SBIR · STTR America's Seed Fund

U.S. DEPARTMENT OF ENERGY | SBIR/STTR Programs Office

Fiber optic interconnects are cables made of glass optical fiber with a connector at each end. They have replaced most Cu cables in data centers because of their higher bandwidth, which allows for data transmission at rates of 400 GB/s without significant signal losses. Fiber optic interconnects are the most numerous device in a data center, totaling hundreds of thousands of cables connecting all the servers with switches and storage devices. Today these cables are managed using manual processes, which are highly inefficient, particularly as data centers scale. Hardware upgrades, migrations, scaling, and new customer requirements demand daily managing of interconnects. However, because connections are made manually, with an inherent risk for human error, many companies delay modifying connections, which negatively impacts network performance. Telescent was founded to address this opportunity with a clever, innovative solution.

FACTS

PHASE III SUCCESS
While working on their 3rd SBIR Award, Telescent reported $5M in product sales and $13M in Angel investments, a 5X return on the SBIR investment. Product sales are projected to reach $250M in 4 years.

IMPACT
Using innovative algorithms and special robotic designs, Telescent has introduced a fiber optic cross-connect capable of automating the physical layer of fiber optic connections in data centers, eliminating current inefficiencies linked to manual operations.

DOE PROGRAM/OFFICE
Advanced Scientific Computing Research (ASCR).

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The technical challenges involved in robotically reconfiguring fiber optic strands without physical entanglement has stymied progress for several decades at the leading telecom research laboratories in the U.S. and Japan. Telescent was founded in 2008 by Dr. Anthony Kewitsch and Prof. Amnon Yariv with the vision of automating the physical layer of fiber optic connections by leveraging software sophistication rather than hardware complexity.

An N × N optical interconnect switch connects any of N optical inputs to any of N optical outputs in a one-to-one optically transparent and arbitrary fashion. The challenge consists in rearranging thousands of optical fiber strands within the volume of the interconnect switch so that each strand passes through without entangling with other strands. Telescent's key breakthrough is a framework for modeling fiber strands based on a topological mathematical representation used in String Theory and DNA folding/unfolding, namely the Theory of Knots and Braids, which yields the required strand reconfiguration algorithm. This was the genesis for the Telescent KBS (Knots, Braids, Strands) algorithm, which enables a system with thousands of fibers to be arbitrarily reconfigured while uniquely scaling as N, a significant advantage over the N^2 scaling of other non-blocking cross-bar switches. Before Dr. Kewitsch demonstrated the validity of the KBS algorithm using mathematical rigor, many experts in the field believed Telescent's approach was impossible. Telescent's unique contribution in this field was published in the Journal of Lightwave Technology[*] and led the company down the path to product realization and commercialization. Telescent's innovative, software-intensive approach makes it possible to reduce optical complexity to the lowest possible level, eliminating costly and signal-degrading lenses, micro-electro-mechanical mirrors, micro-optics, and precision opto-mechanics. In this way, Telescent was able to bootstrap its operations and quickly introduce the largest scale (1008 × 1008 ports) automated fiber optic cross-connect ever produced.

With early commercial interest of Verizon, support from the U.S. Department of Energy (DOE) SBIR Program, and an exceptional team of software and hardware engineers, Telescent set forth to commercialize this technology. Software modularity, reliability, and manufacturability using industry-standard, scalable processes were the focus of the company's efforts. Engineering a system of thousands of dynamic fiber strands, each strand having a minimum bend radius, low friction, and suitable wear resistance, proved to be technically challenging. "Developing the robotics to enable the reconfiguration of strands was the hardest part of the project" explains Dr. Kewitsch, "because a special robot design had to be developed *ex novo* to manipulate the strands in a reliable way." The resulting patent portfolio for Telescent totals 38 patents and is growing.

Telescent has received three SBIR Awards from DOE's Advanced Scientific Computing Research (ASCR) for a total of $4M in funding, and it is currently in the Phase IIB of the third Award. Dr. Kewitsch describes ASCR's Richard Carlson as a visionary Program Manager for recognizing the merit and innovation of Telescent's proposal. He also defines the SBIR grants as critical for enabling Telescent to exist and grow as a company. The first Phase I alone gave the company the credibility needed to get some investors interested. At the end of the first Phase II, Dr. Kewitsch had been able to raise $400k, and the following SBIR Award opened up the door to significant Angel investments.

The recently introduced Telescent G4 Network Topology Manager (NTM) is the result of an intensive, multi-year engineering tour de force supported by $13M in Angel investment, in addition to the SBIR support. The Telescent G4 NTM has proven to be a highly reliable, Telcordia-qualified system, suitable for high availability operational networks. It exemplifies the growing reliance on robotics and artificial intelligence across all market sectors. The NTM is now deployed across the globe in 15 large-scale data centers, and the number of deployments is rapidly growing. Verizon is one of the current clients with 5 systems already in place. Present sale revenues total $5M and Telescent is on an aggressive growth trajectory set to exceed $250M in revenues in 4 years. Use cases include automated traffic engineering, troubleshooting, fast provisioning, as well as advanced data center architectures optimized for high utilization and efficiency.

Ongoing SBIR R&D focuses on increasing the number of fibers from 10^3 to 10^4, and on introducing radio frequency identification (RFID) technology. Data centers have millions of cables but the record keeping of cable connections is done manually and is therefore error prone. Even communication giants like Google and Verizon have incorrect records of how the networks are connected at the physical level with the result that if the wrong cable gets unplugged the entire data center may shut down. RFID allows for the connection status to be monitored in real time, offering an additional protection layer.

With its innovative technology and sound results, Telescent has been able to attract the interest of several investors, including some Venture Capitalists who had been early investors in Apple Computer and AOL. Presently, Telescent is completing a Series C financing.

The Telescent team currently totals 36 employees and is forecast to exceed 100 in the near future. Telescent's product roadmap of unique Physical Software-Defined Networking (SDN) management solutions promises to capture a significant share of an emerging $10B+ market opportunity.

Written By Claudia Cantoni, Commercialization Program Manager, DOE SBIR/STTR, January 2018.

[*] JOURNAL OF LIGHTWAVE TECHNOLOGY, VOL. 27, NO. 15, AUGUST 1, 2009.