

More Mobile than Mobile

Will Dietz, Kevin Larson, Shivaram Venkataraman
University of Illinois at Urbana Champaign

1 Introduction

Mobile devices today run many third party applications to perform complex tasks like web browsing, banking and gaming. Recent studies have found that smartphones are the target of an increasing number of malware attacks [12], [3], [4] and their security is important as personal data such as contacts, credit card numbers and passwords are often stored on the device. While some security models [2] provide a stronger process level isolation among applications, operating system bugs such as [8], [6], [7] allow malicious applications to take over the device. We believe that virtualization can be useful for secure isolation of third party code from confidential data and provide a greater defence-in-depth against attacks on the system.

In recent years, virtual machines have become prevalent in cluster computing environments [1] as they lower power costs and help in conserving data center space. Hardware improvements have meant that smart phone configurations found today resemble desktop machines from few years ago and many of them run commodity operating systems. There is a growing interest in academia [14] and industry [5] about the benefits of virtualization on these devices. We believe that virtualization can provide better security guarantees in mobile devices and enable useful applications like environment migration.

Environment migration has been studied earlier, in the context of servers in a cluster [13] and enables administrators of clusters to perform maintenance tasks without interruption. On the other hand, migrating a system to a mobile device can take advantage of network or computation facilities that are closer to the user's location and provide the user with a consistent experience irrespective of the network connectivity. Migration techniques also help maintain consistent snapshots which allow easy transfer of data when users switch mobile phones and to roll-back the system to a previously known state.

NOTE: Need to mention OK-L4 and ARM Trustzone

1.1 Existing Work

Currently, there are many solutions available for virtualization on desktop environments. VMware is a popular closed source solution which implements a variety of virtualization techniques and is used in both industry and academia. KVM [15], QEMU [11], and XEN [10] are all open source solutions, implementing their own assortments of virtualization techniques. These solutions for the most part do not work well in a mobile environment for performance, security, and usability reasons.

Recently there has been a surge of research done for mobile virtualization. One such solution is MobiVMM [17], which prioritizes performance and security at the cost of usability and portability. Work has been done to port KVM to Android [9], focusing on performance and functionality. All of these solutions either dual-boot the OS or require disabling the phone's existing runtime stack to use them.

VMware's MVP project [16] is most similar to ours. They introduce a very thin hypervisor with an emphasis on usability, performance, and security—without sacrificing the phone's functionality. However their implementation does not integrate with the host OS, but rather replaces and contains it. This is useful, but tangential to our work. As described in Section 1.2, we aim to provide a Type II VM and prioritize live migration capabilities as well as usability. Furthermore, we are mostly concerned about containing applications for isolation, security, usability, and portability. Instead of virtualization the existing OS to protect others from it, we assume it is trusted and only have to isolate new applications. This provides for a very different architecture in our implementation.

NOTE: Add some discussion about power usage, memory constraints ?

1.2 Our solution

We intend to improve upon the existing mobile virtualization solutions through superior usability. By integrating with the host OS and building upon the existing user experience and bring added value to existing devices. A pri-

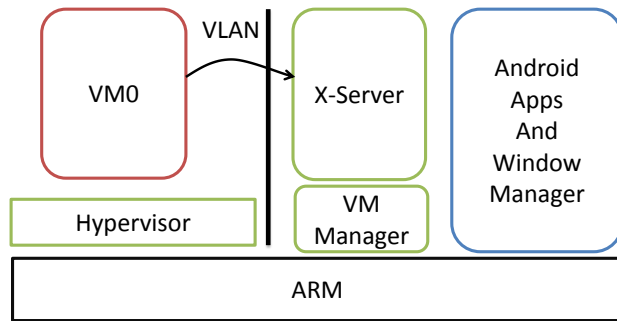


Figure 1: Architecture diagram

mary goal of ours is compatibility with existing x86 and x11 applications such that upon our project completion we can immediately take advantage of the vast quantity of applications that already use these. We also provide emulation which appears to the user to be at the application level, making it simpler conceptually to work with. Our biggest contribution is the way we bring live migration into this. This is the most novel part of our program.

2 Timeline

2.1 Feb 17 - March 17

- Explore architecture details of ARM and finalize design details for the hypervisor.
- Build a thin x86 hypervisor on ARM using the mobile device toolchain.
- Compile and run X-server on the mobile device.

2.2 March 17 - April 27

- Integrate X-server with Window Manager of the mobile device.
- Implement VMManager to spawn the virtual machines and X-server
- Investigate performance improvements to make emulation faster

2.3 April 27 - May 11

- Document appropriately and write up the final report

3 Evaluation plan

We evaluate our system focussing on our design goals of portability, isolation and usability

- Running existing unmodified x86 binaries mobile device.
- Measure performance impact of x86 emulation on ARM.

- Evaluate the latency of an interactive application which renders using the native X-server.
- Profile the memory and power overhead due to virtualization.

4 Anticipated results

- Working implementation of x86 Hypervisor on ARM
- VMManager integrated with the mobile device window manager

References

- [1] 16 percent of workloads are running Virtual Machines. <http://www.gartner.com/it/page.jsp?id=1211813>.
- [2] Android Security and Permissions. <http://developer.android.com/guide/topics/security/security.html>.
- [3] Cyber-criminals target mobile banking. <http://www.v3.co.uk/vnunet/news/2173161/cyber-criminals-target-mobile>.
- [4] iPhone Privacy. http://seriot.ch/resources/talks_papers/iPhonePrivacy.pdf.
- [5] Mobile Phones, The Next Frontier. <http://blogs.vmware.com/console/2009/08/mobile-phones-the-next-frontier.html>.
- [6] Vulnerability Summary for CVE-2009-0475. <http://web.nvd.nist.gov/view/vuln/detail?vulnId=CVE-2009-0475>.
- [7] Vulnerability Summary for CVE-2009-2204. <http://web.nvd.nist.gov/view/vuln/detail?vulnId=CVE-2009-2204>.
- [8] Vulnerability Summary for CVE-2009-2692. <http://web.nvd.nist.gov/view/vuln/detail?vulnId=CVE-2009-2692>.
- [9] D. A. Andreas Nilsson, Christoffer Dall. Android Virtualization, 2009.
- [10] P. Barham, B. Dragovic, K. Fraser, S. Hand, T. Harris, A. Ho, R. Neugebauer, I. Pratt, and A. Warfield. Xen and the art of virtualization, 2003.
- [11] F. Bellard. QEMU, a fast and portable dynamic translator. In *ATEC '05: Proceedings of the annual conference on USENIX Annual Technical Conference*, pages 41–41, Berkeley, CA, USA, 2005. USENIX Association.

- [12] A. Bose and K. Shin. On Mobile Viruses Exploiting Messaging and Bluetooth Services. *Securecomm and Workshops, 2006*, pages 1–10, 2006.
- [13] C. Clark, K. Fraser, S. Hand, J. Hansen, E. Jul, C. Limpach, I. Pratt, and A. Warfield. Live migration of virtual machines. In *Proceedings of the 2nd conference on Symposium on Networked Systems Design & Implementation-Volume 2*, page 286. USENIX Association, 2005.
- [14] L. Cox and P. Chen. Pocket Hypervisors: Opportunities and Challenges. In *Eighth IEEE Workshop on Mobile Computing Systems and Applications, 2007. HotMobile 2007*, pages 46–50, 2007.
- [15] Qumranet. Kernel-Based Virtual Machine. [Online], 2009. Available: <http://linux-kvm.org>.
- [16] VMware. VMware MVP (Mobile Virtualization Platform). <http://www.vmware.com/products/mobile>.
- [17] S. Yoo, Y. Liu, C.-H. Hong, C. Yoo, and Y. Zhang. MobiVMM: a virtual machine monitor for mobile phones. In *MobiVirt '08: Proceedings of the First Workshop on Virtualization in Mobile Computing*, pages 1–5, New York, NY, USA, 2008. ACM.