Technical Evaluation of Cloud Migration

(Technical Paper)

Revolutionizing Businesses in the Cloud and Their Profound Impacts on the Future

(STS Paper)

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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

Technology trends come and go, but the cloud is no simple data hub but a pivotal force in revolutionizing companies' infrastructure to leverage and enable their applications and data with endless potential. The cloud migration initiative has been seen globally and popularized in the early 2010s; the goal is to transition all the data, applications, and software from companies' private servers (on-prem) to cloud-hosted virtual servers. Cloud servers are provided by companies such as AWS and Amazon Web Services, which provide extensive tools and services for cloud-hosted applications. The cloud restructures the existing applications and software with enhancements of increased accessibility, scalability, efficiency, and diminished IT and operational costs. Cloud services remove companies' sole responsibility and headache in developing and running their data centers and give them tools to continue cultivating and innovating their system services.

During the summer of 2023, from June to August, I served as a software engineering intern at Fannie Mae, a mortgage financing company that purchases mortgage loans from lenders and makes them more accessible to borrowers by backing these loans on the mortgage market. Notably, the company made a strategic decision to embark on the trend of cloud migration, resulting in the migration of all its assets and applications to the AWS Amazon Web Services cloud. In my technical report, I will focus on my responsibilities during my internship, with a particular emphasis on my main project: migrating my team's financial file upload service to the cloud. This project serves as a pivotal point of interest, highlighting my experience learning the services and technology required for the successful migration of critical assets and the vast improvements in capabilities the cloud-hosted software provided.

In my STS research, I will explore the impact of post-migration, shedding light on the implications and outcomes of this substantial technological shift within companies and the world. With more users utilizing the cloud, data, and applications can be reached on a grander scale across the globe with incredible speeds and ease. These capabilities provided by the cloud bridge the digital divide, fostering collaboration, innovation, and communication on a global scale. However, due to such a drastic, exponential increase in cloud users and the internet, the dependence on the current infrastructure of data centers worldwide is not environmentally sustainable. The power usage of these data centers is unparalleled in the drastic energy consumption to fuel these servers and cool them with mainly non-renewable energy sources. This excessive energy consumption has resulted in tangible environmental impacts, including water scarcity, noise pollution, and increased carbon emissions near data centers. My cloud research strives to explore the necessary sustainability measures vital for the flourishing potential of cloud migration. Such can transform the landscape of applications and data for businesses and the global community, all within a sustainable cloud infrastructure framework.

Technical Discussion

During my internship at Fannie Mae, I was exposed to the practical realities of working as a software engineer in a corporate setting. This hands-on experience allowed me to engage in the complete software development cycle and gain valuable insights into the intricacies of cloud migration and how it is a revolutionary transition. My internship occurred with Fannie Mae's Lender Technology Development Engineering team, specifically ER Frontier, which was responsible for the business recon process in matching financial transaction data and reports to businesses. My main project was the cloud migration of my team's on-prem asset, which serves

the critical function of transferring bank and mortgage files for our team. One of the company's primary missions was to be fully cloud migrated, and such an application was the last for my team, requiring urgent time to ensure our department's migration was completed on time. The overarching aim for the migration was to propel Fannie Mae's systems forward, introducing innovation that would revolutionize the company's applications and data management in ways previously considered unimaginable.

The existing on-prem system could only support flat files and was in dire need of flexibility to accept various file formats from all sources efficiently. The cloud migration was the solution to upgrade my team's application. Hosting the application on the AWS cloud would enable superior compatibility, make it fully scalable and more accessible, and provide more significant data analytics. Successful onboarding to the cloud required implementing various technologies such as Fannie Mae's sign-on service (FMSSO), AWS, CDX services, and Apigee. The code of the existing system had to be deconstructed and reconfigured to accommodate these services. One key takeaway was the essential role of collaboration within and across teams when working on such multifaceted projects. This collaborative approach was particularly evident when I ran into debugging and troubleshooting issues in transitioning the legacy code with the services that the authors have left the company and cannot help. To brainstorm solutions for adapting the code to the services, I had to effectively communicate with the multiple teams responsible for managing the underlying technologies to explore solutions and gain insight into other applications' cloud migration. Due to the novelty of such technologies, rigid documentation is not available, forcing my team to creatively restructure the systems to fit the company's framework best to maximize the potential cloud services provided.

To facilitate the transition to the cloud, I designed a new website to host the application with an intuitive, user-friendly interface that simplified its functionality. The website was connected to the company's sign-on services for internal users, allowing the Fannie Mae database to be linked to the cloud. To verify and successfully deploy the database connections, I incorporated JavaScript to ensure correct successful access to the application. An AWS lambda function was required to manage the code's execution to migrate the system's code. Lambda is a serverless event-driven computing service that runs and triggers the application's code. A benefit of the service is the ability to scale the application up rapidly when high in demand and down to zero when not, enabling automated efficiency for the application to be always available and efficient in high traffic. To verify the successful deployment of the software via lambda, a Jenkins pipeline, an automation server for development, was used to check each stage. The code hosted in the lambda could now accept all banking files, not just flat text files. To finalize migration, the website I created was hosted utilizing an AWS S3 bucket storage service and connected with the lambda function written. The application would run from the website with the connected lambda function executing the file application, and the hosted S3 bucket would serve as the new data source for the files. The cloud-residing website is the link to facilitate the successful deployment of my team's final asset to the cloud, equipped with enhanced capabilities and positioned for future growth.

My migration project vastly impacted how I perceived the cloud's operation in all its intricacies and enabled vast technical innovation applicable to all applications. Although cloud migration is a breakthrough for businesses and the world, the hardware and energy needed to provide this exponentially growing cloud raises concerns about finding a sustainable balance for the growing migration.

STS Topic

My STS topic explores the multifaceted impacts of cloud migration, a transformative force that holds the power to revolutionize the digital world. This remarkable trend has swept across businesses of all sizes, driven by the shared aspiration to reshape the landscape of their applications and data to foster innovation on an unprecedented scale. Nevertheless, this digital revolution comes at a potential cost to the environment, as the demand for cloud migration fuels the construction of ever more data centers and an insatiable need for energy to sustain their performance. In pursuing a more sustainable cloud-hosted future, it is crucial to examine the implications of this drastic growth on the ecosystem surrounding data centers. This examination is not merely a question of environmental responsibility but a fundamental necessity to ensure the continued flourishing of cloud technology for society. By striking a delicate balance between technological progress and environmental sustainability, the limit for the cloud is the stars.

Andy Still's observation in 2016 (Still, 2019) underscores the widespread adoption of cloud technology, with 90% of businesses already incorporating it into their operations. In contemporary times, the cloud has transitioned from a cool storage trend to a foundational component for businesses striving to remain competitive. The cloud-host infrastructures allow for more incredible innovation and capabilities to improve services to users and reduce operational costs. The cloud continues to grow exponentially with the ever-growing increase of internet users who depend more on these technologies to scale with their increase in demand. The advantages of cloud migration are undeniable, especially concerning improving internet performance and accessibility. Migration sets in motion a network effect, leading to consistent performance upgrades and new services to accommodate the growing community of cloud users. This progression extends the global reach and accessibility of data and services, digitally

connecting the world faster and fostering enhanced collaboration and innovation. Cloud services work by having data centers in diverse regions scattered across the globe, such as providing closer access points for all users to provide low latency, higher speeds in accessibility, and secure availability in having multiple server sources if one goes offline. Another notable benefit of cloud migration is its minimal impact on the existing system, as it can recreate the same resources and architectures (Garrison, 2018). Such provides versatility in cloud migration, where all kinds of software applications can be deployed to the cloud, appealing to all businesses and users. For instance, AWS offers many helpful tools and training, enabling companies to migrate their existing systems while emphasizing new scalability and capabilities. Drawing from my experience onboarding an asset to the cloud, I witnessed firsthand the significant improvements and capabilities that AWS tools and metrics brought to the application. This transformation illustrates how the cloud has enhanced and advanced the software development processes within companies, providing more scalable, accessible, and innovative services.

However, the growing reliance on data centers within society poses significant challenges. The exponential increase in data center usage places substantial demands on power and land resources, with no signs of this trend abating. These data centers, dispersed across diverse locations from rural to urban areas, significantly contribute to the ecological impact of our digital age. Notably, data centers currently account for 1% of the world's electricity consumption, which is expected to rise (Masanet et al., 2020). This surge in energy consumption, combined with their global proliferation, leads to heightened concerns about the environmental impact. Many large cloud services companies such as Amazon, Google, and Microsoft have pledged to be 100 percent renewable. However, a fully renewable energy-sourced cloud is far from being closed. AWS has expanded operations in Virginia by 59 percent since 2017; Virginia's

primary energy provider, Dominion Energy Supply, is mainly fossil fuel with limited renewable energy sources (Cook, 2019). Dominion has even justified new investments in natural gas supply and generation capacity to match the rising power demand of data centers. Cloud companies must take more severe action to generate more renewable energy sources. In turn, the power companies are not motivated to invest in more expensive, cleaner energy sources to meet the growing cloud consumption. The impact of using such dirty energy is seen in the local environments around the data centers. The community, particularly, faces a rise in carbon dioxide emissions, noise pollution, and even droughts. Data centers require immense power to the point where a single data center consumes the equivalent electricity of 50,000 homes (Monserrate, 2022). Monserrate highlights an even more staggering figure where, in some cases, only 6 to 12 percent of the energy consumed is devoted to active computational processes. Data centers are designed with reliability as a core principle. Such relies on maintaining extra servers and data in a standby state to ensure uninterrupted operations, which require extensive energy to idle. To ensure such servers do not overheat, the data centers must regulate cooling down the servers, requiring more energy and resources such as water, which contribute to droughts.

It is essential to recognize that not all data centers are equal, whether in the area or the infrastructure. Some are hyperscale facilities that facilitate energy with renewable sources; many are small-scale traditional ones that lack energy-optimizing infrastructures, causing a 25 percent difference in energy consumption. Cloud and power companies dictate the energy consumption of data centers and their need to take steps towards eco-friendly centers. The cloud will not pass away; it is a rapidly growing entity, especially in regions like Virginia, where an astonishing 70 percent of all data is stored and powered primarily by non-renewable, unclean energy sources.

Failing to adopt sustainable practices jeopardizes the cloud's sustainability amid growing demand.

Research Questions and Methods

My research aims to find the balance between the performance and sustainability of cloud migration to foster a sustainable cloud. I will determine the extent of cloud deployment within national and global business landscapes, ascertaining the extent to which the world genuinely embraces cloud technology and how beneficial it has been for their infrastructure. Such will paint the picture of the current reach of the cloud globally and how progressive it has been and will be, specifically if the endeavor of deployment has paid off for the users and determine the future aspirations of the cloud. I will explore the impacts of the surge of users to see if demand is being appropriately scaled to accommodate performance and accessibility. However, the growing need for higher performance means greater power to run the data centers, and the impacts need to be examined. The local environments around the data centers and even the states face the most challenging environmental impacts. The state in which the data centers reside dictates primarily the types of energy sources available for consumption, and even the designs of the data centers strain energy use. I intend to research the improvements needed for data centers to operate more eco-friendly and what steps need to be taken by companies and states to accommodate the migration for successful deployment now and in the future.

Conclusion

Cloud migration has arrived at the forefront of businesses and the world, and this is just the beginning. The growth in technologies and internet usage has created a newfound

dependence on the cloud for businesses and applications to operate. Dependence, however, comes at the cost of staggering power consumption that needs to be balanced with environmental sustainability. Cloud integration has lifted digital services to limitless potential with a treasure chest of data analytics and services to significantly improve the software development process and progression. The cloud's scalability, accessibility, security, and diverse services provide necessary features all in one.

Nonetheless, the promising horizon of the cloud should not mask the tangible impacts it exerts on the physical world, particularly concerning the ecosystems surrounding the expanding data centers that grapple with persistent environmental challenges. Given the escalating reliance on non-renewable energy sources, these enduring issues reverse societies' progress in combating global warming. Unless the current migration trajectory is corrected, the cloud will fail to propel society toward more excellent connectivity and innovation, instead broken and doomed.

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