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Operating System Convergence:

An Example via the Maru OS Project



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Acknowledgements

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What we'll discuss today

- What is Convergence?
- ► Examples
- The Compatibility Problems

- Maru OSOverview
- Future Works
- Questions?



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Operating System Convergence

- What is desktop mode?
- What is convergence?

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- Bottom-up convergence
- What is operating system (OS) convergence?
- OS convergence on other form-factors?



What are the Differences?

Bottom-up Convergence vs OS Convergence

Bottom-up Convergence

<u>Advantages</u>:

- Only one codebase maintained.
- Better performance because there is no virtualization overhead.

<u>Disadvantages</u>:

- UI redesign typically required. Unfamiliar end-user UI.
- System rewrites are expensive.
- Only one application ecosystem.
- No additional security via strong isolation provided.

OS Convergence

<u>Advantages</u>:

- ► Familiar end-user components kept (ie: UI).
- Provides multiple application ecosystems.
- Virtualization can add immutability and component modularity.
- Virtualization provides additional strong isolation/security.

<u>Disadvantages</u>:

- Virtualization adds both memory and CPU overhead.
- Multiple kernel/user space implementations must be maintained.



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Different Convergence Implementations

Bottom-up Convergence:

- Ubuntu Touch / PostmarketOS
- Windows Continuum
- Samsung Dex

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OS Convergence:

- Ubuntu on Android
- Maru OS
- C-Android (No Desktop Mode)



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The Compatibility Problems

Application Compatibility Problem:

- Lack of application ecosystem can kill a product.
- OS convergence can be used to boost application ecosystem. (Compatibility-layers)
- ► Ex:

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- WSL/Wine
- Noah/WSL2
- Waydroid

System Compatibility Issues:

- System component incompatibility
 - Systems use different graphical compositers.
- Operating system (kernel) incompatibility
 - · Kernel missing modules.
 - System uses entirely different kernel calls.
- Device driver incompatibility
 - Devices drivers compiled differently.
 - Drivers not written for one system.





What is Maru OS?

Maru OS is an Android distribution that provides desktop mode by running a Debian(Linux) LXC container alongside the Android userspace. The phone can be attached to a monitor or lapdock and become a full-fledged workstation.

- Open-source project
- Application ecosystem of both Linux and Android!
- Why not use KVM?
- Contributions?





Architectural Overview

Since Android is based on the Linux kernel, Linux modules such as LXC can be enabled to allow the use of system containers. Both userspace implementations can run simultaneously while sharing the same kernel resources with little overhead.

- Android userspace and LXC container
- Framebuffer manipulation
 - mflinger(Android) / mclient(Linux)
- Diagram shows Maru OS if libhybris was implemented.
 - Current solution?



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Lapdoc Example:

A lapdock is a laptop shell with no internal processing power. A device can be attached to computationally power the lapdock.

- Nexdock 360 was used ► in POC.
- Cords!!! ►

USB

Port

Is there a wireless ► solution?

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- Miracast •
 - BT500





Maru OS in Action





Figure 3.



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Future Work

And Additional Use Cases



Libhybris, Halium, and Waydroid

- Halium is a framework built around libhybris.
 - Runs <u>Android</u> in a LXC container!
- Waydroid is an Android compatibility layer. It can use Halium for Bionic-based devices.
- Rebase Maru OS on top of Waydroid/Halium!

Investigate Functional Safety

- Run both Linux and Android in containers (LXC).
- Multiple IPC mechanisms
 - Binder is interesting because each application is executed as isolated DVM instance.



Android Fragmentation Problem and Fedora

- Android is particularly fragmented among devices, particularly with the kernel.
- Run Android on top of standardized Fedora (Or Debian!) kernel.
- Rebase Maru OS on top of an Fedora kernel and Gnome.



OS Convergence Framework

- A framework built on virtualization techniques (LXC and KVM) that provides seamless convergence of multiple OS ecosystems that scales over multiple compute platforms.
- Android convergence in IoT / Far Edge.



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Questions?





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Thank you!



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