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The VDSL2 Silicon Slalom

In recent months, Ikanos has become an even better company, and upon closer inspection its original technology looks more on the mark than it seemed at first blush.

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"Is Ikanos still a good deal?"

It had been a pretty good day until George asked me the inevitable. **Ikanos**'s (IKAN) market cap for its business of advanced digital subscriber line (DSL) chips had just surged to another new high and was up a whopping 79 percent since joining our Telecosm list eight weeks earlier. Let's see, that's a rate of 3,200 percent per annum. A 33-bagger.

So I looked him straight in the eye: "George, you'll never get a 10-bagger if you sell it as a two-bagger."

Well, maybe that's what I *should* have said. After all, that was George's sage counsel a day earlier to our savvy readers on our "Telecosm Lounge" subscriber message board. The key rule, he said, "is don't get discouraged when your investments go down (nearly all of them will) and sell only modestly as they go up (some of them will go up higher than you think possible)."

Hide your Chicken Little helmets and Fred Hager hedges, hold onto your hats and

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FEATURED COMPANY: Broadwing (BWNG), From PIPE to Pipeline

Where are the shares? Over a year ago, when Broadwing was routinely paying its quarterly installments on the dreaded $225m convertible notes (known as a "private investments in public equities" or PIPE transaction), my forecast was to brace yourselves for 100m shares in the kitty when the bleeding ended. That's one bad forecast I'm happy to talk about. Last week CFO Lynn Anderson made half of the final payment in cash and half in stock, and based on the price of Broadwing shares over the previous 20 days, we estimate that about 2m shares were added, bringing the total diluted count to some 76m.

Wow. I really *did* blow it. Thankfully. A good bit of my dilution illusion came from the wrong focus. I was looking for the mega contract wins that would take Broadwing home. Well, none showed up and, consequently, Broadwing *isn't* home yet. But in the meantime they saved a million here, earned a million more there, and gradually it turned into real money—enough to pay a good bit of the converts in cash and end up with a liquid current ratio of 1.4 in December, down only slightly from 1.5 in the year-ago quarter, and a quick ratio of 1.2, down from 1.4. The only debt now on the balance sheet is approx $20m in long-term capital leases.

Just as encouraging, cash flow from operations for 2005 *almost* broke even, missing by only $1m compared to a loss of $112m the previous year. After factoring out improvements in cash flow that resulted from more efficient use of working capital, we find that Broadwing lost $59m running the network itself. That's only half of the loss shown on the income statement, which was weighed down by Anderson's aggressive depreciation of some of Focal's assets.

Broadwing's slow but steady progress came from upgrades, grooming, and architectural improvements in the network; integration of the Focal network; leveraging of Focal's sales and administration resources; and increases in traffic volume that more than offset price declines. December marked the ninth consecutive quarterly rise in data, Internet, and broadband sales, up 4.4% sequentially and 14.8% over last year's quarter and contributing 56% of revenue. Growth came from virtually all broadband products, but especially from sales of high-speed broadband transport to other service providers and large enterprises.

Local and long-distance voice services, including VoIP, contributed the remaining 44% of Broadwing's

revenue for the quarter. Local voice sales slipped 2.4% sequentially, mainly because of the December holidays, and grew 6.1% over last year due to new customers. Similarly, long-distance revenues fell 5.1% sequentially because of the holidays. The more substantial 20% plummet since the previous December reflected falling prices for traditional voice products and loss of business due to a margin-motivated decision to increase wholesale voice pricing.

Significant in the face of pricing pressure throughout 2005 was the 15% improvement in networking gross margin, increasing from 30.9% to 35.5% as a result of new customer agreements, a shift in the product mix to higher-margin local voice revenues from long-distance voice, and the aforementioned network upgrades. Meanwhile, as the networks were being integrated, Broadwing moved forward developing new products such as converged, VoIP, media, and managed services—*all* for only $11m in capex.

With the new services in place, Scott Widham, head of sales and marketing, has been aggressively pursuing sales to enterprises and large business in the 23 local markets across the country where he can offer a full package, including local voice. It was apparently Broadwing's voice coverage that helped him secure the Lufthansa deal, announced last week, to provide the German air carrier with voice services in over 40 locations throughout the US. In January, Broadwing and Hong Kong–based Hutchison Global Communications established the first trans-Pacific Ethernet network in a partnership that extends Broadwing's converged services into Asia and Hutchison's into the U.S.

Currently, most customers are testing the waters on the layer 2 and layer 3 converged products, coming initially for trials before moving their entire legacy networks over to Broadwing. Even so, the converged network has been growing steadily and Widham reports that customers are becoming increasingly interested after getting their feet wet. Industry consolidation is creating yet more opportunities. Carriers and enterprises, both here and abroad, have been telling Widham that they want to use Broadwing as a second source in an industry where their choices have been dramatically reduced. All told, Widham's bullish about his sales pipeline.

The consolidation is also helping to stabilize pricing. Many providers say that pricing pressures are easing already this quarter, and they, along with Broadwing, are raising rates for the high bandwidth services increasingly demanded by enterprises burdened with data and the need for new services. Also ascending are wholesale voice prices, which Broadwing is raising across the board.

With founder David Huber having recently resigned from his CEO post while keeping his chairmanship, Widham, Anderson, and Kim Larsen (general counsel) have been appointed by the board to oversee the business. The triumvirate has already begun moving corporate headquarters to Austin, where Broadwing operations are concentrated. As a result of the consolidation, some 35 people will leave the company, slimming headcount to about 1,600 and reducing overhead by $4m annually after restructuring charges of about $2m.

The board has hired an executive search firm to look for a new CEO. Reportedly there are a number of "strong" candidates, both internal and external, in whom the board is interested. (If Widham is one, he had a good "interview" during the call.) The board's pick should tell us a lot about where they want Broadwing to head, and we await the decision with great anticipation. For certain, the new CEO will have everything in place for success: network and operations streamlined, pipelines stuffed, products first-class, prices firming.

Sound like a Broadwing commercial? Well, it isn't. Remember this, please … Broadwing *isn't* home yet. They've only boarded the plane. To fuel a takeoff, they *still* need some of those big wins I've been looking and looking and looking for—or an exponential engorgement of smaller and mid-sized accounts. Commendably, Broadwing operations broke even in December before non-cash charges, and will certainly move north of that this quarter. But this is a capital intensive business; without a well maintained and equipped network, there is no Broadwing. Last year Anderson spent about $44m or 5% of communications revenue on maintaining the network and turning up circuits for new customers. With all of the new products rolled out and the network integrated and streamlined, Anderson believes capex will be limited to that 4–5% range going forward.

Which means, quite simply, that Anderson needs to shave more than 5% off of cost of sales and administrative overhead before he comes clean. Minus guidance on the network's incremental margins, we must conclude, based on the heroics needed to attain a gross margin of 35.5%, that they are still a long way from rush hour. Thus, placing a current value on the company is problematic. However, a free-cash-flow positive Broadwing should certainly be worth two times sales ($24 based on today's revenue stream) or more, depending on how much cash spills over the 5 percent barrier. Until then, we need to see progress toward that end and not get hung up on today's price, which will likely change dramatically once Broadwing's die is cast.

– Charlie Burger, March 1, 2006

(CONTINUED FROM PAGE 1)

your stocks, folks, and let's go hunting. In five years we'll all be millionaires.

Nah, George, that's too EZ. What about the four-baggers that sink to half baggers, like **Synaptics** (SYNA), or decompose to garbage baggers, like Global Crossing? Okay, I'm only being half fair to George, who also reminded us that "in a high risk arena like technology," the less risky potential doubles on our list, such as **Intel** (INTC), **Corning** (GLW) and **Qualcomm** (QCOM), will "compensate for the number of losers that are inevitable" when you swing for 10-baggers without carefully counting the financial bases "in a high-risk arena like technology."

I am the one who is supposed to do the counting and bring the bad or good news about the finances of our technology longshots.

George's advice on not selling too soon gets at least some support from academia. As early as six years ago, Terrance Odean reported in *The American Economic Review* (December 1999) that investors with discount brokerage accounts trade far too much; their newfound securities, on average, underperform those they sell. He concludes that these investors must be systematically misinterpreting information.

In our telecosmic universe, the *GTR* attempts to steer you

clear of such systematic errors by sticking to paradigms and listening to the technology while ignoring the short-term gyrations—unless they are signaling potential paradigm adjustments.

For instance, Telecosm Lounge stalwart and astute analyst Jim Mullens warns us of an impending downward gyration of **Broadcom**'s (BRCM) share price, recently buoyed by a succession of upsides which though predicted by us seem to have surprised almost everyone else. Jim warns us that huge stock options expenses, to be reported beginning this quarter in compliance with the new accounting rules, could gouge Broadcom's earnings. If the accounting police succeed in rattling investors, expect a swift sell-off and fulfillment of Jim's warning. Indeed, with the stock having fallen at one point almost 12 percent from its 8 February peak, the descent may have already begun.

But this gyration doesn't signal a paradigm problem, and we stand by our latest analysis (see the Gildertech.com Subscriber Homepage) that Broadcom remains well focused as we approach the age of the fabled teleputer and *Life After Television*. Regardless of how the political spitzers and sarboxers and "stockholder defenders" at GAAP, Congress, and the SEC huff and puff to the contrary, as they try to persuade investors to put their money in state lotteries instead, there is no way that the value of stock options to a recipient is a cost to a company. Now racing at 10 percent per year, stock dilution has long been a fact of life at Broadcom, as we have noted before. But compensating for the possible cost to diluted shareholders may be improved employee loyalty and focus at the company. For the last several years, given a certain bubble era give-and-take, Broadcom stockholders have had no reason to complain. Meanwhile, free-cash-flow (mushrooming) and the balance sheet (robust) will become even more critical in assessing the company's financial footing. Of more consequence than options is the distracting and potentially costly 3G suit with **Texas Instruments** (TXN) and Qualcomm.

Then there's a gyration at **Advanced Micro Devices** (AMD), off 5 percent at the opening bell the morning after **Dell** (DELL) CEO Kevin Rawlins announced during his company's quarterly call that he has no plans to use microprocessors from AMD. Could be a negotiating tactic. But no matter, a much bigger threat to AMD could come later this year when archrival Intel introduces its new Merom core, which may begin to push the price-performance advantage back to Intel even as the chip titan increasingly leverages its quadruple play trumps: massive manufacturing capacity, waferfab technological supremacy, a Moore's law lead, and a swollen war chest.

The price war we foresaw while ruminating over the whys of Intel's forecasted weakening gross margin (see analysis on Gildertech.com) may begin in earnest come spring, when Intel plans to cut prices on dual-core desktop processors up to 50 percent. Meanwhile, AMD is reportedly swinging its own sword, slashing prices on Opteron dual-core server processors by up to half, on dual-core Athlon 64 X2 desktop processors by up to a fifth, and Turion 64 notebook processors by up to a third. Ouch. Don't let the Dell reel divert your focus.

Ikanos is another case where a focus on the stock price might lead investors astray as the company makes crucial strategic moves to cement its dominance of the field. Two months ago, we thought the company had the DSL technology and valuation to give it good downside protection against the coming competition in the germinating VDSL2 (very high bit rate digital subscriber line) market. In recent months, Ikanos has become an even better company, and upon closer inspection its original technology looks more on the mark than it seemed to George at first blush.

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So instead of getting distracted by the gyratory jump in its price and anchoring our evaluation in the past, we need to parse Ikanos's paradigm edge anew as demand takes off for broadband chips.

To gauge the Ikanos opportunity, imagine this conversation with your wife about four years from now: "Honey, please, you simply *can't* watch the news now. The game starts in five minutes and it's in high definition." It's just what the various telcos deploying new broadband systems *don't* want to imagine. The kicker for broader bandwidth is the coming high-definition (HD) multimedia era. Using existing MPEG2 compression familiar in cable or satellite systems, HDTV requires about 20 megabits per second (Mbps). With the onset of MPEG4, it requires 10 Mbps. Standard TV requires 4 Mbps, Internet data up to 6 Mbps, low-end gaming 1 Mbps. And although voice over Internet Protocol (VoIP) adds a trifling 64 kilobits per second (kbps), it imposes strict latency requirements so your mother-in-law doesn't think you hung up on her. With your wife watching the unfolding election returns, your daughter videoconferencing with her sister in college, your son gaming with his high school buddy, and your brother sending a video clip from his trip to Shanghai, suddenly DSL stands for *dumb slow line* … when you want to keep your mother-in-law on the subcarrier circuit while the Bruins game is on.

Competing with cable modem technology and with fiber to the home and curb (FTTX), DSL is the way the phone company delivers millions of bits per second of broadband over its existing twisted pairs of narrowband copper wire that were made to carry 4 thousand hertz (kHz) of voice signals. The inherent difficulty of this feat is often underplayed in this age when technology conferences often imply that it is

Advanced Micro Devices (AMD)
Altera (ALTR)
Analog Devices (ADI)
Broadcom (BRCM)
Broadwing (BWNG)
Cepheid (CPHD)
Corning (GLW)
Energy Conversion Devices (ENER)
Equinix (EQIX)
Essex (KEYW)
EZchip (LNOP)
Finisar (FNSR)
Flextronics (FLEX)
Ikanos (IKAN)
Intel (INTC)
Microvision (MVIS)
National Semiconductor (NSM)
NetLogic (NETL)
Power-One (PWER)
Qualcomm (QCOM)
Semiconductor Manufacturing International (SMI)
Sigma Designs (SIGM)
Sprint Nextel (S)
Synaptics (SYNA)
Taiwan Semiconductor (TSM)
Texas Instruments (TXN)
Xilinx (XLNX)
Zoran (ZRAN)

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Analog Devices (ADI)

PARADIGM PLAY: ANALOG EVERYWHERE & SOFTENING RADIOS

MARCH 1: 39.20; 52-WEEK RANGE: 31.71 – 41.48; MARKET CAP: 14.35B

Still a bit of a blur, Analog Devices is coming into better focus with the sale of its digital signal processor or DSP-based DSL business (Fusiv line) to Ikanos. We have been advocating for some time that this premier analog company should take the **National Semiconductor** (NSM) approach to excellence: Refocus on higher-margin analog products and sever non-core digital in order to keep up with **Linear** (LLTC), **Maxim** (MXIM), and National Semi as a leader in analog semiconductors.

In the January quarter, revenue increased 7% over the year-earlier quarter to $621m, driven by an 11% increase in analog sales, now 82% of total revenue. Analog growth offset a 9% decline in DSP products, now 18% of revenue. But "general-purpose" DSP products, which represent 7% of total revenue, grew 19% over the previous January. This will likely encourage ADI along its current path toward a restructuring of digital into higher-margin products, where they will compete with the likes of **Texas Instruments** (TXN) and **Freescale** (FSL), rather than redirecting the entire company toward higher-margin analog, where ADI employs a goodly share of the world's scarce analog design talent.

Why compete with TI when you don't have to, and when you are struggling to turn around your PC segment where sales have declined 7% since last year? In particular, ADI is trying to make headway into portables from the slower-growing desktops where it still sells a good share of its power management products. Also taming the company's growth is the communications unit where sales were almost flat with last year. Thriving are consumer electronics, up 18% on strength in digital cameras, flat screen TVs and monitors, and a cornucopia of stereo and home theater sound systems. Also healthy are industrial products for test equipment, automotive, medical, and defense that grew 16%.

Digital or no, ADI is still a good investment at the current price. Operationally, the company is in the process of closing its California manufacturing operations to consolidate plants in Ireland and Massachusetts. The restructuring is expected to enable a doubling of global fab capacity after a relatively small increase in spending on capital equipment. Gross margin is already nearing the company's goal of 60% as revenue continues to climb.

Overall, ADI remains financially stellar: Cash and short-term investments of $2.7b dwarf current liabilities of $604m, and the company holds no long-term debt. During the fiscal year ending in October, ADI generated $587m in cash from operations after subtracting capital investments. In response, the board increased the dividend 20% to $0.12 and is following with an encore this quarter. Based on management's guidance for the April quarter, the company is on a run-rate through the first half of this fiscal year to reach a full-year EPS of $1.60 (ex options expense and restructuring charges), an increase of 38% over last year's $1.16. At the recent price of $38, shares are trading at only 23.8 times our forward earnings estimate, which assumes no growth after April. Add a wee bit of growth and you are north of $50 with a PE of 30. — *CB*

EZchip (LNOP)

PARADIGM PLAY: A GENERATION AHEAD IN NET PROCESSORS

MARCH 1: 5.74; 52-WEEK RANGE: 4.56 – 9.49; MARKET CAP: 66.77M

Bursting forth from EZchip are two new pinholes of illumination. First, design wins for the long-anticipated NP-2 are up to "over" 40 from a previous count of 32 back in November. Among the potential customers are "first-tier global communications companies from all continents," which sounds impressive if vague. It will be more impressive if these global giants actualize their potential, which is something the NP-1c design freaks haven't done. Yet.

Which brings us to the more surprising pinhole—and the more relevant one for those hoping for slightly quicker gratification. EZ counts 15 NP-1c customers in production and yet only a "handful" have contributed to revenue. Meaning we should expect NP-1c revenues this year from many more customers? (Wow.) Or, to put on my Puddleglum hat, does it mean that lots of NP-1c customers in production are trying to give away their products, soon to be joined by the other 20 NP-1c customers that EZ expects to enter production this year?

Either way, we all know that NP-1c targets service cards, whereas the NP-2 goes into line cards, meaning many more chips per box and substantially higher revenues. But with the first NP-2 customers not expected to enter production until the second half of the year, don't expect serious NP-2 revenues until 2007—at which time we will all be a little older and a little wiser, and look either really smart or like first-rate suckers as we recall the revenue blip after NP-1c went into "production." Whichever, I'm persuaded that, as of now, even CEO Eli Fruchter doesn't have much of an idea what's going to happen to these NP-1c products.

What is EZ worth today? That's even more problematic than estimating what Broadwing's worth (See Page 1). Compounding it is that EZ may have to go back to the markets before NP-2 bubbles up. But with working capital of $20.6m conflagrating at less than $2m per quarter, we can put that thought on the back burner for a while and hope for better things from NP-1c. With LanOptics owning 60.4% of EZchip, the recent share price of $5.70 gives EZ an enterprise value of about $89m or 15x last year's revenue.

But here's a better way to look at it. If you're hoping for at least a triple to compensate you for your risks and long wait and previous losses with EZ, a price of $17.10 implies an EPS of $0.34 (at a PE of 50) or earnings of $4m with 11.6m shares. Backing up still further, at the gross margin of 55% and with current expenses, we need to see revenue of $17m or a little over $4m per quarter. Man, if that isn't EZ, what are we doing here? — *CB*

Online Bonus Material: For additional analysis on AMD, Altera, Corning, Energy Conversion Devices, Intel, NetLogic, Power-One, and Texas Instruments, plus financial updates on Broadcom, Xilinx and Zoran logon with your *GTR* subscriber ID at www.Gildertech.com.

possible to send gigabits per second over multi-mile lines of *al dente* linguini. But the fact is that DSL is so hard that it is already essentially obsolete and survives the competition of fiber only because of the stupendous global installed base of copper wire lines and the intriguing challenge they offer to communications engineers who relish trying to push bits to rates beyond the Shannon limit (Claude Shannon's formula for computing the intrinsic maximum capacity of a communications path).

Some five years ago, Ikanos took up the challenge of expanding the capacity of DSL from the amazing 4 megabits per second theoretically possible with conventional DSL to the awesome 100 Mbps of VDSL. This feat entails superimposing on the 4 kHz voice signal an additional signal of up to 30 MHz. In a process called discrete multitone (DMT), invented by John Cioffi of Stanford (see January 2005 *GTR*), the super-fast broadband undulation is in turn broken up through a process of Fourier transforms into hundreds of slower 4 kHz frequency bands that are easier to manage and interpret.

Familiar to geeks, Fourier is a kind of mathematical magic that converts electromagnetic waves from the time domain in which we live and in which twisted pair signals undulate, into the frequency domain where we hear pure tones and see pure colors. Demonstrating the ultimate futility of the DSL competition with fiber, **Essex Corp.** (KEYW) (see December 2005 *GTR*) has developed "Hyperfine" technology. This breakthrough invention in analog optics expands Fourier conversions into the trillions of hertz (terahertz) of broadband coverage and down to kilohertz of narrowband sensitivity. This feat makes wavelength division multiplexing (WDM) of optical signals over fiber lines the supreme technology for all wireline communication. Until sometime in the next decade, however, when fiber to the home is widely deployed, there will be a large market for good-enough broadband.

Hey, not so fast...

But that does not necessarily mean we should care about Ikanos's inner workings. Even if the company excels in the intricacies of VDSL2, will it ever find a market large enough to matter to investors? In the process of mastering the intricacies of VDSL technology, Ikanos took some 70 percent of the high end of this market, mostly in Korea and Japan, and is on the verge of breakthrough contracts in Europe and the U.S. Yet the company had only $85 million in revenue to show for it last year and is already valued at a market cap of almost seven times that. Meanwhile, more economical ADSL (asymmetric DSL)—not exactly a bit-rate tortoise—continues to be the copper solution of choice worldwide.

Standard ADSL uses the first 1.1 MHz of spectrum with the first 4 kHz reserved for analog voice telephone. The 288 tones available are typically divided into 256 tones for downstream and 32 tones for upstream traffic (hence asymmetric), resulting in data rates of about 8 Mbps down and 1 Mbps up. And immediately you ask, "How can that be? My DSL service promises a maximum of only 1.5 Mbps up and 500 kbps down, and I rarely reach two thirds of that." Like most Americans on DSL, you have the light beer version of ADSL, a variant protocol appropriately nicknamed G.lite that is simpler to install since it obviates splitting the voice and data signals. For teetotalers, **Verizon** (VZ) has recently begun offering a totally nonalcoholic version of ADSL promising data rates about half that of G.lite.

Making the right decision to bring fiber directly to its customers is Verizon.

The rest of the world, though, is moving toward the real broadband of ADSL2 at 12 Mbps, and ADSL2+, which doubles the spectrum band to 2.2 MHz and performance to 24 Mbps (though only at shorter distances).

ADSL is great, if you and your carrier live inside the same testing laboratory. (Theoretical ADSL signals can reach you if you are within 18,000 feet of the simulated central office.) However, the bit rate delivered outside the lab in real-world links (which have crosstalk among pairs and an average of 20 splices from end to end) is often less than the ideal. For this reason, many service providers don't support ADSL beyond 15,000 feet. To increase bandwidth to the customer, service providers can bond DSL wires together, effectively providing more than one DSL, so that aggregate bandwidth meets requirements for short distances. In 2006, **BellSouth** (BLS) plans a kludgy pastiche of triple-play services using a combination of FTTN (fiber to the neighborhood) and bonded ADSL2+.

By contrast, a single VDSL line from Ikanos and its rivals can deliver 54 Mbps at up to 1,500 feet, beating ADSL out to 5,000 feet by extending the transmission band to 12 MHz. So far, deployment has been very limited because VDSL chips cost a lot more, work over a shorter range, and high-definition content won't become common for a while. Just as unsettling for carriers, jumping the gun of the standards process, VDSL has been deployed in proprietary versions, with most carriers restricted to the same chip vendor at both ends of the subscriber line.

Full speed ahead

Ikanos has been by far the most successful vendor, shipping close to 8 million ports to major original equipment manufacturers (OEMs), mostly in Japan where fiber extensions have significantly decreased the distance between the customer and optical terminus. Others shipping VDSL silicon include the formidable **Infineon** (IFX) and **Metalink**

(MTLK) (which has decided to finesse VDSL2 in pursuit of ambitious plans in the home gateway market).

Approved in May 2005 by the International Telecommunications Union (ITU), the VDSL2 standard extends the transmission frequency from VDSL's original 12 MHz to 30 MHz using Cioffi's discrete multitone (DMT) Fourier technology as the sole modulation scheme. This makes VDSL2 backward compatible with DMT versions of VDSL as well as all versions of ADSL. With proprietary systems gone, modems will be able to negotiate with the central office to choose the fastest available bit rate, from VDSL2 down to basic ADSL, depending on distance and line conditions. At the maximum 30 MHz frequency range, data under ideal conditions can be transmitted as far as 1,200 feet both upstream and downstream at 100 Mbps.

A major supplier of ADSL and VDSL, Infineon has become a formidable foe to its pure-play rival, Ikanos.

With the increasing need for speed, service providers are deploying a greater number of remote or mini-DSLAMs (DSL access multiplexers) to shorten loop lengths for faster connections. DSLAMs terminate the copper pair from each user's premise and have traditionally been placed in the central office where space is at a premium and the distance to many customers is often too far for DSL. By moving the DSLAM into the neighborhood or the basement of a high-rise, therefore, the capabilities of DSL can be greatly extended.

Significant deployments of VDSL2 probably will not begin until late this year at the earliest. But with carriers worldwide extending fiber closer to the end user as high-def D-day approaches, VDSL2 port shipments should rise rapidly as chip prices drop, to reduce the cost of VDSL2 to the cost of the cheapest ADSL connection today. Infonetics Research expects that the number of DSL subscribers will double to 200 million from 2005 to 2008. But shipments of DSL modems will increase faster because existing subscribers will be upgrading to faster technologies. Infonetics forecasts that 60 percent of the installed DSL based will be VDSL2 by 2010. Translating these figures for us, the Linley Group estimates that annual sales of VDSL chipsets will be north of $500 million during 2008 and approach $600 million by 2010. No small prize for Ikanos or any other vendor who joins the quest.

Following Ikanos, both Broadcom and **Conexant** (CNXT) have demonstrated VDSL2 chipsets, but only at 60 Mbps using frequencies up to 17 MHz, with Texas Instruments and **Centillium** (CTLM). Notably, TI could take advantage of its 65-nm technology to integrate additional system-level functions that are external today.

In the move to VDSL2, Infineon in some cases has equaled or exceeded Ikanos in integration and surpassed the rest of its competitors by offering chips that function at all speeds up to 100 Mbps. Quickly overcoming an initial disadvantage of having used QAM (quadrature amplitude modulation) for its VDSL, the German goliath licensed intellectual property from **Aware** (AWRE), the leading supplier of DSL intellectual property for broadband silicon.

Integrate or disintegrate

A complex mix of analog transmission and digital processing, DSL modems are divided into their own triple play of digital data pump, analog front end (AFE), and analog line drivers. The data pump sits on the backend of the chipset nearest the local area network (LAN) on the customer side of the subscriber line and the backplane on the DSLAM side. The digital data pump frames, modulates, and processes signals in multiple protocols for transmitting data in both directions. For example, it may send voice, data, and video streams down different paths for quality assurance, reorder DMT tones to reduce interference, scramble the data for security, and reduce transmission errors using forward error correction.

Sandwiched between the digital data pump and analog line drivers that couple directly to the wires, the AFE converts the digital stream from the data pump to analog signals, which it then amplifies, shapes, and sends to the line drivers. In the reverse direction, the AFE amplifies the analog stream coming from the subscriber line, filters out noise, and converts to digital for processing by the data pump.

DSLAM chipsets can stand alone or be configured on a line card that includes a network processor or NPU for processing packets, a microcontroller to control traffic, and SerDes (serializer/deserializer) to connect to an Ethernet backplane multi-trace bus. Line cards typically support 36 to 72 ports and are located in central offices, which are generally crammed and hot. Remote equipment must pack into yet smaller neighborhood enclosures where power is limited to that available from the twisted pair. Thus OEMs are always looking for smaller, denser chipsets that also run cooler and offer more ports for connectivity.

DSLAM chipsets for the more mature ADSL2 standard currently offer 8–16 ports, compared to only 2–4 in initial VDSL2 chipsets, which also use separate chips for line drivers, AFE, and data pump. Increasing integration of these components will be mandatory, and because VDSL2 drives high-power signals down the line, those integrated solutions will likely use specialized processes such as BiCMOS that join potent bipolar drive transistors with ordinary CMOS logic.

Ikanos has taken advantage of the higher bit rates possible from remote DSLAMs (closer to the residence) to divide its early-generationVDSL2 chipsets into two product families. Its leading-edge product comprises 11 chips and extends the frequency band to the full 30 MHz to transmit 100 Mbps symmetrically over the final few hundred meters from remote mini-DSLAMs (often located at passive optical networks or PON terminals). But Ikanos also offers a cheaper 12 MHz

product with seven chips that can transmit up to 60 Mbps over distances of 3,300 feet from the central office.

Both product lines include a programmable real-time operating system to configure different bandwidths and protocols, enabling OEMs to develop, for each chipset, a single line card for all carriers and service plans.

Unlike Ikanos, the German goliath Infineon boasts a single VDSL2 chipset for all DSLAM deployments, from the central office to the neighborhood, supporting all VDSL2 transmission bandwidths from 8 MHz to 30 MHz where it enables 100 Mbps symmetrical data rates for up to 350 meters. By using a single line driver for all VDSL2 bandwidths and all protocols, Infineon surpasses Ikanos in adaptability by enabling a common line card for different regions, carriers, and service plans, simplifying inventory management for OEMs—but at the cost of a less optimized solution, especially for the overcrowded central office.

Surprisingly, Ikanos CEO Rajesh Vashist told us at the Needham Growth Conference in January that the competitor he fears most is *not* Infineon but rather Broadcom because analog is a big part of VDSL2 technology and Broadcom is its best rival in analog. Two competing chipsets with an identical number of modem chips per port could enable significant variations in line-card complexity depending on the integration and capabilities of processors, filters, converters, and so forth. Furthermore, power dissipation, programmability, and cost are also critical parameters that OEMs and carriers will weigh against each other when optimizing at the systems level. Thus, medal winners in the DSLAM silicon slalom will be determined by a complex of variables, many proprietary, making it too difficult to resolve the current technology leader between Ikanos or Infineon. But there's another race that concerns us more, the one for the much larger market of customer modems, routers, and gateways. Much simpler than its DSLAM cousin, the customer premises modem terminates a single broadband line and connects to the customer's LAN using either an Ethernet or USB port. It's that race for the home device that Ikanos was clearly losing back in December.

Home run

Two years ago, Infineon gained a gateway-processor line through its $100 million acquisition of Taiwanese chip vendor ADMtek. This has enabled Infineon to develop the most integrated customer premise equipment (CPE) solution, a single-chip data pump, AFE, and line driver for all VDSL2 frequencies. And Infineon is one of the few companies that can offer a complete gateway, including a VoIP and multiple Ethernet ports, WLAN, a PCI bus for local peripherals, and a traffic manager for QoS. How can they lose?

The entire situation changed last month, however, when Ikanos acquired **Analog Devices**' (ADI) Fusiv line. A positive transaction for both companies, for Ikanos it was truly a home run that clears the way for a run into your home. At a purchase price of $30 million or about 1 times revenue, Fusiv appears to have come relatively cheaply. With over 20 design wins, 10 percent market share in DSL chips, and a team of some 450 engineers with 4 years of experience building this technology, Fusiv opens wide the gateway for Ikanos both today and tomorrow while expanding the company's customer base.

The competitor Ikanos fears most is not Infineon but Broadcom, its best rival in analog.

Using ADSL2+ technology licensed from Aware, the basic Fusiv chipset combines an integrated data pump/DSP with a separate AFE and its integrated line drivers, receiver, filters, and AD/DA converters. To move beyond standalone modems to routers and full-featured gateways, Fusiv adds Ethernet and USB interfaces, an Ethernet switch chip, an external 802.11 WiFi chipset, and support for additional interface protocols such as Bluetooth. It also offers software for virtual private networks (VPN), VoIP, network management and security, routing and switching, and the telcos' preferred asynchronous transfer mode (ATM).

Crucially, Fusiv's combination of the central processing unit (CPU) and packet engines can process packets at the top VDSL2 speed along with QoS, firewall, and the other gateway functions. Thus, not only does Fusiv give Ikanos immediate revenue via a still vibrant ADSL market, it enables Rajesh to develop "overnight" (as he puts it) the only complete VDSL2 gateway that can operate at a symmetrical data rate of 100 Mbps. If Ikanos can integrate its VDSL2 data pump into Fusiv, it will have a powerful gateway chip and an early advantage over competitors such as Broadcom, Conexant, and Texas Instruments that can't process packets at top speed because their technology dates back to when 100 Mbps data rates were not expected.

"Is Ikanos still a good deal?"

Yes, George, but only for patient and vigilant investors. Most notably, it's worth the risk because Ikanos excels in a technology that's hard to do *well* and that few have tried to do at all on both ends of the subscriber line. The result is that, currently, only one competitor is capable of giving Ikanos a run for its money when VDSL2 comes of age. True, there's time for the likes of Broadcom, TI, and Conexant to catch up, but time is also on Ikanos's side as it continues to integrate with the goal of staying two steps ahead.

Short-term, with significant VDSL2 shipments unlikely to start before late 2006, VDSL products will drive Ikanos's revenue through most of this year, along with Fusiv's ADSL line for CPE deployments. With Ikanos capturing about two-thirds of all VDSL sales last year and most competitors now working on VDSL2, there's no reason to believe that the company will lose its current lead. But with VDSL fading

into VDSL2 by 2007 and integration of the Fusiv into Ikanos and Ikanos (VDSL2) into Fusiv, this will be a critical transition year for Rajesh's crew as they are challenged by slowing VDSL growth and increased overhead, particularly R&D.

It's already showing up. Based on the company's post Fusiv forecast, we estimate earnings from operations of $0.07 this quarter compared to $0.20 last quarter (excluding stock-based compensation) despite a sequential revenue increase of 15 to 20 percent. After adding in acquisition costs, GAAP will be below water. Using $0.07 as a run rate, the current PE is a lofty 80. Short-term, then, look for pressure on the stock, requiring patience for those seeking an entry point and patience for those already in.

Last month, Ikanos acquired Analog Devices' Fusiv line, a positive transaction for both companies.

By 2008, the VDSL2 floodgates will be opening up with plenty of opportunity for Ikanos. If the company maintains its current share of the market and carries through with its long-range financial model, operating earnings, after taxes, could reach between $1.65 and $2.00 yielding a share price of somewhere between $40 and $50 at a PE of 25. That's a double over today's lofty valuation.

To get there, Rajesh must first transition Japan from VDSL to VDSL2, where his current accounts are likely in the bag when the changeover comes. More cricitally, he must win many new customers for VDSL2. In these new accounts, Ikanos will face stiff competition from Infineon, Conexant, Broadcom. These vendors have established relationships with the leading OEMs, and they have broader product lines than Ikanos. Broadcom, after limited success with its first product, now claims more than 20 percent of the DSL market with its ADSL2+ chipsets. Based on a recent design win with **Alcatel** (ALA), Broadcom should continue to increase its market share for ADSL2+ ports in the central office, while getting a head-start for any future VDSL2 products developed by the French OEM.

Conexant continues to lead in DSL chip revenue after capturing about 40 percent of the market share in 2004. To complement its DSL chips, Conexant offers several communications processors. Thus, even though it lags both Ikanos and Infineon technologically, the company still managed to win the recent contract for **Zhone Technologies**' (ZHNE) end-to-end VDSL2 product.

Ikanos may well never be a 10-bagger or even a 5-bagger at the current price; its market as currently defined will never be big enough and the challenges are too numerous. With DSL technologies inherently more difficult and less capacious than fiber, it remains a viable business only as long as copper continues to connect the ever-shrinking distances between the end user and the telcos' optical networks.

Currently, the combined costs of stringing fiber strands to the customer and installing the passive optical networks (PONs) that extend the reach of optical communications in the last mile are higher than leveraging copper using DSL. That's why PON deployments continue to lag DSL by more than an order of magnitude, from only 1.5 million subscribers worldwide in 2004 (mainly in Japan and Korea) to 21 million in 2008 as forecast by Infonetics. It's also why both **AT&T** (T) and BellSouth, with immediate capex concerns in mind, are installing the halfway solutions of extending fiber to the curb and the neighborhood and leaving shortened copper bottlenecks.

But the costs of laying fiber and PONs are also decreasing rapidly and will be approaching that of DSL later this decade. Making the right decision to bring fiber directly to its customers is Verizon, whose optical network will be mostly installed and paid for when its major rivals scramble to extend and reengineer their own antiquated DSL architectures sometime during the next decade.

Fiber is the future. But DSL is now, and the possibility of Ikanos earning another double over its current valuation, though difficult, is quite realistic.

– Charlie Burger, with George Gilder
March 1, 2006

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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