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ONIE and Secure Boot

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ONIE and Secure Boot

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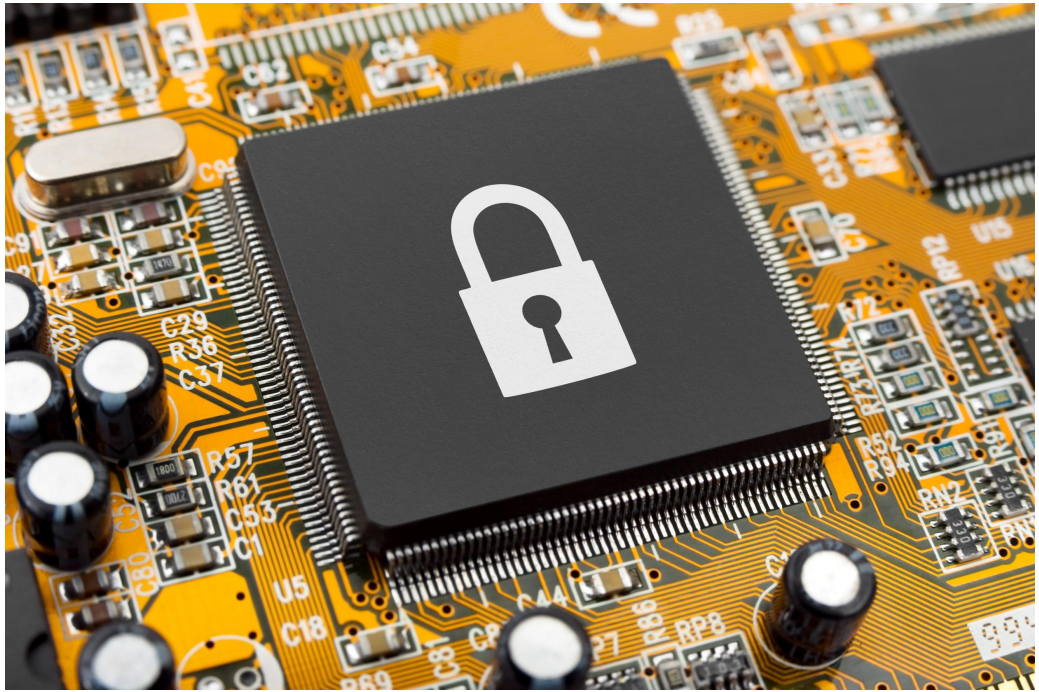
Talk Overview

- A Question of Trust
- Cryptographic Concepts
- Secure Technologies
- Applying it to ONIE

A Question of Trust

- Trusting Hardware
  - CPU
  - FPGA / CPLD
  - Boot Firmware
- Trusting Software
  - ONIE
  - Network OS Installer
  - Network OS Runtime



Security and Cryptographic Concepts

- Lots of Terminology
- Lots of Specifications
- Lots of Jargon

Security and Cryptographic Building Blocks

- Secure Hash (Digest)
  - `digest = sha256(message)`
- Hash Extend
  - `A = hash(original A || message)`
- Public / Private Key Crypto
  - `encrypt(key_public, message) => M'`
  - `decrypt(key_private, M') => message`

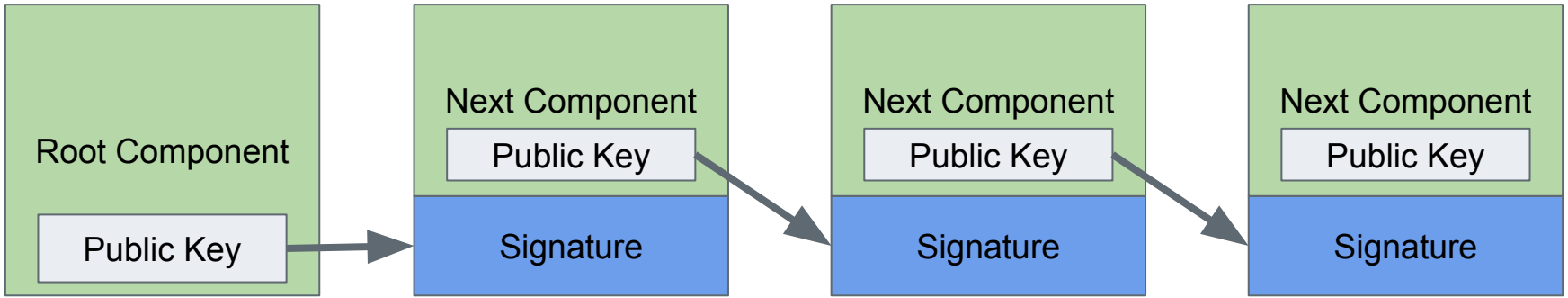
Digital Signatures

- Creating a Signature, sender
  - `signature = encrypt(key_private, hash(message))`
- Send original message and signature to recipient
- Verifying Signature, recipient
  - `digest = hash(message)`
  - `claimed_digest = decrypt(key_public, signature)`
  - `does (claimed_digest == digest) ??`

Root of Trust, Chain of Trust

- Ultimately a core component of the system is “trusted”
- The trusted core verifies the next stage of the boot process before handing off control
- The next stage continues the trust relationship, verifying the next stage before handing off control
- Repeat

Root of Trust, Chain of Trust, Cont.

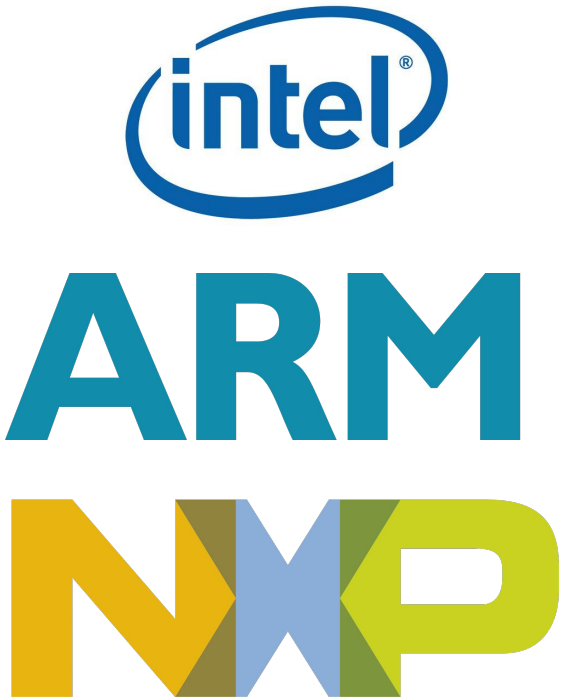


Each component verifies the next component

CPU Security Technologies

- Varies by CPU Manufacturer
  - x86_64 - Intel Boot Guard, UEFI, TXT
  - ARM - Trust Zone, UEFI / Verified Boot
  - NXP
  - Thousands of pages of specifications

- All verify digital signatures in one form or another. Forms the root of trust for measurement.



Trusted Platform Module (TPM)

- Does a lot. Thousands of pages of specification.
- Measured Boot
  - Platform Configuration Registers
  - Hash Extend Platform State

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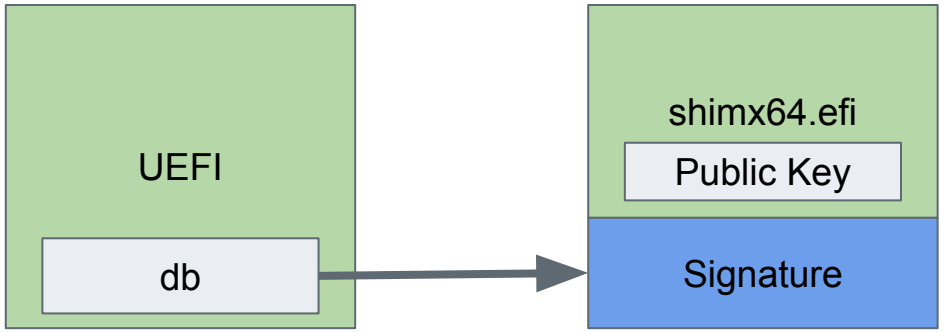
Linux Secure Boot on x86_64

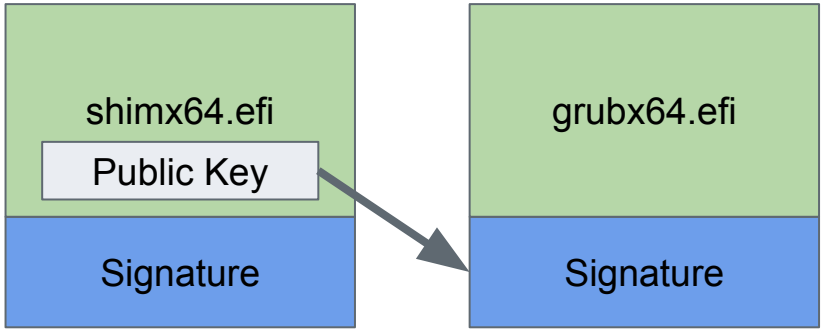
- Unified Extensible Firmware Interface (UEFI) firmware
  - Maintains a database of authorized public keys - **kek, db**
  - Maintains a database of blacklisted (revoked) keys - **dbx**
- shimx64.efi
  - Thin EFI application, signed by private key whose public key is in UEFI db
  - Contains a public key for verifying the next stage
  - Verifies and loads next stage
- MokManager.efi
  - Machine Owner Key (MOK) database
  - Supplementary database of keys for verification
  - Used by shimx64.efi during image verification

Linux Secure Boot on x86_64, Cont.



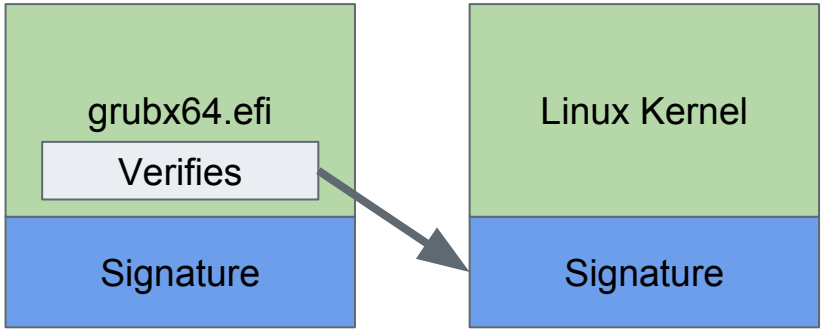
- UEFI verifies shimx64.efi
- shimx64.efi is signed by a private key, whose public key is in the UEFI db

Linux Secure Boot on x86_64, Cont.



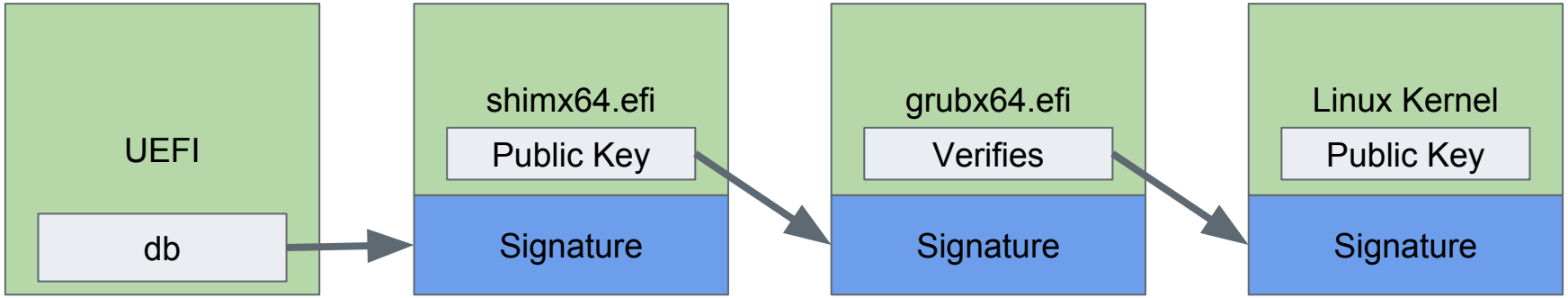
- shimx64.efi verifies grubx64.efi using one of:
  - Internal key
  - UEFI db, dbx
  - MOK db, dbx
- Provides verification interface for grubx64.efi to use
- Measures grubx64.efi image and MOK database into TPM PCRs

Linux Secure Boot on x86_64, Cont.



- grubx64.efi verifies Linux kernel
- Uses interface provided by shimx64.efi for verification
  - consults UEFI kek, db, dbx, MOK db, MOK dbx

Linux Secure Boot on x86_64, All Together



- UEFI verifies shimx64.efi
- shimx64.efi verifies grubx64.efi
- grubx64.efi verifies Linux kernel
- Linux kernel verifies kernel modules, etc.

Applying to ONIE

- ONIE is a Linux based operating system
  - Linux Kernel
  - initramfs

- The ONIE Secure Boot flow will follow the shim model
  - ONIE shimx64.efi
  - ONIE grubx64.efi
  - ONIE kernel and initramfs

ONIE Image Discovery Waterfall - NEW

- Locate an installer via the image discovery waterfall
  - Local file
  - DHCP options
  - etc...
- **NEW** - Verify the signature on the installer before execution
  - UEFI kek, db, dbx
  - MOK db, dbx
  - Continue waterfall if verification fails
- Execute the Installer
  - NOS installer prepares its NOS for Secure Boot

Collaboration and Input Needed

- Open Questions and Details:
  - What about secure firmware updates?
  - Build system modifications
  - PKI, Certificate Authorities and key management

Further Reading

- Unified Extensible Firmware Interface Specification
  - Version 2.6, January 2016, http://www.uefi.org/
- Platform Initialization Specification: Volume 1
  - Pre-EFI Initialization Core Interface
  - Version 1.5, July 2016, http://www.uefi.org/
- TCG PC Client Platform Firmware Profile Specification
  - Level 00 Revision 00.21, March 30, 2016
  - https://trustedcomputinggroup.org/
- TCG PC Client Specific TPM Interface Specification
  - Version 1.3, 21 March 2013
  - https://trustedcomputinggroup.org/

Thank you!

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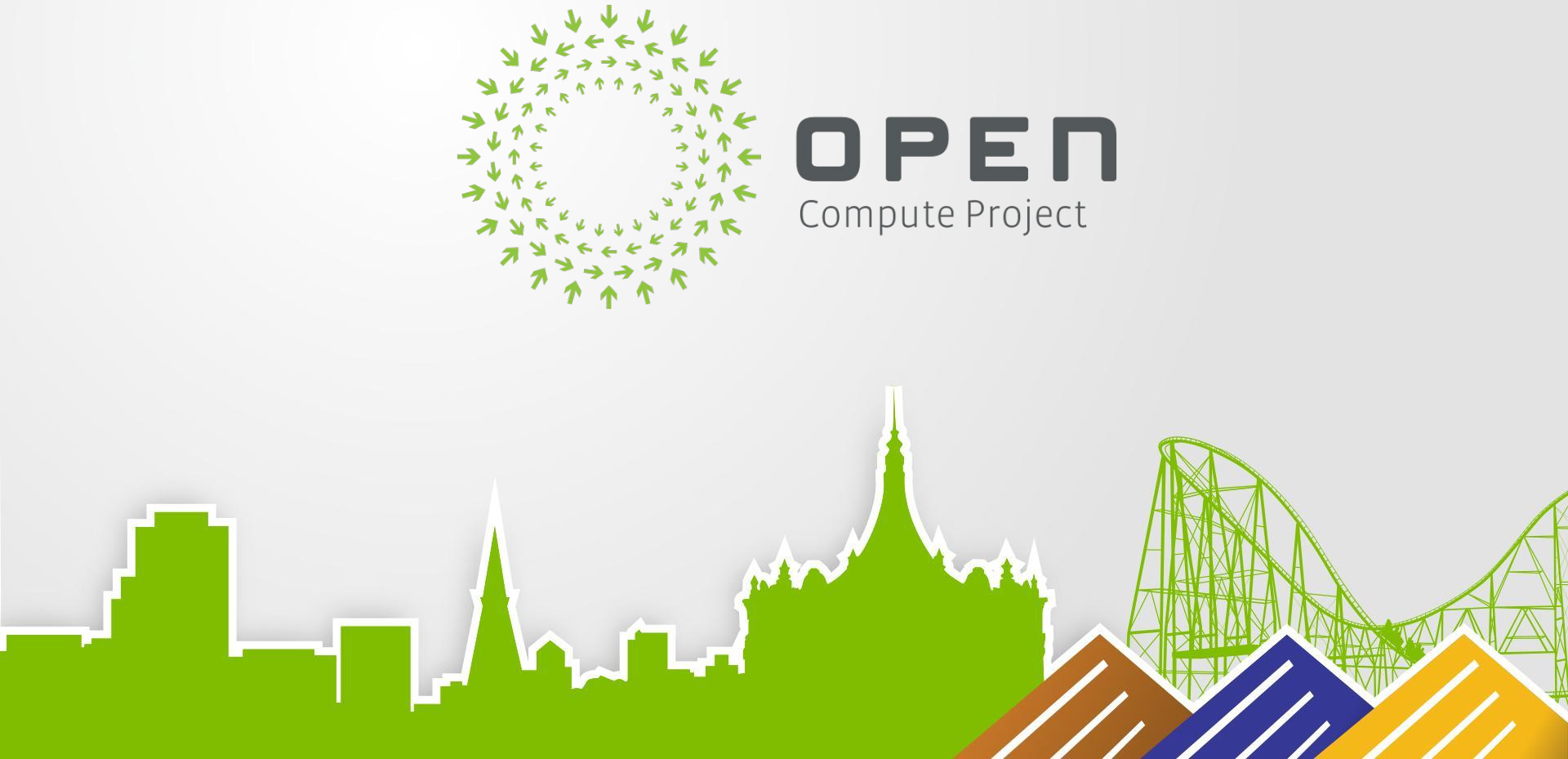
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