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How do you update your embedded Linux devices?

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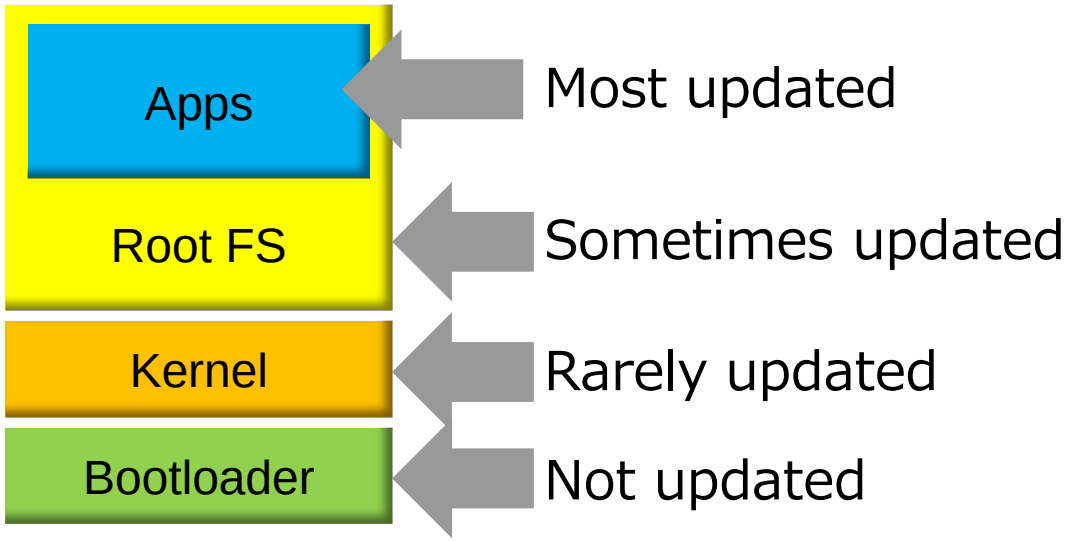
Introduction

- **Goal of this BoF session**
  - Discuss the availability and properties of **generic tools** for updating arbitrary embedded Linux devices.
  - Share **know-how** on updating techniques.
  - Get an idea of what needs to be done **next**.
- **Schedule**
  - 10’ of presentation
  - 30’ of interactive discussion

Get involved!

Survey results

- **No single solution for all**
  - Local vs remote, manual vs automated, 10's vs 1000's devices, criticality, allowed downtime, storage limitations, air-gap vs network
- **Used tools: custom scripts**
  - A lack of quality open source tools or easy to follow guidelines?
- **Main purpose: application related updates**
  - Security fixes added by inertia (especially on stand-alone systems)
  - Bug fixes have risks (busybox: 6bd3fff51aa74e2ee2d87887b12182a3b09792ef)



Typical requirements

- **Easy**
  - Well documented (for various update patterns)
  - Autogeneration of config files, crypt/hash/signs, deltas..
  - Platform integration (OpenEmbedded/Yocto, buildroot..)
  - Small runtime dependencies (busybox, shell scripts..)
- **Extensible**
  - Custom hooks/plugins for each update step
- **Robust**
  - Fail-safe: version rollback, watchdog, sanity test, factory reset, atomic (all or nothing), power cuts
  - Good error messages on failure
- **Secure**
  - CIA triad (confidentiality, integrity, authenticity)
  - Compatible with secure boot

Typical update patterns

- **Manual install (CD/USB/LAN..)**
  - Gets harder as the number of devices increases
- **Dual partition/copy**
  - Chrome OS, CoreOS..
- **Overlay**
  - Ostree (git-like), Snappy, overlayfs, docker, lxc, chroot..
- **Network boot**
  - PXE, tftpboot..

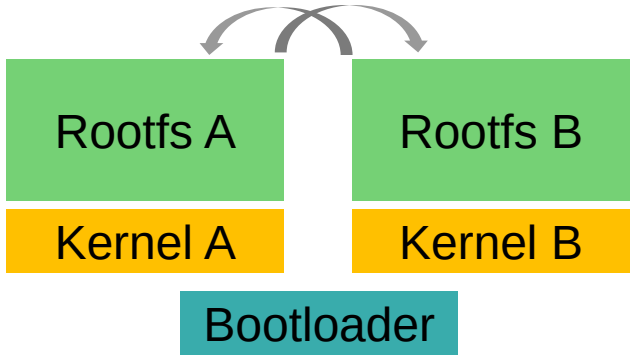


Fig 1.- Dual-partition update pattern

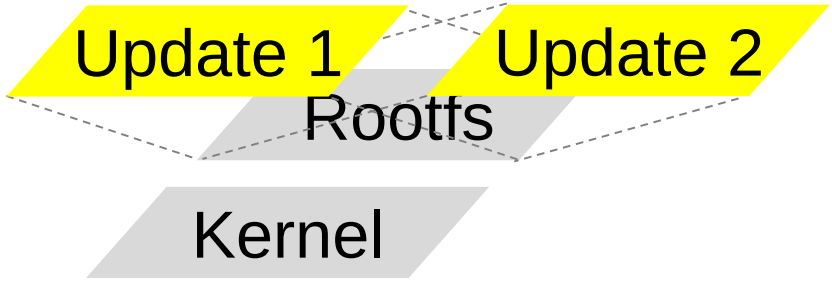
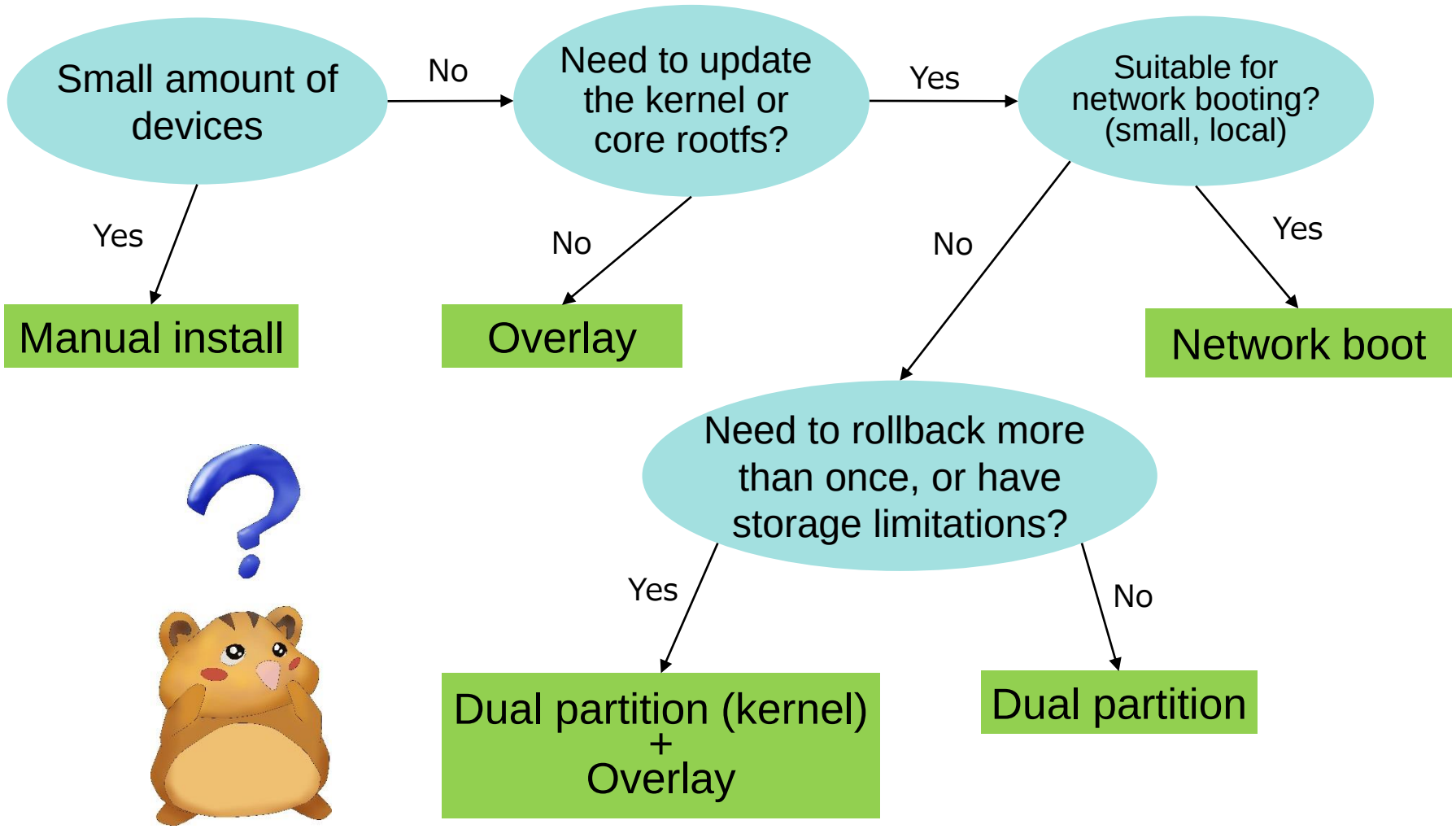


Fig 2.- Overlay update pattern

Note: package management tools (apt-get..) are orthogonal to these patterns.

Decision flow diagram (simplified)



Dual partition example: Chromium OS

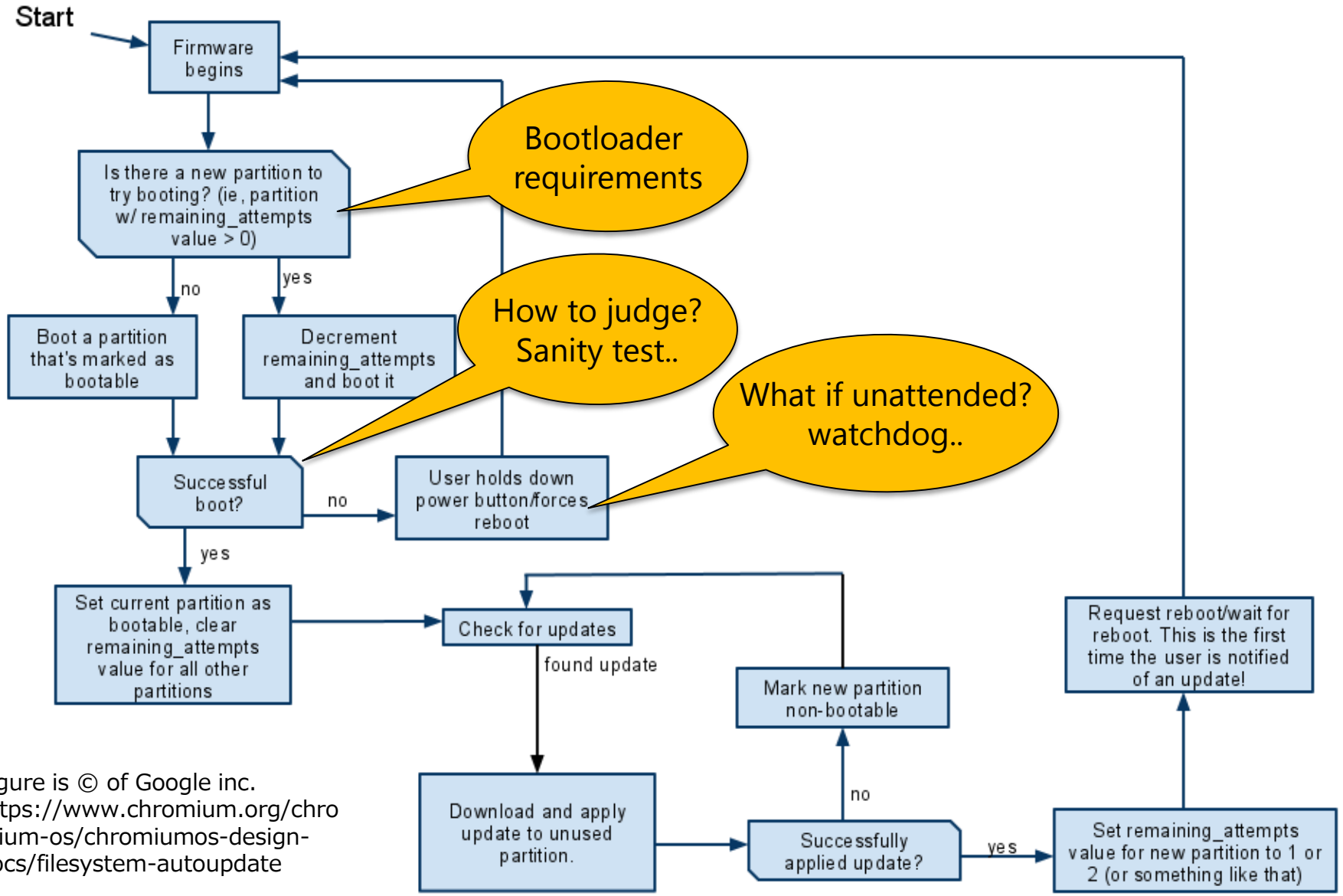


Figure is © of Google inc.
https://www.chromium.org/chromium-os/chromiumos-design-docs/filesystem-autoupdate

Generic tools

- **Bootloader support**
  - U-boot: bootlimit/bootcount/altbootcmd, redundant env, SPL
  - GRUB2: fallback (no redundant env?)
  - Chromium OS: coreboot + u-boot + GPT flags
- **Update tools**
  - Swupdate: nice and extensible software update framework
  - Ostree: git-like software update framework
  - Mender: dual-partition pattern oriented framework
  - Swupd: revisioned software update mechanism (clearlinux)
  - Fwup: configurable image-based firmware update tool
  - Sysup: update rootfs from the initramdisk
  - Resin: docker/nodejs-based framework
  - Dynamic update tools: kpatch, kgraft..

Ref: https://lists.linuxfoundation.org/pipermail/automotive-discussions/2016-May/002061.html

Related projects

- **Projects for reference on software updates**
  - Chromium OS autoupdates (dual-partition)
  - Android OTA updates (manual recovery mode)
    - Android 'N' will follow Chromium OS (dual-partition)
  - OpenWRT sysupgrade/LuCI (manual recovery)
    - overlay failsafe mode, tftpboot flashing, JTAG debricking
  - VyOS (network OS, manual rollback through grub)
  - CoreOS (dual-partition), Project Atomic (rpm-ostree), Snappy Ubuntu (transactional delta updates), ClearLinux (swupd)

Related presentations during this event

- **Automotive Grade Linux**
  - Yannick: "Secure boot and Secure software updates"
  - Arthur: "Secure updates for Linux-based IVI systems"
    - http://advancedtelematic.github.io/rvi_sota_server/
  - Eystein "Securing the Connected Car"
- **Civil Infrastructure Platform (CIP)**
  - Kobayashi&Jan: "Introducing the CIP project"
  - Hayashi: "Generating a reproducible and maintainable Embedded Linux Environment with Poky and Deby"
- **LTSI/Fuego: automated testing (contribute!)**
  - Tim bird: "Introduction to the Fuego test framework"

Extra references

- Deviceside Software Update Strategies for Automotive Grade Linux (Konsulko Group, sponsored by Advanced Telematics Systems GmbH)
- Software Update on Embedded Systems (Stefano Babic, DENX Gmbh, ELCE 2014)
- Building a robust Embedded Linux platform (Thilo Fromm, FrOSCon 2012, video)
- Updating Embedded Linux devices in the field (Chris Simmonds, 2net Ltd)
- Building Murphy-compatible embedded Linux systems (Gilad Ben-Yossef, Codefidence Ltd)
- Safe upgrade of embedded systems; Upgrade without Bricking (Arnout Vandecappelle, Essensium N.V.)
- Redundant Booting with U-Boot (Thomas Rini, TI)

Discussion time!

- What software **tools** do you use for updating (swupdate, custom, ...)?
- Do **bootloaders** require extra functionality (watchdog..)?
- What do you think about **rollbacks** with chroot, overlayfs, docker, brtfs..?
- What characteristics must a **deployment** framework have? (version synchronization across devices..)
- What **other** problems do you have in software updating?

Possible issues (1/3)

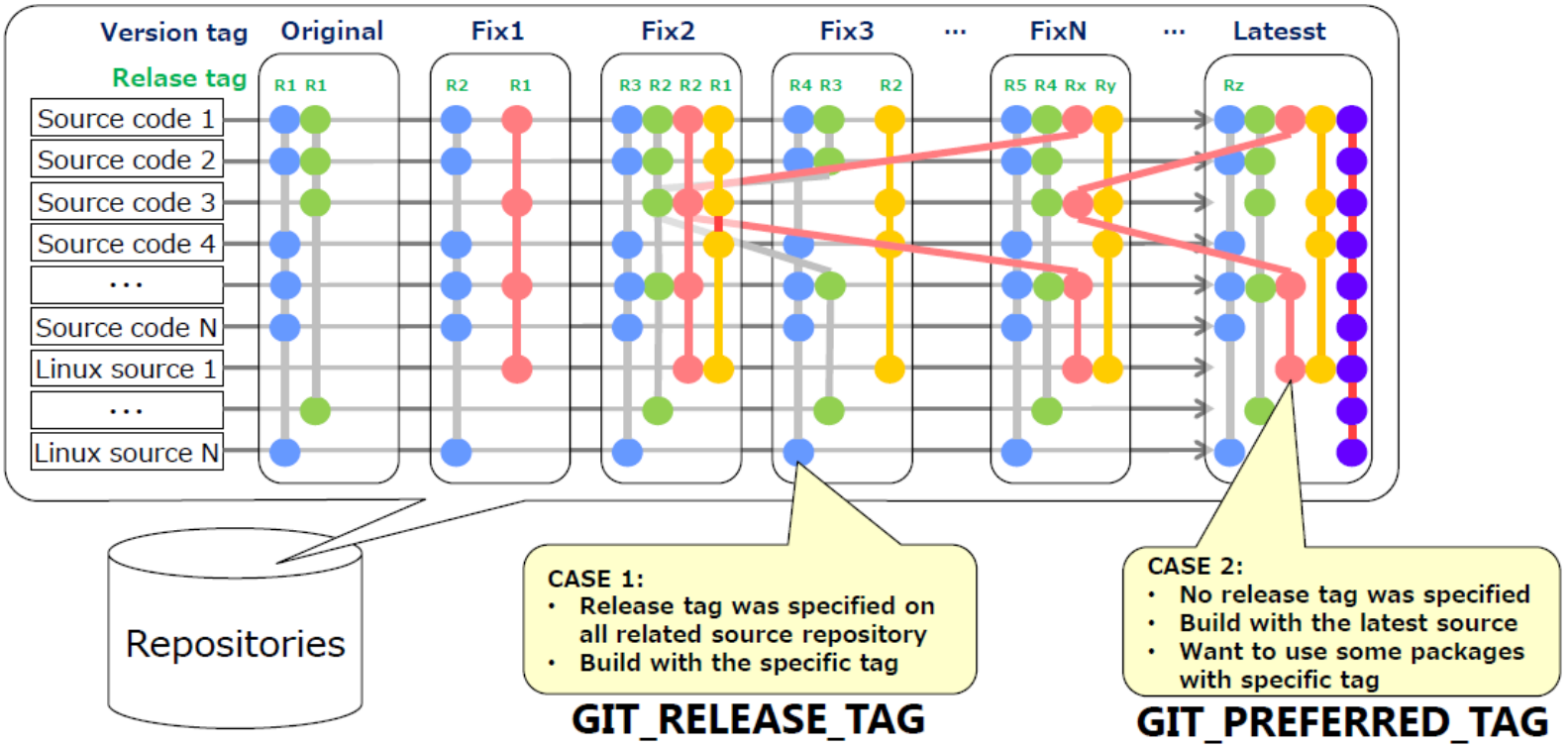
- **Disconnection between projects**
  - Don’t reinvent the wheel.
- **x86 support**
  - Most tools and documentation focus on ARM (or PowerPC).
- **Bootloader fail-safe support**
  - GRUB2: no redundant environment.
  - Watchdog support (kernel panic timeout is not enough).
- **Distributed systems**
  - All units may need to synchronize to the same version.
- **Bugs in the server/client update tools**
  - Write clean code, avoid rarely used libraries, fuzzy tests..
- **Documentation**
  - End-to-end guidelines, patterns and tools comparison.

Possible issues (2/3)

- **Sanity testing after an update**
  - Checksum files after installation.
  - Automated tests on the board.
  - Check that you can install future updates.
- **Compatibility with security tools**
  - Secure boot, Linux IMA/EVM.
  - LSM: tomoyo, smack, selinux, apparmor.
- **Target update tool's dependencies**
  - Favor stable maintained long-term library versions.
    - Eg: Same versions as stable long-term distros (Jessie..).
  - Embedded systems have many constraints.
    - Minimize language dependencies, dependencies on boot scripts, size, version conflicts and recipe backporting.

Possible issues (3/3)

- **Source code management**
  - Each update may add/remove/update parts of the rootfs
    - Git-tag the source code for each rootfs (see Deby)

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