Issues in Mobile Virtualization Techniques: A Review

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Abstract: In this modern era the use of mobile devices is increasing tremendously, people are shifting from desktops to smart handheld devices. With improvements in technology much better hardware can be accommodated into much smaller form factor such as a mobile device. Smartphone technology is so successful that the organization and their employees cannot even think of a day without them. Every employee of an organization can remain connected to his/her updates through the smart phones irrespective of their location. Instead of carrying two different mobile devices to keep personal and professional data separate we can have single device with two different operating systems without breaching the security needs. This can be achieved by the advent of virtualization on smart phones. Virtualization on mobile phones can be implemented by different techniques of mobile virtualization. In this paper, different types of virtualization techniques and their comparative study has been discussed.

Keywords: *Virtualization, Smartphone, architectures, Android*

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I. INTRODUCTION:

Smart phones are increasingly ubiquitous, thus the use of mobile devices is increasing day by day. Besides making phone calls, nearly all smart phones today are natively used for tracking and providing location through GPS, accessing local information, clicking pictures, playing music, keeping track of appointments and contacts. There is large number of mobile applications available in the market to be readily downloaded to fulfill the requirements of the user. The ease of downloading new software has increased the risk of downloading malicious applications without user's knowledge. These malicious software's can easily gain access to the personal and sensitive data present on the device. [5]Data leak and data loss are some of the unsolved issues in using smart phones in corporate world. For this reason, employees need to carry two different phones for work and personal use. Application developers also carry a separate mobile device to protect themselves from misbehaving applications corrupt their primary device. [5]Parents even wish they had a separate phone when their children use their mobile phone to make a phone call or accidently buy an app from the app store, handling such situations would be tricky.

The solution to this problem is mobile virtualization. The term virtualization was coined by IBM in the year 1960. Virtualization allows the user to isolate personal and professional data on two different operating systems on a single handset. Virtualization framework in smart phones is very useful as it runs multiple virtual instances without affecting each instance of a virtual phone. Even if one virtual instance stops working the user can switch to another virtual instance on the same device to accomplish computational needs. The benefits of virtualization technology include cost saving, infrastructure management, network efficiency. Due to these enormous benefits of virtualization in computer systems, the virtualization technology is now ready to be implemented on the smart handheld devices such as Smartphone's. Proposing virtualization technology in Smartphone creates two different environments and increases the security of the mobile device This paper investigates different techniques of virtualization.

II. LITERATURE REVIEW:

Following section describe the literature review as:

(Abdul SammadAmad, et.al.)[1] in their paper they explained the mobile virtualization techniques such as Cells architecture, Xen on ARM architecture, KVM on ARM, ViMo architecture. The paper concludes by giving a comparative study on the all four architectures. Their future scope is to explore enhance real time scheduling, compatibility and scalability of all the architectures.

(Md. Tauqir Ansari, et.al. March 2013) [2] in their paper they explained most recently used mobile OS platforms then elaborates on how mobile virtualization is implemented on them. Mobile OS platforms explained are Android, IOS, WebOS, Windows phone, Symbian, Bada. With the comparative study on mobile OS platforms they conclude that mobile virtualization is a new concept and has a great scope in future.

A paper published by(CELLROX,November 2011)[3] introduces Cellrox ThinVisor lightweight Para virtualized solution. Their methodology used is Cellrox ThinVisior system architecture. The study strongly suggested that

Thinvisor is completely functional across different Android devices.

(Shakuntala P. Kulkarni, et.al. 2015)[4]discussed about overcoming security issues using different types of virtualization techniques. Mobile virtualization techniques explained are Cells, ThinVisior, TISSA, and TrustDriod. The basic functionality of all the techniques such as architecture, security and implementation are discussed. Their future scope is to explore these techniques for other functionalities like compatibility, scalability etc.

(Jeremy Andrus, et.al. 2011) [5] proposed prototype of cells that supports a multiple Android virtual phones on the same phone. The research methodology used is cells architecture. They have implemented a cells prototype that runs the latest open-source version of android on the most recent Google phone hardware. Cells architecture is supported for nearly all android devices.

(LeiXu, et.al. 2015) [6] presented mobile based virtualization on ARM processor. Different types of mobile virtualization are explained:OS level virtualization, Para virtualization, Hardware assisted full virtualization, Microkernel virtualization. The paper is concluded by performing a series of performance evaluations on all the four types of virtualization. Their future scope is to research on containers technology.

(SangwonSeo 2015) [7] discussed about virtualizing a system using Xen hypervisor on ARM and to work on its implementation issues. Their research methodology used is Xen architecture. Discusses patch *known* as Xen-On-ARM architecture.

(JunaidShuja, et.al, 2016)[8] describes a survey on software and hardware based mobile virtualization techniques. Type-1 and type-2 hypervisors are explained. They presented comparison of mobile virtualization solutions based on various desirable features.

(Hyun-sukRoh,et.al, 2014) [9] proposes a system based on android-x86 virtual machine. Using proposed schemes we can provide various smart services to light-weight devices. In the future, they will expand their techniques to multiple user virtualization environments.

(David Jaramillo, et.al, 2014) [10] presented a case study of a mobile virtualization solution for BYOD security. Their research methodology used is pilot container solution. Pilot container not only offered users freedom from security constraints but also improved core enterprise application usability.

(Soo-Cheol Oh, et.al, 2011) [11] proposed ViMo that is the virtual machine monitor using the full virtualization for mobile systems based on ARM architecture. Their research methodology used is ViMo architecture..The future scope is to increase the performance of mobile virtualization.

III. COMPARISION ON MOBILE VIRTUALIZATION TECHNIQUES**:-**

Mobile virtualization techniques differ from devices to devices. The mostly frequently used architectures in mobile operating systems for virtualization are Cells architecture, ViMo architecture, Xen on ARM architecture, KVM on ARM architecture, ThinVisior architecture.

Table 1

Performance comparison between Virtualization techniques

Features /Architecture	Cells	ViMo	Xen on ARM	KVM on ARM	ThinVisor	OKL4 Microvisior	Application Containers
Platform	Open source	Open source	Open source	Open source	Open source	Open source	Open source
Mobile Virtualization techniques	Para virtualization	Full virtualization	Para virtualization	Para virtualization	Light weight virtualization	Para virtualization	Light weight virtualization
Performance	Very good	Low	Very high	Poor	Very high	High	High
Compatibility	High	Low	Not specified	Low	High	High	Very high
Scalability	High	Moderate	Not specified	Low	Very high	High	High
Context switching	Moderate	Low	Low	Low	High	Low	High
Power Consumption	Moderate	Low	High	Not specified	Moderate	Moderate	Very high
Graphics support	High	Low	Not specified	Not specified	Very high	Moderate	High
Security	High	High	High	moderate	Very High	High	Moderate
Transparency	High	Low	Not specified	Not specified	Very high	Not specified	High
Runtime overhead	Low	High	Not specified	Low	Low	Low	Moderate
Memory usage	Low	High	Not specified	Not specified	Low	Low	Low

3.1 Cells:-

Cells architecture enables the user to run multiple virtual phones on a single device. It represents a model which has one foreground virtual phone and many background virtual phones. The foreground virtual phone has direct access to the hardware and the background virtual phone has a shared access. For example if the Wi-Fi connectivity is requested by the foreground virtual phone then the background virtual phones need not have to request for the same. Each virtual phone is isolated from each other to maintain security.

Cells is a light weight virtualization architecture which operates on all the open source platforms. It uses Para virtualization technique which gives good performance in terms of usage. This architecture allows the user to run multiple virtual phones on a single device with minimal disruption. It has high compatibility and scalability. It supports moderate context switching. Power consumption is moderate. Cells has high graphics support with low minimum runtime overhead. In cells architecture virtual phones run in an isolated manner without interfering with each other's functionality. This provides maximum security to the end user.

3.2 ViMo:-

ViMo stands for Virtualization for Mobile. It uses full virtualization technique. There are two modes of operation, one is the user mode in which the applications are present and other is the supervisor mode in which the guest OS is

present. A scheduler is used to periodically switch from different virtual instances. In ViMo, the tasks can be performed in two different modes like secure mode and normal mode. The tasks executing in secure mode can access all the resources while the task executing in normal mode has limited access to hardware resources.
ViMo provides minimal performance and compatibility. It has low context switching and power consumption. ViMo runs on all the open source platforms. In ViMo, tasks executing in secure mode can access all the resources while the task executing in normal mode has limited access to hardware resources. This increases the runtime overhead but provides maximum security.

3.3 Xen on ARM:-
Xen on ARM is a Para virtualization technique used by ARM based mobile devices. Whenever the guest OS generates a request for any of the hardware resource a virtual interrupt is generated and queued in the channel it is then sent to the destination. It has two modes of operation, supervisor mode and user mode.
Xen on ARM is a Para virtualization technique which runs on open source platforms. It has very high performance and low context switching. This architecture provides maximum security to the mobile device.

3.4 KVM on ARM:-
In KVM-on-ARM based approach, the Linux kernel is directly implemented on the hardware of the device. The hypervisor is implemented as the kernel module which interacts with the hardware through the Linux kernel interface. Multiple guest operating systems are operated on the top of the host kernel as separate processes.
KVM-on-ARM is a Para virtualization technique which runs on open source platforms. It has poor performance and low context switching. It results to a moderate performance and low context switching.

3.5 ThinVisor:-
ThinVisor is a mobile virtualization technique developed by Cellrox. ThinVisor makes it possible to run multiple virtual instances on a single device with each instance known as a "persona". The key benefit of using ThinVisor for mobile virtualization is that it allows the user to transfer the personas created on one mobile device to the other.
[4]

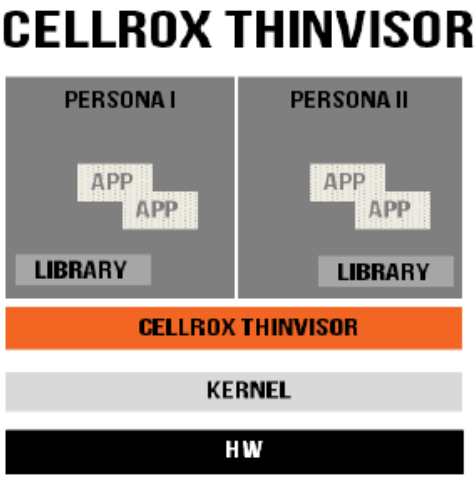

Fig 1:Architecture of Cellrox ThinVisor

ThinVisor ,is a light weight virtualization technique which runs on open source platforms. Using Linux kernel namespaces increases performance, transparency and security. ThinVisor delivers excellent compatibility and scalability. It even provides very high security and graphics support.

3.6 OKL4 Microvisor:-
The OKL4 microvisor enables user to run multiple guest operating systems on a single mobile device. This microvisor uses secure Hyper Call technology to virtualize a mobile device.
OKL4Microvisor is a Para virtualization technique which runs on all open source platforms. It provides high performance, compatibility and scalability. Graphics support is moderate and security is high due to the crisp isolation between different guest operating. It has minimum runtime overhead and memory usage.

3.5 Application Containers:-
Application containers give the way to use a mobile device for both personal and professional life. The container based solution provides secure and encrypted transmission of data. It limits the number of applications that can run on within the container. The organizations who have developed their own application containers are: Good Dynamics Technology, Divide by Enterpriod, TrustDriod. The example of Divide by Enterpriod application container is given below:
[12]Fig 1.1
Divide personal/enterprise screen shots

Application containers are a Para virtualization technique which runs on all open source platforms. It has very high compatibility and scalability. It provides moderate security and high transparency.

IV. CONCLUSION:

In this paper, we compared six mobile virtualization techniques: Cells, ViMo, Xen on ARM, KVM on ARM, ThinVisor, OKL4 Microvisor and Application Containers. The features of all the techniques such as platform, Mobile virtualization technique, performance, scalability, compatibility, security, scalability, context switching, graphics support, transparency, runtime overhead, and memory usage are discussed. From the above comparison we conclude that Cells and ThinVisor are the most powerful techniques for virtualization with prominent features.

REFERENCES:

[1] Abdul SammadAmad, SanamShahla Rizvi and Mohammad Daud Awan ," ."An Analysis on Virtualization Techniques in Smart Phones", Preston Univeristy, Islamabad, Academic.edu

[2] Md. Tauqir Ansari, Naveen Garg, Vikas Deep." "Mobile Virtualization: A Futuristic Approach", International Journal of Latest Trends in Engineering and Technology (IJLTET), March 2013,

[3] White Paper, The ThinVisor Mobile Device Virtualization Architecture, CELLROX, November 2011.

[4] Shakuntala P. Kulkarni, Prof Sachin Bojewar "Survey on smart phone virtualization techniques " International Research Journal of Engineering and Technology , Volume: 02 Issue: 04 | July-2015.

[5] Jeremy Andrus,Christofer dall, Alexander Van't Hof, Oren Laadan and Jason Neih "Cells: A virtual mobile smartphone architecture", Department of Computer Science,Columbia University October 2011.

[6] Lei Xu, Zonghui Wang, and Wenzhi Chen "The Study and Evaluation of ARM-Based Mobile Virtualization" Hindawi Publishing Corporation, International Journal of Distributed Sensor Networks, Volume 2015, Article ID 310308, 10 pages, http://dx.doi.org/10.1155/2015/310308, 2015

[7] Sangwon Seo "Research on System Virtualization using Xen Hypervisor for ARM based secure mobile phones", Seminar "'Security in Telecommunications"' , Berlin University of Technology, Korea Advanced Institute of Science and Technology WS2009/2010 (Version on January 14, 2010)

[8] JUNAID SHUJA, University of Malaya, Malaysia, ABDULLAH GANI, University of Malaya, Malaysia, KASHIF BILAL, COMSATS Institute of Information Technology, Pakistan, ATTA UR REHMAN KHAN, King Saud University, Saudi Arabia, SAJJAD A. MADANI, COMSATS Institute of Information Technology, Pakistan, SAMEE U. KHAN, North Dakota State University, USA, ALBERT Y. ZOMAYA, University of Sydney, Australia, "A Survey of Mobile Device Virtualization: Taxonomy and State-of-the-Art", ACM Computing Surveys, Vol. 0, No. 0, Article 0, Publication date: January 2016

[9] Hyun-suk Roh, Hyun-woo Lee, Sang-ho Lee "A Study on Mobile Virtualization",ISBN ICACT 2014 978-89-968650-3-2 , ICACT 2014

[10] David JaramilloMichael Ackerbauer "A user study on mobile virtualization to measure personal freedom vs.enterprise security", IEEE 2014

[11] Cheol Oh, KangHo Kim, KwangWon Koh, and Chang-Won Ahn, "ViMo (Virtualization for Mobile) : A Virtual Machine Monitor Supporting Full Virtualization For ARM Mobile Systems" IARIA, 2010, ISBN: 978-1-61208-106-9.

[12] Divide, Inc google, http://www.divide.com/