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What fiber glut?

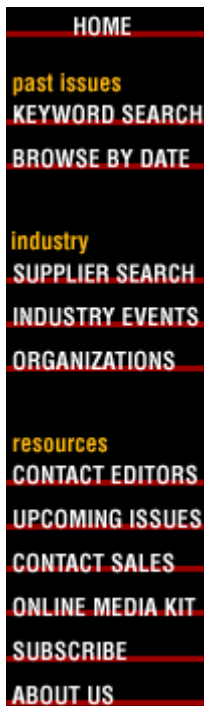
Fiber development gives copper a run for its money.

By Rick Muscoplat

There's no sound of screeching tires, no smell of nitro in the air, but there's no doubt that when it comes to the competition between electrons and photons, the race is on. And like a driver putting the pedal to the metal, this competition is pushing today's technology past the red line of tomorrow. The purse is large, the players competitive, and the lure of "ever faster" speeds the addiction.

It's a race for the likes of Tim (the "Tool Man") Taylor, complete with toys such as erbium doped optical amplifiers (Arrggghh! Arrggghh!), regenerators and dense wavelength division multiplexed (DWDM) superchargers. You've even got your basic dispersion-correction gearbox to upshift those hormone-crazed lightwaves and keep them from tailgating one another. Throw in a few multiple-fiber thermal strippers, a fusion splicer and a player named Pirelli, and it feels just like Memorial Day at the Indianapolis Brickyard.

But this race won't be won by a quick turn of a wrench or an extra two degrees of suspension toe-in. Those days of minor tweaking and fancy footwork are gone forever. This is high technology at its finest, with laser "timing lights" wielded by physicists and photonics engineers, and glass core index profiles calculated by scientists with designer pocket protectors.



Two years in the pits

Like automakers caught short by the exploding demand for sport utility vehicles, fiber manufacturers were unprepared for the huge increase in demand for their products. The painful shortages and allocations of the past few years frustrated everyone. It had all major players, such as Corning, Lucent and Pirelli, scrambling to put more production capacity online and fast. Corning, for example, recently fired up a major expansion at its Wilmington, N.C., facility and is scheduled to open a completely new plant in Charlotte by the end of the decade.

It's more than just an issue of adding more manufacturing square footage, however. Manufacturers have been heeding the call to lower attenuation, improve fiber concentricity and pack more fiber into every square inch of cable. These production improvements have resulted in significant investments in new process monitoring and manufacturing equipment. Between brick and mortar and new equipment, the Wilmington and Charlotte plants reflect a capital investment by Corning in excess of \$1 billion. With last year's announcement of a \$350 million expansion at its Atlanta Works facility in Norcross, Ga., Lucent has increased its global fiber-optic production five-fold since 1991.

That kind of expansion has brought fiber supply and demand into a more comfortable equilibrium. Back-orders are now at a two-year low and fiber prices are beginning to fall. At the same time, DWDM is being installed at staggering rates. In a very short period of time, we've seen added supply and quantum leaps in carrying capacity of existing fiber. Does that translate into lower demand for fiber? Should we

expect to see a fiber glut in the near future? Hardly. Consider these three market factors:

- The demand for bandwidth continues to increase at exponential rates and is predicted to do so well into the future.
- Asynchronous digital subscriber line (ADSL) is picking up steam by leaps and bounds, proving that copper's demise has been greatly exaggerated. Copper not only lives but, ironically, has actually increased the demand for more capacity in the fiber backbone. Rate-adjusted ADSL is sure to result in an explosion of residential and business traffic load onto backbone and wide-area network (WAN) fiber-based networks.
- Recently introduced ultra-high-tech fibers offer buyers some significant competitive advantages for the future.

She's real fine, my 409

In racing, it's all about cubic centimeters, horsepower, and top end speed. Lest we think that the telecommunications industry is immune to such ratings, you need only glance at the latest manufacturers' brochures to see that we, too, have developed a similar case of insecurity - fiber-count envy being but one of the many symptoms.

So it made perfect sense when Pirelli upped the ante on 288-fiber-count cable by introducing its 432-count cable. Whether you blow it or pull it, that's a significant reduction in labor. Turning right around with another market coup, Pirelli recently stunned the same marketplace with its new RILT - high-count Ribbon In Loose Tube cable. In addition to a chest-pounding count of 720 fibers per cable, the new RILT also eliminates core flooding gels,

making installation cleaner and faster.

Going the distance

One of the more fascinating aspects of the race to build tomorrow's fiber-optic network is the fact that we're talking huge distances - city to city, coast to coast and continent to continent. In these long runs, the cost of the raw fiber pales in comparison with the cost of labor and rights of way. But to the fiber manufacturers, getting the contract for thousands of kilometers of fiber is what this race is all about.

When companies such as Williams Communications and Level 3 Communications let it be known that they're in the mood to buy 400,000 and 2 million kilometers of fiber, respectively, you can understand why fiber manufacturers pour so much money into R&D -- they need the technological edge to pull down those kinds of contracts. Product improvements in long-distance fiber not only reap greater returns on investment because of higher prices, but also result in the large opening orders that justify new equipment and added plant capacity. Both Williams and Level 3 purchased Corning's new non-zero dispersion shifted fiber with large effective area fiber (Corning LEAF).

Where the rubber meets the road

LEAF technology represents a major departure from conventional fiber manufacturing techniques. In long-distance applications, the major issues are signal attenuation, dispersion and non-linear effects, including four-wave mixing (FWM), self-phase modulation (SPM) and cross-phase modulation (XPM) which are among the most troubling. Conventional non-zero, dispersion-shifted (NZ-DSF) fibers address the dispersion and non-linear

effects issues, but they cannot completely solve the nonlinearity problem.

Increasing light intensity which arises from increasing data rates and channel counts in DWDM systems can overcome the inherent capabilities of conventional NZ-DSF with smaller effective area the attenuation problem, but it does so at the cost of nullifying the corrections inherent in NZ-DSF. In fact, fiber non-linearities are directly proportional to light intensity. So, the more you pump up light intensities, the more you have to fight all non-linear effects.

Corning's approach with LEAF is to increase the light-carrying cross-section (its effective area) to manage these inherent increases in light intensity. With an increase in light-carrying effective area to 72 square microns, LEAF has almost a one-third increase over the closest competing product.

It has a larger mode-field diameter, but that alone does not explain the increased effective area. LEAF technology is far more than just more of the same glass. Corning starts with a triangular core surrounded by dual rings of high-index glass. The inner triangular core provides extremely low attenuation, while the dual high-index rings distribute light from the central core out to provide a larger field distribution. The result is a larger effective area of light transmission that is more efficient in total than merely the increase in fiber mode-field diameter. Since the fiber has a larger effective area, customers may opt to increase light intensities without aggravating non-linear effects.

The higher tolerance of Corning's LEAF to increased light intensity also provides a gain an advantage of 1dB to 2dB, and thus can achieve

greater distances between amplification and regeneration sites. One Corning customer reports that LEAF allows the company to go one amplifier span farther before regeneration. More miles per gallon and better traction in snow? Corning says yes to the efficiency issue, but defers to Pirelli on the question of traction.

Lucent goes into overdrive

Using a proprietary ultrapurifying manufacturing process that eliminates water peak attenuation in glass fiber, Lucent's newest AllWave fiber offers 50% more wavelengths, opening up the entire spectrum between 1280 nm and 1625 nm. Figure 1 shows how conventional unshifted fiber encounters a sudden signal loss at the 1400-nm range. Figure 2 shows a more acceptable attenuation curve with AllWave technology. Lucent also keeps dispersion low, reporting that transmission in the 1400 nm spectrum has one half as much dispersion as might be encountered with conventional fiber in the 1550 nm band. The extremely low dispersion allows signals to travel twice as far without compensation.

With full-spectrum 400-channel DWDM capabilities and low dispersion, Lucent is billing its AllWave fiber as the perfect short-haul metro cable. When combined with Lucent's upcoming WaveStar All-Metro OLS DWDM network equipment, local operators reportedly can provide multi-terabit service at cost-effective rates. Lucent hopes to have its WaveStar All-Metro equipment available in late 1999.

In the meantime, interest in AllWave fiber is strong among cable TV (CATV) and fiber to the home (FTTH) buyers. The ease with which AllWave can perform optical adds/drops and pass throughs may

make it an attractive choice for metropolitan markets. Lucent's recent press announcements reveal advanced talks with at least one regional Bell company and several CATV companies.

Not to be outdone in the long distance arena, Lucent's TrueWave RS fiber continues to rack up sales gains. TrueWave RS is a reduced slope fiber that reduces signal spread in the 1530 nm to 1620 nm range. Lucent recently completed an agreement with Viatel Inc., to supply TrueWave RS to Viatel's Circe pan-European Network connecting Antwerp, Amsterdam, Brussels, Cologne, Dusseldorf, Essen, Frankfurt, London, Nancy, Paris, Rotterdam, Strasbourg and Stuttgart.

The Indy infinity

One thing is sure in today's race: As soon as you bring yourself up to speed on one technology, you'll find at least one new one around the bend. If this pace continues, we'll be seeing new fiber product introductions every six months. That point seems to have been lost on a few authors whose recent articles and special reports have suggested that the small number of fiber manufacturers have the market cornered simply because they control the patents. Rest assured, we're told, that the fiber market will open up to new competitors once the patents expire in the very near future. Then, we are told, real competitors will enter the market and prices will tumble. Don't hold your breath.

That argument makes as much sense as thinking that James Bond's Aston Martin is still your best bet for evading world-class criminals. Sure, it can blow a smoke screen and lay down an oil slick, but that's pretty outdated technology. Wouldn't you rather have Bond's latest BMW-the one with the guided

missiles? That's the point. When technology advances come every six seconds, no company can depend solely on patents to blow away the competition.

Starting up a fiber optic manufacturing plant isn't like starting up some microbrewery in your basement bathtub with \$500 worth of hops and yeast. The capital investment in fiber-optic plant and equipment is astronomical, which is the real reason why fiber production seems to be concentrated among only a few players. To think that the expiration of a few 17-year-old patents will change that is as naive as quitting your job because your horoscope said you'll be winning the lottery this weekend.

The inventor Jack O'Neil used to say, "You know you're on firm foundation when you have your feet firmly planted in mid-air." Think about that the next time you hear some prognosticator predict the end of copper, the takeover of the network by ADSL or the demise of a fiber manufacturer because its patent expired.

No one knows what new technology will leap off the front page of tomorrow's newspaper. But at least for today, this much we do know: Companies are burying fiber as fast as it comes off the production line. Fiber makers are changing fiber construction and manufacturing techniques as soon as the new designs fly out the laboratory door. Finally, we know there is no checkered flag in sight. If you're in this race for the long haul, you'd better fuel up, buckle up and pack a lunch.

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