PROVE & RUN

Proven Security for the Internet of Things (IoT)

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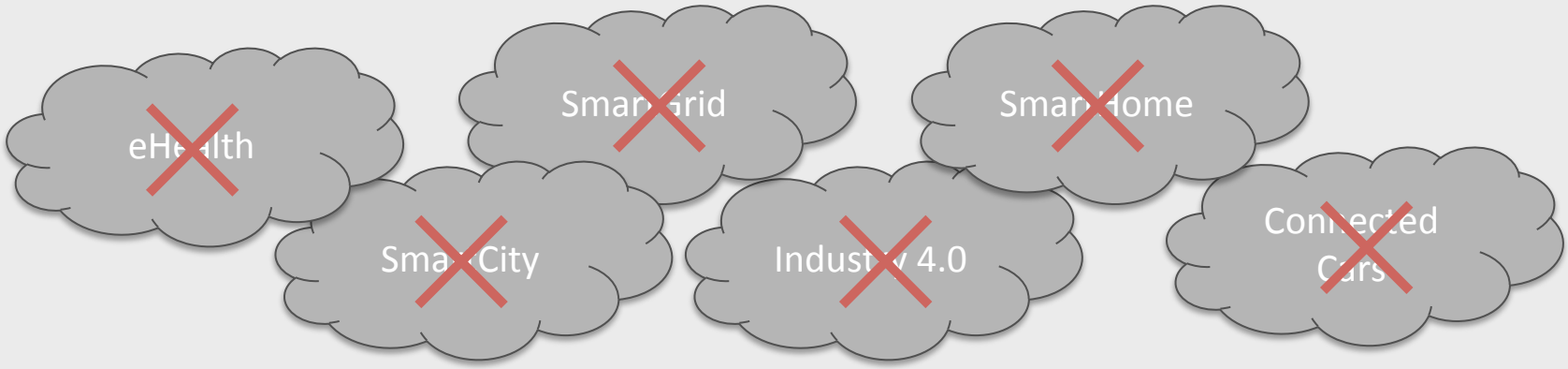
Prove & Run's mission

Enable the Internet of Tomorrow =

Internet of Things + Security

Without security:

- Impossible to deploy a network of connected devices
- Impossible to scale the Internet of Things
- Impossible to trust a system to keep data private & confidential



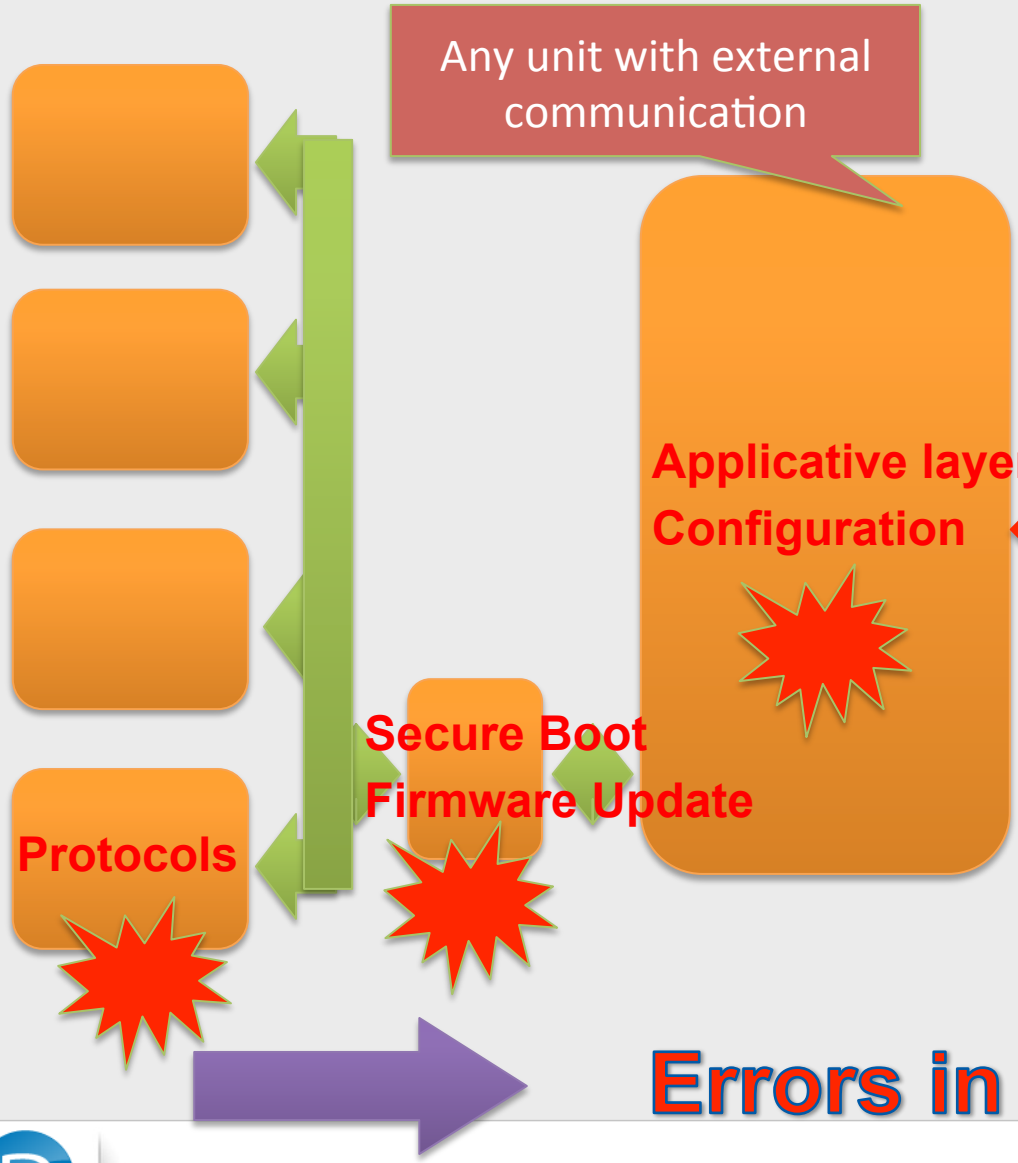
July 2015 Miller & Valasek's Attack

- Malicious connection to infotainment through Uconnect™
- Malicious firmware update
- Sending fake / impersonating commands (commands for the air conditioning, for the engine, etc.)

Wired Magazine 7/21/2015

⇒ Combination of logical problems on open architecture

Car Hacking – Jeep example



- Hackers can use communications with the external world to exploit errors in:
  - Applicative layers,
  - Protocols,
  - Configuration,
  - Personalization,
  - Firmware update,
  - Secure Boot,
  - OS/Kernel,
  - ...

Errors in security rationale

Security is as strong as its weakest link

- **Security chain:**
  - Cryptographic algorithms
  - Cryptographic protocols
  - Technology and know-how to resist physical attacks
    - Ex: Smartcards
  - Technology and know-how to resist logical attacks
    - Hackers will exploit bugs, weaknesses and errors that exist in thousands in the software of embedded systems, in particular Operating Systems.
    - Existing OSs such as Android, Linux and large RTOSs cannot be technically secured and used as such:
      - 1000's of bugs officially reported / year

Security is changing …

- **Traditional: small TCB with few peripherals and small attack surface**
  - Secure element is usually the right solution
  - Resistance to physical attack is the biggest challenge
- **More peripherals and thus larger TCB and larger attack surface (typically mobile security)**
  - Use a small secure OS kernel (TEE),
  - Resistance to physical attack can be addressed with secure elements or similar embedded IP,
  - Resistance to logical attack becomes the biggest challenge

Security: the IoT disruption

- **IoT case: Still more peripherals, better business model for hackers, larger damages at stake, with large TCB and large attack surface, in many cases remote device is unattended, etc.**
  - Logical and Physical TCB are to be distinguished
  - Resistance to physical attack can still be addressed with secure elements or similar embedded IP
  - The secure OS kernel (such as the TEE), and all other complex parts of the TCB need to be formally verified
  - Resistance to logical attack is achieved using a trusted and reliable security rationale (attacks exploit error in the security rationale)

Addressing the New Challenge

- **Use of a state-of-the-art security methodology to clearly identify the security issues of the targeted system**
  - For example the Common Criteria methodology
  - The rationale of why security is achieved needs to be provided in an auditable format:
    - Perform a Risk Analysis
    - Confidence in rationale is key
    - Identify the “Trusted Computing Base” (TCB)
    - TCB should be small enough to be trustable
    - Large OSs such as Linux or Android when used should not be part of the TCB
- **For the OS and kernels that are included in the TCB;**
  - Apply formal methods to the complex part of the TCB (this includes kernels)
  - Ability to get as close as possible to “Zero-Bug”
  - Ability to demonstrate security (proof and certification)
- **Reach the highest levels of security at cost/skills requirements compatible with value chain constraints**
  - Reuse COTS to control the cost of developing a secure product

Prove & Run answer's to the challenge

- **Two critical secure COTS (ready for integration) that are needed to host "security sensitive" applications and to build layered security perimeters:**
  - ***ProvenCore***: Microkernel proven for security to secure gateways and connected devices (Industrial Things), smartphones, tablets, etc.
    - Execution of security-critical applications
    - Secure protection of the "Smart and Safe world" (Existing OS)
    - Provided together with its *Secure Boot*
  - ***ProvenVisor:*** Proven secure hypervisor for mobile devices and IoT virtualization solutions
    - Secure isolation of existing OSs and legacy SW stack
  - ***Built with ProvenTools***: A patented software development tool that makes it possible to formally prove the correctness of the software
    - Be as close as possible to "zero-bug"

Remote attacks exploit entry points

Rich OS based system (Linux, Windows, Android, …)

AUT

CL

SB

FU

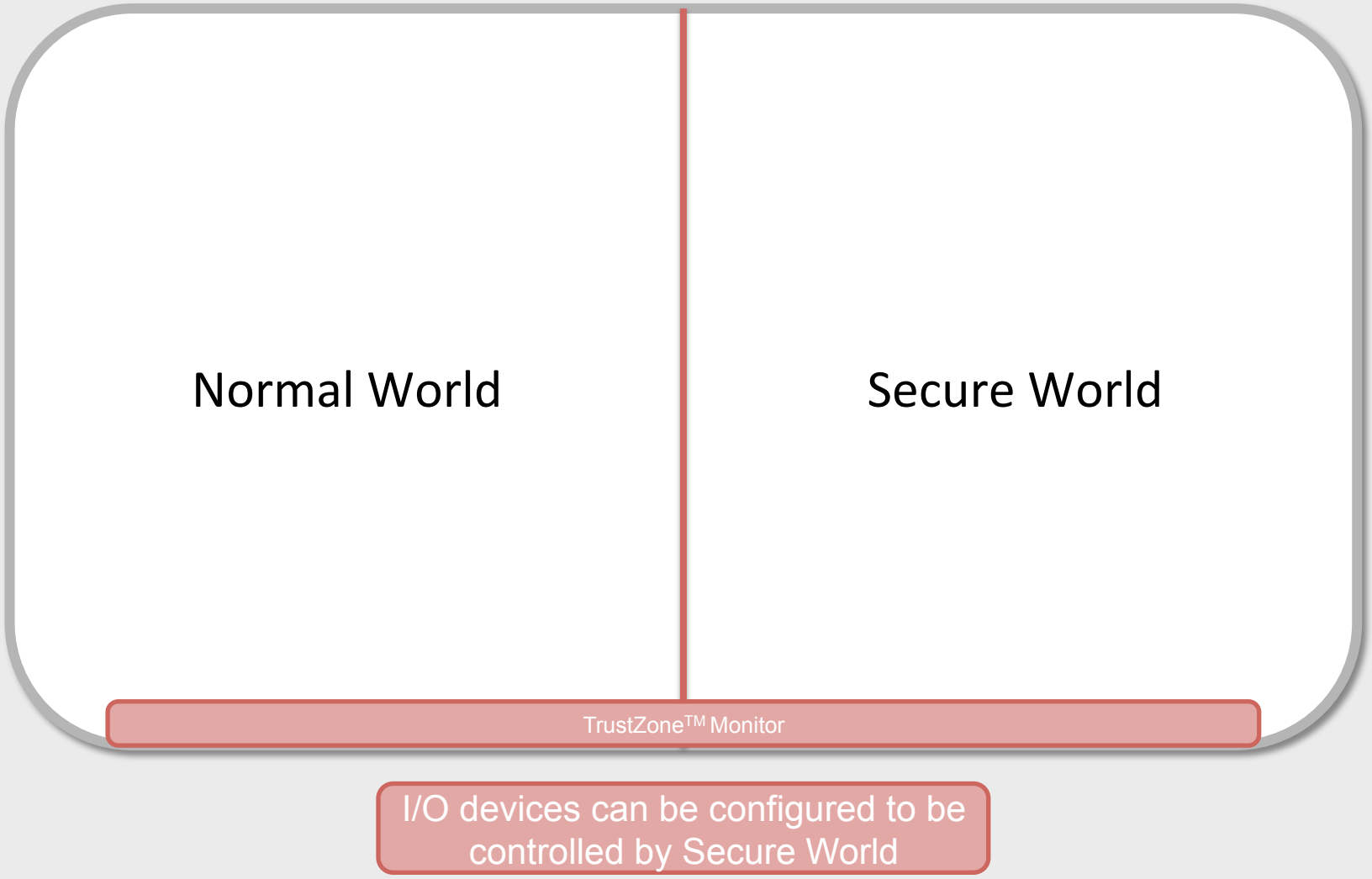
FW

SS

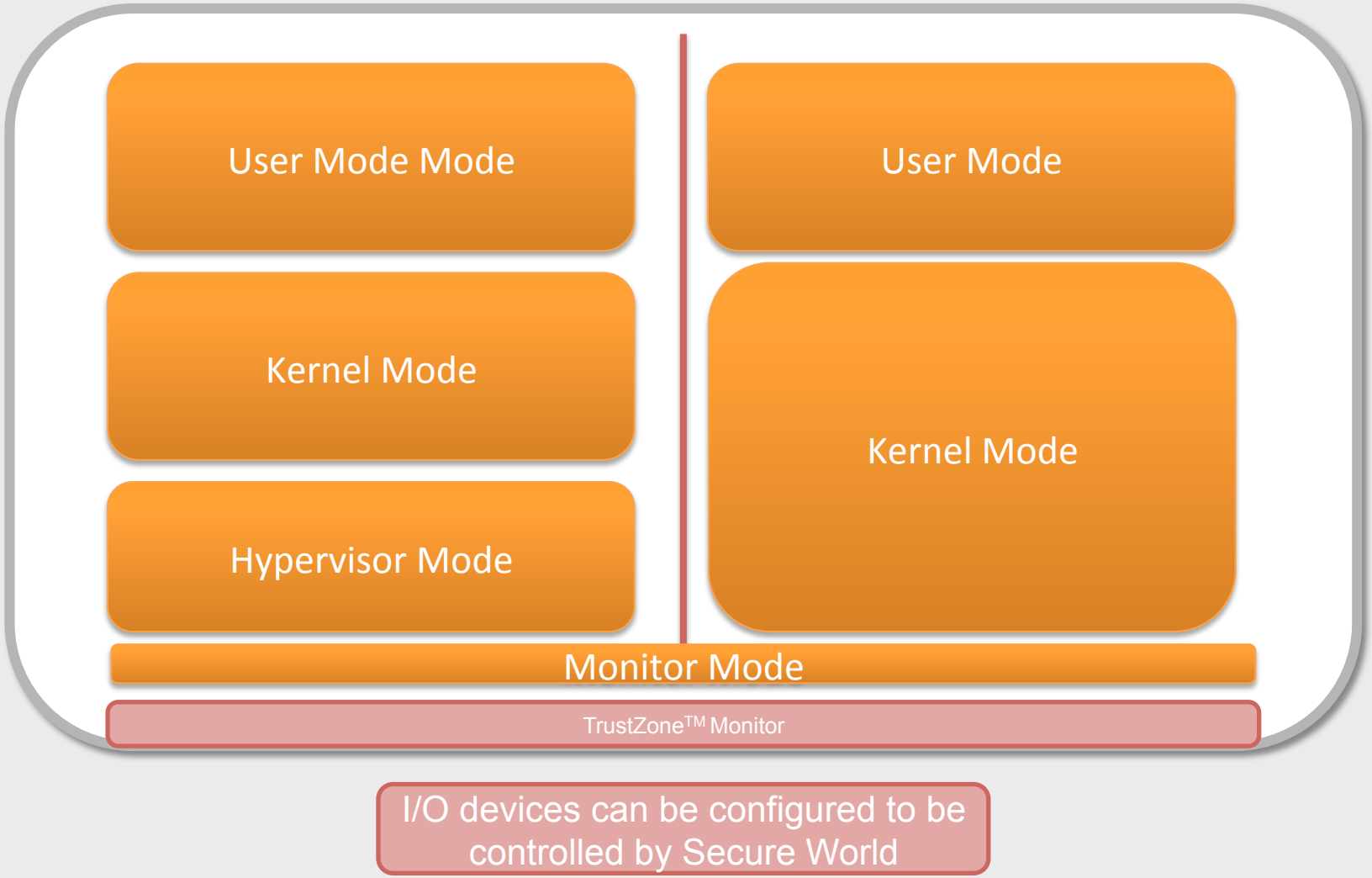
SB:	**Secure Boot**
FU:	**Firmware Update**
FW:	**Firewall**
SS:	**Secure Storage**
CL:	**Crypto Library**
AUT:	**Authentication**

Trusted Computing Base

TrustZone ARM Cortex A – High Level Principles

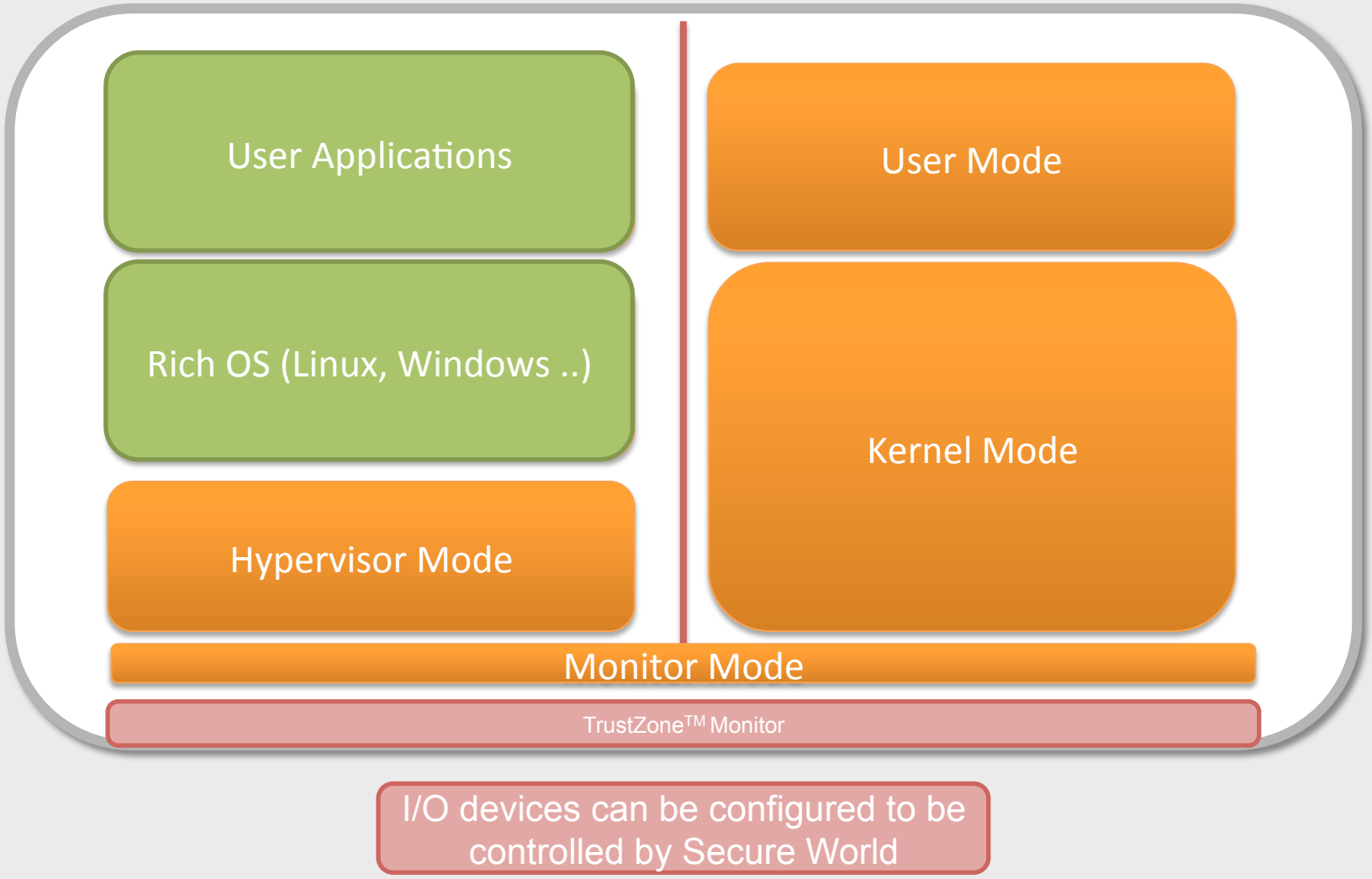


TrustZone ARM Cortex A – High Level Principles

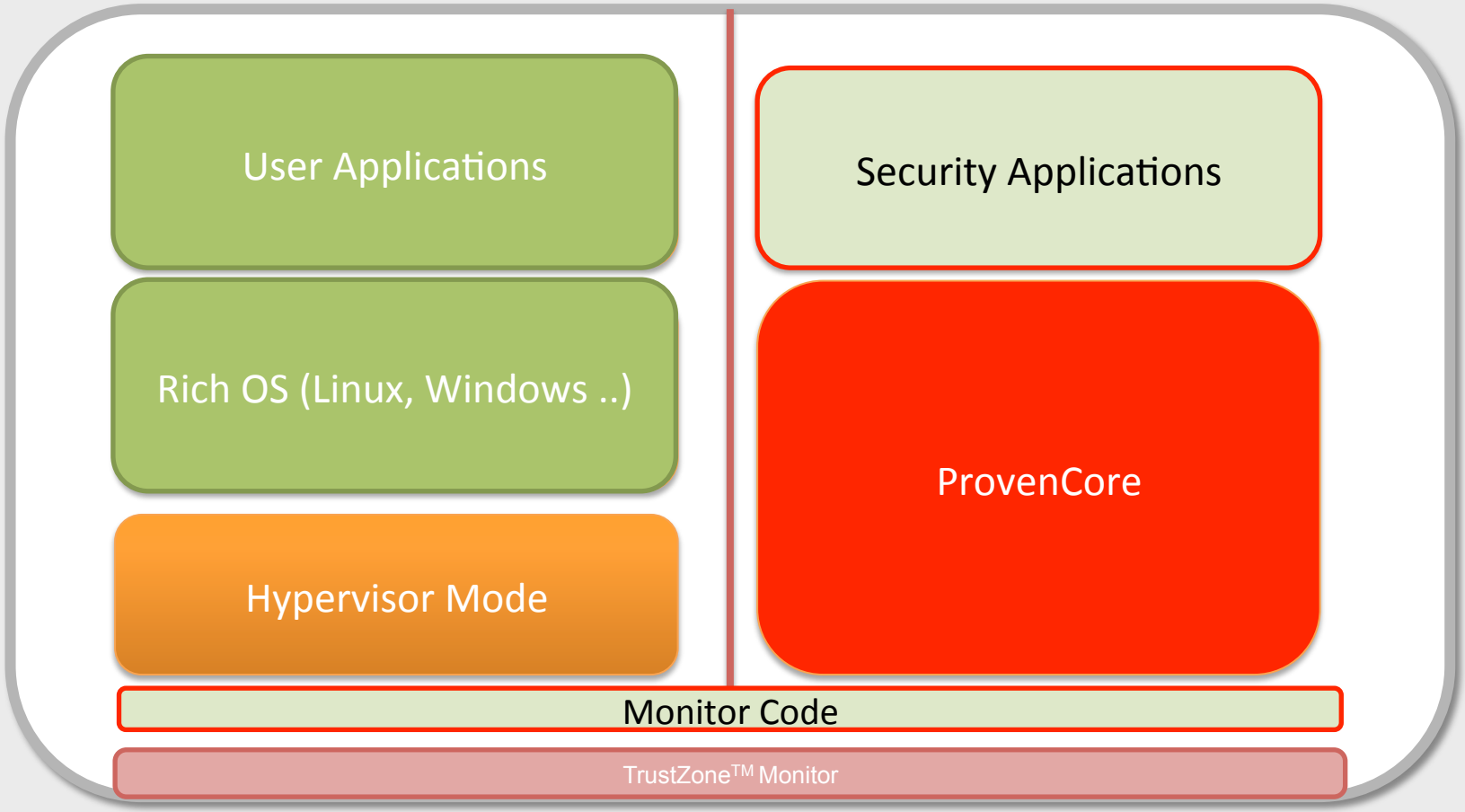


I/O devices can be configured to be controlled by Secure World

TrustZone ARM Cortex A – High Level Principles



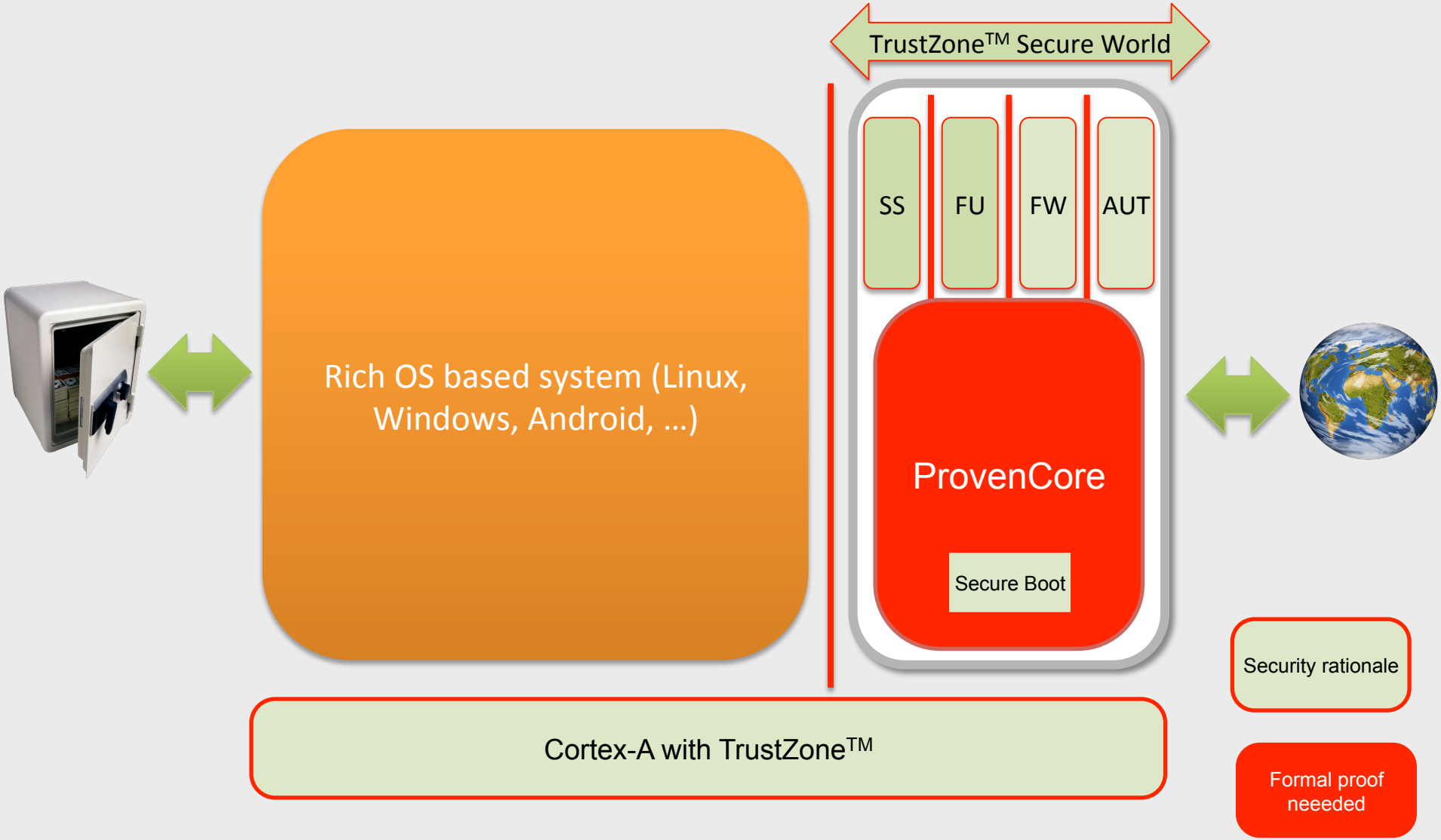
TrustZone ARM Cortex A – High Level Principles



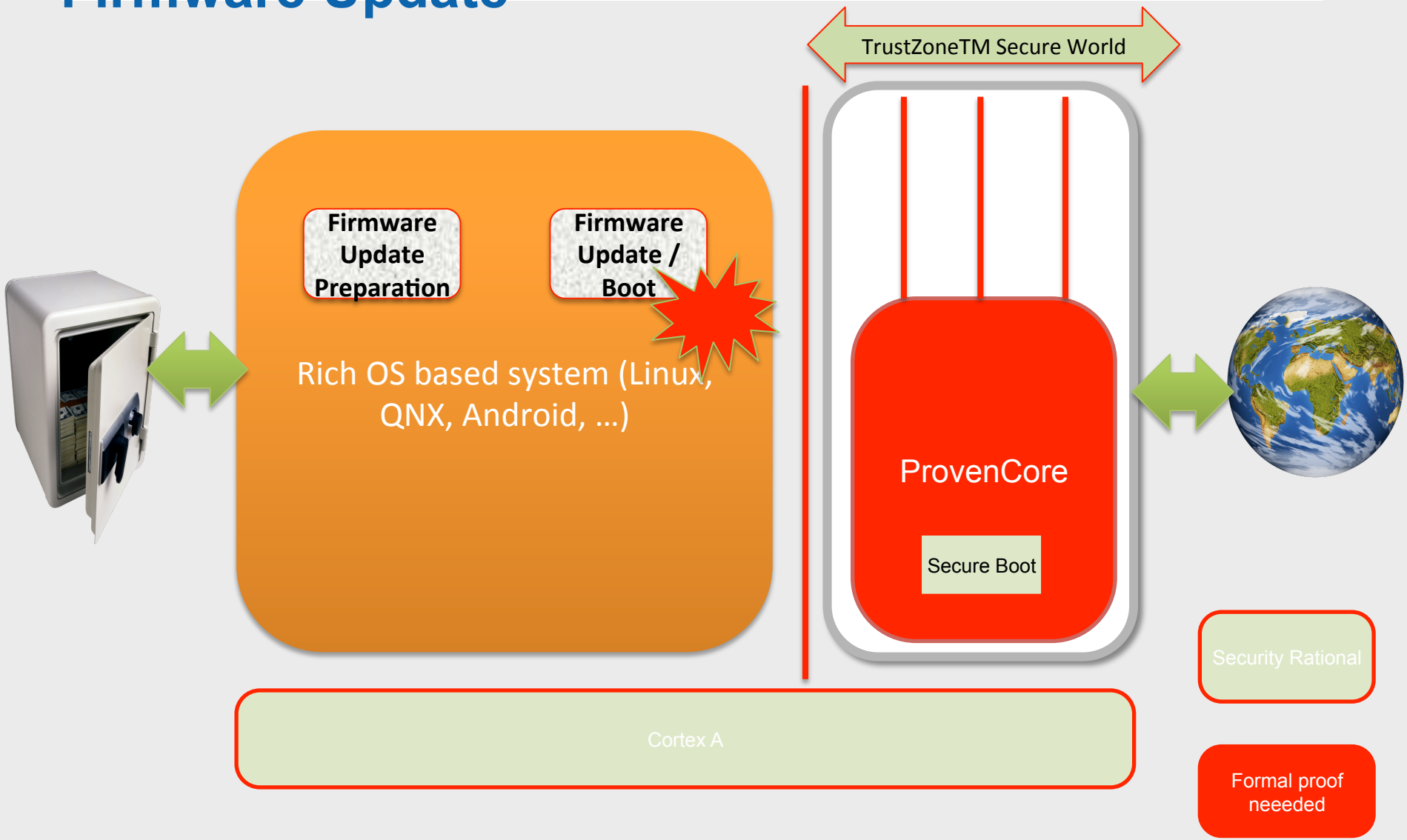
I/O devices can be configured to be controlled by Secure World

Formal proof neeeded

Securing an Entry Point on ARM Cortex-A



Looking more closely to the Secure Remote Firmware Update



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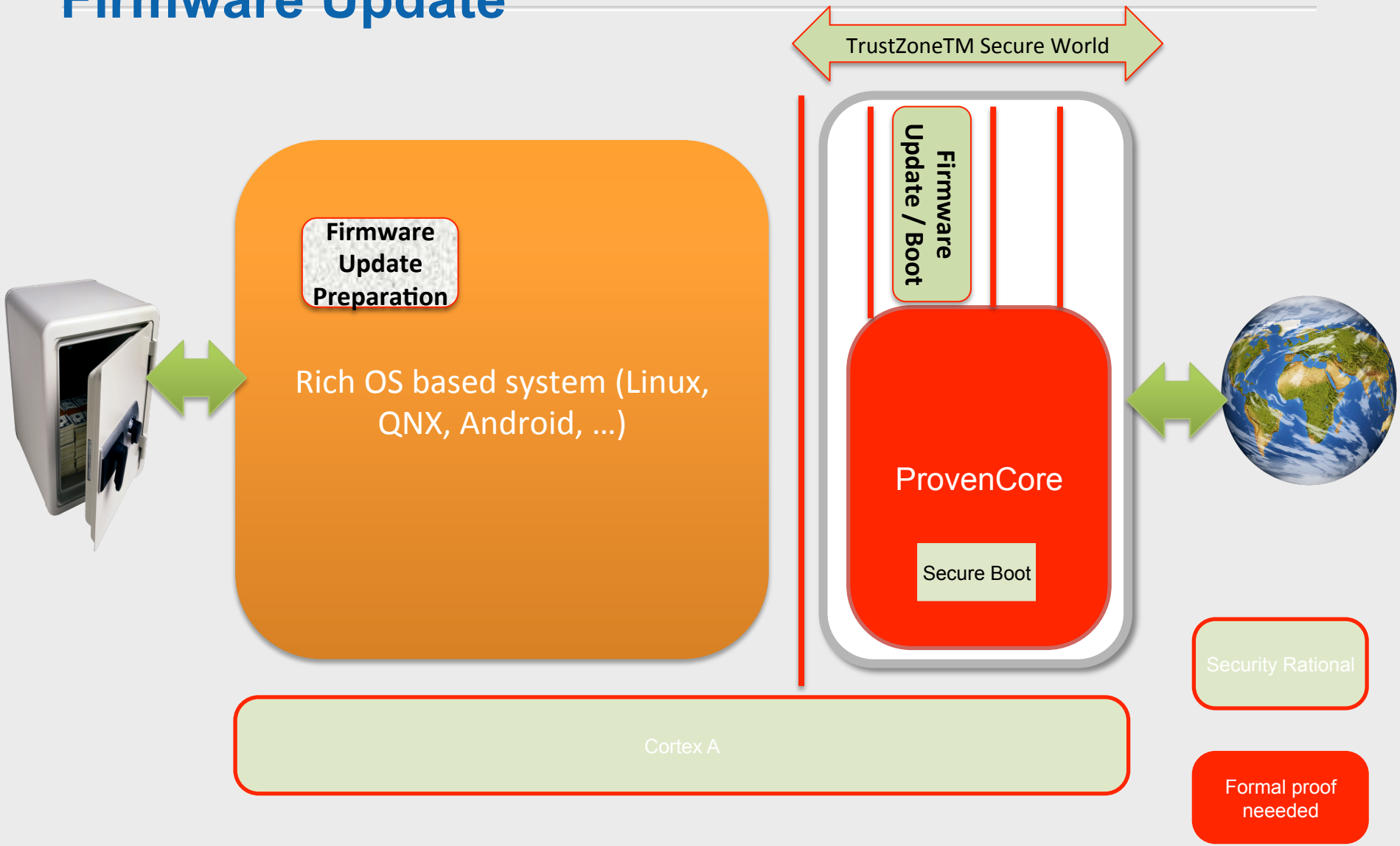
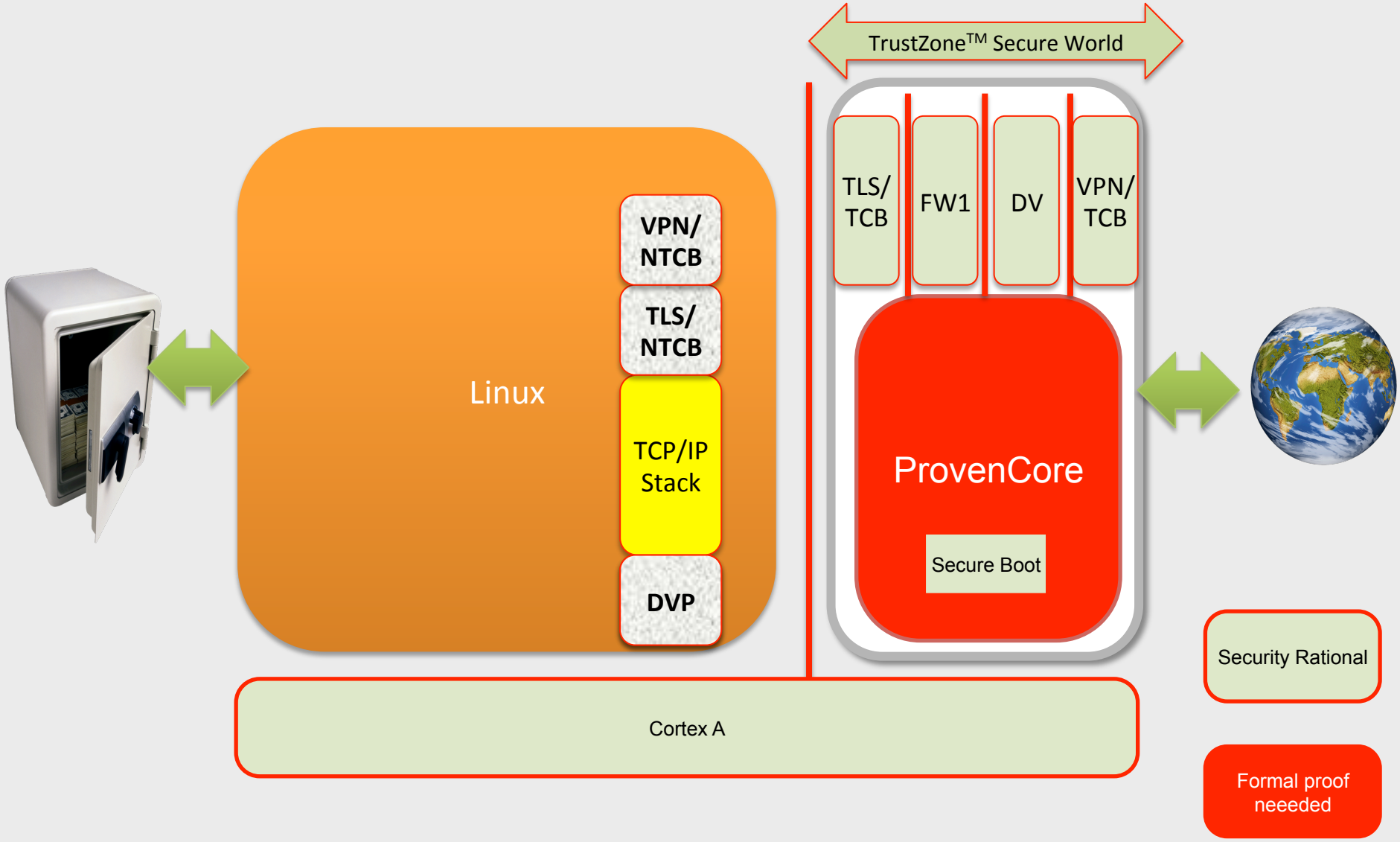
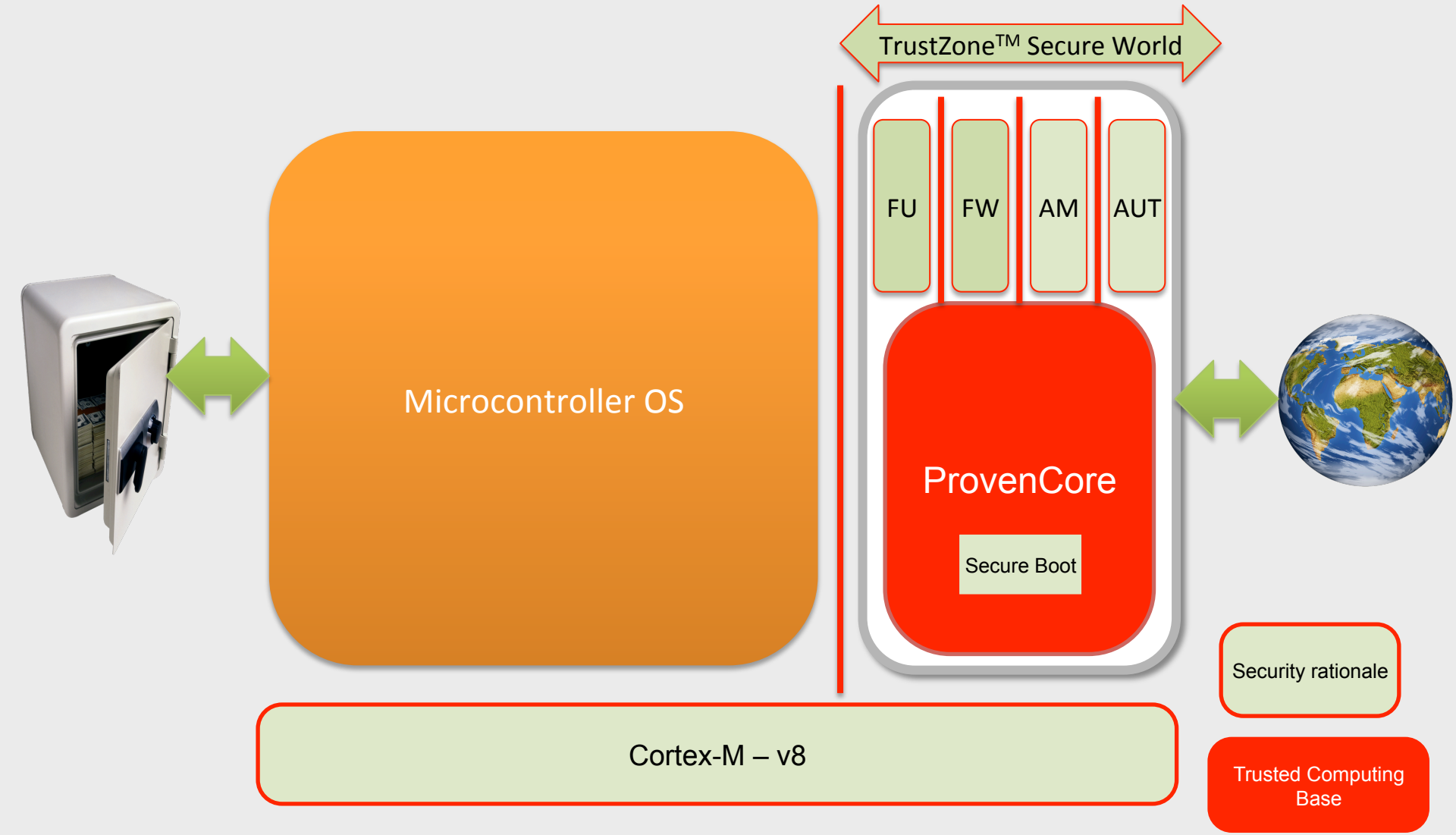


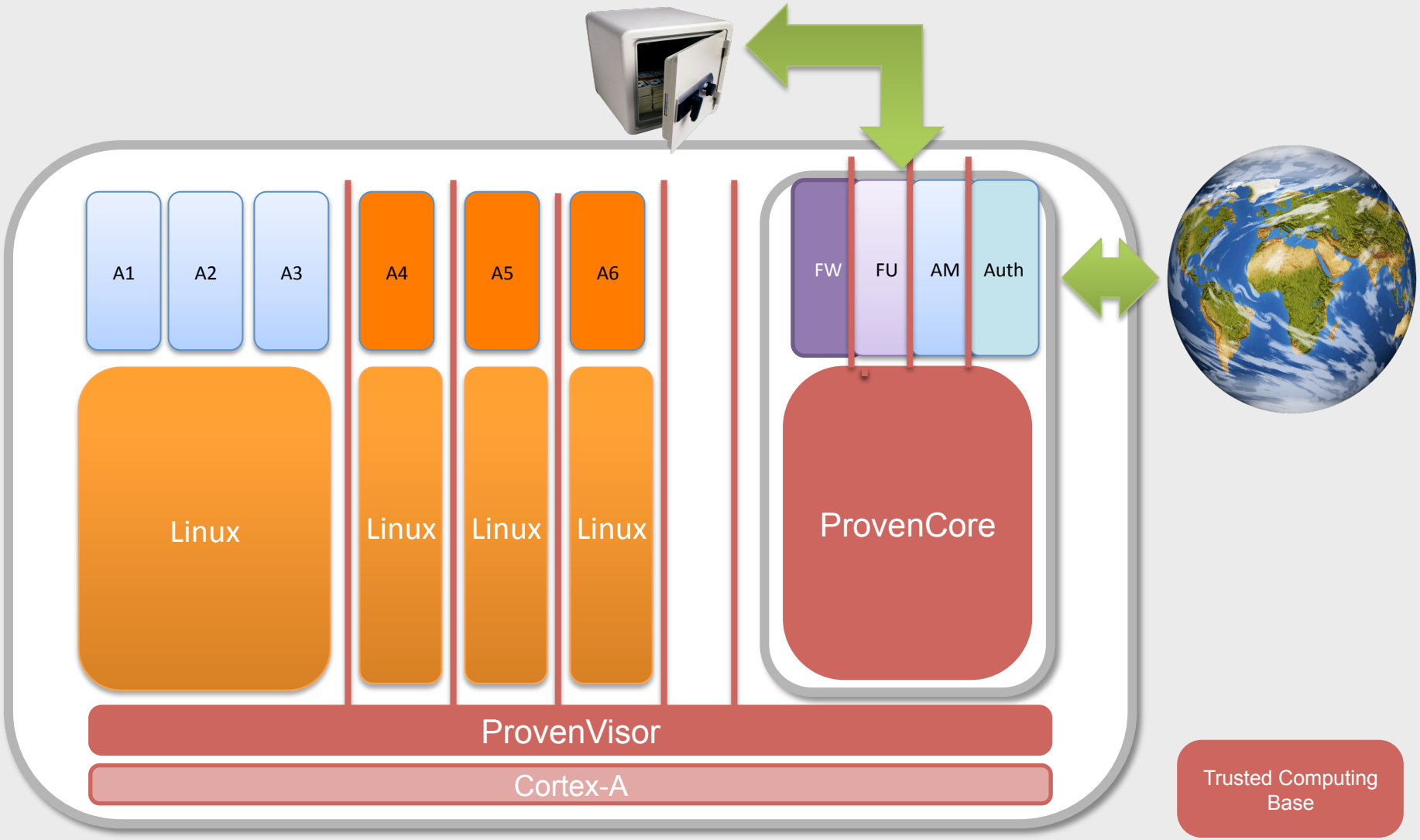
Looking more closely to the TCP/IP Firewall



ARM next-generation microcontrollers (Cortex-M v8)



Using a Hypervisor



Using an Hypervisor

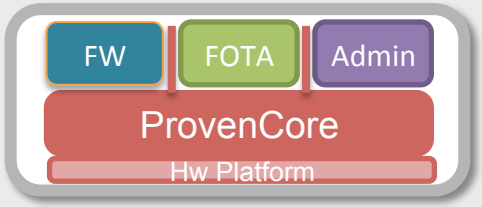
- **An hypervisor may be used to virtualize hardware or create virtual hardware isolation**
  - Either because you want to replace two or more processors by a single one
  - Or because you want to have more virtual chips to isolate software stacks.
- It is thus important to do it securely and this is why we need a really secure hypervisor such as **ProvenVisor**

But an hypervisor is just not enough

But a secure OS kernel is required

- **You need to have security applications to do various tasks:**
  - Filtering various communications channels, Firmware Update (FOTA), Using and managing keys, Administrating configurations and security, Logging events, possibly Performing various analysis and attack responses, etc.
- **You need to place such secure applications on a trusted and robust ground:**
  - Not on a large untrusted OS such as Linux (even sitting on a hypervisor, as it will have to communicate and interact with the peripherals and is thus vulnerable)
  - Not on hardware,
  - Not on a hypervisor (which would provide by definition a similar hardware abstraction)

Requires a secure OS/kernel



Conclusion

- **With a secure boot and ProvenCore you can cope with a very large set of security issues:**
  - ***ProvenCore***: A microkernel proven for security
    - Execution of security critical applications (firewalling, FOTA, etc.)
    - Secure protection of the “Smart and Safe World” (Existing OS)
- **For more sophisticated cases, you may need to have a secure hypervisor**
  - ***ProvenVisor:*** A proven secure hypervisor
    - Secure isolation of existing OS and legacy SW stack
  - ***ProvenCore and ProvenVisor are built with ProvenTools***:
    - To be as close as possible to “zero-bug”