Final Report to Improve Workstation Imaging at the College of Education, Criminal Justice and Human Services

By

Ian Johnson

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University of Cincinnati
College of Applied Science

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Ian Johnson                     Date

Sam Geonetta, Faculty Advisor   Date

Hazem Said, Department Head    Date
TABLE OF CONTENTS

Statement of Need.................................................................3
Product Description and Intended Use.......................................4
Design Protocols.................................................................5
User Profiles.................................................................6
Deliverables.................................................................8
Proof of Concept...........................................................12
Testing.................................................................17
Risk Management Plan......................................................19
Conclusions and Recommendations........................................20
Appendix A: References.....................................................21
Appendix B: Timeline........................................................22
Appendix C: Budget........................................................26
Appendix D: Hardware and Software......................................27
STATEMENT OF NEED

The College of Education, Criminal Justice, and Human Services (CECH) has been using the same workstation imaging solution for the last five years. The imaging solution is slow and inefficient. Eight technicians are required to support the current imaging solution. CECH will face unprecedented budget cuts (13% or two million dollars) for the 2009-2010 school year (12). One of the many cuts will be that the Information Technology (IT) office will have to layoff four of eight technicians. If the present image solution is not changed the CECH IT office will not be able to function with only four technicians (12). The purpose of this senior design project was to improve workstation imaging at CECH by increasing the imaging speed and automating imaging tasks.

The current imaging process is extremely slow and requires a significant amount of labor on the part of the technician. The imaging server is a virtual machine that is housed on a server overloaded with virtual machines (12). This is the main reason imaging is slow. It requires 45 minutes to pull down an image from the server. Additionally, to make a backup image of a computer takes over an hour or longer depending on the amount of data on the hard drive. Nothing about the current imaging process is automated. A technician has to make a backup image, pull down the image, restart the computer, log in the user, and finally install software with the user logged into the computer.

The project has primarily been a networking project and has programming as the secondary focus. The main focus of the project was to build a new server for
distributing workstation images across the network. Linux scripts were used to automate imaging tasks.

**PRODUCT DESCRIPTION AND INTENDED USE**

This senior design project has improved workstation imaging at CECH in many ways. First, a physical server has been built for imaging rather than a virtual machine. Second, ZENworks Configuration Management (ZCM) 10 is the software used to push and pull images to computers. Third, Linux scripts have been used to automate imaging. Fourth, software has been added to the image so that it is already installed when the image is pulled down.

These improvements to workstation imaging have allowed technicians to deliver computers to faculty and staff faster and more efficiently. By moving imaging to a physical server, imaging speed has gone from 45 minutes to less than 10 minutes. ZCM 10 also has features that have improved imaging in the college's computer labs. An imaging strategy recommended by Novell restores a lab to a clean state (6). This is now done remotely from the imaging server eliminating the need for a technician to reimage every computer in a lab.

Due to budget cuts, CECH IT needs to greatly reduce its overhead or CECH IT will no longer be able to provide IT services to CECH users. The current imaging solution is slow, and inefficient. This senior design project will greatly improve speed and efficiency of the workstation imaging process.
DESIGN PROTOCOLS

The current imaging process is very slow and requires many steps on the part of the technician. Figure 1 shows the process the technician follows to reimage a machine with the Current Imaging Solution:

1. Insert ZENworks boot CD
2. Run Backup Image Command
3. Run Reimage command
4. Reboot the computer
5. Log the Faculty or staff into the computer
6. Install Software over the network

The technician does this entire process without any help from network administrators. This was one of the main requirements for the project. A technician needs to be able perform imaging work without any aid from the network administrators.

This project has been designed so that it is fast and easy for technicians to use. Technicians were given a similar ZENworks boot CD to connect with the new image server. This CD has a script on it that automates the entire imaging process. Figure 2 shows the process the technician followed to reimage a machine with the Senior Design Imaging Solution.
machine with the Senior Design Imaging Solution:

1. Insert the ZENworks Boot CD
2. Run Automation Script
3. Wait for process to complete and deliver computer to user

With the current image solution technicians are required to visit every lab computer to reimage an entire lab. This project has made it possible to multicast images to lab computers. To accomplish the multicast of image to lab computers the ZCM web interface was used. By viewing the web interface network administrators were able to see all lab computers. The lab image was also saved in the web interface. Administrators were able to apply the lab image to the lab computers. This reimaged the labs without requiring a technician to do any imaging work.

**USER PROFILES**

There are two users of this senior design project: network administrators and technicians.

**Network Administrators**

- **Demographics:** There were two network administrators in the CECH IT office.

- **Experience:** Each network administrator has a degree in Information Technology. One administrator has an Associates degree and one administrator has a Bachelors degree. The network administrators have experience supporting Novell products but this is the first ZCM 10 server added to the CECH IT infrastructure. One administrator has attended ZCM
training sessions to be able to support this project. The administrators are familiar with Linux scripting.

- **Frequency of Use:** Administrators need to use the ZCM server to reimage labs, add features, or troubleshoot any problems. Administrators are responsible for starting the multicast process. Added features include additional software that will be automatically installed.

- **Hardware and Software:** In order to make any changes to the ZCM server the administrators only needed a web browser to connect to the server. This required a computer with internet access. The backend of the ZCM server was SuSe Linux Enterprise Server (SLES) 10. Both administrators have experience supporting SLES. The physical server was a HP DL380; the administrators had a support contract with HP for the server.

**Technicians**

- **Demographics:** There are eight technicians that are using this senior design project. All technicians are student workers enrolled in a higher education program.

- **Experience:** Not all technicians are in an IT discipline. This provided for a wide range of experience in the CECH IT office. All technicians are well versed in the current imaging solution. This senior project is very similar in use to what the technicians are used to except it is faster and they have less work.
• **Frequency of use:** This project is used every day by technicians, to distribute workstations to faculty and staff. If a technician can’t solve a computer problem the technician reimages the machine using this project.

• **Hardware and Software:** The only hardware technicians need to have to use in the project is the ZENworks boot CD provided by the network administrators. Technicians use the boot CD to connect to the imaging server to make backup images and reimage machines. The only software the technicians need is the Linux script that automated the imaging process. The script was written for technicians to run; the technician needs no knowledge of what happens during the script. This script is run from the ZENworks boot CD.

**DEVIERABLES**

**List of Project Deliverables**

• Built SuSe Linux Enterprise Server

• Installed ZENworks Configuration Management (ZCM) 10

• Configured imaging On ZCM 10 server

• Wrote a Linux script to automate imaging process

• Made a new faculty/staff image with preinstalled software

• Made a new lab image with preinstalled software

• Enabled multicasting of Lab Image to Labs

**Built SuSe Linux Enterprise Server**

SuSe Linux Enterprise Server 10 (SLES) is the backend for this project. This was installed on the HP DL380. ZENworks could also be installed on a windows
2000/2003 backend server but SLES was preferred for many reasons. Every piece of hardware of the HP DL380 is on the SLES 10 hardware compatibility list. YaST (yet another software tool) can be used with SLES making installing software extremely easy. Throughout the project YaST has been used to install additional plug ins and software. SLES servers have been much more stable than Windows servers in the college’s environment (12). Windows servers in this environment have to be regularly restarted while SLES servers are usually restarted once a year.

**Installed ZENworks Configuration Management 10**

ZENworks Configuration Management (ZCM) 10 has been installed on the SLES server. ZCM 10 is a suite of applications provided by Novell for workstation management on a network. A feature of ZCM 10 that makes it unique from previous ZENworks versions is that ZCM 10 is web-based. This means that a network administrator can perform administration remotely. The web-based management has been advantageous to completing this project. Working remotely was easy and convenient.

**Configured Imaging on ZCM 10**

Once ZCM was installed, imaging in the CECH environment was configured. This was a two-part process. First, the server needed to be configured to send and receive images. Once the server was configured a ZENworks boot CD was made to connect a workstation to the imaging server. A technician inserted the boot CD into a computer and turned the computer on. The computer then booted to the boot CD. This connected the computer to the imaging server to perform imaging work.
This was a difficult deliverable to complete for many reasons. Novell has poor documentation for its products; Novell lists .pdf's that give overviews of its products. No published third party documentation for ZENworks 10 could be found. The Novell documentation explained concepts of building and configuring a ZENworks imaging server. Putting these concepts into practice involved a lot of trial and error. An example of this was a firewall problem. Novell recommends installing on ZENworks on SLES 10. After installed and configuring, an image still could not be put on the server. The reason was the SLES firewall. There was nothing about the SLES firewall in the documentation but this had to be configured to allow imaging. What was frustrating was that Novell had designed SLES to be the OS for ZENworks but Novell has not provided documentation or notification about the firewall. Turning off the firewall was not an option due to the security risk. Online research revealed that 23 ports on the firewall had to be opened to allow imaging.

**Wrote Linux Script to Automate Imaging Process**

A Linux script was used to automate the imaging process. In the previous system a technician had to make the backup image, then the technician had to pull down the good image, and finally the technician had to restart the computer. The Linux script performed this process automatically. All the technician needed to do is use the boot CD, and run the script after the computer boots.

Creating the script to automatically backup the computer and reimage the computer was not difficult. During testing, it was found that if the backup image failed, the script continued the reimaging process. If this had happened in production a faculty's computer could have been reimaged with out being backed
up. It was challenging to determine a check to insure that a successful backup had been made. The solution to this problem ended up being very simple. When the server performed a backup image the server output text to the screen after completion, “Operation Successful.” That output was then sent to a file. The automation script then checked the file for “Operation Successful;” if the script found the “Operation Successful” the script continued. If the script didn’t find the text then the script sent an error message that the backup didn’t finish and the script ended without reimagining the hard drive.

**Made a New Faculty/Staff Image with Preinstalled Software**

This is the image that technicians install on all machines going to faculty/staff. This image has Office 2007 and Adobe 9 installed before the machine is sysprepped. Once the machine is sysprepped an image is taken of the machine. Using Microsoft sysprep the image is able to be distributed to multiple different computers (10). This image is the image that is distributed to all faculty/staff across the college.

I and other technicians heavily tested this image. At CECH we first gave this image to graduate students and student workers. This image is now being pushed to faculty and staff.

**Made a New Lab Image with Preinstalled Software**

A lab image has been created that is very similar to the image that is used for faculty/staff machines. The lab image has much more software installed on the image. Software installed is NVivo 8, Captivate, SPSS, and Inspiration 8.
Enabled Multicasting of Lab Image to Labs

Once the lab image was made lab computers were added to the ZCM 10 server. Once the lab computers were added the ZCM 10 server was able to send out images to lab computers. This will be the new method for delivering images to the lab rather than a technician visiting every computer to pull down an image.

This deliverable has been completed and was well tested but it can’t be put into production. In order for the machine to be able to receive an image from the server, the ZENworks 10 Agent needed to be installed on each machine (2). The ZENworks agent connected the computer to the ZENworks server. This connection allowed the ZENworks server to perform network management tasks (2). All lab machines have to keep the ZENworks 3 agent on them; this connects the lab machines with our previous generations of ZENworks servers. The ZENworks 10 agent and the ZENworks 3 agent have problems if both agents are on the same machine. Even though ZENworks 10 has been configured for imaging, configuring it for software management, remote control, delivering network drives, or other network management tasks has not been done. Once the college completely migrates all services to ZENworks 10 will it be possible to get rid of the previous agent and only use ZENworks 10.

PROOF OF CONCEPT

This project aimed to fix many problems with imaging that cause imaging to be slow and inefficient. The project addressed these problems and showed some impressive numbers.
Imaging speed was a problem that this project has fixed. When comparing imaging speed with the previous solution and the imaging speed of the project solution significant time has been saved. Moving imaging from a virtual to a physical machine has greatly improved speed with the backup image and the reimage process. Making a backup image takes 45 minutes as opposed to 2 hours with the previous image solution. Making a backup image with the senior design image solution took 15-30 minutes. With the previous imaging solution it took 45 minutes to pull down a 2.5 Gigabyte (GB) image. The senior design solution pulled down a 6 GB image in 15 minutes.

The script for automating imaging was completed in February. The script was added to the previous image solution. This script didn’t improve speed but the script did automate the work a technician has to do. The script has been implemented on the senior design project server for imaging and has been successful for automating imaging. By combining the speed of the project server and the automation of the script, the senior design project is powerful. The previous image solution took 2-3.5 hours to complete a reimage process and is very labor intensive. The senior design project completed a reimage process in 30-50 minutes with very little work required on the part of the technician. A technician just needs to type “autoxp.s” at the command line; answer four questions and the image process can begin. You can see this process in Figure 3 below.
Once the script has been run the imaging process can begin. The script makes a backup image of the computer, and then reimages the computer.

ZCM web interface was used to multicast images to computers. In order for images to be multicast from server to computer a couple of things needed to be done. First, an image bundle was created. Clicking “New” started the “bundle creation wizard”. This walked the administrator through creating a bundle. In figure 4 you can see where to start the “bundle wizard” and bundles that have already been created.
Once a bundle was created it needed to be applied to a group of computers. There were 6 groups of computers created. Each group represented computers in a lab. Administrators only needed to apply a bundle to the group, and the next time the computers checked for image work they pulled down the bundle. Administrators applied the bundle by clicking “Action” on the menu bar. This can be seen in the Figures 5 and 6.
This project shows some impressive numbers. The senior project is more efficient and faster than the previous image solution. Reimaging of computer labs was a process where a technician was required to visit every computer to pull down
an image, and install software. Now the administrators only need to perform a few clicks to reimage the labs by using the ZCM web interface.

**TESTING**

This project aimed to fix an entire process for delivering machines to faculty/staff and labs. Implementing many technologies will complete this improvement. Each technology that was implemented needed to be tested. I performed most of the testing. Once the project was deployed and the technicians and administrators begin to use the project, errors surfaced that were not foreseen in the testing plan.

Once the SLES 10 was installed, it needed to be tested to insure it is stable, updates can be performed, and software can be added without a problem. Nondestructive testing was used to test the server. The server was tested to assure that it could receive regular updates, and to make sure that installing software through YaST and using server CDs is not a problem. Throughout the building and implementation of this project the stability of the SLES server was monitored.

After ZCM was installed and implemented, it not only needed to be tested but also evaluated. The reason this project is being done is because the CECH imaging process is so inefficient and slow. Image speed was monitored and documented throughout this process. This data was used to compare to the previous image solution to ensure that this project is faster and more efficient. The data was clear that the project was significantly faster.

By automating imaging a potentially dangerous situation was created. With the current solution a technician started the backup image process and the starts
the reimage process. A technician saw if the backup failed and performed it again if need. If a script was automating this process and the backup failed, the script needed to stop so that the script didn’t reimage a machine without a backup being created. This was something that was not foreseen in the writing of the script and during the testing one of the network administrators discovered this error. An error check will need to be created in the script to make sure that the backup image is successful. Once this error check is created, many possible scenarios' where a backup image can fail will need to be created and tested to see if the scripts exits or continues.

When the image was created for faculty/staff it needed to be tested to insure the image is stable and software is installed correctly. Plans for testing this were to constantly use this image on my own machine at work. Bugs were fixed as they are recognized. Other technicians at CECH volunteered to test the image as well. The image that is going to be distributed to the labs was initially tested by me. Once some initial testing was done the technician who is required to monitor the lab for student access tested the image. Testing of the image was easily completed while the lab technician was in the lab doing routine monitoring/fielding questions for students. Most issues that came up were noticed when I began using the image on my own machine.

The final part of the project that needed to be tested was the multicasting of the image to the lab. This was tested after hours and on weekends. This put a huge load on the network and on the server. How much load is put on the network and
the server was determined through the testing process. The multicast was started on Friday night and finished Monday morning requiring no intervention.

**RISK MANAGEMENT PLAN**

Figure 8 provides a list of possible risks to this project. One of the unique risks is the risk of managing. A joke on the Novell forums is that whoever automates an imaging process has a job for life (8). I will not be maintaining this project, but the CECH administrators will be maintaining this project (12). It will be very important for them to have a thorough understanding of each part of the project so that the administrators can support the project.

<table>
<thead>
<tr>
<th>Risk</th>
<th>Risk Level</th>
<th>Risk Mitigation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Security:</strong></td>
<td>High</td>
<td>• Strong Passwords</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Server will be patched</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Log files periodically checked</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Server behind locked doors</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Email Alerts</td>
</tr>
<tr>
<td><strong>Managing:</strong></td>
<td>Medium</td>
<td>• I am making sure he is aware of every change and why changes are made</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Scripts created have lots of comments.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• I am also maintaining detailed notes, documenting important changes made.</td>
</tr>
<tr>
<td><strong>Reliability:</strong></td>
<td>High</td>
<td>• Support Contracts; 24/7 phone support and a 4 hour response time from a Novell tech.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Server log files will be monitored.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Since the server will be used everyday monitor performance will be very easy.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Regular backups of the server will be taken.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• A redundant server would be nice but the college can't afford the server.</td>
</tr>
<tr>
<td><strong>Disaster Damage:</strong></td>
<td>Low</td>
<td>• Off site Backups of the server will be kept.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Drains are in the server room to prevent flooding.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• We have a water free fire suppression system.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• The server is hooked to two different Battery UPS.</td>
</tr>
</tbody>
</table>
CONCLUSION AND RECOMMENDATIONS

This project has greatly improved workstation imaging at CECH. Technicians are able to deliver computers faster, with less work, to faculty and staff. This project eliminates the need for a technician to spend days reimaging a computer lab. Reimaging of labs will be completely automated and initiated from the server when the college upgrades to ZENworks 10. With the upcoming budget cuts the College faces, this project will allow CECH IT to do more with less.

When looking at my entire college career, this project will be my most memorable experience. I put much more work into this project than originally planned and it has paid off. I underestimated how much I would get out of completion of this project. I have dramatically increased my knowledge of workstation deployment, ZENworks 10, and windows/Linux scripting. I was looking for a job after college during March. I mentioned my senior design project on my resume, cover letter, and during an interview. One of the main reasons why I was hired at my current job was because my new employer wants me to implement a similar solution.
APPENDIX A: REFERENCES


   <www.novell.com/coolsolutions/feature/18872.html>


   <http://www.microsoft.com/technet/scriptcenter/default.mspx>

   <http://www.pctools.com/guides/scripting/>


APPENDIX B: TIMELINE

2/16 – 2/23 Complete Presentation
The project will be presented on March 2\textsuperscript{nd} to the class and faculty. The presentation will be done a week in advance in order to test presentation and practice the presentation. The presentation will include a PowerPoint that describes the project verbally and pictorially.

2/23 Test Presentation
The presentation will be tested in the classroom to insure that there will be no audio/visual problems on the actual presentation day.

2/23 – 3/2 Practice Presentation
Once the PowerPoint presentation and demo is complete and working, the oral presentation will be practiced and timed to ensure a smooth execution on 3/2.

2/23 Writing Lab Rough Draft
Much work in regard to enhancing the content and refining the verbiage in this paper has been done since it was first submitted to Dr. Thompson in Blackboard. Additional editorial guidance in the preparation of this paper was obtained from the English Department.

2/23 – 3/2 Complete Revisions on Design Freeze
Once I have professor Thompson's revisions and writing lab revisions I will revise my design freeze and have it prepared for 3/2.

3/2 – 3/6 Make a lab image with Preinstalled Software
I will add upon the image I have already made by adding more software to the image. Software to be added will be all the software that Professors use in our labs, including Software to add will be SPSS, NVivo 8, Inspiration 8, Captivate 3, and the Adobe Web Suite.

**3/9 - 3/13 Testing of Lab Image**

Once the image is configured, it will be tested to make sure all software was installed and works properly.

**3/16 – 3/20 Configure Multicast Prototype**

The Multicast of the Lab Image will be configured in a very small environment. Using ZCM 10 a Prototype group of three computers will be made. The lab image will be sent to those three computers. It is anticipated that a special configuration will need to be made to the server and to the computers receiving this image to make this work.

**3/23 – 3/27 Configure Multicast for Computer Labs**

Once the prototype is complete the Multicast for the computer labs will be configured. Configurations learned in the “Configure Multicast Prototype” will be applied.

**3/30 – 4/3 Test and Evaluate Multicast in Labs**

Once multicast is complete it will need extensive testing and evaluation. In the proposed prototype an image is sent to three machines. For the actual implementation of this project an image will be sent to 30 machines. The time it takes to send the images to 30 machines and the effect this has on the network still
needs to be determined. The multicast may have to be performed after hours but this will be determined during this process.

4/6 – 5/7 Prepare for TECH EXPO

Here is the time to build display, and prepare 10 minute presentation at TECH EXPO. I see three main tasks to complete for tech expo. First I need to have a demonstration for my project. Second I need to build a booth that highlights my demonstration and all parts of my project. Third I need to prepare a speech to give to people who come up to my booth and practice the speech using the booth.

5/1 – 5/11 Prepare Rough Draft

I will need to have my rough draft ready to be submitted to Professor Thompson on 5/11.

5/11 – 5/18 Prepare and Give Speech

I will be giving my speech on the 18th. This will involve completing many tasks with the end goal be a successful presentation. First I will need to prepare a demo of my entire project. Second I will need to prepare a PowerPoint to describe my project and integrate my demo into the presentation. Third I will need to test my PowerPoint and demo at the classroom to insure no problems.

5/25 – 5/27 Rough Draft Revisions

Once I get revisions back from Professor Thompson I will need to make revisions and give the paper to Professor Geonetta.

5/29 Hazem Said Signature

Once I have made Professor Geonetta’s revisions I will need to fix those problems and get the signature from the IT department head, Hazem Said.
6/1 Library Turn In

Once I get Professor Said's signature I will need to put all documents, PowerPoint's into a manila folder and turn it into the library.
APPENDIX C: BUDGET

While describing the budget please refer to Figure 7.

Figure 7 Updated Budget

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Retail Cost</th>
<th>Cost Incurred</th>
</tr>
</thead>
<tbody>
<tr>
<td>Server</td>
<td>Provided by Employer</td>
<td>5,559.00</td>
<td>$0.00</td>
</tr>
<tr>
<td>3x Desktop</td>
<td>Provided by Employer</td>
<td>3000.00</td>
<td>0.00</td>
</tr>
<tr>
<td>SLES 10*</td>
<td>Provided by Employer</td>
<td>4050.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Book</td>
<td>Windows Admin Scripting</td>
<td>$32.97</td>
<td>$32.97</td>
</tr>
<tr>
<td>ZCM 10 **</td>
<td>Provided by Employer</td>
<td>$42,000</td>
<td>0.00</td>
</tr>
<tr>
<td>FlashDrive</td>
<td>8 GB used for transferring files</td>
<td></td>
<td>$20.00</td>
</tr>
<tr>
<td>Labor</td>
<td>14.50 X 280</td>
<td>$4,060</td>
<td></td>
</tr>
</tbody>
</table>

| Retail Total: | $58,926.97 |
| My Total:     | 52.97      |

*SLES 10 is free, however there is a charge for updates and support

**ZCM 10 is part of a bundle deal that covers more than just ZCM support but that is the price of the bundle

Although cost for this project was close to $60,000 dollars, the cost to the college is only out what it is paying me to complete this project $4050.00. SLES, ZCM, and the server had already been purchased. It was estimated that this project would take 280 total hours to complete. This project has been one of my main responsibilities at CECH and I estimated spending 20 hours a week on this project. This involved researching, and making changes to the project. Multiplying my hourly wage of $14.50 times 280 hours results in $4060 being the technician cost to develop and implement this project.
APPENDIX D: Software and Hardware

Hardware

- HP DL380 G4 Server
  
  This will be the hardware used for the imaging server.
  
  o 3.04GHz Xeon Processor
  o 6GB RAM
  o Six 72GB hard drives in RAID 5 Array

- Desktop PC

  This will be the machine used to make the image to put onto other machines.
  
  o 3.33GHz Intel Core Duo
  o 1GB RAM
  o 120GB Hard drive
  o 19” Wide Screen Monitor

Software

- SuSE Linux Enterprise Server (SLES) 10
  
  This will be the OS on the server.

- ZENworks Configuration Management 10 SP1
  
  In the ZCM 10 suite there are imaging services. This project will configure these imaging services.

- Microsoft Sysprep
  
  This will be used to help make the image for the machines.