Cloud Storage for PC Gaming

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Introduction

Technology is continuously changing every day and we must keep up with it and take advantage of the opportunities presented to us to make our lives easier as technology advances. Cloud based storage is new technology and has been used for storing pictures like family photos, saving your files for important school or work projects, movies from Netflix or videos of your child's birth, and many more. All this stored data are data that holds value to people. Lately, gaming console platforms like Sony Play Station and Microsoft Xbox has recently created cloud services for their games. If gaming consoles can use this type of technology, then why do we not have cloud services for Personal Computer video games? You may think that this innovation is just a way push cloud storage technology for PC gaming. That may be true, but this innovation plays a big role with cybersecurity. Cybersecurity deals with all kinds of threats and protecting your assets whether it is your hardware, software, and data. What makes this protection unique to data is that one person values data differently from someone else and that is what cybersecurity is all about, which is protecting your asset. That asset, which in this case is data, holds a lot of value to PC gamers because the joy and gaming experience is what makes that data unique, and we want protection so PC gamers can continue and enjoy playing their latest games online whenever and wherever they want.

There are a few problems we discuss associated to hard drives like hard drive failures and denial of service. The solution to these issues is cloud based storage. There are different benefits of cloud storage and four different types of cloud computing and they are public cloud, private cloud, community cloud, and hybrid cloud. Learning the four different flavors helps us understand what flavor of cloud we would like to promote for our innovation. There are also

three types of cloud computing services and they are Infrastructure as a Service, Platform as a Service, and Software as a Service. Understanding these different types of services also shows the different benefits received from them and what service works best with our innovation. Latency is something PC gamers value and the cloud affects and benefits latency at different levels. There are also computer characteristics divided into three groups that beneficial to cloud computing and they are non-functional aspects, economic considerations, and technological aspects. Each of the groups has their own characteristics which we will discuss later. This innovation can also be viewed outside of the cybersecurity perspective and we can apply economics to this innovation. Because of the COVID-19 pandemic, supply and demand has affected the market in different ways and the rise of PC gaming has increased due to people forced to staying home. At the end, we want to make sure that our innovation is successful and we try to gather data through surveying, funneling, and looking at our return on investments. To make this innovation a reality there are also requirements to be fulfilled and a few things to be done as our next step.

Problem description and innovation

First, I would like to address and describe the problems that this innovation can solve, or at least lessen the inconveniencies and vulnerabilities. One problem with PC gaming is the vulnerabilities that you can face when an attacker tries to take over your hard drive. In the article titled “Acoustic Denial of Service Attacks on Hard Disk Drives”, it describes the denial of service an attacker can cause to a hard drive. Shahrad writes, “Hard disk drives (HDDs) are the most commonly used type of non-volatile storage. Since their introduction in the 1950s, their storage capacity, cost-effectiveness, energy efficacy, and reliability have significantly improved. These advances in HDDs, along with the ever-growing data storage demand, has made them an

integral part of numerous computing systems. HDDs have a critical role in modern computing systems. Although there have been numerous studies on their failure and reliability models, their security has been overlooked. HDDs hold essential software components and sensitive data, and thus, can be appealing targets for a plethora of attackers. A few recent studies have shown the feasibility of information leakage from HDDs through electromagnetic and acoustic emanations" (Shahrad, et al., 2018, p. 34). This shows the use of the hard drive as storage and its critical role in computing systems and the importance of their security. There are three properties that makes cybersecurity a solid type of security or protection and they are confidentiality, integrity, and availability. Confidentiality is what allows the asset to be viewed by authorized people or users, integrity is what makes sure that the asset is not modified or fabricated, and if so, only by authorized users, and availability is the ability to make sure that the asset can be used only by authorized users. When an attacker tries to take over your hard drive, it affects the availability part of your hard drive in which the problem addressed was the hard drive's vulnerability to denial of service through electromagnetic and acoustic emanations.

Furthermore, we look at the approach that the attacker uses for this acoustic signal. "The attacker can either apply the acoustic signal by using an external speaker or exploit a speaker near the target. Towards this end, they may potentially use remote software exploitation (e.g., remotely control the multimedia software in a personal device), deceive the user to play a malicious sound attached to an email or a web page, or embed the malicious sound in widespread multimedia, for instance in a TV advertisement or an embedded audio targeting gaming consoles" (Shahrad, et al., 2018, p. 36). This type of attack can be frightening because if the attack can happen to gaming consoles, then the attack can also happen to PC gaming. This type of attack affects the property of integrity because the hard drive has been modified or fabricated.

The hard drive no longer does what it is intended to do, which is store data or games and instead, it plays a malicious sound. I know I would not want this to happen to me because my games would not be playable.

There is another potential damage that can occur on the hard drive. We try to understand the problem much further as Shahrad writes, “Driven by rapid advances in storage technologies, modern HDDs offer a high areal density. Supporting such a high areal density requires a careful design of a head positioning scheme that can accurately place read/write heads of the HDD in the appropriate position. Even a small displacement of the head leads to malfunctioning of the HDD and may even accidentally scratch the platters, causing permanent damage to the HDD” (Shahrad, et al., 2018, p. 36). This shows the problems that not only can an attack cause you to lose your hard drive but a faulty design can cause permanent damage. This is like creating an art work that took you so much time and effort to make a masterpiece then someone accidently spills liquid over it and destroys your artwork. It is not recoverable. Same goes for the storage of your PC games. It took you hours to download each game and updating your games to the latest patch so that they are playable online. Once that damage occurs, all those games are erased and all that time to download and update your game was wasted.

Another problem that PC gamers can face is failures or a crash on your hard drive. Barron writes, “No one really expects a disk crash but drive failures do happen-and often at the most inconvenient times. In addition to the possible loss of important datafiles, a disk crash can leave you with the daunting task of having to replace the dead drive and reinstall your operating system and all of your applications. While you're doing this-assuming you know how to do this, your computer remains nonfunctional. While this "rebuilding" time can range from mildly annoying to extremely aggravating for a home computer user, it can bring a computer-dependent

small business, or even a large office, to a virtual standstill. Whatever you use your computer for, having a quick and easy-to-restore backup can eliminate both the distress and the expense of the prolonged down time normally associated with a hard drive failure" (Barron, 2008). This shows that if your hardware fails, especially your hard drive, you can expect to rebuild your computer. This has happened to me because of a hardware that was too old. Because technology is also mortal and with age and time, it breaks as well. The time spent trying to hunt down and gather hardware took a while. After building and putting your parts together for the PC, it took more time to install the software and redownload all the games with updates and patches. This process or example also shows how tedious it can be with a physical hard drive breaking.

Next, a personal experience and something that most PC users can relate is the limited amount of storage a hard drive can have. A typical hard drive can store up to one terabyte of space. Games today can average to about fifty gigabytes of storage. That does not leave much for the games that you can store even if you had the money to buy every game you want. Everyone wants the latest and greatest games, but you have to make sure you have the right amount of storage space on your hard drive. A temporary fix for that is to buy more hard drives. The problem with adding more hard drives is the physical space in your PC is limited as well and you can only fit a few.

Solution

Now, we have a solution to our storage problems for our hard drives which is cloud computing or cloud storage. We must first try to understand what cloud storage is. A good definition of cloud computing is defined by the United States National Institute of Standard and Technology (NIST): "Cloud computing is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (for instance,

networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service vendor interaction" (Nicoletti). What we are trying to promote for our innovation is the storage, applications, and services that are found in cloud computing. We want to further this technology and take advantage of it for PC gamers because the typical physical hard drive can store a limited amount of data and there is also a limit to how much hard drives you can physically put inside your computer case. With cloud-based technology, your storage can go as far as you want it to go. All your data, applications, or games can be securely stored into our platform without you having to worry about losing your data or having your physical hard drive break due to age and time or whatever natural disaster may occur.

Furthermore, there are different kinds of cloud computing. "Cloud is a stack of hardware or software residing in a data center. It has at least four flavors - public cloud (available to general consumer mass with a free or pay-per-use model), private cloud (restricted to a specific organization for its use), community cloud (shared and maintained by a group of organizations, generally for a common cause), or hybrid cloud (a combination of public, private and community clouds). Cloud computing refers to delivering a stack of hardware or software residing in a data center as a utility-like service over the network" (Phaphoom, Oza, Wang, & Abrahamsson, p. 46). Understanding the different types of flavors that the cloud-based platform offers shows us who we aim or have as a targeted audience which are PC gamers. These PC gamers or customers fall into the public cloud category because they are a mass number of customers who want to store their PC games using our cloud storage-based platform. We use this type of category because it is a pay-per-use model since PC gamers can always upgrade their storage space to what their heart desires. This way, anyone can keep up with the latest games and will not be held

back from buying games and limiting the amount of games they can have because there is not enough space on their hard drive.

From the article titled “Does Cloud Computing Deliver the Promised Benefits for IT Industry?”, there are three benefits to cloud security. “They include (a) increased user and stakeholder collaborations due to a capability of anytime/anywhere/any device access to applications and data; (b) minimized software maintenance activities due to a shift of work such as installation, upgrade, backup, and license control to the cloud provider; (c) centralized quality assurance as the responsibility on quality control such as availability, security and performance is transferred to the provider” (Phaphoom, Oza, Wang, & Abrahamsson, p. 46).

The first benefit of cloud security is helpful and convenient for PC gamers. Laptops can be brought anywhere but they are not as powerful as a gaming PC if you decide to play a game with intense graphics. A lot of PC gamers like to build their own gaming rig and the towers can be huge. Packing your fragile PC and flying it with you would cause a burden to you. It would be convenient if you wanted to travel across the country and play your games on your friend’s powerful PC that can be loaded into it. The cloud can let you run your games instantly rather than having to download each game one by one on your friends PC. On top of that, you will have to make sure your games have the latest patch to be able to play online. Not only does it eliminate bringing your bulky PC across the country, but it is securely saved in the cloud ready to play.

The second and third benefit as discussed from the article is the minimized maintenance and quality control of the cloud service is transferred to the provider since the cloud is a virtual storage for the customer and the cloud servers are securely kept in a facility. That physical maintenance is the responsibility of the provider, which is us, the innovators of this service. Not

only is the maintenance physical, but we make sure that your games, drivers, and patches are up to date because what we aim from this innovation is to make sure you can play your games within seconds unlike having games stored in your hard drive and patches are required for your game to play the latest version online. If you have a group of seven friends that want to play online but all are required the latest update which can take an hour to update, then that is seven hours wasted assuming each one of your friends downloads the update at different times.

There are three types of cloud computing services and all three have their own benefits as well. Those three cloud computing services are Infrastructure as a Service (IaaS), Platform as a Service (Paas), and Software as a Service (SaaS). Understanding these different types of services shows the different benefits received from them and what service works best with our innovation.

First we look at one of the layers of cloud computer services called Infrastructure as a Service or IaaS. “IaaS aggregates computing resources (e.g., CPU, memory, disk storage, network I/O) at the infrastructure layer, then abstracts these resources as an individual machine presented to tenants, based on a virtualization technique. The benefit is that the tenant has exclusive and complete dominion to control the entire software stack” (Wang, Gao, & Fan, 2015). Sometimes we think that owning is better than leasing. In this example, leasing would be beneficial because we transfer the responsibilities to the owners of the virtual machine. They are responsible for maintaining the servers and making sure they are running properly. This would benefit our business as well if we decided to form partnerships with other companies who already have cloud services so they can maintain the cloud services. Not only that, but customers can also take advantage or the virtualized servers to fulfill their storage needs. They can pay as

they go. In our case, they can buy more storage as they run out of space so that they can continue gaming and they control their demand.

The next cloud computing layer is Platform as a Service or PaaS. “Platform as a service (PaaS) provides resources at the platform layer, such as operating system (OS) and software development environment, to allow tenants to develop applications and manage their configuration settings” (Wang, Gao, & Fan, 2015). This layer is what our innovation relies on because we provide the platform that the PC gamers can use. Our platform is the application or software in this case. The customer uses our platform so they can store their games and on top of that, keep their games updated to the latest patch so that they can load their game instantly without having to wait for a fifty-gigabyte patch to play online.

The last layer of cloud computing is Software as a Service or SaaS. “Software as a service (SaaS) provides computing resources (i.e., infrastructure and platform) as services to execute applications developed by tenants, achieving better performance, availability, and lower operating cost. SaaS is an almost web-based application while IaaS provides a virtual environment for platform deployment, monitored by web-based monitoring tools. As a result, the majority of current research on cloud service evaluation is derived from the web service evaluation methods” (Wang, Gao, & Fan, 2015). Because SaaS is a web-based service, this type of layer would be helpful because it would be easy to use and convenient. Anyone can just use this cloud-based layer just by going onto their favorite internet browser or application. Not only that, but it also gives better performance and most importantly, availability because availability is one of the properties of what make cybersecurity as discussed earlier. With having availability, this shows that SaaS is a great source for protecting your asset.

There are two factors that affect PC gaming and that is frames and latency. Gamers always say that frames win games. Frames all depends on how great your graphics card is. The goal there is to have higher amount of frames per second. We can't control the frames per second since that is more for the video card but the cloud can control latency. Latency is important because it is the time it takes for your personal computer to communicate with the server. So, if you were playing competitive games like first person shooter games, you don't want your computer to tell you that you lost without you knowing because there was a spike in latency and the communication was lost on how you did not win the game. This delay in latency is also known as lag.

First, we must understand the different types of levels in the cloud and how they will affect latency for PC gamers all over the world. The different levels are Home Users, Small Enterprises, Mid-size Enterprises, and Large Enterprises. Home users are for a simple setup which contain several computers. Small enterprise can run up to a thousand servers, mid-size enterprises can run up to ten thousand servers. The last one is what we want to promote which is large enterprises. "Clouds and large enterprises run over 10,000 servers, cross multiple time-zones, often literally at a global level, with large data centers distributed across all continents and often in tens to hundreds of countries. Especially in cloud setups, high speed networks allow global-wide distribution and integration of load from thousands of individual points of load. This in turn flattens the 24-hour overall load curve and allows for efficient peak handling and comparably high utilization factors" (Chen & Sion). Our goal is to run over ten thousand servers and for our company to take over globally. The reason for that is because this offers lower latency to whoever is close to the servers and that one server from only one area is taking all the

load. We aim to have all PC gamers connected and be able to play together all over the world and we want them to have the best gaming experience with lower latency.

To explain further and back this up, it is important to have multiple cloud services spread out for lower latencies to customers rather than using a single cloud service. “This is because a multi-cloud webservice deployment has a larger set of data centers to choose from when serving its users. As a result, a webservice can take advantage of the fact that 1) one cloud service may have a data center in a particular region while another may not, or 2) even if multiple cloud services have data centers in a region, the data center in one of those services may have lower latencies to users in that region due to less circuitous routing” (Wu & Madhyastha, 2013). This shows that having multiple data centers spread throughout the region lowers latency because of less circuitous routing of that data and having it more to a direct path. It is like a hub of different post offices. If you were to pick up a package at a post office and there are only a few post offices around you and the closest one is thirty minutes away, it would take that long for you to get your package. Having the conveniency of a closer one reduces that travel time.

Not only does the cloud benefit gamers but it can also benefit the PC gaming business because it prevents piracy. “The shift toward cloud software brings about three fundamental changes to the software industry: software piracy problems can be better managed in the cloud; the cloud software service requires the support of a significant information technology (IT) infrastructure; and cloud and on-premises software may offer complementary value to each other. Piracy has long been regarded as a critical problem in the software industry. Much has been discussed on prevalence of piracy of individual user applications, such as games and productivity suites. However, enterprise software piracy is also a serious problem” (Zhang, Yue, & Hui, 2019). This shows that a lot of gamers can take advantage of getting the games for free.

This would hurt the gaming business because of PC gamers obtaining a copy illegally. Since games are now sold on disks, a lot of gamers can just make a copy of that game. Because of cloud technology, gaming companies can now just have the customer download the game into the cloud and the way to obtain it is to have a cloud platform. This would benefit both the gaming business and our business because it can form a partnership.

Finally, there are three groups that will help you understand why cloud technology is beneficial. “The European Commission “Expert Group Report” makes a summary of most common cloud computer characteristics divided in three groups: Non-functional aspects – “represent qualities or properties of a system, rather than specific technological requirements”. Economic considerations – “are one of the key reasons to introduce cloud systems in a business environment in the first instance”. Technological aspects – come from the opposed of non-functional and economical aspects and ‘typically imply a specific realization’” (Reixa, Costa, & Aparicio, p. 62). Each group has many characteristics under them and we will focus on the characteristics that benefit PC gaming.

The first group of cloud characteristics is non-functional aspects which are properties of a system. The characteristics we care about this group is elasticity, reliability, quality of service, and availability. We care about elasticity because we want the cloud to adapt to the changing environment. For example, when the gamer wants more storage, the cloud can offer more storage to the customers needs. For us to enable this, we can charge for and upgrade for storage space in the cloud. Reliability is important because the gamer wants to make sure that he can load his game with no issues. The gamer trusts our storage service that his game was saved and loaded from the last time it was played. Quality of service is why the customer continues to use our

platform for their gaming needs. It ensures that the expectations the customer has from us are being met.

The second group is economic considerations which are the reasons to bring the cloud systems to a business surrounding or environment. The characteristics we look at for PC gaming are cost reduction, pay per use, and “going green”. To apply cost reduction, we are lessening the maintenance and cost for infrastructure for the consumer. All the maintenance will be taken care from our business and the requirements for space is reduced for the consumer because there is no need for physical hard drives on the gaming PC. Pay per use is a great characteristic because our innovation enables the customer to continue buying storage space depending on their needs. They can pay for more storage as they need to use more space. The last characteristic from this group is “going green” which reduces the resource requirements. This characteristic helps the consumer because it eliminates the need for a physical hard drive that will take up space on the computer.

The last group of cloud characteristics is technological aspects. This characteristic’s meaning is in the name itself. It fulfills a specific technical characteristic. The characteristics we care for PC gaming are virtualization, security, privacy and compliance, data management, programming enhancements, and tools. Virtualization is the most important characteristic our innovation offers. The games customers have are stored virtually without the need of worrying about a physical hard drive or having the game locally. It is allowed for the game to be used anywhere they go. Security, privacy and compliance is another big characteristic since we are also promoting cybersecurity. This deals with the CIA triad where only authorized users can see, access, and modify their games. Data management is where the customer is aware of data location and assures its consistency. With our innovation or platform, we promote storage for PC

games. This ensures that it is not cluttered with other files we save onto our computers for work, school, or other personal use so that the data saved, which are the games, are always consistent and easy to be aware of when and upgrade to storage space is needed. Programming enhancements is a great characteristic because there is no need for the customer to worry about managing their games. Their games are safely stored into the cloud and are always updated to the latest patch to play online. The tools characteristics is basically our platform. It allows the customer to use our platform as way of making their gaming experience enjoyable and ease of use.

How the problem and innovation relate outside of cybersecurity

Now, how do we apply this innovation outside of cybersecurity? For example, like my undergraduate major in Economics? Believe it or not, we all are economists just like how we are all entrepreneurs because entrepreneurs solve problems. When you think of economics you think of supply and demand. When supply goes down, demand goes up and if demand goes down, supply goes up. When the COVID-19 pandemic hit, it forced a lot of people to stay home, lots of businesses were put to a pause, and a lot of people lost their jobs. When businesses were put to a pause, production slowed down. Not only did production of toilet paper slow down and increase its demand, production of hardware like video cards and hard drives were slowed down causing the demand of these computer hardware. Without enough space on your hard drive, you are in demand for more storage space and the only option to solve that problem is to buy another hard drive which is short in supply.

To make everyone happy, we want to be where supply meets demand, and our innovation helps everyone get there. Each customer can control that because the moment they need or are in demand for more storage space, they can always control that market because they can always

immediately upgrade for more storage space. Applying this concept is why we all are economists because we make decisions like this in our everyday lives and this is just an example of our needs. Because of the pandemic, everyone is forced to stay home and the solution for entertainment while socially distancing was playing video games. Gamers were able to play and connect with the world through video games while maintaining six feet apart which is why the market for video games sharply rose.

From the article titled “Contract-based Cloud Architecture”, Schnjakin writes, “Cloud Computing is a concept of utilizing computing as an on-demand service. It fosters operating and economic efficiencies and promises to cause an unanticipated change in business” (Schnjakin, Alnemr, & Meinel, p. 33). We believe that cloud gaming is the future because it is more efficient. Technology is changing and this is reducing the cost of materials to create a hard drive for every PC gamer needing to buy as well as requiring the physical hardware and space needed. The demand for cloud services will rise as more people are aware of this technology.

How to determine the innovation is effective

We want to make sure that we are successful when we come up with an innovation because we want to make a positive impact for society. Bringing the joy and making gamers happy using our service lets us know that we are doing our job correctly. In order to view that our customers are getting the service that they want, there are a few ways to find if our innovation is effective. We can conduct surveys from our customers and use a business funnel to determine if the innovation is effective.

First, we would provide a ten-day free trial to our customers where they can store one terabyte of games in our cloud storage. After the ten-day trial is over, we will ask our customers to fill out a survey of what they think of the product and how we can improve. Gathering all this

information such as their thoughts and opinions will help us assess our product. Our goal is to make this product better than it was before and to make sure that it is the best gaming cloud storage out there that will satisfy our PC gaming customers.

Next, we can apply business funneling or the funnel analysis from what we have learned from our class module. The funnel analysis can be used to see our user fallout rates. For example, after our ten-day trial of one terabyte storage, we can ask our PC gamers if they would like to continue with a subscription. We would like to view how many customers would make a purchase and register for a subscription compared to how many would not. Seeing the drop rates from our customers shows us that we need to improve our service to make our innovation successful.

Another way to see if our innovation is effective is simply looking at our return on investment. We put a lot of time, money, and effort on this innovation so we want to make sure that we are not in debt or losing any money. We have hired employees, formed partnerships, paid for advertisements, and put a lot of money elsewhere to bring this innovation to reality. If our amount of money gained is more than our cost, then our innovation is successful. No one wants to be a returning customer if the product or service is terrible.

What is needed to turn the innovation to reality

Now that you understand our innovation and what cloud storage offers, there are a few requirements to make our business successful and to turn this innovation into reality. To make cloud storage better we require better security, privacy, availability, auditing, archiving, quality of service, and scalability.

We will start off with the requirement of security. “High security concerns are usually associated with virtual environments which include virtual components such as hypervisors for

running virtual machines and virtual networks for virtual machines communications. In addition, it is necessary to make sure that the service providers themselves cannot access the users' data. Therefore, issues arise as an organization's security requirements and policies cannot be fully reflected in Cloud environments" (Hanna, Mohammed, & Al-Jaroodi, p. 788). This shows that not only do we have to think about security in the cyber realm we have to think of security inside the organization because majority of the threat can come from insider threats and someone you already know. Having a good physical security team monitoring the employees who are running the virtual machines can help prevent this problem. We also need to have security cameras on our important assets like our servers, monitoring who comes in and out of the facility.

Next, we need to ensure privacy. "Privacy is an important Cloud computing issue to be addressed in the direction of raising users' trust in the Cloud computing paradigm. This lack of transparency raises high concerns especially that privacy regulations and policies differ from one country to another. In addition, data stored in Clouds may be at risk of unauthorized usage by the service provider" (Zhang, Yue, & Hui, 2019, p. 788). This shows that our customers don't know what is going on with their data when they store their PC games in our virtual storage. They trust that their games will load exactly the last time they saved it. We need to ensure that our employees are not accessing their data because some gamers like to buy virtual items for their game like character skins, weapons, and many more. We want to make sure that our employees are not stealing that. Also, since gamers store their information like their address, phone numbers, or credit cards on their gaming accounts, we want to make sure that information is securely kept.

Third, we want to make sure that we maximize their availability provided by the cloud services. As discussed earlier, availability is one of the important properties of cybersecurity and

it is a property we need to be kept secure. “Cloud computing environments need to make serious provisions to react quickly and efficiently to such outages and ensure continuity of Cloud services. Therefore, the ability to efficiently and seamlessly recover from outages is an important factor to consider when comparing Cloud services” (Zhang, Yue, & Hui, 2019, p. 788). Everyone has encountered technical difficulties or some unforeseen events that can happen. We want to make sure that the service is always available. In order to do that, we need back up cloud servers that has all our customers’ files stored in case the servers go down. This keeps the redundancy in the system just in case something fails.

The fourth requirement to make this innovation a reality is to do some auditing. “They require monitoring and recording all operations performed within an organization’s system and keeping close track of all activities. Nevertheless, appropriate auditing capabilities for the Cloud computing paradigm have not been founded yet. Various issues including storage needs, authenticity and correctness of the audit logs need to be resolved while not affecting the overall performance and availability of the services. Furthermore, adding trustable auditing facilities to Cloud services would certainly enhance the approval rate of this paradigm from the enterprise point of view” (Zhang, Yue, & Hui, 2019, p. 788). The auditing requirement would go well with our privacy requirements. They seem to complement each other because with auditing, we can monitor what is being done inside our business. This can ensure that we keep our integrity because integrity another big property of cybersecurity. It makes sure that there was nothing modified or fabricated, and in this case, the data stored in our cloud servers. With just the characteristic of integrity, it gives our customers a good sense of trust with the company. With good trust, we can form better relations and the word will spread to other customers who can subscribe to our services.

The fifth requirement is flexibility. “The ability of an enterprise to rapidly respond to varying business requirements depends on the flexibility of its system. Cloud computing service providers should be able to offer flexible plans and services that allow an enterprise to quickly and efficiently adapt to changes in their goals, customer demands and global changes” (Zhang, Yue, & Hui, 2019, p. 788). Technology is always changing and our competitors always want to try to innovate something new as well to keep attracting customers and beat competitors. We must adapt to these changes as well and stay flexible. Not only that, we must ensure we are efficient and meet our customers’ demands and expectations. In order to grow, we need to listen to our customers and all the feedback they provide us so we can always strive for success and make them happy because PC gamers want to continue gaming and the joy of gaming is what we want to always be available.

The sixth requirement is archiving which provides storage of long-term data that is not needed momentarily. “A Cloud computing service with an archiving feature and easy access to archived data is among the essential requirements for many organizations whose operations involve archiving large amounts of data that may be needed for later use” (Zhang, Yue, & Hui, 2019, p. 788). We never know if we need anything from the past. For example, if we lose our key, we may have a back up key to unlock our door that was stored somewhere safe. We did not need it at the time but we kept it just in case something happens. The same goes for archiving our data. If for some reason all the new data that was stored gets destroyed, we at least have data that can keep our service running.

The seventh requirement is quality of service. “There are different QoS parameters to consider in any service such as response time, reliability and trust/security. Generally, these QoS parameters need to be dynamically updated from time to time due to regular changes in industry

operations" (Zhang, Yue, & Hui, 2019, p. 789). We want our customers to be happy and as mentioned from one of the parameters is response time. Having to wait for a game to update or load is frustrating. Every gamer wants to launch their game immediately because the time loading and updating could be time used to play their PC games. We also want to be a reliable company and as discussed earlier, we form that trust and security from our other requirement of auditing and privacy.

The final requirement is scalability. "The capability to scale (grow while maintaining acceptable performance) is one of the most important factors in providing successful Cloud services. Cloud scalability is mainly enabled by increasing the capacity and number of IT resources such as compute nodes, network connections, and storage units. Scalability requires dynamic configuration and reconfiguration as well as an automatic resizing of used virtualized hardware resources" (Zhang, Yue, & Hui, 2019, p. 789). This shows that with cloud storage we must be able to advance and grow because technology is always changing and with change, we must also make sure that performance does not take a hit. Attackers also come up with new ways to attack users so we must also prepare for these new attacks. In order to do this, we must also harden our security and keep it up to date. We must always be aware of new vulnerabilities that are out there, so we know how to react if we were happened to be a target from an attacker.

After understanding the technical requirements to get our innovation into reality, we also must think outside the box and look further. For example, I did not have the luxury of having a group to brainstorm this innovation. I am at a greater disadvantage because if I were to compete with my peers, I would lose if they came up with the same innovation. They say two heads are better than one and when coming up with an innovation, brainstorming with other innovators makes this innovation much closer to reaching reality. In order to make myself stronger, I can

form partnerships. Companies like Google and Amazon already offer cloud services. They can provide the resources and the cloud storage for PC gaming while I integrate my service or application with them. Not only does forming a partnership give me their resources, it also lowers my cost for hardware and maintaining the equipment and servers, as well as keeping the service secure.

Of course, we want to provide our idea of the cloud servers but we have to go back to cybersecurity basics. Without applying cybersecurity, then our innovation will not be effective. Protecting both our customer's assets and our assets is important because without it, we would not have a business to run. We must ensure we protect the CIA triad or confidentiality, integrity, and availability of our assets. Our biggest assets are our cloud servers because if they go down, we will not have any storage which is affecting availability. To do this, we will monitor our servers for any threats and vulnerabilities. Once there are vulnerabilities identified, an attacker can exploit that and bring down our servers. A vulnerability means it is an open door for the attacker. Just like what we have experienced to the gas line shut down or meat processing company, we do not want that to happen to us. If our servers are up and running twenty-four hours, seven days a week and there are no threats and vulnerabilities due to our monitoring, then our servers are running effectively and are doing what they are intended to do which is provide virtual cloud storage to our customers.

Next steps

There are a few more steps once we have gotten this far. Getting our innovation out there is first step because we need to introduce our service. Creating advertisements and getting our customers to us is what we want. Attending gaming conventions like Blizzcon hosted by Blizzard Entertainment is a huge step because they are a big PC gaming company with many

popular games. They hold this gaming convention once a year and we can showcase our innovation on their gaming floor. Also, since we want to have our innovation to go globally, we can also attend the San Diego comic convention that is held yearly and is always a sold-out event. This can target all the customers from around the world because the comic convention has a vendor floor where they can showcase their games or anything game related. Since comic con brings a lot of comic fans and gamers into one convention from all over the world, we can also take a survey of what they think of our product.

Not only do we have to be with everyone face to face, we can advertise this on the television to commercialize our service. Tech TV is the best way we can introduce our innovation as well as having TV commercials. G4 is also a big channel for gamers and having our innovation broadcasted there will bring us customers.

The second step is to test our innovation. Just like when every great game releases, there is a beta testing phase to find and search for any bugs and anything wrong within the game. This testing can be done by our business and partners. Once we test it, we can launch the beta testing where it is open to customers. Having a testing or beta phase allows us not to only get it tested but to also get it advertised out to PC gamers. While testing the service, they can find any bugs or anything wrong that we have missed. They can also submit a survey at the end of the beta and tell us what they think of the service or product then we can invite them to our release date with a free ten-day trial for trying out our product.

Lastly, we always want to improve. Getting this innovation right the first time is impossible. We must learn from our mistakes so that we will not repeat them. It is best to fail early than fail later down the road where a lot of money had been invested. Learning from our failures and mistakes helps us grow to be a better business. Even if we are the best company out

there, we should always strive to learn so we can always stay on top because technology is constantly changing. With this, we must also adapt to our environment as whether it is our customer's needs to cyber threats out there.

Self-reflection

To the director of advanced technology center, thank you for taking your time to understand my innovation. All in all, this innovation is a target to PC gamers who love to continue playing their PC games. If you are a gamer, you understand that your hard drive is limited to what it can do. If it breaks, then all the information and data stored on there are all gone. Also, if it is attacked by hackers, then your data can be lost or not usable affecting the confidentiality, integrity, and availability. All of these are properties of cybersecurity. Everyone values their assets differently and PC gamers value their games or data stored on their hard drive. What makes this data unique is because cybersecurity is all about protecting an asset. This asset we are protecting are the games that the PC gamers value.

Our solution to the hard drive problems and issues that can occur is our innovation of cloud storage for PC gamers. The cloud storage has been useful for storing files like school projects, videos of birthday celebration, and many more. We decided to make this innovation for PC gaming where PC games can be stored. It is useful because it keeps your games secure and playable if you were to have hard drive problems occur.

There are also a lot of things that I have learned through the course of this project. I did not know that there was an acoustic denial that can happen on a hard drive allowing the attacker to play or embed a malicious sound on the hard drive. As I researched further, I learned that from the solutions there are benefits from cloud computing. For example, there are three layers for cloud computing and they are Infrastructure as a Service, Platform as a Service, and Software as

a Service. I learned that our innovation falls under the Platform as a Service because it allows the customer to manage their configuration settings and in this case, how much games they want to store on the cloud. This allows the gamer to never run out of space because they can always upgrade once they run out of space for their games.

Not only did I learn what the cloud provides, I learned how it can make gaming better due to reduced latency. As a PC gamer, there are two things we care, and they are frames per second and latency. I learned that with having more cloud storages being located at different parts of the world can reduce latency because that server is closer to the user. I learned that this would help my business not only for latency issues but to help my business expand globally and get all PC gamers to connect from all over the world.

Furthermore, I learned that there are characteristics for the cloud divided into three groups. Those groups are non-functional aspects, economics considerations, and technological aspects. Each of these three groups has many different characteristics which shows why the cloud is beneficial.

I think that students can find value from this project because it can help them learn more about cloud computing. A lot of students may think of the cloud as something magical where you can store your homework to be saved or worked on later. It can give them an idea how it works and what kind of services they can benefit from the cloud. Also, just like me, it can help them think outside the box because the cloud is more than just storing your school projects, movies, and pictures. It can be used for many other things and I hope that someone can find more useful things that it can offer as well as the benefits the cloud may have. Technology is always changing, and the next student may be the one to further the technology and services the cloud can provide.

What I would do differently is to give myself a chance to grow and be a better cybersecurity expert. I just started my first semester in cybersecurity and I am only taking two classes. My knowledge is as far as the progress I have been through my two courses. I would like to apply a greater knowledge and skills through what my classes have taught me and also deliver myself from a well-rounded perspective. Not only completing my master's degree is something I would like to add or do different, I would also like to reach out to other cybersecurity companies to get hands on experience. The only experience I have so far is in the Navy but I can apply what we call "deck plate leadership." It is leading by example because I am walking around understanding my people, equipment, and the mission which is why I would like to reach out for experience so I can take care of the people and whatever organization I may be with in the future.

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