LIGHT AT THE DAWN OF THE INTERNET

The Foundation

What innovation led to the explosive growth of the Internet?

Some would say the Mosaic browser, introduced in January 1993. Others cite the free release, by Tim Berners-Lee, of the World Wide Web (WWW) on April 31, 1993. While these garnered well deserved recognition, let us consider another, less well known candidate.

A few months after the arrival of the browser and the free Web, Dr. David Huber and Kevin Kimberlin began working together to make high-capacity optical networking systems. Based on Huber’s pioneering research at General Instrument and Optelecom Inc. (the firm started by the inventor of the laser,) they launched a new company -- filing their corporate charter and issuing its founder’s shares to Huber and Kimberlin on November 12, 1993. And so CIENA Corporation sprang to life.

An initial equity investment by Spencer Trask affiliates was followed by the strategic and venture firms noted in Fiber Optics and Communications: “Prior to the IPO, private equity investors following Spencer Trask included AT&T Venture affiliates, Siemens AG Venture affiliates and Sevin Rosen.” Spencer Trask & Co. rounded out the start-up funding with a $3 million equipment lease from Dominion Ventures.

The Breakthrough

With this firm footing, CIENA hired 15 people and licensed 28 patents developed by Dr. Huber. The team, then led by CEO Pat Nettles, set out to make a revolutionary communication system.

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based on light. It was inspired by Albert Einstein’s concept -- the stimulated emission of light -- the cornerstone of both the laser and the optical amplifier. Determined to master such devilishly complex physics, the CIENA engineers attacked the gating question: how to regenerate these stimulated light waves over vast distances? They sweated for two years, finally emerging from their lab with a crown jewel: their elegant, dual–stage, all-optical amplifier. It could scale fiber bandwidth by orders of magnitude.

The patent for this dual-stage amplifier was filed on November 13, 1995. Sensing a landmark event, technology pundit George Gilder proclaimed its significance:

“Popularized by Ciena Corporation....the all-optical amplifier.... is an invention comparable to the integrated circuit.”

The Partner

To commercialize their optical breakthrough, Dr. Huber and Pat Nettles needed a customer with real backbone -- a fiber-optic backbone specifically. Their timing was perfect: just as a ravenous hunger for bandwidth emerged from three distinct corners.

(1.) Commercial -- After Tim Berners-Lee unleashed the WWW, the number of Web servers in the world quickly rose from 500 at the end of 1993 to 10,000 by December 1994. Because it ran the first long-distance commercial Internet service, Sprint Corporation was well positioned to serve this new demand. Needless to say, CIENA zeroed in on Sprint.

(2.) Academic -- Then on May 31, 1995, the nation’s high-speed optical backbone -- run by the National Science Foundation -- completed its handoff to commercial operators. This was a major shift: from its beginning, the NSF backbone had been reserved exclusively for academic and government users. But with this commercial transition, SprintLink and the “Sprint and Washington D.C. Network Access Points....began to carry much of the traffic for the U.S. Internet.”

These two developments -- the World Wide Web and a newly privatized NSFNET -- caught Sprint planners flat-footed. In one year (between 1992 and 1993), their fiber utilization had grown from 55% to 65% and by 1995, certain routes were completely overloaded. Sprint’s Director of Network Planning, Doug McKinley succinctly laid out the problem, “We had huge customers

5 United States Patent #5696615; “Wavelength division multiplexed optical communication systems employing uniform gain optical amplifiers.” (USPTO)
7 http://www.merit.edu/research/nsfnet_article.php
(who) wanted everything -- voice, video, data -- and they wanted it fast. How were we going to give them the capacity they needed?"

He found the answer by establishing a partnership that would change the world -- "teaming with CIENA....developing high-capacity fiber-optic transmission systems called Dense Wave Design Multiplexing (DWDM)."8 Making good on their end of the bargain, the CIENA team incorporated their dual-stage optical amplifier into a 16 channel wave division configuration. After several tests in Sprint’s live backbone, they pronounced the results an overwhelming success, as reported by The New York Times:

"Ciena is the first company to market with a technology called wave division multiplexing....This is definitely the best way to transmit more information over a fiber optic network...”9

(3.) Consumer -- Sprint then took one more leap, its confidence bolstered by the prospect of much more bandwidth. On August 20, 1996, just 8 weeks after CIENA delivered the first-ever scalable DWDM system, Sprint made its “comprehensive Internet capabilities directly available to the general public.”10 Only 200,000 residential customers were invited to ‘test-drive’ the new service, so it received little notice at the time. But nonetheless, it opened up Sprint’s high-speed, low-cost communication network to all comers.

Together, these three data streams -- from its enterprise, government and consumer users -- all converged in the summer of 1996 to make Sprint "the world's largest carrier of Internet traffic.”11

This was the dawn of the popular Internet.

The Public Offering

By scaling Sprint’s network, CIENA grew rapidly. “As far as we can determine, this is the all-time record for a revenue ramp by any company,”12 a Goldman Sachs analyst noted about CIENA's first year of shipments. In order to pursue the opportunity it had created, CIENA went public -- completing what The New York Times said was “the largest stock offering by a start-up in history”8 -- an IPO that the Wall Street Journal called “one of the

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8 Dense Wave Division Multiplexing; https://aresu.dsi.cnrs.fr/IMG/pdf/dwdm_ciena.pdf
10 http://www.thefreelibrary.com/Sprint+announces+plans+to+launch+consumer+Internet+service.-a018607156
11 ibid
biggest payouts in venture capital history.”

**Free Communications**

We are now in a position to determine which innovation is most responsible for the explosive growth of the Internet. Consider its seminal developments: the ARPANET and optical fiber (both arriving in 1969), and five years later, the Ethernet and TCP/IP protocols. Several browsers emerged, as did the World Wide Web. These, and other advances were necessary first steps, certainly. But people using the networks in those early years lumbered along on what can only be described as a 'slow-lane'. Fundamental as these primordial developments were, it is hard to attribute to one of them undue credit for the explosion of communications that began in the mid-1990s.

But then something startling happened. Beginning in the mid-1990s, Dense Wave Division Multiplexing harnessed the speed of light. With that, data transmission efficiency in single mode fiber -- measured in bits per dollar -- rose some 40,000 fold. For all intents and purposes, this pushed the cost of sharing information to zero.

CIENA was chartered in 1993 to make this possible, at a time when the Internet carried a mere 1% of all telecom traffic. By 2008, it was 97%. In those few short years, DWDM became the basis of all high-capacity metro, regional and long distance systems. \[14\] This high-capacity comes from dividing and multiplying light with countless optical amplifiers, the 'integrated circuits' integrated into the very fiber that transports most of all human communication. \[15\] Bedrock of the Information Age, it is fair to say that these light-powered networks are to the 21st Century what electricity-powered networks were to the 20th -- the infrastructure for modern civilization.

With these thoughts in mind, we come to an inevitable conclusion: open DWDM enabled the explosive growth of the Internet and serves as its foundation today.

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Adapted from the upcoming book “How to Morph the World”

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15 Optical Fiber Telecommunications Volume VIB: Systems and Network; edited by Ivan Kaminow, Tingye Li, Alan E. Willner, page 1.