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Trusted Computing and Securing Devices

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Introduction

• The cloud today is connected with numerous devices

• Security continues to evolve to address threats
Device Security Techniques

- **Traditional:** PCs with TPM
  - Proven trusted computing benefits

- **Recent:** IoT Devices with TPMs
  - Fabulous when practical

- **IoT Devices with DICE**
  - Something new in draft from TCG
  - Device Identifier Composition Engine (DICE)
DICE Goals

• Improve security for updatable boot code
• Supports low power and low cost devices
• Identify the device and its software when connecting to cloud services
• Protect data by preventing access by old versions of software
• Cryptographically agile
Technology Timeline

• April 2016: Microsoft Research Robust Internet of Things (RIoT) Paper
• October 2016: TCG forms the DICE Architectures working group
• December 2016: TCG shares a draft DICE specification for public comments
• Ongoing: Microsoft publishes example code
DICE Basics

- Security is divided into boot layers
- Starts with unconditional actions in immutable code
- Secrets are passed to each layer of the boot process
- There is no persistent isolated environment
  - (Major difference from a TPM)
- Security components are intended to be combined with the device ROM and firmware by the manufacturer
Device Identifier Composition Engine (DICE)

- Platform reset starts in a trusted state
- Engine computes a value based on mutable code
Generating the Compound Device Identifier

- Immutable code has access to the Unique Device Secret, but the mutable code does not.
- Immutable code only passes the Compound Device Identifier to the first mutable code.

Diagram:
- Measurement of mutable code
- Unique Device Secret
- One way Function
- Compound Device Identifier
- Device Identifier Composition Engine Computation

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Mutable Code Actions

- Each layer of mutable code receives a secret
- The secret can be used to prove the identity and software booted
- Secret is combined with a measurement of the next boot layer
DICE Boot Flow Revisited

• The secret at each layer depends on the device identity and the code (including lower layers)

Reset

Immutable Code

Device Identifier Composition Engine

Secret: Compound Device Identifier (CDI)

Mutable Code 1

Use CDI and prepare for next layer

Secret: For the next layer

Mutable Code 2

Use secret and prepare for next layer

…..
Proving device identity and software

• The CDI can be used with a key derivation function to make an asymmetric key with a public and private portion
• If the first mutable code never changes, the CDI and the derived key values will be stable
• For the first layer, the manufacturer can issue a certificate for each device it makes and include the public portion of the key
• When the device performs a computation using the private portion of the key, it proves its identity and boot software
Proving software for later in boot

• The first layer of software has a certificate from the manufacturer.
• The each layer of software can use its private key and certificate to issue a certificates for the next layer
• Each successive layer can do the same thing, creating a chain of certificates
• The certificate chain can be used to establish TLS sessions proving the device and software
Chained Certificate Issuance

Once: Manufacturer issued certificate for the CDI derived key

Boot Time: Device issued certificate for secret A derived key

KDF(CDI)  KDF(Secret A)

Boot Time: Device issued certificate for secret B derived key

KDF(Secret B)

Immutable Code

Mutable Code 1

Mutable Code 2

Secret: Compound Device Identifier (CDI)

Secret A: For the next layer
MiniDICE Prototype Overview

• Open source example code implementing draft DICE requirements
• Tooling to help with common development and manufacturing tasks
• Hardware: STMicroelectronics M0+ Cortex microcontroller
• Shows how adaptable DICE concepts are for different platforms
MiniDICE Prototype Tooling

• Supports common Device Firmware Update (DFU) tool for application updates
• Tooling helps create application versions and signature blocks that include the identity of the previous version
• Helps manufacturers lock down the device by provisioning the signing key required to update the application payload later
• Shows an example of how the manufacturer might sign a device certificate
MiniDICE Prototype ROM Code

- Includes both the DICE Engine and the first layer of “mutable code” in ROM so they cannot change
- Authenticates updates and boot application
- Supports data migration by passing the CDI for current and the previous application payload
- Prevents rollback by storing and checking the application signature timestamp
Demo

• Initial ROM code and device identity already provisioned
• Build, sign and deploy an application payload
• Show the device identity secret
• Show the calculation of the compound identity
• Show how a certificate is made to prove the device’s application code measurement
Conclusion

• DICE shows promise as a new security technology

• Participate by
  – reviewing publications from Microsoft about RIoT
  – reviewing publications about DICE from TCG
  – joining TCG and working with other stakeholders
  – using published samples and adapting the features to your requirements
Resources


• TCG draft DICE specification: https://members.trustedcomputinggroup.org/kws/draft_specs/161012_Device_Identifier_Composition_Engine_Member_IP_and_Technical_Review.pdf

• MiniDICE reference code: https://github.com/LordOfDorks/miniDICE