GILDER TECHNOLOGY REPORT

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Storewidth Processors

EZchip remains what it has always been: An elegant architecture for the next generations of network processor. The ultimate market remains huge.

After **EZchip** (LNOP) reported uninspiring sales of $2 million in the June 2005 quarter, many investors threw up their hands in despair and pushed the shares down 12 percent, trimming EZchip's implied market cap by some $20 million in a day or two to $124 million. The tantrum was understandable. After all, we first wrote about the company some five long years ago, in our September 2000 report. It was based on EZ's first network processor design, announced at InterOp in Atlanta in September 1999, which as I noted at the time was laid out on an an ingeniously reconfigurable substrate of PowerPoint slides. Maybe, in the transition to silicon, there had been some slippage.

Back then, in the halcyon days before the crash, CEO Eli Fruchter had hurled down his stupendous design in a gnomic Israeli accent, in the face of competition from **Motorola** (MOT), **IBM** (IBM), **Intel** (INTC), **Applied Micro** (AMCC), MMC Networks, **Agere** (AGR), and a host of mostly long forgotten startups, seeking to attract attention with misspelled names, such as T.sqware, Cartezian, **HiFn** (HIFN), XaQti (acquired by **Vitesse**–VTSS), C-Port, and **Xcelerated**. Some of them (Intel, C-Port, IBM, Agere) had the disadvantage of actual slow (100-megabit) silicon in hand and some of them (Hyperchip and Cartezian), planned to use even slower configurable cores from ARC cores (now **ARC International**) and **Tensilica**, familiar to devout *GTR* readers. By 2001, however, EZ taped out actual prototypes of their NP-1 chip, which operated at 10 gigabit per second full duplex wire speed. By 2003, most of the rivals went away and EZ claimed 25 customers. In 2004, they signed up the two leading Chinese network equipment companies. Now it is mid-2005. Their slides claim 59 design wins. Hey, say our subscribers plaintively, slides won't cut it anymore, Eli, show us the money!

I admit it. I was smitten by Eli's elegant PowerPoints. The key to a processor that could put a wire-speed 10 gigabit per second router on a chip and hollow out **Cisco** (CSCO) according to the paradigm, was memory bandwidth and application specific parallel processors. Everyone else was using fast power-hungry off-chip static RAMs with bottleneck buses between them and on-chip general-purpose processors. With Gilder's law still trumping Moore's law, these general-purpose devices based on reduced instruction set computing (RISC), were advancing at speeds far less rapid than the network. To compensate, the new "netprocessors" kept pushing key functions off-chip to co-processors doing the traffic management and classification of packets. The whole shebang tended to be slow, complex, and power-hungry, without being discernibly superior to the application specific integrated circuit (ASIC) solutions, together with **Altera** (ALTR) and **Xilinx** (XLNX) field programmable gate arrays (FPGAs), that router companies such as Cisco, **Juniper** (JNPR), Foundry (FDRY), Alteon (acquired by **Nortel** –NT), **Avici** (AVCI), and **Extreme** (EXTR), were already using. Who needed network

processors that required you to re-design your system without obvious benefits?

Fruchter's PowerPoints used several megabytes of dynamic random access memory (DRAM) cells on the chip itself where the memory bandwidth can run at up to 500 gigabits per second, thousands of times greater than bandwidth down pins and across boards to off-chip memories. He added ingenious new content addressable memory (CAM) algorithms that allowed rapid access to the routing tables containing the paths to other routers on the network. To perform the parsing, classifying, modifying, and forwarding of the packets at wire-speed were 64 task-optimized parallel processors that managed to present the programmer with a single software image. For additional storage, attach cheap low power DRAMs.

Cisco is increasingly outsourcing the key functionality of its routers to outside chip companies, such as NetLogic and Cavium

It seemed to me that these guys, some of them from Intel's Israeli design center where many of that company's best chips originated, had hit a home run. They were at work on a network processor that was two generations ahead of the products planned by the competition. I wrote about the company and touted the shares of LanOptics (then with 78 percent EZ ownership) as an opportunity for my subscribers to do some high-risk, high-reward venture investing.

Despite treacherous spikes of pricing (from $1 dollar to nearly $40 per share during the turbulence of bubble and crash and aftermath and back to $16 when we put it on the list), the news continued to be great. On September 28, 2004, **Huawei**, China's leading network equipment company, joined its fast moving rival **ZTE**, and a potpourri of wanabe U.S. and European router stars and put the EZ device into several Huawei products. We then went a bit overboard saying EZ was no longer a venture investment but a rip roaring buy that might never again sink below $10. It did sink, most recently with its August announcement of another quarter without significant revenues. Some of our subscribers around the Telecosm Lounge (www.gildertech.com) are understandably anxious or disgruntled.

Preparing for Telecosm 2005 (September 26 – 28), where EZchip will present, we are not especially concerned. Remember, this company is not only two generations ahead of its competitors. It is also, so it seems, some two generations ahead of its *customers*, which—if you think about it—may not be the best place to hang out. Producing full-duplex 10 gigabit per second chips for a world still using 100-megabit to one-gigabit gear, EZ has incurred some delays in generating significant revenues. But last October, we projected that by the end of 2005 between 10 and 15 of EZ's customers would be making equipment containing EZ's first generation NP-1c network processor. Already 14 customers are in production, with eight more coming online by the end of the year, for a total of 22.

So far the customers' products are not yielding substantial sales, but with each piece of networking equipment that hits the market, the odds for breakthrough products improve. Last autumn we projected a low-end revenue estimate of $7 million for all of 2005. EZ will exceed that even with its current modest run rate, and could hit the middle of our range as the number of distinct EZ-based systems on the market increases by 60 percent over the next five months. Inventories? For the quarter EZ's inventories grew to $2.4 million (around $6 million in prospective sales) as EZ built up a buffer for customers that then failed to meet their forecasts. But NP-1c sales are in line with our projections and the number of customers in production is far ahead of schedule.

Bringing the company down-market into the local area network (LAN) and metro space, onto line cards as well as central router functions, the new NP-2 remains EZ's make-or-break product. This quarter, NP-2 picked up an additional five or six design wins for a total of 25, some feat for a product that only sampled at the end of May. Total company design wins now stand at 59.

Network Processor (NPU)—A general-purpose programmable microchip used to sort and route packets on a network. Network processors are most often third-party general-purpose designs that can be bought off the shelf and programmed by the Ciscos of the world to be used across a range of network equipment. A rough analogy can be made to microprocessors, which enabled PC makers to build modular machines with third-party parts, disrupting the mainframe and minicomputer makers, who designed and built integrated systems in-house. NPUs must parse, classify, modify, and resolve (forward) packets at wire-speed.

Content Addressable Memory (CAM)—A CAM is a hardware search engine often used in high-speed networking applications. Its chief virtue is the ability to complete a full search operation in just one clock-cycle. Most algorithmic or software-based systems require more cycles. As the amount of processing per IP packet increases with new quality of service (QoS) requirements, security concerns, and large IPv6 routing tables, CAMs are increasingly used for searching large tables and security lists. Many router and switch makers design their own packet processing ASICs to take advantage of CAM memories, though CAMs can also be used with some NPUs. Although faster for many applications, CAMs tend to be expensive and power-hungry compared to DRAM.

First scheduled to sample at the beginning of 2005, NP-2 slipped by five months. Although such a delay is not unusual for a chip of NP-2's size and complexity, with embedded DRAM and around 1,400 pins, products containing NP-2 won't really hit the market until mid-2006. We originally projected 10 customers would reach production with NP-2 in 2006, but that number now seems *conservative*.

With more NP-2 customers than expected, EZchip could achieve NP-2 revenues of between $50 and $60 million in the four quarters beginning in July of 2006 and NP-1c sales could easily add $10 to $20 million. Implied sales of $70-80 million, net income of $26-32 million, and a P/E of 25 would thus yield a market cap of between $650 and $800 million and a stock price between 4 and 6 times higher than today's. With gigabit and 10-gigabit networking now blossoming, along with RBOC fiber-to-the home, customers should be moving to market at a faster pace.

The company is also getting lots of inquiries for "ATCA" cards (advanced telecom computing architecture), a new standard "motherboard" for telecom products rather than PCs. Companies like Motorola and **RadiSys** (RSYS) are starting to make these modular cards that can plug into diverse equipment across the Net. With most of the engineering and software performed by third-party component manufacturers, companies like **Dell Corp.** (DELL) and **HP** (HPQ), who are moving more and more into networking, could even creep up into carrier grade markets.

With the networking sector reviving at last, the evolution of the industry is beginning to conform to the paradigm. Almost five years ago we asserted that just as Intel's microprocessors hollowed out the mainframe, with most of the value of the computing box migrating to the Pentium, so network processors would swallow up most of the value of a network router or switch. Although initially inferior in performance to the optimized chips and systems designed in-house by Cisco, network processors would be good enough and their costs low enough, to induce numerous companies, from Dell to then-unknown Huawei, to build networking products centered on this new router-on-a-chip.

But network processors did not explode onto the scene. Most of the 50 or so net processor start-ups went under, and Vitesse, IBM, and Motorola abandoned their NPU projects. In 2004, NPU sales across the industry and around the world totaled just $145 million. EZchip remained viable, a feat in itself, but still had less than 5 percent of the market in 2004.

Now, however, our prediction of disruption at Cisco is unfolding. Cisco is increasingly outsourcing the key functionality of its routers to outside chip companies, such as **NetLogic** (NETL) and **Cavium** and increasingly faces rival products based on network processors. No domineering, margin-gorging "Intel inside" has yet hollowed out the router industry, but lurking among the companies supplying router components are many ambitious candidates for the role.

Circumstantial evidence of the threat is also evident at Cisco itself. With huge fanfare last year, the company announced its new BFR core routers. To be deployed as an integrated, omniscient web of big iron machines to administer "intelligent" networking, the BFR is an ultimately futile effort to replenish the newly hollowed router by sucking functionality (security, "policy," quality of service) from the servers at the edges of networks to the core.

As Clayton Christensen explains in his canonical *Innovator's Dilemma*, such an up-market rush is typical of established players like Cisco faced with modular products (like network processors) that usurp much of the specialized functionality of their products. Just this May, following similar moves by archrival Juniper and discreet competitor **Citrix** (CTXS), Cisco paid $70 million for a company called Fineground, an upstart in the "applications acceleration" arena pioneered by Wall Street darling **F5** (FFIV). Despite a recent stumble, F5 built a $1.6-billion market capitalization with its Big-IP product line under CEO John McAdams, IBM's former manager of web services. Garnering $251 million in sales and $52 million in net income over the last twelve months, F5 has changed the focus of Cisco and the industry.

IPv4—Internet Protocol version 4: The reigning flavor of IP since it was published in 1981, IPv4 governs the addressing and routing of data across the Internet. IPv4 uses 32-bit addresses, for a total of 4.3 billion distinct addresses worldwide. Network address translation (NAT) has helped to overcome the limited address space but cannot compensate forever.

IPv6—Internet Protocol version 6: The coming flavor of IP, now being widely deployed in network equipment in Asia and on the cusp of hitting the American and European markets. Some 95% or more of Western networks are still IPv4. IPv6 uses 128-bit addresses, four times as long as v4, yielding an essentially unlimited number of unique addresses. With IPv6, each mobile phone, automobile, FedEx package, and network node, no matter how tiny, can have its own IP address, with undecillions left over. Although some consider 128-bit addresses overkill, IPv6 will prevent fragmenting of large blocks of IP addresses that are often assigned to one organization. Japan, China, Korea, and India have been leading the adoption of IPv6 for several years, and in 2003 the U.S. Department of Defense mandated that all new equipment it deploys be IPv6 compliant.

TELECOSM TECHNOLOGIES

Advanced Micro Devices (AMD)
Agilent (A)
Altera (ALTR)
Analog Devices (ADI)
Broadcom (BRCM)
Broadwing (BWNG)
Cepheid (CPHD)
Corning (GLW)
Equinix (EQIX)
Essex (KEYW)
EZchip (LNOP)
Flextronics (FLEX)
Intel (INTC)
JDS Uniphase (JDSU)
Microvision (MVIS)
National Semiconductor (NSM)
NetLogic (NETL)
Power-One (PWER)
Qualcomm (QCOM)
Semiconductor Manufacturing International (SMI)
SK Telecom (SKM)
Sprint (FON)
Synaptics (SYNA)
Taiwan Semiconductor (TSM)
Texas Instruments (TXN)
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.

Broadcom (BRCM)

PARADIGM PLAY: LEADING FABLESS BROADBAND DESIGNS

AUGUST 3: 43.44; 52-WEEK RANGE: 25.25 – 44.87; MARKET CAP: 14.45B

During the second quarter, broadband innovator Broadcom boasted broad strength across its broad technology portfolio, driving a surprising sequential sales surge of 10% to $605m. This follows a strong first quarter, when we alerted subscribers to expect more growth spurts as Broadcom innovates into mounting markets such as Bluetooth, VoIP, digital TV, GigE, and WLAN. This quarter, GigE burst forth as enterprise networks began upgrading from fast Ethernet. The race to speed has just passed the starting gate, and as a major supplier of switching ICs, Broadcom could benefit for years. In networking, Bluetooth revenues grew 40% sequentially with a repeat expected this quarter as the wireless technology marches into 3G cell phones, notebook computers, mice, keyboards, PDAs, printers, music and video players, stereo headsets, you name it. As satellite and cable customers discover digital video, sales of high definition, digital video recorders are taking off with Broadcom on board. Modem ICs for cable and DSL sold well on the rise of VoIP and WLANs, and yet to ramp are the newly introduced, cutting-edge chipsets for VDSL2 supporting 100 Mbps on a single line or up to 200 Mbps when utilizing channel bonding. Also announced was a wireless solution for Nintendo's next-generation gaming system, even as Broadcom shipped its 50 millionth Wi-Fi chipset.

A potent purveyor of the paradigm, Broadcom has no long-term debt, and cash & equivalents at $1.4b are more than double total liabilities of $661m. Flourishing free-cash-flow, just under half a billion dollars last year, should break that mark this year. Broadcom's market cap translates to an enterprise value (selling price) of $15.1b or 26.9x estimated free-cash-flow for 2005, not excessive if the company runs with the technology and sheds its ugly suit against Qualcomm. *– CB*

Broadwing (BWNG)

PARADIGM PLAY:THE PARAMOUNT ALL-OPTICAL COMPANY

AUGUST 3: 4.84; 52-WEEK RANGE: 3.46 – 15.90; MARKET CAP: 363.4M

All-optical Broadwing continues to outperform its optoelectronic cousins as communications revenue increased $4.2m sequentially in June and almost all of the gain passed through to gross profit. Its new converged network has already turned up at a major consulting firm, and Broadwing is currently installing the system at national and international enterprises while negotiating contracts with several others. (See the June *GTR*.) These complex multi-location networks require longer sales cycles and installation time, which will push out initial sales from converged services to the first half of next year. Look for some upside surprises in 2006.

Until then, Broadwing will continue its transition to an end-to-end provider of retail and wholesale services. Grooming and hubbing to optimize the interconnected Focal-Broadwing network should be completed this year, generating substantial one-time circuit-termination charges. For example, Broadwing still runs dual DS-3 hubs in several cities—one legacy Focal, one legacy Broadwing. To further simplify operations and reduce overhead, Broadwing will end sales of its optical convergence switch this quarter, folding the remains of the equipment division into network operations.

Still boasting a positive net long-term cash position, Broadwing's weakening balance sheet remains relatively strong compared to an industry mired in net debt. The decrease in net cash of $28m during the first half of 2005, from $82.5m to $54.7m, was less than the $34m in capital investments during the period, and the current ratio has held steady at 1.5 and the quick ratio at 1.3. The $34m of capex—used for network expansion, maintenance, Focal integration, customer wins, and new services—should begin to lower costs in the second half of the year.

Continuing to put pressure in the stock are the three remaining tranches on the convertible note. Broadwing has elected to pay the first one, due 19 August, in cash, reducing its bank balance by another $33.4m. The remaining two payments, due in November and February, will likely be made in stock unless Broadwing secures conventional refinancing or surprises with a strong sales upside prior to 2006. Also pressuring revenues going forward will be the decline in voice services, reflecting Broadwing's goal to maximize voice margins at the expense of revenue.

All in all, Broadwing continues to make progress against its competitors in a muddled and over regulated market still suffering from telechasm malaise. *– CB*

Corning (GLW)

PARADIGM PLAY: FIBER TO THE EXTENSION

AUGUST 3: 20.09; 52-WEEK RANGE: 9.29 – 19.69; MARKET CAP: 28.59B

In Corning's burgeoning liquid crystal display (LCD) glass business, the generations roll relentlessly along. For LCD substrates, next generation means bigger, and bigger means better. To make LCD screens, manufacturers cut two sheets of thin glass (each less than a millimeter thick) from a

MEAD'S ANALOG REVOLUTION

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

COMPANIES TO WATCH

ADAPTIX
AMEDIA (AANI.OB)
ATHEROS
ATI TECHNOLGOIES (ATYT)
BLUEARC
COX (COX)
ENDWAVE (ENWV)
FIBERXON
LINEAR (LLTC)
LUMERA (LMRA)
ISILON
LENOVO
MEMORYLOGIX
NOVELLUS (NVLS)
POWERWAVE (PWAV)
SAMSUNG
SEMITOOL (SMTL)
SIRF
SOMA NETWORKS
STRETCH INC.
SYNOPSYS (SNPS)
TEKNOVUS
TENSILICA
VIA TECHNOLOGIES
XAN3D

large piece supplied by a glass company such as Corning and press them together, with the chemicals that form the images sandwiched between. As these glass sheets or substrates grow with each generation, unit costs shrink since makers of LCD TVs can cut more screens out of each sheet. They can also make larger sets. Thus, over the past two years, Samsung, Philips, and others have invested more than $20b in new plants that are able to use ever larger sheets of glass. Most of these plants use sixth generation substrates, which yield eight 32" panels. Just coming online now, Gen 7 substrates yield twelve 32" panels. Construction of Gen 8 size glass capacity in Japan is underway. Even as Corning works to improve Gen 7 yields and bring Gen 8 to market, it is talking about Gen 10. Samsung is too, planning to build LCD screens up to 100" as 60" screens become affordable. Gen 8 glass sheets will be large enough to cover one king size bed, and Gen 10 sheets will be large enough to cover two.

Last quarter, sales in Corning's display technologies unit increased 30% sequentially to $415m as substrate shipments increased 32%. Segment margins increased from 60% to 65%. Corning estimates that two thirds of desktop monitor sales are now LCD and believes that 10% of TVs sold this year will be LCD models, rising to 15% next year. This would increase volume demand for LCD glass by 50% in 2005, and Corning is responding by expanding its own capacity by almost two thirds. Crucial to the demand forecast will be further falls in prices of LCD TVs. Prices declined 40% over the past year according to Corning, which forecasts volume sales of display glass to grow 15% sequentially in the current quarter on relatively flat pricing. Corning sells half of the glass used to make LCDs and appears to be taking market share.

On the telecom side, revenues declined 3% to $415m as sales of optical fiber and cable to China remained subdued and Verizon worked off inventory for its FTTP projects. Long-term, with just under 100% of all homes worldwide yet to be passed by fiber and with many regional and backbone builds yet to be started, Corning's prospects look bright.

In June, Corning announced a public offering of 20m shares for proceeds of approximately $350m. Of that, $275m will be used to repurchase the remaining converts due in 2015, bringing Corning's debt below $2b. In May, both S&P and Fitch promoted Corning to investment grade status. We put Corning on our Telecosm Technologies list on March 24, and in a little over four months the stock has appreciated 77% for a still reasonable forward PE of 27.4 considering that earnings for 2005 are on a trajectory to grow 76% over 2004. *– CB*

NetLogic (NETL)

PARADIGM PLAY: CUSTOM LAYER 3 AND 4 PROCESSOR

AUGUST 3: 19.94; 52-WEEK RANGE: 5.92 – 21.99; MARKET CAP: 353.94M

In January, we endorsed NetLogic Microsystems, a maker of "knowledge based processors" used in telecom switches and routers. Then trading at $11.29, NETL now sells for $19.94, making it one of our best picks of the first half of the year. We liked NETL as a proxy for Cisco, but without the bloat and baggage inherent in any conglomerate. The company had some 14 design wins at Cisco and was rapidly toting them up at other networking companies. However, NETL surprised even us in the first quarter with a 43% sequential sales increase to $21m, 85% of which come from sector giant Cisco. It turned out one of Cisco's contract manufacturers was in the process of moving operations to Asia from the U.S. and had double ordered for the quarter. NETL thus expected June quarter sales to revert to between $16.7m and $17.7m, a 10% to 16% increase over December sales. June quarter sales of $18.7m beat NETL's high-end estimate by 6%. After years of quarterly losses, the company is now solidly profitable.

Although Cisco will continue to be its best customer (73% of sales in 2Q05), design wins at other major equipment vendors should start coming on line in the second half of 2005 and into 2006. Products coming off the line at Foundry and Alaxala (a joint venture of NEC and Hitachi) could mean significant sales of NETL's newest processor, the NL6000. Now an 8% customer, NETL expects Alaxala to be a 10% customer in the September quarter and that an additional customer will reach the 10% threshold in 2006. The company also has design wins at Force 10, Huawei, and Juniper.

NetLogic's knowledge based processors are essentially ternary content addressable memories (TCAMs) with special logic features for pipelining and parallelism. TCAMs, in turn, are SRAM based memories with extra comparison circuitry. As the amount of processing per IP packet increases with new quality of service requirements and security concerns, CAMs are increasingly used for searching large routing tables and security lists. Their chief virtue is the ability to complete a full search operation in just one clock-cycle. Most algorithmic or software-based systems require more cycles, and thus more time, which is not abundant at a 10 gigabit line rate.

CAMs, though, tend to be expensive and power-hungry. NetLogic's first generation processor, the NL5000, consumes 10+ watts and costs around $200, compared to a few hundred milliwatts for a DDR2 DRAM memory at around $7. Cisco doesn't seem to mind and is voraciously gobbling up NETL's CAM-based chips, purchasing some $13.7m worth (around 100,000 chips) in the June quarter. For the next generation, NETL's NL6000 will consume half the power and run up to twice as fast as the NL5000 on a 15% smaller die. This advance lets customers place more devices on each piece of equipment.

NetLogic's main competition comes from IDT (IDTI) at the high-end and from Cypress (CY) at the low-end; Cypress's Ayama line of TCAMs is not as powerful as NETL's NL5000/6000 family. Earlier this year T.J. Rogers sampled Cypress's new Sahasra line of algorithmic SRAM-based network search engines that are much less expensive and power-hungry than traditional TCAMs. Cypress believes Sahasra is more than sufficient for most IPv4 applications, which still account for some 95% of the U.S. market, and says high-end TCAMs can be used to complement Sahasra by storing IPv6 routes and for policy-based and security features.

In March, NetLogic introduced its NETLite line for cost sensitive entry-level layer 2/3 switches and access and aggregation equipment. NETLite sheds the highly parallel searches and deep pipelining of the NL5000/6000 family and thus some of the power and cost. Don't expect substantial revenue for either NETLite or NL6000 until 2006. To date, NetLogic's products have served the layer 2 through 4 market. At the end of this year the company may announce a new line of products for layers 5 through 7. With Cisco aggressively ascending the OSI ladder, the move makes sense.

Currently, NETL is approaching an $80m a year run-rate and an operating margin of 10%. The company envisions consistent operating margins of 20%, and a $100m run-rate could bump NETL to that level. On average, analysts expect $86m in sales for 2006. That appears too low. Sales growth of just 6.5% per quarter would yield revenue of $100m in 2006, generating $21m in net income based on current expenses. Using the consensus estimates at today's market cap of $376m gives a PE of around 29, implying a market value of some $630m, a 67% premium over today's price, at $100m in annual sales. *– BTS*

Texas Instruments (TXN)

PARADIGM PLAY: PIONEER OF NEW PROCESSORS FOR TELEPUTERS

AUGUST 3: 32.50; 52-WEEK RANGE: 18.06 – 32.74; MARKET CAP: 54.02B

Everything's coming up roses in Texas: high-performance analog up 13%…digital signal processor sales up 8% driven by strong growth in wireless,

also up 8% as the 3G market builds…digital light processor revenue up 10%…all driving total revenue up 9% sequentially to $3.24b last quarter. Management knows how to cultivate an American Beauty, producing an all-time high operating profit of $669m, fertilized by high factory utilization and cost controls, which drove gross margin to 47% from 42.3% at the end of last year. Free-cash-flow of $863m during the first half of 2005 enabled TI to repurchase an additional 52m shares last quarter for $1.3b and still retain just under $4b in net long-term cash. Diluted shares outstanding decreased by almost 4%, and the board boosted TI's stock repurchase authorization by $2b.

The future looks rosy too; the scent leads us to expect EPS growth of about 25% this year to around $1.30. But you don't buy a rose bush because of one or two good blooms. You buy a bush that will keep blooming this summer and that will survive next winter only to look even lovelier next summer. Those varieties come only from paradigm nurseries, such as the one that strengthened TI into the world's largest supplier of cell phone chips with two-thirds of the market, the one that enabled TI to begin sampling the first wireless digital baseband processor using 65 nm geometries, the one that invests most of its capital on forward-looking 65 nm and 90 nm processes. It is also leveraging its DSP and power management expertise to bring a budding line of digital power-management products to market. Prospects improve with each new bloom in the analog and teleputer rose garden to come. *– CB*

Zoran (ZRAN)

PARADIGM PLAY: DSPS FOR DIGITAL CAMERAS & DVDS

AUGUST 3: 15.24; 52-WEEK RANGE: 8.71 – 18.70; MARKET CAP: 663.14M

The first quarter of 2005 may have been Zoran's low water mark, as revenues rose 28.7% in June with strength across all business units: DVD, DTV, mobile, and imaging. In particular, DTV grew 48% and digital cameras 78%. Zoran's turnaround in the promising digital entertainment and digital imaging markets is being steered by the innovations described in the May *GTR*. Of note, Zoran's COACH processor now powers the world's first reusable digital video camera selling for under $30. A well-managed firm, net long-term cash more than doubled during the downturn, to $77m. The loss of $0.10 per share (excluding one-time items) improved from a $0.14 loss in March, and Zoran projects a $0.26 per share surge to a profit of $0.16 for the current quarter ending in September on the strength of another 20% revenue ramp. The stock currently trades at a forward PE multiple of 23.8 based on a full-year extrapolation of September's EPS estimate. *– CB*

Cavium (private)

As Cisco, Juniper, Nortel, and the other box makers move up the network layer stack—into the realm of storewidth—chip vendors with the right skill set lie in wait to capture most of the added value of the new equipment. The leading contender is Cavium Networks, a private company from Silicon Valley and around the globe that in four years has defined the state of the art in storewidth security chips.

Cavium CEO Syed Ali's theory on Internet evolution tracks the Cisco strategy almost exactly. From 1985 until 2005, he says, we built the physical infrastructure—the fiber and switches—and the logical architecture—the protocols and routing tables—needed to move packets around the globe. In other words, over the last 20 years we built layers 0-3 of the OSI stack. Over the next 10 years, Ali believes, most of our energy (and money) will be spent on applications, services, and security. In other words, layers 4 through 7.

Cavium entered the market in 2002 with its Nitrox security processor, which gained rapid acceptance and now claims some 160 design wins in the equipment of every networking heavyweight and most of the lightweights, too. Nitrox administers IPsec and SSL (secure sockets layer) encryption used for VPNs (virtual private networks) and many transactional web applications. Versions of the Nitrox processor appear in high-end routers, mid-range application accelerators, and wireless hubs. The slightly newer Nitrox SOHO (for homes and small offices) is a 32-bit MIPS processor that integrates some routing functionality with security features and is now appearing in small gateway routers at a rate of 250,000 shipped per quarter.

Cavium offers numerous versions of each chip, from Nitrox Lite at 50 Mbps up to Nitrox II at 10 Gbps, and three versions of Nitrox SOHO ranging from 20 Mbps up to 150 Mbps. The basic Nitrox security chip competes chiefly with Broadcom, Safenet, and HiFN. The down market Nitrox SOHO rivals Broadcom, Intel's Xscale, and possibly AMD's Geode line (acquired from National Semi).

F5's recent market success and darling status among analysts and investors makes it Cavium's most talked-about customer. But from Cisco, Juniper, HP, and Samsung to Aruba, CheckPoint, SonicWall, and Symantec, Cavium has blanketed the entire industry.

On the strength of Nitrox and SOHO alone, Cavium expects to break even by the end of the year. With quarterly expenses of around $5 million and gross margins in the mid-60s, that means projected revenue of about $8 million in the December '05 quarter.

Promising sales in 2006 is a flagship 10-gigabit "network services processor," dubbed Octeon, that starts with between one and 16 general purpose 64-bit MIPS cores and then integrates application specific co-processors for security and special services, including TCP termination and compression/decompression. A Google on a chip, it also offers 16 "regular expression engines" for unique pattern matching of text strings and integrates up to eight gigabit Ethernet MACs (media access controllers).

With Octeon and Nitrox, Cavium claims to have products for the network core, the home gateway, and every routing, storage, and security device in between. Like Nitrox, Octeon's MIPS cores are scalable depending on the application, and the special security cores can be shed if needed, yielding a range of devices from $125 to $750. Cavium says Octeon already has 20 design wins for applications such as load balancing, intrusion detection, SSL VPNs, applications acceleration, and content based processing of XML and HTTP.

Cavium has technical teams in Silicon Valley, Taiwan, and Hyderabad, India, but its core chip team designed the gigahertz Alpha and VAX processors at Digital Equipment Corporation and is still in Marlboro, Massachusetts. It has raised $62 million, led by Menlo Ventures, and will probably go public in 2006.

With full TCP and SSL offload and sophisticated text searching, with XML and HTTP processing, and a full range of encryption and security options, Cavium offers storewidth on a chip.

Many have asked if Cavium is a competitor, or even mortal threat, to EZchip. Ali believes that commodity network processors like Intel's IXP2800 will be squeezed from the bottom by PHYs (physical layer devices) that integrate layer 2 functionality such as MACs (media access controllers) and from the top by Cavium and other layer 4-7 devices. But although Cavium claims to do routing at layer 3, it cannot really do high-speed routing and switching while simultaneously executing its higher layer heroics. Even to execute more than one of its higher layer functions at 10 gig wire speed, one might need a number of Octeons concatenated on a board. EZchip, meanwhile, has always been marketed as a 7 layer NPU, but does not have the fine grained layer 7 functionality of Cavium or other CPU-based devices. EZ, for instance, does do some processing of text strings but does not have Cavium's sophisticated pattern matching capability. Cavium and EZ both shun CAMs (content addressable memories) for their high power consumption and cost, preferring instead commodity DRAM. Each company admits, however, it uses CAMs for very large lists and look-up tables.

While there may be some overlap for a few applications, the general answer is no, Cavium and EZchip are not direct competitors. EZchip is for bandwidth. Cavium is for storewidth. *– BTS*

As e-commerce continues its rise, databases and other corporate applications become accessible from the web, putting an increasing premium on security, speed, and bandwidth management. Load balancing server clusters, managing bandwidth usage, and authenticating and authorizing users of networks and applications, F5 and its rivals often partner with **SAP** (SAP), **Microsoft** (MSFT), **Siebel** (SEBL), **Oracle** (ORCL), and others to optimize the performance of their database software and corporate apps.

Integrating storage and bandwidth at wire-speed, applications optimization boils down to "storewidth," a concept we also outlined five years ago. The tagline of Cisco's Fineground nicely summarizes the theme: "wide area application delivery, wide area file service." Sponsors for our Storewidth Conference went away in the crash, but the idea lives on and now seems to be driving the networking industry.

In the second half of 2004, Cisco announced four strategic areas of concentration: VoIP (voice-over-IP), storage switching, security, and application optimization. Three of the four are pure storewidth. Two years ago 70 to 75 percent of Cisco's revenues came from layer 3 and below, referring to the switching and routing of packets. Today, just 55 percent of its business is layer 3 and below. Cisco has made a concerted move up the OSI stack of telecom layers.

Remember the seven layers: 1) physical, 2) datalink, 3) network, 4) transport, 5) session, 6) presentation, and 7) application. Think of Layer 1 as the physical signals moving down a wire. Ethernet is an example of a Layer 2 protocol, where media access control (MAC) addresses are sorted by *physical* location or device. In Layer 3, IP is used to sort *logical* addresses. End-to-end connections and reliability are established and ensured in Layer 4, usually via TCP (transfer control protocol). Layer 5 establishes TCP/IP "sessions." Layer 6, long an empty vessel, is now a hotbed of advance with SSL (secure sockets layer) and other forms of encryption and security. Layer 7, meanwhile, is associated with HTTP, FTP, and SMTP (simple mail transport protocol), among many other communications applications, mostly in software.

As competition intensifies from routers based on network processors from Dell, Huawei et al, Cisco is moving and morphing from the "commoditized" routing space into the business processes of corporations and the deep niches of e-commerce and web content—from layers 2, 3, and 4 up to layers 5 through 7. It calls this strategy "AON"—applications oriented networking. Or could it be code for Avoid Oncoming NPUs?

In June, still chasing F5, Cisco bought a tiny 11-person security company—a group of researchers, really—called MI Secure, which is developing VPN (virtual private network) products that integrate transport and application layer security. The two founders, Michael Herne and Igor Plotnivik, previously had founded uRoam, which later was acquired by F5.

F5 networks boosted its own security bone fides with last year's $29 million acquisition of MagniFire and its TrafficShield line of applications firewalls. Juniper had previously bought the much larger NetScreen for $4 billion. Central to this arena of web applications and security is SSL. When the URL of a password protected website begins with *https:* rather than *http:*, it means a secure SSL link to the host server. F5 purchased MagniFire and Juniper's NetScreen had acquired Neoteris to acquire SSL technology to complement their legacy offering of IPsec (Internet Protocol security).

If routing is being commoditized and Cisco, Juniper, and others are fleeing to the upper layers of the OSI model, what does this mean for our router-on-a-chip company, EZchip?

While EZ is the clear performance leader in 10-gigabit layer 2-4 switching and routing, there are some higher layer functions EZ cannot perform. For example, data storage and security applications require TCP acceleration or SSL security. With EZchip, both of these processing intensive functions entail a special off-chip co-processor.

If routing is being commoditized what does this mean for our router-on-a-chip company, EZchip?

Like economics and life, technology always presents trade-offs. But EZ was smart to finesse a grab for fine grained Layer 7 applications as that market took off. It is a terrific market, and companies such as F5 and Cisco supplier Cavium (see page 6) are fortunate to be at the right place at the right time. But EZ would have had to reorient its small company, and necessarily lose its focus as the leader in high-density, low-power, programmable routing.

With its next generation NP-2 network processor, EZchip has chosen to use the additional transistors afforded by Moore's law and **Taiwan Semiconductor's** (TSM) fabs to integrate two traffic managers for QoS (quality of service), essential for video and voice-over-IP services. According to the independent chip experts we consulted, EZchip's achievement of more than one million Layer 4 connections per second at line-speed (10 gigabits per second) is about four times the best performance achieved by Foundry, Extreme, Cisco, or F5. EZchip retains the lowest cost, power, and space per port in the gigabit and 10-gigabit Ethernet routing arenas.

The basic reason for EZchip's failure to generate significant early revenues lies not in the competition but in the end markets. Until the delivery of the NP-2, EZchip revenues will remain dependent on wide deployment of 10 gigabit per second technologies. This has yet to happen. In the fourth quarter of 2004, 3.4 million ports of modular one-gigabit Ethernet were sold, for the first time eclipsing sales of modular Fast Ethernet (100 Mbps) ports at 3.1 million. Sales of 10-gigabit Ethernet ports are still comparatively small.

Slowly but surely, though, the market is moving toward EZchip, with the curve of growth consistent for each Ethernet generation. In 2002, a total of 166 million Ethernet ports of

all varieties were sold, growing to 193 million in 2003. In-Stat expects the number to rise to 508 million in 2008.

Today, 10 GigE has a list price of around $1,000 per port in the enterprise. Just two years ago, One-gigabit Ethernet sold for around $4,000 per port in the enterprise but now sells for just $100 (maybe even $60) in a Layer 3 enterprise switch. Dell now sells a simple 24-port GigE switch for $1,600.

The pressures of cost and power budgets mount. Today a 10 GigE blade, full of ASICs, optics, CPUs, co-processors, glue logic, and TCAMs (ternary content addressable memories, an ingenious ascendant pattern matching memory), might consume a massive 600 watts. In-house development of ASICs, which usually require high-power TCAM's, is a fight against the grain of the paradigm.

EZchip's persistent choice of commodity DRAM over specialized memories looks smarter than ever

These pressures may not convince every company. Cisco is said to have just approved an in-house network processor roadmap, with an in-house chip ready to go in early 2006 and products using it slated for the end of 2006. In this vein, Cisco also may have committed itself to an architectural path that will require costly and power-hungry CAMs for the next 10 years. But this reflects inside politics at Cisco, whose four strategic concentrations—"storage, applications processing, VoIP, and security"—tell you what is really on John Chambers' mind.

Although applications servers and security are right now the "hottest" markets around, EZchip's goal of dominating the high-volume gigabit and 10-gigabit Ethernet spaces is sound. Although lacking encryption and fine grained pattern matching, EZ can still achieve many higher layer functions, like modest text string searches, stateful session tracking, load balancing, and network address translation (NAT). It can serve much of the firewall, intrusion detection, and VPN appliance space with its new NP-2/5, a $400 device with 5-gigabit full-duplex routing and two integrated traffic managers. It offers more than double the processing power for the same price as other solutions and is intended for "pizza box" appliances like those that F5, **Radware** (RDWR), Citrix, and increasingly Cisco are building. Provided you are looking for high density gigabit Ethernet networking, pairing an EZchip with a security co-processor, a TCP offload engine (TOE) for storage, or TCAM for large access control lists (ACLs) still will yield the lowest-cost, lowest-power solution in most cases.

Looking to the future, EZchip's persistent choice of commodity DRAM over specialized memories looks smarter than ever. EZchip already boasts industry-leading memory bandwidth of some 500 Gbps via embedded memory and vast amounts of processing overhead via its four types of task optimized processors (TOPs). New and ingenious vertical chip-stacking technologies from the likes of **Xan3D** (of New Hampshire) and **Zycube** (of Japan), however, will mean further massive gains in memory bandwidth using cheap DRAM. Today, memory bandwidth is limited by the bus-width of off-chip wires, the number of pins dedicated to I/O (input/output), the "bit-line" length, and the relative sloth of DRAM. SRAM and SRAM-based TCAMs are fast, but they are expensive, hot, and only one-tenth as dense as DRAM. EZchip was an early adopter of embedded on-chip DRAM, which boasts high density, wide busses, and lower latency. IBM reports that 30 percent of the chips it produces for fabless customers today contain embedded DRAM. But embedded DRAM is expensive, increases chip size, and decreases yield. Connecting memories vertically, rather than horizontally, will excel embedded DRAM performance even as it shrinks the primary processor chip, reduces the number of pins, simplifies process steps, and increases yield.

EZchip remains what it has always been: An elegant architecture for the next generations of network processor. The ultimate market remains huge. But nobody said it would be easy or free of risk. The company continues on its innovative course and the industry is slowly turning to meet it. The key year is not 2005 but 2006, when the 10-gigabit markets will be coming on and the one-gigabit market will be in full flood.

— George Gilder and Bret Swanson
August 3, 2005

Got Questions?

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