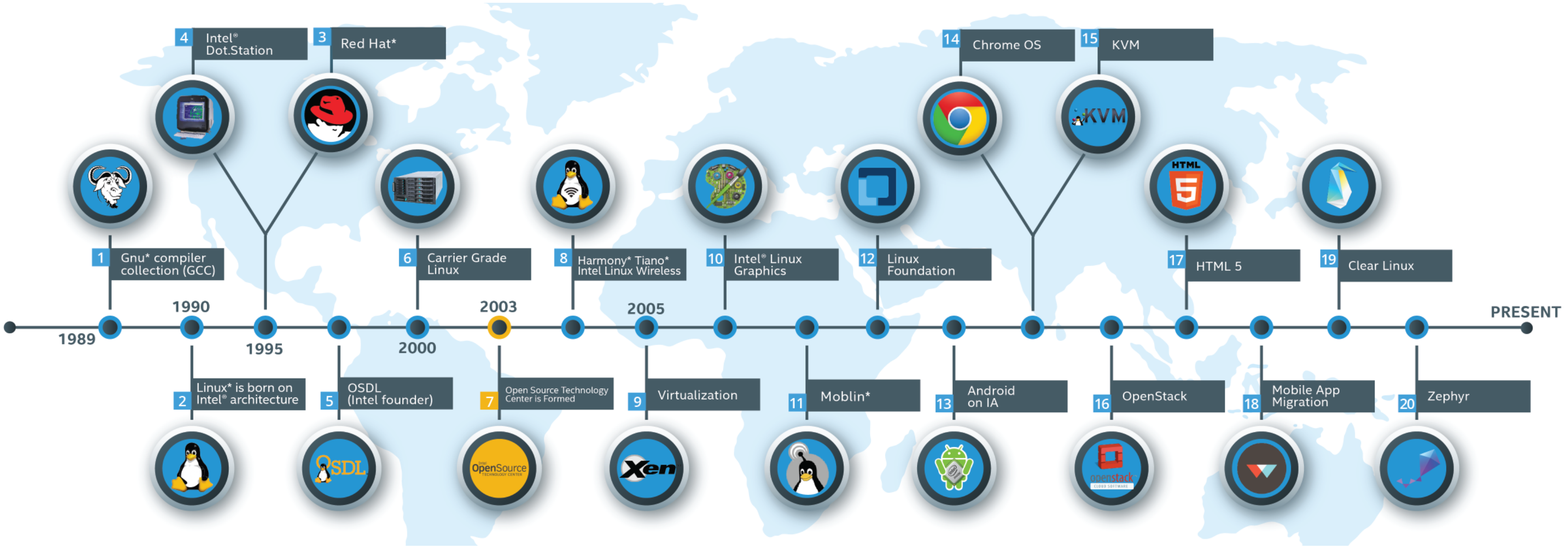
Automotive Grade Linux
Open Source Low Level Hypervisor

Dominig ar Foll
Intel Open Source

Intel & Open Source



Intel Open Source
Some examples

ofono
open source telephony
Vulkan
KVM
openstack
CLOUD SOFTWARE
yocto
PROJECT
Bluetooth®
Intel
OpenSource
TECHNOLOGY CENTER
OPNFV
minnowboard.org
OpenGL®
hadoop
Zephyr
Project

What is an Hypervisor?

Not a new technology

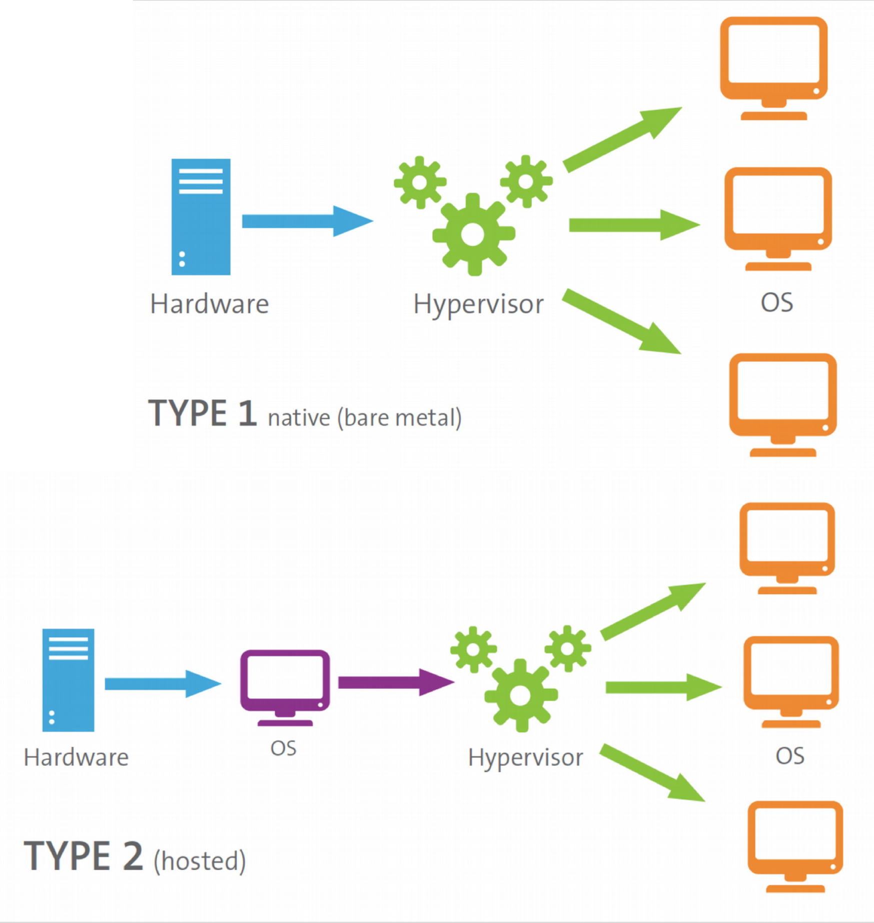
- First used by IBM in 1967 in CP/CMS
- Allows to run multiple OS on the same HW
- Provides some level of isolation

Type 1 and 2

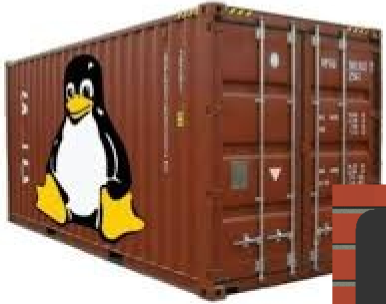
- Type 1 runs on bare metal (e.g. Jailhouse)
- Type 2 runs from a Host OS (e.g. VirtualBox)
- KVM blurs the models

What for

- Legacy code or alternative OS support
- Isolation (e.g. cyber security requirements)
- Real time sub-system
- Functional safety



AGL and Virtualisation



Virtualisation expert group

- Full virtualisation (kvm/xen)
- Container (name space enabling in AppFW)
- Low level virtualisation (Jailhouse)

Motivation

- Cyber Security
- Functional safety
- Enable legacy code, alternative OS
- Critical Real Time

Jailhouse

Xen Project

Cyber Security

Crypto Locker

- May 12th, 2017 blocks Nissan and Renault factories
- Soon enough: our own cars

Private data

- Last trips
- Phone books
- High way remote tolls

Crime

- Remotely controlled “accidents”

What Happened to
Your important files are enc
Many of your documents, ph
accessible because they have b
recover your files, but do not w
our decryption service.

Can I Recover My Files?
Sure. We guarantee that you can r
not so enough time.
You can decrypt some of your files
But if you want to decrypt all your
You only have 3 days to submit the
Also, if you don't pay in 7 days, you
We will have free events for users v

How Do I Pay?
Payment is accepted in Bitcoin onl
Please check the current price of I
click <How to buy bitcoins>.
And send the correct amount to t
After your payment, click <Chec

Today our factories, tomorrow, our cars

Functional Safety

Reduces complexity

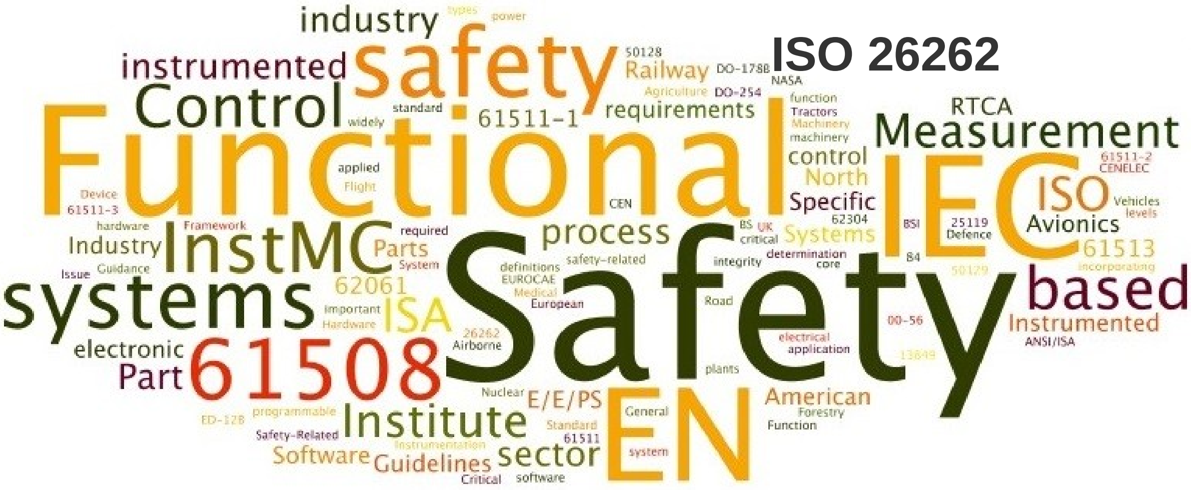
- Isolate critical code
- Simpler code vs full Linux

Still share the SoC

- HW virtualisation
- Multiple core
- Unknown: SoC level firmware

A Smart Coprocessor

- Improved controllabity
- Heath check
- Feedback loop



ISO 26262

Only use Hypervisors when you have to

AGL App/Middleware

- Built outside of the OS
- Installed under supervision from the OS

AGL Jailing system

- Smack security context
- Dynamic Privilege check (Cynara)
- Optional dedicated Name Space and c-group (container mode)

Legacy code

- Cost of port is often low
- Maintenance costs range up to 80% of the total SW costs

Do not add complexity when it's not required

Hypervisor use shall remain minimal

Real time

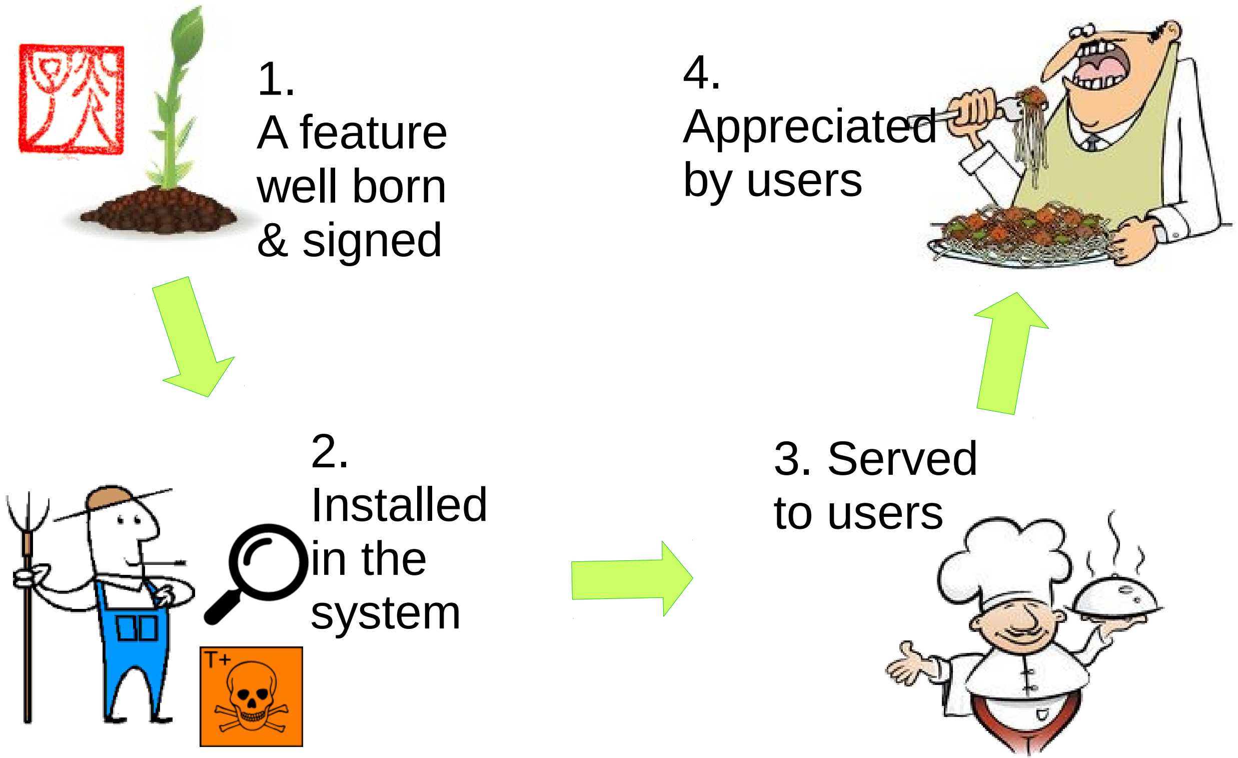
- Real time is not fast response
- Linux PrempRT is your friend
- Micro controller / FPGA

Cyber Security

- Hidden security is dangerous
- AGL base is very strong
- Fast update requirement is mandatory

Run Apps as non root

- Low privilege UID
- Dynamic profile from Cloud



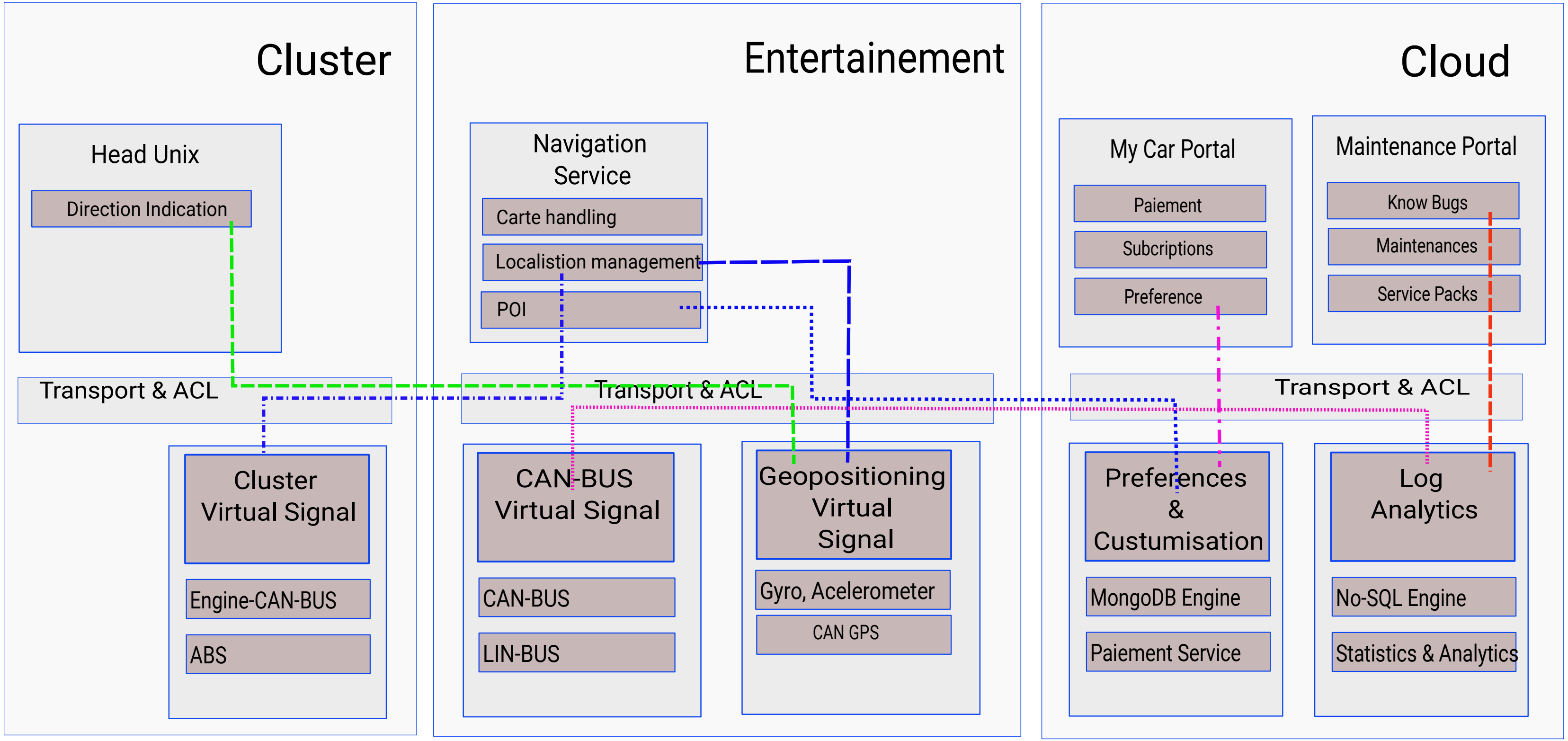
1. A feature well born & signed

2. Installed in the system

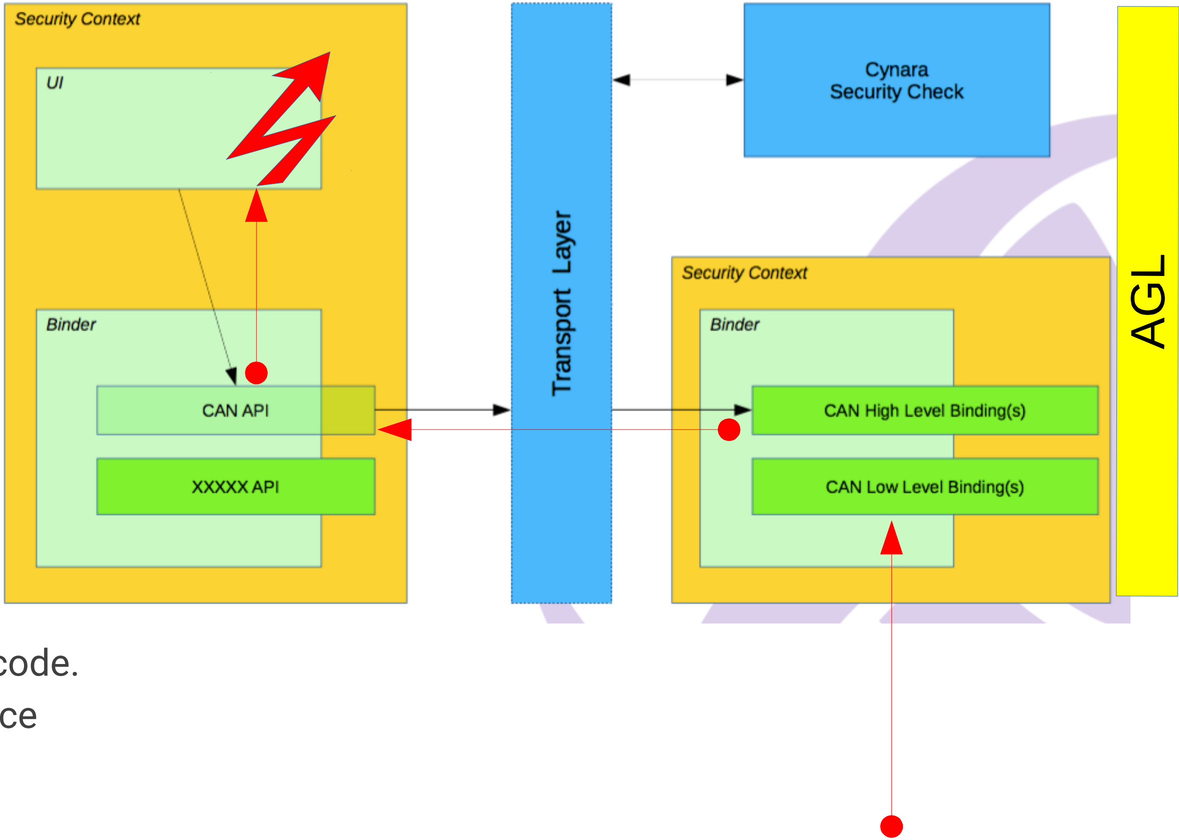
3. Served to users

4. Appreciated by users

The core AGL architecure



Example use case : emergency CAN alert



Default AGL mode

- CAN alert (e.g. brake failure)
- Read by CAN low level binding
- Push to subscribed App(s)
- App take action:
  - display error
  - limit speed
  - locate near service dealer
  - ...

No feedback

- Bug could alter expected behavior
- Bug could be in code (OS/App) or microcode.
- Complexity is too big for static compliance check.

Example use case : emergency CAN alert

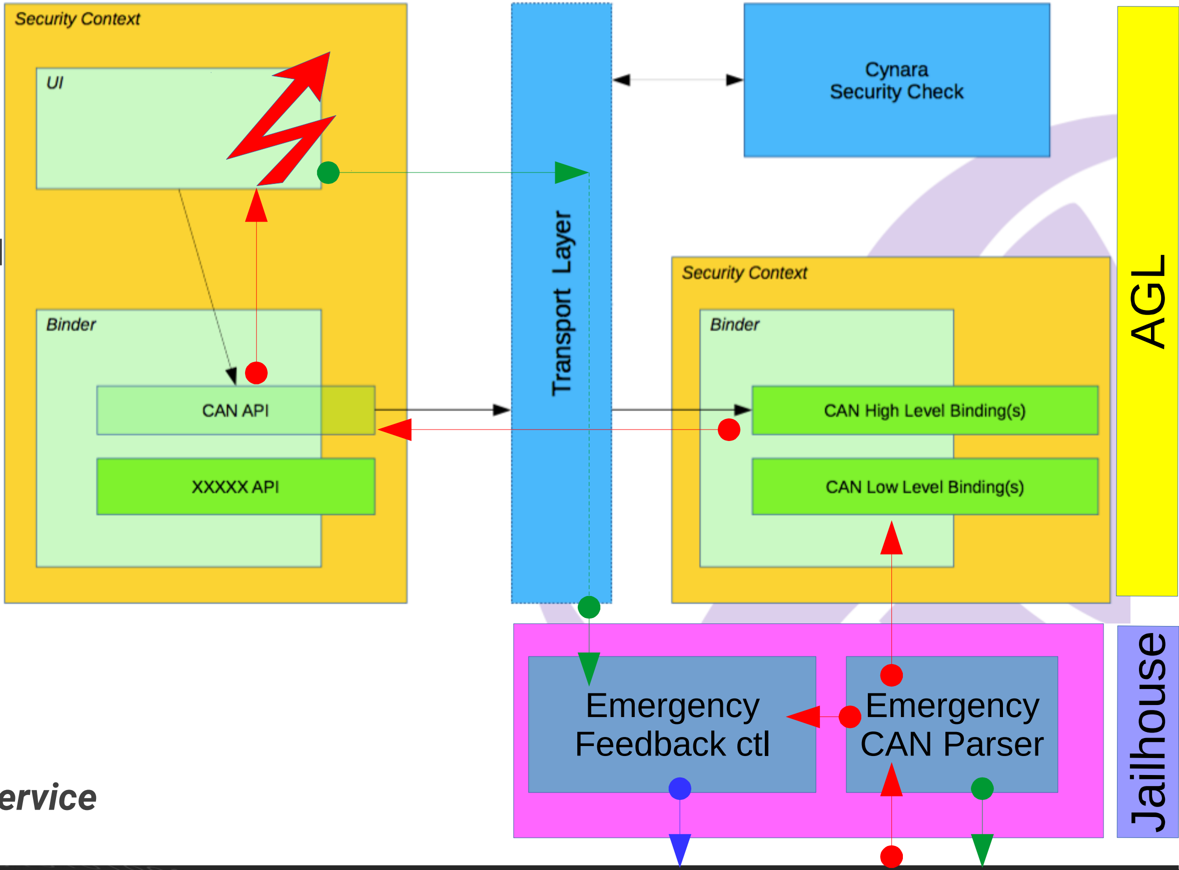
With controller

- CAN alert message triggers
  - Push over CAN AGL Binder
  - App feedback request
  - Immediate secure speed mode via CAN
- App manages standard process
  - error message (cluster & heads-up)
  - deactivate cruise control
  - ...
- Send feed back via AGL transport layer

On No Feedback received

- Set Alert LED on Cluster via CAN or gpio
- Set alert buzzer via gpio
- ...

Note: An FPGA could provide the same service



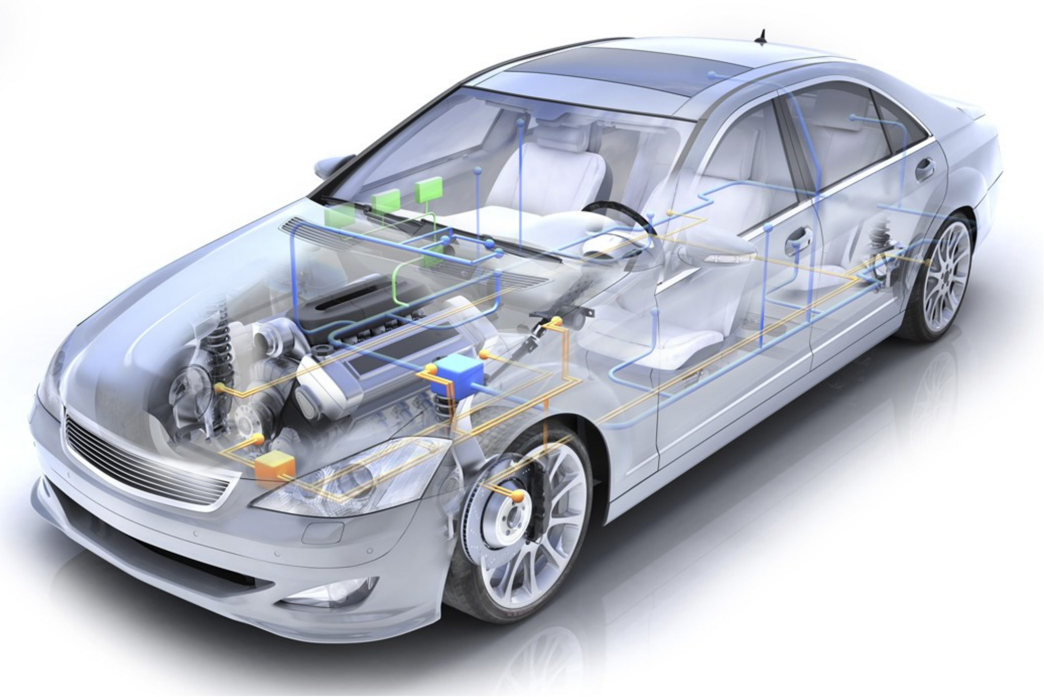
Many valid use cases for Hypervisor

Controller / feedback check

- CAN
  - CAN firewall
  - CAN very fast response
  - CAN emergency message
  - ..
- Watchdog
  - Check system App/Middleware health
  - ...

Real time

- Benefit dedicated CPU and RAM allocation
- Run nonLinux OS (e.g. Autosar)



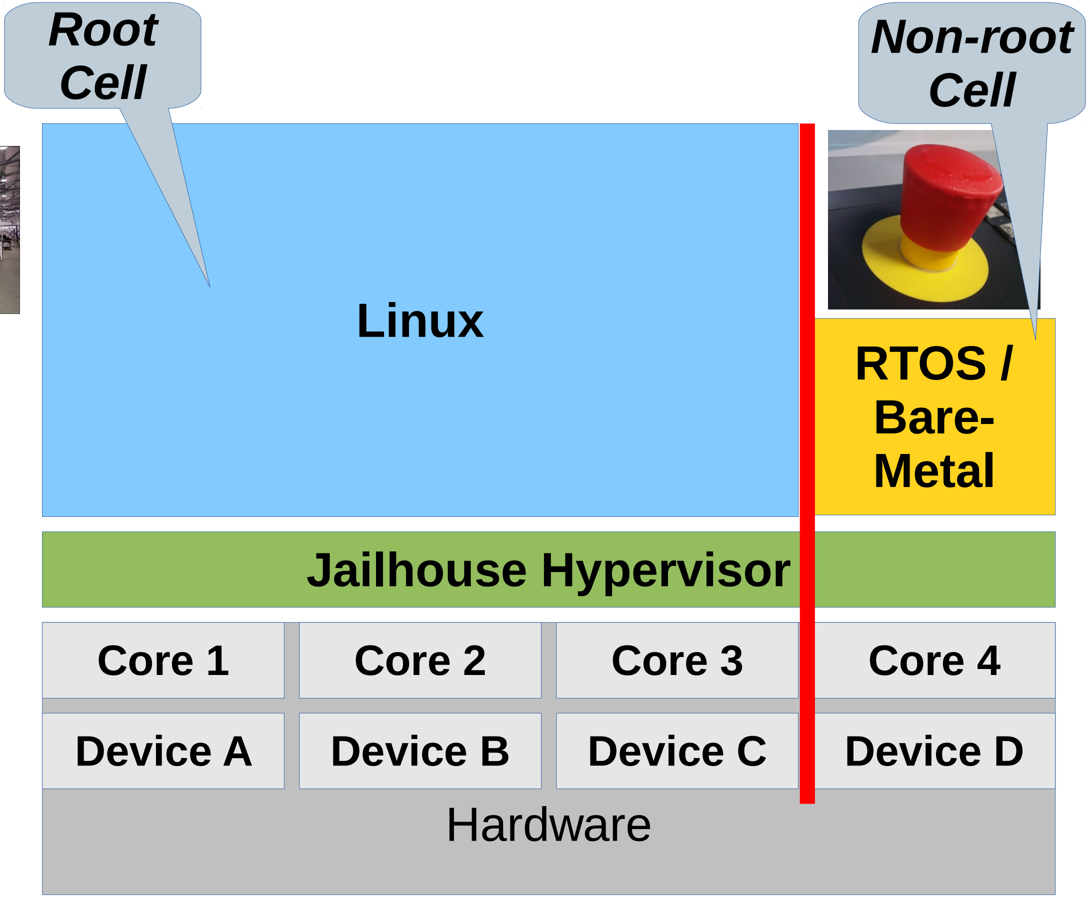
Jailhouse

What is it

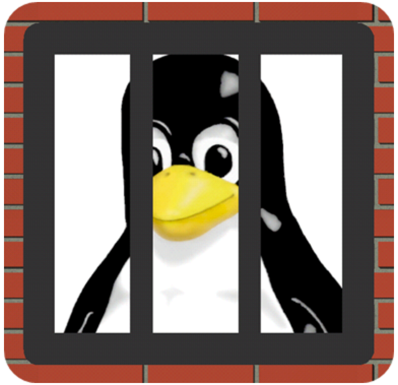
- Open Source project
  - Originated from Siemens
  - Maintainer: Jan Kizka
  - https://github.com/siemens/jailhouse
  - Active project
- Aim
  - real time & safety tasks
  - Asymetric Multiprocessing Platforms (AMP)
  - a side of Linux
  - Multi architecture (Intel & ARM)

Key values

- Strong & clean isolation
- Bare metal performances
- Open Source (GPLv2)
- Very small and simple *(~3000lines)*
- Configured and initialised from Linux



Jailhouse is NOT



!=

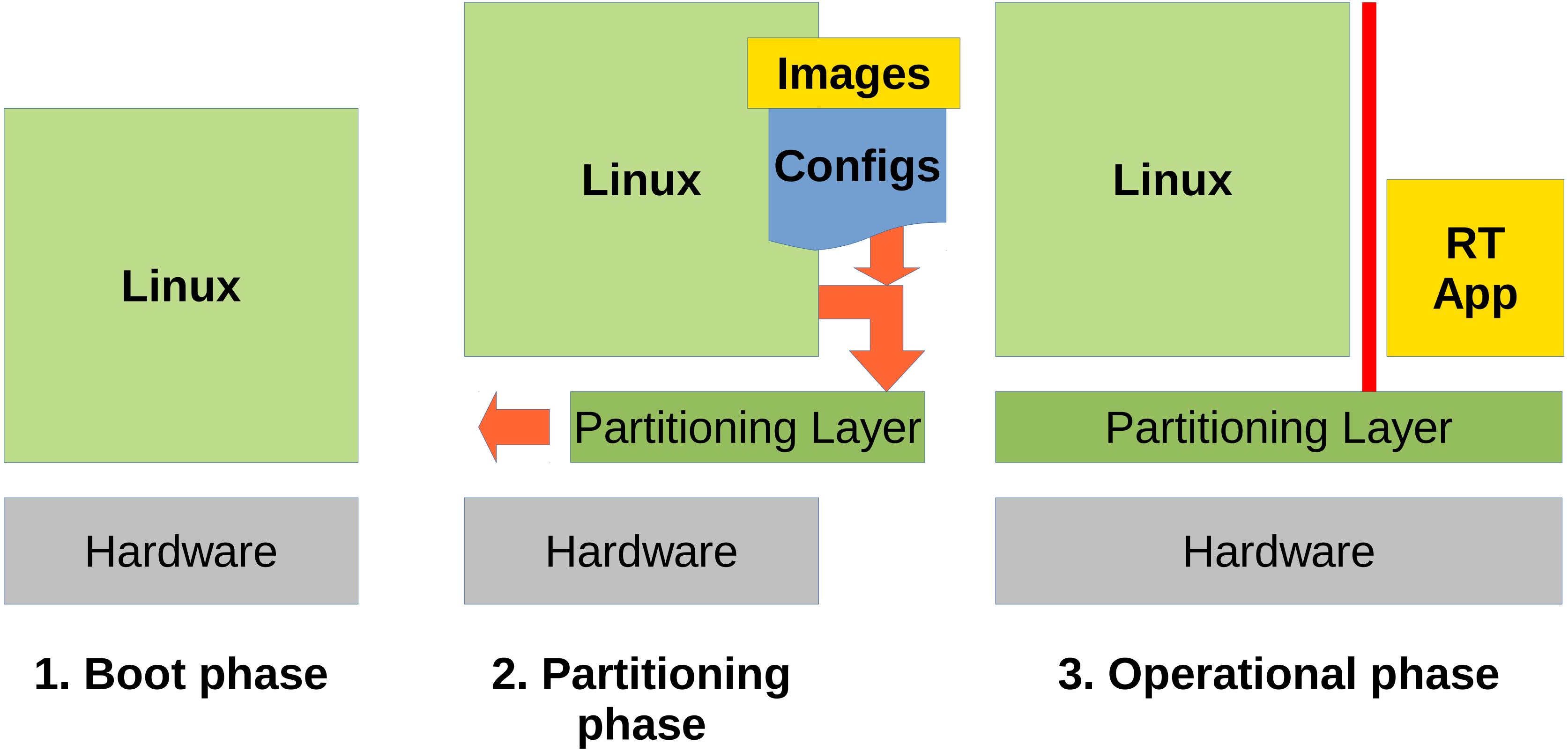
KVM

Xen®

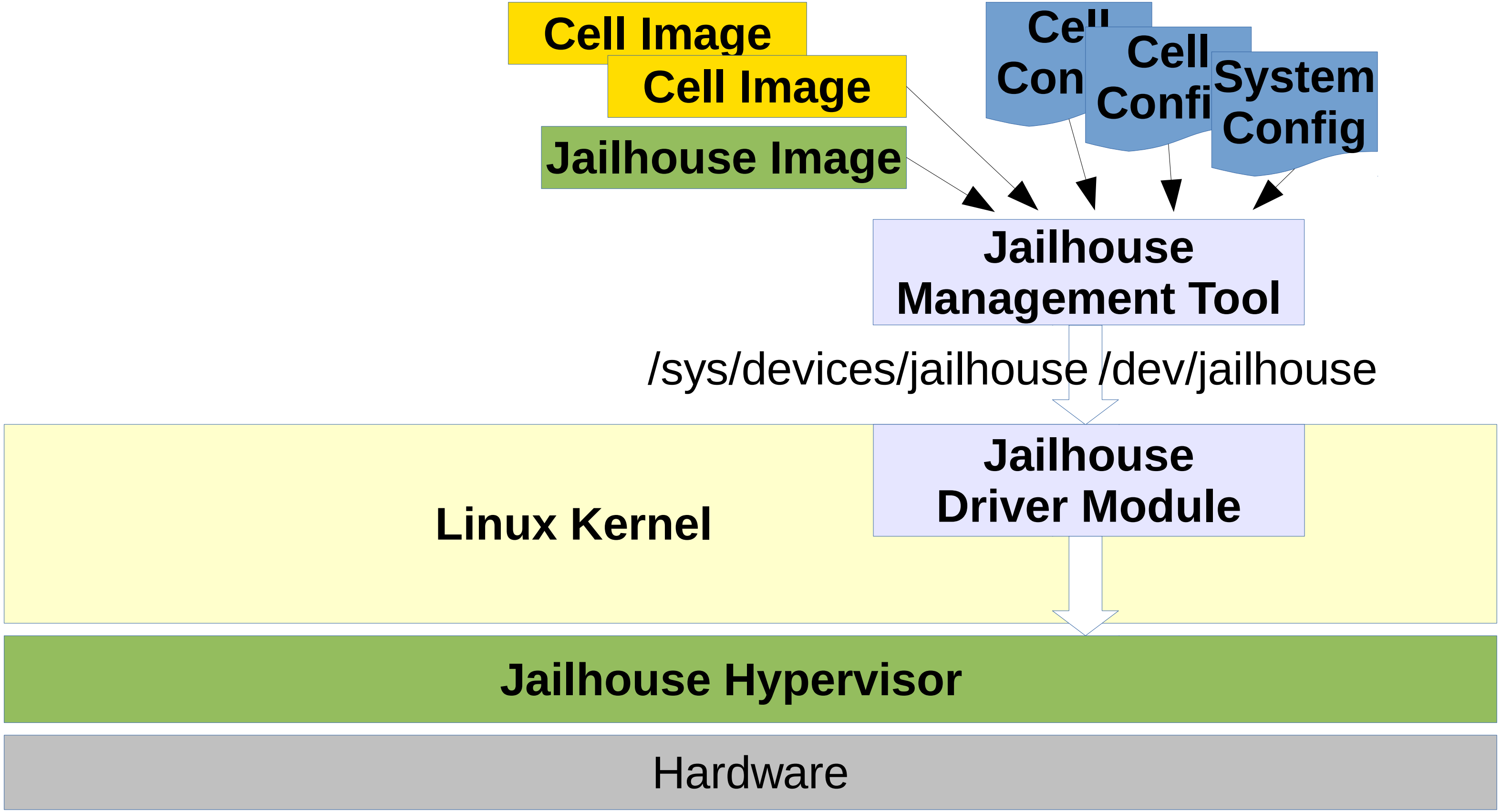
docker

...

Standard Linux boot and update process

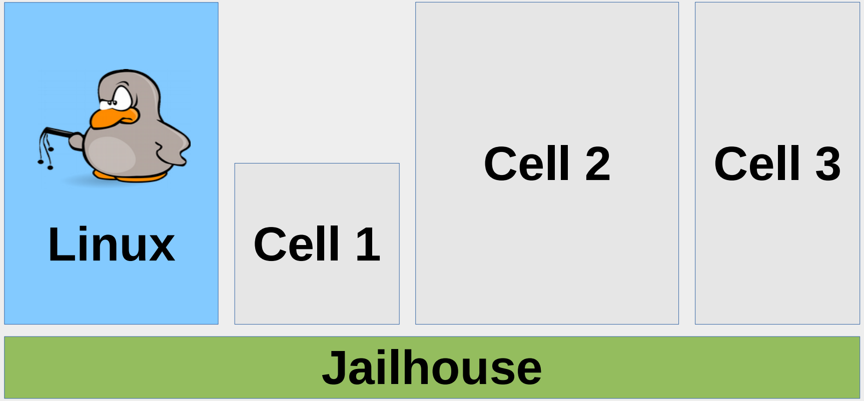


Jailhouse components



Jailhouse Management models

Open Model



Linux

Cell 1

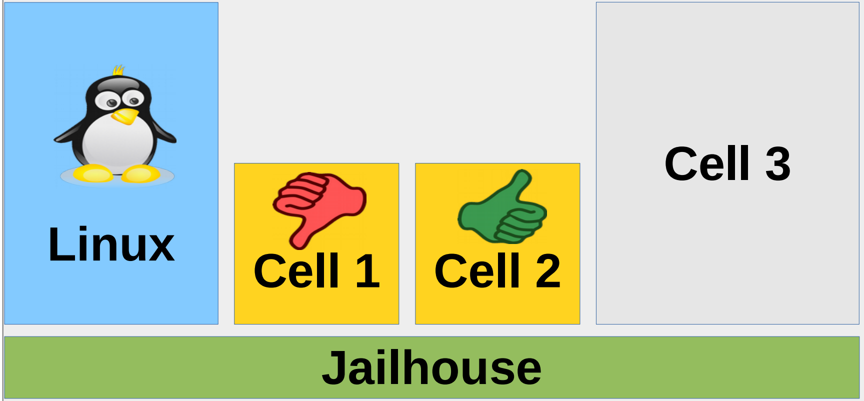
Cell 2

Cell 3

Jailhouse

- Cells not involved in management decisions
- Sufficient if root cell is trusted

Safety Model



Linux

Cell 1

Cell 2

Cell 3

Jailhouse

- Linux controls, but certain cells are configured to vote over management decisions
- Building block for safe operation

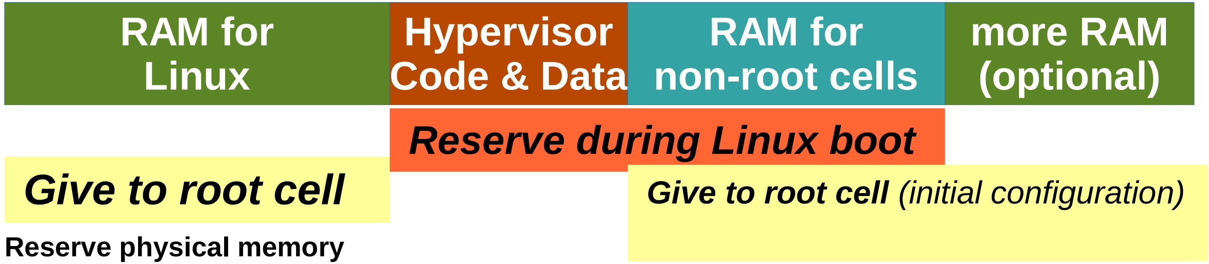
Status

What can be configured

- CPU
- Memory regions
  - Read-write-execute
  - DMA, IO, IRQ
  - Comm_Region
  - ..

- Work in progress
  - Cache region
  - Config tools
  - automatic conflict check
  - ARM64 support still new (Huawei over 1 year)

Typical RAM layout (generated and used for QEMU)



RAM for Linux

Hypervisor Code & Data

RAM for non-root cells

more RAM (optional)

Reserve during Linux boot

Give to root cell

Give to root cell *(initial configuration)*

Reserve physical memory

- `memmap=SIZE$ADDRESS`
- `mem=PHYSICAL_SIZE_MINUS_RESERVATION`
- Device tree (ARM/ARM64 only)

- **grub2 is ~~your friend~~ evil**
  - Use proper escaping in `/etc/default/grub`

```
GRUB_CMDLINE_LINUX_DEFAULT="memmap=66M\\\$0x3b000000"
```

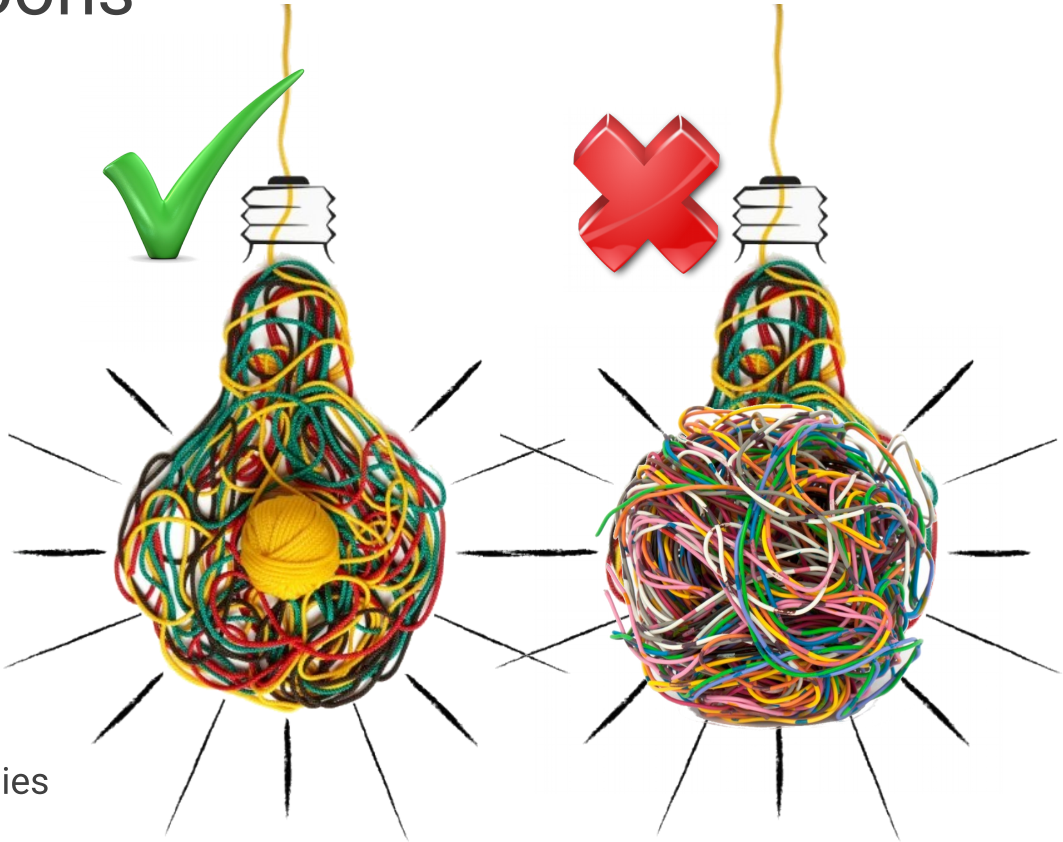
Hypervisors Pros and Cons

Pros

- Simple and certifiable
- Bare metal performances
- Run any OS as guest
- Strong isolation

Cons

- No coding or configuration standards
- Debugging is far from simple
- Easy to badly use
- Still rely on a shared HW resource
- Micro code / cache conflicts can be a a black zone in the certification process.
- Does not work on every SoC
- Most of them requires specific update strategies (not Jailhouse)



Q & A