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WIRELESS WONDERLAND

With your Qualcomm HDR you will be able to plug your notebook into your CDMA cellphone and get faster net access than on your T-1 line at the office.

As November zoomed by, I celebrated my sixtieth birthday by resolving to right once and for all October's gaffe on the speed of the planet and me, even if I had to circle the globe to do it. As many of you pointed out on the Forum at gildertech.com, the earth does not ordinarily revolve around the sun at 38 miles a second. That is just an optoelectronic illusion, marking how fast the telecosm seemed to revolve around me in the ferris whirls and windmills of my mind.

Beginning my tour, I set off for Tokyo, leaving from Newark on October 28 after my opening speech to our boffo transcendental New Economy Conference at the Millennium Hotel in Times Square. (Commercial message intended; zap it if you like). Buffeted by the new economy bennies still buzzing in my brain, I ended up going in the wrong direction. Thus I found myself on my first ever complete contrarian circumnavigation of the globe. Some eight hours after leaving Newark, I was traversing the Zurich airport, where I paid passing tribute to the **JDS Uniphase** (JDSU) laser plant now popping out optical amplifier pump lasers in nearby Ruschlikon at a pace of hundreds of thousands per year (no one will give an exact count, but just two years ago the number was in the low thousands). Unlike some of the fiber bandwidth stars of IPO stage and screen, JDS Uniphase with its scores of efficient factories around the globe is anything but an optical illusion.

In This Issue:

Then from Zurich I was off across Russian skies on my way to Japan, where I would discover a breakthrough in the market for wireless data. **NTT-DOCOMO**'s *iMode* Internet wireless phones gained a million subscribers during their first six months after a February launch, then picked up another million in August and September, and were headed toward half a million more in October. **NEC** executives who supply chips and handsets for the 14.4 kilobit web enabled devices said that the chief limit on sales was the company's inability to manufacture the phones and chipsets fast enough.

Demonstrating the huge market for wireless data, DOCOMO nonetheless currently suffers from TDMA (time division multiple access) and thus labors under a need to break up bursty data flows into a lockstep stutter of tiny time slots. As a result, DOCOMO's momentum is flagging and the company had to resort to a handset giveaway in October. The fastest growing cellular phone companies were the CDMA team of **DDI** and **IDO**, which for the first time together gained more than one half (51.7 percent according to Merrill Lynch) of all new October sales, in a market with an installed base still almost totally dominated by **NTT**. The CDMA advance will accelerate this month with the introduction by DDI and IDO of CDMAOne, a 64 kilobit per second data service. Faster than a typical dialup interconnection, this IS95B technology is already being widely sold in Korea. This service will be launched in the U.S. sometime in 2000.

Available bandwidth will increase 80 fold over the next four years while demand will rise between 100 and 260 times. The result is a bandwidth crunch.

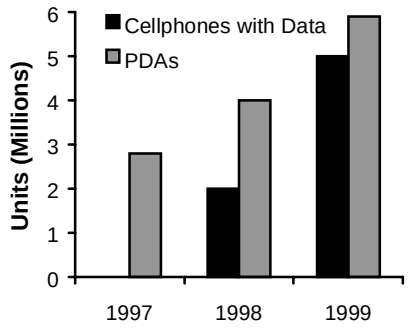
Next April, NEC plans to introduce the first Wideband CDMA (code division multiple access) phones for megabit Internet access, paying **Qualcomm** (QCOM) the requisite royalties but not using the CDMA 2000 system that Qualcomm favors. The Japanese, I was told, are extremely proud of defining this new Wideband CDMA standard.

Qualcomm data

Qualcomm, however, has trumped them all with their demonstration on November 9 of new 2.4 megabit per second (Mbps) burst capable High Data Rate (HDR) system compatible with all existing CDMA deployments and offering a range of IP services including Internet access. Ironically, HDR is a dynamically adaptable form of power controlled TDMA which fits seamlessly into unused 1.25 megahertz CDMA channels. (Irwin Jacobs reminds us that he and his Qualcomm team won TDMA patents back when they were at a company called **Linkabit**). With HDR coming on in 2001, you will be able to plug your notebook into your CDMA cellphone and get faster access than your office T-1 line (1.544 Mbps). Soon the HDR chipset will become your PC's onboard wireless modem. In recent trips to Tokyo and London I was repeatedly assured that the U.S. is behind in wireless data. But for data, U.S. penetration is, in fact, slightly greater than Japan's and Europe's, and U.S. data advances come in the context of twofold higher Internet use. With Qualcomm launching a superior technology today, the U.S. will continue in the lead in wireless Internet.

Chart 1

Wireless Data Challenges PDAs



Sources: IC Insights, Nokia

Novell joins the list

More important for Qualcomm–and promising for **Sprint PCS** (PCS) (soon-to-be **WorldCom PCS**)–is the fact that after a near decade of false starts, flaky service, huffing, puffing, hyping, and then fluffing the technology, wireless data is now bursting into exponential ascent. Once again wireless skeptics are proved massively wrong. Cell phones are no longer merely conversational devices. They are multiplying as different forms of database access "thin clients" or teleputers. Tapping the troves of information on the Net, these appliances require an increasing focus on how to share data among heterogeneous devices, thus bringing the storewidth, directory, Java, and Jini paradigms to the fore. **Sun** (SUNW), **Novell** (NOVL), and an ever expanding array of companies that enable direct access to network storage, wherever you are, will play an increasing role in the paradigm for the new century.

Novell's stronger than ever focus on storage directories since Sun co-founder Eric Schmidt joined as CEO places the company at the sweet spot of the storewidth paradigm. The explosive fusion of infinite bandwidth and nearly limitless storage that powers the storewidth paradigm also identifies directories as the crucial missing link technology which enables its fulfillment, and as Drucker reminds us, to the missing links go the highest margins. More than 90 percent of Novell revenues now come from directory related products and services and caching systems, and we this month add Novell to the roll of Telecosm companies.

I love Qualcomm and revere the pdQ phone. And I adore the elegant CDMA 1900 megahertz purity of Sprint PCS. I have been hooked ever since I stole a ride in President Andrew Sukawaty's limo to the Orlando Airport from the Wireless World 1997 shindig and heard his aggressive plans to lead the world in Internet wireless access. Even though Andy Seybold declares Sprint's coverage to be as porous as Al Gore's worst nightmares of the ozone layer, Sukawaty has managed to stay several steps ahead of Seybold by adhering aggressively to CDMA.

Thus I had never dared confess, until today, that I had never in my life carried a cellphone. To family and friends, I have declared that I would not buy one until a CDMA signal made its way onto my front lawn, a considerable challenge in the Berkshire Hills. Oh, I had tested the devices, but I had never actually carried one on my own. Then, on the return from my circumnavigation, I stopped off at Qualcomm in San Diego to help celebrate the tenth anniversary of the first CDMA phone call and Paul Jacobs offered me a pdQ to try. When he showed up with one in Vancouver at our Disruptive Innovation conference, I grabbed it.

Off I was with my first very own cell phone, CDMA and with a Palm organizer on board. I did not dare open the box in Vancouver, suspecting that there would be "some assembly required." But when I arrived home, I prepared to sign up for Sprint PCS and challenge Roger ("e-pockets") McNamee or Andy (air-head) Seybold as road ready wireless warriors. I was assured that I could readily transfer all my address and datebook information from my Palm V organizer to my pdQ.

I confidently called the Sprint 800 number, artfully negotiated the "press one" for phone activation, and awaited service. Fortunately, I was using a wired phone at the time, for it is no surprise that Tyringham, Massachusetts, constitutes one of the dimmer pores in Sprint coverage. Finally, I got Sprint customer service. But the young man had not heard of the pdQ and seemed baffled by the challenge of activating it. After about ten minutes he tracked down the instructions, got me a password and phone number, and then mysteriously disappeared from the line. I called again. I was delighted to discover I did not have to start from scratch. But it turned out that subsequent steps required me to connect to the network with my pdQ. That proved impossible from my living room. Low and behold, on my lawn, my son Richard detected a stray signal, certifiably CDMA, that had wandered down from a tower on the Massachusetts Turnpike some four miles away.

Gilder connected...

Almost ecstatically wireless–Seybold and McNamee would have nothing on me–I minced out into the night with a cordless phone in one ear, my pdQ in hand, and in case I should wish to call anyone I actually know, my Palm V in my pocket. I was committed. The Sprint rep asked me whether the time of day had come up on the screen. Well, yes, Pacific Standard Time. I changed it and then proceeded to a series of instructions required to activate the handset. Press the number one six times, press done, press one…at which point my cordless phone slipped from my ear and hurtled across the lawn to come to rest in a puddle in the driveway. By the time I retrieved it and wiped off the mud, I had lost the connection to my Sprint PCS guide. Back inside to contact the 800 number again. Alas, he spoke in a strange dialect unknown in Tyringham. No linguist myself, it was all I could do to assure him that the pleasure of making his acquaintance was all mine and we would talk again soon. I dialed again and after much to and fro was dispatched back onto the lawn. Once again I minced out with the cordless pressed to my right ear–pressed too hard as it turned out. Just as I began tapping in the six ones on the pdQ, my cheek bone somehow depressed one of the myriad buttons and turned the cordless off. I was left with my glorious though unfortunately still mute pdQ. I returned to the house to try again.

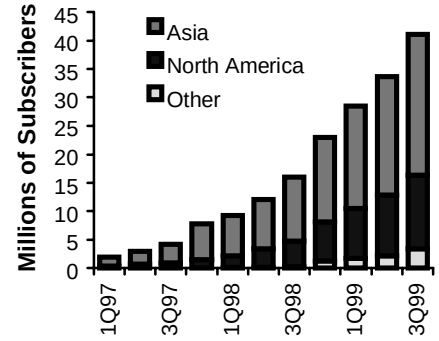
With the failure of a further effort to summon another signal on my lawn in the dark, the Sprint representative recommended that I activate my pdQ from a Radio Shack in the vicinity. I tried several. After offering insistently to sell me a phone, each gave way under my relentless questioning (not for nothing was I a wireless guru) and confessed that a signal could not be raised on their premises. But they assured me that there was "no problem." To activate my phone would be simple. "All you have to do is call the Sprint PCS 800 number." "Sure," I said grimly.

In the end, I set off for the Holyoke Mall 50 miles down the Turnpike to find a Sprint outlet that could summon a Sprint connection on my machine. Arriving at the Radio Shack on the third floor of the Mall, I showed off my pdQ proudly. It aroused general consternation. No one had ever seen such a thing before and all implied doubt that it was really a cellphone at all. They would be happy to sell me a real phone…how about this slim and light **Nokia** (NOK) model? Or wouldn't I like the "latest thing," one of these snappy MP-3 players that I could plug into my PC without any of that wireless nonsense? I said I had several in the house (**Audible.com** [ADBL] had been a Disruptive Innovation Conference sponsor).

Finally, though, in a happy ending, I walked out of the store with my phone fully activated. Having completed a call to my wife with the famous CDMA acoustics superior to wireline, I felt like Alexander Graham Bell. Now everyone I call gratifyingly professes their amazement at my resonant timbre and subtle undertones, but perhaps most of all at the profound and pregnant silences that have become my conversational signature as I go rapping around the Berkshires to the stroboscopic spread of Sprint's hip-hop coverage.

Chart 2

CDMA Wireless Subscribers Worldwide



Source: CDG

... and pdQ addicted

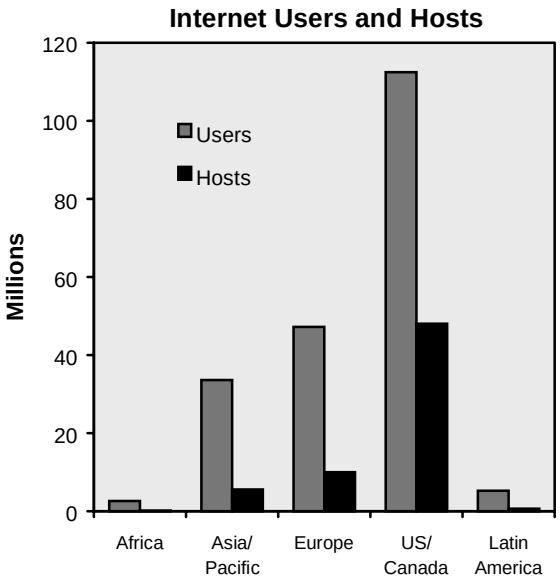
Despite the gaps in hill-county coverage, within the week I was entirely addicted to my pdQ. The seamless integration with my address book and calendar, the called and caller ID, and the flawless acoustics within Sprint's ever expanding zones of coverage allowed the Qualcomm device to displace both wireline phones and my Palm V. In my enthusiasm, however, I ran up an initial bill of $97 (I am told I chose the wrong billing plan for a constant user). The bottom line is that for all its size and challenges, the pdQ defines a devastating product.

November being my month for Canada, I was soon lugging the pdQ to Montreal for interviews with optical executives from **Nortel** (NT). They were fresh from the Quadrennial ITU (International Telecommunications Union) bash in Geneva where they announced 80 wavelengths on a fiber and demonstrated 80 gigabits a second on one wavelength. Pointing out that this added up to 5.4 petabits per second on one 864 fiber cable, Nortel was bullish on bandwidth and had the data to prove it. Pointing

Sun, Novell, and an ever expanding array of companies that enable direct access to network storage will play an increasing role in the paradigm.

The Internet Spans the Globe
But Still Centers in the U.S.

Chart 3



Source: NUA Internet Surveys, Telcordia

Even as the Net becomes ever more global it remains powerfully centered in the U.S. and continues to subvert the law of locality which predicts that in any network the overwhelming majority–80 percent is the figure usually cited–of traffic will be local.

Though the U.S. and Canada still lead the world's regions in Internet users, with rapid growth in Europe and Asia in the past two years their percentage of the global total is down sharply to 56 percent from 84 percent in 1997. On the other hand the North American lead in Internet hosts (computers permanently connected to the Internet which respond when hailed at the appropriate IP address) has actually grown to 75 percent, up from 70 percent in 1997 (**Chart 3**).

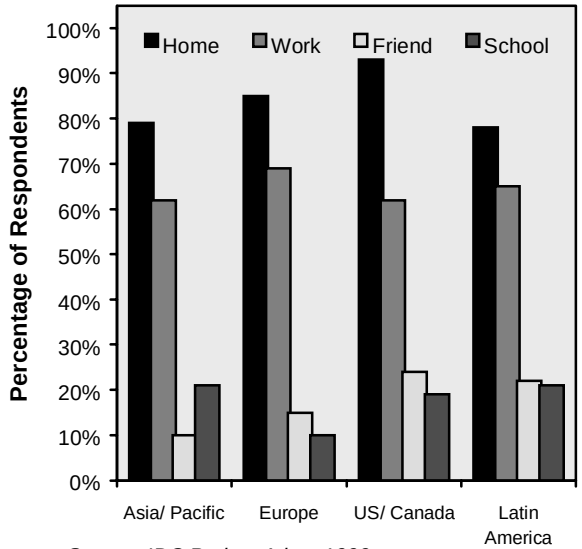
The 47 million European users and 34 million Asian users seem to be following patterns similar to those of users in the U.S. and Canada, according to an online survey of 29,000 web users from more than 100 countries recently conducted by IDC (International Data Corporation). In Europe and Asia, just as in the U.S. and Canada, if you are a web user you probably go online both at home and at work. In both Europe and Latin America, web users are actually more likely to access from work than they are in the U.S. and Canada (**Chart 4**).

E-commerce is catching on rapidly outside the U.S., especially in Europe where already web users are almost as likely as their American counter-parts to be online purchasers (**Chart 5**). Where are they buying? Not surprisingly given the imbalance in hosting sites, 90 percent of U.S. spending is at U.S. sites, whereas as much as 75 percent of e-commerce in some countries crosses borders.

When web-users contact foreign sites, where do they go? Based on data from a *Telegeography* survey of 300 ISPs operating internationally with links between 200 cities in 100 countries it's clear that most go to or through the U.S.–that's where the bandwidth is. (The 10 largest international ISPs control 70 percent of international Internet bandwidth so this 300 ISP study accounts for essentially all international net bandwidth).

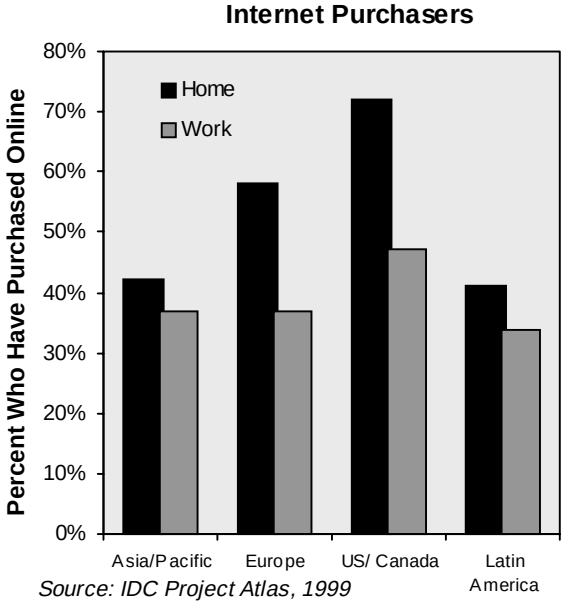
Just as Africa trails other regions in Internet users, it is desperate for the bandwidth that will be provided by the **Global Crossing** (GBLX) managed AfricaOne undersea fiber network and by the **Loral** (LOR)-**Alcatel** (ALA) SkyBridge broadband satellite system. *Telegeography* found only South Africa, Morocco, Tunisia and soon Egypt with international Internet connections of 10 Mbps or more. For all of Africa, international Internet bandwidth totals a mere 249 Mbps. Sixty eight percent of that international bandwidth consists of links to the U.S. and Canada. Twenty eight percent goes for links to Europe. As for one African country linking to another: such links account for only three percent of the total (**Chart 6**).

Chart 4



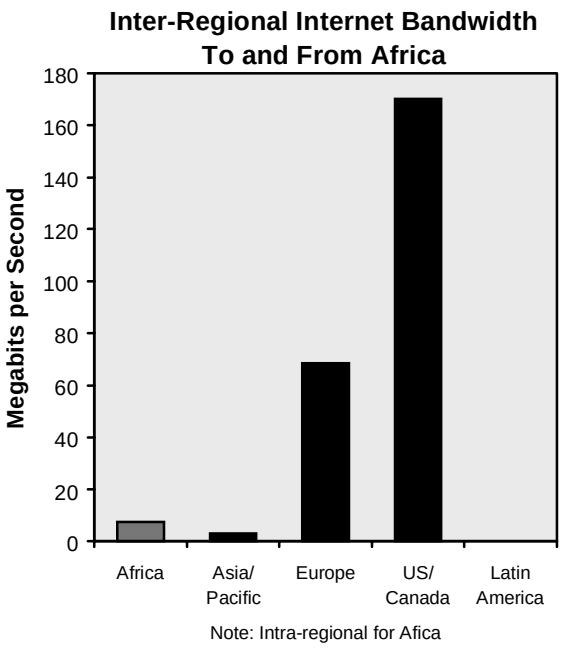
Source: IDC Project Atlas, 1999

Chart 5



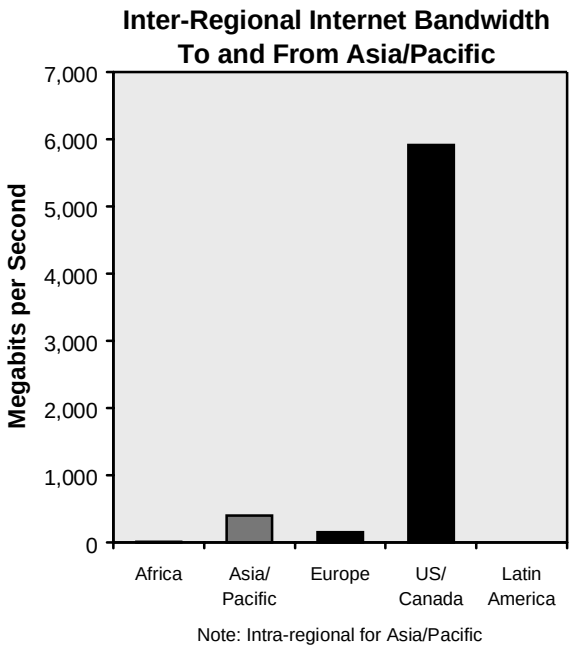
Source: IDC Project Atlas, 1999

Chart 6



Source: Telegeography

Chart 7



Source: Telegeography

Some 92 percent of the Asia/Pacific region's 6.5 Gbps of international bandwidth is in links to the U.S. and only 2.4 percent is devoted to direct links to Europe. International links within the region amounted to just under 400 Mbps, just about six percent of the total. But connectivity within the region will increase substantially with new Asian initiatives from Global Crossing and **Level 3** (LVLT).

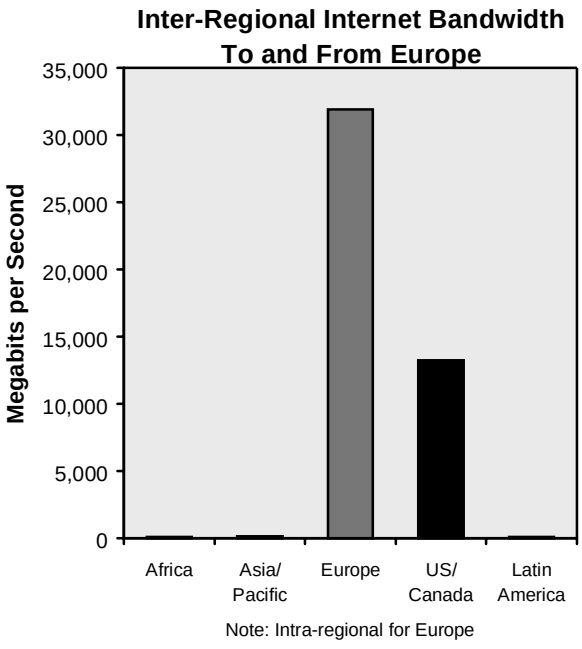
With telecom liberalization and the rise of new pan-European networks from carriers such as Global Crossing, Level 3, and **WorldCom** (WCOM), Europe has seen the largest increase in intra-regional international bandwidth. In fact Europe is the only region in which international links are more likely to be with other countries in the region than with the U.S. and Canada. International bandwidth within Europe (31.9 Gbps) is some 2.4 times the bandwidth of external links to the U.S. (**Chart 8**).

The European links with the U.S. and Canada (13.3 Gbps) represent over 47 percent of Europe's 28 Gbps of international bandwidth, with 28 percent connecting to the U.S. and Canada, and another 21 percent linked to Asia (**Chart 9**).

Latin America's 1 Gbps of total international Internet bandwidth, 89.5 percent was connections with the U.S., 5.9 percent connections with Europe, and 4.6 percent international links within Latin America itself.

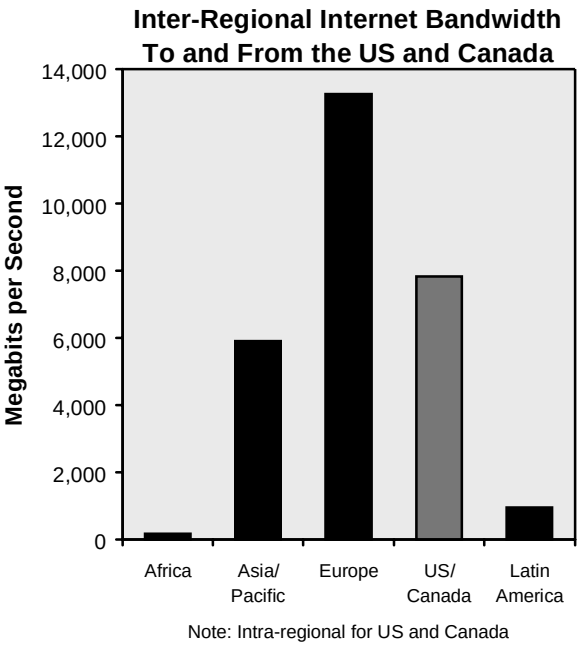
-Ken Ehrhart

Chart 8



Source: Telegeography

Chart 9



Source: Telegeography

Globalstar's costs for one minute of call time are just five cents. Lucky for them, their wholesale price to their retail partners averages 47 cents.

out that some 500 previous industry bandwidth projections had all drastically underestimated bandwidth demand, Anil Khatod, President of Nortel's optical Internet project, stepped me through an authoritative demonstration that he had developed initially for Jim Crowe of **Level 3** (LVLT). It showed that far from a bandwidth glut, the following four years ending in 2003 would see a capacity crunch.

Nortel's bandwidth blowout

To quell doubts, he offered a multi-factor equation that aims to measure the elusive interplaying of forces shaping bandwidth. It combines connectivity speeds (up 60 percent per year), subscriber adoption rates (20 percent per year), geographic patterns or average distance traveled per bit (15 per cent per year), average user interval or connection timespan (20 percent), with rise of application program complexity (lines of code and multimedia effects), bandwidth attractiveness (it is crucial to reduce 1998 Web waits of some 2.5 billion hours, says Khatod), microprocessor bandwidth (rising 33 percent per year), and residual price elasticity after all the other factors are accounted (a factor of 1.7). Putting all these numbers together and adjusting for double counting, Khatod shows that available bandwidth will increase 80 fold over the next four years while demand will rise between 100 and 260 times. The result is a capacity crunch.

The supply side of the Khatod formula encompassed all the Nortel portfolio of products including newly acquired all-optical distance champ **Qtera** (see box). But bandwidth crunch will offer opportunities for suppliers outside the Nortel ambit. The most obvious will be satellite, pushed into the mainstream by a combination of collapsing space launch costs and Moore's Law improvements in signal processing and power.

Whenever such a wireless opportunity arises, you are sure to find Craig McCaw somewhere in the vicinity. After typically making the wrong initial technology choice (TDMA, complex in-orbit links for Teledesic), he then plays a heroic game of catch-up marketing (**AT&T** [T] cellular, **Nextel** [NXTL]). When McCaw decided in the last month to make a play for failed satellite operator **ICO Global Communications**, the bid initially baffled Wall Street. When the rumors began spreading that he might also be after the remnants of **Iridium** (IRID)–the even more spectacularly failed satellite telephony venture now residing somewhere between Chapter 11 and The End–skeptics muttered that this time McCaw's payload had really slipped off his rocket.

McCaw and ICO

Not likely. First he moved to snag more PCS spectrum from near bankrupt CDMA venture **Nextwave**, until Global Crossing et al beat him to it. Now he sees ICO and maybe Iridium as crucial scavenging chances in the looming contest for radio resources in space. Although spectrum resources are theoretically unlimited, and divisible down to a lambda per user, battery power constrains some applications from operating in higher frequencies. For example, analog cellular signals (800 to 900 Mhz) can propagate up to 30 to 40 miles whereas PCS digital signals (1800 Mhz) are constrained by their power budgets to a 4 to 7 mile range.

Iridium, Globalstar, and **Odyssey** were the only companies to win mobile telephony spectrum at the FCC's original satellite telephony auctions. Iridium, which uses TDMA, was granted a dedicated slice of the spectrum near the 1.6 Ghz range. The CDMA carriers, Globalstar and Odyssey, were pushed into a shared portion of spectrum that CDMA can handle without interference. Globalstar operates with 10 megahertz at 1.6 GHz for upstream links from the handset to the satellite and at 2.4 GHz for downstream links from the satellite to the handset. McCaw presumably wants to seize Iridium's spectrum real estate meant for a TDMA system, use the Iridium system until expiry, and then transfer the spectrum to his newer ICO constellation whatever it may turn out to be. More spectrum would allow ICO to add more users.

This play would not gratify **Loral**'s (LOR) Bernie Schwartz, who will try to induce the FCC to stop McCaw from making another spectrum grab. In the end winning in wireless is about deploying an efficient infrastructure. Part of that efficiency equation is building a larger storefront on the electromagnetic spectrum**.** But Globalstar already commands the capability to serve some 4 million customers and future advances will expand both the number of users and the bandwidth.

We have long harbored doubts about McCaw's predilections for building his corner of the telecosm on shaky second rate technologies scarfed up at bargain prices, and the ICO and Iridium TDMA

Nortel Goes Long with Qtera

Nortel Networks' recent capture of Qtera, one of the most promising optical startups, assures extension of its lead in long haul optical systems. Like **Corvis**, Qtera's mission is to boost by 5 or 10x, the current 400-600km distance an optical signal can travel without costly electronic regeneration. Qtera is the first to complete successful field trials, and at truly astonishing distances.

Using the Qwest test-bed for a 30-day trial, the Qtera WDM system, including transmitters, receivers, optical amplifiers, and optical add-drop mulitplexers, carried signals 2,400 km, without opto-electronic regeneration, at 10 Gbps, the highest bitrate commonly used today. Qtera says it can do 4000km.

The Qtera system can add or drop a wavelength at any node, shedding for all but local traffic the expensive SONET ritual of converting, reading headers, and reconverting the entire signal at every node. In the Qtera system thru traffic can pass through untouched.

Qtera also shifts protection and restoration–the ability to build an alternate path around any fiber cut within 50 milliseconds–from SONET to the optical layer and does it in 10 milliseconds.

The Qtera grab, like Nortel's capture of Cambrian Systems and its all-optical Optera Metro platform, confirms the company's commitment to pushing its own high margin but doomed SONET gear out of the network core before somebody else does it for them.

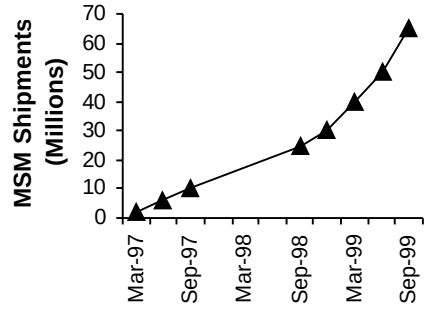
–Jeff Dahlberg

systems would both qualify for that description. But ICO would provide McCaw 10 megahertz of global spectrum for a MEO (mid earth orbit) configuration of satellites. Since ICO is yet to be launched it could be adapted to carry up to 48 kilobits per second, advancing McCaw's broadband ambitions, which have been dimmed by the current dormancy of **Teledesic**. Iridium would offer an additional 5 megahertz, but the spectrum is unrelated and the satellites are obsolete and already in orbit and beyond adaptation.

LEO technology is still in its infancy and gaining momentum. Space launch costs are coming down, as younger companies like **Orbital Sciences** and **Kistler Aerospace** aim to lower the cost of reaching space (neither has had breakthrough success). Although Orbital's Pegasus using Lockheed TriStar 1011s does reduce the cost per pound of low-weight launches, the system was rejected by Globalstar for larger payloads. More promising is **VentureStar**, the joint **Boeing-Lockheed** reusable launch vehicle project. Using linear aerospike engine technology–the first major advance in rocket technology in thirty years–VentureStar will reduce the cost of lifting a pound into space from $10,000 to $1,000. Space launch and insurance costs can consume up to 25 percent of total constellation capital costs. Falling launch costs could ultimately make satellite phone systems easier and cheaper than terrestrial wireless since satellite systems have many fewer nodes, and the cost of bribes alone for placing mobile transceiver towers continue to rise.

Chart 10

Qualcomm MobileStation Modem Chip Sales Accelerate



Source: Qualcomm

LEO satellites flying at about 700 miles above the earth enable smaller mobile user terminals. An **Inmarsat** phone running on a geostationary satellite is the size of a small briefcase, while a Globalstar phone is less than twice the size of one of the slimmer Nokia phones and about the same size as my wonderful Qualcomm pdQ.

The cost and capacity of the infrastructure determine whether the system will find customers. Iridium's constellation of 66 satellites with complex onboard processing capabilities, pushed total system cost to about $7 billion. **Motorola** (MOT), the prime contractor, compounded that mistake by using a TDMA air interface with a system capacity of only 1.5 billion minutes of use per year. With a design life of around 5 years, Iridium had to charge about $1 per minute just to cover the costs of the system.

Having been in the satellite business for about thirty years, Space Systems Loral, with crucial aid from Qualcomm, designed Globalstar far more intelligently. Using the patented path diversity of rake receivers provides for three simultaneous connections between user terminal and satellite. Path diversity allowed Space Systems Loral to design a LEO system with only 48 satellites, 18 less than Iridium. With a 9.6 kilobit per second vocoder, compared with Iridium's 2.4 kilobit device, the Globalstar system also allowed for better voice quality. Its CDMA soft handoff function results in a level of dropped calls under 5 percent, comparable to the best cellphone systems. Designed as a cellular extension in remote areas, Globalstar handsets automatically adapt software to default first to the prevailing local CDMA and secondly to the local analog system. A "letcha" rather than a "gotcha" strategy, the quicker and more seamless the handoff the easier it will be for Globalstar to persuade you that your Globalstar phone is the only one you need, as long as you manage to stay within 700 miles of the surface of the earth. Then you use the satellite minutes more.

Globalstar rising

CDMA efficiencies help Globalstar support 10 billion minutes a year, compared to Iridium's 1.5. The system's bent pipe satellite design reduces network complexity and kept capital cost of the system down to only $4 billion. The satellites were designed to last about 10 years–twice Iridium's. Some numbers on a napkin show one minute of call time costs Globalstar about five cents including operating costs. Lucky for them, their wholesale price to their retail partners averages 47 cents–good enough for 85 percent cash flow margins at peak use.

With all 48 birds in orbit by early December, Globalstar's technical advantages are now being tested by thousands of beta users around the globe. According to Globalstar co-inventor Ming Louie, the results are in and all the advantages of the LEO CDMA combination are proven. The stock is still down because of the aftershock of the TDMA failures at Iridium and Teledesic. Around here, this is not exactly a surprise.

We are not market timers. But as a historian, I note that Globalstar is an ascendant technology, and that the stock has yet to ascend. You do not have to be a rocket scientist to recognize that such a discrepancy between potential and kinetic energies–such an underestimation of CDMA and bandwidth demand–historically supplied the voltage for the explosive ascent of Qualcomm. 'Nuff said.

George Gilder (with Thomas Lehrman)
December 21, 1999

Falling launch costs could ultimately make satellite phones systems easier and cheaper to run than terrestrial wireless.

TELECOSM TECHNOLOGIES

ASCENDANT TECHNOLOGY	COMPANY (SYMBOL)	REFERENCE DATE	REFERENCE PRICE	NOV-99: MONTH END	52 WEEK RANGE	MARKET CAP.
CABLE TECHNOLOGIES/SERVICES						
Cable Modem Chipsets	Broadcom Corporation (BRCM)	4/17/98	12 *	179 1/16	42 1/2 - 215 1/4	18.640B
CDMA Cable Modems	Terayon (TERN)	12/3/98	31 5/8	62 1/16	25 3/4 - 74	1.353B
MICROCHIP TECHNOLOGIES						
Analog, Digital, and Mixed Signal Processors	Analog Devices (ADI)	7/31/97	22 3/8	57 1/2	19 3/4 - 65	10.033B
Silicon Germanium (SiGe) based photonic devices	Applied Micro Circuits (AMCC)	7/31/98	11 11/32	83 1/8	14 13/16 - 96	4.489B
Programmable Logic, SiGe, Single-Chip Systems	Atmel (ATML)	4/3/98	17 11/16	44 13/16	11 13/16 - 51 3/4	4.514B
Digital Video Codecs	C-Cube (CUBE)	4/25/97	23	44 49/64	17 1/4 - 52 3/8	1.817B
Linear CDMA Power Amplifiers, Cable Modems	Conexant (CNXT)	3/31/99	13 27/32	59 1/4	6 1/2 - 67 3/4	11.548B
Single Chip ASIC Systems, CDMA Chip Sets	LSI Logic (LSI)	7/31/97	31 1/2	60 7/16	15 5/16 - 66 15/16	8.993B
Single-Chip Systems, Silicon Germanium (SiGe) Chips	National Semiconductor (NSM)	7/31/97	31 1/2	42 1/2	8 7/8 - 44 15/16	7.289B
Analog, Digital, and Mixed Signal Processors, Micromirrors	Texas Instruments (TXN)	11/7/96	11 7/8	96 1/16	37 17/32 - 104 15/16	76.118B
Field Programmable Gate Arrays (FPGAs)	Xilinx (XLNX)	10/25/96	16 7/16	89 1/2	24 15/16 - 95 1/8	14.266B
OPTICAL NETWORKING						
Wave Division Multiplexing (WDM) Systems, Components	Ciena (CIEN)	10/9/98	8 9/16	43 15/16	12 7/16 - 54 1/2	6.073B
Optical Fiber, Photonic Components	Corning (GLW)	5/1/98	40 15/16	93 11/16	39 5/8 - 101 7/8	22.930B
Submarine Fiber Optic Networks	Global Crossing (GBLX)	10/30/98	14 13/16	43 5/8	17 3/8 - 64 1/4	34.673B
Wave Division Multiplexing (WDM) Components	JDS Uniphase (JDSU)	6/27/97	14 1/2	228 3/4	26 1/2 - 273 5/8	39.734B
Broadband Fiber Network	Level 3 (LVLT)	4/3/98	31 1/4	67 13/16	32 3/4 - 100 1/8	23.130B
Broadband Fiber Network	Metromedia FIber Network (MFNX)	9/30/99	24 1/2	38 3/4	12 3/16 - 47 9/16	9.021B
Broadband Fiber Network	NorthEast Optic Network (NOPT)	6/30/99	15 1/16	65	8 3/4 - 79	1.060B
WIRELESS TECHNOLOGIES/SERVICES						
Low Earth Orbit Satellite (LEOS) Wireless Transmission	Globalstar (GSTRF)	8/29/96	11 7/8	24	12 5/8 - 33	1.973B
Satellite Technology	Loral (LOR)	7/30/99	18 7/8	18	13 1/2 - 22 7/8	4.408B
Nationwide Fiber and Broadband Wireless Networks	Nextlink (NXLK)	2/11/99	20 7/16	51 1/4	11 3/16 - 61 7/8	6.821B
Code Division Multiple Access (CDMA) Chips, Phones	Qualcomm (QCOM)	9/24/96	19 3/8	362 5/16	24 1/2 - 406 1/8	59.780B
Nationwide CDMA Wireless Network	Sprint PCS (PCS)	12/3/98	15 3/8	91 3/4	14 1/16 - 94 3/4	47.531B
Broadband Wireless Services	Teligent (TGNT)	11/21/97	21 1/2 *	56 9/16	27 1/8 - 75 5/8	3.060B
INTERNET TECHNOLOGIES/SERVICES						
Internet Enabled Business Management Software, Java	Intentia (Stockholm Exchange)	4/3/98	29	28 7/8	17 1/2 - 35 1/4	0.690B
Telecommunication Networks, Internet Access	MCI WorldCom (WCOM)	8/29/97	29 15/16	82 11/16	58 3/8 - 96 45/64	156.284B
Directory, Network Storage	Novell (NOVL)	11/30/99	19 1/2	19 1/2	16 1/16 - 31 3/16	6.005B
Java Programming Language, Internet Servers	Sun Microsystems (SUNW)	8/13/96	13 3/4	132 1/4	36 3/16 - 140	103.155B
BROADBAND TELECOM TECHNOLOGIES/SERVICES						
Wireless, Fiber Optic Telecom Chips, Equipment, Systems	Lucent Technologies (LU)	11/7/96	11 25/32	72 7/8	42 1/4 - 80 7/8	222.998B
Wireless, Fiber Optic, Cable Equipment, Systems	Nortel Networks (NT)	11/3/97	23	74 3/16	22 1/16 - 82 11/16	100.818B

ADDED TO THE TABLE: NOVELL

* 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. Reference Price is a company's closing stock price on the Reference Date, the date on which the company was added to the Table. Since March 1999, all "current" stock prices and new Reference Prices/Dates are closing prices for the last trading day of the month prior to publication. Mr. Gilder and other GTR staff may hold positions in some or all stocks listed.

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