Systematic Overview of Mobile Virtualization Platforms: Comparative Analysis

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***Abstract* — Desktop virtualization has been enabled by VMware, consequently, the manufacturers are expected to soon adopt the virtualization technology within mobile devices. The traditional smartphones no longer apply to secure virtualization on the mobile devices. With ever-increasing demands of smartphones for work as well as personal usage, smartphones are no longer seen as stand-alone devices. Mobile virtualization is expected to provide a new direction to mobile technology that enables hardware to run with less memory, reduced cost, increased energy efficiency and better flexibility. This paper provides an analysis of virtualization technology with respect to its application within the mobile devices, followed by its offerings and benefits. Further, this paper presents a detailed comparison among the most popular mobile operating systems, including Android, iOS, Windows and Symbian.**

***Keywords*— Mobile Virtualization, VMware, Operating System (O.S.), Android, iOS, Windows, Symbian.**

I. INTRODUCTION

Now-a-days mobile devices have become a big part of our life as they provide various services and applications over a network as well as on handheld devices. In today's era this is very common that most of the time we download an application for smart phones and encounter that the hardware requirements is fulfilled or not. It is reality that smart phones come with already pre-installed OS. So inspiration of buying a new mobile phone is figured out by someone usage patterns and their suggestions. Thus we can conclude that our decision for buying it will depend on the application environment that will fulfill and complete our requirements. As a result, with the continuous development in the technologies devices will soon become outdated time to time [1].

The new version of the same operating system will not be able to adopt the backup of our previous mobile phone. This issue is managed by the mobile virtualization now-a-days comfortably .This technique will give a way to developer in the direction to upgrade and enhance the already developed task using the existing tools. Its advantages includes the long life of applications with the security construct and let the hypervisor to bind hardware and software constructs such that multiple operating systems will work on a single core processor. Mobile industries are now using the technique of virtualization on a large scale. Main motive of mobile virtualization technology are decrement in the cost, reliable to provide security measures, usability and also experiences to the end users. Virtualization provides more efficient use of the hardware so that it decrements the porting charges and gathering newer and licensed designs in substitution to the IP security in isolation and consistency [5]. Mobile virtualization makes it possible to host two or more operating system on a single processor and at the same time considering all the security measures and the limitations that are directed at the safeguarding the network and also isolating the IP of the open source O.S. such as Google Android [1].

The rest of this paper has been structured as follows: Section II focuses on literature review followed by Section III which provides an analysis of mobile virtualization. Further, Section IV enlists the benefits of mobile virtualization followed by Section V, which outlines the memory management and address translation stages in mobile virtualization and Section VI discusses the hardware support required for virtualization. Section VII provides detailed comparison among most popular mobile operating systems, ending up with Section VIII which concludes the paper.

II. LITERATURE REVIEW

Jorg Brakensiek et al. [10] analyzes and investigates the virtualization technology with respect to its potential within the mobile devices. Further, the author focuses on the security issues being faced by the mobile devices and discusses the usefulness of virtualization for securing the mobile devices.

Ken Barr et al. [6] explores the potential of leveraging virtualization within mobile devices in order to address mobile security, manageability, application development, compliance and deployment challenges that are plaguing the present-day enterprise. The author discusses the use case behind VMware's Mobile Virtualization Platform (MVP) and briefly discusses the hypervisor's design and implementation. Further, the author presents an architecture for mobile virtualization and describes key aspects of core and platform virtualization with respect to the mobile devices.

III. ANALYSIS OF MOBILE VIRTUALIZATION

The latest virtualization in the market these days directs to the mobile phones. It is similar to that of server virtualization but the difference is in the way of hosting two operating systems on a single handset. With the increase in the number of operating systems the issue of less memory space arises so we require a very thin layer of hypervisor in the middle of the OS and the hardware because it acquires less memory. Thus, the basic idea of virtualization will remain similar. Different vendors use different virtualization technologies and simultaneously test them. Benefits of mobile virtualization technology are decrement in the cost, reliable to provide security measures, usability and also experiences to the end users [4].

The idea of virtualization of mobile is for everyone, from the developer of mobile phone, the application developer up to the end users. The most essential part of the virtualization technique is to provide security overall. The phone user can use both virtual machine that is one for private persona communications, gaming, photos, songs etc and second one can be used at enterprise persona,. The advantage of this technique is that we have virtual machine protected environment without any concern of the personal virtual machine. Any malware or destruction in the mobile will not affect the hardware associated to it but only affects the private virtual machine [3] [4] [9].

Mobile virtualization will provide profiles at both enterprise and personal end. So it will help people not to hold multiple phones together to have many profiles. This would directly decrements the cost of mobile phones at higher times. Based on the requirements, the user may connect to one of the profiles by simply logging onto it. Mostly the manufacturers will use circuit boards and the processor chips for these functionalities. With the increase in the requirement of mobile virtualization and also the hypervisor, a different core chip must be introduced for all the operations which can be further broken into individual virtual machines. So the cost of buying new devices will automatically be reduced [3] [7].

IV. BENEFITS OF MOBILE VIRTUALIZATION

Some of the benefits offered by Mobile Virtualization are as follows [8] [9]:

- Whole processing environment is migrated live in any case of errors, bugs, mistakes; this will make mobile virtualization more reliable and robust.
- It will consider all the secure and safe issues faced during the designing phase.
- Cost of convenience will be reduced for several licensed software.
- Tremendously fast relocation of all features and functionalities, hence reducing the overall overhead.
- It increases the energy efficiency by reducing its BOM (Bill of Materials) cost.
- It maintains integrity for the enterprise by hosting two or more operating systems.
- It is possible to run non-native applications on any of the operating systems.

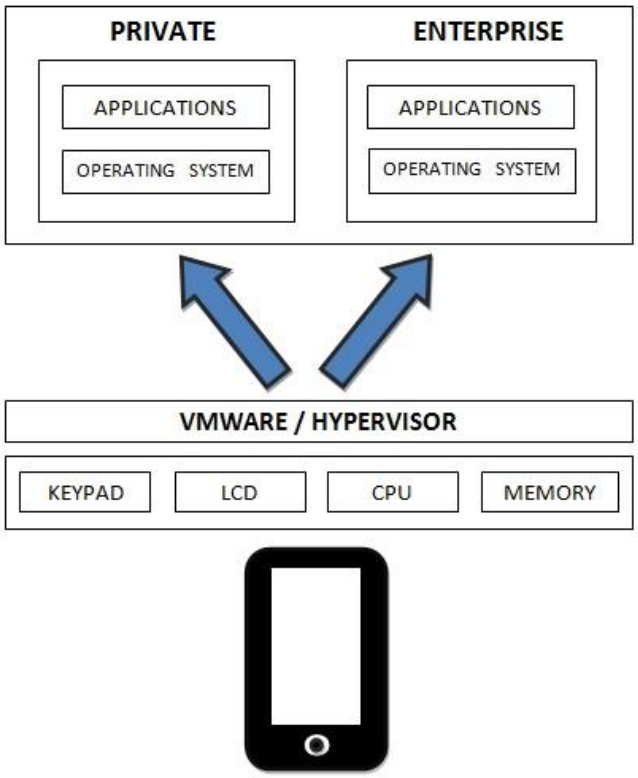

Fig. 1. Mobile Virtualization

V. MEMORY MANAGEMENT AND ADDRESS TRANSLATION STAGES IN VIRTUALIZATION

In a virtualized environment, the management of memory is an essential aspect. This will affect the complexity of the system. The main role of Operating System is to manage the virtual memory by dividing the physical memory. The guest O.S. operates in virtual memory developed by virtual machine, rather than in physical memory. So, virtual memory acts as physical memory and its distribution is controlled by VMM [9].

The first address translation stage in the virtualized systems is from intermediate physical address (IPA) to physical address (PA) and second stage is from virtual address (VA) to intermediate physical address (IPA). In the present hardware system, only one address translation is provided. When CPU includes MMU, it is required to maintain relationships with

intermediate physical address, virtual address and physical address. Hypervisor handles personal translation tables, also known as shadow tables that reflect the changes in the guest operating system. Thus, protection must be provided at all appropriate stages. The method involved being too complicated; the better alternative is to use hardware assistance in the translation stages [9].

VI. HARDWARE SUPPORT FOR VIRTUALIZATION

Modern computer architectures provide multiple operational modes, each mode having a totally distinct level of privilege with respect to the hardware resources of the system, its configurability and special instructions execution. The ARM architecture of virtualization differentiates between the User mode and the Supervisor mode13. The architecture of the x86 offers rings from the higher-privilege mode (RING-0) to the lowest one (RING-3). Operating Systems are usually designed to execute on the native hardware. The O.S. expects to run in the highest privileged mode or the Supervisor mode (RING-0) and it also has the proper control over the system. In virtualization, the VMM executes in the privileged mode, and the O.S. at a lower privilege level.

During the booting process, the O.S. configures the processor, the input/output devices and the peripherals. During execution, access to all such devices is required, which includes changing the peripherals' configuration, managing the interrupt controller, changing the MMU Page Table Entries, and initiating the DMA transfers. A major issue in the de-privileged mode is that the Guest O.S. is not able to run the privileged instructions required for driving the hardware. Also, the VMM hosts multiple Guest O.S., so direct changes of shared devices and memory need cautious approach.

VII. COMPARISON AMONG MOBILE OPERATING SYSTEMS

TABLE I. COMPARISON AMONG MOST POPULAR OPERATING SYSTEMS

PARAMETER	**ANDROID**	**iOS**	**WINDOWS**	**SYMBIAN**
O.S. FAMILY [9]	LINUX, UNIX LIKE	DARWIN UNIX BASED	WINDOWS CE/WINDOWS NT 8+	MOBILE OS, EMBEDDED OS
SUPPORTED CPU ARCHITECTURE [11]	ARM, MIPS, POWER ARCHITECTURE X86	ARM	ARM	ARM
SUPPORTED LANGUAGES [9]	JAVA (WITH EXTENSIBLE C/C++ LIBRARIES)	OBJECTIVE C	MULTIPLE	C++
PROGRAMMED IN [9]	C, C++, JAVA	C, C++, OBJECTIVE C	PROPRIETERY	PYTHON, JAVA MT, WEB RUNTIME
MULTITASKING	YES	VERY POOR	IN WINDOWS 8	LIMITED
PROCESSOR	MONOLITHIC LINUX (1.6 GHZ DUAL CORE)	INTEL ATOM Z550, 1.3 GHZ DUALCORE	1.4GHZ	ARM FAMILY, X086 FAMILY
RAM	1GB	1080MHZ	1GB	16KB , 32KB
CLOCK SPEED	1.4GHZ	250MHZ	800MHZ	680MHZ
STORAGE	8, 16, 32 GB	16, 32, 64GB	8, 16, 32 GB	4, 8GB
KERNEL TYPE	ARM IT CORE	HYBRID	MONOLITHIC	REAL TIME MICRO KERNEL, EKA2
FREQUENCY	620GHZ	2GHZ	UPTO 24 KHZ	2.4GHZ

INSTRUCTION SET	ARMV6	X86	X86	ARM
OPEN SOURCE	YES	NO	MORE OPEN SOURCE THAN iOS	SYMBIAN v2 IS OPEN SOURCE

VIII. CONCLUSION

Virtualization in the mobile environment is a new concept and has a great scope in the near future. It has the potential to secure our professional and personal data. Also, it reduces complexity and increases flexibility. There are several domain areas where further research work can be carried out to advance the application of mobile virtualization. Therefore, for the mobile platforms, new and innovative safety policies and device proprietorship policies can be proposed. Great campaigning needs to be advocated as few people possess sufficient knowledge of this technology. Thus, we conclude that with the advent and development of virtualization technology in the mobile domain, soon the day would arrive when we would be having access to multiple operating systems on our finger tips.

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