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Why Light Is Good, Why Electrons Are Bad

http://www.forbes.com/asap/00/0821/059-60sb.htm

By Kip Crosby

Why Light Is Good:

It's Lite. Light has almost no mass. In fact, it may have no mass, depending on whom you listen to.

It's Fast. Light travels--well--at the speed of light. If you're trying to build a fast computer, you can't do better than enlist the help of the fastest thing in the universe.

It's Colorful. Unlike electrons, photons can be had in an infinite variety of useful colors, each of which can carry its own data stream.

Why Electrons Are Bad:

Too Tiny. Before too long, a typical feature on a microprocessor will measure 0.1 microns wide--micron being short for micrometer, one-millionth of a meter (or 1/270,000th of an inch). That means new processes of making chips, such as X ray lithography, are becoming complex and expensive. Plus, smaller features are closer together, which speeds up circuitry but also makes the chip run hotter as electrons bang along their walls and create all sorts of weird neighborhood effects.

Too Hot. Electronics has three canonical enemies--heat, size, and weight--but heat is by far the worst. Electrons moving inl wire scuff against the inside of the wire and make heat. This is unavoidable--at least at room temperature, and it is too costly to maintain at cryogenic temperatures. Most of today's microprocessors have "hot spots," where electrons have to go around corners.

Too Pricey. At a billion bucks a pop, today's chip fabrication plants can still be cost-effective because what they produce has such high margins. But if, in the near future, lithography can no longer employ visible light, if silicon fabrication needs vacuum instead of air (and a few more "ifs"), then the figure of $200 billion per plant has been seriously mentioned. This is so much money that it's not clear such a plant would be worth building.

Cover Story

The Race for Fiberspace

Cisco, Nortel, Lucent...Who's Going to Own the All Optical Network?

http://www.forbes.com/asap/00/0821/065.htm

By Steven P. Pizzo

Picture yourself running a small technology startup, which you have headquartered in a rural community to keep costs down. Your product is anything but sexy--it's a bland-looking optical network switching box. The product has begun to attract customers, and with luck you hope to gross $10 million this year. Then the phone rings. The world's biggest company wants to buy your little company--for $7 billion. About now you figure the alarm clock will wake you up to the grim realities of another day of scraping by.

But this was no dream. It happened to Carl Russo and his small Petaluma, California-based company, Cerent, acquired last August by Cisco Systems. Unusual? Not these days. Hardly a month goes by that a Cerent-like story doesn't surface as Cisco Systems, Lucent Technologies, and Nortel vie for the leadership position in what is nothing less than the Holy Grail of the telecommunications industry: the all-optical network. Much of the existing worldwide network remains a cobbled conglomeration of new fiber-optic lines mixed in with older telephone-age technologies. This hybrid electrical/optical network is expensive and inefficient and eventually will be brought to its knees by the explosive growth of 21st-century Internet and multimedia traffic.

For those who can manage to deliver a cheaper, more efficient all-optical system, one that could well provide almost limitless bandwidth, the payoff could be huge, perhaps as great as $1 trillion in the next 20 years. So it's no wonder that Cisco, Lucent, and Nortel, as well as a bevy of independent wildcatters, have all established their own optical networking Manhattan Projects. It's also no wonder that almost daily they seem to proclaim another major "breakthrough" that makes them the "undisputed world champion" in the optical arena. But when the hyperbole and corporate spin are stripped away, a much more complicated and murky picture emerges. The all-optical network will, someday, be a reality--but what that will look like remains unknown. No matter how much they'd like to, none of the Big Three offers an end-to-end, all-optical solution.

The race, then, has really just begun, and even normally outspoken and opinionated telecom analysts shift nervously from foot to foot when asked which of the Big Three is on the winning track. Granted, it's a hard call, made all the more difficult by this complicated, fast-moving industry. Yet, even at this early stage, it is possible to handicap each of the Big Three and make a few educated guesses on who's ahead, who's behind, and who ultimately may be the winner. To do that, however, we first need to understand a little about how the network is broken up and what turf each of the Big Three claims as its own.

Analysts like to divide the network between its core (or "backbone") and its edge. Think of the network core as those long-distance stretches from country to country or city to city. This part of the network is currently the closest to being all-optical, using lasers and optical fiber to send data at the speed of light. The network core uses a technology called dense wave division multiplexing (DWDM), which sends an enormous number of unrelated signals of light down the same fiber, each identified by a unique color or wavelength. Lucent and Nortel hold dominant market shares in this part of the network, a legacy of their telephony roots. Cisco, meanwhile, has watched its share of the long-haul transport market shrink to just 10%.

At its core--no pun intended--the battle between Nortel and Lucent is a battle over bandwidth one-upmanship. Nortel was first, with a 10-gigabit-per-second transport backbone (a giga is a billion) and is now testing and marketing an upgraded 40-gigabit-per-second system. At that bit rate, 90,000 volumes of an encyclopedia could be transmitted in just one second. Lucent now has 10-gigabit-per-second systems, but since it missed the boat on the upgrade, the company is trying to leapfrog Nortel with an 80-gigabit-per-second system due this summer or early fall. By late 2001 or early 2002, both players will be pushing to be the first to deploy a 6.4-terabit (trillion bit) system.

Why all this bandwidth braggadocio? Because demand (and for the Big Three that means juicy revenue) is likely to keep up with supply. "The total bandwidth in the entire network--voice, video, data, everything on a global basis--in the next four years will need to grow from 100 to 200 times its current total capacity," says Don Smith, head of optical networks at Nortel. "What intrigues me is that what's there today is only 1% of what will be required by then."

Because it wasn't the first to market with the current standard (10 gigabits per second), Lucent has come under considerable criticism for its failure to seize the optical networking issue soon enough--and, when compared to Nortel, it is considered the underdog by many analysts.

"I won't lie to you. The company is all too aware of this," says Harry Bosco, president of Lucent's Optical Networking Group. "We were behind the eight ball when it came to 10-gigabit systems. But now we feel we are leading in DWDM systems and have a full family of products."

Where does this leave Cisco? Owning "the edge," the other part of the network. If the core is the long-distance part of the network, the edge is the local part, where light (and the data it carries) must be switched and routed to its destination. No one knows the network's edges better than Cisco. After all, Cisco has become one of America's most successful firms, thanks to a single product: the router, which, as its name implies, routes data to their correct destination. Without Cisco's routers there would be no Internet. Cisco's dominance in the router market has been compared to Microsoft's dominance of PC operating systems.

Glossary Of Terms

Core of the network: Often called the backbone, this is the long-distance part of the network.

"Delaminators": Generally small companies that, unlike the Big Three, are working for an open architecture in the all-optical network. Such an architecture would let the delaminators sell their niche technologies, as opposed to a full suite of products.

DWDM: Dense wave division multiplexing is an optical technology used to increase bandwidth over existing fiber-optic backbones. DWDM works by sending numerous, unrelated light signals down the same fiber, each identified by a unique color or wavelength.

Edge of the network: This is the local part of the network, where light must be switched and routed to its correct destination.

Fiber optics: Hair-thin fibers typically made of glass that light and data travel down. These fibers replace the copper wires employed in electronic networks.

Last-mile problem: The inability of businesses and consumers to access super fast fiber-optic cables at their offices and homes because of the high cost of building such a network.

Optoelectronic: The blending of photonics and electronics--photons for transmitting data and electrons for switching. This hybrid system is how our current communications network operates. In the future, our PCs also will be optoelectronic.

The Top 3: Lucent, Cisco, and Nortel

The Niche Players

http://www.forbes.com/asap/00/0821/065a.htm

By Steve Pizzo And Michelle Jeffers

Since the Big Three can acquire only so many niche players in the optical networking space, those they don't buy will have to compete against them. In that case, the only way these niche companies can succeed is to create an open system, like the Internet, that is not solely owned by the big players and will accept plug-and-play products from the smaller guys. The push to establish an open system is the driving force behind optical domain service interconnect, which maintains its own Web site at www.odsi-coalition.com. This coalition, spearheaded by Sycamore Networks, now has about 130 participants, the vast majority of which are private.

Here's a list of the coalition's top 15 public companies by market cap:

Alcatel (ALA) is the large French telecommunications company.
FY1999 sales: $23 billion.
Market cap: $13.7 billion.

Cabletron Systems (CS) sets up high-performance networks.
FY2000 sales: $1.5 billion.
Market cap: $4.6 billion.

Celestica (CLS) helps large companies design, prototype, assemble, and test electronic products.
FY1999 sales: $5.3 billion.
Market cap: $8 billion.

Ciena (CIEN) sells products for optical networks.
FY1999 sales: $482 million.
Market cap: $24.1 billion.

Corning (GLW) sells products ranging from those that go into optical networks to those found on your computer screen.
FY1999 sales: $4.4 billion.
Market cap: $79.2 billion.

Ditech Communications (DITC) sells products that facilitate communications over fiber-optic networks.
FY2000 sales: $116.9 million.
Market cap: $2.6 billion.

ECI Telecom (ECIL) makes digital telecommunication and data transmission systems.
FY1998 sales: $806 million.
Market cap: $2.7 billion.

GlobeSpan (GSPN) makes integrated circuits for digital subscriber lines (DSL), a technology that greatly increases bandwidth to the consumer.
FY1999 sales: $56.2 million.
Market cap: $8.0 billion.

Intermedia Communications (ICIX) provides a variety of Internet and network services, including connectivity and Web hosting.
FY1999 sales: $906 million.
Market cap: $1.6 billion.

ONI Systems (ONIS) develops communications networking equipment based entirely on optical technology for metro area and regional networks.
FY1999 revenues: $3 million.
Market cap: $13.5 billion.

Redback Networks (RBAK) helps companies deploy high-speed access to the Internet and corporate networks.
FY1999 sales: $64.3 million.
Market cap: $25.7 billion.

Siemens Information and Communication Networks (a division of the German firm Siemens AG, [SMAWY]) sets up voice and data networks.
FY1999 sales: $134.1 billion.
Market cap: $89.8 billion.

Sycamore Networks (SCMR) develops products for optical networks.
FY1999 sales: $11.3 million.
Market cap: $28.1 billion.

UUNET (division of WorldCom [WCOM]) provides a slew of network services.
FY1999 sales: $37 billion.
Market cap: $129.2 billion.

Williams Communications (WCG) provides voice, data, Internet, and video services to communications service providers.
FY1999 sales: $2 billion.
Market cap: $2.3 billion.

Among the companies in the ODSI Coalition, here are three private ones that analysts like.

ALIDIAN NETWORKS A 2-year-old startup out of San Jose, California, Alidian has technology that gives metro service providers more efficient bandwidth. The company is led by a former Lucent executive and has been financially backed by Institutional Venture Partners and Accel Partners.

AVICI SYSTEMS This high-end switch router company has filed to go public. Customers include AT&T, Enron, and Williams Communications.

TENOR NETWORKS This Acton, Massachusetts, company enables network service providers to deploy bandwidth wherever it is needed. The company has received more than $28 million in venture financing from North Bridge Venture Partners, Greylock, Matrix Partners, and others.

Cover Story

Why Did The Chicken Cross The Pond?

Bandwidth, bandwidth, and more bandwidth

http://www.forbes.com/asap/00/0821/077.htm

Niall McKay

One of the world's most advanced fiber-optic data networks isn't used by the military, space, or even high tech communities. Rather, it's used by Hollywood to carry pictures of lumpy gravy and crazy chickens.

Sohonet is the high-speed data network that recently played a leading role in the making of the claymation movie Chicken Run. It began life as a small network for London's special effects houses but now is used to transfer movie clips between studios in Los Angeles, where the films typically are produced, and the postproduction houses in London, which add special effects.

"For Chicken Run, we spent hours deliberating over whether or not the gravy should be lumpy or smooth," says William Sargent, chief executive of the Frame Store Group, a London-based postproduction facility. "Seems like an easy decision on the face of it, but the film was produced by Dreamworks SKG in L.A., shot on location at the Aardman clay animation studios in Bristol [England], and the lumpy gravy was added by our special effects wizards in London."

With Sohonet's high-speed network, team members were able to send, almost instantly, high-resolution images among the three locations. As a result, they could make quick decisions, saving precious time and money in the process.

For decades, London's Soho district has been the world's capital for high-end special effects, with dozens of boutique postproduction houses located in the half-mile-square area south of Oxford Street. The problem is that Hollywood is 10 hours by air, and eight time zones away. So movie companies can lose weeks during postproduction, shipping computer hard disks and digital tape back and forth between continents.

Full-motion movie clips (along with seismic data used by geologists) are among the largest frequently used files known to man and take the most time to transfer. Transferring a minute of Chicken Run film is the equivalent of transferring a CD every two seconds. Until now, the postproduction and special effects process was arduous and time-consuming. Live action footage shot on film was transferred into a digital format in one facility, then couriered to a second facility where the special effects were added. The rough cuts were then sent to the client by courier for suggestions and changes, and the process would begin again.

That changed with Sohonet, which was cooperatively built in 1995 by London's postproduction houses. Sohonet uses fiber-optic cable to firehose data down the line at the speed of light. This technology, combined with wave division multiplexing (a method of using different colors of light to split glass cabling into many different channels) and with rooftop infrared laser technology, makes Sohonet the most advanced commercial network of its type in the world.

Transferring film with Sohonet gets faster and cheaper each month. Within the next six months, Sohonet's staff plans to upgrade the network so that it will transfer pictures at speeds of one gigabit per second between London and Tinseltown.

Then, as Hollywood's special effects wizards leave for the evening, they will be able to transfer footage to production houses in London, which will work on the film and have it back to the studios by morning, U.S. time.

"Sohonet is the Internet for the movie business," says Jon Ferguy, Sohonet's head of technology. "It will change forever the way that people make movies."

Niall McKay is a San Francisco-based writer and journalist who covers science and technology.

An Enlightening Guide ***Illuminating the uncharted terrain of optics***

http://www.lightreading.com/ …and….
http://www.lightreading.com/document.asp?doc_id=335

Peter Heywood

The optical networking industry is a strange new world, even to the people working in it. Half of them are experts in Internet infrastructure, and the other half understand fiber optics. Few understand the whole story. For those trying to figure out the likely winners and losers in this space, that's a dangerous state of affairs. A poor understanding of who's doing what is bound to result in some costly mistakes. The solution? Get a reference guide. Here's ours:

DENSE WAVE DIVISION MULTIPLEXING (DWDM)

This technology boosts the carrying capacity of networks by packing multiple wavelengths of light into a single strand of fiber. DWDM is already widely used in long-distance networks, and it's starting to be used in metropolitan networks.

Currently, 40 wavelengths per fiber is commonplace, but systems for carrying hundreds of wavelengths are under development. A large number of wavelengths isn't always a good thing. It can reduce the carrying capacity of each wavelength. Also, more wavelengths mean more equipment at either end. Advances are being made in extending the distance over which DWDM systems can operate. Right now, light pulses can't travel more than a few hundred miles before they become too weak to be identified properly. As a result, the light pulses have to be strengthened by converting them into electrical signals and then converting them back to photons before retransmitting them. This requires expensive equipment. Anything that stops or cuts down on this conversion is a great cost saver.

SELECT PLAYERS

Adva Fujitsu OptiMight Alcatel Hitachi PhotonEx Ciena Lucent Qtera Cisco Systems Marconi Sorrento Networks Corvis NEC Sycamore Networks Ericsson Nortel Networks Xtera Communications

EDGE SWITCHES

As the name implies, these devices sit at the edge of the optical backbones (see "Glossary of Terms"), acting as gatekeepers for a variety of services, including telephone calls and Internet access. They also enable telecom operators to guarantee the performance of their services, and collect traffic statistics so they can bill their customers.

SELECT PLAYERS

ADC Cisco Systems Mahi Networks Appian Cyras Systems Nortel Networks Astral Point Dynarc Redback Networks Chromatis Networks Fujitsu Sirocco Systems Ciena Geyser Networks Tenor Networks

PASSIVE OPTICAL NETWORKS

This equipment offers a low-cost way of connecting customers to optical backbones. Instead of connecting each customer with a separate fiber, up to 32 of them share a single fiber. Each one gets a separate wavelength or data stream. This equipment is called "passive" because the key component--the device that splits the light into different wavelengths--doesn't require any electrical power. It works like a prism, splitting light into different colors. No power means there's nothing to go wrong or wear out. It also means the device can be installed in places where there's no electricity supply, like manholes in the road. More often than not, that's precisely where the prism sits, in a manhole adjacent to a cluster of buildings. It's also where the prism directs each of those 32 wavelengths or datastreams to the appropriate buildings near the manhole.

THE PLAYERS

Alcatel Lightchip Paceon Alloptic Lucent Quantum Bridge CS Telecom Marconi Terawave Fujitsu NEC

OPTICAL SWITCHES

These devices switch light as it travels down the optical backbone in the same way that trains must be switched to run from, say, New York to Los Angeles. There are two broad categories:

Optical switches with electrical cores. These convert light pulses into electrical signals in order to switch them. This technology is the more developed of the two. It is also more granular, capable of switching fairly small streams of traffic within a wavelength of light. But it may not be able to handle the huge increases in traffic expected in years to come.

All-optical switches. These steer light pulses between fibers without converting them into electrical signals (see above). They have enormous potential to cut costs (no need for equipment to make the conversion) and greatly speed up the network. But there's a big question mark over whether they'll ever win widespread acceptance by telecom companies because the technology is so novel and unproven.

There's a big drive toward boosting the capacity of both types of switches, so they can handle the massive increase in wavelengths resulting from the deployment of DWDM. There's also a big drive to develop software to control whole networks of switches, so that telecom companies can slash the time it takes to install connections.

THE PLAYERS

Optical switches with electrical cores:

BATM Ciena Sycamore Networks BrightLink Networks Cisco Systems Tellium

All-optical switches:

Calient Networks Ilotron Nortel Networks Corvis Lucent Siemens

OPTICAL SWITCHING SUBSYSTEMS

Cutting-edge technologies form the core of all-optical switches. They include:

MEMS (micro-electro-mechanical systems). These arrays of tiny mirrors can be tilted very accurately to deflect beams of light from one fiber to another. The technology is already used in very large video screens at sports events and pop concerts.

Liquid crystals. Electric currents alter the properties of liquid crystals (like those in your laptop screen) so that light passing through them is polarized in different ways. Passive optical devices then steer each wavelength of light one way or the other, depending on its polarization.

Tiny bubbles. These act like mirrors, glancing light onto intersecting paths as they traverse microscopic troughs carved in silica. The bubbles are generated using ink-jet printer technology.

Thermo-optical switches. This technology fuses together two lengths of fiber to form a Y-shaped junction. Light is carried up the leg of the Y and is diverted to the left or right depending on the refractive index of the glass, which is altered by heating it using an electrical coil.

Tunable lasers. Normal lasers pump out light at a fixed wavelength. Tunable lasers can pump out light at a variety of wavelengths and can switch between wavelengths very quickly in some cases. This can be used to create the equivalent of an actual switch, by steering different wavelengths of light on different routes.

Sound waves. Another technology used in very large video screens. This one uses sound waves to divert beams of light being shone through a crystal.

SELECT PLAYERS

MEMS: Astarte Fiber Networks, Cronos Integrated Microsystems, C Speed, Onix Microsystems, Optical Micro-Machines

LIQUID CRYSTALS: Chorum Technology, Corning, SpectraSwitch

BUBBLES: Agilent Technologies

THERMO-OPTICAL SWITCHES: JDS Uniphase, and many others

TUNABLE LASERS: Agility Communications, Altitun, CoreTek, Marconi

SOUND WAVES: Gooch & Housego, Light Management Group

OPTICAL COMPONENTS

These are the building blocks for making complete optical systems. There are dozens of different devices, but they fall into two groups--"active" ones that require power to work and "passive" ones that require no power. Vendors are investing billions of dollars in optical component manufacturing plants, which is just as well. Demand is outstripping supply and current processes are labor intensive.

SELECT PLAYERS

Alcatel Optronics JDS Uniphase Nortel Networks Agilent Lucent SDL Corning

OPTICAL INTEGRATED CIRCUITS

In a rerun of the early days of the semiconductor industry, optics vendors are developing ways of making the optical equivalent of integrated circuits. Currently, vendors have to buy separate components to do things like generate light, break it up into pulses, and boost its strength and clarity. In the future, they'll be able to give the design to a semiconductor vendor who'll make a chip that will do all these things. Such a chip will eliminate a lot of time and cost, and the result will be much more reliable and much, much smaller--a big issue for telecom operators whose buildings are crammed to the ceilings with equipment.

SELECT PLAYERS

Bookham Tech. Lightpath Tech. Lumenon Innovative Lightwave Tech. Kymata Lightwave Microsys. Nanovation Technology

TIPS ON SHORT-TERM INVESTING

A few non-U.S. optical companies are likely to go for a Nasdaq listing in the coming months. They look undervalued in comparison with their U.S. counterparts. One of them is the UK's Marconi. Another is Israel's BATM.

Some big takeovers are also in the cards. It's possible to figure out likely candidates by examining portfolios. Some startups that have had IPOs and now have enormous market caps (e.g., Sycamore and Juniper) are anxious to broaden their portfolios. On the other hand, some of the monster vendors need to buy their way in to new markets. Cisco, for instance, doesn't make optical components and will probably have to find a way of securing a supply.

TIPS ON LONG-TERM INVESTING

One of the safest bets is to buy shares in one of the companies that manufactures optical equipment on behalf of vendors. These companies include Adept Technology, GSL Lumonics, and Keithley Instruments. These companies are a good way of avoiding dependence on a technology that ends up going sour. Component vendors offer similar benefits.

Peter Heywood is founding editor of Light Reading, an online analytical source for optical networking (www.lightreading.com).