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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

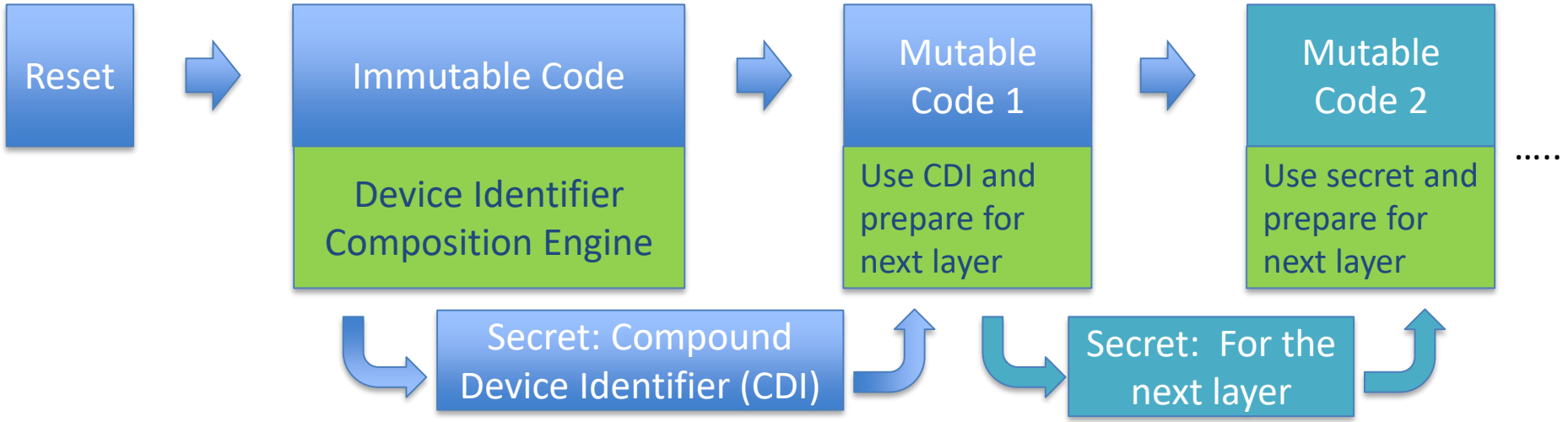
- April 2016: Microsoft Research Robust Internet of Things (RIoT) Paper
- October 2016: TCG forms the DICE Architectures working group
- December 2016: TCG shares a draft DICE specification for public comments
- Ongoing: Microsoft publishes example code

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

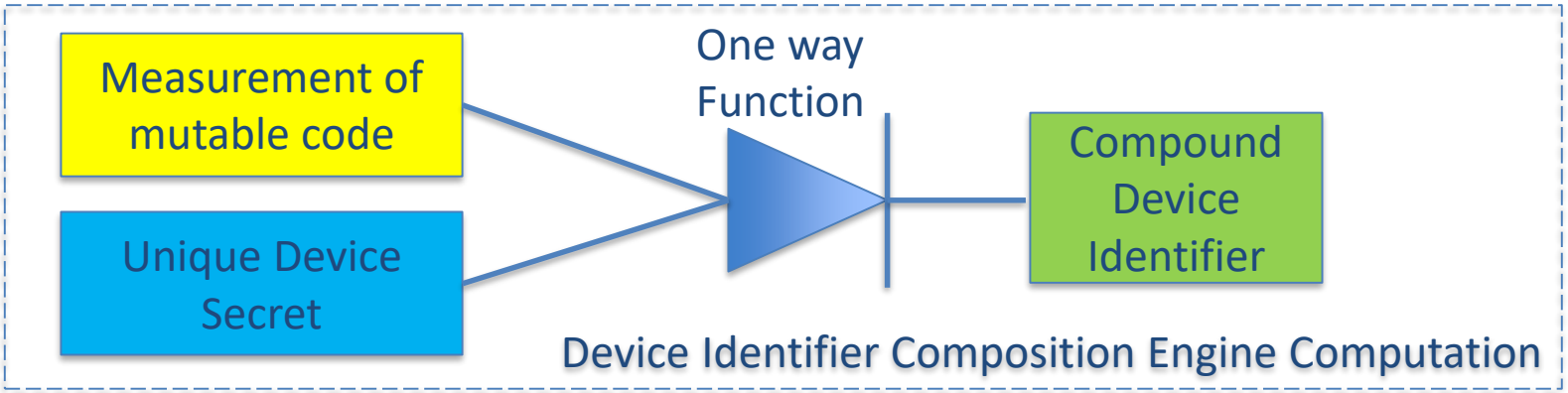
Device Identifier Composition Engine (DICE)

- Platform reset starts in a trusted state
- Engine computes a value based on mutable code



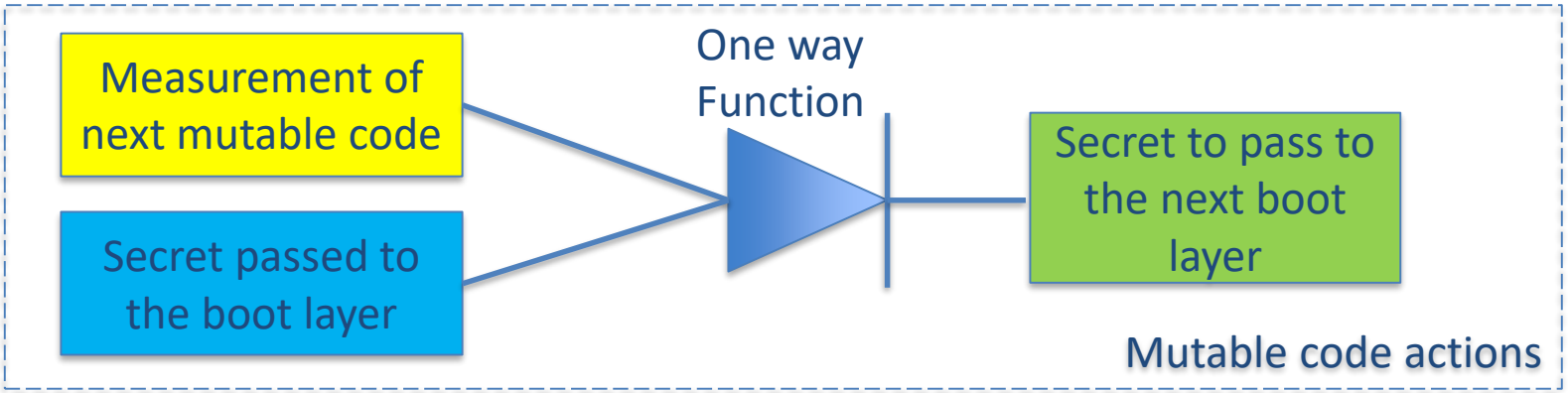
Generating the Compound Device Identifier

- 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



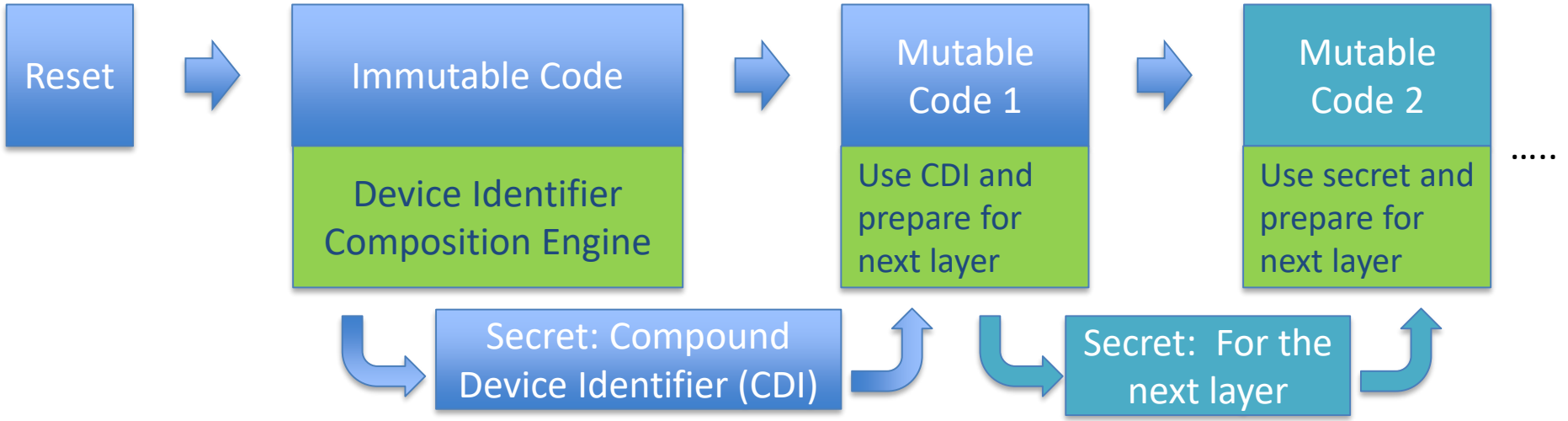
Mutable Code Actions

- 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)



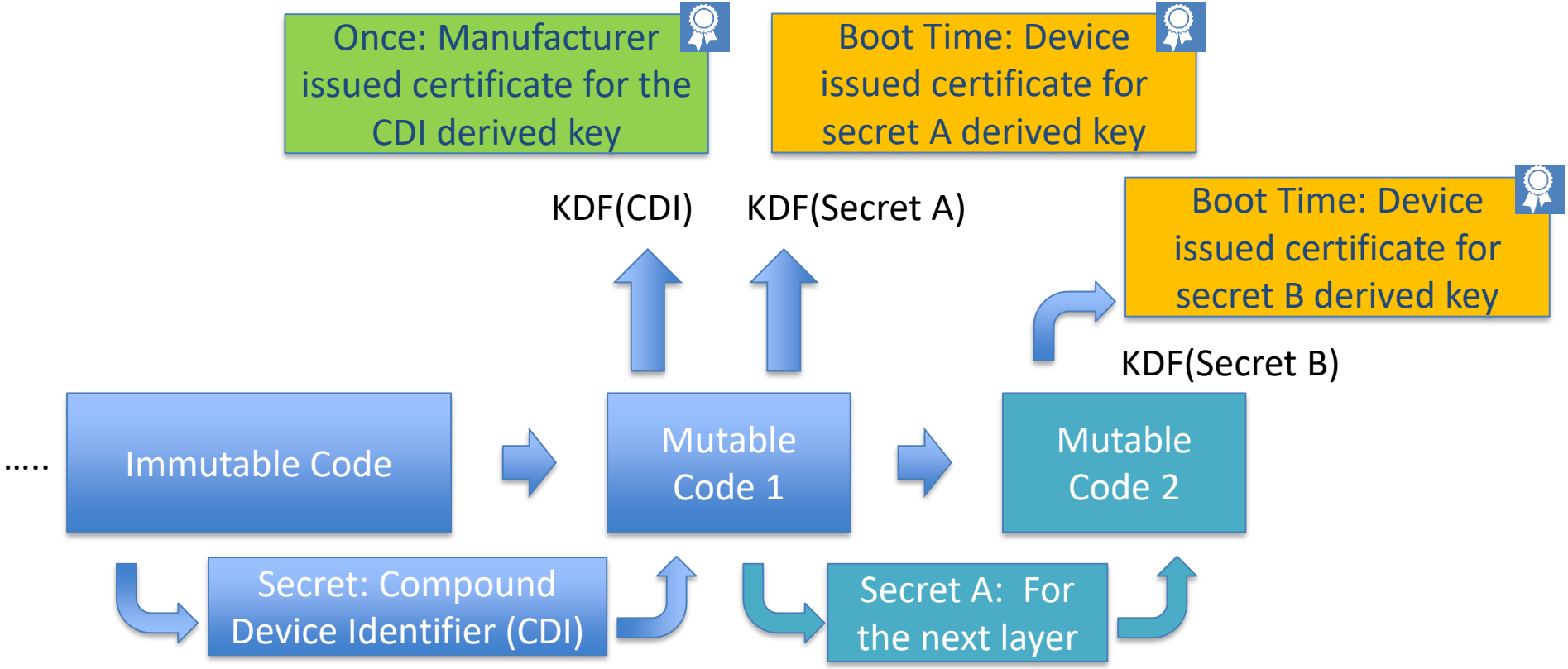
Proving device identity and software

- 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



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

- Microsoft Research Robust Internet of Things (RIoT) Paper: https://www.microsoft.com/en-us/research/publication/riot-a-foundation-for-trust-in-the-internet-of-things/
- 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