A Study on Software Rejuvenation Techniques on Virtualized Environment

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Abstract - **Now a days, it has been noticed that software issues are destructive than the hardware issues. Software aging is the phenomenon in which software systems hang/ crash or show decreased performance. Software rejuvenation is the proactive technique proposed to counter software aging. This is a proactive mechanism to remove the accumulated faults to enhance the availability. Virtualization is the technology that enables many operating systems run on one physical machine. Virtualization is the recent trend in the computing field that is rapidly changing the way of computing [1]. Several researchers have studied the advantages of virtualization technology to rejuvenate the softwares running on virtual machines and address the software aging problem. In this paper we discuss few such studies and discuss how virtualization has helped software rejuvenation strategies.**

Key words - **Software aging, software rejuvenation, Virtualization**

I. VIRTUALIZATION AND SOFTWARE REJUVENATION

Virtualization is the technique that allows computing resources to be shared among several operating systems using methodologies like hardware and software partitioning or aggregation [2].

Software aging of virtual machines is becoming critical as server consolidation using virtual machines is carried out. The performance of VMs is dependent up on virtual machine monitor (VMM) which suffers performance degradation or crash failures. An example of software rejuvenation in virtualized environment is to reboot VMM. But, this process is not recommended as rebooting VMM will result in rebooting all operating systems on VMs. To counter these problems various researchers have done the work in this area. This paper throws light on the work carried out in the area of software rejuvenation on virtualized environment.

II. REJUVENATION TECHNIQUES ON VIRTUALIZED ENVIRONMENT

Dan Pelleg et al. [3] developed an approach to monitor virtual machines for problems. The approach used hypervisor directly for monitoring of the resource requests. The readings are then analyzed using machine learning. The pitfalls associated with in-band monitoring can be overcome by using out-of-band monitoring. The problems can be identified with high accuracy using machine learning and virtualization.

The disadvantages of existing in-band and out-of band approaches were explained by authors. In-band agents run on the same system they monitor. This adds workload to the system they are monitoring. An agent may face resource shortage as operating system may divest resources like CPU time or memory.

Out-of-band agents run on different machine other than the system being monitored and hence have reduced visibility into system behavior. The ability to respond is limited to the extent of just informing the administrator about the degrading resource.

The authors successfully identified the hard-to-detect kernel hangs that lead to saturation of CPU resources using their new approach. They also demonstrated that virtualization and statistical analysis is better than the in-band monitoring accuracy. The authors demonstrated Vigilant system, a way to monitor problems occurring in virtual machines. This out-of-band approach can detect hard-to-detect failures like kernel hang which is actually detectable by an in-bound agent.

Aye Myat Myat Paing and Ni LarThein [4] presented stochastic Petri nets model for time-based rejuvenation policy for VMM to analyze the availability of virtualized server system and resource usage management algorithm to support live VM migration.

The authors presented optimization of resource usage on virtualized environment by accepting several services requests. They also presented rejuvenation policy to deliver high availability thus avoiding downtime from failures due to software aging. This stochastic petrinets based models were evaluated using SHARPE (Symbolic Hierarchical Automated Reliability and Performance Evaluator) tool simulation.

Running VM can be migrated from one physical machine to another using live migration technology without outage. The VMM running on the physical machine suffers aging as

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the time degrades. When the software aging or some potential anomaly happens in one of the physical machine in the resource pool, the rejuvenation manager of management server will trigger a rejuvenation operation. All the new requests and sessions are migrated from the virtual machine of the aging affected physical machine to virtual machine of other physical machine in the resource pool. When the ongoing requests are finished in aging infected PM, these VMM will be rejuvenated. The authors used stochastic Petri nets (SPN) model with time-based rejuvenation policy.

The obtained results show that the use of virtualization, clustering technology and software rejuvenation mechanism can provide a very fast recovery to cut down the mean time to recovery to the minimum. It can achieve minimize downtime even in case of service restart.

Jean Araujo [5] presented an approach for software rejuvenation in cloud using Eucalyptus Cloud Computing framework. By using thresholds and time series based forecasting, the authors implemented a resource-usage-aware rejuvenation policy. An accurate forecast of critical points of resource degradation is possible by trend analysis of software aging –related data, matched against multiple time series models.

Utilization of software and hardware resources was analyzed in scenarios in which some cloud operations were performed continuously. A rejuvenation method was applied to prevent unavailability of the system by scheduled process restart.

Luis Moura SilvaIn et al [6] suggested that self-healing techniques can be applied to readymade application servers and internet sites. Virtualization can help software rejuvenation and fail-over in the occurrence of temporary application failures and software aging.

The authors goal was to achieve the fast recovery to reduce the MTTR (Mean time to repair), no data loss or rejected requests during rejuvenation time and also no overhead during run time. The work was focused mainly in the healing of the software aging and transient failures. Permanent software bugs and hardware failures were not in scope of proposed work. The authors used XEN virtualization middleware to create 3 virtual-machines per application server: one VM was used to run software load balancer, the other one to run main application server and the third one was the replication of the application server. The third VM worked as hot standby.

To detect software aging and trigger a rejuvenation action, they used third VM having load balancer and also a software module. First, standby server was to be started, and then all the new requests and sessions are to be shifted to second server. The session state is migrated from primary server to secondary server. Once on-going requests are finished in the primary server, the server is restarted without losing any in-flight request or session state. This is called "clean" restart.
The authors opined that by using virtualization layer and some software modules, a zero downtime can be achieved without any loss of work. It does not suffer from performance degradation also. The same technique can be applied to single server or clusters also.

With the automated rejuvenation scheme the researchers were observed that it is possible to avoid a crash. The sustained level of performance was kept, within the limits defined for the Throughput-SLA. This mechanism has proved to be very effective to achieve some self-healing capabilities for the application servers, without any additional hardware and any change in the applications.

Fumio Machida et al [7] presented an approach for a data center consisting of cluster of servers and hosted virtual machines. VMS and VMMs are prone to software aging which results in failures in long run. The authors proposed a solution where VM and VMM are rejuvenated simultaneously. The proposed technique can achieve increased resource utilization and enhance the availability of the VMs.

The proposed technique suggests the idea of performing rejuvenation of VMs simultaneously with VMM. This can reduce the downtime considerably and heal the software aging impacts on both VMM and VM.

The steps of the proposed starts with detection of VMM aging in which periodic resource monitoring and analysis for all VMMs are done followed by preparation for VMM rejuvenation, restarting VMM and VMs.

The experimental results show that the proposed technique improves the VM availability close to the performance of Migrate-VMR without introducing any additional standby host servers.

N.M.Hemadevi et al [8] conducted a survey on virtual machines to identify aging related bugs and approaches to avoid them. The authors propose three rejuvenation techniques, Cold-VM rejuvenation, Warm-VM rejuvenation and Migrate-VM rejuvenation. In Cold-VM rejuvenation, first all the virtual machines are shut down whatever may be their execution states. Then VMM rejuvenation is done followed by VM restart. In Warm-VM rejuvenation, virtual machines are suspended before VMM rejuvenation and execution is resumed after completion of VMM rejuvenation. In Migrate-VM rejuvenation, first, hosted VMS are migrated another host, then rejuvenation of VMM is done and then VMs are returned to original host.

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The numerical solution of Stochastic Reward Nets using Stochastic Petri Net Package was used to compare the three rejuvenation techniques. The various parameters, value and mean time are compared to find steady state availability of VMM rejuvenation technique. Migrate-VM rejuvenation achieves higher steady -state availability compared to the other two due to the ability to preserve the VM execution, during VMM rejuvenation.

III. CONCLUSION AND THE ROAD AHEAD

Software rejuvenation on virtualized environment is the emerging research area. As the availability of reliability of servers running on virtual environment needs to have zero down time in the current business scenarios, more optimized, effective software rejuvenation techniques for virtualized environment are the need of the hour. As many firms are moving from physical hardware usage to cloud services, development of very effective rejuvenation techniques for cloud environment will contribute a lot to service provider as well for the users.

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