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Distance Labs

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A Distance Lab Environment for Online Computing Courses

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ITL Program

A Distance Lab Environment for Online Computing Courses

Introduction

This capstone paper is a compilation of the information we discovered during our research on the topic of distance lab environments for online computing courses. We provide our research, our findings, and our supporting evidence to answer the following question: How can La Salle University deliver a comparable hands-on learning experience for its online student population without requiring the students to attend on-campus? Initially, our research suggests a solution for the Economic Crime Forensics (ECF) courses; however, it will benefit all lab related computing courses at La Salle University.

This paper will show: (a) that the goal of using a distance lab for the Economic Crime Forensics (ECF) courses is obtainable, and how it will benefit students by completing the lab assignments in the computing courses; (b) our literature review; (c) and our research findings from several sources. Our research includes discussions with La Salle University Faculty; sample sessions with three public cloud computing services: CloudShare ProPlus, Skytap, and Amazon Web Services (AWS); and implementations from schools using a private cloud service on-campus with the IBM Virtual Computing Lab Initiative (VCL) Model including how Higher Education is using commercially available virtualization software from VMWare (VCloud) on top of their own architecture.

Problem Statement

La Salle University would like to offer the ECF courses fully online by replacing the on-campus lab requirement with an online distance lab. The ability to offer the courses fully online will provide numerous benefits to all stakeholders. The students could enroll in an online course without the requirement of completing lab assignments on-campus. This would make it easier for the students to balance school with other responsibilities. For La Salle University, having the courses fully online could prove to be a monetary benefit by attracting students from all over the nation, potentially from all over the world.

ECF Courses

The goal of the ECF courses is to educate students entering the field of economic crime and digital forensics. The students will have the opportunity to work as internal and external fraud auditors, digital forensics specialists, data and network security managers, and additionally, technology managers will be able to pursue leadership careers integrating financial compliance with business goals.

The ECF courses will equip students with the background to detect, deter, and investigate instances of economic crime, misconduct, and abuse. The courses incorporate key components from three La Salle University graduate programs: Computer Information Science (CIS) and Information Technology Leadership (ITL), and the Fraud Forensics Accounting Certificate Programs. The combination of all of these courses integrates theory and practice for the students through: [a] evaluation of relevant case studies; [b] evaluation and analysis of computer software products and data; and [c] justification of research areas related to economic crime (McCoey).

La Salle ECF Professors

The first and most important task was to learn the requirements of the lab related ECF computing courses by collecting information from the Director of CIS and ITL Graduate Programs and three of the Professors who will be teaching the courses. The most effective way to collect the information was to interview via phone conference and to communicate via email. In preparation for the interviews we prepared a set of questions that are included in Appendix A.

Professor Peggy McCoey

We met with Professor Peggy McCoey, via phone, to discuss the overall system requirements for the ECF courses. In our discussions we learned that the proposed distance lab service should allow both professors and students to load an operating system, such as Windows or Linux, and either a desktop or server into the cloud. The service must be device agnostic, providing support for Windows and Linux, Mac, and other client operating systems such as Mac iOS and Android. Users will be able to use common access methods such as Remote Desktop Protocol (RDP), Secure Shell (SSH), and HTML5 to access the service. The proposed solution must permit users to run applications such as: TCP/IP Diagnostic Utilities, Ping, Nslookup, and Netstat, etc., password grabbers, Cain & Abel and Brutus, network spoofing utilities, and packet sniffing utilities. Users of the service should be able to share folders across the cloud network. Users of the service will be able to analyze both captured data from within the environment and data provided to the student by the professor.

Professor Matthew Ryan

Our first phone conference with one of the professors teaching in the program was with Professor Matthew Ryan. He did not give us specific requirements for using a distance lab in his course, but he did explain the specifics of his course. Professor Ryan currently teaches *FACC 704: The Computer and Internet Fraud* in the Fraud Forensics Accounting Certificate Program at

La Salle. This course will be taught as ECF 604. Overall, this course teaches students how computer fraud and manipulation is accomplished and what security measures should be taken to prevent it. Professor Ryan pointed out that the point of forensics is to perform a physical seizure of the evidence to keep in custody to complete an investigation. In this course the students are required to complete lab exercises by running decryption software and using open source and freeware software.

Currently, his students do not have the opportunity to have a distance lab hands-on experience in this course. However Professor Ryan feels this course satisfies the need for the students to physically deal with the evidence to conduct the proper image activity needed to complete the lab exercises without having to be physically present on-campus. This task is accomplished because "the image," which is the evidence, "is loaded to a USB drive and shipped directly to the students by US Mail or UPS Service. The students begin to record what happens to the evidence from the moment they get the delivery of the evidence installed on to their own machines" (Ryan).

Dr. Stephen Longo

Dr. Stephen Longo, currently teaching in the CIS and ITL Programs, returned our questionnaire with his requirements for a hands-on distance lab for his students. Dr. Longo teaches *CIS 619: LAN Administration* and this course will be taught as ECF 619. His requirements for the distance lab included: virtual computers simulating different system configurations allowing students the opportunity to investigate and also to become acquainted with various tools and scenarios; the lab should be available 24/7; students should be able to take snapshots of the systems they are working on and taking snap-shots of the system would be beneficial in case a student makes a mistake to be able to go back to the previous snapshot

instead of starting over. He also offered his opinion that having a distance lab capability will allow for improving the students' learning experience as it is most educators' contention that a hands-on experience simulating real situations can improve the learning experience (Longo).

Professor Thomas Pasquale

Professor Thomas Pasquale currently teaches *INL 644: Data Security Technologies.* This course will also be taught as ECF 644. Professor Pasquale met with us via phone conference to discuss ECF 644 course requirements for his lab assignments. He informed us that there are currently two different versions of the security course being taught at La Salle, one that is more technical for the CIS students and one that is less technical for the ITL students because the version in the ITL Program is geared more towards managers. The less technical security course will be taught to the students taking the ECF courses and these students would not be required to go on-campus to complete the labs. However, he seemed very interested in having an online distance lab for the networking course, ECF 619 (Pasquale).

After we described CloudShare ProPlus, which was the first public cloud service we tested, we let him know that we were already successfully testing out the ECF 644 lab assignments as well as the ECF 619 lab assignments in that service. Professor Pasquale seemed interested and that perhaps a public cloud service could be a good fit for the ECF 619 lab assignments.

One specific requirement that Professor Pasquale did say the distance lab would need to have is the ability to back up a user's configuration also known as a snapshot.

Because Professor Pasquale is also the Network Administrator at La Salle University and because another public cloud service, Skytap that we were evaluating has a "bring your own licensing model" we also inquired about La Salle's Microsoft licensing agreement in order to use

Skytap. In this part of the discussion he did not agree that we could use La Salle's licensing in the cloud service, however he led us to believe that this would be a different conversation (Pasquale).

System Requirements

Once we gathered enough information from the Director of CIS and ITL Graduate Programs and the Professors on their course requirements we were able to list the requirements to figure out what we needed from a cloud service.

Users will be able to:

- Load an Operating System
- Build, copy, and distribute environments to others for review, and if desired, to incorporate into their own environment
- Upload and download virtual desktop images
- Take multiple snap-shots of an environment
- Upload and install applications
- Run applications, including user installed applications

System will need to:

- Be end-user device agnostic (Windows, Linux, Mac…)
- Support common access methods such as – Browser, Remote Desktop Protocol (RDP), Secure Shell (SSH)
- Route data between environments and user's computing device and/or customers data center
- Provide for shared network storage
- The environment should be persistent

From the list of requirements we proceeded with our research to see if we could find the best fit for the ECF computing courses delivered through a public cloud service. Our plan was to contact the vendors and subscribe to the services, set up the distance lab environments to test the functionality and to run the lab assignments through to see if they worked. See Appendix B for specific questions that we asked the vendors. As for attempting to contact Amazon Web Services to subscribe to their service, we filled out a form on their Web site and never received a reply. However, we were able to subscribe to the service via the Web by signing up for the AWS Free Usage Tier through an existing Amazon account. Amazon requires a credit card number to do so ("AWS Free Usage Tier FAQs").

Cloud Computing Services

The following research findings are from data that we read on various cloud computing services' Web sites, our experience implementing the labs in the services, and fact-finding information we learned during our phone interviews with the vendors' representatives. We will begin by defining a Public Cloud, describing each public cloud service that we did our research on, CloudShare ProPlus, Skytap and Amazon Web Services, and continue with describing the similarities, the differences, and lessons learned from implementing the lab assignments in each service. We provided individual tables, per service, pointing to the appendixes to see the results for all labs implanted in the cloud. For the sake of our argument in how a public cloud service provider could work for our lab related computing courses, we describe one lab, per course, extensively. See Figures 2, 3, and 4 in the "Experience Implementing Labs" section of this paper.

What is a Public Cloud Service?

According to the National Institute of Standards and Technology (NIST), "The cloud infrastructure is provisioned for open use by the general public. It may be owned, managed, and operated by a business, academic, or government organization, or some combination of them. It exists on the premises of the cloud provider" (Grance). There are a few good reasons to subscribe to a public cloud service for students to do course work. These benefits include IT not needing to set up special infrastructure, servers, special software, virtual machine configurations, and storage; the professors being able to easily set up and distribute the students' environment online, and the students being able to seamlessly access their distance lab environment through a Web browser and Internet connection.

CloudShare ProPlus Public Cloud Service

Introduction

CloudShare ProPlus was founded in Israel in 2007 and moved its headquarters to San Mateo California by 2009. Their customer base is primarily small to medium size businesses as well as Fortune 500. The architecture is VMware with support for HTML5 and it is device agnostic. CloudShare ProPlus delivers a virtual training solution for customers to develop, test, share and deploy projects in the cloud. CloudShare ProPlus uses a browser-based interface for all system management, and hosts a library of pre-configured virtual machine images. Images can be configured as necessary and shared among other CloudShare ProPlus users. See Table 1 for cloud service cost comparison details.

	System Users	VMs per User	RAM per User (GB)	Snapshot storage per User (GB)	Hourly Usage per Month per User	Monthly Costs	Course Duration (months)	User Semester Costs	Overall Semester Costs
Amazon AWS	21	2	2		Unlimited	$36.00	4	$144.00	$3,024.00
CloudShare	21	10	10	300	Unlimited	$35.00	4	$140.00	$2,940.00
Skytap	21	2	2	100	23.81	$32.00	4	$128.00	$2,688.00

Table 1. *Cloud Service Cost Comparison*

How it Works

A user builds and configures an environment to share with other CloudShare ProPlus users. An environment consists of one or many virtual desktops and/or server images. An environment can be loaded with virtual desktop images created from preconfigured templates located in the Image Library. Once loaded, configuration changes can be made to it and software can be installed onto the virtual desktop images. Users can view and manipulate the shared environment and any virtual machine it contains or be limited to an exact replica. The user can make configuration changes and install applications to the virtual desktops in the environment. Changes made will not affect the original copy of the environment. It is important to note that users can upload their own virtual machine images.

Skytap Public Cloud Service

Introduction

Like CloudShare ProPlus, Skytap also delivers a virtual training solution for customers to develop, test, share and deploy projects in the cloud. Skytap Cloud uses a browser-based interface for all system management, and hosts a library of pre-configured virtual machine images. Images can be configured as necessary and shared among other Skytap users. Skytap's pricing model is based on three variables, Skytap Virtual Machine (SVM), VM running time, and storage. A SVM

is defined as 1 Gig of RAM and 1 processor. A virtual machine requires a minimum of 1 SVM. Quotas can be assigned to users to control costs. (See Table. 1 for cloud service cost comparison details.)

Skytap is a U.S. company located in Seattle, Washington and was originally developed at the University of Washington. Their customer base is both in education (Palm Beach State College, Georgia Tech University, Ferris State University) and business. The architecture currently is VMware ESXi4 with support for HTML5 and is device agnostic. Customers in Skytap can build and configure an environment to share with other Skytap users.

How it Works

Skytap is similar to CloudShare ProPlus in the way it works. Users create environments and load machine images from pre-configured templates that the services provide. The templates are stored in an image library for the user to easily access. Like CloudShare ProPlus, users can also upload their own virtual machine images to use in the service. The differences are in the interface in which the environment is created, managed, and manipulated. The differences will be explained in full detail in the "Experience Implementing Labs" section of this paper.

Amazon Web Services

Introduction

Amazon Web Services (AWS) is a multinational company with facilities located around the world. Their headquarters are located in Seattle, Washington. Amazon Web Services (AWS) offers a highly reliable, scalable, low-cost IT infrastructure in a cloud environment for organizations to run their computing resources. The benefits of AWS include: low cost, pay-as-you-go pricing with no up-front expenses or long-term commitments; agility and instant elasticity to quickly innovate and experiment, grow and scale down based on demand; open and

flexible, which provides an agnostic platform that makes the most sense for an organization, and the security with industry-recognized certifications and audits (“About AWS”). AWS costs are based on the number of servers the business/University will need to run, storage utilized, and the number of hours per month the servers operate. AWS also charges for information that is transferred in or out. (See Table 1 for cloud service cost comparison details.)

How it Works

As with Skytap and CloudShare ProPlus, AWS allows users to create environments and load machine images from pre-configured templates from the service provider. The templates are stored in an image library for the user to easily access. The differences are in the interface in which the environment is created, managed, and manipulated. The differences will be explained in full detail in the “Experience Implementing Labs” section of this paper. It is important to note that users can upload their own virtual machine images. In AWS, the user has access to all the functionality but not all of the functionality pertains to needs for a distance lab environment, i.e., instruction or training on a virtual desktop.

AWS in Education

Educational institutions are leveraging AWS to deliver advanced courses, tackle research endeavors, and explore new IT projects using Cloud-based infrastructure services. The AWS in Education Program allows educators, academic researchers, and students to obtain free usage credits to tap into the on-demand infrastructure of the AWS Cloud.

> Teaching Grants will enable usage of AWS infrastructure services for coursework and student projects. AWS services supported in the grants include Amazon EC2, Amazon S3, Amazon SimpleDB, Amazon RDS, Amazon SQS, Amazon CloudFront and Amazon Elastic MapReduce. Cluster GPU Instances for Amazon EC2 are only available for grant

recipients on a limited basis by written consent of the program administrator ("AWS in Education").

A Private Cloud in Education

We learned that there are schools using distance labs for many purposes and some have implemented their own private clouds hosted on their own network and on campus. The colleges and universities that we found employing a private cloud in one form or another are: North Carolina State University, North Carolina Central, George Mason, Georgia State, and California State University - Fullerton. (See Appendix C for these University sources.)

Although there are a few ways to implement a private cloud, in this section we primarily focus on the IBM Virtual Computing Initiative (VCL). This initiative has been around the longest and there was more information available on the Internet. We begin by defining a Private Cloud and then introducing the IBM Virtual Computing Initiative and how it began with North Carolina State.

What is a Private Cloud?

According to NIST, "The cloud infrastructure is provisioned for exclusive use by a single organization comprising multiple consumers (e.g., business units). It may be owned, managed, and operated by the organization, a third party, or some combination of them, and it may exist on or off premises" (Grance). Why build a private cloud in an educational institution? The two main reasons why colleges and universities are building private clouds in their own data centers is because IT Departments want to have control over the universities' data and at the same time be certain of their own security measures.

IBM Virtual Computing Initiative: A Private Cloud

A possible alternative to subscribing to a public cloud service, such as CloudShare ProPlus, Skytap, or AWS, is hosting a private cloud in-house, on-campus and in La Salle's own data center. The IBM Virtual Computing Initiative is a Virtual Computing Lab (VCL) is an in-house private cloud project that has been around for a decade. This project is supported by IBM and made available as a free, hardware-agnostic Apache open source project. North Carolina State University (NCSU) was the first school to implement the IBM virtual computing lab and there are a growing number of schools that have adopted it.

What is Virtual Computing Lab (VCL)?

Virtual Computing Laboratory (VCL) is an open source implementation of a secure on-demand service oriented technology used to dynamically provision and broker remote access to a virtual computing environment for an end-user (Mladen 1). Physical resources of the VCL system are typically housed in a data center and may be physical blade servers, traditional tower and rack mounted servers, or virtual machines. Additionally, the VCL system can broker access to physical computers such as those housed in a University's computer lab (Apache 1).

Operation of the Virtual Computing Lab began in 2004 at the North Carolina State University. The VCL project began as a joint effort between the University's departments of Information Technology & Engineering Computer Services and the High Performance Computing team of Office of Information Technology to address a growing set of computational needs and user requirements. The objective was to implement a service to enable students to use their own machines, login through the Web, select an image of a machine to work on and proceed with their work. North Carolina's Virtual Computing Lab provides both faculty and students access to physical and virtualized desktops, servers and services, and high-performance

computing resources, which would be difficult or impossible to run on end-user computing devices due to physical memory, CPU, and storage restraints as well as vendor licensing restrictions (Sam 1). By 2008, the VCL computing environment at North Carolina State was serving a population of more than 30,000 students and faculty (Mladen 1). In 2008, the NCSU donated the VCL source code to the Apache Software Foundation to expand its use and development. VCL pilot programs have sprung up across the state of North Carolina at many University campuses, the North Carolina Community College System, as well as many of out-of-state universities – most of which are members of the IBM Virtual Computing Initiative.

The IBM Virtual Computing Initiative provides support to educational institutions that are interested in deploying a VCL environment. In 2008, the North Carolina State University and IBM announced plans to provide every student in the state of North Carolina with access to advance resources provided by North Carolina State's Virtual Computing Lab (IBM 1). Students across the state of North Carolina, including K-12 schools and colleges, and the University of North Carolina would have access to educational materials, software applications, and computing and storage resources.

Users access the VCL environment through a web portal. Upon logging in to the portal, users are presented with a menu from which they can select a combination of applications, operating systems, and services they need. If the selected combination is not already available as an "image", an authorized user can construct a new "image" from the VCL library components. VCL manager takes the user's request, maps it to available software application images and hardware resources, and then schedules it for either immediate use or for later use (Averitt 2). The method of access to the constructed environment by the end-user depends on the types of resources they have requested. Access methods include Remote Desktop Protocol (RDP) Virtual

Network Computing (VNC) an ssh-based or X-Win access to a Linux service, web-based access, proxy access to a computational cluster (Mladen 3).

The VCL infrastructure is made up of three levels: a web server, a database server, and one or more management nodes (Peeler 1). VCL's architecture is comprised of four components, an end-user access interface, a resource manager, an image repository, and computational, storage and networking hardware (Mladen 2).

VCL Infrastructure

Web Server:

Software components consist of Linux Operating System, Apache web server, and PHP scripting language. Tools provided by the web server application permit users to request, manage and govern all resources of the VCL system (Peeler 1).

Database:

The database role consists of a server running a Linux operating system and MYSQL database management system. The database stores all data related to VCL reservations, system security access controls and an inventory of available machines and environments, and system logs (Peeler 1).

Managements Node(s):

The management node consists of a server class machine running a Linux operating system and the VCL application code, and an image library (Peeler 1). The primary function of the Management node is controlling access to a subset of VCL resources. Resources consist of blade servers, virtual machines, or standalone machines. Physical computers within the VCL resource pool can be running in a base metal environment or a Virtual Machine hypervisor. Supported commercial hypervisors include VMware vSphere, Windows Hyper-V, and Citrix XenServer.

Supported Open source hypervisors include KVM and Xen (Peeler 1). Xen powers public cloud and hosting services, such as Amazon Web Services and Rackspace Hosting and Linode (Xen 1). There can be anywhere between 80-120 physical computer nodes under the direction of a single management node. Multiple management nodes can be utilized for purposes of system scalability and service availability (Peeler 1). The VCL code running on the management node processes reservations and jobs assigned through the VCL web portal. Its primary purpose is making sure that the requested environment is loaded and available for the requesting user. An environment can consist of bare-metal hardware such as a blade server or rack mount server, a lab machine, or a pre-configured virtual machine image.

EDUCAUSE

Shaping the Higher Education Cloud: Is a Higher Education Cloud a Reality

EDUCAUSE describes how colleges and universities are considering forming a consortium to obtain a cloud broker to help cut the costs of subscribing to vendor services and to also bargain for the best services. EDUCAUSE and National Association of College and University Business Officers (NACUBO),[1] being respected organizations and committed to advancing higher education, gathered approximately 50 leaders from higher education to conduct a two-day workshop in May of 2010. This workshop was conducted and led by Diana Oblinger, President and CEO of EDUCAUSE and John Walda, President and CEO of NACUBO. The theme of the workshop was how virtualization and cloud computing are assuming a place in the IT landscape and how can higher education get onboard. There were common concerns such as:

[1] See About NACUBO, a resource for financial management of higher education: http://www.nacubo.org/About_NACUBO/Strategic_Plan_and_Bylaws.html

which cloud opportunities make the most sense; the criteria for selecting providers; and how to alleviate the risk of third-party handling of sensitive information.

The key interest centered on forming a consortium and finding a higher education broker to bring together all the different offerings to be able to maximize the benefits of cloud computing. It was recommended that

> EDUCAUSE and NACUBO [as organizations] take action to educate their members about the emerging opportunities and risks, to clarify issues related to cloud computing, and to provide members with tools to make informed campus sourcing decisions. Participants asked EDUCAUSE, Internet2 [also present], and NACUBO to convene a Task Group to evaluate the possibility and issues of creating or otherwise facilitating an entity that would aggregate demand for and supply of services on behalf of higher education (Hignite).

Sloan-Consortium

Sloan Consortium: Five Pillars[2]

Many educators are already aware of the effective practices learned from the individuals, institutions and organizations that are members of the Sloan Consortium. Sloan-C's primary commitment is to quality online education. Frank Mayadas, president of Sloan-C, "notes that all institutions offering online learning should focus on quality in five inter-related areas of learning: learning effectiveness, access, scale (capacity enrollment achieved through cost-effectiveness and institutional commitment), faculty satisfaction, and student satisfaction." These five pillars are known as Sloan-C's Five Pillars of Quality in Online Education and are the "building blocks which provide the support for successful online learning" (Sloane). Being able to offer a distance

[2] See Five Pillars of Quality Online Education – an excellent resource for Design, Evaluation, and Marketing of quality online courses. http://sloanconsortium.org/5pillars

lab environment for students at La Salle will satisfy all five pillars established by the Sloan Consortium.

Learning Effectiveness

There are many online environments that present unique active learning experiences for students. Instructors can take advantage of these environments. Providing a hands-on experience in a distance lab for students can enhance the effectiveness of the education by having an engaging learning space online and by making the active learning more convenient for both educators and students. According to Janet C. Moore, Chief Knowledge Officer at Sloan-C, "when relevant, active interaction with content enables learners to apply skills and concepts [they are learning]. Technology [the distance learning lab] offers options for simulations, online labs, and collaborations that support active learning." (100).

Scale (Cost Effectiveness and Commitment)

According to the Five Pillars of Quality Online Education, "Scale enables institutions to offer their best educational value to learners and to achieve capacity enrollment. Scale in online education is often a reflection of institutional commitment to providing quality online, so that online education achieves outcomes that are at least equivalent to outcomes achieved in other delivery modes in ways that are affordable for providers and for learners" (Moore 101). Having technology and program scalability supports La Salle's mission to continuously improve educational services while reducing costs. Having a computing lab available online would remove the constraints of managing a computer lab for the IT staff and remove the costs of maintaining a physical lab.

Access

Currently, with the ECF courses being limited to a local geographic area, La Salle University is not able to reach a wider student market because the students are required to go on-campus for the lab component of the courses. By having a hands-on distance lab La Salle University could open up the market for students from all over the nation and quite possibly open up international markets.

Faculty Satisfaction

According to Moore, instructors want to find the online teaching experience "personally rewarding and professionally beneficial" (109). With a distance lab faculty can offer an opportunity to extend an interactive learning opportunity to a variety of students while enhancing their learning experience.

Student Satisfaction

Providing a distance lab environment for students would provide an enriching learning experience that is part of La Salle's online program goals.

Possible Cloud Solutions

In this next section we have identified reasons that it is likely for La Salle to subscribe to a public service cloud provider and less likely to go with an in-house private cloud (See Fig. 1).

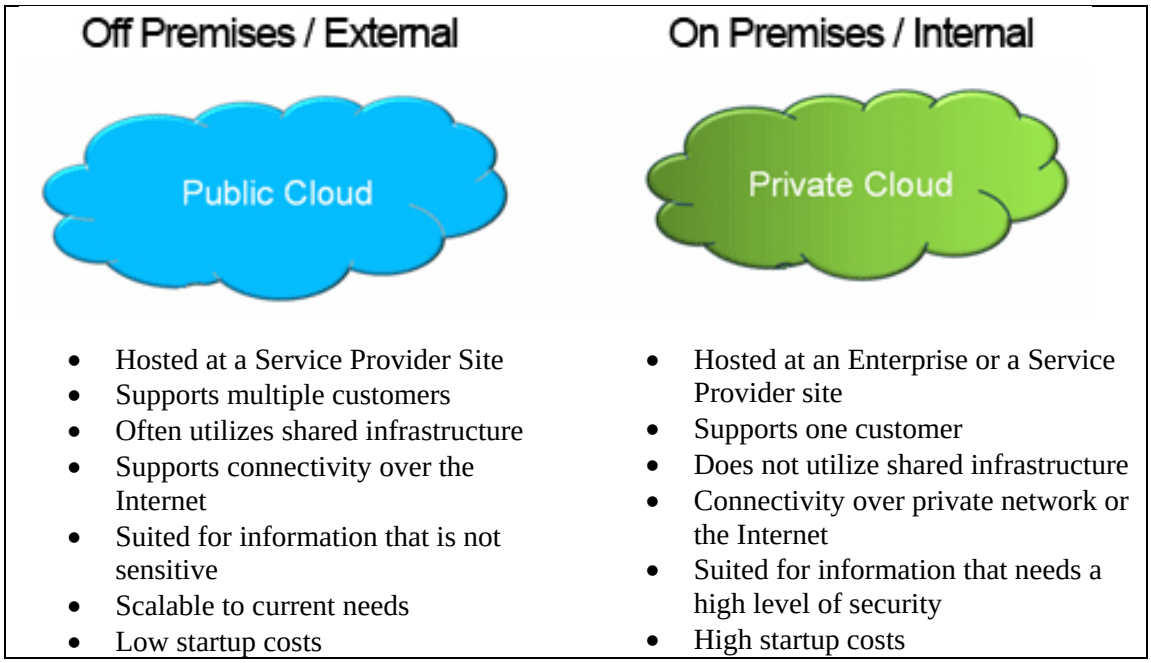

Fig. 1. Public Cloud or Private Cloud (**Source:** Cloud Storage Strategy)

In-house Private Cloud

Because of the high initial costs of implementing an in-house private cloud, due to expense related to purchasing the required hardware (servers, storage and networking components) and operating software, and because there are only a few computing courses currently candidates to use a distance lab for students, it is less likely that La Salle would choose an in-house private cloud. La Salle's IT Department would need to consider the initial start-up costs of the physical hardware and virtualization software and to project the maintenance cost and the staffing it takes to implement a private cloud. Also, chances are that the computing power will be shared in some way so that the academic units and administrative units could be competing for the same computing power.

Public Cloud Service Provider

With a public cloud service you do not need to purchase any physical resources, such as hardware, virtualization and operating systems software, and most likely not any licensing either because La Salle has their own licensing agreements with Microsoft for the Microsoft

environments. With the cloud service the value added is scalability. The subscriber can order what is needed as the program expands as well as scale up and buy additional resources, computing power, networking and storage. If La Salle subscribes to a public cloud service, resources and services can be scaled up or down based on the computing needs of the ECF courses. As a result, La Salle will only need to pay for the resources being utilized. In contrast, if La Salle chooses to build its own private cloud they must scale their virtualization infrastructure to meet the demands for the busiest times of the academic year; which could lead to unused resources during slower times of the year.

From Users to Choosers

At La Salle University, the Information Technology (IT) Unit is responsible for administrative and academic computing needs/processes. The Academic side needs to have some computing flexibility for the students they are teaching. While an IT Unit is responsible for both the administrative needs and academic needs of the institution, the Academic Unit is responsible for just the pedagogical needs of the institution and public cloud computing would help to address their individual needs (Yanosky 126). If La Salle builds a private cloud on the school's existing infrastructure it would require close monitoring from the IT Unit for security and privacy issues therefore adding more responsibility to the IT Unit's computing load. For the Academic Unit, having such close monitoring may not be the most favorable situation because there may be limitations on what they would need to do. For example, if IT could not provide the software and the support for the students in the private cloud environment, then the course, the professor, and the students may not be able to satisfy the requirement that is essential for the students to learn. Another example is that it is risky to have students running lab scenarios on a server in a production environment. If the student takes the server down then everything else on that server

goes down. With a public cloud, a distance lab would run in an environment separate from La Salle University's infrastructure.

Experience Using the Public Cloud Services

We implemented the labs for two of the ECF courses: ECF 619: LAN Administration and ECF 644: Data Security Technologies. We were hoping to implement labs for ECF 604: The Computer and Internet Fraud but due to the time involved to become familiar with the services and running the labs we were not able to. For the lab assignments that we were able to run, we utilized both wireless and hard-wired desktops and laptops running Windows XP, Windows 7, and Mac OS X operating systems; and utilized various browsers: Internet Explorer, Safari, and Google Chrome.

CloudShare ProPlus

CloudShare has two versions, ProPlus and Enterprise. After speaking with CloudShare and reading about the product, we felt that ProPlus would be a good place to start. CloudShare offered a 14-day free trial for its ProPlus version and had the features and functionality built into it that would enable us to demonstrate that CloudShare ProPlus could be a viable solution for La Salle University.

All CloudShare ProPlus management functions are performed through its web portal (See Fig. 2). The portal itself is intuitive and extremely user friendly. One of the features we found to be most helpful was CloudShare ProPlus's context aware help menu. As we navigated through each of the areas of the portal, or selected a task within it, the questions within the help menu

changed. When an item within the menu was selected, the link opened to a detailed answer to the question.

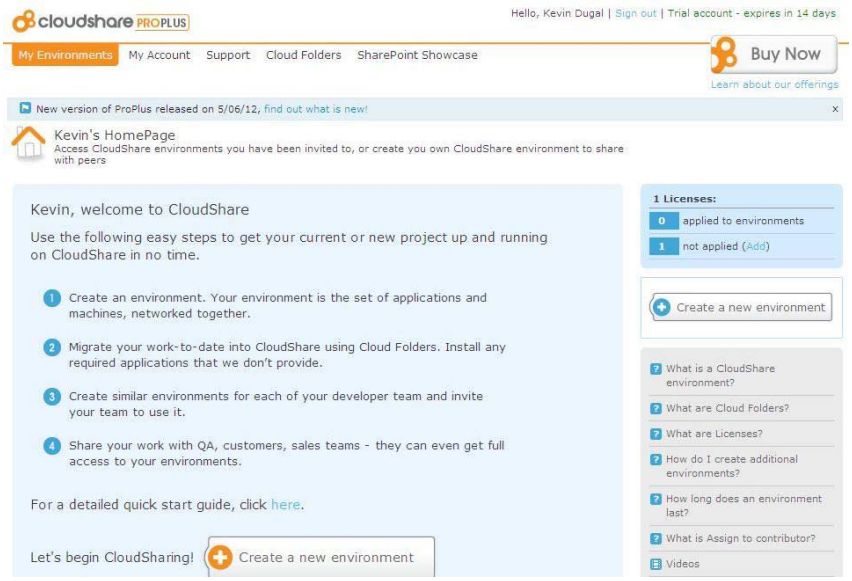

Fig. 2. CloudShare ProPlus Web Portal

To begin using CloudShare ProPlus an environment must be configured. Environments consist of virtual machines (VMs), storage, and the necessary networking components to link VMs together. With each licensed instance of CloudShare ProPlus, users are allotted 10 GB RAM, 10 CPUs, and 300 GB of storage which can be used to build one environment comprised of up to ten 1CPU/1GB-RAM virtual machines. If more resources are needed for an environment, additional licenses can be purchased. If multiple CloudShare ProPlus environments are required, CloudShare Enterprise may be a better fit. Adding a VM to an environment is a very easy task using CloudShare ProPlus's library of pre-configured VMs, which CloudShare calls templates. CloudShare ProPlus's library consists of over 30 different templates that have been pre-loaded with operating systems such as Microsoft Server 2008 R2, Windows 7 Pro, Xubunto and applications such as Oracle 11g, Microsoft SharePoint, and Microsoft SQL. All operating systems

and applications come fully licensed. In addition, CloudShare ProPlus offers a feature they call VM import. With VM Import, users of CloudShare ProPlus can upload their own VMs. CloudShare ProPlus supports two VM file formats, Open Virtualization Format (OVF) and Open Virtualization Alliance (OVA). Virtual machines created by VMware, VirtualBox, and Kernel-based Virtual Machine (KVM) Hypervisors provide support for these two file formats. After a Virtual Machine has been loaded into an Environment, it is possible to edit the number of CPUs, disk space, and memory it contains.

Restrictions applied are based on the guest operating system and available CloudShare ProPlus resources, which is determined by your license agreement with CloudShare. There are no time-based restrictions for CloudShare ProPlus. Users can connect to CloudShare ProPlus as often and for as long as they choose. However, if CloudShare ProPlus detects that a user has disconnected from an environment or if CloudShare ProPlus determines there hasn't been any activity on any of the VMs in the environment for a period of 60 minutes, CloudShare ProPlus will suspend the environment. When an environment is suspended, everything is saved and stored. Even unsaved changes to an open document will be available to the user. The time-to-suspend period can be extended to 180 minutes at no extra cost. For an annual fee of $599, it can be extended indefinitely.

Once an environment has been configured, it is a good idea to take a snapshot of it. A snapshot takes a picture of the environment just as it appears at that moment in time. All virtual machines within an environment, VM configuration, and installed applications, as well as any user-generated data stored on the VMs are captured in the snapshot. Snapshots allow the user to rollback to a known good configuration in the event that an unforeseen configuration change is made. In addition, taking a snapshot will allow the user to share an environment with others. An

environment can be shared with others in one of two ways an invitation or a “Permalink.” When an invitation is created, a URL to the users’ environment is emailed to the person(s) the user is inviting to share the environment with. From this URL, the invited person(s) will have the option to incorporate the snapshot into their environment. The invited person(s) will have full access to the environment and the resources (VMs, applications, and data) that it contains. Changes made by the user will not affect the environment, nor will the chages affect any other person(s)’ environment that received the same invitation to share. The second way to share your environment is via a “Permalink”. Each time a Permalink is accessed, an independent, separate copy of the environment will be made available to another person(s) for viewing, testing, and editing without affecting the original users’ environment.

Our CloudShare ProPlus environment consisted of two virtual machines, a Windows 7 Pro VM and a Windows Server 2008 VM. We chose our VMs from CloudShare ProPlus’s template library. The process was very simple. We selected the template representing the host operating system we wanted to work with, gave it a user-friendly name, and chose “Add This Machine.” Once both templates were added, we saved our configuration. CloudShare ProPlus then started building the virtual machines and added them to our environment. The entire process took less than ten minutes.

Once our environment was built, we needed to access it so we could begin running the labs through and evaluating CloudShare ProPlus’s functionality. CloudShare ProPlus provides two access methods, (1) CloudShare ProPlus Console and Remote Desktop Protocol (RDP) for Windows-based VMs, and (2) CloudShare ProPlus Console and Secure Shell (SSH) for Linux-based VMs. Both access methods can be performed through CloudShare ProPlus’s web portal. In addition, CloudShare ProPlus provides an external address per VM. An RDP client can be

configured with this address to allow access to the VM independent of the web portal. We utilized CloudShare ProPlus Console and RDP access through the portal and, at times, the RDP client running on our computers for our evaluation; all three access methods worked well to access CloudShare ProPlus's cloud services.

Skytap

Skytap's management portal (See Fig. 3) is completely web-based. It provides all the functionality required to create, share, manage, and monitor a cloud-based instructional environment. If a user is new to Skytap and/or needs help, a "Help Topics" area is located on the main page of the management portal that links to a "Getting Started" page. This page provides information on all of Skytap's features that the user would need to use to create, share, manage, and monitor an environment. The "Quick Start Guide" is sufficiently helpful in the beginning stages of constructing a virtual environment.

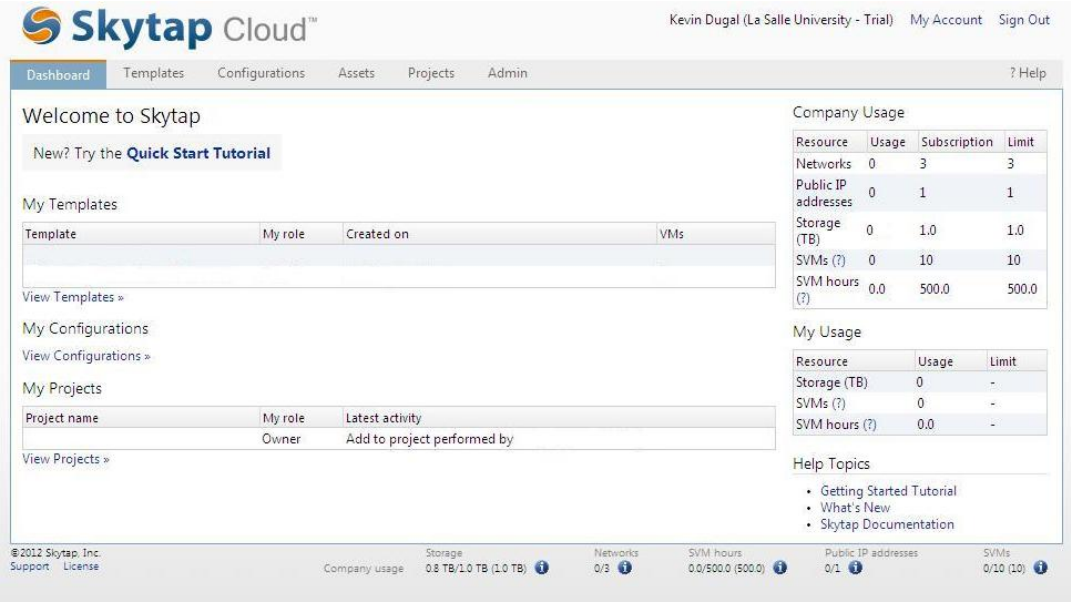

Fig. 3. Skytap Management Portal

Skytap resources are broken down into a number of VMs, VM hours, and available storage – SVM stands for Skytap Virtual Machine. For our evaluation, Skytap provided us with 10 SVMs, 500 SVM hours, 1 TB of storage, 3 networks, and 1 public IP address. SVM resources are assigned to an account, the amount of which is based on your subscription. The availability and usage of SVMs, as well as other resources (configurations, templates, and assets) within Skytap, is controlled through the assignment of the quotas to the organization's Skytap users. Additional SVM resources can be hard-set, or overages may be permitted -- all of which are controlled through the management portal.

To get started using Skytap, a configuration must be created. A configuration consists of one or more virtual machines and one or more networks. The process of creating a configuration is fairly straightforward, especially with the help of Skytap's "Quick Start Guide." The first step is choosing a template. Templates are read-only blueprints of a configuration that can be a single virtual machine (VM) or multiple VMs and networks. From the management console, the templates page provides a listing of all templates in Skytap. It is possible to create your own templates from a configuration or from a VM that has been uploaded to Skytap. Only VMs in a VMware VMX/VMDK or OVK/VMDK format are supported (Skytap). VMware is supported. Skytap's image library contains over 100 available templates containing configurations of numerous Microsoft products such as Server 2008 R2, Windows 7 Pro, as well as a number of Linux versions such as Xubunto and Red Hat Enterprise Linux.

Skytap's licensing model is a "bring-your-own" model. Some Windows VMs (including Windows 7 and 2008 R2) will allow you to use your own applications and operating system for a predetermined period of time. In the environments we created, we were able to use Windows 7 and Server 2008 R2 without any problems. However, we were notified that the version of

Windows we were using was not genuine. We asked Professor Pasquale if La Salle University's Microsoft licensing agreement would allow us to utilize their license keys in a virtualized environment such as Skytap's. Based on what Professor Pasquale told us, we believe La Salle University could do so, but we feel that a conversation between La Salle University and Microsoft should take place if Skytap is pursued as a solution.

Once a template has been selected from the library, the next step is to select the "Create Configuration" button. When the initial configuration has been created, it is possible to add additional VMs and networks to it. Adding additional networks is particularly useful if you intend on adding more than one network card to a VM. Additionally, it is also possible to edit individual VM hardware settings. Changes, such as adding an additional network card and attaching it to a new network or linking it to a public IP address, publishing services (such as SMTP, Web, and RDP), adding CPUs and RAM, resizing a disk, even adding a new disk, are all possible.

Before an additional user starts working in the original user's configuration, or grants another access to it, it's a good idea to create a backup. This will allow the additional user to roll back to a known-good configuration in the event there are changes to the configuration that have unforeseen consequences. This is possible using the "Save as Template" function that is available when viewing a configurations settings. Users can save as many templates as needed. The only limitation is the amount of remaining storage on the account.

Our Skytap configuration consisted of two virtual machines -- a Windows 7 Pro VM and a Windows Server 2008 VM. We chose our VMs from Skytap's template library. The process was very simple. We selected the template representing the host operating system we wanted to work with, gave it a user-friendly name, and chose "Add This Machine." Once both templates were

added, we saved our configuration. Skytap then started building the virtual machines and added them to our environment. The entire process took less than ten minutes.

After our environment was built, we needed to access it so we could begin running and evaluating Skytap's functionality. Skytap provides four types of access to a configuration and/or VM: Skytap Remote Access (from portal), Published URL for Windows and Linux-based VMs, Remote Desktop Protocol (RDP) for Windows-based VMs, and Secure Shell (SSH) for Linux-based VMs. A Published URL is a web link to an environment. The URL may be password protected. Using a browser, users can connect to a configuration and interact with it, even make changes to it. Depending on the settings defined in the configuration, users may also have the ability to start VMs within a configuration even after they have been suspended. We utilized Skytap Remote Access and Published URLs to access our environments.

Amazon Web Services (AWS)

Amazon Web Services management functions are performed through a web service console much like CloudShare ProPlus's and Skytap's. However, unlike their consoles, the AWS Management Console can be a little overwhelming to new users because of the additional services that AWS offers. In total, over twenty different services can be managed through the AWS Management Console (See Fig. 5). As a user navigates through each of the services, users will start to see a common theme. On each service's main page, users will notice a functional dashboard to the left, a quick start guide in the center, a resources section in the upper-right corner, and a link to the services getting started guides in the lower right corner. The "Getting started guides" are very helpful. They provide step-by-step instructions to common tasks that can be performed, as well as detailed descriptions on what the service does. However, for

instructional purposes, if the trainee/student has instructions on what to do from the instructor there should be no problem.

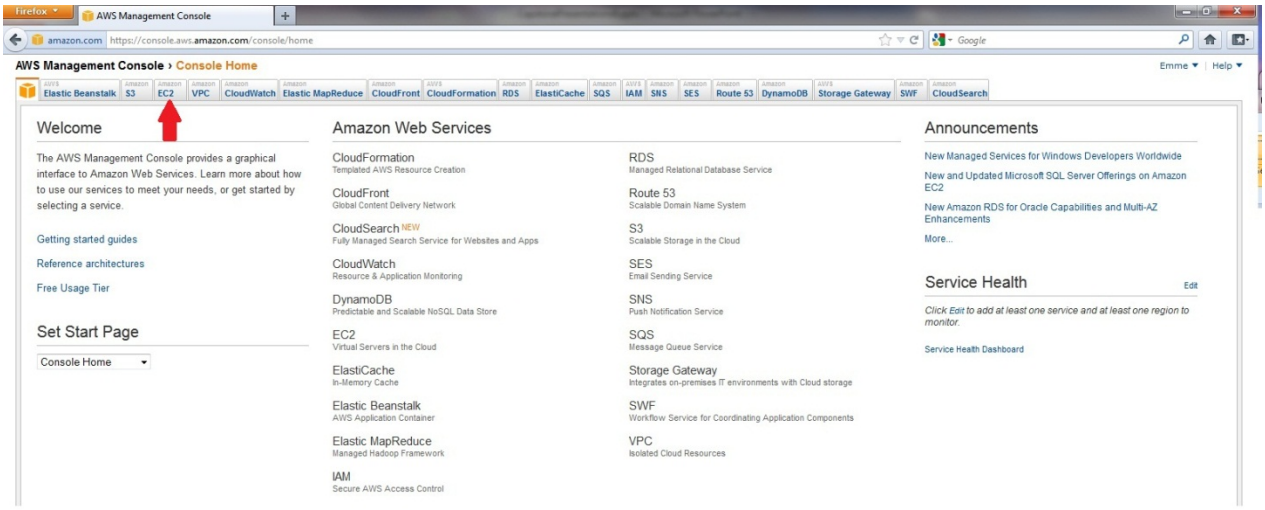

Fig. 5. AWS Management Console

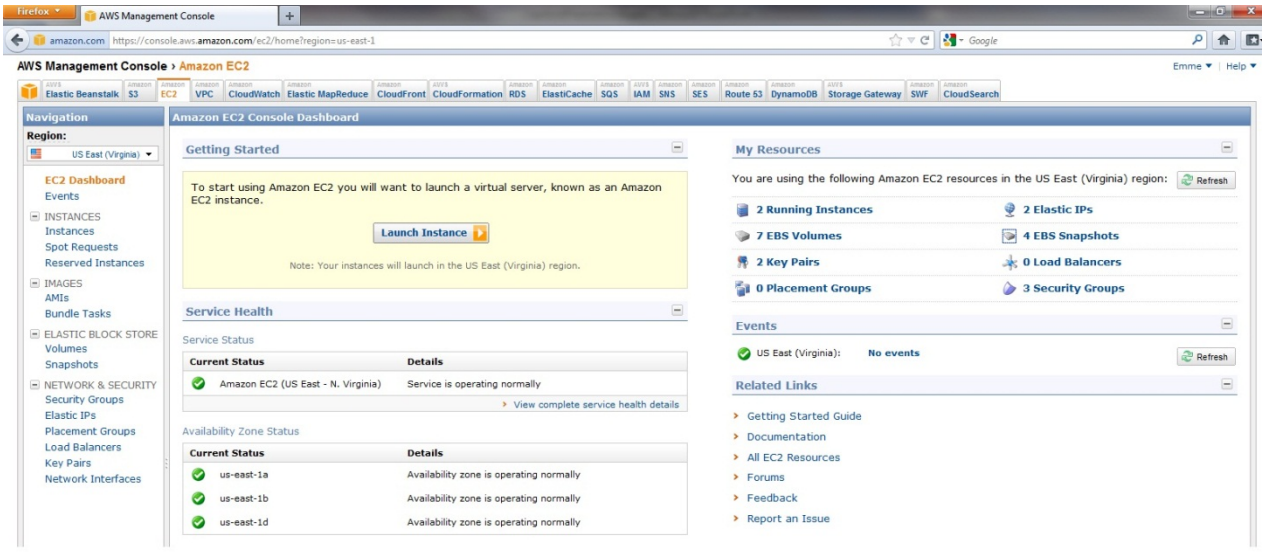

Fig. 6. Amazon Services EC2 Console

To construct our testing environment using AWS, we utilized Amazon Elastic Cloud (EC2) service (See Fig. 6). Amazon Elastic Cloud provides a pay-as-you-go computing power pricing model, and the ability to construct virtual machines. Amazon Virtual Private Cloud allows the user to define a virtual network topology resembling a traditional network. Our environment consisted of virtual machines running Windows Server 2008. Amazon refers to virtual machines running in their AWS environment as Amazon Machine Images (AMI). Amazon Web Services does not provide support for client operating systems such as Windows 7 and Windows XP. From what we learned from Amazon's website, they only offer server-based operating systems such as Red Hat Enterprise Linux, SUSE Linux Enterprise Server, Ubunto Server, and Microsoft Server 2008 and 2003. This would not limit our ability to fairly evaluate Amazon Web Service's functionality. Amazon does mention support for additional AMI operating systems in the future, however they do not say which operating systems will be supported or when they will become available. Similar to CloudShare ProPlus and Skytap, Amazon Web Services also provides a mechanism for users to upload their own virtual machines into Amazon's cloud service. Supported Windows-based VMs include those created with VMware, Citrix, and Microsoft's Hyper V. There is no support for client operating systems, such as Windows 7 and XP, at this time.

Creating a virtual machine, known as an "instance," is a fairly straightforward process. From the AWS Elastic Cloud page, a "Launch Instance" button provides the user with a wizard, which takes them through the process of creating an instance. After invoking the wizard, the user must choose Amazon Machine Image from the list of available images. As stated earlier, we chose Microsoft Windows Server 2008 images. Users have the option of a 64 and a 32 bit operating system; we chose 64 bit. Once on the next screen, users can choose the number of

instances they wish to create, the instance type, and how charges will be calculated – by the hour or for a predefined period of time; instance types are measured by the number of CPUs and the amount of memory they contain. We chose a Micro instance, which equals 2 ECUs, each being equivalent to 1 Core, and 613 MB of system Memory. In addition, the AMI (MS Server 2008) that we chose had a total storage capacity of 30 GB. Additional storage can be added to an AMI as needed. We were not required to do so for our testing purposes.

The next screen provides users with the ability to choose advanced options and whether or not to enable CloudWatch monitoring services. On the following screen, users are given the option to specify an existing key pair or create a new key pair. Key pairs allow users to securely connect to an instance after it launches. We set up a key pair. On the next configuration screen, users choose a security group or create a new group to assign their instance to. Security groups control access to an instance by opening or blocking network ports, similar to how a firewall operates. Our security group was configured to allow communication between all AMIs in our environment. In addition, we created a rule that permitted connections to our AMIs using Remote Desktop Services.

The final screen displays a summary of the chosen options that can be reviewed and edited before the requests are committed, at which time AWS will begin creating the instance/virtual machine. The entire process of creating virtual machines takes less than 15 minutes. It is a good practice to take a snapshot of the environment. With Amazon a user can take multiple snap-shots of the environment, therefore ending up with multiple snap-shots, which we are noting that satisfies one of the most essential ECF course requirements. This back-up process is similar to Skytap's function but unlike CloudShare ProPlus because CloudShare does not allow the user to save more than one snapshot at a time. The advantage of being able to save multiple snap-shots is

if there is a need to go back to a previous snapshot the user can. Skytap works the same way, however CloudShare ProPlus is different because the user can only save the last snapshot.

With our environment configured, we could begin testing the functionality of AWS as it pertains to our system requirements. To access an AWS virtual machine, AWS provides two options, Remote Desktop Protocol for Windows-based AMIs and secure shell (SSH) for Linux-based AMIs. Connection details such as public DNS address and authentication credentials are acquired from the AWS Management Console. To make connecting to our environment easier, we configured RDP connection files for each of our virtual machines and saved them to our desktops.

Similarities of Public Cloud Services

The first thing we noticed after logging into our virtual machine was its familiarity; after logging into a virtual machine running Windows 7 the interface looked just like a desktop computer running Windows 7. It did not matter which cloud service we were using, CloudShare ProPlus, Skytap, or AWS, everything looked and behaved just as it would have if we were sitting in front of the physical machine. All the icons and toolbars on the desktop, the applications on the Windows Start Menu, and the devices installed on the computer looked the same, regardless of the operating system running on the virtual machine.

Differences of Public Cloud Services

We did notice network latency issues in some of our environments. This was true when the cloud service's web-console was used to access its virtual machines. Only CloudShare ProPlus and Skytap provide this ability. When an RDP client was utilized, we did not experience these issues. The same is true for Published URLs, which are a feature of Skytap. Even still, the connection methods provided by each of the cloud service vendors we evaluated proved to be more than satisfactory.

Lab Implementations and Successes

Windows Account Management Lab

We have chosen several labs that will demonstrate that having a distance lab for our students is possible and notably successful. First, we chose a lab assignment that we designed ourselves, Windows Account Management. We felt it was important to show how cloud-based services could be used to demonstrate common network administration tasks commonly performed in a production environment.

The installation of Active Directory (AD) for Windows Account Management in our test environments proceeded as expected. We were prompted for information relevant to a typical AD installation, such as a name for our new domain, and installation paths for AD directories. Since a DNS service was not already installed in our environment prior to AD setup, we were prompted to do so during installation. It's important to note that CloudShare ProPlus had a prebuilt template for Windows Server 2008 with Active Directory, but we felt it was necessary to install Active Directory in its entirety. After the installation was completed, we performed basic network administration tasks such as creating shared folders, and assigning permissions to allow users to

save documents in what could be a secure location – versus the user's desktop. We setup and configured network accounts, specified home folder paths and assigned the users to a group that we created. The group was given access to the directories that were created. Within both our CloudShare ProPlus and Skytap environments, we joined a Windows 7 computer account to our Active Directory domain. Because Amazon Web Services does not provide Windows 7 machines, we substituted with a Windows Server 2008 machine. After everything was setup, we verified our work. We did so by logging into the Windows 7 and Server 2008 machines with an AD account we setup. We tested the creation of a home folder and our ability to save documents to it. We also mapped a network drive to a shared network folder and performed file save/modify/delete tasks within the folder. This lab was completed successfully in each of the cloud services' environments.

NAT Lab

A second lab that we completed within our testing environments was named Lab 6 NAT from Network Administration. This lab demonstrates the ability to share one Internet connection among many client devices using a service called Network Address Translation (NAT). To complete the lab, we needed to install a service called Routing & Remote Access (RRAS) with support for NAT on our virtual machine running Windows Server 2008. This task was easily accomplished in each of our three cloud services' environments. In addition to the software requirements we also were required to install and configure a second network interface card (NIC) into the same virtual machine. To perform this task, we needed to install a software application called USB 2.0 to Fast Ethernet onto the server. The software did not function as expected in any of our environments. After reading about some of the added functionality Skytap provided, we determined that it would be possible to install a virtual NIC into our server running

in Skytap. Doing so allowed us to successfully complete and test the configuration of our Skytap environment. Unfortunately, CloudShare ProPlus and Amazon Web Services do not provide the same functionality as Skytap. It is our understanding that CloudShare Enterprise provides this added functionality but we were unable to evaluate it.

Password Snooping Lab

A third lab that we chose to evaluate in our testing environments was named Password Snooping. This lab assignment was another lab that we designed ourselves. To perform the lab, a computer attached to a network and an application named Wireshark are required. Wireshark is a free product that can be downloaded from the Internet. Wireshark allows a user to capture data as it moves through a network; the data can be viewed while using Wireshark providing the data has not been encrypted. We were able to successfully install the software onto each of virtual machines in our testing environment. To test the functionality of Wireshark within our environments, we attempted to authenticate to a website while the software was capturing data being transmitted and received by the virtual machine's network card. Upon capturing the data, we were able to locate and read the unencrypted username and password within it. We were successful within each of the cloud services environments.

Comparison Tables

Cloud Services

The Cloud Service Product Comparisons Table (See Table. 2) is a comparison of Amazon Web Services (AWS), CloudShare ProPlus, and Skytap Public Cloud service providers. This table provides a company overview, a comparison of supported Virtual Machine (VM) operating systems and client device operating systems, and a comparison of the relative features and the

functionality of each public cloud service. Most importantly, this table shows the results of the Network Administration and Information Security labs that were run through each of these public cloud services (See Table 2).

	CloudShare ProPlus	Skytap	Amazon (AWS)
Company Overview:			
Country of Origin	Israel	United States	United States
Headquarters	San Mateo, California	Seattle, Washington	Seattle, Washington
Founding Year	2007	2006	AWS 2002 and EC2 2006
Stock	Privately Traded	Privately Traded	Publically Traded
Supported VM Operating Systems:			
Windows Server	Yes	Yes	Yes
Windows Desktop	Yes	Yes	No
Linux Server	Yes	Yes	Yes
Linux Desktop	Yes	Yes	No
Supported End-User Client Devices:			
Microsoft	Yes	Yes	Yes
Apple	Yes	Yes	Yes
Linux	Yes	Yes	Yes
iOS	Yes	Yes	Yes
Android	Yes	Yes	Yes
Features:			
VM Operating System Licensing	Included	Not included	Included
Support for Third-Party Software	Yes	Yes	Yes
Local File Storage (Persistent)	Yes	Yes	Yes
Support for Multiple Network Cards	No	Yes	No
Multi-User Access to Environments and VMs	Yes	Yes	Yes
User Resource (VMs, storage, time) Quotas	No	Yes	No
Technical Support - Basic (free)	Technical FAQs, Forum and Email	Technical FAQs, Forum and Email	Technical FAQs and Forum
Technical Support – Premium (fee)	No	No	All of the above, Email and Phone
Functionality:			
File Transfer between VMs	Yes	Yes	Yes
File Transfer between VM and Client Device	Yes	Yes	Yes
Internet Access from VMs	Yes	Yes	Yes
Share Environments and VMs	Yes	Yes	Yes

	CloudShare ProPlus	Skytap	Amazon (AWS)
Virtual Machine Import	Yes	Yes	Yes
Virtual Machine Export	No	Yes	Yes
Connection Methods:			
Console	HTTPS	HTTPS	HTTPS
Environment	HTTPS and RDP	HTTPS	RDP and SSH
Data Center Telco Facility Overview:			
Data Centers	1	2	8
Data Center location in the US	Florida	Chicago and Washington	Virginia, Oregon and California
Telco Facility Certification	Not available	SSAE 16 / SAS70	SSAE 16 / SAS70
Service Level Agreement (SLA)	Not available	Not available	99.95%
Labs Supported in Service:			
Network Administration Labs -			
Lab 6 and 7 - DNS	Yes	Yes	3 of 29 steps not supported
Lab 8 - DHCP	Yes	Yes	No
Lab 9 – NAT	No	Yes	No
Lab 10 – IIS	Yes	Yes	Yes
Active Directory (our lab)	Yes	Yes	Yes
Supported Security Labs -			
Lab 1 – Preparing System	Yes	Yes	Yes
Lab 2 – Protocol Analyzer	Yes	Yes	Not performed
Password Capture (our lab)	Yes	Yes	Yes

Table 2. Amazon (AWS), CloudShare ProPlus, and Skytap Product Comparisons

Labs Implemented

Tables 3 through 5 provide a list of all labs implemented in the cloud services. The labs' associated appendix numbers are listed. The tables reference the steps performed for each lab and their outcomes. Table 3 is a list of instructor-provided labs from the Network Administration and Information Security courses that were run through CloudShare ProPlus. Similarly, Tables 4 and 5 list the same labs run using Skytap and Amazon Web Services, respectively.

CloudShare ProPlus		
Instructor and Course	***Lab***	***Appendix***
Our Own Networking Lab	*Active Directory*	*Appendix D*
Dr. Longo -- ECF 619	*Lab 6 and 7 - DNS* *Lab 8 - DHCP* *Lab 9 - NAT* *Lab 10 - IIS*	*Appendix E* *Appendix F* *Appendix G* *Appendix H*
Professor Pasquale – ECF 644	*Lab 1 – Preparing System* *Lab 2 – Protocol Analyzer*	*Appendix I* *Appendix J*
Our Own Security Lab	*Password Capture*	*Appendix K*

Table 3. Implemented Lab Assignments in CloudShare ProPlus

Skytap		
Instructor and Course	***Lab***	***Appendix***
Our Own Networking Lab	*Active Directory*	*Appendix D*
Dr. Longo -- ECF 619	*Lab 6 and 7 - DNS* *Lab 8 - DHCP* *Lab 9 - NAT* *Lab 10 - IIS*	*Appendix E* *Appendix F* *Appendix G* *Appendix H*
Professor Pasquale – ECF 644	*Lab 1 - Preparing System* *Lab 2 - Protocol Analyzer*	*Appendix I* *Appendix J*
Our Own Security Lab	*Password Capture*	*Appendix K*

Table 4. Implemented Lab Assignments in Skytap

Amazon Web Services *(AWS)*		
Instructor and Course	***Lab***	***Appendix***
Our Own Networking Lab	*Active Directory*	*Appendix D*
Dr. Longo -- ECF 619	*Lab 6 and 7 - DNS* *Lab 10 - IIS*	*Appendix E* *Appendix H*
Professor Pasquale – ECF 644	*Lab 1 - Preparing System* *Lab 2 - Protocol Analyzer*	*Appendix I* *Appendix I*
Our Own Security Lab	*Password Capture*	*Appendix K*

Table 5. Implemented Lab Assignments in Amazon Web Service (AWS)

Recommendations

Current Blended Lab Assignment Implementation:

In the current method, all students taking the ECF courses have to go to on-campus computer labs because they cannot perform the lab assignments at home due to not having access to the required software. And most importantly, they do not have access to a machine that is running the Windows Server operating system. This is an essential requirement to complete the lab assignments for the ECF 619 Network Administration course.

Proposed Lab Assignment Implementation:

In our proposed method, students will be able to complete their lab assignments from the Internet, at home, or from anywhere because with the public cloud service the professors will be able to pre-configure the distance lab environment with all the necessary software applications that they need.

Implementing a distance lab for the ECF lab related computing courses would require subscribing to either CloudShare or Skytap public cloud service providers. Our firm recommendation is to consider Skytap as the public cloud service and to seek out negotiating the cost.

Our reason to consider Skytap is because we were able to run all the labs. CloudShare ProPlus did not match up as well because it did not have the functionality, such as, the service did not have the functionality to add a second network card to the virtual machines, which was a requirement for Lab 9: Network Address Translation (NAT). The same is true for AWS; we were not able to add the second network card. There was also one other lab that was unable to work in AWS – AWS provides the user with DHCP services and the user cannot turn it off, as well as not being able to set up a DHCP server. We found out that this is true from the “Running own DNCP

server on VPC subnet" Amazon.com blog, posted on January 31, 2012. The inquirer on the blog asked:

> Can I create my own DHCP running on my own VPC subnet to ensure all my newly created EC2 servers will obtain IP address from my DHCP serer [server] and not the one provided by Amazon?

The Amazon rep replied that, "none of these options are available or supported right now and did not mention that there are future plans to do so."

Subscribing to a Public Cloud Service for La Salle University

In our research of the public cloud services we found out that there are many benefits and concerns for La Salle University to consider before subscribing to any of these services.

Benefits

- *Cost effective* – no physical hardware or virtualization software start-up costs; and no specialized infrastructure for IT to set up
- *Pay-as-you-go model* – pay for only the services and resources that La Salle University's needs
- *Expandability on-demand* – get all the capacity that La Salle University needs based on the class size (amount of students/and courses)
- *Availability* – benefits of access at any time and from anywhere
- *Scalability to satisfy demand* – satisfies the demand of a heavier demand of computing at various times of the year
- *Speed to market* – with no need to purchase hardware and software there is a short set up time for implementation

- *Ease of distributing software* – setting up software in the cloud service is easier to distribute to students and is more cost effective for both La Salle University and the students
- *Our proposed solution meets the Sloan-C 5 Pillars in Quality Online Courses* – learning effectiveness, access, scale, faculty and student satisfaction

Concerns

- *Support issues for the professor* – as a customer, the professor should be able to contact the cloud service provider for support on the services available to construct and run their labs.
- *Support issues for the student* – there may be issues with initially using the cloud service such as network connection issues and possible difficulties with the assignment itself, which the professor would need to be prepared to deal with.
- *La Salle's help desk involvement* – users typically will go to La Salle University's online help desk first, however it would be important to know if a help desk service is included in the Service Level Agreement that accompanies the subscription to the cloud service
- *Training* – how will the Professors and students get the introduction to the cloud product and how will the Professors train the students to use the product?
- *Administrative tasks* – who will be responsible for the semester to semester administration of the service, such as keeping track of which courses are using the cloud service
- *Exit strategy* – What happens to the information if the cloud service provider goes out of business? How important is it to capture all the data and move it to another cloud

service? Is the data mission critical or a good start to begin experimenting with a public cloud service?

- *Service Level Agreements (SLA)* – With SLA's there needs to be a clear understanding of what the priorities, responsibilities, guarantees, and warranties are between the provider and the University.

Conclusion

We have answered our initial question of how La Salle can deliver a comparable hands-on computing experience to its online student population without requiring them to go on-campus, starting with the students in the ECF courses. To find this answer we gathered the requirements of the lab related computing courses from the Director of the MS CIS and ITL Program and the Professors who are teaching the ECF courses; we implemented lab assignments successfully on CloudShare, Skytap, and AWS public cloud services and also found supporting data from the leaders of organizations that are committed to quality online education and leaders from organizations that are committed to aligning technology with business goals for and in education. We compared and contrasted three public cloud providers and determined which best met our specifications. We listed benefits as well as concerns of implementing online distance lab. Taken together, our work demonstrates the feasibility of this approach.

Bibliography

"About AWS". Amazon Web Services. Web. Retrieved 04/2012. http://aws.amazon.com/what-is-aws/.

"Amazon Elastic Compute Cloud (Amazon EC2)". Amazon Web Services. Web. Retrieved 03/2012. <http://aws.amazon.com/ec2/>.

"AWS in Education". Amazon Web Services. Web. Retrieved 03/2012. <http://aws.amazon.com/education/>

"AWS Fee Usage Tier FAQs", Amazon Web Services. Web. Retrieved 04/2012. <http://aws.amazon.com/free/faqs>.

Averitt, Sam, Michael Bugaev, Aaron Peeler, Henry Shaffer, Eric Sills, Sarah Stein, Josh Thompson, and Mladen Vouk. "Virtual Computing Laboratory (VCL)" North Carolina State University. 2007.

"Cloud Computing: Academic Initiative Program". IBM. Web. Retrieved 03/2012. <http://www.ibm.com/developerworks/university/teachingtopics/cloud_computing.html>.

Cloudshare, Katilius, Gay. Personal interview. 24 Feb. 2012.

Cloud Storage Strategy. <http://cloudstoragestrategy.com/2010/01/cloud-storage-for-the-enterprise---part-2-the-hybrid-cloud.htm>.

Grance, Timothy and Peter Mell. NIST. "The NIST Definition of Cloud Computing." Web. Retrieved 04/2012. <http://csrc.nist.gov/publications/nistpubs/800-145/SP800-145.pdf>.

Hignite, Karla Richard N. Katz, Ronald Yanosky. (2010). “Shaping the Higher Education Cloud” <http://www.educause.edu/Resources/ShapingtheHigherEducationCloud/205427>. Web. Retrieved 03/2012.

IBM. “North Carolina State University and IBM Extend Access to Educational Resources to the World Through Cloud Computing”. Web. Retrieved 03/2012. <http://www03.ibm.com/press/us/en/pressrelease/25752.wss>.

Longo, Stephen. Personal interview. 15 Feb. 2012.

Mladen, Vouk Sam Averitt, Michael Bugaev, Andy Kurth, Aaron Peeler, Henry Shaffer, Eric Sills, Sarah Stein, et al. “Powered by VCL – Using Virtual Computing Laboratory (VCL) Technology to Power Cloud Computing.” Roc. 2nd International Conference on Virtual Computing (ICVCI). May. (2008): 1-10. Web. 02 Feb. 2012. <http://vcl.ncsu.edu.news/papers-publications/powered-vcl-using-virtual-computing-laboratory-vcl>.

Moore, Janet C., (2011). A Synthesis of Sloan-C Effective Practices. *Journal of Asynchronous Learning Networks*, Volume 16: Issue 1 “Oracle VM VirtualBox User Manual”.

McCoey, Peggy. Personal interview. 29 Feb. 2012.

Pasquale, Thomas. Personal interview. 3 Apr. 2012.

Peeler, Aaron. “How It Works”. North Carolina State University. 2008. Web 02/2012. <https://vcl.ncsu.edu/help/general-information/how-it-works>.

Ryan, Matthew. Personal interview. 27 Feb. 2012.

“Skytap Cloud” Skytap. Web. Retrieved 02/2012. <http://www.Skytap.com/Skytap-cloud>.

Skytap, Vestal, Patrick. Personal interview. 23 Mar. 2012.

"Tech Republic Review: CloudShare Pro virtual environment" Tech Republic. Web. Retrieved 02/2012. <http://www.techrepublic.com/blog/products/review-cloudshare-pro-virtual-environment/1366>.

The Apache VCL Incubator Project. Apache VCL. The Apache Software Foundation. Web. Retrieved 02/2012. <https://cwiki.apache.org/VCL>.

"The Five Pillars" The Sloan Consortium. Web. 02/2012. <http://sloanconsortium.org/5pillars>.

"The Invisible Computer Lab" Inside Higher Ed. Web. 02/2012. <http://www.insidehighered.com/news/2011/01/20/virtual_computing_labs_could_boom_as_colleges_trim_costs_and_grow_enrollments#ixzz1mO4WmowGInside Higher Ed>.

"The Virtual Training Solution You Always Wanted" CloudShare. Web. Retrieved 02/2012. <http://www.cloudshare.com/solutions/virtual-training.aspx>.

"Virtual Computing Lab" North Carolina State University. Web. Retrieved 02/2012. <http://vcl.ncsu.edu/>.

"VMLogix LabManger Cloud Edition" VMLogix. Web. Retrieved 02/2012. <http://www.vmlogix.com/Products/LabManager-Cloud-Edition/>.

"VMWare vCenter Lab Manager" VMWare. Web. Retrieved 02/2012. <http://www.vmware.com/products/labmanager/overview.html>.

Yanosky, Ronald. "*From Users to Choosers: The Cloud and the Changing Shape of Enterprise Authority.*" EDUCAUSE <http://educause.edu/ir/library/pdf/PUB7202m.pdf>.

Appendices

Appendix A
Questions for Professors Teaching ECF courses:

1. If La Salle University procured a distance lab environment from a cloud service vendor, what do you need a distance lab environment to do?

2. What kind of programs do you need to run in the labs?

    i. For example, do you need network analysis tools like Wireshark and password recovery tools such as Cane & Able?

3. What are the functional requirements for a cloud service for the courses you are going to teach?

    i. For example, do you need to a distance lab environment to be available 24/7 for the duration of the course?
    ii. Does the distance lab need to save the students work after each session?
    iii. Please provide any other requirements that you need.

4. Do you feel a distance lab capability will enhance the student learning experience?

5. The assignment scenarios we envision for students could be as follows:

    i. A student receives an assignment posted online in the LMS: the instructs the student to download, install, and set-up a free software package from the Web, performs what the instructor requires for the assignment, and then provides a summary of the experience to receive the grade.
    ii. A student goes to an on-campus class, instructor gives an assignment that is set-up on the school's network (student has the opportunity to experience the hands-on experience with instructor), performs the assignment to receive the grade.
    iii. A professor sets up a lab assignment on a cloud service provider's environment, the student is instructed to login to the environment, the student performs and completes the assignment, the instructor accesses the cloud environment to check the assignment and gives the student a grade.

Given the options, iii being the best lab assignment scenario, investigating a cloud service would be ideal. In order for us to fully investigate a cloud solution can you provide us with information about the structure (tools and procedures required) of your hands-on lab assignments as well as what you are trying to accomplish with your students?

Appendix B
Questions for Cloud Computing Vendors:

1. Here are the applications we need to run and here are the requirements. Can we do this in the distance lab environment that you offer?

2. Can the student's virtual environment be replicated and saved for testing off-line?

3. Do we construct and have complete control over the virtual environment?

4. What type of support can we have in building our distance lab environment?

5. Do we get one online course lab up and running and then do we support ourselves?

6. What are the costs?

7. Are there different plans, such as a pay-as-you-go subscription?

8. What are the features of your cloud-based service; for example, does it matter if the student is accessing the distance lab environment through Mac, PC or Linux?

9. What are the limitations that we should be aware of?

Appendix C
Sources from Universities Using VCL

There are many universities who have adopted VCL. The following Universities are listed in "A Private Cloud in Education" section of this paper:

- North Carolina State University

  http://vcl.ncsu.edu/

- North Carolina Central

  http://proc.isecon.org/2008/2343/ISECON.2008.Murphy.pdf

- George Mason and Georgia State

  http://www.insidehighered.com/news/2011/01/20/virtual_computing_labs_could_boom_as_colleges_trim_costs_and_grow_enrollments#ixzz1mO4WmowG

- California State University – Fullerton

  http://www.youtube.com/watch?v=R43IvczoXmU

- Old Dominion

  http://occs.odu.edu/labs/vcl/VCL.swf

Appendix D – (*Our Own Networking Lab*)
Lab: Windows Account Management: Using Active Directory

Course: ECF619, Network Administration, Note: this is a lab assignment that is not currently in the course because the way the computer labs are set up for students it cannot be accomplished, however, with a public cloud service it is possible. We made this lab assignment up to help further prove our proof of concept that a public cloud service would be beneficial to the M.S. ECF curriculum**, Lab - Windows Account Management: Using Active Directory**
Our Goal: Utilizing cloud-based services to demonstrate basic user account management functions in a Microsoft Active Directory environment (See Table 6 below).
Environment: A Windows 7 Pro VM (VM1) and a Server 2008 VM (VM2) were utilized for CloudShare ProPlus and Skytap. For Amazon AWS we utilized a Microsoft Server 2003 VM (VM1) and a Microsoft Server 2008 VM (VM2).
Time to construct environment:

- CloudShare ProPlus – 15 minutes
- Skytab – 15 minutes
- Amazon Web Services – 20 minutes

Time to run lab through environment:

- CloudShare ProPlus – 1.5 hours
- Skytab – 1.5 hours
- Amazon Web Services – 1.5 hours

Task:	**CloudShare ProPlus**	**Skytap**	**AWS**
Install Active Directory (AD)			
Rename VM2 hostname to DC01	Successful	Successful	Successful
From VM2, install Active Directory Role. To do so, run DCPROMO from Start-Run. Name domain, “lasalle.edu.”	Successful	Successful	Successful
Network Administration			
From VM2, create and configure a directory for user home folders at C:\UserDocs. Share as “userdocs$.” Then configure network share and NTFS folder permissions accordingly.	Successful	Successful	Successful
From VM2, using Active Directory Users and Computers	Successful	Successful	Successful

snap-in, create a group named "Students." Create and configure user accounts. Assign users to AD group "Students."			
From VM2, create and configure directory named "Usershare." Share as Usershare. Configure network share permissions and NTFS folder permissions to allow the AD group named "Students" to connect to and create new folders within this folder.	Successful	Successful	Successful
From VM1, change hostname to win1-01and join host to domain "lasalle."	Successful	Successful	Successful
Network Account Verification			
Log into VM1 with login name that you created earlier.	Successful	Successful	Successful
Open the Computer link from Start, verify existence of home directory with drive letter H.	Successful	Successful	Successful
Create and save a document to H drive.	Successful	Successful	Successful
Map network drive to UNC path of \\servername\sharename (\\dc01\usershare$) - assign drive letter S.	Successful	Successful	Successful
Create and save a document to the S drive. This should fail.	Successful	Successful	Successful
Create a folder name "YourLastName" in S drive. Now, save document to S:\YourLastName	Successful	Successful	Successful
From VM2, verify existence of files created in both directories.	Successful	Successful	Successful

Table 6. Results of Windows Account Management: Using Active Directory Lab

Appendix E
DNS Service Configuration Assignment Results

Course: ECF619, Network Administration, *Lab 6 and 7 - DNS* **- DNS Service Configuration - - LMHost (WANs), NetBIOS (LANS), and DNS (WAN)**
Our Goal: to make sure the lab can be successfully carried out in proposed Cloud Services environment (See Table 7 below).
Environment: A Windows 7 Pro VM (VM1) and a Server 2008 VM (VM2) were utilized for CloudShare ProPlus and Skytap. For Amazon AWS we utilized a Microsoft Server 2003 VM (VM1) and a Microsoft Server 2008 VM (VM2). Note – Skytap and Amazon tests pending access to services.

Time construct environment:

- CloudShare ProPlus – 15 minutes
- Skytab – 25 minutes
- Amazon Web Services – 35

Time to run lab through environment:

- CloudShare ProPlus – 1.5 hours
- Skytab – 1.5 hours
- Amazon Web Services – 1.5 hours

Task:	**CloudShare ProPlus**	**Skytap**	**AWS**	**Comments**
Verify Connectivity				
From VM1, ping VM2 IP address	Successful	Successful	Successful	
From VM1, ping VM2 hostname	Successful	Successful	Successful	**CloudShare** – required initial configuration of clients DNS settings **Skytap** – had to disable the firewall on the server
NetBIOS (LANS)				
From VM1, ping VM2 IP address (ping -4)	Successful	Successful	Successful	
Disable IP6 on VM1	Successful	Successful	Successful	
From VM1, remove DNS server address	Successful	Successful	Successful	
From VM1, disable LMHOSTS lookup	Successful	Successful	Successful	
From VM1, disable NetBios over	Successful	Successful	Successful	

TCP/IP				
Verify inability to ping VM2 hostname	Successful	Successful	Successful	
From VM1, enable NetBios over TCP/IP	Successful	Successful	Successful	
From VM1, ping VM2 Hostname	Successful	Successful	Unsuccessful	AWS AMI's are on different subnets. DNS must be enabled. NetBios is not routable across subnets.
LMHOSTS (WANS)				
From VM1, edit "host" file	Successful	Successful	Successful	
From VM1 browser, verify URL	Successful	Successful	Unsuccessful	
Install/Configure DNS Service				
Rename VM2 hostname to "netsrvcs"	Successful	Successful	Successful	
From VM2, add DNS role	Successful	Successful	Successful	Amazon VM NIC TCP/IP configuration mimicked AWS DHCP supplied settings. (same IP, Mask, and GW)
From VM2, create Forward Lookup Zone named "dugal"	Successful	Successful	Successful	
From VM2, add host name for VM1 and VM2 to domain dugal	Successful	Successful	Successful	
Testing DNS				
On both VM1 and VM2, add IP address of DNS server	Successful	Successful	Successful	
On both VM1 and VM2, add DNS suffix for domain created in previous step	Successful	Successful	Successful	Amazon – Existing DNS suffix. We added our DNS suffix to the end of the list.
From each VM, ping the other VMs IP address	Successful	Successful	Successful	
From each VM, ping the other VMs hostname	Successful	Successful	Successful	
Add alias www to DNS server zone name dugal	Successful	Successful	Successful	
From either VM1, ping alias name	Successful	Successful	Successful	

Nslookup				
From both VMs, run Nslookup – server name should be the same	Successful	Successful	Successful	
From VM1 cmd prompt, type "NSLOOKUP ls dugal" *Note- this command will not work because the DNS is not configured to allow a zone dump*	Successful	Successful	Successful	
From VM2, set DNS server to allow zone dump	Successful	Successful	Successful	
From VM1 cmd prompt, type – "NSLOOKUP ls dugal"	Successful	Successful	Successful	
Auto Updating DNS				
From VM2, set DNS to Allow dynamic update	Successful	Successful	Successful	
Delete VM1s hostname from DNS server	Successful	Successful	Successful	
Reboot VM1, verify VMs hostname record on DNS server	Successful	Successful	Unsuccessful	

Table 7. Results of DNS Service Configuration -- LMHost (WANs), NetBIOS (LANS), and DNS (WAN) Labs

Appendix F
DHCP Service Configuration Assignment Results

Course: ECF619, Network Administration, Lab 8 - DHCP Service Configuration
Our Goal: to make sure the lab can be successfully carried out in proposed Cloud Services environment (See Table 8 below).
Environment: A Windows 7 Pro VM (VM1) and a Server 2008 VM (VM2) were utilized for CloudShare ProPlus and Skytap. For Amazon AWS we utilized a Microsoft Server 2003 VM (VM1) and a Microsoft Server 2008 VM (VM2). Note – Skytap and Amazon tests pending access to services.
Time construct environment:

- CloudShare ProPlus – 15 minutes
- Skytab – 15 minutes
- Amazon Web Services – 15 minutes

Time to run lab through environment:

- CloudShare ProPlus – 1 hour
- Skytab – 1 hour
- Amazon Web Services – We could not complete the installation of DHCP services.

Task:	**CloudShare ProPlus**	**Skytap**	**AWS**	**Comments**
Install DHCP				
From VM2, add DHCP Role	Successful	Successful	Unsuccessful	Amazon provides DHCP services. It is not possible to disable.
From VM2, bind DNS server to 192.168.1.1	Successful	Successful	Unsuccessful	
From VM2, Add DHCP scope, configure IP range, gateway, and disable IPv6	Successful	Successful	Unsuccessful	
From VM1, set LAN adapter to obtain IP automatically	Successful	Successful	Unsuccessful	
From VM1, verify IP address – address 192.168.1.x	Successful	Successful	Unsuccessful	
From VM2, verify VM1 hostname entry in DHCP console	Successful	Successful	Unsuccessful	
Ping VM1 and VM2 hostnames	Successful	Successful	Unsuccessful	

Table 8. Results of DHCP Service Configuration Lab

Appendix G
NAT Service Configuration Assignment Results

Course: ECF619, Network Administration, Lab 9 - NAT Service Configuration
Our Goal: to make sure the lab can be successfully carried out in proposed Cloud Services environment (See Table 9 below).
Environment: A Windows 7 Pro VM (VM1) and a Server 2008 VM (VM2) were utilized for CloudShare ProPlus and Skytap. For Amazon AWS we utilized a Microsoft Server 2003 VM (VM1) and a Microsoft Server 2008 VM (VM2).
Time construct environment:

- CloudShare ProPlus – 20 minutes
- Skytab – 20 minutes
- Amazon Web Services – 20 minutes

Time to run lab through environment:

- CloudShare ProPlus – Service didn't allow us to install an additional network card.
- Skytab – 1.5 hours
- Amazon Web Services – Service didn't allow us to install an additional network card.

Task:	**CloudShare ProPlus**	**Skytap**	**AWS**	**Comments**
Configure Server				
From VM2, install additional LAN adaptor	Unsuccessful	Successful	Unsuccessful	CloudShare and Skytap did not allow us to add additional NIC card
From VM2, stop DNS and DHCP services	Unsuccessful	Successful	Unsuccessful	
From VM2, rename network adapters to Private and External	Unsuccessful	Successful	Unsuccessful	
From VM2, configure network adapter settings as listed below in notes area	Unsuccessful	Successful	Unsuccessful	
Install NAT Server				
From VM2, add role Network Policy and Access Services Role select Routing and Remote Access Services (RRAS)	Unsuccessful	Successful	Unsuccessful	
From VM2, configure RRAS – choose NAT, select External	Unsuccessful	Successful	Unsuccessful	

interface				
Test Client				
From VM1, configure network adapter settings as listed below in notes area	Unsuccessful	Successful	Unsuccessful	
From VM1, connect to http://yahoo.com	Unsuccessful	Successful	Unsuccessful	
From VM2, examine RRAS folders				
Activate DHCP				
From VM1, remove IP settings and set to use DHCP	Unsuccessful	Successful	Unsuccessful	
From VM2, activate DHCP service	Unsuccessful	Successful	Unsuccessful	
From VM1, issue an ipconfig /renew command	Unsuccessful	Successful	Unsuccessful	
From VM1, connect to http://yahoo.com	Unsuccessful	Successful	Unsuccessful	

Table 9. Results of NAT Service Configuration Lab

Appendix H
IIS Assignment Results

Course: ECF619, Network Administration, Lab 10 - IIS
Our Goal: to make sure the lab can be successfully carried out in proposed Cloud Services environment (See Table 10 below).
Environment: A Windows 7 Pro VM (VM1) and a Server 2008 VM (VM2) were utilized for CloudShare ProPlus and Skytap. For Amazon AWS we utilized a Microsoft Server 2003 VM (VM1) and a Microsoft Server 2008 VM (VM2). Note – Skytap and Amazon tests pending access to services.
Time construct environment:

- CloudShare ProPlus – 15 minutes
- Skytab – 15 minutes
- Amazon Web Services – 15 minutes

Time to run lab through environment:

- CloudShare ProPlus – 2 hours
- Skytab – 2 hours
- Amazon Web Services – 2 hours

Task:	**CloudShare ProPlus**	**Skytap**	**AWS**
Configure IIS			
From VM2, verify non-existence of c:\inetpub directory	Successful	Successful	Successful
From VM2, verify Users and Groups, found 2 and 18 respectively	Successful	Successful	Successful
From VM2, add Web Server (IIS) server role	Successful	Successful	Successful
From VM2, verify IIS installation: • Verify IIS Admin tools • Users – no change • Groups – IIS_IUSRS	Successful	Successful	Successful
From VM2, verify access to directory wwwroot and existence of 2 files	Successful	Successful	Successful
From VM2, open html file in wwwroot – from IE open site localhost – they should look the same	Successful	Successful	Successful
From VM2, open IIS MMC, disable anonymous authentication and	Successful	Successful	Successful

windows authentication			
From VM2, using IE, verify inability to connect to default web site	Successful	Successful	Successful
From VM2, enable anonymous authentication, then verify access to default web site	Successful	Successful	Successful
From VM2, create file C:\inetpub\wwwroot\mypage.htm	Successful	Successful	Successful
From VM2, using IE, open site localhost\mypage.htm	Successful	Successful	Successful
From VM2, using IIS MMC, add "myPage.htm" to Default Documents	Successful	Successful	Successful
From VM2, using IE, open site localhost – "myPage.htm" should open	Successful	Successful	Successful
Setup Virtual Directory			
From VM2, create directory C:_myWeb	Successful	Successful	Successful
From VM2, create file C:_myWeb\default.htm	Successful	Successful	Successful
From VM2, using IIS MMC, create a Virtual Directory name MyWeb	Successful	Successful	Successful
From VM2, using IE, verify access to: http://localhost/myweb http://127.0.0.1/myweb http://192.168.1.2/myweb or http//hostip/myweb http://netsrvcs/myweb	Successful	Successful	Successful
From VM1, using IE, verify access to http://netsrvcs/myweb	Successful	Successful	Successful
Setting default page of a site			
Change file name, verify web access, set Default Document, verify web access	Successful	Successful	Successful
Adding Second Web Directory			
From VM2, create directory C:_myWeb2	Successful	Successful	Successful
From VM2, copy myPage.htm to C:_myWeb2 and create file C:_myWeb2\myPage2.htm	Successful	Successful	Successful

From VM2, using IIS MMC, create a Virtual Directory name myWeb2	Successful	Successful	Successful
From VM2, using IE verify inability to connect with http://localhost/myWeb2 - then try http://localhost/myWeb2/myPage2.htm	Successful	Successful	Successful
Directory Browsing			
From VM2, using IIS MMC, enable Directory Browsing on VD myWeb2	Successful	Successful	Successful
From and VM1 and VM2, using IE, verify access to directory http://NETSRVCS/myWeb2	Successful	Successful	Successful
Directory Structure and Security			
From VM2, create folder Web3 in folder C:_myWeb2, and add noweb.htm file to folder Web3	Successful	Successful	Successful
From VM1 and VM2, using IE verify access to http://NETSRVCS/myWeb2/Web3 directory, open myPage.htm, then open http://NETSRVCS/myWeb2/Web3/noweb.htm	Successful	Successful	Successful
From VM2, create new user “noweb” with password of “Lasalle1234%”	Successful	Successful	Successful
From VM2, set file permissions on noweb.htm, only allow user noweb access	Successful	Successful	Successful
From VM2, using IE verify that noweb.htm has been denied	Successful	Successful	Successful
From VM2, using IIS MMC, enable Windows Authentication on Virtual Directory MyWeb2	Successful	Successful	Successful
From VM1 and VM2, using IE access noweb.htm – you should be prompted for a username and password – use account noweb	Successful	Successful	Successful
Create Additional Sites			
From VM2, create folder C:\Site-	Successful	Successful	Successful

1024, copy myPage.htm to C:\Site-1024, edit myPage.htm			
From VM2, using IIS MMC, create web site “site1024”	Successful	Successful	Successful
From VM2, using IE, browse http://localhost:1024	Successful	Successful	Successful
From VM2, create folder C:\Site-1024\Second1024 and add default.htm to folder	Successful	Successful	Successful
From VM1 and VM2, using IE, browse site http://netsrvcs:1024/second1024/1024.htm	Successful	Successful	Successful

Table 10: Results of IIS Lab

Appendix I
Preparing System Assignment Results

Course: ECF 644, Information Security, Lab 1 - Preparing System
Our Goal: to make sure the lab can be successfully carried out in proposed Cloud Services environment (See Table 11 below).
Environment: A Windows 7 Pro VM (VM1) and a Server 2008 VM (VM2) were utilized for CloudShare ProPlus and Skytap. For Amazon AWS we utilized a Microsoft Server 2003 VM (VM1) and a Microsoft Server 2008 VM (VM2). Note – Skytap and Amazon tests pending access to services.
Time construct environment:

- CloudShare ProPlus – 15 minutes
- Skytab – 15 minutes
- Amazon Web Services – 15 minutes

Time to run lab through environment:

- CloudShare ProPlus – 15 minutes
- Skytab – 15 minutes
- Amazon Web Services – 15 minutes

Task:	CloudShare ProPlus	Skytap	AWS	Comments
Setup Environment				
Add Windows 7 VM image from available templates	Successful	Successful	Successful	Amazon doesn't support Win7, our test VM ran Windows Server 2008
Log into to VM. Record IP address of VM. Is DHCP enabled?	Successful	Successful	Successful	Amazon does not support static IP addresses
Download Wireshark to VM	Successful	Successful	Successful	
Install Wireshark	Successful	Successful	Successful	
Run Wireshark	Successful	Successful	Successful	

Table 11. Results of Preparing System Lab

Appendix J
Protocol Analyzer Assignment Results

Course: ECF 619, Information Security, Lab 2 – Protocol Analyzer
Our Goal: to make sure the lab can be successfully carried out in proposed Cloud Services environment (See Table 12 below).
Environment: Two Windows 7 Pro VMs - (VM1) and (VM2) were utilized for CloudShare ProPlus and Skytap. For Amazon AWS we utilized a Microsoft Server 2003 VM (VM1) and a Microsoft Server 2008 VM (VM2). Note – Skytap and Amazon tests pending access to services.
Time construct environment:

- CloudShare ProPlus – 15 minutes
- Skytab – 15 minutes
- Amazon Web Services – 15 minutes

Time to run lab through environment:

- CloudShare ProPlus – 1 hour
- Skytab – 1 hour
- Amazon Web Services – lab not completed due to time limitations

Task:	**CloudShare ProPlus**	**Skytap**	**AWS**
Take a screen shots of TCP/IPV4 information on both VM1 and VM2	Successful	Successful	
Verify that Windows Firewall is not blocking Ping. Do this for both VMs.	Successful	Successful	
Examine Ping Packets			
From VM1 launch Wireshark – don't start a capture yet.	Successful	Successful	
From VM2, send one ping packet to VM1	Successful	Successful	
From VM1, start packet capture	Successful	Successful	
From VM2, send one ping packet to VM1	Successful	Successful	
From VM1, end packet capture – analyze data	Successful	Successful	
From VM1, start another capture	Successful	Successful	
From VM2, send one ping packet to VM1	Successful	Successful	

From VM1, end packet capture – analyze data	Successful	Successful	
Examine Booting Packets			
From VM1, end packet capture. Shutdown VM2. From VM1, start packet capture. Start VM2. From VM1, analyze captured packets.	Successful	Successful	
Examine Shutdown Packets			
From VM1, end packet capture. Shutdown VM2. From VM1, analyze captured packets.	Successful	Successful	
Examine IP Conflict			
While Wireshark is capturing packets, shutdown VM2. Analyze captured data.	Successful	Successful	

Table 12. Results of Protocol Analyzer Lab

Appendix K - (*Our Own Networking Lab*)
Password Capture Assignment Results

Course: ECF 619, Information Security, Password Capture
Our Goal: to make sure the lab can be successfully carried out in proposed Cloud Services environment (See Table 13 below).
Environment: Two Windows 7 Pro VMs - (VM1) and (VM2) were utilized for CloudShare ProPlus and Skytap. For Amazon AWS we utilized a Microsoft Server 2003 VM (VM1) and a Microsoft Server 2008 VM (VM2). Note – Skytap and Amazon tests pending access to services.
Time construct environment:

- CloudShare ProPlus – 15 minutes
- Skytab – 15 minutes
- Amazon Web Services – 15 minutes

Time to run lab through environment:

- CloudShare ProPlus – 1 hour
- Skytab – 1 hour
- Amazon Web Services – 1 hour

Task:	CloudShare ProPlus	Skytap	AWS	Comments
From VM1, launch Wireshark and start new capture session.	Successful	Successful	Successful	
From VM1, connect to URL http://www.marsd.k12.nj.us/owa	Successful	Successful	Successful	Internet is disabled on CloudShare. We utilized a Virtual Directory created on a VM2.
Attempt to login to site using a bad password	Successful	Successful	Successful	
From VM1, stop capture session	Successful	Successful	Successful	
From VM1, analyze packets; look for an http packet with “Info” starting with “Post.” Right click and choose “Follow TCP Stream.”	Successful	Successful	Successful	
A new window will open showing content of the HTTP stream. Look for the login name and password used to authenticate.	Successful	Successful	Successful	

Table 13. Results of Password Capture Lab