Software update for IoT

the current state of play

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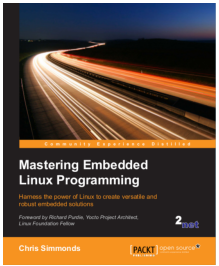
License

About Chris Simmonds



- Consultant and trainer
- Author of *Mastering Embedded Linux Programming*
- Working with embedded Linux since 1999
- Android since 2009
- Speaker at many conferences and workshops

"Looking after the Inner Penguin" blog at `http://2net.co.uk/`

`https://uk.linkedin.com/in/chrisdsimmonds/`

`https://google.com/+chrissimmonds`

Overview

- Software update 101
- Update clients
- OTA update
- OTA implementations

What could possibly go wrong?

- **Mirai**: a recent > 600 Gbps DDoS attack
- Very simple: looks for open Telnet ports and logs on using default, well-known, name and password
- Prime target: Dahua IP CCTV cameras

Details on PenTestPartners:

https://www.pentestpartners.com/blog/optimising-mirai-a-better-iot-ddos-botnet

Problems

Problem 1

- Embedded software is non-trivial (=> has bugs!)
- Devices are often connected to the Internet
  - Allowing intruders to exploit the bugs remotely

Problem 2

- We would like to deploy new features, improve performance, etc.

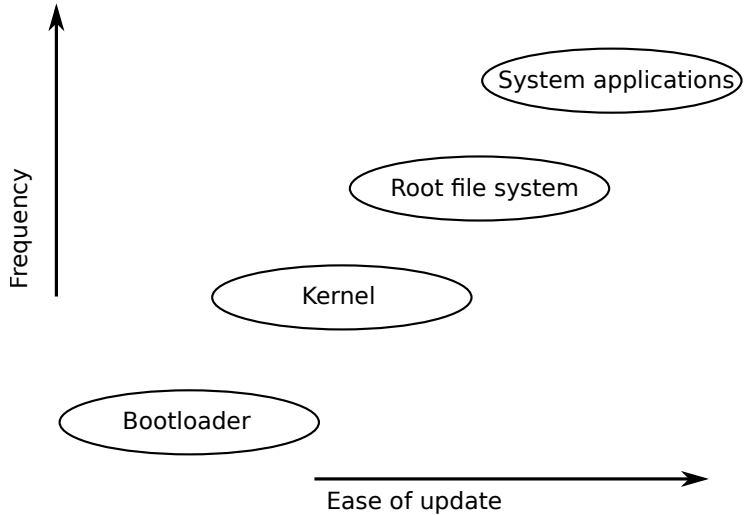
Conclusion

- We need a software update mechanism

Requirements for SW update

- Secure, to prevent the device from being hijacked
- Robust, so that an update does not render the device unusable
- Atomic, meaning that an update must be installed completely or not at all
- Fail-safe, so that there is a fall-back mode if all else fails
- Preserve persistent state

What to update?



Update granularity

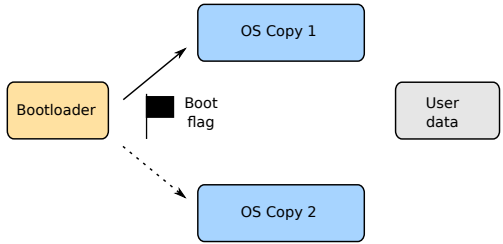
- File:
  - not an option: hard to achieve atomicity over a group of file updates
- Package:
  - `apt-get update` works fine for servers but not for devices
- Container:
  - neat idea, so long as you have containerised applications
- Image:
  - the most common option: fairy easy to implement and verify

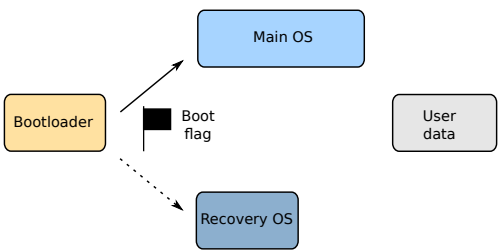
Device update != server update

- Server
  - Secure environment, no power outage, no network outage
  - If update fails, human intervention is possible
- Device:
  - Intermittent power and network mean update quite likely to be interrupted
  - Failed update may be difficult (and expensive) to resolve

Options for image update

Symmetric A/B (Android after Nougat)





Asymmetric normal/recovery (Android before Nougat)

Statelessness

- Image update of a filesystem implies no state is stored in that filesystem
- See my talk about read-only rootfs http://www.slideshare.net/chrissimmonds/readonly-rootfs-theory-and-practice

Update agent

- Update agent is the code on the device that manages the update
- Tasks
  - Receive update from local storage (e.g. USB) or from remote server
  - Apply the update
  - Toggle boot flag

swupdate

- Image-based update client
- License: GPLv2
- Code `https://github.com/sbabic/swupdate`
- Documentation `http://sbabic.github.io/swupdate/index.html`

swupdate features

- Symmetric and asymmetric update
- Bootloader support: U-Boot
- Volume formats: MTD, UBI, MBR and UEFI partitions
- Yocto Project layer: meta-swupdate
- Remote/streaming using curl (http/https/ssh/ftp)
- integrated REST client connector to hawkBit
- Signed images

RAUC - Robust Auto-Update Controller

- Image-based update client
- License: LGPLv2.1
- Source Code: `https://github.com/jluebbe/rauc`
- Documentation: `https://rauc.readthedocs.org/`

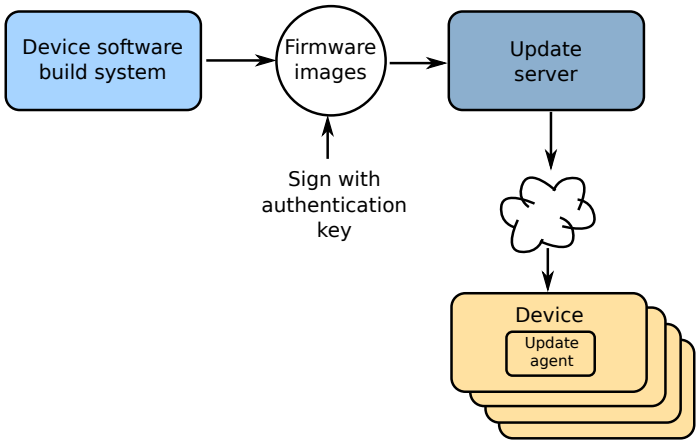
RAUC features

- Symmetric and asymmetric update
- Bootloader support: grub, barebox
- Volume formats: MTD, UBI, MBR and UEFI partitions
- Build systems: Yocto Project (meta-ptx), PTXDist
- Remote/streaming using curl (http/https/ssh/ftp)
- Cryptographic verification using OpenSSL (signatures based on x.509 certificates)

OTA update

- Solutions so far are mostly suitable for
  - Local update (man with a USB thumb drive)
  - User initiated/attended remote update
- Local or attended remote update does not scale
- Hence, OTA (Over The Air) update
  - Updates pushed from central server
  - Update is automatic (or semi-automatic as with Android/IoS)

OTA update components



Complexities of OTA update

- Authentication (is this update legit?)
- Security (am I receiving what you are sending?)
- Roll-back (if update fails to boot, switch to previous version)
- Scale (roll out to large populations)
- Monitoring (keeping track of status of the population of devices)

Roll-back

- Boot limit count
  - Feature of bootloader (e.g U-Boot)
  - Increment count in bootloader
  - Reset after successful boot
  - If reboot with count > 0, bootloader knows boot failed and loads alternate rootfs
- Hardware watchdog
  - If hang in early boot, watchdog times out and resets CPU
  - Bootloader checks reset reason
  - If watchdog, loads alternate rootfs

Mender.io

- OTA update server and client
- Full system image update
- Licenses: Server and Client: Apache 2
- Code (client): https://github.com/mendersoftware/mender
- Documentation: https://docs.mender.io

Mender.io features

- Symmetric A/B image update client
- Bootloader support: U-Boot
- Volume formats: MBR and UEFI partitions
- Update commit and roll-back
- Build system: Yocto Project (meta-mender)
- Remote features: deployment server, build artifact management, device management console

Resin.io

- OTA update server and client
- Container (Docker) based updates
- Licenses: Client: Apache2; Server: proprietary
- Code (client): https://github.com/resin-os/meta-resin
- Documentation: https://docs.resin.io/introduction

resin.io features

- Symetric A/B rootfs for core OS ("Resinhup")
- Applications packaged into Docker containers
- Build integration: Yocto Project (meta-resin)
- Docker images can be preloaded into YP build
- Remote features: deployment server, integration with git

Brillo

- Brillo is cut-down Android for IoT
- License: Apache 2.0
- Android OTA update client
- Symmetric and asymmetric image update
- Licenses: Client: Apache2; Server: proprietary
- Code (client): `https://android.googlesource.com`
- Documentation: `https://developers.google.com/brillo`

Conclusion

- Software update is a hot topic
- Open source solutions described in this presentation:
- Stand-alone update clients
  - swupdaed
  - RAUC
- End-to-end solutions
  - mender.io
  - resin.io

- Questions?

Slides on Slide Share

http://www.slideshare.net/chrissimmonds/software-update-for-iot-the-current-state-of-play

