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THE UP-SPECTRUM LEAP

As investors, tossed to and fro by a refractory world economy, a gnomic Federal Reserve, Amazonian stock prices, and dog-wagging tails in Washington, you now have to confront one of the most radical and sudden shifts in the recent history of technology. Over the period of a month, while I traipsed innocently through Europe engrossed by an incandescence of new optical concepts and companies, there erupted back in the States a tectonic slide toward a broadband wireless paradigm for network access.

McCaw has often compromised on technology, which is why we have never, until this issue, put a McCaw company on the Telecosm list.

Enabled by a bold vault of wireless up the spectrum of microwaves, several of the titans of world communications technology–**Lucent** (LU), **Nortel** (NT), **Siemens**, and one-man-band leader Craig McCaw–all went spectronic at once. They invested their money and prestige in such telecosmic outriders as **Teligent** (TGNT), **Winstar** (WCII) and **P-Com** (PCMS) and in bleak reaches of microwaves between 24 gigahertz and 38 gigahertz.

This is an amazing turnaround. Eight years ago, prompted by Bernie Bossard of CellularVision (now **SpeedUs.com**: SPDE), I began writing about these up spectrum frequencies as a huge opportunity for communications, offering such advantages as tiny antennas, low-power transmissions, and many gigahertz of bandwidth. But experts everywhere dismissed them–microwaves after all–as good chiefly for frying errant pigeons and other gullible investors. Today, they are offered as a favored way to cook the geese of the telecom establishment.

Inside This Report:

As Internet traffic doubles every few months and moves up spectrum to higher frequencies better suited to carrying large volumes of information, the globe is increasingly shining with microwave radiance. In the face of this sphere of Internet light, the moon is green with envy, Jupiter is aligned with Mars, and Bill Gates moves into low earth orbit with Craig McCaw and **Teledesic**. In Davos, Kevin Kalkhoven of **Uniphase** (UNPH) dons a yarmuke from Josef Strauss of **JDS Fitel** (Toronto Exchange) as the once rabid rivals merged. Evidently, peace will rule the planets and people everywhere will solemnly exchange their astrological signs…But, hark, it's 1999 not 1969. Unlike the hallucinogenic "revolutions" of the 1960s, the huge realignments going on today will reshape the world economy and change the boundaries of our lives in time and space.

The new developments stem from the new source of radiance, between 24 and 38 gigahertz, now beginning to surge across the ball of light, ecompassing LMDS (the misnamed local multichannel distribution service) and other slots suitable for broadband, high capacity wireless services. Along with the polychrome fiber optics that it resembles, this microwave spectrum is becoming the core of the new paradigm. The movement of communications up spectrum toward the light moves the ethersphere toward the fibersphere and links them together. Today this ascent is happening for real and for keeps. LMDS, and similar up-spectrum wireless services, the titans agree, will serve as a crucial downtown access ramp, realigning traffic patterns everywhere. This changes everything including the price for linking up your downtown office building to a fiber network. Yesterday: $300,000 a go. Tomorrow: $5,000.

With that kind of massive movement going on, GTR subscribers may need to do a little realigning them-

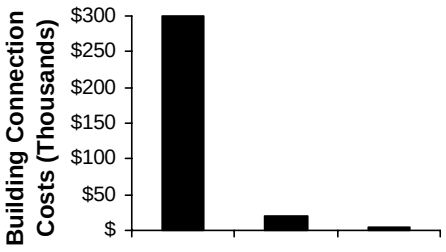
Microwave radios provide the "missing link" between high-capacity backbones and the 95 percent of buildings that cannot be cost effectively served by fiber.

selves, including of portfolios and pension fund holdings.

Flashback. March 1998. The FCC, ignoring our sage warnings against creating yet more artificial spectrum monopolies, is finally conducting its long threatened auction of the LMDS spectrum. We say that LMDS, hovering at the dizzying upper limits of the radio band, microwave radio, right up there in the supposedly unusable stratosphere of 20 plus gigahertz, is a potentially crucial locus of Telecosmic activity, a paradigmatic powerpoint. (The auction was actually restricted to the regions circa 28 to 31 gigahertz, technically defined as LMDS by the FCC, though LMDS-like equipment can operate both above and below the FCC's defined version.) Microwave transceivers operating in the LMDS regions could provide wireless bandwidth that surpasses cable in speed and capacity–if P-Com, Nortel et al could get the things to work.

Chart 1

Wireless Broadband Connections 1/66th Cost of Fiber Links



While not approaching fiberspeed these microwave radios could provide the most economical of all solutions to the fiber optic networks greatest challenge–last-mile hookups from fiber optic trunks to end users.

The Telecosmic paradigm says that the world of communications is bursting out of the copper cages of wireline links into the crystal palace of fiber optics. Fiber optic carriers can hold perhaps a billion times more traffic at one billionth of the error rate offered by copper wires.

This fibersphere is the heart of the Telecosm. It yields the bandwidth abundance that will shape the new era in technology. But with direct fiber hook-ups to end users such as office buildings costing at least $300,000 and with a lead-time of months, fiber access is too costly for all but the most well-heeled corporations. In a pathbreaking analysis, consultants Bart Stuck and Michael Weingarten estimate that direct fiber link-ups are cost effective for only about five percent of all business buildings.

Today we patch from fiber trunk to end user in a variety of more or less unsatisfactory ways. Cable is promising in many ways, but it chiefly serves residential areas. Highly touted, ADSL (asymmetrical digital subscriber line) is rolling out relatively slowly, and in most situations offers less bandwidth than cable.

Microwave radio transmission is the answer. It provides the "missing link" between a high-capacity backbone and the 95 percent of buildings that cannot be cost effectively served by fiber. High bandwidth, relatively low cost, and if a provider has set up shop in your city, you can have a system in place in several days, if not hours. And the short distances and focused beams mean you can readily reuse channels without fear of interference–just the thing for urban local access.

Microwave (referred to as millimeter wave) radios, the heart of these systems, are able to transmit data at rates as high as 200 Mbps. Not close to fiber-optic rates, but twenty times higher than most cable modems, this would serve the needs of most companies, a single channel accommodating a number of businesses in a single building.

There are two types of systems. Point-to-point systems simply connect the user at one end and the public switched telephone network at the other. The second type, point-multipoint systems, are hubs that enable many more buildings to be reached dramatically reducing deployment costs and installation time. Point-to-point installations run as high as $25,000, while point-multipoint drop to around $5000 per building.

Chart 2

$579 Million LMDS Auction Dwarfed By PCS Billions

Source: FCC Reports

Leading up to the auction, however, the skeptics were in full voice. The radios would never work, raindrops kept falling in their paths, and the laws of physics rendered spectrum that high useless for all purposes more exalted than a four-minute baked potato. The auction results warmed the skeptics hearts, yielding only $579 million compared to FCC expectations as high as $4.1 billion, while the chorus sounded in the background: "Who needs LMDS anyway?"

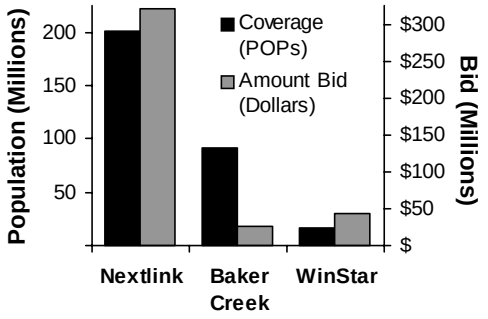
Apparently one needy soul was Craig McCaw whose **Nextband**, a 50/50 joint venture between his **Nextel** (NXTL) and his **Nextlink** (NXLK), bid $137.7 million to win a combination of A (1,150 MHz) and B block (150 MHz) licenses for 42 markets with 104.8 million people. That was at the March auction.

Then, on January 14 of this year, Nextlink bought

WNP Communications, the highest bidder at the auction, acquiring their 40 mostly A block licenses for markets with a population of 105 million for $695 million in cash and stock. That's four times what WNP originally paid, some 20 percent more than the total FCC revenues for the entire LMDS auction last March. But then the intervening nine months had brought further proof of broadband wireless as a link to fiber, including WinStar's completion of its Washington, DC beta test, ending successfully with a commercial launch this past December.

Completing the picture, Nextlink also announced its planned purchase of Nextel's 50 percent stake in Nextband. Through both transactions Nextlink becomes the largest owner of LMDS spectrum, covering 95 percent of the top 30 markets.

Chart 3
Nextlink Wins LMDS Auction with Combined Nextband and WNP Licenses

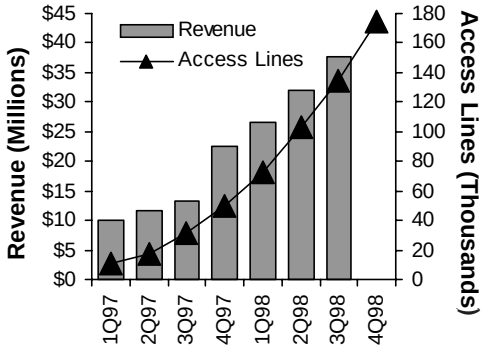


Source: FCC Reports

Though shortlived, WNP itself was part of the movement of titans toward wireless broadband. WNP's founder and president Thomas Jones, along with former MFS Communications CEO Royce Holland and former cable TV executive Trygve Myhrem, saw the value of this arctic spectrum allowing wireless links at speeds previously only attainable through fiber. Backed by seven venture capital firms, WNP adopted a business plan based not on deployment plans but on the likely turnaround value of its spectrum.

Why did McCaw consolidate the LMDS licenses at Nextlink? Because Nextlink will offer a complete line of local and long distance telecommunications services, including broadband Internet and data services while bypassing the ILECs (incumbent local exchange carriers). With wireless, Nextlink can quickly and inexpensively connect buildings within its markets to its own fiber networks, adding value that wireless-only or fiber-only players will be hard pressed to match. Testing of the wireless link-ups is set to begin early this year and rollout by the end of 2000.

Chart 4
Nextlink Growth



Source: Company Reports

Nextlink began by building and acquiring fiber networks in mid-sized markets with a focus on linking small and mid-sized businesses throughout downtown and suburban areas. In February 1998, Nextlink expanded on this strategy through an agreement with **Metromedia Fiber Network** (MFNX) for exclusive rights to multiple fibers on its network stretching from New York and Connecticut down through Philadelphia, Wilmington and Baltimore to Washington, DC. Then in July 1998, through **Internext**–a company 50 percent owned by Nextlink and 50 percent owned by Craig McCaw's Eagle River Investments, with an anticipated one third stake going to Nextel–Nextlink bought rights to roughly one quarter of the potential bandwidth of the **Level 3 Communications** (LVLT) 16,000 route mile nationwide fiber net.

For a $700 million investment in the buildout of Level 3's network, Internext will receive exclusive interest in 24 fibers in a shared conduit, one entire empty conduit and 25 percent of the fibers pulled through the sixth and any additional conduits in the network. Confirming a policy of purposefully "overbuilding" its fiber networks, Nextlink's Level 3 purchase separates it from the competition. A WinStar deal with **Williams** (WMB) Communications and Teligent's deal with **Frontier** (FRO) are less far reaching.

Nextlink is a CLEC (competitive local exchange carrier) with a difference; it actually competes directly with the Bells rather than reselling access to their equipment. Using a homogeneous national fabric of advanced Nortel DMX 500 central office switches linking fiber and microwave networks, Nextlink plans to bundle local access and long distance services. Because the facilities are optimized for the latest telecom gear from Nortel, Nextlink can offer bundled services both richer in features and more reliable for prices 10 to 15 percent below the Bells.

The John Stockton of telecom, McCaw is a master of the pick and roll, using regulators to neutralize rivals while he runs in to score. A single bundle of services, consolidated billing, and consistent end-to-end connections, this is what the old Bell System offered, what many customers preferred and what **AT&T** (T) and **SBC** (SBC) would like to do once again with the Internet. But the FTC, FCC, and state Public Utility Commissions will all obstruct AT&T and SBC at every turn, while opening a clear path to the basket for Nextlink.

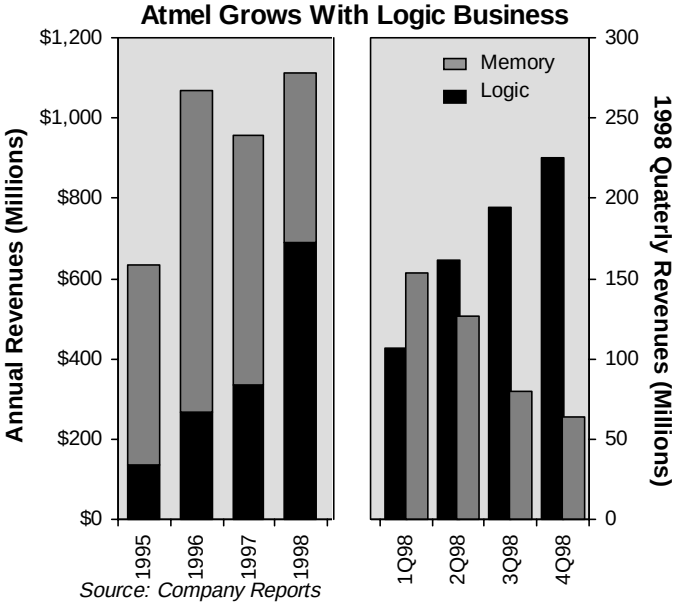
Infusing the Nextlink moves is Craig McCaw's

The Nextlink LMDS raid may be the final confirmation that McCaw not only gets the paradigm but would like to bag it, stuff it, and mount it in his den.

ATMEL TARGETS VOLUME IN KEY LOGIC MARKETS

Chart 5

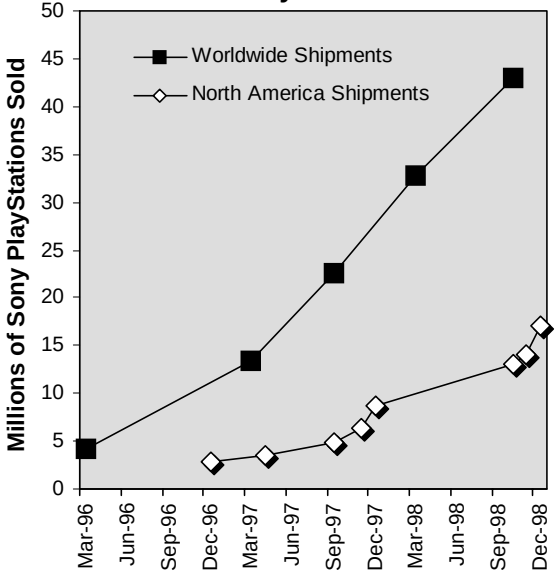
Atmel Grows With Logic Business



Source: Company Reports

Chart 6

Atmel-based Sony PocketStation to Build on PlayStation Success



Source: Company Reports

Atmel continues its strategic shift from commodity memory to specialized logic.

*Atmel's 4Q98 results showed continued strong growth in its profitable ASIC, microcontroller, logic and RF businesses and slowing decline in its de-emphasized memory business. This strategic shift, highlighted in the April 1998 GTR, brought 1998 growth of 16%, more than reversing 1997's 10% slide. Atmel begins 1999 with two important deals raising its future opportunities. (***Chart 5***)*

Atmel chip chosen for Sony PocketStation aimed at 43 million PlayStation users.

*Sony PlayStation's 65% share dominates the market for advanced video game consoles (***Chart 6***). Now Sony plans are challenging Nintendo's popular GameBoy with the PocketStation which allows users to download games from the PlayStation for play anywhere. PocketStation is based on an Atmel low-power single-chip solution including an ARM processor core, Flash memory, RAM, an LCD controller, digital-to-analog converters for audio and infrared communications capability, demonstrating Atmel's ability to serve the huge consumer electronics markets and fast growing markets for complex portable systems. (See next page.)*

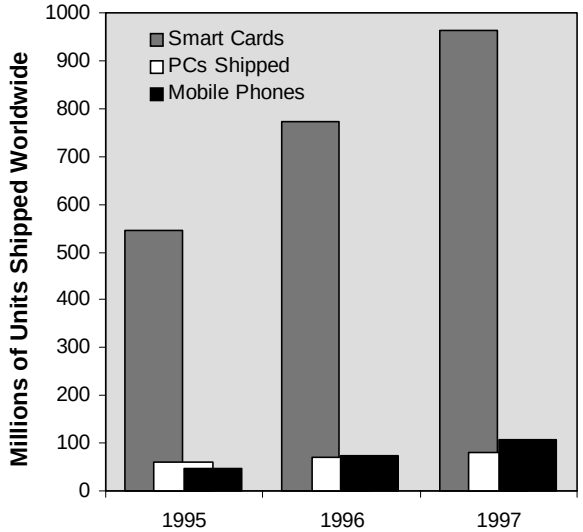
With Motorola buy, Atmel stakes its claim in huge smart card market.

*Smart cards are the highest volume end-user electronics product (***Chart 7***). Smart cards differ from ordinary plastic "credit cards" by including an embedded microcontroller unit (MCU) or memory chip. With its January 28, 1999 purchase of Motorola's smart card IC business, Atmel becomes the world's 2nd biggest supplier of MCU-based smart card ICs (***Chart 9***). And in the total smart card IC market including memory-only cards (almost 80%), Atmel becomes the 3rd largest producer with 13% share, behind STMicroelectronics (38%) and Siemens (37%). With emerging applications such as corporate network security and multiple application Java cards, the smart card market is expanding along with Atmel's prospects.*

-KE

Chart 7

Atmel Buys Into Huge Smart Card Market

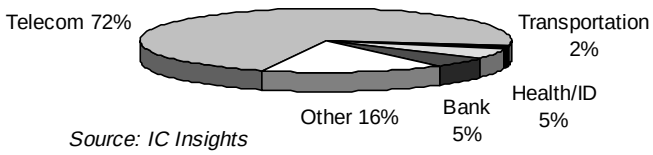


Sources: Dataquest, IC Insights

Chart 8

Telecom Phone Card Dominance of Smart Card Market to Fade with New Applications

1997

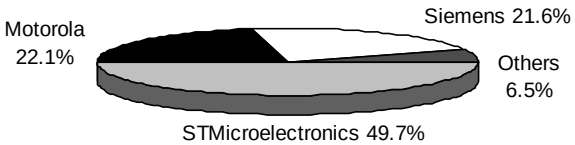


Source: IC Insights

Chart 9

Atmel Buying Motorola Share of MCU-Based Smart Card Chip Market

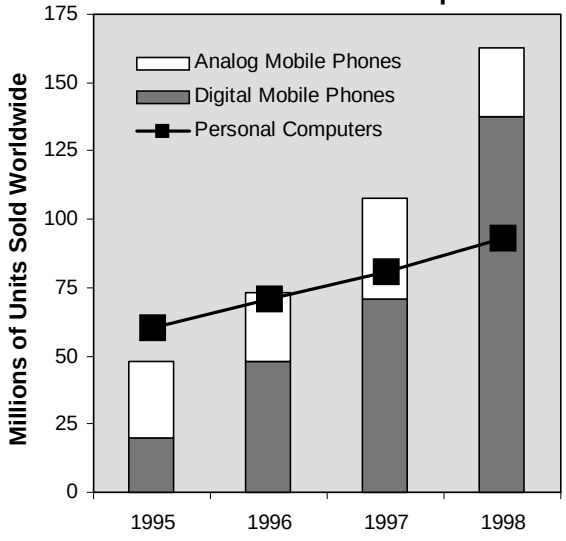
1997: 217 million units



Source: Instat

Chart 10

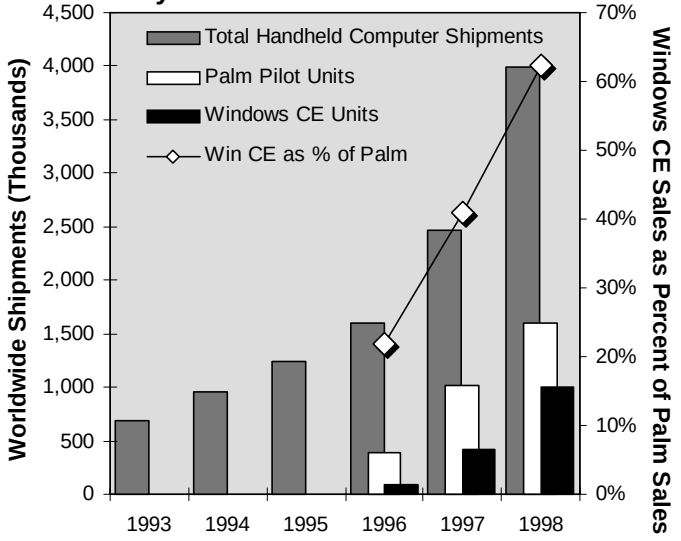
Smart Phones Will Become the Most Common Computer



Sources: Dataquest, IC Insights

Chart 11

Today's Handheld Computer Market May Determine Smart Phone Future



Source: Dataquest

The most common PC of the Telecosm will be a digital cellular phone.

*As mobile as your watch and as personal as your wallet; it will recognize speech, it will navigate streets, it will collect your mail and your paycheck, and help you spend it. It will command an Internet address and a Java runtime engine, and link to a variety of displays, keyboards, and other input-output gear through radio frequencies and infrared pulses. In 1998, digital mobile phones passed PCs in units shipped (***Chart 10***).*

The new PC may open your garage door, but might not do Windows.

*The operating system running these devices will likely evolve out of the systems battling in today's explosive market for handheld computers. The current market champ is 3COM's Palm (Pilot) handheld, and the Palm OS has been selected for Qualcomm's pdQ smart phone. But Microsoft is vigorously pursuing the market with Windows CE running on a range of devices, which taken together are nearing Palm in annual unit shipments (***Chart 11***).*

Sprint PCS's nationwide CDMA network will enable the new smart phones.

*Wirelessly linking these new machines to ever more capacious fiber networks is a core challenge of the new epoch, which Sprint PCS, working with Qualcomm, Lucent, Nortel, and Motorola, is quickly solving. During 4Q98 Sprint PCS coverage increased from 160 to 260 metropolitan markets covering 150 million people in 4,000 communities, producing a record for new wireless subscribers in a quarter (***Chart 12***).*

Digital signal processor sales grow with sales of wireless devices.

*DSPs (digital signal processors) are a crucial component of many Telecosm technologies including broadband wireless. The explosive growth of general purpose DSP chips (***Chart 13***), reflects only a portion of the DSP market, as DSP cores are increasingly integrated into single-chip systems. Three Telecosm companies, TI, Lucent and Analog Devices, led the 1998 DSP market with 44%, 28% and 12% market share. Analog hopes to gain share through its DSP alliance with Intel, announced February 3, 1999.*

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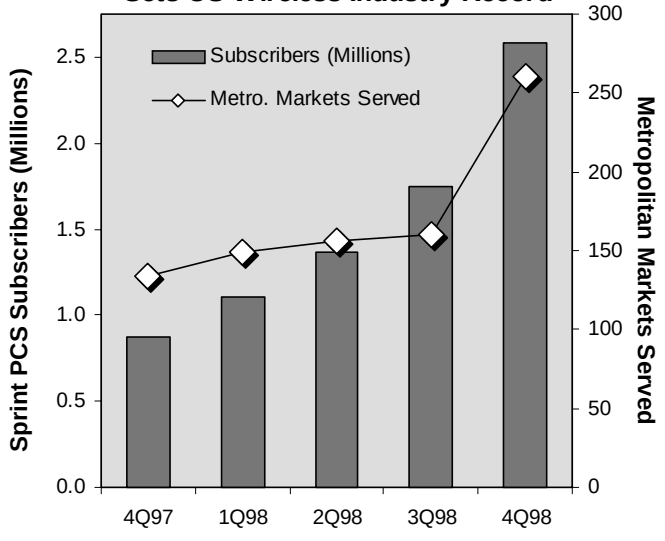
Chart 12

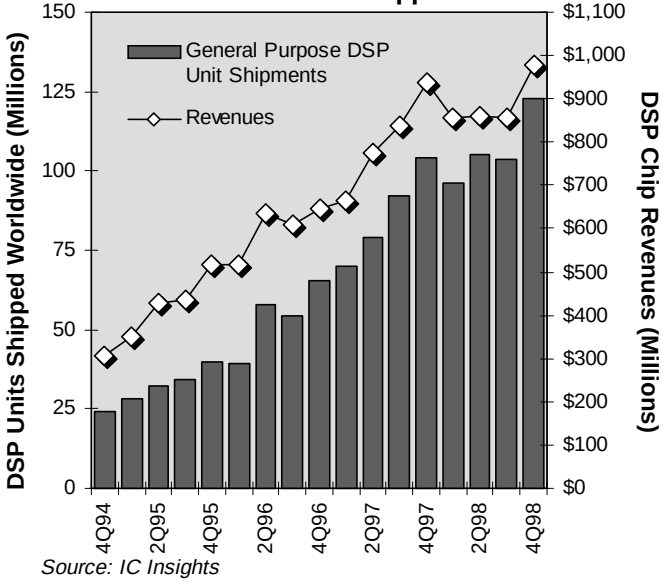
Sprint PCS 4Q98 Subscriber Growth Sets US Wireless Industry Record



Source: Company Reports

Chart 13

Digital Signal Processor Market Grows with Wireless Applications



Source: IC Insights

Competing with the Bells and their 43 million tons of installed copper is an expensive business, with a blood-curdling burn rate.

vision of the future of telecommunications, focused on wireless access at every level. Nextel has been extremely successful in turning what was previously considered low-value SMR (specialized mobile radio) spectrum into a mobile wireless voice service rivaling the nationwide networks of AT&T and **Sprint PCS** (PCS). Nextlink has assembled the fiber and previously undervalued LMDS microwave licenses to offer broadband services to businesses throughout the major markets of the US. And the Teledesic LEO (low Earth orbit) satellite system, envisioned by McCaw and Bill Gates and adopted by **Motorola** (MOT), will open all regions of the planet to fixed broadband services.

From Nextel to McCaw Cellular, both based on obsolescent TDMA, McCaw has often compromised on technology, which is why we have never, until this issue, put a McCaw company on the Telecosm list. The Telecosm list is for patient but bold and ambitious money, seeking long-term wealth creation. For that kind of long-term confidence clever manipulation of dubious technologies doesn't cut it. Our premise is that companies with ascendant technologies that drive the telecosmic paradigm to completion will be good for decades, or as long as the paradigm holds, even if their CEOs aren't quite as clever as McCaw. As microcosmic sage Carver Mead proclaimed long ago, "Listen to the technology." Craig only fitfully did.

But with Nextlink, McCaw has built a quintessential paradigm company. The LMDS raid may be the final confirmation that McCaw not only gets the paradigm but would like to bag it, stuff it, and mount it in his den. Together with WDM (wave division multiplexing) optics and LEO satellites also within the Nextlink ambit, up-spectrum wireless is as ascendant as technology gets. Along with the other pieces of the puzzle McCaw has been putting together it may place the McCaw empire at the center of the paradigm.

Nextlink's two entrenched competitors in up-spectrum wireless are Teligent and WinStar. Teligent's parent company got a national footprint of 400 megahertz at 18 gigahertz as an FCC favorite "pioneer" at a time when these microwaves were regarded as possibly "unusable." When McCaw's Teledesic protested that the Teligent system would interfere with Teledesic's Low Earth Orbit downlinks, Teligent was moved to the 24 gigahertz band, which it shares with police radar, and was awarded 350 more megahertz, presumably to compensate for the enhanced risk of speeding tickets.

As the value of microwave spectrum became clearer, WinStar bought much of CellularVision's New York City LMDS holdings for $32.5 million, after previously spending the third highest amount in the LMDS auction, over $43 million for licenses in 15 markets including the San Francisco Bay Area.

Now WinStar is racing Teligent to deliver last mile broadband connectivity to business users. For a fraction of the cost of laying fiber to commercial buildings, the two companies are installing wireless point-to-point and point-multipoint radios with capacities from 45 Mbps to 200Mbps. The capacity is then used to offer a complete range of telecommunications and data services, from local and long distance telephone to Internet access and Virtual Private Networks (VPN).

WinStar has been quite busy since we last reported on them (July 1998 GTR). Offering services in 30 US markets, WinStar is also moving to extend services internationally in Amsterdam in this quarter, in Buenos Aires and Sydney this spring, and in London and Paris in the fall. On January 5, it an-

RADIO RUMBLES

The companies creating these up-spectrum radios, notably **P-Com** (PCMS), **Nortel Networks** (NT) and **Digital Microwave** (DMIC), have competed in a spirit- and margin-crushing market in the face of fierce skepticism about the technology. Now more competitors are joining the field, adding credibility to the notion that broadband wireless link-ups have arrived, but making it even tougher to secure a sustainable portion of the market. **Hughes Network Systems**, **Netro**, **Alcatel** (ALA), and **Bosch** all exhibited radios at Cellular Telephone Industry Association (CTIA) this month.

Although point-multipoint radios come in varied configurations, the basic designs are similar. The rooftop units are divided into sectors containing a radio transceiver and antenna facet to transmit signals to the buildings served by that sector. Supporting this outdoor installation is an indoor unit that multiplexes signals and directs them to the appropriate transceivers in the rooftop hub.

At these high frequencies power is dear; output ranges from 500 milliwatts to one watt. This limits reach to 4 miles at best, and most receivers are placed within two miles to boost reliability. **Triton Network Systems**, using **Lockheed Martin** (LMT) technology, makes radios achieving up to 2 watts of power at 38 GHz, extending their reach, but these are point-to-point systems only.

Rumors persist that **Teligent**'s (TGNT) point-multipoint radios from Nortel's Broadband Wireless Access Group are unreliable. But Nortel radios are being used in the field by Teligent which has more experience in point-multipoint than any competitor.

Siemens likes P-Com's radios, which **WinStar** (WCII) has employed so far. But WinStar has also tested Nortel's radios, and expects to deploy them as well in a multi-vendor strategy. Still more threatening for P-Com, **Lucent** (LU), about to fund WinStar's efforts to the tune of $2 billion, has a soft spot for **Netro** of San Jose, California, which reportedly has a good radio. P-Com, a technology leader, will have to be more agile than ever as competition mounts.

Millitech, of South Deerfield, MA, another radio maker is working with **Newbridge Networks** (NN), a Canadian systems integrator and has been selected by **Formus Communications** as a supplier for deployments in Denver, Poland, New Zealand, and Ecuador.

nounced an agreement with two Japanese companies, **KDD Corporation** and **Sumitomo Corporation**, to build out wireless networks in Japan before the end of the year. A new company, **KDD WinStar** has been formed (WinStar holds 35 percent) to obtain spectrum licenses and create a broadband wireless network. Some fifty international markets are planned.

For domestic fiber links, WinStar has contracted with Williams Communications to sell capacity in WinStar's fixed wireless networks for $400 million over 4 years, while WinStar will get approximately 15,000 route miles of four strands of fiber for $640 million over 7 years. WinStar claims this agreement will result in an immediate saving since long-haul capacity was previously obtained at a higher cost.

The most momentous development, however, was the blessing of perhaps telecom's most prestigious titan, Lucent Technologies, with its venerable Bell Labs. Lucent has made a strategic alliance with WinStar worth some $2 billion to design, build, and operate a worldwide broadband network. Not only can WinStar avail itself of Lucent's immense resources, it also can draw on $2 billion of capital equipment financing (in $500 million tranches). In an unusual concession, Lucent will even make up to 30 percent of the money available for purchase of equipment from other vendors, so WinStar can buy the "best-of-breed" components for the network. This includes the lighting of dark fiber from Williams with Lucent's WDM equipment. This all encompassing global broadband network is expected to cost up to $4 billion. WinStar has just completed a follow-on stock offering of 4.2 million shares for approximately $170 million to bolster the coffers. The new credibility conferred by Lucent should make this offering a slam dunk.

WinStar's radios are supplied by P-Com with Siemens doing the system integration. That's a resounding vote of confidence from the German titan both for microwave wireless link-ups in general and for P-Com which gained new credibility only slightly short of WinStar's Lucent prestige. Siemens attests that the P-Com radios work fine. In the past, however, it has been difficult to ascertain just how many buildings WinStar, which also functions as a wireline carrier, a content vendor, a software supplier, and a publicity smokestack, actually serves with wireless.

While WinStar has the lead in plans and projects, hey, plans are easy. The only point-multipoint service currently available from the company is still the system in Washington DC we discussed in July.

Teligent has the lead in deploying point-multipoint systems. Teligent is offering services in 23 markets nationally, and of these 18 use point-multipoint configurations. With a single hub able to reach as many as 100 buildings, this should give Teligent an important edge.

Summing up the opportunity for all these companies, Teligent offers a rule of thumb: for buildings with fewer than 12 lines coming in, go copper; for those with more than 450 lines, go fiber; for the rest, some 740 thousand buildings, broadband fixed wireless access will prevail. To date, WinStar claims rights to more than 4,200 buildings, Teligent some 2,000, Nextlink some 10,400, leaving some 724 thousand to go. There would seem to be plenty of business out there for all the contestants in the field.

Competing with the Bells and their 43 million tons of installed copper is an expensive business, with a bloodcurdling burn rate. Teligent estimates that they go EBITDA positive in individual markets within 18 to 24 months. Well financed and aggressively led by Alex Mandl, Teligent calculates that it will be EBITDA positive as a company by 2002.

Teligent has agreements with Frontier for long-haul services, and with **Concentric Network** (CNCX) for Internet connections. The company plans to work

LMDS A BOOST FOR TRIQUINT?

These highly sophisticated radios used for LMDS employ microchips of esoteric substances such as gallium arsenide, and increasingly silicon germanium. These chips must be able to transform and encode data signals using complex modulation schemes to cycle billions of times per second.

Silicon germanium has been moving up spectrum, bringing with it the advantages of economical silicon manufacturing, and is beginning to be used in wireless IC's such as wireless LAN chipsets and PCS handsets by **Harris** (HRS) Semiconductor. The February 9th announcement by **Qualcomm** (QCOM) that the company will use **IBM**'s silicon germanium technology in its radio frequency chips may signal silicon germanium's coming of age. **Atmel** (ATML) is taking silicon germanium to a BiCMOS process for wireless chips.

Yet despite silicon germanium's rapid development, it has yet to challenge gallium arsenide in the highest frequency wireless chips. Gallium arsenide is an expensive recalcitrant, but companies using it for monolithic microwave integrated circuits, diodes, etc., include **Anadigics** (ANAD), **Vitesse** (VTSS), Sanders, a **Lockheed Martin** (LMT) company, **TRW** (TRW) MilliWave, and **AMP**'s (AMP) M/A-Com. None of the parent companies, however, is likely to soon get much bottom line boost from wireless chips, which account for little of their business.

A pure play on gallium arsenide is **Triquint Semiconductor** (TQNT), which is partnering with **Boeing** (BA), for turn-key design and foundry services. Triquint was the third largest supplier of these ICs in 1998. Revenues rose more than 68 percent in the fourth quarter, to $30.9 million. Net income for the quarter also hit a record at $3.5 million, a 129 percent jump versus the fourth quarter of 1997. For the year revenues reached $111.6 million, a 56 percent boost. For all of 1998, the company did report a net loss of $4 million, compared to net income of $6.9 million, for 1997. But the loss was primarily due to special charges in the first quarter related to the acquisition of the Millimeter Wave business from **Raytheon** (RTNa).

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TELECOSM TECHNOLOGIES

ASCENDANT TECHNOLOGY	COMPANY (SYMBOL)	Reference Date	Reference Price	Price as of 2/11/99
Cable Modem Service	*@Home* (ATHM)	7/31/97	19 1/2	109 7/8
Silicon Germanium (SiGe)	*Applied Micro Circuits* (AMCC)	7/31/98	22 11/16	40 1/4
Analog to Digital Converters (ADC), Digital Signal Processors (DSP)	*Analog Devices* (ADI)	7/31/97	22 3/8	30 15/16
Dynamically Programmable Logic, SiGe, Single Chip Systems	*Atmel* (ATML)	4/3/98	17 11/16	15 1/2
Single-Chip Broadband Data Transmission	*Broadcom Corporation* (BRCM)	4/17/98	24 *	123
Digital Video Codecs	*C-Cube* (CUBE)	4/25/97	23	22
Erbium Doped Fiber Amplifiers, Wave Division Multiplexing (WDM)	*Ciena* (CIEN)	10/9/98	8 9/16	22 1/4
Fiber Optic Cable, Components, Wave Division Multiplexing (WDM)	*Corning* (GLW)	5/1/98	40 15/16	49 9/16
Submarine Fiber Optic Networks	*Global Crossing* (GBLX)	10/30/98	29 5/8	60
Low Earth Orbit Satellites (LEOS)	*Globalstar* (GSTRF)	8/29/96	11 7/8	17 3/4
Business Management Software	*Intentia* (Stockholm Exchange)	4/3/98	29	26 3/4
Wave Division Multiplexing (WDM), Fiber Optic Equipment	*JDS Fitel* (Toronto Exchange)	5/1/98	19 1/4	41
Broadband Fiber Network	*Level 3* (LVLT)	4/3/98	31 1/4	59 11/16
Single Chip ASIC Systems, CDMA Chip Sets	*LSI Logic* (LSI)	7/31/97	31 1/2	27 1/16
Telecommunications Equipment, WDM, CDMA, SiGe	*Lucent Technologies* (LU)	11/7/96	23 9/16	101 1/8
Telecommunications, Fiber, Internet Access	*MCI WorldCom* (WCOM)	8/29/97	29 15/16	80 7/16
Single-Chip Systems, Silicon Germanium (SiGe)	*National Semiconductor* (NSM)	7/31/97	31 1/2	11 7/16
Nationwide Fiber and Broadband Wireless Networks	*Nextlink* (NXLK) +	2/11/99	40 7/8	40 7/8
Telecommunications Equipment, WDM, CDMA, SiGe, Cable Modems	*Nortel Networks* (NT)	11/3/97	46	60 5/8
Point to Multipoint (7-50 Ghz), Spread Spectrum Broadband Radios	*P-COM* (PCMS)	11/3/97	22 3/8	7 1/2
Code Division Multiple Access (CDMA)	*Qualcomm* (QCOM)	9/24/96	38 3/4	68 1/8
Broadband Fiber Network	*Qwest Communications* (QWST)	8/29/97	20 3/8	59
Linear Power Amplifiers	*Spectrian* (SPCT)	7/31/98	14	16 1/4
Nationwide CDMA (Code Division Multiple Access) Wireless Network	*Sprint PCS* (PCS)	12/3/98	15 3/8	33 3/4
Java Programming Language, Internet Servers	*Sun Microsystems* (SUNW)	8/13/96	27 1/2	105 5/16
Broadband Wireless Services	*Teligent* (TGNT)	11/21/97	21 1/2 *	38 3/16
CDMA Cable Modems	*Terayon* (TERN)	12/3/98	31 5/8	37 1/2
Digital Signal Processors (DSPs)	*Texas Instruments* (TXN)	11/7/96	23 3/4	95 1/16
High-Speed Copper Networking	*Tut Systems* (TUTS)	1/29/99	18 *	53 5/8
Wave Division Multiplexing (WDM) Modulators	*Uniphase (UNPH)*	6/27/97	29 3/8	84 3/8
Field Programmable Gate Arrays (FPGAs)	*Xilinx* (XLNX)	10/25/96	32 7/8	82 1/8

\+ New Addition * Initial Public Offering

Added to the table: Nextlink

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.

with Concentric for future Web hosting and Internet services management, but stops well short of providing content. Teligent has the advantage of remaining more focused on the task of providing broadband local access which is a full-time job.

Advanced Radio Telecom (ARTT), of Bellevue WA, is also a player, albeit one with fewer resources and a slower start. ART's nationwide 38 GHz license footprint covers 90 of the top 100 US markets and a total of 210 markets. ART also has licenses in the UK and Scandinavia. The company is currently offering point-to-point services in Seattle, Portland, and Phoenix. ART has chosen Lucent as its system integrator. Lucent will also provide some $200 million of financing subject to various conditions, but ART is usually treated as a takeover target.

The other major LMDS winner was **Baker Creek Communications**, controlled by established carriers **Adelphia** (ADLAC) and **Hyperion** (HYPT), which won licenses spread out over 232 low density markets covering a population of 90 million. Cable TV operator Adelphia, an early proponent of cable modem services, and Hyperion Telecommunications, the CLEC owned mostly by Adelphia, were uncovered as large players lending additional credibility to LMDS.

Peter Drucker asserts that the largest profits go to the companies that supply a pivotal missing element that enables and completes a system. The historic convergence of titans around LMDS signals that a cornerstone of the Telecosm is falling into place. Consummating the bandwidth abundance of the fibersphere around the globe will be the suppliers of broadband wireless. It is the missing link that can enable a new business civilization.

George Gilder, February 16, 1999

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