Summer in the City – An Internship at CIENA Corporation (Cupertino, CA)

A Report
by

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Submitted to
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Background Information
CIENA Corporation sells optical network elements such as dense wavelength-division multiplexing (DWDM) systems, optical cross connect systems, and optical add/drop multiplexer (OADM) systems for both long haul and metro applications. It is headquartered in Maryland and has operational (manufacturing/design/research) facilities at Cupertino, CA, and Marlboro, MA. The aforesaid internship was completed at the Core Switching Division in Cupertino, CA.

Additional information pertaining to CIENA corporation, and the optical networking industry are available on-line at:
http://www.ciena.com/
http://www.oni.com/solutions/op_mktoverview.html

Tasks/Projects completed
The Core Switching Division at Cupertino, CA, has developed a proprietary modeling and simulation tool (MPS) for off-line network planning and research to test the performance and simulate provisioning, protection mechanisms for SONET/SDH connections in fiber-optic networks. I was employed as an intern reporting to Mr. Derek Sanders, Manager – MPS, and the following list summarizes my activities for the period 06/06 – 07/28. All research activities were followed through with a research/summary report, and references are cited as appropriate.

- Developed an original and unique integer programming formulation for simultaneously routing multiple SONET/SDH connections; current approaches are based primarily on provisioning connections one-by-one using Dijkstra’s shortest path algorithm – consequently, my formulation is of tremendous value in providing globally optimal connections and enormous cost savings. The formulation has been coded (in GAMS) and tested on both the AT&T US network, and random networks. Also, the algorithm has proven to be remarkably powerful in being extendible to supporting multiple source-sink connections, optimal capacity planning, and automatic proofing to eliminate infeasible connections. (Ref: “The Multi-Commodity Network Problem,” and “The Multi-Commodity, Multi-Product Network Flow Problem”)

- Designed and developed a random network generator that generates random networks complete with a graphic display, random creation of APS lines, and VLSR rings to be used for in-house research and performance testing of the MPS system, and verification of CIENA’s proprietary OSRP routing protocol and network protection schemes.

- Developed a heuristic procedure for supporting hit-less reconfiguration of SONET/SDH connections on AT&T networks. (Ref: “Notes/Ideas on the Sequential Routing Algorithm”)

- Developed a Markovian model to support reliability studies of CIENA’s market leading optical switch, the CoreDirector. (Ref: “Some Random Thoughts on Availability Modeling”)

- Proposed several approaches to design better networks and protection schemes based on hub-and-spoke network topologies. (Ref: “Better(ing) Networks – Some Ideas”)

- Developed an original mathematical programming model to support simultaneous optical routing and wavelength assignment in WDM networks. This effort is unique in being the first algorithm to effectively balance the physics of signal propagation, and balance the costs involved in signal generation, wavelength translation/conversion, and signal
regeneration owing to pulse-dispersion and EDFA induced noise effects, etc. (Ref: “(Ir)relevant Thoughts on Configuring WDM Networks” and “Optimum Routing and Wavelength Assignment in WDM Networks”)

Summary
This internship has been a fantastic learning experience for me in my capacity as a problem solver here at CIENA Corporation. I have been involved in solving problems from both Software (Managers: Derek Sanders, Dr. Greg Bernstein, Raj Venkatesan, and Madhavi Hegde), and Hardware (Managers: Dr. Philippe Delansay, and Jim Casciani). With my experience in mathematical reasoning and ability to solve problems, I have both dazzled and impressed all that I have had the fortune to work with, and I leave with the tremendous benefit of knowledge and working experience in one of the most promising technologies of the day. In other words, to paraphrase Julius Caesar, *veni, vidi, vici*.

Research Reports (listed in order of publication)
1. The Multi-Commodity Network Flow Problem
2. Notes/Ideas on the Sequential Routing Algorithm
3. Some Random Thoughts on Availability Modeling
4. The Multi-Commodity, Multi-Product Network Flow Problem
5. Better(ing) Networks – Some Ideas
6. (Ir)Relevant Thoughts on Configuring WDM Networks
7. Optimal Routing and Wavelength Assignment in WDM Networks