VR Data Center

by

Matthew Kenkel, Michael Reuss, Rebecca Drury, Elliot Lang

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Matthew Kenkel

Matthew Kenkel – Project Manager

Rebecca Drury

Rebecca Drury – Unity Apps Developer

Michael Reuss

Michael Reuss – Network Engineer

Elliot Lang

Elliot Lang – Cyber Security Analyst

Ryan Moore

Ryan Moore – Technical Advisor

University of Cincinnati
College of
Education, Criminal Justice, and Human Services

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Prepared by:

Matthew Kenkel, Project Manager
Micheal Reuss, Network Administrator
Rebecca Drury, Software Developer
Elliot Lang, Security Analyst

Students of
University of Cincinnati
College of Education, Criminal Justice, and Human Services School of Information Technology
cech.uc.edu/it

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ABSTRACT

Many people envision the cloud as a service that “just works”. What most do not realize though, is that the “cloud” is in fact a co-location center, a building housing a massive datacenter that is willing to provide its resources to companies for an annual cost. Someone needs to maintain these co-location centers, and when searching, recruiters often look for someone with experience. Acquiring enterprise level, hands-on experience for the job can be both quite expensive and hard to come across. VR Datacenter (VDC) plans to fix this. VDC is an application that leverages users’ consumer hardware to simulate an enterprise level environment. VDC aims to allow users to create assets that not only appear physically in the virtual reality environment, but also have functionality tied into a VMWare vSphere server environment. This includes controlling device connectivity, power, rackmount location (RU), readouts from the virtual machines (VMs), etc. VDC plans to better define the breadth of knowledge that an entry level IT administrator possesses.

1. Introduction

1.1 Problem

Many entry level positions in the field of Information Technology require experience that individuals may not have yet acquired to obtain the job. One notable example resides within datacenter roles. Even in co-op and intern positions, access is strict throughout most of the time that you're on the job, and many of the full-time roles within a datacenter environment you end up missing out on experiencing, thus providing little to no experience that can carry over into a full-time position. There are many skills that are required to work in a datacenter, some examples of said skills include the ability to monitor and regulate power consumption throughout the facility, basic networking and security concepts, system administration, etc. Though these can be taught in college level courses, companies would much prefer hiring someone with real world, hands on experience under their belt.

1.2 Solution

A suitable solution to the problem at hand is providing real world, hands on experience to individuals seeking specific IT jobs. Although this would be risky within a live production environment, performing actions within an application would overall be both much safer and significantly more fault-tolerant. A virtual reality application can also immerse users into an environment similar to that of a real datacenter, where the necessary skills can be taught and practiced while preventing any outages or issues that would arise in a production environment. The functions and actions performed in the application can reflect to a test environment containing various systems and servers that reflect the changes in real time adding to the immersion for the user.

1.3 Project Goals

VR Data Center will be a virtual reality data center application that will allow users to interact with a life-like virtual environment that will reflect changes made in a test environment as mentioned above. By performing the actions within the virtual environment, users will gain the valuable skillset they need to move on to a real-world environment. VR Datacenter can be used as a training tool, learning environment, or can even be manipulated to fit the needs, layout, or environment of any potential company.

1.4 Overview

The reason behind our project is to better educate individuals on what it's like to go through a typical day of working in a data center. Nothing too overbearing for new individuals to feel overwhelmed, but at the same time, we'd like to push users to explore their outside of their comfort zone and encourage them to break things in our environment to better demonstrate the repercussions that can affect a data center.

2. Discussion

2.1 Project Conception

VR Datacenter is a virtual reality application that will allow users to gain experience working on the job in a datacenter. Cables can be unplugged or moved around, power can be killed, and servers may be manipulated to give users the most realistic experience while also providing real world concepts and knowledge. The idea for this project had been envisioned based on personal experience from working within various data centers. As an intern or co-op,

it's hard to gain experience working in a datacenter as security is tight, and the learning curve is high.

2.2 Design Objectives

With VR Data Center, our top priority we set out to achieve had been to provide consumers with an affordable test environment. To achieve this, we essentially replace existing hardware networking solutions with new software-defined networking solutions that will end up running on the same consumer-grade hardware that will simultaneously run our VR Environment. Following up on affordability, we also wanted to provide users with the ability to experience adverse effects when modifying the connectivity of assets within a "live" virtual environment.

A goal that we unfortunately had to drop from the get-go was expansive model selections. To further clarify, we wanted to provide the end-user with a wide selection of varying appliances to choose from. However, due to the realization that this would end up requiring ongoing support for functionality, we decided to drop the idea.

2.3 Methodology/Technical Approach

Our groups' workflow and technical layout is simply categorized by the respective track we're currently in. Matt's responsibility within the group entails being both project manager and assisting Michael with the networking aspect of the project. Roles of the project manager include writing out all documentation on process and procedure, initiating and scheduling meetings with faculty and staff for the group, and lastly building conclusive reports for the team. Michael's role within the group is to oversee and control the networking operations that take place, such as the

initialization and configuration of both VMware vRealize, VMware NSX. Rebecca's role within the group is to lead the way within the Unity Application development, ensuring that the environment follows through with development and is reactive to what the end user performs within it. Elliot's role is to get insight on potential vulnerabilities and threats our programs and practices could be exposed to. Later on in the Spring semester, Elliot will take on the role of implementing a monitoring service that will constantly oversee our project and be able to provide us with feedback of vulnerabilities or threats we may need to examine.

2.4 User Profile

Table 1: User Profile provides an in-depth explanation about the audience or group of individuals we aim to cater our product towards. This table cover the potential users of our application, Software and/or related experiences to our application, as well as the task experience that we expect the users can accomplish after using our application extensively.

Project: Data Center Simulation in Virtual Reality
Potential Users: ● Individuals of whom don't understand the adverse effects that can come from Data Center Management ● People of whom would like to simulate their data center environment to perform testing to ensure themselves of the intended outcome ● A company's Asset Management team
Software, Interface, and Related Experience: This project will be targeted towards individuals of whom wish to learn more about the inner workings of a data center. This includes an understanding of basic equipment functionality, the necessity for both power and connectivity redundancy, basic concepts for the layout of a data center, etc. F

Experience with Similar Applications: ● VMware vSphere ● Proxmox ● Hyper-V ● XenServer ● SteamVR ● Oculus ● PiMax ● Gear VR ● Google Cardboard
Task Experience: The program will operate as if the individual using it has a very basic understanding of computer hardware. However, the person using it may excel if they already understand basic networking concepts as well.
Frequency of Use: We hope that this application may be used whenever an individual is hired on for a data center management role and needs to perform training.
Key Project Design Requirements that the Profile Suggests: ● All-inclusive guide covering the basics of data center management ● Visual guidance through operations ● Rundown on the importance of each component ● Intuitive controls for easy functionality

Table 1: User Profile

2.5 USE CASE DIAGRAM

Figure 1: Use Case Diagram Below displays the user case scenario for VR Data Center. Most of the functionality provided to the end user is also able to be performed by the Administrator, with exception of the ability to move appliances, which will be limited to VR users exclusively.

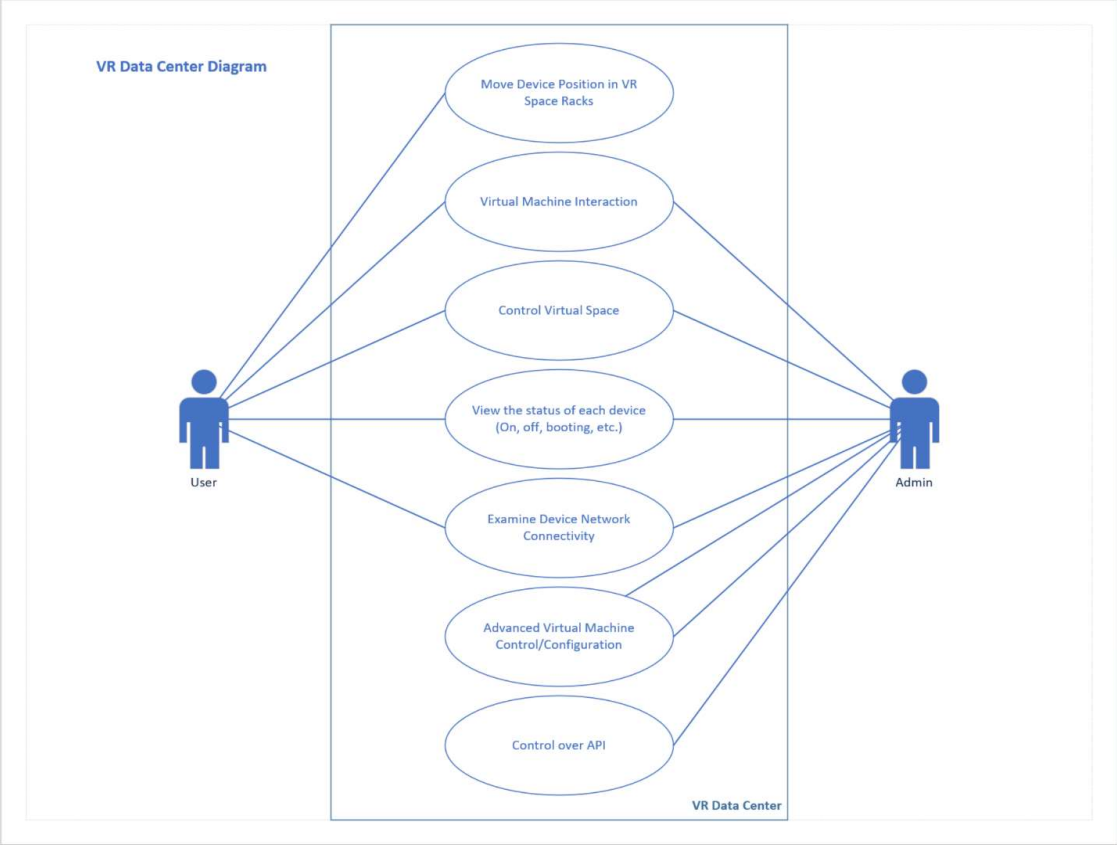

Figure 1: Use Case Diagram

2.6 TECHNICAL ARCHITECTURE

Our project consists of a Unity3D engine allowing us to form our virtual reality environment. We were able to implement various models to use as our servers and to create the interior of a datacenter that our users could interact with and manipulate. With this type of design within an engine such as Unity3D, our users can download our application and run it using programs such as SteamVR and with devices such as Oculus Rift and HTC Vive amongst the most popular VR headsets. The backend behind our Unity environment is programmed with the C# language. However, in order to connect it to our server environment, Python scripts were used.

Our server environment was hosted on a couple of servers that are running at a team member's house. The servers run a VMWare vSphere environment which allows us to create a number of virtual machines that we can use inside of our virtual reality environment. With the scripts implemented, our Unity environment was able to populate our server racks with the names of each of the servers that were hosted in vSphere. The below section displays the technical diagram for the assignment and the flow of data between the various aspects.

Technical Diagram

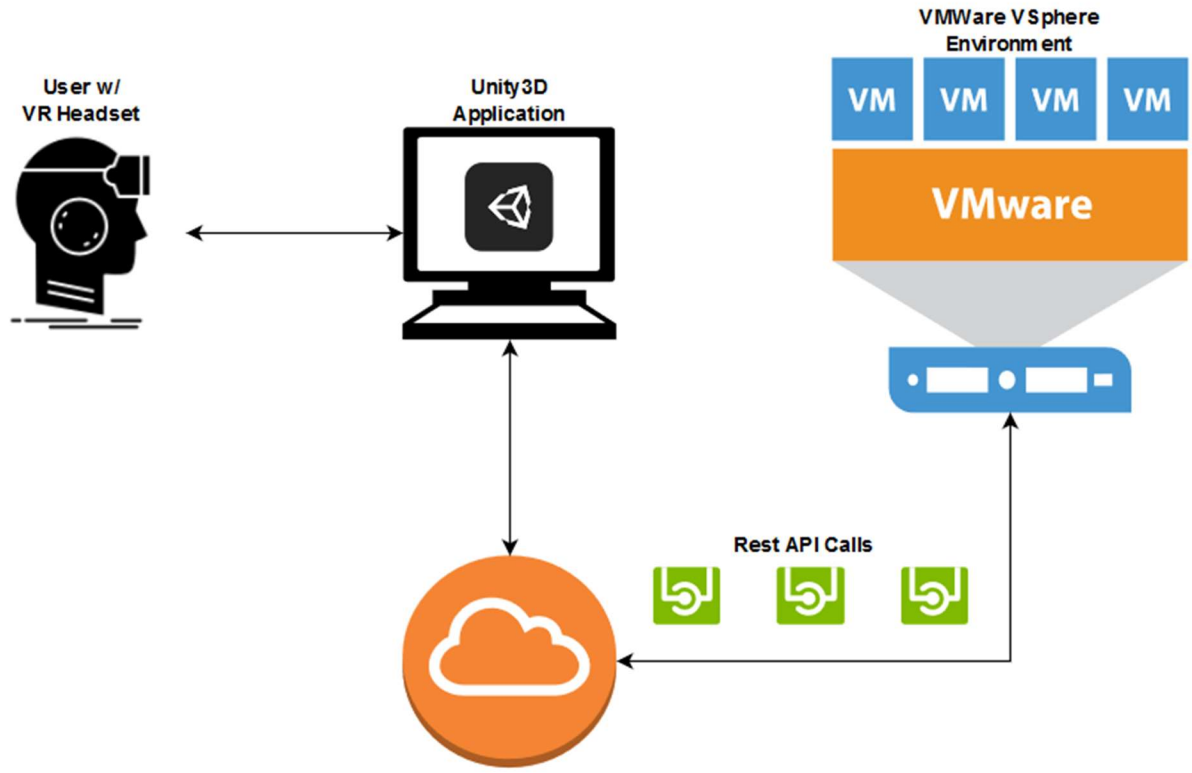

Figure 2: Technical Diagram

2.7 TECHNICAL DISCUSSION

As mentioned in the above section, our project consists of the following components: Unity3D Engine, VMWare vSphere environment, and scripts. The scripts that we incorporated

into our environment made our project possible as it allowed for us to connect both of the environments together for a real time update between the two. Our users are able to interact with objects in the Unity application whilst seeing the actual servers respond to the actions within VR. The scripts work via rest calls over the internet, connecting into the remote server environment that we are able to display alongside whatever the user is viewing in VR.

2.8 TESTING

Testing Procedures

Steps taken to ensure proper testing has been conducted are as followed:

- Document all intended scenarios and use cases
- Proceed to test both use cases and scenarios
- Create a log the results observed

Below are the tests we plan to perform upon our project:

Prerequisites Test - This test is focused upon the interaction with the application will require both Unity3D and PowerCLI to be installed to run as intended. Once both installed, testing will take place, making sure that PowerCLI is able to communicate with the vCenter server, and that Unity3D is able to open our compiled Unity3D Application.

Functionality Test - This test will primarily focus on ensuring the basic features of the application have been implemented and are working consistently.

User Interaction Test - This test is to make sure that users are able to infer or easily understand the controls available to them through the VR space to perform the actions they wish to.

Pass/Fail Conditions

If any portion of the testing phase had been failed, our team is expected to document and remedy the issue presented. Once remediation had taken place, we'd repeat the same testing procedure from start to finish until all tests were passed successfully.

Testing Report

Feature #	Feature	Expected Outcome	Pass/Fail	Actual Outcome
1	Clients can securely access the vCenter Environment through the VR App	Clients should be able to view the vCenter environment when you open the VR App.	P	Upon the application's launch, a instance of PowerCLI will launch and will use a command to authenticate with the ESXi Host using a predefined username and password.
2	Add/Remove Devices	Users should be able to have the ability to either add or remove devices with the VR Application and have it accurately reflect within Vmware vCenter.	P	Clients are able to now both add or remove devices with the VR Application and have it accurately reflect within Vmware vCenter through Unity3D using PowerCLI.
3	Add/Remove Network Connections	Users should be able to have the ability to either add or remove network connections from devices and switches within the VR Application and have it accurately reflect within Vmware vCenter.	P	Individuals can now add/remove connections from both the devices and switches within both the VR App and through VMWare vCenter.

4	Ensure vCenter and the Unity App are in sync when launched	When someone decides to launch the Unity3D App, the application should be able to view assets, network connections, RU positions, etc. that may have already been created through either the last time the app had been used, or the last time anything had been modified through vCenter.	P	When an indivudal launches the program now, starting at launch, PowerCLI will run a series of commands that will grab the information already available from the server-side, and return them to the VR app, where the information pulled will be displayed through the VR Space.
5	Move Existing Devices	If the user feels the need to move an appliance from one location to another, that information should be stored somewhere.	F	The temporary workaround to the feature is that this can be stored on the client side within the VR app. Ideally, we'd prefer to keep it on the server side to allow multiple client logins, but until we determine how to do that, we will be storing the data this way.
6	Display Statistical Information on machines in the VR Application	Through the action of pressing a button on the controller, a user should be able to be able to view information about each machine. Some examples of information displayed are CPU/RAM Usage, ambient temp of the devices, active connections, etc.	F	Users are able to do so currently, however the information is only available currently through a PowerCLI window. In the near future, we plan to work on displaying the info within the VR Application.
7	Power on/Power off machines within the application	Clients should have the ability to control the on/off state of each VM through the VR Application.	P	We've mapped a button to the location of the power button on a model of our servers that when pressed, sends a command through PowerCLI to either power on/off a VM.

Table 2: Testing Report

Problems Encountered and Resolved

During the early development and initiation of our project, our original intent was to request Administrative UC Sandbox access for a nested ESXi and vCenter hosted environment that we could remotely connect to as at the time, we didn't own any personal resources that'd allow us to host our own environment. Unfortunately, upon requesting access for our own resources to initiate an environment, UC's Sandbox space had been running rather low on sandbox space, thus preventing us from creating the environment. However, later on down the line, our group decided to invest in a bare-metal server and host outside one of our member's houses. During this portion of the project, we ran into yet another issue, which in fact had been providing secure access to users outside of the hosted network. Our original intent was to port forward all of the necessary services outside of the network. For the sake of ease of access this could have worked fine, however after determining that port forwarding easily exposes our environment to threatening outside sources, we decided it'd be best to host a VPN server as it'd provide the best security for accessing our environment remotely.

2.9 GANTT CHART

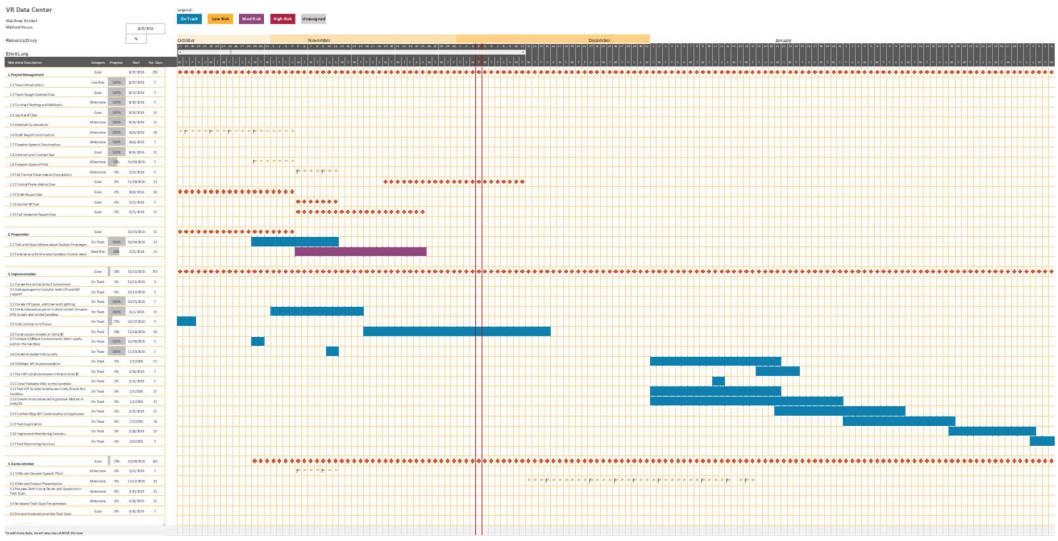

Figure 3: Gantt Chart

2.10 PROBLEMS AND ISSUES ENCOUNTERED

We've been fortunate enough to keep the amount of problems we've come across to a minimum, and for the errors that we have encountered, they've been easy to remedy. Our first problem we'd run into along the away had dealt with implementing Python scripts into a native format of C#. To solve this issue, we decided to use python plugins for Unity instead. Our second issue that we've come across is that setting up testing environment for everything can be quite expensive if no one has dedicated hardware. To solve the issue at hand, we used programs and simulations of VRTK that allow for the testing of the environment without actual VR equipment. Our final problem we'd encountered this semester dealt with the scaling testing of the environment with other VR equipment. We later concluded that we could solve this, or at the very least, reduce the number of usable headsets to one we preferred to work with, and ended up focusing on only HTC Vive compatibility.

2.11 FUTURE RECOMMENDATIONS AND IMPROVEMENT

If we had to start the project over again, it's safe to say we would have liked to start smaller. The initial scope of work was quite large and we were only able to complete several of the tasks we had planned on. In the event that we had more time to work on the project, we would continue developing the different tasks that the user can complete in VR. We have completed the ability for the user to power on and off servers, however; we would like the users to be able to unplug cables, move ethernet cabling around to different servers, and even implement networking capabilities with switching, routing, and firewall features. People have suggested what was listed in the above paragraph in that we incorporate cabling into the project

as well as broaden the number of servers we had included in the server room. The users enjoyed moving around in VR, but they all wanted more features to interact with.

In terms of what we plan to do with the project in the future, we have discussed continuing to work at the many features we wanted to implement at the beginning of the fall semester 2018, but the future is open ended. Our project was an amazing representation of an interactive environment that users, companies, schools, etc, could use to demonstrate their infrastructure in a way that wouldn't cause any issues to a production environment. The sky is the limit with our project at this point.

3. CONCLUSION

3.1 LESSONS LEARNED, FALL AND SPRING

In terms of what we've learned throughout the fall semester, we've come to a better understanding of what it's like to work in cooperation with a small group of individuals. Understanding great communication is utmost essential when working on a project of this magnitude with such few people. On top of that, our group has come realize the importance of observing documentation and changes as time goes on. Through every step of the way, it's important to ensure that all members of the group can agree unanimously upon changes made to ensure the outcome is what we envisioned it being.

In terms of what we've learned throughout the spring semester, we've continued to improve upon the communication and cooperation of the group as a whole. When working in a group environment, communication is a skill that constantly grows. Our team worked to be sure we knew each other's' schedules and each of us worked to define what needed to be completed, and who would be taking the initiative on each piece of the project. Each piece of the project was carefully developed and tested by more than one group member at a time. Each of us worked up until the day of the IT Expo to ensure that the project was completed and ready to present to the judges and many people that would attend the event.

3.2 ABILITIES AND SKILLS

Overall, we've come to better familiarize ourselves with and understand what exactly we're looking for within Software Defined Networking Tools and server virtualization software (VMware vSphere). Not only that, but we've also managed to gain a better understanding with what exactly it's like working within Unity 3D to create a VR Space. We all have also managed

to gain a much greater understanding over the importance of effective group communication and transparency. As the early design phase takes place for our tool, we need to ensure that our opinion is heard amongst one another to better ensure that we don't regret our decisions made much later down the line and decide to backtrack through the progress we've already made.

For the Spring Semester, we need to delve further into understanding how to integrate connectivity between our Software Defined Networking tools, VMWare NSX, and tie everything in together with no issues or complications. On top of that, with us knocking out a majority of the VR models and components this semester, we need to work on a definitive solution to creating and modeling our assets specifically to the way we intend for them to both look and function.

3.3 SPRING SEMESTER PROJECT COMPLETION

Since the fall semester 2018, VR Datacenter has really taken shape. Our team was able to complete the virtual reality environment within our Unity3D software and have been able to develop our design for use with SteamVR and both Oculus Rift and HTC Vive. This gave us flexibility when it came time for the IT Expo in that we could pick either set of equipment to use, and have the other to fall back on in the event of hardware failure.

With the virtual reality environment complete, we then focused our effort on working with Python plugins for Unity3D in order to bridge the gap between our virtual environment and our server environment. This particular piece of the project took a lot of hours to get right, and a few more to fine tune any issues that we experienced along the way. The final result was the ability for our users to power on and off the servers that existed in the virtual reality environment, and to call our scripts based on these actions to power on and off the servers in our server environment. All of the functions that the user could do were completed in real time and this made an excellent display at the IT Expo.

3.4 IT EXPO

The IT Expo was a great way to end the semester. Our team had worked hard to complete the VR Datacenter and were proud to show it off to anyone who walked by. The IT Expo was a great way for each of us to go a little out of our comfort zones in order to present our project to the many people that walked by the booth. There were a couple times where all of our team members were talking to two, three, or even four groups of people as everyone wanted to be a part of our project and try on the VR headset. Looking back at the event, it can be safe to say that we as a group learned to be proud of what we accomplished over the last two semesters and we put that pride into our many presentations to those at expo.

Appendix A. References

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