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REPORT

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The Intel of the Telecosm

Several months ago we joked that the Intel of the Telecosm may turn out to be none other than…Intel. Today it is no joke.

Inside:

As we approach our sixth Telecosm conference, IPigeons throng to our portals and Windows sills with so many packets of excremental spam and other fragrant poop that we almost scooped up and recycled several deceptively savory hors d'oeuvres. The sources were industry prophets Nicholas Negroponte and Roxane Googin, and I will get to their intriguingly silly ideas in due course. But I should first tell you about a recent summons to the Boston digs of prominent investor-inventor Bob Metcalfe.

Bob wanted to show me the amazing video conferencing feats of a company called Avistar Communications (AVSR), which had a video conferencing network deployed through his house using its new Video Operating System. Avistar's VOS enabled us to link readily to a NTSC CNN feed, a marketing executive in Redwood Shores on 384 kilobits per second of ISDN, a desk in the Hancock towers in Microsoft (MSFT) NetMeeting, and a wafer fab in Singapore on IP video.

I get around, and one of the things everyone wants to show me is their video conferencing. Avistar's is the most robust and adaptable that I have seen. The images were all sharper than you expect, the setup seamless to a hot list of available callers, the latency undetectable even to Asia, and the software startlingly agile and protocol-polyglot. It could readily record calls, publish streams, add conferees, videofy emails, display PowerPoints, and invoke programs such as Siebel (SEBL) Customer Relationship Marketing.

Bob and I are not alone in our enthusiasm. Hundreds of power users, including the CEO of one of the world's largest investment firms, use the program an average of two and one-half hours a day. The 8,000 other users average more than 40 minutes a day, about the same as voice telephone users. The big financial institutions that are Avistar's initial market, such as Deutsche Bank (DB), are giving away the program to customers, and they in turn use it to contact others on an ever-expanding hot list. Metcalfe's law in action. However, the company's ever-expanding motif crashed when the targeted group of customers laid off 40 percent of their workers and banned discretionary expenditures. Avistar's revenues dropped from $20 million last year to around $12 million this year, and its stock dropped to around 50 cents.

Founder and operating system guru Jerry Burnett, an MIT computer science Ph.D., and his partners invested some $50 million from their winnings in Tibco. Formerly a Technikron subsidiary also begun by Burnett, the wafer-fab software OS company was bought by Reuters and spun off. They got $30 million more in a misbegotten late 2000 IPO. They have $10 million left, a market cap of $13 million, 46 patents, and a video OS that everyone should boot up at $200 per seat (a few pennies per minute for heavy users). Like everything else, I suppose they may go broke. But Jerry says sales are coming back a little and like everyone else they hope for a turnaround next year. Meanwhile, you can have the satisfaction of buying a piece of a great company for 50 cents. Whether Avistar makes it or not, they have many competitors, prominently including Polycom (PLCM) and Tandberg, and they have proven at last that if you give people robust and convenient video at a reasonable price they use it relentlessly. That can solve a lot of the problems of the Net.

Every chip depression offers a tectonic opportunity. In 1985, in the teeth of a

frigid recession, Intel (INTC) transformed the company and the industry. It abandoned Amr Mohsen's 256K DRAM design, left the memory-chip market that it had created, closed down its Oregon fab in midstream, and poured scarce billions of capital into microprocessor manufacturing. The company emerged with a roar from the pits to take a global lead in microchips against Japanese rivals that were assumed to be impregnable. Now in the teeth of an even more catastrophic downturn, Intel is doing it again.

Post-Pentium Plans

From the outset, the *GTR* has focused on super low-power analog VLSI (Moore's law analog) and silicon germanium as keys to the future of the industry in single-chip systems. Our target product was software-adaptable radio technology usable in billions of cellphones, PDAs, and PCs around the world. Twice as fast and half as power-hungry as the competition—yet manufacturable on conventional wafer fabs—silicon germanium would be critical to single-chip systems with radio frequency functions. Our silicon germanium focus led us to put Atmel (ATML) and Conexant (CNXT) on the list. Our analog bias led us to Analog Devices (ADI) and National Semiconductor (NSM) and to disparage Intel.

In recent issues of the *GTR*, we continued to warn against overrating Intel's technically amazing feat of pushing Pentium processor speeds to 3 gigahertz (GHz) and beyond. Power consumption increases proportionally with clock frequency and by the square of the voltage. Now, power is going through the roof as Intel achieves runaway clock rate gains. But companywide efforts have largely failed to bring gate potentials much below their leaky limits, around one volt. Moreover, the extra clock cycles are mostly wasted in "wait states," as megahertz memories lag well behind the gigahertz processors.

Avistar's video-conferencing system is the most robust and adaptable that I have seen

What computer users need today is not a heroic churn of logic power and heat but more communications speed across the chip, across the board, and across the last mile. We cited National Semiconductor's focus on low-power processors—it's Geode GX2 operates at one-tenth of the new Pentium frequency (333 MHz), consumes less power (about 2 watts versus 55-plus watts in a full-fledged Pentium), and can thus eliminate the costly heat-sink and fan—as a key advantage in the diverse and growing market for PDAs, set-top boxes, tablet computers, and other getaway gizmos.

In the last week, however, Intel has made a series of announcements that show not only an unexpected forte in silicon germanium and analog but also a resolve to use these technologies in single-chip cellphone radios. Its new Banias platform for the first time also integrates dual-band Wi-Fi (802.11a/b) wireless connectivity onto the motherboard. For even thinner devices, Intel's XScale architecture will also include 802.11b.

In keeping with our contention that Intel and Applied Materials (AMAT) are the leading *real* nanotechnology companies (you can identify fake nanotechnology companies by the "Nano" in their names), CTO Pat Gelsinger announced that Intel is pushing full speed ahead with 90-nanometer design rules (lines a few billionths of an inch wide) on 300 millimeter wafers (one foot wide). Together these moves approximately triple the amount of processing power on a wafer. Eventually to cost close to $2 billion, the Hillsboro, Oregon, fab will not only offer SiGe but will also integrate analog devices like resistors, capacitors, and inductors that are needed to make radios. When Foveon and National put a camera's shutter, f-stop, and ISO settings on the image plane, we can have an integrated Wi-Fi picture party.

Beyond radios, Intel's process advances promise three-dimensional transistors and the first fully functional nanotubes and nanowires that can extend Moore's law silicon into optics, from photodetectors to simple and cheap Fabry-Perot tunable lasers. For leading edge applications, free-space optics from Avanex (AVNX) and Essex (ESEX) outperform silicon mass manufacturing. But Intel is spending $4.5 billion a year in R&D. If anyone can make silicon optics happen, it is probably Intel.

Intel's entry into single-chip communications will put it up against TI (TXN), Analog Devices, National, and scores of other targeted companies such as Broadcom (BRCM) and WiFi chip leader Intersil (ISIL). They possess much of the world's precious mixed-signal and analog-design talent and close relationships with Asian foundries such as Taiwan Semi (TSMC). But while TSMC retrenches its move to 300 mm wafers, Intel's capital outlays of $5.2 billion will be $2 billion more than all the Asian foundries—TSMC, United Microelectronics (UMC), and Chartered Semi (CHRT)—combined.

Intel seems on the cusp of a new era of dominance. Several months ago we joked that the Intel of the Telecosm may turn out to be none other than … Intel. Today it is no joke.

Five-Year Fiber Plan

The joke is that the basic market for these devices is still telecommunications. Nicholas Negroponte and Roxane Googin bring us the exciting news that telecom as we know it is dead. When these folk talk, however, even dead people listen. Pundit-panhandler for MIT's Media Lab, original dealer of the death of television, successor of Saint John in the vatic caves of Patmos, Negroponte has been a force in the industry for decades. A more recent discovery, Googin has been a crisp and trenchant analyst of telecom investments who warned of a crash in the nick of time in 2000.

We have met her previously as the most articulate voice in the David Isenberg camp of futilitarian optics ("The better the network, the less money it makes.")

Now predicting a stunning "inning-by-inning," nine-step descent to perdition for the entire telephony establishment, Roxane would have us put our trust in socialism. Of course she spurns the label: "We are not closet socialists," she avers in her pungent *High Technology Observer*. But both she and Isenberg show suspicious enthusiasm not only for government networks in the backbone but also for metropolitan fiber ventures by cities and towns in both the U.S. and Canada.

The key problem, says Googin, is the total evaporation of pricing power in all telecommunications businesses. With the largest Internet backbone Worldcom's UUNET and the most extensive global links still Global Crossing's, she sums it up, "The Internet is broke." With the second largest backbone, Sprint (FON) teeters, and Googin offers no hope. With an eye for irony, she adds Genuity (GENU), GTE's legatee of BBN, the company that built the original Internet in the early 1970s. It now gasps with a market cap around $3 million and a debt around $3 billion and a price of 30 cents. The RBOCs are pretending to make money, dutifully writing off over decades plant and equipment that is already obsolescent. In other connections, this is called "capitalizing costs," but when the government mandates it, it is mandatory. (Otherwise it's felonious.)

As a result, private sector telecom is already dying. But, our experts opine, nationalized optical networks can save the day. It will be the Defense Education Highway Act redux. The White House will rule the fiber backbones, presumably administering a perfect distillation of passive optics, lithium niobate modulators, social security trust funds, Raman amplifiers, airport checkpoints, wavelength division multiplexers, post office zip codes, vertical-cavity surface-emitting lasers, highway tollbooths, Internal Revenue printers, copiers, and subpoenas, and intercontinental ballistic missiles. In the local loop, mayors will emerge as the new magnates of border gateway protocols, weighted fair queuing theory, and rush-hour routing.

Wi-Fi Wonderland

But don't give up yet, ye of little faith in a Googinplex of government-guided photonics. Nicholas has a better idea. "Everything you assumed about telecommunications is about to change. Large wired and wireless telephone companies will be replaced by micro-operators, millions of which can be woven into a global fabric of broadband connectivity." 3G is dead. That's to get your attention. Put your faith in lily pads. These are small cells of Wi-Fi 802.11 wireless connectivity with their stems linked to the Net. You know the rub: at first the pond is nearly empty. At some pace of doubling, the pads creep across the waters, covering inlets, bays and coves, nooks and niches, an Apple (AAPL) AirPort in your basement, 500 Starbucks here, DFW Airport there, campuses across the land, Intel Wi-Fi single-chip smart radios on the South Bridge, $200 Toshiba (TOSBF) full-service access points in the pizza parlor, seamless Microsoft XP Wi-Fi SSID sniffers with IP SEC in every machine OS, and sure enough, 50 million home networks leaking like all get-out into the nomadic streets. One day the pool is less than half-covered, the next it is nearly full. Before you know it, *Boingo*, there is a new telecom paradigm, with spectral "frogs" hopping from one pad to another all across the land. Eventually even the stems to the Net will wither away in the face of free microwaves leaping among the laps and lily pads.

The image appeals to many. Lily pads limber enough to bear exabytes of information weightlessly, frail enough to tumble the Leracheteers and treble damage anti-trusters into the soup along with the lumbering Gulliver Bells and the globe-running gurus of 3G networks. All the giants end up sinking under the Lilliputian webs of microwaves.

A genuine prophet, Nicholas ten years ago ordained the Negroponte switch. Then overwhelmingly running on wires, voice communication would henceforth move to the air. Then dominantly airborne and broadcast, video transmissions would shift to wires, namely fiber optics. Those predictions were uncannily on target. Wireline voice minutes actually shrunk last quarter at an annual rate of 7 percent while wireless voice ascended to half of the global business. The only contrary movement on the horizons of the Negropontine universe is satellite television. But Nicholas also has that covered, predicting long ago that the bulk of video would flow in a store-and-forward form rather than in streams of pay-per-view. Although too slow for conversations and other instant transactional use, satellites are potent for forwarding large multimedia files. The peer-to-peer boom confirms this Negroponte insight as well.

Lily Pad Links

Now in an acclaimed article in the October *Wired*, he explains how Internet data will follow voice in moving to the air. Replacing the entire hierarchical kit and kaboodle of the telco and cable local loop will be a heterarchical mesh: a bottom-up Wi-Fi revolution. The first version of Wi-Fi (802.11b) offers three links of 100 feet or so up to 11 megabits per second in the 2.4 gigahertz unlicensed band of frequencies. The next version (802.11a) moves the system up to the 5 gigahertz unlicensed band to provide links of 54 megabits per second and accommodate 8 to 12 links at a time. *Eleven a* uses a technology called Orthogonal Frequency Division Multiplexing (OFDM), which is already popular in wired applications in DOCSIS cable and DSL and is now being promoted heavily in wireless. Supported by Qualcomm (QCOM) founder Andrew Viterbi, a company called Flarion envisages a form of OFDM called Flash for mobile applications. Some alarmists see a Qualcomm killer in this ingenious

TELECOSM TECHNOLOGIES

Corvis (CORV)

WDM SYSTEMS, RAMAN AMPLIFICATION, EDGE SWITCHES

AUGUST `02 MONTH END: 0.56 52-WEEK RANGE 0.51-3.90 MARKET CAP: 230M

T TRIALS—AT&T may be the first carrier to resume meaningful long-haul capital expenditures. T will supposedly evaluate Corvis, Ciena, and Lucent solutions over the next several months, with Corvis rumored as the early front runner, bolstered by its strong balance sheet, commercially proven technology, and field-proven interoperability with legacy infrastructure and the Ciena CoreDirector. It is said T will spend $500M-$1B upgrading its network over the next three to four years, a project that could galvanize Corvis as the undisputed long-haul leader. We'd love to see AT&T actually pursue such a sound *technology strategy*, rather than the malicious political one that has wreaked the telecom carnage all around us. The real question is whether AT&T will last long enough to pay Corvis. Maybe David Huber can take T's last billion bucks.

JDS Uniphase (JDSU)

ACTIVE AND PASSIVE OPTICAL COMPONENTS

AUGUST `02 MONTH END: 2.53 52-WEEK RANGE 2.06-12.44 MARKET CAP: 3.5B

OPTO-EXODUS—With Lucent, Nortel, Corning, and Alcatel all exiting or scaling back their optical components businesses, Agere's decision to shutter optoelectronics by June 2003 signals a continued consolidation around JDSU.

OptronX Acquisition: JDSU has acquired the transceiver/transponder business unit of OptronX, a startup focused on the 10 Gb/s optical transmission market. OptronX is already selling product in the single millions of dollars per quarter range and should have an immediate positive impact on JDSU.

Avanex (AVNX)

ADAPTIVE PHOTONIC PROCESSORS

AUGUST `02 MONTH END: 2.12 52-WEEK RANGE 1.57-9.40 MARKET CAP: 136M

MOVING ON—Putting the blocked Oplink merger behind it, Avanex continues to streamline. In a move to reduce its cash burn to $4 million per quarter, it will eliminate 140 more positions and shift almost all manufacturing to China, while retaining the crucial elements of design, engineering, product integration, and prototype capabilities. In top-line news, Avanex's new PowerEqualizer Dynamic Gain Equalizer received its first commercial order from a major systems provider, and several metro and long-haul optical systems houses are buying the PowerShaper FDS Dispersion Compensation Module.

Simon Sighting: Former Avanex CTO Simon Cao has turned up at a stealthy startup named Corlux, whose CEO, Brett Casebolt, is the former Avanex VP of business development.

KEY

Ciena (CIEN)

METRO WDM PLATFORMS

AUGUST `02 MONTH END: 4.06 52-WEEK RANGE 3.38-22.0 MARKET CAP: 1.8B

DELL'ORO DOLDRUMS—The release of Dell'Oro's 2Q optical networking numbers offered few surprises but was depressing nonetheless. Total worldwide optical systems revenue for the quarter came in at $1.92 billion, missing the $2 billion mark for the first time in four years. Speakers at the annual NFOEC fiber optic conference in Dallas agreed there is little chance of an optical revival before early 2004.

Bait and Switch: Even as Cisco said it would re-enter the optical switch market, replacing its failed Monterrey project with the new 15600, Ciena extended its optical switching market share lead to 53%.

Essex (ESEX.OB)

OPTICAL PROCESSORS

AUGUST `02 MONTH END: 2.60 52-WEEK RANGE 2.15-8.25 MARKET CAP: 14M

GOOD GOVERNMENT—The Department of Defense has purchased a 16-channel hyperfine WDM device with 6.25 GHz spaced channels. The agency will use the device, to be delivered in early 4Q 2002, in developing high capacity research networks.

StorageNetworks (STOR)

DATA STORAGE MANAGEMENT, SOFTWARE

AUGUST `02 MONTH END: 1.56 52-WEEK RANGE 1.18-8.10 MARKET CAP: 154M

BYE-BYE BILL—StorageNetworks' co-founder and CTO, Bill Miller, will leave the company and the board of directors. David Dew has been named the new CTO and will be joining us at Telecosm this month. Dew's experience as director of BMC Software's Storage Solutions Development complements StorageNetworks' ongoing transition from remote storage utilities to storage management software and services.

Scale Eight

MASSIVELY PARALLEL GLOBAL STORAGE

PRIVATE

SPANNING THE GLOBE—Scale Eight has won the business of Wired Entertainment, which is based in Australia, and now supports customers on four continents.

Mirror Image Internet

GLOBAL CACHING AND STOREWIDTH PLATFORM

PRIVATE

SUMMER VACATION—Customer Wins: Pacific Sunwear and Orvis.

Equinix (EQIX)

SECURE INTERNET BUSINESS EXCHANGES

AUGUST `02 MONTH END: 0.31 52-WEEK RANGE 0.31-3.53 MARKET CAP: 31M

GAME ON!—Electronic Arts, the $1.7 B (sales) leader in sports video game software, has selected Equinix's Internet exchange services and Internet Business Exchange centers to enhance the speed and reliability of its online gaming offerings.

MEAD'S ANALOG REVOLUTION

NATIONAL SEMICONDUCTOR (NSM)
SYNAPTICS (SYNA)
SONIC INNOVATIONS (SNCI)
FOVEON
IMPINJ
AUDIENCE INC.
DIGITALPERSONA

COMPANIES TO WATCH

ANALOG DEVICES (ADI)
AVISTAR (AVSR)
BARCELONA DESIGN
BLUE ARC
COMCAST (CMCSK)
COX (COX)
ENDWAVE (ENWV)
POWERWAVE (PWAV)
SAMSUNG
XILINX (XLNX)

Sprint PCS (PCS)

NATIONWIDE CDMA WIRELESS NETWORK

AUGUST `02 MONTH END: 3.96 52-WEEK RANGE 2.36-29.05 MARKET CAP: 3.9B

SMILE!—Early indications from Radio Shack and Sprint PCS retail stores point to better than expected demand for Sprint's Vision, its newly launched CDMA2000 1x data network. The popularity of the Samsung A500 phone and Handspring Treo PDA has continued and is now joined by the Samsung N400, which like the A500, offers the digital camera feature, allowing users to take and send pictures over the PCS network. Walter Mossberg continues to say Sprint's Treo PDA is the best all-in-one communication device, hands down.

Qualcomm (QCOM)

CDMA INTEGRATED CIRCUITS, IP, SOFTWARE

AUGUST `02 MONTH END: 27.71 52-WEEK RANGE 23.21-66.59 MARKET CAP: 21.5B

QUALCOMM DOWNUNDER?—Telstra, Australia's largest mobile provider with nearly 6 million users, is considering CDMA2000 for its planned 3G upgrade. Telstra is currently conducting commercial tests of CDMA2000 1x, encouraged by the monumental successes enjoyed by its Asian neighbors—KDDI in Japan, China Unicom, and all three Korean carriers. Korean handset sales for August reached 1.49 million units, up 6% from July and 10% year-over-year. Color handsets, much like the ones offered by Sprint PCS, continue to drive demand, accounting for 75% of August sales. KDDI extended its dominance of the Japanese 3G market, adding 498,000 new 1x subs in August for a total of 2.1 million. Meanwhile, competitor NTT DoCoMo added 6,000 FOMA subs in August for a total of just 134,000 in 11 months of operation. Slow out of the blocks, China Unicom's CDMA network is now showing signs of life, adding 435,000 subs in August to break the 2 million mark. Building on this momentum, our favorite handset provider, Samsung, has agreed to supply China Unicom with 700,000 CDMA2000 1x color screen handsets between October and December. Although the Street is skeptical as to where all these ASICs are going, Qualcomm announced that it would ship at least 20 million MSM chipsets in the September quarter, 15M of which will be 1x, and at least 22 million units in the December quarter.

Revelation: After more than 500 million sales of Qualcomm chipsets for CDMA phones around the world since 1995, Michael Murphy of the *California Technology Stock Letter* earnestly announces that Irwin Jacobs and his band of persistent engineers down there in San Diego *finally* have the technology working. QCOM is his stock pick of the year. Welcome aboard, Mike.

Altera (ALTR)

PROGRAMMABLE LOGIC DEVICES

AUGUST `02 MONTH END: 10.71 52-WEEK RANGE 10.19-31.05 MARKET CAP: 4.1B

STRATIX STRENGTH—Altera's mid-quarter update on August 26 shows sales tracking with expectations. The new high-end Stratix family of PLDs continues to garner strong customer design-win traction. Since its introduction in May 2002, Stratix devices have shipped to over 100 customers, and the rollout of 6 members of the Stratix family remains on track.

Broadcom (BRCM)

BROADBAND INTEGRATED CIRCUITS

AUGUST `02 MONTH END: 16.49 52-WEEK RANGE 14.69-53.35 MARKET CAP: 4.5B

WI-FI RAMPING—Sales of wireless LAN products will reach into the millions of dollars this quarter as shipments ramp a quarter ahead of schedule. Broadcom's 802.11b Wi-Fi solution is being implemented in at least 30 significant platforms with a half dozen or more customers. Curiously, volume production of 802.11g is expected by year-end with 802.11a to follow during the 1H03.

Terayon (TERN)

BROADBAND CABLE MODEMS, HEAD-ENDS

AUGUST `02 MONTH END: 3.13 52-WEEK RANGE 0.86-14.75 MARKET CAP: 228M

BATTING .500—Adelphia's September 9 announcement that they plan to deploy Terayon's DOCSIS 2.0-based modem means three of the top six U.S. cable operators are currently deploying Terayon's unique next-gen modem.

EZchip (LNOP)

10 GIGABIT NETWORK PROCESSORS

AUGUST `02 MONTH END: 7.00 52-WEEK RANGE 2.70-16.45 MARKET CAP: 51M

TROPHY CASE—EZchip's NP-1 network processor has been named winner of the 2002 Comet Award from *Communication Systems Design* magazine. Now we need CEO, Eli Fruchter, to trade some of his trophies for design-wins.

National Semiconductor (NSM)

SINGLE-CHIP SYSTEMS, ANALOG EXPERTISE, FOVEON IMAGERS

AUGUST `02 MONTH END: 15.99 52-WEEK RANGE 15.44-37.30 MARKET CAP: 2.9B

POWER PLAY—National was unable to avoid the perils of a weak PC market when it reported its 1Q03 earnings on September 4, and a nonexistent back-to-school market this quarter leaves little hope for strong holiday sales. Blunt CEO Brian Halla blames a "crappy world economy and an especially crappy U.S. economy." Wireless, however, continues to be strong, now representing 30% of sales. And power management is a huge upside surprise for National, with orders growing 75% sequentially and 250% year-over-year. The proliferation of handsets with color screens and integrated cameras, which require increasing analog semiconductor content, play to National's strengths. COO Donny McLeod says National is playing less and less in commodity markets and winning customers not with better prices but with unique and sometimes customized technology. National may be the world's cheapest semiconductor stock, according to the Street. With $10 per share in cash and a price to sales ratio of 1.44, National is currently valued at less than one-third of the industry average of 4.70 and nearly half the average of the S&P 500.

Image-ine That: In its most recent earnings call, National executives stressed the potential of its CMOS imager line like never before. Foveon, of course, leads the pack, but lower-end imagers are already going into production of mobile phones.

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Synaptics (SYNA)

TOUCH-SENSORS, FOVEON IMAGERS

AUGUST `02 MONTH END: 6.00 52-WEEK RANGE 3.52-20.75 MARKET CAP: 139M

YOU NEED TO DIVERSIFY—A weak PC market is bad for the leading provider of notebook computer touchpads. Synaptics must therefore continue to broaden its product offering. As National Semiconductor corners the power management aspect of the booming handheld device market, Synaptics is moving to conquer the interface arena with products like ClearPad, a transparent touchscreen, and Spiral, an inductive pen-sensing solution.

Intel (INTC)

MICROPROCESSORS, SINGLE-CHIP SYSTEMS

AUGUST `02 MONTH END: 16.67 52-WEEK RANGE 15.03-36.78 MARKET CAP: 111.2B

SIX-YEAR LOW—Intel last hit $15 in 1996. But we would argue that, bad economy aside, Intel is a better company now than when it traded at $70. With its new focus on Wi-Fi, SiGe, single-chip systems, radios, and multifarious CMOS sensors—not to mention its $4.5 billion R&D budget and $5 billion in cap-ex—it is far better positioned for the next five years than it was for the last five. Did we mention that worldwide PC sales, though in a funk right now, will only continue to grow for years to come? In other words, the Pentium is still a strong foundation from which to launch even higher-growth products. On a price/sales and price/book basis, Intel is historically cheap, and its price/earnings multiple of 20 (2003 earnings) is near the low of 18 achieved in the 1998 earnings trough. Barring a sustained depression, Intel's financial power and newfound technology leadership should help the company emerge on the other side with a jump on its numerous communications chip competitors.

Texas Instruments (TXN)

DIGITAL, ANALOG, MIXED-SIGNAL PROCESSORS

AUGUST `02 MONTH END: 19.70 52-WEEK RANGE 18.16-37.00 MARKET CAP: 34.2B

EYE ON INTEGRATION—Texas Instruments announced the development of a new wireless chip designed to connect mobile devices to short-range wireless networks. TI's latest WLAN processor for embedded Wi-Fi applications is said to be less expensive, 44% smaller, and most importantly, 25% more efficient than the leading solution. TI also announced plans to integrate several technologies, such as Wi-Fi and global positioning system locators (GPS), into one chip and to look for these single-chip cellphones "in stores" within two years.

Narad Networks

GIGABIT ETHERNET COAXIAL CABLE NETWORKS

PRIVATE

BUILDING BACKLOG—Narad is now shipping products to every continent but Australia, yielding a $27 million backlog and monthly revenues of $3 million.

Soma Networks

BROADBAND WIRELESS ACCESS, NETWORK SOFTWARE

PRIVATE

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.

application of Fast Fourier Transforms to multiply frequency paths and of adaptive equalization to find the best ones. OFDM has already won in 802.11a for fixed- data traffic, where it can complement Qualcomm's mobile standards. But Drucker's law—to displace an established player entails a tenfold advantage—marginalizes OFDM. With all its Viterbi flash, OFDM is not remotely a tenfold winner against CDMA for mobile uses. Indeed it may well not be better at all.

With photographic, teleconferencing, and gaming capabilities galore, CDMA2000 is BREWing up a storm. Wi-Fi will serve as a valuable complement. It will not compete with Qualcomm systems or with fiber; it will compete with wired LANs everywhere. With Broadcom and Intel putting every television set-top box and PC on wireless LANs, the ultimate outcome will be an electronic universe of sand and glass and air: what I call the Telecosm.

Negroponte explains that in top-down networks a flood of new users would crowd the available bandwidth (consider how cable modem service degrades as neighbors come on-line). But bottom-up meshes improve with more users. With every user also an access point, the Net spreads virally, with the per-customer bandwidth increasing as the number of customers rises. Hence bottom-up Wi-Fi will prevail.

Picture it. Bearing discreet antennas and Wi-Fi chips on every motherboard, your laptop, notebook, Palm, Treo, and cellphone will all function as richochet routers to neighboring nodes. Negroponte describes his own experience: "802.11 systems … do not stop at the walls of your home … they can radiate more than 1,000 feet [Well, not really, but let it pass]. Since I live in a high-density area, my system reaches perhaps 100 neighbors. I do not know how many use it (totally free)—frankly I do not care. I pay a fixed fee and am happy to share."

As you travel and link to the Net, you will provide connections through your antenna to nearby computers and you will happily use others' antennas to hop across the land. For rural applications, so Negroponte avers, directional antennas can afford links of up to 20 kilometers or more, leading to a Wi-Fi renaissance in the boondocks around the globe. And in outer space, the signals can travel for light-years without amplification, bringing convenient service to indigent Klingons for millennia to come.

Whee! It's broadband, it's democratic, it's peer-to-peer, it's picturesque, it's bottom-up, it's viral, it's free! Perhaps it's even organic. Nicholas warns that Europeans are sensitive to the health implications of electromagnetic "smog." Living longer than anyone else on the face of the earth, and with more cellphones, Finns and Swedes have more years than the rest of us for senile fears and phobias. In any case, Nicholas's vibratory lily pads will emit low-power, short-distance waves, bearing a maximum of just one watt. "One can assume that lower power means lower health risk," he says. Tell that to the barracuda bar.

The Lilypaddington world will have to wait, however.

Wi-Fi shares a small, congested span of 85 megahertz of spectrum at 2.4 gigahertz. It is the home of Industrial, Scientific, and Medical (ISM) uses that take priority. It is the home of Bluetooth short-range links to computers, handsets, and other personal area networks of up to 30 feet in diameter. It is the home of subtle harmonies from microwave ovens, garage door openers, and other diurnal radiance. It accommodates cordless phones, wireless audio speakers, baby monitors, and TV video extenders. Why is it then that every venture capitalist, microchip entrepreneur, telco equipment vendor, and systems engineer in the U.S.—and half the software coders in Bangalore—are now rushing into this junk spectrum band as if it were a new wireless nirvana?

Negroponte would claim it is the intrinsic attraction of an elegant technology, with the disruptive dynamics of bottom-up adoption. But the actual reason is simple. It is the same reason that Cisco (CSCO) is increasing its market share dominance in communications gear by focusing on enterprise networks. For those who emit less than one watt of energy, spread their spectrum, and follow the rules, the ISM bands are relatively unregulated. That's all it is. Junk spectrum, cluttered and thronged, with a noise floor like a turnpike at rush hour, can attract money from Mars if it escapes the reach of the auctioneers and bureaucrats in Washington and across the country. What all those road-to-ruin companies caught in the nine-inning Googin gantlet have in common is one overriding vulnerability: regulation by several branches of the federal government and by 50 state public utilities commissions. The chief cause of the telecom crash is the devastating collision between a technology advancing its capabilities some 3,000-fold every five years with a hydra-headed bureaucracy that taxes, controls, and stifles anything that moves faster than it does.

Traffic Update

With an incisive analysis of Internet traffic, our Charlie Burger explains the crisis that befell telcos over the last decade. According to the optical team at RHK, U.S. Internet backbone traffic for June 2002 was around 136 petabytes (10^{15} bytes). This is an awesome number representing some 9,000-fold growth since June 1995. But just as important was the transformation in the nature of the traffic. During this period, U.S. Internet traffic grew from a level of roughly 17 terabytes (10^{12}), a few hundredths of one percent of total voice traffic, to a level some 10 percent higher than voice traffic. While regulators twiddled a million words of new Telecom law and litigators swarmed, an explosive transformation of the balance of traffic from voice to data entailed a huge new buildout of optical networks.

Financing this reconstruction for data around the world was roughly a trillion dollars of debt. According to all our rear-view wisdom, some of the money was wasted. More important, however, was that all of the money was deflated. With the dollar rising 40 percent against gold, other commodities, and currencies after 1996, telco debtors had to repay in dollars between 25 and 40 percent more valuable than those they borrowed. The result was bankruptcy and chaos cascading through the supply chains of telecom.

A continued tsunami of Internet traffic from rapid rollout of multi-megabit broadband links could have saved the day. But instead the courts scotched Napster, the regulators botched the local loop, and Internet growth slowed sharply to around 85 percent this year, down from a doubling in 2001 and from 130 percent growth in 2000 and 160 percent growth in 1999. Combining RHK's results with the latest figures from both Larry Roberts and the University of Minnesota's revered expert Andrew Odlyzko shows that traffic has been roughly doubling yearly since the Browser Boom of 1995–96 when it grew 9.7x annually. These were the glory days when John Sidgmore of WorldCom UUNET declared that traffic was doubling every three months, and so it was, for two years or so, on Sidgmore's business-oriented UUNET.

A comparison of these traffic growth rates to TeleGeography's figures on network lit capacity offers little hope for U.S. long-haul components and systems vendors for four more years. Metro, however, is a different story. As of mid-2002, in the top U.S. markets, Internet connections created a maximum gateway onto the Net of 5 Gbps. Although 5 Gbps equals only 5 percent of lit metro fiber, allowing for peak rate usage dictates that metro links begin to clog in just over 12 months: good news for Ciena-ONI (CIEN), Avanex, Essex, and other stars of metro optics.

With the U.S. in dreamland, I think power in the world economy will shift toward China and other countries that take technology seriously

These predictions may be pessimistic. Catastrophists contemplating the world of telecom have long compared traffic with bandwidth for a critical index of the utilization of the network. Coming up with tiny rates under 1 or 2 percent of the capacity of the fiber, they bemoan an egregious glut and prophesy the failure of all the companies in the field. But from the beginning, the voice network has never maintained utilization rates any higher than the current fiber network does. The twisted-pair lines to your household lay fallow all but 20 minutes every day: half of that time the user is listening; half of the talk time is devoted to pauses. Thus real use of the line fell well below 1 percent.

Clearly the phone companies can succeed without full utilization of their facilities. The fact that 9-1-1—perhaps the most important service—is almost never used at all suggests the need for a new model of network value. The key is not traffic or bandwidth itself but ubiquitous and reliable connectivity at a threshold level of bandwidth. Driving the current doldrums is a rise in the threshold by two orders of

magnitude as the network shifts from voice applications to Internet multimedia and video teleconferencing. From 64 kilobits per second to at least 6 megabits per second and from dialup availability to always-on connectivity, the network has drastically changed its criteria of adequacy.

In the context of the new network, only true broadband connections impart pertinent connectivity. That means all the fears of monopolistic Bells are groundless. Unless the Bells are permitted to escape their copper cages, they will become gigantic bloated bureaucracies athwart the path to a broadband infrastructure. To achieve the new broadband infrastructure will require visionary deregulatory policies in Washington and around the world. We cannot delude ourselves that government mandates and Wi-Fi pipedreams can bring alive a vast new optical web of fiber trunks and multifarious wireless and wireline access points.

At Telecosm, our annual conference on the industry, beginning on September 30, we'll explore these issues on a high level. Leading six or so codgers up Greylock Mountain in the Berkshires and coming in 22 out of 68 in the race last week, I am in shape to lead any bold climbers up Squaw Peak above the Telecosm Inn. There vistas of futurity will open at our feet. From the summit we can look out beyond the clouds and cliffs, storms and bears, and glimpse Lake Tahoe shining in the sunlight. On a clear day we can see Nevada, if not Nirvana, in the gloaming—the exponential advance of Negropontine Wi-Fi "lily pads" across the lake to Incline Village, to sniff out sage judgments on the valuation of junk bands of spectrum from Michael Milken, and across the country to Great Barrington, perhaps backed up with a global Googinplex of federal fiber trunks and vertebrae.

The China Phenomenon

But I doubt it. With the U.S. in dreamland, I think power in the world economy will shift toward China, Korea, India, and other countries that take technology seriously. As Nick Tredennick showed in the August *Dynamic Silicon* reporting on his trip to China, this country of 1.3 billion people is no paper techer. With Taiwan in tow—and integration of the Taiwanese economy on the Hong Kong model continuing apace even if political integration lags—China already commands the world's best independent semiconductor facilities in TSMC and UMC. With TSMC preparing to invest $898 million over the next four years on the mainland, mainland China will offer the world's second largest foundry capacity by next year. With 167 million users, China is already the world's largest cellphone market, and it is set to double in two years.

China is determined to use this market dominance to achieve technical and commercial dominance as well. A possible spearhead will be its proprietary TD-SCDMA (Time Division Duplex Synchronous Code Division Multiple Access) 3G cellular system that exploits smart antenna technology and time division multiplexing to enhance spectral efficiency—the number of bits per second carried per hertz of frequency. Essentially the smart antenna isolates users in space and TDMA spreads the signals through time. Enhancing the signal along the vectors of time and space incurs a burden of complexity and cost. But CDMA itself trades complexity and cost for the systemic benefits that are giving it dominance today.

Contrived in a ten-year partnership with Siemens (SI) of Germany, TD-SCDMA is designed as a seamless upgrade for the world's billion GSM phones. As a CDMA system, TD-SCDMA tramples all over Qualcomm's intellectual property. Even Chinese use of TDMA for separating upstream and downstream transmissions asymmetrically repeats the essential insight of Qualcomm's Data-Only 2.4 megabit per second system that rotates the users in time. But with most of the world's cellphones in China and TD-SCDMA targeted at GSM users, intellectual property rights may not matter.

Writing in *IEEE Wireless* in April, engineers from China, Taiwan, and Siemens/Infineon (IFX) explained the reason the country was pursuing this anomalous cellphone standard. They declared the new system to be vital in case of a "possible war with the U.S. and its allies." The bald bellicosity of this Chinese article might add a political caveat to projections of revenues from Qualcomm's relationship with China Unicom (CHU) and EZchip's (LNOP) breakthrough design-win at the Chinese router company ZTE.

Tredennick's *Dynamic Silicon* report stresses the awesome two-edged sword of this emergent Titan with 700,000 engineers graduated annually, ten times as many as in the U.S., and soon a wireless market three times as large as the U.S. There is no reason to panic. China is turning toward free markets, as the article also avers, and free markets are not zero-sum. The riches of China can also be our own, if we cultivate this coming capitalist colossus, enhance our educational and entrepreneurial energies, and unleash new opportunities though free market trade and investment policy. We have to cut tax rates, stabilize the dollar, and deregulate telecom. It would be easier if potential allies in the industry did not disable their minds with fantasy.

—George Gilder and Bret Swanson, September 20, 2002

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