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A Comparison of Linux Software Update Technologies

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Overview

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- Background of Linux software update
- Linux software update strategies
- Detailed look at each FOSS project
  - Strategy employed
  - Other features
  - Maturity
  - Community
  - Downstream projects

Linux software update history

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- H.J. Lu's Boot-root distributions
  - Boot and build the rest, no update mechanism
- MCC, TAMU, and SLS
  - Packages in tarballs, no dependencies
- Slackware
  - Packages in tarballs, no dependencies
  - Per release scripted updates, flaky if too old

Linux software update history

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- Debian, Red Hat Linux / Fedora, SUSE
  - Modern deb or rpm package management with complete set of dependencies
  - Non-atomic incremental updates
  - Release updates by designating a set of package versions
  - Driven by complex set of pre/post install scripts which can leave updated systems in a non-working state.

Linux software update requirements

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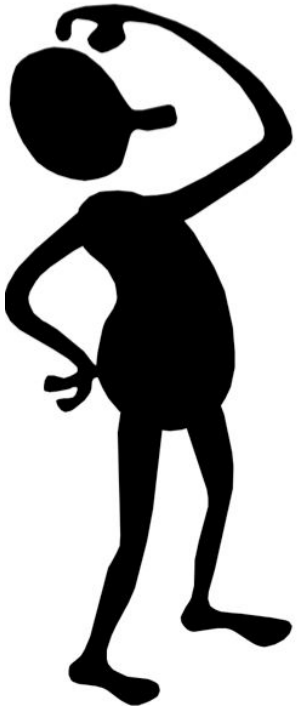
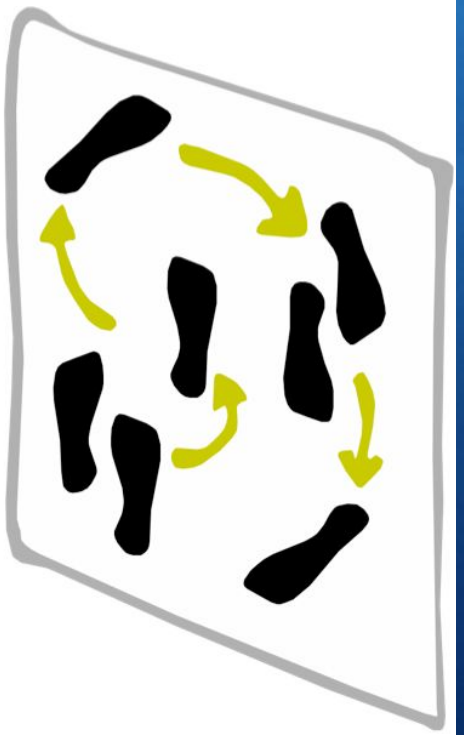
- There are many requirements
  - Tradeoffs are unique for each product.
  - No exact steps only guidelines
- Power fail safe?
- Frequent/infrequent updates?
- Bandwidth of update delivery channel vs. size of updates?
- Speed of update?
- Verification/Authentication?





Linux software update strategies
Traditional method

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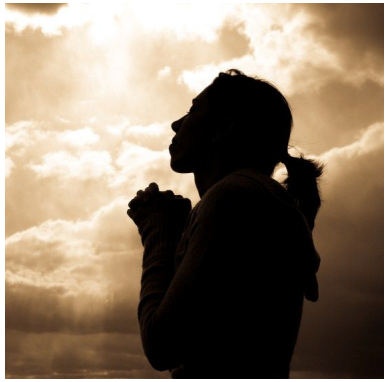
- Traditional non-atomic package-based releases
  - Package based granularity with dependency hierarchy
  - apt and yum based updates may require luck or other methods for reliability.
  - Unacceptable for the embedded zoo.



Linux software update strategies
Full image updates

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- Has been the standard approach since Linux in embedded systems was popularized.
- Single image approach assumes the new update will boot
  - Recoverable if update can be performed from an immutable mechanism (fallback factory bootloader)
- Dual image approach is inherently atomic
  - Bootloader will fallback to previously working image on failure of update
- Update speed relative to size of full image

Linux software update strategies
Full image updates

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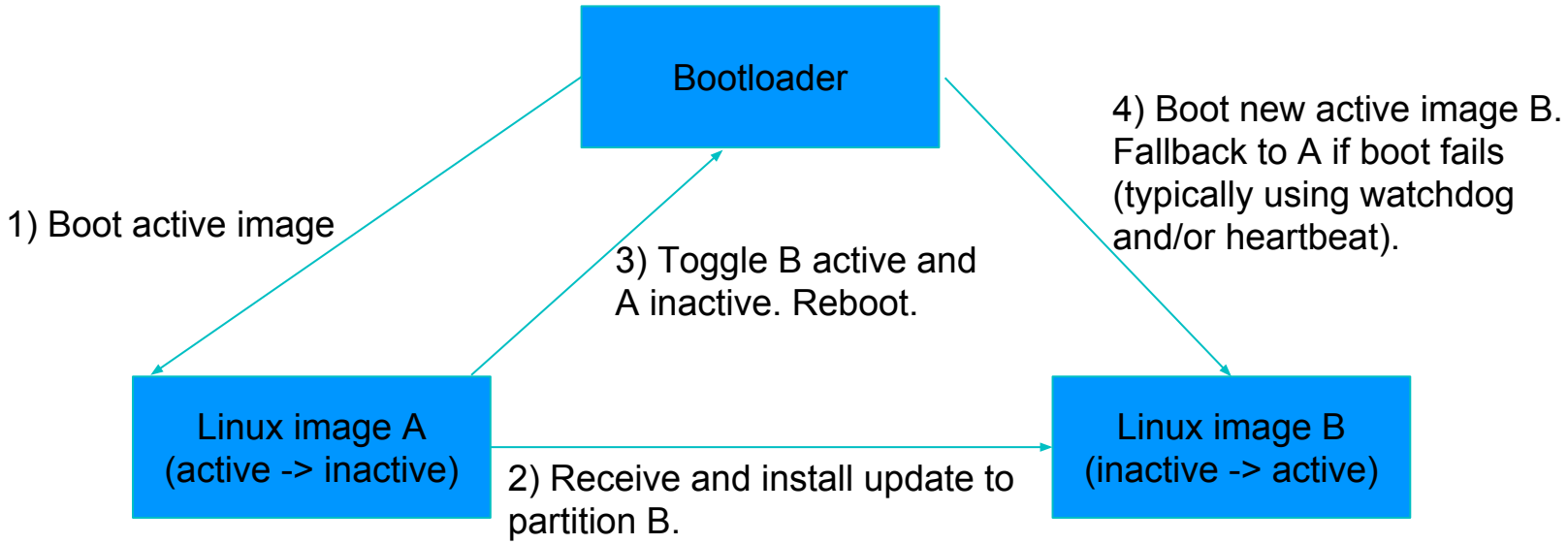
Completely unrealistic and simplified dual image example



Linux software update strategies
Incremental atomic updates

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- The new kid on the block that does crazy stuff, likely to be called *balderdash* by the old guard.
- Driven initially by server needs
  - Incremental atomic upgrades that can be quickly deployed or rolled back on demand.
  - Complete history of deployments
- Releases are composed of binary deltas
  - Not a package granularity
  - Deltas are per file modified
  - Size of updates are minimized

Linux software update strategies
Containers

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- Not usually a complete upgrade solution
- Built on top of a core immutable distribution
- Applications only exist in a container instance
- Updates rolled out in container deltas

SWUpdate

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- Single or dual image update framework
  - https://github.com/sbabic/swupdate
  - Written in C. GPL2 license.
  - Attempt to be modular with plugins
  - Supports signed images, local/remote updates, and U-Boot.
  - meta-swupdate layer for Yocto Project
- Has several contributors besides original author
- Used at least by Siemens (http://sched.co/7rrA) and Stefano's own projects

SWUpdate

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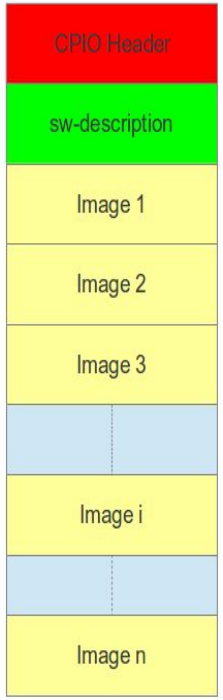
- Updates delivered in simple CPIO archive
- Each individual image is described in sw-description and integrity is validated with a SHA256 hash.
- Handler plugins implement the details of how each described image is handled.
  - U-Boot env update
  - NOR, NAND, UBI partition and write
  - MMC/SD/eMMC partition and write
  - Custom installers can enable FPGA bitstream or uC firmware updates



SWUpdate

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- sw-descriptions can be extended using custom LUA parsers to support new features
  - multiple hardware platforms in one image
- Configuration file support via libconfig or XML format by default
- Uses Kbuild for configuration
- Supports Mongoose web server and REST interface to Hawkbit server for remote update
- Strange stuff exists like an implementation of a userspace GPIO library that duplicates other projects.

mender.io

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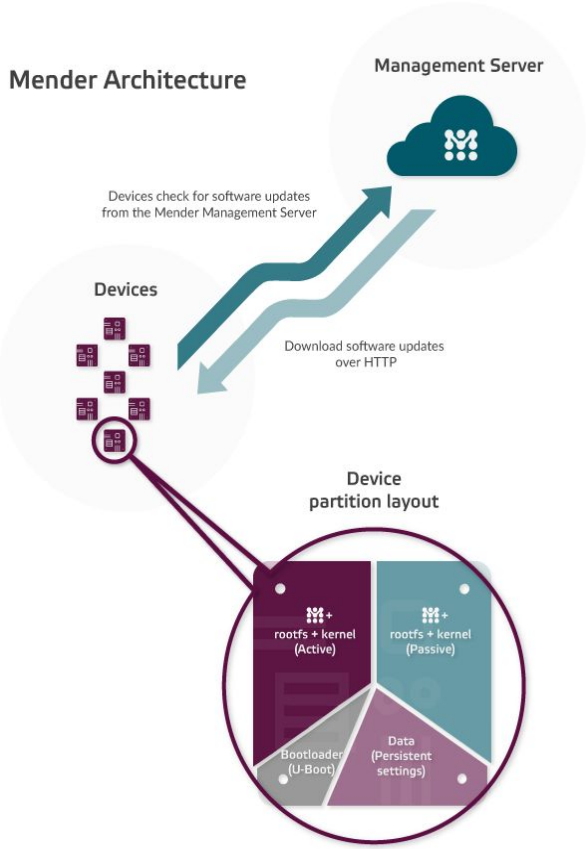
- Dual image update framework
  - https://github.com/mendersoftware/mender
- Designed as a client/server system for OTA updates. Written in Go. Apache 2 license.
- meta-mender layer supports building the client into a device image using YP/OE
  - https://github.com/mendersoftware/meta-mender
- Project contributors are overwhelmingly represented by Mender employees.



mender.io

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- Two client modes
  - Standalone - updates are triggered locally (suitable for physical media or any network update in pull mode)
  - Managed - client is a daemon and will poll the server for updates.
- mender's dual image or "A/B" scheme uses a notion of "commit" when and update has booted properly. On failure it will toggle the inactive/active partitions as with a standard dual image approach

mender.io

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- QEMU and BeagleBone Black reference platforms
  - That's the bee's knees for getting started easily
- As a complete demonstrable solution, mender relies on some assumptions:
  - U-Boot Boot Count Limit, ext2/3/4fs, and Linux env tools, and a specific U-Boot configuration
  - systemd (and required kernel config options) for managed mode
  - a fixed layout of U-Boot in one partition, a persistent data partition, and two A/B partitions with rootfs/kernel.

mender.io

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- Does not support raw NOR, NAND, UBI partitions and volumes.
- Excellent documentation on use and customization.
- Ready to use platforms to test operation.
- Established project CI loop.
- Test/QA tools all available freely.

OSTree

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- Incremental atomic upgrade mechanism
- https://github.com/ostreedev/ostree
- Self-described as “git for operating system binaries”.
- Uses a git-like object store to record and deploy complete file system trees using binary deltas.
- Depends on an immutable filesystem hierarchy for the updated root filesystem (https://www.freedesktop.org/wiki/Software/systemd/TheCaseForTheUsrMerge/)
- Persistent data kept in /etc

OSTree

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- How does it work?
  - Target has a local copy of a repository in /ostree/repo
  - Target has any number of “deployments” stored in /ostree/deploy
- A deployment is stored physically in /ostree/deploy/$OSNAME/$CHECKSUM and uniquely identified with a SHA256 checksum
- Each deployment has its own copy of /etc
- Activation requires a reboot

OSTree

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- Deploy and rollback
  - ostree-admin-upgrade
  - ostree-admin-deploy {REFSPEC}
  - ostree-admin-status
  - ostree-admin-undeploy {INDEX}
- Atomic updates are guaranteed by atomically swapping a /boot symlink to a new deployment /ostree/boot.foo directory
- A bind mount is established at boot time pointing to the currently deployed filesystem.

OSTree

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- There are many projects that have adopted OSTree
  - Gnome Continuous https://wiki.gnome.org/Projects/GnomeContinuous
  - Project Atomic http://www.projectatomic.io/
  - Flatpak https://github.com/flatpak/flatpak
  - Pulp Platform https://github.com/pulp/pulp_ostree
  - Automotive Grade Linux https://jira.automotivelinux.org/browse/SPEC-194
  - https://git.automotivelinux.org/gerrit/gitweb?p=AGL/meta-agl-extra.git;a=summary

swupd

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- Incremental atomic upgrade mechanism
- Originally part of ClearLinux project
  - https://github.com/clearlinux/swupd-client
  - https://github.com/clearlinux/swupd-server
- Functionality is very similar to OSTree.
- Updates are delivered as a stream of bundles containing binary filesystem deltas.
- meta-swupd supports YP/OE target image builds
  - http://git.yoctoproject.org/cgit/cgit.cgi/meta-swupd

swupd

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- Key difference is that the swupd-client does not require a reboot to activate a newly released bundle
- swupd-server tool handles creation of bundles and feed update streams to a client.
- Project shows no contributors outside of Intel
- Only projects adopting swupd are ClearLinux and Ostro OS, both Intel projects.

Container-based solutions

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- Resin.io
  - Base OS is flexible, Docker-based deltas
- Ubuntu Snappy
  - Base OS is minimal Ubuntu with deltaed containers
- Project Atomic
  - Base OS managed with OSTree, Docker-based deltas
- Focus on application and middleware update

Related sessions

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- Generic System for Safe Upgrades
  - Tuesday 10:00 http://sched.co/7rrp
- ResinOS
  - Tuesday 15:00 http://sched.co/8PTZ
- OSS Remote update for IoT Devices
  - Tuesday 15:00 http://sched.co/7rrA
- Mender.io BoF
  - Tuesday 18:10 http://sched.co/8PeA
- Continuous Delivery with Yocto (Ostro)
  - Wednesday 10:45 http://sched.co/7rrB
- Software update for IoT
  - Wednesday 14:00 http://sched.co/7rrJ
- Software updates for connected devices
  - Wednesday 15:00 http://sched.co/7rrK

Q&A

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