
AC 2012-3509: A COLLEGE-INDUSTRY PARTNERSHIP FOR ENTERPRISE COMPUTING

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A College-Industry Partnership for Enterprise Computing

Abstract

Growth at Old Dominion Freight Lines, Inc. (NASDAQ: ODFL) necessitated the relocation of the present Disaster Recovery (DR) center in Greensboro, NC to a newly constructed center located in Thomasville, NC. The old DR site was functional and equipped with modern equipment comparable to most other corporate DR sites. The relocation provided a unique opportunity for ODFL and North Carolina Agricultural and Technical State University (NCA&T SU, NCA&T). ODFL is a third-generation North Carolina Triad area business with an established history of giving back to their community. ODFL made a grant of the existing DR center to NCA&T SU and to Davidson County Community College (DCCC) for the purpose of establishing state-of-the-art IT data center research and experience-based learning labs.

The long-term goal of this project is to improve data center management techniques for better information availability, reliability, security, and cost efficiency. Several additional projects have emerged and are reported in this paper. The broader impact of this project includes development of advanced IT skills in the Triad workforce. This project has enhanced learning outcomes of enterprise computing technology students at NCA&T, area community colleges, and high schools by engaging students in applied research and providing hands-on experienced-based learning. Additionally, the authors expect availability of a skilled IT workforce to expand the Triad area economy by assisting the expansion of existing Triad enterprises and attracting new information technology dependent enterprises to relocate to the Triad.

Implementation of this grant award began in November, 2011. This paper reports the initial project completions and describes how the grant resulted in new, unplanned projects. The authors believe this college-industry partnership model can be replicated readily at other institutions in need of an equipment infrastructure to foster education and research.

The opportunity

In the days when moving freight meant loading trucks with a hand truck, the difference among freight carriers was service. For three generations, Old Dominion Freight Lines has provided outstanding service to its customers. This Thomasville, NC based company has grown to a billion dollar company specialized in Less Than Truckload (LTL) shipping. Service today means knowing the exact location of each of millions of items in ODFL's care, and communicating that information to customers instantaneously. Trucks move the freight, and computers move the information for ODFL. Of course, ODFL has replicated data centers for disaster recovery. ODFL's continued growth led to the construction of a completely new, state-of-the-art disaster recovery data center. Once the new site was complete, the old site in Greensboro, NC was set for decommissioning.

ODFL has long been a recognized leader in community involvement in the Triad, NC area. Triad residents recognize and depend upon ODFL's annual sponsorship of holiday season food and clothing drives. Less well-known is ODFL's support of area schools, especially in the area of

information technology.

NCA&T is one of the nation's oldest and largest Historical Black Colleges and Universities (HBCU). As a land grant university, NCA&T has a Congressional mission to provide workforce development, especially in the area of technology. The School of Technology has a strong program in high performance computing, mainframe operations, virtualization, and cloud computing. In addition, NCA&T is a leader in the education of technology instructors.

ODFL and NCA&T saw a unique opportunity to improve IT education. Researchers at NCA&T developed a proposal requesting ODFL to grant the decommissioned data center in place to NCA&T, and ODFL generously awarded the grant of the fully functional data center in October, 2011. The results of this grant have already far exceeded expectations; example results are presented later in this paper.

The data center consisted of approximately 60 carrier-class servers, equipment racks, switches, cabling, fiber guides, and mass storage. Vendor, specification, and age of the equipment varied, but all equipment was well-maintained and in production use at the time of decommissioning. The data center was located about two kilometers from the NCA&T campus.

The first positive outcome of the grant was unique. Students of the School of Technology, under the supervision of faculty and ODFL IT managers, disassembled the data center and transported the equipment to the staging center in a lab at NCA&T. University students engaged in the study of IT rarely have the opportunity to visit a commercial data center. The opportunity for students to gain practical, hands-on experience under the guidance of veteran corporate IT managers was experiential learning at its finest. Students not only gained experience, but they also developed self-confidence to work in the intimidating environment of a large data center.

ODFL also made a grant of some equipment to Davidson County Community College (DCCC). IT Faculty of DCCC and NCA&T routinely collaborate. Students and faculty from DCCC participated in the decommissioning, and the students instantly formed *ad hoc* teams.

ODFL's IT team is staffed to meet the demanding tasks of operating a global IT network. Decommissioning a data center requires a bolus of additional staff. One positive outcome for ODFL is that the data center was completely decommissioned and vacated without the need to place additional workload on the IT staff.

Locating the data center

The immediately obvious question is, “Where did you put all that equipment?” Once again, innovation is required. NCA&T has production data centers, and those centers generally have little spare capacity and are subject to strict access control. The School of Technology does not have dedicated research lab space, nor a data center. The primary desire for the NCA&T researchers was to have a data center for research of innovative configurations and applications of enterprise computing, and an environment that is conducive to active undergraduate and graduate student research participation. The research plan called for the equipment to be installed in classroom labs. The primary location shares space with an industrial controls lab, and has

existing three-phase power and network connectivity. The cooling capacity of the lab is not suitable for 24/7 operation of several racks of servers, but is adequate for intermittent use of several hours. Noise is not an issue, since the equipment is not operated during classroom lectures. Several on-going projects will evolve to require near continuous operation. NCA&T IT Services is highly focused on supporting students and researchers, and will allow limited relocation of a few racks of equipment into production data centers, with limited access to faculty for physical maintenance and configuration modification.

Undergraduate student involvement

Researchers organized the equipment in NCA&T's labs in November and December, 2011. Beginning in the spring, 2012 semester, students in a Linux System Administration course and students in a Video Communications course collaborated to create an Internet Pre-Execution Boot Environment (IPXE)¹ to install and configure automatically a Scientific Linux 6.2 Linux², Apache³, MySQL⁴, PHP⁵ (LAMP) system on the servers through a combination of DHCP, DNS, TFTP, and HTTP servers. Linux administration students continued to install and configure directory services, secure FTP, and virtualization support. Video communications students continued to install and configure streaming audio, streaming video, and video-on-demand servers and clients. Senior project students used the lab to create high availability clusters, a Virtual Computing Lab (VCL)⁶, and a Moin⁷ wiki farm.

The researchers' expectation was gradual incorporation of the lab into enterprise computing courses. The rapidity and breath of student involvement in the lab exceeded expectations.

Research projects

Initially, researchers planned for a limited research program focused on configurations, security, and green energy. However, the data center equipment has proved to be a catalyst for research in all departments of the School of Technology, the University, and beyond. Researchers expected this result, but not the timing. In hind sight, this rapid expansion of projects should be expected. Researchers in the School of Technology face somewhat of a “chicken and egg” dilemma. Promising new areas of research require access to a dedicated computing infrastructure, but it is extremely difficult in the present economic environment to find funding for general-purpose equipment infrastructure required for innovative, but unproved areas of research. This is especially true when the research is focused on community involvement in economically-depressed regions. The ODFL grant provides the computing infrastructure incubator to enable researchers to pilot research programs. Descriptions of some of the research projects started or accelerated by the data center grant demonstrate how the corporate generosity and partnership of ODFL has impact on science and the community far beyond the transportation industry.

Improving technical education in eastern North Carolina

School systems have suffered repeated financial blows in recent years. Technology education is among the most expensive curricula, and hardest hit. Researchers at NCA&T, with the support of the North Carolina School Board Black Caucus (NCSBBC), are working with county school systems and community colleges to provide a cloud computing educational development

platform. This program allows school system educators and IT personnel to “test drive” various virtualization and cloud implementations to determine the best fit of these technologies for local needs. The data center lab provides the virtualization platform to enable this research. One outcome of this research addresses technology education for school system staff and provides opportunities for Science, Technology, Engineering, and Mathematics (STEM) teachers to assess the pedagogical impact of virtual computing resources in the classroom. A second outcome allows IT staff to assess the financial impact of increased reliance on virtual computing as an augmentation for physical computing.

Determining the impact of non-profit weatherization programs

Several cities in the Triad area have active non-profit community organizations to assist low-income homeowners with energy-saving weatherization. Do these programs actually reduce energy consumption, and if so, to what extent? NCA&T researchers have wanted to use GIS mapping technology to extract heat loss data from aerial images, then use this data to provide an objective, automated analysis of before and after heat loss of homes in the weatherization project. The ODFL grant has provided the computing infrastructure to accomplish the analysis, and a first analysis is underway in Burlington, NC. Undergraduate and graduate students are engaged in developing the necessary data extraction programming and energy analysis. An expected outcome is a method for objective validation of energy conservation programs. A second outcome is an information model to maximize the impact of limited energy conservation funds.

Bio-hazard threat analysis

A related GIS research project concentrates on the determination of the potential effect of a bio-hazard incident on the NCA&T campus and surrounding community. If an intentional or accidental release of a chemical or biological substance occurs, will the hazard spread across campus and the surrounding community? If so, what is the timing of the spread? With the ODFL grant, NCA&T researchers and students now have the computing resource to extract building information management (BIM) and weather data from GIS databases to map localized dispersion models. An anticipated outcome is a planning model to assist University administrators in locating new facilities or relocating existing facilities to minimize the impact of a bio-hazard incident. A second outcome is to provide a planning resource to assist emergency management planners in the development of first response plans.

Lecture on demand system

Economic constraints have forced larger class sizes at most schools, including NCA&T. A well-established principle of education is that different people learn in different ways and at different speeds. Most people can relate to a learning mental block that goes, “I just could not understand his explanation, but the way she explained it really made sense.” The NCA&T faculty contains a subject matter expert on almost any topic. What if each faculty member produced a few well-designed ten-minute presentations on key points of the curricula, and these presentations were available to students anytime, anywhere, to review on-demand from computers, laptops, tablets, and smart phones? What if students and teachers in area schools had access to these

presentations? What if area businesses could replicate the technology for sales and product briefings? NCA&T researchers and students are using the ODFL equipment to develop an open source video capture and lecture on-demand system as a continuation of the aforementioned video communications course. An expected outcome is to allow research into the pedagogy and efficacy of such a lecture capture system.

Pedagogy of virtual computing in technology education

New technologies such as virtualization, cloud computing, and video on-demand have potential to improve STEM education, but will the potential be a reality? Education is replete with the failure of just dumping technology into the classroom. Researchers at NCA&T with expertise in training technology instructors are using the ODFL equipment to study the impact of these new technologies in the classroom. One expected outcome of this research is the discovery of optimal use of the technology as a classroom tool. A second anticipated outcome is the education of technology instructors on how to revise lesson plans to include these new technologies.

Improved high availability / high reliability computing configurations

The advent of cloud computing and high performance computational clusters creates a demand for IT experts in the specification, configuration, and operation of computer clusters. The ODFL equipment provides both a research and a teaching tool. The availability of multiple carrier-class servers in a data center environment allows IT students to gain hands-on project experience in the installation, configuration, and operation of advanced computing installations. Researchers at NCA&T are engaged in a project to model distributed data replication and disaster recovery. This project is a collaborative effort with faculty from DCCC.

Automated installation and configuration of advanced computer systems

NCA&T researchers are engaged in a project to improve the IT capabilities of Triad small businesses. Most small businesses do not have a dedicated IT staff. Most do not have an IT planning process for disaster recovery and business continuity. Most do not have effective IT security procedures. The result is that these businesses are at great risk of economic disaster from natural disaster or cyber attack. Using the ODFL equipment, researchers and students are developing and implementing automated systems for over-the-Internet automated installation and configuration of enterprise business platforms. An expected outcome of this project is to make available an open source resource to Triad businesses, private schools, and community organizations to install and maintain IT platforms. A follow-on project is expected to provide a best practice business and security planning resource.

Conclusion

An industry-university partnership between ODFL and NCA&T has transformed a routine corporate occurrence, the decommissioning of a data center, into an incubator for IT research aimed at improving Triad communities. ODFL's primary motivation was continuation of its history of giving back to the local community. However, ODFL's cost of IT staff time to coordinate the grant was offset in part by reducing the workload on IT staff for the

decommissioning process.

The grant solved a long-time problem for NCA&T researchers in the School of Technology by providing an infrastructure for enterprise computing dedicated to research in an environment that allows frequent modification and reorganization of the equipment.

The expected outcome of the grant was the gradual incorporation of the data center lab into enterprise computing courses and support for data center specific research projects. The experience of the first six months has more than fulfilled the original expectation. Two undergraduate courses have incorporated the data center lab, and senior enterprise computing projects have been completed that would have been impossible without the grant. Additionally, community-focused research projects in education, green energy, and bio-hazard preparedness have started or accelerated as a result of the data center lab.

This experience of college-industry partnership can serve as an example and motivation to other schools and industries to explore equipment grants to incubate educational and research enhancement.

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