

## **Masters of Science in Computer Science Internship Report**

**Author:** Steve Palmer

**E-mail:** sp368077@XwcupaY.ZeduZ

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**Company Name:** Verizon Communications

**Telephone Number:** 610/407-2000

**Supervisor:** Rob Bunyon

**Phone:** deleted for web publishing

**E-mail:** deleted for web publishing

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# 1 Abstract

I performed my internship at a Verizon Communications office in the Great Valley Corporate Center, 52 E. Swedesford Road, Frazer PA 19355.

I was a member of Verizon Information Processing Services (VIPS), a regulated Verizon affiliate. My role has been a support role, providing UNIX server, firewall and network support for another, unregulated Verizon affiliate, Verizon Network Integration Corp.

During the time of my internship, my primary goal, as stated by the departmental vice president, has been to provide the highest possible availability at the lowest possible cost. Meeting this goal entails work during and outside of business hours. Outside of normal business hours, I was expected to be reachable by pager at all times.

My key perceptions about the business involve the state of disruption evident in today's telecommunications industry. Convergence, long anticipated in the telecommunications sector, is becoming a reality. Verizon is faced with the erosion of its historical core product, which is voice telephony on a dedicated infrastructure. Business consumers are substituting broadband Internet for second phone lines. Many consumers are even giving up their first phone line, long considered a necessity, and opting instead for wireless phones or voice over IP (VoIP, voice telephony on a shared, Internet based infrastructure). Accordingly, Verizon is in a state of transformation; seeking to replace this lost revenue with new offerings including wireless services, broadband technologies (DSL and FTTP) as well as supplemental products which exploit those technologies. These new services include IOBI, television over broadband and VoIP. Another key insight has been how the federal regulatory landscape continues to impact Verizon's ability to conduct business efficiently.

Technical activities included work on Sun/Solaris, Checkpoint Firewall-1, Apache web server, Red Hat Linux, HP OpenView Network Node Manager, SunCluster clustering for NFS, DNS & oracle, StoneBeat firewall cluster, Solstice Networker, TeamQuest Performance Framework, Lotus Notes, Lotus Sametime Instant Messaging, MS Office, Remedy Help Desk, BizTalk & Ewis work flow managers and ESP scheduling from Cybermation.

## 2 Introduction

I interned for Verizon Information Processing Services (VIPS), which is a division of Verizon Service Corp.

Verizon Service Corp. is regulated as a Local Exchange Carrier (LEC) under the telecommunications act of 1996. This classifies it as a local telephone company. This classification affects how computer and network can be provided for other Verizon affiliates. Unregulated affiliates, like Verizon Network Integration Corp (VNIC), can be supported as long as the appropriate charge back mechanisms are in place. Affiliates regulated under section 272 of that act, known as 272 affiliates, cannot be supported by LEC resources unless those resources are available to any and all long distance companies, whether owned by Verizon or not. Complicating it further, unregulated affiliates like VNIC can and do communicate with these same 272 affiliates.

In addition to working to meet my primary operational goal; highest possible availability at lowest cost, I also participated as a member of two project teams. One tasked with a network migration project and the other with a UNIX platform job scheduling replacement.

Further, I participated on departmental strategy advisory board. Strategy questions are submitted through a web site by up to 9,000 VIPS employees and are researched by this board; the answers are approved by the company's Chief Information Officer (CIO) and published on the departmental web site.

Finally, I participated in a VIPS leadership training program, the Information Systems Orientation Program (ISOP). This program is intended to provide mentoring and networking opportunities to VIPS employees who are identified as "future leaders".

This report is intended to describe my activities in support of each of the above mentioned functions.

## 3 Project Description

### 3.1 Operations

My primary responsibility has been operational support for UNIX hardware and operating systems and resident firewalls. Among other duties operational support entails a daily review of e-mail reports containing output from scheduled jobs. In addition to daily review of e-mail, high severity events are delivered to my pager and addressed. This review enables identification of existing or potential problems with the goal of repairing them before any of the system users encounter them. Potential problems being checked for include:

- Disk space shortages.
- Errors or failures in scheduled processes (cron jobs).
- System intrusion or other anti-social network activity, like virus infections.
- Network disruptions.
- Server hardware problems.

If problems are observed or anticipated, I would determine an appropriate corrective measure and implement it. It is worth noting that all of these outputs are generated by programs or scripts which I wrote, prior to the time of the Internship. They include a mix of C programs and ksh and perl scripts.

This aspect of my work, UNIX server support, involves administering the operating systems for 40 Sun and linux machines, both server and workstation class. These machines perform functions which include firewalls, DNS, NFS file services, web servers, oracle database servers and application servers for help desk call tracking. Operating systems include Solaris 2.6, Solaris 8, Solaris 9 and RedHat Linux.

A second operational support role is the maintenance of firewall rules. Because of the complex network and the well known world wide shortage of IP addresses, VNIC's network uses addresses set aside by Internet RFC 1918. Thus for communication with outside entities, Network Address Translation (NAT) is employed. Essentially every packet passing through the firewall has its internal IP address and checksum rewritten with one appropriate for routing on the Internet or Intranet. This lets us hide our reserved class B network (up to 65,534 hosts) behind 3 class C networks (765 addresses).

Most of my time was spent enabling communication among various Verizon affiliates, making firewall changes to accommodate business needs without compromising security or regulatory compliance. To ensure compliance with complex regulations, there are 3 paths from the VNIC owned network to other Verizon owned networks: a LEC network connection, a 272 network connection and a connection to a wholly unregulated transport network.

Because of the complexity of Verizon's other networks, and because there are three connections to other Verizon networks, it has also been necessary to use address translations to hide the external Verizon addresses from VNIC's internal devices. Otherwise, return routing might not be possible.

This configuration, designed by me before the time of the internship, is known as dual NAT. This makes it possible to handle almost any regulatory requirement, but can also lead to some time consuming trouble-shooting efforts and confused end-users when problems arise.

To protect these network connections, I have been maintaining two single-system firewalls running on Sun Ultra E 250's and one clustered system running on a pair of Sun Ultra E420's. Additionally, there is another firewall protecting the Internet network connection. This connection is protected by another clustered pair of Sun machines, Ultra E450's.

Another aspect of my operational support role has been working closely with the network support personal. They maintain a network of Nortel gear, including 450 and accelar switches as well as ASN, ARN and BCN routers. I am often invited to assist them with trouble-shooting; especially when the communications path under study crosses one of the firewalls in my control.

A final operational support requirement is for monthly maintenance. One Saturday each month is designated for operational maintenance of a disruptive nature. This maintenance includes operating system patches, firmware updates, hardware replacements or additions and operating system configuration changes. Maintenance windows during the internship occurred on August 21, 2004 and September 18, 2004. The servers are on a bi-monthly patch rotation, so every server in the environment experienced some level of maintenance during at least one of those two windows.

As an example, one interesting operational problem I encountered has been an intermittent network connectivity disruption. I spent a large amount of time trouble-shooting why two Sun servers, both on the same network segment occasionally lost the ability to communicate with each other. After extensive trouble-shooting, I noticed that arp whois requests were being received by the target server, but it was not responding with the expected arp reply. Therefore, the source server could not determine where to deliver the traffic. The problem was determined, by Sun, to be a bug in the Solaris 9 operating system. Since they do not yet have a fix, the bug was worked around by installing static arp entries in each server.

## 3.2 Network Migration

The purpose of this project is to migrate information resources used by VNIC personnel from a VNIC owned network with Nortel hardware onto a VIPS owned infrastructure using Cisco hardware. The main complexities to this project have been identifying and involving the right VNIC personnel and identifying and clearing regulatory hurdles. This project has been in progress for over a year. It will complete on December 18, 2004.

My role has been extensive in this project. First, I have acted as project manager for the Frazer office portion of this network move. In that capacity, I have facilitated a weekly meeting among VIPS and VNIC staff, identified communications requirements, planned moves and assigned and tracked tasks towards completion. Additionally, I have been the task owner for UNIX server or firewall moves which had to take place. In addition to planning and tracking these moves, I have also implemented them.

For UNIX server move implementation, my strategy has been roughly as follows.

- 1.) Identify the servers targeted for relocation
- 2.) Raise a second interface on the servers, connected to the VIPS infrastructure, without disconnecting from the VNIC infrastructure.
- 3.) Test connectivity over VIPS infrastructure
- 4.) Change DNS to refer to the new interface
- 5.) Change any communications partners to use the new interface
- 6.) Disconnect the 'old' interface from the VNIC infrastructure
- 7.) Unconfigure the 'old' interface
- 8.) Reboot, Test for permanence

My final role in support of this project has been identifying and implementing the firewall changes necessary for migration of remote offices. The VNIC network topology was a hub and spoke topology with 33 remote offices connected to the Frazer, PA office by T-1 connections.

Each of those offices was migrated onto the more complex VINet infrastructure. The VINet infrastructure is essentially a looped network back-bone with fully redundant spokes from the loop to any connected office. When each of the 33 offices were migrated, supporting firewall changes had to be made to allow the traffic from VINet onto the VNIC network infrastructure.

### **3.3 Scheduling Platform Replacement**

I have had a somewhat limited role in the Scheduling Platform Replacement project. This project has been on-going for several years. The project is a massive, multi-year project to replace UNIX scheduling tools throughout Verizon with a single scheduling platform.

My role has been to participate in a weekly coordinating call, observe product demonstrations and receive and evaluate prototype software.

### **3.4 Strategy Board**

The VIPS departmental web page includes a section where any of roughly 9,000 VIPS employees can ask strategy questions of the Chief Information Officer (CIO). I am on the advisory board that researches the questions, composes answers and submits them to the CIO for his review and approval. If approved, these answers are posted on the web site as his response.

During the time of the Internship, I was assigned and submitted an answer to the CIO for approval. The question pertained to the use of the Software Engineering Institute's Capability Maturity Model within Verizon.

### **3.5 ISOP**

The Information Systems Orientation Program is a type of program often referred to as a grooming program. The ISOP mission is to increase the effectiveness of Verizon's future leaders by offering leadership development activities and by providing networking and mentoring opportunities with Verizon's current leaders.

Candidates, including myself, met biweekly at various locations throughout the North East corridor. The program lasted throughout the Internship period, beginning in April and ending in December. At meetings, we received presentations from two or three Verizon executives per day. Presenters have included, among other executives, Doreen Toben-Verizon's Chief Financial Officer, Shadman Zafar- Senior Vice President in charge of new technology, Dr. Judith Spitz- Senior Vice President in charge of Network Systems and Dr. Michael Brodie Verizon's Chief Scientist in IT. At graduation, Verizon's Chief Executive Officer, Ivan Seidenberg will be presenting. Mr. Seidenberg is also a member of the Federal Commission on Systemic Interoperability (for the health care industry). I am eagerly looking forward to his presentation.

Presentations have focused, repeatedly on the increasingly competitive landscape, the gradual erosion of Verizon's traditional core business and Verizon's anticipated transformation into a converged communications company. Information Technology and IT savvy employees will be a key enabler for that transformation.

In addition to attending presentations, our ISOP class identified 3 business needs which we hope to see addressed by Verizon, researched them and will be submitting the business cases in support of these proposals. Research was conducted during the bi-weekly meetings and at other times, both inside and outside of business hours. The business case I was most involved in was evaluating work flow management products to accomplish a proprietary purpose. The products we evaluated included internally and externally developed solutions. We will be recommending an internally developed solution for implementation during 2005. We chose this approach because it is already an internal standard, thus driving lower support & maintenance costs, even though it is not a technical 'best of breed' product.

## 4 Analysis

This internship has dramatically improved my understanding of Computer Science in the telecommunications industry. In the telecommunications industry, the technological, regulatory and competitive landscapes are all experiencing unprecedented transformation. To cope with these changes, Verizon is looking at a broad spectrum of innovative ideas.

Some of these are technology based, like Fiber to the Premise (FTTP), Digital Subscriber Lines (DSL), IOBI ([www.verizon.com/iobi](http://www.verizon.com/iobi)), VoIP ([www.verizon.com/voicewing](http://www.verizon.com/voicewing)) and television service over broadband. Others, of a proprietary nature, have also been disclosed inside the corporation.

Additional innovations have to do with business transformation. Reorganizations and staff realignments to cope with change are nearly continuous. We observed in ISOP how innovative HR practices like telecommuting and job sharing are taking hold. Dr. Spitz, one of the ISOP presenters, is an expert in speech & natural language processing. She disclosed the huge cost savings and consumer benefit being realized by the addition of speech recognition systems. During this year's historic hurricanes in FL, tens of thousands of calls were handled by automated systems that simply could not have been handled by human operators. Clearly, Information Technology is a key enabler for all of these innovations.

What I did well, during the internship:

- I maintained flexibility in the face of constantly changing priorities.
- I maintained an eagerness to learn.
- I used creativity to match business needs with regulatory requirements, facilitating communications only across appropriate network infrastructures.

What I would improve or do differently if I had the opportunity:

- I could be better organized, especially with regards to paper work required for capital purchases and expense reporting for business travel.
- I could learn to manage my time better, planning parallel execution of some short duration activities when long running operational activities are occurring. This would reduce personal idle time when waiting for long duration activities to complete.

## 5 Conclusion

I would like to thank West Chester University and my graduate advisor Dr. Elaine Milito along with Verizon Communications and my manager, Rob Bunyon for this opportunity. During this internship, I have learned a great deal about how Information Technology is shaping and transforming the telecommunications industry.

Because of the things I've learned during this internship, I now look forward to a period of intense competition, change and opportunity in this industry. Also because of happenings during this internship, I laid the basis for my planned thesis. I had the opportunity to speak with Verizon's chief scientist, Dr. Brodie, about a proposed thesis topic. Dr. Brodie was very excited by my topic, research into efficient algorithms for graphs which are too big to fit in main memory, so I intend to undertake research into that topic in the spring of 2005. Thus, I hope this internship will serve as a spring-board into a successful and valuable master's thesis.

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