Study of Virtualization Technologies and their Performance in Cloud and HPC

[1]Anju Lalwani,[2] Dr. Dhaval Vyas
[1]Center Manager,[2]Dean(MPhil), C U Shah University,
[1]Academics,
[1]Thinkzzy Innovative Solutions PVT LTD, Ahmedabad, India.

Abstract: This paper tries to cover varied virtualization technologies and their performance in varied computer technologies and in HPC. Cloud computing has become possible because of virtualization technologies. Cloud computing became popular in 2006, whereas virtualization was there from 1960s. Extra layer of virtualization has been always an issue in performance, improvement in which will lead to improved cloud performance. For this reason this paper tries to study different virtualization technique's performance in cloud and in other computer technologies and in HPC. HPC is available to common man through cloud computing.

IndexTerms **– Virtualization, Container, HPC, Cloud.**

1) Hypervisors vs. Lightweight Virtualization: A Performance Comparison (IEEE 2015)

This work compares traditional hypervisor based virtualization and new lightweight solutions on their performance thoroughly.

Method includes benchmark tools for processing, storage, memory and network aspects to comprehend potencies, failings and variances of KVM(Hypervisor based system), LXC(Container based system), Docker(Container based system) and Osv(Cloud os solution- os for cloud) - in terms of processing, storage, memory and network.

Results stare that containers perform better than traditional virtual machines and other modern solutions. Even though LXC, Docker containers provide clearly more efficient deployment of virtual machines, the performance variation with KVM and Osv in many results is comparatively small.

Performance of KVM has been enhanced drastically as compared to before. But Disk I/O competence still needs to be improved this can due to discrepancies of different tools.

OSv represents an interesting work-in-progress alternative, although it introduces some limitations in terms of software portability.

Osv is an emerging option but it has software portability issues.

For further studies this work should be done with LXD which asserts to provide better security with better performance because security and isolation of container need detailed examination.

2) Performance Analysis of LXC for HPC Environments (IEEE 2015)

This work compares performance of LXC- Linux container and KVM Hypervisor for HPC tasks.

Experiment aspects include CPU and communication – network and inter process communication.

Results show clear cut difference in performance of LXC and KVM in the way HPC application uses resource.LXC performs better than KVM in Cloud computing environments where physical resources are distributed in many logical space that is the reason LXC is very good fit for HPC applications specially where Beowulf Clusters runs Message Passing Interface(MPI) application .

Satisfactory isolation levels were not being offered by LXC for now, guest could interfere in host in some situations. Besides lxc-halt is not working properly.

Authors of this paper want to study I/O performance of conventional Hard Drives, SSD devices and single server as well as cluster environment Graphical Processing Unit(GPU) for LXC and KVM.

3) A Performance Isolation Analysis of Disk-intensive Workloads on Container-based Clouds(IEEE 2015)

This study focuses on disk-intensive workloads performance interventions in KVM and LXC when hardware components CPU, Disk I/O and memory are stressed.

KVM is hypervisor based technology, each VM gets separate operating system and that is why gets completely isolated space from others resulting in total isolation of resources as opposite of LXC.LXC doesn't provide separate os to each user because of which resources can't be isolated completely at this moment but it admired and used more because it comes with Linux operating system.

This paper compared hypervisor and container based virtualization technologies in future authors would like to examine container based clouds for disk-intensive workloads in details and in more combinations.

4) Performance Evaluation of Hypervisors for HPC Applications(IEEE 2015)

KVM and VirtualBox hypervisor's performance is studied under HPC jobs in terms of full and paravirtualization.
Processor, RAM, inter-process communication and network communication performance was examined using HPCC(HPC Challenge Benchmark).

Performance of KVM hypervisor was greatest and was as good as native performance in cases wherever execution was with paravirtualized instructions. while with HPC performance of VirtualBox was very bad in full as well as paravirtualization.

Authors would like to take this paper work further in study of KVM and VirtualBox performance in HPC Graphical Processing.

5) A Performance Comparison of Container-Based Virtualization Systems for MapReduce Clusters(IEEE 2014)

This work focuses on MapReduce clusters. How container based technologies like Linux VServer, OpenVZ and LXC behave and handle on MR systems and compared all mentioned container based technologies to see which one work best for MR Systems.

All container based technologies perform as good as they are running on local machine for MR activities, performance behavior and handling abilities of LXC, particularly isolation performance are suitable most for the MR systems. Because I/O demanding activities can benefit LXC's new resource isolating facilities like blkio which was not available before and resulted in weak isolation performance and security [9].

Limiting and controlling resources abilities are enhanced in LXC and are that is why reflected in outcomes of isolation performance.

Isolation performance of in terms network is subject to future examination.Green computing subject matters are also expected to be researched in hypervisor and container technologies with regards to compromise between energy spending and performance.

6) An Updated Performance Comparison of Virtual Machines and Linux Containers (IEEE 2015)

Docker linux container and KVM hypervisor virtual machine are examined and compared in terms of performance.

CPU, memory, storage and networking resources are stressed by a group of demanding activities.

In all scenarios, KVM doesn't perform as good as Docker but I/O demanding applications are not managed properly by both.

Single server's isolation performance which executes many activities, VMs and containers size changed on the run time, balancing increasing and decreasing demands, balancing live migration and restarting are some of the valuable areas for future study.

7) Performance Evaluation of Container-based Virtualization for High Performance Computing Environments (IEEE PDP 2013)

This work has examined performance of container based systems LXC, OpenVZ and VServer for HPC in great details and presented isolation in comparison to performance.
Both isolation and performance of Xen are compared with mentioned container based virtualization systems. Xen is typically used hypervisor based virtualization comparing latest container technologies with well established hypervisor technology gives perfect idea of upcoming system performances and helps in decision making of which system to choose.

CPU, memory, disk and network perform as good as local machine in LXC, OpenVZ and VServer. Isolation and security aspects deserve attention, handling of resources controlling is different in all these container management systems. cgroups handle resource management in LXC while Linux-VServer and OpenVZ control resources with their individual competence for example there is possibility to limit number of processes because of which guest system can't interfere with host system. It would be beneficial for LXC if same features are included in cgroups.

For different kind of jobs, the isolation and performance of container based technologies can be further examined to see how competent containers behave in challenging environments like data demanding activities of MR systems.

8) Analysis of Virtualization Technologies for High Performance Computing Environments (IEEE 2011)

FutureGrid resources of HPC Systems check the implementation possibilities of currently famous Xen,KVM and Vbox virtualization systems in terms of features and performance at a detailed level.

Different hypervisor produces different performance issues but they perform well also and are not same, every hypervisor has its own positives and negatives. HPC implementation on cloud can benefit greatly from KVM.KVM shows better results than Xen and Vbox.

KVM on cloud systems will provide good performance for FutureGrid system as Xen implementations are not performing as well as KVM, which is obvious from experiment results.

Conclusion

This literature has review of KVM, Docker, Lxc, Osv, virtual box ,Linux VServer, OpenVZ, xen and vbox technologies.

Methods used in review research papers are experiments, benchmark tools, suite of workloads that stress the CPU, memory, storage, networking resources and other aspects.

In general, conventional virtual machines and other latest solutions perform worse than containers.
Host gets intruded by guest users in some situations because required isolation is not given by LXC at the time of experiments whereas total resource isolation is offered by KVM.
Resource handling facilities are the key differentiations which decide isolation and security performance.
I/O intensive activities need more attention by Containers and virtual machines

REFERENCES

[1] Morabito, R., Kjällman, J., & Komu, M. (2015, March). Hypervisors vs. lightweight virtualization: a performance comparison. In Cloud Engineering (IC2E), 2015 IEEE International Conference on (pp. 386-393). IEEE.

[2] Beserra, David, et al. "Performance analysis of LXC for HPC environments." Complex, Intelligent, and Software Intensive Systems (CISIS), 2015 Ninth International Conference on. IEEE, 2015.

[3] Xavier, Miguel G., et al. "A Performance Isolation Analysis of Disk-Intensive Workloads on Container-Based Clouds." Parallel, Distributed and Network-Based Processing (PDP), 2015 23rd Euromicro International Conference on. IEEE, 2015.

[4] Beserra, David, et al. "Performance evaluation of hypervisors for hpc applications." Systems, Man, and Cybernetics (SMC), 2015 IEEE International Conference on. IEEE, 2015.

[5] Xavier, Miguel Gomes, Marcelo Veiga Neves, and Cesar Augusto Fonticielha De Rose. "A performance comparison of container-based virtualization systems for mapreduce clusters." Parallel, Distributed and Network-Based Processing (PDP), 2014 22nd Euromicro International Conference on. IEEE, 2014.

[6] Felter, Wes, et al. "An updated performance comparison of virtual machines and linux containers." Performance Analysis of Systems and Software (ISPASS), 2015 IEEE International Symposium on. IEEE, 2015.

[7] Xavier, Miguel G., et al. "Performance evaluation of container-based virtualization for high performance computing environments." Parallel, Distributed and Network-Based Processing (PDP), 2013 21st Euromicro International Conference on. IEEE, 2013.

[8] Younge, Andrew J., et al. "Analysis of virtualization technologies for high performance computing environments." Cloud Computing (CLOUD), 2011 IEEE International Conference on. IEEE, 2011.