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Life After Television Redux

The main contenders to become the entertainment server of choice are multimedia PCs from Dell and Compaq/HP, set-top boxes from Digeo, Motorola and Scientific Atlanta, and gaming machines from Microsoft and Sony

Inside:

A few weeks ago, I received the manuscript of a new book by Scott Kipp, author of two books on storage networking and a leader of what we call the Storewidth industry. Storewidth defines all the conflicted interfaces between ever more abundant data storage facilities and ever more ample network bandwidth. A technical chief of the Fibre Channel Industry Association (FCIA), Kipp represents **McDATA** (MCDTA) corporation at standards bodies mastering the mazes of storewidth in enterprises.

Reading Kipp's book prompted us to investigate McDATA. Already holding a 57 percent share of the high end of the storage switch market based on its close collaboration with **EMC** (EMC), which accounts for 62 percent of its sales, McDATA now stands to increase its role with **IBM** (IBM)—already 18 percent of sales. McDATA is the only storage switch vendor with a significant offering based on FICON (fibre connection), which is IBM's fiber upgrade for its mainframe industry standard connector, ESCON (enterprise systems connection). New Merrill Lynch storewidth analyst, Shelby Seyrafi, reports that "McDATA will own FICON, a good place to be" with the release of EMC's first storage array with FICON support last month, and at a time of widespread IBM FICON upgrades. McDATA's acquisition of Sanera, which boasts machines scalable to 1,500 ports, should help fend off rivals **Cisco** (CSCO) and **Brocade** (BRCD) in these markets.

More exciting to us, though, was our discovery that McDATA had recently purchased the pioneering Storewidth startup Nishan after a previous run at the company by Brocade, which resold Nishan gear. Like several companies at our annual Storewidth conference, Nishan made grand claims of translating both SCSI (small computer systems interface) and fibre channel (the high end, high bandwidth storage protocol) for passage over IP networks. But only Nishan dared to go all the way, inventing iFCP (Internet fibre channel protocol) to convert fibre channel for full TCP-IP transmission rather than simply tunneling fibre channel data between two storage area networks (SANs) across an IP link, as the prevalent FCIP (fibre channel over IP) protocol does.

Converting both storewidth standards to flow over the Internet, the Nishan-McDATA four-port switch allows remote devices in different storage area networks (SANs) to swap diverse files across the network box-to-box without setting up a special fibre channel tunnel between SANs. Now launching the Nishan system, under the name Eclipse 1620, McDATA lowers the cost of SANs for midsize, small and eventually even branch or home offices. With Nishan iFCP capabilities and wirespeed processing from a fast **Xilinx** (XLNX) field programmable gate array (FPGA) chip, the latest version of the 1620 promises to be some three times faster than the competition. And don't expect a slow down. Products now in design will be powered by **Altera**

CONTINUED ON PAGE 2

(ALTR) Stratix FPGAs with up to 1 million gates and capable of running up to 3.125 gigabits per second (Gbps).

Nishan's 100 existing customers and 50 percent sequential quarterly revenue growth testify to a healthy IP storage market, in which McDATA is steadily gaining market share. McDATA's new Nishan system can emancipate SANs from their specialized niche of a some $1 billion fibre channel market into the $93 billion world of Ethernet and IP storage.

McDATA is the only storage switch vendor with a significant offering that supports FICON

McDATA joins our list as an exemplary exponent of the Storewidth paradigm.

Soon, however, it became clear that Kipp is not merely an enterprise nerd. Through his company All Digital, he is launching a consortium of creators of digital content for the net. He is also a lucid writer and incisive thinker. Receiving many manuscripts in the mail, I often set them aside until they yellow enough for assimilation by the "recyclist" to be krugged and compacted with the piles of paper garbage. But this one appealed to me with its title, *Broadband Entertainment,* and the implication of its many informative charts that my long heralded "life after television" is finally on its way.

I read Kipp's book and ascertained that it is "a broadband home run, Delphic, detailed and definitive, a call to action for the next frontier of the Internet revolution—the spectronic residence." That is the blurb-speak. The book is available at *www.broadent.com*. For the nerd-speak, I proceeded to look up its author, who invited me to address the FCIA in Boston in August. Recalling my many prophecies that fibre channel would soon succumb to gigabit Ethernet, I gulped and stammered something about my past dismissal of his favored technology. But Kipp was merely amused by my idea that fibre channel was moribund, and he renewed the invitation. In Boston, I learned that there is still life in the fibre channel standard as it morphs to subsume Ethernet protocols at the 10 gigabit level. I also encountered Kipp as the visionary voice of a revolution in home entertainment that would finally render the household a key center of growth for the storewidth technologies that dominate the enterprise.

Regulatory paralysis in the local loop seems to deepen with every new edict of the runaway FCC and with every new pettifog from the Bush Administration, the U.S. Senate, and other federal branches of the **AT&T** (T) lobby (which is apparently unfazed by the 15 straight quarterly revenue declines of its famous telecom subsidiary). Broadband in the U.S. is like basketball in Japan: too little and too latent. Defined as capability for robust two-way full motion video, broadband is nearly ubiquitous in Korea, advancing rapidly in Japan, emerging fast in the Italy and other parts of Europe and even Canada, but virtually absent in the U.S.

Korea now has some 40 times more per capita bandwidth to homes than the U.S. does. As telecom guru John Wohlstetter has wryly observed in his *Bandwidth* blog from the Discovery Institute, U.S. last mile bandwidth numbers resemble North Korea's more than South Korea's. Now under the prodding of **Softbank** (SFTBF.PK) and **Yahoo** (YHOO) in Japan, Japan is coming on massively as well, with a major campaign to deploy VDSL (very high speed digital subscriber line) at between 13 and 55 megabits per second (Mbps) depending on distance to the node.

What the U.S. calls "broadband" is mostly mere one megabit pipes with 200 kilobit upstreams. In most American homes, the only true two-way broadband channel lies between personal computer storage and the PC monitor—the bus between hard-drive, CD/DVD player, and the PC display. Rather than being based on bandwidth to homes, therefore, broadband in the U.S. is based on storewidth in homes.

Although homes will not soon sprout with storage area networks based on fibre channel standards, a major paradigm shift is at last underway driven by hard disk prices under a dollar for a gigabyte (10^9), blue laser optical disc capacities moving up to 27 gigabytes, PC bus bandwidths of well over a gigabit per second, and **United Parcel Service** (UPS) last mile bus capacities of petabytes (10^{15}) of DVDs. As an expert both on storage and on home entertainment, Scott Kipp commands the expertise to show the path of storewidth to the broadband home. I asked him to collaborate with me on the October issue of the GTR.

Although most of the ideas stem from his book, we have edited and addited his draft for our readers. Kipp should not be held responsible for my views on **Rambus** (RMBS), **Cree** (CREE), and other companies tangentially included here. I hope Kipp's view of the coming transformation will yield intriguing new investment ideas.

— George Gilder with Mary Collins Gorski

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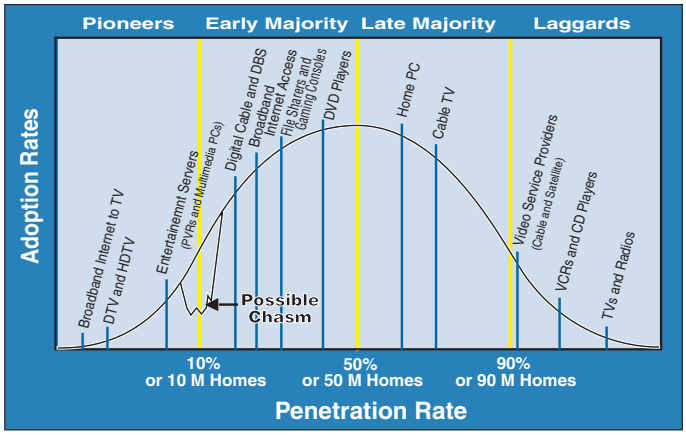
George Orwell's classic novel 1984 proclaimed "resistance is futile" as the mantra of a government employing "telescreen" technology to snoop on its subjects. Orwell assumed that the "telescreen" would be an instrument of centralized power. As Peter Huber explained in *Orwell's Revenge* (Free Press 1994), however, the "telescreen" did not turn out as expected. Rather than a top-down instrument of centralized tyranny, digital technology fosters a bottom up cornucopia of education and entertainment increasingly shaped and controlled by its users.

Broadband American style

The U.S. broadband industry is at last *Crossing the Chasm* as Geoffery Moore puts it in his classic analysis of the treacherous passage between innovation and mass consumption. To surmount the chasm requires a penetration rate of over 10 percent or approximately 10 million of the 108 million American homes. Even in the face of lagging bandwidth to homes,



The adoption of new products over time usually follows a bell-shaped curve. Geoffery Moore described the difficult problem of crossing the chasm to mainstream adoption by an early majority.

advances in storage, compression, and processing are near to propelling the broadband world across the chasm in 2004.

In one direction only, entertainment bandwidth to most U.S. homes is already hundreds of megabits per second. Most cable networks have been upgraded to digital broadcasts with tens of channels each delivering 19 or 38 Mbps of digital data. Though blocked from merging by the regulatory vandals, **Hughes** (GMH) and **Echostar** (DISH) deliver as many as 500 direct broadcast satellite (DBS) channels each bearing some 2 Mbps of standard definition television (SDTV) and tens of megabits per second of HDTV (high definition TV). Eighty percent of major metropolitan areas have five or more digital stations. To see this arena as a monopoly realm of ever diminishing choices, you have to be a politician or regulator.

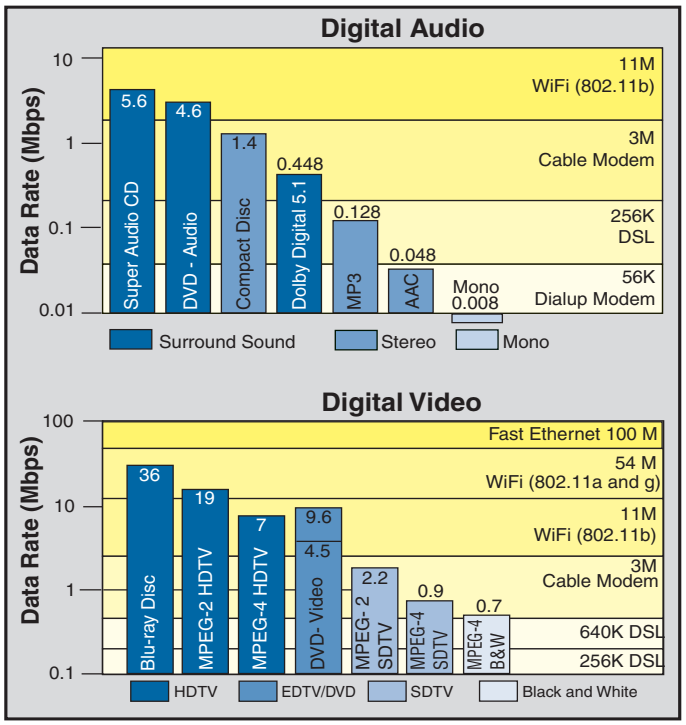
Internet access, however, slows down to the about 1 Mbps of cable modems or the mostly 256 Kbps links of DSL. New DSL modems rev up to 12 Mbps (or even 50 Mbps in new Korean and Japanese deployments), but in the U.S., the copper cage of wires to the home limits the speed of these distance-sensitive lines. Two-way satellite connections deliver up to 400 kbps, but less than 1 percent of the population pays their high up-front cost. Backed by Kleiner Perkins Caulfield and Byers, Echostar, and others, a company called "Wild Blue" will soon project Internet satellite services up spectrum into the Ka band (17-30 GHz), where they promise downstream speeds of some 3.2 megabits per second.

Could we be saved by the blues? Wild Blue will not get all its birds and bandwidth on line until 2005 and even then will suffer downstream latency and upstream narrowband. Since streaming Motion Pictures Expert Group–2 (MPEG-2) SDTV requires over 2 Mbps of bandwidth, most Internet-based television will be downloaded to a storage device in the home for the next several years.

Blu-ray, the third generation of optical disc, targets HDTV and will become available about the time that Wild Blue delivers two-way broadband in satellites. The Blu-ray uses a blue laser at 405 nanometers to store between 23 and 27 GB of information on the same 12 centimeter disc used by CDs and DVDs (digital video or versatile discs). Storing roughly three times as much as a double-layered DVD (8.5 GB) and 40 times as much as a CD (650 MB), Blu-ray disc players and recorders are already available in Japan and should reach America in 2004. Incompatible with existing disk players, however, they are unlikely to cross the chasm for at least five more years. Leading candidates to bring the blue lasers down the learning curve are **Nichia** in Japan, which invented the technology, and Cree of Raleigh, North Carolina, which developed the process to produce it. The two companies have negotiated cross licenses on their technology, but neither company has yet made the product or process sufficiently robust for a mass consumer item.

In the U.S., over a million DVDs are shipped through the mail every day from such companies as **Netflix** (NFLX), **Walmart** (WMT), and **Amazon** (AMZN). With most feature films using dual-layered DVDs, about 10 petabytes of data are shipped through the mail everyday. Since global Internet traffic is estimated at about 3 PB per day, DVD-by-mail offers over 3 times the throughput. If two DVDs can be shipped to your home in two days, that's equivalent to an around-the-clock data rate of 787 kbps – it's "broadband" American style! With the continuing last mile paralysis, a thriving trade in postal DVDs, and release of Blu-ray discs, data in the mail may well exceed U.S. Internet delivery for many years.

On personal computers, storage capacities roughly double annually, with one gigabyte of hard drive disk space now pur-



Three generations of audio formats are compared against broadband data rates that could support them in real time. Fast Ethernet and the 802.11a and g variants of WiFi can support any entertainment format. Third generation MPEG-4 video compression technology requires less than 50% of the data rate of MPEG-2 at the same quality level. While a DVD player can deliver 9.6 Mbps of data, most movies only transmit at about 4.5 Mbps.

TELECOSM TECHNOLOGIES

Altera	(ALTR)
Analog Devices	(ADI)
ARM Limited	(ARMHY)
Avanex	(AVNX)
Broadcom	(BRCM)
Cepheid	(CPHD)
Chartered Semiconductor	(CHRT)
Ciena	(CIEN)
Corvis	(CORV)
Cypress	(CY)
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)
Qualcomm	(QCOM)
Samsung	(05930.KS)
Sonic Innovations	(SNCI)
Sprint PCS	(PCS)
Synaptics	(SYNA)
Taiwan Semiconductor	(TSM)
Terayon	(TERN)
Transmeta	(TMTA)
United Microelectronics	(UMC)
VIA Technologies	(2388.TW)
Wind River Systems	(WIND)
Xilinx	(XLNX)

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.

Altera (ALTR)

PROGRAMMABLE LOGIC DEVICES

OCTOBER 23: 18.34, 52-WEEK RANGE: 10.10 – 23.36, MARKET CAP: 7.01B

Third calendar quarter revenue of $209.4 million was up 16% year-over-year. Net income of $43.8 million, or $.11 a share, grew 87%, and gross margins hit 68.7%. The company also repurchased $58 million worth of its stock and ended the quarter with $1.1 billion in cash. New products accounted for 42% of sales, with the Cyclone line breaking into new markets.

The company unveiled a timetable for launching new products manufactured in TSMC's 90 nanometer process. The high-end Stratix II will debut in the first half of 2004, and the value-oriented Cyclone II will be available mid-year. Altera touts its work in completely rearchitecting for 90 nm, where the performance benefits of moving down the Moore's law process curve were not obvious. In order to take advantage of smaller transistors without trading away performance gains in much higher power consumption, Altera substantially redesigned its first generation Stratix and Cyclone products, resulting in 50% better performance and 50% lower cost. In other news…

Wireless: The company introduced an inexpensive co-processor to facilitate high-speed data transfer in 3G wireless networks. For as little as $7, Altera's Cyclone product can relieve the computational burden on base-station DSPs by off-loading the intense processing of Turbo Codes, an advanced forward error correction scheme used in both the cdma2000 and WCDMA wireless standards.

Medical breakthrough: 3D-Computing Inc. announced that using Altera FPGAs, it has developed a system that for the first time makes PET scans safe for routine preventative body screening. By incorporating up to 2,000 FPGAs in each system, 3D-Computing accelerates photon-detection previously performed only with DSPs and reduces radiation exposure by some 96%.

Broadcom (BRCM)

BROADBAND INTEGRATED CIRCUITS

OCTOBER 23: 29.89, 52-WEEK RANGE: 10.45 – 33.22, MARKET CAP: 8.86B

Broadcom restructured the company into four units: Enterprise Computing (Gigabit Ethernet, ServerWorks I/O); Network Infrastructure (VoIP chips, 10GbE PHYs); Mobile & Wireless (Wi-Fi, Bluetooth, EDGE); and Broadband (cable modems, DSL, satellite). Each group achieved growth in a third quarter where revenue totaled $425.6 million, a record, and a 46% improvement over last year's quarter. Because of Broadcom's many acquisitions during the boom years, the company still reports a modest GAAP loss of $6.3 million, but pro forma operating profits grew to $43.8 million, or $.14 a share.

The company announced the shipment of its 12 millionth NetExtreme Gigabit Ethernet controller. Building on that success, it also announced a new generation of GbE controllers for servers, desktops, and notebook PCs, which are the first chips to employ the new PCI Express host interface.

Corvis (CORV)

WDM SYSTEMS, RAMAN AMPLIFICATION, EDGE SWITCHES

OCTOBER 23: 1.36, 52-WEEK RANGE: 0.47 – 2.09, MARKET CAP: 551.53M

The company announced a restructuring that will reduce head-count from 1,400 to 1,200, saving $30-40 million and reducing quarterly cash burn to $7-10 million per quarter. Corvis now expects to end the calendar year with $275-300 million in cash. With no debt and a market cap of around $600, Corvis's business units are now valued at some $300 million.

The company's Broadwing network unit also hired three new senior executives : John McLeod, a former Metromedia Fiber senior VP; Mike Stewart, former president of NTT-Verio's broadband unit; and Jack Brooks, former HR head at Efficient Networks.

Cypress (CY)

BROADBAND SOLUTIONS, VOICE OVER IP

OCTOBER 23: 19.60, 52-WEEK RANGE: 4.25 – 20.98, MARKET CAP: 2.33B

Third calendar quarter earnings were $11.1 million, or $.08 a share, on sales of $216.6 million. True to form, CEO T. J. Rodgers was bold in his outlook: "Our recent growth appears to be the result of a broad-based recovery, with improvements and market-share gains in consumer, wireless and computation. Even the long-dormant networking business began to show a few signs of life, particularly on the enterprise side of the business. Historically low customer inventories and a narrowing of the gap between semiconductor supply and demand are prompting a change in customer purchasing habits. With unit demand continuing to improve, an increasing number of our products are experiencing longer lead times. We shipped 160 million units in the quarter, a record, beating the 157 million units we shipped at the peak in Q3 2000. If these trends continue, we believe there is a strong possibility that the modest recovery of 2003 will turn into a boom in 2004–2005." The company also acquired the privately held Cascade Semiconductor, a maker of 1T Pseudo SRAM that has been averaging sales of $3 million a quarter. One transistor memory is useful in mobile phone applications where space is a premium and serves to fill out Cypress's already strong offerings in the mobile device arena.

Equinix (EQIX)

SECURE INTERNET BUSINESS EXCHANGES

OCTOBER 23: 19.11, 52-WEEK RANGE: 2.00 - 23.65, MARKET CAP: 173.63M

Asia continues to make the news, as Equinix signed

agreements with Japan Telecom, Asia Netcom, and Success Corporation, all for connectivity and services at the Japan Internet Business Exchange. Look for the Earnings Report on October 27.

Essex (EYW)

OPTICAL PROCESSORS

OCTOBER 23: 7.75, 52-WEEK RANGE: 1.80 – 8.55, MARKET CAP: 69.23M

In the last month, the company added almost $60 million in new defense-related government contracts for hardware and software in radar and high-end signal processing. "The breadth of technology projects underway at Essex is exciting and challenging," said Leonard E. Moodispaw, CEO and President. "It is very rewarding to see years of research and development work now being applied to real intelligence and defense problems. We are focused on transforming several technologies into products for sale in both the commercial and government markets."

Essex stock is up some 300% in the last year but still commands a market cap of just $70 million.

EZchip (LNOP)

10 GIGABIT NETWORK PROCESSORS

OCTOBER 23: 10.00, 52-WEEK RANGE: 3.88 – 11.20, MARKET CAP: 72.91M

Nokia announced it will use EZchips in its new 3G wireless base-stations. BATM/Telco Systems, an Israeli maker of IP access equipment, selected EZchip's NP-1c to power its new IPv6 router. The companies introduced the new routing platform at the International Telecommunications Union "Telecom World 2003 Exhibition" in Geneva and the Network Processor Conference (NPC) West 2003 in San Jose.An Israeli newspaper sparked Internet chatter by referring elliptically to a possible acquisition of the company by its much larger rival, Intel.

Intel (INTC)

MICROPROCESSORS, SINGLE-CHIP SYSTEMS

OCTOBER 23: 31.22, 52-WEEK RANGE: 14.15 – 32.78, MARKET CAP: 203.46B

Third calendar quarter revenue hit $7.8 billion, which topped the company's guidance and represented the best third-quarter sequential growth in more than 25 years. Net income was $1.7 billion, up 85 percent sequentially and 142 percent year-over-year. Earnings per share were $0.25, up 79 percent sequentially and 150 percent from $0.10 in the third quarter of 2002. Margins were an astounding 58%, with projections of 60% for the fourth calendar quarter.

When we recommended Intel at $15 a share in September of 2002, we cited not only Intel's move into mixed-signal chips for communications but also its aggressive capital and R&D investments during the downturn as a key source of leverage as the economy rebounded. As it turns out, the company needed every bit of that new capacity. In the company's October 14 conference call, COO Paul Otellini said logic fab utilization rates are "very high."

All of Intel's growth comes from new products, and much of it from Asia and developing Europe. China, India, Taiwan, and Australia yielded record revenue, and sales in Japan were up 73% year-over-year. But maybe the best news was that the mature markets of Western Europe and the U.S. were strong, too. Sales of flash memory, used mostly in cellphones, were weak, down 23% year-over-year and hinting a loss of market-share. Indeed, rival AMD announced very strong flash sales just a few days later.

Looking forward, Intel could potentially earn $1.50 over the next year, meaning the stock could reach $45 with a P/E multiple of 30.

McDATA (MCDTA)

MULTIPROTOCOL STOREWIDTH HARDWARE

OCTOBER 23: 11.41, 52-WEEK RANGE: 5.83 – 15.90, MARKET CAP: 1.32B

Added to the list this month.

National Semiconductor (NSM)

SINGLE-CHIP SYSTEMS, ANALOG EXPERTISE,FOVEON IMAGERS

OCTOBER 23: 36.63, 52-WEEK RANGE: 12.30 – 39.82, MARKET CAP: 6.79B

National and ARM jointly released PowerWise Interface (PWI) technology, an open standard for interconnecting digital processors with power-management chips in portable devices. Battery life is a key factor in building the whole range of handheld, tetherless devices: mobile phones, PDAs, notebooks, tablets, cameras, music players, game machines, etc. But while Moore's law quickly increases both processing performance and power consumption, advances in battery technology come much more slowly. The solution is to use battery energy more efficiently, and National is more focused on power-management than any other company. Intel and Samsung, among others, praised the new PWI standard.

The company also expanded its China strategy, launching a joint analog and mixed-signal technology laboratory at Hangzhou's Zhejiang University, one of China's best engineering schools.

National Inside: Intel's big third quarter and positive outlook bodes well for National, which has had good success in placing numerous devices into Pentium-based notebook PCs.

Qualcomm (QCOM)

CDMA INTEGRATED CIRCUITS, IP, SOFTWARE

OCTOBER 23: 43.87, 52-WEEK RANGE: 29.58 – 46.05, MARKET CAP: 34.82B

The company sampled its MSM6025 chipset, an inexpensive 3G data-ready solution intended for entry-level phones in emerging markets. Also, China Unicom announced it added 1.29 million new CDMA subscribers in the month of September, bringing its total CDMA customer count to 13.34 million in less than two years of operation.

Look for the Earnings Report November 7.

Sprint PCS (PCS)

NATIONWIDE CDMA WIRELESS NETWORK

OCTOBER 23: 4.41, 52-WEEK RANGE: 2.61 – 6.79, MARKET CAP: 4.56B

PCS added a net 501,000 subscribers in the quarter, for a total of 19.3 million, and revenues grew 8% sequentially to $3.34 billion. PCS revenue now accounts for half of Sprint total revenue and is the only reason consolidated Sprint revenue is growing once again. The PCS Vision data service now claims 2.7 million users, up 600,000 from the second quarter. Unfortunately, CEO Gary Forsee still plans to recombine the FON and PCS stocks, rather than spinning off the PCS division.

Terayon (TERN)

BROADBAND CABLE MODEMS, HEAD-ENDS

OCTOBER 23: 7.21, 52-WEEK RANGE: 1.39 – 8.25, MARKET CAP: 536.82M

Terayon revised quarterly estimates higher, projecting revenues of $37-38 million, versus a previous estimate of $33-36 million. The upward guidance resulted from a "better product mix," meaning the company sold more CMTS units (cable head ends) than expected.

The company announced that Comcast, the largest U.S. cable MSO, is cooperating with Terayon on its deployment of next-generation DOCSIS 2.0 cable modem systems, which expand bandwidth, reduce noise, and enable new telecom and data services. Comcast specifically committed to a multi-vendor strategy, which virtually ensures significant future orders of Terayon's most advanced and highest-margin product. The DOCSIS 2.0 standard is based on Terayon's formerly proprietary S-CDMA technology.

Also: The second largest cable operator in Austria, Liwest, announced it has deployed twenty-six Terayon DOCSIS 2.0 CMTS platforms in and around Linz, the nation's second largest city.

Although the stock is up 316% since we recommended it in June of 2002, Terayon's forward-looking P/S multiple is still below industry average using conservative sales estimates.

Xilinx (XLNX)

PROGRAMMABLE LOGIC DEVICES

OCTOBER 23: 28.84, 52-WEEK RANGE: 16.71 – 32.80, MARKET CAP: 9.83B

Third calendar quarter earnings were $.16 a share (up 45% year-over-year) on sales of $315.5 million (up 14% yoy). Gross margins crept from 60% to 61%, and operating margins jumped from 18% to 22% sequentially. "Much of this improvement," noted CEO Wim Roelandts, "has been driven by the shift to 300mm wafer production, which enables significant cost reductions. In the September quarter, over 50% of our wafers were produced using 300mm wafers, up from approximately 40% in the prior quarter."

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chasable for under a dollar on a PC. Under this pressure, the $10 price of a gigabyte on an entertainment device will soon fall sharply. Meanwhile compression technology relieves the strain on existing infrastructure. Layer 3 (MP3) of the MPEG-1 audio standard compresses CD audio files from 1.411 Mbps to about 128 kbps. MP3's compression ratio of over 10 enables song-swapping across the Internet and MP3 players based on flash memory modules from **Sony** (SNE) and **Sandisk** (SNDK) and flash memories from **Advanced Micro Devices** (AMD), **Intel** (INTC), **Samsung** (05930.KS), and **Atmel** (ATML). MPEG-1 is revolutionizing the music industry.

As the compression code used in direct broadcast satellite, digital cable, digital TV, and DVDs, MPEG-2 standardizes interlaced video for television screens. First to broadcast the standard was Hughes DirecTV, which beamed nationwide in 1994. The cable companies responded by upgrading their hybrid fiber coaxial (HFC) networks to deliver two-way interactive services. Investing over $70 billion between 1998 and 2002, these upgrades enabled MPEG-2 broadcasts, cable modems, cable telephony, and video-on-demand. Riding this surge in cable spending are companies such as **Terayon** (TERN), **Broadcom** (BDCM), **Arris** (ARRS), **8X8** (EGHT) and **Vonage**. In 1998, the Advanced Television Systems Committee standardized on MPEG-2 for over-the-air digital TV broadcasts. A DTV tuner can decode the DTV broadcasts and deliver unaltered standard digital television (SDTV), enhanced definition television (EDTV), and HDTV.

Even the best MPEG-2 codecs (compression-decompression algorithms), however, do not compress the video enough to stream SDTV over most U.S. broadband Internet connections. Enter MPEG-4. Using object-based compression techniques running on relatively simple digital signal processors, the latest MPEG-4 codecs deliver superb quality standard television at about 750 kbps and HDTV at 7 Mbps together with stereo audio at 48 kbps. Although most U.S. DSL and even cable modem links cannot support a 750 kilobit stream without interruptions, MPEG-4 gives hope for cheap Internet TV in the U.S. sometime before the Koreans begin doing immersive 3-D games.

The entertainment server

The technical spearhead of the video industry, multimedia gaming, is an increasingly popular form of entertainment that does require intense processing. The gaming console must supply realistic, 2-D graphics 30 times a second. Simulated cameras take repeated snapshots of a 3-D rendering of the game's environment that changes with the interactions of the player and possibly thousands of avatars on the Internet. An extreme example of parallel computing, online gaming creates a complex and diverse virtual world. The intelligence of the games runs on the CPU and regulates the graphical renderings of the graphical processing unit (GPU).

Made by **nVidia** (NVDA) (Microsoft X-box), **ATI** (ATYT) (X-box 2), or Sony (Playstation 2), the GPU is the powerhouse of animated graphics. The latest GPUs, sometimes called visual processing units (VPUs), contain over 100 million transistors—about twice as many transistors as an Intel Pentium 4. Leading GPUs from nVidia and ATI use double data rate (DDR) dynamic random access memory (DRAM). DDR-DRAM effectively doubles the clock rate by reading the data on the rising and falling edge of the clock pulse. Optimization tricks like DDR increase the performance of the GPU to render the best graphics.[1.]

Since many GPUs include MPEG codecs, DTV tuners, and personal video recorder (PVR) functionality, they will be the source of the next generation of entertainment devices. As any gamer can tell you, the graphics card with the GPU is more important than the CPU for delivering high-quality gaming. Combining the GPU with an audio processing unit yields an immersive audio-visual experience.

Together these broadband enablers combine to create a market for a device that can scan the spectrum for streams of content and save them for the desired viewing time. That device will decode the compressed signals and interface with an assortment of peripherals and services from around the world. As the foundation of home entertainment in the 21st century, it will be known as an entertainment server, media center, digital hub, high-end set-top box, and home gateway. It will simplify the cluttered array of multiple devices in today's entertainment centers with a single device that can aggregate, zap-clean, and time-shift audio and video.

The first generation of entertainment server was the personal video recorder (PVR), also known as the digital video recorder, hard disk recorder, and by the popular brand name **TiVo** (TIVO). Already in several million homes, PVRs are getting ready to cross the chasm into mainstream use. Enabling viewers to time-shift video, skip pesky commercials, and free up their schedules, the PVR has won some of the industry's highest ratings for customer satisfaction.

The entertainment server builds on the advanced functionality of the PVR and takes it to the next level. Containing a legal FM transmitter, it will send stored and streamed content to the ubiquitous radios in the home,

[1.] A company called Rambus (RMBS) in Mountain View now claims to have "invented" this industry standard way of accelerating data flows. The key to double-data-rate, however, is not the idea, which is absolutely conventional, but the refinement of the waferfab process to the point that the device can be reliably produced. Although the "invention" is neither "non-obvious" nor "reduced-to-practice," nor devoid of relevant "prior art"—conditions once required to validate a patent—the company has none the less managed to ramboozle the courts into supporting its claim. If the claim is upheld, these patent scammers and their lawyers will be big winners in the next phase of the industry. --GG

including the **XM Satellite Radio** (XMSR) and **Sirius** (SIRI) digital radio streams becoming ever more popular in automobiles for their hundreds of ad-free or ad-scarce choices. Storing vast music collections, the entertainment server will deliver FM stereo throughout the home and yard.

Since the FCC will not let you broadcast UHF or VHF signals, Wireless Fidelity (WiFi) will have to deliver the signals to other entertainment servers, computers, and remote control devices. Particularly in the form of 802.11g, which delivers HDTV at up to 54 Mbps, WiFi will be the home network of choice for its high speed, portability, and compatibility with 802.11b WiFi in the unlicensed 2.4 gigahertz band of frequencies. While other home networks based on coaxial cable, phone lines, CAT-5, and power lines are possible, the consumer electronics industry is creating standards for WiFi and building products for it. Instead of using more wires and multiple home networks, WiFi will untether devices and employ the air to connect all types of digital systems.

Pulling content from around the globe, the entertainment server also allows authorized agents, such as **Wave Systems** (WAVX)[2]. Wavexpress's TVTonic to push content to the home on a regular basis. Also a player in digital rights management and hardware security, Wave's system allows even relatively narrowband channels to deliver a few hours of selected programming to your hard drive during the night while you sleep.

The contenders

The main contenders to become the entertainment server of choice are multimedia PCs from **Dell** (DELL) and **Compaq/HP** (HPQ), set-top boxes from **Digeo**, **Motorola** (MOT) and **Scientific Atlanta** (SFA), gaming machines such as **Microsoft's** (MSFT) Xbox 2 or Sony's Playstations, and perhaps some elegant new machine from **Apple** (AAPL).

With Microsoft's September release of Windows XP Media Center Edition 2004, a PC with the right graphics card can take center stage in the living room, with an excellent PVR, free electronic programming guide, up to 320 gigabytes of disk space, and a remote user interface. Usable from a distance of ten feet, the remote can effectively control the computer as it plays songs, shows, and games. While buying and booting up a $1000 computer, logging in, configuring the system, and patching it takes time that many users will not pay, Linux based entertainment servers from companies like **Interact-TV** (ITVI.PK) are alternatives that may prove their worth with enough open-source code. To become a success in the living room, the multimedia PC needs to deliver an enjoyable experience and be easy on the eyes.

Ninety-one percent of Americans watch television by subscribing to cable or satellite. While some TVs decode digital television signals, most TVs require a set-top box tuner, perhaps with disk drives to store programs. The satellite industry has been successful with the PVR model and the cable companies are hot on their heels. Digeo's Moxi Media Center is the best example of a high end, set-top box that acts like an entertainment server. The Moxi Media Center offers DVD playback, dual-tuner PVR, HDTV, WiFi, and auxiliary units. But most cable companies do not support these expensive Moxi boxes and even Moxi does not support advanced gaming. As long as cable can retain its customer base, stripped down set-top boxes will continue to be deployed at the low end of the market.

Bearing advanced multimedia capabilities for years, gaming consoles offer surround sound, high resolution graphics, Internet connections, and DVD players. Dominating this market is Sony's PlayStation 2 (PS2) with 20 million consoles in the U.S. and over 60 million worldwide. In its new PSX, Sony has combined the PS2 with a 250 GB disk drive and a personal video recorder in a shiny silver box with broadband connectivity and living room style. Already being sold in Japan, the PSX should arrive in the U.S. in 2004.

Sony uses its own integrated central processing unit/graphics processing unit (CPU/GPU). One of the most formidable chip designs on the planet, it will soon to be rendered on leading edge fabs, built by Sony for some $2.7 billion, that can resolve features down to 90 nanometers. Shrinking the chip by nearly 80 percent over the former 180-nanometer process and aimed at volumes over 20 million units, the new process will bring Sony to the forefront of world chip manufacturers.

Relying on the wafer fabs of the **Taiwan Semiconductor Manufacturing Corporation** (**TSM**), Bill Gates is offering Sony its most formidable challenge on the gaming path to the entertainment server. Designed for broadband connectivity from the start, Microsoft's Xbox has a built in Ethernet connection to enable massively multiplayer online role-playing experiences. The Xbox Live online gaming network ensures support for a variety of games. But Microsoft's next generation gaming console, the Xbox 2, must be delivered before Sony's awesome PlayStation3, or the Xbox may remain a relatively minor player.

The PS3 is a highly debated topic in the gaming industry. Based on a multi-"cell" processor, the PS3 will use distributed computing to deliver a teraflop (1 trillion floating point operations) of processing. Teaming with **Toshiba** (TOSBF.PK) and IBM, Sony wants to take gaming to the next level. Aimed to become the industry's most complex and powerful mass produced processor, the cell chip will be manufactured on a 65-nm process and will contain several processor cores. If it can consummate these plans, Sony may well become Intel's most dangerous rival.

Also ascendant on the chip front is ATI, which has won

[2] George Gilder serves on the Wave board of directors..

several design awards in 2003 for their advanced GPUs (they call them VPUs). Stealing the honors from nVidia, ATI will be the GPU supplier for Microsoft's Xbox Next and **Nintendo's** (NTDOY.PK) GameCube and is becoming the preferred vendor for many multimedia PCs.

When more people understand the benefits of personal video recorders, they may upgrade their computers to entertainment servers with ATI's All-in-Wonder graphics cards. These $300 cards transform computers with minimum capabilities into PVRs with teletext, clock radios with recording, DVD authoring stations, and surround sound audio players. Adding an ATI audio card to a PC turns a computer into a broadband entertainment server.

The darkhorse candidate for the entertainment server is Apple Computer. Apple has style. Entertainment is a luxury and goes beyond functionality. Apple has always been a step ahead of the competition in designing enjoyable, easy-to-use products. Innovative products like the iPod continue to win fans.

Besides the iPod's sleek design, it embraces the four forces of broadband entertainment. The iPod has plenty of bandwidth to load songs quickly over FireWire at 400 Mbps. The iPod has plenty of storage with 1.8-inch disk drives that have 10 GB (2,500 songs), 20 GB (5,000 songs) and 40 GB (10,000 bloody songs) of capacity. Rising above any MP3 players, the iPod also uses the latest MPEG-4 audio compression technology. Instead of using a power hungry processor, the iPod has a svelte DSP that saves energy, enabling a portable player that weighs 5.6 ounces and has a form factor smaller than a deck of cards. For navigation among the thousands of songs, iPod has adopted an ingenious new **Synaptics** (SYNA) haptic wheel. This new input device offers a popular intuitive interface and provides a key breakthrough for Synaptics beyond notebook touchpads.

Digital rights and wrongs

Apple's iTunes meanwhile has won rave reviews for enabling customers to easily buy songs over the Internet. On October 17, Apple began selling songs to the Windows market and immediately proved to have the industry's best online music system. With $5.7 billion in cash, Apple is not going away. Boasting Quicktime as the world's first widely deployed MPEG-4 video codec, Apple is in a good position to create a full functioned entertainment server if it can resist the temptation to go it alone.

From any source, a multimedia PC can offer all of the functionality of the entertainment server, but it costs a lot of money and is not easy-to-use. Set-top boxes are incorporating PVRs and HDTV, but they will not provide gaming without significant upgrades. The next generation gaming consoles may be the perfect match if they can deliver HDTV with the gaming. Sony is aggressively positioning itself for the next era in broadband entertainment. Microsoft and Intel beware.

The entertainment server's time has come. Echostar's DISH Network and DirecTV have together deployed nearly 2 million PVRs. Add a few more million multimedia PCs connected to televisions and a raft of cable rollouts, and most analysts predict PVRs will cross the chasm with 10 million subscribers in 2004.

The chief remaining hurdle to widespread adoption of broadband entertainment is security. Piracy has the music industry running scared. Unlike the software industry, the music industry has focused on revenues they may have lost instead of on revenues available to win. The entertainment industry needs to give their customers what might be termed "curb-high" security, which is not perfect but is "good enough" to deter mass piracy. A digital rights management success story is the content scrambling system (CSS) of DVDs. The CSS is considered curb-high security because the encryption system has been cracked many times. Never the less, DVDs continue to bring in record profits for the movie industry. The DVD is successful because it provides high-quality entertainment at an affordable price and prevents most illegal sharing without being overly restrictive. This model can pave the way to the early triumph of the entertainment server and launch a new era in storewidth.

—Scott Kipp with George Gilder

Pre-publication copies of Mr. Kipp's book, Broadband Entertainment, are available at ***www.broadent.com.***

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