

GILDER TECHNOLOGY REPORT

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BRIAN HALLA'S FANTASIES

A fourth quarter boom in PC sales vindicated our year long pitch that low prices are good for all and would soon pull the semiconductor industry in tow.

Happy New Year, all ye devotees of dumb bandwidth. On the cable side, **Broadcom** (BRCM), **@Home** (ATHM), and **Terayon** (TERN) have had a very good year. The optics are luminous too with **Global Crossing** (GBLX) and **Uniphase** (UNPH) in gear and **Qwest** (QWST), **Level 3** (LVL3), **Corning** (GLW), et al ascendant. Collaborating with **Cisco** (CSCO), **Ciena** (CIEN) is fighting back with integrated metropolitan systems free of telco SONET. Broadband wireless is rolling out at last, with **Teligent** (TGNT) delivering multipoint services in thirteen cities and possibly even **Winstar** (WCII) getting its act together on the crest of a \$2 billion equipment financing deal with **Lucent** (LU) and links with **KDD** and **Sumitomo** in Japan.

Our paradigmatic cellphone standard, CDMA (code division multiple access) has been renamed "wide" and is triumphant even among the vendors of GSM (Global System Mobile) in Europe. They now purport to have invented this famous **Qualcomm** (QCOM) "scam" which was variously described to me in the past as violating either the securities statutes, or the laws of physics, or both. Despite fears to the contrary, this is all very flattering to Qualcomm and the paradigm and also bodes well for **Spectrian** (SPCT), which makes power amps linear enough for wideband CDMA.

The laws of physics also scotched Global Warming (GWBS). Don't buy it. It crashed when our friend Arthur Robinson enlisted 18 thousand scientists to refute the fictitious "scientific consensus" from CNN and Kyoto that a heat wave here or there can trump global satellite, weather balloon, and historical data that show it has been hotter through most of human history (Greenland used to be as green as Gore). Global warming remains a critical problem for chips, however, as transistor densities double every 18 months under Moore's Law, giving a new meaning to Fry's electronics and portending a new paradigm in microprocessors.

Our networked software paradigm, **Sun's** (SUNW) Java, won in the courts and in the hearts of 89.5 percent of businesses with web pages and fewer than 100 employees. Java is beginning at

last to disrupt the software trade. Clayton Christensen, our favorite business theorist, disrupted the world of commerce from the cover of

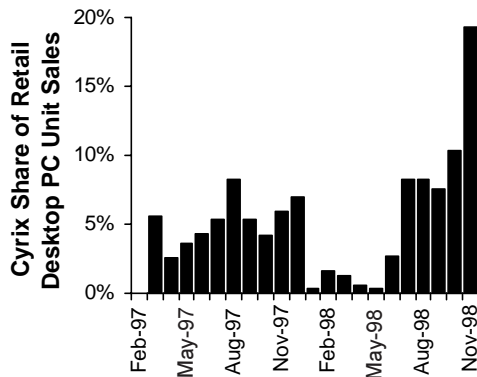
the current *Forbes* ("Stealth Attack," January 25). You will hear more from him. Finally, a fourth quarter boom in PC sales (closing in on 100 million for 1998) vindicated our year long pitch that low prices are good for all and would soon pull the semiconductor industry in tow.

All in all, looking back at 1998, it would be easiest to call this our holiday letter, shoot off some celebratory HTML

fireworks on the webpage edition, chat away about heartwarming family triumphs, cute dogs and cats and darling infants in Guy's garage.com, and glory in what the French call *les neiges d'antan*—the snows of yesteryear.

But that is not what you pay me for, alas. Deep in Vermont, I have been putting final touches on

Chart 1
National's Cyrix Market Share Surges



Source: ZD Market Intelligence

National Semiconductor has been shaking our seismographs recently with the most integrated central processor solution on the market — its MediaGX.

Telecosm, while my daughters wax my cross country skis for *les neiges du futur*, which is more to the point. Secreted at Stowe, with the hills around the Trapp Family Lodge alive with the sound of music and frozen raindrops falling on my head, I did some auscultation of the paradigm for 1999.

The triumphs of 1998 were mostly in the domains of dumb bandwidth—raw fiber optics, WDM (Wavelength Division Multiplexing), and cable modems—that increasingly eclipsed tricky asynchronous transfer mode, SONET time division systems, DSL (Digital Subscriber Line), and complex quality of service guarantees. It seems that Internet traffic grew some eightfold globally in 1998 mostly down the same old “best efforts” channels. That keeps up and we’ll have a thousandfold rise in four years and a good explanation for runaway Internet commerce stock prices. Companies that use the resource with fastest growing abundance and steepest slope of prices gain market share on everyone else. That resource is clearly Amazonian bandwidth rushing over an historic cliff of costs.

Crimping the new year’s celebration, however, was the slack performance of paradigm stocks outside the bandwidth bonanza. You know their names. This report will focus on one of our favorite frosted flakes, **National Semiconductor**

(NSM)/Cyrix. National has been shaking our seismographs recently. With the most integrated central processor solution on the market in its MediaGX, its share of PC slots has risen to nearly five percent, and its share of the retail sub-\$1000 market has neared one third. PC Magazine’s John Dvorak hailed its reference model for a WebPAD, an 8 by 11 inch haptic handheld with megabit wireless modem on board, as a Comdex “hot ticket” and “fabulous gizmo.” You have to begin somewhere.

Andrew Grove calls all this “the fantasies of Brian Halla.” Halla calls it the single-chip system strategy. We call it the new paradigm of scarce power and silicon area as the desktop PC becomes a minority niche. The rise of digital cellular devices, such as Qualcomm’s pdQ, as the prevailing PCs of the next decade, dictates the increasing resort to single multi-module chips fueled by batteries and oriented more toward communications than fast computing. You want some futurism? By 2005, Qualcomm will be vying with **Nokia** (NOKa) to become the top unit producer of PCs. That’s the world that National is addressing. So are **Xilinx** (XLNX), **Atmel** (ATML), **ARM** (ARMHY), and **LSI** (LSI)—Halla’s previous fantasy incubator.

Microchip architecture is imploding. The speed

of light constraint ordains that the next generation of chips will be the last that is governed by a single clock. There will simply be no time for a pulse emitted at one point on the chip to reach more than 16 percent of the rest before the transistors switch. The penalty for going off chip rises sharply as the lightspeed limit restricts the possibility of improving memory access speeds, and as multimedia data leaps all over the lot, defying the laws of locality that make caches efficient. More futurism from the scarce silicon area perspective: Watch for the death of hierarchical caches, where much of processor silicon is devoted to redundant copies of data based on increasingly faulty predictions of what the processor might want to do next. In Merced, **Intel** (INTC) is still deep in this game.

In the new era, chips will increasingly contain several functional modules, with separate intellectual property and clocking. In the end, processors will be

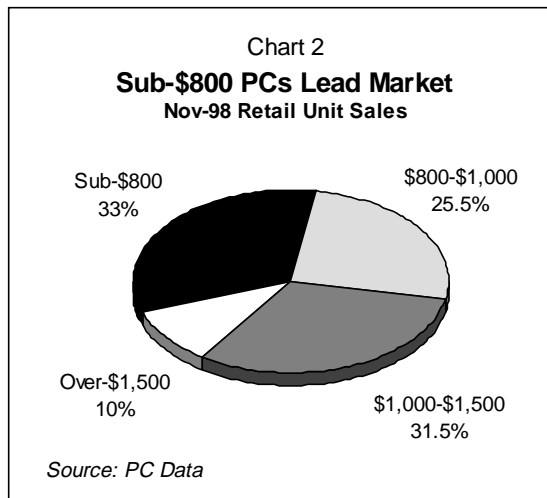
on memories rather than memories on processors. As the industry moves from multi-chip modules to multi-module chips, asynchronous logic will necessarily prevail. This is a change resembling Java’s threat to **Microsoft** (MSFT) suites and Intel shows no particular understanding of it. Under Halla, by contrast, National has fixed its strategy on mastering the single-chip system. Increasingly bringing analog functions

on board, as for input and output, the single-chip paradigm fits National’s skill set. If National can master the power saving disciplines of asynchronous system design, Halla’s fantasies become a route to industry leadership.

To many observers, it has all seemed one National fantasy too far. But there has been method in the maelstrom. Cyrix burst into the PC processor business by powering the sub-\$1,000 PC introduced by **Compaq** (CPQ) in February of 1997. Cyrix moved within six months from virtually zero retail PC market share to grab 8.3 percent of the market by August, when the company merged with National.

After the merger, though, disaster struck. Cyrix’s share plunged to 0.4 percent in early 1998 while **AMD**’s (AMD) retail share quadrupled to 30.8 percent. AMD had stolen the market from Cyrix and Brian Halla’s tenure at National was rumored to be in jeopardy. On April 22, National announced a 1,400 employee, or 10 percent, reduction in its workforce.

At the time, **IBM** was making Cyrix’s processors, taking half, and then competing with Cyrix in selling them. To end this self-defeating arrangement, Halla enlisted Kamal Aggarwal from LSI Logic, who had just led most of the industry into the .25 micron generation in a leading edge fab he built near Portland,



Oregon. At National, he set to work creating a state of the art facility near Portland, Maine. He was well down the learning curve in sub-micron Portland wafer fab. By September 25, National was able to terminate its foundry arrangement with IBM and meet its own and IBM-customer demand through production at its own .25 micron fab. Sordid details of the termination, and asset transfers to IBM, resulted in National taking a one-time charge of \$48.6 million, recorded as cost of sales during its second quarter of fiscal 1999, ending November 29, 1998.

As National began reforming its fab strategy, Halla on April 6, 1998 outlined his vision for the ultimate National chip, an entire PC on a chip. By conventional logic this was another fantasy too far. You integrate all those devices and your processor can become obsolete if an outside company improves one function. You reduce the number of processors you can produce on a wafer. You reduce the size of your onchip caches and impede performance.

Cyrix's MMX-enhanced MediaGX microprocessor does all this and more. It integrates the traditionally external graphics, audio, memory control and PCI interface functions. The PC on a chip would further merge the dozen or more additional devices typically found on a PC motherboard into a single die. Going beyond the features typical of a PC, the PC on a chip could include the integration of TV tuners, audio subsystems, video decoders, DVD controllers, network interfaces and other systems required of the brains within settop boxes, DVD players and other appliances. Few companies command the range of analog and digital skills and intellectual property to achieve this feat. But National does, more or less. And in the new world of handheld devices as the dominant PC units, integration will trump state-of-the-art MIPS every time.

On May 21, the beat went on as National announced an alliance with **Packard Bell-NEC** that sparked a revival for both. With 90 percent of sales coming from sub-\$1,000 systems—which in turn surged to more than half of all retail units sold in the industry—Packard Bell attained its highest unit market share in a year at 22 percent, second only to Compaq's 27.3 percent. Not only was Packard Bell's \$565 Cyrix-based M820 November's best selling retail PC model at 7.3 percent, but National's share of processors in sub-\$1,000 PCs surged ahead of Intel's to 30.1 percent. Counting sales from just five PC models based on Cyrix processors, National's share of all retail desktop sales nearly doubled between October and November, and National scored designs

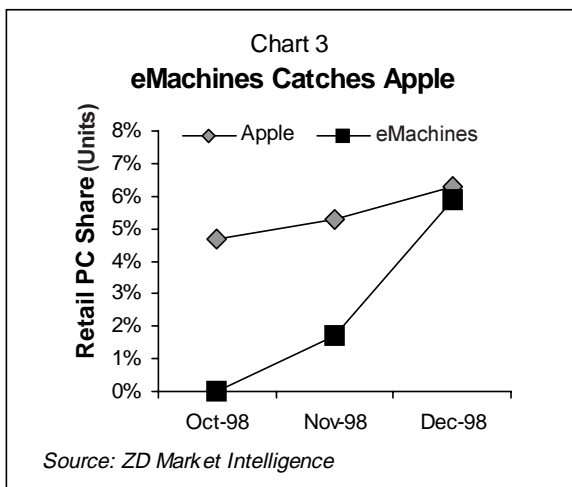
also with Compaq and IBM.

Hey, don't short Intel just yet. It is roaring back with Celeron. Only 20 percent of PCs are in the retail sub-\$1000 category. But its need for integration makes it a harbinger of future markets.

Watch the low-end. **eMachines**, a US based joint venture backed by two Korean PC suppliers, expanded distribution of its \$399 Cyrix-based PC beyond **Best Buy** (BBY) and **Office Depot** (ODP) into the top nationwide and regional channels. On the strength of heavy sales, eMachines announced a 50 percent production hike to over 300,000 units in 1Q 1999. Moving from near zero in October to 5.9 percent of total retail desktop share in December, eMachines challenged 5th place **Apple** (AAPL) in units. Its \$413 average selling price was one third of Apple's and half Packard Bell's (\$813). With an iMac look-alike promised for the Spring, the eMachines strategy threatens to derail Apple's much hyped recovery and to shake up the industry, forcing changes throughout the chain from PC design through marketing.

Also offering a sub-\$400 PC are the retailer **MicroCenter** and, on an OEM-basis, **First International Computer**. "An AMD K6 is too expensive, much less an Intel solution," according to Jason Kuo, of FIC. Both Kuo and Stan Swearington, Vice President of Marketing at Cyrix,

Such low priced systems make the OS software one of the most costly components, and raise questions about the viability of Microsoft Windows 95/98 in these fastest growing markets. Java anyone?



go on to question the continued viability of Microsoft Windows 95/98 in such low priced systems where the operating system software becomes one of the most expensive components. Java anyone?

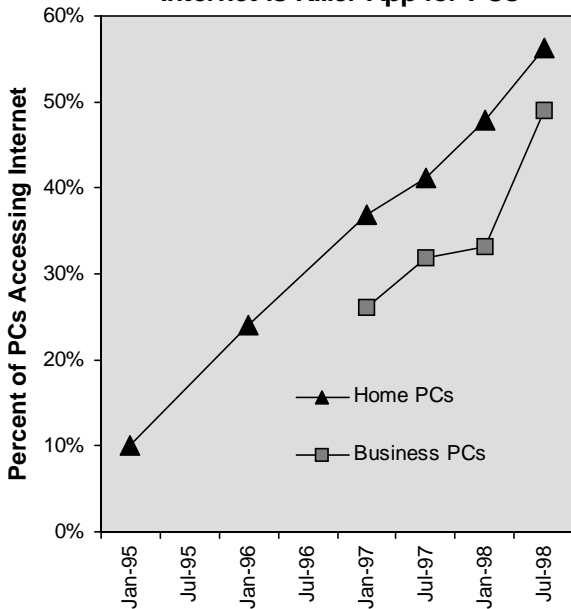
Driven by price declines, the global PC market outlook remains positive into 1999, with Dataquest, IDC and Deloitte Consulting reporting strong European growth and better than expected Asian sales. Retail PC sales in Japan, as reported in the November GTR, continue to surge, with over 90 percent year to year growth in the first week of November and over 75 percent growth in the first week of December, 1998.

While also pursuing plans for a highly integrated leading-edge processor code-named Jalapeno—to be manufactured at 0.18 microns at the South Portland fab—National continued expansion at the lower end. National and Packard Bell-NEC announced December 10, the NEC Ready 120LT, the first full featured sub-\$1,000 notebook PC. The two companies hope to stampede into the notebook market with the same sub-\$1,000 marketing that has driven the PC market over the past two years.

But you can't disrupt a market by going head to head with the dominant producer, particularly if it's Intel. What makes National more than a processor

Chart 4

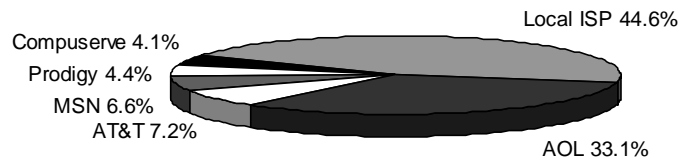
Internet is Killer App for PCs



Source: ZD Market Intelligence

Chart 5

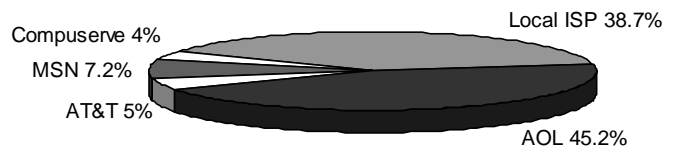
ISP Residential Market Share, Jan-98



Source: ZD Market Intelligence

Chart 6

ISP Residential Market Share, Aug-98



Source: ZD Market Intelligence

Internet and AOL Use Surge

Internet access has become the killer application for both home and business PCs. From January 1998 to July 1998 the number of home and business PCs accessing the Internet grew by more than 16 million or over 35%, according to ZD Market Intelligence. By mid-year a majority of PCs in use were accessing the Internet (Chart 4). With the second half surge in PC sales, many purchased for gaining Internet access, the final 1998 numbers should be phenomenal.

The number of AOL subscribers surged at the end of 1998, hitting 15 million before New Year's Eve. Surviving the threat that "pure" Internet Service Providers (ISPs) posed to AOL's proprietary online offering, AOL's flat rate service passed local ISPs' total share of the residential access market. (Chart 5 and 6). ZD Market Intelligence has found that while ISP customers are better educated, AOL users are typically younger, better off and more likely to have children. AOL users were also reportedly more likely to shop online (60% vs. 50% for ISPs). In addition, AOL announced some \$1.2 billion of 1998 holiday sales through its retail partners.

TV Goes Digital (Sort of)

EchoStar announced January 7 deals with WebTV and Gateway to bring interactive and Internet TV to its customers. While worldwide WebTV subscribers climbed near 700,000, standalone DVD player sales to US dealers surged to 1.4 million, climbing at a faster rate than DBS subscribers (Chart 7).

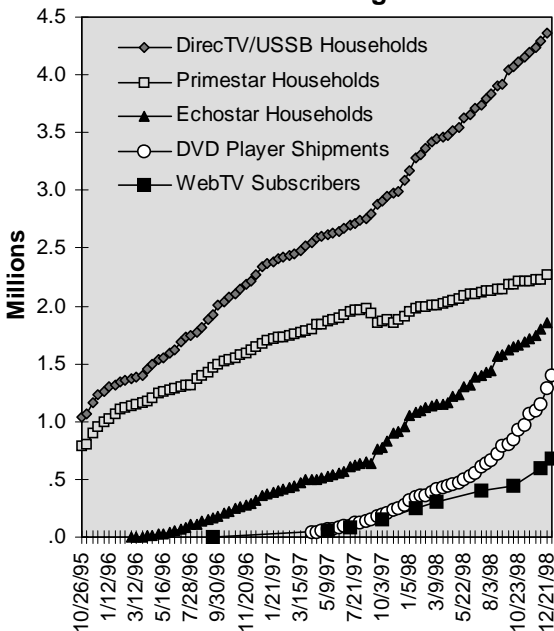
P-Com Scores with WinStar

P-Com announced purchase orders during 4Q98 of \$31.4 million versus \$58.4 million a year earlier (Chart 8). But, good news came January 7, with the announcement of a P-Com partnership with Siemens building point-to-multipoint systems for WinStar, and on the 12th, with a \$12 million order for digital millimeter wave radio systems.

-KE

Chart 7

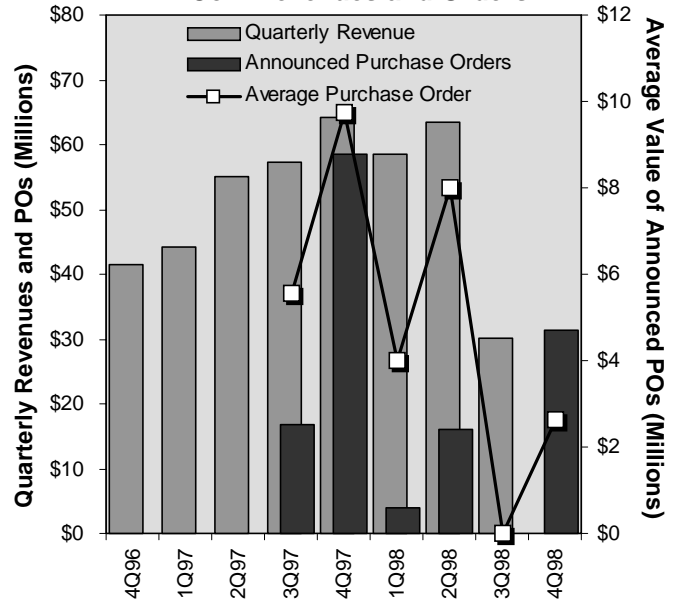
The Status of "Digital TV"



Sources: DBS Digest, CEMA, WebTV

Chart 8

P-Com Revenues and Orders



Source: Company Reports

APPLIED MICRO CIRCUITS CORPORATION

Telecosm chip company specializing in exotic fab processes.

Applied Micro Circuits Corporation (AMCC) commands extensive mixed-signal design capability and system expertise, as well as a wafer fab with multiple silicon process technologies, including advanced silicon germanium (SiGe) from IBM. These skills give it an edge in the high-performance communications market, from gigabit ethernet to 10 gigabit OC-192 SONET chips.

SiGe provides AMCC's development teams with lower power requirements, higher level of integration, and cooler operating temperature benefits over the gallium arsenide technologies currently used for nearly all high frequency applications.

Meanwhile, AMCC is also innovating in CMOS, introducing the S2060, the first gigabit ethernet tranceiver in conventional CMOS, and the S2066, a four port chip. AMCC hopes to cooperate with others to standardize its unique pinout.

For the six-month period ended September 30 1998 in FY 1999, AMCC announced net revenues of \$48.8 million, up 39 percent over FY98. Net income for the first six months of fiscal 1999 was \$8.9 million, or \$0.36 per share, compared to \$5.9 million, or \$0.32 per share, in the first six months of the prior fiscal year.

BROADCOM

Fabulous cable player, broadening scope without fab.

Broadcom (BRCM) is the dominant chip designer for the bandwidth explosion in the cable industry. Offered to the public in April 1998 at \$24 a share, the company designs, develops and markets integrated circuits (ICs) for broadband markets including cable set-top boxes, cable modems, high-speed networking (Ethernet/gigabit Ethernet devices), satellite and terrestrial digital transmission, and digital subscriber line (xDSL) applications for such customers as **3Com** (COMS), **Nortel** (NT), **Cisco** (CSCO), **General Instrument** (GIC), **Motorola** (MOT), and **Scientific-Atlanta** (SFA). In August, it entered an alliance with **MIPS Technologies** (MIPS) to gain access to a processor core for single-chip systems.

Established as the leader in cable modem chip architecture, the company has announced a new single-chip design, the BCM3300, which provides the first implementation of extensions to DOCSIS (Data Over Cable Service Interface Specification) for advanced Quality of Service (QoS). With constant bit rate capability, the chip supports services such as cable telephony and videoconferencing over a cable network, allows cable operators in the US and Europe to offer multiple access speeds at different price points, and also enables "push services," such as stock tickers, news, and sports scores.

In November, Broadcom and **Terayon** (TERN), another strong Telecosm player, were selected by CableLabs, the cable industry's R&D/standards group, to create a new advanced cable modem standard. Based on Terayon's S-CDMA (synchronous code division multiple access), the technology allows use of unconditioned cable for broadband Internet access upstream at up to 60 megabits a second.

Revenue for Broadcom in the third quarter of 1998 was a record \$52.5 million, an increase of 467 percent over the \$9.3 million reported in the third quarter of 1997. Net income was also a record, at \$8.2 million, compared with a net loss of \$1.8 million in the third quarter of 1997. This company has rocketed off the pad from its IPO in 1997 and will be a major player in a number of Telecosm technologies well into the coming century.

These super financials partly reflect a decision to be fabless. Unlike AMCC and other rivals in the field, Broadcom apparently plans to be a dominant player in communications chips without developing a capability for manufacturing chips. This strategy may not cut it, as frequencies rise in state-of-the-art devices and processing expertise in exotic materials becomes more important to success than ingenuity in bandwidth-saving quality of service algorithms. Dumb networks tend to be wafer process intensive.

JDS FITEL

Optical star partners with Corning, Allied Signal

JDS Fitel (JDS.TO), a Canadian fiber optic component supplier on December 4, announced a contractual joint venture with **Corning** (GLW) to develop and extend the JDS line of optical isolators. JDS FITEL will design, develop, and manufacture the isolators, while Corning will supply certain materials and other needs for the project.

Isolators are passive optical devices that are used to reduce reflections and eliminate interference in optical transmission systems, chiefly optical amplifiers, a forte of Corning Photonic Technologies, which is the world's largest supplier of optical amplifiers.

On November 24, JDS Fitel announced the \$19 million acquisition of the photonics division of **Akzo Nobel** (AKZOY), which is a leading supplier of waveguide technology for optical switching. These planar waveguide based switches use specialized optical polymers for low loss and increased flexibility of application in WDM (Wavelength Division Multiplexing). To maximize this technology, JDS Fitel has entered into a strategic alliance with **AlliedSignal** (ALD), a pioneer in the development of optical polymers for telecommunications applications.

JDS Fitel has had an average annual revenue growth of greater than 50 percent over the past six years, with FY 98 sales nearly doubling that of the previous year. Earnings have followed, with substantial annual earnings growth every year since 1992. This steadily accelerating growth has created the need for expansion, and the company has embarked on an ambitious project: a new corporate campus with a total of approximately 500,000 sq. ft. of additional R&D, manufacturing, and office space.

Jeff Dahlberg

Driving all National's businesses is Halla's understanding that the future is based on network connections and single-chip systems.

pest is its new markets. On August 3, National announced that Europe's leading manufacturer and distributor of point-of-sale systems (POS), **Siemens Nixdorf**, had incorporated the Cyrix MediaGX processor into its Beetle point-of-sale system. The system will deliver the full capability and compatibility of a Windows PC-based POS system, in the form factor of the world's smallest electronic cash register.

The Cyrix MediaGX processor is also bringing low-cost graphics intensive x86 compatibility to the coin-operated video-game arcade industry. On October 6, National and Atari Games Corporation, a subsidiary of **Midway Games** (MWY), announced Atari's new video arcade game, Site4, would incorporate the Cyrix processor.

While **Oracle** (ORCL) blundered with Network Computers and Sun's JavaStation suffered from delays and sticker shock relative to low end PCs, the idea of thin-client, network based machines remains attractive to businesses suffering from high total cost of computer ownership. National's Cyrix processors are powering new generations of high performance thin-clients at lower prices. Among MediaGX buyers are Japan's leading producer of thin-client systems, **Takaoka Electric**, the leading US producer, **Boundless** (BDLS), and Seattle-based **Cedar Systems**.

National makes the case for these devices from its own experience. National deploys a combination of Cyrix MediaGX-based Windows-based terminals, supplied by **Wyse Technology**, and PC-based client software to about 800 desktops, a conversion of about 10 percent of National's desktop systems. National reports that its thin-client venture cuts about \$2,000 from the \$7,500 to \$8,000 yearly cost (hardware, software and support) of running a PC desktop.

In addition to the sub-notebook announced by Packard Bell-NEC, National has announced handheld PC design wins with **Casio** and **Palmax**. But excitement at Fall Comdex in November centered on National's reference design for its WebPAD. The Cyrix booth in the North Hall of the Las Vegas Convention Center was crowded with people trying to see proof-of-concept prototypes of the new wireless Internet access device.

The WebPAD features a full color 10.4 inch touch-screen LCD display and speakers in an 8.5 by 11 inch, 2.7 pound tablet. The wireless tablet is linked using a **Harris** (HRS) Semiconductor 2.4-GHz direct sequence spread spectrum radio design resembling CDMA and offering a 2 Megabit per

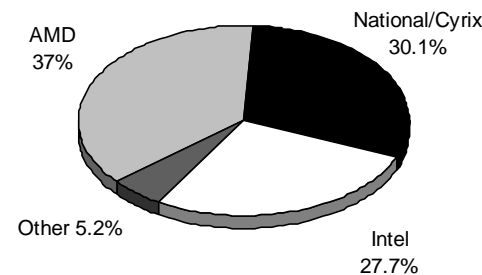
second data rate to the pad's base station up to 500 feet away. Base station options would range from RJ-11 dial-up Internet connections to always-on, high-speed cable modems. Ethernet LAN connections or **Tut's** HomeRun telephone wire ethernet could allow file and software storage on other networked PCs. Additional connectivity for expansion or peripherals is offered through USB ports. The WebPAD battery should power 6 hours of use or 20 hours in stand-by mode between charges in a cordless phone-like charging cradle.

The WebPAD reference design will be available to OEMs on a no-fee license program in 1999. The prototypes were powered by existing MediaGX processors, and would initially carry a manufacturer's cost of about \$500. This is too high. But, display price drops, increasingly integrated Cyrix processors, and volume production could bring the price down significantly.

National's WebPAD suggests the InfoPad conceived by Robert Brodersen at UC Berkeley. It was

developed early this decade to provide a light-weight, low-price, low-power, wireless tablet with a liquid crystal display (LCD) to connect large groups of people (classrooms, boardrooms) to broadband video, audio and computing networks. A promising focus is the education market which consumes 18 percent of the commercial PCs sold in the US, second only to the services

Chart 9
National Tops Intel in Sub-\$1,000 PCs
Nov-98 Retail Sales



Source: PC Data

industry's 20.6 percent.

Driving all National's businesses is Halla's understanding that the future is based on network connections and single-chip systems. On September 15, National announced it had licensed Tut Systems' HomeRun technology allowing 1 megabit ethernet networking over copper wires simultaneously used for telephone wiring. The Tut technology will be combined with National's traditional Ethernet technology to create a single chip solution for home and LAN networking.

Illustrating the power of National's analog-digital ambidexterity, on December 1, it introduced the first scanner-on-a-chip, the LM9830. This chip incorporates all the functions of a high-performance color scanner, including analog front end, sensor clock generation, microstepping motor control, data buffering and parallel port interface, into a single integrated circuit.

National's wholly owned subsidiary, Mediamatics, has brought National increasing success in the hot DVD market where the Mediamatics' DVD playback solution was adopted this fall for Compaq Presarios and IBM Aptivas

with DVD players. National's plans include integration of Mediamatics DVD functions directly in future processor models, adding value to the choice of Cyrix.

Siemens POS systems, \$400 eMachines, Atari arcade games, a sea of thin-clients, hand-held computers, DVDs, and the WebPAD, demonstrate the range of products being enabled by highly integrated, low cost Cyrix processors. As National moves forward with the development of its PC on a chip, it will continue to develop reference designs for innovative new products. But, as Christensen explains about disruptive technologies, the full range of markets usually cannot be known in advance. The key is to take existing technologies in directions that could not be envisioned under the constraints of old marketing models.

National's stealth attack in new markets gives it the edge over AMD, which currently leads in confronting Intel in conventional PCs. IDC forecasts the information appliance market will grow some ten-fold from 5.9 million units in 1998 to over 55 million in 2002. National is helping to power that transition.

National revenues remain well behind the levels of previous years when the company was a major producer of commodity devices. But orders for Cyrix processors, networking, PC motherboard, and wireless products all improved over the summer quarter; and analog bookings grew almost twice as fast as the company as a whole. Overall, second quarter fiscal 1999 orders grew 12 percent sequentially from the previous quarter. Within the quarter, October topped September, and November saw the strongest bookings in twelve months. Before one-time charges and after National moved production of Cyrix processors in-house, gross-profit margins more than doubled to 28 percent. And, reducing the impact of fixed costs, capacity utilization rates grew from 41 percent to 62 percent.

The struggle of integrating Cyrix into National and of reordering chip fabrication around National's Maine fab, are now behind National. Looking into 1999 and the dawn of the Telecom, Brian Halla's fantasies may soon become a Christensen case study.

QUALCOMM

Meanwhile, as you may have noticed, Qualcomm is provoking the usual clueless coverage in the press, which prompts queries galore to GTG. Is the company truly "desperate," as the *Wall Street Journal* opined? Can **Ericsson** (ERICY) and the EU truly capture the next generation of broadband wireless and swipe CDMA from Qualcomm merely by shuffling papers at standards bodies, repurposing old TDMA (time division multiple access) patents, and in general raising the noise level in wireless way above the signal? I gather you want to know. If you are a faithful reader of

this Report, though, you grasp that in the end the best technologies, executed most competently, nearly always prevail.

Exemplifying the spectronics paradigm of "wide and weak" (see GTRs passim), code division multiple access pioneered by Qualcomm is still on track to become the third generation (3G) of worldwide wireless transmission technologies. The ITU (International Telecommunications Union), which shapes worldwide telecom standards, has been accepting 3G proposals and all the key parties have endorsed some form of CDMA. These proposals will be reviewed and selections will be made in 1999.

Despite the general acknowledgment of the efficacy of CDMA, there are significant legal and political barriers to be surmounted, primarily placed by Ericsson, the European telecom giant, and its minions. They stumbled into the CDMA party late in the day, drunk with the success of GSM around the world. In September 1996, the company initiated a lawsuit against Qualcomm for infringement of amorphous Ericsson wireless patents allegedly applying to the Qualcomm technology that Ericsson long deemed in violation of the laws of physics. Qualcomm filed a countersuit, and has refused to negotiate licenses on a non-discriminatory basis (an important tenet of the ITU's policy), unless the Europeans support a form of CDMA compatible with Qualcomm's existing systems. Ericsson's preemptive patent strike, however, has begun to disintegrate, and on October 20, the company felt compelled to drop all claims under three of the patents, and admitted the invalidity of the claims asserted against QCOM on two others. There are other unresolved patent questions, including a challenge to an important Qualcomm CDMA patent in Europe (EP0265178) by **Motorola** (MOT), and possible opposition to others as well, which bear on 3G.

A mock "conciliatory" Ericsson on December 8 proposed a 3G CDMA system claimed to be compatible with the important second generation digital wireless technologies. But this system has a chip rate of 3.84 Mcps that addles Qualcomm's existing cdmaOne systems, and yet has no important demonstrable advantage over the slightly lower chip rate Qualcomm proposes (3.68 Mcps).

The telopoly oriented ITU has sent a warning to the warring parties: settle the dispute, or risk CDMA being excluded from consideration. Although the ITU stance may seem menacing to Qualcomm, standards bodies in practice cannot control the marketplace. Qualcomm is barred from Europe today and will probably be barred tomorrow. It can launch CDMA2000 without European endorsement if necessary. The Europeans may well lack the technical mastery of CDMA to launch Wideband CDMA as a third generation standard within two years of Qualcomm's planned move next year. The technical papers on CDMA from the EU contain serious misconceptions based on

Exemplifying the spectronics paradigm of "wide and weak", CDMA pioneered by Qualcomm is still on track to become the third generation of worldwide wireless transmission technologies.

TELECOSM TECHNOLOGIES

ASCENDANT TECHNOLOGY	COMPANY (SYMBOL)	Reference Date	Reference Price	Price as of 1/12/99
Cable Modem Service	@Home (ATHM)	7/31/97	19 1/2	100
Silicon Germanium (SiGe)	Applied Micro Circuits (AMCC)	7/31/98	22 11/16	41 1/2
Analog to Digital Converters (ADC), Digital Signal Processors (DSP)	Analog Devices (ADI)	7/31/97	22 3/8	28 7/8
Dynamically Programmable Logic, SiGe, Single Chip Systems	Atmel (ATML)	4/3/98	17 11/16	17
Single-Chip Broadband Data Transmission	Broadcom Corporation (BRCM)	4/17/98	24 *	138
Digital Video Codecs	C-Cube (CUBE)	4/25/97	23	29 5/32
Erbium Doped Fiber Amplifiers, Wave Division Multiplexing (WDM)	Ciena (CIEN)	10/9/98	8 9/16	14 5/8
Fiber Optic Cable, Components, Wave Division Multiplexing (WDM)	Corning (GLW)	5/1/98	40 15/16	47 3/8
Submarine Fiber Optic Networks	Global Crossing (GBLX)	10/30/98	29 5/8	42
Low Earth Orbit Satellites (LEOS)	Globalstar (GSTRF)	8/29/96	11 7/8	22 7/8
Business Management Software	Intentia (Stockholm Exchange)	4/3/98	29	33 3/4
Wave Division Multiplexing (WDM), Fiber Optic Equipment	JDS Fitel (Toronto Exchange)	5/1/98	19 1/4	28 15/16
Broadband Fiber Network	Level 3 (LVL3)	4/3/98	31 1/4	40 3/8
Single Chip ASIC Systems, CDMA Chip Sets	LSI Logic (LSI)	7/31/97	31 1/2	19 1/16
Telecommunications Equipment, WDM, CDMA, SiGe	Lucent Technologies (LU)	11/7/96	23 9/16	107 7/8
Telecommunications, Fiber, Internet Access	MCI WorldCom (WCOM)	8/29/97	29 15/16	72 1/2
Single-Chip Systems, Silicon Germanium (SiGe)	National Semiconductor (NSM)	7/31/97	31 1/2	15 5/16
Telecommunications Equipment, WDM, CDMA, SiGe, Cable Modems	Nortel Networks (NT)	11/3/97	46	53
Point to Multipoint (7-50 Ghz), Spread Spectrum Broadband Radios	P-COM (PCMS)	11/3/97	22 3/8	7 29/32
Code Division Multiple Access (CDMA)	Qualcomm (QCOM)	9/24/96	38 3/4	60 7/8
Broadband Fiber Network	Qwest Communications (QWST)	8/29/97	20 3/8	54 15/16
Linear Power Amplifiers	Spectrian (SPCT)	7/31/98	14	17 3/8
Nationwide CDMA (Code Division Multiple Access) Wireless Network	Sprint PCS (PCS)	12/3/98	15 3/8	26
Java Programming Language, Internet Servers	Sun Microsystems (SUNW)	8/13/96	27 1/2	93 3/8
Broadband Wireless Services	Teligent (TGNT)	11/21/97	21 1/2 *	36 1/4
CDMA Cable Modems	Terayon (TERN)	12/3/98	31 5/8	43 1/4
Digital Signal Processors (DSPs)	Texas Instruments (TXN)	11/7/96	23 3/4	92 1/4
High-Speed Copper Networking	Tut Systems (Private)		Anticipated IPO	
Wave Division Multiplexing (WDM) Modulators	Uniphase (UNPH)	6/27/97	29 3/8	63 1/2
Field Programmable Gate Arrays (FPGAs)	Xilinx (XLNX)	10/25/96	32 7/8	65

* Initial Public Offering

Tut Systems' Initial Public Offering is expected in February. Lead underwriter is Lehman Bros. Inc.

Note: This table lists technologies in the Gilder Paradigm, and representative companies that possess the ascendant technologies. But by no means are the technologies exclusive to these companies. In keeping with our objective of providing a technology strategy report, companies appear on this list only for these core competencies, without any judgement of market price or timing.

applying TDMA principles to the very different technology of spread spectrum.

Any way you cut it, the decision by ETSI, the European telecom standards body, to choose any kind of CDMA for the next generation of GSM is a huge victory for Qualcomm. The pretense that it's Ericsson's W-CDMA cannot conceal the Qualcomm concepts that make it possible: rake receivers, soft handoff, power control. The anti-competitive edict by the EU has been challenged by the US Government. In a letter of December 19, the Secretary of State, Secretary of Commerce, and the Chairman of the FCC cautioned the European Commission against the "unfortunate precedent" which would be set if an exclusive regional standard were chosen prior to the ITU's standards process.

Hey, throw me into the briar patch! This is where Qualcomm has thrived for more than ten years. The only difference is that in the past the US State Department endorsed GSM as a stan-

dard, and Qualcomm was a tiny startup with no allies at all and few revenues. Nonetheless, the power of its CDMA and entrepreneurial boldness has made it a \$3.3 billion company, quadrupling revenues over the last three years and prevailing against all the powers and principalities of the telecom establishment. Generation 3? One way or another, a piece of cake.

George Gilder and Ken Ehrhart, January 13, 1999

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Editor: George Gilder; Associate Editors: Charles Frank and David Minor;

Director of Research: Kenneth Ehrhart.

Monument Mills P.O. Box 660 Housatonic, MA 01236 USA

Tel: (413) 274-0211 Toll Free: (888) 484-2727 Fax: (413) 274-0213

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