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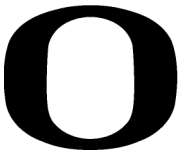

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The Value of Transitioning to a Cloud-based Phone Platform for an SME

CAPSTONE REPORT

Christopher Schwartz
Information Technology Manager
Cayuse Shared Services, LLC

University of Oregon
Applied Information
Management
Program

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Continuing and Professional
Education
1277 University of Oregon
Eugene, OR 97403-1277
(800) 824-2714

Approved by

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Dr. Kara McFall
Director, AIM Program

The Value of Transitioning to a Cloud-based Phone Platform for an SME

Christopher K. Schwartz

Cayuse Shared Services, LLC

Abstract

This study assists in understanding the value of transitioning to a cloud-based phone solution for an SME. The target audience is SME leaders and their IT stakeholders seeking innovative technology solutions rather than on-premise PBX telephony systems. The sources are limited to publications between 2009 and 2019, focusing on cloud-based environments and UCaaS systems. The study is significant in addressing the value of a CBP over a PBX solution that can support an SME.

Keywords: cloud-based phone, cloud PBX, on-premise, PBX, SME, UCaaS, virtual PBX, VoIP

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Introduction to the Annotated Bibliography

Statement of the Problem

A private branch exchange (PBX) is a telephone system within a business that switches calls between users on local lines while allowing all users to share a certain number of external phone lines (Rouse & Payne, 2011). The primary intent of a PBX is to save the cost of providing a line for each user to the telephone company's central office (Rouse & Payne, 2011). Hosting a PBX has traditionally been time-consuming and costly for small-and medium-sized enterprises (SMEs) (Drake & Turner, 2019), defined as "all enterprises with fewer than 500 employees" (United States International Trade Commission, 2010, pp. 1-2).

Private branch exchanges are widely used by SMEs to route telephone calls within their own premises; a PBX may also support a larger-scale use, such as a call center (Shinder, 2006). Varying types of PBXs are implemented by SMEs that allow for a variety of functionalities and capabilities; these uses may include having extensions, placing calls, sending Short Message Service (SMS) messages, and sending and receiving faxes (Lukinskikh, 2015).

Having a PBX has traditionally posed challenges for SMEs (Drake & Turner, 2019). Issues arise with PBXs when leasing options, renewals, standard maintenance, and simple frustrations impact the time management and finances of an SME (Alexander, n.d.). Leasing options pose problems in the long run, as an SME will enter into a lease agreement that ends up costing more than purchasing the equipment outright (Alexander, n.d.). Depending on the terms, the company may also be obligated to pay after the lease ends, or even have to forecast lease buyout options, including the buyout fee and the current market value of the leased equipment (Alexander, n.d.).

Standard maintenance of a leased PBX is challenging for an SME because maintaining equipment according to the leasing company's specifications can get expensive while owning the

equipment outright enables the owner to determine the maintenance schedule (Alexander, n.d.). Finally, SME users of a PBX and those who are tasked with maintaining these systems may experience frustrations with the phone equipment itself, caused by the need to perform tasks to meet vendor management obligations (Chapman, 2009). All of these issues result in time that must be spent maintaining and supporting the PBX and lease agreements, and financial resources that SMEs typically do not have (Alexander, n.d.).

In recent years, cloud-based enterprise phone solutions have become more affordable, versatile, and resilient solutions for SMEs (Cortés-Mendoza et al., 2016). For the purposes of this study, cloud-based is defined as a virtual framework facilitating critical business applications, such as a phone solution, to be executed in a controlled, virtualized environment on servers, while the client-side software can be immediately deployed to any computing device to interact with the business applications or solutions (Ding et al., 2013). More recently, cloud phone services have become more popular because they provide less costly and complicated phone solutions than owning and operating an on-premise PBX (Hu et al., 2011).

Cloud-based phone (CBP) solutions are increasing due to their availability and the lowering of prices for cloud solutions across all industries (Tchernykh et al., 2018). For the purposes of this study, cloud-based phone, or Internet telephony Voice over Internet Protocol (VoIP), refer to a platform for making calls according to the internet protocol (IP) standard delivered through the internet, which does not rely on traditional on-premise hardware or costly maintenance (Tchernykh et al., 2018). Voice over Internet Protocol has a considerable amount of hosted VoIP platforms available on the market, offering full-blown telephony systems where the phone communicates over the Internet through a remote PBX (Rashid, 2013).

These cloud-based solutions for SMEs have become easily attainable to meet their business strategies, which include cost-saving measures (Khatua, 2015). Cloud-based phone

solutions have become the solution set for many small businesses to adopt as they move away from their on-premise PBX to the cloud (Tchernykh et al., 2018). However, cloud-based phone solutions do pose issues, including security concerns such as privacy, access control, and the encroaching demand for bring-your-own-device (BYOD) to work (Karopoulos et al., 2015). Privacy is a concern because as individuals, we interact with one another, while on multimedia servers on the back end, the media traffic that passes through different network elements such as proxies and trusted or untrusted IP networks reveals private information about users' identity, behavior, location, and other factors (Karopoulos et al., 2015). Access control is an issue because traditional access control mechanisms are not sufficient for cloud environments (Karopoulos et al., 2015). Finally, BYOD poses problems for businesses because they introduce new entry points and unknown factors via employees' personal devices, which leads to more threats that reduce the security of the cloud network (Karopoulos et al., 2015).

The main underlying problem for small businesses that want to transition to a CBP solution is that a number of small businesses are locked into leases with their Internet Service Providers (ISPs) or telephony providers, making it costly to switch (Durcevic, 2019). However, SMEs can benefit the most from cloud-based solutions (Durcevic, 2019; Hu et al., 2011). As a range of small and large communications vendors are shifting their services to cloud-based delivery, they are affording customers the choice of having hardware that sits on their own premises as a hybrid model, or accessing a virtual PBX through unified communications (UC) platforms via the cloud (Butler, 2012), both less expensive options than on-premise PBXs (Beltran & Bertin, 2015).

Purpose of the Study

The purpose of this qualitative study is to provide literature to aid in the assessment of the value of a cloud-based phone solution such as Unified Communication as a Service (UCaaS)

within the small and medium-sized enterprise (SME) community. Unified Communication as a Service is a cloud mechanism for delivering communication to the business (O'Connell, Elliot, & Benitez, 2017). The design of the study is literature-based. The method of inquiry is the compilation and analysis of selected research and scholarly articles. The focus of the study is the value an SME gains by switching from an on-premise PBX phone system to a cloud-based phone solution. The study is significant in addressing the value for an SME of a cloud-based phone solution compared to the value of a PBX on-premise solution and is timely due to the rapid availability of cloud technology (Varghese & Buyya, 2018).

Research Questions

The guiding question around which I will structure this study is:

Main Question. What is the value for an SME transitioning to a cloud-based phone solution?

Sub-questions.

- How does the cost of a cloud-based phone solution compare to the cost of an on-premise PBX system for an SME?
- Can growth be incorporated into a CBP solution and include a heterogeneous network environment?
- What are the security risks of relying on the cloud service provider (CSP) for phone solutions?

Audience

The primary audience for this study is small-and-medium-sized business leaders, including their information technology (IT) department key stakeholders who seek innovative technology solutions for their on-premise PBX telephony systems. The following specific roles might have an interest in this study: chief executive officers (CEOs), chief information officers

(CIOs), chief financial officers (CFOs), and chief operating officers (COOs). Chief information officers and chief financial officers will be drawn to the information on potential cost savings, flexibility, and the return on investment (ROI) offered by a CBP compared to an on-premise PBX. Chief executive officers and chief operating officers will value the growth, scalability, and capabilities provided by a decentralized phone system in the cloud. Understanding the value provided by a CBP solution gives substance to the decision-making process for opting for a CBP over maintaining a PBX.

The study is significant in addressing the value of a CBP solution over a PBX on-premise solution that can support an SME. More importantly, the research into a CBP solution will afford a different perspective for SME leaders to make important IT decisions.

Search Report

Search strategy. I limited sources to those that were published within the last ten years and found that there was relevant information regarding cloud-based environments and UCaaS systems published within the previous five years. I focused my selection of works on the three areas of interest for SMEs:

- Value of CBPs,
- CBP security, growth, and scalability, and
- Problems related to CBP platforms.

I was challenged after discovering a limited amount of scholarly sources available, specifically in the area of cloud-based phone platforms. Therefore, not all of the works selected are scholarly works; however, the material was weighed against the reference criteria evaluation. This is because there are not a lot of scholarly research available, so in fact, the sources represented below are only a narrow representation of the published material available.

Keywords. I performed an initial search of the literature related to CBPs in three areas:

- Initial costs and overall cost savings,
- Growth and scalability, and
- Maintenance and security.

I used the following keywords:

- Unified Communications as a Service,
- UCaaS,
- Cloud-based phone solutions,
- CBP,
- Cloud phone solutions,
- SME cloud-based phone solutions,
- SMB cloud-based phone solutions,
- Internet telephony VoIP,
- Cloud VoIP,
- SME cloud VoIP,
- SMB cloud VoIP,
- SME Internet telephony VoIP,
- SMB Internet telephony VoIP,
- Cloud PBX,
- Cloud Private Branch Exchanges,
- On-premise PBX versus Cloud VoIP,
- On-premise PBX versus Cloud phone platform, and
- Virtual PBX.

Search engines and databases. The leading search engine I employed was the University of Oregon (UO) Libraries' main search tool and their shared collaborative scholarly search engines, which include Interlibrary Loan, Gale Cengage Computer Database, and General OneFile.

Documentation approach. I generated a Microsoft Excel spreadsheet to aid in establishing a tracking method of the relevant references discovered for this study. The categories I created included authority, timeliness, relevance, quality, and any lack of bias with the source. While reviewing the content of the article, I applied a drop-down selection as an additional column that contained the following three choices: the value of CBPs for SMEs; CBP security, growth, and scalability; and problems related to CBPs for SMEs. I uploaded all documents into Adobe portable document format (PDF) and stored the documents on my personal Google drive in a file labeled "Research." I used a naming convention for all PDF sources of author_title_year. In the case of multiple authors, I used the first author's last name on the source for simplicity.

Reference Evaluation Criteria

I evaluated references using the five characteristics described in the *Evaluating Information Sources* guide by the University of Florida's Center for Public Issues Education (CPIE) (2014).

- **Authority**: I limited my sources to those with authors whose credentials indicate postsecondary degrees, experience in the field, or a significant number of scholarly publications that have been peer-reviewed. I did not exclude authors associated with respected institutions or government agencies.
- **Timeliness**: The topic itself, with its recent technology, has limited the timeframe to less than ten years — anything before this timeframe is considered theoretical, conceptional, speculative, or outdated.
- **Quality**: I did not select works with grammar, spelling, and punctuation errors, except sources that have been peer-reviewed. The intent was to take into consideration authors whose first language is not English.
- **Relevancy**: I accepted only scholarly works that are directly focused on my topic of cloud-based phone solutions, either from an online or paper publication source.
- **[Lack of] Bias**: Due to the rapid explosion of CBP and cloud technology in all industries, scholarly articles in this field have not caught up to the discipline. Therefore, there are a limited number of scholarly works available to draw upon. However, there are a significant number of other sources from vendors that sell a service or a product. I included a selection of these sources with the understanding there is the potential for bias in the information; I reviewed these sources with extra scrutiny to avoid biased content. Further, if a scholarly source has a one-sided view, a

lack of evidence, or is attempting to persuade through argument, I did not select the reference due to bias.

Annotated Bibliography

Introduction

The following Annotated Bibliography presents 15 references that examine cloud-based phone factors that are described in the literature to support the value for an SME to transition away from an on-premise PBX to a CBP solution. References were selected to assist SME leaders and IT key stakeholders in addressing: initial costs and overall cost savings, growth and scalability, and maintenance and security of a CBP solution. References are presented in three categories that describe and support CBP: (a) value of CBPs for SMEs, (b) CBP security, growth, and scalability, and (c) problems related to CBP platforms for SMEs.

Each annotation consists of three elements: (a) the full bibliographic citation, (b) an abstract, and (c) a summary. The abstracts included are either complete as published or written by the author of this annotated bibliography in the absence of a published abstract. The summaries present discussions of the three categories related to cloud-based phones, either individually or as a combined factor of the categories.

Value of CBPs for SMEs

Beltran, V., & Bertin, E. (2015). Unified communications as a service and WebRTC: An identity-centric perspective. *ScienceDirect: Computer Communications, 68*, 73-82. doi: 10.1016/j.comcom.2015.07.01

Abstract: Software-as-a-service (SaaS) is gaining momentum for all business applications, including Unified Communications as a Service (UCaaS). In this context, user identity will play a key role in connecting the future fragmented communication suites in both corporations and cloud SaaS providers. However, SaaS solutions impose strong security challenges to the enterprise's Identity Management (IdM), since cloud

services need to be provided with the employees' identities. UCaaS solutions should, therefore, enforce security properties such as trust relationship, anonymity, or control on information disclosure. WebRTC is reinforcing the trend towards cloud-based UC by adding real-time voice and video capabilities into browsers. WebRTC does not tackle IdM, and hence it is not evident how WebRTC-based cloud services can meet the corporate requirements on IdM. In this paper, we discuss various IdM models for cloud-based corporate services, and we introduce the major requirements for managing user identities in UCaaS. We assess the impacts of these requirements on WebRTC-based UC services. We finally propose a slight modification of WebRTC to meet the corporate requirements on IdM

Summary: Beltran and Bertin introduce unified communications (UC) and discuss how UC deployment has been mainly driven by advances in IP technology, presence, and instant messaging. The authors discuss how this particular cloud computing trend, Unified Communication as a Service (UCaaS), has become widely held as a reliable replacement to the conventional UC for corporate communication and collaboration tools.

Beltran and Bertin state the evolution towards UCaaS is being inspired by a new, *under-standardized*, real-time technology referred to as WebReal-Time Communication (WebRTC), which is disrupting the market of real-time communications. WebRTC is an evolving HTML5 technology that facilitates web developers in amalgamating real-time audio, video, and data communications in their web pages. This technology facilitates enterprises in combining in-content communication into their web services.

Beltran and Bertin address topics related to UC security, specifically Identity Management (IdM), attributed-based access control, bring-your-own-device (BYOD),

and privileged user management. Beltran and Bertin assert that handling IdM separately from the enterprise is the most common practice of today's cloud providers. They refer to this model as "cloud identity" since user identity information is created inside each cloud service. Beltran and Bertin strongly suggest that user identity in UC is moving away from a modest telephony feature and is instead growing into a core mastermind of the various user communication methods to deliver a real unified user experience.

Beltran and Bertin discuss other alternative models where identity information is stored, such as the IdM model, connector-based provisioning model, web identity federation model, and identity as a service (IDaaS) model, all models that store identity information and distribute the information from the enterprise to the cloud. The two suggest that small companies will be more enthusiastic about saving costs by farming out IdM to a third-party. Finally, Beltran and Bertin mention hybrid solutions that combine cloud-based and on-premise IT infrastructure, noting they will adapt well over a period of time to the needs of large enterprises with multiple businesses, such as subsidiaries.

Beltran and Bertin's article gives relevance and justification to employing a UCaaS platform for an SME that is transitioning to a cloud-based phone solution and details the security risks associated with CBP.

Leonard, J. (2012). How SMEs can punch above their weight. *Computing*, 1. Retrieved from https://www.springer.com/journal/607

Abstract: This abstract was written by the author of this annotated bibliography in the absence of a published abstract. The author discusses the emergence of the employment of unified communication solutions among SME companies in the United Kingdom (UK). These small firms see unified communications (UC) as potentially offering plenty of quick wins. By tying all communication streams including voice, mobile, video, IM,

IP, and presence together, employees at small firms can maintain contact efficiently and effectively by means such as video conferencing, increasing oversight, and reducing the sense of isolation with the individual and the business. The author notes that a unified account is also easier to manage than multiple vendors, with layers of complexity removed. The author further stresses how cloud computing is giving small firms access to markets that would otherwise be out of their reach. This article provides relevance to the trend of the employment of UC by SMEs and provides insight into the advantages UC offers to these organizations.

Summary: Leonard asserts that small and medium-sized enterprises (SMEs) competing against the 'bigger fish' such as Starbucks, Google, and eBay have distinct advantages over these larger companies in the digital economy. Leonard states that in the United Kingdom (UK), SMEs are split in their use of the most common enabling technologies. Most UK SMEs are virtualizing their businesses, some SMEs are in the process of adopting unified communication (UC), while others are implementing cloud services.

Leonard mentions that a side effect of Internet 1.0 and 2.0 is the new breed of co-opting technology, including the creation of the public cloud. Co-opting technology is a strategy employed by big companies that require a more practical approach to innovation, in which they collaborate with startup innovation efforts with small businesses (Jadhav, n.d.). Leonard asserts that the public cloud is essential because it provides benefits that enable SMEs to thrive. For example, Leonard related how many smaller companies outside of the IT industry are maximizing the benefits of their customer relationships by using cloud-based customer relationship management (CRM) systems, which can be employed in minimal effort and time.

Leonard also asserts that many small firms employ UC, which, in theory, offers plenty of rapid gains. The first of these gains is simplifying mobile working by permitting employees to work remotely away from the office, enabling the retention of better-qualified staff, increased productive hours, and an increased footprint of the organization while reducing the requirement for office space. Leonard sums up his thoughts on UC by stating that UC makes a lot of sense for smaller firms in their efforts to compete, and there is wisdom in replacing existing telecom contracts and traditional PBXs with a UC solution.

In this article, Leonard addresses the value of employing a UC system for an SME, the wisdom of replacing existing telecom contracts and traditional PBXs with a UC solution, and the importance for SMEs of incorporating a CBP solution into an SME network environment.

Ribas, M.,Furtado, C., Neuman de Souza, J., Barroso, C., Moura, A., Lima, A. S., & Sousa, F.R. (2015). A Petri net-based decision-making framework for assessing cloud services adoption: The use of spot instances for cost reduction. *ScienceDirect: Journal of Network and Computer Applications, 57*, 102-118. doi: https://doi.org/10.1016/j.jnca.2015.07.002

Abstract: Cloud services are widely used nowadays, especially in Infrastructure as a service (IaaS), with vendors offering several purchasing options and expanding the range of services offered on almost a daily basis. Cost reduction is a major factor promoting the adoption of cloud services among enterprises. However, qualitative factors need to be evaluated as well, thus rendering the decision regarding the adoption of cloud services among enterprises a non-trivial task for Information Technology (IT) managers. In this paper, we propose a place/transition or Petri net-based multi-criteria decision-making (MCDM) framework to assess a cloud service in comparison with a similar on-premises

service. The framework helps IT managers choose between two such options, and can be used for any type of cloud service: Infrastructure as a Service (IaaS), Platform as a service (PaaS), Software as a service (SaaS), etc. Because its low cost is among the most important reasons for adopting cloud services, we also propose a Petri net to model cost savings using the spot instances purchasing option in public clouds. Through simulation of several scenarios, we conclude that spot instances present a very interesting cost-saving opportunity in the auto-scaling process, even for simple business applications using few servers.

Summary: In this peer-reviewed article, Ribas, Furtado, Souza, Barroso, Moura, Lima, and Sousa examine the decision-making process for cloud service adoption and the cost reductions that result from that decision. The team begins by making a strong statement about Information Technology (IT) managers: “One of the many difficult decisions facing Information Technology (IT) managers nowadays is to choose between adopting an IT service in its cloud model and having the service hosted according to the conventional, on-premises model” (p. 102). This statement sets the tone for the rest of the article. The authors state that their objective is to guide the business management decision of categorizing the factors and restrictions to determine the advantages and disadvantages of using cloud services in comparison with on-premise solutions for enterprise business applications, with an emphasis on fashioning the flexibility of cloud services while reducing the cost. The team also acknowledges that if a cloud service is adopted by an organization, then IT will have limited control over their infrastructure and ultimately will depend on the fulfillment of the service level agreements (SLAs) to achieve the required service.

The team of seven examines a practical framework to evaluate the adoption of cloud services in contrast with that of an on-premise PBX solution. The authors' framework was anticipated to identify quantitative and qualitative factors related to cloud services and to merge them in a controlled method to generate a final ranking of the solutions. Their preliminary investigations point out that security threats, performance uncertainty, and economic risks demonstrate a central role in the ranking of the solutions.

The team state that the "cost advantages must be sufficiently high to overcome these obstacles, or else it would be inefficient to adopt cloud services" (p. 116). The authors developed a model for cost reduction in cloud services that involves exercising spot instances and carried out extensive simulations to examine possible savings from the model. They deduced that using spot instances in auto-scaling dramatically decreases the cost of cloud services, enabling adoption.

The team also looked into extending their framework to handle the SLA requirement. The authors provide a framework that is useful in identifying the value an SME gains by transitioning to a cloud-based phone solution. Additionally, their focus on the cost of a cloud-based phone solution versus an on-premise solution provides valuable context for this analysis.

Tchernykh, A., Cortés-Mendoza, J., Bychkov, I., Feoktistov, A., Didelot, L., Bouvry, P., Radchenko, G., Borodulin, K. (2018). Configurable cost-quality optimization of cloud-based VoIP. J*ournal of Parallel and Distributed Computing, 133*, 319-336. doi: 10.1016/j.jpdc.2018.07.001

Abstract: In this paper, we formulate a configurable cloud-based VoIP call allocation problem as a special case of dynamic multi-objective bin-packing. We consider voice quality influenced by CPU stress, cost contributed by the number of billing hours for

Virtual Machines (VMs) provisioning, and calls placed on hold due to under-provisioning resources. We distinguish call allocation strategies by the type and amount of information used for allocation: knowledge-free, utilization-aware, rental-aware, and load-aware. We propose and study a variety of strategies with static and dynamic policies of VM provisioning. To study realistic scenarios, we consider startup delays for VM provisioning, and three configurable parameters: utilization threshold, rental threshold, and prediction interval. They can be configured and dynamically adapted to cope with different objective preferences, workloads, and cloud properties. We conduct a comprehensive simulation on the real workload of the MIXvoip company and show that the proposed strategies outperform ones currently in-use.

Summary: A mixed group of eight scholarly and IT professionals analyze multi-objective scheduling strategies with billing hours, calls placed in a hold status, and voice quality as the criteria for optimization of a cloud-based VoIP. The group proposes a model to allocate calls in the cloud VoIP model and address the feasibility and benefits of the approach. The authors identify three configurable parameters for their proposed approach: Utilization Threshold (UT), Rental Threshold (RT), and Prediction Interval (PI). Utilization Threshold is a set parameter that is used to activate a request for a new VM once the current utilization has reached the threshold. Rental Threshold is a time interval before the VM finishes its renting period, and it impedes call allocations to VMs before the rental time is completed. Prediction Interval is a time interval for which a prediction is performed, as the predictor performs an estimation of utilization during each time step.

The team describes how the simulation model improves the decision-making of the VoIP provider when determining UT, RT, and PI in order to maximize the value

related to the quality of service and cost of infrastructure. In particular, an online nonclairvoyant strategy that consists of a dynamic bin packing problem with examined solutions for provider cost, quality of service, and robustness optimization. Key findings include: (a) To choose a good, non-clairvoyant strategy, you must perform a joint analysis of conflicting goals based on the degradation in performance of each strategy under each metric, and consider coverage rank and coverage count to provide guidance to select an adequate approach. (b) Strategies that have a high quality of service will average only 0.073 percent of calls placed on hold for one month, with 0.92 percent of quality reduction. (c) Proposed strategies with RT and prediction outperform known strategies in provider cost, slightly decreasing quality of service. These can reduce the billing hour by up to 30 percent, increasing calls placed on hold from about 2 to 9 per day. (d) The importance of robustness to withstand adverse variations of VM startup time delays, demonstrating that a low variation of three criteria even with high dispersion of VM startup has time delays. The authors provide parameters that can be adjusted to address the performance and reduce the cost of a cloud-based VoIP phone solution for businesses.

CBP Security, Growth, and Scalability

Cortés-Mendoza, J. M., Tchernykh, A., Drozdov, A. Y., & Didelot, L. (2016). Robust cloud VoIP scheduling under VMs startup time delay uncertainty. In R. Bilof & M. Bartosik (Eds.), *IEEE/ACM 9th International Conference on Utility and Cloud Computing (UCC)* (pp. 234-239). Piscataway, NJ: IEEE Computer Society. Retrieved from https://ieeexplore.ieee.org/abstract/document/7881638/authors#authors

Abstract: In this paper, we address cloud VoIP service orchestration and scheduling to provide appropriate levels of quality of service to users, and performance to VoIP service providers. We consider voice quality affected by call processing, and cost contributed by billing hours for used VMs in a cloud. We believe that this bi-objective focus is reasonable and representative of real installations and applications. We conduct a comprehensive simulation of our calls load balancing strategies on real data and show that not all approaches provide a suitable quality of service. We analyze eight on-line dynamic non-clairvoyant scheduling strategies with variations in VM startup time delays to deal with realistic VoIP cloud environments. We show that the proposed strategies outperform currently in use strategies in terms of quality of service and provider cost. The robustness of these strategies is also discussed.

Summary: Cortés-Mendoza, Tchernykh, Drozdov, and Didelot developed a study on scheduling problems associated with cloud VoIP service with virtual machine (VM) startup time delays. The group outlines a bi-objective model with provider cost, supplied by billing hours for used VMs, and quality of service (QoS), affected by call processing, as the optimization criteria. The group elaborates further on the optimization criteria, noting that provider costs include server costs, infrastructure costs, operational costs, and network costs, and that both quality of service and provider costs are improved by

addressing inefficient resource utilization, which hurts performance and cost. The goal of the bi-objective model is to obtain a set of compromise solutions for both objectives that represent a good approximation of several unique sets of solutions.

The authors build upon a model proposed in their previous work, where cloud VoIP infrastructure consists of heterogeneous super node clusters; in this new version of the model, the virtual machine is described by a tuple, a finite ordered list of elements or a sequence of *n* elements, that consists of its request time, startup delay, and the processing capacity in millions of instructions per second (MIPS) (p. 237). The authors analyzed eight online, non-clairvoyant scheduling strategies with real data established on a one-month basis with a commercial VoIP company service to encompass realistic VoIP cloud environments.

The group was able to identify low variation in billing hours even with high dispersion of VM startup time delays. The authors explained that the projected strategies outperform recognized ones in terms of QoS and provider cost, including those QoS strategies currently engaged by call companies. The group similarly assessed the robustness of their model in the face of ambiguity of VM startup time delay variations. The authors were able to demonstrate hypothetical benefits and stability in handling call arrival rates and startup time delay variation; note the research employed near-to-real-time data versus live data in a real domain.

The authors' analysis provides support for achieving the objectives of cost, scalability, and growth with a CBP solution. Further study remains in assessing the actual performance and effectiveness of a new version of the model by introducing startup delays where the VM is described by a tuple that consists of whether its request time is less than or equal to zero, the startup delay, and the processing capacity size in MIPS.

Ding, J.-H., Chien, R., Hung, S.-H., Lin, Y.-L., Kuo, C.-Y., Hsu, C.-H., & Chung, Y.-C. (2013). A framework of cloud-based virtual phones for secure intelligent information management. *International Journal of Information Management, 34*(3), 329-335. doi: https://doi.org/10.1016/j.ijinfomgt.2013.11.006

Abstract: As mobile networks and devices being rapidly innovated, many new Internet services and applications have been deployed. However, the current implementation faces security, management, and performance issues, which are critical to the use in business environments. Migrating sensitive information, management facilities, and intensive computation to a security-hardened virtualized environment in the cloud provides effective solutions. This paper proposes an innovative Internet service and business model to provide a secure and consolidated environment for enterprise mobile information management based on the infrastructure of cloud-based virtual phones (CVP). Our proposed solution enables the users to execute Android and web applications in the cloud and connect to other users of CVP with enhanced performance and protected privacy. The organization of CVP can be mixed with centralized control and distributed protocols, which emulates the behavior of human societies. This minimizes the need to handle sensitive data in mobile devices, eases the management of data, and reduces the overhead of mobile application deployment.

Summary: A team of seven researchers, Ding, Chien, Hung, Lin, Kuo, Hsu, and Chung address the following issues for information security and management in an enterprise IT infrastructure: (a) operating environments, (b) security and isolation, (c) sensory application, and (d) consumerization of IT surrounding cloud-based virtual phones. The team proposed a framework for enterprises to address these problems, emphasizing manageability and security. They based framework, called cloud-based virtual phone

(CVP) technology for mobile devices, on the team's previous work with a virtualized execution environment for smartphones.

The team describes the security weaknesses in current solutions employing mobile device management (MDM) and virtualization desktop infrastructure (VDI) with related works, including bring-your-own-device (BYOD) security issues. Mobile device management is software that allows IT administrators to control, secure, and enforce policies on smartphones, tablets, and other endpoints (Steele & Rouse, 2017). Virtualization desktop infrastructure is a virtualization technology that hosts a desktop operating system on a centralized server in a network and is sometimes referred to as server-based computing (Rouse, Barrett, & Steele, 2017). The authors assert that the implementation of mobile technologies and consumerization of IT will provide enterprises with more agile, cost-saving measures, and increase employee efficiencies. However, the team states the following: “the current mobile environments come with serious security threats and management issues which require innovative solutions” (p. 334). Their recommended solution set is to employ TaintDroid for security and privacy monitoring with shadow phone employment for information management.

Motivated by the behavior of human societies and federalism, the team proposed a CVP system that removes the fragmented problem of mobile networks, which is due to diversified operating environments from new technologies that are evolving so fast. Their CVP system makes the development and deployment of business applications more manageable and establishes a secure mobile environment that employs the virtualization technique, malware detection, and informal behavior monitoring. Their solution involves a secure mobile environment with virtualization techniques such as virtual phones (VP)-big, VP-little, VP-limited, and VP-guard; malware detection and informal behavior

monitoring. VP-big and VP-little are virtual phones represented with more computing resources or less computing resources, respectively. VP-limited is a high-secure virtual phone with more constraints to limit behavior, while VP-guard is responsible for threat detections from insecure public networks.

This peer-reviewed article is useful for this study because the authors address concerns related to the security risks of relying on a cloud service provider (CSP) as a phone solution.

Karopoulos, G., Portokalidis, G., Domingo-Ferrer, J., Lin, Y.-D., Geneiatakis, D., & Kambourakis, G. (2015). Security and privacy in unified communications: Challenges and solutions. *ScienceDirect: Computer Communications, 68*, 1-3. doi: https://doi.org/10.1016/j.comcom.2015.08.004

Abstract: This abstract was written by the author of this annotated bibliography in the absence of a published abstract. This editorial article is authored by six well-known, scholarly, and professional experts on Unified Communications (UC). The discussion includes merging different communication technologies, types of products, and services from various manufacturers, operators, and countries following various policies and standards. Specifically, in the context of UC, the authors describe the integration of a range of communication tools in a way that enables both businesses and individuals to manage all of their communications in one entity instead of using a decentralized approach.

Summary: The authors, six well-known scholarly and professional experts on Unified Communications (UC), concentrated their focus on issues associated with the domains of security and privacy in UC from different perspectives. The authors presented open

issues and algorithms, protocols, policies, frameworks, standards, and UC tailored solutions to address the problems.

The group notes their concerns on location privacy as an issue for UC customers and present a new solution known as Spatial Bloom Filter (SBF), which is a means of preserving users' privacy when mobile devices have location-aware services turned on. The SBF solution works by managing spatial and geographical compact data structure that allows for computing in an efficient way, whether an element is a member or not of the set filter, which is well-suited for enabling privacy in location-aware applications (Calderoni, Palmieri, & Maio, 2015). The authors also propose a privacy-preserving framework that can sustain the accuracy of recommendation systems used with online networks that deliver multimedia services; the framework works by getting meaningful recommendations for other products through a set number of algorithms searching for privacy protection. The authors also introduce the idea of eVoting through a VoIP framework to maintain end-users' privacy in surveys completed on mobile devices employing VoIP technologies.

The group summarizes concerns about dynamic access control in mobile cloud computing with the following point: "Traditional access control mechanisms are not sufficient in an environment where UC enables seamless data sharing across heterogeneous networks and devices from anywhere and anytime" (p. 2). Finally, the authors discuss the issues with security in BYOD, noting that the BYOD trend creates new entry points for attackers. The authors convey strong concerns with these new security challenges and note the need for original resolutions for the problem of BYOD in UC environments. The authors propose the implementation of an open-source system

called MUSES to address the problem, which applies machine learning and computational intelligence to improve security rules based on users' behavior.

This source is useful for this study because the authors are able to address concerns with the security risks of relying on the cloud service provider (CSP) as a phone solution.

Lukinskikh, K. S. (2015). Unbiased assessment method for voice communication in cloud VoIP-telephony. *Journal of Theoretical and Applied Information Technology, 80*(1), 75-83. Retrieved from http://www.jatit.org/volumes/Vol80No1/7Vol80No1.pdf

Abstract: This paper covers the issues of unbiased assessment of voice communication quality in cloud VoIP telephony. For the solution of this task, the main quality criteria from the point of view of a common user are as follows: unnatural voice (robot voice); delays in voice transmission one way or other way; echo; signal interruptions (both long and any short stirs); amplitude changes (overloaded or too quiet voice); extraneous noise caused by environment and equipment of connecting subscribers, transmitting medium or digital signal processing methods. Also, basic requirements related to the cloud are: the solution applied should not create extra load on the network, and it should be able to automatically control the quality at the section between client and service. The developed expansion of the methodology is oriented at problem elimination due to a sequence of assessments: analysis of signal's statistical parameters, analysis of vocal track consistency; analysis of timing errors instead of a single aggregate assessment, as well as extra assessments of echo and volume level assessment.

Summary: In his peer-reviewed article, Lukinskikh provides an unbiased assessment method to determine whether to employ VoIP in the cloud. The author begins by establishing a foundation by relaying facts about VoIP cloud:

> Along with the widespread of broadband Internet, VoIP technologies are gaining more and more popularity. Such a trend is caused by various reasons including relatively low cost of communication services (especially international) with acceptable quality, simple use, and flexible infrastructure, the ability for integration with various information systems, and Internet services. (p. 75)

The author wants to establish a general level of quality with VoIP cloud from an end-user perspective with three basic factors: (a) quality of voice information transmission, (b) availability of communication functions at a random moment, and (c) quickness of client's needs processing. From this selection, a final set of criteria was developed: (a) realization of the required range of functions, (b) ensuring the maximal quality of voice transmission, (c) high productivity, and (d) stability to various faults.

The author discovered the range of functions with the criteria would be hard to apply, so he limited his attention to control and ensuring the quality of voice transformation. Lukinskikh also discussed quality degradation factors, which include non-optimal network conditions, number of channels transmitting signals, geographic distance, and using the wrong codec or communications protocol.

Lukinskikh discusses the process of selecting an optimal method of voice communication quality assessment by reviewing existing objective assessment methods. These two objective methods include analyzing network conditions and analyzing resulting audio streams. The author also examines the specifics of the IP-telephony cloud service and considers the remoteness to the end-user, which affects communication quality; distribution, which implies the solution has access to information about the cloud service's structure; and the psychological aspect of the end-user, noting that because some clients will find the available quality to be insufficient, "the threshold levels of

quality at which notifications are sent to administrators and automated quality control tools are activated must be changed" (p. 78).

Lukinskikh notes that the research in the paper contains enough information to begin the realization of a software analyzer for voice communication that is capable of detecting problems without the participation of connecting parties or service engineers. This means that feedback from the optimization of simulating devices may be used as a part of the system for various aspects of VoIP-telephony cloud service, resulting in improved quality data. The relevance of this research affords an SME the tools for a baseline or foundation for performing assessments on CBP services.

Varghese, B., & Buyya, R. (2018). Next generation cloud computing: New trends and research directions. *ScienceDirect, 79*(3), 849-861. doi:10.1016/j.future.2017.09.020

Abstract: The landscape of cloud computing has significantly changed over the last decade. Not only have more providers and service offerings crowded the space, but also cloud infrastructure that was traditionally limited to single provider data centers is now evolving. In this paper, we firstly discuss the changing cloud infrastructure and consider the use of infrastructure from multiple providers and the benefit of decentralizing computing away from data centers. These trends have resulted in the need for a variety of new computing architectures that will be offered by future cloud infrastructure. These architectures are anticipated to impact areas, such as connecting people and devices, data-intensive computing, the service space, and self-learning systems. Finally, we lay out a roadmap of challenges that will need to be addressed for realizing the potential of next-generation cloud systems.

Summary: In their peer-reviewed article, Varghese and Buyya, examine the question "So what does cloud computing in the next decade look like?" (p. 849). They set the

underlying tone of the article by noting, “resources and services offered on the cloud have rapidly changed in the last decade” (p. 849). The authors discuss how distributed cloud infrastructure will make use of the network edge in the future. The network edge is also referred to as the wide area network (WAN) edge and is where an enterprise network connects to a third-party network service, such as a cloud-based phone provider (Froehlich, 2019).

Varghese and Buyya elaborate further on the changing infrastructure that is moving towards a multi-cloud strategy, including hybrid cloud and federated cloud, microcloud and cloudlet option, and an ad hoc cloud strategy. A multi-cloud strategy is the use of two or more cloud service providers and can be constructed with a hybrid cloud environment that mixes on-premise with private cloud, third-party, or public cloud services, with an arrangement between the two platforms. The other option is a federated cloud, which is the deployment and management of multiple cloud computing services, either external or internal, to meet the company’s requirements.

Another multi-cloud strategy is employing microcloud and cloudlets; these are small-scaled datacenters or even a cluster of computers that provide cloud services within proximity to the site location. An ad hoc cloud strategy is changing by using ad hoc computing with increasing connectivity of a large variety of resources to the cloud, becoming popular for smaller mobile devices such as smartphones.

The two authors examine the two-tier applications that will be replaced by new multi-tier cloud architectures; consequently, new computing architectures are emerging. These emerging computing architectures include volunteer computing, fog and mobile edge computing, serverless computing, and software-defined computing. Serverless computing is a format where code execution is fully managed by a cloud provider as an

alternative to the traditional method of developing and deploying applications on servers (Carey, 2019). Applications now aim to leverage cloud infrastructure by making use of heterogeneous resources from multiple providers in contrast to how resources from a single cloud provider or data center were used traditionally (p. 849). This change is impacting several social and scientific areas, which leads to the question of what a new marketplace will need to be exploited for resources at the network edge.

The authors also assess the next-generation cloud computing impacts for both social and scientific avenues. These avenues of influence connect people and devices with their internet-of-things (IoT), big data computing, service space, and self-learning systems.

The authors finally note that security and sustainability are crucial to architecting future cloud systems. Their research direction includes guaranteeing enhanced security though the cloud, achieving expressivity of applications for future clouds, and developing a marketplace for emerging distributed architectures. The two authors also discuss offering efficient management strategies in the computing ecosystem and ensuring the reliability of cloud systems.

This source is useful for this study because the authors are able to address concerns with the security risks of relying on the cloud service provider (CSP) and growth by incorporating a heterogeneous cloud network environment. Cloud-based phone platforms are applications that fall directly under a CSP offered as a service.

Problems Related to CBP Platforms for SMEs

Alexander, P. (n.d.). Should you lease or buy your tech equipment? *Entrepreneur*. Retrieved from https://www.entrepreneur.com/article/80230

Abstract: This abstract was written by the author of this annotated bibliography in the absence of a published abstract. Peter Alexander is a seasoned Cisco Vice President who has written nearly thirty articles for *Entrepreneur* in the areas of the network, technology, IT security, IT vision, and growth strategies. This article provides an in-depth look at the pros and cons of leasing versus buying technical equipment for a business. Alexander notes that there are substantial benefits to both leasing and buying. Alexander points out that with a lease, the business passes the financial burden of uselessness back to the equipment leasing company. This means the business can acquire newer and faster technology from the leasing company, maintaining a predictable monthly cost while keeping up with competitors. Alexander notes that buying technical equipment can also provide fewer complications with terms, can enable more negotiation on pricing, and offers a deductible during tax season. In addition, as the owner of the equipment, the purchaser is afforded more control over maintenance and upgrades.

Alexander identifies the downsides to each option. When leasing, the business will pay more in the long run, and there may be an obligation to keep paying after using or returning the equipment, depending on the lease terms. When buying, the business may need to extend its lines of credit and funds from other sources to meet the price tag of the equipment, which will eventually become outdated legacy technology. Alexander points out that with either decision, the business needs to ask the right questions to determine the best option.

Summary: In his online article, Alexander provides an in-depth look at the advantages and disadvantages of leasing versus buying technical equipment for a business. Alexander notes there are substantial benefits to both leasing and buying. The benefits of leasing technical equipment include allowing the business's technical equipment to be

up-to-date, having predictable monthly expenses, no upfront expenditures, and allowing the business to keep up with competitors. Alexander does address the downsides to leasing, which include paying more for the long term and obligations to pay when the lease on the equipment has expired.

Alexander discusses the benefits of buying technical equipment, which include fewer complications than leasing, control of the maintenance of equipment, and tax-deductions. The author directs his audience to the downsides of buying, which include expectations of the initial purchase may be more than planned, and eventually, the business will be stuck with legacy equipment.

Alexander describes the importance of asking the right questions, which may include asking what type of lease, capital versus operating; if there is a buyout option; the length of the lease; whether insurance is required; whether additions can be made to the lease; and whether early termination of the contract is allowed. With either leasing or buying of technical equipment, Alexander states that asking the right questions will offer the business the best option.

This article by Alexander describes the differences of leasing versus buying options for technical equipment, lessons that can be applied to the decision of which type of CBP platform is appropriate for a business, whether it is leasing a PBX or purchasing a CBP service.

Butler, B. (2012). Managed communication services move to the cloud. *Network World*. Retrieved from https://www.networkworld.com/article/2189469/managed-communication-services-move-to-the-cloud.html

Abstract: This abstract was written by the author of this annotated bibliography in the absence of a published abstract. Brandon Butler is a senior editor for Network World and

focuses on the cloud computing industry and social collaboration applications. This article centers on why vendors are increasingly offering cloud-based PBX and communication systems and understanding why customers have been slow to respond. Butler offers that the delayed response may be due to mobile device management (MDM) concerns rather than a desire to remain with a PBX. Butler points out that vendors are shifting their services to cloud-based delivery, giving customers the choice of having hardware that sits on their own premises or accessing PBX and other unified communication (UC) platforms that are hosted by the provider or a third party. However, despite those options, Butler notes that customers are showing concern about managing their workers' mobile devices contrasted to traditional boxed communications systems such as a PBX. Unlike a managed or hosted service, cloud offerings have a pay-per-use model, with the ability to scale up or scale down, and they are offered from a multi-tenant environment. Butler does convey that most corporations have developed communication strategies related to cloud offerings. Butler discusses the hesitation to adopt, with vendors reporting a slow and steady increase in interest in cloud-based solutions. One explanation for the gradual acceptance of voice-based cloud solutions is that there are already affordable market alternatives, not in the cloud.

Butler sums up by asserting the real reason for the urgency of cloud-based PB and communication systems is due to the emergence of MDM and the bring-your-own-device trend (BYOD). Butler interviewed Dan Bieler, an analyst for Forrester, a well-known consultant company on the existing and potential impact of technology, stated that "BYOD is an important part of collaboration and voice and UC are just a part of that . . . but now handling the deluge of devices and technologies workers bring in and want to use for work purposes . . . is the greater opportunity."

Summary: In his online article, Butler notes the recent changes with communications, declaring that PBX and enterprise communication platforms are increasingly being offered through the cloud (Butler, 2012). He further conveys that a range of communication vendors are shifting their services to cloud-based delivery, affording customers the options of having hardware that sits on their own premise or accessing PBX and other unified communication (UC) platforms that are hosted by a third-party provider. Butler addresses how a different CBP environment, such as UC, can be integrated into a business by employing the functionality with web-based UC while realizing the savings that are commonly associated with the cloud, which include transitioning from a capital expense to an operating expense and eliminating the onsite server.

Butler does address concerns from analysts who note that customers are more troubled about managing their workers' mobile devices compared to traditional boxed communications systems, such as a PBX, thus slowing customer adoption of a unified communication system. Butler notes that a range of small and large communication vendors are shifting their services to cloud-based delivery, giving customers flexible choices.

Butler asserts that collaboration has become increasingly significant as enterprises deliberate what variety of social tools will be used to allow for communication within the enterprise (Butler, 2012), and mentions SalesForce.com’s aggressive push of its Chatter feature as an example. Butler does express that most corporations have established communication strategies interrelated to cloud offerings (Butler, 2012). The author discusses the reluctance of customers to implement, with vendors noting a slow and steady increase in interest in cloud-based solutions. One explanation for the measured

acceptance of voice-based cloud solutions is the availability of affordable market alternatives that are not in the cloud; acquiring *voice* is getting cheaper by the day in the market.

Butler interviewed several top IT industry specialists, including Dan Bieler, an analyst for Forrester, who emphasizes the actual motivation for the prompting of cloud-based PBX and communication systems is due to the emergence of mobile device management (MDM) and the bring-your-own-device (BYOD) trend. Bieler also addressed the importance of BYOD in collaboration and integration with voice and UC systems.

This source is useful to this study because Butler addresses how a different CBP environment, such as UC, can be integrated into a business and describes the problems related to transitioning to the CBP platform due to alternative and affordable solutions that are not cloud-based.

Durcevic, S. (2019). *10 cloud computing risks & challenges businesses are facing in these days*. Retrieved from Datapine: https://www.datapine.com/blog/cloud-computing-risks-and-challenges/

Abstract: This abstract was written by the author of this annotated bibliography in the absence of a published abstract. Sandra Durcevic is a ten year veteran in strategic communication planning and creating optimal data analytic tools for tech organizations such as datapine, ADiSoft Web Development, KG Media, Kapital Croatia, and Amnesty International. This article focuses on cloud risks and challenges businesses face in today's venue. Durcevic makes a profound statement in the beginning in order to set the tone for the rest of the article, "[w]hile "the cloud" is just a metaphor for the internet, cloud computing is what people are really talking about these days." She wants the

readers to understand the duality of the term. Durcevic describes cloud computing as the delivery of various hardware and software services over the internet, through a network of remote servers. These remote servers are busy storing, managing, and processing data that enables users to expand or upgrade their existing infrastructure. Durcevic introduces the cloud's evolution in the digital age and its need for immense storage capacity for data analytics. The cloud provides better data storage, data security, flexibility, increased collaboration between employees, and changes the workflow of small businesses and large enterprises to help them make better decisions while decreasing costs. Durcevic lists her challenges, starting with security issues. She moves on with cost management and containment, the on-demand and scalable nature of cloud computing services bring upon unwarranted quantities and costs. Other challenges include a lack of resources and expertise. SME organizations finding support can be extensive and costly. In today's cloud-based world, under governance and control, reliance on cloud service providers (CSP) may be a risk. Another challenge is when businesses move data from their internal storage to a cloud; it is faced with being compliant with industry regulations and laws. An additional factor with challenges is the segmented usage and adoption of the cloud.

Instead, ad-hoc strategies have sprouted, fueled by several components. These include the speed of cloud adoption and the expiration of data center contracts and equipment. Durcevic sums up the article acknowledging that cloud computing challenges do exist, to make the best out of it and overcome issues. This includes taking a strategic iterative approach to implementation, explore hybrid cloud solutions, involve business and IT teams, invest in a CIO, and choose the right BI SaaS partner. But more importantly, to do your research first before investing.

Summary: Durcevic emphasizes the risks and challenges associated with the cloud that businesses face today. The author notes that security issues pose challenges. Security risks of cloud computing have become a reality for every organization, small or large. Durcevic notes that data breaches, compromised credentials, broken authentication, hacked interfaces and APIs, and account hijacking have become commonplace and added to concerns.

The author points out that for cost management and containment, the on-demand and scalable nature of cloud computing services make it sometimes difficult to define and predict quantities and costs. Lack of resources or expertise poses problems in the management of tools for the business. Small and medium enterprises may find adding cloud specialists to their IT teams to be excessively costly. Information technology departments do not always have full control over cloud provisioning, de-provisioning, and the operations of infrastructure relying on cloud service providers (CSPs).

The author notes that another challenge arises when businesses move data from their internal storage to a cloud they must ensure they are compliant with industry regulations and laws such as the Health Insurance Portability and Accountability Act of 1996 (HIPAA), Sarbanes-Oxley Act of 2002 (SOX), and Payment Card Industry Data Security Standard (PCI DSS).

The segmented usage and adoption of the cloud also pose challenges. One challenge is the speed of cloud adoption, while another is the staggered expiration of data center contracts and equipment, which leads to intermittent cloud migration. Durcevic also identifies a challenge that is the key to why migration to the cloud for business is challenging. She cites findings from a recent survey conducted by Velostrata that indicates the common challenges businesses faced were extensive troubleshooting,

security challenges, slow data migrations, migration agents, cutover complexity, and application downtime.

This article identifies different problems associated with a cloud platform, which has a direct correlation to implementing a cloud-based phone platform. There is value in understanding the transition to a cloud and the relatable problems associated with the move. Specific challenges for SMEs migrating to the cloud also provide useful context.

Hu, F., Qiu, M., Li, J., Grant, T., Tylor, D., McCaleb, S., Butler, L., Hamner, R. (2011). A review on cloud computing: Design challenges in architecture and security. *Journal of Computing and Information Technology, 19*(1), 25-55. doi:10.2498/cit.1001864

Abstract: Cloud computing is becoming a powerful network architecture to perform large-scale and complex computing. In this paper, we will comprehensively survey the concepts and architecture of cloud computing, as well as its security and privacy issues. We will compare different cloud models, trust/reputation models, and privacy-preservation schemes. Their pros and cons are discussed for each cloud computing security and architecture strategy.

Summary: Hu, Qiu, Li, Grant, Tylor, McCaleb, Butler, and Hamner study the design challenges and security issues of cloud computing. The authors present a comprehensive survey on the concepts, architectures, and challenges of cloud computing. The authors introduce the five abstraction layers of the cloud from bottom to top: hardware as a service (HaaS), software kernel, software infrastructure layer (infrastructure as a service or IaaS), software environment (platform as a service or PaaS), and application layer (software as a service or SaaS).

The authors describe the two main reasons why cloud computing can be viewed as beneficial: its cheap cost and efficient utilization of computing resources. For small

businesses, obstacles to entering markets that demand substantial amounts of computing power are considerably reduced. This means that small companies have newly found access to computing power that they otherwise would never have been able to obtain. Despite these advantages, the negative aspect of cloud computing involves performance interference effects occurring in virtual environments, data transfer limitations, and its associated costs. The laws that govern the physical datacenter location of the cloud provider may also provide complications.

The authors discuss the security of a cloud-based computing environment, including how easy it is for employees to access, falsify, and divulge data. The authors agree that security issues are the most crucial challenge in cloud computing. The authors assert that encryption is the ideal solution to solve the dilemma, but note that this solution is not foolproof. The authors identify the underlying issue as cloud users' lack of control over and knowledge of what could happen to their data.

The authors comprehensively survey the security issues and the methods of addressing security challenges that were available at the time of publication. Their approach was to look at what the big three, Amazon, Microsoft Azure, and Google are doing to secure their cloud environments. These methods include encryption-on-demand, trusted virtual data center implementation, third party auditors, trusted cloud computing cooperation, privacy model, intrusion detection strategies, Dirichlet reputation model, and network slicing.

This article is relevant because the authors identify the advantages and disadvantages of cloud computing. A cloud computing service is a conduit for any cloud-based phone service for the provisioning of a unified communication platform. Any challenges or problems with the cloud computing service, such as security concerns, will

have a direct correlation to the provisioning of a cloud-based platform onto an SME network environment.

Khatua, S. (2015, June). Cloud meets telecom & application in open source asterisk (IPPBX). *International Journal of Electrical, Computing Engineering, and Communication (IJECC), 1*(3), 49-52. Retrieved from http://orbilu.uni.lu/bitstream/10993/28808/1/Main.pdf

Abstract: The evolution of technology in the past years together with the release of Voice over Internet Protocol (VoIP) products and services, lead to an increased usage of these advanced communication technologies. As VoIP became very popular, it has been changing the face of business every day. Corporations, Small and Medium Businesses (SMB) have integrated VoIP in their daily businesses in order to lower operational costs at the infrastructure level. Dynamic optimization based on incoming load analysis and load prediction, pro-actively scaling the available resources in order to handle the incoming traffic, is one approach to prevent this type of problem. The anticipation of the computational load induced on processors by the incoming requests is used to optimize load distribution and resource allocation.

The main domains investigated in the scope of the thesis are: load prediction of the incoming traffic, allocation of tasks to processor and provision of computational resources in order to ensure Quality of Service (QoS). Powerful prediction models that evolve, adapt and consistently deal with varying factors, used for shaping future traffic patterns and capacity planning, are designed. The developed prediction framework proposes a combination of different methodologies, namely, Interactive Particle System (IPS) which is based on interactive particle algorithms, Gaussian Mixture Model (GMM) that is model-based learning of mixture of Gaussians, and supervised learning that

defines distributions over functions Gaussian Process (GP). Insights of how particle algorithms are used for optimization, in conjunction with implicit learning models, are given.

Load balancing techniques are designed for a real VoIP system, and the problem of job allocation for VoIP in cloud computing is addressed. VM-Aware Adaptive Rate of Change (VMA-AdRoC) is an extension of the RoC-LB algorithm, particularly useful for systems that handle VoIP traffic, sensitive to poor network configurations, and poor resource distribution management. A site load distribution method was built using an Integer Linear Programming (ILP) approach, a model that integrates prediction and takes decisions based on the objective of minimizing the cost via minimizing the number of running machines that handle the placed calls. When fitted into the Domain Name System (DNS) framework, Global Server Load Balancer (GSLB) is provided and the selection of voice nodes to handle calls is based on-site health conditions, site response time, geography-based site, routing cost and so further. Dynamic bin packing with open bins is a variation of the well-known one-dimensional online bin-packing problem, considered to address congestion and overload issues at the level of a cloud-based VoIP systems. Different bin packing strategies, First-Fit, Best-Fit, WorstFit, are developed and their performance is compared with two widely used server load balancing strategies, namely Round Robin and Random.

Summary: Khatua published a scholarly article discussing cloud solution sets that include an open-source software implementation, which is a communication toolkit that supports several VoIP protocols, including the most common, Session Initiation Protocol (SIP). The high interest in cloud VoIP is driving the quest for knowledge to provide a better understanding of its potential as a cost-effective solution.

The author offers potential solutions for the development of telecom platforms in the cloud, with an understanding of the value of an open-source solution versus the purchase of licenses for CVP. One solution Khatua suggests is a cloud at telecom equipment, which involves the business use of telecom equipment from one or more cloud vendors creating the cloud infrastructure. Another solution the author mentioned was a cloud environment with high capacity telecom equipment and optimized cloud solutions. This approach is mainly employed by Telecom Service Providers with very high capacity equipment from a single cloud vendor.

The final solution entails the implementation of Asterisk IPPBX (internet protocol PBX) into the cloud as an affordable option to provide quality assurance with open source applications. An IPPBX is a private branch exchange that switches calls between VoIP users on local lines while allowing all users to share a certain number of external phone lines (Rouse, 2008).

Khatua highlights the challenges in the cloud with telecom: (a) laws and acts are under different jurisdictions, (b) lack of security with data residing globally, (c) risks with transferring confidential data, (d) specific end-user restrictions with their cloud provider, and (e) downtime that impacts Internet connectivity.

This source is useful to this study because Khatua addresses how a specific cloud PBX, an IPPBX solution, is cost-effective over an on-premise PBX and provides more substance to the value for an SME to transition.

Whaiduzzaman, M., Haque, M. N., Chowdhury, M. R., & Gani, A. (2014). A study on strategic provisioning of cloud computing services. *The Scientific World Journal, 2014*, 1-17. doi: 10.1155/2014/894362

Abstract: Cloud computing is currently emerging as an ever-changing, growing paradigm that models "everything-as-a-service." Virtualised physical resources, infrastructure, and applications are supplied by service provisioning in the cloud. The evolution in the adoption of cloud computing is driven by clear and distinct promising features for both cloud users and cloud providers. However, the increasing number of cloud providers and the variety of service offerings have made it difficult for customers to choose the best services. By employing successful service provisioning, the essential services required by customers, such as agility and availability, pricing, security and trust, and user metrics can be guaranteed by service provisioning. Hence, continuous service provisioning that satisfies the user requirements is a mandatory feature for the cloud user and vitally crucial in cloud computing service offerings. Therefore, we aim to review the state-of-the-art service provisioning objectives, essential services, topologies, user requirements, necessary metrics, and pricing mechanisms. We synthesize and summarize different provision techniques, approaches, and models through a comprehensive literature review. A thematic taxonomy of cloud service provisioning is presented after the systematic review. Finally, future research directions and open research issues are identified.

Summary: Whaiduzzaman, Haque, Chowdhury, and Gani examine cloud computing's current paradigm emerging into a new standard of "everything-as-a-service;" consequently, virtualized physical resources, infrastructure, and applications are being provided through service provisioning in the cloud. Cloud computing is the distributed computing model that provides computing services and resources to users with the intent to increase the opportunities for cloud users to access leased infrastructure and software

applications anywhere and anytime. For example, a specific software-as-a-service offering is a cloud-based phone solution, such as a unified communication platform.

The authors acknowledge that due to the rising number of cloud service providers (CSPs) and the assortment of service offerings, it has become challenging for new clients to choose the best-provisioned services for their business. The authors recommend service provisioning techniques, mechanisms, and approaches that can be used to evaluate the provisioned services in terms of user requirements and costs. One such service provisioning technique is employing a brokerage aided provisioning method. This concept involves collecting the CSP's properties, which are then indexed by 'best matched service' and analyzed for cloud service discovery, service negotiation, and service composition in comparison to other CSPs or cloud-based phone providers. Another approach encompasses combining cloud and internet of things (IoT), referred to as "cloud of things" (CoT). This approach requires combining heterogeneous resources that are tailored to specifications, thus enabling things as a service. The authors also assessed high-tech service provisioning for small businesses, with objectives that included agility and availability, pricing, and security associated with adopting from a CSP. They determined the need for continuous service provisioning, which can fulfill the user requirements, should be a mandatory feature for the cloud user and is vitally important for cloud service offerings.

The relevance of the research performed by Whaiduzzaman, Haque, Chowdhury, and Gani is they provide the means of assessing the overall implications, positive and negative, of provisioning a cloud computing service, and a cloud computing service is a conduit through which cloud-based phone services are provisioned.

Conclusion

In recent years, cloud-based enterprise phone solutions have become more affordable, versatile, and resilient solutions for SMEs (Cortés-Mendoza et al., 2016). This annotated bibliography provides sources that address the overall value for an SME to transition an on-premise telephony PBX system to a cloud-based phone (CBP) platform. Sources were identified from either limited peer-reviewed journals or vetted sources that met the evaluation criteria. These vetted sources were carefully securitized for potentially biased information. Topics are presented in three categories that describe and support the transition to a CBP: (a) value of CBPs for SMEs, (b) CBP security, growth, and scalability, and (c) problems related to CBP platforms for SMEs.

Value of CBPs for SMEs

For small businesses considering entering markets that demand substantial amounts of computing power, obstacles are considerably reduced with cloud solutions (Hu et al., 2011). Among SME companies in the United Kingdom, the emergence of unified communication (UC) solutions is providing these small businesses with plenty of quick wins (Leonard, 2012). These wins are seen in the value of integrating a variety of communication streams together, including voice, mobile, video, IM, and physical presence, thus removing the sense of isolation from the business (Leonard, 2012). These cloud-based phone technologies are maturing and shifting, making a strong business case for a CBP solution such as a UC (Elliot, 2008).

There is an evolution towards unified communication as a service (UCaaS), a cloud mechanism for delivering communication to the business (O'Connell et al., 2017). With this evolution towards UCaaS, free, open-source, alternative real-time technology, referred to as WebReal-Time Communication (WebRTC), is disrupting the market of real-time communications (Beltran & Bertin, 2015). WebReal-Time Communication, an HTML5

technology, permits web developers to combine real-time audio, video, and data communications in their web pages (Beltran & Bertin, 2015).

Tchernykh et al. (2018) analyzed multi-objective scheduling strategies with billing hours, calls placed in a hold status, and voice quality as the criteria for optimization of a cloud-based VoIP in a small business call center. Tchernykh et al. (2018) used three configurable parameters in their approach: Utilization Threshold (UT), a parameter that is used as a trigger to request a new virtual machine; Rental Threshold (RT), a time interval before the virtual machine finishes its renting period; and Prediction Interval (PI), a time interval for which a prediction is performed. The results provided parameters that can be adjusted to address performance issues and reduce the cost of a cloud-based VoIP phone solution for businesses such as the small business in the study (Tchernykh et al., 2018).

The focus on the cost of a cloud-based phone solution versus an on-premise solution provides valuable context for the argument towards value (Ribas et al., 2015). One of the difficult decisions facing IT managers is opting to adopt a cloud model hosted by a third party vendor or continuing to host the telephony service according to the conventional on-premises model (Ribas et al., 2015). Ribas et al. 2015 assert that the decision boils down to cost, as cost reduction is the major expected benefit. A study by Khatua addresses how a specific cloud PBX, an internet protocol PBX (IPPBX) solution, is cost-effective over an on-premise PBX and provides value for an SME that transitions to this solution (Khatua, 2015).

Ribas et al. (2015) developed a practical framework to analyze the merits and risks of adopting cloud-based phone services in contrast with an on-premise lease option (Ribas et al., 2015). They developed a comparison framework to identify quantitative and qualitative factors associated with cloud services in order to establish a ranking of a cloud-based phone solution and an on-premise solution (Ribas et al., 2015). This framework points out that security threats,

performance uncertainty, and economic risks demonstrate a central role in the ranking of the solutions between cloud and on-premise (Ribas et al., 2015).

CBP Security, Growth, and Scalability

Unified communications is a cloud-based phone solution that integrates a range of communication tools to enable both businesses and individuals to manage all of their communications in one entity instead of using a decentralized approach (Karopoulos et al., 2015). A noted security concern with UC is the bring-your-own-device (BYOD) trend; the issues with security in BYOD include the introduction of new entry points and unknown factors via employees' personal devices, which leads to more threats that reduce the security of the cloud network (Karopoulos et al., 2015). There are strong concerns with these new security challenges and the need for resolutions with the problem of BYOD in UC environments (Karopoulos et al., 2015).

Another security weakness with unified communications is employing mobile device management (MDM) and virtualization desktop infrastructure (VDI) (Ding et al., 2013). Mobile device management is software that allows IT administrators to control, secure, and enforce policies on smartphones, tablets, and other endpoints (Steele & Rouse, 2017). Virtualization desktop infrastructure is a virtualization technology that hosts a desktop operating system on a centralized server in a network and is sometimes referred to as server-based computing (Rouse et al., 2017). Ding et al. (2013) assert that the implementation of mobile technologies and consumerization of IT will provide enterprises with more agile, cost-saving measures, and increase employee efficiencies; however, they also note that serious security threats and management concerns accompany the current mobile environments.

One potential remediation for the security threats posed by MDM and VDI is an innovative Internet service and business model that will deliver a secure and consolidated

environment for the infrastructure of cloud-based virtual phones (CVP) (Ding et al., 2013). Ding et al. (2013) propose a secure mobile environment with virtualization techniques such as virtual phones (VP)-big, VP-little, VP-limited, and VP-guard; malware detection; and informal behavior monitoring. VP-big and VP-little are virtual phones represented with more computing resources or less computing resources, respectively. VP-limited is a high-secure virtual phone with more constraints to limit behavior, while VP-guard is responsible for threat detections from insecure public networks. Ding et al. (2013) found that their proposed CVP system made the deployment of business applications scalable, decentralized, and more manageable and established a secure mobile environment that engaged virtualization, malware detection, and informal behavior monitoring (Ding et al., 2013).

Despite security risks, cloud computing is growing, with more providers and service offerings (Varghese & Buyya, 2018). Along with the widespread growth of the broadband Internet, VoIP technologies are gaining in popularity (Lukinskikh, 2015). This trend is led by the low cost of communication services, acceptable quality, ease of use, flexible infrastructure, the ability for integration with various information systems, and Internet services (Lukinskikh, 2015).

In one analysis, Cortés-Mendoza et al. (2016) assess the performance and effectiveness of a CBP model functioning through a heterogeneous super node cluster with an optimization criteria of cost and quality of service. This team assessed the actual performance and effectiveness of a CBP model by introducing a study on scheduling problems associated with cloud VoIP service with virtual machine (VM) startup time delays compared to that of an on-premise PBX (Cortés-Mendoza et al., 2016). The group outlined a bi-objective model with provider cost, supplied by billing hours for used VMs, and quality of service (QoS), affected by call processing, as the optimization criteria (Cortés-Mendoza et al., 2016). The study

demonstrated that a CBP model outperformed an on-premise PBX in terms of growth and scalability (Cortés-Mendoza et al., 2016).

Varghese and Buyya (2018) identify the changing infrastructure of cloud computing, noting that the infrastructure is moving towards a multi-cloud strategy, including: (a) hybrid cloud, a combination of public and private clouds or IT infrastructure; (b) federated cloud, or the gathering of multiple cloud providers under a single umbrella; (c) microclouds, small, low cost, low power computing processors that are collocated with routers and switches or located in dedicated places that are closer to user devices; and (d) a cloudlet option, used for mobile computing and an ad hoc cloud strategy. Applications now aim to leverage cloud infrastructure by making use of heterogeneous resources from multiple providers in contrast to how resources from a single cloud provider or data center were used traditionally (Varghese & Buyya, 2018). This change is key because decentralized cloud solutions that support cloud-based phone platforms (Varghese & Buyya, 2018) provide more flexible and affordable options for SMEs.

Problems Related to CBP Platforms for SMEs

A cloud computing service is a conduit for any cloud-based phone service for the provisioning of a unified communication platform (Whaiduzzaman et al., 2014). Any challenges or problems with the cloud computing service, such as security concerns, will have a direct correlation to the provisioning of a cloud-based platform (Hu et al., 2011).

For businesses considering leasing versus buying telephony technology, Alexander (n. d.) notes there are advantages and disadvantages of leasing versus purchasing technical equipment. The benefits of leasing include up-to-date equipment, predictable monthly expenses, and keeping up with competitors, while the downsides consist of a payment that never ends and limited ability to manage maintenance (Alexander, n.d.). Buying has its value, which includes control over maintenance and fewer complications with leasing; downsides include the fact that

expectations of the initial purchase may be more than planned, and eventually, the business will be stuck with legacy equipment. (Alexander, n.d.).

In terms of cost management and cost containment, the on-demand and scalable nature of cloud computing services make it difficult to define associated quantities and predict costs (Durcevic, 2019). Cloud-based phone environments, such as UC, can be integrated into business easily, having a direct impact on financial savings that are commonly associated with the cloud (Butler, 2012). Transitioning from a capital expense to an operating expense provides cost savings; however, there are alternative and affordable solutions that are not in the cloud, which adds to the reluctance of some customers to implement cloud-based solutions (Butler, 2012).

Khatua highlights challenges with telecom businesses providing cloud services, which include: (a) laws and acts are under different jurisdictions, (b) lack of security with data residing globally, (c) risks with transferring confidential data, (d) specific end-user restrictions with their cloud provider, and (e) downtime that impacts Internet connectivity (Khatua, 2015). This list (Khatua, 2015) is significant because most studies do not address the disadvantages that are associated with a CBP platform.

Lack of expertise poses problems in the management of cloud tools for business (Durcevic, 2019). Small and medium enterprises may find adding cloud specialists to their IT teams to be excessively costly (Durcevic, 2019). Regardless, due to the rising number of cloud service providers (CSPs) and the assortment of service offerings, it has become challenging for new clients to choose the best-provisioned services for their businesses (Whaiduzzaman et al., 2014).

Final Thoughts

In review, the overall value for an SME of implementing a cloud-based phone solution is determined by the SME's business strategy and the direction of the company (Alexander, n.d.).

Having the right framework to make that evaluation and analysis provides the additional worth of *value* once a decision is made (Ribas et al., 2015). Determinations of value including following the UC trend (Leonard, 2012), integration of multiple communication platforms (O'Connell et al., 2017), combining in-content communication with web services (Beltran & Bertin, 2015), or even the cost difference between CBP and PBX (Ribas et al., 2015) all provide information for SME leaders considering adoption of a CBP.

The security, growth, and scalability of a CBP solution afford the best value for an SME (Varghese & Buyya, 2018). Mediating a solution for integrating BYOD (Karopoulos et al., 2015), managing the incorporation of mobile devices into a CVP (Ding et al., 2013), and looking at the growth and scalability opportunities a cloud solution has to offer (Varghese & Buyya, 2018) are all factors in transitioning.

There are problems related to CBP platforms, which are an integral part of the selection process for SMEs to consider (Alexander, n.d.). An SME considering CBP adoption must understand both the benefits (Ribas et al., 2015) and challenges associated with the adoption of a cloud-based solution (Whaiduzzaman et al., 2014). Understanding all the challenges, including the simple aspect of leasing versus buying (Alexander, n.d.), has significant sway on the value and even the return on investment provided by a CBP (Butler, 2012). All elements of cost have an impact on the decision to transition to a CBP or not (Butler, 2012).

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