VFAST Transactions on Software Engineering
http://vfast.org/journals/index.php/VTSE@ 2018 ISSN(e): 2309-3978;ISSN(p): 2411-6246
Volume 6, Number 1, January-December, 2018

pp. 01-06

OPTIMIZING WINDOWS REDSTONE 3 BOOT PROCESS

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ABSTRACT. Almost every Microsoft Windows user at some point in life must have experience that his/her laptop or desktop has gone down slow and is just not performing swiftly as it used to do when Windows was initially installed on that system. This results in decreased performance of the system in over a few weeks of fresh installation of Microsoft Redstone 3 OS, the system starts to show degraded performance and increased bootup and shutdown times. This is not only the case, the loading of documents and power point files along with other programs gets slow. The system gets slower and slower. To tackle this challenge, we propose a solution in this paper that will optimize the starting and shutdown times of Redstone 3 OS with marked improvement.

Keywords:Redstone 3 , Slow Boot up , Slow Shutdown

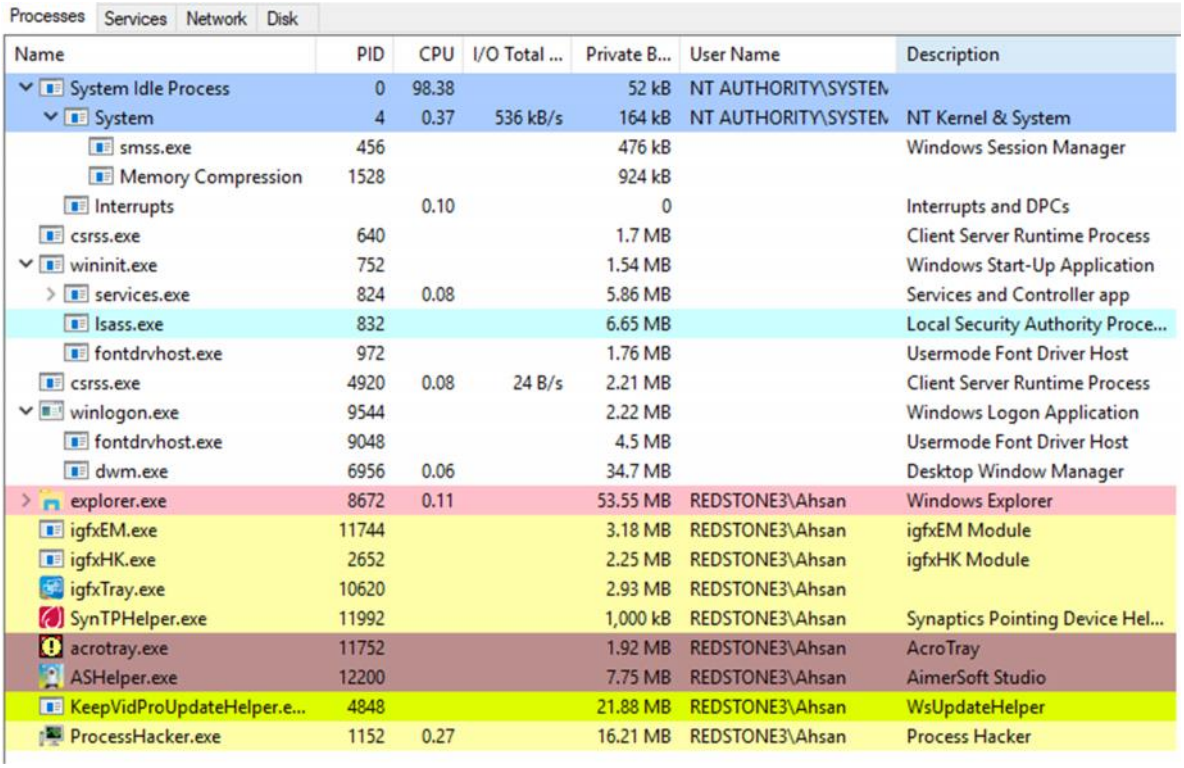
1.**Introduction.** We all experience the issues of slowdown of Microsoft Windows installed notebooks/laptops, desktops with the passage of time. Because of this the corporate sector lose productivity from their employees, hardware upgrades are urgently needed, and the IT staff gets bogged down with customer calls. The use of hibernation file along with the use of Condusiv performance application results in desktops/laptops to perform even better than new by limiting the amount of I/O to disk with the DRAM caching technique and removal of performance robbing fragmentation so that the defragmentation processes are not started. The general system utilities that are provided with Microsoft Redstone 3 and related editions are not so intelligent. These utilities start their action only when the data has already been written on the fixed drive in a fragmented state.

These system utilities then start up on user intervention or as per schedule and consume a lot of system resources as well as hard drive storage to shuffle data trying to minimize the fragmentation that has already occurred. This performance application discussed in this paper works from the very start and steps right where the application is trying to write data to your hard drive, it inspects the data and allocates it the best possible place on the hard drive so that fragmentation is minimized right at the start of the disk write. It runs seamlessly in the background occupying very little system resources. This also reduce the seek times of your hard drive resulting in more speed gains. It does it with its Intelligent Write technology. The drivers tcesd.sys and tcefs.sys intelligent cache hot data and takes care of I/O operations as they are requested by the application. Both drivers are loaded at different stages of system boot and are found and shared for user knowledge in the given figures (5) and (6). A user work analysis engine tracks how a user works on the system for 72 hours, it notes the specific I/O requests to cache most recent data within available system memory to improve the response time of applications and files, which further reduces the amount of I/O data sent to disk. Section 2 tells a brief history of the issues that motivated the author for this paper, in Section 3 a solution using hibernation file along with performance application is proposed, experiments and its results are provided in Section 4, Section 5 deals with recommendations, Section 6 shares related works and Section 7 provides conclusion and way forward. References are shared at the end.

2. Background and Motivation: Since the introduction of Windows XP in early 2002, the race for a smooth and better performing Operating Systems has gained momentum. After XP, Vista was introduced by Microsoft,

but it failed to gain popularity due to its heavy system hardware requirements and poor memory management. This was the main issue that forced Microsoft to launch Windows 7 and it immediately captured the consumer attention due to its smooth performance and better memory management. The hardware requirements were also not much high. One very important thing from an end user point of view from initial installation of Operating Systems is that the "**Loading time of Windows**" and its "**Shutting down time**".
They both affect the working of an end user, if a system is taking more than two minutes in just reaching the LOGON prompt of windows and taking more than a minute or in some cases a lot more just to get your machine Shutdown, is really frustrating and wastage of time resources. Not only this, the I/O activity with the passage of time also increases, which leads to more slowness of the machine. Every second day the user installs more and more software in his/her system. This results in an increase of the registry size and more services are required to be started on windows loading time and the drive gets fragmented.

Microsoft Office Applications loading times: Within few weeks of installation of Microsoft Redstone 3 Enterprise and Microsoft Office Professional 2016, we started to notice that opening time of word documents and power point files has increased. It was really frustrating when a 5MB to 8MB PowerPoint file was taking a lot of time to open. We immediately realized that there is something wrong in I/O operations that is causing this degradation. Disk fragmentation is one of the issue and plays a major role in decreasing the I/O response time of any application. A properly defragmented disk volume will surely provide better response time than a disk volume cluttered with files with many empty spaces between them.



Name	PID	CPU	I/O Total ...	Private B...	User Name	Description
System Idle Process	0	98.38		52 kB	NT AUTHORITY\SYSTEM	
System	4	0.37	536 kB/s	164 kB	NT AUTHORITY\SYSTEM	NT Kernel & System
smss.exe	456			476 kB		Windows Session Manager
Memory Compression	1528			924 kB		
Interrupts		0.10		0		Interrupts and DPCs
csrss.exe	640			1.7 MB		Client Server Runtime Process
wininit.exe	752			1.54 MB		Windows Start-Up Application
services.exe	824	0.08		5.86 MB		Services and Controller app
lsass.exe	832			6.65 MB		Local Security Authority Proce...
fontdrvhost.exe	972			1.76 MB		Usermode Font Driver Host
csrss.exe	4920	0.08	24 B/s	2.21 MB		Client Server Runtime Process
winlogon.exe	9544			2.22 MB		Windows Logon Application
fontdrvhost.exe	9048			4.5 MB		Usermode Font Driver Host
dwm.exe	6956	0.06		34.7 MB		Desktop Window Manager
explorer.exe	8672	0.11		53.55 MB	REDSTONE3\Ahsan	Windows Explorer
igfxEM.exe	11744			3.18 MB	REDSTONE3\Ahsan	igfxEM Module
igfxHK.exe	2652			2.25 MB	REDSTONE3\Ahsan	igfxHK Module
igfxTray.exe	10620			2.93 MB	REDSTONE3\Ahsan	
SynTPHelper.exe	11992			1,000 kB	REDSTONE3\Ahsan	Synaptics Pointing Device Hel...
acrotray.exe	11752			1.92 MB	REDSTONE3\Ahsan	AcroTray
ASHelper.exe	12200			7.75 MB	REDSTONE3\Ahsan	AimerSoft Studio
KeepVidProUpdateHelper.e...	4848			21.88 MB	REDSTONE3\Ahsan	WsUpdateHelper
ProcessHacker.exe	1152	0.27		16.21 MB	REDSTONE3\Ahsan	Process Hacker

Figure 1:- Processes in Microsoft Redstone 3

The above screenshot in Figure-1 shows processes running ina Redstone 3 Enterprise 64bit system equipped with intel i7 processor and 8 GB of RAM with 500 GB Hdd. It shows that number of services and system programs are increasing with every new release of Windows and most of them are to be loaded at Windows startup and cause degraded boot performance. The booting log in the system can be checked to see the new drivers loaded with every new edition of Microsoft Windows.

3. Proposed Solution. The proposed solution to make the starting and shutting down time of Microsoft Redstone 3 fast is based on using hibernation file to load kernel and system drivers at much faster speed from the hard drive. What happens as default in Microsoft Redstone 3 startup is that the system performs POST, runs

necessary pre-boot system files, starts system initialization in which it loads necessary drivers, starts services and loads Session 0, the final step is the User Session Init which starts the WinLogon Process and we get the user name and password input dialog box. Now when the system is going to perform a Shutdown, rather than just clearing everything in RAM, if Windows saves the loaded kernel and drivers information in Hibernation file. So that when the system boots up again, instead of loading everything from the scratch, it simply loads this hiber file, making booting times much faster [4]. The idea is represented in the Figure-2.

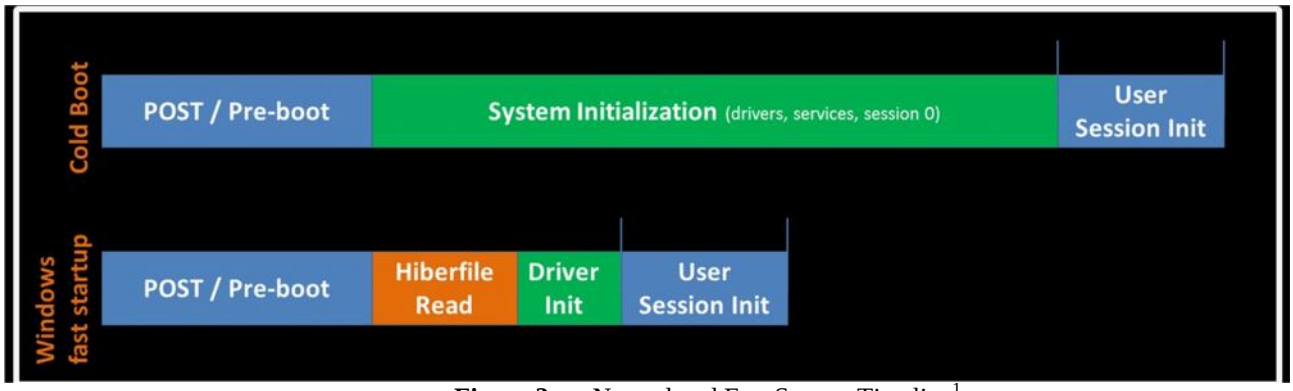


Figure 2:- Normal and Fast Startup Timeline[1]

You can see from the Figure-2 ; that if this is implemented, it would result in speed gains. For that the power setting in hive HKLM needs to be changed for a fast bootup. The value HiberbootEnabled set to 1.

This would enable first part of the proposed solution and Windows will start using the hibernation file for fast startup of the machine. Along with this there needs to be some sort of intelligent caching mechanism that can prevent fractured writes inefficiencies of Microsoft Redstone 3, for that we use Condusiv Diskeeper [3] performance application. It is the combination of using hibernation file and performance application that results in decreasing the startup and shutdown times of Windows. If implemented stand-alone the speed results are not significant, the hibernation file loading technique needs to be beefed up by an intelligent DRAM caching mechanism. Now it is time to do some experiments and provide results from the above change.

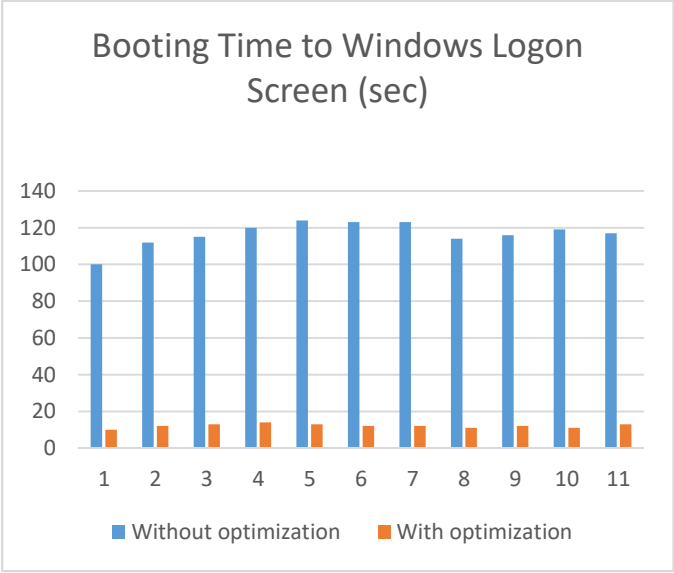


Figure 3:- Booting times of eleven PCs

[1]https://www.tenforums.com/tutorials/4189-fast-startup-turn-off-windows-10-a.html [on 22nd Dec. 2017]

4. Experiment and Results. Multiple experiments were performed in University of Management and Technology, Information Processing Laboratory on more than 50 Dell PCs to evaluate the hibernation file and performance application, the results (both booting times and shutdown times of computers) from eleven Dell Computers are produced below.

Dell, i7 (fifth generation) Systems,
8 GB DDR3 RAM and 500 GB SATA Hdd,
On AC Power with optimization services disabled:
Figure-3 & 4.
Avg Booting to Windows logon time: ~116 seconds
Avg Shutting Down time:~ 66 seconds
On AC Power with optimization services enabled:
Figure-3 & 4.
Avg Booting to Windows logon time: ~12 seconds
Avg Shutting Down time:~ 6 seconds

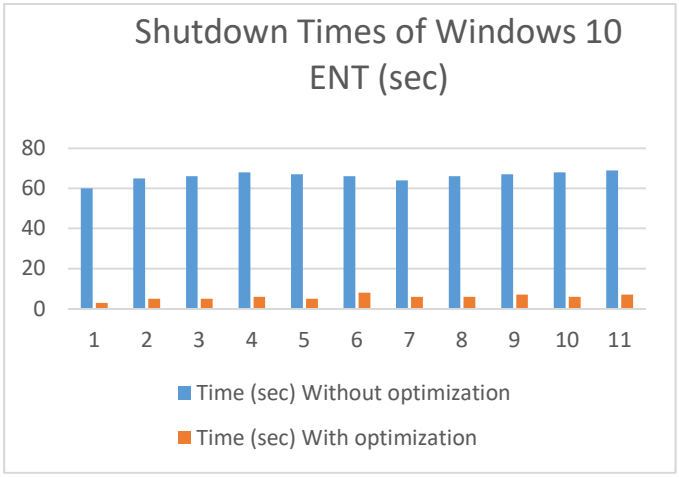


Figure 4:-Shutdown times of eleven PCs

The timings obtained for booting into windows logon screen and shutdown from Figure-3 & 4 clearly shows the benefits of performance application. The resulting speed gains in Booting as well shutting down times are ~90% for Boot up and 91% times faster for Shutdowns, which is great.

The above speed gains are achieved by strategically moving files into sequential order on hard drives to minimize the number of I/O requests and random I/Os during the boot process. Involving cache and filter drivers to cache I/O.

Not only this, the factors below also contributed for this rapid response.

1. The unnecessary boot time file logging is disabled.
2. The crucial boot time files to be loaded are placed in the initial sectors of hard disk, so that they can be loaded much more quickly.
3. Intelligent cache is used to track the loading of files and then load all driver files collectively in one go, instead of multiple I/O operations.

Trade-offs:

As far as trade-offs are concerned there is no major trade-off with respect to resource utilization on the computer. It uses minimum resources and that too when CPU is idle.

1. 4 GB RAM is needed for Intelligent Memory caching to work optimally.
2. 2-3 GB HD space for hibernation file.
3. The caching/speed gains are not there on soft restarts of the Redstone 3 Operating System.
4. The boot time logging of drivers does not work.

The issue of I/O operations slowing down an operating system performance is quite common. Whatever operating

system it may be, whenever the I/O operations will exceed the system performance is bound to go down, same is the case here which we experienced in Redstone 3 Enterprise x64 bit edition.

A. The general disk defragmenter that comes with Redstone 3 is not as smart as it should be. Instead of running defragmenting tool later, how is this that the files are initially stored in a better way so that there is minimum fragmentation of HD space as the OS stores them.

In the above case, **Intelligent Write operations** are needed to be deployed to prevent split I/Os (which are the redundant I/Os) from being generated when a file is broken into pieces before being written to disk.

B. As more and more applications are being installed on the system and the registry is also getting bloated, the Read operations from the HD needs to be optimized as well. So that more and more that is read from HD with minimum CPU cycles involved.

In the above case, **Intelligent Read operations** are needed so that Hot Data [5] (the most likely to be accessed data) is cached properly in much faster DRAM. This will enhance the application and files response time. In this case a special
driver sits in the background and do the trick. It also maintains the list of recent I/Os and intelligently predicts the upcoming I/O requests as well.

5. Recommendations. Diskeeper performance application can be further used to provide statistical reports to show how I/O reduction and optimization of data can be helpful in both physical and virtual environments [4], [6]. Notable enhancements in storage can be gained without any need of additional hardware. The performance application is installed directly on the Redstone 3 OS running on a guest machine as a light file system driver to direct the OS information on file sizes and help choose the best write allocations. Since the software is running at the point of I/O creation, redundant I/O can be reduced. Below you can see the two special driver files that are loaded at boot time for Diskeeper. One is the caching storage filter driver "tcesd.sys" and the other is "tcefs.sys" the file system filter driver.

Load order for drivers and services:

Start value	Group name	Tag	Service/Device	Display Name	Image path
Boot	System Reserved	n/a*	pcw	Performance Counters for Windows Driver	System32\drivers\pcw.sys
Boot	WdfLoadGroup	n/a*	Wdf01000	@%SystemRoot%\system32\drivers\Wdf01000.sys,-1000	system32\drivers\Wdf01000.sys
Boot	Boot Bus Extender	7	acpiex	Microsoft ACPIEx Driver	System32\Drivers\acpiex.sys
Boot	Boot Bus Extender	2	msisadrv		System32\drivers\msisadrv.sys
Boot	Boot Bus Extender	3	isapnp		System32\drivers\isapnp.sys
Boot	Boot Bus Extender	3	pci	@pci.inf,%pci_svcdesc%;PCI Bus Driver	System32\drivers\pci.sys
Boot	Boot Bus Extender	4	vdrvroot	@vdrvroot.inf,%vdrvroot_svcdesc%;Microsoft Virtual Drive Enumerator	System32\drivers\vdrvroot.sys
Boot	Boot Bus Extender	n/a*	partmgr	@%SystemRoot%\system32\drivers\partmgr.sys,-100	System32\drivers\partmgr.sys
Boot	Boot Bus Extender	n/a*	pdc	@%SystemRoot%\system32\drivers\pdc.sys,-100	system32\drivers\pdc.sys
Boot	Boot Bus Extender	n/a*	tcesd	tcesd	system32\drivers\tcesd.sys
Boot	System Bus Extender	7	intelide		System32\drivers\intelide.sys
Boot	System Bus Extender	3	ebdrv	@netevbda.inf,%vbd_srv_desc%;QLogic 10 Gigabit Ethernet Adapter VBD	System32\drivers\evbda.sys
Boot	System Bus Extender	4	nvraid		System32\drivers\nvraid.sys

Figure 5:- tcesd.sys, caching driver identified

The third important service is the velocity service itself, which runs as a background "performance software service" in Redstone 3 (DKService.exe) providing the GUI interface to interact with the optimization software and to extract system statistical reports as well as to get the Benefit analysis report.

Load order for drivers and services:

Start value	Group name	Tag	Service/Device	Display Name	Image path
Boot	PnP Filter*	n/a*	iorate	@%SystemRoot%\system32\drivers\iorate.sys,-101	system32\drivers\iorate.sys
Boot	Network*	n/a*	Mup	@%systemroot%\system32\drivers\mup.sys,-101	System32\Drivers\mup.sys
Boot	n/a*	n/a*	Ramdisk	Windows RAM Disk Driver	system32\DRIVERS\ramdisk.sys
Boot	PnP Filter*	n/a*	rdyboost	ReadyBoost	System32\drivers\rdyboost.sys
Boot	n/a*	n/a*	sbp2port	@sbp2.inf,%sbp2_ServiceDesc%;SBP-2 Transport/Protocol Bus Driver	System32\drivers\sbp2port.sys
Boot	n/a*	n/a*	scmbus	@scmbus.inf,%scmbus.SvcDesc%;Microsoft Storage Class Memory Bus Driver	System32\drivers\scmbus.sys
Boot	n/a*	n/a*	storufs	@storufs.inf,%UfsServiceDesc%;Microsoft Universal Flash Storage (UFS) Driver	System32\drivers\storufs.sys
Boot	n/a*	n/a*	volsnap	@%SystemRoot%\system32\drivers\volsnap.sys,-100	System32\drivers\volsnap.sys
Boot	n/a*	n/a*	volume	@volume.inf,%VolumeServiceDesc%;Volume driver	System32\drivers\volume.sys
Boot	Core Security Extensions*	1*	WindowsTrust...	Windows Trusted Execution Environment Class Extension	system32\drivers\WindowsTrustedRT.sys
Boot	Core Security Extensions*	2*	WindowsTrust...	@WindowsTrustedRTProxy.inf,%WindowsTrustedRTProxy.SVCDESC%;Microsoft Windows Tru...	System32\drivers\WindowsTrustedRTProxy.sys
System	SCSI CDROM Class	1	cdrom	@cdrom.inf,%cdrom_ServiceDesc%;CD-ROM Driver	\SystemRoot\System32\drivers\cdrom.sys
System	FSFilter Encryption	n/a*	FileCrypt	@%systemroot%\system32\drivers\filecrypt.sys,-100	system32\drivers\filecrypt.sys
System	FSFilter Activity Monitor	n/a*	tcefs	tcefs	\??\C:\Windows\system32\drivers\tcefs.sys

Figure 6:- tcefs.sys file system filter driver identified

Together these drivers and system files work hand in hand to provide better I/O operations and speedy Boot

up in Redstone 3 as well as swift shutdown. The beauty is that we may install as many application programs and services but the speed gains provided by Diskeeper are never lost.

6. Related work. Lab [2] experimentation done on different windows machines shows a major boost in the I/O operations [1] intelligent handling by the operating system and the drivers as mentioned above. Condusiv is doing aggressive research in this area, it is a more than thirty years old software company housed in California. The DRAM technology helps in treating the dynamic RAM available in the systems as an intelligent cache. Those systems which have SSD disk can take more advantage of such caching resulting in a super performance, as the not used RAM is being used intelligently to cache hot data. Later, when RAM is needed for other processes, it is always available for them. Raxco PerfectDisk and O&O Defrag are the two other companies doing a lot of research in this field of file system optimizations, but the speed gains provided by Diskeeper exceeds them easily.

Conclusion and Future work.In order to constantly maintain a fast and responsive machine, it is necessary that I/O operations needs to be streamlined along with optimized loading of drivers and services at Boot time to ensure minimum time wastage during the system boot. Same goes with the shutdown of Windows whose time also should be minimum. In this context, we can say without a shadow of the doubt that this hibernation file usage along with I/O reduction from performance software application from Condusiv Technologies known as “Diskeeper” [3] is indeed very helpful and can give an end user as well as an IT professional a much better solution for speeding up their machines without spending extra money on the hardware.
Although this hibernation file process and the performance application gives very good results, but still there is a need for improvement as the size of Operating Systems is increasing with an increased number of services and drivers being loaded at boot up. Thus, it is necessary to implement a caching technology that works with both soft and cold booting of the systems.

REFERENCES

[1]. *IDC Technology spotlight. Managing the I/O explosion without additional hardware*. Retrieved from http://www.techrepublic.com/resource-library/whitepapers/idc-spotlight-managing-the-o-explosion-without-additional-hardware-using-v-locity

[2]. BURBANK, CA--(Marketwired - November 17, 2015) *Validation Data from ESG Labs* . Retrieved from http//www.marketwired.com/press-release/esg-labs-validates-results-condusivs-v-locity-i-o-reduction-software-reducing-up-50-2074493.htm [Accessed: 15-Sep-2018].

[3]. *V-locity Application Accelerator: Overview | Application Performance in Virtual, Physical, and Cloud Environments*. Retrieved from http://www.condusiv.com/business/v-locity/overview/.

[4]. Zheng, D., Jin, H., Liao, X., & Zhang, Y. (2014, August). Accelerating the Massive VMs Booting Up. In High Performance Computing and Communications, 2014 IEEE 6th Intl Symp on Cyberspace Safety and Security, 2014 IEEE 11th Intl Conf on Embedded Software and Syst (HPCC, CSS, ICESS), 2014 IEEE Intl Conf on (pp. 197-204). IEEE.

[5]. Soundararajan, V., & Anderson, J. M. (2010, June). The impact of management operations on the virtualized datacenter. In ACM SIGARCH Computer Architecture News (Vol. 38, No. 3, pp. 326-337). ACM.

[6]. Azmandian, F., Moffie, M., Alshawabkeh, M., Dy, J., Aslam, J., & Kaeli, D. (2011). Virtual machine monitor-based lightweight intrusion detection. *ACM SIGOPS Operating Systems Review*, *45*(2), 38-53.

[7]. Khan, Y. D., Ahmad, F., & Anwar, M. W. (2012). A neuro-cognitive approach for iris recognition using back propagation. World Applied Sciences Journal, 16(5), 678-685.