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Hardware Softens, Software Hardens, PLDs Prevail

Playing the paradigm on multiple levels, Qualcomm is our choice as the best technology company in the world

Inside:

For the last ten years, the programmable logic business, led by **Altera** (ALTR) and **Xilinx** (XLNX), has been moving to center stage of the microchip industry. With steadily growing profits, this $3 billion tail is beginning to wag the $70 billion silicon dog of fixed-function circuits.

Over the last month, the makers of programmable logic devices (PLDs) made new bets on the future. Issuing a portentous challenge to the microprocessor and application-specific-integrated-circuit (ASIC) players that have long dominated the industry, Altera will soon unveil a new version of its Nios soft-core processor line and Xilinx purchased **Triscend**.

Triscend sells microcontrollers based on its own low-end, eight-bit microprocessor "cores" or on cores defined by **ARM** (ARMHY). Using Triscend's software, engineers "drag and drop" functions into a bloc of on-chip programmable logic to create unique microcontrollers for a huge variety of end products.

Bearing logic programmable and reprogrammable in hardware, Triscend offers a limited set of chips that serves a broad range of applications. In contrast to microprocessors like **Intel** (INTC) Pentiums that perform as central processing units for PCs, microcontrollers are "embedded" in other systems, such as cell phones or ovens. Flooded with thousands of microcontroller choices, today's microcontroller market is so fragmented with low-margin chips that few manufacturers make money on them. As a startup in a crowded field, Triscend failed either to consolidate the market with its cheap and functional technology or to create a sufficient number of unique up-market microcontrollers with high margins. So after running through $66 million of venture money, it faced fire-sale offers of $13 million from ARM and then $26 million from Xilinx for the entire company.

For ARM the bid made eminent sense, giving it a shot to downplay its low margin, low end microprocessor cores and consolidate the microcontroller market as an ARM domain. But for Xilinx the deal seems merely a move to preempt potential competitors in the increasingly strategic programmable logic market.

To a first approximation, the PLD market is $3 billion, the application-specific integrated circuit (ASIC) market is $30 billion, and the microprocessor market is $40 billion. With both **Samsung** and **Gartner** (IT) chiming in this week with yet further increased projections for cell phone handset sales, market emphasis has shifted from devices that get power from a wall socket (tethered) to devices that carry their power sources (untethered). This shift changes the key design goal from cost performance to cost-performance-*per-watt*. With one-million-dollar photomask sets that imprint the design on a microchip wafer and ever-smaller and more-power-leaking transistors on ever-denser chips, the fixed-circuit semiconductor industry is cruising toward a wall in the untethered realm.

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The ASIC market

The first crisis is coming in the ASIC market dominated by companies like **IBM** (IBM), **Fujitsu**, and **LSI Logic** (LSI). In the midst of a semiconductor boom, ASIC design starts are down substantially and they will continue to decline. At perhaps ten times the price of the photomask set, it's just too expensive to design an ASIC for any but huge-volume markets. To lower costs and enhance volumes some ASIC innovators such as **Chip Express** and **eASIC** are struggling to "soften" ASICs into adaptable structured ASICs and other ASIC manufacturers are producing application-specific *standard products* (ASSPs) such as chips sets for cell phones sold by **Motorola** (MOT) and **Texas Instruments** (TXN). From the customer's point of view, ASSPs have the advantage of lower development cost, but they make product differentiation difficult for manufacturers because competitors use the same chips.

ASICs require hardware designers: people who understand the physics of microchips. Microprocessors require programmers. There are more programmers than hardware designers. So microcontrollers, produced by Xilinx (Triscend) and many others, will displace ASICs on the low end. But the profits will tend to go to programmable logic makers. Allowing just-in-time customization rather than multi-year design cycles, programmable logic is on a fast arc of advance. The key to its superiority is its business model for intellectual-property.

Integrating intellectual property

The semiconductor industry is dividing into a small set of vertically integrated device manufacturers (IDMs), such as Intel, Texas Instruments, and **NEC** (NIPNY), a larger number of intellectual property (IP) inventors and packagers, such as ARM and **Qualcomm** (QCOM) (which also sells chips and systems), a small group of IP aggregators, such as Altera and Xilinx, which assemble IP from many sources, and a growing circle of foundries, such as **Taiwan Semiconductor** (TSM) and **United Microelectronics** (UMC) in Taiwan that manufacture the chips. It has been a struggle for IP inventors, with few successes. Qualcomm and ARM are the most successful companies in the IP business; others struggle.

Moore's law has multiplied the number of transistors on a single device to the point that one chip typically contains intellectual property from many sources. But to the industry, IP means a packaged design database that can be purchased to perform a function on a chip. Chip designers have four main sources of such IP: pure IP companies (ARM, **CommStack, Digital Core Design, MIPS** -MIPS, **Nova Engineering, Sciworx**), design-automation software companies (**Cadence** -CDN, **Mentor** -MENT, **Synopsys** -SNPS), programmable logic companies (Altera, Xilinx), and foundries (**Chartered** -CHRT, **Semiconductor Manufacturing International** -SMI, TSMC UMC), which offer IP libraries with their manufacturing services but little other design help.

Altera and Xilinx look like chip suppliers, but they are actually suppliers of design-automation software at prices drastically lower than what design-automation companies can offer. From companies such as Cadence and Synopsys, design-automation software and access to the corresponding IP libraries can cost *hundreds of thousands of dollars per user "seat"* regardless of how many chips are sold. This is cost effective for high-volume chip designs, such as microprocessors or memories, but not for the zoos of different microcontrollers, for example, each with a specialized use. As early as 1991, Altera offered design tools on the Microsoft Windows platform priced per chip sold rather than per seat filled. Altera and Xilinx provide their design software as a loss leader for their chip sales. Per-chip amortization is much better than per-seat amortization, giving Altera and Xilinx a solid long-term position against design-automation software companies. Their component pricing is set to *prevent* excessive distribution—to prevent swamping their support lines with calls from hobbyists. But I expect Altera and Xilinx to some day offer free software and 900-number support. It would multiply design seats without making them guess at the dividing line between serious designers and hobbyists.

In addition to supplying chips and design-automation software, Altera and Xilinx are distribution channels for intellectual property. Each has its own library of intellectual property "cores" (basic functions) and each distributes cores from third parties. Chip revenues subsidize the development of in-house IP. Altera and Xilinx don't offer one-stop shopping (for some IP, you "click through" a link and deal with a third party for a license), but one-stop shopping could be on the way too.

System-on-chip

Under the pressure of Moore's law, everything heads toward system-on-chip (SoC) implementations. The typical SoC comprises a microprocessor core, memory, and application-specific peripherals. To participate in the growth of SoC, Altera and Xilinx offer chips with either hard-core or soft-core microprocessors. A hard core is a set of custom circuits designed for a particular semiconductor process or for a particular foundry. A soft core is a software description that is implemented by configuring pre-existing logic on the chip. The soft core is less efficient, but it is independent of the manufacturing process used to make the chip. Altera's Excalibur chips incorporate a hard-core ARM microprocessor with a standard set of peripheral functions. Xilinx's Virtex-II Pro chips incorporate from one to four hard-core PowerPC microprocessors. Altera's soft-core microprocessor is Nios; Xlilnx's soft cores are MicroBlaze and PicoBlaze.

This may be where Altera and Xilinx part company

strategically. Altera seems to be de-emphasizing hard-core microprocessor implementations. Instead, Altera is concentrating on its soft-core microprocessor, Nios. Xilinx implements hard-core PowerPCs in its leading-edge Virtex-II Pro components and it has bought Triscend to obtain products with two more hard-core microprocessors. Xilinx seems committed to hard-core microprocessors for its programmable logic chips. In a world where hardware is inexorably softening into programmable logic, Altera would seem to be riding the wave.

ARC and Tensilica

While Xilinx collects new hard-core processor designs, programmability is now softening the hardest heart of the fixed-function regime, the very instruction sets of microprocessors. **ARC** (ANAIF.PK) and **Tensilica** offer microprocessors with "instruction set" functions that can be configured on chip using software that allows the engineer to tailor the device to a particular application. This instruction-set customization can boost application performance by a factor of ten. It's a great idea and a great opportunity for these companies to join the assault on the $70 billion semiconductor fixed-circuit entrenchment. With more of the design done by widely available software programmers than by rare chip-design engineers, productivity per dollar improves. Moreover, since the result is microprocessor-based, it is possible to adjust system functions or even correct errors in software, without the costly and time-consuming delay of producing new chips.

This approach spurs new creativity in system architectures. ARC and Tensilica found that designers were using more than one configurable microprocessor per chip. Changing its strategy, Tensilica now advocates to SoC designers that, rather than implementing a controlling microprocessor and a host of custom-circuit peripherals, they should design with a controlling microprocessor and a host of configurable microprocessor cores implementing peripheral functions. This advance puts the algorithms in software where they can be written more efficiently, where corrections are possible, and where they can be more readily tested (on a desktop PC). A common design base for all functions makes sense for design consistency and for sharing information.

These pioneering products show the way for Altera and Xilinx to exploit their soft-core microprocessors and offer the advantages of custom-tailored instruction sets to the users of programmable logic devices.

The answer and a kicker

This has been a whirlwind tour of the semiconductor industry. It's time to say what it all means.

Programmable logic from Altera and Xilinx will invade market segments now held by ASICs, ASSPs, and structured ASICs. It will do this because it is supported by excellent design software, because its performance is good enough, and because it remains affordable while alternatives get more expensive. Programmable logic's capabilities grow faster than requirements grow for the bulk of the market, so programmable logic will gain share. Altera and Xilinx will become the primary distributors of IP cores for themselves and for third parties.

In microprocessor markets, programmable logic will grow in market segments now held by microprocessors, microcontrollers, digital signal processors, and microprocessor-based systems on a chip (SoCs). It will do so for the same reasons that it overtakes competitors in the ASIC market. In the microprocessor and SoC markets, soft-core microprocessors from Altera and Xilinx can offer the advantages of custom-tailored instruction sets as further inducement. In the new foundry-based IP regime, soft-core microprocessors will gain on hard-core microprocessors because they are independent of the specific semiconductor processes available at a particular foundry. It might seem that a hard-core microprocessor would have substantially better performance than a soft-core microprocessor, but the hard-core microprocessor is held back by connections to the surrounding logic. The soft-core microprocessor matches the surrounding logic; it'll be slower, but it will be good enough for most applications. The soft-core microprocessors from Altera and Xilinx can occupy as little as one percent of the resources of a high-end programmable logic device and perhaps only twenty percent of today's low-end devices. With a soft core that represents only one percent of chip resources, SoC designers can exploit programmable logic devices with a strategy mirroring that of Tensilica, but with less design risk.

Altera and Xilinx have a great future based on a combination of generic programmable logic chips, low-cost development, and excellent software that enables programmers as SoC designers.

The kicker? As designs move from tethered to untethered applications, there is enormous incentive to develop a non-volatile memory cell with the speed of SRAM and the density of DRAM. When this new memory cell arrives the programmable logic companies will be primary beneficiaries. Today's SRAM-based programmable logic devices will be replaced with chips based on the new memory cell. They will offer six to ten times the logic capacity, with better performance and lower cost. Their penetration into the much-larger ASIC and microprocessor markets will accelerate. The further kicker, however, is that from nanotubes to ferroelectrics to our own tentative pick of ovonics from **Energy Conversion Devices** (ENER), no one has yet given a persuasive existence proof of what this newry will be.

—Nick Tredennick and Brion Shimamoto

Advanced Fibre Communications	(AFCI)
Advanced Micro Devices	(AMD)
Agilent	(A)
Altera	(ALTR)
Analog Devices	(ADI)
Avanex	(AVNX)
Broadcom	(BRCM)
Cepheid	(CPHD)
Chartered Semiconductor	(CHRT)
Ciena	(CIEN)
Corvis	(CORV)
Energy Conversion Devices	(ENER)
Equinix	(EQIX)
Essex	(EYW)
EZchip	(LNOP)
Flextronics	(FLEX)
Intel	(INTC)
JDS Uniphase	(JDSU)
Legend Group Limited	(LGHLY.PK)
McDATA	(MCDTA)
Microvision	(MVIS)
National Semiconductor	(NSM)
Proxim	(PROX)
Qualcomm	(QCOM)
Samsung	(05930.KS)
Semiconductor Manufacturing International	(SMI)
Sonic Innovations	(SNCI)
Sprint PCS	(PCS)
Synaptics	(SYNA)
Taiwan Semiconductor	(TSM)
Terayon	(TERN)
Texas Instruments	(TXN)
VIA Technologies	(2388.TW)
Wind River Systems	(WIND)
Xilinx	(XLNX)
Zoran	(ZRAN)

Note: The Telecosm Technologies list featured in the Gilder Technology Report is not a model portfolio. It is a list of technologies that lead in their respective application. Companies appear on this list based on technical leadership, without consideration of current share price or investment timing. The presence of a company on the list is not a recommendation to buy shares at the current price. George Gilder and Gilder Technology Report staff may hold positions in some or all of the stocks listed.

THE PARADIGM MARCHES ON

With this issue, we are returning to the list, to define the paradigm propositions of all our chosen companies. George Gilder conceived of the cell phone as teleputer on a worldwide web of glass and light and began expounding the paradigm in the late 1980s and early 1990s in *Microcosm* (1989) and *Life After Television* (1990 and 1993).

"The vision of the network as one colossal processor…will allow teleputers to enter and interact with huge databases of digital video – tens of thousands of movies, art exhibits, courseware products, 3D experiences, and other possibilities bounded only by the reach of the mind and by the span of the global ganglion of computers and cables, the new worldwide web of glass and light." Pg 23, *Life After Television* (1993).

Re-examining our list with Bret Swanson and Nick Tredennick, we have honed and amplified the original vision.

ADVANCED FIBRE COMMUNICATIONS (AFCI)

PARADIGM PLAY: ACCESS GLASS_FIBER TO THE CURB & PREMISES

MARCH 15: 23.54, 52-WEEK RANGE: 13.93 – 27.50, MARKET CAP: 2.05B

The core of the paradigm is the fibersphere—the worldwide web of glass and light at the heart of the emerging broadband Internet. But the all-optical-core network needs compatible links to neighborhoods, premises, and ultimately homes. AFCI is the chief supplier of fiber to the premises technology, being used by **Verizon** (VZ) in a billion dollar rollout in 2004 and 2005. With the purchase of the North American assets of **Marconi** (MRCIY) in March 2004, AFCI also commands leading-edge fiber to the curb technology, used by **BellSouth** (BLS).

Addressing skeptics who have heard the Bell fiber-to-the-x story many times over the last 15 years, CEO John Schofield on March 9 said Verizon has already begun ordering AFC systems.

ADVANCED MICRO DEVICES (AMD)

PARADIGM PLAY: INTERNET COMPATIBLE PROCESSORS

MARCH 15: 14.60, 52-WEEK RANGE: 5.50 – 18.50, MARKET CAP: 5.14B

The Avis of microprocessor design is AMD. In the all-Internet all-the-time teleputer paradigm, the DNA (digital normative architecture) will be the instruction set of the x86 microprocessors from Intel and AMD that inform both Windows and Linux operating systems and the applications that invoke them. Although posing no long-term threat to the Intel imperium, AMD has gained a tactical edge at the top end with x86 extensions for 64-bit processors and at the bottom end with the purchase of the x86 Geode line from **National Semiconductor** (NMS).

In late February, **Hewlett-Packard** (HPQ), long an Intel partner and the original source of Intel's high-end Itanium design, announced it would build servers with x86-friendly AMD64 chips. After this blow to the embattled Itanium, Intel admitted it would have to rush an x86-friendly 64-bit chip to market. AMD shares trade down more than $2 from their recent high of 17.50.

AGILENT (A)

PARADIGM PLAY: MICROCOSMIC OPTICS, CDMA POWERAMPS

MARCH 15: 30.27, 52-WEEK RANGE: 13.00 – 38.70, MARKET CAP: 14.55B

Agilent is Hewlett-Packard Classic—all the test equipment, optics, analog microchips, and interface devices abandoned in the new Compaq HP as it endeavors to become a printer and 'puter colossus. For the future, Agilent is developing an optical transceiver transplant for silicon chips that can potentially close the gap between the external bandwidth of chips and their bandwidth on chip. This is the heart of a new paradigm of microcosmic optics also being pursued by a variety of stealthy startups. As paradigm bonuses, Agilent is also the leading manufacturer of CDMA (code division multiple access) power amplifiers and it commands an all-optical switch that might be revived when optical telecom comes back.

ALTERA (ALTR)

PARADIGM PLAY: SOFTENING HARDWARE, HARDENING SOFTWARE

MARCH 15: 20.34, 52-WEEK RANGE: 12.64 – 26.82, MARKET CAP: 7.70B

In the paradigm, software is hardening and hardware is softening. Programmable logic titan Altera does both. Its programmable logic softens hardware by rendering it reprogrammable in real time. Its robust design tools automate, simplify, and thus "harden" the programming of its chips. These capabilities enable Altera (and its rival Xilinx) to expand from the $3 billion market for programmable logic into the $30 billion market for supplanting application specific integrated circuits. Clearly in view of Altera's soft core Neos device that can be implanted on any Altera chip is the $40 billion market for microprocessors and digital signal processors.

ANALOG DEVICES (ADI)

PARADIGM PLAY: ANALOG EVERYWHERE & SOFTENING RADIOS

MARCH 15: 46.60, 52-WEEK RANGE: 26.65 – 52.37, MARKET CAP: 17.42B

A key to the paradigm is the continued power of analog in a digital age. With a global total of perhaps five thousand analog designers, analog expertise is rare and costly and ADI has a meaningful share of the world's analog design talent, several hundred analog engineers. Radio frequency (RF) expertise, a form of analog, is also hard to find, and ADI is well equipped, particularly in the paradigmatic software radio field. MEMS (microelectromechanical machines) were ascendant in the microcosm before the new nanotech NEMS fashion became charismatic in Washington. ADI does real MEMS—accelerometers and gyros.

AVANEX (AVNX)

PARADIGM PLAY: MAGIC OF WAVELENGTH DIVISION MULTIPLEX (WDM)

MARCH 15: 4.49, 52-WEEK RANGE: 0.71 – 7.57, MARKET CAP: 607.14M

The all-optical network is at the heart of the para-

digm. Multiplying the carrier colors that bear both the message and signify its route is key to the future of the network. Avanex has been a favorite vendor of devices, such as optical multiplexers and demuxes that obviate the bother and burden of optoelectronic conversions. Since the crash, the company has purchased optical component divisions from **Corning** (GLW), **Alcatel** (ALA) and **Vitesse** (VTSS) and broadened its line to cover the field of optical and hybrid modules. We still like Avanex, though it is no longer a pure and focused all-optical play.

BROADCOM (BRCM)

PARADIGM PLAY: LEADING FABLESS BROADBAND DESIGNS

MARCH 15: 38.48, 52-WEEK RANGE: 11.86 – 45.00, MARKET CAP: 11.65B

Since Carver Mead of Caltech first predicted it in the 1970s, a key to the paradigm has been the horizontal disaggregation of the microchip industry. With foundries (independent wafer "fabs") doing the manufacturing and fabless teams doing the design, the industry changes from a hierarchy dominated by integrated device manufacturers such as Intel and Texas Instruments to a heterarchy where fabless companies such as Qualcomm and Broadcom are ascendant. Predicted by Mead, the result is an explosion in the number of designs produced in the industry. Next to Qualcomm, Broadcom is the most successful of the fabless companies, and like Qualcomm, it focuses on paradigmatic bandwidth and communications chips.

In March Broadcom continued its dive into new but high-volume markets, as it announced new Gigabit Ethernet and storage chips for small and medium sized businesses and consumers. Especially interesting is the new "Network Attached Storage on a chip" solution (NASoC). Designed to bring the connectivity, redundancy, capacity, and sharing capabilities of enterprise level RAID storage systems to small offices and homes, the chip will facilitate the easy networking of consumer-class PCs to one another and to hundreds of gigabytes or terabytes of storage in new office and entertainment servers.

CEPHEID (CPHD)

PARADIGM PLAY: MICROELECTRONIC MACHINES FOR DNA IDENTITY

MARCH 15: 9.03, 52-WEEK RANGE: 3.03 – 13.56, MARKET CAP: 324.17M

One of Nick Tredennick's specials and a prime choice in the MEMS space, Cepheid was founded by one of the inventors of the polymerase chain reaction process, the PCR method of identifying and multiplying DNA sequences. Co-founder Kirk Peterson, an articulate MEMS exponent, sees his company as the leading candidate to create a lab on a chip for identifying dangerous toxics in an era of terrorism.

CPHD shares have suffered their first retreat in more than a year, trading in the mid-8s, after reaching 13.56 in January. The company projects a net loss of $10.5-$12.5 million this calendar year, but with projected sales reaching $42-$46 million (compared to $15.8 million in 2003), growth is rapid.

CHARTERED SEMICONDUCTOR (CHRT)

PARADIGM PLAY: MICROCHIP FOUNDRY SPECIALIST

MARCH 15: 8.89, 52-WEEK RANGE: 3.45 – 11.40, MARKET CAP: 2.22B

Epitomizing the new heterarchy, Chartered is the fourth foundry in revenues, behind TSMC, UMC, and IBM. Headquartered in Singapore, Chartered recently concluded a deal with IBM for access to its 90-nanometer process technology.

CIENA (CIEN)

PARADIGM PLAY: OPTICS AND ACCESS TO FIBERSPHERE

MARCH 15: 5.25, 52-WEEK RANGE: 4.191 – 8.14, MARKET CAP: 2.49B

David Huber's initial vessel for his all-optical vision, Ciena went astray into hybrid modules and optoelectronic kludges. But then it bought metro optics leader ONI and made its way back onto the list. Following an acquisition strategy, Ciena now focuses on multiprotocol edge devices such as WaveSmith and router newcomer Laurel. Hey, we still need a digital edge. Huber went on to pursue his grail with Corvis.

CORVIS (CORV)

PARADIGM PLAY: THE PARAMOUNT ALL-OPTICAL COMPANY

MARCH 15: 1.80, 52-WEEK RANGE: 0.51 – 3.07, MARKET CAP: 865.64M

A core vision of the paradigm is the all-optical network pioneered by Corvis. A pivot of paradigm strategies is the *integration* and *modularity* scheme of Harvard Business School professor Clayton Christensen. In overshoot industries, such as personal computer hardware, where the technology exceeds the real demands of customers, the winners follow a modular strategy, standardizing interfaces and outsourcing key components, such as microprocessors and disk drives. Telecom, however, is an undershoot industry, where existing technology is too complex and expensive and fraught with delay to enable desired applications such as robust and reliable Internet broadband, video teleconferencing and interactive multiplayer 3D gaming. In undershoot situations, Christensen prescribes an *integration* strategy, in which all the interfaces are optimized and customized for ultimate system performance, usually by one company. In optical networks, that company is Corvis. Returning to the vertical structure of the original Bell system, including optical circuit switching, Corvis is an integrated pure play in all-optical networks, inventing the equipment and running its subsidiary Broadwing as an all-optical carrier. It is a prime mover of the paradigm.

Early this month, Corvis announced its acquisition of Focal Communications, a CLEC provider of voice and data services to 4,000 enterprise customers with networks in 23 tier-one markets. The deal advances the Corvis "Access Forward" strategy of substantially lowering local network leasing charges by building or buying its own facilities on the edge of the network. In nine markets, Focal owns its own fiber optic facilities. Focal sales in 2003 were about $320 million, but bargain shopper Corvis paid just $210 million.

CYPRESS (CY)

OFF THE LIST: MEMORIES AND INTERFACES BEING USURPED, MEMS AND OPTICS LAGGING

MARCH 15: 20.74, 52-WEEK RANGE: 6.51 – 24.08, MARKET CAP: 2.55B

Cypress is led by a smart and outspoken CEO, T.J. Rodgers. Cypress stock has had a great run over the last 18 months, moving from 4 to a recent high of 24. But some of its fastest growing products are about to hit a wall, and two of its new ventures have not broken through. Cypress content addressable memories (CAMs and TCAMs) and network search engines (NSEs) are the expensive sidekicks of network processors and networking ASICs, used across the communications equipment spectrum. Cypress gained substantial NSE market share in 2003, growing sales to $28 million for 33 percent of the market. The market is likely to continue expanding…until it falls off a cliff because of the integration expertise of EZchip, which incorporates all CAM and NSE functions on a single processor with commodity DRAM. Likewise, Cypress is a leader in buffers, interfaces, and clocks for backplanes and circuit boards, but new optical I/O technologies that enable direct chip-to-chip connections will eliminate many of these functions over the next five years. Cypress also entered the MEMS and digital light processor businesses a few years ago but has made nary a dent in these high growth markets. The company remains an innovator in memories (SRAM and CellularRAM) for portable devices, but new memory technologies are coming fast and furious from many parties, and until Cypress demonstrates clear leadership, we're giving it a breather and removing it from our list.

ENERGY CONVERSION DEVICES (ENER)

PARADIGM PLAY: FAST LOW-POWER RETENTIVE MEMORY FOR TELEPUTERS

MARCH 15: 7.25, 52-WEEK RANGE: 6.75 – 19.24, MARKET CAP: 182.50M

Crucial to the triumph of the teleputer—the modal all purpose mobile device of the new era—is the development of a cheaper, better, denser and faster low-power random access memory (RAM) that is non-volatile (it keeps its contents when the power goes out). Among the host of contestants, from nanotube devices at NEC to magnetic RAM at NVEC and ferroelectric RAM all over, the most advanced and densest chips come from Energy Conversion Devices. Originating with the amorphous silicon of Stanford Ovshinsky's ovonics, it has attracted support from Intel and **STMicroelectronics** (STM). But there is zoo of rivals, most recently **Axon**'s demonstration of the efficiency of a technology of ionized silver embedded between two conductors, which promises a fast and dense memory, but has yet to attract significant funding.

EQUINIX (EQIX)

PARADIGM PLAY: STOREWIDTH STAR—WHERE STORAGE & BANDWIDTH CONVERGE

MARCH 15: 31.44, 52-WEEK RANGE: 2.85 – 37.54, MARKET CAP: 487.54M

With magnetic storage plummeting with unwonted speed to an awesome price of a dollar per gigabyte and with Corvis optical transport improving its cost effectiveness by 16,000-fold in seven years, the *GTR* four years ago launched a Storewidth paradigm. It focuses on the still costly and costive interfaces between abundant bandwidth and copious storage, between capacious all-optical networks and ascendant hard drive disk systems. As bandwidth expands and proliferates among mobile devices, led by cell phone cameras and camcorders with huge image files and meager memory, both storage and processing must migrate toward the core of the network. The spearhead of the storewidth paradigm is Equinix, providing protocol neutral storewidth and peering exchanges for the global Internet. Started by Jay

Adelson of the Palo Alto Internet Exchange (PAIX), Equinix has no peer in providing the most secure and open data warehouses and it has lured the world largest networks and content companies into them. Neither major carriers nor leading content providers can shun these interop nodes of the net.

ESSEX (EYW)

PARADIGM PLAY: "TURPIN'S LAW"—ANALOG OPTICS GALORE

MARCH 15: 8.53, 52-WEEK RANGE: 2.85 – 10.45, MARKET CAP: 76.31M

Epitomizing the ascendancy of analog optics is the all-optical network, which shunts digital to the edge of the net. Governing the destination of a signal in these systems is the color of the light that carries it. Determining the number of messages is the number of colors that can be converged on a single fiber. Today Corvis uses hundreds of colors. Essex Corporation's Hyperfine system promises as many as ten thousand colors. In the early 1970s, Carver Mead summed up the *law of the microcosm* by declaring that as transistors were miniaturized and pushed closer together on microchips, they would run faster, cheaper, cooler and better. Essex chief technologist Terry Turpin sums up the promise of the *telecosm* by declaring that as wavelengths are pushed closer together on fiber optic lines they run faster, cheaper, cooler, and better. According to Turpin, one of the world's leading geniuses in analog optics, the all-optical era is just beginning.

EZCHIP (LNOP)

PARADIGM PLAY: TWO GENERATIONS AHEAD IN NETWORK PROCESSORS

MARCH 15: 8.76, 52-WEEK RANGE: 4.20 – 12.17, MARKET CAP: 63.87M

Intel Inside sums up the heterarchy of microelectronics, with the profits and creativity migrating to the providers of the microprocessor CPU from the computer's system architects. *EZchip Inside* sums up the ambitions of a group of chip designers defecting from Intel to engineer industry leading network processors. The paradigmatic hope is that the profits and creativity in routers, access gear, firewalls, wireless basestations and other network nodes will migrate to network processors from EZchip. To achieve this goal, EZchip also pioneered in parallel processing, with 64 task optimized processors on-chip, with a single software programming view. Epitomizing its bold creativity, EZchip became the first company to put DRAM cells, which are six times smaller than the usual SRAM, on board the processor chip, drastically increasing the memory bandwidth and reducing the cost of network nodes. Other advances, equally impressive, are in the works.

EZchip now boasts some 33 customer wins. About half the wins are in Asia, half are still from tier-one manufacturers, and the China market is especially strong. Over the last eight quarters, EZchip's design wins have risen at a consistent pace, starting with 3 wins in 2Q02, 7 total in 3Q02, then 11, 15, 20, 24, 28, and now 33 total wins. Three customers started shipping in this March quarter, and a similar number of customers are expected to enter the production phase in each successive quarter.

Customer evaluations are finding that *one* NP-1c processor achieves 5 times the performance (packet throughput) as *two* Intel 2800s, the leading competitive product. NP-1c also is 90 percent less complex to program.

On March 15, the company said it would sample in the fourth quarter two versions of its second generation chip, the NP-2. Each version incorporates two traffic managers as well as Ethernet MACs (media access controllers). Priced at $795 in bulk, the same as today's NP-1, NP-2"s" offers fine-grained Sonet capabilities, up to 192 T-1 streams. NP-2"e" is an Ethernet pure play but costs just $595.

FLEXTRONICS (FLEX)

PARADIGM PLAY: CONTRACT MANUFACTURER MOVES UP AND INTO CHINA

MARCH 15: 16.29, 52-WEEK RANGE: 8.05 – 19.62, MARKET CAP: 8.62B

Beginning as a humble "board stuffer" doing simple electronics assembly, Flextronics has become a leading contract manufacturer of electronic goods from cell phones to PCs and it is moving up to do system design as well. It is heavily invested in China and thus plays both in the outsourcing paradigm and the Asian ascendancy.

INTEL (INTC)

PARADIGM PLAY: MICROPROCESSOR KING MOVES ONTO NETWORK

MARCH 15: 27.10, 52-WEEK RANGE: 16.26 – 34.60, MARKET CAP: 175.72B

The colossus of microprocessors is now moving systematically into network processors. Although EZchip is still two generations ahead at the high end, Intel is capturing the low end of the market and moving up portentously. According to Tredennick's law, Intel is likely to prevail ("*Pursue volume first and you get performance; pursue performance first and you sacrifice volume and ultimately performance as well.*") We still love EZ, which is agile and ingenious, but Intel will be a major player in this telecosmic space, while retaining its franchise in microprocessors.

JDS UNIPHASE (JDSU)

PARADIGM PLAY: COMPONENTS GALORE FOR THE FIBERSPHERE

MARCH 15: 4.08, 52-WEEK RANGE: 2.60 – 5.885, MARKET CAP: 6.11B

JDSU is still the giant in optical components, with a salutary stress in mass manufacturing. Plunged deep into pump lasers at the top of the market, but retaining the broadest portfolio of devices in the industry, JDSU is a paradigm player that will rise apace with the market in optical systems.

LEGEND GROUP (LGHLY.PK)

PARADIGM PLAY: DOMINATE CHINA AND INUNDATE WORLD

FOREIGN STOCK EXCHANGE

The leading PC manufacturer in China, which means it is likely soon to become the leading PC manufacturer in the world, Legend is now moving into cell phones. It is a China choice and beneficiary of Tredennick's law (see Intel above).

MCDATA (MCDTA)

PARADIGM PLAY: STOREWIDTH IN INTERNET PROTOCOL

MARCH 15: 7.72, 52-WEEK RANGE: 7.39 – 15.90, MARKET CAP: 902.95M

Moving strongly into storewidth products over the Internet Protocol (IP), McDATA brings the benefits of storage area networks to wide area applications. It should gain share as IP becomes dominant in storage networks of all kinds.

MICROVISION (MVIS)

PARADIGM PLAY: HEADS-UP TELEPUTER DISPLAYS

MARCH 15: 8.35, 52-WEEK RANGE: 3.70 – 10.93, MARKET CAP: 179.0M

The triumph of the teleputer will ultimately require the invention of more powerful and mobile displays. Microvision currently supplies heads-up displays and helmet-mounted monitors for the military. Based on MEMS technology, they fulfill Tredennick's model of a phased movement toward nanotech, and provide the teleputer with a screen-free visual image the size and resolution of a notebook computer monitor. The stock has retreated from its recent high near 11 to about 8.5.

NATIONAL SEMICONDUCTOR (NSM)

PARADIGM PLAY: ANALOG LEADER AND IMAGER PIONEER

MARCH 15: 39.59, 52-WEEK RANGE: 16.11 – 45.25, MARKET CAP: 7.05B

The paradox of the digital age is that as more functions go digital, such as CDs and DVDs, MP3 music and MPEG video, value migrates to the residual analog interfaces to the real world. Moreover, as more functions become portable, power economy becomes more important than processing power. National combines the analog paradigm with the teleputer regime of low-power portable devices (providing some 70 percent of the power control chips for handsets). As a free premium NSM also owns 30 percent of **Foveon**'s revolutionary new imager that is likely to dominate the industry over the next five years.

The company blew away earnings expectations in its March 11 quarterly report, delivering $.48 per share compared to estimates of $.41. Sales grew 8.5 percent sequentially to $513.6 million. Company executives speaking to analysts offered some interesting new metrics:

- out of the 192 million color-screen mobile phones that shipped last year, NSM supplied the power management for two-thirds of them.
- NSM supplies the power management for more than one-fourth of all flat-panel displays.
- NSM is doing much better in 3G wireless basestations than in 2G or 2.5G. It is selling between $120 and $250 worth of chips into 3G basestations, where it only sold $10-$50 into 2.5G basestations.

The company is also excited about its new line of stereo audio products for mobile phones, MP3 players (think Apple iPod), and combination phone/MP3 devices.

PROXIM (PROX)

PARADIGM PLAY: LAST MILE WIRELESS

MARCH 15: 2.18, 52-WEEK RANGE: 0.47 – 2.90, MARKET CAP: 267.49M

The fibersphere of all-optical networks needs the atmosphere as the lungs need air. With the more highly rated and more pricey **Alvarion** (ALVN), Proxim is a leading supplier of microwave equipment for last mile wireless broadband for both enterprises and homes and Proxim also provides a portfolio of WiFi (802.11x) equipment. It has recently achieved a breakthrough in China.

QUALCOMM (QCOM)

PARADIGM PLAY: AIR KING—WORLD'S BEST TECHNOLOGY COMPANY

MARCH 15: 62.82, 52-WEEK RANGE: 29.58 – 64.52, MARKET CAP: 50.58B

Qualcomm was the first and core holding chosen

for the *GTR*'s wireless list. Playing the paradigm on multiple levels, it is our choice as the best technology company in the world. It is the number one fabless semiconductor company in revenues and profits during an era of ascendancy for Carver Mead's horizontal model of fabless designers supplying specialized foundries. It is overwhelmingly the leading wireless player during an era when wireless is becoming the dominant mode of Internet access. It is the champion manager of intellectual property at a time when share value is increasingly based on IP. It is the most effective broadband player in America at a time when broadband is gaining momentum among customers (I expect about half of DSL and WiFi customers, and a good many cable modem subscribers as well, eventually to switch to EvDO for most of their Internet access). It is the worldwide leader in 3G and is expanding its technology portfolio through GSM and TDMA. With some 20 million current customers, it is the most successful U.S. company in the ascendant domains of China and it now has 10 million subscribers in India. It is pervasive in Latin America and gaining in Russia. It will be the pivotal player in the new world of ubiquitous still and motion photography to be unleashed as Foveon breaks through in coming months. It is a leading software vendor with its robust BREW platform for wireless applets and with its pioneering Eudora email program. It is a leading satellite player with OmniTRACS. It has an ever more resourceful portfolio of new technologies, such as software radio and QChat. And it dominates location-based services using GPS and complementary technologies. What more could anyone want?

SAMSUNG (05930.KS)

PARADIGM PLAY: LEADER OF WORLD CHAMPION KOREAN INTERNET

FOREIGN STOCK EXCHANGE

Korea is the paradigm nation. While the U.S. indulged in bubbleheaded recriminations and dotcom buyers' remorse, Korea deployed Qualcomm's CDMA2000 and broadband fiber and now commands some forty times more last mile bandwidth per capita than the U.S. does. As a result Koreans transact about a third of their GDP on the net, compared to under two percent of U.S. GDP transacted on the net. Samsung is Korea's pivotal broadband company, supplying handsets that can download TV video, flash memories to store photographs and other data, liquid crystal display screens of world-beating size and quality, and an array of CDMA equipment that gives Korea world leadership in wireless connectivity.

SEMICONDUCTOR MANUFACTURING INTERNATIONAL (SMI)

NEW TO THE LIST: MAINLAND CHINA'S BIGGEST SILICON FAB

MARCH 17 IPO

A U.S.-China trade flap hit SMIC shares on their very first day of trading and created a buying opportunity for investors. Founded by former Texas Instruments and Taiwan Semi executive Richard Chang, SMIC is China's biggest silicon fab, already the fifth largest in the world, and one of the highest profile IPOs of the year. The company, based in the Pudong hi-tech zone of Shanghai, began trading American Depositary Receipts (ADRs) on the New York Stock Exchange and ordinary shares in Hong Kong (traded under the stock code "981") on Wednesday, March 17, raising $1.8 billion in capital.

Total industry investment in semiconductor capital equipment is expected to rise 42 percent this year, but investment by independent foundries, or fabs, is expected to more than double. Foundry investment is expected to reach almost one-quarter of total industry investment. New fabs, moreover, will outspend the Big 3 (TSMC, UMC, Chartered) by some 137 percent this year. Six new fabs will come online in China this year, four of them using 300 mm wafers, but SMIC will still account for 60 percent of total mainland fab investment. SMIC is increasing capacity at headquarters in Shanghai, upgrading its Tianjin plant, purchased from Motorola, and inaugurating its Beijing 300 mm line, the first in China.

The foundry model is flourishing, and SMIC is the biggest foundry in the fastest growing nation, in the fastest growing region, with potentially the largest domestic market for all manner of digital devices, and already the biggest market for mobile phones and teleputers. Sales in 2003 vaulted by a factor of 7 over 2002, rising from $50 million to $360 million. The company is up to a year behind rivals in technology, as just 10 percent of its 4Q03 shipments were .13-micron, about half in .18, and a third in .25 and .35 geometries. TSMC and UMC are already shipping .09-micron chips, and politicians in the U.S. and Taiwan could still block sales of the most advanced capital equipment to the mainland. But future technological credibility is provided by the almost 1,000 veteran engineers Richard Chang lured to the mainland from the island fab known as Taiwan.

The IPO price of $17.50 implied a market cap of about $6.4 billion, but that number dropped 10 percent the first day to well under $6 billion. Using forward looking estimates, SMIC therefore trades at about the same price-to-sales multiple as top-dog TSMC, and a similar price-to-book as UMC. But SMIC sales are expected to almost triple this year, and are poised to keep growing faster than the industry, at least for several years. We think the risks are worth the potentially large rewards.

SONIC INNOVATIONS (SNCI)

PARADIGM PLAY: FRUITFUL INTERPLAY OF ANALOG, DIGITAL & BIONICS

MARCH 15: 11.50, 52-WEEK RANGE: 1.94 – 11.90, MARKET CAP: 230.93M

Another Mead company, Sonic Innovations' hearing aids are based on analog models of the cochlea contrived by Mead and his students at Caltech. Customizable for each hearing problem and capable of directional hearing, this company has taken world leadership in hearing aid technology and is steadily gaining market share against all rivals.

SPRINT PCS (PCS)

PARADIGM PLAY: PIONEER OF GTR WIRELESS PARADIGM

MARCH 15: 8.52, 52-WEEK RANGE: 3.40 – 10.70, MARKET CAP: 8.83B

Qualcomm is the inventor of the prevailing technology of the next generation of ubiquitous wireless connectivity. Called CDMA, it is a spread spectrum technology that uses all the available spectrum all the time for every call rather than dividing the spectrum band into narrow spectrum slices (FDM) or time slots (TDMA). Sprint PCS was the first company to commit fully to CDMA for a nationwide network.

In the wireless paradigm, serving teleputer camcorder phones everywhere, ubiquity is critical. While WiFi hype continues, Sprint PCS offers cells some 25 thousand times larger than a WiFi access point "hot spot." With broad coverage over the entire continent, Sprint is making the entire nation a "hot spot." Sprint PCS pioneered Qualcomm's CDMA in the 2 gigahertz band assigned to personal communications services and built up the only national CDMA PCS network. Although 38 million subscribers make Verizon the dominant CDMA carrier in the U.S., with nearly double Sprint's numbers and with plans to deploy broadband EvDO technology, PCS has been aggressively deploying its Vision data system and remains a paradigm player. Both Sprint and Verizon, though, sharply lag Korean carrier **SK Telecom** and Japan's **KDDI** in broadband deployment of CDMA2000 data services and in per capita data revenues. On April 23, the PCS tracking stock will be reabsorbed by parent **Sprint** (FON) at a price of .5 shares of FON for each share of PCS.

SYNAPTICS (SYNA)

PARADIGM PLAY: ANALOG-DIGITAL INTERFACES FOR HAPTICS: FOVEON

MARCH 15: 14.94, 52-WEEK RANGE: 6.55 – 22.424, MARKET CAP: 369.09M

Founded in 1987 by microprocessor pioneer Federico Faggin and Carver Mead to create new microprocessors based on largely analog neural networks, Synaptics was the original host of the Mead camera project that came to fruition as the revolutionary Foveon imager. In the early 1990s, Faggin led the team of mostly Mead students into haptics (touch-based technology) and seized dominant market share in touchpads from **Logitech** (LOGI) by 1997. Now under CEO Francis Lee, Synaptics is supplying haptic controllers to such additional products as **Apple** (AAPL) iPods and Samsung DVD players while retaining dominance in notebook computers, the fastest growing part of the PC industry. Synaptics still owns 16 percent of Foveon and new Foveon CEO Faggin promises to give the imager pioneer the kind of raptorial strategic leadership he gave to Synaptics as he led it to leadership against Asian rivals in touchpads. NSM owns a some two times larger share of Foveon than Synaptics does, but the Synaptics Foveon holding comprises a 15-fold larger share of Synaptics than NSM's 30 percent share of Foveon represents of NSM. So Synaptics is a more efficient way to play a likely blockbuster Foveon IPO.

TAIWAN SEMICONDUCTOR MANUFACTURING CORPORATION (TSM)

PARADIGM PLAY: WORLD'S LEADING MICROCHIP FOUNDRY

MARCH 15: 10.25, 52-WEEK RANGE: 6.287 – 12.93, MARKET CAP: 41.47B

In the fulfillment of Mead's horizontal vision for the microchip industry, TSMC is as prominent on the manufacturing side of the paradigm as Qualcomm is on the fabless chip design and engineering side. TSMC is the world's leading foundry, two times as large as ranked UMC, and long the most profitable semiconductor company outside of Intel. Among the foundry's prime customers are Altera and graphics leader **Nvidia** (NVDA). It also just lured EZchip from IBM. The only shadow on TSMC is Intel's widening lead in process geometries. Intel is manufacturing Pentiums in a 90-nanometer fab and has demonstrat-

ed 65-nanometer capabilities. TSMC has just begun manufacturing Altera devices on a 110-nanometer process. Nick Tredennick, however, offers evidence that the bulk of the market is moving away from leading edge processes toward the TSMC sweetspot. TSM shares trade around 10.22, after recently peaking at almost 13.

TERAYON (TERN)

PARADIGM PLAY: MOVING CDMA INTO CABLE

MARCH 15: 3.21, 52-WEEK RANGE: 1.55 – 8.25, MARKET CAP: 240.35

CDMA is the optimal technology for access to the fibersphere through noisy media, whether the air or upstream cable. Celebrating Terayon for its success in applying CDMA technology to cable modems, we cited it as a potential Qualcomm. Unable to retain control of its proprietary SCDMA system, standardized in the industry's DOCSIS 2.0 specifications, Terayon could not fulfill this hope through *patents*. But its tacit learning, what we call its *latents*, have enabled the superiority of Terayon's technology to manifest itself in a steadily expanding share of the market in cable modems and cable headends. Terayon is a paradigm player in last mile broadband.

Terayon stock is down substantially from its recent high of 8.25, trading for just 3.31, which yields a forward estimated P/E of just 11.

TEXAS INSTRUMENTS (TXN)

BACK ON THE LIST: PIONEER OF NEW PROCESSORS FOR TELEPUTERS

MARCH 15: 29.12, 52-WEEK RANGE: 15.96 – 33.98, MARKET CAP: 50.45B

Alright already. So far in 2004, TI has launched a series of industry leading microchips for the teleputer, including ingenious CMOS radio frequency emitters, paradigm CDMA and retro-digm GSM/GPRS processors, Bluetooth personal area network enablers, and leading-edge media processors for digital cameras and camcorders that are reprogrammable on chip. Now TI has put it all together in a can-you-top-this omnibus: a two-chip programmable module called the OMAP2 media access processor that combines an ARM9 core, high-speed TI DSP, a graphics accelerator for games, interfaces for high resolution liquid crystal displays, links to TV monitors, cameras and camcorders at up to 4 megapixels, capable of playback and capture of 720 by 480 pixels (Super VGA) at 30 frames per second. Built on TI's 90-nanometer wafer fab, this do-it-all-and then change your mind and re-do-it processor is a low power device designed for your cell phone teleputer. Already gaining share and valuation altitude, TI seems on a roll that can effect upside surprises and make shareholders happy. TI shares have recently retreated from 34 to 29.

TRANSMETA (TMTA)

OFF THE LIST: INGENIOUS LOW POWER PROCESSORS GO ASTRAY

MARCH 15: 3.84, 52-WEEK RANGE: 0.91 – 5.51, MARKET CAP: 542.62M

Transmeta joined the list because of its then industry leading low power microprocessor technology, which we believed would suit it for battery powered devices such as cell phones and notebook computers. However, Transmeta fell between the two markets, creating a device too power-hungry for cell phones and too slow to compete Intel for computer slot. We also believed Transmeta would design a soft-core based on the x86 instruction set (see AMD), but this large opportunity was never seized. Hence Transmeta leaves the list.

UNITED MICROELECTRONICS (UMC)

OFF THE LIST: USURPED BY SMIC

MARCH 15: 5.32, 52-WEEK RANGE: 2.8651 – 5.96, MARKET CAP: 16.75B

As a result of SMIC's addition to the list, and TSMC's dominance in Taiwan, UMC departs our Telecosm Technologies list this month.

VIA TECHNOLOGIES (2388.TW)

PARADIGM PLAY: INTEL OF CHINA?

FOREIGN STOCK EXCHANGE

Another Taiwanese star moving heavily into China, Via gets the design expertise for its microprocessors and motherboards from a team headed by former IBM fellow Glen Henry in Austin, Texas. A key customer is China's PC maker Legend (see above). Via's designs are compact enough to be embedded in set top boxes and the company aims to become the Intel of China.

WIND RIVER SYSTEMS (WIND)

PARADIGM PLAY: WINDOWLESS REAL TIME OPERATING SYSTEMS

MARCH 15: 10.08, 52-WEEK RANGE: 2.71 – 11.66, MARKET CAP: 809.53M

A paradigm theme is the increasing prevalence of real time systems, as opposed to von Neumann architectures based on time-consuming fetches of data and instructions from remote memories. Wind River provides a real time operating system for embedded applications, such as network processors and cell phone handsets that must perform complex operations without discernible delays.

XILINX (XLNX)

PARADIGM PLAY: PIONEER OF PROGRAMMABLE LOGIC

MARCH 15: 37.60, 52-WEEK RANGE: 23.00 – 45.40, MARKET CAP: 12.96B

Softening hardware by making it reprogrammable, Xilinx is one of the earliest paradigm companies. It competes neck and noggin with Altera (see above) in the rapidly expanding markets for programmable logic, which is used wherever fast adaptation to new demands is more desirable than the utmost in chip density and performance. As chip technology advances it tends toward performance overshoot, giving the programmable logic players more and more of the total microchip market. Xilinx has the kind of down market edge that can disrupt the players above. Shares have recently retreated from over 45 to 38.

ZORAN (ZRAN)

PARADIGM PLAY: DSPS FOR DIGITAL CAMERAS & DVDS

MARCH 15: 16.51, 52-WEEK RANGE: 11.91 – 27.88, MARKET CAP: 697.58M

The TI Junior company, Zoran aspires to run your electronic life through its digital signal processors, graphics ASICs, and full motion camera chips. Key to the teleputer paradigm are chips to manage video in real time. Beginning as an expert on digital signal processing chiefly for military operations, Zoran has moved massively into consumer electronics and image processors. Its COACH (camera on a chip) processor competes with **Canon**'s (CAJ) DIVIC and TI's media processors for marketshare in digital cameras. Its DSPs are embedded in DVD/CD players, digital TVs, and other consumer electonics products. Among many rivals are little **ESST** and giant National Semiconductor.

Shares of ZRAN appear attractive at 16.5, down from a 52-week high of almost 28.

-George Gilder, Bret Swanson, and Nick Tredennick

Got Questions?

Visit our subscriber-only discussion forum, the Telecosm Lounge, with George Gilder and Nick Tredennick, on www.gildertech.com

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