Unix-Based Networking in Cloud Computing

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***Abstract*—This report defines cloud services and how Unix-based operating systems can be used within the cloud, particularly for networking purposes. Unix is the original open-sourced operating system and has been developed into an efficient and powerful system capable of providing many different services, and is most commonly used in the IT industry as a server operating system. Cloud-based infrastructure lends itself perfectly to the application of Unix virtualisation, as Unix systems are by design, extremely flexible and modular, which means that additional cloud resources can fit in seamlessly with Unix-based servers.**

I acknowledge that late submission without a prior arranged extension limits this report to a Pass grade

I. Introduction

The Unix operating system began development during the late 1960s, and since then has undergone drastic changes and has become one of the most commonly used operating systems for computing operations such as; workstations, servers, supercomputers, and in more recent times Cloud Computing [1]. The historical significance of Unix cannot be understated, as it was the first true open-sourced operating system that spearheaded a revolution within the IT world, and would later lead to the creation (or a major influence) of most operating systems today. Being an open-sourced operating system, all distributions frequently used today have been rigorously tested and are known for their high levels of reliability and flexibility in terms of configuring additional services as required [2]. Given that Unix is very modular and can be configured to be very resource-efficient, coupled with being an excellent server-based OS, it makes sense why many organisations are using Unix-based operating systems to manage critical tasks [3].

Cloud Computing is the broad term that describes services or applications that can be accessed anywhere from the internet, usually on a paid subscription for that service. Customers can rent the resources that they require, and can dynamically change those resources to meet changing demand [4]. This means that one does not need to worry about the physical hardware, network, or software limitations that may be cause for concern with in-house infrastructure. Cloud computing falls into three general categories; Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS). IaaS refers to the physical hardware of a computer that can be accessed via the cloud, such as storage or virtual machines running on cloud hardware. PaaS defines the hardware and software that are required for a development environment for creating and maintaining cloud-based applications. Finally, SaaS refers to any software that can be accessed remotely via the cloud, instead of running a local instance on your device. [4], [5]

Cloud-based services are becoming more frequently available and convenient for consumers, as almost any modern computing function can be rented, generally for substantially less than the cost of building an equivalently capable system yourself [4], [5].

II. Discussion

A. Considerations for Unix-based network services

Unix and Linux system distributions are known for their highly customisable configurations and interoperability with other system versions and Operating Systems [2]. Unix software updates are developed and tested rigorously by a large community of developers that are constantly creating new features, improving over older features, or fixing bugs that may exist on certain updates. Given the nature of open-sourced code sharing, their have been significant splits into different distributions, each focusing on a more specialised set of features and requirements for different operating tasks needed by the end user, but all different versions of Unix or Linux share a common core design, thus it is very easy to find a preexisting distribution that would meet your needs, or with the correct resources one could develop/customise a new system tailor-made for your personal or organisations requirements [6].

Current distributions of Unix operating systems are all compatible with networking software, to establish the device as a server for a myriad of networking services such as; DNS, FTP, HTTP/S, SMTP, DHCP, SSH, etc. These services can be easily added or removed, and allow the administrator to change any aspect of the service to suit their specific requirements [7]. The ease of network service configurations, general high performance, and the extremely resource-efficient nature of Unix operating systems lends itself perfectly for cloud-based network infrastructure and software, and this is seen within the industry, as most large organisations are using Unix to run almost all of their online business needs [8].

A major issue with all modern operating systems is how they handle task interrupts, and how much latency is created via incorrect prioritisation, or general poor use of time and resources. This problem becomes amplified when said device handles more data and throughput [9]. These issues certainly

still exist within Unix and Linux distributions, but most general-purpose operating systems handle these interrupts in a predefined way, but with Unix one has greater control over how tasks are processed, that coupled with newer developments in container-based virtualisation of network resources, Unix for network deployments is the faster and more reliable system choice compared to Windows or Mac OS [9]–[11].

B. Integrating Unix into the Cloud

Due to conflicts within different Operating Systems, it can be difficult to switch between Cloud Service Providers as you may run into compatibility issues with your current system running on a different cloud service [12]. Using a Unix system to run your network operations on the cloud would help to alleviate some of the struggle with compatibility, as most Cloud Service Providers have built there services using Unix-based systems, and due to the customisable nature of Unix systems, we can develop systems that can migrate to any different cloud network with minimal change to system performance or downtime. The current state of the Internet and Cloud Computing, Unix-based operating systems make up approximately 90% of all cloud infrastructure and 96% of all web servers [8].

Cloud services are designed with scalability in mind, using virtualisation of different operating systems to most effectively utilise the hardware or software outputs of a particular server [4]. These different instances can be moved between servers within the cloud if your current applications are slowing due to being particularly demanding or their being potential bottleneck issues within that network segment, so that your service is always running at optimal performance [4], [5]. Given that networking services are required to be running constantly with very little downtime, using cloud-based services to facilitate the infrastructure you need means that you are almost guaranteed constant network performance, with any issues arising being due most likely to an administrative error or other network anomalies, such as an attempted hack.

A growing trend within Cloud Computing is using a container-based virtualisation approach, in which a 'container' holds all required software and hardware in order to fulfil the desired task [11]. This creates an abstraction from the operating system, which allows for more effective utilisation of hardware for applications and tasks. Using this technology, we can create images of Unix or Linux applications (such as the services mentioned above) and run them via a virtual container, maximising the already more efficient Unix-based applications with better hardware support [6], [11].

General considerations for Cloud Services should include; quality of service, support, cost, scalability, security, and flexibility [4], [5]. Quality of service should be guaranteed by your service provider, particularly in the case of integrating networking services into their cloud. Monitoring software can be used to ensure that your provider is meeting the standard performance as per your contracted Service Level Agreement [12]. Hosting network services, especially organisationally crucial services such as a web or file server, your service provider must ensure that there is no interruption to regular performance, as significant downtime could result in millions of dollars lost in business, particularly within e-commerce or banking [4].

1) Infrastructure as a Service: A Cloud Computing term used to describe hosting resources on the cloud that can be made accessible to users as required. These resources can range from something like more storage for data, to networking infrastructure, to virtual machines running a different operating system [5].

For Infrastructure as a Service, Unix-based operating systems work extremely well given how simple it is to make modifications to the systems software or hardware with minimal issues, which is due to Unix/Linux being open-source and not hardware/manufacturer dependant [1]. IaaS allows for dynamic increase or decrease of hardware usage as required, so that the client is only paying for the infrastructure that they need at the current time, with additional servers and hardware being reserved for your use, but naturally inducing greater cost [5].

An example, Apache Virtual Computing Lab (VCL) is a current IaaS wherein resources within the network are dynamically reserved for use as needed by the client, such as hosting a virtual machine, or running resource-intensive physics simulations [12].

2) Platform as a Service: The term used to describe fully integrated development environments used by developers to create and manage applications. This encompasses all the necessary hardware and software with the cloud network in order to meet the requirements of modern app development [5].

A commonly used Platform within the market is Heroku, a Linux-based platform that supports development in many different programming languages. The Heroku platform uses Linux virtual containers to dynamically allocate more resources as your applications require, as well as automatic management and monitoring over your environment and active applications [13].

3) Software as a Service: The term used to describe software running on the cloud network, accessible anywhere on the internet. This is opposed to running that particular software on your current device, which may be due to compatibility issues with operating system or hardware requirements that your current device cannot meet [5].

These services are more for everyday services, such as Netflix, Spotify, Uber. All of these examples are technically SaaS's, as we are interfacing with software via the internet, and that requires membership for the service.

Utilising Cloud Services for creating a Unix-based network should be relatively easy for the engineers/administrators of an organisation, as Unix is built to be modular and customisable for any particular application or service you require. Unix is particularly good at providing network services, and as mentioned above, it is currently the operating system running

a vast majority of internet and cloud infrastructure due to its ease of deploying Unix as a server for various applications and services [1], [8]. Coupling Unix with cloud services, which allow for the rapid deployment of additional resources as you require them, and the use of cloud virtual containers to most effectively use all the hardware being utilised, makes the integration of Unix-based operating systems within the cloud a perfect choice for any organisation that requires high performance, which is true for any Unix service, not just networking [4], [5], [11].

III. Conclusion

This report has covered the main concepts of using Unix-based operating systems for hosting networking services, and how we can integrate these services into the cloud. Unix provides the modular and customisable operating system that is perfect for configuring new services on, and the cloud provides the dynamically assigned hardware/software requirements of the desired network, in addition to full integration into the internet. The integration of Unix into cloud services is seamless, as with the development of virtualisation and virtual containers, a technology that is only getting better with time, almost any hardware within the cloud is compatible with any operating system or software applications.

The quality and performance of the services provided by the cloud are assured by your contract with the provider, meaning that more of an organisations resources can be put into applications and network design/administration, insuring that smaller organisations can still operate with high-performance infrastructure that they otherwise couldn't justify purchasing, or for larger organisations that require massive amounts of network traffic management or data processing.

Unix operating systems are the single most popular systems on the internet for hosting network services [8], and this reputation is well deserved, with decades of development and innovation, Unix will continue to be the dominant operating system on the internet into the foreseeable future.

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