Cloud Computing's Impact on Game Developers' Relationships with Users

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On my honor as a University student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments.

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Introduction

Video games have come a long way since their inception and have become a leading form of entertainment for the public. Game development falls under the category of software development, as video games are based on software applications and follow a similar development cycle. Recently, many development teams have moved to cloud computing as a result of the popular games it supports. Cloud computing is defined by the National Institute of Standards and Technology to be "a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources" (Mell & Grance, 2011, pg. 2). The core idea behind utilizing cloud computing is the delegation of processes to a third-party cloud provider to reduce the workload of the developer company. A stable, reliable method to host and handle this workload is imperative, as current day online, digital applications serve up to millions of users every day.

The technical project utilizes cloud computing technology to host application development through GitHub, a version control platform used to manage code among multiple developers. Social Networks and Archival Context (SNAC) is a free online resource that helps users discover information about families, organizations, and persons that are documented in historical resources and the connections they may have with one another. SNAC is an international cooperative that includes archives, museums, and libraries working together to build a collection of reliable descriptions of families, organizations, and persons that link to and provide a contextual understanding of historical records. It is different from other data collections due to a heavier focus on providing connections between entities and other entities, documents, or subjects for a user to further explore outside of SNAC (Glass, 2019). The records contained in SNAC are sourced and managed by approved editors who are a part of a

participating institution. However, the current method of making changes to the data collection is tedious and inefficient. To alleviate this, SNAC has adopted OpenRefine, a third-party data cleanup and transformation tool developed by Google that maps data to the corresponding fields from uploaded files. The capstone development team aims to integrate a SNAC extension to the OpenRefine tool so that the users can upload and edit entries more readily.

While my technical capstone actively uses cloud computing, this research paper takes more of a conceptual approach and focuses more on the relationship between cloud computing and its users using the technological momentum framework. The application of this framework can help identify the possible consequences of decisions made by developers, players, and cloud providers and whether or not cloud computing has a place in the future of technology and society. Researching cloud computing's impact on game developers' relationships with users can reconceptualize how growing technologies can affect social relationships.

History of Cloud Computing

Cloud computing was first mentioned in the 1960s, yet it took fifty years for the term to be coined in 2008 (Arutyunov, 2012). Cloud computing is quickly growing in popularity especially in game development, with improvements and new ideas constantly being developed (Riungu-Kalliosaari, Kasurinen, and Smolander, 2013). It has limitless capabilities and variations, but it is up to development teams to find the ideal fit with their methodologies and goals.

Riungu-Kalliosaari, Kasurinen, and Smolander (2013) conducted interviews with several gaming organizations and gathered their views and applications of cloud gaming. The study found five key points: cloud services and cloud gaming are well known in the gaming industry,

but are considered too unreliable for main game products; gaming organizations need clear business models and success stories to convince them to adopt cloud gaming; cloud services and cloud gaming business models don't focus on any platform or organization size; organizations consider cloud services and cloud gaming models to steer products towards services and user groups toward communities. For these reasons, companies are hesitant to fully invest in cloud computing but are aware of the potential and current uses. Current uses on the development side are for code and document hosting. For the user-facing side, the common uses of cloud computing include server-side processing or online game hosting. Although, it's worthy to note that the opinion on this seems to have changed over time due to the large mass of games that appear to rely on cloud computing now.

The most prevalent models of cloud computing are: infrastructure as a service (IaaS), platform as a service (PaaS), and software as a service (SaaS). IaaS allows consumers to choose the software and storage setup such as how much storage they want to run applications on. PaaS lets users work with base software as well as install custom software, leaving the provider to manage the underlying infrastructure of the system. SaaS simply lets the consumer use the provider's applications that run on their cloud infrastructure. Cloud provider technology already handles load balancing so that demands don't overload a single cluster of computers and traffic is directed to other clusters of computers. The computing plans set by a user also scale according to their demands (Arutyunov, 2012).

Some newer present-day multiplayer games such as Fortnite have utilize cloud computing to host their servers that users play in. For some games, their operations reside heavily on the cloud to host and process their game on the server-side (Chen, Huang, and Hsu, 2014). The type of model they utilize depends on the team's needs and capabilities. Another

model, data as a service, is utilized by many gaming platforms to store game data on the cloud and allow remote purchase and download of games from the provider straight to the player. Games like Super Mario Maker 2 by Nintendo enable users to create their own levels and save them on remote cloud servers for others to download and play at a later time. Some mobile games leave the game processing to the cloud, making the load for a user's mobile console smaller and more manageable**.** The player's device only needs to process image frames sent by the cloud server that did the logic processing and send back user input to the cloud server (Cai, Leung, and Chen, 2013). As for console or PC games, game streaming services (server-size processing) like PlayStation Now allow users to pay a subscription fee and have access to games on-demand through a cloud streaming the game straight into their device ("PlayStation Now", 2019).

In lieu of cloud computing's uses, the leading cloud providers, Amazon Web Services, Microsoft Azure, and Google Cloud Platform, use supercenter warehouses to house and maintain the cloud hardware to provide digital services across the nation. Despite cloud computing being a relatively new technology, there are many everyday products that rely on cloud providers such as Apple products' iCloud and Google Photos. Since there is such a large dependency for cloud computing services, there are many backup systems and generators to ensure that failure does not occur. When considering cloud, companies have to weigh the costs of working with providers as opposed to handling the services themselves.

Understanding cloud computing's current uses puts the advantages and disadvantages into perspective and allows for discussion on whether or not a development team should consider it to engage their players. Cloud computing can be a key player in the future of video games, and

the usefulness it provides will determine how well development teams and the players will receive it as a new technology.

The Future for Cloud Computing and Gaming

The rest of this research paper will expand on cloud computing and its impact on the relationship between game development teams and their users or players. This can be viewed through the technological momentum framework, which states that the relationship between technology and society is time-dependent and reciprocal, as they both influence each other. The history of evolving systems can be pictured in phases: invention, development, innovation, transfer, growth, consolidation, and competition (Hughes, 1987). *Invention* is the phase where the radical or conservative product is created, such as the constant new technologies being added onto cloud computing's pool of services. For the *development* phase, social construction of the technology exerts strong influence, as those working on the product must understand how it will fit in society and what role it will play when environmental factors are considered. In the *innovation* phase it is revealed how the technology systems will become tied to the product. It establishes the resources to use, who will "make" the product, and how it will be handled. The *transfer* phase is characterized with changes made to the product to account for the different environment or resources available to manufacturers based on location. To host a datacenter for cloud computing, it takes a lot of deliberation and decision making, with electricity and internet strength as an example of a driving decision of where to settle. *Growth* as a phase can be measured in many ways including profits, demand, or more, but is fairly self-explanatory once the measurement criteria is set. The *consolidation* phase covers the idea that some products may combine with their competition or related businesses to benefit all parties. Lastly, *competition*

involves the adaptation and evolution of products to respond to competitive clones of said product, such as Amazon versus Google (Hughes, 1987).

However, these phases aren't simply sequential but rather they overlap and backtrack. An example of backtracking occurs with *reverse salients*, which are components within a system that have fallen behind or are out of phase with the others (Hughes, 1987). In a rapidly growing technology field, a reverse salient can occur when video game companies or the cloud computing businesses they work with use outdated computing infrastructures which bottleneck the rest of the system, resulting in slower network and integration issues. However, modern maintenance and upgrades to the technology at play often prevents this from becoming an issue. For the most part, cloud computing is in a cycle between the competition, innovation, and growth phases identified in the technological momentum framework.

In order to experience growth as stated in the framework, a game needs to prosper and grow. The success of a video game often depends on the relationship between video game companies and their player-base, which is composed of users. If their relationship is lacking, then trouble often ensues. Video games are supported and kept running by both the development team and the player-base in different but unique ways. Developers, in particular, rely on users to fund the continued development of their game through microtransactions, initial game purchase, and in-game advertisements. It is in the best interest of developers to cater to the players who influence their decisions (Pagano & Brügge, 2013). This not only applies to video games, but to cloud computing technologies as well.

According to a literature review by Abelein, Sharp, and Paech (2013), there is a 92% positive correlation among 133 studies based on user involvement's role in influencing the success of a system. Users fund and enable the developers to continue updating and creating

more products by buying games/cloud services or items within the games, spreading by word of mouth, and offering suggestions. Cloud computing is a quickly emerging and readily available technology to developers and users to aid in design, development, and enjoyment of a game. Ideally, an implementation of cloud computing should better the user experience/user satisfaction of a game by improving game performance, adding enjoyable game features, or both.

Despite cloud technology being new, the feedback loop between cloud developers, game developers, and the game developers' player-bases have led to cloud computing's evolution in the scope of gaming to what it is today. Should the implementation of cloud into a game result in an enhanced gaming experience, then positive feedback will result, which will then encourage more support and investment in cloud from gaming companies.

The player-base can encourage cloud computing if said group enjoys the experience that cloud provides in a game. This can incentivize the development teams to invest in a cloud-based future especially if increasing profits are possible. With more investment and reputation, cloud computing can take off and become even more influential than it already is. It can feature new ways to engage users both inside and outside the game whether it is multiplayer support, speedy processing time, or out-of-game notifications. Enjoyability of a game affects the success of it and how it influences its players. By listening to feedback from users in pre and post development, teams can work towards user satisfaction which nurtures a better relationship between developers and users. It goes beyond a relationship of user and game, but instead is a relationship between users, technology surrounding the game, and the game developers.

Research Question and Methods

The primary research question is: How has the advent of cloud computing impacted game developers' relationships with users? The success of cloud computing can be measured through company earnings, usage metrics, infrastructure costs, case studies, and interviews. Besides providing definitions and analysis on the technology, developers, and players, the research paper investigates data from existing companies and games that utilize cloud computing. A case study by Ruggles, Wadley, and Gibbs, supported by a plethora of interviews with game development companies, gives credible evidence on the importance of the player-base to the game developers. Another study from Teng, Chen Y, Chen M, and Li covers the player dynamics that game developers can form to better support the developer-player relationship. That study is a synthesis of multiple papers related to the psychology around gaming. Interviews with software development teams informed perspectives on how developers handle user engagement within the cloud and whether cloud computing affects their approach to maintaining their relationships with their users. While software and game developers maintain some level of commonality, this paper investigates the differences in how cloud computing affects both fields.

Cloud Computing in Video Game Development

Cloud computing's inception has enabled many new methods of development for teams and a multitude of new game features as a result. It's allowed teams to scale their games to meet increasing demands, heighten security, and save on infrastructure costs. It has enabled new channels of communication between teams and their player-base and resulted in better user engagement and feedback. The origins of the technology aren't crystal clear, as it came gradually due to the effort of general individuals wanting to advance computing technology. What is

known however, are those who capitalized on the technology and made it publicly accessible. Many of the top publicly traded video game companies, such as Activision Blizzard and Nintendo, are successfully utilizing cloud computing. The success and profitability of cloud computing (shortened to "cloud") can be seen across various gaming platforms, as Activision Blizzard and Nintendo specialize in computer games and console games, respectively.

Activision Blizzard

The quarterly financial reports of these companies showcase how using cloud has successfully increased profitability and user-activity. In 2012, Activision Blizzard partnered with OpenStack, an open standard cloud computing platform, to balance server hosting for online players (Truong & Cross, 2019). Blizzard's general operating cash flow was $1.3 billion in the beginning of 2012 (Activision Blizzard, 2012a). Seven years later in the end of 2019, it was $1.83 billion (Activision Blizzard, 2020). Although this increase is not solely due to the move to cloud, the continued usage of cloud even today has contributed to the change in profits since 2019. The number of active users, defined as "individuals who accessed a particular game in a given month", also increased during the advent of cloud computing from roughly 51.6 million players in the beginning of 2012 to around 409 million players in the beginning of 2020 (Activision Blizzard, 2012b). Activision Blizzard also recently announced a move to Google Cloud Provider (GCP) in 2020, which means that the company still sees value in utilizing cloud and did active research in finding the provider best fit for them. (Sinclair, 2020).

Nintendo

Nintendo, while known for their popular consoles, also offers paid online download of their games. These distributed games are made possible through a globally distributed cloud platform, which contains the game contents for download. Nintendo utilizes its cloud servers to stream games to consoles that are physically incapable of handling the high levels of processing. Nintendo's continued adoption of this cloud infrastructure, starting as early as the Wii's online software shopping channel in 2006, to its present-day successor in the Nintendo eShop, signals cloud's effectiveness in accomplishing Nintendo's goals of maintaining user relationships, serving a quality gaming experience, and being a profitable business to continue their operations (Nintendo of America's Corporate Mission, 2020). Nintendo reported ¥135.8 million-yen gross profit in 2006, at the start of the Wii shopping channel (Nintendo, 2006). In the end of 2019, it continues to grow with cloud technology as an integral part of its operations, reporting ¥466.0 billion-yen (Nintendo, 2020).

Developers and Player Relationship Explored

Video games, or software in general, act as a medium for players to communicate with other players as well as the development team. In the case of Activision Blizzard's first-person shooter console and PC game, Overwatch, the developer-user relationship nurtures a sense of community through feedback from players, patch notes, and developer posts. Feedback is elicited from players which allows the development team to make adjustment and announce the changes, resulting in a generally positive feedback loop. (Blizzard Entertainment, 2020). The game offers an experimental mode that allows players to experience the suggested changes in-game. This is to help players gather first-hand experience and make an informed opinion to give

useful feedback to developers before releasing it to the general public (Blizzard Entertainment, 2020). This experimental mode is backed by their distributed network of cloud servers, which allow fast rollouts of changes to the game that the developers make for the players to test. The cloud network's load balancing also ensures that players do not experience network issues when the changes attract a larger concentration of players who want to test and play. The result is that satisfied players feel that their input is appreciated and valued when the development team makes the suggested changes. The viability of this experimental mode can only be made possible through cloud and communicates to the company that cloud is a valuable asset to their efforts in improving their customer relations (Blizzard Entertainment, 2020). Games like Overwatch thrive when the servers are working and suffer significantly when things go wrong with their cloud network. There is no multiplayer, no community fostering, and no gameplay satisfaction when the cloud falls.

Video game developers are already well aware that the online community of a game is vital to that game's success. Based on past games' successes, any game expecting to grow a player-base knows that they need to cater towards the changing tastes of their players in order to keep the game appealing. Whether the games are single-player or online multiplayer games, development teams aim to support and nourish game-based online communities by implementing the players' feedback (Gibbs, Ruggles, Wadley, 2005). Discussion about the game through these communities encourages and supports new players while developing strategies, plots, and content for the developers. Examples of this include bug reports to fix problems encountered through the game, and in-game statistics to give developers insight on what is strong, weak, or how to balance the characters. Hosting player discussion forums on the developers' behalf allows for an approved meeting place for players to communicate with each other and developers. All

aforementioned examples are all typically powered by cloud systems around the world managed by parties separate from the developers (Gibbs, Ruggles, Wadley, 2005).

Thanks to the Internet, which is assisted by cloud, players are able to form online communities to share tips, form relationships, and provide value to each other via gaming communication (Chen et al., 2012). Players rely on each other oftentimes to overcome demanding challenges in a game, and developers can enable players to better play with and assist each other via aforementioned forums, in-game chat functionality, and allowing players to progress together online. Some games enable players to send a call for help to other players so they can assist each other and form friendships through the game. People want to be included in multiplayer games. They want to win and do accomplish tasks together (Chen et al., 2012). To properly enable this activity and allow players to experience this community building, developers must be in touch with their player-base via techniques enabled by cloud computing.

Cloud Developers' Perspectives

Interviews with development teams from WillowTree, a client-based mobile application design and development company, and Capital One, a large tech-focused banking company, were conducted in both video calls and physical in-person sessions. The interviewees from both companies have noted that cloud is immensely helpful for saving costs, time, and resources. A development team only has to focus on their product and doesn't need to concern over "underlying resources, security patches, set up, or upkeep of product hosting servers" because this is the primary job of the providers (Slattum, 2020). With this out of the way, the teams can spend more time developing quality products for their consumers. A better-quality product

enables a good user experience, and typically, more support from the user for the development team's company.

The downsides that the interviewees pointed out include "unfinished products from providers and consolidation of the internet" (Landis & Loy, 2020). Unfinished products typically result from a product race between large cloud providers such as Amazon Web Services (AWS), Google Cloud Provider (GCP), and Microsoft Azure (MA). Although these three aren't the founders of the technology, they are responsible for the widespread popularity of cloud computing today since these companies are already massively well known. Many providers are guilty of releasing unfinished products, but these three are in a constant race to provide new and innovative services to attract users. Oftentimes, the products are rushed and aren't fully functional or ready for the consumer's needs, especially those that are responses to their competition's new products (Landis & Loy, 2020). This aligns with the technological momentum phases of competition and innovation, as the competition between these companies drives innovation in any given big cloud computing provider in an attempt to beat their competitors.

Lastly, consolidation of the Internet revolves around the idea that the largest cloud providers, AWS, GCP, and MA, make up a concentrated mass of the Internet as they have a hand in hosting many sites and services across the internet, which coincides with the consolidation phase of technological momentum. The fear of these companies controlling so much of the Internet raises concerns about what they could do with this power. Beforehand, the Internet was concentrated around universities, which would yield a decently distributed network of data centers, resulting in lesser damage if some were to fail. Nowadays, the interviewees fear that any natural disaster on their data centers can wipe out a huge portion of the Internet. In addition to

this, any outdated or malfunctioning hardware on the provider's end can snowball and affect the entire data center's performance, creating a reverse salient. (Landis & Loy, 2020).

Understanding the Research on Cloud Computing

The results clearly indicated that cloud computing is avidly used in video game development with little to no signs of stopping or stagnating. Though concerns such as consolidation of the Internet are valid, game development companies can't afford to pass up such a valuable resource and risk falling behind other companies. Cloud-based programming will continue to grow as companies and users invest and favor the benefits of building user engagement through this new technology. In return of this support, following the framework of technological momentum, cloud computing has enabled game developers to better connect with their players. This reciprocally growing relationship between cloud computing and game developers has enabled both parties to benefit from each other. Cloud computing continues to cycle through multiple phases of technological momentum, with the growth phase being particularly prevalent as the technology continues to see increased usage in the world.

While this paper only addresses cloud's impact on the video game and software industry, cloud has been growing in other fields. Banking, military, finance, and medical are some of the fields actively utilizing cloud and are exploring more uses of the technology to benefit their respective fields. Although their reasoning for their continued use of cloud may differ, cloud garners support from multiple professional fields of work due to their continual usage of cloud computing. This aligns with the technological momentum framework of society impacting the technology whether it's by financial support or technical feedback.

The evidence and research I gathered is not completely indicative of why or how cloud computing, or any games or products, found success. Many factors can attribute to why cloud and the companies it is used in continue to see growth that are not covered here. For video games, cloud is a valuable tool to aid in a team's goal of attracting a loyal player-base, but it requires good design on all other aspects of the game from said team.

I could have interviewed more people to gain more unique perspectives. More specifically, I could have interviewed dedicated game developers and professionals in other fields, such as banking. It would have been useful to look into potential cases of negative impacts of cloud such as the privacy issues of storing private customer data on third party servers. In addition, it would have been interesting to examine different companies that vary in company sizes, device types, and even nationality to see if other factors affect the success of cloud. Looking deeper into communities formed from cloud from other games, companies, and professional fields would also reveal cloud's impact on relationships there.

As a software developer, I know more strategies of gathering feedback and have more knowledge about the field I am working in. My future plans don't predict professional game development, but should that ever happen, I will be prepared with knowledge of how cloud computing played a role.

Future Steps for Cloud Computing Research

This research shows how a technology can go through phases of technological momentum. The technology impacts people and their relationships while people affect cloud's development throughout its progression through the phases of technological momentum characterized primarily by growth, competition, and innovation. The technology brings many

tools to the table and enables developers across many fields of study to scale and deliver quality products to their patrons. Such speed of growth and adoption warrants an impartial evaluation on the implications of cloud computing's rapid entrance into everyday activities

This paper should serve as a reference point to help in investigating further how cloud computing has impacted professional companies. Companies can utilize cloud computing for more than one aspect of their business, and finding more correlations of cloud adoption, company success, and user-developer engagement will require further research. Continuation of this research would require more time and effort put into gathering unique and ranging perspectives about cloud computing's uses in the professional game development scene. Deeper research into user reception of numerous different game features enabled by cloud computing and how that impacted the player-base's relationship with the developers could prove useful. Technology can bring people together just as much as it can tear people apart. Like it or not, new technology will continue to be developed and evolve. However, how well it coexists and affects society will ultimately be a massive decider in the technology's future.

References List

Abelein, U., Sharp, H., & Paech, B. (2013). Does involving users in software development really influence system success? *IEEE Software*, *30*(6), 17-23.

Activision Blizzard (2012a). *FIRST QUARTER 2012 FINANCIAL RESULTS*. Retrieved from https://investor.activision.com/static-files/dabb1caf-df96-4295-aaf5-fd757d0c477c

Activision Blizzard (2012b). *Fourth Quarter 2012 Results*. Retrieved from https://investor.activision.com/static-files/9cff3600-ee20-4760-87b5-54ba90f1aa70

Activision Blizzard (2020). *FOURTH-QUARTER AND 2019 FINANCIAL RESULTS*. Retrieved from https://investor.activision.com/static-files/fafbcb7a-0ddd-44ae-acf3-7f5aec4ea3ea

Arutyunov, V. V. (2012). Cloud computing: Its history of development, modern state, and future considerations. *Scientific and Technical Information Processing*, *39*(3), 173-178.

Blizzard Entertainment (2020, February 22). Jeff Kaplan and Michael Heiberg on Experimental mode, Triple Damage, and ice cream economics. Retrieved from https://playoverwatch.com/en-us/news/23317715/jeff-kaplan-and-michael-heiberg-on-experimental-mode-triple-damage-and-ice-cream-economics

Cai, W., Leung, V. C., & Chen, M. (2013, March). Next generation mobile cloud gaming. In *2013 IEEE Seventh International Symposium on Service-Oriented System Engineering* (pp. 551-560). IEEE.

Chen, K. T., Huang, C. Y., & Hsu, C. H. (2014, July). Cloud gaming onward: Research opportunities and outlook. In *2014 IEEE International Conference on Multimedia and Expo Workshops (ICMEW)* (pp. 1-4). IEEE.

Hughes, T. P. (1987). The evolution of large technological systems. *The social construction of technological systems: New directions in the sociology and history of technology* (pp. 52-80). Cambridge, MA: MIT Press.

Important information about the closure of the Wii Shop Channel. (2017, September 29). Retrieved from https://www.nintendo.co.uk/News/2017/September/Important-information-about-the-closure-of-the-Wii-Shop-Channel-1285994.html

Kaye, L. K., & Bryce, J. (2012). Putting the fun factor into gaming: The influence of social contexts on the experiences of playing videogames. *International Journal of Internet Science*, 7(1), 24-38.

Landis, S., Loy, J. (2020, February 11). Personal interview

Mell, P. M., & Grance, T. (2011). The NIST definition of cloud computing. NIST Special Publication 800-145. doi: 10.6028/nist.sp.800-145

Nintendo (2006). *Outline of consolidated financial results for the six months ended September 30, 2012 and consolidated earnings forecast for the fiscal year ending March 31, 2013.* Retrieved from https://www.nintendo.co.jp/ir/en/events/121025summary/index.html

Nintendo of America's Corporate Mission and Philosophy. (n.d.). Retrieved from https://www.nintendo.com/corp/mission.jsp

OpenRefine. (n.d.). *Introduction to OpenRefine*. Retrieved from http://openrefine.org/

Pagano, D., & Brügge, B. (2013, May). User involvement in software evolution practice: a case study. In *Proceedings of the 2013 international conference on Software engineering* (pp. 953-962). IEEE Press.

PlayStation Now – Online Game Streaming Services on PS4 or PC. (n.d.). Retrieved from https://www.playstation.com/en-us/explore/playstation-now/.

Riungu-Kalliosaari, L., Kasurinen, J., & Smolander, K. (2013). Cloud services and cloud gaming in game development. in Proc. the IADIS Game and Entertainment Technologies, 22(24.7), 2013.

Ruggles, C., Wadley, G., & Gibbs, M. R. (2005, September). Online community building techniques used by video game developers. In *International Conference on Entertainment Computing* (pp. 114-125). Springer, Berlin, Heidelberg.

Sinclair, B. (2020, January 24). Activision Blizzard and Google sign esports, cloud deals. Retrieved from https://www.gamesindustry.biz/articles/2020-01-24-activision-blizzard-and-google-sign-multi-year-esports-cloud-deals

Slattum, A. (2020, February 28th). Personal interview

Social Networks and Archival Context. (n.d.). *About SNAC*. Retrieved from https://portal.snaccooperative.org/about

Teng, C. I., Chen, M. Y., Chen, Y. J., & Li, Y. J. (2012). Loyalty due to others: The relationships among challenge, interdependence, and online gamer loyalty. *Journal of Computer-Mediated Communication*, *17*(4), 489-500.

Truong, D., & Cross, J. (2019, April). Open Infrastructure Summit. Open Infrastructure Summit. Denver. Retrieved from https://www.openstack.org/videos/summits/denver-2019/how-blizzard-entertainment-uses-autoscaling-with-overwatch