Mobile Virtualization: A Futuristic Approach

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Abstract - At present smartphones clam computing skills as of mainframe computers and workstations. Mobile CPU functions at mega to giga hertz with 32 bit processor get into GBs of memory. With 3G, 4G and 5G technology, mobiles stream data at the speed of broadband.

With coming of desktop virtualization by VMware that day is not far when smartphone manufacturer will adopt this technology on their mobile devices giving support to mobile virtualization. As a result, mobile virtualization will motivate machine OEMs, mobile network operators (MNOs), and semiconductor suppliers enhanced security, portability, reliability, license IP isolation, and hardware consolidation.

With increase in demand at personal as well as enterprise level, smartphones are no longer stand alone device. The concept of mobile virtualization will give new dimensions to mobile technology and also conflict with handset OEMs for better integrated functionality, cost efficient and flexibility.

In this paper we propose a design of mobile virtualization and its benefits. We also compare various mobile platforms and their technical specifications.

I. INTRODUCTION

In today's scenario it is very common that we download an application for our mobile phone and find that it is compatible against installed OS or hardware requirements are not complete. It is very common that smartphones come with pre-installed OS and each of them is not compatible with each other. So buying new smartphones is generally inspired by seeing them being used by our friends or sometime even recommended by someone. Thus we can say that our decision making depend upon the application environment that meets our needs. As a result in a greater confusion among the end users, that with faster technical development our device becomes outdated. Also backup of our device may not work on the updated version of the same OS. This issue is easily tackled by mobile virtualization.

Mobile phone virtualization provides the developers a stage in addition to powerful tools to meet various development tasks. It outspread application long life, construct security and let machine OEMs merge hardware and software by allowing multiple OSs to operate on a single core processor.

Mobile industry has recently begun to take advantage of mobile virtualization. Chief motives of this technology are cost decrement, security, usefulness and end-user experience. We have gone for Xen (popular open source hypervisor) and ARM architecture for embedded system virtualization. With advanced technology mobile virtualization can easily work on single or multi core processor.

Virtualization assures more extra efficient use of the hardware to decrease software porting charges by assembling newer and authorized designs in supplement to IP isolation and increasing security, welfare and consistency. These aids lets implicit assurance that virtualization will be playing great character for many OEMs and semiconductor suppliers for end user products.

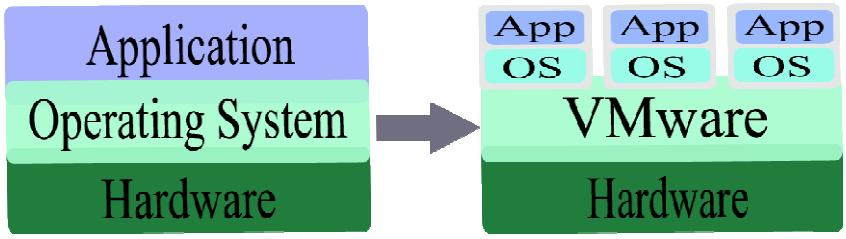
II. RISE OF VIRTUALIZATION

In past years there has been tremendous growth in virtual technology from a suitable technology to that of being popularly used to run servers and data centres with added efficiency than previously. Many programs normally

perform at 20 to 40 percent of their full capacity on their servers. Generally servers stay dull with least utilization. With demand we may require buffers when the traffic on the servers is high. As there are multiple servers are installed in a data centre, their regular demand is low except at peak traffic. So in such cases cooling and power demand is high as compared. So, we need a system where such challenges can be met. IBM came with virtualization concept were these problems could be solved at certain extent. It is in last few years people has begun using virtualization on normal servers as well.

The essential component of virtualization is a section of software named as 'hypervisor'. It operates above the device's hardware as a thin layer or module between hardware and OS. The use of hypervisor is its capability to help many Oss operating in parallel peak of hypervisor. Every OS act as different device and can use hardware of base machine via hypervisor. Every single OS is named as a virtual machine. Virtualization helps in operating multiple virtual machines on a single set of hardware. The tools of the base device is utilised between virtual devices by hypervisor. The resource utilization may vary among VMs dynamically as per need to allow virtual machines gaining access to the available resources in extreme data load condition. The priority of VMs can be altered as per utilization without shutting down the base machine.

1.1. Traditional Architecture and Virtual Architecture



Traditional Architecture Virtual Architecture

Traditional architecture – before virtualization
• One OS in one machine
• Hardware and software are strongly moulded together
• Multi-programming on single device, sometime conflict arises
• Resources are underutilized
• Note flexible and increases infrastructure cost

Virtual architecture - after virtualization
• Hardware is not dependent of OSs and applications
• Virtual machines can be installed on any embedded device
• May handle OS and application as one by encapsulating them into virtual machines

III. MOBILE VIRTUALIZATION

Latest type of virtualization in IT industry is new occurrence mobile virtualization. It resembles to server virtualization, but in this case we are operating multiple OSs above Hypervisor (small software). Since there are loads of drawbacks in mobile platform like available memory is much lesser, we need thin layered hypervisor between OS and hardware which will require less memory. Thus, the base idea of virtualization remain exact but in terms of mobile technology. For example, the virtual machine may be a mobile OS for complicated chores and applications operating simultaneously with a real-time operating system (RTOS) which pays attention to the usual phone errands. Distinct types of virtualization techniques are being carried out and tested by different vendors. The advantage of this virtualization is that the developer does not need to develop separate applications for each platform or operating system since the hypervisor takes care of all interactions with the base operating system and hardware. Another advantage is that this can run on basic feature phones and provide advanced applications to users which are normally provided by smartphones.

The concept of mobile virtualization is for everyone, i.e. from phone producer, app creator to the end users. The most important field virtualization is to provide security. The phone handler can have - one safe virtual machine for corporate interaction and second for personal purposes like communication, ringtone, games, songs, pictures, etc. The benefit of such setting is for a safe VM which is secured from any concern arising because of personal

VM. Any damage due to malwares and crashes can only harm the personal VM without affecting the secure one intact with the hardware.

Mobile virtualization gives the user to get many profiles like of corporate and personal one. So those people who carry multiple phones can get their choice of platform for different profiles. Thus cost of mobile purchasing will reduce to multiple times. Depending on the needs the users can switch from one from profile to another either by logging in or other mechanism. Most mobile phone producers use their own microprocessor chips and other circuit board for different functionalities. With the enactment of smartphone virtualization and the hypervisor, a distinct core chip can be provided for all operations which can be divided into separate VMs. Thus cost of purchasing new devices decreases.

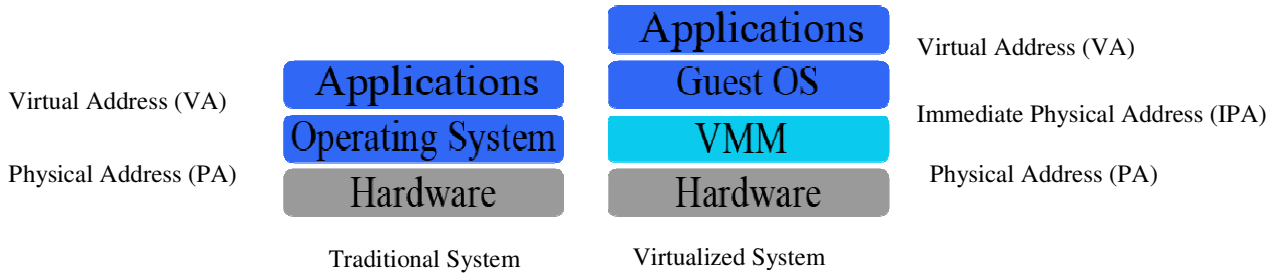
Mobile virtualization will also translate in shorter period of time to market for OS developers. It is because for each traditional smartphones, different chips and new OS model is implemented on the specific hardware. With mobile virtualization this overhead is reduced as hypervisor will take care of differences between hardware for each new model.

IV. MEMORY MANAGEMENT CHALLENGES IN VIRTUALIZED SYSTEMS

Memory management is a crucial aspect in a virtualized system. It may guide to substantial complexity. The principal function of OS is to provide a stage of virtual memory management to splitting the physical memory handled by the operating system along multiple operations. The memory being assigned to the Guest OS is not a true physical memory of the system rather a virtual memory created by the virtual machine inside which a Guest OS is operating. So, in reality the virtual memory is nothing but an immediate physical memory. Thus VMM honestly handles the distribution of the physical memory, thus fulfilling a role of arbiter of the shared physical resources.

V. ADDRESS TRANSLATION STAGES IN TRADITIONAL AND VIRTUALIZED SYSTEMS

The approaches to hale the address translation are – one from virtual address to intermediate physical address (VA to IPA) and two from intermediate physical address intermediate physical address (IPA to PA). At present only one memory address space translation is provided in current systems hardware. For example, using the MMU in the CPU, the hypervisor need to manage the relationship between VA, IPA and PA directly. It is usually done by hypervisor, maintaining its own translation tables (called shadow translation tables), which is done by interpreting each Guest OS translation tables. All changes in Guest OS are reflected in the shadow structure, which is ensured by hypervisor. Thus enforcing protection and redirecting access faults to the appropriate stage. The mechanism required for this will be complex and add performance overhead. The use of hardware assistance to both stages of translation is a better alternative, and is enabled by ARM SMMU.



VI. MOBILE PLATFORMS

6.1 Android from Google Inc. (free and open source)

Android was introduced by a small start up company - Android Inc. It was procured by Google Inc. in 2005 and since then Google is continuously updating the software. Android is Linux based OS supported by Google and many important software and hardware developers like Samsung, Motorola, Intel, HTC, ARM and etc altogether 86 companies. It was later named as the Open Handset Alliance. Android gain its peak popularity in 2010 when it world's top smartphone platform. The gaining of peak is due to its multi-network and multi-service operating system.

6.2 iOS from Apple Inc. (closed source, proprietary, on top of open source Darwin core OS)

The Apple iPhone, iPod Touch, iPad and second-generation Apple TV all use an operating system called iOS, which is derived from Mac OS X. Native third party applications were not officially supported until the release of iOS 2.0 on July 11th 2008. Before this, "jailbreaking" allowed third party applications to be installed, and this

method is still available. Jailbreaking allows the installation of different OSs like Linux kernel and Android. Currently all iOS devices are developed by Apple and manufactured by Foxconn or another of Apple's partners.

6.3 Windows Phone from Microsoft (closed source, proprietary)

Microsoft launched its own mobile OS, Windows Phone in 15th February 2010. This new OS includes newer generation of user interface inspired by Microsoft's "Metro Design Language". It has complete consolidation of Microsoft services like Xbox, Xbox Live games etc. It is also integrated with many other services like Facebook and Google accounts, which non-Microsoft services. It has gained huge response from the users till now.

6.4 Symbian OS from Nokia and Accenture (open public license)

Symbian holds the largest smartphone share in most of the mobile markets. It is used by many manufacturers like Nokia, Samsung, LG and etc. At present Symbian devices are manufactured by Nokia, Sony Ericsson, Fujitsu, etc. At present Symbian is facing challenges from Android, Windows Phone and Apple devices, etc. Thus its worldwide market share has reduced from 50% to 40% only. Nokia handed the development of Symbian to Accenture, which will continue to support the OS until 2016.

6.5 Linux based operating system (open source, GPL)

Motorola using Linux has strongest market hold in China and in Japan DoCoMo is in huge demand. Rather than being an OS in its own right, Linux is used as a basis for a number of different operating systems developed by several vendors, including Android, GridOS, Boot to Gecko, LiMo, Maemo, MeeGo, Openmoko and Qt Extended, which are mostly incompatible. PalmSource (now Access) is moving towards an interface running on Linux. Another software platform based on Linux is being developed by Motorola, NEC, NTT DoCoMo, Panasonic, Samsung and Vodafone.

The other OS in mobile platforms are Bada from Samsung Electronics, BlackBerry OS from BlackBerry, GridOS from Fusion Garage, LiMo 4 from LiMo Foundation, MeeGo from The Linux Foundation, Brew from Qualcomm, webOS from HP Inc, etc.

Some upcoming mobile OS platforms are Aliyun OS from Alibaba/AliCloud, Firefox OS from Mozilla Foundation, Tizen from The Linux Foundation, etc.

Table 1 : Comparison of different mobile OS platforms (based on latest device available in market)

Platform	iOS	Android	webOS	Windows Phones	Symbian	Bada
OS Family	Darwin, Unix based	Linux, Unix like	Linux	Windows CE 7/ Windows NT 8+	Mobile OS/ Embedded OS	FreeBSD, NetBSD and OpenBSD
Supported CPU Architecture	ARM	ARM, MIPS, Power Architecture, x86	ARM Cortex A8+ PowerVR SGX	ARM	ARM	ARM
Programmed in	C, C++, Objective C	C, C++, Java	C/C++	Proprietary	Python, Java ME, Flash Lite, Ruby, .NET, Web Runtime(WRT)	C++
Multitasking	Very poorly, Apple – approved functionality only. OS 4+	Yes	Yes	In windows 8+	Limited, pre-emptive	Yes
Processor	1.3 GHz Dual Core Apple – designed ARM v7s Apple A6	1.6 GHz Dual Core, Quade Core		1.4 GHz	ARM family, Intel's XScale, X086 family	1.4 GHz
RAM	1GB	1 GB	512 MB	1GB	-	512 MB

Clock speed	250 MHz	1.4 GHz	600 MHz	800 MHz	-	-
Storage	16, 32, or 64 GB	8GB, 16 GB, 32 GB	8, 16 GB	8GB, 16 GB, 32GB	-	-
Battery consumption	Audio : 40h Video : 10h Talk over 3G : 8h Standby : 225h	Talk time : 22h Stand by : 830h	-	-	-	-
ROM	-	512 MB, 1 GB	-	-	ROM v1.0, ROM v1.1	-
Kernel Type	Hybrid (XNU)	Monolithic (modified Linux kernel)	Monolithic (Linux)	Monolithic (Windows CE) (Windows Phone 7) Hybrid (Windows NT) (Windows Phone 8)	Real Time Microkernel, EKA2	RTOS or Linux kernel

Table 2 : Comparison of different mobile processors

Processor	Intel Atom Z550	ARM 11 core	Qualcomm MSM7201A RISC Chipset	Texas Instruments OMAP 2430 RISC Chipset	Nvidia Tegra APX 2500
Frequency	2.00 GHz	620 MHz	528 MHz	450 MHz	750 MHz
Cache	512K	16K	-	32K(data)/ 32K (instruction)	-
Power	2.4W	0.45mW/MHz	-	-	2.5-4W
Instruction Set	X86	ARMv6	ARMv6	ARMv6	ARMv6
CPU Core	LPIA SoC codename Lincroft	ARM11	ARM1136EJ-S	ARM1136	ARM11MP

VII. BENEFITS OF MOBILE VIRTUALIZATION

1. Live migration of complete processing ecosystem in case of mistakes or errors, makes mobile virtualization more robust and reliable system solution.
2. It will proficiently address the hardest safe, legal or secure design issues.
3. Convenience cost will be decreased for large number of legacy software.
4. Fast relocation of features and functionality.
5. Helps in increasing energy efficiency by reducing lesser BOM costs.
6. Possible to host two (or more) Operating Systems on the same handset, simultaneously addressing the security restrictions and limitations aimed at safeguarding the integrity of the corporate network.
7. Feasible to support all necessary non-native operating environments on the handset of choice, and run non-native applications on any Operating System.
8. In addition, network operators, handset OEMs and semiconductor suppliers will be able to deploy a single software stack across multiple hardware platforms, and software programmers will not have to port applications for each operating system or platform.

VIII. CONCLUSION

With deep study and analysis on current virtualization techniques and different mobile platforms available at present we conclude that mobile virtualization is a new concept and has a great scope in future. With coming of mobile virtualization there will be an increase demand of devices supporting this technology. Mobile virtualization will provide flexibility and security to our personal as well professional data. Mobile virtualization will help the users to have multiple profiles, like one for personal and professional purposes. It will help those users who usually carry multiple phones with them to their office, meetings etc. It reduces the cost and complexity. Virtualization increases energy efficiency by reducing lesser BOM costs.

We can easily move our data from one platform to another as data translation is done by hypervisor. Entire execution environment live migration helps in case of failures or faults, making the device more robust and gives a reliable system solution. For mobile virtualization and hypervisor software, a single core chip can be designed for different functions which are split into several virtual machines.

We have discussed the vital importance of mobile virtualization. But we must not forget that the platform we are discussing here is very small and finite. Swapping from the VM to OS can be complex and burdensome. A single OS occupies many resources and memory space. When there will be multiple OSs on a single machine, it may lead to bad operation of virtualized applications. Battery related issue is pitiable when it come mobiles and tablets. This reduces mobile proficiency. As we have discussed that virtualization provides security. So, for mobile platform new safety policies and device proprietorship policies must be proposed. Great campaigning should be done as only handful of people has sufficient knowledge of virtualization.

Thus we can say that the rapid growth in mobile technology, that day is nearby when we will have multiple OSs on our finger tips. It can only be implemented by mobile virtualization.

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