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A. IQBAL, C. PATTINSON, A. KOR

Leeds Beckett University, United Kingdom

USING SNMPV3 FOR RESOURCES MONITORING OF HOSTED AND BARE-METAL HYPERVISORS

Simple Network Management Protocol (SNMP) is the protocol which comes with the feature of accurate monitoring and controlling IP based devices. Now a days, most of the IP based devices in the market come with SNMP protocol feature. In this research, SNMP protocol is used to monitor a Cloud Computing Environment, where monitoring of Virtual Machines (VMs) is performed. An investigation is conducted to determine whether SNMP could be used to monitor a hypervisor. Type I hypervisor VMware ESXi and Type II hypervisor Oracle Virtualbox are installed and configured with their VMs. Microsoft and Linux Operating Systems are installed in the VMs. Furthermore free and open source Zabbix is used as Network Management System (NMS) to store monitored data collected by SNMP, and to display them as graphs.

Key words: *SNMP, virtualization, hypervisor, Zabbix, cloud computing.*

Introduction

Monitoring of the virtual machines with high security and minimal overhead is always very important, especially in those environments where hundreds of Virtual Machines VMs are running on dozens of physicals servers. This paper presents the results of monitoring the VMs configured on hosted and bare metal hypervisors with SNMP version 3. The aim of this research is to investigate whether detailed resource consumption could be obtained through hypervisor monitoring alone or to be accompanied by VMs monitoring.

To conduct the experiment of resource monitoring, HP ProLiant DL380 Gen8 server is used, where VMware ESXi 5.5 bare metal hypervisor is installed. Bare metal hypervisor does not need any Operating System because it runs directly on the machine. As it can be seen in Figure 1, that HP server with VMware Hypervisor is directly connected with a laptop. Two of the virtual machines are configured on Hypervisor and Zabbix is installed in the laptop.

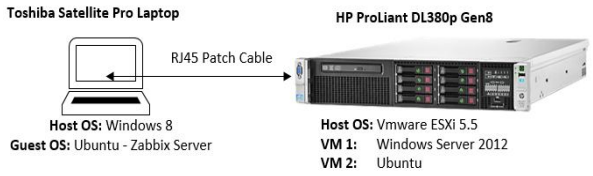

Fig. 1. VMs on Bare Metal (Type I) Hypervisor

To monitor the VMs of Type II hypervisor, two laptops are used. As shown in Figure 2, Ubuntu and Windows Server 2012 are the VMs on Windows 8 host Operating System. Open Source Sun Virtualbox is used as a Type II hypervisor. Type II hypervisors cannot run directly on the hardware because they require an Operating System (OS) and that is the reason why Windows 8 is used as host OS for the experiment.

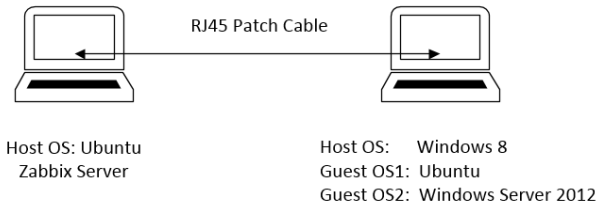

Fig. 2. VMs on Hosted Hypervisor

1. Literature Review

1.1. Hypervisor

Hypervisor is also called Virtual Machine Manager. It is a software which creates and runs Virtual Machines (VM). There are two types of hypervisors:

– bare Metal Hypervisor;

– hosted Hypervisor;

Bare Metal Hypervisor are hypervisors which run directly on the hardware. There is no layer between bare metal hypervisor and hardware. Such type of hypervisor is used for the experiments presented in this paper. Hosted hypervisors run on the OS, and the disadvantage of hosted hypervisor is that in the event of a host OS failure or crash, hypervisors will not be able to run and all VMs will stopped [1].

1.2. SNMP

SNMP stands for Simple Network Management Protocol. SNMP is used to monitor the IP based devices installed in the network. SNMP facilitates remote collection of management data from devices and also remote configuration of devices [2]. SNMP consists of three components: managed device, SNMP manager, and SNMP agents. One or more agents will run concurrently on all the managed devices and will communicate with the SNMP manager.

There are two important issues to be addressed when SNMP is considered for monitoring. Firstly, it is about overhead and secondly, is about security. The actual overhead on network bandwidth and hardware in most SNMP implementations is minimal and should be little cause for concern [3]. SNMP version 3 comes with the authentication and privacy and it is used for monitoring in my research work.

1.3. MIB

A management information base (MIB) is a formal description of a set of network objects that can be managed using the Simple Network Management Protocol (SNMP). The format of the MIB is defined as part of the SNMP [4]. MIB files are placed in /usr/share/mibs/ietf directory on SNMP Server. It is compulsory to have the MIB of the network devices which need to be monitored.

1.4. Zabbix

Zabbix is Linux based open source software which can be used to monitor the performance of Operating systems. Zabbix comes with its own precompiled agent, called Zabbix Agent. However, it also works with SNMP Agent. Zabbix server provides a user friendly web interface, which can display results collected by agents. In this experiment, Zabbix is used to display the collected resource consumption data in the form of graphs by using MySQL database. Zabbix and SNMP server are configured on the same machine, and that is why the name of the machine is Zabbix.

The reason why Zabbix has been chosen as a Network Management System (NMS) is because it is free and open source and it also allow developers to customize the code according to their requirements. Comparison of Zabbix with other NMS can be seen in Table 1.

2. Related Work

Peng and Chen (2011) propose the use of SNMP with VM monitoring. In this paper, they use two standard MIBs, MIB-II and Host Resources MIB to monitor the performance and to obtain the information for VM [5]. To elicit information about the resource consumption of each VM instance, Peng and Chen define an enterprise MIB, NCNU-VM-MIB and deploy Agent X as an alternative SNMP agent. Also a web monitoring interface was designed to present the monitored data.

Table 1

Zabbix Comparison with other NMS

NMS Comparison			
Features	**Spiceworks**	**PRTG**	**Zabbix**
SNMP v3 supports	No Encryption	Full	Full
Limitations	None	30 sensors in Free edition	No Limitations
Prices	Free	$13,500 for unlimited sensors	Free and Open Source
Supported OS	Windows	Windows	Linux/Debian

Swarna (2012) explores the auto-discovery of the hosts. It is not a good practice to add or delete the host entry manually in a cloud computing scenario, if the cloud is expanded. To obtain auto-discovery work, they extend the custom MIB through the AgentX functionality. To test their work they use NMS, MibParser and AgentX. Zabbix is free and open source software which is used as an NMS [6].

Hillbrecht develops a MIB, called Virtual-Machine-MIB which conducts control operations: create, delete, restart, turn on, pause and shut down virtual machines [7]. This MIB is an upgraded version of the earlier MIB version produced by Hillbrecht, which is used to perform only monitoring operations. Hillbrecht conducts 9 experiments on two different hypervisors after creating the Virtual-Machine-MIB. These experiments consist of: (1) get the name and version of VMM; (2) list the VMs on a physical machine; (3) create a new VM (4) change the name of newly created VM; (5) change the amount of RAM of the newly created VM; (6) connect a given virtual disk in the newly created VM; (7) start the newly created VM; (8) insert another virtual CPU in the newly created VM; (9) delete the newly created VM.

Blanquicet and Christensen evaluate a new SNMP power state MIB and its agent to expose equipment power state to the network [8]. Power management capabilities and its settings, active, inactive and sleep times and statistics on wake-up and sleep events are included in this MIB. They implement the agent in the Windows OS. This agent provides information for the following objects: totalSleepTime, totalInactiveTime, totalActiveTime, lastInactiveTime, and lastActiveTime. The agent consists of two functions. Firstly, it monitors the activity of keyboard and mouse every minute and secondly, it stores and retrieve collected information to

and from the new SNMP power state MIB.

A summary of research work of 4 different researchers have been discussed. One important point is that none of them has in their research papers the version of SNMP used. For the research by Blanquicet and Christensen, it is certain that SNMP version 3 has not been employed because the agent is installed on a Windows OS. This is the identified gap relating to SNMP version 3 on VM or cloud computing.

3. Configuration and Implementation of SNMP Agent and Zabbix

3.1. Zabbix Installation

To install, Zabbix, Ubuntu OS was installed on the physical machine. Installation was done in the command line terminal with the following command.

Sudo apt-get install Zabbix-server-mysql php5-mysql Zabbix-frontend-php

It is compulsory to install PHP and MySQL because Zabbix frontend is designed in PHP which can be accessed via a browser once zabbix is installed and configured.

3.2. Configurations of SNMP v3 agent on Vmware ESXI 5.5 hypervisor (Type I)

It is important to enable the snmpd package on the hypervisor before the configuration is carried out. According to Vmware, the following are the steps of an SNMP agent configuration on vsphere ESXI [9].

1. Configuration of SNMP Engine ID.
2. Set SNMP Authentication and Privacy Protocols.
3. Configure SNMP Users.
4. Configure SNMP v3 Targets.

SNMP v3 agent has been configured successfully on the bare-metal hypervisor ESXi. Testing screenshot is depicted in Figure 3.

3.3. SNMP Agent on Windows Server 2012

All the operating systems provided by Microsoft, does not support SNMP version 3. There is no existing Microsoft publication on installation and configurations of SNMPv3 in Microsoft OS. Additionally, it is discussed in Microsoft community/forums that Microsoft does not support SNMP version 3. Technically speaking, SNMP Informant products are SNMP extension agents, and as such require an SNMP stack (service) in order to function [10]. The native Microsoft SNMP stack only supports SNMPv1 and SNMPv2, and not SNMPv3. As such, SNMPv3 commands are not passed through to any extension agents, including SNMP Informant.

4. Experimental Results

4.1. Hypervisor Vmware ESXi 5.5

To monitor hypervisor performance, MIBs provided by VMware are used. Specifications and utilizations of processor, memory, storage and network are monitored. The load on all cores of processors are also monitored. The total number of running services and their details can be collected easily using SNMP.

Figures 4 and 5 show the Virtual Machines status and specification collected by monitoring the hypervisor using SNMP. Both machines are powered-On and in running state. Figure 5 also shows the memory and NIC allotted to the VMs.

4.2. VM2 Ubuntu Monitoring

To monitor a VM, snmpd package is installed on Ubuntu and SNMPv3 user is created. 12345678 is defined for SNMP authentication of user (asif3) and "ASIFIQBAL" is specified for Privacy (DES). SNMP command runs on the SNMP server to investigate the processor utilization of VM2-Ubuntu by providing user asif3 with password as displayed in Figure 6. Additionally, physical memory size and its consumption are displayed in Figure 7 and the number of octets received on VM2-Ubuntu is displayed in Figure 8.

4.3. Display Result in Zabbix

All the information or values which are collected with SNMP commands in terminal can be displayed in a graph by using Zabbix. A couple of MIB objects configured in the Zabbix to obtain the result of VM2-Ubuntu is shown in Figure 9. Detailed configuration of memory consumption in Zabbix is shown in Figure 10.

4.4. Hypervisor vs VM Monitoring

Resource monitoring of hypervisor and virtual machines has been performed separately. Monitoring of the hypervisor reveals how much memory is utilized by the server, but it is not possible to identify the type and amount of resources consumed by a virtual machine. To find out the resources consumed by virtual machines, an agent is configured on them and virtual machines resources are monitored by the agent.

4.5. Hosted Hypervisor (Sun Virtual Box and VMs)

Sun Virtual Box is a hosted hypervisor, and it is not possible to monitor the hosted hypervisor, because it is not itself an Operating System. Additionally, SNMP can only monitor the IP based devices. All the VMs running on these hypervisors are monitored and all the results are stored in Zabbix.

```
~ #
~ # esxcli system snmp test
   Comments: There are 2 targets configured, send warmStart requested, test completed normally.
~ #
~ #
~ #
~ # esxcli system snmp get
   Authentication: MD5
   Communities: com1
   Enable: true
   Engineid: ABCDEF
   Hwsrc: indications
   Largestorage: true
   Loglevel: info
   Notraps:
   Port: 161
   Privacy: AES128
   Remoteusers: asif3/MD5/f45a313cb647e80e120c63c52320b2fd/AES128/e5d299853ea454bc92ea2b1d4ac8e47b/ABCDEF/
   Syscontact:
   Syslocation:
   Targets: 192.168.5.1@162 test-esxi
   Users: asif3/f45a313cb647e80e120c63c52320b2fd/e5d299853ea454bc92ea2b1d4ac8e47b/priv
   V3targets: 192.168.137.22 asif3 priv trap
~ #
```

Fig. 3. SNMP v3 agent configurations

```
asif@Zabbix:~$
asif@Zabbix:~$
asif@Zabbix:~$
asif@Zabbix:~$ snmpwalk -v3 -l authPriv -u asif3 -a MD5 -A 4144ebf493e341de4dbc6b95d556fc1d -x AES128 -X 395f7ab166dc1b4852a6eb55ae093315 192.168.137.5 VMWARE-VMINFO-MI
B::vmwVmConfigFile
VMWARE-VMINFO-MIB::vmwVmConfigFile.1 = STRING: /vmfs/volumes/54ef2e96-d55b9c34-70aa-d89d6723eae8/New Virtual Machine/New Virtual Machine.vmx
VMWARE-VMINFO-MIB::vmwVmConfigFile.3 = STRING: /vmfs/volumes/54ef2e96-d55b9c34-70aa-d89d6723eae8/Windows Server 2012/Windows Server 2012.vmx
asif@Zabbix:~$
asif@Zabbix:~$
asif@Zabbix:~$
asif@Zabbix:~$ snmpwalk -v3 -l authPriv -u asif3 -a MD5 -A 4144ebf493e341de4dbc6b95d556fc1d -x AES128 -X 395f7ab166dc1b4852a6eb55ae093315 192.168.137.5 VMWARE-VMINFO-MI
B::vmwVmState
VMWARE-VMINFO-MIB::vmwVmState.1 = STRING: powered on
VMWARE-VMINFO-MIB::vmwVmState.3 = STRING: powered on
asif@Zabbix:~$
asif@Zabbix:~$
asif@Zabbix:~$
asif@Zabbix:~$ snmpwalk -v3 -l authPriv -u asif3 -a MD5 -A 4144ebf493e341de4dbc6b95d556fc1d -x AES128 -X 395f7ab166dc1b4852a6eb55ae093315 192.168.137.5 VMWARE-VMINFO-MI
B::vmwVmDisplayName
VMWARE-VMINFO-MIB::vmwVmDisplayName.1 = STRING: Ubuntu
VMWARE-VMINFO-MIB::vmwVmDisplayName.3 = STRING: Windows Server 2012
asif@Zabbix:~$
asif@Zabbix:~$
```

Fig. 4. VMs Status

```
asif@Zabbix:~$
asif@Zabbix:~$
asif@Zabbix:~$ snmpwalk -v3 -l authPriv -u asif3 -a MD5 -A 4144ebf493e341de4dbc6b95d556fc1d -x AES128 -X 395f7ab166dc1b4852a6eb55ae093315 192.168.137.5 VMWARE-VMINFO-MI
B::vmwVmCpus
VMWARE-VMINFO-MIB::vmwVmCpus.1 = INTEGER: 1
VMWARE-VMINFO-MIB::vmwVmCpus.3 = INTEGER: 1
asif@Zabbix:~$
asif@Zabbix:~$
asif@Zabbix:~$ snmpwalk -v3 -l authPriv -u asif3 -a MD5 -A 4144ebf493e341de4dbc6b95d556fc1d -x AES128 -X 395f7ab166dc1b4852a6eb55ae093315 192.168.137.5 VMWARE-VMINFO-MI
B::vmwVmMemSize
VMWARE-VMINFO-MIB::vmwVmMemSize.1 = INTEGER: 4096 megabytes
VMWARE-VMINFO-MIB::vmwVmMemSize.3 = INTEGER: 4096 megabytes
asif@Zabbix:~$
asif@Zabbix:~$
asif@Zabbix:~$
asif@Zabbix:~$ snmpwalk -v3 -l authPriv -u asif3 -a MD5 -A 4144ebf493e341de4dbc6b95d556fc1d -x AES128 -X 395f7ab166dc1b4852a6eb55ae093315 192.168.137.5 VMWARE-VMINFO-MI
B::vmwVmNetNum
VMWARE-VMINFO-MIB::vmwVmNetNum.1.4 = STRING: Ethernet 1
VMWARE-VMINFO-MIB::vmwVmNetNum.3.4 = STRING: Ethernet 1
asif@Zabbix:~$
asif@Zabbix:~$
asif@Zabbix:~$ snmpwalk -v3 -l authPriv -u asif3 -a MD5 -A 4144ebf493e341de4dbc6b95d556fc1d -x AES128 -X 395f7ab166dc1b4852a6eb55ae093315 192.168.137.5 VMWARE-VMINFO-MI
B::vmwVmNetName
VMWARE-VMINFO-MIB::vmwVmNetName.1.4 = STRING: VM Network
VMWARE-VMINFO-MIB::vmwVmNetName.3.4 = STRING: VM Network
asif@Zabbix:~$
```

Fig. 5. VMs Specifications

```
asif@Zabbix:~$ snmpwalk -v3 -l authPriv -u asif3 -a MD5 -A 12345678 -x DES -X AS
IFIQBAL 192.168.137.12 HOST-RESOURCES-MIB::hrProcessorLoad
HOST-RESOURCES-MIB::hrProcessorLoad.196608 = INTEGER: 47
asif@Zabbix:~$
asif@Zabbix:~$
asif@Zabbix:~$ snmpwalk -v3 -l authPriv -u asif3 -a MD5 -A 12345678 -x DES -X AS
IFIQBAL 192.168.137.12 HOST-RESOURCES-MIB::hrProcessorLoad
HOST-RESOURCES-MIB::hrProcessorLoad.196608 = INTEGER: 47
asif@Zabbix:~$
asif@Zabbix:~$
asif@Zabbix:~$
asif@Zabbix:~$ snmpwalk -v3 -l authPriv -u asif3 -a MD5 -A 12345678 -x DES -X AS
IFIQBAL 192.168.137.12 HOST-RESOURCES-MIB::hrProcessorLoad
HOST-RESOURCES-MIB::hrProcessorLoad.196608 = INTEGER: 54
asif@Zabbix:~$
asif@Zabbix:~$
asif@Zabbix:~$ snmpwalk -v3 -l authPriv -u asif3 -a MD5 -A 12345678 -x DES -X AS
IFIQBAL 192.168.137.12 HOST-RESOURCES-MIB::hrProcessorLoad
HOST-RESOURCES-MIB::hrProcessorLoad.196608 = INTEGER: 64
asif@Zabbix:~$
```

Fig. 6. Processor Load on VM2-Ubuntu

```
asif@Zabbix:~$
asif@Zabbix:~$ snmpwalk -v3 -l authPriv -u asif3 -a MD5 -A 12345678 -x DES -X AS
IFIQBAL 192.168.137.12 HOST-RESOURCES-MIB::hrStorageSize.1
HOST-RESOURCES-MIB::hrStorageSize.1 = INTEGER: 4048384
asif@Zabbix:~$
asif@Zabbix:~$
asif@Zabbix:~$ snmpwalk -v3 -l authPriv -u asif3 -a MD5 -A 12345678 -x DES -X AS
IFIQBAL 192.168.137.12 HOST-RESOURCES-MIB::hrStorageUsed.1
HOST-RESOURCES-MIB::hrStorageUsed.1 = INTEGER: 2568444
asif@Zabbix:~$
asif@Zabbix:~$
asif@Zabbix:~$ snmpwalk -v3 -l authPriv -u asif3 -a MD5 -A 12345678 -x DES -X AS
IFIQBAL 192.168.137.12 HOST-RESOURCES-MIB::hrStorageUsed.1
HOST-RESOURCES-MIB::hrStorageUsed.1 = INTEGER: 2570220
asif@Zabbix:~$
asif@Zabbix:~$ snmpwalk -v3 -l authPriv -u asif3 -a MD5 -A 12345678 -x DES -X AS
IFIQBAL 192.168.137.12 HOST-RESOURCES-MIB::hrStorageDescr.1
HOST-RESOURCES-MIB::hrStorageDescr.1 = STRING: Physical memory
asif@Zabbix:~$
```

Fig. 7. Physical Memory of VM2-Ubuntu

```
asif@Zabbix:~$
asif@Zabbix:~$ snmpwalk -v3 -l authPriv -u asif3 -a MD5 -A 12345678 -x DES -X AS
IFIQBAL 192.168.137.12 IF-MIB::ifDescr
IF-MIB::ifDescr.1 = STRING: lo
IF-MIB::ifDescr.2 = STRING: eth0
asif@Zabbix:~$
asif@Zabbix:~$ snmpwalk -v3 -l authPriv -u asif3 -a MD5 -A 12345678 -x DES -X AS
IFIQBAL 192.168.137.12 IF-MIB::ifSpeed.2
IF-MIB::ifSpeed.2 = Gauge32: 1000000000
asif@Zabbix:~$
asif@Zabbix:~$ snmpwalk -v3 -l authPriv -u asif3 -a MD5 -A 12345678 -x DES -X AS
IFIQBAL 192.168.137.12 IF-MIB::ifInOctets.2
IF-MIB::ifInOctets.2 = Counter32: 58179334
asif@Zabbix:~$
asif@Zabbix:~$ snmpwalk -v3 -l authPriv -u asif3 -a MD5 -A 12345678 -x DES -X AS
IFIQBAL 192.168.137.12 IF-MIB::ifInOctets.2
IF-MIB::ifInOctets.2 = Counter32: 58216957
asif@Zabbix:~$
asif@Zabbix:~$
asif@Zabbix:~$ snmpwalk -v3 -l authPriv -u asif3 -a MD5 -A 12345678 -x DES -X AS
IFIQBAL 192.168.137.12 IF-MIB::ifInOctets.2
IF-MIB::ifInOctets.2 = Counter32: 58525208
asif@Zabbix:~$
```

Fig. 8. Number of Octets In - VM2-Ubuntu

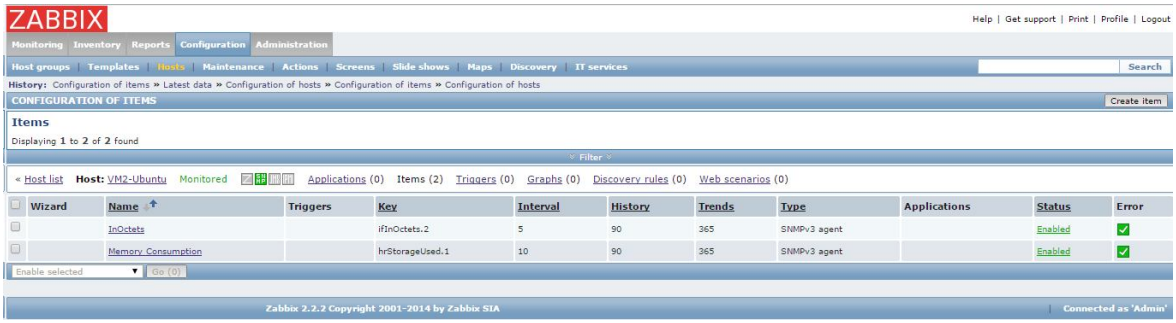

Fig. 9. Memory Consumption and InOctets

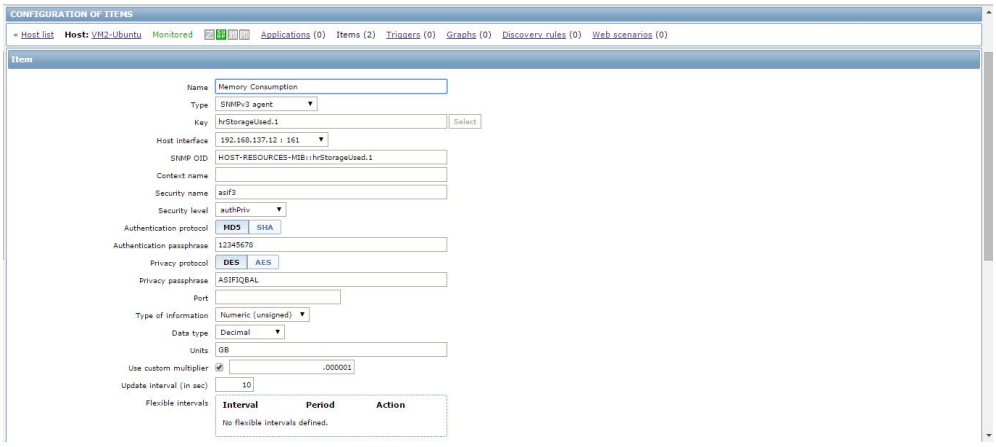

Fig. 10. Configuring of HOST-RESOURCES-MIB::hrStorageUsed.1

« Template list **Template:** SNMPv3 CPU Applications (1) Items (5) Triggers (1) Graphs (0) Screens (0) Discovery rules (0) Web scenarios (0)

Wizard	Name	Triggers	Key	Interval	History	Trends	Type	Applications	Status
	Prcoessor1		hrDeviceDescr.196608	30	90		SNMPv3 agent	Processor	Enabled
	Processor1 Load	Triggers (1)	hrProcessorLoad.196608	3	90	365	SNMPv3 agent	Processor	Enabled
	Processor2		hrDeviceDescr.196609	30	90		SNMPv3 agent	Processor	Enabled
	Processor2 Load		hrProcessorLoad.196609	5	90	365	SNMPv3 agent	Processor	Enabled
	Running Processes		hrSystemProcesses	30	90	365	SNMPv3 agent	Processor	Enabled

Fig. 11. SNMPv3 CPU Template

4.6. Zabbix and MIB

To perform monitoring with any MIB object, it is compulsory to add it into Zabbix templates. To make the setup look professional, five templates are created in this experiment. Each template has different MIB objects. In "SNMPv3 CPU" template, there are 5 items. In Figure 11, details of the items available in "SNMPv3 CPU" template are displayed. Information about the total number of running processes are collected and utilization of both processors is measured. Currently, only two processors are added for experimental purpose but more can be added if necessary.

4.7. Graphs

Graphs are actually used to display data with timeline. Various graphs are created to display data. Comparisons of two or more Object Identifiers (OID) can be seen in the graphs. These OIDs could be from the same machine or from different machines where comparisons of resources utilization can be made. Figure 12 is displaying the comparison of two processors installed on a Zabbix Server, where the green line is processor 1 load and red dotted line is processor 2 load.

4.8. Triggers

There is one trigger created in CPU template to generate an alert when processor 1 utilization has crossed 70% for over 20 seconds. Another trigger is defined for Zabbix Server to generate a message when memory utilization crossed 2GB for over 30 seconds.

Conclusion and Future Work

SNMP v3 protocol is employed for resource consumption monitoring of Type I hypervisor and VMs of Type I and II hypervisors. VMware ESXi 5.5 is a type I hypervisor, installed on HP ProLiant DL380p Gen8 machine. Two of the virtual machines are configured on the type I hypervisor. Both virtual machines and hypervisor are monitored with SNMPv3. It is found that monitoring the hypervisor only will not allow us to know what resources are being consumed by each virtual machine. Each Virtual Machine individually needs to be monitored, in order to find out their respective resources consumption. VMs configured on type II (hosted) hypervisor are also monitored.

The whole experiment is based on MIBs, provided by VMware or those that come with SNMP. New MIBs can be defined for a hypervisor to obtain information about the resources consumed by virtual machines. Also, current systems do not allow us to change the resources while virtual machines are powered ON, but it can be achieve by using SNMP controlling features. Additionally, VM migration will be a great idea for future work, VMs can be migrated to other hypervisors if resources allow us to do so and turning off one physical machine will enable us to save energy consumption. Future work on accurate monitoring of the system is very important.

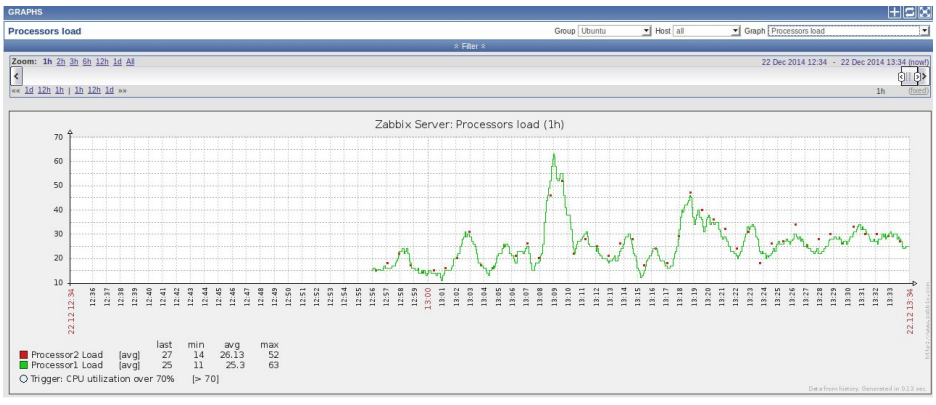

Fig. 12. 2-Processors load comparison of Zabbix Server

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ИСПОЛЬЗОВАНИЕ SNMPV3 ДЛЯ МОНИТОРИНГА РЕСУРСОВ ХОСТОВЫХ И АВТОНОМНЫХ ГИПЕРВИЗОРОВ

А. Икбал, К. Паттинсон, А. Кор

Простой протокол сетевого управления (SNMP) является протоколом, который поставляется с функцией точного мониторинга и управления IP-устройств. В наше время, большинство IP- устройств поставляются на рынок с функцией протокола SNMP. В данной работе, протокол SNMP используется для контроля среды облачных вычислений, в которой выполняется мониторинг виртуальных машин (VM). Данное иссле-

дование проводится с целью определить, может ли SNMP быть использован для контроля гипервизора. Гипервизор первого типа VMware ESXi и гипервизор второго типа Oracle VirtualBox установлены и настроены с их виртуальными машинами. На виртуальных машинах установлены операционные системы Microsoft и Linux. Кроме того, в качестве системы управления сетью (NMS) для хранения отслеживаемых данных, собранных с помощью SNMP, и отображения их в виде графиков используется Zabbix – бесплатная система с открытым исходным кодом.

Ключевые слова: SNMP, виртуализация, гипервизор, Zabbix, облачные вычисления.

ВИКОРИСТАННЯ SNMP V3 ДЛЯ МОНІТОРИНГУ РЕСУРСІВ ХОСТОВИХ І АВТОНОМНИХ ГІПЕРВІЗОРІВ

А. Ікбал, К. Паттінсон, А. Кор

Простий протокол мережного управління (SNMP) є протоколом, який поставляється з функцією точного моніторингу та управління IP-пристроїв. В наш час, більшість IP- пристроїв поставляються на ринок з функцією протоколу SNMP. У даній роботі, протокол SNMP використовується для контролю середовища хмарних обчислень, в якому виконується моніторинг віртуальних машин (VM). Дослідження проводиться з метою визначити, чи може SNMP бути використаний для контролю гіпервізора. Гіпервізор першого типу VMware ESXi і гіпервізор другого типу Oracle VirtualBox встановлені і налаштовані з їх віртуальними машинами. На віртуальних машинах встановлені операційні системи Microsoft і Linux. Крім того, в якості системи управління мережею (NMS) для зберігання відслідкованих даних, зібраних за допомогою SNMP, і відображення їх у вигляді графіків використовується Zabbix – безкоштовна система з відкритим вихідним кодом.

Ключові слова: SNMP, віртуалізвація, гіпервізор, Zabbix, облачные хмарні обчислення.

Asif Iqbal – PhD Student, School of Computing, Creative Technologies & Engineering, Leeds Beckett University, Leeds, UK, e-mail: a.iqbal8836@student.leedsbeckett.ac.uk.

Colin Pattinson – Professor, Head of School, School of Computing, Creative Technologies & Engineering, Leeds Beckett University, Leeds, UK, e-mail: c.pattinson@leedsbeckett.ac.uk.

Ah-Lian Kor – Doctor, Senior Lecturer, School of Computing, Creative Technologies & Engineering, Leeds Beckett University, Leeds, UK, e-mail: a.kor@leedsbeckett.ac.uk.

Асиф Икбал – аспирант кафедры информатики, новаторских технологий и инженерии, Городской университет Лидса, Лидс, Великобритания, e-mail: a.iqbal8836@student.leedsbeckett.ac.uk.

Колин Паттинсон – профессор, заведующий кафедры информатики, новаторских технологий и инженерии, Городской университет Лидса, Лидс, Великобритания, e-mail: c.pattinson@leedsbeckett.ac.uk.

Ах-Лиан Кор – доктор, старший преподаватель кафедры информатики, новаторских технологий и инженерии, Городской университет Лидса, Лидс, Великобритания, e-mail: a.kor@leedsbeckett.ac.uk.