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Seize the Day

More than two years ago, just as the market for SONET networking equipment was headed into its greatest two years ever, last year topping $15.2 billion—just when **Cisco** (CSCO) announced it was purchasing SONET-startup Cerent for $7 billion—we announced that SONET was about to die. Paradoxically, it would die *because* its sales were about to soar.

By blindly discounting shares of Telecosm and SONET companies alike, the market is creating a huge opportunity for investors

The synchronous optical network, SONET, is the time division muxed (TDM) opto-electronic system developed by Bell Labs to adapt the old voice networks to fiber optics. With one hundred thousand "rings" deployed in the U.S. and some two hundred thousand related synchronous digital hierarchy (SDH) rings deployed overseas, SONET is the voice network reconstructed for data at a huge expense, broadly estimated at nearly $300 billion since 1985. SONET currently accounts for some 98 percent of the revenues to the Bell survivors termed incumbent local exchange carriers (ILECs) and nearly as much of the revenues of long distance inter exchange carriers (IXCs). In the history of technology, its death, a little more than a decade after its colossal launch, is a cataclysmic event, and it opens up an immense opportunity for investors.

Dying technologies do not just go away or get interred in coffins under the marmoreal headstones of corporate offices. SONET will long linger as a protocol for "framing" transmissions and informing software for network OSS (operations support systems) such as billing and maintenance. But new deployment slows and withers. After an Indian summer of renewed expectations, it collapses. Just as vacuum tubes peaked right before being wiped out by transistors, SONET is dying because it has become an intolerable tax on a far more fruitful technology, wavelength division multiplexing (WDM). Allowing us to merge many lambda light paths onto a single fiber, WDM enables fiber optics to slash costs and add capacity at a three times Moore's law pace. But SONET imposes nearly the same multi-million dollar costs on each new WDM lambda as it would on an entire fiber, squandering WDM's abundance and producing an intolerable conflict. As we wrote in October 1999:

"With the arrival of WDM, self-healing SONET rings have become **Nortel** (NT) nooses and **Lucent** (LU) lodestones…1999...has been the biggest year in SONET history, 2000 will be better, and the market may eventually grow to $10 billion—right before it collapses. The money flowing into SONET out of telco profits will make them desperate to kill it off."

As we rush from 16 lambdas deployed on a fiber in 1996, to 160 today, to thousands in the lab from **Avanex** (**AVNX**) and **Essex** (ESEX.OB), WDM is enabling order of magnitude price reductions every

In This Issue:

12 to 18 months that will drive the marginal costs of transmitting a bit toward zero and demand toward infinity. As we explained in last month's *GTR*, the cost of a DSO- (64 Kbps) mile-month has dropped 500 fold since 1995, while Internet traffic has risen 3,000 fold (from 15 terabytes per month to 45 petabytes per month). Although forms of bandwidth range from dialup modems to backbone OC-192, these numbers express a crude index of elasticity of demand for bandwidth of six. Assume, though, Nortel's usual estimate of four for the impact of prices alone. That is, every one percent reduction in bandwidth increases demand by about four percent.

The cap-ex cutbacks of the current "optical collapse" mask a very specific shift to WDM optics

The WDM price collapse will release an elastic rebound of profits beyond the most roseate wishes of the tech boom, for those that lead the way, while those who cling to SONET will sink with its heavy iron and copper. As we wrote in the May 2000 *GTR*, "all other apparent imperatives, especially those that seem to require [SONET] electronics in the core, will inexorably yield…because a WDM network cannot tolerate electronics. For electronic devices, WDM is not a harbinger of abundance but a death sentence."

Thus, while sales of still costly WDM gear were lagging at less than 5 percent of the SONET market, we made projections for WDM that seemed gilded figments of some far off theoretical future of no help to investors then or now. For refusing to share our assurance, we removed first **Ciena** (CIEN), then Lucent and Nortel from the list. And then the cap-ex collapse began and the Telechasm yawned, techno-dollars dissolved and deflated, and the Gilder Technology Forum became a support group for ex-millionaires.

The optical collapse

Through it all the progress of WDM was relentless, the chief factor in driving the capital cost (the much dreaded cap-ex) of a unit of marginal bandwidth down some 58 percent a year from 1995 through 2000. A unit of bandwidth increase that cost $1 in cap-ex in 1995, cost just cents in 1998 and a penny last year. For 2001 our Charlie Burger estimates the annual reduction in cost per bit will plummet 79 percent. These reductions arise not just from the cost of WDM equipment itself, anymore than the costs of "SONET" networking arise solely from the cost of SONET boxes. The largest gains come not from new components, but from new architectures. The mostly passive optics of WDM simply eliminates the costs that get worse when we try to combine WDM and SONET. This year alone, cap-ex drops 75 percent through replacing on a smallish 3,000 km 80 channel network, SONET system with a WDM only system, enhanced by next generation transport technologies from the likes of **Corvis** (CORV) or Avanex that eliminate some $36 million in SONET electronics.

When Lucent and Nortel started to implode, there was a lot of noise in the signal of the SONET collapse. Not only did both companies refuse to disaggregate revenues, but SONET's decline led a recession-driven triage of cap-ex cuts across the board regardless of technology.

Now dribbling in from carrier sources and market surveys are data confirming the unfiltered signal. The dramatic cap-ex cost cuts will continue. But *the great bulk of cost cutting will be achieved by replacing SONET style networking with WDM networking*.

Our favorite Wall Street optical analysts, James Jungjohann, Rick Schafer, and the rest of the optical team at CIBC, report that last year "carriers devoted approximately 80 percent of their CAPX dollars" not to optical innovation but to desperate and unprofitable efforts at "keeping the dying legacy voice (i.e. SONET) network on life support…due, in large part, to the operators' attempt to force the voice network to be something that is not (and cannot be)—a scalable, efficient solution for surging data traffic growth." The data business, thriving on ever higher volume at ever lower cost, needs WDM but cannot afford the SONET tax. Retaining SONET on a 160 channel system can cost $10 million per SONET site. "The implications for carrier CAPX are obvious."

Thus, in the midst of the across-the-board cap-ex cutbacks of the current "optical collapse" is a very specific shift in favor of WDM optics. Even in the face of overall carrier cap-ex reductions of 10 percent this year and next, CIBC estimates that after this "year of transition" the WDM optical sector should "quickly" jump back to roughly 25 percent normalized annual growth as SONET continues to decline. Carriers "have no choice but to more expeditiously invest in next generation optical gear."

Documenting the demise of SONET in an August survey of spending plans from 74 carriers is the Aberdeen Group: "While the optical networking industry has been perceived to be in a serious downward spiral, our research shows that the market has simply shifted into next generation systems that are not offered by traditional networking giants. … Money historically spent on circuit switching and SONET/SDH transport gear will be increasingly used on next generation intelligent optical systems."

Aberdeen estimates worldwide carrier cap-ex peaked at $180 billion in 2000 and will decline to $162 billion by 2002, only slowly climbing back up to $195 billion by 2005. That is the SONET collapse. Meanwhile the carriers predict a near sevenfold increase in capital spending on next generation optical equipment. Aberdeen found "a definite shift away from the traditional telecom vendors such as Lucent, Nortel, **Alcatel** (ALA) and **Fujitsu** (FJTSY), which are losing market power 'at an accelerating pace' to next generation optical suppliers."

In a struggle to keep market share, the traditional SONET suppliers—Nortel, Lucent, Alcatel—resort to deep discounts and vendor financing focused on second and third tier carriers lacking the technical sophistication

to manage and maintain their own networks. Translation: Dominating sales to the worst financed, most technologically unsophisticated customers, the big three will further burden them with debt to buy overpriced, uncompetitive technology and then will charge them to maintain it until they go broke.

We hardly ever cite such "market research" projections in the *GTR*; they usually prove wildly inaccurate. Aberdeen's prediction of 45 percent CAGR in next generation optics over the next five years is way over-precise. No matter. For investors the crucial point is that by blindly discounting the shares of Telecosm and SONET companies alike, the market is creating a huge opportunity for investors in companies that build the WDM network and in the carriers that have staked their future on it.

As Internet traffic continues to double every six months, Aberdeen's survey suggests carriers "with existing wavelength products will be installing at least as much dense wavelength division multiplexing (DWDM) gear over the next 18 to 24 months as they have currently existing in their networks." Since the survey was taken, a number of the same companies have announced deeper cap-ex cuts to cope with the deepening recession and unhappy capital markets. But when spending resumes it will be for WDM and next generation optics, sans SONET. The optics analysts at RHK give a gratifying answer to Wall Street's plaintive question: Who will buy the new gear now that the new carriers are pressed to the wall? RHK's survey of "carriers who account for 95 percent of carrier spending" found that one way the traditional carriers are "cutting" cap-ex is by leasing capacity from next generation carriers like **Broadwing** (BRW), **Qwest** (Q), and **Williams Communications** (WCG)—most of whom have minimized SONET. In effect, the old Bells and bellhops are outsourcing their construction to the next-gen carriers' WDM.

Corvis brightens Broadwing

Eighteen months ago, Broadwing was a humdrum combination of a solid RBOC (Cincinnati Bell) and a modestly sized next generation long haul network, IXC, running 3 OC-192s of Nortel backbone capacity with **Level 3** (LVLT) as its biggest customer. (Jim Crowe was still deep in the trenches with his 12 conduits.) Seeking an edge, says Chris Rothlis, VP of engineering, the company looked at ultra-long-haul technology bubbling up from the labs, and saw—lots of bubbles. But beneath the froth was David Huber's Corvis team promising that by employing Raman amplification, forward error correction, and a few other tricks, Corvis could send lambdas thousands of kilometers without electronic regenerators. Moreover, its super secret all-optical cross connect would suck all the SONET add-drop switches out of the core of the network to boot, cutting capital costs by half compared to a Nortel SONET network. After deploying the 10,500 mile system in three large loops this spring, Broadwing found that Huber was wrong: Corvis actually beat the SONET price by 75 percent. Broadwing's cap-ex savings may have amounted to more than $400 million.

Not to mention the snow shovels: last winter, Broadwing teams in the Midwest sent out to upgrade or repair circuits first had to remove the snow from the regenerator huts. Not this winter. On a coast-to-coast link, just four line cards are needed to bring up an additional Corvis WDM lambda versus installing 48 O-E-O interfaces, requiring dozens of truck rolls to light a traditional SONET circuit over the same distance. Thus, along with SONET vanishes most of the labor for upgrades and repairs, ultimately adding up, Rothlis hopes, to an even bigger savings on operations (op-ex) than on cap-ex. Op-ex accounts for 70 percent of a carrier's budget on average.

Corvis provides the payback carriers have not been getting from attempts to prop up SONET

Cutting provisioning times for a new channel from months to weeks or days has allowed Broadwing, almost uniquely in the industry, to sell "Service Level Agreements," money back guarantees essentially, on how quickly it can set up new circuits for customers. Industry surveys show the one thing customers most want from their carriers is the ability to add new circuits in days not months. But because a SONET network requires such an elaborate electronic build out for each lambda lit, SONET carriers traditionally deploy capacity first and then sell it, which means guessing where the demand will be. When the international Canadian carrier Teleglobe recently hit the bandwidth market looking for more than a quarter of a terabit in the typically underbuilt Southeast U.S., quickly, the SONET networks could offer nothing for the better part of a year. Broadwing lit 38 OC-192 circuits for Teleglobe in 45 days. Williams, also a Corvis customer and Teleglobe supplier, deployed four coast-to-coast lambdas for Teleglobe in 11 days, and this month lit a 10 gigabit lambda between New York and Washington, DC, in 48 hours.

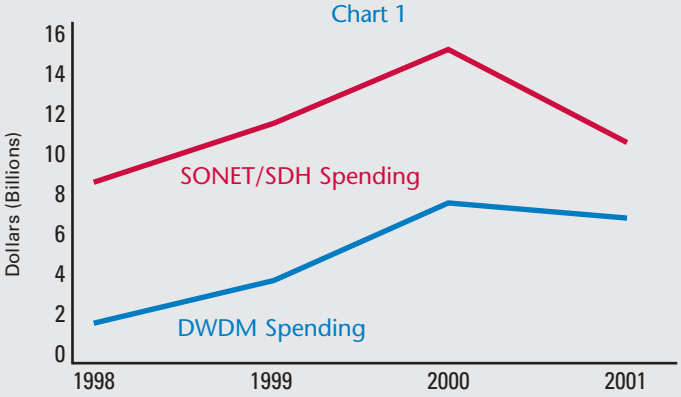
Nortel's speedtrap

With or without a cap on cap-ex, the Corvis system provides just the payback carriers have *not* been getting from their attempts to prop up SONET. Given the advantages of WDM, why won't the legacy suppliers give in and beat their noveau rivals at their own game? It is an issue of the two basic telco components—wires and switches—around which form the two great polar architectures, and even religions, in communications theory. At heart a switch company, like all the great Bell era firms, Nortel just cannot stop spending on switches to economize on wires. Nortel cannot let go of the idea that too many wires—even wires of light—are as much of a problem as an opportunity. All those wires must be switched and so their collective burden grows even as WDM drives down the cost of each one individually. Nortel's only answer is to speed up the switches by multiplexing ever bigger and faster SONET bit streams onto a single channel, leading the industry first to the ten gigabit pressures of OC-

THE GREAT DIVIDE

The SONET Tax Rebellion

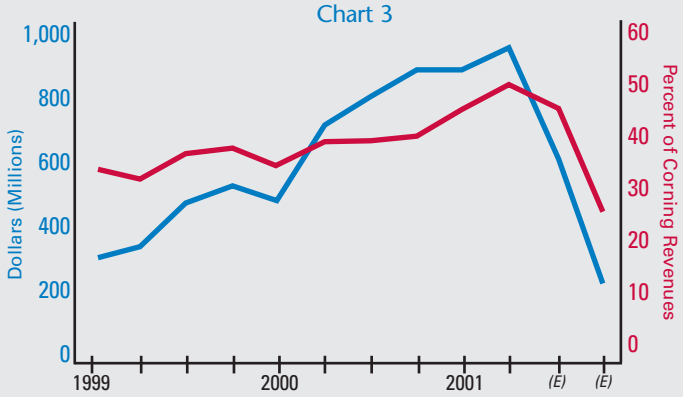
Chart 1



Source: Dell'Oro Group

Blinded by the light, Corning's fiber sales slip

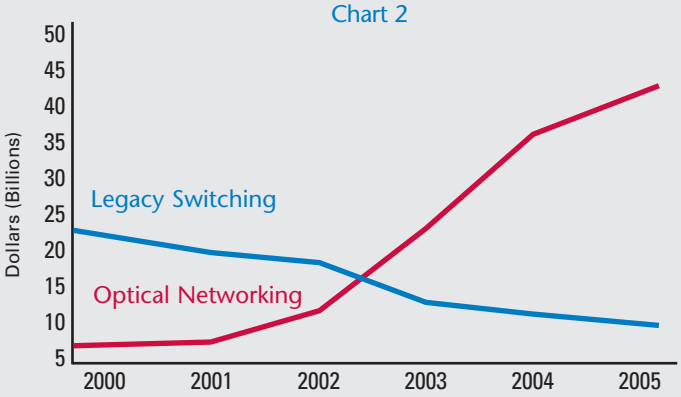
Chart 3



Source: Merrill Lynch

The Long Goodbye

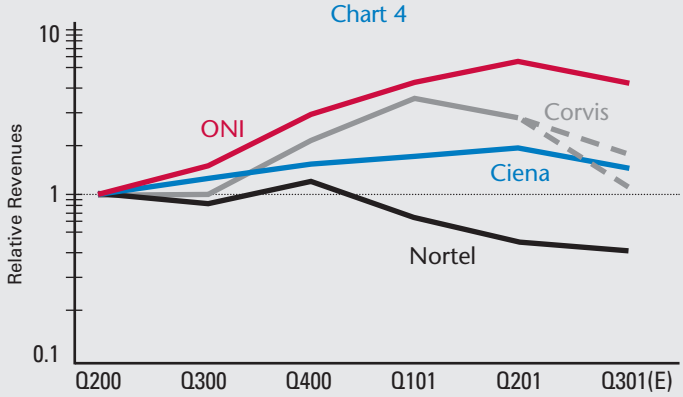
Chart 2



Source: Aberdeen Group, August 2001

Relatively speaking, ONI's the one.

Chart 4



Source: Company Reports

192 and now to the forty gigabits of OC-768. As Michel Belanger, who heads Nortel's Optera Long Haul 5000 optical transport platform, told *LightWave*, OC-768 allows carriers to "reduce the number of channels required in a network."

In other words, Nortel recognizes just as clearly as Corvis or Avanex that TDM and WDM cannot readily co-exist. As the world leader in TDM, its margins are dependent on the ever faster SONET boxes it provides two years ahead of its rivals. The super fast 40 gigabit per second boxes at OC-768 not coincidentally would vitiate all the recent progress on optical ultra-long-haul. So long to the pesky Corvis. Nortel's new box would require the carriers to add back all those hundreds of millions in O-E-O equipment, made right at Nortel. Nortel's preference for SONET is deep in company DNA.

In the realm of wires and switches, Corvis and Broadwing instead are using lambda abundance to take a first but crucial step toward the other architectural pole: the switchless network. With enough cheap lambdas, the most efficient choice when you need new connections is not to buy another switch but to light another wavelength "wire." In a Bell company heresy, you do not bother to groom (fill up each lambda to maximum capacity with TDM) or switch to avoid "blocking" (wherein a message stream on a given frequency cannot go from A to B because that frequency is already in use for a different purpose). You approach the network nirvana of replacing switches altogether with passively, prismatically shuffled wires of light. The ultimate switchless network would provide a lightwave link between every two terminals. The Corvis switchless network provides dedicated lightwave paths connecting regional hubs.

To get around blocking, Broadwing and Corvis create a two-layer network. Broadwing's old Nortel long haul network has been transformed into 15 regional networks. Each of these regional systems links into the new Corvis national "express network" via a Ciena CoreDirector. Connections in the core itself use the Corvis all-optical "switches," each able to reconfigure up to 960 lambdas into semi-permanent paths.

Since the regional networks do not connect directly to each other, no blocking problems arise there either. The Ciena CoreDirectors in the regional nets do all the grooming and wavelength conversion on the edge, so express traffic starts off on the right lambda. But by building a two-layer net-

SONET, which once rode the wavelengths of WDM, is now being washed away by them. Through last year, SONET spending by carriers worldwide rose with WDM, though at much higher levels, as each new lambda required a complete new set of SONET devices, just as if it were a new fiber (Chart 1). Last year this SONET "tax" peaked at $15.2 billion and then began to collapse under its own weight. Dell'Oro Group analyst Shin Umeda comments that the SONET collapse will be "ongoing," while the much softer WDM retreat in 2001 reflects largely the general rollback in carrier cap-ex to conserve cash and placate the capital markets.

Chart 2 violates our usual rule against projections, with a caveat not to take the out-year numbers very literally, and focus on the direction of the projections, based on the Aberdeen Group's interviews with 74 carriers. Legacy witching, Aberdeen's category, is largely SONET. Optical networking includes WDM systems, next generation transport systems, optical switches, and network management systems. We don't expect optical switches to be nearly as important a product as Aberdeen projects.

As fiber sales drop (Chart 3) we are once again seeing both the cap-ex cap and the more permanent impact of WDM. Corning warns its sales will be down 10 percent for the year as opposed to its expected growth of 15 percent. Corning will abandon its planned fiber plant expansion in Oklahoma City, close its Deeside, Wales, fiber plant, and idle its three other plants from late October through the start of 2002, resuming manufacturing "as business conditions improve." In Q2 2001, fiber and cable peaked at approximately 50 percent of Corning revenues. Business conditions or no, the "physical layer" is no longer the fiber but the light. At 160 and eventually 700 lambdas per fiber in deployed systems (and thousands in the lab) we need less fiber—for now. Moreover, next generation transport systems like Corvis's equalize all fibers, making upgrades with specialty fiber unnecessary. But Nortel's OC-768 dreams probably will require advanced fibers, another reason to think the dream will die. Ultimately WDM will so boost the demand for bandwidth that fiber sales should come back, especially overseas and toward the edge of the network, as every gigabit Ethernet link on a LAN requires single-mode fiber to go more than 300 meters.

Chart 4 shows the relative collapse of the leading legacy networker, Nortel, compared to its upstart rivals, especially ONI. (Corvis 3Q projections diverge widely at this time.) Revenues are log normalized to the second quarter of last year: e.g. in dollars Nortel starts at $6.6 billion and drops to an estimated $2.8 billion in the third quarter of this year (a 57 percent contraction), while ONI starts at $10 million and burgens to approximately $45 million in Q3 (a 350 percent expansion). Despite last quarter's hiccup, ONI's meteoric rise undercuts claims that optical networking will be slow to break into the metro arena, and highlights one of the most contrarian investment opportunities in the Telecosm.

Charles Burger and Richard Vigilante

work Corvis eliminates additional expensive CoreDirector ports from Broadwing's network.

Hardly a "switch" at all in conventional terms, the Corvis optical cross-connect reportedly incorporates no MEMS mirrors or indeed moving parts of any sort. Using only familiar optical components including fiber Bragg gratings, which steer light by wavelength, it is apparently a passive, "prismatic" device. It thus offers confirmation of Simon Cao's insight that with hundreds of thousands or millions of lambdas on a network we must not run a "railroad" switching system, where the tracks move, but a highway system where the cars steer themselves over at least semi-permanent pathways.

ONI's power play

In the "express core" of the network, the switchless nirvana is on its way. But in the metro, where the bulk of grooming and add-drop functions are necessarily performed, SONET seems stickiest. According to most industry prognosticators, SONET will persist locally for years to come. Here emerges a huge opportunity for contrarian investors. Precisely because the metro arena is more active than the core, the SONET tax is higher and the advantages of sweeping it away greater. Suppose a typical 160 km SONET metro ring with 16 channels. Such a span in a long haul network might not incorporate a single SONET box since there would be no need to regenerate at such a short distance. But in a metro network there might be up to sixteen SONET nodes to groom, add and drop. At current—and rapidly declining—prices, replacing the SONET add-drop muxers with optical add-drops, and incorporating new advances in optical amplification yields a system costing less than 25 percent of the SONET version. Heightening the SONET/WDM conflict, the disparity grows as we add lambdas. A 32-channel WDM system with optical add-drop costs a mere 18 percent of the SONET architecture.

ONI is doing for the metro what Corvis is doing for the long haul, shedding electronic burdens where possible and using next generation optics to slash costs and provisioning times. ONI's "Broadwing" is breakthrough metro carrier **Sphera** for whom ONI recently lit an OC-192 circuit in New York City in 10 days, compared to the usual 60 to 90, never taking down a lit circuit. Crucial was ONI's automated measurement and adjustment of optical power levels that fluctuate when changes are made to the network.

Automated power control does to truck rolls in the metro what eliminating regenerators does in the core. The company's WDM system scales to a connectivity-rich 160 channels per fiber, well beyond current metro-network deployments. Plowing a quarter of revenues back into R&D, CTO Rohit Sharma is focused on cutting the cost of marginal lambdas by an order of magnitude over the coming year.

A 32 channel metro WDM system with optical add-drop costs a mere 18 percent of the SONET architecture

The cap-ex crunch is supposed to be the natural result of furious overspending from too many carriers competing furiously for traffic. Now, it is said, wiser heads will prevail and the capital markets will put their foot down against destructive competition and force a consolidation. But the real victims will be SONET and legacy system builders. No matter how essential SONET features like 50 millisecond restoration have been deemed up to now—no matter how Bell-friendly and painstakingly-Telcordia-certified the legacy boxes—customers will balk at the growing SONET tax.

Over the next couple of years the great divide between the costs of a SONET dependent network and sans SONET WDM will widen even more rapidly. The 58 percent—now apparently 79 percent—annual reduction in the capital costs of bits per second actually radically understates the cost-cutting, demand-building potential of WDM. As explained in last month's *GTR*, those annual cost reductions are based on comparisons between gross industry cap-ex and total network traffic. But SONET networking, whose costs decline much slower than WDM alone, has accounted for the overwhelming majority of carrier cap-ex. As the SONET waste drops out, the remaining cap-ex, dominated by WDM will add capacity far more efficiently, accelerating the annual percentage decline of bandwidth and connectivity costs. Operational cost reductions, only now measurable in next generation networks like Broadwing, will come into play, again accelerating the decline in the total cost of bits per second. Profiting will be an array of Telecosm companies which, after the worst of the recession is past, will be employed solving the cap-ex problem rather than suffering from it.

Telecosm vs. deflation

The flip side of the opportunity, alas, is that the grip of a global deflation depressing all prices and punishing all debtors imperils some of the best companies that could issue the most attractive bonds. (See Jude Wanniski's excellent essay "The Deflation Monster" at www.gilder.com.) In a world in which the still robust **Global Crossing** (GX) can be spoken of as a likely victim of the recession and **AT&T** (T), an efficient capital killer for the past twenty years, can see its stock rise more or less as a result, any evil thing can happen. The prudent Telecosm investor thus will take advantage of the market's current irrational pricing to invest across a broad swathe of companies set to benefit from The Great Divide, knowing that some of the most worthy may fall into the Telechasm.

At the heart of the opportunity are the WDM network builders. Central is tiny Corvis, with only a handful of customers including cash-starved Williams. Yet, Corvis also has the industry's most compelling story in Broadwing. Add ONI and relatively established Ciena for a risk-balanced trio of optical networkers that will gain market share as Nortel and Lucent's networking businesses wither with SONET. Ciena is not currently on the Telecosm Table (which is not a model portfolio but a list of paradigm exemplars) because it has treated lambda abundance as almost as much of a problem as Nortel has. But Ciena is the leading WDM company among those not bound to any Bell legacies, and will now be forced to move in Corvis's direction. ONI is taking market share from Ciena almost as rapidly as Ciena is taking it from Nortel. All three are trading at less than 10 percent of their 52-week highs.

Investing through the noise

Beyond the network builders virtually every company on the Telecosm Table benefits from accelerated reductions in the cost of bits per second. The optical component companies like **JDS Uniphase** (JDSU) and Avanex benefit enormously from a global shift toward WDM. The edge processors—**Altera** (ALTR) and **Xilinx** (XLNX), **Broadcom** (BRCM) and **EZChip** (LNOP), **Terayon** (TERN), **Cypress** (CY), and **Conexant** (CNXT)—all will thrive on the increased traffic.

For carriers the principle effect will be to boost traffic on that four to one price elasticity curve, but only the carriers whose networks lead the cost cutting will survive the price wars. Corvis customers like Broadwing, Williams, and now Qwest can gain an edge, though Williams could run out of cash before it can reap the rewards.

As if to silence Telecosm markets still roaring with irrational exuberance, comes now a nasty late hit from *Forbes* on the alleged accounting shenanigans of Global Crossing and other next generation carriers. At issue are so-called bandwidth swaps, whereby GX sells capacity to another carrier, say AT&T, and buys something back in return—wavelengths, dark fiber, or colocation, for instance. Since the income is booked immediately while the purchase is treated as a capital investment (to be depreciated over years), these transactions strike the sharp-eyed Sherlocks at *Forbes* as a scheme to pump up the income statement in order to allow Gary Winnick to dump some more shares of stock at puffed prices of over a dollar.

Unless, Global Crossing actually needs capacity from Oshkosh to Peoria, which AT&T has, while T needs a line from London to Frankfurt, which GX has. By buying from AT&T what they otherwise would have to build, GX is making a legitimate capital expenditure and taking a bite out of cap-ex. Originally budgeted at $5.2 billion, Global Crossing's cap-ex was reduced to $4.25 billion this year in part by such devices. Surely, it is better to

make the cap-ex purchase out of income from capacity sales than by adding yet more debt.

Global Crossing, after all, is in the business of turning raw capacity into income, which is what such IRU (indefeasible rights of use) sales do. Technically IRUs are long term leases, though the cash comes up front. In this case, having the most complete and coherent global network, Global Crossing sold some $400 million more capacity than it purchased. So the market should be happy and *Forbes* should calm down, right?

CEO John Legere and CFO Dan Cohrs have a real concern, which they talked through with us. Sometimes in eagerness to make a sale to another carrier, the first carrier will make a capacity or dark fiber buyback at a sacrificial price. Legere said that one reason for GX's bad 3Q revenue miss was that Legere, Cohrs and company, as a matter of policy, spurned a number of such marginal deals toward the end of the quarter. They also said no to several straight IRU sales where the demanded price was uneconomic.

GX's sell-by date

Regardless of the noise around the "reciprocal agreements," Global Crossing probably has two years left in which to prove that it commands a potentially thriving operating business. The company now has just short of $8 billion in debt and $2.4 billion in cash, including the $1.7 billion line of credit the company drew down this summer. In this, the last year of the network build out, it will spend another $1 billion on cap-ex in the fourth quarter, plus make interest payments of approximately $150 million. Assuming the worst possible case, zero EBITDA in the fourth quarter, and no IRU swaps at all to lay off some of the cap-ex, GX would end the year with $1.25 billion in cash.

With completion of the network, next year's cap-ex budget drops some 70 percent to only $1.25 billion, which is approximately equal to cash on hand at the beginning of the year, in this worst case scenario. But unlike this year's cap-ex budget, much of next year's is variable, consisting of the labor and equipment needed to light up lambda capacity for immediate sale, or to provide Internet services. No sales, no cap-ex, or at least a lot less. In addition, the company needs to come up with $600 million in interest payments. How daunting is this?

Last year, recurring adjusted EBITDA was $1.5 billion. In the first half of 2001 alone, GX sold $1.1 billion in IRUs at margins around 70 percent. Even in the disastrous third quarter, GX sold $250 million in IRUs. Next year it could make its interest payments and get through the year even if the entire business—IRUs and all—should shrink by 75 percent in the face of still booming Internet traffic. *Forbes* and the market are assuming World War III. But with World War III, Global Crossing could cut out half its cap-ex and pile up cash by selling assets. Planned asset sales, including IPC and Global Marine, the undersea cable laying group, for which there are already buyers lining up, should produce somewhere between $750 million and $1 billion, leaving GX's cash position at the beginning of 2003 better than 2002.

Ultimately, for GX to succeed, IRU sales must come back and the global Internet services business must take off, with GX winning contracts from *Forbes* 1,000 customers as the primary or secondary carrier, not just a few goodwill gambits tossed to the new kid on the block. Grim as it seems now, the IRU sales side is the most likely place for good news next year, in part because the Internet business, while growing 100 percent a year is still relatively small. Expecting total traffic growth of 75 percent this year, the world's carriers built their inventories accordingly a year or more ago. The recession intervened, overall traffic growth was closer to 50 percent, inventories clogged, carriers did everything possible to cut costs, and IRU sales fell off a cliff.

Today, however, most major carriers are running their networks at 50 percent of capacity or more. This rate is much too high for comfort for the bursty Internet data that is the target of Global Crossing's IP network. The Internet today is around 20 percent of the total growing four times faster than the rest of the business. But in the telopolies the bandwidth buyers are still playing chicken, looking for bargains from next generation carrier sellers desperate for revenue. Sellers, including GX last quarter, have begun to say no. Even with "modest" 50 percent a year traffic growth, the sellers that survive must eventually have their way, almost certainly before the end of next year.

Global Crossing probably has two years left to prove it commands a potentially thriving business

The triumph of WDM, accelerating the reduction in terrestrial bandwidth prices and producing a 4x increase in demand, can only help GX. It is far more difficult to add undersea than terrestrial capacity, as **360networks** (TSIXQ) and **Tycom** (TCM), among others, can testify, and GX's global "missing links" become far more valuable in a WDM world.

Most Telecosm companies now trade at prices reflecting the cap-ex collapse as if it were undifferentiated, as it might seem from afar. The recessionary noise in the signal—ONI and Corvis miss projections along with Nortel—creates confusion... and opportunity.

The only reason to actively manage your own investments, rather than just buying index funds with appropriate risk profiles, is to take advantage of brief and rare moments of market irrationality, such as when technological innovation upsets the market's normal brutal efficiency so that prices are briefly "wrong." That moment is now.

George Gilder and Richard Vigilante
October 18, 2001

TELECOSM TECHNOLOGIES

ASCENDANT TECHNOLOGY	COMPANY (SYMBOL)	REFERENCE DATE / PRICE		SEPT '01: MONTH END	52 WEEK RANGE	MARKET CAP
FIBER OPTICS						
Optical Fiber, Photonic Components	Corning (GLW)	5/1/98	13.64	8.82	8.23 - 112.67	8.2B
Wave Division Multiplexing (WDM) Components	JDS Uniphase (JDSU)	6/27/97	3.63	6.32	5.12 - 111.19	8.3B
Adaptive Photonic Processors	Avanex (AVNX)	3/31/00	151.75	2.96	2.75 - 131.00	192.5M
All-Optical Cross-Connects, Test Equipment	Agilent (A)	4/28/00	88.63	19.55	18.00 - 68.00	9.0B
Tunable Sources and WDM Components	New Focus (NUFO)	11/30/00	20.31	3.23	2.10 - 98.50	243.8M
Crystal-Based WDM and Optical Switching	Chorum (private)	12/29/00	—	—	—	—
WDM Metro Systems	ONI (ONIS)	12/29/00	39.56	4.03	3.50 - 111.13	555.9M
WDM Systems, Raman	Corvis (CORV)	3/30/01	7.03	1.52	1.19 - 89.50	547.4M
Metro Semiconductor Optical Amplifiers	Genoa (private)	3/30/01	—	—	—	—
Optical Processors	Essex (ESEX.OB)	7/31/01	5.90	5.85	1.50 - 6.70	29.0M
LAST MILE						
Cable Modem Chipsets, Broadband ICs	Broadcom (BRCM)	4/17/98	6.00*	20.30	19.00 - 262.00	5.3B
S-CDMA Cable Modems	Terayon (TERN)	12/3/98	15.81	7.19	2.36 - 41.94	491.7M
Linear Power Amplifiers, Broadband Modems	Conexant (CNXT)	3/31/99	13.84	8.30	6.90 - 47.00	2.1B
Broadband Wireless Access, Network Software	Soma Networks (private)	2/28/01	—	—	—	—
WIRELESS						
Satellite Technology	Loral (LOR)	7/30/99	18.88	1.30	1.03 - 6.56	433.3M
Low Earth Orbit Satellite (LEOS) Wireless Transmission	Globalstar (GSTRF)	8/29/96	11.88	0.25	0.20 - 11.19	27.4M
Code Division Multiple Access (CDMA) Chips, Phones	Qualcomm (QCOM)	7/19/96	4.75	47.54	42.60 - 107.81	36.2B
Nationwide CDMA Wireless Network	Sprint (PCS)	12/3/98	7.19 *	26.29	15.72 - 39.19	24.7B
CDMA Handsets and Broadband Innovation	Motorola (MOT)	2/29/00	56.83	15.60	10.50 - 33.00	34.4B
Wireless System Construction and Management	Wireless Facilities (WFII)	7/31/00	63.63	4.47	3.31 - 67.00	202.0M
GLOBAL NETWORK						
Metropolitan Fiber Optic Networks	Metromedia (MFNX)	9/30/99	12.25	0.34	0.30 - 26.94	208.4M
Global Submarine Fiber Optic Network	Global Crossing (GX)	10/30/98	14.81	1.80	1.89 - 32.50	1.6B
Regional Broadband Fiber Optic Network	NEON (NOPT)	6/30/99	15.06	2.74	2.16 - 38.06	58.5M
National Lambda Circuit Sales	Broadwing (BRW)	6/29/01	24.45	16.08	14.51 - 29.00	3.5B
Internet Backbone and Broadband Wireless Access	WorldCom (WCOM)	8/29/97	19.95	15.04	11.50 - 30.81	44.5B
STOREWIDTH						
Java Programming Language, Internet Servers	Sun Microsystems (SUNW)	8/13/96	6.88	8.27	7.52 - 61.94	26.9B
Network Storage and Caching Solutions	Mirror Image (XLA)	1/31/00	29 .00	1.06	1.00 - 21.69	120.3M
Remote Storewidth Services	StorageNetworks (STOR)	5/31/00	27.00*	3.96	3.65 - 111.75	383.7M
Hardware-centric Networked Storage	BlueArc (private)	1/31/01	—	—	—	—
Virtual Private Networks, Encrypted Internet File Sharing	Mangosoft (MNGX.OB)	1/31/01	1.00	0.49	0.34 - 8.13	13.2M
Massively Parallel Global Storewidth Solutions	Scale Eight (private)	8/31/01	—	—	—	—
MICROCOSM						
Analog, Digital, and Mixed Signal Processors	Analog Devices (ADI)	7/31/97	11.19	32.70	29.00 - 93.94	11.8B
Silicon Germanium (SiGe) Based Photonic Devices	Applied Micro Circuits (AMCC)	7/31/98	5.67	6.99	6.23 - 109.75	2.1B
Programming Logic, SiGe, Single-Chip Systems	Atmel (ATML)	4/3/98	4.42	6.68	5.48 - 18.44	3.1B
Single-Chip ASIC Systems, CDMA Chip Sets	LSI Logic (LSI)	7/31/97	15.75	11.75	9.78 - 34.88	4.3B
Single-Chip Systems, Silicon Germanium (SiGe) Chips	National Semiconductor (NSM)	7/31/97	31.50	22.00	17.13 - 43.50	3.8B
Analog, Digital, and Mixed Signal Processors, Micromirrors	Texas Instruments (TXN)	11/7/96	5.94	24.98	20.10 - 57.81	43.3B
Field Programmable Gate Arrays (FPGAs)	Xilinx (XLNX)	10/25/96	8.22	23.53	19.52 - 91.94	7.8B
Seven Layer Network Processors	EZchip (LNOP)	8/31/00	16.75	3.22	2.70 - 38.44	20.8M
Network Chips and Lightwave MEMS	Cypress Semiconductor (CY)	9/29/00	41.56	14.86	13.72 - 44.81	1.9B
Field Programmable Gate Arrays (FPGAs)	Altera (ALTR)	1/31/01	30.25	16.38	14.66 - 54.38	6.3B

* INITIAL PUBLIC OFFERING

NOTE: The Telecosm Table is not a model portfolio. It is a list of technologies in the Gilder Paradigm and of companies that lead in their application. Companies appear on this list only for their technology leadership, without consideration of their current share price or the appropriate timing of an investment decision. The presence of a company on the list is not a recommendation to buy shares at the current price. Reference Price is the company's closing share price on the Reference Date, the day the company was added to the table, typically the last trading day of the month prior to publication. Mr. Gilder and other GTR staff may hold positions in some or all of the stocks listed.

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