International Journal of Trend in Scientific Research and Development (IJTSRD)
Volume 5 Issue 1, November-December 2020 Available Online: www.ijtsrd.com e-ISSN: 2456 – 6470

Ecosystem of Virtualization Technologies

Atilla Erguzen, Ahmet Ozcan, Erdal Erdal

Department of Computer Engineering, Kırıkkale University, Kırıkkale, Turkey

ABSTRACT
Virtualization technology, which forms the infrastructure of data centers and cloud technology, is constantly evolving. The process that started with machine virtualization has turned into taking applications into containers and virtualizing applications. Virtualization aims at efficient use of hardware by sharing resources. Today, hypervisor and container-based virtualization approach are widely used. Powerful servers that are physically operated thanks to hypervisor platforms are operated by installing different operating systems according to the need. When virtual machines use all the resources of the operating system on which they run, the container is shared only with the kernel of the operating system on which it is located. Thus, it offers faster and more services using fewer system resources. Container technology is widely used to operate data centers with minimum energy consumption and maximum business capacity with an environmentally friendly approach that is becoming widespread today. The ecosystem of virtualization and container technologies that constitute the infrastructure of cloud computing is presented in our study.

KEYWORD: *virtualization; cloud; container; docker; kubernetes*

How to cite this paper: Atilla Erguzen | Ahmet Ozcan | Erdal Erdal "Ecosystem of Virtualization Technologies" Published in International Journal of Trend in Scientific Research and Development (ijtsrd), ISSN: 2456-6470, Volume-5 | Issue-1, December 2020, pp.879-882, URL: www.ijtsrd.com/papers/ijtsrd38081.pdf

IJTSRD38081

I. INTRODUCTION

Effective use of system resources has become an important problem in the field of informatics in recent years. Virtualization technologies have been developed to solve this problem. Especially since 2000, virtualization technologies have been used in classical data centers to use resources more rationally. In this technology, logical layers are established on existing physical systems, allowing users and applications to work on guest systems. This solution developed has been expressed as "Virtualization".

The process that started with the virtualization of machines, continued with the virtualization of the infrastructure, platform, applications and services respectively. The technology that has come today is the virtualization of functions. Efficient sharing of system resources is very important in cloud computing environments with high installation costs. Technological developments that enable sharing of existing CPU, memory, disk and I/O resources determine the future of virtualization methods. In corporate data centers and cloud environments, both hypervisor and container-based virtualization approaches are widely used.

II. VIRTUALIZATION

Virtualization technology is implemented on server computers and provides efficient use of memory, processor and disk space of the server system. Hypervisor-based virtualization technologies developed for this purpose are listed in the following list;

- Server virtualization
- Desktop virtualization
- Application virtualization
- Storage virtualization
- Network virtualization

With virtualization technology, the resources of a single physical system are shared by the virtual systems installed on it and when necessary, resources are re-managed and shared. The memory and processors of the currently idle virtual operating system can be assigned to the virtual operating system, which requires intensive processor and memory. Thus, a more flexible and scalable virtualization system emerges.

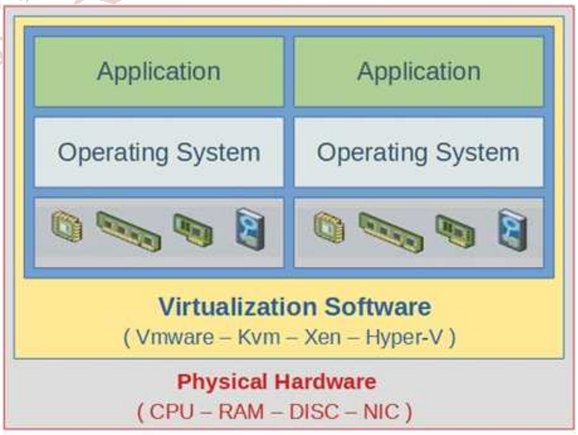

Figure 1: Data center virtualization architecture

Today, data centers are virtualized by hypervisors (virtualization platforms). Hypervisors such as Hyper-V, Xen, Kvm, VMware allow different operating systems to be installed on the physical or virtual computers they manage. This situation is described in Figure 1. The large data centers that make up the cloud infrastructure are managed by hypervisors. As shown in Figure 2, powerful servers that are physically operated thanks to the hypervisor platforms can be operated by installing different operating systems (Windows and Linux on the same physical server) according to the need. Different operating systems that are virtualized must be installed by the hypervisor on the disk partitions allocated to them on the physical server.

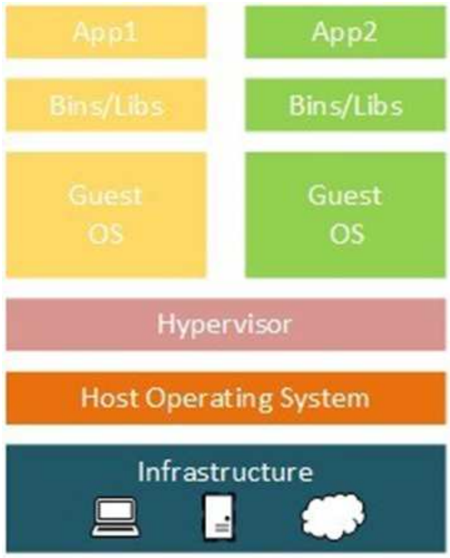

Figure2: Virtual machine architecture

Virtualization has many advantages over physical data centers.

- Virtualization technologies reduce the software costs of institutions. A software used with a single license can be installed and run on more than one virtual machine.
- Ownership, maintenance and operation costs are also reduced with more than one virtual server installed on a physical server. By having fewer physical servers, electricity, cooling and rack costs in the system rooms are reduced [1].
- Virtualized machines can be used within minutes with pre-prepared templates [1].

However, virtualization technology may be insufficient if data is shared between data centers. That is why cloud technology, which makes data transfer easier, is widely used today. Cloud technology enables data and applications to be moved, managed and monitored between different data centers. However, it is preferred due to its more scalable architecture. In fact, cloud technology is an upper model of virtualization and provides data movements in a safe environment in a traceable environment.

III. CLOUD TECHNOLOGY

Cloud technology enables data storage on the internet, data mobility, application and data accessibility from anywhere. This is the biggest feature that distinguishes cloud technology from virtualization. Internet access is mandatory for cloud technology. Large data centers create a cloud platform by opening all their resources to people and organizations over the internet. Virtualization technologies are used in the backbone of the cloud architecture. In the cloud platform, virtual machines with the desired hardware are allocated to users for a fee. Cloud service providers can also provide on-demand infrastructure (IaaS), platform (PaaS), software (SaaS) services.Cloud service providers provide services according to three basic models. Besides, different service models can also be seen [2]. These service models (Figure 3) are as follows;

- Infrastructure Services (IaaS - Infrastructure as a Service)
- Platform Services (PaaS – Platform as a Service)
- Software Services (SaaS – Software as a Service)
- In addition to these models, cloud companies have been in line with new technological developments in recent years.
- Container Services (CaaS - Container as a Service)
- Function Services (FaaS - Function as a Service)
- Anything provides service (XaaS - Anything as a Service).

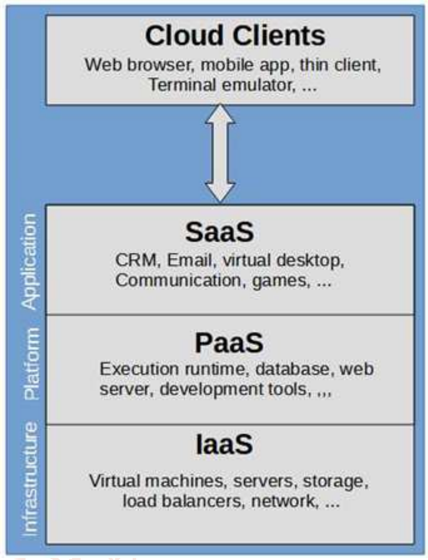

Figure 3: Cloud service models

IV. CONTAINER TECHNOLOGY

When virtual machines use all the resources of the operating system on which they run, the container is shared only with the kernel of the operating system on which it is located. Thus, it offers faster and more services using less resources. It does not always work correctly when an existing software is moved from one computer environment to another. It uses container technologies to solve this problem. This solves the problem of correctly configuring system settings and resources for programmers. Container images are independent pieces of software with the code, tools, resources and necessary system settings necessary for the software to work.

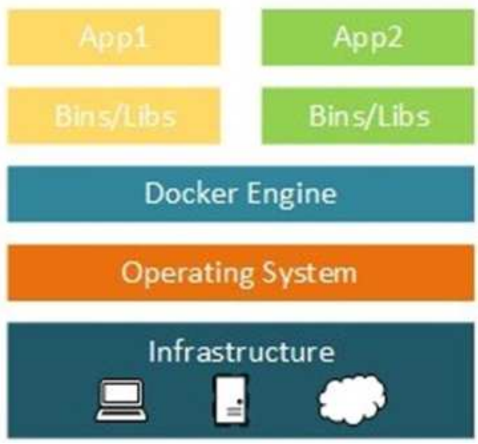

Figure 4: Docker container architecture

Container technology has been known since the 1980s. Unix users were able to start isolated processes similar to today with the "chroot" command. Container technology has become very popular in recent years, by minimizing the micro-service structure of the software running on servers and making it light and flexible. Containers are run in virtual machines with tools called engines (Podman, Cri-O, Docker). Today, Docker is the best known container run platform in the world (Figure 4). The Docker is built on Linux Containers (LXC), which was added to the Linux kernel in 2008. LXC offers successful solutions in creating and managing containers that share the same operating system and are isolated from each other.

Container-type virtualization solution is developed on Linux namespaces (Linux Namespaces) and control groups (cgroups), which are Linux kernel features. Provides isolation of Linux namespaces and resources. It provides resource management of containers with control groups [3]. Nowadays, just writing code is not enough to develop applications. In addition to these findings, it is also necessary to control all components required for the life cycle of the software. The Docker platform allows developers to control the tools, application stacks and distribution environments and versions they choose for each project they work on.

It is quite easy to control a few containers in the working environment. However, if the number of inclusive clusters increases compared to some situations where the number of containers and workloads increase, management will be very difficult. How to manage the server system in possible error and load balance situations is an important problem. Container management software has been developed for this purpose. This section will explain the most common inclusive management software.

V. CONTAINER MANAGEMENT

Container management software takes on critical tasks such as easy deployment and management, scalability, equal distribution of system load, virtualization of operating system resources, continuity and redundancy. There are many software produced for this purpose. Kubernetes, Amazon Elastic Kubernetes, Azure Kubernetes, IBM Cloud Kubernetes, Azure Service Fabric, Docker Swarm and Helios are the most common software available.

Kubernetes (K8s) is an open source management software developed by Google in 2014. Containers can be automatically deployed, rolled out or rolled back. Scalability and controllability is provided automatically. The health of working containers is monitored and load balancing is done. It is preferred by DevOps users as it can offer tools such as Kubernetes, Docker as PaaS or IaaS.

Amazon Elastic Kubernetes (EKS) is a version of Kubernetes software adapted for Amazon Elastic Cloud. It works integrated with other software of Amazon company running in the cloud. It also provides serverless container service with AWS Fargate software. With this feature, users are charged per application running. EKS has improved monitoring of containers, traffic control and load balancing. Azure Kubernetes Service (AKS) can provide basic Kubernetes functionality as well as simplified deployment and management of systems that are highly complex for machine learning. Visual Studio Code Kubernetes and Azure DevOps tools are available. Access and management is provided through Azure Active Directory. It also supports scalable sourcing service for IoT solutions.

With advanced services such as IBM Cloud Kubernetes Service, IBM Watson and Blockchain, it can offer users fast and efficient applications. In addition to a secure and simplified cluster management service, it also has flexible and self-healing container support.

Amazon Elastic Container Service (ECS) is a container editing tool that runs applications on a managed Amazon EC2 instance cluster. Similar to EKS, ECS clusters run on Serverless AWS Fargate. AWS app integrates with Mesh and other AWS services, enabling more features (Amazon Route 53, Amazon Cloud Watch, IAM, AWS Identity) to be used.

Azure Service Fabric enables container-based applications to be deployed on-premises or cloud-based. Supports running microservice applications on different machines and platforms under the principle of "run everything anywhere". Runs multi-tenant SaaS applications. It can also perform IoT data collection and processing tasks.

Docker Swarm provides fast, scalable and seamless solutions for distributed applications. Supports Windows and Linux operating system. Legacy applications can also be imported into the container through Windows Server containers. Creating, sending, and running distributed systems can be performed faster. It can provide a DevOps environment equipped for developers, testers and the deployment team.

Helios is an open source platform for Docker developed by Spotify. Can run containers on many servers. It can process multiple HTTP requests at the same time. It can be managed via command line and HTTP API. Although it is not dependent on any operating system, JVM (Java Virtual Machine) and ZooKeeper must work.

Institutional requirements and processes must be determined in the selection of container management software. A study on which enterprise applications container management software gives better results [4] shows that Kubernetes outperforms its counterparts for complex application deployments, while other management tools may be a good choice for simpler deployments.

VI. RELATED WORKS

A virtualized environment is easy to back up and restore for disaster recovery purposes. In short, downtime can be minimized. This helps companies improve efficiency and reduce costs [5].

Today, the electricity consumption of data centers is enormous, for example it reached 0.5% of the world's electricity consumption in 2013 [6]. It can even be said that all data centers have more carbon emissions than North America and the Netherlands combined [6]. In this respect, virtualization has become the most important information technology needed for the green environment today. In our literature study, it was determined that a lot of work was done on the energy consumption of physical servers between 2009 and 2015. In the following years, the number of studies is decreasing [7].

Traditionally in data centers, a server operating system is installed on physical machines. The operating system's tools are used for resource sharing, security, performance and isolation. However, this is not enough for service providers.

Service providers have important problems such as account, security, resource management as well as performance, electricity consumption.

It is possible to group the studies carried out to this day with the general headings of performance, energy consumption, performance-energy relationship [7]. Virtualization performance studies are performed to find optimal features of the virtualized system and minimize performance degradation. These studies aim to maximize this by using virtual machine consolidation algorithms, tracking and benchmarking methodologies [8].

Energy-related studies aim to maximize energy efficiency. There are many literature studies on this area [11, 5, 12, 13]. In order to improve power and energy consumption and energy efficiency: i) frameworks, ii) schematics, iii) system architectures and iv) algorithms based on virtual machine migration with prediction models are proposed. In recent studies in this area, it is aimed to investigate the power and energy properties of four hypervisors and container engines [11, 14].

Nowadays, cloud computing and virtualization technologies, mainly in artificial intelligence (AI), machine learning (ML), computer vision (computer vision) studies are carried out on current performance, such as optimization [12]. These studies have spread from virtual machine placement to areas such as application startup, energy saving, and security issues [8, 9]. In addition, IoT (Internet of Things), Big Data, SDN (Software Developed Network), NFV (Network Function Virtualization), which have been popular in recent years, are also being explored together with virtualization.

VII. CONCLUSION

The evolution process continues in the virtualization technologies ecosystem. The process that starts with machine virtualization on physical hardware is shaped according to the problems faced by data center managements on a narrow scale and cloud providers on a large scale. The solutions produced after every problem that arises determine the route of technological developments. Container technology is widely used to ensure that data centers operate with minimum energy consumption and maximum work capacity with an environmentally friendly approach that has become widespread today. In addition to adapting existing applications to containers, the container-based development of applications that will work in the cloud enables servers to handle more workloads with less effort. In recent years, running container applications on a server less platform reduces the costs of running applications. In the near future, we can say that in order to increase the performance of servers, containers may turn into a level that will run frameworks or code snippets instead of applications.

REFERENCES

[1] CISN, "Sanallaştırma," Computing & Information Services Newsletter, 2011. http://cisn.metu.edu.tr/2011-19/sanal.php (accessed May 26, 2020).

[2] P. Mell and T. Grance, "The NIST Definition of Cloud Computing," Computer Security Resource Center, 2011. https://csrc.nist.gov/publications/detail/sp/800-145/final (accessed May 26, 2020).

[3] G. Işık, U. Gürel, and A. G. Yavuz, "Bulut ortamlarında hipervizör ve konteyner tipi sanallaştırmanın farklı özellikte iş yüklerinin performansına etkisinin değerlendirilmesi," Uludağ Univ. J. Fac. Eng., vol. 25, no. 2, pp. 981–1002, 2020, [Online]. Available: http://acikerisim.uludag.edu.tr/bitstream/11452/12772/1/25_2_23.pdf.

[4] I. M. A. Jawarneh et al., "Container Orchestration Engines: A Thorough Functional and Performance Comparison," in ICC 2019 - 2019 IEEE International Conference on Communications (ICC), 2019, pp. 1–6, doi: 10.1109/ICC.2019.8762053.

[5] D. Richard Scroggins, "Virtualization Technology Literature Review," Glob. J. Comput. Sci. Technol. Vol 13, No 1-G Glob. J. Comput. Sci. Technol., 2013, [Online]. Available: https://computerresearch.org/index.php/computer/article/view/317.

[6] M. H. Ferdaus and M. Murshed, "Energy-aware virtual machine consolidation in IaaS cloud computing," in Cloud Computing, Springer, 2014, pp. 179–208.

[7] B. Bermejo, C. Juiz, and C. Guerrero, "Virtualization and consolidation: a systematic review of the past 10 years of research on energy and performance," J. Supercomput., vol. 75, no. 2, pp. 808–836, 2019, doi: 10.1007/s11227-018-2613-1.

[8] P. Nema, S. Choudhary, and T. Nema, "Vm consolidation technique for green cloud computing," Int J Comput Sci Inf Technol, vol. 6, pp. 4620–4624, 2015.

[9] A. Al-Dulaimy, W. Itani, A. Zekri, and R. Zantout, "Power management in virtualized data centers: state of the art," J. Cloud Comput., vol. 5, no. 1, p. 6, 2016.

[10] M. A. Khan, A. Paplinski, A. M. Khan, M. Murshed, and R. Buyya, "Dynamic virtual machine consolidation algorithms for energy-efficient cloud resource management: a review," in Sustainable cloud and energy services, Springer, 2018, pp. 135–165.

[11] C. Jiang et al., "Energy efficiency comparison of hypervisors," Sustain. Comput. Informatics Syst., vol. 22, pp. 311–321, 2019.

[12] U. B. Usman, F. U. Ambursa, E. J.Onyiyechi, and T. J. Jaremiah, "Virtual Machine Migration Techniques in Cloud Computing Environment: A Review of Load Balancing Algorithms," Int. J. Artif. Comput. Intell., vol. 1, no. 4, 2020.

[13] S. Gharehpasha, M. Masdari, and A. Jafarian, "Virtual machine placement in cloud data centers using a hybrid multi-verse optimization algorithm," Artif. Intell. Rev., pp. 1–37, 2020.

[14] S. Sagar and N. Pradhan, "A Review: Recent Trends in Green Computing," in Green Computing in Smart Cities: Simulation and Techniques, Springer, 2021, pp. 19–34.