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Intel vs. Qualcomm

The leading proponents of Wi-Fi and WiMAX are Intel, Cisco, and IBM, currently suffering attack from Qualcomm and the teleputer

Inside:

More than a decade ago in *Forbes ASAP*, I wrote of a coming "new world of wireless." It would be an era of oceanic spectrum abundance based on aerobatic smart digital radios that could navigate the air without a license like a gymnast on a trampoline on the moon. The dominant access device would be a "teleputer" that could perform all the functions of a personal computer in a handset running **Sun's** (SUNW) Java software and leaving **Microsoft** (MSFT) Windows in its wake. Widespread would be up-spectrum, two-way digital video systems that would simultaneously kill television and bypass the local loops and cable links of existing carriers. And dominant as an access mode would be code division multiple access (CDMA) pioneered by a company in San Diego called **Qualcomm** (QCOM).

At times, I touted Metricom's frequency hopping Ricochet networks that could link laptops in a wireless mesh, Steinbrecher's "datacell" based on "paramixers" that could handle any frequency or modulation scheme, Hovnanian's Cellular Vision wireless cable that could deliver both TV and phone service in the 28 gigahertz band, ArrayComm's smart antennas that could add the space domain of directionality to the current slots of frequency, time, and code in wireless base stations, Craig McCaw's omnibus "Charlie" handset that could bring down the wireline establishment. Nearly fourteen years later I have to acknowledge that I was mostly wrong about everything but Qualcomm, CDMA, and the features of smart radios and teleputers that Qualcomm has adopted. The other technologies were all viable, but the business plans were faulty and the claims hyperbolic. Software radios have made little impact beyond the military. Unlicensed spectrum has chiefly served in wireless local area networks for Wi-Fi. Wireless mesh networks are a dream-come-false. Java software is as widespread as I expected, but other systems, including wireless Windows, Microsoft's Java-cleptic .Net, Europe's favored Symbian, and Qualcomm's BREW (binary run-time environment for wireless), are now gaining share. Broadband two-way wireless links still have negligible market penetration.

At the same time, my "wireless new world" is now coming alive in the new helium economy of Washington, where politicians tout gaseous future technologies in order to divert attention from their suppression of available technical advances in everything from bioengineering and nuclear power to the telecosm and microcosm. Cropping up everywhere and invoking the same panaceas that led me astray in the early 1990s are parvenu wireless sages with lobbyists in tow. They are transmuting Ricochet into the Wi-Fi dream of a global mesh of unlicensed wireless devices. They are remaking the CellularVision as WiMAX, moving it down spectrum and taking it into politics. The smart digital radio has become the software-defined radio (SDR).

CONTINUED ON PAGE 2

Together with the unlicenced spectrum bands, SDRs are now a popular panacea at the FCC, **Intel Corporation** (INTC), and sophisticated leftoid Think Tanks in Washington. In Korea a couple months ago, I met Martin Cooper of ArrayComm again and he is still touting smart antennas and they would still be extremely promising if the wireless business could ever slow down enough to adopt them widely. As the legendary Andrew Viterbi has said, "Space division is the last frontier in wireless."

The only fully correct judgment I made in those early wireless articles in *ASAP* was Qualcomm and CDMA. But the helium technologists are totally uninterested in the huge achievements of this company that has actually invented and delivered a wireless new world of two-way broadband networks. In response to a request for a foreword to a superb new book on the company by David Mock, *The Qualcomm Equation* (ANACOM February 2005), I revisited the Qualcomm triumph in the view of the new world of wireless redux. The following is heavily adapted from my Foreword.

Information, please

Qualcomm is an information technology company based on a theory of information. The key founders of Qualcomm, both doctorates in electrical engineering, were Irwin Jacobs and Andrew Viterbi, paramount students and teachers of the information theory of Claude Shannon. A genius at MIT and Bell Laboratories, Shannon began in 1948 with a narrow effort to gauge the carrying capacity of any communications channel in the presence of noise, but he ended up creating the fundamental science behind modern information technology. With pivotal prompting from another Qualcomm founder, Klein Gilhousen, Jacobs and Viterbi extended Shannon's ideas into the engineering systems that underpin Qualcomm's success.

Shannon defined information in digital bits and measured it by the concept of information entropy: unexpected news or surprising bits. A basic principle of information theory is that it takes a low-entropy carrier (with no surprises) to bear high-entropy messages (full of surprises and news). Unless the carrier is predictable and relatively free of entropy, it will not enable the detection of surprising messages at the other end.

The epitome of a low-entropy carrier is the electromagnetic spectrum, from radio to light, a regular radiance of perfect sine waves limited by the speed of light and differentiated only by their hertz, the number of times they undulate every second. Because of its supreme regularity, the spectrum can bear a measurable modulation, a deliberate distortion detectable at a remote receiver. Because of its radiance, it consists of patterns of energy that can be enhanced and harbored, amplified and resonated long distances down wires or through the air. As a result of these features, all the entropy of the information economy is rapidly migrating toward using the regular radiance of the electromagnetic spectrum for communications. As a company that progresses reliably, radiantly, and predictably, Qualcomm is capturing a steadily increasing share of the business.

Qualcomm entered the wireless fray in the early 1990s, during the period when the industry was moving from analog transmissions, using every point on the waveform to simulate the sound or image, to digital solutions (based on Shannon's binary bits) conveying only a numerical rendition of the message. Using every point on the waveform, analog seems more efficient, but it means that any interference or noise distorts the outcome—as in snow on a TV image or static on a radio—while digital messages remain robust as long as their two possible states are intelligible.

Having studied with Shannon at MIT, Qualcomm's founders were far better prepared to deal with the new era of digital radio than were the veterans of analog radar, telephony, and television who dominated most other wireless companies. In particular, Jacobs and Viterbi grasped the new Shannon revelation of the relations between information, power, and noise in digital systems. While added power improves the efficiency of an analog signal—you can hear the unexpected sound more clearly if it is louder—Shannon showed that more power degrades digital efficiency. If you receive a bit at all, it doesn't matter how loud it is—a bit is a bit. But a loud signal can drown out other bits around it. What matters for digital communications is not maximizing power but reducing it to the minimum that remains intelligible. The object is not to blast a particular signal, such as a television or radio program, over a long distance, but rather to maximize the total number of bits—the amount of entropy—that can be transmitted and received by all radios in the area. Qualcomm was the first wireless company optimized for this Shannon mindset in the Shannon era of low-power communications.

The coming of Qualcomm

Now Qualcomm is entering a new era marked by wireless's increasingly global dominance in voice telephony, internet access, computer communications, broadband local links, and national economic and strategic power. This development at once opens huge opportunities for Qualcomm and presents new competitive threats and political perils.

Crucial to every radio communications system is its air interface and modulation scheme. The system must translate audio or video signals from a phone or computer into a stream of bits that are modulated onto radio frequencies in the air. There are four ways to share spectrum: divide it into time slots (time division multiple access or TDMA), into frequency bands (frequency division multiple access or FDMA), space (by the location and directionality of transmitters), and Shannon's new way as developed and adopted by Qualcomm: piling up messages on top of one another in the same frequency bands while differentiating them by codes. Called code division multiple access (CDMA), Qualcomm's system uses a spread spectrum technology: Rather than dividing a spectrum band into narrow slices—in frequency slots (FDMA) or time slots (TDMA)—CDMA spreads out the message over all the available spectrum all the time for every call or connection.

Qualcomm's founders initially developed this technology for satellite communications. It may have been Gilhousen who first saw its advantages for terrestrial systems. Eliminating the shuf-

fling of frequencies between cells and time slots that afflicts other techniques, CDMA enabled other transmitters in a cell to exploit routine silences in conversation and allowed "soft handoffs" to neighboring cells without changing the frequency or briefly dropping the call. Using all the assigned spectrum all the time also meant that CDMA was superior for sending data, which tends to come in bursty transmissions that would overflow a single time slot but could be absorbed across a broad CDMA spread of spectrum. These insights started Qualcomm on its ascent to its current position as the world's exemplary technology company.

During an era when wireless is becoming the dominant mode of Internet access and telephone communications, Qualcomm is the world's leading source of wireless technology innovation. During an era of ascendancy for Carver Mead's horizontal "fabless" model of the semiconductor industry—where microchip designers pass on their output to specialized foundries for manufacture—Qualcomm is ranked the world's number one fabless semiconductor company in revenues and profits. At a time when share value is increasingly based on intellectual property, Qualcomm is the global champion manager of intellectual property, with a portfolio of more than one thousand patents for the implementation of its CDMA, generating royalty revenues of nearly one billion dollars each year.

Qualcomm is also fast becoming America's most effective supplier of broadband Internet links at a time when broadband is gaining momentum among customers. With the increasing use of handsets for still and motion photography, I expect about half of phone company digital subscriber line (DSL) and a good many cable modem subscribers as well eventually to switch to Qualcomm's system for most of their Internet accesses.

Qualcomm is the worldwide leader in third-generation (3G) wireless networks and is expanding its technology portfolio through Europe's GSM (global system mobile) and other time division multiple access methods. With some 20 million current customers, Qualcomm is the most successful U.S. company in the ascendant domains of China, and it now has 10 million subscribers in India. Qualcomm's GSM1x chipset, which links CDMA systems to GSM networks, enables the company to sell its technology to the entire mass of several hundred million users of GSM. Pervasive in such previous GSM strongholds as Latin America and Russia, Qualcomm is the pivotal player in the emerging new world of ubiquitous voice and video communications.

Long lagging Europe's unified GSM standard, the once balkanized U.S. mobile market has now gone decisively CDMA. Now building a nationwide WCDMA (wideband CDMA) network are **AT&T Wireless** (AWE) and **Cingular** (SBC), both longtime users of TDMA and now in the midst of merging to form the nation's largest wireless company with over 45 million subscribers. They join the next two largest U.S. networks, **Verizon** (VZ) and **Sprint** (FON), already firmly CDMA. Only niche players **T-Mobile** and **Nextel** (NXTL) resist CDMA's siren call. Even **AT&T** (T), now free of AWE conflicts but also without a wireless network, is buying capacity from Sprint to sell new wireless services to business customers.

Qualcomm began as a satellite technology supplier and remains a leading satellite player. Not only does CDMA's use of global positioning technology to synchronize its cell sites put Qualcomm in the forefront of location-based services, but Qualcomm's OmniTRACS system maintains logistical communications with trucks, boats, and other vehicles around the globe.

Because its computer technology is hidden in cell phones, Qualcomm is not widely seen as the world's ascendant computer company, in both hardware and software. But it is. With its intricate single-chip systems for handsets and base stations, Qualcomm produces some of the world's most complex and efficient computer chips. With its robust BREW platform for applets and with its pioneering Eudora e-mail program, it is a leading software vendor. Qualcomm also has an ever more resourceful portfolio of new technologies, such as software radio and QChat. But now the company faces what is widely seen as a deadly challenge—a powerful international alliance of companies dedicated to overthrowing its newly dominant position in wireless.

The perils of Qualcomm

Shaping the strategic consciousness of nearly all technology companies over the last decade has been Clayton Christensen's vision of "disruption." In electronics, the prime example is the personal computer, which though inferior to mainframe and advanced minicomputers supplied a good enough product that sold for far less and thus ended up dominating the industry. At the outset mainframes and minicomputers could hugely outperform the PC, but the PC offered cheap functionality for undemanding users and rapidly achieved economies of scale that dwarfed the established computer industry. With larger volumes, the PC industry moved down the learning curve and ultimately supplied higher performance as well at ever-lower prices, displacing mainframes and servers even in high-end 3D graphics and database access applications. In massively parallel configurations, PC microprocessors now even fill most supercomputer functions. By the rough index of millions of instructions per second (MIPS), the PC ended up providing over 99 percent of all the economy's computing power. Because of the initial conditions of overshoot and over-price in mainframes and minis, the inferior technology of PCs could succeed first in disrupting and then in displacing the entire establishment of the computer industry.

Called Wi-Fi and WiMAX, the latest dazzlers in disruption are targeted at Qualcomm. The dominant standard for wireless local area networks, Wi-Fi provides Internet links for computers in homes and offices and "hot spot" access points, such as coffee shops, hotels, and airport lounges. In *Wired* magazine, Nicholas Negroponte of MIT's MediaLab famously predicted that like lily pads on a pond—hardly noticeable until the very day they suddenly eclipse the water—Wi-Fi hot spots would spread to cover the country and eclipse the Qualcomm regime for wireless Internet access. Then, first for backhaul and fixed broadband, finally for mobile applications as well, would come WiMAX. Promising cell sites thousands of times larger than Wi-Fi's hot spots, WiMAX now claims to offer mobile services at a rate of up

TELECOSM TECHNOLOGIES

Advanced Micro Devices	(AMD)
Agilent	(A)
Altera	(ALTR)
Analog Devices	(ADI)
Broadcom	(BRCM)
Cepheid	(CPHD)
Chartered Semiconductor	(CHRT)
Corvis	(CORV)
Equinix	(EQIX)
Essex	(KEYW)
EZchip	(LNOP)
Flextronics	(FLEX)
Intel	(INTC)
JDS Uniphase	(JDSU)
Legend Group Limited	(LGHLY.PK)
McDATA	(MCDTA)
Microvision	(MVIS)
National Semiconductor	(NSM)
Power-One	(PWER)
Qualcomm	(QCOM)
Samsung	(SSNLF/SSNHY)
Semiconductor Manufacturing International	(SMI)
Sonic Innovations	(SNCI)
Sprint	(FON)
Synaptics	(SYNA)
Taiwan Semiconductor	(TSM)
Terayon	(TERN)
Texas Instruments	(TXN)
VIA Technologies	(2388.TW)
Wind River Systems	(WIND)
Xilinx	(XLNX)
Zoran	(ZRAN)

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

Avanex (AVNX)

OFF THE LIST: NOT WORTH THE WAIT OR THE RISK

AUGUST 25: 2.42, 52-WEEK RANGE: 1.95 – 7.57, MARKET CAP: 346.70M

Where's Simon? Where are the lambdas? Where's the cutting-edge technology? Where's the excitement leading to the next conference and demo? It just ain't no fun following Avanex anymore. Not that they did anything wrong in trying to consolidate and survive. And though they no longer tout lambdas, they still believe in the all-optical network. They know their customers want subsystems and they aim to please. But that's not why they got on the Telecosm list in April 2000, at the market peak. It was because of Simon Cao's telecosmic vision, including his PowerMux multiplexer, which was poised to make rainbows across the Telecosm.

So we ask ourselves, if Avanex were not on the "list" today, would we add it? As we follow Avanex, we hear a busy patter of footsteps trying to keep up with Big Brother (JDSU). Not that Junior can't rally and turn into a reasonable investment. His balance sheet is in good shape. Plenty of liquidity. And a promise of a 10% revenue rise next quarter suggests that Junior may eventually get there. But be prepared to wait; at its current rate of progress (10% to 13% improvement in operating margin per quarter), it takes Junior 13 quarters to approach within 17% of breakeven, where JDSU is today. And with net cash plus investments falling from $188m to $133m over the past three quarters alone, Avanex may exercise its $100m shelf-registration by adding 50m new shares (at $2/share), a 35% dilution.

With its technology vision obscured, Avanex is not worth the wait or the risk.

Cepheid (CPHD)

PARADIGM PLAY: GAINING MOMENTUM IN BIOTECH MEMS

AUGUST 25: 8.15, 52-WEEK RANGE: 4.30 – 13.56, MARKET CAP: 341.58M

One of Nick Tredennick's specials and a prime choice in the MEMS space, Cepheid is a leading candidate to create a lab on a chip for identifying dangerous toxics in an era of terrorism. Growth has been rapid; revenues have been steadily increasing, from $2.4m in the first quarter of 2002 to $11.3m in Jun 04. Most notably, revenues leaped from $5.3m in Dec 03 to $7.3m in Mar 04 or 38%, and from $7.3m in Mar 04 to $11.3m currently or 55%. The acceleration was due to sales of the second generation product. The first generation product (SmartCycler) enables rapid genetic analysis of a sample. The second platform (GeneXpert) adds to the SmartCycler by automating sampling as well. GeneXpert, still in the final stages of development, has already been sold to the biothreat market, most notably to a Northrup Grumman led consortium developing an anthrax tester for the USPS. The Northrup sales are expected to continue through the rest of the year, which will end the first phase of the contract. Based on the results, USPS will then decide on phase 2. Otherwise, Cepheid anticipates the commercial launch of GeneXpert in the nonclinical market during the second half of this year and in the clinical market in 2005.

Cepheid has a fairly high level of fixed costs, particularly R&D. Thus, higher revenues going forward should have a strongly positive effect on net income, helped further when gross margins rebound back to the 50s. Although management still expects negative cash flow from operations (CFO) through the end of this year, cash suffices to get through several more years based on planned expenditures and investments.

Thus Cepheid is growing and is relatively free of financial worry. Is it a good investment? That depends on the evolution of the biothreat market and how far Cepheid can penetrate the clinical market, specifically testing for cancer and infectious diseases. The stock seems to be fully valued currently—at $8 per share, market cap is $336m which is 6.2x net cash. Enterprise value is 9.4x trailing revenue and 6.1x concurrent revenue. If revenue projections hold for the year, they will have increased by $28m in 2004 over 2003 (from $16m to $44m). Apply the same $28m increase to 2005 due to the commercial introduction of GeneXpert, and we get an EV/S of 3.8x, which may be the market's expectation. Strong technology makes Cepheid a good bet in biotech MEMS.

Ciena (CIEN)

OFF THE LIST: CONFIDENCE CAVES AS CASH IS CONSUMED

AUGUST 25: 1.98, 52-WEEK RANGE: 1.67 – 8.14, MARKET CAP: 1.13B

The eternal turn-around story, Ciena has been on acquisition life-support since ceding all-optical leadership to Corvis half a decade or so ago. The latest purchases, Catena (broadband access) and Internet Photonics (cable equipment), both consummated the first days of the July quarter, masked Ciena's latest sequential revenue decline—a hefty 29 percent. Catena and IPI were generating combined quarterly revenues of $30m on their own. Thus, with no additional growth, Ciena's sales should have increased from $75m in April to $105m in July instead of falling "flat." The sales stumble was blamed on order delays in core transport and weakness in DSL deployments. The previous quarter's stumble, a sequential drop in gross margin from 31.5% to 11%, was blamed on unfavorable product mix. And so it goes. Other recent acquisitions include Akara (Sonet-based storage area networking) and WaveSmith (multiprotocol edge devices) in 2003 and once luminous ONI (metro optical transport) in 2002. Yet trailing-twelve-month (ttm) revenues have stagnated between $256m and $287m since January 2003 and ttm gross margins have anchored in the mid-20s over the past five quarters.

A snapshot of the balance sheet looks impressive—working capital of $580m and tangible assets

greater than total liabilities. Ciena still has time. But time has not been on Ciena's side. Burning 55% of its cash reserves since July 2002, net cash plus investments has fallen steadily from $1,343m to $657m today. And the conflagration continues. If Ciena reaches the still elusive 30% gross margins, we must await a tripling of revenues before the company earns its first dollar.

The only acquisition that counts—that of visionary paradigmatic leadership—has consistently eluded Ciena for years. We therefore remove it from the list.

Corbis (CORV)

PARADIGM PLAY: THE PARAMOUNT ALL-OPTICAL NETWORK

AUGUST 25: 1.07, 52-WEEK RANGE:0.88 – 3.07, MARKET CAP: 519.27M

If you have been following Corvis along with us, you could have written the script to the second quarter call. As expected, (1) Broadwing continues to execute by growing data revenues and cutting costs while integrating Focal, and (2) there was a "bump" of one-time charges mainly due to the Access Forward initiative to reduce local access line lease rates going forward, resulting in $4m of circuit termination costs and $5.7m of additional administrative costs. After adjusting for this quarter's bump, Corvis's operating loss has decreased from 24.3% to 7.8% of sales over the past four quarters as communications sales remained steady in the face of continued erosion of wireline voice revenues across the industry.

Over the past several months, the market has undoubtedly accounted for potential dilution from the use of stock to repay a $225m debt issue and the acquisition of Focal. Thus, the fitful downward pressure on share price since the conference call of 4 August is probably due to a continued misunderstanding or mistrust of the Corvis story as well as the recent bear market. We expect upside surprises.

Energy Conversion Devices(ENER)

OFF THE LIST: RISKY WAY TO INVEST IN NONVOLATILE MEMORY

AUGUST 25: 12.60, 52-WEEK RANGE: 6.75 – 19.24, MARKET CAP: 317.18M

A developer of nonvolatile memory based on amorphous silicon technology, Energy Conversion Devices (ECD) is struggling financially:

Revenue decreased from $26.7m in the Dec 01 quarter to $15.9m in Sep 03 and has held near there (+/-3m) since. Gross margin has been consistently close to zero since Dec 01. Operating loss increased from 18.7% of sales in Dec 01 to 101.4% in Sep 03 and improved slightly to 73.3% in Mar 03 (latest quarter reported). Net cash plus investments decayed from $102.5m in Sep02 to $6.7m.

At $12.50 per share, market cap is $313m or 47x net cash plus investments. Enterprise value to sales ratio (concurrent) is 4.7. Two weeks ago management announced a "strategic business restructuring" focused reducing R&D costs and commercializing products in four core businesses, namely: solar panels and photovoltaic systems; NiMH batteries for industry (50-50 joint venture with ChevronTexaco); hydrogen storage systems (50-50 with ChevronTexaco); and finally, nonvolatile memory technology, developed and licensed through Ovonyx (41% owned by ECD), currently being explored with Intel, STMicroelectronics, and BAE.

As part of the restructuring, non-core businesses will be downsized or spun off to raise much needed capital. As for the last twenty years, the first quarterly profit is "expected" in two years.

The most advanced and densest nonvolatile memory chips (nonvolatile memory keeps its contents when the power goes out and is crucial to the triumph of the teleputer) could come from ECD. Hence, with strong prompting from our friend and Micron founder Joe Parkinson (now long gone from Ovonyx), the company made our list. But ECD owns less than half of Ovonyx, and comes with a lot of other technological baggage. Furthermore, there are many contestants in the young field, including Axon's embedded silver capacitors, NVEC and Seagate spintronics, ferroelectric RAM (FRAM), 3D memories from Matrix and IBM, plus nanotubes, twists, whorls, and swiggles. With a shrinking market for its core-less product, non-volatile storage devices are also expected from Krispy Creme. Even if ECD manages to turn itself around, the stock is already fully valued and memory takes up much less than half of the company's efforts. Thus, ECD is likely a risky way to invest in nonvolatile memory and we take it off the list this month.

JDS Uniphase (JDSU)

PARADIGM PLAY: A SAFE BET IN COMPONENTS FOR THE FIBERSPHERE

AUGUST 25: 3.20, 52-WEEK RANGE: 2.84 – 5.885, MARKET CAP: 4.61B

King of components, JDSU continues to justify its status as a safe harbor investment within the turbulent telecosm. Awash in liquidity by all measures (cash plus short-term investments alone are 1.8x *total* liabilities), the company leverages its optical technology on two equal fronts—fiber-optic components, where JDSU offers the broadest portfolio, and commercial/consumer products. With operating margins of 22%, commercial/consumer currently helps offset the components side's negative 15% operating margins, giving JDSU a competitive edge over its more narrowly focused telecosm rivals.

JDSU has made considerable progress rationalizing its business over the past two years without compromising on technology or sales leadership. During the period gross margin has rebounded from 8% to 23% and operating loss has dropped from 72% of sales to 17% of sales (trailing-twelve-month values). Though gross margins may be a bit weaker next quarter due to major product ramps, JDSU promises 30% near-term, meaning operating expenses need only be reduced by another 10% of sales to reach operational breakeven.

Given JDSU's robust finances and proven ability to execute both operationally and technologically, even its rich valuations (concurrent enterprise value over sales of 4.1) the stock should afford some downside resistance. The future remains challenging, however. Assuming a best-case scenario, sales of $1.2b (up 50%), gross margin of 40%, R&D still $100m per year, SG&A 15% of sales, and profit pops to $200m or 14 cents per share. At the current market cap, P/E would equal 22, limiting upside potential.

Proxim (PROX)

OFF THE LIST: LACKLUSTER AT BEST

AUGUST 25: 0.81, 52-WEEK RANGE: 0.65 – 2.90, MARKET CAP: 100.04M

A leading supplier of microwave equipment for last-mile wireless broadband, Proxim is in financial jeopardy. With operating losses of 27.5% of sales, negative cash flow from operations, and steady decay of gross margins, revenues and cash flow do not present any encouragement that Proxim might overcome the loss of its patent infringement suit with Symbol Technologies. Payment to Symbol of $28.7m in accrued royalties is being held up pending further litigation.

To cover the judgment, convert notes (a bridge loan of $49m including 25% interest) have been paid in preferred shares, which will convert to common shares if approved by shareholders (how can they not approve?), a dilution of more than 100%, with the lenders acquiring controlling interest and a place at the head of the table in bankruptcy court.

Working capital as of Jun 04 was –$19.8, which includes the $28.7m royalty judgment. The second bridge loan of $10m was made after the quarter closed, bringing working capital to –$9.8—but by the close of the current quarter it will be worse since Proxim has been losing money. Last quarter, working capital decreased over $10m sequentially. Fathoming the books for a truer measure of net cash, we come up with a number anywhere from –$33.5m to –$43.5m depending on how much money is lost before the second bridge loan is accounted for in the Sep 04 statements.

Proxim might survive if the second litigation does not go against them and if they are able to spread the royalty payments. If they lose the second litigation and if Symbol wins its request for immediate payment, Proxim may well default.

Terayon (TERN)

PARADIGM PLAY: MOVING IP-VIDEO INTO CABLE

AUGUST 25: 1.72, 52-WEEK RANGE: 1.44 – 8.25, MARKET CAP: 129.97M

Though disfavored by Wall Street because of missed numbers and some corporate chaos, beleaguered Terayon probably has a better shot at appreciating 3x than does mighty Qualcomm. Sales of CMTS equip-

ment (cable modem termination systems) are flat—we believe temporarily so—but digital video solutions with gross margins of 70% are growing rapidly and present a new long-term opportunity for the company. New high-definition video programming over cable and satellites demands high bandwidth and new techniques to insert targeted, localized ads and graphics. Terayon has the key product in the field, which Fox is now installing across the country.

We think Terayon stock is protected to the downside because (1) it has just gone through a corporate shakeout, which caused uncertainty and a big stock dip from over 8 to the current 1.62; (2) it is trading at a trailing price-to-sales multiple of just .75; (3) it is looking at profitability within the next few quarters (pro forma loss was just $.02 per share in the June quarter, and analysts are expecting the same $.02 loss in the September quarter); (4) with earnings estimates of $.12 a share in 2005, it trades at a forward estimated P/E of just 14; (5) it has net cash of around $50 million; and (6) U.S. cable MSOs are interested in Terayon's viability because they like competing equipment vendors, especially when Cisco and Motorola are the other key players.

Wind River (WIND)

PARADIGM PLAY: NAVIGATES 180-DEGREE TURN WITH WINDOWLESS REAL-TIME OPERATING SYSTEMS

AUGUST 25: 10.89, 52-WEEK RANGE: 5.55 – 12.97, MARKET CAP: 891.78M

Software developer Wind River Systems provides a real-time operating system for embedded applications, such as network processors and cell phone handsets that must perform complex operations without discernible delays. In decline for several years, Wind River now seems to be making an about face. Revenue, having eroded from $80.5m in Jan 02 to $48.5m in Apr 03, has now rebounded to $59.4m in Jul 04; gross margins, previously in the low to mid-70s percent, are now approaching 80%. EPS based on GAAP was $0.03 in Jan, –$0.05 in Apr, and $0.03 currently, up from –$0.63 in Jan 02.

Working capital reached a low of $39m in Jul 03, down from $144 in Jan 02, but is back to $61m. Long-term "debt" is limited to $150m in converts which come due in Dec 06 and will likely be converted to shares at $24 per share, so we do not include it in balance sheet calculations but instead add 6.25m shares to the current 84m or a dilution of 7.4%. At the recent share price of $10.65, market cap is $959m or 4x net cash plus investments; enterprise value is $898m or 3.7x projected sales.

The new CEO, Kenneth Klein, has been credited for turning Wind River around, though financials began improving in 2003. (Klein arrived this January.) Among other things, Klein has "embraced" Linux, which some analysts believe is making a difference.

Zoran (ZRAN)

PARADIGM PLAY: TI JUNIOR GROWING UP

AUGUST 25: 17.75, 52-WEEK RANGE: 13.40 – 26.52, MARKET CAP: 760.34M

The TI Junior company, Zoran aspires to run your electronic life through its digital signal processors, graphics ASICs, and full motion camera chips. Since acquiring Oak Technology last year to move into the HDTV market, Zoran has been on a tear. Until Oak, revenues bounced around the 30s to mid-40s million. Since then sales have surged to $103.7m in Jun 04 and are projected to reach $130.5m next quarter and $124.2m fourth quarter. Gross margin has been 43% and change for four quarters and management expects it to remain stable. R&D and SG&A, which were fairly steady prior to Oak, jumped to 48% of sales by Dec 03, indicating some difficulty in combining the two companies. But, even as R&D continues to increase in absolute value, operating expenses have since steadily decreased to 36.3% of sales currently and are projected to decrease still further to 31.8% of sales next quarter. (Before Oak, operating expenses were near or just under 30%.)

Operating loss of $3.0m in Dec 03 has ascended to operating profits of $1.8m (2.2% of sales) in Mar 04 … $7.3m (7.0% of sales) in the current quarter … $14.9m (11.4% of sales) projected next quarter. Management expects an operating profit of 73 cents per share for the year. (A better estimate would be 95 cents per share; in its operating expenses, Zoran includes a monetary value for stock compensation.) GAAP will continue to show a loss through the year due to noncash acquisition-related expenses.

The balance sheet is strong, with no long-term debt. At the recent share price of $18, market cap is $815m or 4.7x net cash plus investments. Operating P/E (non-GAAP) for 2004 is 24.7 based on company projections but only 18.9 sans "stock compensation" which has nothing to do with the underlying value of the company. Enterprise value is $707m or 1.6x projected 2004 sales.

Investment in Zoran means a bet that this agile management can continue to find new markets for its chip design skills in the face of remorseless integration of consumer electronics functions by Qualcomm, Intel, TI, Samsung, Sony, and even Conexant, not to dwell on constant challenges from Taiwan and China. It's a good company, but caveat emptor.

to 100 megabits a second over cells 30 miles wide.

In promoting this new disruptor for Qualcomm and the wireless establishment, few analysts noticed that the leading proponents of Wi-Fi and WiMAX are Intel, **Cisco** (CSCO), and **IBM** (IBM), the established leaders in computer networking that are currently suffering attack from Qualcomm and the teleputer. Adding to Intel's dilemma, Qualcomm is leveraging its superiority in mobile radios to invade Intel's traditional turf, computing itself. Just as Intel provided the computing power for the first generation of digital applications—word processors, spreadsheets, calendars, and e-mail—Qualcomm's chips are far ahead in the new generation of digital applications—cell phone photos and video, mobile TV, next generation music players, global positioning, instant messaging, graphics, and games. Just as the Pentium powered the personal computer, Qualcomm is powering the mobile computer. With an estimated 600 million cell phones sold in 2004, compared to some 200 million PCs, cell phones already outsell PCs by three to one. Cell phones outsell laptops and personal digital assistants by ten to one. Cell phones already far outperform PCs as communicators and cameras. Wi-Fi and WiMAX, in fact, are clever stratagems concocted by the PC and computer incumbents to fend off disruption from Qualcomm and the mobile teleputer.

Though claiming bandwidth of over 100 megabits a second, the WiMAX people have not invented any new technology. In their highly speculative "standards" projects, they merely assume allocation of far more spectrum. With promises of fixed line-of-sight connections at up to 134 megabits per second, the first proposed WiMAX standard (802.16) used 28 megahertz channels (about 25 times the size of Qualcomm's 1.2 megahertz CDMA channels). The second standard (802.16A Rev D) assumes 20 megahertz channels and offers fixed or portable services at up to 75 megabits per second. The mobile proposal (802.16e) adopted by the Koreans fits in the same size (5 megahertz) channels as WCDMA and promises up to 15 megabits per second. Employing 1.2 megahertz channels, the new release of Qualcomm's EvDO system, already in use by some 8 million subscribers, offers up to 2.4 megabits per second, being upgraded to 3.1 megabits per second.

Neither WiMAX nor other new contenders such as Flarion achieve better results in the chief metric of spectral efficiency, or bits-per-second-per-hertz. Spectral efficiency largely determines economic efficiency for wireless service providers. A

decade ago Qualcomm did claim, and prove, far higher spectral efficiency than the incumbent systems. By spreading transmissions over a wide band, using digital codes rather than time slots to differentiate signals, and employing sophisticated power control techniques at low power levels, Qualcomm's CDMA did substantially beat the current reigning technology of TDMA (embodied in the GSM standard). Qualcomm accomplished Peter Drucker's rough rule of winning in a technology market by being ten times better than the incumbent.

In true gorilla form, Qualcomm just keeps executing. Qualcomm's CDMA2000 was once thought to be threatened by WCDMA (wideband CDMA)—a competing 3G standard engineered by the Europeans and Japanese to be different from Qualcomm's preferred flavor while still retaining CDMA's inherent advantages. But now Qualcomm has mastered WCDMA ahead of the competition, has 21 customers for its WCDMA chips (10 Qualcomm-enabled WCDMA handset designs are due by year-end), and will soon integrate WCDMA with CDMA2000 EvDO, GSM/GPRS, and Wi-Fi. The company projects the WCDMA handset market to grow quickly from 17 million in 2004 to some 45 million in 2005.

In the wireless paradigm, serving teleputer camcorder phones everywhere, ubiquity is critical. While Wi-Fi hype continues, CDMA offers cells some 25 thousand times larger than an average Wi-Fi access point hot spot. With broad Qualcomm EvDO coverage planned over the entire continent, Sprint and Verizon are making the entire nation a hot spot. Both Sprint and Verizon, though, sharply lag Korean carrier **SK Telecom** (SKM) and Japan's **KDDI** in broadband deployment of CDMA2000 data services and in per capita data revenues.

Thus a more serious threat to Qualcomm is the announced adoption by SK Telecom and the Korean government of WiMAX mobile technology for a future generation of broadband wireless to be launched in 2006. As the first engineers to make Qualcomm's CDMA work well, the Koreans may well launch a version of WiMAX free of Qualcomm intellectual property or royalties. But WiMAX has no intrinsic advantages over Qualcomm's CDMA. **Soma Corporation**, for example, became the leading vendor of broadband wireless telephony after they spurned the precursors of WiMAX and licensed Qualcomm's CDMA. In the noisy upstream, lower 40 megahertz, of cable modem lines, **Terayon's** (TERN) CDMA variant has outperformed rival protocols such as the orthogonal frequency division multiplexing (OFDM) employed in most digital subscriber lines. The cable standard DOCSIS 2.0 uses a form of CDMA adapted for cable modems.

WiMAX will serve more as a negotiating lever for the Koreans with Qualcomm than as a serious competitor for Qualcomm in the market. Over the last ten years, a long list of companies has announced new wireless technologies as superior alternatives to the Qualcomm path of steadily improving and integrating CDMA with other wireless protocols. The introduction of WiMAX today reflects the increasing desperation of Qualcomm's rivals in the computer establishment.

Intel, Microsoft, Cisco run for cover

Led by Intel, Microsoft, and Cisco, the personal computer industry has become a byzantine establishment afflicted everywhere with overshoot products, such as huge software operating suites, gigahertz microprocessor chipsets, motherboard mazes, proliferating network interfaces, and communications protocols too complex to integrate into smoothly performing systems. Comprising a sprawling standards committee of committees, it has designed a gigantic camel that cannot thread the needle's eye of cheap, robust, and secure mobile services needed by billions of new customers around the globe. Meanwhile, a new teleputer industry, led by Qualcomm, is emerging to challenge the incumbent players.

Epitomized by the multipurpose cell phone handset or personal digital assistant, the teleputer is optimized for ubiquitous connectivity. As I described it years ago, it will be as portable as a watch and as personal as your wallet. It takes pictures or videos and projects them onto a wall or screen or onto your retina (**Microvision** -MVIS) and transmits them to any other digital device or storage facility.

It just may not do Windows—certainly not in the conventional form. The teleputer in fact is introducing a new software paradigm based on adaptable applets that are small and agile enough to download to a handset. As early as 1990, Bill Joy of Sun called for such a software model: "As we add more and more of these features to older systems," he said, "the complexity gets multiplicative…I get this feature and that feature but the combinations don't work. What I'd really like to see is a system where the complexity goes up in a linear way but the power goes up exponentially." In software the complexity has long been rising exponentially, while the power rises additively. Niklaus Wirth, the inventor of Pascal and other programming languages, has propounded two new Parkinson's laws for software: "Software expands to fill the available memory" and "Software is getting slower more rapidly than hardware gets faster." In contrast, Qualcomm has introduced BREW—a new operating system, developer platform, billing model, and authentication scheme, all optimized for wireless applications.

Using the BREW 3.1 client software and the user interface toolkit 1.0, operators and handset makers can develop an entire phone user interface, akin to an OS that can be customized to suit the individual operator or manufacturer's requirements. This includes functions like the features of the address book, the messaging menu, and even the color styling and shape of the icons. For enterprises, Qualcomm offers productivity applications for the sales force or for field force automation. Sixteen hundred software developers attended Qualcomm's 2004 BREW mobile software conference. As of June 2004, twenty-six device manufacturers supply 140 BREW-enabled models to thirty operators in twenty-one countries, where some 30 million total BREW handsets have

downloaded 130 million applications and services. Ironically, Sun designed Java for cross-platform neutrality, but in the cell phone domain the system has broken down, as different vendors adapt it to their own proprietary applications. Today Java-equipped handsets will not support BREW, but BREW-enabled handsets can support all Java applets.

The applet and BREW models both halt the elephantiasis in software and provide software that accords with Bill Joy's original vision. Since BREW and Java will soon be on more devices than those running Windows, these new small-works technologies represent a new software paradigm.

Pitting computer chip titan Intel against wireless pioneer Qualcomm, this clash of telecom and technology offers a business and political drama. Intel was the world's best technology company in the 1980s and 90s because it designed and manufactured the best *computing* products. Now Qualcomm is the world's best technology company because it designs, in the form of its proprietary CDMA wireless standard and chips, the best *communications* products. As PC sales growth slows, mobile phones and wireless devices have become the driving force of the semiconductor and software industries, both in sales and the pace of technological advance.

The markets have recognized this tectonic shift in global technology markets, valuing Qualcomm's some $4 billion of revenues four times more highly per dollar than Intel's $30 billion. Within the wireless world, Qualcomm has just one-sixth the revenues of arch-rival Nokia but a market cap ($62 billion) substantially greater than Nokia ($54 billion).

Responding to this juggernaut, Intel is increasingly turning to politics. To evangelize about WiMAX, Intel recruited to its board of directors former FCC chairman Reed Hundt, who now canvasses the halls of Washington in search of spectrum for WiMAX rollouts. The pot of gold is the 700 MHz band, also known as UHF television channels 52-69. Though almost entirely unused, except as bargaining chips by the powerful broadcasters, these channels are perfect spectrum for propagating wireless signals over long distances. Although the 700-band has been scheduled for auction and release for many years, as the broadcasters make their never-ending and futile transition to digital over-the-air TV, the channels remain in spectrum purgatory. Caught in a lobbying net of telecom carriers, equipment manufacturers, smart techno-leftist intellectuals, broadcasters, octogenarian senators, and "public interest" watchdog groups, the FCC is paralyzed from action.

To implement fully its WiMAX vision, Intel would need some 60 MHz or more of this 700 MHz band. If Intel could use its heft to break the Potomac logjam in favor of unlicensed designation of the spectrum, we would applaud and the U.S. economy would be the victor. The problem for WiMAX is that it is intrinsically a high power technology that runs between 25 watts and 50 watts and is entirely unsuited for unlicensed operation. The danger is that the FCC could designate 700 MHz an official WiMAX band, nominally "unlicensed" but without the restrictions on power (below one watt) that render these bands usable without heavy regulation.

True unfettered use would mean major advances in smart radio and smart antenna technology. Today it is Qualcomm, not Intel, that makes the smartest radios around. Making the smartest antennas is Arraycomm, with its WiMAX-busting "iBurst" system proving robust in Australia and South Africa. But Qualcomm is full of experts on antenna technology as well. Qualcomm, moreover, already "owns" channel 55 (716-722 MHz) in five-sixths of the country, though it cannot yet use the spectrum because of the DTV limbo. Perhaps, Qualcomm could master and lead in a new smarter, low power WiMAX if circumstances required.

While Hundt strolls the Capitol, Intel CEO Craig Barrett is in Korea, pushing forward with a plan for a peninsular WiMAX network, which the Koreans, though high on CDMA, are eager to try for their export industries and for leverage in royalty negotiations with Qualcomm. From the start Qualcomm has overcome the odds of incumbency and politics. Its new role of hunted instead of hunter both proves its power and presents fierce new challenges.

For more than 15 years Qualcomm has mastered or broken as needed the complex codes of chips, standards, and intercontinential politics, integrating the information of business just as it mastered the theory of information. In the real wireless new world, Qualcomm remains at the epicenter, reaching out to revitalize all contiguous technologies. Dave Mock's *The Qualcomm Equation* gives us the definitive narrative and analysis of this supreme company.

—George Gilder (with Bret Swanson)
August 25, 2004

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