A Seminar Report On

Performance Evaluation of VM BOX on Windows 7

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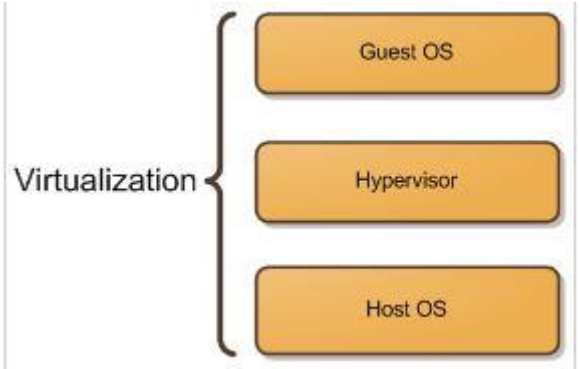
Virtualisation

Virtualization allows multiple operating system instances to run concurrently on a single computer. It is a means of separating hardware from a single operating system. Each "guest" OS is managed by a Virtual Machine Monitor (VMM), also known as a hypervisor. Because the virtualization system sits between the guest and the hardware, it can control the guests' use of CPU, memory, and storage, even allowing a guest OS to migrate from one machine to another**.**

As virtualization disentangles the operating system from the hardware, a number of very useful new tools become available. Virtualization allows an operator to control a guest operating system's use of CPU, memory, storage, and other resources, so each guest receives only the resources that it needs. This distribution eliminates the danger of a single runaway process consuming all available memory or CPU. It also helps IT staff to satisfy service level requirements for specific applications. Since the guest is not bound to the hardware, it also becomes possible to dynamically move an operating system from one physical machine to another. As a particular guest OS begins to consume more resources during a peak period, operators can move the offending guest to another server . This kind of flexibility changes traditional notions of server provisioning and capacity planning. With virtualized deployments, it is possible to treat computing resources like CPU, memory, and storage as a hangar of resources and applications can easily relocate to receive with less demand the resources they need at that time.



VM BOX

Oracle VM virtual box was used to perform the analysis explained above. Virtual Box is a cross-platform virtualization application. It is installed on our existing computers, whether they are running Windows, Mac, Linux or Solaris operating systems. Secondly, it extends the capabilities of your existing computer so that it can run multiple operating systems (inside multiple virtual machines) at the same time. So, for example, you can run Windows and Linux on your Mac, run Linux on your Windows PC and so on, all alongside your existing applications. You can install and run as many virtual machines as you like - the only practical limits are disk space and memory. Virtual Box is deceptively simple yet also very powerful. It can run everywhere from small embedded systems or desktop class machines all the way up to datacenter deployments and even Cloud environments. In a very easy language we can say that this is a tool with which virtual environment for running applications is created!

The techniques and features that VirtualBox provides are useful for several scenarios:

- **Running multiple operating systems simultaneously.** VirtualBox allows you to run more than one operating system at a time. This way, you can run software written for one operating system on another (for example, Windows software on Linux or a Mac) without having to reboot to use it. Since you can configure what kinds of "virtual" hardware should be presented to each such operating system, you can install an old operating system such as DOS or OS/2 even if your real computer's hardware is no longer supported by that operating system.
- **Easier software installations.** Software vendors can use virtual machines to ship entire software configurations. For example, installing a complete mail server solution on a real machine can be a tedious task. With VirtualBox, such a complex setup (then often called an "appliance") can be packed into a virtual machine. Installing and running a mail server becomes as easy as importing such an appliance into VirtualBox.
- **Testing and disaster recovery.** Once installed, a virtual machine and its virtual hard disks can be considered a "container" that can be arbitrarily frozen, woken up, copied, backed up, and transported between hosts. On top of that, with the use of another VirtualBox feature called "snapshots", one can save a particular state of a virtual machine and revert back to that state, if necessary. This way, one can freely experiment with a computing environment. If something goes wrong (e.g. after installing misbehaving software or infecting the guest with a virus), one can easily switch back to a previous snapshot and avoid the need of frequent backups and restores.
- **Infrastructure consolidation.** Virtualization can significantly reduce hardware and electricity costs. Most of the time, computers today only use a fraction of their potential power and run with low average system loads. A lot of hardware resources as well as electricity is thereby wasted. So, instead of running many such physical computers that are only partially used, one can pack many virtual machines onto a few powerful hosts and balance the loads between them.

Project Specifications

Project aims to perform performance evaluation of the virtualization layer to find a limit of stress on Virtual Box (virtualization layer) that can be put keeping considerable performance of host operating system. To achieve this we installed a virtualization software from Oracle VM BOX (info given on next page). Then we installed three different OS's namely Ubuntu 12.04, KDE Linux and Linux Lite on the Windows 7 host operating system. By varying the degree of the stress we try to find the limit of stress where the host operating system slows down and tends to crash. The analysis is done using a software called passmark test software.

For this we first need to establish basic system information and a benchmark(pass mark criteria).System information is as follows –

Host System Information –Summary (full details provided in appendix)

Operating System: Windows 7 Home Premium Edition Service Pack 1 build 7601 (64-bit)

CPU Type: Intel Core i7-3612QM @ 2.10GHz

Number of CPUs: 1

Cores per CPU: 4

Hyperthreading: Enabled

Motherboard: 05TJ3M

Memory: 8GB Micron Technology DDR3 SDRAM

Videocard: Intel(R) HD Graphics 4000

Hard Drive: WDC WD10JPVT-75A1YT0 (1TB)

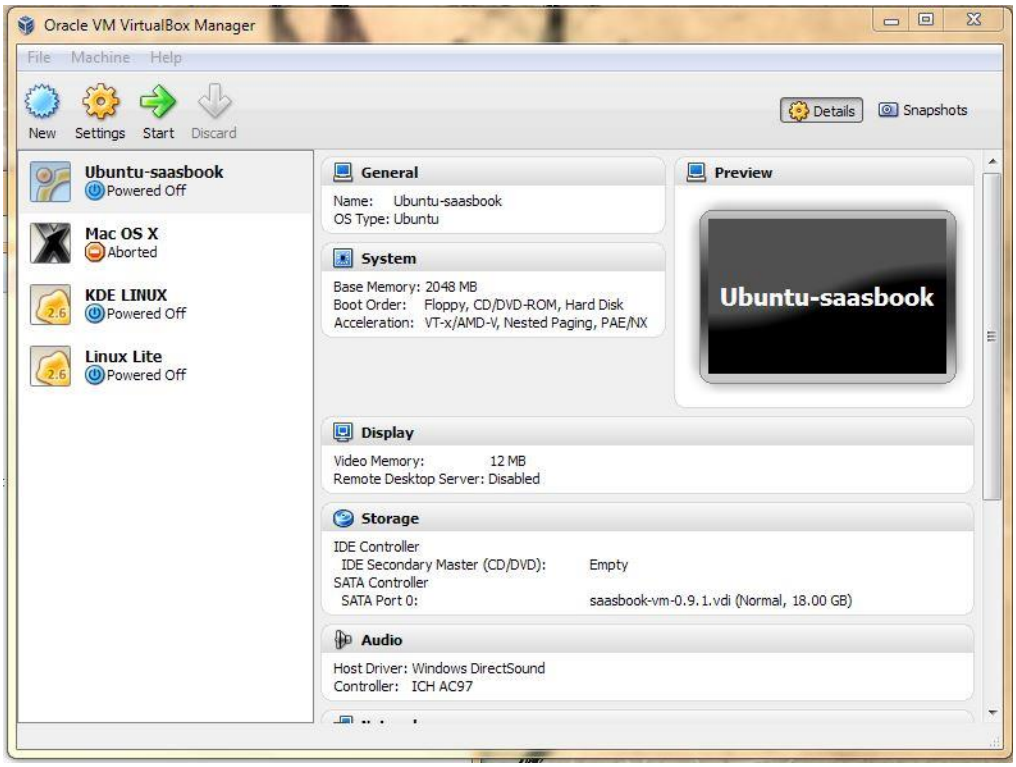
Passmark Rating Criteria:

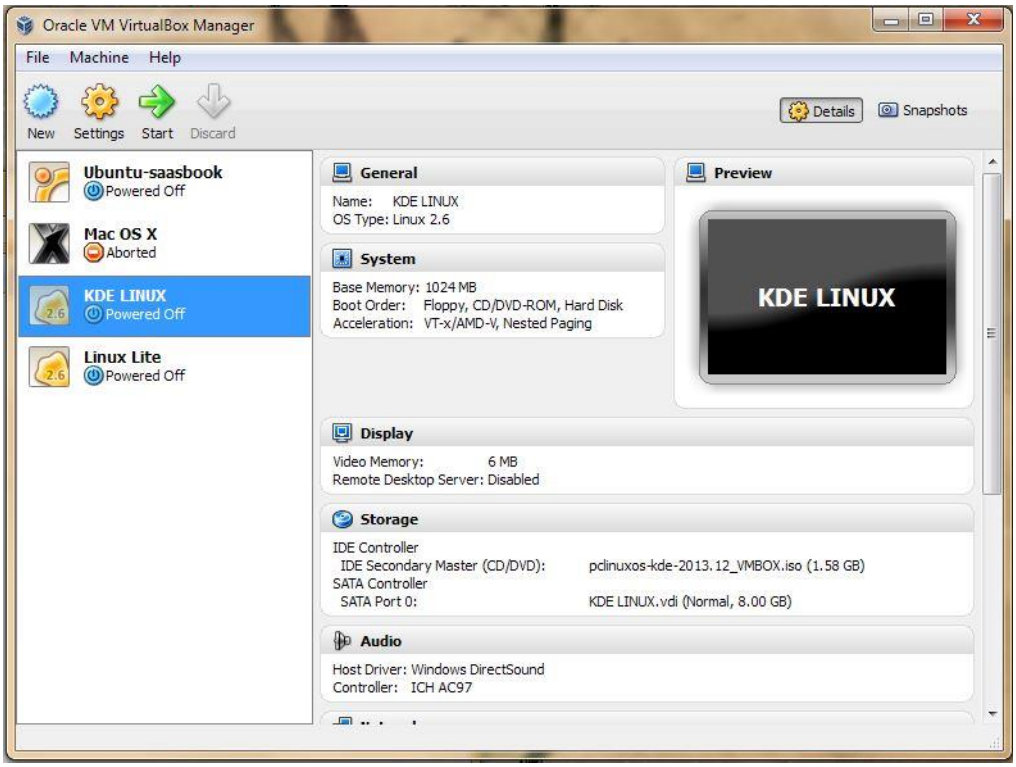
The "PassMark Rating" is a combination of the CPU, 2D, 3D, Memory and Disk Ratings, the bigger the number, the faster the computer. The exact formula for this calculation is as follows:

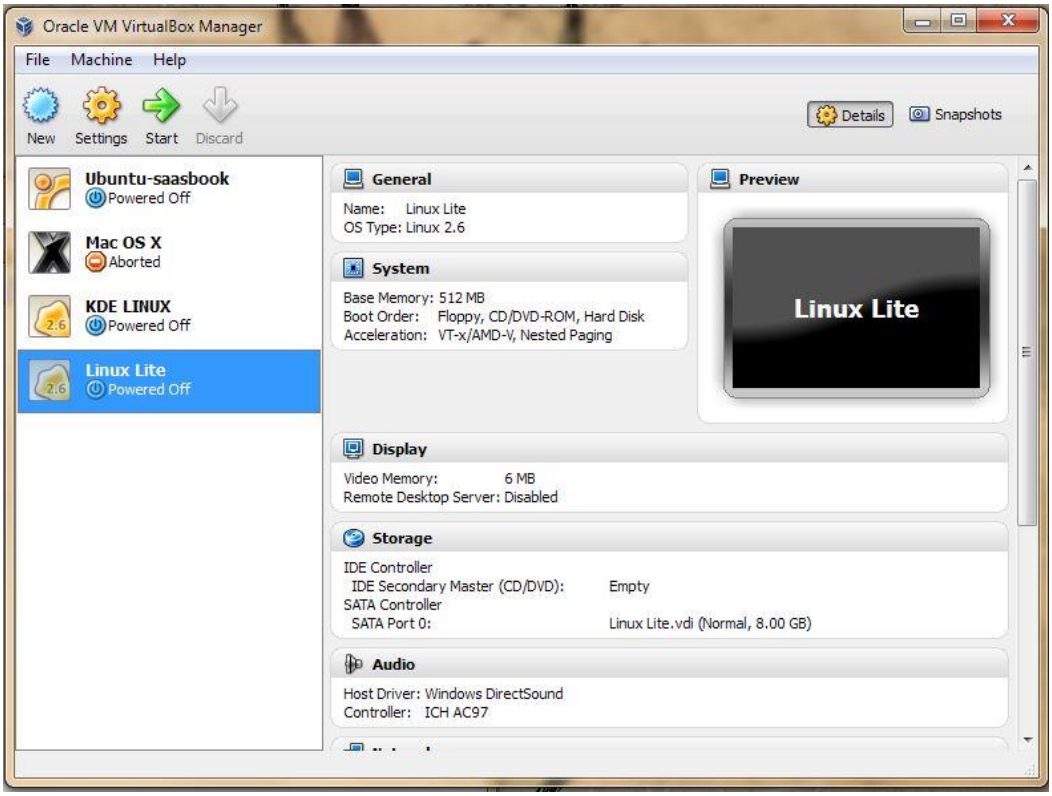
1 / (((1 / (CPU Rating * 0.396566187)) + (1 / (2D Rating * 3.178718116)) + (1 / (3D Rating * 2.525195879)) + (1 / (Memory Rating * 1.757085479)) + (1 / (Disk Rating * 1.668158805)))/5)

In this formula each rating is weighted then inverted, the average of these values is taken and then inverted again. The weight multipliers were calculated from the hundreds of thousands of baselines collected in PerformanceTest 7. The score is also calculated in such a way that a single extremely high value cannot significantly improve the final score. Conversely, a single low score can drag the score down significantly using this formula. All components in a system must be performing well in order for the final score to be high.

Guest Operating Systems' Specification on VMBOX:






Oracle VM VirtualBox Manager
File
Machine
Help
New
Settings
Start
Discard
Details
Snapshots
Ubuntu-saasbook
Powered Off
Mac OS X
Aborted
KDE LINUX
Powered Off
Linux Lite
Powered Off
General
Name: Linux Lite
OS Type: Linux 2.6
System
Base Memory: 512 MB
Boot Order: Floppy, CD/DVD-ROM, Hard Disk
Acceleration: VT-x/AMD-V, Nested Paging
Preview
Linux Lite
Display
Video Memory: 6 MB
Remote Desktop Server: Disabled
Storage
IDE Controller
IDE Secondary Master (CD/DVD): Empty
SATA Controller
SATA Port 0: Linux Lite.vdi (Normal, 8.00 GB)
Audio
Host Driver: Windows DirectSound
Controller: ICH AC97

Statistical Test Observations

1. **Stage 1:**
   Without starting the VMBOX, the performance test was performed on the host Operating System and the result was as follows :

PassMark(R) PerformanceTest 8.0 (http://www.passmark.com)

Results generated on: Friday, April 18, 2014

Benchmark Results

Test Name: This Computer

CPU - Integer Math: 12533.3 (MOps./Sec.)

CPU - Floating Point Math: 4481.2 (MOps./Sec.)

CPU - Prime Numbers: 20.3 (Millions of Primes/Sec.)

CPU - Extended Instructions (SSE): 29.4 (Millions of Matrices/Sec.)

CPU - Compression: 8621.7 (KB processed/Sec.)

CPU - Encryption: 1326.8 (MB/Sec.)

CPU - Physics: 443.2 (Frames/Sec.)

CPU - Sorting: 5586.2 (Thousand Strings/Sec.)

CPU - Single Threaded: 1534.3 (MOps./Sec.)

Graphics 2D - Simple Vectors: 24.8 (Thousand Vectors/Sec.)

Graphics 2D - Complex Vectors: 126.8 (Complex Vectors/Sec.)

Graphics 2D - Fonts and Text: 211.8 (Operations/Sec.)

Graphics 2D - Windows Interface: 100.2 (Operations/Sec.)

Graphics 2D - Image Filters: 703.1 (Filters/Sec.)

Graphics 2D - Image Rendering: 590.5 (Images/Sec.)

Graphics 2D - Direct 2D: 15.6 (Frames/Sec.)

Graphics 3D - DirectX 9 Simple: 66.9 (Frames/Sec.)

Graphics 3D - DirectX 9 Complex: 36.2 (Frames/Sec.)

Graphics 3D - DirectX 10: 9.1 (Frames/Sec.)

Graphics 3D - DirectX 11: 15.7 (Frames/Sec.)

Graphics 3D - DirectCompute: 582.7 (Operations/Sec.)

Memory - Database Operations: 69.6 (KOps./Sec.)

Memory - Read Cached: 20365.4 (MB/Sec.)

Memory - Read Uncached: 11712.4 (MB/Sec.)

Memory - Write: 9299.9 (MB/Sec.)

Memory - Available RAM: 5321.7 (MB Available)

Memory - Latency: 28.4 (Nano seconds)

Memory - Threaded: 22639.6 (MB/Sec.)

Disk - Sequential Read: 95.6 (MB/Sec.)

Disk - Sequential Write: 88.8 (MB/Sec.)

Disk - Random Seek + RW: 7.1 (MB/Sec.)

SUMMARY 1(Composite Average)

CPU Mark: 6669.8

2D Graphics Mark: 627.4

Memory Mark: 2042.9

Disk Mark: 692.6

3D Graphics Mark: 1017.6

PassMark Rating: 2072.4

2. **<u>Stage 2</u>:**
   Once the Virtual OS's were started and stressed a little by starting browser and playing an youtube video (thereby putting stress on the host), performance test was performed once again and detailed result is as follows :

PassMark(R) PerformanceTest 8.0 (http://www.passmark.com)

Results generated on: Friday, April 18, 2014

Benchmark Results

Test Name: This Computer

CPU - Integer Math: 11264.0 (MOps./Sec.)

CPU - Floating Point Math: 4612.9 (MOps./Sec.)

CPU - Prime Numbers: 21.2 (Millions of Primes/Sec.)

CPU - Extended Instructions (SSE): 29.8 (Millions of Matrices/Sec.)

CPU - Compression: 9279.9 (KB processed/Sec.)

CPU - Encryption: 1114.2 (MB/Sec.)

CPU - Physics: 306.5 (Frames/Sec.)

CPU - Sorting: 4258.3 (Thousand Strings/Sec.)

CPU - Single Threaded: 1347.3 (MOps./Sec.)

Graphics 2D - Simple Vectors: 23.2 (Thousand Vectors/Sec.)

Graphics 2D - Complex Vectors: 127.4 (Complex Vectors/Sec.)

Graphics 2D - Fonts and Text: 188.2 (Operations/Sec.)

Graphics 2D - Windows Interface: 92.5 (Operations/Sec.)

Graphics 2D - Image Filters: 700.4 (Filters/Sec.)

Graphics 2D - Image Rendering: 583.8 (Images/Sec.)

Graphics 2D - Direct 2D: 15.0 (Frames/Sec.)

Graphics 3D - DirectX 9 Simple: 63.3 (Frames/Sec.)

Graphics 3D - DirectX 9 Complex: 30.9 (Frames/Sec.)

Graphics 3D - DirectX 10: 8.9 (Frames/Sec.)

Graphics 3D - DirectX 11: 15.9 (Frames/Sec.)

Graphics 3D - DirectCompute: 532.7 (Operations/Sec.)

Memory - Database Operations: 69.0 (KOps./Sec.)

Memory - Read Cached: 19643.5 (MB/Sec.)

Memory - Read Uncached: 11253.7 (MB/Sec.)

Memory - Write: 8696.2 (MB/Sec.)

Memory - Available RAM: 2336.8 (MB Available)

Memory - Latency: 29.5 (Nano seconds)

Memory - Threaded: 21019.9 (MB/Sec.)

Disk - Sequential Read: 98.7 (MB/Sec.)

Disk - Sequential Write: 91.7 (MB/Sec.)

Disk - Random Seek + RW: 6.2 (MB/Sec.)

SUMMARY 2 (Composite Average)

CPU Mark: 6263.4

2D Graphics Mark: 598.5

Memory Mark: 1710.1

Disk Mark: 711.2

3D Graphics Mark: 967.5

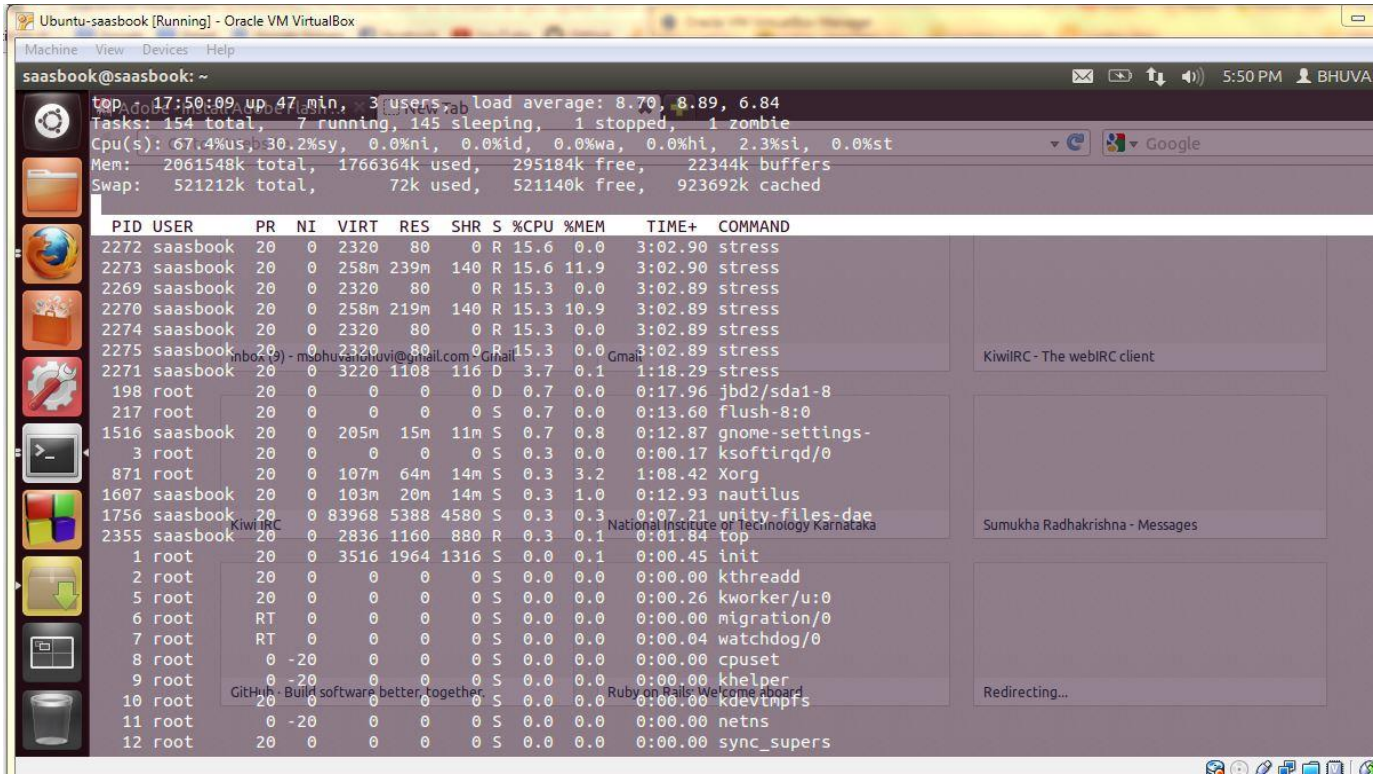
PassMark Rating: 1976.0

By comparing the passmark rating we can say that the host system is a little stressed but still there is scope of stress. Passmark rating has reduced from 2072.4 to 1796.0.

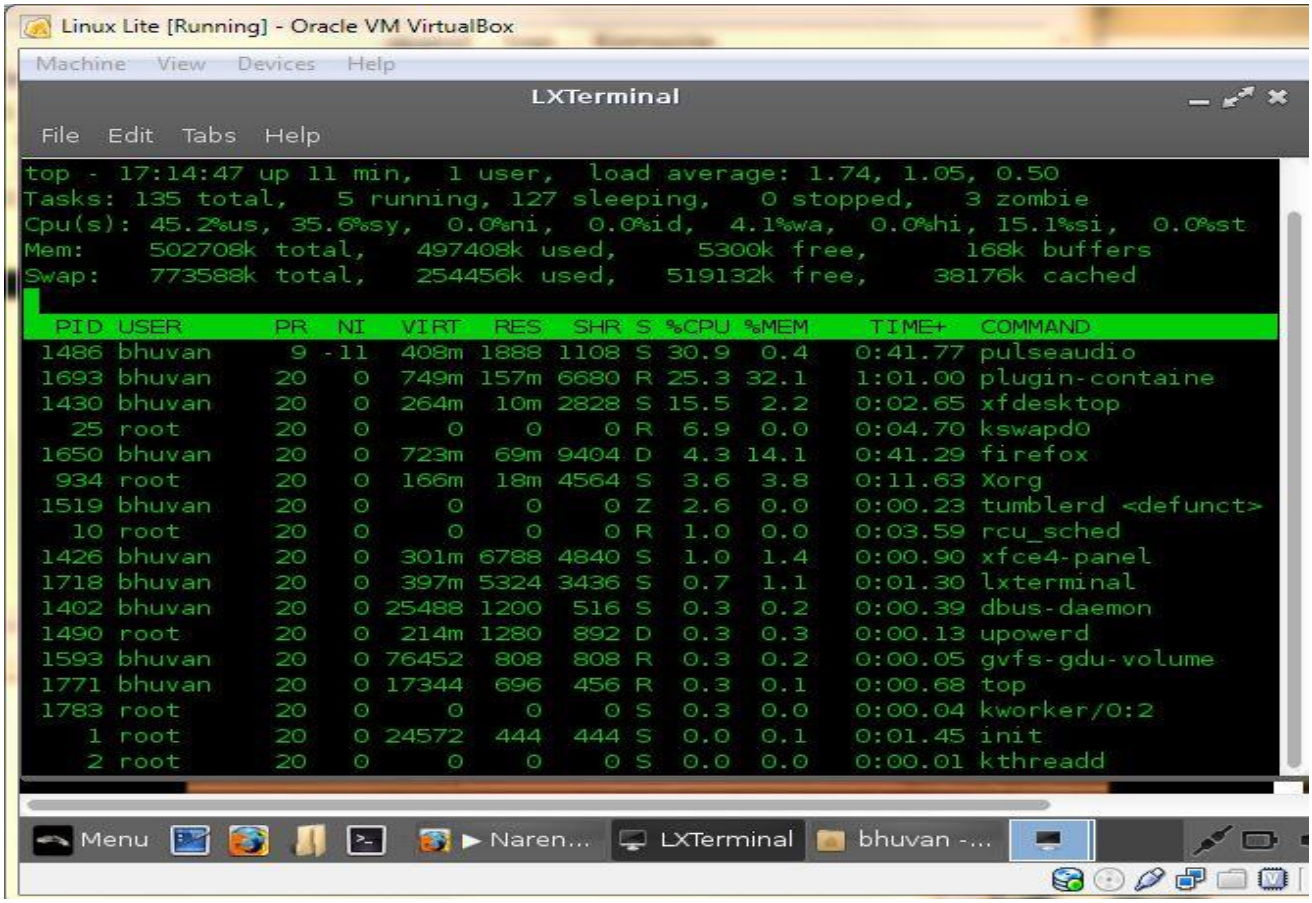
3. **Stage 3:**

*Virtual OS's stressed using **stress** command on ubuntu (stress –c 4 –m 2 –d 1), and on Linux Lite by starting browser and playing an youtube video, and light stress on KDE linux.*

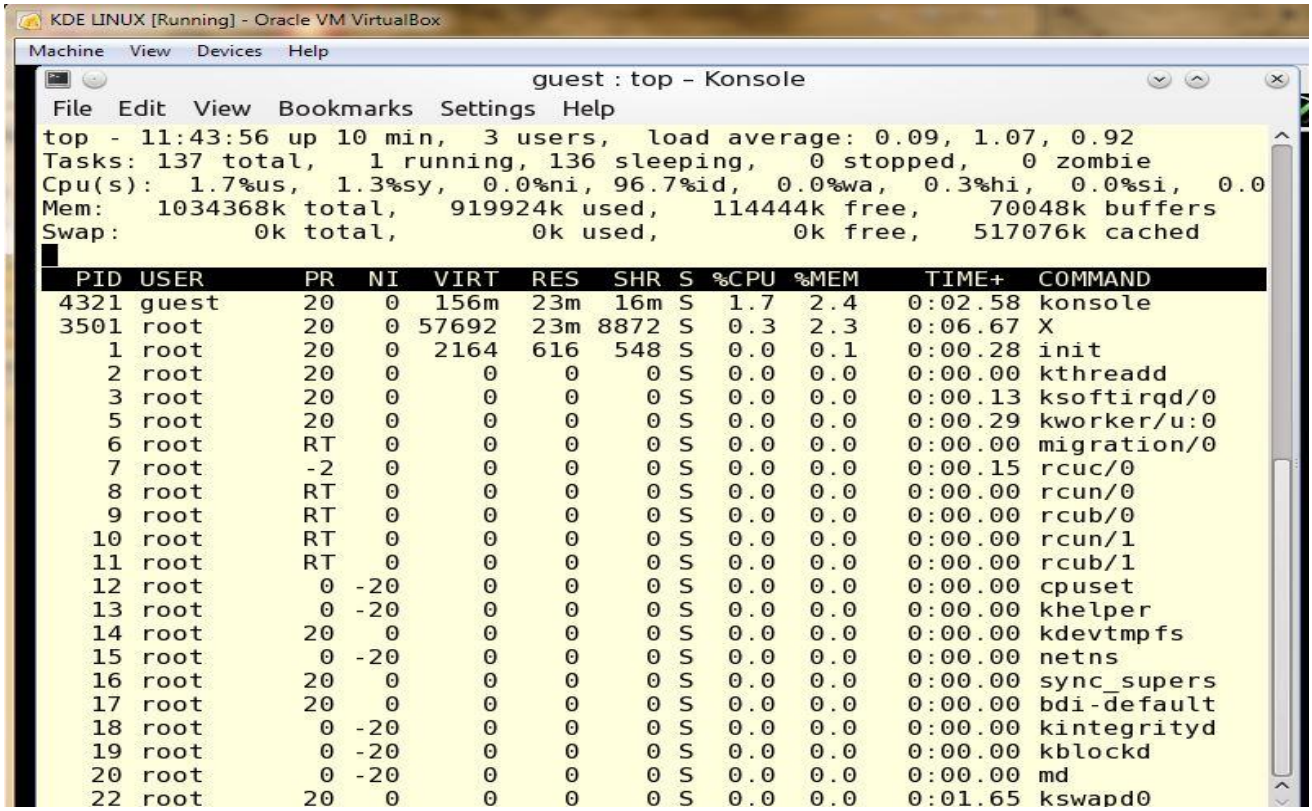
*The system started to slow dowm considerably, hence we limited the stress to this point. The **top** command shows the cpu, memory and disk (swap) including buffers and cached states at this stress point on three guest operating systems as follows:*



Ubuntu "top" command at maximum stress



Lite at high stress



KDE at light stress

Then passmark performance test was performed once again on Host operating system and detailed result is as follows :

PassMark(R) PerformanceTest 8.0 (http://www.passmark.com)

Results generated on: Friday, April 18, 2014

Benchmark Results

Test Name: This Computer

CPU - Integer Math: 10961.5 (MOps./Sec.)

CPU - Floating Point Math: 4884.4 (MOps./Sec.)

CPU - Prime Numbers: 19.8 (Millions of Primes/Sec.)

CPU - Extended Instructions (SSE): 27.4 (Millions of Matrices/Sec.)

CPU - Compression: 8225.3 (KB processed/Sec.)

CPU - Encryption: 1199.2 (MB/Sec.)

CPU - Physics: 374.0 (Frames/Sec.)

CPU - Sorting: 4957.0 (Thousand Strings/Sec.)

CPU - Single Threaded: 1501.1 (MOps./Sec.)

Graphics 2D - Simple Vectors: 23.9 (Thousand Vectors/Sec.)

Graphics 2D - Complex Vectors: 123.0 (Complex Vectors/Sec.)

Graphics 2D - Fonts and Text: 198.6 (Operations/Sec.)

Graphics 2D - Windows Interface: 93.8 (Operations/Sec.)

Graphics 2D - Image Filters: 684.4 (Filters/Sec.)

Graphics 2D - Image Rendering: 574.3 (Images/Sec.)

Graphics 2D - Direct 2D: 14.8 (Frames/Sec.)

Graphics 3D - DirectX 9 Simple: 67.2 (Frames/Sec.)

Graphics 3D - DirectX 9 Complex: 36.3 (Frames/Sec.)

Graphics 3D - DirectX 10: 9.1 (Frames/Sec.)

Graphics 3D - DirectX 11: 15.8 (Frames/Sec.)

Graphics 3D - DirectCompute: 568.6 (Operations/Sec.)

Memory - Database Operations: 67.0 (KOps./Sec.)

Memory - Read Cached: 18343.7 (MB/Sec.)

Memory - Read Uncached: 11137.6 (MB/Sec.)

Memory - Write: 8563.2 (MB/Sec.)

Memory - Available RAM: 1274.8 (MB Available)

Memory - Latency: 29.0 (Nano seconds)

Memory - Threaded: 21090.3 (MB/Sec.)

Disk - Sequential Read: 35.7 (MB/Sec.)

Disk - Sequential Write: 6.5 (MB/Sec.)

Disk - Random Seek + RW: 0.6 (MB/Sec.)

SUMMARY (Composite Average)

CPU Mark: 6007.4

2D Graphics Mark: 599.9

Memory Mark: 1411.0

Disk Mark: 154.7

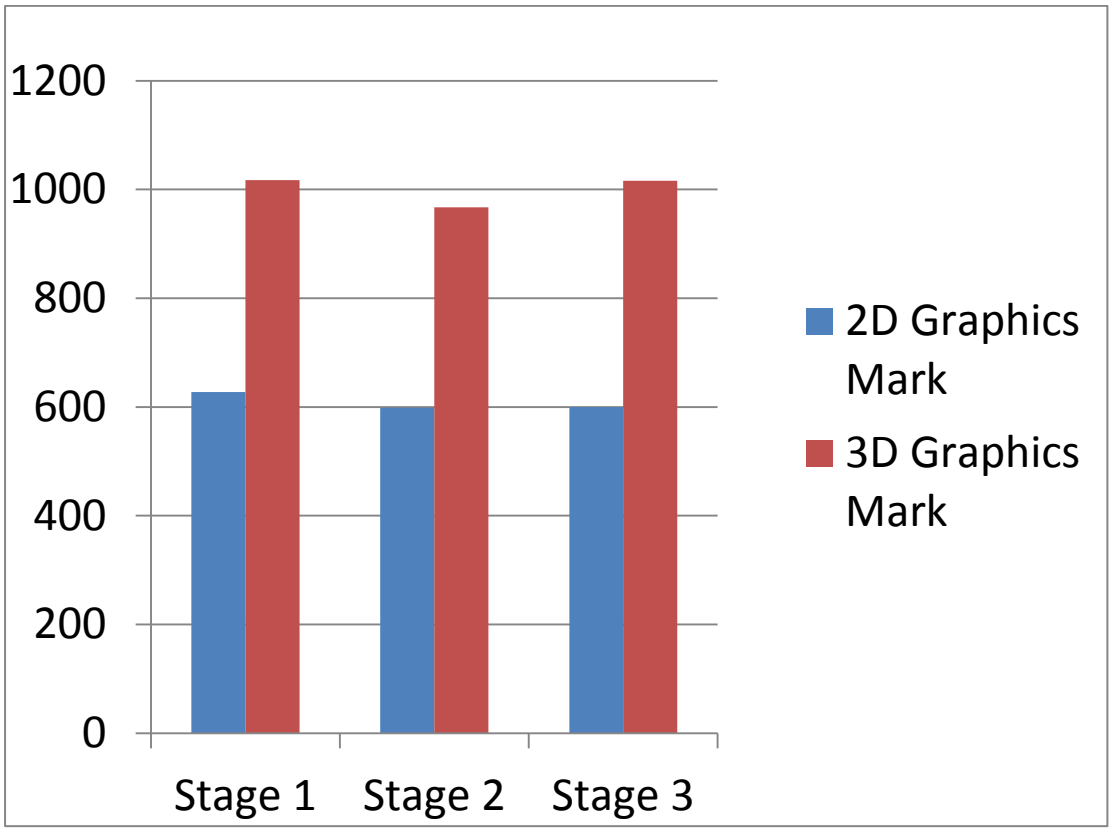
3D Graphics Mark: 1016.0

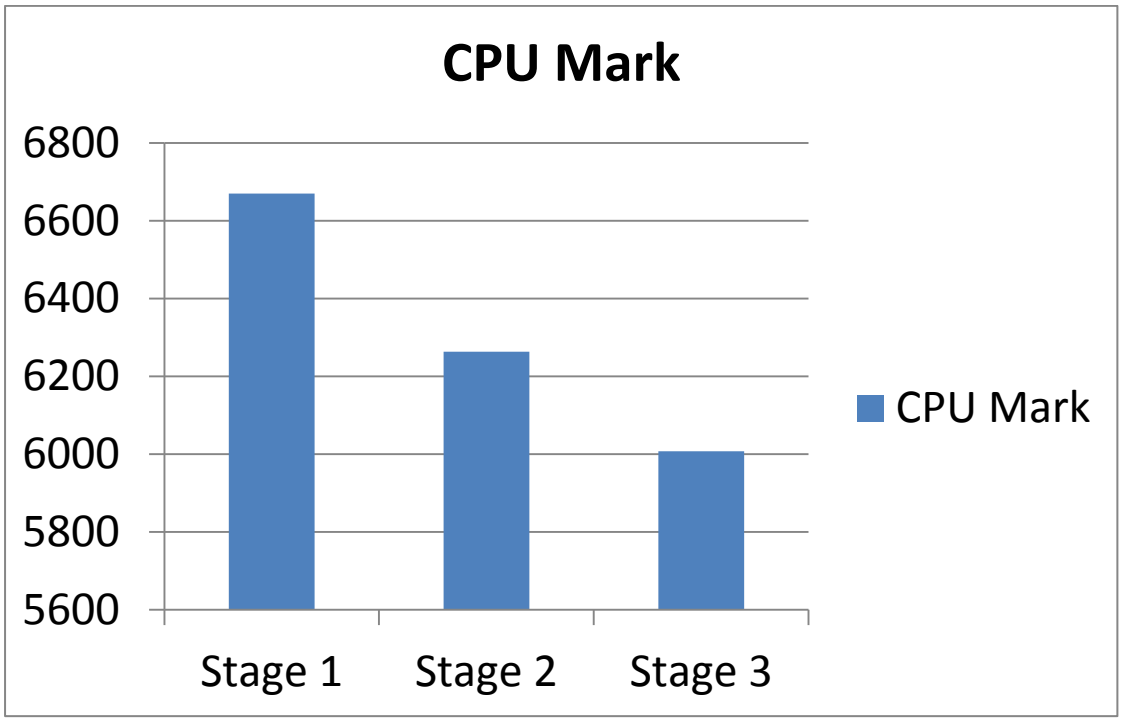
PassMark Rating: 893.8

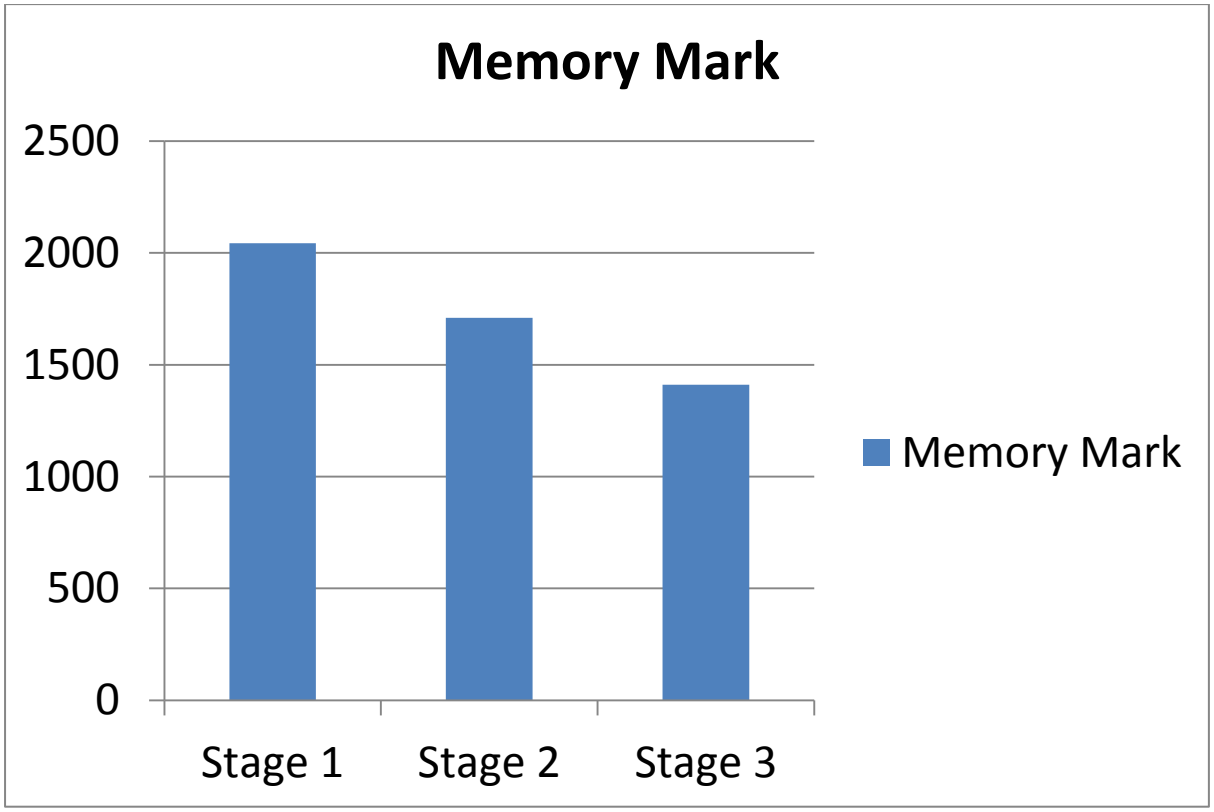
At this stage, no more stress can be applied to the host operating system or it would crash. We observe that the host system rating has considerably fallen from 2072.4 to 893.8 as VMBOX utilised its hardware for supporting 3 other guest Operating systems on high stress.

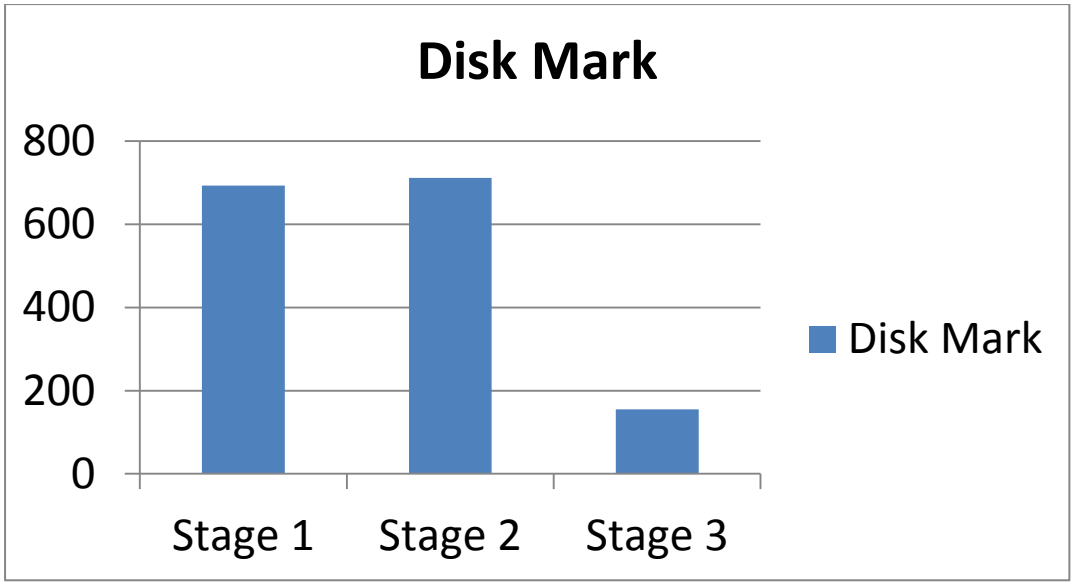
CONCLUSION

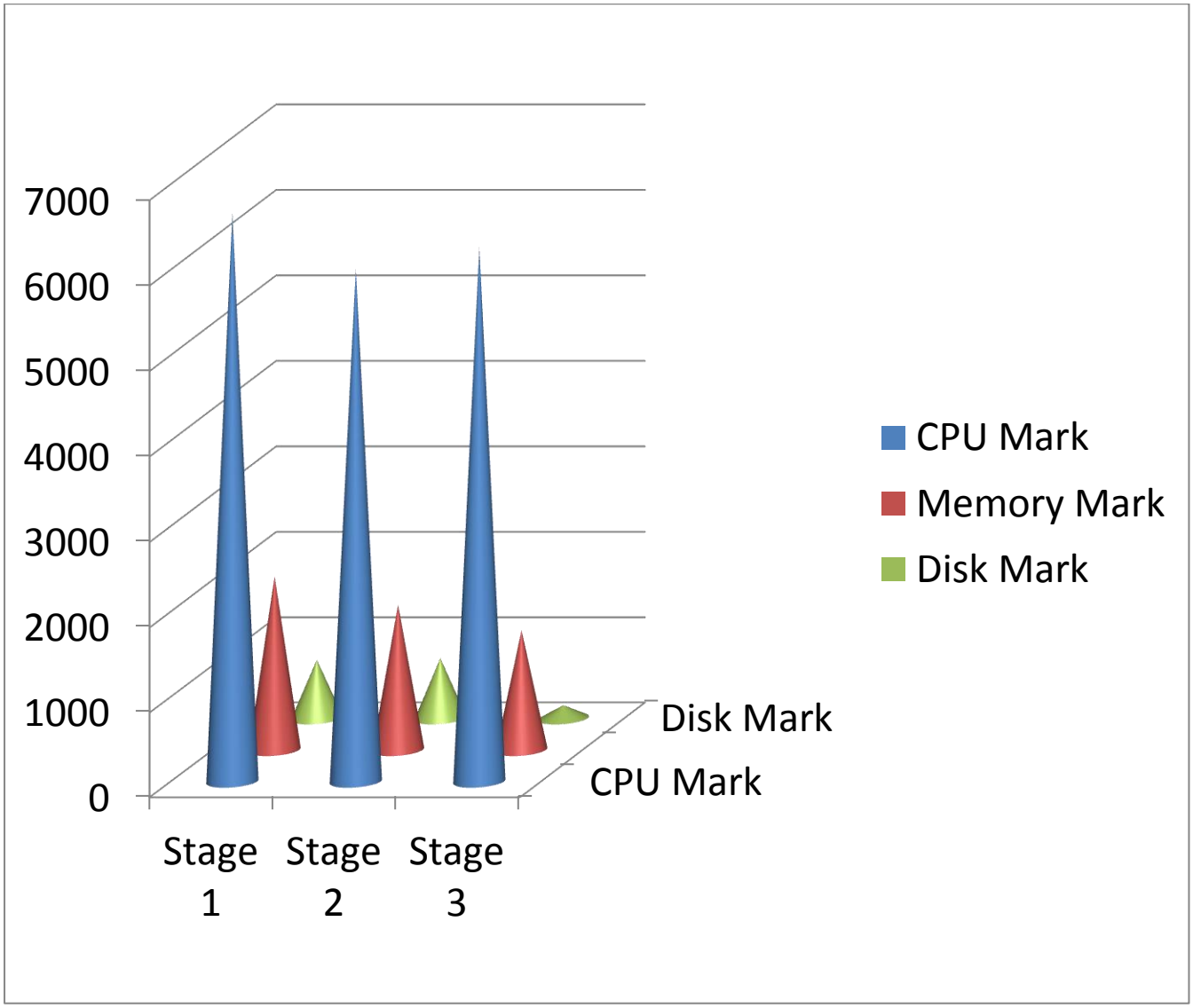
Virualization through VMBOX utilises hardware through a virtual layer to support Guest Operating System by compromising with the Host Operating System's Performance. The passmark test result at three stages suggest that initially the performace rating of host OS being 2072.4 decresed to 1976.0 when the virtualization started with three operating systems running simultaneously. Further stresing the guest OS to the limit where host OS slows down to a point where further stress would crash the system, we find the Host OS performance goes down to 893.8. The top command screenshots potrait the cpu, memory and disk including the buffer states of the guest Operating systems at maximum stress. This makes the analysis more accurate and apt. This report can be used as a benchmark to propose the maximum allowable stress on on VMBOX when run on a Host Operating System with given specifiation (refer appendix). The below graphs pictorially represent the performance degradation of Host System with the increase in stress on virtual layer provided by VMBOX.

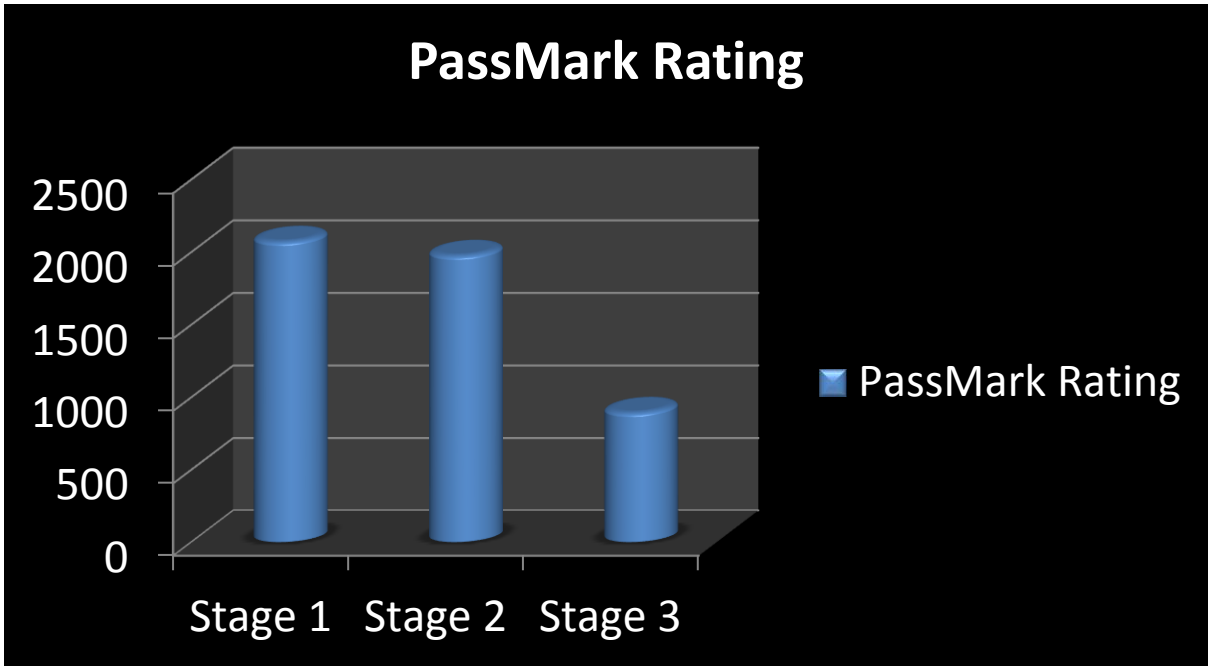



CPU Mark
6800
6600
6400
6200
6000
5800
5600
Stage 1
Stage 2
Stage 3
CPU Mark


Memory Mark
2500
2000
1500
1000
500
0
Stage 1
Stage 2
Stage 3
Memory Mark


Disk Mark
800
600
400
200
0
Stage 1
Stage 2
Stage 3
Disk Mark


7000
6000
5000
4000
3000
2000
1000
0
Stage 1
Stage 2
Stage 3
Disk Mark
CPU Mark
CPU Mark
Memory Mark
Disk Mark


PassMark Rating
2500
2000
1500
1000
500
0
Stage 1
Stage 2
Stage 3
PassMark Rating

APPENDIX

Host System Information – Complete

Item	This Computer
PerformanceTest Information	
PerformanceTest Version	8.0 (1019) WIN64
PassMark Rating	2072
System Information	
System Name	BHUVAN-PC
Model	
Operating System	Windows 7 Home Premium Edition Service Pack 1 build 7601 (64-bit)
Motherboard Manufacturer	Dell Inc.
Motherboard Model	05TJ3M
Motherboard Version	A00
BIOS Manufacturer	Dell Inc.
BIOS Version	DELL - 1
BIOS Release Date	2012/05/17
CPU Information	
Manufacturer	GenuineIntel
Type	Intel Core i7-3612QM @ 2.10GHz
Codename	Ivy Bridge
CPUID	Family 6, Model 3A, Stepping 9
Socket	
Lithography	22nm
Number of CPU's	1
Cores per CPU	4
Logicals per Core	2
Clock Frequencies	
Measured Speed	2095.7 MHz [Turbo: 2794.2 MHz]
Multiplier	21.0X
Bus Speed	99.8 MHz
Front Side Bus Speed	(N/A)
Timing Error Ratio	1.000
Cache per CPU package	
L1 Instruction Cache	4 x 32 KB
L1 Data Cache	4 x 32 KB
L2 Cache Size	4 x 256 KB
L3 Cache	6 MB

Memory Information	
Total Physical Memory	8094MB
Available Physical Memory	5121MB
Memory Devices	
Slot 1	4GB DDR3 SDRAM PC3-12800
	Micron Technology 16JTF51264HZ-1G6M1
	1.5V, Clk: 800.0MHz, Timings 11-11-11-28 (@ Max. freq.)
Slot 2	4GB DDR3 SDRAM PC3-12800
	Micron Technology 16JTF51264HZ-1G6M1
	1.5V, Clk: 800.0MHz, Timings 11-11-11-28 (@ Max. freq.)
Virtual Memory	C:\pagefile.sys (8094MB)

Drive Information	
Physical Drive 1	WDC WD10JPVT-75A1YT0
Drive Size	931GB
Partitions	E: C: G: H: I:
Interface Type	ATA
Bytes per Sector	512
RPM	5400
Optical Drive 1	TSSTcorp DVD+-RW SN-208BB
Optical Drive 2	

Volume Information	
Volume 1	C: [Local drive]
File System	NTFS
Drive Cluster Size	4KB
Volume Size (Free space)	250.0GB (118.1GB)
Volume 2	D: [Optical drive]
File System	
Drive Cluster Size	
Volume Size (Free space)	
Volume 3	E: [Local drive]
File System	NTFS
Drive Cluster Size	4KB
Volume Size (Free space)	13.8GB (4.8GB)
Volume 4	G: [Local drive]
File System	NTFS
Drive Cluster Size	4KB
Volume Size (Free space)	250.0GB (35.7GB)
Volume 5	H: [Local drive]
File System	NTFS

Drive Cluster Size	4KB
Volume Size (Free space)	200.2GB (13.4GB)
Volume 6	I: [Local drive]
File System	NTFS
Drive Cluster Size	4KB
Volume Size (Free space)	187.2GB (56.1GB)

Video Adapters	
Description	Intel(R) HD Graphics 4000
Chip Type	Intel(R) HD Graphics Family
DAC Type	Internal
Memory	2112MB
Video BIOS	Intel Video BIOS
Driver Provider	Advanced Micro Devices, Inc.
Driver Version	8.951.0.0
Driver Date	3-8-2012
Monitor 1	1366x768x32 40Hz (Primary monitor)

Temperatures	
Description	CPU 0 average
Temperature	65.50C
Description	CPU 0 core 0
Temperature	60.00C
Description	CPU 0 core 1
Temperature	65.00C
Description	CPU 0 core 2
Temperature	70.00C
Description	CPU 0 core 3
Temperature	67.00C
Description	HDD 0 (WDC WD10JPVT-75A1YT0)
Temperature	52.00C
Description	GPU 0 (AMD Radeon HD 7730M)
Temperature	53.00C