GILDER TECHNOLOGY REPORT

April 2005 / Vol. X No. 3

Kinetic Qualcomm

The three largest U.S. wireless carriers, with over 80 percent of the market, are aggressively rolling out new Qualcomm networks

Inside:

Is Paul Jacobs, the new CEO of **Qualcomm** (QCOM), the world's luckiest guy or what? Chasing the Shannon-sized bandwidth of the wake and wampum and brain-breadth of his imperial dad Irwin, Paul has finally broken through, to become the new pope and paladin of code division multiple access (CDMA) wireless, which increasingly means all the wireless that runs on cell phones everywhere on the planet.

Oh, we know. Paul got his electrical engineering PhD at Berkeley rather than at MIT like his dad and is an inch or two shorter. Since March 9, when he was named to his new post, Qualcomm shares have taken about a 10 percent tumble (along with many other technology stocks) and are down some 25 percent from their December high. Bureaucrats in Korea, Qualcomm's largest market, are grousing about royalty payments for the rights to the company's thousands of patents that have helped make Korea rich. Intel's new wireless enthusiasm "WiMax" is emerging as an anti-Qualcomm cult and the Koreans and Chinese are both buying in. Handset sales are slowing in China, Qualcomm's fastest growing market, and the Republican U.S. Senate, in an attack on American interests worthy of Al Qaeda, has voted 67-33 for a 27.5 percent tariff on Chinese goods. For some, there is also global warming to worry about, and "dangerously" low tax rates. Irwin may even be retiring to do some of that worrying for us. But all the gloom merely enables you to share in Paul's good luck.

Consider a survey of his global domains. The three largest U.S. wireless carriers, with over 80 percent of the market after consolidation, are aggressively rolling out new Qualcomm networks. **Verizon** (VZ) and **Sprint** (FON) already run CDMA2000 networks and are midway through a nationwide release of Qualcomm's EV-DO (evolution data only) for high-speed data services. In December, Sprint bought the fifth largest U.S. carrier, **Nextel** (NXTL), and over the next two years will migrate Nextel's business-heavy customer base from the old **Motorola** (MOT) iDEN network to CDMA. Although the number four U.S. carrier, **T-Mobile**, runs a GSM (global system for mobile) network from old Europe, the new number five company, **Alltel** (AT), which just acquired **Western Wireless** (WWCA), now boasts 10 million CDMA customers. Meanwhile, longtime CDMA holdouts **Cingular** and **AT&T** (T), recently merged and boasting 50 million customers, are completely overhauling their nationwide networks with WCDMA, the *wideband* Qualcomm variant that provides an upgrade path for GSM. Within two years, some 90 percent of the U.S. will be using CDMA.

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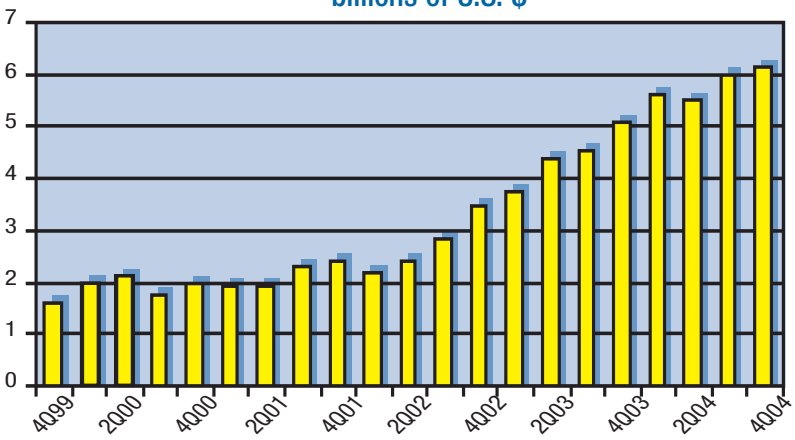
Meanwhile in Europe, after years of delay due to technical snags and debt overhang from 3G (third generation) spectrum auctions, WCDMA is finally making its debut, with about 10 million users on the continent so far and expectations for another 30 million or so this year.

Japan's **NTT-DoCoMo** (DCM) has almost 10 million WCDMA users of its own. Its top competitor **KDDI** has 17 million CDMA2000 users and 2 million more high-speed CDMA EV-DO subscribers. Korea has 33 million CDMA users and more than 10 million EV-DO subs. In China, **China Unicom's** (CHU) CDMA subscribers grew by almost 50 percent in 2004 to more than 28 million, even as its GSM base grew by just 16 percent. China also has its own homegrown CDMA flavor, TD-SCDMA (time division-synchronous CDMA), and three major western telecom companies have partnered with Chinese concerns to build infrastructure: **Siemens-Huawei** (SI), **Nortel-China Putian** (NT), and **Alcatel-Datang Telecom** (ALA). Whatever the outcome of China's ongoing and esoteric technology selection process, Qualcomm is almost sure to benefit.

Although a smaller market than the others and still heavy in GSM, Latin America is actually Qualcomm's fastest growing region for CDMA2000, with sales expected to double from 12 million CDMA phones in 2003 to 24 million this year.

In just three and a half years since the middle of 2001, the number of 3G CDMA users has grown from zero to more than 156 million. As we predicted over and over, no other 3G technologies ever really left the ground, and today virtually all 3G phones are CDMA EV-DO or WCDMA.

Qualcomm expects handset vendors to sell 223 million CDMA/WCDMA phones worldwide in 2005, almost double the total of 117 million achieved just two years ago in 2003. Analysts expect these large unit sales to yield Qualcomm revenues of almost $6.5 billion in calendar year 2005 and more than $8 billion in 2006. Net income could reach $2.1 billion this year and about $3 billion next. Although the company now pays a dividend yielding a little more than 1 percent, its cash hoard of more than $6 billion continues to grow nicely.



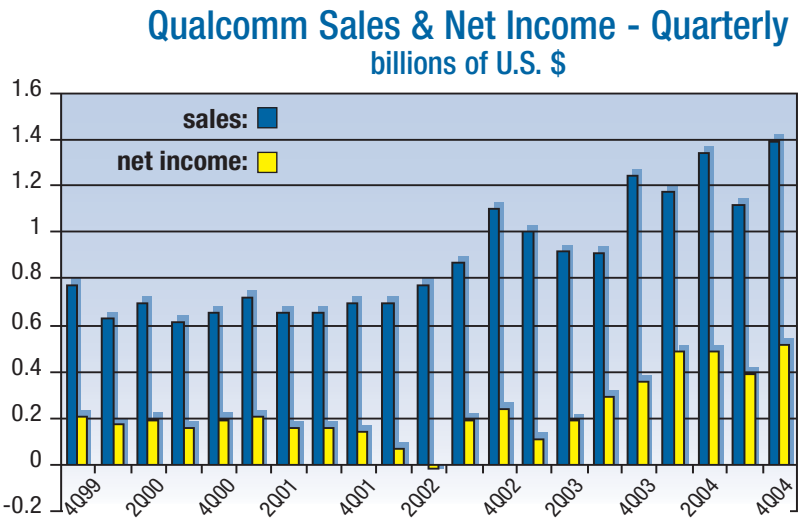
All in all, it's a tough life for Paul. "Here, take this six billion dollar bank account, a couple billion a year in profits, a couple thousand great engineers, a patent portfolio in the thousands and still growing, and try not to mess up." Tough assignment, right?

Offensive action

Actually, Paul Jacobs' job will be tougher than one might think. Many of the challenges he will face are just the opposite of those his father took on. Irwin was an insurgent, in the best sense of the word, fighting the establishment with technological genius, business savvy, and unwavering persistence. To many wireless entrepreneurs, Paul is now the type of establishment figure his father sought to topple, and hundreds of would-be Irwins are swarming, focused intently on the burgeoning wireless market and that luscious stream of Qualcomm profits.

Paul will have to play some defense to be sure, but a better course is to stay on the offense and continue the family's insurgency. Invade **Intel's** (INTC) hegemonic position in computing with mobile CPUs. Break up **Microsoft's** (MSFT) software monopoly with BREW (binary runtime environment for wireless). Disrupt television with MediaFLO (forward link only), the iPod with integrated music players, and the **Sony** (SNE) PlayStation Portable with mobile phone games. For the fourth generation (4G), launch new teleputer technology on integrated devices that combine all these capabilities with advanced imagers for cameras and camcorders. (Why not use **Foveon**?)

Almost no one thought Qualcomm could capture the second generation (2G), but Verizon and Sprint in the U.S. and the Koreans with superior engineering gave Qualcomm its foothold with cdmaOne (IS-95). Then almost no one thought Qualcomm could leverage its still shaky 2G position into a serious 3G lead against EDGE (enhanced data rate for GSM evolution) and GPRS (general packet radio service), the data-kludges assumed to suffice as upgrades for GSM. All wrong. Now, having conceded the third generation to Qualcomm, the entire industry is focused on 4G, and most everyone believes 4G means WiMax.



After beating back the silly notion that Wi-Fi (802.11x) would be an effective competitor to 3G wireless, the WiMax group (802.16x) now claims to bring exotic new technology to bear in the 4G race. It is based on OFDM (orthogonal frequency division multiplexing), which even Qualcomm says is better suited to very wide frequency bands. And as Qualcomm attains the kind of Goliath status previously reserved only for the likes of Microsoft, WiMax has the political and cultural charisma of David's slingshot.

Especially among lefty mayors and university technophiles, WiMax is the analog of open source Linux, virtuous because it supposedly does not dirty its hands with profits, while Qualcomm, like Microsoft, has a proprietary money machine. It's Lawrence Lessig's "free culture" versus Paul Jacobs' profit center.

One key WiMax player, **Flarion**, with the prestigious Qualcomm co-founder and defector Andrew Viterbi on its board, suffered a serious blow when Sprint bought Nextel. Then contemplating a new broadband network using Flarion's frequency hopping Flash-OFDM, Nextel will now become part of the CDMA universe.

Two major metropolitan WiMax projects, in Seattle and Beijing, are the work of small Seattle-based **Adaptix**. Among the twenty or more WiMax and broadband wireless players, Adaptix is generating the most buzz, and probably for good reason. Adaptix is ahead of the WiMax pack largely because it already failed once.

Based around the technical genius of a Chinese scientist named Hui Liu, the company was born as Broadstorm in 2000. Hui Liu was one of the key developers of China's TD-SCDMA standard, which began as a political entry in the 3G game but turned out to be technically robust. After completing work on TD-SCDMA Liu founded Broadstorm to develop and commercialize OFDMA, a version of OFDM that adds a multiple access layer by making more efficient use of OFDM's numerous sub-carrier frequencies. Broadstorm hit the telechasm rocks in 2003 but was brought back to life as Adaptix in the summer of 2004 with a $10 million investment from Baker Capital of New York.

Adaptix says, "We're three years ahead of everybody else because we started four years before everyone else." Other observers say Adaptix might be a year ahead of other WiMax developers, especially when it comes to competing with cell phone systems in their forte: mobility. With perhaps half the patents on OFDMA, Adaptix worked with South Korea to develop that country's "WiBro" (broadband wireless) standard, which is mostly based on OFDMA.

Wireless OFDM uses the same concepts and technologies as wireline DSL (digital subscriber line). Known as "discrete multitone" in wireline, OFDM breaks a wide frequency band into many "sub-carriers," bearing multiple parallel slow streams of data that add up to high-speed flows and redirecting the bits to the highest quality sub-carrier signals. Adaptix systems can utilize either 5 or 10 MHz carriers, breaking them into 512 and 1,024 sub-carriers respectively, and it might build 20 MHz (2,048 sub-carriers) systems in the future.

By contrast, in an effort to fit in with U.S. and other CDMA spectrum planning, Flarion built its OFDM system around the 1.25 MHz carriers defined by Qualcomm as an optimal compromise: "wide" enough for spreading CDMA's codes across the spectrum, but not too wide for existing digital code processing. It also fit the stingy spectrum allocations of most the world's government regulators. But declaring that no 1.25 MHz system can ever be truly "broadband" in itself, Adaptix points out that optimal carrier bandwidth has grown sharply as a result of an additional decade of Moore's law integration advances, with the number of transistors on a chip doubling every 18 months.

To divide the upstream and downstream signals, Flarion relies on frequency division duplexing (FDD), but thanks to Dr. Liu's experience with TD-SCDMA, Adaptix uses time division duplexing (TDD). Like TD-SCDMA, Adaptix's TDD differentiates directions through dynamically adaptable time slots which can be expanded or contracted as needed to accommodate bursts or dearths of data in either direction over time.

WiMax / Broadband Wireless Companies

ADAPTIX
AIRSPAN NETWORKS
ALVARION LTD
APERTO
ARRAYCOMM INC
ARRIS
AXXCELERA
CAMBRIDGE B'BAND
FLARION
INFININET WIRELESS
IP WIRELESS
L3 COMMS (IOSPAN)
NAVINI NETWORKS
NEXTNET WIRELESS
NEXT-G SYSTEMS
PROXIM CORP
REDLINE COMMS
SOLECTEK
SOMA NETWORKS
SR TELECOM
TRANGO B'BAND
TROPOS
VCOM INC
VYYO
WAVERIDER
WI-LAN

Raleigh vs. Rayleigh

As Qualcomm's CTO explains today and as Andrew Viterbi told us in 1994, "Space processing is the last frontier." This means defining the location and directionality as well as the time and frequency signatures of transmitters. On this last frontier, Adaptix is suffusing its buzz of OFDMA with a new sizzle of MIMO (multiple input, multiple output). MIMO is already the basis for a major upgrade of Wi-Fi, known as 802.11n. The new MIMO Wi-Fi will replace the a, b, and g versions and increase the peak throughput from today's 54 Mbps to some 135 Mbps. MIMO uses multiple antennas at both the transmitter and receiver and also multiple OFDM logical data streams in the same spectrum to mitigate multipath fading. One of the chief developers of MIMO, **Airgo** CEO Greg Raleigh, will tell you that MIMO is no mere smart antenna. Via

TELECOSM TECHNOLOGIES

Advanced Micro Devices	(AMD)
Agilent	(A)
Altera	(ALTR)
Analog Devices	(ADI)
Broadcom	(BRCM)
Broadwing	(BWNG)
Cepheid	(CPHD)
Corning	(GLW)
Equinix	(EQIX)
Essex	(KEYW)
EZchip	(LNOP)
Flextronics	(FLEX)
Intel	(INTC)
JDS Uniphase	(JDSU)
Microvision	(MVIS)
National Semiconductor	(NSM)
NetLogic	(NETL)
Power-One	(PWER)
Qualcomm	(QCOM)
Semiconductor Manufacturing International	(SMI)
SK Telecom	(SKM)
Sprint	(FON)
Synaptics	(SYNA)
Taiwan Semiconductor	(TSM)
Terayon	(TERN)
Texas Instruments	(TXN)
Wind River Systems	(WIND)
Xilinx	(XLNX)
Zoran	(ZRAN)

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

Essex (KEYW)

PARADIGM PLAY: "TURPIN'S LAW" – ANALOG OPTICS GALORE

APRIL 13: 15.93, 52-WEEK RANGE: 7.61 – 21.36, MARKET CAP: 334.69M

Energized by Terry Turpin, a genius with analog optics, Essex is projecting another exciting year chasing Bin Laden, interpreting synthetic aperture radar data, integrating multiple battlefield radar measurements into 3-D images, separating the payload from the chaff in antimissile defense, enabling satellites to interpret images in real-time without racks of digital computer boards, and perhaps attempting to transfer the same multi-vector technologies into air and seaport security stations that can actually find explosives without calling in the dogs. Revenues quadrupled to $70.5m in 2004 compared to 2003 while EPS bolted to $0.13 from $0.01. Over the past year Essex raised $87m from a public offering while acquiring, for $83m, three innovators in information security and cognitive computing and mapping, technologies crucial to Essex's continued ascendance.

By our back-of-the envelope analysis, a more than doubling of revenues this year, as Essex expects, could easily triple EPS. Based on that estimate, Essex currently trades at a forward PE of 39, conservative for an embryonic company promising 200% earnings growth. Though it doesn't work widely, optical processing is virtually magical in its niches, and Essex claims much of the field to itself. Thus, look for continued upside surprises not only in defense applications (now 97% of total revenues) but increasingly in commercial uses as diverse as oil and gas exploration and data encryption.

National Semiconductor (NSM)

PARADIGM PLAY: ANALOG LEADER AND IMAGER PIONEER

APRIL 13: 19.36, 52-WEEK RANGE: 11.85 – 24.31, MARKET CAP: 6.76B

CEO Brian Halla's strategy is simple: Focus National's resources on its core analog portfolio. Now his paradigmatic plan has begun bearing fruit. In the February quarter, National nudged gross margin up 2.1% sequential to 52.7% despite flat sales of $449m, low-60s percent factory utilization, and an inventory reduction. In particular, orders for key analog products—power management, amplifiers, interface and data conversion—grew at a higher rate than the company's average. Overall, bookings increased 6% last quarter. In keeping with his analog focus, Halla put National's Singapore test and assembly facility up for sale. The facility specializes in complex, high pin-count (digital) products. A newly opened test and assembly plant in Suzhou, China, supports National's analog businesses along with a facility in Malaysia. In addition, Winbond Electronics of Taiwan has agreed to buy National's Advanced PC division (4% of revenues) with its digital and mixed-signal IP. National's entire PC business currently contributes 13% to company-wide sales, so expect more shedding of that division in the coming months.

With net cash of over half a billion dollars, which includes almost no long-term debt, National is on solid financial footing while trading at a modest forward PE of 20.4 as estimated from management's revenue outlook through May.

Semiconductor Manufacturing International (SMI)

PARADIGM PLAY: MAINLAND CHINA'S BIGGEST SILICON FAB

APRIL 13: 10.01, 52-WEEK RANGE: 9.34 – 15.68, MARKET CAP: 3.65B

China's premier fab swelled 166% last year to almost $1b in sales while turning an operating loss

Sprint (FON)

PARADIGM PLAY: NATIONWIDE CDMA WIRELESS NETWORK

APRIL 13: 23.29, 52-WEEK RANGE: 16.83 – 25.80, MARKET CAP: 34.42B

A Sprint Nextel union, still on schedule for the third quarter, brings both the potent promise of converged technologies and the potential pitfalls of major mergers.

The sum of three businesses, each with different prospects and valuations, Sprint is best known today for its wireless unit. Sprint PCS was the first company to commit fully to CDMA for a nationwide network. Today, a buoyant wireless business masks chronic declines in Sprint's local and long distance units. Though revenues are still shrinking from Sprint's long-distance and global IP networks, they continue to generate cash as the company nurses them along with administrative prunes, sells the wholesale dial-up business to Level 3, and makes wholesale service agreements with Time Warner, Comcast, Mediacom, and Charter. Least attractive are Sprint's local wireline assets (copper wires to homes and businesses), which show losses approaching 3% annually.

The leaching of local is actually good news for Sprint, because wireless displacement of wireline service is driving growth of Sprint PCS in the U.S., particularly among America's youth, encouraged partly by attractive family plans. Sprint's wireless service revenues (excluding equipment sales) increased 14% last year and average revenue per user firmed at about $62, almost 10% of which came from data services, the highest in the US industry and likely an early sign of the success of Sprint's new EV-DO data

MEAD'S ANALOG REVOLUTION

NATIONAL SEMICONDUCTOR (NSM)
SYNAPTICS (SYNA)
SONIC INNOVATIONS (SNCI)
FOVEON
IMPINJ
AUDIENCE INC.
DIGITALPERSONA

COMPANIES TO WATCH

ADAPTIX
AMEDIA (AANI.OB)
ATHEROS
ATI TECHNOLOGIES (ATYT)
BLUEARC
COX (COX)
ENDWAVE (ENWV)
FIBERXON
LINEAR (LLTC)
LUMERA (LMRA)
ISILON
LENOVO
MEMORYLOGIX
NOVELLUS (NVLS)
POWERWAVE (PWAV)
SAMSUNG
SEMITOOL (SMTL)
SIRF
SOMA NETWORKS
STRETCH INC.
SYNOPSYS (SNPS)
TEKNOVUS
TENSILICA
VIA TECHNOLOGIES
XAN3D

of $73m in 2003 to a profit of $82m. According to IC Insights, SMI's global market share increased 3%, besting all other foundries worldwide in 2004. Bucking a slumping industry, revenues grew 6% in the fourth quarter, aided by 19 new customers and an increase of 15% in wafer shipments. Fab utilization remained strong at 95% of a rapidly expanding capacity. With over 463 fabless semiconductor companies and design centers in a nascent China, SMI's prospects look bright; currently, the mainland accounts for only 10% of sales. Preparing for that future, the Shanghai foundry spent $2b last year on capital projects and plans to spend another $1b this year to further grow both 200 mm and 300 mm capacity while beginning production in the cutting-edge 90-nm process. But with the expansion will come near-term growing pains, which began last quarter as gross margin dropped sequentially from 26.4% to 20.3% and operating expenses rose 175%, resulting in a return to operating losses which will continue at least into the current quarter when gross margin is expected to further plummet to the low single digits as wafer shipments, average selling price, and fab utilization all decline.

Causing the pain are a less favorable product mix, including a decline in DRAM pricing, an inventory charge, 90 nm development costs, increased depreciation expense, and costs for ramping Fab 4. Last quarter alone, current net cash dropped sequentially to $67m from $233m. With the cash-burn furnace still hot, be alert for short-term liquidity issues. The stock currently trades at an enterprise multiple of 4.2x last year's sales.

Taiwan Semiconductor (TSM)

PARADIGM PLAY: WORLD'S LEADING MICROCHIP FOUNDRY

APRIL 13: 8.52, 52-WEEK RANGE: 6.60 – 9.89, MARKET CAP: 39.6B

Taiwan Semi must have read the script from Gartner's Dataquest division. Or was it the other way around? According to Dataquest analysis, worldwide foundry utilization and sales bottomed in the March quarter and should begin recovering. Meanwhile, TSM reaffirmed its earlier guidance of a sequential decline of 13% in first quarter sales along with a slide in gross margin to 39% from 42.5%. As reported in the February GTR, the largest pure-play foundry is busy buying its return ticket to growth, with plans to boost capital expenditures this year by 8% to $2.6b in a bid to grab a glob of the 90 nm market and further embrace 300 mm manufacturing efficiencies. Still in its early stages, revenue contribution from advanced technology had already swollen to 36% last quarter. TSM currently trades at a PE (estimated through March) of 14.7.

network. In addition, Sprint offers cells some 25,000 times larger than a Wi-Fi access point "hot spot." In the wireless paradigm, serving teleputer camcorder phones everywhere, ubiquity is critical. With broadband coverage over the entire continent, Sprint is making the entire nation a hot spot.

Overall, Sprint revenues rose 4.7% to $27.4b in 2004, with wireless increasing 15.4% to $14.6b as wireline sales slid 5.6% to $13.3b. Excluding one-time items, EPS was $0.93. On the other side of the aisle, Nextel revenues rose 23.5% to $13.4b with an EPS of $2.62, and all-wireless Nextel brings to the union an even higher revenue per user at $69. The companies are expecting $12b of post-merger savings due to economies of scale. Both businesses are already generating cash after capital expenditures—$4b last year. At the end of 2004, Sprint claimed 9.8% of U.S. wireless subscribers and Nextel 8.3%, for a total of 18.1%, compared to Cingular's 27.2%, Verizon's 24.3%, T-Mobile USA's 9.6%, and the remaining regional operators at 20.7%. In addition to the typical headcount, administrative, and operational synergies, substantial savings may come from more efficient capital spending. Combined with the Sprint CDMA digital network, Nextel can more easily upgrade its Motorola iDEN network, which lacks voice capacity and cannot do high-speed data, increasingly crucial to the data-hungry business users who are the foundation of Nextel's subscriber base.

Should Sprint move ahead with a plan to sell its 6,300 cell towers, it could pocket up to $1.5b pre-tax. Sprint also plans to spin off its local access unit in early 2006, and departing with it could be a substantial portion of Sprint's debt. The merged company may not be a cash taxpayer for a couple of years due to net operating loss carry-forwards. Yet another upside could be the use of 2.5 GHz MMDS (multichannel multipoint distribution service) spectrum for future wireless broadband service offerings. Sprint and Nextel are by far the two largest owners of MMDS spectrum, with licenses covering 85% of the top 100 markets. Deployment of broadband wireless networks in the MMDS slot has so far been disappointingly slow, but the unification of these disparate licenses could be portentous.

Nextel brings to Sprint one of the lowest churns in the industry, at 1.6%. Churn—the percentage of total subscribers who drop out during a quarter—has been a persistent problem for Sprint wireless, where churn remains above the industry average at 2.7%. To keep customers from sliding out, Sprint is pushing more subscribers toward 2-year plans and improving customer service and network quality. To reduce involuntary churn, Sprint must improve the credit-worthiness of its subscriber base. Currently, 25% of subscribers are "subprime," and the red tide is swelling, with about 40% of new customers falling into the subprime space. Another trouble spot involves the Nextel Partners affiliates. The merger will cause Nextel to breach its affiliate agreement, triggering a payment to the Partners of perhaps $5.7b depending on the results of an independent evaluation. The payment could be made in cash or stock, either at the time of the merger or over a year and half period following. Sprint has some 12 affiliates, but unlike Nextel Partners, the merger will not likely create a breach, and the new company could acquire those affiliates via stock or cash.

Though "Sprintel" looks like an overall telecosmic positive both financially and technologically, mega-mergers are administratively daunting, and different corporate chemistries often react rather than mix. With arbitrageurs hard at work turning Sprint and Nextel into trading twins, we find to no surprise that they are on sale at almost identical enterprise values, when compared to free cash flow, with Sprint trading at 21.5x and Nextel at 22.8x last year's free cash flow for a combined Sprintel multiple of 22.1x. If you are comfortable answering questions such as, How much will Nextel Partners "put" it to Sprintel? … How much of Sprint's hefty $15b of long-term debt will go with local access (if they can sell it)? ... Will Nextel successfully upgrade its network? … and if you can envision with reasonable confidence a Sprintel balance sheet, you may want to invest now at this reasonable valuation, using to your advantage your telecosmic smarts, which presumably few arbitrageurs possess. Otherwise, as with many IPOs, you may want to buy in after the dust settles.

– Charlie Burger

special space-time codes, it uses multiple signals in the same frequency to deliver more spatial information and thus more throughput.

These systems take advantage of "multipath," multiple "copies" of a single signal bouncing off walls or trees to arrive at a receiver at different times and angles, often causing destructive interference effects called Rayleigh "pits" and potholes. Crude forms of MIMO may have existed since the 1970s and Emre Telatar of Bell Labs wrote seminal papers in the early 1980s. But starting in 1996 at Stanford, Airgo's Greg Raleigh proposed to exploit multipath as an opportunity. Working with DSL expert John Cioffi (see more on Cioffi and his new DSL company, **ASSIA Inc.**, January 2005 *GTR*), Raleigh proposed deliberately multiplying the multipath by transmitting more than one signal in the same frequency to add spatial information at the receiver. Because of the intense computing needed to process the extra data in the space-time codes, MIMO is just now being commercialized in 802.11n. Using Airgo's chipset, **Belkin** is the first Wi-Fi router and card maker to debut a MIMO product. Because the "n" standard is not yet ratified, Belkin preens as marketing a "pre-n" system, but it has handily outperformed existing non-MIMO Wi-Fi routers and cards, delivering data speed increases of 50 percent or more.

Adaptix says that adding MIMO to its system doubles both downlink and uplink data capacity, increasing its 5 MHz non-MIMO downlink from 10 to 20 Mbps, for instance. Using an asymmetric allocation of the resources, the company can also increase the MIMO-enabled downlink to 30 Mbps in exchange for a slower uplink.

Adaptix benefits from wi-fiddles and fibberdoodles from politicians pushing so-called "muni-nets" from Philadelphia to New Orleans to Chaska, Minnesota. After driving a thousand companies into telecom bankruptcy, governments now find the coast sufficiently clear for new entry into the telecom business. One Indiana Republican state senator wants to cover the entire state, cornfields and all, with a "WiMax cloud." He's holding up a mild telecom deregulation until he gets his backwoods megabits.

Qualcomm rivalry

In any case, Seattle's high-profile municipal network will employ five 3-sector Adaptix base stations stretching from north Seattle to the SeaTac Airport. Meanwhile, Beijing Airway Communications is covering Beijing's ShiJingShan District with an Adaptix system that will serve the new Digital Entertainment Demo Center being established by the Beijing Science & Technology Committee. Adaptix is also supplying wireless cards for 1000 PCs at a conference in Korea in the fall.

Tropos Networks, headed by the able and articulate Ron Sege, with Reed Hundt bristling on board, is fighting efforts across the nation to block these public networks. Wi-Fi is feckless as a wide area networking solution, but at the Telecosm conference, Sege showed that Wi-Fi mesh networking might cover downtown spaces, with the antennas on telephone poles and parking meters. Tropos is technically satisfactory and politically brilliant and appears to be doing well marketing to mayors and economic development consultants.

But as we have said for almost four years, all the exciting ingenuity of Adaptix or Tropos or **Soma Networks**—or even Intel itself—fails to pose a serious threat to Qualcomm. Korea may be using WiBro (broadband wireless) as "a club," as one WiMax enthusiast put it, to beat Qualcomm over the head over its royalty stream, but this exercise cannot negate the huge mutual gains from the Korea-Qualcomm partnership. And Adaptix is stuffing the envelope with multiple technologies that seem to trump Qualcomm in mobile broadband data. The Adaptix MIMO system might someday deliver data speeds almost twice those of WCDMA or of Qualcomm's best current offering, EV-DO Revision A (3.1 mbps), and handle a stunning 7 to 10 times the number of users in a given sector. But this projection assumes that CDMA stands still, forgoes bonding together groups of EV-DO streams in new integrated devices, and fails to adopt CDMA enhancements such as Terry Turpin's OPERA, a noise-nulling process from **Essex** (KEYW) (which Qualcomm might be able to duplicate in silicon as Moore's law advances).

Qualcomm has its own roadmap. From the beginning, the company pioneered phase compensating "rake receivers" that buffer and recombine as many as three signals. Qualcomm is now enabling further transmit and receive antenna resources in its handset and base station chipsets, with new dual- and quad-diversity chips doubling voice capacity versus the first generation of CDMA2000 and quadrupling capacity compared to cdmaOne (IS-95). Little noticed was a statement in a Qualcomm release about its two new multimedia delivery systems, EV-DO Platinum Multicast and FLO. "Qualcomm has been working on multimedia enhancements for more than eight years," said Steven R. Altman, the new Qualcomm president. "The Company has approximately 200 issued or pending patents relating to these enhancements and to applications of OFDM, OFDMA and MIMO (multi in, multi out), making Qualcomm one of the most active companies in this space." Indeed, the new MIMO form of Wi-Fi, 802.11n is partly based on intellectual property from a Qualcomm MIMO local area network project begun in 1997. CTO Roberto Padovani believes that MIMO's fortes are downstream multimedia and local area networks, not the mobile data systems that are now being touted by competitors. In general, these OFDM/MIMO combinations need high-signal-to-noise, lots of bandwidth, and a rich multipath environment. These conditions prevail among walls and obstacles indoors in wireless LANs operating at 2GHz and above but dwindle in a wireless arena with ubiquitous coverage, point-to-point links from towers, and crowded spectrum assignments.

Is MIMO for real?

"It sounds like the war of peak data rates is heating up in Japan," said Dr. Roberto Padovani, CTO of Qualcomm. George Gilder was relating news from his latest Far East trip, where certain Japanese mobile executives were touting performance claims of 4G equipment hopefuls, who in turn were touting WiMax and MIMO (a new multi-antenna technology that can be incorporated with WiMax to deliver bigger throughput).

Some think the Japanese talk of WiMax and the Korean flirting with cousin WiBro is in part marketing machismo. The two big Japanese mobile providers, DoCoMo and KDDI, for instance, must constantly outdo the other's claims of network speed. And MIMO allows them to talk big. MIMO systems supposedly will yield data rates two or three times higher than today's single antenna technologies.

Are these claims true? Is Qualcomm doing enough to keep up?

Dr. Padovani, who joined Qualcomm at its founding in 1986 and is a chief developer of Qualcomm's EV-DO high-speed data technology, offers a broad perspective. "Time and frequency have been conquered," he says, referring to two domains that have been squeezed dry of most all potential capacity gains. "The next area is space processing."

That's why at Qualcomm's request, all KDDI phones now have two receive antennas that exploit spatial diversity, using the extra information that is imparted from the phase, angle, and time of signals arriving at close but distinct locations. Qualcomm also has been pushing all its operators to put four receive antennas in their base stations to leverage spatial diversity on the uplink.

MIMO goes further, using not just multiple receive antennas but also multiple transmit antennas, from which two or more distinct logical signals are sent. "The theory of MIMO is well established and elegant. It holds water," says Dr. Padovani. "What is much less understood is the practicality."

MIMO's very real advantages only hold if two important conditions are met. First, MIMO likes a very rich scattering environment—lots of walls and objects off of which to bounce its signals. Second, MIMO needs "well-defined channels" which means high signal-to-noise ratios. These two conditions are met most obviously in offices and homes, where multipath bounces are many and there is little interference, or noise, from the outside. The first MIMO implementations are thus arriving in Wi-Fi local area network products, which do show substantial throughput gains.

Although Padovani says there is great potential in MIMO and that Qualcomm has been working on it since 1997, he believes MIMO's applicability in larger cellular systems is less obvious. There is less multipath scattering in the great outdoors—in fact, MIMO offers zero throughput increase if there is line-of-sight—and the frequency reuse patterns of the carriers mean signal-to-noise ratios are fairly low. What's more, to access MIMO's theoretical power, you probably need four transmit antennas, which may be possible on a notebook PC but is almost impossible on a tiny handset operating at 2GHz. The astounding data rate claims of WiMax systems using MIMO are theoretical, not real world.

OFDM does offer some advantages on the downlink of wide-band systems, and it also makes implementing MIMO easier. Qualcomm in fact is using OFDM in EV-DO and FLO and is even talking of logically binding up to 15 EV-DO carriers together to offer data rates of 46 Mbps if some carrier can find a spare 20 MHz frequency band.

But on the uplink CDMA still trumps OFDM. To maximize CDMA's theoretical power, which comes from all users transmitting at the same time across the entire frequency, Qualcomm over the next few years will be using interference cancellation to null out all unwanted users and signals. This has been the idea behind Essex CTO Terry Turpin's OPERA system, which uses analog optics to sift through the dense correlations. Moore's law may allow Qualcomm to achieve the same feat with digital electronics by 2008.

—Bret Swanson

In any case, rivals should not imagine that Qualcomm is an intoxicated monoculture of CDMA. Although Adaptix claims amazing performance for its MIMO solution, its non-MIMO system is actually less capable than Qualcomm's EV-DO Revision A, and Qualcomm's offerings will be improved as it employs MIMO and other enhancements in appropriate ways.

For those worried about Qualcomm's valuation of $53 billion even after a 25 percent drop, we point to some commentary by Deutsche Bank's Brian Modoff: "We are currently estimating they will report $1.60 in FY06 EPS, which gives us a 22x PE, while the consensus estimate of $1.46 yields a 24x PE. Even if we assume that the Street is right, QCOM would still be trading at a discount to **Circuit City** (CC), **Walgreen**'s (WAG), **Visteon** (VC) and the **Plum Creek Timber Company** (PCL)."

Carrier Interference

As is so often the case, Qualcomm's biggest challenges may come from its best customers. On March 9, Qualcomm CFO Bill Keitel, while in New York at a Deutsche Bank conference, identified a key concern. 3G data prices are too high, he said. The U.S. and Europe will never see the kind of 3G uptake that has occurred in Korea with today's prices. Keitel did say that Verizon's pricing for its new VCAST service, which sends prepackaged video clips to EV-DO users, is a step in right direction.

Verizon, however, remains the worst offender. Its pricing strategy department seems never to have learned about the experience curve, demand elasticity, or even revenue maximization. If they keep it up, they will have the best U.S. network with no customers. EV-DO data costs $80 per month. Basic data at less than 100 kilobits per second costs $45 a month (versus just $10 at Sprint). Try downloading a ring tone to your sleek new LG Verizon phone, and the pricing will confuse. The website says $9.99 for four (4) uses. Surely that doesn't mean it costs $2.50 every time your phone rings! Yep. No wonder U.S. wireless data revenues dramatically trail foreign data revenues.

Consider switching to Verizon from Sprint because of much better coverage at your house and most everywhere else, but the Verizon pricing model is a severe deterrent. You probably will stay with Sprint. Verizon would make more money on photos and ring tones charging one one-hundredth of what it does today.

When Sprint initially came out with Vision (1xRTT basic data) it tried to charge large sums per megabyte downloaded to phones. In Kansas City for an analyst preview before the Vision launch, I told them this strategy would fail. It did. And to Sprint's credit, Len Lauer came in and quickly changed the policy to $10 flat rate pricing. I don't use my data service all that often, but I pay the $10 because I never know when it will come in very handy. I would not pay $45 per month for the same occasional usage.

Verizon also tries to lock users into Veriz-only content and discourages connecting devices and moving content to and from your phone. AOL learned that AOnly content paled in comparison to the long-tail Internet. Verizon should not pretend it has all the answers and good ideas. It should provide a fairly open platform. Its own proprietary integrated applications and services—enabled by Qualcomm's BREW operating system, by the way—will still work better than most web-based apps, and will thus be attractive to users, but the company should not drive customers away by prohibiting outside content, apps, and connections.

Get with it, Verizon. Don't ruin a good thing.

Although Sprint has been plagued by too many "subprime" customers, it has been reducing the rolls of undesirables, and more importantly, its Nextel acquisition brings a large contingent of business customers, aka people who pay their bills every month. And large bills they are. Sprint already boasted a strong ARPU (average revenue per user), and Sprint-Nextel will have the highest ARPU in the industry. The merger also will enhance Sprint's famously spotty coverage, though like most carriers, Nextel's mostly urban, suburban, and Interstate presence still won't do much for cornfield senators. As the company divests most of its local wireline holdings, it will become the largest pure wireless play in the U.S. and thus an attractive investment for those who believe the industry will continue to grow.

The Koreans have matched their dominance in deploying bandwidth with dominance in deploying their mobile phones to hands all over the world. Last year one quarter of mobile phones sold were Korean. In 2005 that number is expected to reach 30 percent. **Samsung** overtook Motorola for the number two market share spot last fall, only to see Motorola snatch the spot right back in December. But Samsung is vastly more profitable than Motorola. Motorola earns about the same share of profits as its share of unit sales. But Samsung has nearly double the share in profits as in units. Nokia after stumbling the last few years has regained market share momentum, moving back above 30 percent, and is just about as profitable as Samsung. LG has rocketed up the mobile phone ladder and is the number one CDMA phone in the U.S. Its share of profits match its unit sales. LG wants to be the number three mobile phone company in the world, and after seeing their phones, I don't doubt they will achieve it. The rest of the mobile industry gets by on very thin margins.

— Bret Swanson, with George Gilder,
April 13, 2005

Got Questions?

Visit our subscriber-only discussion forum, the Telecosm Lounge, with George Gilder and Nick Tredennick, on www.gildertech.com

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