than one or two carriers will remain, each maintaining and upgrading various networks of its own. **Broadwing** (BRW), which has not lit all of its Corvis lambdas, is already contemplating network expansion into Florida. In addition, average traffic over lit lambdas will continue to decrease as carriers waste more and more bandwidth to drive switches and electronics from their networks, lowering precious overhead and remaining solvent. So, several hundred lambdas really *won't* do. We'll need a few more.

How many more is not the point. Our order-of-magnitude calculations tell us that if today's Internet backbone traffic doubles annually over the next several years—a growth rate that has roughly prevailed since 1997—the additional traffic through 2004 will require extra backbone bandwidth *on the order of* the total capacity of a few Corvis systems. With surplus carriers going bankrupt, freeing up their networks, this does not make for a robust economic model.

Bandwidth or spanwidth

But don't despair, just yet. In the mid-1990s, all sensible people knew that Internet traffic would forever double year over year, even as it was growing at 5 times that pace. By the late '90s, extreme expansionism became chic, though traffic growth had already tumbled back to its pre-1995 pace. Now we project the dot.com doldrums on into the future. Yet all such projections are doubtful. The average last mile link now stands at less than 100 kilobits per second. But the average *wireless* local area network (802.11b) operates at four or five megabits a second after overhead, and the next generation (802.11a-x) will carry 30 megabits per second or more in its 54-megabit stream. With more than a million already deployed, these wireless LANs are the fastest growing technology in networking. Meanwhile, wire-line local area networks are moving from 10-100 Ethernet cards to gigabit per second Ethernets. Though the dream of rapid deployment of gigabit Ethernet throughout the metro has come a cropper with the bankruptcies of **Yipes** and **Metromedia Fiber** and with the collapse of the **Cogent** (COI) and **Telseon** business models, the potential remains alive for better-capitalized companies to pursue. All the incumbent local exchange carriers (ILECs)—the generic name for the once "Baby" Bells—are now sampling gigabit Ethernet equipment. With most of the competitive local exchange carriers (CLECs) near bankruptcy, the now geriatric Bells might seem unlikely to venture into new technologies. But there are powerful reasons for the Bells to ply various forms of Viagra in the local loop. Those reasons are cable and satellite.

Cable's promise goes far beyond trumping satellite. It has become a dire threat to the Baby Bells as well.

In the early 1990s, I wrote a cover story for *Forbes* titled "Why Cable Will Win." Published at a time when cable revenues were one-tenth of telco revenues and cable profits were non-existent, I based my confidence on the greater bandwidth of coax, which I estimated to be potentially 80 thousand times the bandwidth of the twisted pair lines that comprise the copper cage of the RBOCs (regional bell operating companies). Key to unlocking the bandwidth of cable was the transition to digital transport. While analog capacity of coax was some 370 megahertz at the time—some 60 analog one-way TV channels—CableLabs had demonstrated the possibility of sending 8 gigabits per second of two way digital data over it. At the time, the capacity of twisted pair dialup was estimated to top off at about 100 kilobits or so. Thus came the 80 thousand estimate. Now various forms of digital subscriber line technology have raised the capacity of telco copper to a megabit or so, while the cable potential now has been demonstrated to reach tens of gigabits per second. Cable's potential last mile bandwidth remains more than ten-thousandfold greater than the bandwidth of the telcos.

If bandwidth is king, why are cable company stock prices in the doldrums? One answer is *spanwidth*. When I predicted that cable would win, satellites had yet to emerge as an important rival. While cable companies offer more bandwidth per customer, satellite companies offer a hugely more cost effective broadcast technology. Just three satellites can spray the entire surface of the earth with 500 channels of broadcast video. The **Hughes** (GMH) Ku-band 601 HB satellite, for example, commands 22 transponders that each transmit 36 megahertz signals. At two bits per hertz modulation, one satellite can issue a continuous broadcast stream of 1.58 gigabits per second (some 500 video channels at 3 Mbps) to 100 million homes in the U.S. at a total capital cost of some $300 million, including launch and insurance. For every home passed, that comes to less than two-tenths of a cent per megabit per second. The comparable cable cost is nine cents, some 45 times more. Satellite's spanwidth edge will expand with the deployment of new Ka-band satellites that can increase the bandwidth of a satellite to roughly the same level as cable's current 4.5 gigabits per second.

Although the 250-millisecond delay to a satellite sharply compromises its usefulness for interactive media, whether voice phone calls or games, satellite companies can collaborate with telcos and other terrestrial players to offer two-way services. For example, satellite companies could join with new 802.11 wireless vendors to provide a two-

TELECOSM TECHNOLOGIES

JDS Uniphase (JDSU)

ACTIVE AND PASSIVE OPTICAL COMPONENTS

MAY '02 MONTH END: 10.70 | 52-WEEK RANGE: 2.70 - 16.45 | MARKET CAP: 77.9B

ANCHORS AWAY—Faced with a bit-bummed backbone network, the WDM components giant must avoid the temptation to *anchor*—the tendency to base decisions on a previously established value. For JDSU, that value would be the year-ago quarterly revenues of $920 million. It's tough to cast away anchors. As JDSU's revenues slide toward $200 million per quarter, it must aggressively advance process technology to lower break-even revenues below the current $300 million target. Instead of peering down on its cost-cutting from the mountaintop of old revenues and proclaiming it a huge success, the company must crane its neck from a revenue abyss of $200 million or lower and be able to sight its new profit line without squinting. Increasing revenue by 50 percent or more over the next two years may prove a Herculean task, even for JDSU. And without a profit to show for it, investors would dismiss the feat.

Meet Hercules: Feeling his oats, CFO Tony Muller still sees a surge to $300M in quarterly revenues by next March.

Avanex (AVNX)

ADAPTIVE PHOTONIC PROCESSORS

MAY '02 MONTH END: 2.51 | 52-WEEK RANGE: 2.56 - 13.65 | MARKET CAP: 174.1M

NOT TOO CIVIL WAR—Anemic Internet traffic may pose a still greater challenge to Avanex than to its hulking rival. Even after this month's Oplink merger, the combined entity barely scrapes a tenth of JDSU's revenues. Thus, attacking JDSU's fortress, built on sales volume and attendant process leadership, would be a futile survival strategy. Even if Oplink's Chinese labor force works gratis, automation will ultimately yield savings orders of magnitude above the gains of shifting from domestic to foreign labor. In addition, for any given production process, the volume leader will almost always win on margins. It is absolutely crucial, then, that Avanex remain on the leading edge of wavelength multiplication technology, dramatically cutting the cost while raising the performance of *extremely high* channel count modules, enough to drive WDM deeply into metro and access networks before a dearth of backbone orders renders Avanex anorexic.

No Sell-outs: Still awaiting word on Simon Cao's new role at Avanex (see last issue), we continue to watch for signs of insider sales. So far, no one's thrown in the towel.

ONI Systems (ONIS)

METRO WDM PLATFORMS

MAY '02 MONTH END: 3.94 | 52-WEEK RANGE: 3.50 - 38.45 | MARKET CAP: 558.6M

ONUS ON ONIS—Will leading metro WDM-systems company, ONI, to be absorbed by long-haul vendor Ciena next month, guide the new Ciena out of the backbone and into the more promising metro area networks? Or will the new mimic the old, faithfully switching abundant long-haul bandwidth? (Ominously, CoreDirector sales have dropped in half over the past six months.) And can the vestiges of ONI remain true to the lambda paradigm? Noting that Rohit Sharma, ONI's paradigmatic WDM guru, will become the new CTO of Ciena, we tread cautiously over the optimistic path, likely adding Ciena to our center spread next issue.

Essex (ESEX.OB)

OPTICAL PROCESSORS

MAY '02 MONTH END: 5.00 | 52-WEEK RANGE: 3.30 - 8.25 | MARKET CAP: 26.8M

DEFENSIVE LINE—Terry Turpin continues to spend some $2M annually on R&D, mostly for his Hyperfine wavelength multiplier which is currently in field trials with potential early adopters and possible partners. With research outlays a hefty 75 percent of revenues last quarter, Essex is still seeking a sugar daddy (or two). Meanwhile, a fresh $4 million from new military contracts will help offset the company's mounting losses. Terry's top-secret research, based on the same technological concepts which led to Hyperfine, includes the design of an optoelectronic radar signal processor for U.S. missile protection. With Hyperdense defense, we'll all sleep better.

Corvis (CORV)

WDM SYSTEMS, RAMAN AMPLIFICATION, EDGE SWITCHES

MAY '02 MONTH END: 0.98 | 52-WEEK RANGE: 0.95 - 0.98 | MARKET CAP: 359.5M

PENNY LOAFERS?—Though on the forefront of WDM technology, Corvis has recently joined the growing club of Telecosm penny stocks. No wonder, based on the Internet traffic analysis in this issue of the GTR. Clearly, WDM over fiber is so bandwidth capacious that the Telecosm can't support half a dozen ultra-long-haul systems manufacturers. With long-haul fledglings Innovance, Ceyba, and Altamar beginning to flap their wings, Corvis must relentlessly innovate to maintain its leadership in broadband Raman technology, in multiplying wavelengths, and in driving switches out of optical networks—areas stinted by its upstart rivals, who seem to be counting on scarce bandwidth to put a premium on higher bit rates and more switching flexibility.

StorageNetworks (STOR)

DATA STORAGE MANAGEMENT, SOFTWARE

MAY '02 MONTH END: 1.78 | 52-WEEK RANGE: 1.71 - 19.75 | MARKET CAP: 175.4M

SHIFTING GEARS—The six-month STORos, customer-installable, storage management software beta is over and the central focus of this storage service provider turned storage "utility" company now is to get the product out the door—sell and ship, ship and sell. Step one? The addition of seasoned sales and marketing execs from Computer Associates, DEC and you guessed it, EMC.

Scale Eight

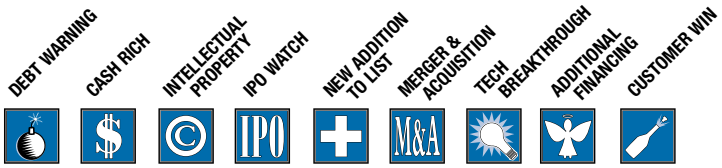
MASSIVELY PARALLEL GLOBAL STORAGE

PRIVATE

$$$$—Big news this month for Scale Eight with customer wins from Fujitsu's Japan-based professional services arm, PFU, and online digital image and audio archiving service dotPhoto. "Big" in this case means multiple terabytes of storage and annual contracts in the half-million dollar range. Trailing just behind largest customer, Microsoft, PFU joins the ranks of MTV/Viacom and Octavo in Scale Eight's healthy second tier of customers.

When the Market Turns: The appointment of John Beletic to the position of Executive Chairman looks to be made with an IPO in mind. With two successful IPOs under his belt, this former VC, turned CEO of Weblink Wireless, PageMart Wireless and Tigon, has a reputation for growing small companies.

KEY



MEAD'S ANALOG REVOLUTION

National Semiconductor (NSM)
Synaptics (SYNA)
Sonic Innovations (SNCI)
Foveon
Impinj
Applied Neurosciences
DigitalPersona

COMPANIES TO WATCH

Analog Devices (ADI)
Cablevision (CVC)
Comcast (CMCSK)
Cox (COX)
Samsung
Seven
Xilinx (XLNX)

Mirror Image Internet

GLOBAL CACHING AND STOREWIDTH PLATFORM

PRIVATE

NO NEWS IS GOOD NEWS?—The performance benefits of MII's existing content delivery network infrastructure logically complement the instant-messaging goals of global Web services. Stay tuned for July customer announcements.

Equinix (EQIX)

SECURE INTERNET BUSINESS EXCHANGES

MAY '02 MONTH END: 0.48 | 52-WEEK RANGE: 0.33 - 3.53 | MARKET CAP: 43.3M

TEAMWORK—Equinix defense continued its aggressive full-court press on debt this month, netting an additional $10 million in retired Senior Notes at significant discounts for a grand total of nearly $150 million in reduced company obligations since October. (Reported long-term debt was $300 million in September.) The offensive squad also fared well, adding leading discount travel site Hotwire to its customer roster, and ramping up performance with access to Genuity's Tier 1 backbone.

Sprint PCS (PCS)

NATIONWIDE CDMA WIRELESS NETWORK

MAY '02 MONTH END: 10.20 | 52-WEEK RANGE: 7.22 - 29.05 | MARKET CAP: 10.1B

WE STILL SEE CLEARLY—The wireless sector is in disarray after Sprint PCS reduced full-year net new subscriber estimates by 10-15% and said Q2 net additions would be closer to 300,000 than the expected 600-650,000. With its stock under $5.00, PCS is betting big on a successful launch of its nationwide 3G data service later this summer. With lots of great new color-screen phones and a solid e-mail offering to counter RIM's Blackberry solution, Sprint should continue its string of 15 quarters leading the industry in growth—and possibly put a few competitors out of business.

Good News: The important average revenue per user (ARPU) metric, already number two in the industry behind Nextel, gets a bump from $60 to $61.50.

Qualcomm (QCOM)

CDMA MICROCHIPS, IP, SOFTWARE

MAY '02 MONTH END: 32.82 | 52-WEEK RANGE: 24.63 - 68.87 | MARKET CAP: 25.3B

COLOR KEY—cdma2000 1x continues to grow at a phenomenal rate, adding nearly 1.5 million subscribers per month. The latest 1x spearhead, Japan's KDDI, has landed 829,000 subscribers in the first two and a half months of operation, gaining 10,000 subscribers a day. Key to cdma2000's success in Japan and Korea, and to Sprint's upcoming 3G launch in the U.S., are a wide array of attractive, powerful, color-screen handsets from Samsung, Sanyo, LG, and others. Qualcomm also owns SnapTrack, the key technology enabling the government-mandated E911 mobile emergency system. Non-CDMA wireless carriers have had difficulty meeting the new requirements, but TI has now licensed SnapTrack for its GSM solutions.

Qualcomm Beats GSM Band: Company just accelerated by three months its new multimode handset module integrating WCDMA with multiple data standards and its RadioOne ("Look, Ma, no IF!") technology.

Altera (ALTR)

PROGRAMMABLE LOGIC DEVICES

MAY '02 MONTH END: 17.77 | 52-WEEK RANGE: 14.66 - 33.60 | MARKET CAP: 6.8B

CORE TECHNOLOGIES—Altera believes business is tracking with expectations of 4-6% sequential revenue growth. The roll-out of its newest, high-end PLD line, Stratix, is on track with the first device expected before the end of June. Several analysts indicate that Altera's processor-core and transceiver-core products have achieved wins at several communications OEMs, and that Altera is surging ahead of Xilinx in these important next-gen PLD technologies. The Ciscos and Lucents of the world are also beginning to demand communications-IC functionality in high-end PLDs—in other words, integrating the physical layer (PHY) into programmable logic. This encroachment into traditional communications chip markets opens up a significant opportunity for ALTR and XLNX. Xilinx expects 8% sequential revenue growth for the June quarter. By month end, the company also begins shipping chips produced on 300mm wafers, potentially boosting growth margins above 60% and further closing the cost gap between PLDs and ASICs. Altera's 300mm project is one step behind.

EZchip (LNOP)

10 GIGABIT NETWORK PROCESSORS

MAY '02 MONTH END: 10.70 | 52-WEEK RANGE: 2.70 - 16.45 | MARKET CAP: 77.9M

AUSTIN'S POWERS—First Dell took PC business from IBM, then server business from Sun, HP, and Compaq, and more recently storage business from EMC. Now a *Forbes* cover story reveals Dell's plans to enter the switch and router business. This is a clear sign that these boxes will go the way of the PC, with the value and profits migrating to makers of software and highly integrated processor chips—and away from big-box building OEMs like Cisco. With the cheapest, fastest, smallest, coolest net processor on earth, EZchip is sure to lead and benefit from this nascent trend.

Watch Out Intel: Progress rumored on the customer front.

Broadcom (BRCM)

BROADBAND INTEGRATED CIRCUITS

MAY '02 MONTH END: 22.59 | 52-WEEK RANGE: 18.40 - 53.35 | MARKET CAP: 6.1B

CABLE KING/VOICE CHOICE—A new generation of cable and satellite set-top boxes, incorporating home-gateway and digital video recorder functionality, is about to explode onto the market. The result will be a fresh boost to sales in a market Broadcom dominates. Also, the Atlanta Supercomm show revealed that Broadcom's voice-over-IP chip has achieved a design win at Cisco, the world's largest VoIP vender. Wide-area-networking products will continue to be weak.

Terayon (TERN)

BROADBAND CABLE MODEMS, HEAD-ENDS

MAY '02 MONTH END: 2.84 | 52-WEEK RANGE: 2.33 - 14.75 | MARKET CAP: 205M

VALUE PLAY—It appears the recent weakness in Terayon's stock stems from Shaw of Canada's reduced expectations for new cable modem subscribers. Shaw has been a 33% customer. Terayon has helped Shaw and fellow north-of-the-border cable operator Rogers achieve more than double the cable modem penetration rates of its American counterparts. Big news could arrive June 20 when CableLabs hands out its latest DOCSIS 1.1 certifications. If Terayon's CMTS (cable modem termination system, a.k.a. head-end) is certified, it can start selling its DOCSIS 2.0 upgradeable solution, which has a six to nine-month time-to-market advantage over competitors. Ultimately, Terayon's chip and head-end businesses may be acquired separately. Cisco and Juniper are the most likely takers for Terayon's number-two-market-share CMTS business…See page 7 of the June 2002 GTR to learn more.

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Texas Instruments (TXN)

DIGITAL, ANALOG, MIXED-SIGNAL PROCESSORS

MAY '02 MONTH END: 28.30 | 52-WEEK RANGE: 20.10 - 39.39 | MARKET CAP: 49.1B

SALES REVIVE—TI CFO, Bill Aylesworth reaffirmed Q2 guidance May 29 stating that the company expects revenues to be around $2.0 billion, a rise of 10% versus the first quarter. Aylesworth went on to state that most of TI's key customers were now buying to meet end-demand and no longer building or depleting inventory.

National Semiconductor (NSM)

SINGLE-CHIP SYSTEMS, FOVEON IMAGERS

MAY '02 MONTH END: 30.70 | 52-WEEK RANGE: 19.70 - 37.30 | MARKET CAP: 5.5B

BACK IN BLACK—National returned to profitability with surprise earnings of $0.03 per share, trouncing the Street's estimated $0.08 loss for the fiscal fourth quarter 2002. Sales of analog devices into wireless handsets and flat-panel displays led the way, with continued strength out of Asia-Pacific, now 50% of sales. Gross margins were up 695 basis points to 43%. National has re-entered the notebook power management area with OEMs currently sampling products for the Pentium-4 platform. Today lap-top makers use between $7 and $10 of National products in each computer, a number expected to reach $15-$20 by next year.

Thin Client, Thick Market: National announced its next generation Geode, the GX2. It's an x86-based microprocessor like a Pentium, but with radically lower power consumption making it perfect for set-top boxes, digital video recorders, tablet computers, and other "thin clients" like the upcoming Microsoft "Mira" detachable-mobile-wireless flat-panel display.

Synaptics (SYNA)

TOUCH-SENSORS, FOVEON IMAGERS

MAY '02 MONTH END: 16.01 | 52-WEEK RANGE: 12.29 - 20.75 | MARKET CAP: 370.9M

NEW MEANING FOR TOUCHTONE—CityOne Network of China announced the inclusion of Synaptics TouchPad modules in its network of public access telephones. The module will combine Synaptics' proprietary QuickStroke Chinese character recognition software with a Synaptics capacitive TouchPad for public as well as home telephone handsets. This is an encouraging sign that Synaptics is leveraging its technology and diversifying into emerging communications markets beyond lap-top computers.

Narad Networks

GIGABIT ETHERNET COAXIAL CABLE NETWORKS

PRIVATE

THE COMPETITION—Advent Networks is challenging Narad's "out-of-band" IP cable upgrade with an "in-band" IP solution. Using vacant 6-MHz channels in the standard cable spectrum, Advent delivers 40 Mbps downstream and 8 Mbps upstream, and provides a less-ambitious, lower-cost solution than Narad. Ultimately, both companies dramatically increase the value of the cable companies' network assets.

Soma Networks

BROADBAND WIRELESS ACCESS, NETWORK SOFTWARE

PRIVATE

UNWIRED—NTT Communications of Japan was granted the spectrum license it needs to roll out Soma's residential broadband wireless system. The new service is dubbed WINQ (Wireless, Intelligent, Non-line-of-sight, Quick installation). Are they trying to tell us something?

The Telecosm Technologies list is not a model portfolio. It is a list of technologies in the Gilder Paradigm and of companies that lead in their application. Companies appear on this list only for their technology leadership, without consideration of their current share price or the appropriate timing of an investment decision. The presence of a company on the list is not a recommendation to buy shares at the current price. Mr. Gilder and other GTR staff may hold positions in some or all of the stocks listed.

way Internet capability. For more demanding business customers, an alliance with **Soma Networks** could yield full two-way links at 11 megabits per second plus 4 carrier-class voice-over-IP services. Moreover, digital video recorders from TiVo and Sonic Blue or from satellite set-top box vendors could permit provisions of near video on demand. With satellite already fully digital, it can integrate with other Internet services more readily than cable lugging its legacy of 370 megahertz of analog channels.

Ingenious new satellite technologies allow robust Internet services. In the rural aerie of Tyringham, I myself link to the Net through a DirectWay always-on two-way connection to a Hughes satellite that currently runs at about 400 kilobits per second downstream and 56 kilobits per second upstream. This service will drastically improve with the rollout of new Ka-band satellites and other new technology.

Clearly, satellites will offer devastating competition to cable in broadcast services. Yet broadcasting is the least lucrative of all communications models. Two-way communications bring some ten times more revenues than one-way communications. The satellite challenge to the current cable business model of video broadcasting is likely to push the industry toward opportunities that conform far better to the real bandwidth advantages of the cable fiber-coax plant.

Direct Broadcast Satellite is the last television play. It is now winning in broadcast applications. Its all-digital systems and personal video recorders are luring many of the best cable customers. By contrast to all-digital DBS systems, with their hard-drive accessories for time shifting, cable TV remains a partially analog, defectively digital hybrid, with circuit switched voice, botched business data, and a cumbersome modem kludge that constrains upstream flows to a strangled hundred kilobits per second. In this losing broadcast battle with satellite, cable's marketing scheme allows prices to drift upwards while its services stagnate and it depends on lobbying and litigation to keep satellite at bay with must-carry mandates and local bans. Satellite will blow away this strategy in the broadcast market since its ever-advancing spot-beam technology and terrestrial alliances will soon allow it to offer local and interactive services.

Ultimately, however, satellite spanwidth cannot trump cable bandwidth. Although satellite promises to offer some 5 gigabits a second of bandwidth from three satellites, comparable to cable's 4.5 gigabits a second, in fact cable's bandwidth is 60 million times larger since it can be separately linked to each of its scores of millions of customers. Satellite is inexorably limited in bandwidth. All its systems put together could hold less than one percent of Internet traffic, and Internet traffic doubles every year.

By exploiting cable's inherent bandwidth advantage to offer personal video services on demand and broadband communications links, the industry can regain the initiative against satellite, relegating DBS to a niche service for rural areas and worldwide broadcast applications.

But cable's promise goes far beyond merely trumping satellite. Cable has become a dire threat to the Bell local exchange carriers as well.

Some $50 billion in new investment over the last five years has transformed the old one-way tree-and-branch CATV networks into two-way hybrid-fiber-coax (HFC) networks that could potentially serve the current $65 billion communications market of small and medium-sized enterprises. These customers provide the Bells with a large share of their profits. With an array of new technologies that exploit the bandwidth of hybrid fiber-coax networks, cable is poised to become a full service telecommunications player. It may even fulfill the gigabit Ethernet plans of the competitive local exchange carriers. If so, all the old optimistic projections of Internet traffic might come true over the next five years.

Coax to the max

Cable is on the verge of a bandwidth bonanza. Recent issues of the GTR have focused on **Narad Networks**. By eventually quintupling the current bandwidth of cable to accommodate multiple gigabit Ethernet business services, Narad alone can entirely transform the technological and financial frontiers of the industry.

Although Narad systems can be deployed incrementally as opportunities arrive, Narad changes the frequency characteristics of the cable by overlaying first 1.14 gigahertz and then 5 gigahertz two-way channels above the existing cable service (which is restricted to frequencies below 860 megahertz). While the Narad system does not affect existing cable spectrum or service, the overlay does entail the substantial cost of replacing all the amplifiers between the neighborhood node and a particular business customer. For any substantial business, the investment has an almost immediate payback. Just three business customers can quadruple the revenues from an entire existing neighborhood system. Indeed, this Narad opportunity represents an immense upside for cable and allows the industry almost instantly to emerge as a devastating competitor with the telcos in the local loop. A Narad deployment could ultimately allow a cable operator to replace the entire cumbersome 860 megahertz analog-digital system with a fully Digital Narad Ethernet system that can offer two-way broadband video and telephony to businesses and residences alike.

In the short run, however, millions of smaller companies, proprietorships, and home ventures need bandwidth but cannot compensate readily for the disruptive effects and costs of replacing network amplifiers. Cable industry insiders declare that Narad faces a long uphill trek in persuading MSOs to hire new specialized personel and add custom devices to their expensively upgraded facilities. For these operators and small business customers, **Advent Networks** offers a cheaper alternative that requires only two additions to the plant—at the headend and the customer premises—that give each subscriber a dedicated IP channel within vacant channels in the existing cable spectrum. (Cable operators have left open anywhere between one and four 6-megahertz channels for next generation services like Advent.) This channel can reach any content, at any time, from any source, including other subscribers across the Net. Consisting of an Ultraband rack of switch-router blades and a gateway at any customer, the Advent system is a unified digital transport platform that can theoretically transform the entire 860 MHz of cable into a two way network upgradeable without truck rolls. Providing 5 to 40 megabits a second of downstream speed in 5-Mbps increments and 0.5 to 8 megabits a second of upstream, Ultraband does not disturb the MSO with any need to change its existing cable spectrum assignment. Advent has the advantage of playing within the existing bounds of cable standards and spectrum.

This conservatism is both Advent's marketing strength and its technological weakness. It does not create any new bandwidth. Since much of the cable is underused, and Advent needs only one 6 megahertz channel to get started, there will be many opportunities to deploy the system. But Advent has to enter the fray and compete with current services in what is arguably a zero sum game. Narad transcends the zero sum game and adds an entirely new game: domination of all the communications services in the local loop.

Terayon's return

The third, more immediate, option for widespread cable services to small businesses is the DOCSIS 2.0 cable modem. Made possible by **Terayon**'s (TERN) previously proprietary S-CDMA technology, DOCSIS 2.0 is now the next-generation industry standard that will triple upstream bandwidth to enable voice-over-IP and other two-way services. Terayon has working modems and head-ends and enjoys at least a six-month lead on chip-competitors Broadcom and TI and has even more of a jump on its chief head-end competitor **Cisco** (CSCO).

Advent offers a cheaper way to reach small businesses, but Narad alone can entirely transform the industry

Because it is so out of favor on Wall Street, however, Terayon is a powerful investment opportunity. Wall Street simply hates Terayon. The company trades at a remarkably low price-to-sales multiple of 0.41. By comparison, Broadcom's P/S ratio is around 6, as is the industry average. The P/S for the entire S&P 500 is 3.17. Terayon's market cap of just $141 million is about one-third its cash-holdings of $310 million. Having retired much of its debt at 20 cents on the dollar, Terayon's long-term obligations are $178 million, down from $300 million a year ago. The Street's skepticism springs partly from rapidly declining prices and shrinking margins in the cable modem business, where Taiwanese manufacturers are taking over. Nevertheless, Terayon's strength overseas, its plans to exit the modem business and focus solely on chips and head-ends, and a possible break-

through with DOCSIS 2.0 systems in the U.S. point to a potential high upside for the stock.

At least one industry insider is excited about a fourth means of reaching small enterprises, a new concept called "surface fiber." Developed by TeraSpan, the system replaces deep boring with shallow trenching of a virtually uncrushable tube conduit, greatly reducing the cost of putting optical fiber into the ground. Cheap Gigabit Ethernet optics would then create a fiber-fiber architecture instead of the usual hybrid-fiber-coax system.

None of these four approaches is readily available to satellite rivals and only "surface fiber" is open to the telcos. As cable comes to terms with its losing position in any broadcast competition with satellite, visionary MSOs will break out of their legacy trap and grasp their real opportunity. Cox in particular already has substantial telephony and data services for small and medium-size businesses. Though suffering with the rest of the cable industry from association with **Adelphia** and its debt and leadership issues, the Atlanta company offers a compelling chance for investors to get aboard a vessel of broadband digital communications at a time when most of their potential competitors—the CLECs—are near bankruptcy.

Reflation

For the first time in more than two years, we see genuine good news on the economic front. Deflation, the dearth of money that caused the 2000-02 market slide, is abating. Sky-high real interest rates are falling. With the highly predictive price of gold at $317, up 25 percent from its 20-year low of $254, and with the dollar slightly weakening from super-strong levels, the Fed is finally supplying enough money to relieve much of the downward pressure on prices, on dollar debtors, and potentially on capital investment budgets. The Bank of Japan is also at long last ending the yen's deflation and sparking a resurgence in Asia.

The end of deflation is especially positive for America's cable operators, who have historically financed their businesses with debt. (Comcast, for example, carries $12 billion in debt; Cox, $7 billion; Charter, $17 billion.) For much of the last two years, the cable companies, while not immune to the market downturn, avoided the catastrophic fate of the highly leveraged telecommunications sector. Unlike the start-up next generation networks and CLECs who suffered severe deflationary price declines and customer cutbacks and were unable to roll-over their debt, the cable companies were largely impervious to cash-flow slumps because of their semi-monopoly status in most geographic areas. But recently, as deflation kept eating away at telecom, reaching all the way up to tier one companies like **Qwest** (Q) and **WorldCom** (WCOM), the cable industry's leverage has become a real concern. Adelphia, the nation's fifth largest cable MSO, is on the verge of bankruptcy, and the sector's stocks are trading at historically low price-to-EBITDA ratios.

Fortunately, "reflation" appears to have arrived in time to rescue the balance sheets of the remaining cable operators. But is it enough to spark a broad-based market revival?

Mike Darda of Jude Wanniski's firm, Polyconomics, says we aren't going to see the market pop like it did in the 1982 and 1985 reflations. Then, equity multiples (e.g., P/E ratios) were at rock bottom. Those market booms were the product of reflation *and* multiple expansion. Today, even after a two-year bear market, multiples have only regressed to historical averages. In other words, a growing and reflating economy is good, but it's not likely to be accompanied by a multiple explosion. Darda thinks it's a "stock picker's market." Don Luskin of Trend Macrolytics agrees. He says the S&P 500 yield gap—a comparison of earnings expectations and prevailing long-term bond yields—is back to its average for the first time since 1998, signaling a fairly or even under-valued broad market. According to his model, tech stocks are still slightly *overvalued*, but he is beginning to look at select names in technology.

Nevertheless, with the full coterie of supply-siders—David Malpass, Brian Wesbury, Jude Wanniski, Don Luskin, Larry Kudlow, John Rutledge, and Art Laffer, among others—on the same generally optimistic page for the first time in a while, flickering macroeconomic lights can be seen at the end of the dark telecosmic tunnel.

George Gilder, Charlie Burger, and Bret Swanson
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