UNIX Integration With Cloud Computing

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***Abstract*—This paper aims to explore the integration of UNIX with cloud based computing systems, particularly UNIX-based tools and services available for the network stack. UNIX is already well established for server infrastructure due to its modular and scalable design. The cloud computing environment is different to the traditional server environment; however the strengths of UNIX transfer well when compared to other operating systems. UNIX shows promise for implementation in cloud computing platforms due to both its structural and distribution choices.**

***Index Terms*—UNIX, Cloud, Networking, Operating Systems**

I. Introduction

UNIX operating systems have long been a staple of non-user facing systems such as servers[1]. The longevity of UNIX, as well as the open-source nature have culminated in an efficient, modular operating system that is adaptable and well suited to a variety of computing environments[2]. It is not surprising then that UNIX is being deployed in a growing number of cloud computing environments; competing with other established operating names such as Microsoft with Microsoft Azure[3] and Amazon AWS, which relies on Linux itself[4]. There are several key qualities of UNIX that make it specifically suited to the cloud environment:

- Open source code-base
- Modular and compartmentalised structure
- Scalable and efficient nature

Each of these qualities will be explored in the following sections. For simplicity the use of 'UNIX' throughout this report refers to both UNIX itself as well as UNIX-like operating systems, such as Linux/BSD.

II. Open Source Code-Base

One the main draws of UNIX operating systems is the fact that many are open-source[5], whereas many of the major competitors use proprietary software. Being open-sourced provides many benefits for UNIX such as greater security and lower entry costs for users of the software[6]. The collaborative and transparent development environment of open-source software means that there are more people browsing the code and rectifying mistakes. This leads to greater security as there is less opportunity to maliciously introduce flaws or backdoor access[6]. Being open-source also means that UNIX is distributed for free[7], allowing more people to have access to the software compared to costly enterprise operating systems. Windows Server, for example, has not only costs associated with the operating system itself but also with each user who accesses the cloud infrastructure[8]. The free distribution of UNIX provides a much lower barrier of entry compared to enterprise software, this is especially applicable with cloud infrastructure where the number of end devices can expand rapidly. This would result in massive cost increases when using enterprise software, however it is not an issue with UNIX operating systems.

III. Modular Structure

One of the largest differences between UNIX operating systems and competitors such as Windows Server is their modular structure. UNIX operating systems are composed of a collection of independent programs that work together to perform more advanced actions[9]. This methodology is surmised in the UNIX design philosophy: "Write programs that do one thing and do it well. Write programs to work together. Write programs to handle text streams, because that is a universal interface." (McIlroy 1978) By following this design philosophy throughout its development, UNIX has grown as an efficient and modular operating system that can be configured for specific hardware environments[9]. The modular structure of UNIX operating systems greatly increases their efficiency and flexibility, both of which are important qualities for operating in a cloud computing environment.

IV. Scalable Nature

UNIX operating systems have been at the forefront of resource scaling since their inception[10]. This is due to the original objective of UNIX: to allow multiple users to access a single computing architecture concurrently[11]. This approach to operating system design belies many scalability advantages to UNIX; the ability to dynamically expand and contract resource usage for an elastic computing environment[12] is greatly valued in a cloud computing architecture. This scalable nature allows UNIX to seamlessly adapt to variable hardware availability[13]. Combined with the modular structure of the operating system explored above, this means that UNIX is uniquely suited to the rapidly expanding and variable cloud infrastructure.

V. Compatibility with Cloud Computing

From the sections above it can be seen that UNIX operating systems contain many desirable attributes for implementation in cloud computing. The modular structure and scalable nature that arise from the guiding development philosophy of UNIX provide a distinct suitability for use in cloud computing[2].

Cloud computing infrastructure is often composed of multiple disparate devices working in concert to provide cloud services; making the ability to abstract hardware devices under UNIX also a coveted feature[14].

VI. Tools for Network services

The network services that are available for UNIX encompass a wide range of services. This includes low-level functionalities such as DNS and DHCP, to higher-level network services such as email, web-hosting, and more. The specific tools available on UNIX to run these services are discussed below. Each of these services is a disparate component of the UNIX operating system and can be scaled up or disabled depending on the requirements of the system.

- **Domain Name Service:** DNS can be configured on UNIX using the Berkeley Internet Name Domain (BIND) service. BIND is the most commonly used DNS service for UNIX and accounts for 65% of DNS servers on the internet[15]. BIND is configured using 'zone' files that define the forward and reverse translations for IP addresses and host-names, respectively.
- **Dynamic Host Configuration Protocol:** DHCP can be configured on UNIX using the DHCP Daemon (dhcpd) service. Dhcpd is developed by the Internet Services Consortium (ISC) and was one of the first DHCP services to be developed, as well as the most widely utilised[16]. Dhcpd is configured using a range of IP addresses that are available for end devices to reserve. It can be configured to work with DNS to create dynamic DNS, where the dynamic allocations for DHCP are communicated back to the DNS server.
- **Email Hosting:** Email hosting can be configured on UNIX using the Exim service. Exim is the most commonly used Mail Transfer Agent (MTA) for UNIX and accounts for 60% of MTAs running on the internet[17]. Exim is a scalable solution that can be used for large amounts of both email recipients and email traffic.
- **Web Hosting:** Web hosting can be configured on UNIX using the Apache service. Apache is a commonly used HTTP server for UNIX and it is used for 31% of HTTP servers on the internet that can be identified[18]. Apache can be used to host multiple separate websites on the same host device through the use of virtual hosts.
- **VoIP Hosting:** VoIP hosting can be configured on UNIX using the Asterisk service. Asterisk is a popular open-source Session Initiation Protocol (SIP) for UNIX with over one million servers[19]. Asterisk can handle many of the expected features of a VoIP service including IVRs, hunt groups, and voicemail inboxes[19].

VII. Conclusion

UNIX operating systems incorporate many desirable features for cloud computing as standard. The modular structure and scalable nature of UNIX provides a desirable foundation for implementing and scaling up cloud infrastructure. UNIX is also valued as a cloud operating system due to its open-source and free distribution. This allows new cloud infrastructure to be deployed for reduced costs compared to proprietary operating systems, as well as allowing the increased adaptability that comes with open-source software. The design choices and features of UNIX make it a promising choice for deployment in cloud computing infrastructure.

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