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QUALCOMM OVER THE RAINBOW

What is on the other side of the paradigm? Beyond the up-spectrum rainbows, what do we do when the pots of gold overflow? Where do fiber surfers go when their wave comes in? Perhaps they eagerly await an IPO for **Softcom**, the coming Telecosm star that is attacking the telco establishment from a redoubt in Freemont, California, with an OC-48 (2.5 gigabit) transponder card on an ordinary PCI bus on your personal computer motherboard. This portends a revolution that can soon shake the telco and networking establishment to its foundations. But most of us are too impatient to wait for this new wave, heralded by this frothy crest in the opening graph of the GTR. So do we retire to the beaches of our dreams come true? Or what?

Qualcomm CDMA gained a near total worldwide triumph

Such a fairy tale fulfillment of the Telecosm seems ever closer as **Qualcomm**'s (QCOM) CDMA (Code Division Multiple Access) technology–the prime call of this letter from the outset and my leading technology enthusiasm since 1991–gained a near total worldwide triumph. By spreading the signal across a wide spectrum band and differentiating calls by codes rather than time slots as in TDMA, CDMA enables mobile phones and other communicators with unsurpassed acoustics in spectrally noisy environments. It also can handle bursty Internet data as efficiently as voice, for it already treats voice as statistical data. CDMA also uses far lower power than other mobile technologies, allowing longer battery life, and is automatically encrypted by its code. The Europeans declared that it violated the laws of physics.

In This Issue:

For eight long years Qualcomm's most avid enemy and ardent detractor was **Ericsson** (ERICY), first as a leading producer of GSM systems (a TDMA variant predominant everywhere but North America) and then as champion of a CDMA version sans Qualcomm's cooperation or key Qualcomm patents. Last month the Swedish giant came to the table and ate a huge helping of crow, while swallowing as well the infrastructure division of Qualcomm. Ericsson agreed to create with Qualcomm a common, world-wide, third-generation wireless standard and technology mostly based on Qualcomm patents and compatible with existing Qualcomm equipment–a truly awesome capitulation.

Meanwhile Qualcomm loses nothing by selling its infrastructure division to Ericsson, since the division loses money, held only seven percent market share, and was launched in the first place chiefly to demonstrate CDMA's feasibility.

Similarly manifesting the new power of CDMA was the announcement on March 21 of an international roaming agreement in Asia. The agreement joined Hong Kong's **Hutchison**, South Korea's **Shinsegi**, and Japan's **DDI** and **Nippon** (NTT) IDO Tsushin, all major players in their home markets. An historic advance, this deal allowed the first ever international roaming for Japanese customers, previously trapped in proprietary cellular standards, and made CDMA the lingua franca of Asian cellphones. Also portentous were China's announced acceptance of CDMA and the inauguration of CDMA systems in Australia.

As Europe completes its already ordained move out of GSM and into wideband CDMA, and the rest of

Conexant has increased its output 150 percent over last year

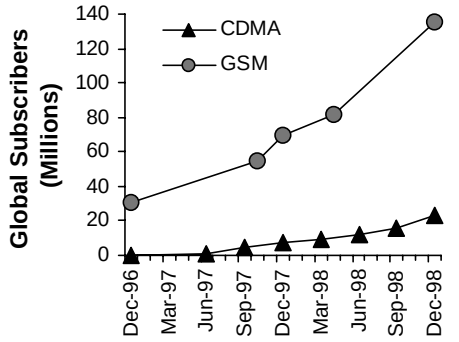
the world follows, Qualcomm technology and its portfolio of some 400 CDMA patents will dominate a market already six and a half times the size of the CDMA market today with much more to come. (See Chart 1)

Qualcomm's share price has surged from the low forties in September and October to more than $140 as we go to press, as investors race to catch up with the prospects of a $4 billion company that had increased its revenues threefold and its earnings fivefold over the last three years while barely budging its stock.

Nevertheless, Qualcomm remains undervalued, laboring within an acrid fog of "fear, uncertainty and doubt" spread by the same European and American FUDcasters that now find themselves compelled to adopt its technology. As wireline voice moves to the Internet at nominal prices, CDMA mobile phones will capture the bulk of profitable new voice minutes over the next five years, and encroach heavily on the revenues of existing wireline carriers. At the same time, Qualcomm will become the **Intel** (INTC) of the personal communicators that will emerge as the most common PCs of the new era. (GTR Feb. '99, Oct. '98) Qualcomm's pdQ, with a Palm [Pilot] on board and a potential 2 megabit modem, will spearhead the move toward wireless Internet access. Qualcomm's deal with **Microsoft** (MSFT) to develop a new single chip modem using the CE operating system could enable a wide range of other portable products.

Chart 1

New CDMA Wireless Market Will Include Current GSM and More



Sources: CDG, GSM Association

Meanwhile, **Globalstar** (GSTRF) is Qualcomm's CDMA satellite entry, beset by inefficient TDMA rivals such as **Iridium** (IRID). Long on our Telecosm list and finally ready to loft its entire network by July, GlobalStar will penetrate markets around the world otherwise unserved by wireless systems. GlobalStar is worthy of interest for investors looking for CDMA bargains in the face of Qualcomm's surging share price.

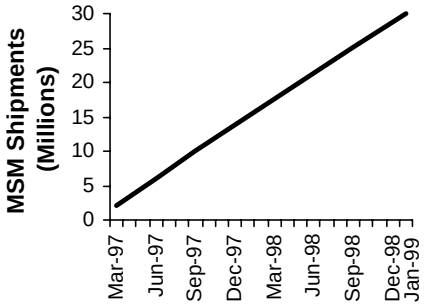
Companies using CDMA in a different context will also attract attention in coming months as the impact of Qualcomm's victory becomes apparent. With CDMA as an antidote to noise in any communications channel, **Terayon** (TERN) applies CDMA to the noisiest realm of all, the bottom 40 megahertz of a cable TV line. It worked for air communications, it will work for equally noisy cables. Terayon began with a system that was incompatible with the DOCSIS (data over cable service interface specs) and thus could make gains only overseas, in Israel, Europe, and Canada. But now that it is DOCSIS compliant, Terayon will gain share of cable modem business around the world.

Conexant

Among the prime winners in the new CDMA era will be producers of the specialized and exacting components that make the system possible. We used to think that **Spectrian** (SPCT), the manufacturer of ingenious low-noise power amplifiers, would be a leader. But barging past Spectrian in the marketplace and ousting it from the Telecosm list this issue is **Conexant** (CNXT). Formerly the market-leading modem producer as part of **Rockwell** (ROK), Conexant has shipped some 25 million digital cellular and PCS power amplifiers to CDMA vendors, from **Samsung** to Qualcomm. Comprising 80 percent of the CDMA handset market, this number compares with Qualcomm's shipment of some 30 million mobile station modem chipsets worldwide for CDMA handsets. (See Chart 2)

Chart 2

Qualcomm Ships 30 Million MobileStation Modem ASICs



Source: Qualcomm

Shipping two million power amps per month, Conexant has increased its output 150 percent compared to last year. Conexant also competes with **Broadcom** (BRCM) in cable modems, produces chips for Digital Subscriber Line (DSL) applications for fast Internet links over phone lines, supplies Direct Broadcast satellite receivers, and an array of other products, including GSM chipsets. Its old Rockwell modem business is also doing well. With good leadership, the company should become a stalwart of the Telecosm list.

GBLX hits the beach

In gaining a telecosmic pinnacle, Qualcomm took its own Sysyphean time, putting its advocates through an eight year ordeal, battling indignant Wall Street shorts and mini-skirts, mid-Atlantic professors of engineering, analog physicists, European industrial pols,

and **AT&T**'s (T) tintinnabulation of Bellhead prejudices.

By contrast to this agonizing ascent up walls of worry and continental weltzsmertz, **Global Crossing** (GBLX), my number one technology choice for 1998, is an instant gratification winner. Global Crossing promises to do for worldwide fiber networks what Qualcomm is doing for wireless technology–establishing a foundation for future dominance. Global Crossing seems poised to become the AT&T of the new era in telecommunications.

Following the Peter Drucker rule that the largest profits go to the provider of the missing link that completes a system, the genius of Gary Winnick of Global Crossing was to focus on undersea, the largely missing link in the global Internet. The 10 thousand pounds of undersea pressure per square inch subject packaging, conduits, and sheaths to crushing stresses that severely limit the physical size of amplifiers and cables. Compounding the problem has been the dominance of the undersea business by cartels and consortia of giant telopolies who refrain from building capacity until they need it themselves. Undersea, they contend, is such a treacherous and titanically costly environment that normal financial markets and competitive principles do not apply.

Over the last six months, Global Crossing has been challenging all these submarine facts of physics and politics. Using junk bonds and other rakish forms of finance, it has raised a total of some $2 billion at a pace faster than any of its telopoly rivals. On grounds of anti-trust, it has initiated action in Congress and the FCC to outlaw the cozy consortia that have rendered the oceans a giant socialist Jacuzzi for telco bureaucrats. And it has joined with partners **Lucent** (LU) and **Tyco** (TYC) to overthrow the assumption that undersea services are necessarily a narrowband public utility open only to the telopoly "clubs."

Partly driven by advances in **Uniphase** (UNPH) pump lasers, the gap between undersea and terrestrial fiber technology has been closing fast. The first GBLX Atlantic Crossing cable, begun on May 25, 1998 and completed on February 22 of this year, provides 2.5 gigabit per second transmissions on four wavelengths on four fiber pairs, for a total of 40 gigabits per second. AC-2, which will be completed at the beginning of 2001, will offer 10 gigabits per second on 32 wavelengths on eight fiber pairs, for a total of 2.5 terabits per second. That's a 680 fold rise in Atlantic undersea bandwidth potential in 23 months.

Because of Global's multi-loop topology (see, GTR Nov '98) and its use of latest **Lucent** (LU) wavelength division multiplexing (WDM) technology, the cost of AC-2 will be $500M. By contrast, FLAG Atlantic–a rival club project announced in December, with completion scheduled for December 2000–will use **Alcatel** (ALA) equipment providing a comparatively modest 1.2 terabits, but it will cost more than twice as much, a total of $1.2 billion. Uh, oh. GBLX, starting out three months later, gained a factor of four advantage in unit costs for a system with a superior topology that will be open for business just thirty days later.

Atmel makes breakthrough on back of GSM

Meanwhile in the GSM world, **Atmel** (ATML) has introduced a power amplifier for wireless handsets, which provides the best combination of power, efficiency, size, and cost currently available. This amplifier is the first to use silicon germanium (SiGe), a semiconductor material that has the advantages of efficient silicon production with a higher frequency capability which is beginning to rival gallium arsenide (GaAs).

GaAs, which is used in virtually all high frequency applications is both difficult to work and expensive. SiGe is increasingly challenging its hegemony in the wireless world, as well as in other high-speed applications such as optical demultiplexers. Atmel's March 98 purchase of Temic Semiconductors, developers of SiGe applications, is beginning to bear fruit.

Although GSM will ultimately be replaced, a vigorous market for GSM handset components should persist for years. For Atmel, the highest ultimate value of the residual GSM market may be in the chance to move further along the SiGe learning curve.

Meanwhile, from the Halls of Montezuma to the Shores of Tripoli– and other more telecosmic locales such as Sao Paulo and Osaka–Winnick's fleets of undersea cable laying vessels are now charging the beaches to disgorge landing parties of paradigm marines.

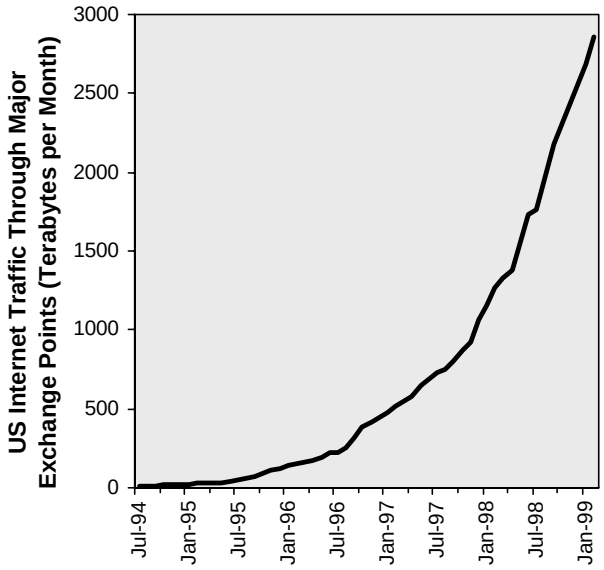
The purchase of **Frontier** (FRO), announced March 17, gives Global Crossing arguably the world's most advanced terrestrial fiber networks. The promise of the **Cisco** (CSCO)-**Ciena** (CIEN) collaboration to put WDM transponders directly on Internet router backplanes–thus bringing nearer the grail of all optical networks–is now bearing fruit. As we go to press, Frontier announced that it is doubling the capacity of its IP backbone by running Internet Protocol packets directly over WDM and getting phone company costs and complexities out of the way of the Internet. Within the next three months, it will deploy the Cisco 12000 Gigabit Switch Router (GSR), finessing the cumbersome SONET or ATM layers, on two 2.5 gigabit circuits between LA and New York. This link will join to the IP over WDM system Frontier has had running between LA and San Francisco since mid 1998.

Just as important, Global inherits from Frontier a chain of Internet server hubs, called "Global Centers", in Silicon Valley, Orange County, Arizona, Washington, DC, New York, London, and Melbourne. These giant "server farms" host arrays of mostly **Sun** (SUNW) computers that perform 60 percent of all Internet searches and 70 percent of all online financial messages and house 300 of the top

Frontier gives Global Crossing arguably the world's most advanced terrestrial fiber networks

Chart 3

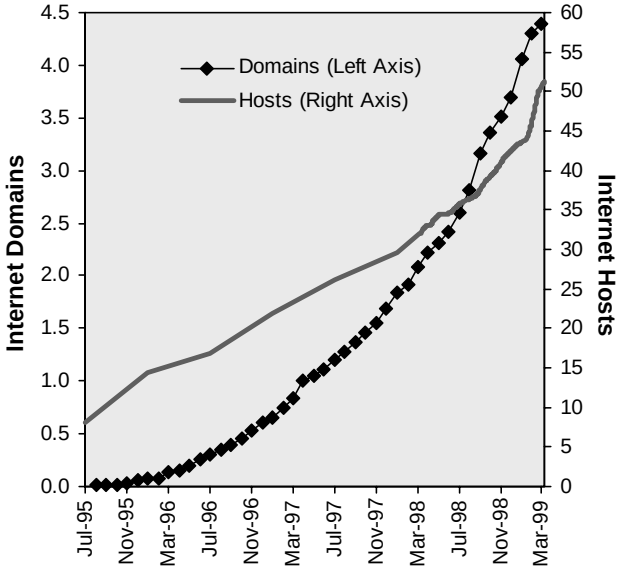
GTR Internet Traffic Estimates are Back!



Source: Gilder Technology Group

Chart 4

New Domains Mark the Rise in Companies and Content Attracting Internet Users



Sources: Netcraft, InterNic, Network Wizards, Bellcore

"Myth of Internet Growth?"

Our friends at Upside *and at* Business Communications Review *profess to have discovered a new "myth," propagated by yours truly, about "Internet growth." Specifically, David Futrelle of* Upside *interviewed Peter Sevcik of Northeastern Consulting Resources in Boston, who had first vented this "Myth" in BCR. They also attack the estimate of John Sidgemore of UUNet WorldCom–well above GTR estimates–that traffic has been growing close to ten times per year. Their articles are well worth reading, for they clarify several issues and illustrate the degree of confusion currently afflicting nearly all measurements of the Net.*

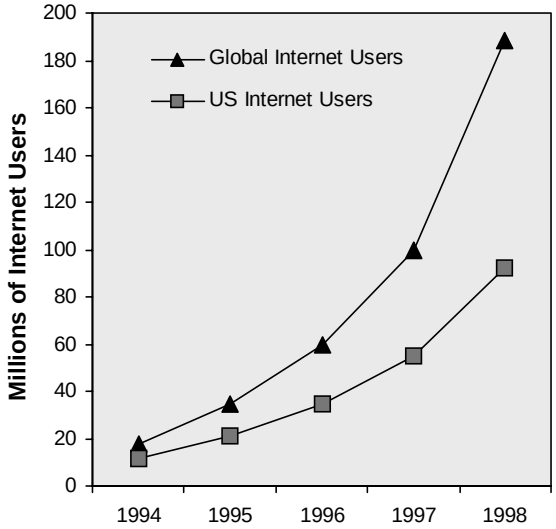
In a project run by Ken Ehrhart since our first issue nearly three years ago, GTR has published estimates of Internet growth, based on traffic through US NAPs (network access points) and MAEs (metropolitan area exchanges). In April 1998, however, this data became unavailable. Meanwhile, the share of traffic per user exchanged through these public hubs dropped drastically as a share of total traffic (MCI and Sprint estimate that at least 80 percent of traffic is now exchanged privately) and the share of total traffic represented by the US dropped sharply.

Chart 3 above does not contain adjustments for these two factors. But it does bring the public hub data up to date with projections that adjust the last available public hub figure for the rising numbers of US households and individuals on line and the rise in traffic per user. Over the last year, increased traffic reflects rises in modem speeds, hours online, email use, web page complexity, the transition from streaming audio to streaming video, and the runaway popularity of MP3 music files, which can range from 2 to 5 MBs per song.

These adjustments in Chart 3 yield a roughly 3 times increase in public US hub traffic from 1 petabyte per month in January 1998 to 2.9 petabytes in January 1999. An extremely rough correction for the move to private exchanges over the last year and the upsurge of overseas users would increase this nearly threefold rise by some large amount–perhaps as much as four times, making the UUNet projections not entirely out of the question. However, some double counting seems inevitable, as some foreign traffic flows through the US and some privately exchanged traffic does pass through public hubs. So pick your number for global growth, but it is more than 3 times growth per year and probably well under 10 times. Even if the growth should slow to a measly three times per year, it would add up to a nearly 60 thousand times increase in traffic over the next decade, which seems plenty mythopoeic to us. (GG)

Chart 5

The Rise in Internet Users is a Global Phenomenon



Source: Computer Industry Almanac

Some 4.5 million institutions and individuals worldwide have staked claims to Internet Domains

Content attracting online users has expanded dramatically, as reflected in the increase in Internet domains (i.e. gildertech.com) and hosts to 4.5 million. Excluded are the tens of millions of PCs of dialup users who are assigned an IP address but no name when temporarily connected to the Net. (Chart 4)

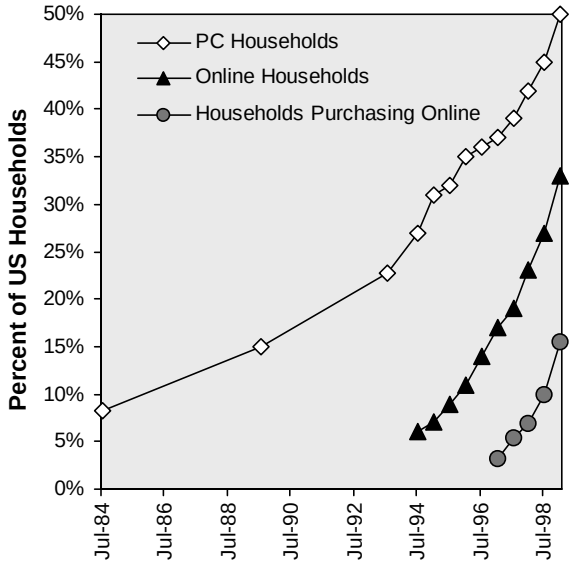
Number of people in the US with Internet access is larger than the total population of the 742 biggest US cities

At the end of 1998, there were 189 million Internet users worldwide and 92 million in the US. Nielsen//NetRatings puts the US 1Q99 total at 97.1 million people. Media Metrix reports there are now an equal number of men and women online, whereas the web was still more than 80% male in January 1996. NetZero, offering advertising-supported free Internet access, has claimed the rank of 10th largest US Internet service provider by signing up 500,000 users in just five months. (Chart 5)

-KE

Chart 6

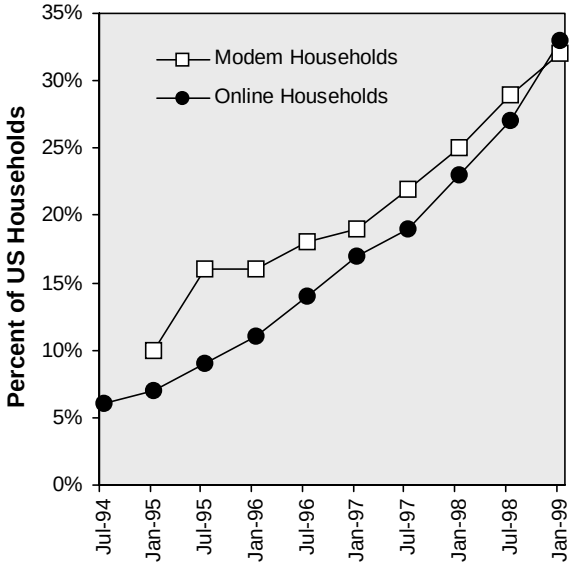
PC Ownership, Online Access and e-commerce are Linked in Growth



Sources: Odyssey, US Census

Chart 7

Online Households now Equal Modem Households



Source: Odyssey, CEMA/EIA

A majority of US homes now have a PC, two-thirds are online, and nearly half of online households buy online

The rise in PC household penetration directly coincides with the even quicker growth of online households and the still faster rise in e-commerce. Marketing data suggests the recognized importance of computer literacy for children justifies PCs as an investment (as opposed to TVs) and the opportunity to go online is seen as a crucial component of the educational benefit and the return on the PC investment. (Chart 6)

Nearly every household that can go online does so, as online households now outnumber modem households

With Internet access as the dominant home PC application, buyers of even the cheapest PCs demand modems over floppy drives suggesting online attractions are a heady motive for PC purchase . Nearly every modem household is now online cementing the link between the rising online population and new PC sales. (Chart 7)

1998 Breaks 1995's record for unit rise in consumer PC sales, with 52% increase.

Despite the availability of set-top Internet access devices such as WebTV, and the future potential of video game players and other appliances accessing the Net, PCs remain the most popular Internet access device. (Chart 8)

With cheap and even free PCs surging, Internet access and PC ownership will continue their climb

Fears that PC penetration would stall when reaching lower income households were shattered with the boom in sub-$600 PC sales. emachines, which entered the retail PC market in November with a $399 PC, claimed a 9.9 % market share by February 1999, passing both Packard Bell/NEC and Apple. With Microworkz offering a Cyrix-based PC for $299, including one year's free Net access, and several online companies giving away "free" PCs to boost online advertising impressions, the low-end market for both PCs and online access is vibrant. (Chart 9)

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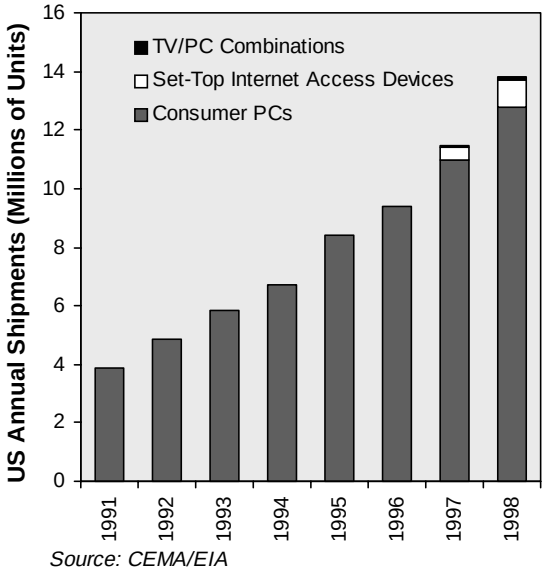
Chart 8

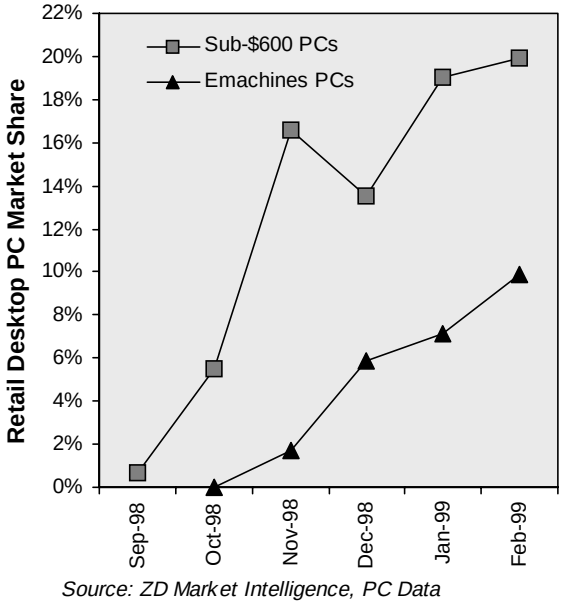
PCs Dominate US Consumer Online Access Device Market



Source: CEMA/EIA

Chart 9

PC and Online Households will Grow with emachines and the Sub-$600 PC



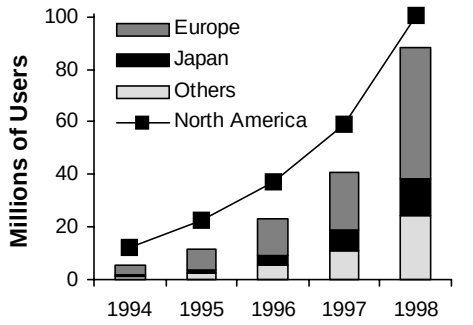
Source: ZD Market Intelligence, PC Data

Qwest under Joe Nacchio has made heroic contributions to the paradigm

500 Internet sites. A some $110 million business growing 120 percent per year, Frontier Global Centers' customers include **Yahoo** (YHOO), Netscape, USA Today, **Electronic Arts** (ERTS), **Playboy** (PLA), and Pacific Bell @Hand**,** generating 1.8 billion hits a day, 1.25 million hits a minute, and as many as 250 thousand Netscape browser downloads per day. Most significant are the browser downloads, which portend a day when nearly all software will be downloaded ad hoc for purchase or rent on the net.

Jack Scanlon, Global's Vice Chairman (formerly CEO), who brought 24 years of experience at AT&T to the company, declares that GlobalCenters will become the Central Office nodes of the new global network. Interlinked by the Global Crossing Web, these hubs can reduce the number of hops on a typical Internet call from an average of around 16 today to one or two, and the average access delay from seconds to milliseconds. Honed in the ferocious world of the World Wide Web, these hubs can take their place as business centers for corporations around the globe. Improving the performance of the Net, they can tap the fabulous elasticities of bandwidth expansion and continue the onrush of new traffic. Such data opportunities give Global Crossing executives a complacency about the future of voice traffic that is hard to sustain at AT&T where voice represents 80 percent of the revenues and profits. As Frontier CEO Joseph Clayton puts it: "We think voice will be essentially free." With this pro-data bias, Global Crossing could become the new AT&T, projected on a worldwide stage.

Chart 10
Global Internet Growth Drives Undersea Connection Market



Source: Computer Industry Almanac

At the announcement of the Frontier purchase the market frowned, sending GBLX down eight points or 20 percent, where it has been treading water ever since. The fear was that the 45 percent premium Global paid over Frontier's previous closing price of roughly $7.7 billion was too high. Actually Frontier looks like a steal.

The purchase of Frontier cost $11.2 billion in Global Crossing stock. For that amount, Global gained a Global Center business comparable in size to **Exodus** (EXDS), a web hosting rival with less desirable clients and no global network, commanding a market cap of $3.0 billion. Global also gained access to 24 fibers along most of the **Qwest** (QWST) network, which Frontier purchased as the anchor tenant. Global gained Frontier's revenues, which at $2.9 billion in 1998 were roughly 33 percent higher than Qwest's $2.2 billion. It gained command of a more advanced network, based on Frontier's pioneering use of IP over WDM at OC-48 rates across the country and between Los Angeles and San Francisco. It gained the cash flow or potential sales value of Frontier's incumbent local carrier business in Rochester (easily insulated from the leading edges of the company). Purchase of Qwest plus Exodus and a local loop cash cow would have cost upward of $35 billion. Global Crossing got a superior asset for less than a third of that price. Trained at the side of Michael Milken, Winnick made a deal worthy of his former boss, the world's most resourceful dealmaker.

The Qwest climacteric

I told you about the potential of Global in November and have been touting Qualcomm forever. But patting myself on the back with both hands, though anatomically challenging, is the easy part of your servant's chore this month. The harder part is sticking a shiv into the back of an eminent paradigm star which is also a luminary in my new book. But the emergence of the Global Crossing and Frontier combination is so powerful that it pushes Qwest into an also-ran category.

What else can you do when a favorite firm with a huge futuristic market cap fulfills its paradigmatic role and then goes astray, seeking not to displace AT&T but to become part of it. According to all reports, our friends at Qwest have adopted the goal of selling out to a giant telco. This might well be favorable for its stock in the short run, but it casts shadows over its future as a spearhead of paradigm technology.

On the positive side, Qwest under Joe Nacchio has made heroic contributions to the paradigm of broadband communications. After assembling rights of way all across the US and into Mexico, it moved with dazzling speed to deploy and light some 18,000 miles of fiber, which will be completed by midyear. In Europe, the Qwest/**KPN** (KPN) partnership is apparently on track to deploy 9,000 miles of fiber over the next two years. (Though it remains unclear why Qwest wants to share profits and gum up decision making with a sleepytime Continental telco. Global Crossing is keeping its 7,800 kilometer Pan Europe Crossing to itself). Nacchio has also been a superb success in driving revenues to a run rate now above $3 billion and garnering a market cap eight times revenues.

By contrast, rival **Level 3** (LVLT) offers scintillating presentations from CEO James Crowe, who grasps the Gilder paradigm better than any other CEO, and has achieved major marketing successes, including a $700 million prospective sale of indefeasible rights of use (IRUs) of 24 fibers and an empty conduit to **NextLink** (NXLK). But Level 3's some

$300 million annual revenue run rate still is based on lines leased from others, including Qwest. Level 3 has yet to entrench more than 500 miles of conduit, let alone install fiber or light it. If 90 percent of success comes from being there first, Qwest is preeminent.

The sad fact remains, however, that Qwest is no longer a technology leader. The Qwest buildout uses advanced Lucent TrueWave fiber and **Nortel** (NT) industry standard SONET switches. Nominally operating at OC 48 (2.5 gigabits a second) or OC 192 (10 Gbps), these million-dollar machines take data from ordinary telco systems, translate them into optical form, combine the bitstreams into huge OC SONET frames, feed them into the fiber backbone, and perform the inverse functions at the other end. Advertised as WDM systems, they are more accurately described as switches adaptable for WDM, but now used with only one wavelength (or lambda, as physicists call it). On this one lambda run IP over SONET Time Division Multiplexed frames of 64 kilobit slots indistinguishable from the rest of the old phone network.

They say that when a smaller company buys a larger one, it becomes the larger one. Last year, Qwest bought LCI, a long distance carrier, and now all too many Qwest offices redound with telco erlangs and languor. This industry is becoming increasingly binary: Either you are milking the voice margins that give AT&T and other telopolies 80 percent of their revenues or you are driving voice toward a price near zero. Either you are attempting to kill AT&T and its kith and kin or you are trying to be bought by AT&T.

Another way to describe the issue is a choice between multiplying lambdas on WDM or expanding the bitrate of SONET. At Denver headquarters, Qwest talks more of increasing its SONET bitrate to OC-768 (40 gigabits per second) than of multiplying the number of lambdas on the fiber.

But this strategy will not cut it. The problem is the huge cost of lighting up this system and making it accessible to companies outside the Forbes 50. For a typical network of 10 to 15 thousand miles, one lambda costs some $250 million to light up at OC-192. Further 10 gigabit lambdas cost another $100 million apiece through the eight lambdas that can fit in the SONET scheme. Then you are back to another $250 million for the ninth lambda. To access these huge bitstreams, even for a single 64 kilobit voice slot, entails reading headers on all the some 150 thousand packets on the line every second. That requires an add drop multiplexer/demux which costs some $3 million to $5 million including an office to house the equipment and link it to the customer's line, all according to Level 3 estimates.

In other words, this technology is good for point-to-point backbone links and giant corporate, government, and university clients in big cities, and is useless for everyone else. Our Publisher Richard Vigilante calls it an autistic network: "There's a lot going on in there, but no one can get it out." Qwest serves 48 out of the top 50 companies of the Forbes 500, some of which may be able to justify the massive therapy required to make the autistic network speak. But Qwest serves many of its other more modestly sized customers though lines leased from others. In the face of the tens of millions in costs for lighting up at OC-48 and the hundreds of millions for OC-192, not to mention millions more for add-drop, most of Qwest's network necessarily still consists of OC-3 tributaries to mostly empty OC-192 shells.

In interviews, Nacchio has disparaged the need for WDM. But over the next five years, if you are not a master of WDM, you will find yourself trapped in a SONET cage as confining as the copper cages of the local Bell phone companies.

Softcom Brandishes Gigablade

The opposite of an autistic network is a dumb promiscuous network that can link readily to anyone without multi-million-dollar mux/demux optoelectronics. Ultimately allowing as many as a thousand wavelength channels on one fiber thread, Lucent's AllWave fiber breakthrough (see March '99 GTR) means that this kind of network is suddenly much closer than anyone supposed. This breakthrough signals the end of the line for huge autistic bitstreams that require costly intelligent switches to extract information. When the contents of the pipe are divided into thousands of wavelengths–each of which can be switched independently with passive optics–messages will be able to ride from origin to destination entirely on wings of light.

Using thousands of wavelengths on each of multiple fibers and bringing the light ever closer to the

Gigablade can cut away telco red tape, outsized switch prices, and megadollar add-drop machinery

Go To www.gildertech.com

Our GTR website (www.gildertech.com) is getting exciting. With the help of webmaster Tobias Casey, we have launched our own subscriber bulletin board, the Gilder Technology Forum, on which I find myself spending hours at a time because of the quality of questions and comments from our subscribers.

Also up is "George's Book Picks," with brief reviews of seminal Telecosmic works and a "Book of the Month" selection, currently Clayton Christensen's *The Innovator's Dilemma*.

At the same time Toby has supplied an HTML format version of the GTR. That means just about every subscriber should now be able to read the report online. (Your super secret password is cleverly hidden right on the mailing label of the GTR envelope.)

Most important of all, we now can notify you by e-mail 24 hours before the next issue of the GTR is posted to the web. You can sign up for this service by clicking "Report" on the home page and then filling out the form on the bottom of the page.

We hate for any of our readers to get the Report late while waiting for snail mail. The only way to be sure to be on time is to read the GTR online.

GG

TELECOSM TECHNOLOGIES

ASCENDANT TECHNOLOGY	COMPANY (SYMBOL)	Reference Date	Reference Price	March: Month End
Cable Modem Service	@Home (ATHM)	7/31/97	19 1/2	157 1/2
Silicon Germanium (SiGe)	Applied Micro Circuits (AMCC)	7/31/98	22 11/16	42 3/4
Analog to Digital Converters (ADC), Digital Signal Processors (DSP)	Analog Devices (ADI)	7/31/97	22 3/8	29 3/4
Dynamically Programmable Logic, SiGe, Single-Chip Systems	Atmel (ATML)	4/3/98	17 11/16	15 3/16
Single-Chip Broadband Data Transmission	Broadcom Corporation (BRCM)	4/17/98	12 *	61 5/8
Digital Video Codecs	C-Cube (CUBE)	4/25/97	23	19 3/16
Erbium Doped Fiber Amplifiers, Wave Division Multiplexing (WDM)	Ciena (CIEN)	10/9/98	8 9/16	22 1/2
Linear Power Amplifiers, Cable Modems	Conexant (CNXT) +	3/31/99	27 11/16	27 11/16
Fiber Optic Cable, Components, Wave Division Multiplexing (WDM)	Corning (GLW)	5/1/98	40 15/16	60
Submarine Fiber Optic Networks	Global Crossing (GBLX)	10/30/98	14 13/16	46 1/4
Low Earth Orbit Satellites (LEOS)	Globalstar (GSTRF)	8/29/96	11 7/8	13 7/8
Business Management Software	Intentia (Stockholm Exchange)	4/3/98	29	21 1/2
Wave Division Multiplexing (WDM), Fiber Optic Equipment	JDS Fitel (Toronto Exchange)	5/1/98	19 1/4	56 11/16
Broadband Fiber Network	Level 3 (LVLT)	4/3/98	31 1/4	72 13/16
Single Chip ASIC Systems, CDMA Chip Sets	LSI Logic (LSI)	7/31/97	31 1/2	31 3/16
Telecommunications Equipment, WDM, CDMA, SiGe	Lucent Technologies (LU)	11/7/96	23 9/16	108
Telecommunications, Fiber, Internet Access	MCI WorldCom (WCOM)	8/29/97	29 15/16	88 9/16
Single-Chip Systems, Silicon Germanium (SiGe)	National Semiconductor (NSM)	7/31/97	31 1/2	9 5/16
Nationwide Fiber and Broadband Wireless Networks	Nextlink (NXLK)	2/11/99	40 7/8	56
Telecommunications Equipment, WDM, CDMA, SiGe, Cable Modems	Nortel Networks (NT)	11/3/97	46	62 1/8
Point to Multipoint (7-50 Ghz), Spread Spectrum Broadband Radios	P-COM (PCMS)	11/3/97	22 3/8	7 5/8
Code Division Multiple Access (CDMA)	Qualcomm (QCOM)	9/24/96	38 3/4	124 3/8
Nationwide CDMA (Code Division Multiple Access) Wireless Network	Sprint PCS (PCS)	12/3/98	15 3/8	44 5/16
Java Programming Language, Internet Servers	Sun Microsystems (SUNW)	8/13/96	27 1/2	125 1/16
Broadband Wireless Services	Teligent (TGNT)	11/21/97	21 1/2 *	41 5/8
CDMA Cable Modems	Terayon (TERN)	12/3/98	31 5/8	40
Digital Signal Processors (DSPs)	Texas Instruments (TXN)	11/7/96	23 3/4	99 1/4
High-Speed Copper Networking	Tut Systems (TUTS)	1/29/99	18 *	49 3/4
Wave Division Multiplexing (WDM) Modulators	Uniphase (UNPH)	6/27/97	29 3/8	115 1/8
Field Programmable Gate Arrays (FPGAs)	Xilinx (XLNX)	10/25/96	16 7/16	40 9/16

Added to the Table: Conexant
Removed from the table: Qwest, Spectrian

+ New Addition *** Initial Public Offering**

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

customers, though, requires a way of accessing the network far cheaper than the existing multiplex of opto-electronic converters, packet engines, gold plated interface cards, and add-drop muxes. This is where Softcom Microsystems enters the scene with its swashbuckling "Gigablade." It can cut away telco redtape, outsized switch prices, add-drop megadollar machines, and $100 thousand router cards like a Global Crossing cable cleaving the oceans.

To connect a PC to an OC-48 (2.5 Gbps) wavelength on a fiber currently requires an $100 thousand line card from Cisco in a router and a SONET line card from Nortel in an add drop mux, for a total of at least $200 thousand. With the Gigablade, suddenly all these gadgets and big iron–the router or switch and fiber optic terminal in an add-drop multiplexer–become unnecessary. You can replace them all with a $10 thousand Softcom card that plugs into the PCI bus in your PC or server. With large volumes, the $10 thousand card can drop to a few hundred dollars. With the next generation of DSPs (digital signal processors) from **Texas Instruments** (TXN) and **Analog Devices** (ADI), this putative $500 card could become a single general purpose DSP chip programmable in software to handle gigabit ethernet or any OC level up to 2.5 gigabits, with 10 gigabits to come soon–ultimately for under ten dollars, courtesy of Moore's Law, or what Level 3's Crowe calls "silicon economics."

The current users or testers of Softcom chipsets reportedly include all the companies in the Gigablade's path–Nortel at layer one (the physical layer), Lucent in switches at layer two, and Cisco in routers at layer 3 (in their $100 thousand OC-48 cards).

What is on the other side of the up-spectrum rainbow? More rainbows and more gilded horizons.

George Gilder, April 9, 1999

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