Native Execution of iOS Apps on Android

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COLUMBIA UNIVERSITY
IN THE CITY OF NEW YORK

March 4, 2014
ASPLOS 2014, Salt Lake City, UT
The Goal
Virtualization
Binary Compatibility

**WINE**

API Reimplementation

- immense implementation
- 20 years later: still incomplete
Binary Compatibility

Kernel ABI Compatibility

- missing kernel subsystem
- opaque driver interfaces

BSD Linux Compatibility
Cider: OS Compatibility

- Direct execution of unmodified iOS apps
- Reuse existing libraries
- Reuse existing open source kernel code
- iOS apps can use Android libraries
Cider: OS Compatibility

- Personas
  - distinguish iOS and Linux threads
- Duct Tape
  - XNU code in the Linux kernel
- Diplomats
  - iOS apps use Android libraries
Cider: OS Compatibility

Motivation

Duct Tape

Diplomats

Evaluation

iOS

Android

Cider Linux Kernel

XNU syscall Interface

Linux syscall Interface

Mach-O Loader
Per-Thread Personas

Cider Linux Kernel

- XNU syscall Interface
- Linux syscall Interface

Persona Management
Mach-O Loader
Cider: OS Compatibility

Overview

Cider Linux Kernel

XNU Source
Mach IPC

XNU syscall Interface

Linux syscall Interface

Persona Management
Mach-O Loader

Motivation
Duct Tape
Diplomats
Evaluation

iOS
Android
Duct tape

Cider Linux Kernel

- XNU Source
- Mach IPC
- Duct Tape
- XNU syscall Interface
- Linux syscall Interface
- Persona Management
- Mach-O Loader
Duct tape
Duct tape

lck_mtx_lock() \Rightarrow \text{mutex_lock()}

lck_mtx_t \Rightarrow \text{struct mutex}

XNU Source

Mach IPC

Mach IPC syscall stubs

Linux kernel memory, synch, list management, etc.

kmalloc, spinlock, list...
Duct tape

Overview

Motivation

XNU Source

Mach IPC

Synchronization, List Mgmt

Mach Semantics

Mach IPC syscall stubs

kmalloc, spinlock, list...

Cider

Linux

Kernel

iOS

Android

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Cider: OS Compatibility

- iOS OpenGL
- Apple GPU?!

- XNU Source
- Mach IPC
- Duct Tape

- XNU syscall Interface
- Linux syscall Interface

- Persona Management
- Mach-O Loader

- Cider Linux Kernel

Motivation | Overview | Personas | Duct Tape | Diplomats | Evaluation
---|---|---|---|---|---
iOS | Android
Cider: OS Compatibility

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Android OpenGL

ELF??

??

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Cider: OS Compatibility

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Android OpenGL

OpenGL

Android

iOS
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Android Libraries

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Android
Diplomats

iOS App links against diplomats - not iOS symbols!

Cider Linux Kernel

Motivation  Overview  Personas  Duct Tape  Diplomats  Evaluation

iOS  Android
Cider: Architecture

Cider Linux Kernel

XNU Source
- Mach IPC
- Duct Tape

XNU syscall Interface

Linux syscall Interface

Persona Management

Mach-O Loader

Android Libraries

launchd
configd
...
Cider: Prototype

- Nexus 7 (Tegra)
  - Integrated iOS app launch

iOS Apps!

Android Apps!
Cider: Prototype

- Nexus 7 (Tegra)
  - Full multi-touch support
  - OpenGL for 2D/3D graphics
Cider: Experimental Results

- PassMark benchmark application
- Android App
  - Stock Nexus 7
  - Cider
- iOS App
  - Cider
  - iPad mini
Cider: Experimental Results

**PassMark Benchmark**

<table>
<thead>
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<th>Task</th>
<th>Cider Android</th>
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<td>Memory Write</td>
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<td>Memory Read</td>
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</tbody>
</table>

Normalized Performance
Cider: Experimental Results

PassMark Benchmark

- Integer
- Floating Point
- Solid Vectors
- Find Primes
- Transparent Vectors
- Random String Sort
- Complex Vectors
- Data Encryption
- Image Rendering
- Storage Write
- Storage Read
- Memory Write
- Memory Read

Cider Android
Cider iOS
iOS
Cider: Experimental Results

PassMark Benchmark

- Solid Vectors
- Transparent Vectors
- Complex Vectors
- Image Rendering
- Image Filters
- Simple 3D Test
- Complex 3D Test

Cider Android | Cider iOS | iOS
Conclusion

- Direct execution of unmodified iOS apps
  - Per-thread Personas
  - Duct Tape
  - Diplomats
Thank You

http://systems.cs.columbia.edu/projects/cider

Logo design by: Steve Lovelace (http://steve-lovelace.com/)