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Deep freeze and the NSSA Labs

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By

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Abstract

This work represents a formative evaluation of the effect of Deep Freeze on the labs in the Networking, Security, and Systems Administration department. This department maintains 4 labs for student use and has implemented Deep Freeze, a software package intended to maintain a standard set of configurations on each computer. In order to provide a proper focus to the evaluation, the process consisted of identifying specific evaluation questions, first through a diverging process, including the input of key stake holders, followed by a converging process. The data was collected using both a survey instrument and interviews, providing both quantitative and qualitative data. This process resulted in information that Deep Freeze does indeed save time for the lab technicians, both in the duration of imaging and in the number of times the labs need to be imaged. Additionally the labs are kept more consistent, the practicals run smoother, and the students like the program. However, students do need to be constantly saving their work off the computer in order to prevent data loss due to Deep Freeze.

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I. Executive Summary

Evaluations take on many forms; this one is intended to ascertain the effect Deep Freeze has had on the Networking, Security, and Systems Administration (NSSA) department labs and to identify areas of improvement. In addition to understanding how this program has affected the way students, lab technicians (labbies), and professors interact with the labs, it is also in partial fulfillment of the requirements for a Master's degree in Networking and Systems Administration. This particular study involved many constraints, the biggest being time to collect the actual data. Additional constraints include an extremely limited budget, restricted communication with key stakeholders, inadequate response from participants, and personal bias.

The first step of an evaluation is to identify the evaluation object, thereby giving focus to the whole evaluation. The NSSA department, housed in the Golisano College of Computing and Information Sciences, provides degrees in Networking & Systems Administration and in Information Security & Forensics at both the Bachelor's and Master's levels. It maintains four labs for student use and classroom instruction on anything from switching and routing to scripting to wireless communication. Ann Gover, lab manager, is responsible for all of the lab technicians and the configuration of these labs. Every quarter there are open lab hours, hours in which classes are taught, and hours during which the students have a timed, hands-on test also known as practicals. Prior to the Deep Freeze implementation, lab technicians imaged all the computers with fresh configurations using Norton Ghost before each class and practical. Students were also advised to image the computers with fresh configurations prior to working during open lab hours. In order to support this endeavor the lab technicians maintain an imaging infrastructure separate from the regular network connection which uses a variety of images of different Operating Systems. Deep Freeze, a program distributed by Faronics, is intended to

maintain a consistent set of configurations on the computer. This program allows students to make whatever changes they desire but as soon as they reboot the computer all of those changes are discarded and the computer resorts back to its standard image, thereby reducing the need to re-image the computer.

The specific evaluation questions provided additional focus to this evaluation. After consulting with the lab manager and other key stakeholders, the long list of potential questions became four primary questions. The first question deals with the time-savings aspects of Deep Freeze. The next question involved the consistency of the labs. Question three is intended to focus on the affect of Deep Freeze on the teacher workload. The final question tried to consider the perception of the students and labbies about Deep Freeze.

The actual process of conducting the evaluation influenced the outcomes and utilized a mixed qualitative and quantitative approach. The survey, developed specifically for this evaluation, provides the qualitative data. Interviews and personal experience, the qualitative data, will be used to validate the survey responses. Additionally, by providing open-ended questions in the survey and the interviews this evaluation can encompass more than the anticipated questions. The population for this evaluation consisted of: a random sampling of 60 students in the NSSA department, all of the labbies, and all of the professors. Quantitative data will be evaluated using descriptive statistics, with chi-squared tests to validate the statistical significance of the data. The qualitative data was coded based upon themes in the responses.

The actual results of the data collection process represent the bulk of the paper. Of the 149 people asked to participate in the survey, only 51 responded: 6 faculty members, 13 labbies (who are also students), and 32 general students (not labbies) for a response rate of 34%. All those interviewed agreed that Deep Freeze saved time with some estimates being around 20-50

minutes each day. The survey showed that time was an important consideration to students when asked to identify the benefits they saw from this program. Labbies reported that Deep Freeze not only reduced the amount of time spent imaging each week but it also reduced the frequency of reimaging. As far as consistency is concerned, the survey asked respondents to rate the labs both before and after the implementation of Deep Freeze. This resulted in a significant shift to fewer problems with the lab image after this implementation. The third question dealt with teacher workload and while not enough teachers responded to make any valid inferences about their comments, both the students and the labbies suggested that Deep Freeze reduced the imaging incidents during practicals. This frees the teacher up to take care of other issues, meaning there can be a reduction of workload. While the majority of the comments about Deep Freeze were positive, there were some negative side effects like data loss and difficulty in preparing lab images. Finally, and unanticipated at the outset of this evaluation, many students reported that Deep Freeze brought them a peace of mind knowing that the labs could always be reset to their standard state, allowing them to take better advantage of open lab hours.

The conclusions and recommendations portion of the paper concludes the evaluation. While there are clear benefits like the time-savings and the consistency of the labs, many students also worry about data loss. The labbies must also support an additional program which makes it harder to build images. One suggestion for improvement is to remove Deep Freeze from the battery-driven laptops for wireless labs because they are prone to power loss and, because of Deep Freeze, data loss. Additionally, it might be beneficial to provide storage either in a thawed partition or a network share to allow students a temporary location to save data that will not get deleted upon reboot. Finally, a more comprehensive Deep Freeze image to include all of the programs needed in the labs is recommended.

II. Introduction

A review of the background behind this evaluation will aid the reader in gaining a more complete understanding of its purpose and results. In order to help with that objective, this introductory section discusses the purpose of the evaluation, highlights the intended audience, presents the limitations and constraints of the evaluation, and briefly explains the remaining content of this report.

A. Purpose of the Evaluation

The primary purpose for this evaluation is to better understand how the implementation of Deep Freeze has impacted, whether positively or negatively, the lab environment within the Networking, Security, and Systems Administration (NSSA) department. By completing this evaluation I want to better understand how Deep Freeze has affected students, lab technicians, and faculty members. Because it is such a recent implementation in the NSSA labs it deserves attention: to see if the department is truly achieving the perceived benefits and to identify ways of improving this particular implementation.

This evaluation relates to the networking and systems administration area because it deals with understanding the result of a change to the operating environment. Often times in a computer network environment new applications or hardware are implemented because they are the latest and greatest or promise improved performance. Rarely, however, are these new additions fully evaluated to understand whether they actually improve the network or not. By performing this evaluation I hope to gain experience to better understand the change process and to be better prepared in the future to evaluate changes.

A secondary purpose is to fulfill the requirements for the NSSA Master's degree in Networking and Systems Administration. In order to assist in this endeavor, I have enrolled in

the Learning and Knowledge Management program capstone course: 4002-865 Program Evaluation. This report serves as an organized presentation of my evaluation for both the course and the Master's degree requirements.

B. Audience for the Evaluation Report

While the potential audience for this report could be broad indeed, including anyone who is interested in the effect of Deep Freeze in a computer lab environment, the actual intended audience is much more specific. There are at least three intended audiences for this report: the faculty members who must approve this graduate work, the faculty and staff of the NSSA department who work with Deep Freeze, and those students who may be conducting similar evaluations or attempting to write similar reports.

Primarily this report is directed at the faculty members who must approve of my graduation requirements. For this reason I have tried to be as complete as possible in order to fully explain my evaluation and show the comprehensiveness of this project. This report serves to help the reader completely understand the process and results of this formal evaluation. I am hoping to be open to public scrutiny with my analysis and interpretation of the results and to be completely transparent in the methods I followed in order to collect the data.

A secondary audience is the faculty and staff of the NSSA department at RIT. This report is intended to help them better understand the impact of Deep Freeze on the labs and I hope the analysis and interpretation portion is especially beneficial for this purpose. Deep Freeze is just one example of a program that is implemented in the NSSA labs in order to offer the students the best lab environment possible; this report can help the faculty and staff to make better decisions about the future of Deep Freeze and the labs as a whole.

Finally, I hope that other students in the same program will be able to benefit from the thoroughness of this report. I gained insight as I studied Al Naclerio's report on the evaluation of a Gmail application and hope that my report will aid future students. I encourage future students who identify weaknesses or errors in my evaluation to make those improvements in their own work and thereby improve the knowledge domain as a whole.

C. Limitations and Constraints

While this evaluation has been conducted with the best possible intentions, conforming to current practices in the field of program evaluation, the reader needs to be aware of several limitations of this study. The primary constraint was time. Due to external influences, this whole evaluation had to be completed in a period of only a few weeks. That did not provide enough time to thoroughly understand all of the implications of Deep Freeze or include as many stakeholders as would have been ideal. Also because of time and other resource constraints the evaluation questions had to be limited to only a few. Had there been more resources available we could have investigated more questions and better understood the complete impact of Deep Freeze on the current lab environment.

Other limitations include communication with key stakeholders, limited respondents, and an early implementation of the Deep Freeze software. This evaluation began near the middle of November which meant that many of the key stakeholders were either on vacation or convalescing due to surgery. This made communication limited and potentially influenced the focus of this evaluation adversely. Also, largely due to time constraints, the respondents to the survey instrument came primarily from the students and faculty members in the NSSA department. More time would have allowed for the use of a better control group such as another lab environment outside the NSSA department that had not recently changed the imaging

techniques. Additionally, Deep Freeze was only rolled out in the NSSA labs in Fall quarter 2008 (late August) and this evaluation took place in Winter quarter 2008 (late November, early December). This means that the implementation of Deep Freeze is still fairly new and the users are still adjusting to its usage. Since it was not a mature implementation I expected many shortfalls and a lot of unfamiliarity over the course of the evaluation.

I would also like to include a word about bias. As an internal evaluator I am familiar with the history of this program and its general acceptance within the NSSA department. I am also familiar with the key stakeholders and users of the Deep Freeze environment and so, by very nature, my evaluation will show a little bias. I have attempted to control for personal bias through triangulation of the data, both within the survey instrument and the open-ended interviews. The benefit of working from the inside is the familiarity with the decision-making strategies and work flow of the lab environments which aided in completing this evaluation within the time constraints.

A final constraint of this evaluation is that it is merely a snapshot of the current situation. There is no promise that these results translate into future or past performance. With these limitations in mind I will now introduce the reader to the rest of the contents of this report.

D. Overview of Report contents

Besides this introductory section there are four major sections which follow. They are, in order of appearance, the Evaluation Focus, the Evaluation Process, the Results, and Conclusions and Recommendations. A series of appendices are attached to make this report more complete.

The Evaluation Focus section is intended to guide the reader through some of the preliminary steps taken in order to determine the focus of the evaluation. The intent of this section is to present a clear idea of what was evaluated and why. One of the primary features of this section

is the description of the evaluation object. Many people are not familiar with Deep Freeze or the NSSA labs and this description serves to help the reader fully understand the environment under evaluation. It will provide a brief overview of the NSSA department, the lab environment, Deep Freeze itself, and will also include a few comments on what is not included in the evaluation. This section concludes with an explanation of the evaluation questions and the rationale for selecting these particular questions. After reading this section the reader should better understand the scope of the evaluation as well as what determined the particular aspects of Deep Freeze I evaluated.

After the Evaluation Focus section the Evaluation Process section exists to orient the reader to the actual evaluation. This section will include information about how I conducted the evaluation and why it was done in this particular manner in an attempt to make the evaluation process more transparent and open to scrutiny. A main feature of this section is an explanation of the data collection process in order to help the reader to understand the results section.

The Results section reports the actual evaluation data. This section addresses each of the evaluation questions in turn, complete with the data and analysis which support that question. It is in the Results section that the reader will find an analysis of all user responses, both with the survey instrument and with the interview process. I will also provide a little insight from my personal experience as a Teacher's Assistant during the period in which Deep Freeze was implemented. The primary purpose of this section is to openly present and discuss the results of the evaluation and to present the actual data through my interpretation of its significance.

The final section of this report is the Conclusion and Recommendations section. In this section the reader will find the overall conclusions of the Deep Freeze implementation, including both the positive and negative consequences of putting this program into use. Following some

concluding remarks about the evaluation as a whole will be a few recommendations to the NSSA faculty and staff for improving Deep Freeze in the future. This section is intended to terminate the main body of the report and will conclude with suggestions for possible future work.

Attached to the end of the report will be several appendices. Appendix I is a bibliography of sources that proved helpful in better understanding Deep Freeze and this evaluation process. Appendix II is the notes I took on the diverging phase of deciding the evaluation questions. Appendix III is a reproduction of the spreadsheet we used in the converging stage to actually decide on evaluation questions. Appendix IV includes the e-mails I sent out in order to invite students and faculty members to participate in both the survey and the interview. Appendix V is a reproduction of the actual survey instrument and responses with a brief explanation of the rationale and branching involved. Appendix VI is a digitized version of my interview notes with the different volunteers. Appendix VII explains and presents the analysis of the qualitative questions within the survey. Appendix VIII presents a one-page summary of the results in order to present to stakeholders in the NSSA department. Finally, Appendix IX contains an acknowledgment of those individuals who proved essential and very helpful in completing this evaluation.

III. Evaluation Focus

A proper focus is needed in order to fully understand the object under evaluation and the extent of the evaluation. This section explains the Deep Freeze program under evaluation, within the context of the NSSA labs. It is important especially for those unfamiliar with Deep Freeze or the NSSA lab structure. Additionally, this section contains a brief discussion of the evaluation questions including information about the selection of these particular questions.

A. Description of the Evaluation Object

The NSSA department has only recently been organized within the B. Thomas Golisano College of Computing and Information Sciences, drawing from resources of the Information Technology and Computer Science programs. The National Security Agency, the Department of Defense, and the Department of Homeland Security have designated the department as an Academic Center of Excellence, meaning that they have the programs which teach the skills these national agencies are looking for. Currently there are 17 full-time faculty members and about 400 graduate and undergraduate students in the department. The department has a specific focus and offers two degrees at both the undergraduate and graduate levels: a degree in Networking and Systems Administration and another in Information Security.

The school maintains five computer labs where the faculty members teach principles of systems administration, networking, security, telephony, wireless technologies, forensics, and other sundry projects. The labs are distinctly named according to their function: Netlab (primarily used to teach networking classes), Syslab (primarily used to teach systems administration), VoIP (the telephony labs), and Projects (for just about everything else). Students are free to work with whatever software suits their needs but standard images are provided in both Windows and Linux environments. The lab is maintained by a group of about

14 student employees known collectively as “labbies” who are themselves involved at various levels within the program (in other words they also use the labs as students in their classes). In total these labs constitute about 300 computers, over 130 routers and switches, and are estimated to be worth over $2 million. The department works closely with vendors to provide students with state-of-the-art computing equipment in order to teach applicable skills and to prepare them for immediate employment upon graduation.

These labs are used for three primary purposes: open lab hours, class instruction, and practicals. Open lab is a time designated for students to work on their assignments. There is always a labbie or a teacher’s assistant on shift who can answer their questions and it gives students an opportunity to explore. Class instruction is time designated for a specific class to work together on a specific lab assignment. For example, the Introduction to Routing and Switching class has two hours each week where they get hands-on experience manipulating routers and switches. Students who do not finish in the allotted time can then come back during open hours to complete their work. Finally there are the practicals. Usually a class with a lab component will have two practicals: one at the mid-quarter mark and the other at the end of the term. This is a timed test (about an hour long) where the students are asked to perform a series of previously identified tasks in order to prove their acquired knowledge in the particular class. Practicals are stressful for students because they have no foreknowledge, other than the gamut of topics covered in class, as to the content but are still expected to perform within the time requirements. With this understanding of the NSSA labs, it is now possible to introduce the Deep Freeze program.

Faronics developed Deep Freeze, a program designed to help maintain a set of standard computer settings also known as the computer “image.” They market the product as a way of

maintaining computer configurations (especially in lab environments) while giving full access to the users. This provides a more consistent computing experience and prevents the introduction of malicious logic onto the computer. From the Faronics website we read,

> "Faronics Deep Freeze helps eliminate workstation damage and downtime by making computer configurations indestructible. Once Deep Freeze is installed on a workstation, any changes made to the computer—regardless of whether they are accidental or malicious—are never permanent."

In other words the program is intended to prevent change to the computer software. With this program installed, administrators are able to allow users control over the computer but as soon as they press the reset button any changes are removed and the computer is restored to its standard image. This is exactly what the NSSA department was looking for in order to maximize student productivity while reducing the need to reimage computers.

This evaluation has been conducted in order to understand the actual impact that Deep Freeze has had on the NSSA labs, from the perspective of faculty members, lab technicians, and students. The lab workers under the direction of Ann Gover, NSSA department lab manager, tested the Deep Freeze program in Spring and Summer Quarters of 2008 in order to see if this program would help improve the lab environment. The program was implemented in Fall Quarter of 2008 and this evaluation took place in Winter Quarter of that same year, which represents the first quarter following the initial deployment of this software package. This evaluation represents the first time that such a program has ever been evaluated formally in the NSSA department.

Ann Gover selected Deep Freeze to address the problem of reimaging computers in the lab environment. She had experience with this program from a previous job and decided that it would serve her purposes in the current lab situation. According to her, the goal was to provide a more consistent lab environment, to increase student productivity, and to decrease the time it

took to prepare the labs for student use. Additionally, she thought that Deep Freeze would aid the faculty members in their lab coursework especially in streamlining the practicals. Essentially the idea is that students need to be able to have administrative rights on their computers in order to complete their lab assignments; however, the computer labs need to maintain a standard image in order to provide a consistent lab environment for all students. In other words, the work that a previous student did on a machine should not interfere with the work which the current student needs to accomplish, even if it is the exact same task as the previous student. Deep Freeze is the intended solution because all changes are discarded simply with a quick reset, enabling students to start from the same configuration every time.

The primary users of Deep Freeze are the lab technicians who prepare images and set-up the lab for the specific class requirements. Secondary users include the professors who teach with a lab component and the students who would be affected by the change in the imaging process. The principal stakeholders are the students, the lab technicians, the faculty members, Ann Gover, and the department administration.

This evaluation is limited to the evaluation questions presented in the following section and to the particular implementation of Deep Freeze within the NSSA department. These questions were deemed the most germane to the decision makers and the most interesting to the other stakeholders. Other evaluation questions were proposed and could be valid (see Appendix II – Diverging Questions and Appendix III – Converging Process for a brief explanation of choosing evaluation questions) but due to resource constraints the current set of questions were selected. This evaluation is intended to answer these questions in this current situation only and may not be generalized or transferred to other situations. The evaluation consists of a survey questionnaire, several open-ended interviews, and a few personal observations with some

analysis and interpretation on these results. There is no assumption that this data is comprehensive, simply a report of the current state of Deep Freeze in the NSSA labs. This evaluation does not include any treatment or experimental design. While certain summative conclusions could be reached, it is intended that the results be used in a formative sense, as an evaluation of how the program is doing and perhaps how it could be improved.

B. Evaluation Questions

In order to give the evaluation a more specific direction, I established, with the help of a few key stakeholders, the questions I was going to attempt to answer in the process of this evaluation. I primarily worked with Ann Gover, the lab manager, but also sought the input of the student lab technicians who helped to implement and support the Deep Freeze program. I also asked for suggestions and guidance from the Department Chair, Dr. Luther Troell. With each of these parties I asked them originally to help me brainstorm and come up with a wide variety of questions which could possibly be answered in the course of my evaluation. After we had compiled a list of many questions I suggested some criteria (see Appendix III – Converging Process) and then together we judged which questions should be answered given the current constraints. Essentially we decided to look into questions regarding the amount of time-savings Deep Freeze provided, the consistency of the labs, the impact on the faculty members, and the effect on students and labbies.

Time-savings. As I consulted with the lab manager over the course of the design phase for the evaluation, it became apparent that we wanted to find out if Deep Freeze really resulted in time savings. The labs provide open hours when any student can come in and work on projects but it also provides closed labs just for specific classes. With a limited number of resources it was necessary to close the labs during certain hours of the day because of a lack of manning.

The labs were closed at other times in order to prepare the labs for the classes that were coming in. One of the goals in implementing Deep Freeze was to reduce the amount of time spent imaging computers in order to free up student time to work more efficiently and to free up labbie time from the imaging process which they could then devote to helping students and other lab maintenance tasks. In order to get at these answers we asked the question: has the implementation of Deep Freeze reduced the amount of time to image computers in order to prepare the labs for student work?

Consistency. Another important factor involving the implementation of Deep Freeze was whether it improved the consistent state of the labs or not. From the start I wanted to make sure that both the lab manager and I agreed on what it looked like to have a "consistent" lab, so we spent some time clarifying what that meant. Essentially the intention was to understand if the students were able to proceed in their work without lab imaging getting in the way. One of the problems that Deep Freeze was intended to address was to ensure that students were able to start with the same configuration every time. During open lab hours the computers are open to anyone who needs them and it was often difficult to determine what configuration changes were made by the prior student who had used the computer. In order to discover this set of information we asked the question: has the implementation of Deep Freeze resulted in reduced imaging incidents where the student was unable to work due to an incorrect image or prior student work?

Teacher workload. Since Deep Freeze was implemented in an academic setting it was important to determine how it had impacted the faculty members. The faculty members are the ones who develop the lab assignments for the students to complete in the first place and it is through this work that the labs are utilized. It became important to understand how Deep Freeze

had influenced the faculty members' workload and whether it helped or hindered their ability to teach the principles they wanted to teach. The last thing Ann Gover wanted to do is to implement a program which would cause more work for the faculty members without an equivalent improvement to the overall lab environment. Another important use of the labs is the practicals, Deep Freeze was implemented with the goal of making the practicals process better, which is an indirect impact on teacher workload. Therefore we decided that we would ask the question: what effect has Deep Freeze had on teacher workload?

Effect on students and labbies. The primary users of the NSSA labs are the students for which the labs are designed. One of the overall goals of providing a lab environment is so students can have hands-on experience working with the technologies they learn about in classes. It is frustrating for students, who have schedule limits, to arrive in a lab with the intention of working only to find that the lab is not configured the way they need. For this reason a staff of student employees exists to prepare the labs and the answer the student questions. For Deep Freeze to be considered a successful change to the lab environment it would mean that both the students' and labbies' lives are easier as a result of the implementation. The lab manager wanted to know if Deep Freeze had in fact resulted in an improvement from the perspective of both the labbies and the students since they were primary stakeholders in the overall success of the labs. For these reasons we asked the question: what is the perceived impact of Deep Freeze from the perspective of the students and labbies?

By answering these four questions, we hoped to fully understand how the implementation of Deep Freeze had in fact influenced the lab environment from the perspective of all stakeholders. We wanted to make sure that Deep Freeze had met the goals which Ann Gover had established prior to its implementation and that she could address any negative consequences of this

implementation. By going through this process of giving the evaluation a proper focus we hoped to get a better understanding of the time-savings, the consistency, the impact on the faculty members' workload, and the effect on the students and labbies. The next section will explain the process used to obtain answers to these questions.

IV. Evaluation Process

In order to better understand the evaluation results, it is necessary to understand the process. This section is intended to explain why the specific processes were used to conduct the evaluation. This particular evaluation utilizes a mixed-method, cross-sectional approach in order to conduct a hybrid criterion-based and management-oriented evaluation of Deep Freeze. Mixed methods refers to using both quantitative data (the survey instrument—numerical data or data that is countable) and qualitative data (the interviews and few personal observations—the rich details and softer interpretations) in order to better understand the overall impact of Deep Freeze in the labs. The cross-sectional nature of the evaluation takes a snapshot of the current state of the lab environment. This is in contrast to addressing how the labs have changed over time or how Deep Freeze has evolved in both acceptance and use. The hybrid approaches (criterion-based and management-oriented) refer to the approach taken to focus the evaluation. The criterion-based portion means that the evaluation determines if Deep Freeze actually has met the intended goals for its use. Prior to its implementation the lab manager had some specific goals she wanted to meet and this evaluation determines if those goals were met. Management-oriented refers to the primary inclusion and principle correspondence with the lab manager. This correspondence made sure that the evaluation answers the questions which will help her to make better decisions about the lab in the future. In order to better explain the evaluation process, this section will now focus on the methods used for data collection: the survey and the interviews, with a few comments about my personal observations.

The survey had a specific purpose and some important limitations. It was used to obtain a larger understanding of the general effect of Deep Freeze and was the source of the quantitative portion of this evaluation. It also helped to understand broad themes and opinions while

collecting information from a sampling of all lab users. Time became a big issue in the use of this survey instrument since the data collection phase (survey and interviews) was limited to only two weeks due to outside deadlines. There is also a question of the validity of the survey instrument since it was developed in-house. However, there are triangulating questions within the instrument itself (similar questions that are asked in different ways to make sure that the response was valid) and the results are compared with the interview responses to make sure there is consistency in the data.

The survey itself consisted of three phases: development, pilot, and the actual collection of data. Each evaluation question became part of several survey questions in order to remove bias and test for consistency in response (please refer to Appendix V – Survey Instrument and Responses for a reproduction of the actual survey instrument and the raw data). Once the survey instrument was fully developed in *Clipboard* (an online surveying tool developed for the RIT Online Learning community), it was then pilot tested with a small group of faculty members and students from the NSSA department population. Pilot testing lasted only a couple of days with respondents coming from a convenience sample of random students found in the NSSA labs. After the pilot testing was completed, the actual survey was sent out to the selected sample of the NSSA population. In order to provide a quasi-experimental structure to the survey, it was distributed to all students who took the Introduction to Routing and Switching class, 4055-515, in Fall 2007 (prior to the implementation of Deep Freeze) and in Fall 2008 (the quarter in which Deep Freeze was implemented). Additionally the survey was sent out to all labbies, faculty members, and a random sampling of 60 NSSA students in order to address all possible lab users. Once the sample was determined, they received an email on a Friday evening to invite all to participate in the survey, which would only be open until the following Wednesday evening.

Reminders were sent out on Tuesday and Wednesday (see Appendix IV – Invitation to Participate for a reproduction of all three e-mails) to increase participation and gift cards were raffled off as incentive to those who participated.

The survey results will help address the evaluation questions. There were four sections to the survey: a section for all participants, a section for students only, a section for all labbies, and a section for all faculty members. The results will be analyzed in a descriptive manner (percentage of respondents who selected which options, etc) to explain overall responses. Additionally, the open-ended questions within the survey will be analyzed using qualitative analysis. In other words, the responses will be coded based upon common themes and then tabulated based upon these findings (see Appendix VII – Qualitative Analysis for the coding mechanism used and the analysis performed). These open-ended questions help to validate the quantitative data and give the students an opportunity to express opinions otherwise not anticipated in the closed questions.

Chi-squared will be used in order to analyze patterns within the data and to determine its statistical significance. This test is a statistical instrument used to determine whether two variables are from the same group or whether their variance is simply random. It is also used to help find factors that are related. Chi-squared tests show the confidence level that the results are not completely random. In order to be considered statistically significant the confidence level must be at least 95%, meaning that with at least 95% certainty the results obtained were not due to pure random variance in the sample.

The data from the surveys will also be compared with the data from the interviews. The interview data is primarily intended to provide specific examples of the effect of Deep Freeze (see Appendix VI – Interview Notes for a digital reproduction of these notes). This data will

explain how particular individuals interacted with Deep Freeze, either for better or for worse, and will be the basis for presenting some rich details about the whole experience. It provides the qualitative portion of the evaluation. Some limitations of these interviews include the same issues with time that influenced the surveys and the respondents were primarily taken as a convenience sampling. Also, no faculty members participated in the interview process which limited its effectiveness.

The interviews were conducted from the same sample of the NSSA population. In order to find participants, the invitation to participate in the survey included an invitation to participate in the interview. As an incentive to participate in the interview, a gift card of higher value than those raffled off for the survey was raffled off to interviewees. The interviews were mostly open-ended questions inviting the participants to reflect upon their experience with Deep Freeze and to provide some honest feedback. The interviews took place in the Netlab to provide a neutral and comfortable environment for the participants.

The data from the interview will be used to verify the results of the survey and to provide insight into individual experience with Deep Freeze. It will be evaluated by looking for common themes in the respondent answers and will also provide some direct quotes in the results section of this report. The results of the interviews will be reported in a relativist manner, assuming that all respondents interact with the system in a different way, with the hope of providing some stories to back up the qualitative data from the surveys. This will also be a means of providing some responses that were not anticipated in the creation of the survey.

In addition to the survey and the interviews I have some personal observations which may prove helpful. In Spring term of the 2007 academic year I was employed as a Teacher's Assistant for the NSSA department. I was assigned to a section of 515 where I helped to teach

lab principles of routing and switching. For our final practical of the year there was a mistake on which image we used because the labbies had accidentally downloaded the test Deep Freeze image. At this time Deep Freeze had not been implemented officially and was still under review to verify that it would work in our labs. While we felt a little anxiety over this mistake (the practical is full of anxiety as it is, since the students must perform specific task in only a limited amount of time) it turned out to be quite a fortunate event. Instead of having to reimage the computers between practicals we were able to simply reset the computers. This made preparation for the next round of students taking the practical much easier and ensured that they had a clean start to begin with. This accidental experience actually became a sort of "test by fire" which provided impetus and excitement for getting Deep Freeze completely and officially implemented. This experience has influenced my evaluation and has led to some interesting connections while I was trying to analyze the survey and interview responses.

While this particular evaluation utilizes a mixed-method, cross-sectional approach it is not the only way to conduct an evaluation. The primary reason for selecting this particular process to perform the evaluation was the time constraint. With unlimited resources we could have answered more questions or performed our evaluation in a different manner, but given the limitations from the beginning, I feel like this is the best possible manner for conducting it. The data collected will be used to gain a better understanding of the actual impact Deep Freeze has on the lab environment from the perspective of faculty members, labbies, and students in order to demonstrate that it meets the original goals established for this implementation. With this understanding of how the evaluation commenced, it is now possible to better understand the following results.

V. Results

From the outset both Ann and I had a feel for the success of Deep Freeze. Both of us agreed that this was a good thing for the labs and wanted to confirm these gut feelings with some real data. After narrowing down our evaluation questions (see Appendix III – Converging Process), I set about trying to answer them through the surveys and interviews.

The respondents represented a variety of stakeholders and came from different backgrounds. Figure 1 shows respondents classified based upon their relationship to the NSSA department, and if they were a student, their year in school and major. Students constituted the majority of the respondents with 63% and the 25% of respondents who were labbies can also be counted as students for a total of 88%. The survey addressed a fairly even distribution of the population since no more than 27% of respondents came from any particular year in school. Additionally, a full 67% of respondents are in the undergraduate Networking and Systems Administration program which may also represent the proportions in actual enrollment. If this proportion of VNSA undergraduates is not normal the actual results may not reflect the total population.

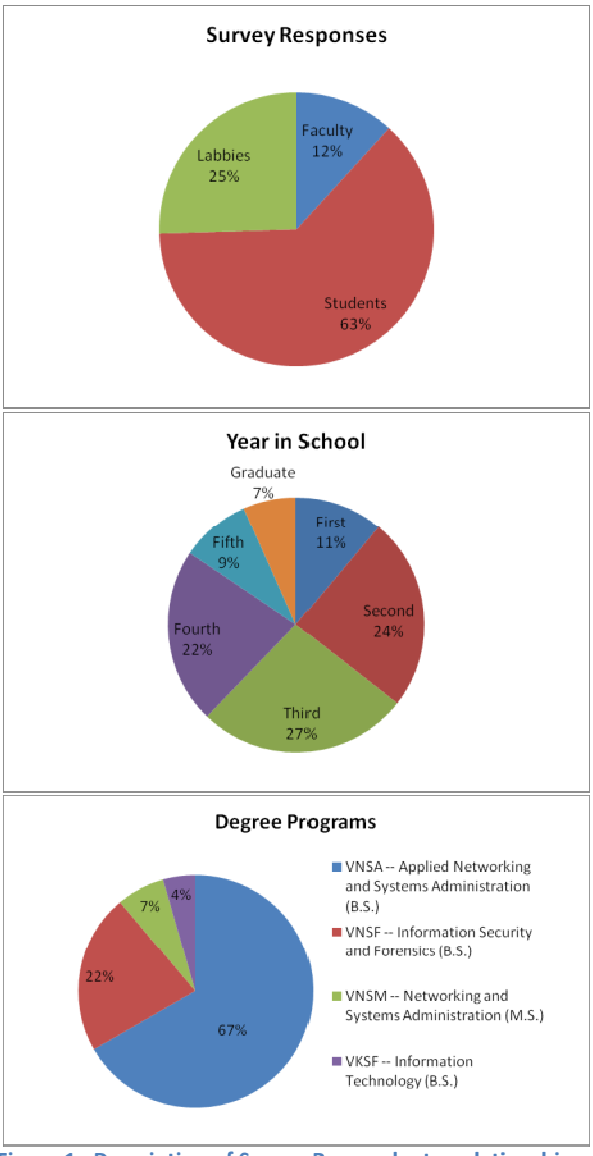


Figure 1. Description of Survey Respondents: relationship to the NSSA Department, year in school, and degree

Figure 2 shows response rates of the different populations in this evaluation. The overall response rate was 34.2% (51 responses from 149 invitations). With the intent of creating a quasi-experimental design by comparing across similar classes I invited all the students who took the Introduction to Routing and Switching class in Fall 2007, before Deep Freeze existed in the labs, and in Fall 2008, after Deep Freeze was implemented; however, the response rate was insufficient to compare the classes as desired. Of the 31 students who took the class in 2007, only 4 responded (12.9%). The 2008 class had a better response rate: of the 33 students invited to participate, 16 responded (48.5%). Both faculty member and student body response rates were consistent with the overall rate: of the 17 full-time faculty members, 6 responded (35.3%); 45 responded to the 132 invitations sent out to the general student body (34.1%). The labbies responded more readily than any of the other populations: of the 14 workers a total of 13 responded (92.9%). In summary, of the 51 responses received, students constituted 45 and faculty members constituted 6. While the survey response was not enough to draw conclusions about specific sub-populations, the responses were sufficient to make inferences about the general population of the NSSA department at RIT.

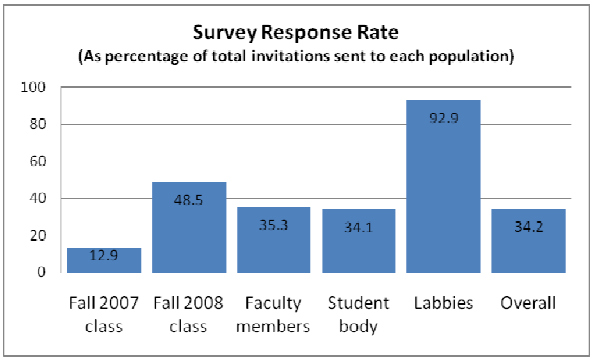


Figure 2. Survey response rate as a percentage of total invitations sent to each population.

The interviews also went well. I interviewed a total of five students who represented both labbies and the general student body. No faculty members responded to solicitations for interviews. Though this was an opportunistic sampling of the student body, it served to reinforce the information gathered from the surveys and provided additional insight into the impact of Deep Freeze. The interviews lasted about 15-20 minutes each and followed an open format

where open-ended questions allowed the students to elaborate as they chose. The students were quite pleased with this implementation but also indicated ways in which Deep Freeze negatively impacted their lab experience.

The rest of this section addresses each of the questions posed at the outset of the evaluation. It also includes additional insight gathered from the data which does not particularly address any of the questions but still proved interesting. The first question addresses the time-savings of this implementation followed by the questions (in this order) of consistency, teacher workload, and effect on students and labbies.

A. Time-savings

To address the issue of time-savings, we asked: has the implementation of Deep Freeze reduced the amount of time to image computers in order to prepare the labs for student work? The labbies are students as well and so their time is very valuable. The time spent at work needs to productively contribute to the lab environment and the less time they spend with imaging or imaging issues the more time they can devote to helping students and answering student questions. Additionally saving time on imaging would mean that the labbies would be free to work on other issues in order to provide a better lab environment for student exploration and instruction.

The results here indicate that the implementation of Deep Freeze may indeed improve labbie effectiveness. The first interviewee repeated “it saves time” several times throughout the interview. While the first interviewee never quantified how much time it saves, the second interviewee gave a better indication of the time savings: “before Deep Freeze we needed to image the labs in preparation for every lab and practical.” He went on to say that now that Deep Freeze is in place, they do not image nearly as often because all it takes is a simple reboot to

restore configurations on the computer. He estimated between 20 and 50 minutes in prep time saved before each class or practical, which added up to "many hours each week in Netlab alone."

The open response questions on the survey also supported these statements. I coded each response to the open questions according to the general idea of their statement. Some statements contained more than one idea and were thus counted more than once in the total responses (for the coding mechanism and the actual analysis of the open-ended questions refer to Appendix VII – Qualitative Analysis). This method of coding aided in culling out the major themes and analyzing the responses. Question 5 asked about the perceived purposes of Deep Freeze, a full third indicated that the intent was to save time (see Figure 3). Interestingly, 42% of the population actually reported the time-savings as a benefit according to question 8 (see Figure 4).

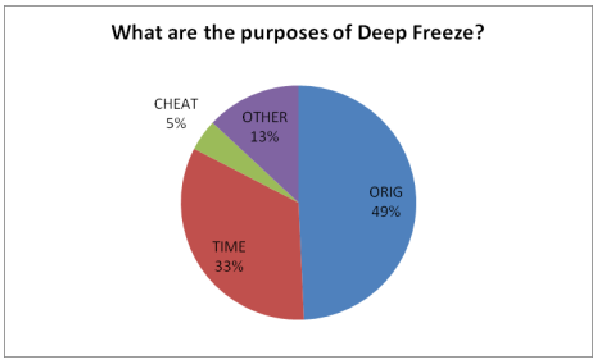


Figure 3. Survey responses to Question 5 explaining the purpose of Deep Freeze.

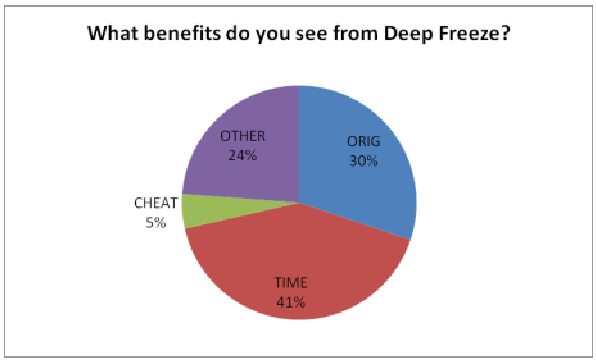
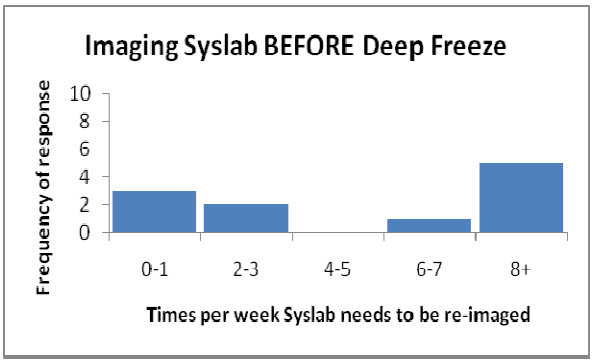


Figure 4. Survey responses to Question 8 explaining the actual benefit seen from Deep Freeze.

The questions specifically for labbies regarding the time-savings produced unexpected results. Questions 26-29 asked the labbies to quantify the number of times they imaged lab computers both before and after the implementation of Deep Freeze in the two major labs: Syslab (Figure 5) and Netlab (Figure 6). These graphs show how the labbies responded to the survey, recording the number of responses in each category. In other words, Figure 5 indicates that three labbies responded that Syslab needed to be re-imaged zero or one times per week before Deep Freeze. Nine labbies indicated the same frequency after Deep Freeze. In both labs,



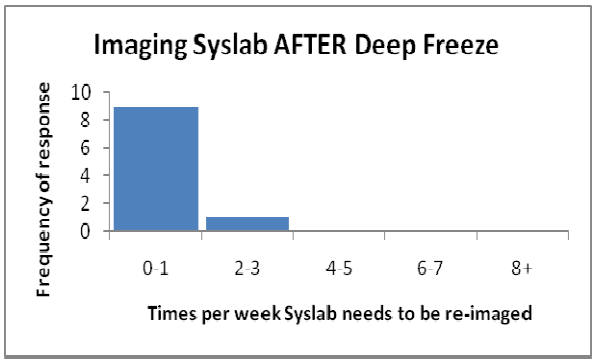
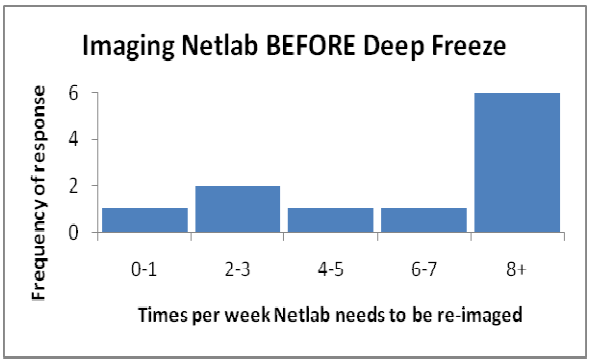


Figure 6. Self-reported frequency with which labbies needed to re-image Syslab before and after Deep Freeze.



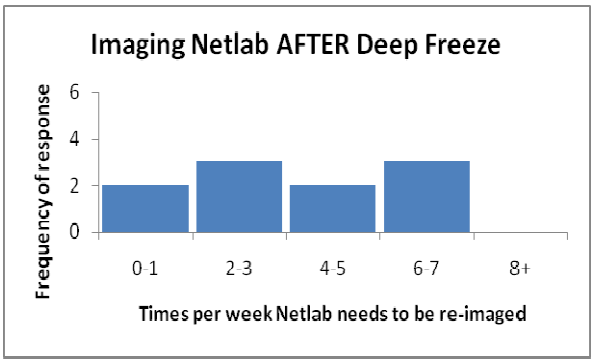
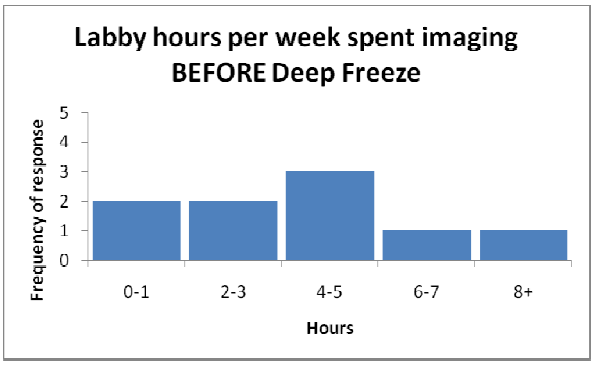


Figure 5. Self-reported frequency with which labbies needed to re-image Netlab before and after Deep Freeze.

the labbies reported a decreasing number of times per week it had to be imaged, meaning that more labbies reported smaller numbers after the implementation. Notably in Syslab, the number of labbies reporting that the lab needed to be imaged zero or one times per week went from three before this implementation to nine after. Additionally, when asked about how many hours per week the labbies spent imaging both before and after Deep Freeze the result is also a decreasing trend (see Figure 7). After Deep Freeze, no more than seven hours were spent each week with



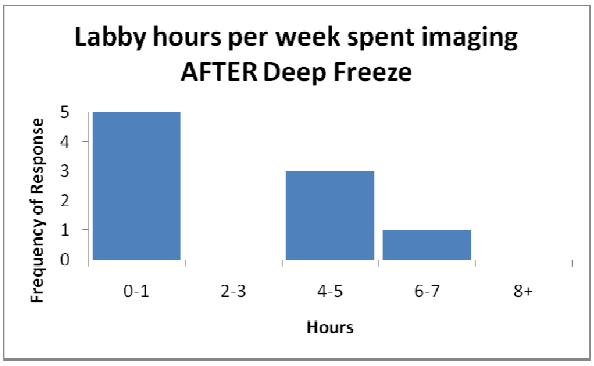


Figure 7. Self-report of how many hours labbies spent on imaging each week both before and after Deep Freeze

imaging, whereas there was one labbie who reported more than eight hours spent each week before the implementation of Deep Freeze. More than half of those labbies surveyed reported zero or one hours spent each week imaging while only two reported the same before Deep Freeze. One labbie summed it up, “it took forever to pull down all the images,” whereas now all she has to do is hit the reset button and all the computers have a fresh image.

B. Consistency

Consistency is a significant issue when working in a lab environment. Oftentimes the choice is to either require each successive student who uses the lab to re-image the computer, or to severely limit the access rights to the computer, thereby preventing the student from making any changes. There are other workarounds, like virtualization, but that has limitations. In fact, many students complain that working in a virtual environment is not quite the same as having an actual, physical device in front of them. One promising feature of Deep Freeze is that it allows students to have administrative rights to the computers while still maintaining a consistent lab environment. In other words, regardless of what changes the previous student made, the current student can be confident that after a simple reboot they can start from a fresh image. This enables students to receive the hands-on learning so vital to computer fields.

As in the previous question, the result of the interviews for this question showed that the students and labbies liked the consistency that Deep Freeze provides. The first interviewee mentioned that it was nice to get into a lab and just start working without worrying about previous students’ work. He also said that it was convenient to simply restart the computer if he was lost or needed to start over to have an unchanged image. Interviewee three summed up his satisfaction this way: “the lab is always consistent—you always know what image is on the computer. You always have a base image.” Interviewee number four stated, “It keeps machines

how they need to be, it keeps them in the same state all the time…you know what to expect when you come in." Similar sentiments of content were shared by the other interviewees as well.

The open-ended survey questions also seemed to suggest that the students were pleased with the consistency Deep Freeze imposed on the NSSA labs. In Question 5 nearly half of the responses were related to the concept of maintaining the systems in their original, untampered state (see Figure 3, reprinted here for convenience). This is also what the students in the interviews indicated as "consistency" in the labs, and we assume that this is also how they interpreted the survey question. Question 8 explained what the survey respondents actually witnessed in the labs. Interestingly, the number of comments relating to restoring the computer to its original state dropped to less than a third (see Figure 4, reprinted here for convenience), which is less than the number of comments related to time-savings. In other words, the survey respondents anticipated "consistency" more often when explaining the purpose of Deep Freeze but actually witnessed the time-savings more. Both time-savings and consistency of labs were important to those who took the survey.

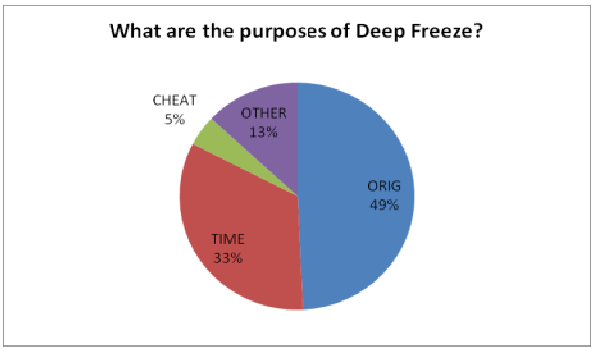


Figure 3 (reprint). Survey responses to Question 5 explaining the purpose of Deep Freeze.

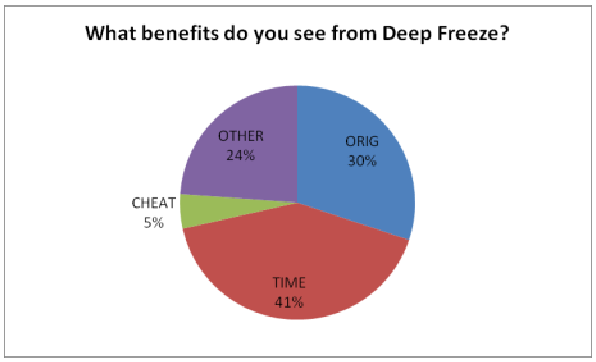


Figure 4 (reprint). Survey responses to Question 8 explaining the actual benefit seen from Deep Freeze.

The quantitative data in the surveys supports this idea that Deep Freeze helped with the consistency of the labs. Survey questions 14 and 15 asked the students, faculty members, and

labbies to rank the performance of the NSSA labs both before and after the implementation of Deep Freeze on the same Likert scale. These two questions asked students to rate the frequency of lab image problems, how often they had to re-image before the lab was useful for their present work, and the frequency of imaging issues hindering their ability to work (see Figure 8).

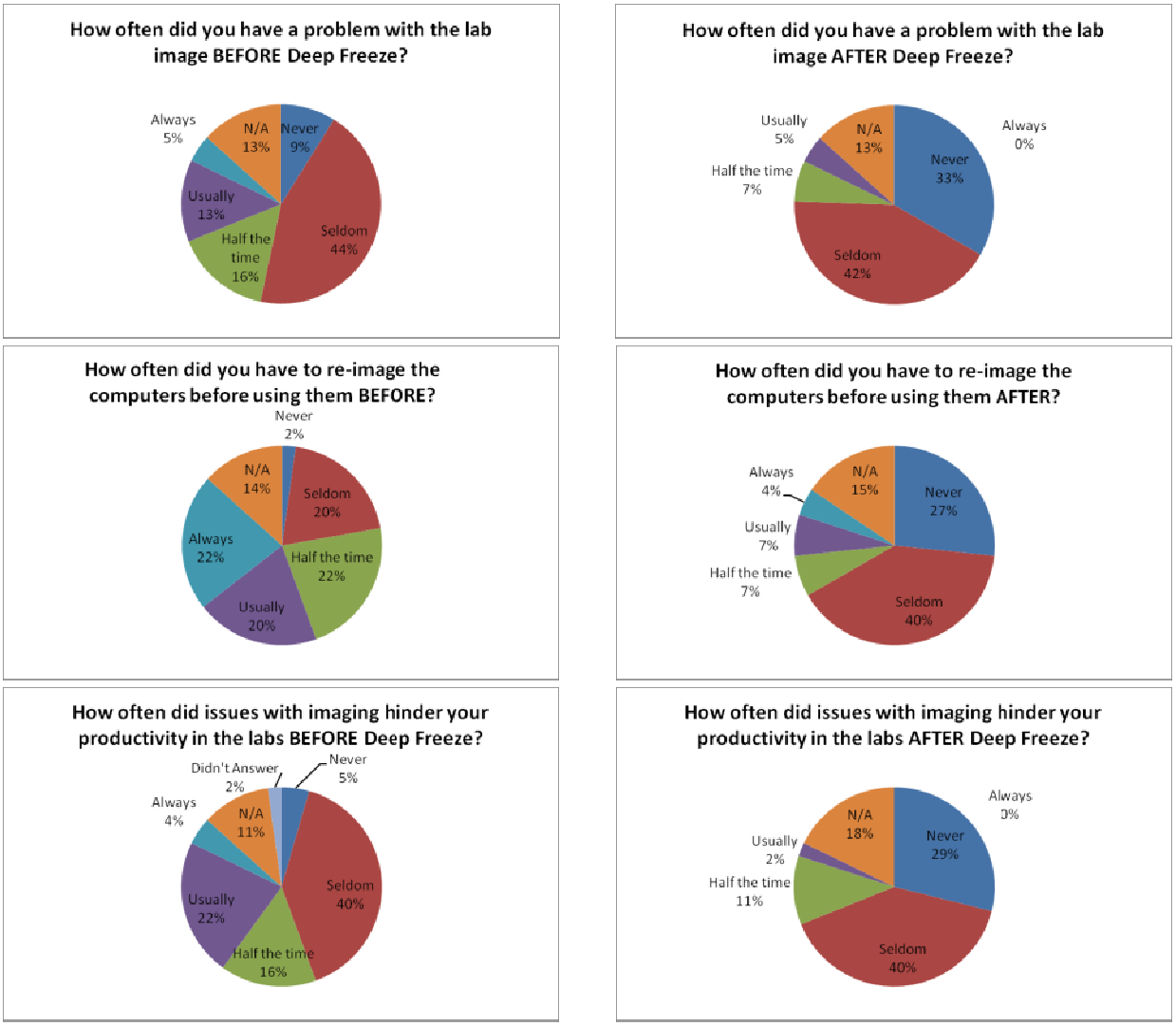


Figure 8. Student responses to imaging problems in the labs before Deep Freeze (Question 14) and after (Question 15).

Performing a chi-squared analysis on the results of these two questions showed that most of these results did not occur by chance, in other words, with a p-value of at least 0.00005 these results are statistically significant when compared to their statistical ideal. The only question that did not show a significant difference from happening by chance was Figure 8b which had a

p-value of 0.146. Most noticeably in these results is that in every case the number of students who responded "never" increased after the implementation of Deep Freeze. Also the number of students who responded "seldom" consisted of a large chunk of the responses after Deep Freeze was implemented. In all three sub-questions, the combined percentages of "seldom" and "never" is around 60%. Also the number of students who responded "always" or "usually" before Deep Freeze was implemented dropped dramatically after the implementation. When asked, for example, how often the students had problems with the lab image, the results show a dramatic change after the labs put Deep Freeze into operation. Before Deep Freeze 5% of students "always" had problems, 13% "usually" had problems, and 16% had problems about half of the time. Only 9% said they never had problems with the images. However, after Deep Freeze, all the negative categories were at least cut in half: 0% "always" had problems, 5% "usually", and 7% said "half of the time" for a combined 12% of the respondents. After Deep Freeze 75% of students "seldom" (42%) or "never" (33%) had problems. In question 16 (Figure 9) the students were asked specifically how they would rate the consistency of the labs both before and after Deep Freeze. The results show that only 20% of students either "strongly agreed" or "agreed" that the labs were consistent before, while those same two categories equaled 69% of respondents after Deep Freeze.

Figure 9. Students' agreement with the consistency of the labs before and after Deep Freeze.

C. Teacher Workload

One of the big questions we wanted to know was the effect Deep Freeze had on teacher workload. Did teachers have to work harder now? How would implementing Deep Freeze influence the way the teachers presented their classes? Even if the students were satisfied with the implementation of Deep Freeze in the labs, what about the teachers? This is an important issue because the faculty members of the NSSA department remain long after the students graduate. Faculty members are key stakeholders in the success of the labs and need to feel comfortable and satisfied with the new tools if they are to be successful.

One difficulty that I ran into as I conducted the evaluation was the lack of responses from the faculty members. Faculty members may have had less motivation to participate in the survey because many of them teach courses which either do not use the labs or use them minimally. It may have also been a timing issue with the faculty members since the evaluation was conducted at the beginning of a new quarter when many teachers are trying to prepare for the rest of the quarter and plan for the classes they will teach in the coming quarter. Teachers reported that they were afraid of students losing their data. One teacher made a comment that Deep Freeze should be taken off the laptops which are used with wireless experimentation, because the user needs to restart the computer after properly configuring it. In any case, it is possible to surmise some of the effect on the faculty members based on the data reported by the students and labbies, especially as it relates to the practicals. More data would be required in order reach any conclusions about the effect on teacher workload.

Practicals are stressful, both for students and faculty members. Essentially the students are asked to perform a series of tasks that they have already seen in the lab, only this time without a lab partner and under a time limit. There are only 16 benches in the lab, and with around 30

students in most classes, the practical is scheduled for two hours: the first hour is devoted to the first half of the students and the second hour is given to the second half. The third interviewee hinted at how Deep Freeze helps the faculty members during the practicals, he said there were only "like 5 minutes" between each session of the practical. He went on to explain that this usually was not enough time to re-image the computers. The fifth interviewee said that the second group of students always waited for the computers to re-image. This could mean that the second group of students ultimately spent more time in the labs, getting more nervous before the start of the practical. After Deep Freeze, the only boxes to re-image were the Linux boxes which, according to the fifth interview, went a lot faster. One key indicator regarding the influence of Deep Freeze on the practicals came from the survey. The labbies were asked to self-report how many imaging incidents they had per practical in questions 23 and 24. The number of labbies that said they had zero imaging incidents per practical jumped from 1 to 5 after Deep Freeze was implemented (see Figure 10).

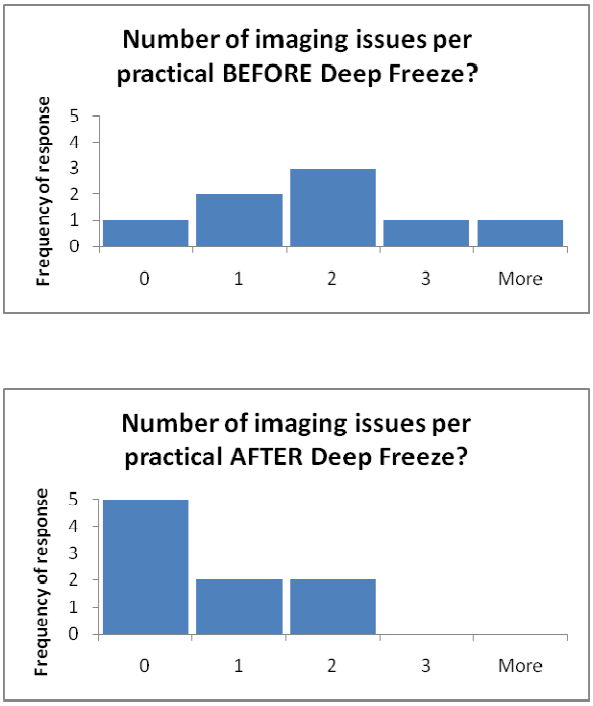


Figure 10. Self-report of labbies' number of imaging problems per practical before and after Deep Freeze.

D. Effect on Students and Labbies

The final question of the evaluation focused on the effect Deep Freeze had on the student population. Students and labbies are the primary users of the labs, and thereby are also the primary users of Deep Freeze, so their perspective matters. The positive results of Deep Freeze

appeared to be fairly obvious from the outset. For this reason, both the interviews and the survey asked for specific negative consequences.

The interviews proved helpful in discovering the perspective of the students and labbies. The first interviewee expressed a valid concern about what would happen in the case of a power loss: if the power went out or someone accidently cut off the electricity to a workstation, students would lose all their data which they had not saved off to another location. While this was a concern for the first interviewee, he also commented, "Deep Freeze has a much more positive impact than a negative one."

The second student interviewed was a labbie who had some good insight. He said that as long as students were aware of Deep Freeze they did not have a problem, and that the labbies had gone to great lengths to inform students. He suggested that one benefit of Deep Freeze, probably overlooked initially, was if students messed up while doing a lab they could just reset the computer and start over again without worrying about undoing everything. He also shared the only negative experience he knew of: where one student was working late on a lab and came back the next morning to retrieve the data, unsuccessfully. While talking with this interviewee, I was reminded of a personal experience: one student whom I met in the labs was unable to save his VMWare image off the computer because the user rights were restricted to prevent networking except to a particular server which, at the time, was not functioning. The VMWare image was larger than any removable media he had with him and he was afraid of losing his work. I think he ultimately borrowed an external hard drive from someone to save his image, but had he been unable to find an external source to save his data, he would have lost all his work. Finally, the third interviewee shared an experience where he was in the middle of a lab and the computer had a critical failure, causing it to reboot. He had been collecting all of his data in a

folder on the desktop but had not transferred it over to an external device; therefore, he lost all his work. These situations illustrate some of the negative impacts on students and labbies: students because they experience the loss and labbies because they must take care of the complaining student. The other interviewees only had positive things to say about Deep Freeze.

The survey data also suggested that few people were dissatisfied with this new program. Question 4 asked the students to rate the helpfulness of the labs in general and of Deep Freeze within the labs. With confidence from chi-squared tests (p-values of 0.0005) that these results are not due solely to random variation, the students overwhelmingly rated the labs as either helpful (63%) or very helpful (27%) while only 4% mentioned that the labs were unhelpful (Figure 11). When asked their opinion of Deep Freeze in the labs, 52% rated the new program as either helpful (31%) or very helpful (21%) with 20% undecided. There were some students who thought that Deep Freeze was unhelpful (a full 14% of responses) or very unhelpful (2%).

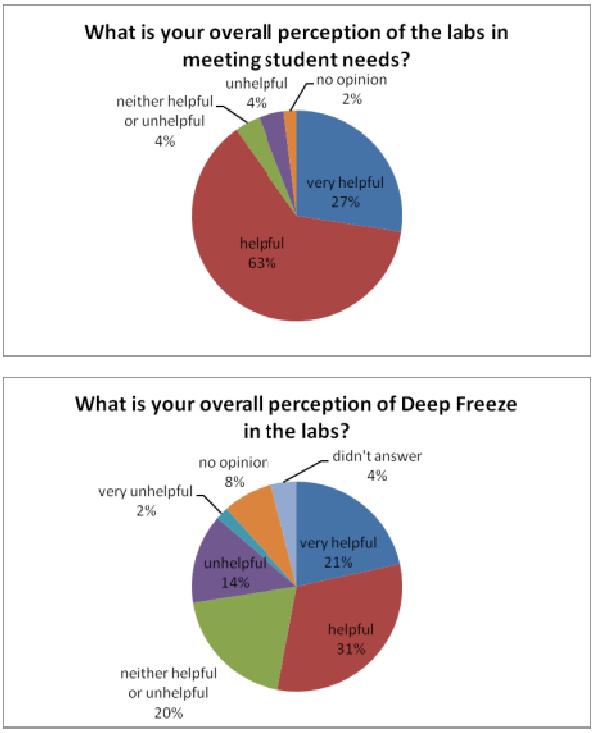


Figure 11. Responses to Question 4 asking survey takers to rate the helpfulness of the labs and of Deep Freeze.

Question 7 gives some insight about why some people would be dissatisfied with Deep Freeze because it asked all survey respondents to specify how this program had negatively impacted their work. Some of these responses included comments that fit into more than one category, more often than not because the person offered more than one suggestion, so their responses were counted in each category (just as in the other open questions). Responses just about data

loss represented 30% of the total while 19% of the comments were about the computer rebooting when it should not have (see Figure 12). Interestingly enough, 32% of the responses indicated that they had no problems with Deep Freeze. The labbies were also asked specifically how they felt about Deep Freeze in questions 22 and 33 of the survey. None of the labbies that responded to the survey indicated that they were dissatisfied with Deep Freeze or felt that it had made imaging worse (Figure 13).

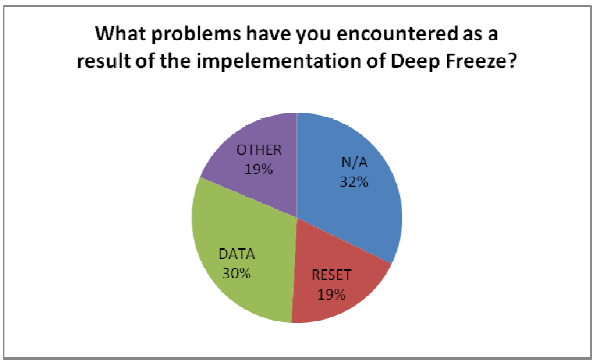
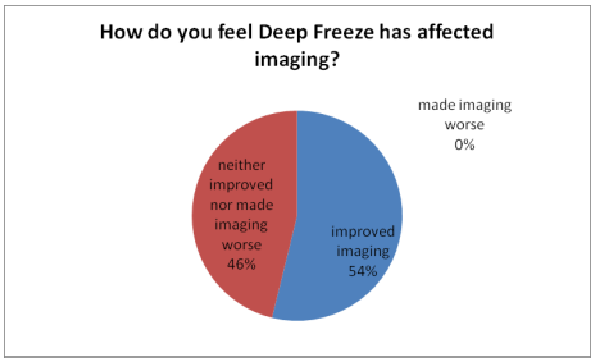


Figure 12. Responses indicating problems with the Deep Freeze install.



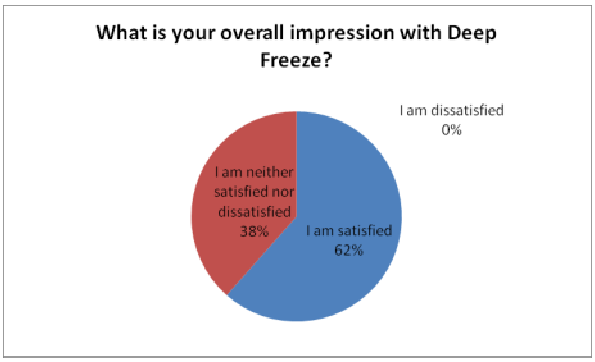


Figure 13. Labbie impressions to Deep Freeze: how it affected imaging and overall.

E. Other Interesting Results

In addition to the aforementioned questions other interesting data emerged as the evaluation progressed. One unexpected result was the peace of mind that Deep Freeze brought students as they worked in the lab. Another interesting, yet unanticipated, aspect of Deep Freeze was how it enabled students to make better use of open lab time.

The fifth person interviewed explained the peace of mind effect when she said, “I personally like the fact that I can just reboot and all my files are gone.” In other words she likes leaving the lab the way she found it without worrying about other students being frustrated by

her configuration changes. Another aspect to the peace of mind effect is that it prevents students from cheating by utilizing the work of previous lab users. This is specifically what the first person interviewed mentioned when asked about the benefits of Deep Freeze. For lack of a better descriptor, I used the code "CHEAT" while evaluating the qualitative data to identify comments relating to either form of the peace of mind effect. This code was not intended to cast a negative light on these comments; rather, it was intended to bring out the idea that students could not utilize another student's work. Referring back to Questions 5 and 8 of the survey, "CHEAT" received the third-highest number of responses, following time savings and restoring original configurations.

Increasing the usefulness of the NSSA labs was another unforeseen effect of Deep Freeze. The second interviewee brought this to light when he commented that Deep Freeze meant that they did not have to kick the students out 45 minutes early to prepare the lab for classes. In discussing Deep Freeze with the lab manager, she said that oftentimes students would not re-image their computers before using the labs, meaning they were inadvertently using the previous student's settings. Those that did remember to re-image the computers would need to spend "like 15 minutes" of their lab time in order to pull down a fresh image. Now all the students have to do is reset the computer and know that it is the standard image. This means they can start working faster on whatever it was that brought them to the labs.

The results of the evaluation showed a positive reaction to Deep Freeze. The labbies indicated that this new program not only saved them time in preparing the labs for classes but also reduced the number of times each week they had to re-image the open labs. The students suggested that Deep Freeze helped the labs to be more consistent by reducing the number of times students had to re-image prior to working in a lab after its implementation. The evaluation

was not as helpful in determining the effect on teacher workload as originally anticipated, but the responses about how Deep Freeze has influenced the practicals may give some reprieve to the faculty members. Several students also recognized the potential for data loss as a negative side effect of this program, even if most students were satisfied with it. Finally, it was interesting to see the emerging data about peace of mind and improved usefulness of the open labs because of Deep Freeze.

VI. Conclusions and Recommendations

From the outset both Ann, the lab manager and I had a pretty good feeling about Deep Freeze. Logically it made sense because it enabled the students to work on the computers with administrative access while still maintaining the consistency of the lab image and saving a little time. At least that is what we hoped. After conducting this evaluation the impact of Deep Freeze on the NSSA labs has become clearer. This section will begin with discussing the advantages that Deep Freeze brings followed by some commentary about the limitations of this particular implementation. Finally I will make some recommendations based upon my observations and the reports of students, faculty members, and labbies and conclude with some thoughts on future work in this area.

Just like we predicted it appears, from this study at least, that the students and the labbies primarily recognize the promised benefits of this program. Of those who responded to the survey 75% never or seldom had problems with imaging after the implementation of Deep Freeze. Every person interviewed said that Deep Freeze saved time and helped keep the lab computers at a standard configuration. The time-savings came not only because the labbies spent less time actually pulling down an image but also because they had to re-image less frequently. The students saw time-savings because they could make better use of open hours in the lab—the labbies no longer needed to kick them out 45 minutes prior to a class in order to prepare the lab and there was limited need to re-image a computer before they could actually begin working. Additionally each student who sat down at a computer to begin working could be confident that with a simple reboot of the computer it would be reset back to a standard set of configurations without worrying about what changes the previous student had made. In addition to time-savings the implementation of Deep Freeze brought a peace of mind to the students who

no longer need to worry about other students use their work or using another students configurations, an unexpected finding of this study. Some other benefits reported by the students of having this program in the labs are the reduced threat of malware since any changes are discarded once the machine is rebooted and less clutter on the desktops. Another benefit of Deep Freeze which was not originally anticipated was its effect on practicals. No longer must the second set of students wait for their computers to re-image before beginning the practical. Also if students feel like they are off course during a practical, or at any time for that matter, they can simply restart the computer and start from scratch without trying to backtrack or re-image the computers. Deep Freeze has some clear benefits.

Additionally there are some limitations with Deep Freeze in the labs. The labbies who are only part-time employees and students must now maintain another infrastructure in support of Deep Freeze. There is some additional work when they are building images for the labs because now they must worry about unfreezing the image, making changes, and then re-freezing the image, and if there are mistakes made in this process then those mistakes are harder to fix. The students also experience the limitations of this program. All students who utilize the labs must now either use some sort of removable media to store their data and have to remember to save frequently in order to prevent data loss or else they must frequently send the data elsewhere (i.e. e-mailing it to themselves). One issue which has not been a problem yet but could potentially become one is that you cannot restart the computer after an install. This is especially problematic when installing drivers (i.e. video drivers) that require a reboot in order to operate fully. The reason for this limitation is because when the machine reboots the changes made with the new install will be removed as part of Deep Freeze's normal operations. Finally there is a potential problem when troubleshooting. Most people familiar with troubleshooting the

Windows Operating System will agree that it is surprising how many problems are resolved when the system is rebooted. In the case of Deep Freeze you must be very careful to back up all data before rebooting the system if that is indeed one of your troubleshooting steps.

Ultimately the purpose of conducting a formative evaluation like this one is to provide suggestions for improvement. Notice that the suggestions offered here are solely based upon this study and there may be other issues at stake and so it is not advised to implement all of these suggestions. One professor was very adamant about taking Deep Freeze off of the laptops on the wireless carts (these are carts with a variety of wireless equipment on them used by students to learn about wireless networks). The reasoning was twofold: the carts run on Uninterrupted Power Supplies (it is difficult to wander around if you are plugged in and an UPS is like a battery for the wireless equipment) and the frequent need to install devices which require reboots. The UPS is a problem because at any time the battery could be exhausted and the computers shut down which would cause data loss with Deep Freeze. Many students recommended that there be a thawed partition or a network share where they can temporarily save log files, screen captures, or other files necessary for proof of completing the labs. In fact data loss prevention was the most common comment when asked about how to improve the current implementation of Deep Freeze. One suggestion which has already been implemented is to allow administrative access to the computers in Syslab so that students can manipulate network settings if needed. Several students suggested that there be a more comprehensive Deep Freeze image: in other words they recommended that the labbies perform a more thorough investigation of what each lab that would be accomplished on those computers would need and install it. This would take a concerted effort on both the part of the labbies and the professors to identify the software needs but it would be worthwhile to allow students a more meaningful lab experience. One common

comment of the labbies was that they still had to worry about the Linux boxes since the version of Linux used in the labs is incompatible with Deep Freeze. In light of these comments I would suggest looking into using a version of Linux in the labs which is compatible so that there was an even more reduced need to image computers. Of course many students complained about the slow speeds or poor equipment in the labs but these complaints did not relate directly to Deep Freeze and so I did not investigate them further. Another good suggestion was to verify that timing is correct on the Deep Freeze-forced reboots because several students mentioned that the computer randomly rebooted in the middle of their lab which caused them to have to start over. Finally many people commented that perhaps there should be some way of temporarily disabling Deep Freeze upon reboot, for example a prompt that says “do not delete my data this time” but that might be something the manufacturer would have to address.

Much can still be done regarding this evaluation and future work. I developed the survey instrument from scratch for this particular evaluation. In order to validate these answers it would be beneficial to test the survey instrument for consistency. Additionally it would be interesting to triangulate this study with other means of learning the information like a time-series survey or a valid quasi-experimental design. Of course more time and resources would have allowed for a better response rate, especially among the professors which would be beneficial since they are the ones who decide what is taught in the labs. Another possibility for the future would be to compare the impact of Deep Freeze with other labs that use other imaging systems like Ghost or Drive Shield.

Appendix I – Bibliography

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Appendix II – Diverging Questions

In order to provide focus for the evaluation I enlisted the help of a small "committee" of stakeholders (though never all together: I communicated with them through e-mail contact, one-on-one) in order to include as many different perspectives as possible in the limited time available. I solicited the help of three key individuals: Ann Gover, NSSA Lab Manager; Luther Troell, NSSA Department Chair; and Silas Cutler, one of the labbies who helped test the Deep Freeze solution prior to its implementation and saw the whole process start to finish. Together the four of us developed the following list of possible evaluation questions:

- Has the implementation of Deep Freeze reduced the amount of time to image computers in order to prepare the labs for student work?
- Has the implementation of Deep Freeze provided a more consistent lab environment?
- Has the implementation of Deep Freeze provided for increased student productivity?
- How has Deep Freeze impacted practicals?
- What effect has Deep Freeze had on labbie workload?
- What effect has Deep Freeze had on the teacher workload?
- What is the student perception of Deep Freeze? Do they prefer it over Ghost?
- How can we improve our implementation of Deep Freeze for the students, faculty members, and labbies?
- What is the perceived impact of Deep Freeze from the perspective of the students and labbies?
- What are the advantages/disadvantages of having Deep Freeze in our environment?
- How does Deep Freeze meet the goals of the NSSA labs?
- What needs does Deep Freeze address?
- How does implementing Deep Freeze fit within the aims of the NSSA department? Of RIT?
- What value do the students, labbies, and faculty members place on Deep Freeze?
- What are the most important priorities for Deep Freeze in the future?
- What alternative uses of Deep Freeze could we implement?
- Are there glitches in the imaging process (i.e. where are the current bottlenecks?)?
- What is the actual work flow of imaging a computer in the labs and how could that be improved?
- How do labbies prioritize which computers to image?
- How much time is spent each week on imaging? Is this acceptable to all stakeholders?
- How many computers are misconfigured when students need to use them (i.e. what percentages of computers need to be re-imaged before the student can actually use them?) now that we have implemented Deep Freeze?

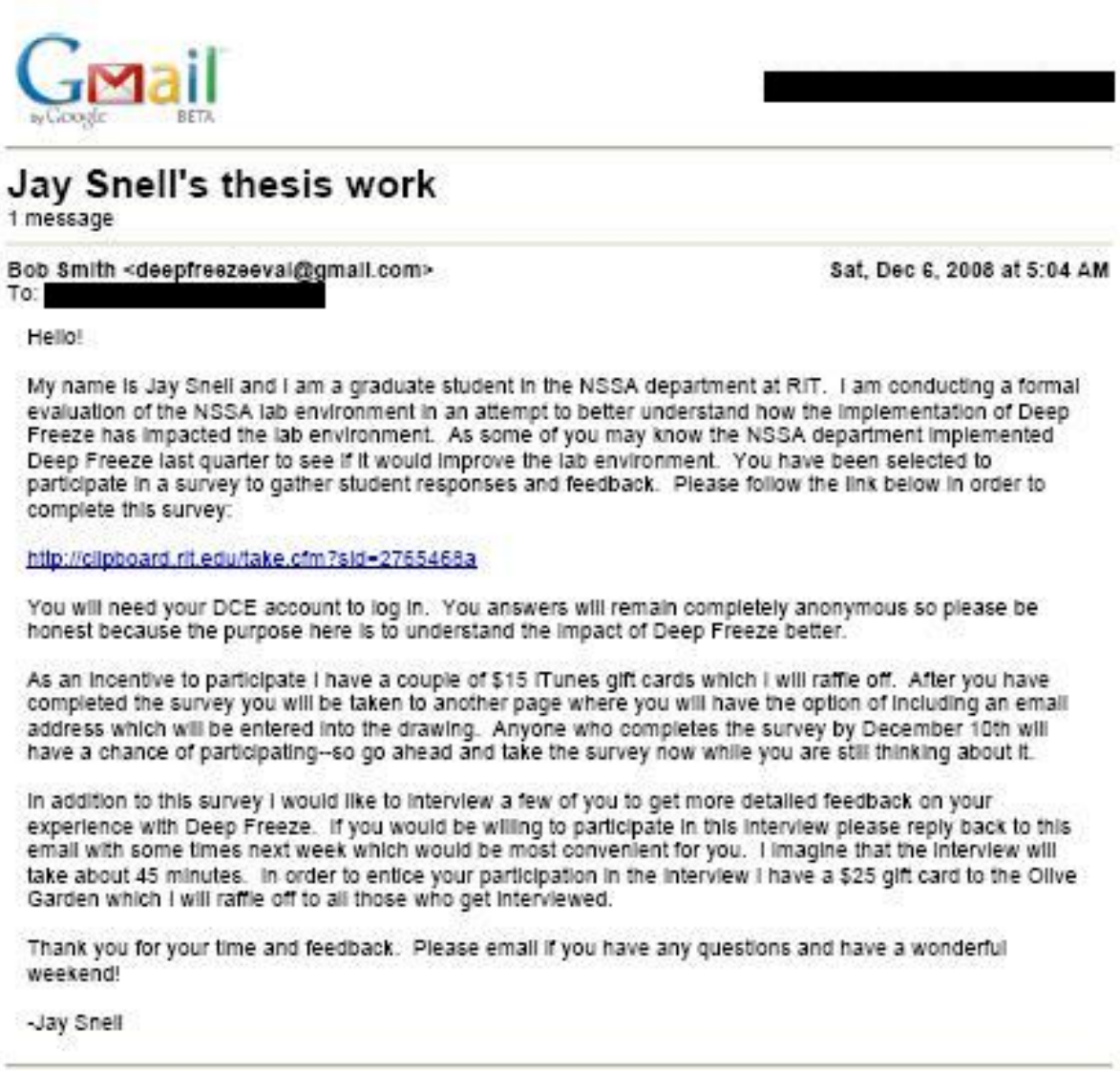
Appendix III – Converging Process

In order to objectively determine which questions to address with this evaluation, I asked the "committee" of stakeholders to evaluate each of the potential questions according to the criteria in the following spreadsheet. Each category was given a score of 1 (lowest) to 5 (highest) and then I tabulated the total score: the questions with the highest score were the ones we chose to focus on. Here is a brief explanation of each of the categories:

- **Usability of information:** to what degree would the answer to this question actually be used, to inform, to correct, etc?
- **Reduction of uncertainty:** to what degree would the answer to this question reduce our present level of uncertainty?
- **Importance of information:** would the answer actually be important or have an impact on current events (this is slightly different than the usability of the answer—usability deals with its use and importance deals with its merit)
- **Continued interest:** to what degree is this question going to be of continued interest or is it merely just a passing concern?
- **Level of influence on future decisions:** to what degree will the answer to this question aid in making choices about the lab environment in the foreseeable future?
- **Answerable in two weeks:** unfortunately I was limited to only a two week window for the data collection so this column was merely asking to what degree it was possible to answer the question in the allotted time.

Evaluation Question	Usability of information	Reduction of uncertainty	Importance of information	Continued interest	Level of impact on future decisions	Answerable in just 2 weeks	Total
Has the implementation of Deep Freeze reduced the amount of time to image computers in order to prepare the labs for student work?							
Has the implementation of Deep Freeze provided a more consistent lab environment?							
Has the implementation of Deep Freeze provided for increased student productivity?							
How has Deep Freeze impacted practicals?							
What effect has Deep Freeze had on labbie workload?							
What effect has Deep Freeze had on the teacher workload?							
What is the student perception of Deep Freeze? Do they prefer it over Ghost?							
How can we improve our implementation of Deep Freeze for the students, teachers, and labbies?							
What is the perceived impact of Deep Freeze from the perspective of the students and labbies?							
What are the advantages/disadvantages of having Deep Freeze in our environment?							
How does Deep Freeze meet the goals of the NSSA labs?							
What needs does Deep Freeze address?							
How does implementing Deep Freeze fit within the aims of the NSSA department? Of RIT?							
What value do the students, labbies, and faculty place on Deep Freeze?							
What are the most important priorities for Deep Freeze in the future?							
What alternative uses of Deep Freeze could we implement?							
Are there glitches in the imaging process (i.e. where are the current bottlenecks?)?							
What is the actual workflow of imaging a computer in the labs and how could that be improved?							
How do labbies prioritize which computers to image?							
How much time is spent each week on imaging? Is this acceptable to all stakeholders?							
How many computers are misconfigured when students need to use them (i.e. what percentage of computers need to be re-imaged before the student can actually use them?) now that we have implemented Deep Freeze?							

Appendix IV – Invitation to Participate



Gmail by Google BETA [redacted]

Jay Snell's thesis work
1 message

Bob Smith <deepfreezeeval@gmail.com> **Sat, Dec 6, 2008 at 5:04 AM**
To: [redacted]

Hello!

My name is Jay Snell and I am a graduate student in the NSSA department at RIT. I am conducting a formal evaluation of the NSSA lab environment in an attempt to better understand how the implementation of Deep Freeze has impacted the lab environment. As some of you may know the NSSA department implemented Deep Freeze last quarter to see if it would improve the lab environment. You have been selected to participate in a survey to gather student responses and feedback. Please follow the link below in order to complete this survey:

http://clipboard.rit.edu/take.cfm?sid=2765468a

You will need your DCE account to log in. You answers will remain completely anonymous so please be honest because the purpose here is to understand the impact of Deep Freeze better.

As an incentive to participate I have a couple of $15 iTunes gift cards which I will raffle off. After you have completed the survey you will be taken to another page where you will have the option of including an email address which will be entered into the drawing. Anyone who completes the survey by December 10th will have a chance of participating--so go ahead and take the survey now while you are still thinking about it.

In addition to this survey I would like to interview a few of you to get more detailed feedback on your experience with Deep Freeze. If you would be willing to participate in this interview please reply back to this email with some times next week which would be most convenient for you. I imagine that the interview will take about 45 minutes. In order to entice your participation in the interview I have a $25 gift card to the Olive Garden which I will raffle off to all those who get interviewed.

Thank you for your time and feedback. Please email if you have any questions and have a wonderful weekend!

-Jay Snell

Gmail by Google BETA [redacted]

Survey Reminder

1 message

Bob Smith <deepfreezeeval@gmail.com> **Tue, Dec 9, 2008 at 6:15 PM**
To: [redacted]

Hello!

I hope that week 2 is treating you well! I just wanted to remind you of the opportunity you have to provide valuable feedback on the Deep Freeze implementation in our labs which could win you a $15 iTunes gift card. The link to the survey is:

http://clipboard.rit.edu/take.cfm?sid=2765468a

If you take the survey by December 10th (tomorrow) you will be entered to win one of the gift cards. You answers are completely anonymous so feel free to share with us what works and what doesn't so we can keep the good and get rid of the bad. Thank you to all of you who have participated thus far.

Also I would like to sit down with a few of you to get a better picture of your experience with the Deep Freeze. Those who choose to participate in the interview portion of my evaluation will be entered into a drawing for a $25 gift card to the Olive Garden. If you are interested please respond to this email with a couple of times that would be most convenient for you. Thanks!

Have a great day!

-Jay Snell

Gmail by Google BETA [redacted]

Final invitation

3 messages

Bob Smith <deepfreezeeval@gmail.com> **Wed, Dec 10, 2008 at 7:20 PM**
To: [redacted]

Hooray, this is the last email reminder you will receive from me!

I just wanted to take one last opportunity to invite you to participate in our survey. Even if you feel you have little or no experience with Deep Freeze your feedback is still important. Please take a quick 5-10 minutes and fill out the questionnaire, even if you aren't interested in winning one of the $15 iTunes gift cards. Here is the link once more:

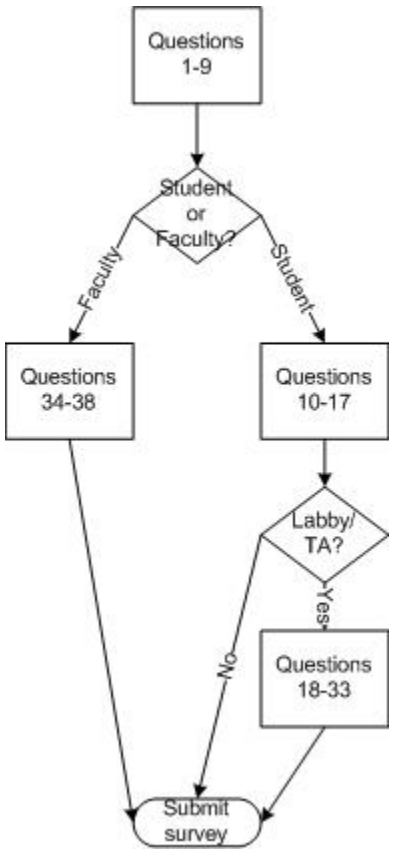
http://clipboard.rit.edu/take.cfm?sid=2765468a

Also I am still looking for people to interview. I made a poor estimate initially and the interviews are only taking 15-20 minutes each. A simple 15 minutes could earn you a $25 gift card to the Olive Garden. While the survey closes today I will be interviewing on Thursday, Friday, Saturday, and Monday---so if you have time on any of these days please send me an email with a few options of when would be best for you. Thanks again for your participation and have a tremendous week!

-Jay Snell

Appendix V – Survey Instrument and Responses

I developed the survey from scratch for the purposes of this evaluation with the input of the lab manager. All those who would take the survey would answer the first set of questions and then they would branch off depending upon if they were a faculty member or a student (see diagram below). Another branching point was designed to ask questions specifically of the



labbies.

Just a note on the following print out of the survey and its results: after the survey ended but before I could close the survey on the website two people added entries. While the responses are completely anonymous the results are grouped by the respondent. Therefore during the actual analysis I did not take into account the responses from the last two individuals. If there are discrepancies between the analysis in the body of this report and those presented here in the appendix, it is for this reason.

An Evaluation of Deep Freeze

< return to response sets

filter responses

Number of Respondents: 53

View by: Count

General Questions

1. Were you aware that Deep Freeze was implemented in the NSSA labs? (hide answers)

50 - Yes
3 - No

2. About how many hours do you spend in the labs each week? (hide answers)

2 - 0
14 - 1-5
11 - 5-10
14 - 10-15
3 - 15-20
5 - 20-25

Other Responses (4)

- 40+
- 30-40
- I am currently on a Co-Op; but usually spend 15-20 hours in the lab each week.
- 25-35

3. What imaging software was used in the labs prior to the implementation of Deep Freeze? (hide answers)

47 - Norton Ghost
0 - Altiris Deployment Solution
0 - Centurion Drive Shield
6 - I do not know

4. The Lab environment and Deep Freeze (hide answers)

	Very unhelpful	Unhelpful	Neither unhelpful or helpful	Helpful	Very helpful	No opinion	did not answer
What is your overall perception of the lab environment in meeting the student	0	2	2	34	14	1	0

needs?

What is your overall perception of Deep Freeze in our labs?	1	7	10	18	11	4	2

5. What is the purpose of Deep Freeze? In other words, why do you think the NSSA department implemented Deep Freeze? (hide answers)

- To restore the computers back to an original state every time they are rebooted.
- It reimages the computers on every reboot. This gives each student a clean working environment free of issues caused by prior students.
- In order to reduce the time needed to image the labs, deep freeze was implemented. All we have to do now is reboot them.
- So re imaging would not be necessary every time a new student uses a machine.
- Clean image after each restart.
- Deep Freeze simplified the setup process of the lab computers by ensuring they could be returned to a default state after each restart, eliminating the need for a lengthy Ghost process each time.
- Deep Freeze prevented an unnecessary need of re-imaging the machines after every lab. With deep freeze, labs could be prepared just about instantly
- so that we can have admin access and not have the computer be messed up for the next student
- To make sure images are kept standard
- To not have to manually reset all the configurations after someone has worked on the computer.
- Deep freeze was implemented to reduce lab prep times in between lab sections and practicals. It provides students the ability to quickly and easily reset the windows systems to make sure they get a clean learning environment without the time consumption of the imaging process.
- So students wouldn't have to waste time re-imaging the machines after someone else possibly messed up the operating system.
- once you restart you're back where you started without wasting an hour reimaging
- so the labby's can be more lazy at doing there jobs
- I think that they implemented Deep Freeze so that after you were finished with your lab, all you would have to do to reset all the settings would be to restart the machine.
- They implemented Deep Freeze in order to provide an effective means of wiping computers each day so that there is less of a chance for problems to occur.
- To prevent student changes to machines to prevent having to re-image the machines for every class
- The NSSA department implemented deep freeze to allow the easy imaging of machines back to a prior state. Ghost was time consuming when used en masse.
- To compensate for slow imaging, particularly in time critical situations such as practicals. It allows the XP machines to simply be rebooted to their original state, instead of having to wait while a new image was pulled from the server. It saves time for the lab staff and students, while also allowing for a more consistent lab environment (not sure if that machine was imaged? just reboot it).
- General purpose is to keep the computer in a "frozen sate" which can be resorted with a simple reboot. Regardless of what changes have been made (aside from modifying Deep Freeze program itself. ie reboot in thawed state etc.
- Because the entire system is not reimaged and VMs are used, the base environment can become corrupted or students could make changes that would not be noticed in the next class. DF allows for the system to easily be rest to some known point after reboot.
- I'm not sure what deep freeze is
- Deep Freeze was implemented to save lab workers time. I see very little purpose for deep freeze anywhere. If it were to be used it should be used for a very focused purpose. In a lab testing

environment deep freeze should never be used.

- The department implemented deep freeze in order to save time with imaging. Now with deep freeze all one has to do is reboot the machine and they have a fresh image ready to go. I also think deep freeze was used to help with time constraints during practical time.
- To save everyone the time and multiple other inconveniences of imaging machines between each use.
- To ensure that a consistant machine was provided to students without the need for constant imaging. With the virtualization and network storage for the VM's, Deep Freeze, with the ability to stop it in case of accdental reboot, has no major negative impact on work.
- Deep Freeze just makes it so when the computer is restarted all changes that were made are no longer there. NSSA labs implemented this because imaging the computers was taking a lot of time.
- to cut down on imaging time.
- To allow faster imaging of the pc's in testlab with vmware. Deep freeze is needed to quickly wipe out the previous students work which in turn cuts down on cheating.
- It will no longer require students to reimage after working on a machine, they can simply restart it and the image will revert back to its original state whiping any configuration changes made. This puts less strain on the computer hardware.
- Reduce imaging time
- To make it faster to set up the labs between open hours and class hours. And to prevent usage of those machines during open hours interfere with classes. As well as the opposite case.
- prevent issues with imaging / damage to base OS
- It allows the computer to be used normally, but allows a student to do a simple reboot in order to be sure that the work they have done cannot be copied or used by the next student who logs in.
- Deep Freeze was implemented to reduce the need for reimaging the labs before labs and practicals and during open hours; this allows the students more working time in the labs.
- Eliminate the delay incurred due to traditional imaging
- It allows the computers to maintain a clean and stable state when they are rebooted as opposed to having to re-image the machine over the network (or a whole lab in some cases) after a lab. This saves at least 15 minutes per machine, more per machine if the entire lab were to be imaged all at once.
- For security purposes and for the ease of clearing machines of user date before another class starts, also for the ability to quickly and easily boot multiple operating systems and various settings.
- To better protect against malicious installations and to prevent the lab PCs from being cluttered up with files accumulated from many students. Gives each student who works at a PC a clean slate to work on.
- to shorten imaging time and work with virtual machines.
- It keeps the students from screwing up stuff labbies will have to fix.
- The main reason I feel the department implemented Deep Freeze is that now labbies do not have to reimage machines to ensure all settings are reset. Also students can be confident that their settings and files will be erased / reset upon reboot. Furthermore, students do not have to worry about undoing changes that someone using the equipment made earlier.
- Deep Freeze allows less pre-lab set up time. Also, the lab workers don't have to worry about deleting everything off the computers because once its restarted, everything is clear.
- No idea
- Because it is easier to setup labs for studends coming into them. Also if you screw up a setup or setting and you are totally lost, you can always just reboot and not have to reinstall the OS to get a fresh start.
- To ease imaging loads and lab reset times.
- Deep Freeze was implemented to speed up the preparation of the labs for classes and exams by removing the need to reimage Windows-based machines.
- Attempt to address imaging problems without correcting the issues.
- to avoid the lag time of reimaging machines all the time
- Deep Freeze was implemented to ease the job of the labbies and when combined with VMWare reduce the stress on the network infrastructure and servers in the labs. For students, it provided them with a consistent software base that they could depend on being the same day in and day out.

6. If you could improve anything about the imaging of the labs what would it be? (hide answers)

- If you're going to image the lab computers, they need to be OPEN so you can actually do work on them. Its ridiculous to have such a system in place if you have to revert to using a VM to actually accomplish anything
- More vmware!
- Nothing that I can think of right now.
- Faster speeds
- Virtualization with the ability to choose any flavor OS would be great.
- Nothing at all
- Don't know
- The imaging system is generally slow and the images are poorly built. If the images were built specifically for one lab with only the minimal operating system requirements. The lab infrastructure is not designed with quick imaging in mind. The infrastructure is running on out dated equipment and the servers are not able to push out the data required. Additionally the lab manager refused to allow labbies to spend time making the imaging servers more efficient/effective.
- I would check out Windows Steady State, its a Microsoft implementation of what Deep Freeze is and it's free, where Deep Freeze isn't.
- labby's
- I would improve the time it takes to load the images; sometimes it takes 15 minutes just to re-image a computer.
- Speed. Get multi-cast working.
- Preventative measure against data loss (saved captures, screenshots, etc) Perhaps a network drive for each student (similiar to syslab perhaps?)
- I believe that even on the machines not in Syslab, having the option to keep your work after a reboot would be advantageous. In the rare case of an accidental reboot. And then of course the common complaint about speed regardless, but this is likely due to a lack of funding for the purchase of new servers.
- redo all the cabling... a lot of the cabling (cat5/6) are improperly terminated (very easy for the wires to be pulled out) and can not be depended on for retaining connectivity to the lab infrastructure.
- Deep Freeze may be good, but we set it up poorly. You could not change network connections, etc. It should be possible to allow us to do anything, change the registry, but still have it reimage after a reboot.
- Faster turn around time
- I would go back to the ghosting network that was previously set up. If possible I would implement Altiris solutions. I did not have a problem using the Norton Ghost setup that we previously had. I am more than willing to wait 5 minutes for my image to load.
- VMware images that students need to use for labs should already be on the deep freeze image instead of students having to go to the server and pull down the vmware image. I believe however, that this was something that was going to be started this quarter.
- Make it faster.
- Figure out why some of the NICs dont work until you run a wireshark capture.
- the ability to still image the computers if we need to.
- faster upload
- Make it fiber. Gig ports are still pretty slow when the whole class is imaging.
- For the networking lab, I would prefer to have the monitors at keyboard level, and put the towers on the top shelf. I sometimes get stiff necks looking up.
- Besides deep freeze, i do not have other answers.
- add some place to save data if the system needs to be rebooted.
- implement better FTP / "thaw zone" to save work
- Nothing, it works fine.

- They pay me to answer this question, I haven't come up with anything new yet.
- I would have images that were more comprehensively equipped with software for EVERY class that uses them. Some classes I took where the lab asked us to use a piece of software, it wouldn't be included on the machine OR the VMWare image, you guys should work on reviewing all the lab-necessary software and include it in your base images/VMWare virtual machines
- I dont know if the wireless carts are included in this, but PLEASE take it off, it was very difficult to use them when it erased your data on a reboot or required a restart to finalize some sort of driver installation for needed materials.

  Over all it seems o.k, there are some occasional snags that I have forgotten at the moment.
- Disable the notifications for auto-updates for every program that is on the PCs. In particular the web browsers and windows update.

  Also, make the Public directory the default directory to save files in to help prevent lost files.
- I don't know
- None that I can currently think of.
- I haven't done enough work behind the scenes with the actual imaging to be able to say.
- don't know
- Have 64bit computers? The network can be flaky at times but that is more or less due to old network equipment, then any negligence.
- Speed and availability of images.
- Nothing comes to mind.
- Implement full disk imaging in a usable timeframe.
- shared public folder that doesnt get deleted if you reboot, just like the sys admin lab has.
- Make sure the times are all the same and ntp is functioning properly

7. What problems have you encountered as a result of the implementation of Deep Freeze? (hide answers)

- No problems per se, just inconveniences. I end up using my laptop or home computer.
- None.
- Random restarts on students' machines during practicals? Yeah...it happens.
- none
- None.
- The systems automatically restart after a timeout period which on many occasions resulted in a loss of ALL lab data not yet backed up (which was impossible in cases of long screen logs and cases with 40+ screen shots per system)
- It was properly explained to us that due to deep freeze we should save all our work to usb flash drives or other media, no real issues
- none
- I lose my shit when it reboots spontaneously
- none so far, all my labs from 515 have worked well with the new deep freeze implementation
- The primary issue that I have noticed is the forced restart time that 'should' be in the middle of the night; except this forced reboot happens in the middle of the day or early evening while classes are in session
- None.
- can't restart when software has to install services
- waiting on labs because the linux box is not imaged correctly
- In some cases windows forces the user to restart after changing specific settings, this causes all the settings to be wiped out regardless of what you do.
- See above.

- Rebooting for drivers causes data to be lost. Rebooting during practical because time is out of sync and machine thought it was 3 am.
- I've lost data as a result of a host unexpectedly restarting.
- Personally I have encountered none.
- Students forget that Deep Freeze has been implemented and restart in an effort to fix a problem but end up losing their work instead.
- No real problems, just frustration with changing some "admin" only settings. I assume the belief was that if we could be admin, we might for some reason disable deep freeze.
- haven't worked with it yet
- There are several times where we need to set up servers and networks for an entire quarter. Having deep freeze on a machine and having that machine turned off wipes all the work you have put into setting up your servers.
- I personally have not encountered any problems with deep freeze. I can imagine however, if there was ever a power glitch that there would be a serious problem :-)
- None.
- I have not encountered nay problems.
- None for myself. I have heard that people have forgeten to take there data off the computer before restarting lossing all of their lab in the process.
- I had captures saved to the desktop and a pc crashed resulting in data loss upon reboot.
- lost files
- If i forget to turn off the pc correctly my data is still there.
- None this year. I heard there were a few problems last year when it was first being implemented, but I have never experienced any.
- Not really
- I personally never came across any issues with the system.
- hardware caused periodic resets that wiped all work due to deep freeze
- Non.e
- In the first few weeks of 20081, some students who missed the numerous warnings on the subject lost work when machines rebooted. I haven't heard of this happening in a couple of months, however.
- Sometimes students forget to save data before resetting. Otherwise it has been a smooth transition.
- No issues, since I always remember to move my files if I used/typed up any on the machine before rebooting.
- Some settings could use improvement. The first that comes to mind was from my old 515 class, in which the NIC commonly used was always turned off by default, yet (i think) the virtual port was enabled (or what ever it is for the network boot)

  At the moment my experience in the lab is somewhat limited so I have been unable to fully explore the various features and different operating systems offered by the lab.
- Accidentally forgetting to save my work before restarting.
- Deep freeze on laptop is a problem. Students lose data due to some laptop randomly self-reboot.
- It can exacerbate simple computer issues and make them more complicated to fix.
- Having Deep Freeze installed on the laptops of the Wireless Carts and when the UPS and battery dies, so does all of the installed programs. In the case of Java, we had to get in range of an actual AP to install Java, which sucked.
- I haven't done it yet, but restarting the computer before saving work or putting on a jump drive could be a problem.
- none
- If the computer is old or the power issue in some of the labs, all the work will be gone if the computer suffers a brown out.
- Deepfreeze locks you out of some parameters like the system clock. In addition, should you need to

install something that requires a reboot, you're out of luck.

- Students occasionally lose work stored on the hard drive due to restarting the system, either because of a system hang or due to lack of knowledge about Deep Freeze.
- Issues with network device responses, loss of student data, etc.
- accidental file deletion if a station reboots due to inactivity
- Still have to download large image files to the computers

8. What benefits do you see from Deep Freeze? (hide answers)

- Restoring to an original state
- Other people don't mess up anything for my labs.
- Not having to spend a TON of time imaging before / between practicals.
- No waiting for re imaging
- Clean, quick image.
- Simplified, quicker imaging. If something gets messed up, the computer simply needs to be rebooted.
- Virtually no reason to ever re-install Windows once you have it set up properly and people can not really mess with your machine once it is in place.
- you can restart and get a fresh machine
- Images are kept standard.
- Less time is spent imaging which means students can get to work faster. They can also reset the windows systems quickly.
- The time not waisted imaging. Also you could attribute less work on the hard drives that have the OS images; allowing for a longer life span of the drives.
- quicker start-overs
- less labor hours
- It is less resource intensive than doing a full re-image of the machine, and takes less time to complete.
- It allows me to have a generally safe OS each and every time I use the labs, which ensures me that my data will not be corrupted or incorrect.
- Saving time
- Much faster than deep freeze when an entire lab needs re-imaging.
- Faster imaging (or image restoration) which really helps when I'm trying to find a bench to do work on, or arriving for my lab section.
- Easier to prepare for each lab class (simple restart)
- VMs are a definite improvement over ghost. The linked clones are quicker and easier, though this process still nees to be improved (smaller vms with useless services like CUPS disabled). It was nice to know that any browsing or work I did could be erased simply by rebooting, and that someone else would not come in and be able to "easily" get this information.
- n/a
- In a lab testing environment I do not see any benefits from deep freeze. Deep freeze is an easy way out to have the machines be able to start from their initial setup.
- I think deep freeze is beautiful. Imaging and getting a fresh image is such a breeze and so easy to do. I like that I can erase or clear my work by rebooting and not have to go through the steps of starting a new image with Ghost.
- Speed of use.
- It is quicker than imaging the computers every lab and if you are having an issue just restarting should fix it.
- I can easily reset a pc by just rebooting it.
- It makes sure my data is gone if I shut down properly.
- It will preserve the lifetime of the hardware in the labs, cut down on imaging time, and reduce the imaging network strain.

- Save the time to image the labs
- I'm not kicked out of any of the open labs 30mins before a class. I have more time in open hours to work.
- Quicker access/imaging
- Makes things faster and simpler.
- The time needed to prepare the labs for classes and other activities has been reduced dramatically.
- See the purpose of deep freeze
- I have implemented this system for a school district, it is quite helpful in maintaining a clean machine state and even some remote control over the machines (if properly seeded/installed you can remotely restart/shutdown and change settings for deep freeze clients). It appears you have done a good job making the install completely transparent (no tray icons etc) and it does its job.
- easy setup and cleanup of machines.
  Uniform platform for labs that ensures that your settings will be uniform no matter what machine you use, no need to worry about what students may have done that were in the lab before you.
- Easier to navigate around the PC and clutter does not build up on the PC over time.
- shorten imaging time
- It keeps students from screwing up the base images too much.
- Just reboot a machine, and all of your personal work is gone and all settings reset, guaranteed.

  I don't have to troubleshoot issues on the machines that someone before me changed without having to reimage all the time.
- Less time spent on seemingly needless, time-consuming tasks.
- don't know
- In certain enviornments it can greatly increase productivity and save time without the risk of security concerns or downtime reseting the computer.
- Lab reset time.
- It takes less time and energy to prepare the labs for classes, and students only need to restart a PC when coming in during open hours as opposed to reimaging it.
- It is getting us thru this tough time but doesn't appear to be a good long term solution for the sysadmin / netadmin curriculum.
- speeds up imaging over ghosting
- I can reboot to erase my work and reboot to get to a "pristine" state where I know I can control the enviroment

9. What is your relationship to the NSSA department?

47 - Student
6 - Faculty or Staff

Student Questions

10. What is your major?

- ANSA
- ANSA
- ANSA
- ANSA
- ANSA
- NSSA
- Applied Networking and Systems Administration
- ISF

- Information Security & Forensics
- NSSA
- ANSA
- VNSA & VNSF
- ansa
- NSSA
- ISF
- Information Security and Forensics
- Information Security and Forensics
- VNSA
- ANSA
- Applied Networking and Systems Administration
- MS NSA
- Applied Networking & Systems Administration
- Networking and Systems Admin
- ANSA
- ANSA
- Applied netwroking and systems administration
- ISF
- information security and forensics
- Information Tech
- ANSA
- Applied Networking and System Administration
- VNSA
- ANSA
- Applied Networking and Systems Administration
- Networking and Systems Administration
- Applied Networking and Systems Administration
- NSSA
- ANSA
- Applied Networking and Systems Administration
- Information Security and Forensics
- Applied Networking & System Administration
- Information Security
- Information Technology
- ANSA
- Applied Networking and Systems Administration
- nssa
- NSSA

11. What year in school are you?  (hide answers)

5 - 1
11 - 2
13 - 3
11 - 4
4 - 5

3 - Graduate

6 user(s) did not answer

12. When did you take 4050-351 Network Fundamentals (hide answers)

11 - Prior to 20071
6 - 20071
6 - 20072
10 - 20073
2 - 20074
1 - 20081
11 - I have not taken this class or am currently enrolled

6 user(s) did not answer

13. When did you take 4050-515/4055-815 Introduction to Routing and Switching? (hide answers)

4 - Prior to 20071
4 - 20071
7 - 20072
6 - 20073
1 - 20074
16 - 20081
9 - I have not taken this class or am currently enrolled

6 user(s) did not answer

14. Imaging problems in the lab BEFORE Deep Freeze (hide answers)

	Never	Seldom	About Half The Time	Usually	Always	Not Applicable	did not answer
How often did you have a problem with the lab image? (for example the image on the computer isn't the image you need to use)	4	22	7	6	2	6	6
How often did you have to reimage the computers before using them?	1	9	10	10	11	6	6
How often did issues with imaging hinder you ability to productively work in the labs?	2	18	8	11	2	5	7

15. Imaging problems in the lab AFTER Deep Freeze (hide answers)

	Never	Seldom	About Half The Time	Usually	Always	Not Applicable	did not answer
How often did you have a problem with the lab image? (for example the image on the computer isn't the image you need to use)	15	20	4	2	0	6	6
How often did you have to reimage the computers before using them?	13	19	3	3	2	7	6
How often did issues with imaging hinder you ability to productively work in the labs?	13	20	5	1	0	8	6

16. Perceptions of the lab environment (hide answers)

	Not Applicable	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree	did not answer
The lab environment was consistent PRIOR TO the implementation of Deep Freeze.	5	3	6	15	13	4	7
The lab environemnt was consistent AFTER the implementation of Deep Freeze.	4	11	21	7	1	2	7
Deep Freeze improved the NSSA labs.	5	9	15	14	1	2	7
The lab computers were better BEFORE Deep Freeze.	5	3	0	16	15	7	7

17. Are you now or have you ever been a labbie/TA? (hide answers)

15 - Yes
32 - No

6 user(s) did not answer

Labbie/TA Questions

18. In which capacity did you work? (hide answers)

5 - Labbie
3 - TA
7 - I have worked as both a labbie and a TA

38 user(s) did not answer

19. During which quarters did you work as a labbie or a TA? (select all that apply) (hide answers)

0 - Prior to 20071
5 - 20071
9 - 20072
8 - 20073
4 - 20074
11 - 20081
12 - 20082

38 user(s) did not answer

20. About how many hours a week did you spend with imaging or imaging issues last quarter (20081)? (hide answers)

1 - 0
4 - 1
1 - 2
0 - 3
3 - 4
0 - 5
0 - 6
1 - 7
4 - I did not work last quarter

Other Responses (1)

- Only worked as TA, so labs were set when I got there. Occasional restarts necessary.

38 user(s) did not answer

21. About how many hours a week did you spend with imaging or imaging issues prior to last quarter? (hide answers)

1 - 0
1 - 1
1 - 2
1 - 3
2 - 4
1 - 5
0 - 6

1 - 7
5 - I did not work prior to last quarter

Other Responses (2)

- 10+. Disclaimer; I manage the imaging infrastructure, so I have to spend more time with it than others.
- 10+. Disclaimer: I maintain the imaging system, so I spend more time using it.

38 user(s) did not answer

22. How do you feel Deep Freeze affected imaging issues? (hide answers)

8 - Deep Freeze improved imaging issues
7 - Deep Freeze neither improved nor made imaging issues worse
0 - Deep Freeze made imaging issues worse

38 user(s) did not answer

23. About how many imaging issues did you have per practical last quarter (20081)? (hide answers)

5 - 0
3 - 1
2 - 2
0 - 3
0 - 4
0 - 5
5 - I did not work last quarter

38 user(s) did not answer

24. About how many imaging issues did you have per practical prior to last quarter? (hide answers)

1 - 0
2 - 1
4 - 2
1 - 3
1 - 4
0 - 5
5 - I did not work prior to last quarter

Other Responses (1)

- I don't know how "many". The issue was how long it took to image

38 user(s) did not answer

25. In what ways has the implementation of Deep Freeze impacted your work? (hide answers)

- Deep freeze has made it easier to image the labs. HOWEVER, when the machines are not imaged correctly in the FIRST place (IE all 3 pcs being xpdf or xp xp netlin)...deep freeze or not; it doesn't make any difference.
- You can't restart the computer...
- Saved time having to image everything
- It no longer takes 30 minutes or more to image a lab for a class. We just need to image the linux machines, which takes closer to 10 minutes.
- in net lab it seems that there were some things that I couldn't change on those machines that I wanted to for the students, or that some bad settings were saved, deep freeze seemed to create problems that did not exsit before, syslab, voip, projects I did not see problems.
- I don't have to go around to every computer and image them anymore. I actually don't do any imaging at all now. I think that it's great imaging can be done directly from the cage
- It simplifies things and speeds them up.
- It has provided me with a second infrastructure to administer in addition to imaging. However, it has improved day to day operations by requiring me to take less time and spend less energy preparing labs for incoming classes.
- So far for 20082, there have been little issue with imaging
- It made imaging for practicales much easier. Using Deep Freeze for syslab is the only arguable sometimes, just depending on the time its easier to use VMs and othertimes its better to use VMs. Eitherway it really doesn't deal with DF.
- I have to devote less time to lab preparation, and I do not need to stick around to ensure that imaging was successful. However, I now need to maintain the Deep Freeze infrastructure.
- Made things easier because students didn't start working on images that had already had settings changed. Change the issues and problems rather than getting rid of issues.

26. About how many times per week do we have to reimage computers in netlab now that we use Deep Freeze? (hide answers)

1 - 0
0 - 1
3 - 2
0 - 3
1 - 4
1 - 5
0 - 6
3 - 7
1 - 8

Other Responses (4)

- not sure at all.
- N/A
- Maybe once per week, maybe
- Don't know

39 user(s) did not answer

27. About how many times per week do we have to reimage computers in syslab now that we use Deep Freeze? (hide answers)

7 - 0
2 - 1
1 - 2
0 - 3
0 - 4
0 - 5
0 - 6
0 - 7
0 - 8

Other Responses (5)

- Occasionally one of two machines.
- Not sure at all. But I don't believe we reimage syslab at all now.
- N/A
- 0 unless a computer starts having issues
- Don't know

38 user(s) did not answer

28. About how many times per week did we have to reimage computers in netlab prior to Deep Freeze? (hide answers)

0 - 0
1 - 1
1 - 2
1 - 3
0 - 4
1 - 5
0 - 6
1 - 7
2 - 8

Other Responses (7)

- A LOT
- >8
- before every lab
- Everyday, maybe in a couple times a day depending upon how many labs were running that day.
- N/A
- few times per day
- Don't know

39 user(s) did not answer

29. About how many times per week did we have to reimage computers in syslab prior to Deep Freeze? (hide answers)

4 - 0
0 - 1
2 - 2
0 - 3
0 - 4
0 - 5
1 - 6
0 - 7
0 - 8

Other Responses (7)

- How is this a question? Every day...miple times for multiple classes.ult
- 100+
- before every lab
- Everyday, several times a day because of the sys admin students
- N/A
- every lab section (numerous times per day)
- Don't know

39 user(s) did not answer

30. About how many computers per practical did we have to reimage prior to Deep Freeze? (hide answers)

0 - 0
0 - 1
1 - 2
2 - 3
1 - 4
0 - 5
0 - 6
0 - 7
0 - 8

Other Responses (10)

- whole lab ... dur
- all
- All of them, to ensure consistency. So 54
- all computers on a bench in net and sys
- Every computer on each bench in the lab at least twice. Once for the first half of a class and again for the second half of the class.
- N/A
- All of the machines in the lab, anywhere from 40 to 80.
- 48 give or take for netlab
- Every PC in the lab.
- Don't know

39 user(s) did not answer

31. About how many computers per practical did we have to reimage after the implementation of Deep Freeze? (hide answers)

1 - 0
2 - 1
1 - 2
0 - 3
0 - 4
0 - 5
0 - 6
0 - 7
0 - 8

Other Responses (10)

- All non-windows
- netlab, 1 set of machines
- Only the linux machines, 18.
- all computers on a bench in net and sys
- Just the linux boxes on each bench in the lab twice. Once for the first half of the class and again for the second half of the class.
- N/A
- Only the Linux machines, typically the 18 in Netlab.
- 16
- Only the Linux machines, primarily 18 in Netlab.
- Don't know

39 user(s) did not answer

32. How would you improve the current Deep Freeze implementation? (hide answers)

- Get better machines in the labs.
- fix timing issues. let students disable DF on reboot, once
- In Netlab, a location where students could save files, and have the option to delete them or not, if the machine was restarted.
- give everyone admin access
- No opinion. Sorry
- I haven't been able to think of anything.
- Allow the option to override Deep Freeze from the student level so that if any intermittent reboots will not erase all work.
- Get better documentation of it?
- Haven't been able to come up with anything.
- Get ntp working

33. What is your overall impression with Deep Freeze? (hide answers)

10 - I am satisfied with Deep Freeze
5 - I am neither satisfied nor dissatisfied with Deep Freeze
0 - I am dissatisfied with Deep Freeze

38 user(s) did not answer

Faculty/Staff Questions

34. Perceptions of Deep Freeze (hide answers)

	Very unbeneficial	Unbeneficial	Neither beneficial or unbeneficial	Beneficial	Very Beneficial	No opinion	did not answer
How beneficial has Deep Freeze been in your courses?	0	3	1	1	1	0	47
How beneficial has Deep Freeze been in the overall lab environment?	0	0	1	4	1	0	47
How has Deep Freeze impacted your practicals?	0	0	2	1	0	3	47
How has Deep Freeze impacted your teaching?	0	2	1	1	0	2	47
How do you percieve the students' reaction to Deep Freeze?	0	2	1	2	0	1	47

35. How has Deep Freeze negatively impacted your courses? (hide answers)

- Students can easily lose their work if not saved in the proper location (p: drive). Or if they fail to answer the question (correctly) regarding work on the P: drive on start.
- No really

- No
- Deep freeze on laptop is an issue for wireless cart projects.
- Reboots and access.
- network connectivity issues, loss of data on reboot, no mechanism to address Microsoft required reboots. (All data is lost on reboot, including new driver installs, etc) Also prevents complete reimaging of machines with CD for OS installs. (You CAN do this in a VM but requiring this limits the student access to issues with full machine OS intallations.)

36. What benefits have you seen from the implementation of Deep Freeze? (hide answers)

- Easier to start over and ensure a semi reliable starting point.
- Not personally.
- None
- limited.

37. What would you like to see in the future with regards to Deep Freeze? (hide answers)

- dfconsole (account) on chewy for TA/professors to work, so IF their is a need we can image specific machines; particularly in syslab.
- Not sure, either implementation improvements or more testing.
- replace it with a full disk imaging suite (Ghost or similar). We are a NETWORKING department and should be able to resolve the imaging issues with some other solution than NOT using the network to image the machines!

38. How did you discover that Deep Freeze was implemented? (hide answers)

- Lab meeting / saw that it was installed on select computers prior to installation on all lab computers.
- From our lab manager
- Informed by Lab Manager
- Testing and then general announcement.

Appendix VI – Interview Notes

Note: 515 refers to the Introduction to Routing and Switching class. Also these notes are not edited for grammatical accuracy in order to preserve the raw data

Start time: 1601, 09 Dec 2008

Stop time: 1611

Interviewee: student, not a labbie, male, year 2, took 515

Location: Net lab Star Trek bench 9

Interviewee knew that Deep Freeze had been implemented in the labs. When asked how the labs were before Deep Freeze he said that it was frustrating because you couldn't tell if the image was good or not—there was no way of telling if someone had used the computer before and messed with the settings. He said that Deep Freeze (DF) is nice because no changes are saved and there is no worry about reimaging. He has had no issue with imaging before or after DF but he said that the process to actually image a computer is slow and so it is nice to have DF: it saves time. I asked him how familiar he was with DF and he said that he used it at work. He is part of the Geek Squad at Best Buy and they use it there on their display computers. Customers can come in and play with the display computers before buying them---then just reset to preserve settings. In his job he doesn't install or configure DF just knows how to remove it so that can sell display computer to customer. Best Buy implemented DF because it allows customers the chance to try before buying a computer, it also prevents issues with software when one customer plays with computer before selling to another, and saves on labor costs to restore computer to original settings before selling. He repeated 6 times through the interview that the primary benefit he has seen in DF is that it saves time. He likes not having to worry about whether or not the settings are off and it is nice to be assured that if you reset the computer everything will just be normal (i.e. with no prior setting changes). His primary concern with DF is losing power: if someone accidentally removes the power cord or you lose power then you lose all your work. He said that "DF has a much more positive impact than a negative one" Last quarter he only had one lab and didn't have any specific incident when DF helped or hindered his work. He liked that you could just sit down at a machine and know you are good to go with default settings. He said that consistency has increased and that DF saves time: both for the students and the labbies. He also liked the peace of mind knowing that he was working with a freshly imaged computer just by resetting. The only change he would make to the lab is to get better hardware: newer PCs and current routers.

Start: 1304, 11 Dec 2008 Stop: 1319

Interviewee: male, Applied Networking and Systems Administration degree, labbie

Location: Net lab Star Trek bench 1

"Before DF we needed to image the labs in preparation for every lab and practical." Students were advised to re-image before they began to work in open hours because you never knew the happenings of that computer prior and could start from a clean slate. They had to close the labs about 45 minutes before the start of each class lab period and practical in order to image the labs. Now they don't have to do that anymore they just image the Linux machines before the practicals. This is probably one of the biggest savings in time both for the students and the labbies. When asked how the decision to implement DF happened he said that he didn't know but probably 20072 (winter quarter) or 20073 (spring quarter) Ann assigned Silas to install and test DF for the quarter project. I asked his experience with DF. He said that he had none prior to it being implemented in the labs but now he was in charge of the imaging infrastructure and therefore also in charge of the DF infrastructure ("in a sense"). He said that it works well as long as the students are aware that it is there on the computers. There were some students that he knew who lost work simply because they didn't know about DF being on the computer. He also said that now that we have DF it SAVES TIME [emphasis of the interviewee]---going from about 45 min prep for each lab to about 1 min just to reset all the computers= no need to kick students out early for prep and students can just reboot computers if they want a fresh start. I asked about his management of DF. He said that it was pretty easy. There is a console where you can tell DF to reboot all the computers associated with it so it saves even more time (don't have to go to all the computers and press the reset button—just those that perhaps have new NICs or didn't get the message from the console). Students don't have access to the console (because of fear that they will be malicious and just reset a whole lab) but labbies do. They have a Remote Desktop session to the DF console where they can reset a whole lab if needed. Teachers do not have access to console because it is the labbies' job to prep labs and teachers shouldn't have to worry about it. I asked if he had personally seen advantages to DF. He said that outside his work he hadn't but that it had really helped him in his work. He does have to take care of DF now which is an additional responsibility but he said it wasn't that bad. In work it has helped him because now he just has to worry about reimaging the Linux boxes (we spoke for a moment about DF not working for Linux, I said that I thought it worked for SUSE but since we don't use that it didn't matter) because DF is on the Windows XP boxes. I asked about disadvantages. He said that he didn't see any down sides, that there was a little more work for him since he now has to take care of DF but a lot less work for everyone else because imaging XP you just press the reset button. He said that as long as students were aware of DF being on the computer they usually didn't have a problem, they just kept a jump drive handy or emailed their work to themselves if they wanted to save it. Also if students mess up on their labs and just

want to start from scratch they can just hit the reset button so there is no need to re-image or try to undo what you just did. I asked about how the students perceived DF. He said that he had only received one complaint about DF from a student who lost work early in 20081 (fall quarter) and hadn't heard any student praise yet (mostly because they hadn't spoken to him about praise). He said that probably students appreciated the extra 45 minutes of open lab per lab session though he thinks that probably doesn't register with them yet. I asked him about the one complaint he had received. He said it was a student who was working late one night in Netlab and came in the next morning looking for some files he'd saved to the desktop of the computer he was using. The interviewee explained to him about DF and pointed out the posted signs at the entrance to each lab. The student was originally upset because he would have to redo the labs in order to get the packet captures he was looking for but the student understood once DF was explained to him and wasn't too upset after that. I asked about the posted signs. He said that in 20081 they posted 8.5" x 11" signs on the doors of each lab in big font to be noticeable about DF. [We had a little side bar here. I told him about a student I met last quarter (20081) who had a problem with DF. The student was working in Syslab and there was an issue with the server to upload his VM image to and so he was afraid he was going to lose his image. Syslab was locked down so he couldn't manage network sharing (i.e. sharing a folder to another computer) and the image was too big for a jump drive. The interviewee told me that they had addressed this issue by taking away the domain logins that they used last quarter and giving all students a common admin login so that they could now manage network settings (20082)]. I asked him to explain just how DF saved time (because he had said it a couple times during the interview). He said that they no longer were closing the labs prior to each class just to re-image the computers. Now they just re-image the Linux computers in Netlab (18 machines total) which is a lighter image than XP and "comes down faster" than XP did. He estimates about 20-50 minutes each "prep" time in savings which is "many hours each week in Netlab alone". He said that Projects and VoIP labs are all XP and so it probably saves an additional 10 minutes in those labs. Syslab they didn't image before and so there was no real savings in that lab.

Start: 1219, 12 Dec 08 End: 1231

Interviewee: male, year 2, Information Security and Forensics program, not a labbie, took 515 in 20081

Location: on the phone

I asked how the labs were before DF. He asked for clarification and I said to talk specifically about imaging or issues with the lab. He said there has always been a bandwidth issue which led to slow imaging. Sometimes he would have only like 10 minutes in order to image---he was told to always reimage the computer before using it because you never knew what the previous student did to the computer. He said it was primarily a time issue---it just took time to image the computers and sometimes he didn't even know which image to use. Usually it took about 7-10 minutes to image when the whole class was there. I asked about his prior experience with DF. He said that at his work (Seatow) they use DF in the customer service center (a dispatch center). He is the sysadmin of the systems and has been using DF for 1.5 years at Seatow. The reason it was implemented there was because they had difficulties managing group policies: "you can only lock a computer down so much before they find a way around and mess things up". At his work DF is beneficial because it reduces downtime. I asked how he found out that we were using DF in our labs. He said that he came back in the fall and they didn't have to image anymore and were told to save all their work because of DF. I asked how he has seen the labs benefit from DF. He said "tremendously" and gave the following reasons:

- When they did practicals they had 2 hours for 40 people to take the test, 20 people at a time. In between there would be like 5 minutes to re-image the lab and imaging would take forever. With DF they just reset the machines and they were ready to go.
- Also "the lab is always consistent—you always know what image is on the computer. You always have a base image"
- He also said that there was no need to figure out which image to use because now there is just the base XP DF image.

I asked how he personally had been impacted by DF. He said for the most part it was great because of the time savings. He did share one negative experience because DF affects the whole drive. He was working on a lab in 515 (Netlab) and the computer blue-screened. He had a working directory on the desktop where he was saving his log files and hadn't transferred them off the computer yet. When the computer came back up he had lost all that work and needed to start over again. He suggested that there be a user partition where students could save their work just in case incidents like this happen or perhaps a network share somewhere where students can temporarily save data. This was his only negative experience, other than that "DF is great"

Start: 1259, 12 Dec 08 Stop: 1308

Interviewee: male, Information Security and Forensics degree, year 2, 515 in 20081, not a labbie

Location: Net lab Oz bench 9

I asked him what the labs were like before DF and he said that he couldn't remember because he really didn't use the labs before we were using DF. He said that last year they could "unfreeze" DF to make changes and then "refreeze" the computer again but this year they changed the password and so students didn't have access anymore. I asked if he had prior experience with DF and he said that he had played with the trial version before but never had a need for it and so hasn't really used it. He worked at a school district and they tested it out but it was not implemented. I asked him what benefits he had seen from DF. He said that it helps with tests when you have a limited time because you can set up the machines however you want and the set-up for classes is the same. He said there was a problem that he noticed: if the person setting up the image had made a problem you can't fix it. He made the example of video drivers, stating that last quarter there was a computer with messed up video drivers which couldn't be fixed because it took a reset to properly install the drivers. He liked being able to turn off DF and then make changes before "refreezing" the computer and suggested that we allow student access to DF for this purpose. He also recognized this could lead to malicious use but suggested that we could educate the students and then open it up to them. I asked how he had personally been impacted from the implementation of DF. He said that it helps a lot, you just reset the computer and it is back to normal, there is no need to change the IP address or anything because all the settings are at the default. He commented that he hadn't really used the machines as much in the labs because he was still a fairly new student. I asked if he had seen any negative impacts of DF. He said "Overall it is very good software to be in here, it keep machines how they need to be, it keeps them in the same state all the time." He also said it was also nice because it keeps students on task: they can't install "fun toys" because they know that it will be gone if they reset so they can't play around but must stay on task. He likes to tinker in the lab and DF is nice because it allows him to have access and install whatever you want. He said the DF is good because if other students tinker he just needs to reset and have a good image. I asked him whether DF led to increased or decreased consistency in the labs. He said that it increased because it is always the same when in the labs unless someone pulls down a different image—"you know what to expect when you come in." As a side note, this interviewee also knows fairly well the first two interviewees.

Start time: 1347, 15 Dec 2008

Stop time: 1355

Interviewee: female, grad student, Networking and Systems Administration program, GA & TA

Location: Net lab Star Trek bench 9

Prior to DF she had to go to every computer and tell it which image to pull down "it took forever to pull down all the images." Now that there is DF she just has to hit the reset button and they are all fresh images. She has had no prior experience with DF. She mentioned imaging for practicals and I asked her to talk specifically about that. She said that before DF the 2nd group of students always lost time because they were waiting for the images to come down so they could start clean. For the practicals they usually have 2 groups of students, each in one hour (i.e. ~36 students/class and only 18 benches). The 1st group was good because usually the lab was prepared for them by the time the practical started, but the 2nd group always had to wait before they could start for the fresh image. After DF was implemented they just had to reboot the computer which was much faster than waiting for a new image. She mentioned they still had to image the Linux boxes "but yeah, a lot faster." I asked how the labs were with DF. She said that the benefit was that the labs "were a lot smoother and more seamless." I asked about what that meant and she said that before DF there was always a question about which image to use and students just didn't know how to use Ghost. Now they just reboot and have the standard image. She said, "I personally like the fact that I can just reboot and all my files are gone" (in other words she likes not having to go through and undo all that she did in the lab so the next student can have a fresh image) so you just reboot and you get a standard image which is nice. I asked about negative impacts of DF and she said she hadn't heard of any student complaints though she could see an issue with students losing power or forgetting to save something or the PC just randomly rebooting. She said that actually that was one of her fears that she would forget to save something and then lose it after the reboot "you're just out of luck." I asked if she had a particular time when she had personally been helped or hindered by DF and she couldn't tell me of any specific stories. I asked if DF decreased or increased the consistency and she said it increased because before the labbies were making images and the students didn't know what image to pull down because there were too many options but now all the images are the same so there is less confusion. I asked how DF affected the lab prep time and she said it was less time now because you don't have to wait for the image to pull down. I asked her overall opinion and she said that it was a good thing especially for practicals.

P.S> after the interview I spoke briefly with the lab manager and she said one of the benefits of DF was that students during open hours would fail to re-image their computers and then try to work with another student's settings or they would have to wait "like 15 minutes" to pull down a fresh image. Now they just reset which equates to more useful open hours.

Appendix VII – Qualitative Analysis

Descriptive Statistics

Response rate: survey invitation sent to 64 former 515 students (33 from 20081 and 31 from 20071), 54 random NSSA students (of the original 60, 6 overlapped with the 515 students data set), 17 faculty members, and 14 labbies/TAs (unknown overlappage with other student categories because I didn't use the distribution list but sent it to the lab manager who sent it out through her distribution list)

Total: 149 (response rate = 51/149 = 34.2%)

By category:

515-20071: 4 responses / 31 invitations = 12.9%

515-20081: 16 response / 33 invitations = 48.5%

Faculty: 6 responses / 17 invitations = 35.3%

Labbies: 13 responses / 14 invitations = 92.9%

Students: 45 responses / 132 invitations = 34.1%

Responses: 45 students (13 labbies, 32 students), 6 faculty members

Labbies: 5 worked both as TA and labbie, 5 just labbies, 3 just TAs

Students: 28 ANSA, 9 ISF, 3 NSA, 2 IT, 3 VNSA

Year: 5 first, 11 second, 12 third, 10 fourth, 4 fifth, 3 graduate

Qualitative data from survey

Note: the bold, all-caps phrase at the beginning of each statement is my classification of the comment based on what I felt were the main ideas of the response. If a comment contained more than one category it was counted for each category. For example if a comment talked about both ORIG and TIME then it was counted twice, once for each category it contained. Also, this data is the actual raw data from the survey (except for the coding) so the text may not be grammatically accurate. This is intentional in order to preserve the actual survey responses.

- **ORIG** – the comment had something regarding restoring the machine to its original state or to default configurations
- **TIME** – the comment dealt with reducing time or speeding up imaging
- **LAZY** – the comment addressed the idea that the staff or lab technicians were simply lazy
- **CONST** – means that the person specifically mentioned the idea of a consistent lab
- **NA** – used when the response either indicates a lack of comprehension or no suggested improvement (i.e. when the person says "I don't know" or "I don't have a suggestion")
- **CHEAT** – simply refers to the concept of erasing configurations so that the next person who uses the machine cannot utilize the work done by a previous student
- **WORK** – refers to increasing the amount of time that students can actually work as opposed to having to do machine prep or other administrative tasks
- **SEC** – the comment addressed security concerns
- **VM** – means that the comment had something to do with virtualization
- **OPEN** – indicates that the comment had something to do with allowing more access
- **EQUIP** – refers to the need to adjust some settings, tweak the hardware, or simply a suggested upgrade in the hardware/software
- **SPEED** – the comment dealt with improving how fast something happens
- **DATA** – indicates that the comment suggested some way of saving data or a complaint of data loss
- **PC** – shows that the student complained of having to use personal computing devices (including thumb drives)
- **RESET** – the comment addressed the issue of resets affecting student work
- **AC** – deals with power loss
- **INST** – means that the comment talks about having to restart the computer for installs

5. What is the purpose of Deep Freeze? In other words, why do you think the NSSA department implemented Deep Freeze?

ORIG = 34

TIME = 23

LAZY= 1

CONST= 2

NA= 2

CHEAT= 3

EQUIP= 1

WORK= 1

SEC= 2

Total responses**= 48** (some responses counted more than once in above categories)

- **ORIG** To restore the computers back to an original state every time they are rebooted.
- **ORIG** This gives each student a clean working environment free of issues caused by prior students.
- **TIME** In order to reduce the time needed to image the labs, deep freeze was implemented. All we have to do now is reboot them.
- **ORIG** So re imaging would not be necessary every time a new student uses a machine.
- **ORIG** Clean image after each restart.
- **ORIG + TIME** Deep Freeze simplified the setup process of the lab computers by ensuring they could be returned to a default state after each restart, eliminating the need for a lengthy Ghost process each time.
- **ORIG** Deep Freeze prevented an unnecessary need of reimaging the machines after every lab. With deep freeze, labs could be prepared just about instantly
- **ORIG** so that we can have admin access and not have the computer be messed up for the next student
- **ORIG** To make sure images are kept standard
- **ORIG** To not have to manually reset all the configurations after someone has worked on the computer.
- **ORIG + TIME** Deep freeze was implemented to reduce lab prep times in between lab sections and practicals. It provides students the ability to quickly and easily reset the windows systems to make sure they get a clean learning environment without the time consumption of the imaging process.
- **ORIG + TIME** So students wouldn't have to waste time reimaging the machines after someone else possibly messed up the operating system.
- **ORIG + TIME** once you restart you're back where you started without wasting an hour reimaging
- **LAZY** so the labby's can be more lazy at doing their jobs

- **ORIG** I think that they implemented Deep Freeze so that after you were finished with your lab, all you would have to do to reset all the settings would be to restart the machine.
- **ORIG + TIME** The NSSA department implemented deep freeze to allow the easy imaging of machines back to a prior state. Ghost was time consuming when used en masse.
- **ORIG** They implemented Deep Freeze in order to provide an effective means of wiping computers each day so that there is less of a chance for problems to occur.
- **ORIG** To prevent student changes to machines to prevent having to re-image the machines for every class
- **ORIG + TIME + CONST** To compensate for slow imaging, particularly in time critical situations such as practicals. It allows the XP machines to simply be rebooted to their original state, instead of having to wait while a new image was pulled from the server. It saves time for the lab staff and students, while also allowing for a more consistent lab environment (not sure if that machine was imaged? just reboot it).
- **ORIG** General purpose is to keep the computer in a "frozen sate" which can be resorted with a simple reboot. Regardless of what changes have been made (aside from modifying Deep Freeze program itself. ie reboot in thawed state etc.
- **NA** I'm not sure what deep freeze is
- **ORIG** Because the entire system is not reimaged and VMs are used, the base environment can become corrupted or students could make changes that would not be noticed in the next class. DF allows for the system to easily be rest to some known point after reboot.
- **TIME** Deep Freeze was implemented to save lab workers time. I see very little purpose for deep freeze anywhere. If it were to be used it should be used for a very focused purpose. In a lab testing environment deep freeze should never be used.
- **ORIG + TIME** The department implemented deep freeze in order to save time with imaging. Now with deep freeze all one has to do is reboot the machine and they have a fresh image ready to go. I also think deep freeze was used to help with time constraints during practical time.
- **CONST** To ensure that a consistant machine was provided to students without the need for constant imaging. With the virtualization and network storage for the VM's, Deep Freeze, with the ability to stop it in case of accdental reboot, has no major negative impact on work.
- **TIME** To save everyone the time and multiple other inconveniences of imaging machines between each use.
- **ORIG + TIME** Deep Freeze just makes it so when the computer is restarted all changes that were made are no longer there. NSSA labs implemented this because imaging the computers was taking a lot of time.
- **TIME** to cut down on imaging time.
- **ORIG + TIME + CHEAT** To allow faster imaging of the pc's in testlab with vmware. Deep freeze is needed to quickly wipe out the previous students work which in turn cuts down on cheating.
- **ORIG + EQUIP** It will no longer require students to reimage after working on a machine, they can simply restart it and the image will revert back to its original state whiping any configuration changes made. This puts less strain on the computer hardware.

- **TIME** Reduce imaging time
- **ORIG + TIME** To make it faster to set up the labs between open hours and class hours. And to prevent usage of those machines during open hours interfere with classes. As well as the opposite case.
- **ORIG** prevent issues with imaging / damage to base OS
- **ORIG + CHEAT** It allows the computer to be used normally, but allows a student to do a simple reboot in order to be sure that the work they have done cannot be copied or used by the next student who logs in.
- **WORK** Deep Freeze was implemented to reduce the need for reimaging the labs before labs and practicals and during open hours; this allows the students more working time in the labs.
- **TIME** Eliminate the delay incurred due to traditional imaging
- **ORIG + TIME** It allows the computers to maintain a clean and stable state when they are rebooted as opposed to having to re-image the machine over the network (or a whole lab in some cases) after a lab. This saves at least 15 minutes per machine, more per machine if the entire lab were to be imaged all at once.
- **ORIG + TIME + SEC** For security purposes and for the ease of clearing machines of user date before another class starts, also for the ability to quickly and easily boot multiple operating systems and various settings.
- **ORIG + SEC** To better protect against malicious installations and to prevent the lab PCs from being cluttered up with files accumulated from many students. Gives each student who works at a PC a clean slate to work on.
- **TIME** to shorten imaging time and work with virtual machines.
- **ORIG** It keeps the students from screwing up stuff labbies will have to fix.
- **ORIG + CHEAT** The main reason I feel the department implemented Deep Freeze is that now labbies do not have to reimage machines to ensure all settings are reset. Also students can be confident that their settings and files will be erased / reset upon reboot. Furthermore, students do not have to worry about undoing changes that someone using the equipment made earlier.
- **ORIG + TIME** Deep Freeze allows less pre-lab set up time. Also, the lab workers don't have to worry about deleting everything off the computers because once its restarted, everything is clear.
- **NA** No idea
- **ORIG + TIME** Because it is easier to setup labs for studends coming into them. Also if you screw up a setup or setting and you are totally lost, you can always just reboot and not have to reinstall the OS to get a fresh start.
- **TIME** To ease imaging loads and lab reset times.
- **ORIG** Attempt to address imaging problems without correcting the issues.
- **TIME** to avoid the lag time of reimaging machines all the time
- 3 people did not respond

6. If you could improve anything about the imaging of the labs what would it be?

OPEN=,1

VM= 4

SPEED= 12

NA= 10

EQUIP= 11

STAFF= 1

DATA= 8

Total responses**= 41** (some responses counted more than once in above categories)

- **OPEN** If you're going to image the lab computers, they need to be OPEN so you can actually do work on them. Its ridiculous to have such a system in place if you have to revert to using a VM to actually accomplish anything
- **VM** More vmware!
- **NA** Nothing that I can think of right now.
- **SPEED** Faster speeds
- **VM** Virtualization with the ability to choose any flavor OS would be great.
- **NA** Nothing at all
- **NA** Don't know
- **SPEED + EQUIP** The imaging system is generally slow and the images are poorly built. If the images were built specifically for one lab with only the minimal operating system requirements. The lab infrastructure is not designed with quick imaging in mind. The infrastructure is running on out dated equipment and the servers are not able to push out the data required. Additionally the lab manager refused to allow labbies to spend time making the imaging servers more efficient/effective.
- **EQUIP** I would check out Windows Steady State, its a Microsoft implementation of what Deep Freeze is and it's free, where Deep Freeze isn't.
- **STAFF** labby's
- **DATA** Preventative measure against data loss (saved captures, screenshots, etc) Perhaps a network drive for each student (similiar to syslab perhaps?)
- **SPEED** I would improve the time it takes to load the images; sometimes it takes 15 minutes just to re-image a computer.
- **SPEED** Speed. Get multi-cast working.
- **DATA + SPEED** I believe that even on the machines not in Syslab, having the option to keep your work after a reboot would be advantageous. In the rare case of an accidental reboot. And then of course the common complaint about speed regardless, but this is likely due to a lack of funding for the purchase of new servers.
- **EQUIP** redo all the cabling... a lot of the cabling (cat5/6) are improperly terminated (very easy for the wires to be pulled out) and can not be depended on for retaining connectivity to the lab infrastructure.
- **SPEED** Faster turn around time

- **DATA** Deep Freeze may be good, but we set it up poorly. You could not change network connections, etc. It should be possible to allow us to do anything, change the registry, but still have it reimage after a reboot.
- **EQUIP** I would go back to the ghosting network that was previously set up. If possible I would implement Altiris solutions. I did not have a problem using the Norton Ghost setup that we previously had. I am more than willing to wait 5 minutes for my image to load.
- **EQUIP + VM** VMware images that students need to use for labs should already be on the deep freeze image instead of students having to go to the server and pull down the vmware image. I believe however, that this was something that was going to be started this quarter.
- **SPEED** Make it faster.
- **EQUIP** Figure out why some of the NICs dont work until you run a wireshark capture.
- the ability to still image the computers if we need to.
- **SPEED** faster upload
- **SPEED** Make it fiber. Gig ports are still pretty slow when the whole class is imaging.
- **EQUIP** For the networking lab, I would prefer to have the monitors at keyboard level, and put the towers on the top shelf. I sometimes get stiff necks looking up.
- **NA** Besides deep freeze, i do not have other answers.
- **DATA** add some place to save data if the system needs to be rebooted.
- **DATA** implement better FTP / "thaw zone" to save work
- **NA** Nothing, it works fine.
- **NA** They pay me to answer this question, I haven't come up with anything new yet.
- **EQUIP + VM** I would have images that were more comprehensively equipped with software for EVERY class that uses them. Some classes I took where the lab asked us to use a piece of software, it wouldn't be included on the machine OR the VMWare image, you guys should work on reviewing all the lab-necessary software and include it in your base images/VMWare virtual machines
- **DATA + EQUIP** I dont know if the wireless carts are included in this, but PLEASE take it off, it was very difficult to use them when it erased your data on a reboot or required a restart to finalize some sort of driver installation for needed materials.

Over all it seems o.k, there are some occasional snags that I have forgotten at the moment.
- **DATA + EQUIP** Disable the notifications for auto-updates for every program that is on the PCs. In particular the web browsers and windows update.

Also, make the Public directory the default directory to save files in to help prevent lost files.
- **NA** I don't know
- **NA** None that I can currently think of.
- **NA** I haven't done enough work behind the scenes with the actual imaging to be able to say.
- **NA** don't know
- **SPEED + EQUIP** Have 64bit computers? The network can be flaky at times but that is more or less due to old network equipment, then any negligence.
- **SPEED** Speed and availability of images.
- **SPEED** Implement full disk imaging in a usable timeframe.

- **DATA** shared public folder that doesnt get deleted if you reboot, just like the sys admin lab has.
- 10 people did not respond

7. What problems have you encountered as a result of the implementation of Deep Freeze?

PC = 1

NA= 19

RESET= 11

DATA= 18

INST= 4

TIME= 1

AC= 2

OPEN= 2

EQUIP= 1

Total responses**= 49** (some responses counted more than once in above categories)

- **PC** No problems per se, just inconveniences. I end up using my laptop or home computer.
- **NA** None.
- **RESET** Random restarts on students' machines during practicals? Yeah...it happens.
- **NA** none
- **NA** None.
- **DATA + RESET** The systems automatically restart after a timeout period which on many occasions resulted in a loss of ALL lab data not yet backed up (which was impossible in cases of long screen logs and cases with 40+ screen shots per system)
- **NA** It was properly explained to us that due to deep freeze we should save all our work to usb flash drives or other media, no real issues
- **NA** none
- **DATA + RESET** I lose my shit when it reboots spontaneously
- **NA** none so far, all my labs from 515 have worked well with the new deep freeze implementation
- **RESET** The primary issue that I have noticed is the forced restart time that 'should' be in the middle of the night; except this forced reboot happens in the middle of the day or early evening while classes are in session
- **NA** None.
- **INST** can't restart when software has to install services
- **TIME** waiting on labs because the linux box is not imaged correctly
- **RESET + INST** In some cases windows forces the user to restart after changing specific settings, this causes all the settings to be wiped out regardless of what you do.
- **DATA + RESET** I've lost data as a result of a host unexpectedly restarting.
- See above.
- **DATA+ RESET + INST** Rebooting for drivers causes data to be lost. Rebooting during practical because time is out of sync and machine thought it was 3 am.
- **NA** Personally I have encountered none.

- **DATA** Students forget that Deep Freeze has been implemented and restart in an effort to fix a problem but end up losing their work instead.
- **NA** haven't worked with it yet
- **OPEN** No real problems, just frustration with changing some "admin" only settings. I assume the belief was that if we could be admin, we might for some reason disable deep freeze.
- **DATA** There are several times where we need to set up servers and networks for an entire quarter. Having deep freeze on a machine and having that machine turned off wipes all the work you have put into setting up your servers.
- **NA + AC** I personally have not encountered any problems with deep freeze. I can imagine however, if there was ever a power glitch that there would be a serious problem :-)
- **NA** I have not encountered nay problems.
- **NA** None.
- **NA + DATA** None for myself. I have heard that people have forgeten to take there data off the computer before restarting lossing all of their lab in the process.
- **DATA** I had captures saved to the desktop and a pc crashed resulting in data loss upon reboot.
- **DATA** lost files
- **DATA** If i forget to turn off the pc correctly my data is still there.
- **NA** None this year. I heard there were a few problems last year when it was first being implemented, but I have never experienced any.
- **NA** Not really
- **NA** I personally never came across any issues with the system.
- **DATA + RESET** hardware caused periodic resets that wiped all work due to deep freeze
- **NA** Non.e
- **DATA** In the first few weeks of 20081, some students who missed the numerous warnings on the subject lost work when machines rebooted. I haven't heard of this happening in a couple of months, however.
- **DATA** Sometimes students forget to save data before resetting. Otherwise it has been a smooth transition.
- **NA** No issues, since I always remember to move my files if I used/typed up any on the machine before rebooting.
- **EQUIP** Some settings could use improvement. The first that comes to mind was from my old 515 class, in which the NIC commonly used was always turned off by default, yet (i think) the virtual port was enabled (or what ever it is for the network boot)

At the moment my experience in the lab is somewhat limited so I have been unable to fully explore the various features and different operating systems offered by the lab.
- **DATA** Accidentally forgetting to save my work before restarting.
- **DATA + RESET** Deep freeze on laptop is a problem. Students lose data due to some laptop randomly self-reboot.
- It can exacerbate simple computer issues and make them more complicated to fix.
- **RESET** Having Deep Freeze installed on the laptops of the Wireless Carts and when the UPS and battery dies, so does all of the installed programs. In the case of Java, we had to get in range of an actual AP to install Java, which sucked.

- **DATA** I haven't done it yet, but restarting the computer before saving work or putting on a jump drive could be a problem.
- **NA** none
- **AC** If the computer is old or the power issue in some of the labs, all the work will be gone if the computer suffers a brown out.
- **OPEN + INST** Deepfreeze locks you out of some parameters like the system clock. In addition, should you need to install something that requires a reboot, you're out of luck.
- **DATA** Issues with network device responses, loss of student data, etc.
- **DATA + RESET** accidental file deletion if a station reboots due to inactivity
- 2 people did not respond

8. What benefits do you see from Deep Freeze?

ORIG= 19

TIME= 26

CONST= 2

EQUIP= 3

SEC= 2

WORK= 3

NA= 2

CHEAT= 3

OTHER= 3

Total responses**= 46** (some responses counted more than once in above categories)

***interesting: compare question 5 to question 8 notice that time is less in 5 and more in 8**

- **ORIG** Restoring to an original state
- **ORIG** Other people don't mess up anything for my labs.
- **TIME** Not having to spend a TON of time imaging before / between practicals.
- **TIME** No waiting for re imaging
- **ORIG** Clean, quick image.
- **ORIG + TIME** Simplified, quicker imaging. If something gets messed up, the computer simply needs to be rebooted.
- **ORIG** Virtually no reason to ever re-install Windows once you have it set up properly and people can not really mess with your machine once it is in place.
- **ORIG** you can restart and get a fresh machine
- **ORIG + CONST** Images are kept standard.
- **ORIG + TIME** Less time is spent imaging which means students can get to work faster. They can also reset the windows systems quickly.
- **EQUIP + TIME** The time not waisted imaging. Also you could attribute less work on the hard drives that have the OS images; allowing for a longer life span of the drives.
- **ORIG + TIME** quicker start-overs
- **TIME** less labor hours
- **EQUIP + TIME** It is less resource intensive than doing a full re-image of the machine, and takes less time to complete.
- **TIME** Much faster than deep freeze when an entire lab needs reimaging.
- **ORIG + SEC** It allows me to have a generally safe OS each and every time I use the labs, which ensures me that my data will not be corrupted or incorrect.
- **TIME** Saving time
- **TIME + WORK** Faster imaging (or image restoration) which really helps when I'm trying to find a bench to do work on, or arriving for my lab section.
- **TIME** Easier to prepare for each lab class (simple restart)
- **NA** n/a

- **CHEAT + TIME** VMs are a definite improvement over ghost. The linked clones are quicker and easier, though this process still nees to be improved (smaller vms with useless services like CUPS disabled). It was nice to know that any browsing or work I did could be erased simply by rebooting, and that someone else would not come in and be able to "easily" get this information.
- **ORIG** In a lab testing environment I do not see any benefits from deep freeze. Deep freeze is an easy way out to have the machines be able to start from their initial setup.
- **ORIG + CHEAT** I think deep freeze is beautiful. Imaging and getting a fresh image is such a breeze and so easy to do. I like that I can erase or clear my work by rebooting and not have to go through the steps of starting a new image with Ghost.
- **TIME** Speed of use.
- **ORIG + TIME** It is quicker than imaging the computers every lab and if you are having an issue just restarting should fix it.
- **ORIG + TIME**I can easily reset a pc by just rebooting it.
- **CHEAT + ORIG** It makes sure my data is gone if I shut down properly.
- **EQUIP + TIME** It will preserve the lifetime of the hardware in the labs, cut down on imaging time, and reduce the imaging network strain.
- **TIME** Save the time to image the labs
- **WORK** I'm not kicked out of any of the open labs 30mins before a class. I have more time in open hours to work.
- **TIME** Quicker access/imaging
- **TIME** Makes things faster and simpler.
- **TIME** The time needed to prepare the labs for classes and other activities has been reduced dramatically.
- See the purpose of deep freeze
- **ORIG** I have implemented this system for a school district, it is quite helpful in maintaining a clean machine state and even some remote control over the machines (if properly seeded/installed you can remotely restart/shutdown and change settings for deep freeze clients). It appears you have done a good job making the install completely transparent (no tray icons etc) and it does its job.
- **ORIG + CONST** easy setup and cleanup of machines.
Uniform platform for labs that ensures that your settings will be uniform no matter what machine you use, no need to worry about what students may have done that were in the lab before you.
- Easier to navigate around the PC and clutter does not build up on the PC over time.
- **TIME** shorten imaging time
- **ORIG** It keeps students from screwing up the base images too much.
- **ORIG** Just reboot a machine, and all of your personal work is gone and all settings reset, guaranteed.

I don't have to troubleshoot issues on the machines that someone before me changed without having to reimage all the time.
- **TIME** Less time spent on seemingly needless, time-consuming tasks.
- **NA** don't know
- **WORK + SEC + TIME** In certain enviorments it can greatly increase productivity and save time without the risk of security concerns or downtime reseting the computer.
- **TIME** Lab reset time.

- It is getting us thru this tough time but doesn't appear to be a good long term solution for the sysadmin / netadmin curriculum.
- **TIME** speeds up imaging over ghosting
- 5 people did not respond

25. (Labbies) In what ways has the implementation of Deep Freeze impacted your work?

- Deep freeze has made it easier to image the labs. HOWEVER, when the machines are not imaged correctly in the FIRST place (IE all 3 pcs being xpdf or xp xp netlin)...deep freeze or not; it doesn't make any difference.
- You can't restart the computer...
- Saved time having to image everything
- It no longer takes 30 minutes or more to image a lab for a class. We just need to image the linux machines, which takes closer to 10 minutes.
- in net lab it seems that there were some things that I couldn't change on those machines that I wanted to for the students, or that some bad settings were saved, deep freeze seemed to create problems that did not exsit before, syslab, voip, projects I did not see problems.
- I don't have to go around to every computer and image them anymore. I actually don't do any imaging at all now. I think that it's great imaging can be done directly from the cage
- It simplifies things and speeds them up.
- It has provided me with a second infrastructure to administer in addition to imaging. However, it has improved day to day operations by requiring me to take less time and spend less energy preparing labs for incoming classes.
- So far for 20082, there have been little issue with imaging
- It made imaging for practicales much easier. Using Deep Freeze for syslab is the only arguable sometimes, just depending on the time its easier to use VMs and othertimes its better to use VMs. Eitherway it really doesn't deal with DF.
- 5 labbies did not respond

32. (Labbies) How would you improve the current Deep Freeze implementation?

- Get better machines in the labs.
- fix timing issues. let students disable DF on reboot, once
- In Netlab, a location where students could save files, and have the option to delete them or not, if the machine was restarted.
- give everyone admin access
- No opinion. Sorry
- I haven't been able to think of anything.
- Allow the option to override Deep Freeze from the student level so that if any intermittent reboots will not erase all work.
- Get better documentation of it?
- 7 labbies did not respond

35. (Faculty or staff) How has Deep Freeze negatively impacted your courses?

- Students can easily lose their work if not saved in the proper location (p: drive). Or if they fail to answer the question (correctly) regarding work on the P: drive on start.
- No really
- No
- Deep freeze on laptop is an issue for wireless cart projects.
- Reboots and access.
- network connectivity issues, loss of data on reboot, no mechanism to address Microsoft required reboots. (All data is lost on reboot, including new driver installs, etc) Also prevents complete reimaging of machines with CD for OS installs. (You CAN do this in a VM but requiring this limits the student access to issues with full machine OS intallations.)

36. (Faculty or staff) What benefits have you seen from the implementation of Deep Freeze?

- Easier to start over and ensure a semi reliable starting point.
- Not personally.
- None
- limited.
- 2 did not respond

37. (Faculty or staff) What would you like to see in the future with regards to Deep Freeze?

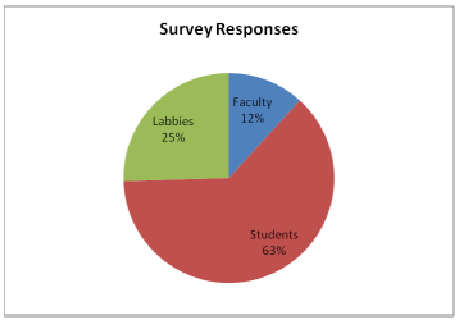
- dfconsole (account) on chewy for TA/professors to work, so IF their is a need we can image specific machines; particularly in syslab.
- Not sure, either implementation improvements or more testing.
- replace it with a full disk imaging suite (Ghost or similar). We are a NETWORKING department and should be able to resolve the imaging issues with some other solution than NOT using the network to image the machines!
- 3 did not respond

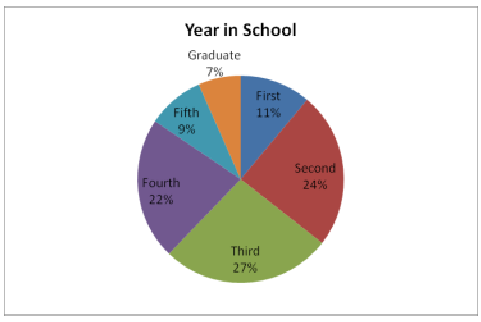
38. (Faculty or staff) How did you discover that Deep Freeze was implemented?

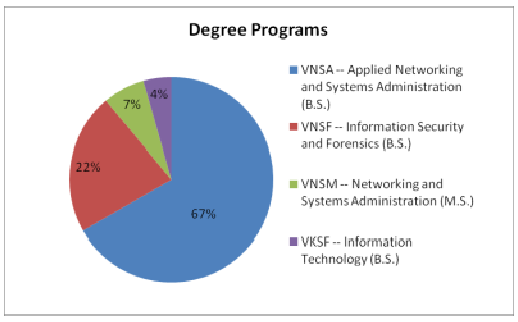
- Lab meeting / saw that it was installed on select computers prior to installation on all lab computers.
- From our lab manager
- Informed by Lab Manager
- Testing and then general announcement.
- 2 did not respond

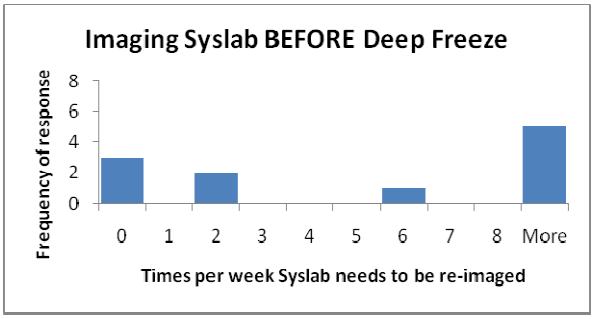
Appendix VIII – One-page Summary

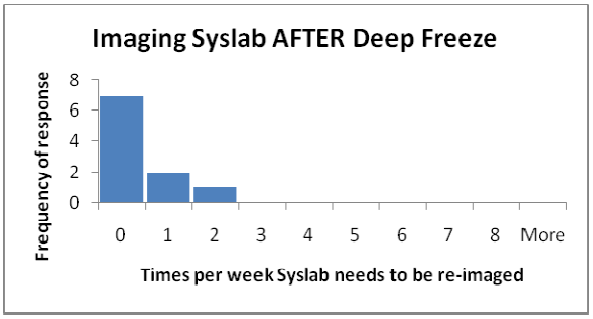
This report can be a bit daunting so here is a very brief summary of some of the most important findings:



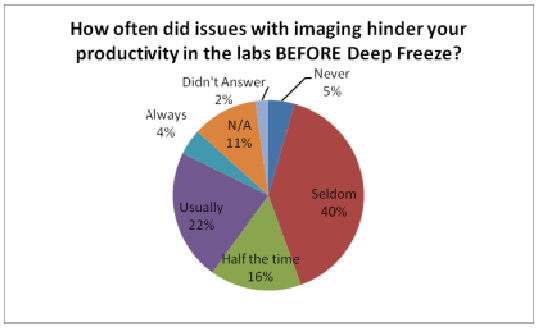


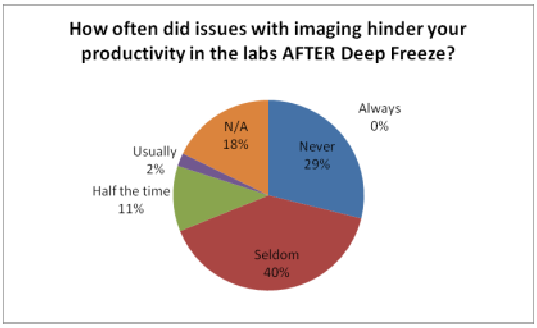




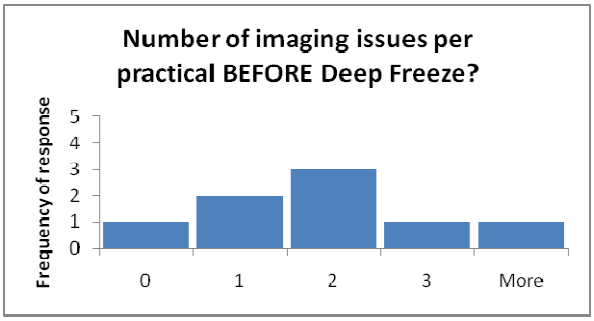


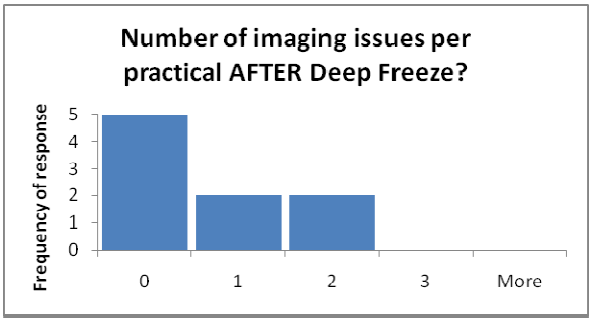
- Seven labbies said that they did not need to re-image Syslab after Deep Freeze, an indication about how this program is saving time.





- Those who "Usually" had imaging problems hinder their labs dropped by 20%, those who "Never" had this hindrance went up by 24%, an indication of effect on consistency in the labs.





- Labbies indicated that the number of imaging issues per practical dropped after Deep Freeze

Conclusions:

- Every person interviewed said that Deep Freeze saved time and helped keep the lab computers at a standard configuration.
- The time-savings came not only because the labbies spent less time actually pulling down an image but also because they had to re-image less frequently.
- The students saw time-savings because they could make better use of open hours in the lab and there was limited need to re-image a computer before they could actually begin working.
- The implementation of Deep Freeze brought a peace of mind to the students who no longer need to worry about other students using their work or using another student's configurations, an unexpected finding of this study.
- Its effect on practicals: no longer must the second set of students wait for their computers to re-image before beginning the practical and there are fewer imaging incidents per practical.

Limitations:

- The labbies who are only part-time employees and students must now maintain another infrastructure in support of Deep Freeze.
- There is some additional work when building images: you must worry about unfreezing the image, making changes, and then re-freezing the image, and if there are mistakes made in this process then those mistakes are harder to fix.
- All students who utilize the labs must now use some sort of removable media to store their data and have to remember to save frequently in order to prevent data loss.
- You cannot restart the computer after an install. This is especially problematic when installing drivers (i.e. video drivers) that require a reboot in order to operate fully.

Recommendations:

- One professor was very adamant about taking Deep Freeze off of the laptops on the wireless carts:
    - The carts run on Uninterrupted Power Supplies: at any time the battery could be exhausted and the computers shut down which would cause data loss with Deep Freeze.
    - There is a frequent need to install devices which require reboots.
- Create a thawed partition or a network share where students can temporarily save log files, screen captures, or other files necessary for proof of completing the labs. Data loss prevention was the most common comment when asked about how to improve the current implementation.
- Also create a more comprehensive Deep Freeze image: in other words the labbies should perform a more thorough investigation of what each lab might need and install it. This would take a concerted effort on both the part of the labbies and the professors to identify the software needs but it would be worthwhile to allow students a more meaningful lab experience.
- One common comment of the labbies was that they still had to worry about the Linux boxes since the version of Linux used in the labs is incompatible with Deep Freeze. In light of these comments I would suggest looking into using a version of Linux in the labs which is compatible so that there was an even more reduced need to image computers.

Appendix IX – Acknowledgments

Words cannot express the gratitude I have for the following people and their significant contributions to making this a reality (in no particular order and an early apology for anyone I may have left out):

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