Comparative Study for Cloud Computing Platform: Apache CloudStack, Morpheus and OpenNebula

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ABSTRACT

Cloud computing is a Service Oriented Architecture that provides numerous benefits such as reduced IT overhead for end-users, flexibility, on-demand services, and cost-effectiveness. Rather than offering IT capabilities as products, cloud services offer them as services. Cloud services can be divided into three categories including Software as a Service, Infrastructure as a Service, and Platform as a Service. Additionally, cloud computing can be categorized into Private Cloud, Public Cloud, and Hybrid Cloud. Private Cloud is gaining popularity among organizations of all sizes. To deploy public or private clouds, there are several open-source software options available, such as Eucalyptus, Nimbus, OpenStack, OpenNebula, CloudStack, and Amazon Web Services. In this paper, we provide a comprehensive study on the one of open-source cloud software options, namely Apache CloudStack, Morpheus, and OpenNebula. The comparison presented in this paper aims to assist developers in selecting the most suitable open-source software option for their cloud implementation project.

Keyword : *Apache CloudStack, Morpheus, OpenNebula*, IaaS, PaaS, SaaS.

1. introduction

Cloud computing is a delivery model for applications and services over the internet (the cloud). This approach enables organizations to avoid the expense of physical hardware and instead utilize shared resources, effectively providing scalable solutions to support their business growth [1].

Cloud computing has become increasingly popular in recent years, as it offers numerous advantages over traditional on-premises solutions. Some of the key benefits include [1][2]:

• Scalability: Cloud services can be easily scaled up or down to meet the fluctuating demands of a business.

• Agility: The cloud allows organizations to quickly adapt to changing business conditions, without the need for lengthy procurement processes.

• Cost-effectiveness: By leveraging shared resources, businesses can often achieve better pricing compared to maintaining dedicated, on-premises infrastructure.

• Reduced management complexity: The cloud removes the need for businesses to invest in complex data center infrastructure and management.

• Global reach: Cloud computing services are accessible from anywhere with an internet connection, making it easier for businesses to expand their operations internationally.

It's important to note that cloud computing does not replace traditional IT infrastructure; instead, it offers a complementary approach that can enhance the capabilities of an organization's existing IT resources.

The different cloud service models, or "deployment models," are typically based on one of the three fundamental service types: infrastructure as a service (IaaS), platform as a service (PaaS), and software as a service (SaaS). Each deployment model provides a different level of flexibility and control to businesses, enabling them to adopt the cloud model that best suits their needs.

Here is a brief overview of the different deployment models [2]:

1. Infrastructure as a Service (IaaS): This model provides access to the underlying physical resources of a data center, such as virtual machines, storage, and networking components. Customers can then configure these resources according to their specific needs.

2. Platform as a Service (PaaS): PaaS is a higher-level model that provides a platform for developing, testing, and deploying applications. Customers can utilize this platform to develop their applications without having to worry about the underlying infrastructure.

3. Software as a Service (SaaS): is a cloud-based service model that allows software to be provided and run on a network over the internet. Users access software and services directly from a web browser. This approach has become popular in recent years due to the increasing reliance on internet connectivity and the growth of cloud computing.

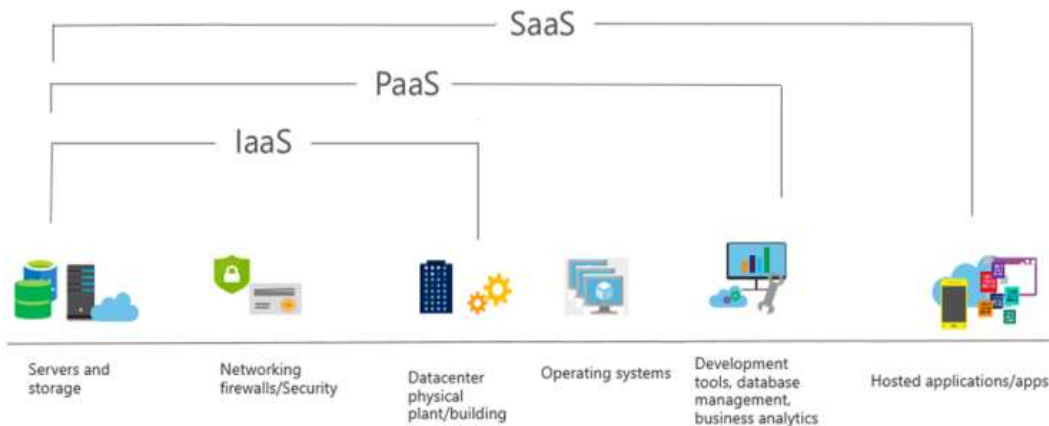The next figure (1) showing the cloud service models [3].

Figure (1): cloud service models

Open-source cloud computing platforms are systems designed to enable self-service and ad-hoc access to shared resources like compute power, storage, and networking. These platforms can be easily customized and extended to meet the unique requirements of specific applications and users.

These cloud computing platforms offer various services and capabilities, catering to different requirements of enterprises. However, they all share the common goal of providing efficient and cost-effective solutions for managing and consuming cloud resources.
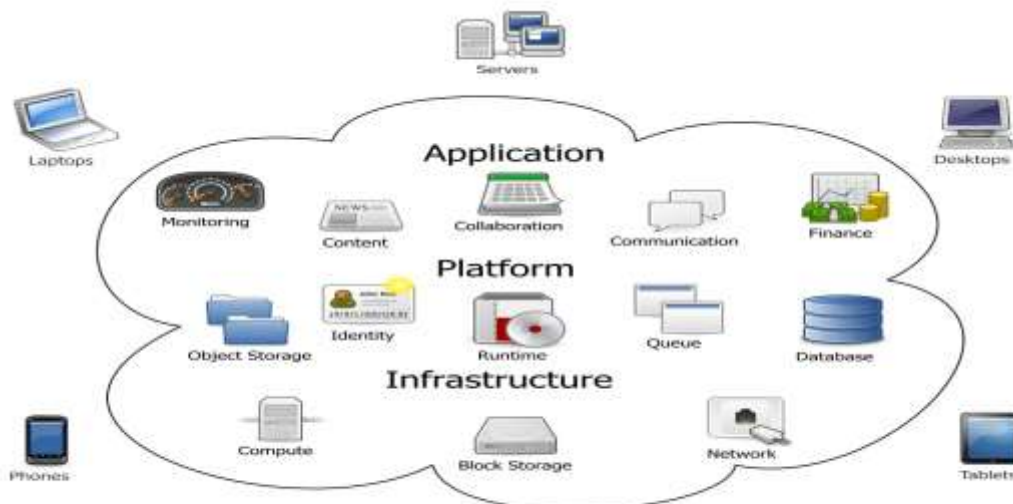
The figure (2) shows a cloud computer metaphor [4].

Figure (2): Cloud computing metaphor

In this study, our aim is to analyze open-source cloud computing services, specifically focusing on three models: Apache Cloud Stack, Morpheus, and OpenNebula. We will compare these models based on a range of important factors.

2. Comparative study

2.1 Architecture and Infrastructure:

Apache CloudStack, Morpheus, and OpenNebula are four different Infrastructure as a Service (IaaS) platforms. They offer a wide range of features, such as resource provisioning, automation, and scalability. The choice of architecture and infrastructure between these platforms depends on factors such as project requirements, existing system landscape, and technical expertise.

Apache CloudStack is an open-source cloud computing platform that supports both Infrastructure as a Service (IaaS) and Platform as a Service (PaaS). It is designed to work on various hardware platforms, such as Xen, VMware, and KVM. Cloud Stack's primary advantage is its ability to integrate with existing infrastructure, making it an ideal choice for organizations looking to build out their private cloud offerings [5].

Morpheus is another open-source IaaS platform that offers a comprehensive suite of features for managing cloud infrastructure. Morpheus focuses on automation, self-service, and multi-cloud support, making it a suitable choice for organizations with complex IT infrastructure requirements [6].

OpenNebula, on the other hand, is an open-source solution that focuses solely on virtual machine and container management. OpenNebula provides a simple and intuitive user interface, making it an excellent choice for small and medium-sized businesses that require basic IaaS functionality [7].

2.2 Integration Capabilities:

Cloud service providers often use cloud management software to manage and control the provisioning of compute, storage, and network resources. This article provides an overview of the integration capabilities comparison between Apache CloudStack, Morpheus, and OpenNebula.

a. Apache CloudStack:

Apache CloudStack is a widely-used open-source cloud management platform that allows organizations to deploy, scale, and manage infrastructure as a service (IaaS) [5].

Key features of Apache Cloud Stack's integration capabilities include:

• Support for integration with popular monitoring tools such as Nagios, Zabbix, and Graphite.

• Built-in support for HA (High Availability) and scalability, enabling the creation of self-healing cloud infrastructure.

• APIs and SDKs available for multiple programming languages, including Java, C#, Go, Python, and PHP.

• Integration with CI/CD (Continuous Integration/Continuous Deployment) tools such as Jenkins, Travis CI, and CircleCI.

• Seamless integration with major cloud providers, such as AWS, Azure, and Google Cloud.

b. Morpheus:

Morpheus is a modern, integrated cloud management platform that enables enterprises to manage and optimize their entire cloud infrastructure [6].

Key features of Morpheus' integration capabilities include:

• Built-in support for over 20 cloud service providers, including AWS, Azure, Google Cloud, and OpenStack.

• Extensive monitoring and alerting capabilities, including integration with tools like Nagios, Zabbix, and Datadog.

• APIs and SDKs available for multiple programming languages, including Java, C#, Go, Python, and PHP.

• Integration with popular CI/CD tools such as Jenkins, Travis CI, and CircleCI.

• Robust support for self-healing infrastructure through features like HA and scalability.

c. OpenNebula:

OpenNebula is an open-source, multi-tenant cloud computing platform that provides tools for creating and managing containerized and virtualized infrastructure [7].

Key features of OpenNebula's integration capabilities include:

• Support for integration with popular monitoring tools such as Nagios, Zabbix, and Graphite.

• APIs and SDKs available for multiple programming languages, including Java, C#, Go, Python, and PHP.

• Integration with major cloud providers, such as AWS, Azure, and Google Cloud.

• Built-in support for HA (High Availability) and scalability, enabling the creation of self-healing cloud infrastructure.

2.3 Reliability and Support:
• Apache CloudStack: It offers excellent reliability with the robust IaaS platform. Apache Cloud Stack's reliability can be attributed to its commitment to community support, continuous improvement, and an active user base. However, support is provided primarily by the community itself, and dedicated customer support may be a bit lacking [5].
• Morpheus: Known for its enterprise-class reliability and support, Morpheus provides top-notch services to ensure a seamless and efficient experience. It offers a robust support infrastructure with dedicated customer support, online resources, and knowledge base. Additionally, Morpheus' enterprise-level features enhance its reliability [6].
• OpenNebula: OpenNebula offers decent reliability but may lack in the support department. OpenNebula is open-source and primarily relies on community support for troubleshooting and resolving issues. While this may suffice for many, it may not be as reliable as paid, dedicated support [7].

2.4 Scalability and Performance:

2.4.1 Scalability:
a. Apache CloudStack:
Apache CloudStack is highly scalable, which allows organizations to deploy a private cloud environment with multiple data centers and resources. It provides an open, modular, and pluggable architecture, making it easier to add more data centers, hypervisors, and storage [5].
b. Morpheus:
Morpheus offers scalability through its centralized control, allowing users to manage resources across multiple cloud environments, including AWS, Google Cloud, Azure, VMware, OpenStack, and others. This approach enables seamless integration of various infrastructure components and enables scaling to meet changing demands [6].
c. OpenNebula:
OpenNebula, being a turnkey solution, provides a more centralized control approach, making it easier to scale infrastructure. However, its scalability is limited to the underlying infrastructure and hypervisor [7].

2.4.2 Performance:
a. Apache CloudStack:
CloudStack is designed for scalability and can handle high load conditions. Its high availability ensures uninterrupted service to users, which translates to high performance [5].
b. Morpheus:
Morpheus is known for its excellent performance. Its lightweight architecture ensures faster provisioning times, making it suitable for enterprises with strict performance requirements [6].
c. OpenNebula:
OpenNebula offers decent performance. Its high-performance design and the use of lightweight components like QEMU for KVM help improve overall system performance. However, its scalability and performance may be limited to the capabilities of the underlying hypervisor [7].

3. Discussing

Apache CloudStack is a robust, multi-purpose solution that integrates well with existing infrastructure, making it suitable for large organizations and complex IT environments. Morpheus offers a comprehensive suite of features for managing cloud infrastructure, making it ideal for organizations with complex IT infrastructure requirements. Finally, OpenNebula is a lightweight, single-purpose solution that provides basic IaaS functionality, making it an excellent choice for small and medium-sized businesses with minimal IT infrastructure needs.
It is important to note that the architectural and infrastructural differences between these platforms are not mutually exclusive. Each platform can be tailored to fit specific needs, making them all valid choices for implementing an IaaS solution.
Each platform has its unique features and capabilities, it's important to carefully consider your organization's requirements and preferences when selecting a cloud management platform.
while all three platforms offer reliability and support, Morpheus is known for its dedicated support offerings, which can make a difference in an enterprise-level deployment. On the other hand, Apache CloudStack is a popular open-source project that benefits from a strong community but may not offer the same level of dedicated support.

OpenNebula, as a primarily enterprise-supported platform, is also worth considering, especially for those who require robust enterprise support.

Apache CloudStack excels in scalability and high performance, making it suitable for large enterprises with complex cloud infrastructure requirements. Morpheus offers a balance between scalability, performance, and ease of use, making it ideal for mid-sized businesses and service providers. On the other hand, OpenNebula's strength lies in its lightweight architecture and high performance, but its scalability is limited to the underlying infrastructure and hypervisor.

4. CONCLUSIONS

Apache CloudStack, Morpheus, and OpenNebula are three cloud management platforms with different features and capabilities. Apache CloudStack is a robust solution that integrates well with existing infrastructure, making it suitable for large organizations. Morpheus offers a comprehensive suite of features for managing complex IT infrastructure, and it is known for its dedicated support offerings. OpenNebula is a lightweight solution with basic IaaS functionality, making it a good choice for small and medium-sized businesses. Each platform can be tailored to fit specific needs, so it is important to consider your organization's requirements when selecting a cloud management platform. Apache CloudStack excels in scalability and performance, Morpheus offers a balance between scalability and ease of use, and OpenNebula is known for its lightweight architecture and high performance.

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