Comparing UNIX-based network services with cloud computing

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I. ABSTRACT

This aim of this report it to look at the different options that are available for configuring a cloud computing environment with a focus on different operating systems and how they compare to using Unix for cloud computing services. As per [2] Amazon have the largest market share for cloud computing services at 32% of the market share. The objective of this research paper is to look at the various cloud computing providers and operating systems that are available to determine what the best cloud computing option is.

II. INTRODUCTION

With more dependence on cloud computing for business operations it is important to pick the best solution for individual businesses. The purpose of this paper is to research the various options that are available to determine in which situations the best option would be. Investigate different cloud providers and what options that offer in terms of features and different OS virtual machines that can be deployed.

III. METHODS

The approach used for this research paper was to conduct research for all the different Cloud computing options that are available, investigate the various OS that are available. Look at the advantages and disadvantages of all the options that are available to determine the best option in various scenarios. Look at how to setup an instance of an IaaS using AWS.

IV. RESEARCH

A. Operating Systems

- Windows
  - Advantages
    * The most widely used OS for client machines that are not mobile devices at 30.12% market share. [4]
    * Requires less technical skills to configure, due to the GUI configuration for setting up network services.
    * More support is available to fix issues compared to Open source OS such as Unix and Linux.
    * Has a wide range of driver support out of the box, compared to other OS
  - Disadvantages
    * Comes with more built in software, so runs slower than compared to Unix/Linux.
    * Requires more resources to run, due to that must run a GUI and cannot be run purely from the terminal/command prompt.
    * Because of the extra resources required to Windows, requires more powerful hardware than compared to Unix/Linux.
    * Higher licensing fees then compared to other OS options.
    * More vulnerable to security threats, due to being a popular option and easier for attackers to find vulnerabilities.
- Linux
  - Advantages
    * Can get free versions of Linux that reduce cost, particular for smaller businesses that require less resources for cloud computing.
    * Popular choice for cloud computing due to lightweight nature, lots of guides online on how to setup cloud computing services.
    * Different builds available, can get lighter builds for systems that have limited RAM or CPU capacities.
    * Connecting via SSH using shell, can be good for low bandwidth internet connections.
  - Disadvantages
    * No support for free versions, need to get enterprise versions for support, e.g. Red Hat Enterprise Linux
    * More technical to setup than compared to Windows.
    * May require custom setup for manually installed hardware drivers that are not included in kernel that comes with edition of Linux that is installed.

- Unix
  - Advantages
    * High level of security built in, due to the way that the OS was originally intended for multiple users and has continued to provide a very high level of security due to permissions and user accounts that are used, so is a good fit for cloud computing.
    * Efficient at multitasking, particularly on systems with lower resources.
    * Modular construction, can remove drivers/applications/services that are not required to make system run faster.
    * Connecting via SSH through terminal, is a good option for systems that are slow or have low bandwidth connections.
  - Disadvantages
    * More technical to setup due to the fact that for servers, it is usually configured using the terminal.
    * Doesn't come with a GUI out of the box, may be harder to setup for Windows users or any other GUI based OS.

Features	Windows	Linux	Unix
GUI	Yes	Most builds	Installed separately
License Cost	Yes	Some	No
Lightweight	No	Yes	Yes
Support	Yes	Paid Version	No
Advanced setup	No	Yes	Yes

TABLE I: Summary of Operating System Comparison

B. IaaS vs CaaS

a) IaaS: **Infrastructure as a Service** - Provides an instance of a virtual machine in the cloud. The process once the instance of the IaaS machine has been created, is still the same to setup the machine as if the device was setup locally. The advantage of this approach is that maintenance of the system hardware, upgrading physical hardware etc, is not required but it does need to be factored into the monthly cost of cloud services. This approach also allows for more customization, because the user can install any supported operating system and customise what services are required for the server.

- Advantages
  - Creates an instance of a virtual machine that can be customized to suit the needs of the business.
  - Fees are based on what is used, e.g. the amount of connections to a web server [6]
  - Dynamically Scale-able [6] Can add instances of servers when high traffic load, and reduce instances of servers when less connections required

- Disadvantages
  - Vulnerable to security threats because maintenance and security is managed by a third party cloud provider. [6]
  - Takes longer to deploy, because you have to configure a virtual machine with an OS.
  - Limited support is available [6]

b) CaaS: **Container as a Service** - Provides an instance of a virtual machine with a container that is used for deploying applications. It is easier to deploy and quick to setup because you don't actually need to configure the OS. They are responsive and lightweight and startup quickly for providing cloud services. Provide less flexibility than an IaaS instance, as you do not get the choose the OS and usually come pre-configured for a specific purpose.

- Advantages
  - Platform independent for providing cloud services [19]
  - Scaleable so that can meet the demands of connections required. [19]
  - Abstracts away the need for configuring the OS and just provides a container for the application to run in. [19]
- Disadvantages
  - Security risks - if a container is has a vulnerability, then containers on the same host may be affected as well. [19]
  - May run into compatibility issues, if the application needs to run on a instance with a different run-time installed. [19]

C. Cloud providers

Referring to *Figure 1*, you can see that Amazon currently has the largest market share with *32%* of the cloud computing market. It is still the 3 big players that have the biggest share in cloud computing, with Amazon first, Microsoft Azure second and Google Cloud third. In this next section we will look at each of the big 3 cloud providers in more detail.

a) **Amazon Web Services(AWS)**: The business model that is used for Amazon, makes it a good choice for lots of consumers. The tiered based system, means that there can be scaling up and down of systems when required, e.g. more web traffic is directed to a web server, during a sale. Because the cost is relatively low for smaller and free when starting out, this makes hosting on AWS, a popular option for lots of businesses. [8]
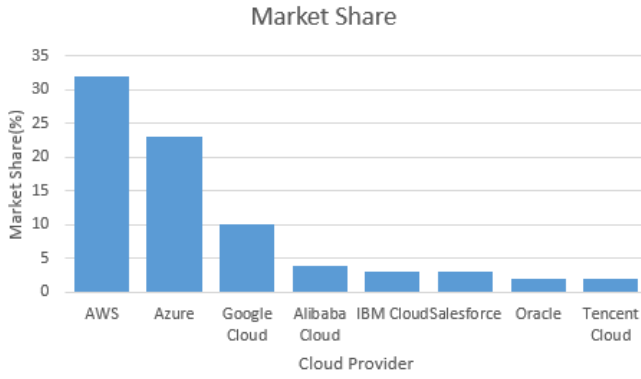
Fig. 1: Market share of cloud providers [5]

b) ***Microsoft Azure****:* Microsoft Azure uses a similar business model to Amazon, in that it provides different levels of virtual machine instances at varied prices, depending on the amount of resources that are required. There is a free tier option, that can be used for testing/development, in this tier you don't get instances of servers, but can deploy up to 10 Web, mobile or API requests for using restful web services. [7]

c) ***Google Cloud****:* Google Cloud also provides a free level of services. It is a bit less clear on the pricing page as how much the pricing will scale compared to AWS/Azure when more resources are required for cloud computing services. The customer support pricing options provide a more clearer picture for the different levels of service plans that are available. [9]

d) ***Vultr****:* Vultr [28] provide cloud hosting services, where you can host virtual machines with Windows, Linux and Unix. There is a free level tier program that is designed to be used for software development testing of virtual machine servers. [29] Depending on how many CPUs, Memory and bandwidth are required for the application, there are various hourly/monthly rate chargers for hosting these virtual servers. [30]

Providers	Windows	Linux	Unix
AWS [12]	Yes	Yes	Yes
Azure [13]	Yes	Yes	No
Google Cloud [14]	Yes	Yes	No
Vultr [37]	Yes	Yes	Yes

TABLE II: Summary of Cloud Providers

D. Network services used for Cloud Computing

- **Web Server/Web applications**
  - Windows [20]
    1) Download and install Apache server.

2) Need to add SRVROOT Folder to httpd.conf file. And make other necessary changes to allow Apache to run.
3) Run Apache from Command prompt
4) Allow access to the service for Windows Firewall
5) Check Apache is running in local browser by going to localhost address.
6) Install Apache as a Windows service, so that the service runs at startup.

  - Linux [21]
    1) Install Apache from the terminal by running: "sudo apt install apache2"
    2) Create gci folder in /www folder
    3) Create an index.html page to test the service
    4) Create Virtual Host configuration file and specify server domain name
    5) Activate the Virtual Host file and restart Apache service
    6) go to the domain name configured in step 4 and test the page can be displayed

  - Unix [17]
    1) Download and install apache24 pkg
    2) Set apache24_enable=yes for rc config file
    3) Start the apache service
    4) Go to the localhost address to test the default index.html in /data folder can be displayed

- **Database storage**
  - Windows
    1) Install and configure SQL database, in this example SQL server is used as database management system. [22]
    2) Create SQL Database and add table for testing
    3) Check that the Database connection can be established and query the database.

  - Linux [23]
    1) Download and install .deb package from MySQL web site
    2) Update path to MySQL bin directory
    3) Start the MySQL from terminal
    4) Create a Database
    5) Give permission to the user to access the database
    6) Install the driver for connecting to mysql database
    7) Configure the obdc.ini file with the Server address, port, username, password and database name

8) Check the a connection to the database can be established a query can be run on the newly created database.

– Unix [24]

1) Install MySQL package from terminal
2) Secure the MySQL configuration by running the command and disabling users that are not authorised to access the database.
3) Start the MySQL service
4) Create a database
5) Connect to the database and determine that the database can be queried.

- **Email**

– Windows

1) Install SMTP Server
2) Configure the email server, roles, services, features and IP address of the email server. [25]
3) Connect to the SMTP server and test an email can be sent.

– Linux [26]

1) Install postfix from command line using sudo apt command
2) Create a user
3) Add the user to the mail group
4) Create a password for the newly added user
5) Install mailutils package
6) Test that the postfix mail server works.

– Unix [27]

1) Go to /etc/mail Directory
2) Configure the mail server settings in sendmail.mc file
3) Configure user account credentials in /etc/mail/authinfo
4) Hash the authinfo configuration file
5) Restart the sendmail service
6) Test that the email can be sent.

V. Integration

A. Deployment

- Amazon Web Services Being the biggest cloud provider, due to the ease of deployment and free level tier it is a popular option for development of cloud services. The documentation and guides on how to use instances and deploy/destroy instances as required. [34] There are limited services that are on a 12 month free tier, such as Elastic Servers (EC2) and various other features that you get include in the free tier of the plan. [31]
- Microsoft Azure Microsoft Azure is also one of the bigger cloud providers. There is a 12 month free tier plan option that is available. [32] There is also a comprehensive list of guides to help get started with deployment. [33] There a wide range of deployment options available for cloud services that are required.
- Google Cloud Google Cloud provide $300 in free credit to get you started with the cloud services that are required. [35] There is also a documentation page that can help with getting all the services required up and running. [36] There are a wide range of services available, and there are also some AI based features that can be implemented to help track and compare results of your cloud services.
- Vultr Vultr provides a wide variety of cloud services, it also provides a $250 of credit for signing up to try Vultr. [37] It has a comprehensive documentation page on how to get all the cloud servers deployed. [38] There are wide range of server options that can be deployed, with IaaS options with a wide range of OS builds and CaaS options for deploying coding platforms, or server applications.

B. Scalability

- Amazon Web Services AWS provides good scalability for businesses because cloud services can be scaled up and down as required. [39] Additional servers or more powerful servers can be used during peak times, when more resources are required for cloud services.
- Microsoft Azure Microsoft Azure provides good options for scaling cloud services as described on the documentation page. [40] Instances can be added during peak times to handle the increased load for cloud services. Instances can also be removed in times when it is not busy, e.g. during non peak times for web traffic.
- Google Cloud Google Cloud offers the option to scale up and down as services are required as described in the documentation page. [41] Depending on the metrics that are set, using autoscalers can be used to increase or decrease the required instances to handle cloud services during times of higher load, i.e peak times and also can scale down during off peak times.
- Vultr Vultr provides scalable cloud services that can expand and shrink depending on the amount of resources required.b42 This also means that you are only charged for the services required, i.e. the amount of instances that are required or the amount of computing power that is required to host your cloud services.

C. Monitoring

- Amazon Web Services AWS has a service called CloudWatch [43] that provides monitoring on all AWS cloud based services depending on what the most important metrics are. This service allows the user to set alarms and custom track metrics of the cloud services, that can provide detailed graphs through the use of Dashboards.
- Microsoft Azure Microsoft Azure has cloud monitoring [44] that allows the user to view all the metrics of the Azure cloud based services that have been created. There is also an Insights [44] that can provide more details of the status of all VM instances and Visualize [44] that can be used to view all the required information for monitoring in a Dashboard.
- Google Cloud Google Cloud has Cloud Monitoring Services [45] that can be used to manage to track all the metrics of instances that have been created and are running. All the data that is required for monitoring cloud instances and services can be viewed through a Dashboard.
- Vultr

VI. RESULTS

A. How to setup Unix in the cloud

- Create an instance on AWS Light sail.
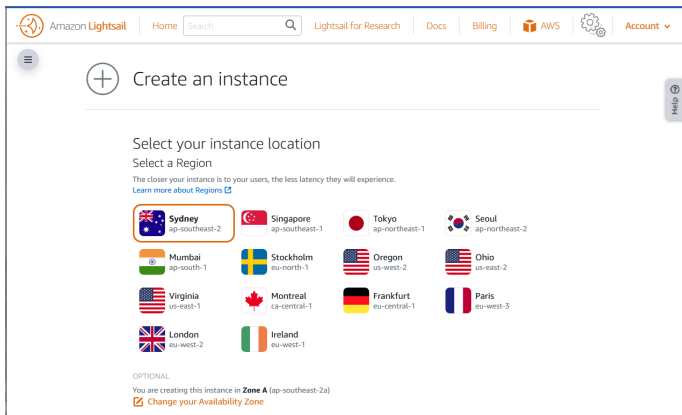- Choose the region for the instance that has been created.

Fig. 2: Choose Zone for creating instance

- Choose the Unix build you wish to use:
- Connect to the Instance using SSH
- Shell is displayed for Unix Instance
- Install Apache24 as per this document [16]
- Modify index.html stores in apache
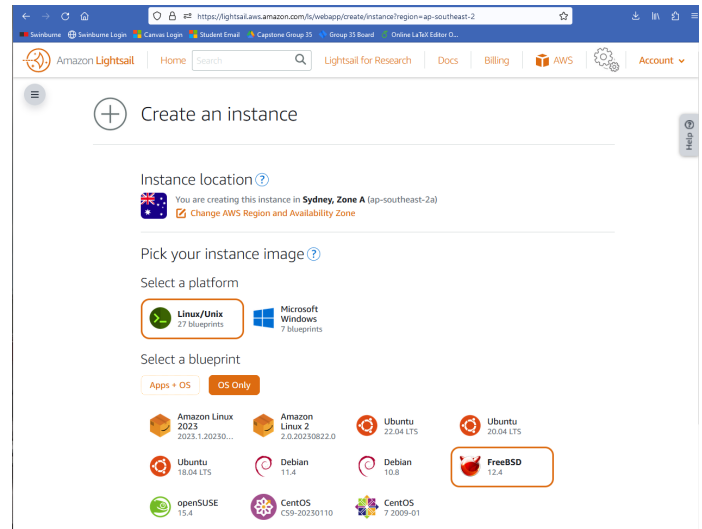- Go to public IP address on Local PC to test server
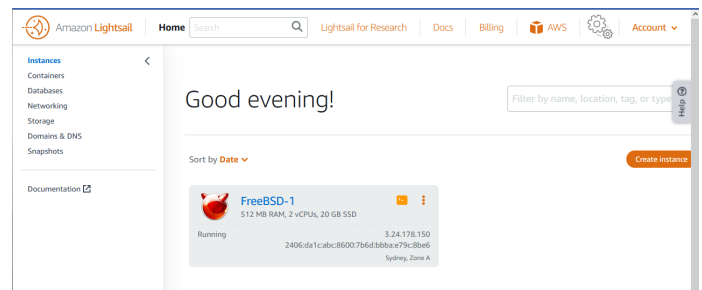
Fig. 3: Choose OS for instance
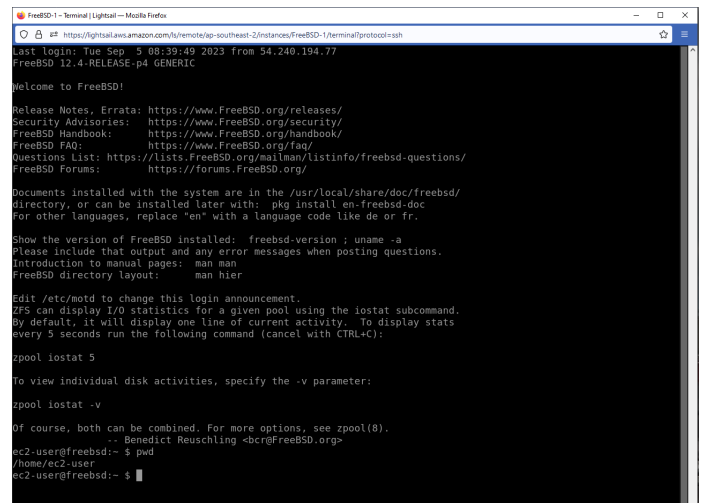
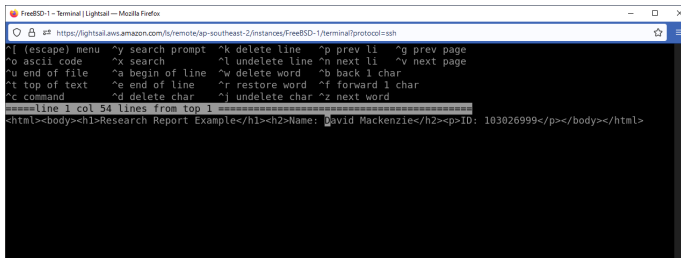Fig. 4: Connect to instance using SSH

Fig. 5: Unix instance Shell

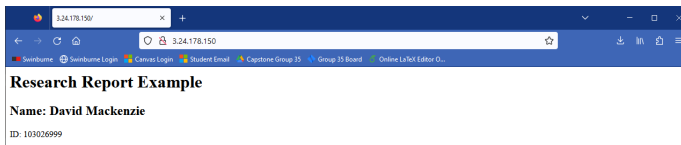Fig. 6: index.html on Unix Instance

Fig. 7: Web page from Unix Cloud Server

VII. Conclusion

Based on the research carried out Unix is a good option for providing cloud computing services. Due to the modularity of Unix, it allows the smallest possible version of the OS to be created. Its memory usage and low resource usage, makes it a good option because it requires less computer power for either a local server, or for using as a cloud computer using an IaaS instance. It handles multitasking very well, so can handle many simultaneous connections for various cloud based applications, such as Web application, email server, database storage and many other cloud based applications. Deploying a copy of FreeBSD on AWS is easy to setup and configure. Within about 5 - 10 minutes you can have a FreeBSD deployed and begin configuring as demonstrated in the Apache server setup. There

are also many reasons why Unix is not a suitable option for businesses to use. The business may use a cloud provider that only supports Window/Linux instances. There may be other reasons for why Unix cannot be used if the eco system at an organisation is Microsoft, Apple based, then it may not be possible to change all the services required to a Unix server. It also may not be a suitable option if the technical team are not familiar with Unix due to the steep learning curve, compared to other cloud computing options that are available. If a single service is required, e.g. a web application, than it might be better to go for a CaaS solution, so that deployment is faster.

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