Re-Imaging Computers for Multipurpose Labs

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Abstract

In lab environments, where multiple computers are used, a method called imaging can be used to handle the challenge of installing and configuring multiple machines. Imaging is a method that uses a client server relationship that allows the client to download and install the necessary software, virus updates, and security patches by selecting an image file that resides on a server. Several software components and services are necessary to successfully image a client. First, a DHCP server provides a connection between the client and the image server by assigning a dynamic IP address to each computer. In addition to a unique IP address, each client is required to have a unique hostname. This hostname is incorporated into the image for each client using a Security Identifier Generator also known as a SID Generator. Finally, the operating system software, application software, and data files are downloaded to the clients by using imaging software such as Altiris and Norton's Ghost.

The ability to create and deploy multiple images in a reasonable time span eliminates the headaches and lost time network administrators would otherwise experience doing repetitive software changes to many machines. This technique also provides for better lab utilization, reducing lab downtime for software maintenance. Other advantages of imaging include facilitating using the lab for multiple classes, research projects, and individual testing, since an entire lab's computers can be imaged within thirty minutes. Some applications require the use of multiple operating systems such as both Windows and Linux. By creating an image that dual boots operating systems computer equipment is fully utilized.

This paper shows the advantages of using imaging software to create and deploy images to large quantities of computers in a lab environment. A network is created with required machines, including a DHCP server, SID generator, an imaging server, and clients. Several images are created with different configurations, including dual booting operating systems. These images are used for class-oriented lab configurations and for various configurations required for research projects that use the same machines.

Introduction

The competitive world of information technology has placed postsecondary educational institutions in a never ending battle to provide students resources needed in order to study the constantly changing and evolving field of information technology. The pressures to keep up with new technologies are seemingly unlimited, while the resources that are needed are not[3].

Professors desire the best for the student, which in turn places them in a constant battle of developing laboratory experiences on the cutting edge of technology.

Computer labs provide both the professor and the student a viable means to learn and keep up to date with cutting edge technologies. However, financing a competitive information technology computer lab is a very expensive endeavor. The hardware and space needed are extremely expensive. Expensive laboratory IT staffing is also necessary to provide stable systems.

A technique called imaging can help mitigate the expenses associated with running an IT lab by reducing labor costs, facilitating the installation of software and configuration of multiple machines. At the same time, it creates a cost-effective solution for the use of available hardware and lab space by providing laboratory configuration flexibility, maximizing the efficiency of each lab room.

Imaging is an efficient, automated technique that uses a client-server computer configuration. This configuration allows a client machine to download and install the necessary system and application software, virus updates, and security patches by selecting an image file that resides on a server. Two major imaging software programs (Altiris and Norton's Ghost) each have distinct advantages for particular applications. This paper will compare and contrast these advantages in a university environment.

Overview of imaging software

Norton Ghost

Norton Ghost imaging software provides powerful tools for creating backups, restoring disks, and replicating or cloning disks across many client computers. Norton Ghost is based on a robust cloning technology that offers the following features[2]:

- **Backups:** Back ups are performed directly to a hard disk or removable media.
- **Peer-to-peer communication:** Peer-to-peer communication using high speed parallel, USB, and network IP connections to back up, restore, or clone a computer configuration.
- **Operating system support:** DOS, Windows 2000/XP/NT/9x, OS/2, and Linux are supported.
- **File system support:** FAT, FAT32, NTFS, and Linux Ext2/3 file systems can be used.
- **Restore individual files:** Using Ghost Explorer individual files can be restored from an image file.

Norton Ghost uses a cloning technology that creates an image file containing the entirety of a computer's disk or partition data, including configuration and hidden data[3]. This information is used to recreate or bring back a computer to its original state. These image files can contain a backup copy of the entire hard disk, a single partition, and/or several partitions. Likewise, the image file can be restored to an entire hard disk, a single partition, and/or several partitions. Image files only contain the valid data that is on the hard disk or partition. For example, if a hard disk that has a 6 GB capacity is 50% full, than the image file will be approximately 3GB or smaller depending whether or not compression is used.

Compressing an image file has its advantages and disadvantages. One disadvantage is when using compression to create an image file, Norton Ghost tends to operate slower. On the other hand, a compressed image file increases performance significantly when cloning a disk to multiple computers, since it speeds up the data transfer when downloading over a network or peer-to-peer communications link.

Altiris

Altiris provides powerful solutions for the configuration, deployment, and manageability of multiple computers. In particular, Altiris Deployment Server™ can be used to remotely image or run scripted install packages for all types of computers across a network or lab environment[1]. Daily tasks can be performed from a central console eliminating the need to attend each computer.

A major advantage Altiris imaging solution offers is an increase in productivity and a decrease in costs. A management console enables full control over multiple computers or labs without an operator ever needing to leave the comfort of his or her workstation. Images containing single or multiple operating systems can be deployed in volume. Deployments can be performed in real time; however, a major advantage is the ability to schedule deployments daily, weekly, or monthly. Installing new software or upgrading existing software is performed remotely, increasing operator time available for other tasks. For example, security updates can be performed using the management console.

Altiris' software deployment process is quite simple. Images are created of a reference computer's hard drive. The reference computer to be cloned can have one or several operating systems installed on its hard drive. Since no two computers on a given network can have an entirely identical configuration, a utility called a SID Generator is also used. The SID Generator is used to replace the computers local SID (security ID) with a unique one as the cloned data is being written to the target computer's hard drive.

Altogether, there are several components that make up Altiris Deployment Server™. Included are a Deployment Server Console, Deployment Server, Deployment Database, Client Access Point, PXE Server, DHCP Server, Deployment Agent, and SID Generator. These components are described as follows:

- **Deployment Server Console:** Console provides remote management of networked computers.
- **Deployment Server:** A group of services used to control the flow of information and work between the network computers. (Deployment Server Console, Deployment Database and Client Access Point).
- **Deployment Database (Microsoft SQL or MSDE):** Can either be Microsoft SQL or MSDE.
- **Client Access Point (file server):** A Novell Netware file server or Microsoft Windows file server used to store images, files, registry scripts, and deployment packages.
- **PXE Server:** Pre-boot Execution Environment Server that provides network computers with Intel's PXE technology the ability to be managed.

- **DHCP server:** Dynamic Host Configuration Protocol server that assigns TCP/IP addresses to network computers.
- **Deployment Agent for Windows and Linux:** client side software that registers network computer configurations with the Deployment Server.
- **SID Generator:** Native 32-bit security attribute modification utility used to avoid name sharing conflicts that occur in a network that requires the use of Domain names.(Windows Domains)

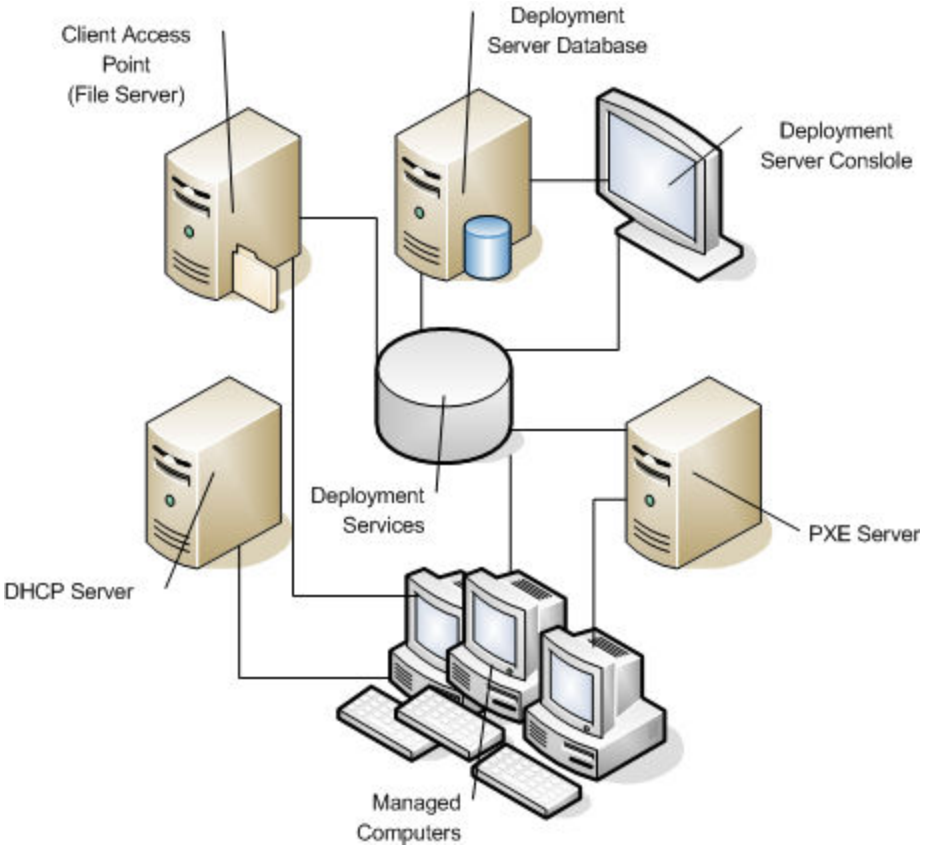

Figure 1 –Deployment Server System.

Advantages/Similarities

Altiris and Norton Ghost imaging software each provide similar benefits. Some major advantages that Altiris and Norton Ghost imaging software provide include the complete creation and restoration of a computer's configuration in a minimal time period. For instance, Norton Ghost has the ability to create an image file or clone (restore) a system's hard disk within 5 to 10 minutes depending on the amount of data on the hard disk and/or if compression is used. Altiris provides similar performance when creating an image or restoring a computer's configuration, although not quite as quickly as Norton Ghost. Whether single or multiple operating systems (and their associated partitions) are being created or restored, the time performance of Norton Ghost maintains a constant linear relationship to the size of the data. Altiris, on the other hand, requires more time if multiple partitions are on the disk that is to be cloned.

Distinct Differences

One distinct difference between the Norton and the Altiris products involves their abilities to clone a computer's configuration across multiple computers. Altiris has the advantage when deploying images across multiple computers in a lab since it allows a hands-off approach. In other words, Altiris can manage an entire lab or network from the comfort of a single workstation. Unlike Norton Ghost, there is no need to attend each machine individually, changing each computer's name and IP address or inserting a floppy disk to point the computer to a network share after cloning the disks. Depending on the number of target computers, Altiris may require between 20 minutes and 2 hours to clone a disk with multiple partitions.

Lab Designs

There are several lab configurations that are needed by Brigham Young University's IT program. The labs are used to facilitate multiple classes, research projects, and individual research. Each lab configuration has its own distinct uses. The following describes each lab design and use.

Multiple Class labs

The multiple class labs consist of 25 workstations and 2 servers. The workstations are connected using four100 Mbs Alcatel switches. The main 100 Mbs Alcatel switch is up-linked using fiber optic medium to a 100 Mbs Cisco switch. The Alcatel switches are all interconnected using fiber optic media. The lab is divided into two sections. One section consists of 16 Hewlett-Packard Pentium-4 1.8 GHz workstations. Each workstation has a 40 Gig hard drive and 512 MB of RAM. The other section includes 9 Dell GXA Pentium-II 400 MHz workstations. Each workstation has a 3 Gigabyte hard drive with either 128 MB or 256 MB of RAM. Two Matrixx Pentium-III 999 MHz servers are for the use of student projects. Each server has over 80 GB of hard drive space and 1 GB of RAM. The lab computers require disk configurations that range from single operating systems to multiple-boot operating systems. Operating systems used in these labs include RedHat Linux 7.3 and 9.0, Debian Linux 3.0, Windows 2000/XP, and Windows 2003 Enterprise server. Figure 2 shows the lab layout for the multiple class labs.

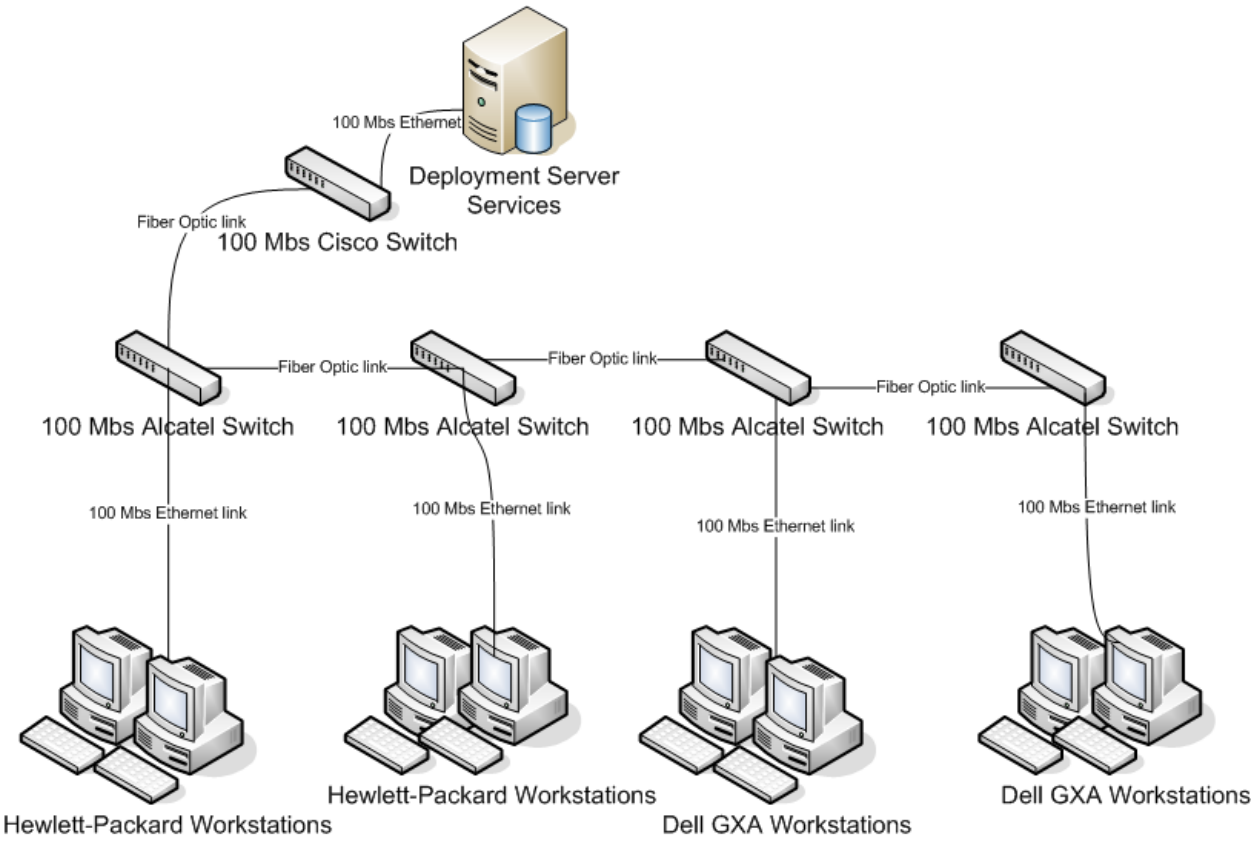

Figure 2- Multiple Class Labs

Research Lab

The research lab consists of 10 individual computers and 3 servers. All the machines are connected to a 100 Mbs Cisco switch. Dell GXA Pentium-II 400 MHz workstations are used for the individual computers. Each workstation contains either an 8 Gigabyte or a 20 Gigabyte hard drive with 128 MBs of RAM. The servers include 2 Hewlett-Packard Pentium-4 1.8 GHz machines with 40 Gig hard drives and 512 MBs of RAM. A 64-bit Hewlett-Packard Itanium server with a 36 hard drive and 512 MBs of RAM is also used. The research lab environment is unique because of the individual research and testing that is performed. The network is isolated from the external network, with the 100 Mbs Cisco switch only attached to the outside IT network when other lab areas need to be re-imaged, since the imaging servers are located within the research lab area. The main reason for this type of isolation is to prevent the spread of malicious code, viruses, or attacks that may be under test in the research lab environment. This lab also has images that range from single operating systems to multiple-boot operating systems. The operating systems that are used include RedHat Linux 7.3 and 9.0, Linux Advanced server 2.1 64-bit, Windows 2000/XP, Windows 2003 Enterprise server, and Windows 2003 64-bit server. Figure 3 provides the lab layout for the research lab.

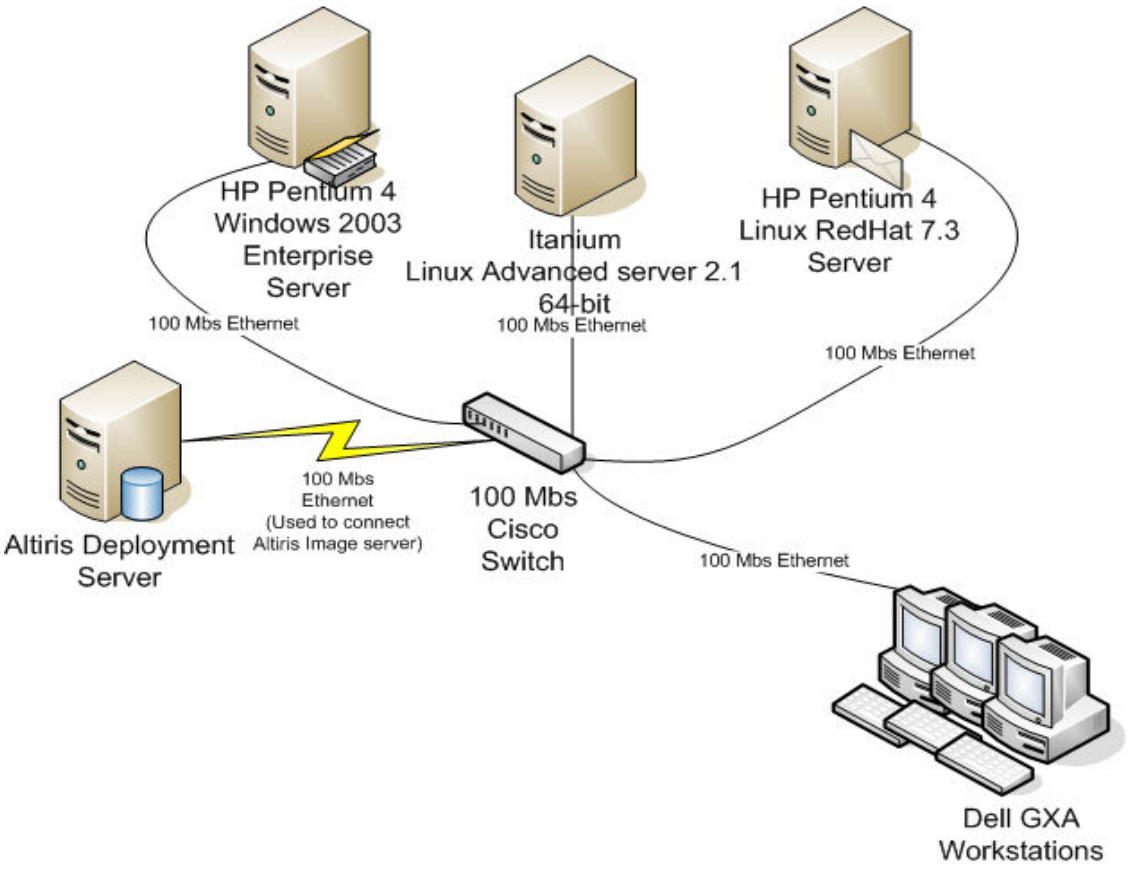

Figure 3- Research Lab

Networking Lab

The networking lab consists of 12 individual computers each attached to a 100 Mbs hub. The 100 Mbs hub is then up-linked to a 100 Mbs Cisco switch. Images are deployed, created, or restored using both Altiris and Norton Ghost. When re-imaging the entire lab Altiris is used, when imaging a single machine Norton Ghost is used. Images used in the networking lab may contain single operating systems as well as multiple operating systems. Operating systems used for the networking lab include RedHat Linux 7.3 and 9.0 and Windows 2000/XP. Figure 4 provides the lab layout for the networking lab.

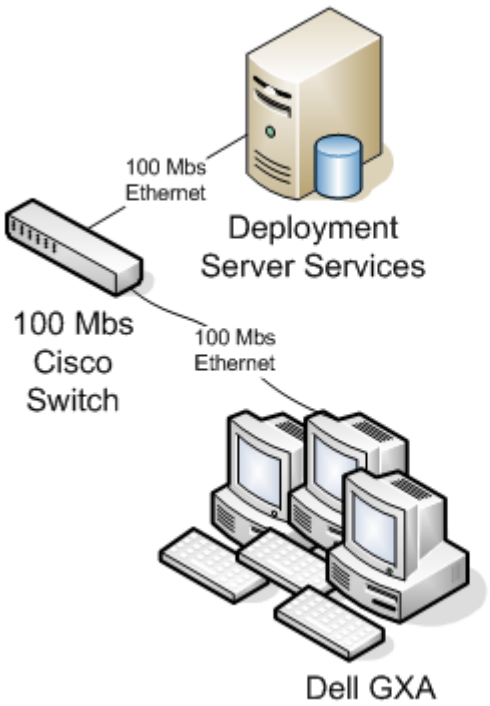

Figure 4- Networking Lab

Image Configurations

A very important tool used by professors in Brigham Young University School of Technology's IT department is the use of multiple computer configurations. The ability to specifically customize a computers configuration for individual courses not only increases the professors' teaching parameters but adds to the students' learning capabilities. Images currently in use include single operating systems, multiple operating systems, and dual-boot operating systems.

Single Operating systems

Images with single operating systems include Linux and Windows. These images are deployed to single or multiple machines (entire lab) using both Norton Ghost and Altiris. Norton Ghost re-images a single computer in 5 minutes and an entire lab in less than 35 minutes. Altiris re-images both single computer or entire lab in 10 to 15 minutes.

Multiple (Dual-boot) Operating systems

Images with multiple operating systems include either Linux or Windows. These images are deployed to single or multiple machines using Altiris deployment services. Altiris will re-image a single computer with multiple dual–boot operating systems in approximately 40 minutes. An entire lab can be re-imaged in approximately 50 minutes to 1 hour and 20 minutes.

Virtual PC Solution for Multiple Operating systems

As mentioned earlier, Brigham Young University's IT department requires the use of several operating systems per class. Solutions that have been implemented include creating images that contain a single operating system and images that contain multiple operating systems that dual-boot. Both of these imaging options provide their own advantages. Some advantages of an image containing a single operating system include the creation and deployment of the image in a short time period (5 to 10 minutes). A disadvantage of an image containing a single operating system is reduced flexibility, which can limit the breadth of an assigned lab. In addition, machines may need to be re-imaged more often, as labs requiring different operating systems may be interleaved during the week.

On the other hand, deployment of multiple operating systems may require more than an hour to complete, in exchange for which there are some advantages. By having both operating systems such as Linux and Windows contained in an image the hardware and lab space used is fully utilized. Lab assignments can require experiments involving different operating systems or other package configurations. Also, re-imaging may be less frequent since all the configurations needed for a multiple-week time-span of lab assignments can be loaded simultaneously.

A solution that provides the advantages of both these scenarios can be reached using an additional utility: Microsoft's Virtual PC. This package allows a computer running Windows the ability to concurrently run multiple operating systems on a single computer, from a single partition. This technology creates "Virtual Machines", that run from independent files that act as each virtual machine's own computer configuration. Beyond the utility software, the main requirement for this type of system to work is sufficient hard disk space to hold all the needed system and application software for the multiple configurations required. In addition, a generous allotment of RAM should be provided to allow for context switching. For the lab configurations used at this institution, 40 GB drives and 128 MB of RAM have proven sufficient for our needs.

Used in conjunction with the imaging software previously discussed, Virtual PC alleviates many of the disadvantages that have been pointed out with multiple operating system configurations. In particular, time savings are considerable when deploying multiple operating system images across many computers. This is because additional Virtual PC operating systems do not need their own partitions or hard disks, but instead create files on the existing hard disk. When using Altiris for cloning a multiple-operating system disk, where the operating systems exist as virtual PC files instead of as disk partitions, time improvements of up to 66% have been measured. That is, cloning a Windows system with Virtual PC installed containing other operating systems (Linux and Windows) requires just 15 to 20 minutes. The complete process of deploying the image to an entire lab takes approximately 40 to 50 minutes. In addition, for the students in the lab Virtual PC provides the ability to switch between operating systems without needing to re-boot, since the multiple operating systems run at the same time. A simple click of the mouse brings up the alternate system. Also, since all the files for the multiple OSs exist on a single partition, moving files between OSs is greatly simplified.

Conclusions and Summary

Disk imaging helps higher education institutions save money and time by providing IT laboratory flexibility and reconfigurability. Altiris Deployment Solution and Norton Ghost allow such institutions to change the OS of a computer system quickly, allowing the same hardware to be used for multiple tasks. Of the two packages, Altiris Deployment Solution provides the most flexibility and scalability, since it allows images to be cloned without operator intervention. Norton Ghost's approach requires less setup and overhead, but when the images are deployed more manpower is required. Brigham Young University's IT program has found that both solutions are needed for the maximum benefit. Altiris is preferred where distributions to many target systems is required, but Norton Ghost still is very useful in more limited scenarios. Both of these solutions allow imaging to be used to save money that would be otherwise spent on redundant computer hardware. In addition, these products allow laboratories to be rapidly reconfigured when needed, minimizing lab down-time. Additional functionality can be gained using Virtual PC, which allows users to dynamically change operating systems on running computers. When used with Altiris, Virtual PC also reduces the time needed to clone multi-OS systems.

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Biography

Charles Higby is a graduate student at Brigham Young University. Charles is currently pursuing a Master's Degree in Information Technology. Mr. Higby has worked as a network system administrators for over 4 years. Mr. Higby is the father of 1 son and currently living in Provo, UT.

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Nathan Blackham is an undergraduate student at Brigham Young University. Nathan is currently pursuing a Bachelors degree in Information Technology. Mr. Blackham has worked as an IT technician for the LDS Foundation supporting their databases, workstations, and servers. He currently runs a small business IT consulting company. Mr. Blackham is recently married and living in Orem, Utah.

Michael G. Bailey has electrical engineering degrees Brigham Young University, the University of Southern California, and the Florida Institute of Technology. Along with 3 years in academia, he has 15 years of experience in the aerospace industry, where he gained a lively interest in Digital Signal Processing and High Performance Computing. Dr. Bailey also enjoys taking his family for adventures in the Utah wilderness.