How to Secure Network Equipment Against Attack

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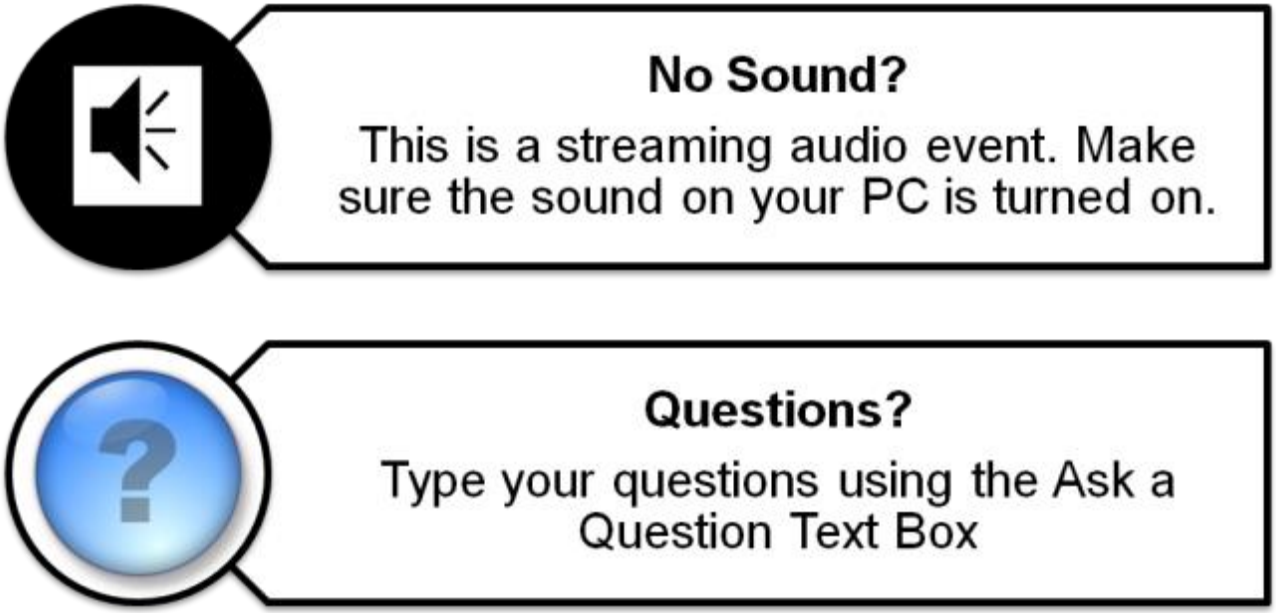
Webcast Logistics



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Today's Presenters

Bill Sulzen
Technical Leader
Cisco Systems

Michael Eckel
Security Technologist
Huawei Technologies

Steve Hanna
Senior Principal
Infineon Technologies

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Agenda

- Threats to network equipment
- Locking down firmware
- Introduction to trusted computing
- Networking applications for trusted computing
- From guidance to reality
- Call to action
- References

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THREATS TO NETWORK EQUIPMENT

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Threats to Network Equipment

- Network equipment is critical infrastructure
- Threats include:
  - Data theft
  - Launch point for further attacks
  - Denial of service
  - Damage to network equipment
- Recent headlines:

  "Russian hackers mass-exploit routers in homes, govs, and infrastructure[1]*"*

  "Over a million vulnerable fiber routers can be easily hacked[2]*"*

  "Wikileaks Unveils 'Cherry Blossom' – Wireless Hacking System[3]*"*

1. https://arstechnica.com/tech-policy/2018/04/russian-hackers-mass-exploit-routers-in-homes-govs-and-infrastructure/
2. https://www.zdnet.com/article/over-a-million-vulnerable-fiber-routers-can-be-easily-hacked/
3. https://thehackernews.com/2017/06/cia-wireless-router-hacking-tool.html

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Securing Network Infrastructure

- Today's scope: Embedded networking systems like routers, firewalls, switches, industrial and IoT gateways

- It's important to consider security at all levels
  - But particularly firmware

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LOCKING DOWN FIRMWARE

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Firmware Attacks

- Why so much focus on firmware attacks?
- It's the first link in the chain of trust
  - **If you skip a link in the chain, the remaining links cannot be trusted**
- Firmware hacks are usually persistent
  - Firmware is not usually updated or examined
    - Good for stealthy attacks!
  - Hacks can be un-removable*

*Without a hardware programmer

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Securing Firmware

Two simple steps:

1. Make sure that the OS cannot modify firmware
   - **This usually needs some kind of hardware help to lock boot flash memory**

2. Make sure that the BIOS (or U-Boot or whatever) won't update itself without checking a signature on the new image

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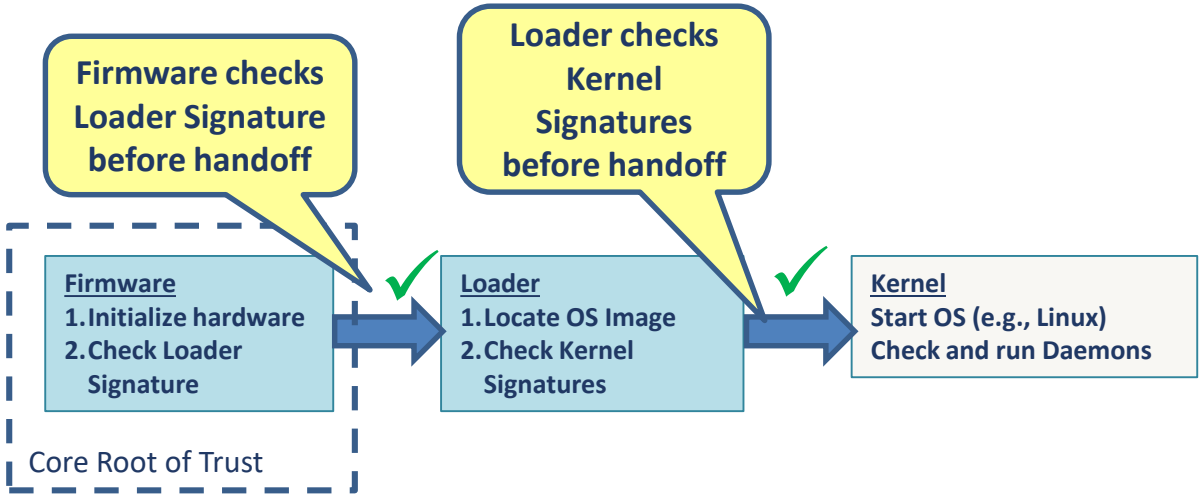
Secure Boot

- Secure boot(*) is a process that ensures that the device boots unmodified, authorized software
- Secure boot is achieved by providing an unbroken “chain of trust” from the first instruction executed after reset through to the OS prompt.



*aka Verified Boot

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INTRODUCTION TO TRUSTED COMPUTING

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What is a Trusted System?

- Predictable, even under stress
- Trust based on experience and/or evidence
- Trust based on fundamental properties:
  - Identity
  - Integrity

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Trusted Computing Group (TCG)

Open Standards for Trusted Computing

- TCG is the only group focused on Trusted Computing standards

- You know TCG for our technical specs & guidance such as:
  - Trusted Platform Module (TPM = ISO 11889)
  - Self-encrypting drives (SED)
  - Trusted Network Communications (TNC)

- TPM specification implemented in more than a billion devices
  - Chips integrated into PCs, servers, printers, kiosks, industrial systems, and many embedded systems

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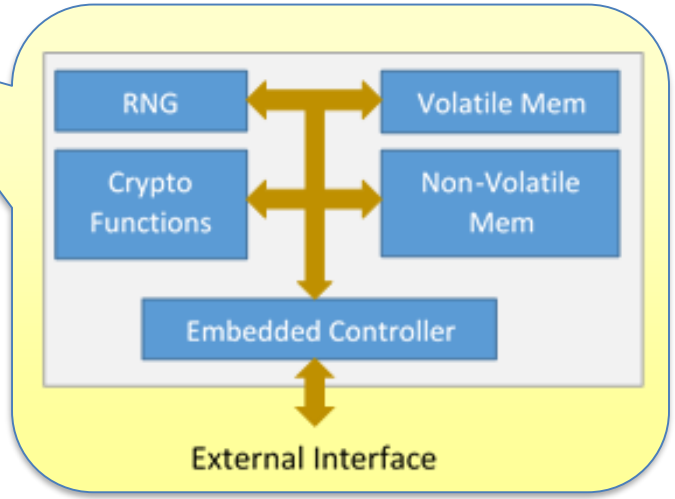
Trusted Platform Module (TPM)

The Standard Hardware Root of Trust



- Trusted Platform Module (TPM)
  - Self-contained security processor
  - Inexpensive & small (~0.1 watt, ~$1)
  - Connects to inexpensive processor buses
- TPM provides:
  - Secure storage of boot state (= hashes of objects)
  - Secure storage of runtime state (= hashes of software applications)
  - Secure storage of cryptographic secrets (e.g. private keys)
  - Cryptographic-quality Random Number Generator
  - Resistance to physical attack (i.e. reverse-engineering) to keep private keys private
- Specified by Trusted Computing Group, a standards group

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NETWORKING APPLICATIONS FOR TRUSTED COMPUTING

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TCG Network Equipment Guidance

- *TCG Guidance for Securing Network Equipment* document
- Developed by TCG members, many involved in networking:
  - Cisco, HPE, Huawei, Juniper, and others
- Intended to help equipment vendors use TCG technology to secure network infrastructure
- Includes use cases, building blocks, and implementation guidance
- Published January 17, 2018

https://trustedcomputinggroup.org/tcg-guidance-securing-network-equipment

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Applications for TPM in Networked Gear

- Cryptographic Random Number Generator (RNG)
  - Unpredictable numbers are critical to secure cryptography
- Sealing secrets
  - Keep VPN keys and other data-at-rest secure
- IEEE 802.1AR cryptographic device identification
  - Use spoof-resistant cryptographic means to identity devices
- Software attestation / health check
  - Use records kept by the TPM to fingerprint each software module run
- … and many others

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Random Number Generator

Essential for Secure Protocols

- Protocols like IPsec, SSH, SSL and TLS use cryptographic keys
- Keys are often generated within the embedded device itself
- Keys are like passwords:
  If you can guess the key, you can break the protocol.
- Cryptographic keys are typically generated from random numbers
- Without hardware help, computer algorithms can only generate pseudo-random sequences, not truly random numbers
- Most TPMs contain a physical source of randomness (aka entropy) which can be used to generate reliable keys

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Sealing Secrets

Ensure that secrets remain secret!

- The TPM can be used to protect secrets like:
  - VPN shared-secret keys
  - Disk Encryption keys
- Configure the TPM so it will only decrypt the secrets for use when the platform is in a specified state, e.g.
  - Known, unmodified OS
  - Specific platform configuration
  - User password

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IEEE802.1AR Secure Device Identity

Proves Which Device is Which

- Many embedded devices are ‘remote’ and difficult to protect or even identify reliably.
- The TPM can be configured with a unique cryptographic identifier based on device serial number – based on IEEE spec 802.1AR (DevID)
- Public Key Cryptography allows the device to assert its identity
- … and then prove possession of a difficult-to-steal private key stored inside the TPM

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How Would a DevID be Used?

- Inventory
  - Ensure the devices you put in place are still there
- VPN login
  - Use DevID for remote login, so only authorized devices are allowed on your network
- Zero-Touch configuration
  - Ensure that only authorized devices can call in to obtain configuration

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Attestation and Measured Boot

Proves What Software was Launched on your Device

- Secure boot works well for *deterministic* early stages of boot
- But multi-core processors tend to be less predictable once the OS layer starts up
- The TPM can be used to record “measurements” (= hashes) of each executable run
- The TPM can then return those measurements to a management station later, signed by a key that only the TPM can know
- “Attestation” provides cryptographic assurance of which executables actually were run.

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FROM GUIDANCE TO REALITY

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Real-World Implementations

- So we have a great document
  - TCG Guidance for Securing Network Equipment
- How is that becoming real?

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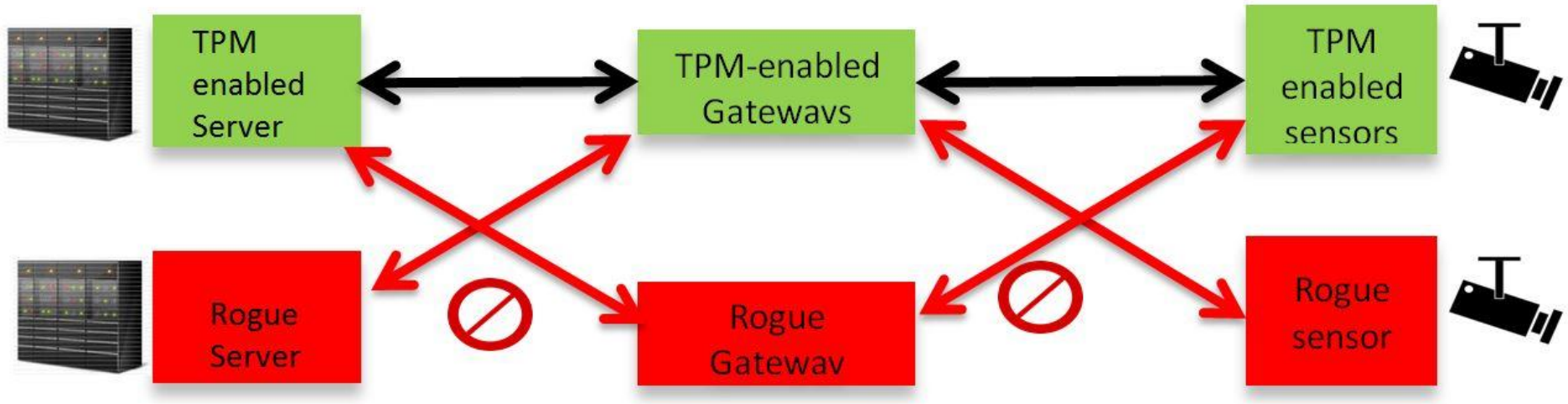
RSA Conference 2015

Cisco and Infineon Secure the IoT with TPM

- Remote attestation with IoT gateway, router, and server
- TPM-Protected Identity on all systems
- Rejects unauthorized or compromised systems



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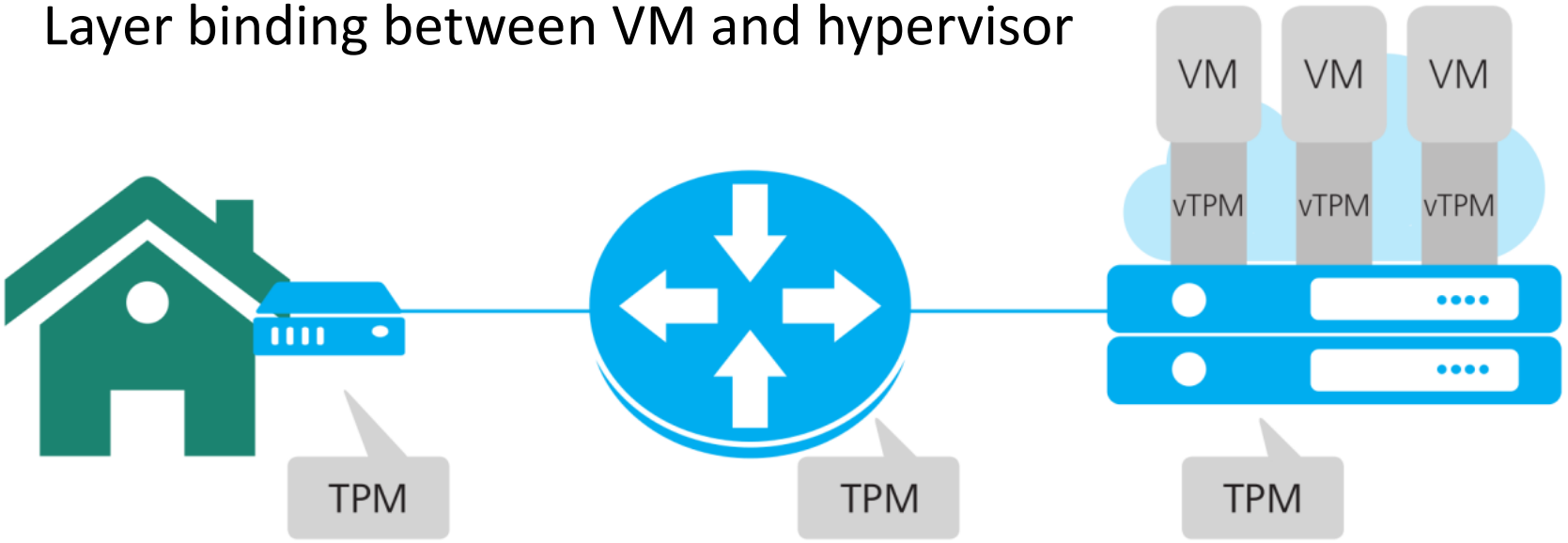
RSA Conference 2016

Huawei and Infineon Secure the IoT with TPM

- Remote attestation with IoT gateway, router, server, and VMs
- ARM, PPC, and X86 platforms equipped with a TPM
- Server running QEMU/KVM with vTPM
- One VM acted as verifier for attestations
- Layer binding between VM and hypervisor



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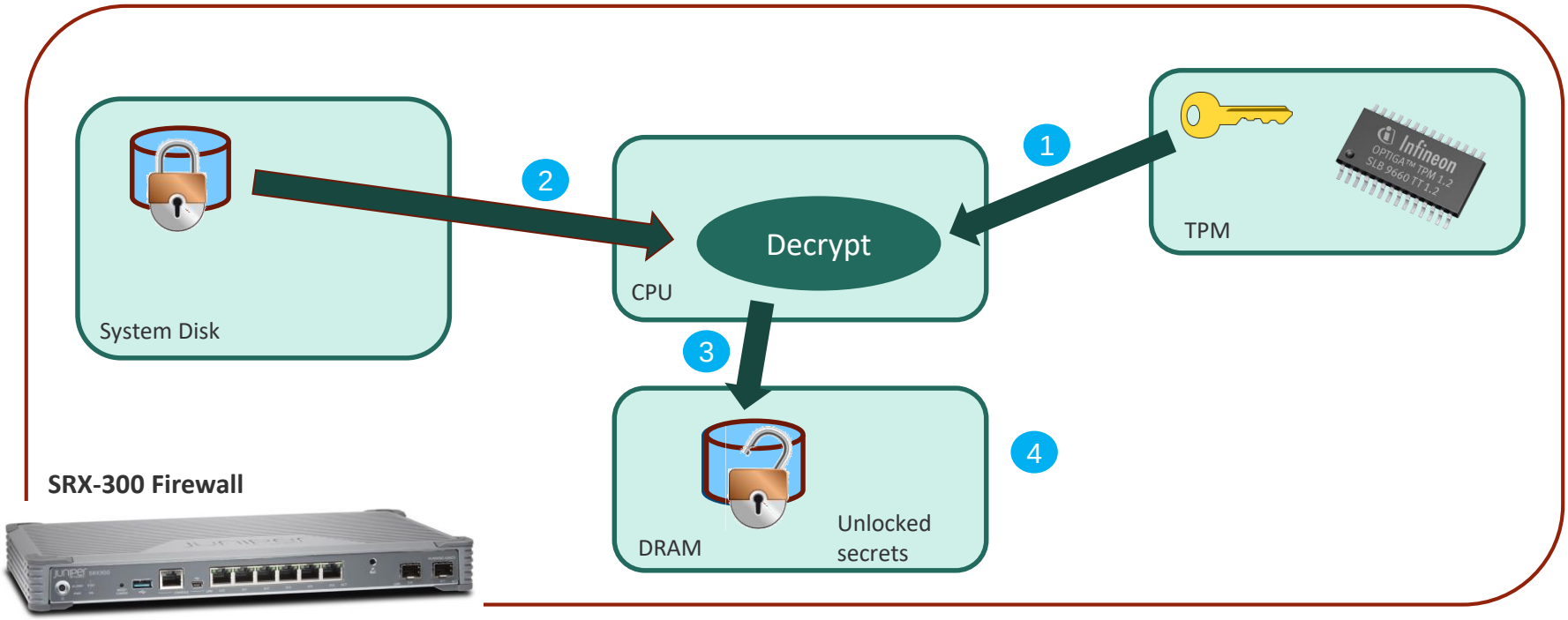
Mobile World Congress 2018

Juniper and Infineon Protect Keys and Configs with TPM



- Sensitive Data decrypted using key from TPM at boot time
- Decrypted secrets may be erased from DRAM when done to avoid exposure
- Secrets cannot be retrieved from a purloined system disk

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CALL TO ACTION

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What Can You Do?

- Review Network Equipment Guidance to learn more:
  - https://trustedcomputinggroup.org/tcg-guidance-securing-network-equipment/
- If you **build** network equipment,
  - Consider adopting the described techniques
- If you **buy** network equipment,
  - Ask your network equipment providers what they're doing about today's advanced threats

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REFERENCES

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Relevant Documents

- Trusted Computing Group:
  - https://www.trustedcomputinggroup.org/
- Network Equipment documents:
  - https://trustedcomputinggroup.org/work-groups/network-equipment/
- TPM documents:
  - http://trustedcomputinggroup.org/work-groups/trusted-platform-module/
  - https://trustedcomputinggroup.org/wp-content/uploads/TPM_Keys_for_Platform_Identity_v1_0_r3_Final.pdf
  - http://forums.juniper.net/t5/Security-Now/What-is-a-Trusted-Platform-Module-TPM/ba-p/281128
  - http://forums.juniper.net/t5/Security-Now/What-s-the-Difference-between-Secure-Boot-and-Measured-Boot/ba-p/281251
- TPM & Secure Boot:
  - https://technet.microsoft.com/en-us/itpro/windows/keep-secure/tpm-recommendations
  - https://msdn.microsoft.com/en-us/windows/hardware/commercialize/manufacture/desktop/secure-boot-overview

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TPM Software

- tpm2-tss
  - https://github.com/tpm2-software/tpm2-tss
- IBM TSS
  - https://sourceforge.net/projects/ibmtpm20tss/
- Mocana IoT Trust Platform
  - https://www.mocana.com/solutions
- OnBoard Security TSS
  - https://www.onboardsecurity.com/products/tss

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Questions?

Post Your Questions Now

Thank You!

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Contacting Trusted Computing Group

www.trustedcomputinggroup.org
admin@trustedcomputinggroup.org

LinkedIn Trusted Computing Group:
https://www.linkedin.com/groups/4555624

Twitter: @TrustedComputin

YouTube channel:
https://www.youtube.com/user/TCGadmin

BrightTalk webcasts (free): www.brighttalk.com, search "trusted computing" for library of demonstrations and presentations

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