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Protecting the Storage Platform through Measurement and Attestation

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Abstract

Securing the operational state of components has become an ever increasing topic amongst the industry. Much of the industry has secured the platforms upon which they operate but the subcomponents have become the next bastion of enforcing a security model. In this talk, we will cover the attack vectors and counter measures to head off the vulnerabilities that previously embedded firmware appeared safe. We will discuss recent events, industry initiatives, the notion of trusted firmware, and what storage users should look for in a secure device.

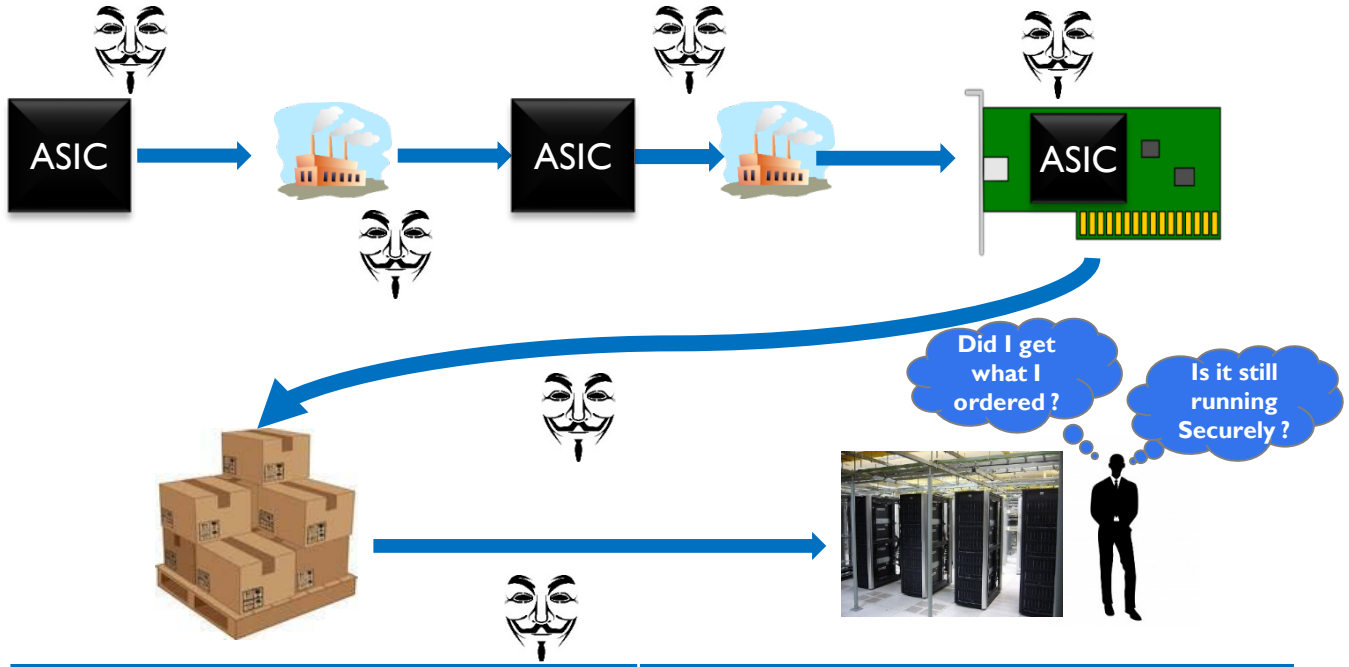
Learning Objectives:

1. Understanding the security landscape and what has ultimately changed in the industry
2. Threat modeling for the new age of protection
3. Understanding how secure trusted firmware translates into solution requirements and product guarantees
4. Learn what attestation measurements are and how they translate into proving to the platform what firmware is actually running

Agenda

- Product Landscape
- Threat model
- Secure boot for everyone
- Attestation, what happens after Secure Boot
- Platform trust establishment
- Secure Update
- Protection through Obscurity
- Secure Debug

Supply Chain



- Various Points of entry
- Where has the adapter been ?
- Is it really the expected adapter?
- Was it intercepted in flight ?

- Is it running altered firmware ?
- Does it contain the intended components ?
- Will it stay that way ?

Threat Modeling

- Global Trade, Manufacturing, and development
  - Worldwide development cites
  - Global Supply
  - Untrusted manufacturing
- Availability of Information, methods, resources (Internet)
  - Embedded Operating Systems available for download
  - Hardware Probes are easily available for purchase
  - Leaked utilities and source to the Internet
- Nation State Actors
  - China, US (NSA), Russia etc.
  - Well Funded – What would you be willing to do for $5M ?
  - Research facilities
  - Production lines
  - Hacking to a whole new level (organized and legitimized)
- Sophistication of the Actor
- Repercussions of the Event (IOT)
  - Power Plants, Flight Controls, Printers, Centrifuge

Sophisticated

HOW THE NSA'S FIRMWARE HACKING WORKS AND WHY IT'S SO UNSETTLING

ONE OF THE most shocking parts of the recently discovered spying network Equation Group is its mysterious module designed to reprogram or reflash a computer hard drive's firmware with malicious code. The Kaspersky researchers who uncovered this said its ability to subvert hard drive firmware—the guts of any computer—"surpasses anything else" they had ever seen.

The hacking tool, believed to be a product of the NSA, is significant because subverting the firmware gives the attackers God-like control of the system in a way that is stealthy and persistent even through software updates. The module, named "nls_933w.dll", is the first of its kind found in the wild and is used with both the EquationDrug and GrayFish spy platforms Kaspersky uncovered.

It also has another capability: to create invisible storage space on the hard drive to hide data stolen from the system so the attackers can retrieve it later. This lets spies like the Equation Group bypass disk encryption by secreting documents they want to seize in areas that don't get encrypted.

https://www.wired.com/2015/02/nsa-firmware-hacking/

Customer Concerns

- Gray Market Products infiltration into the data center
- Lost of information / IP
- Altered products (hardware and firmware)
- Continuous secure operations
- Ability to recover from exploits
- Verification of running systems
- Data Security (Encryption)
- Denial of Service Attacks (System shutdown)

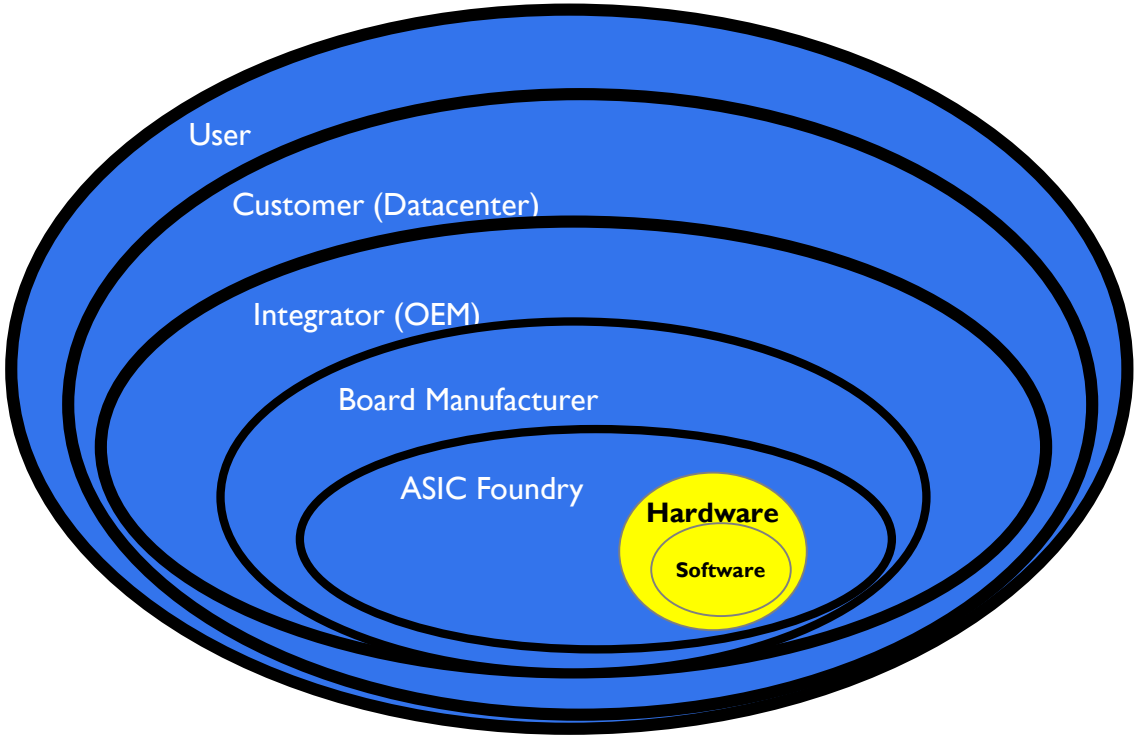
Customer Requests

- Hardware Root of Trust for ASICs
- Firmware Recovery and Restoration
- Continuous Firmware Monitoring and Verification
- Encrypting Firmware
- Reduction in Attack surfaces
- Product Hardening
- Intrusion detection (PCI, Driver, UART, etc)
- Secure Manufacturing (Authorized Products)
- Ownership and Personalization

Market Demand

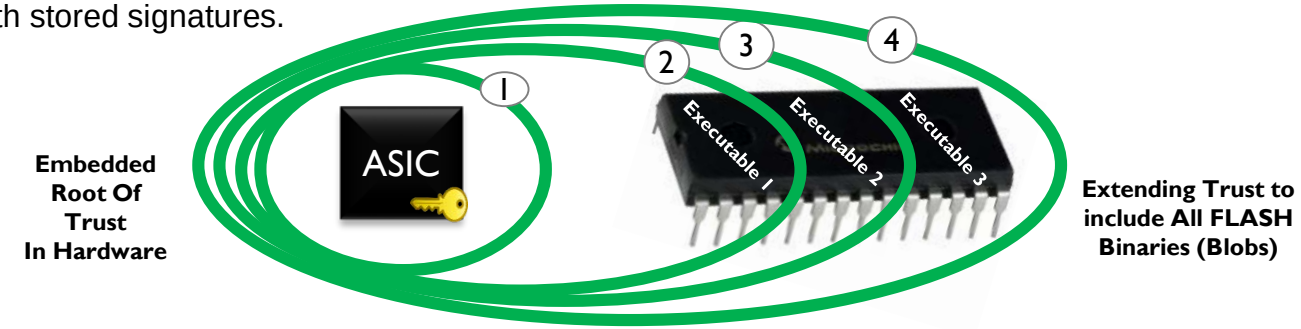
- IBM Announced Secured Systems
- Dell Announced Secured Portfolio
- HPE Announced Secure Server Products
- Companies are now mandating firmware security – Cerberus, Titan, Intel
- Moving from discussion to implementation and standardization – ie OCP Security Project, PCI-SIG Proposals, DMTF (PMCI)
- MCHP/MSCC is a key part of the Ecosystem of Security for storage, switches, platforms ROT and component ROT

Security Is All About Trust



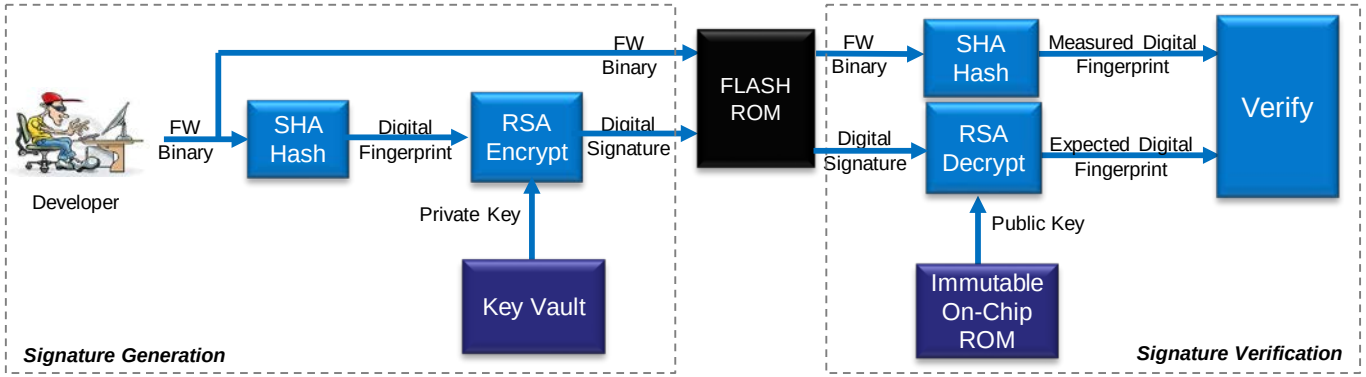
Secure Boot In Action

- Security begins with the Root of Trust contained in the ASIC
  - Embedded Signing Keys
  - Strong Hashing Functions
  - Immutable Authenticating Boot logic in Silicon Boot ROM
- Trust is extended by verifying the authenticity and integrity of FLASH content prior to executing it
  - Digital signatures are supplied with all Firmware and Configuration Binaries
  - Validated with Embedded ASIC signing keys
  - ASIC Calculated Signatures are computed against the stored images and compared with stored signatures.

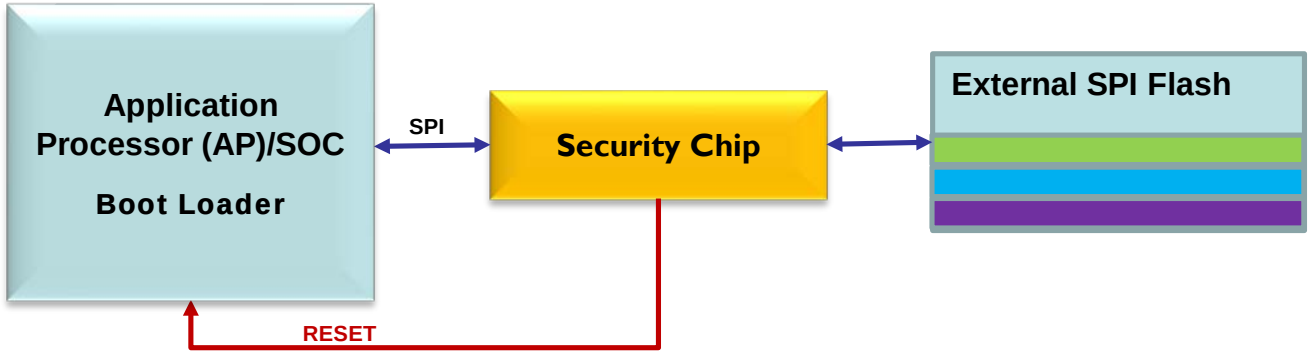


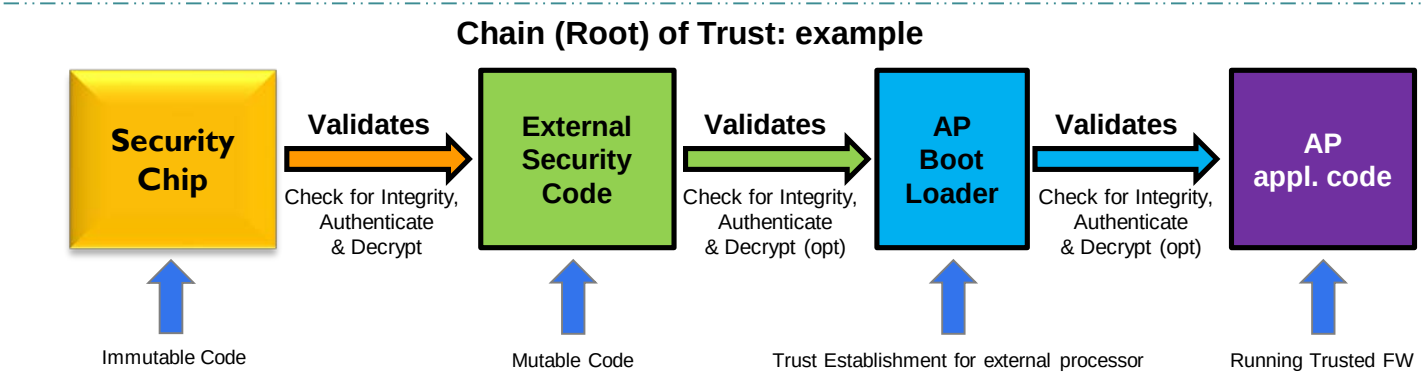
Digital Signatures to Secure Firmware

- Verifies authenticity and integrity
- Generated during FW development process
- Verified during FW boot process.

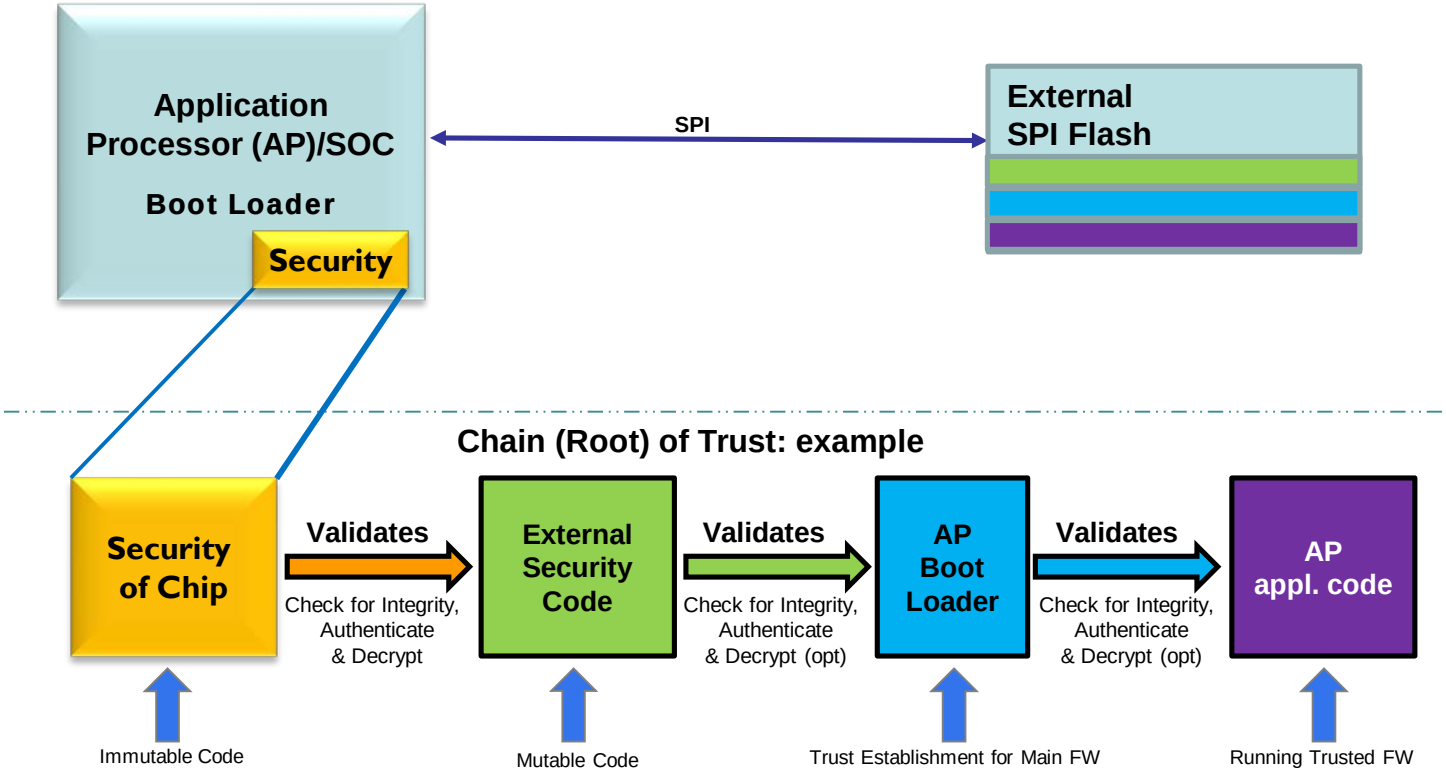


Trust Establishment (Interposers)





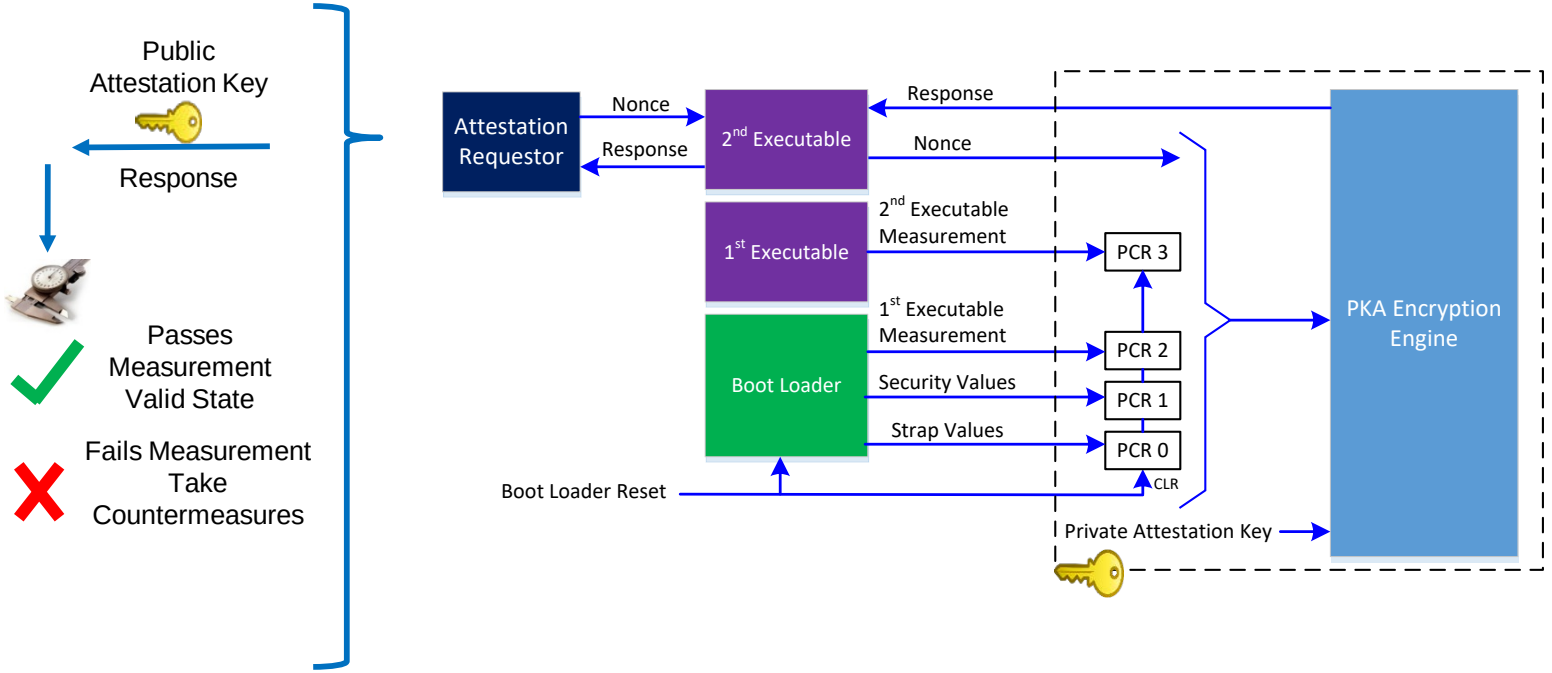
Trust Establishment (Embedded)



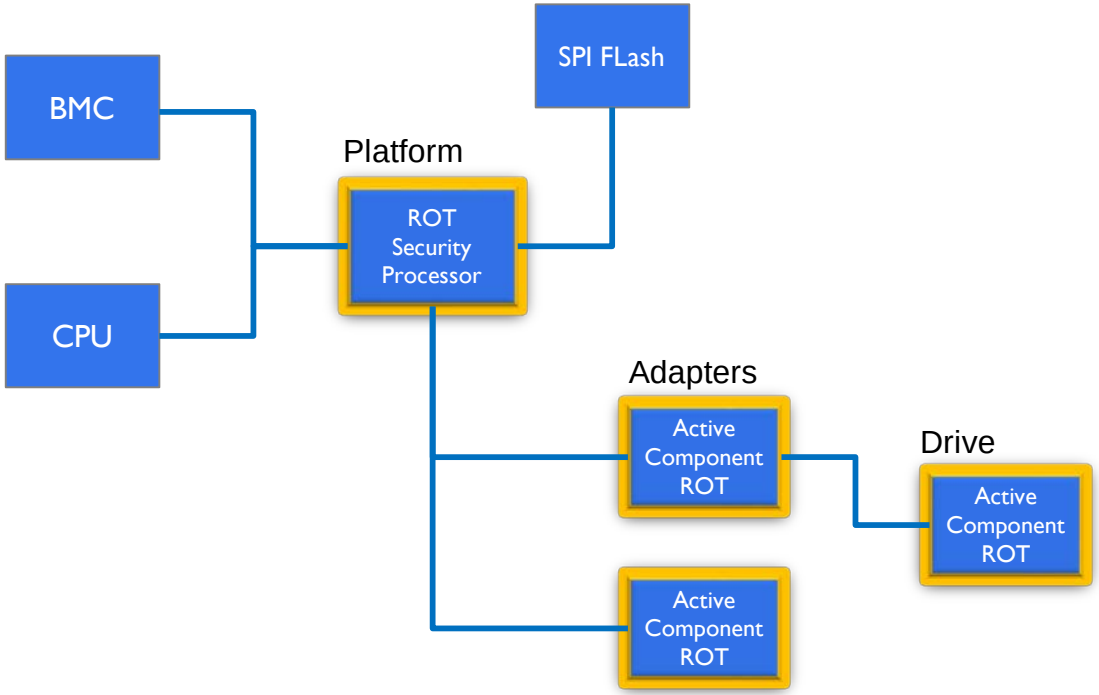
Attestation

- Enables a third party to reliably & easily attest to the status of a platform. Specifically detect changes that have occurred in HW and FW that impact the trustworthiness of a platform.
- Examples
  - Back Dated Firmware Versions – Old with Security holes
  - Valid Firmware but meant for another platform
  - Non – Secured Part detection
  - Secure But Tampered Hardware
- Platform Roots of trust use attestation to continually monitor and validate system components

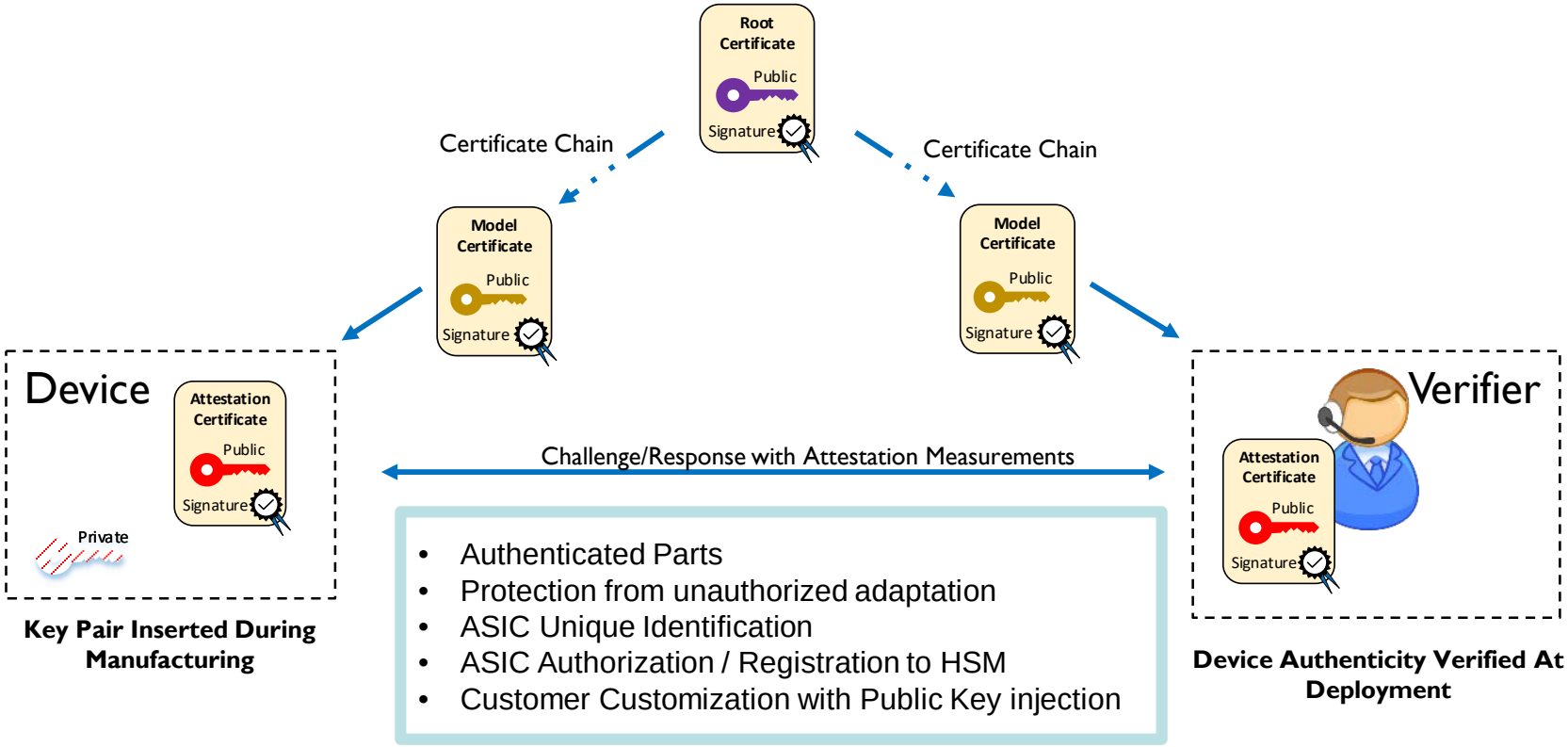
Attestation : Example Flow



System of Trust

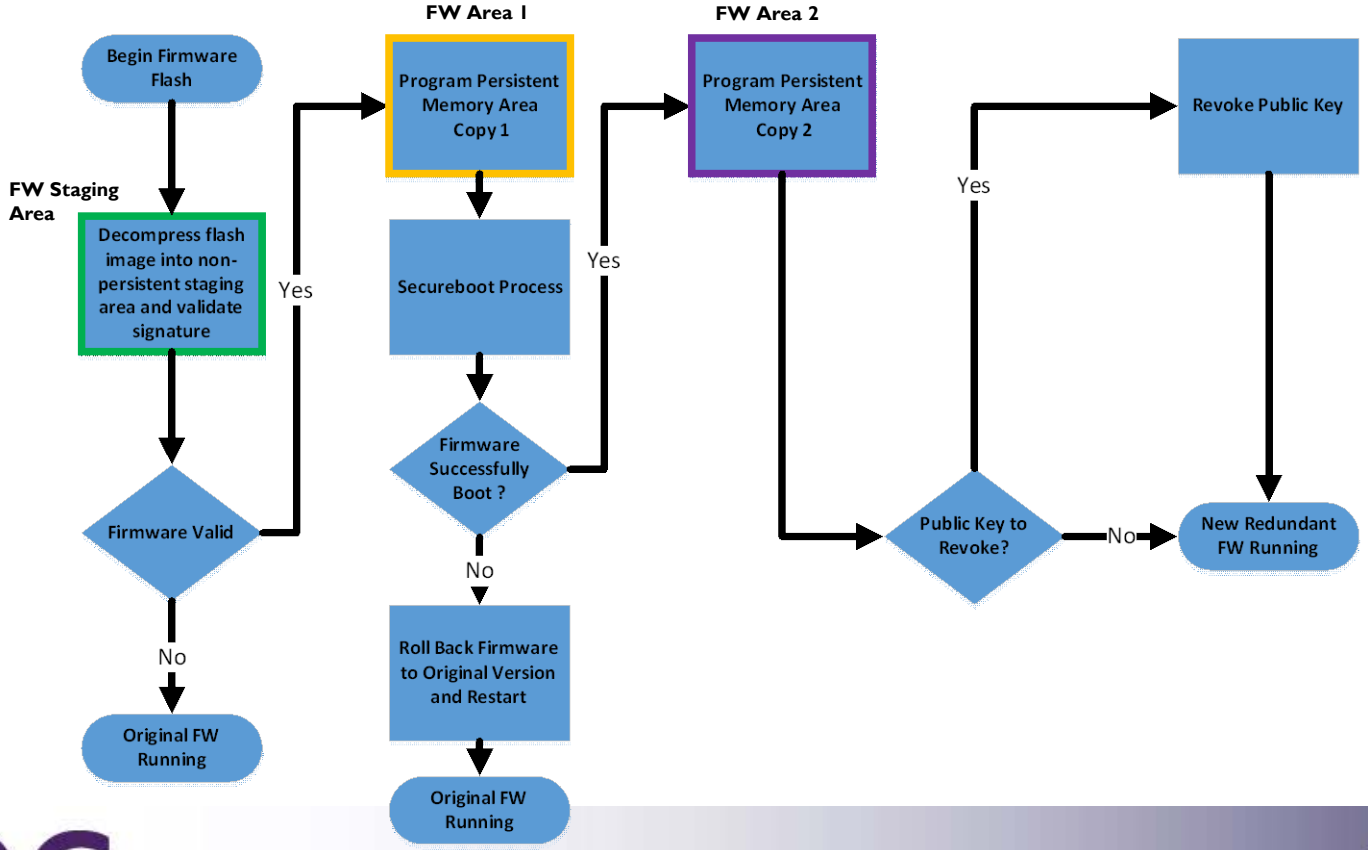


Manufacturing Identification and Authorization



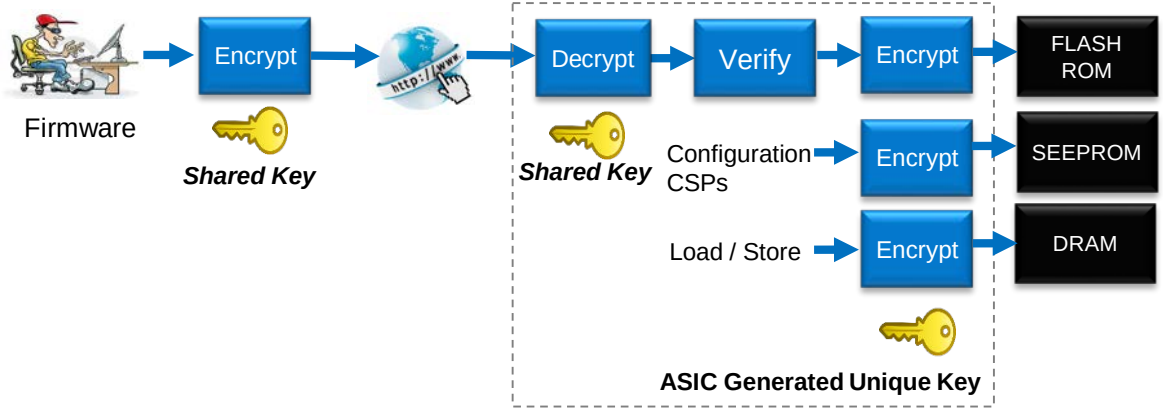
- Authenticated Parts
- Protection from unauthorized adaptation
- ASIC Unique Identification
- ASIC Authorization / Registration to HSM
- Customer Customization with Public Key injection

Secure Firmware Update



Cryptographic Obscurity

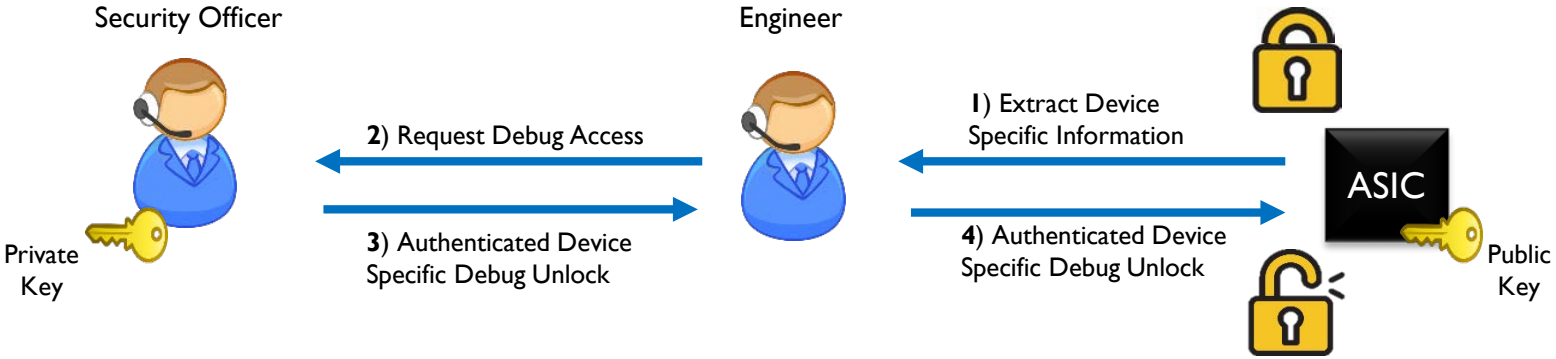
- Encrypted Firmware
- Encrypted Firmware Configuration Parameters
- Encrypted FIPS Critical Security Parameters (CSP)
- Encrypted Operational Memory (DRAM)



Secure Debug Mode

- Secure Debug Mode is the ability to place parts in a debug mode using an authenticated chip specific mechanism
- Ability to detect that a part is in secure debug mode
- Chip Specific mechanisms can not be shared among devices
- Multiple Levels of Forensic Modes
  - Access to UART (Read Only, Read/Write)
  - Access to JTAG/ETAG Debug Ports (Read / Write)
  - Ability to load unsigned firmware
  - Additional Needs and levels

Secure Debug Mode : Example Flow



Industry Security Projects

- OCP Security Project
  https://www.opencompute.org/projects/security
- Intel PCIe Device Security Enhancements
  https://www.intel.com/content/dam/www/public/us/en/documents/reference-guides/pcie-device-security-enhancements.pdf
- NIST SP800-193 – Released May 2018
  https://nvlpubs.nist.gov/nistpubs/SpecialPublications/NIST.SP.800-193.pdf
- Microsoft Project Cerberus
  https://azure.microsoft.com/en-us/blog/microsofts-project-olympus-delivers-cloud-hardware-innovation-at-scale/
- DMTF PMCI Security Task Force
  https://www.dmtf.org/content/get-involved-dmtfs-pmci-security-task-force
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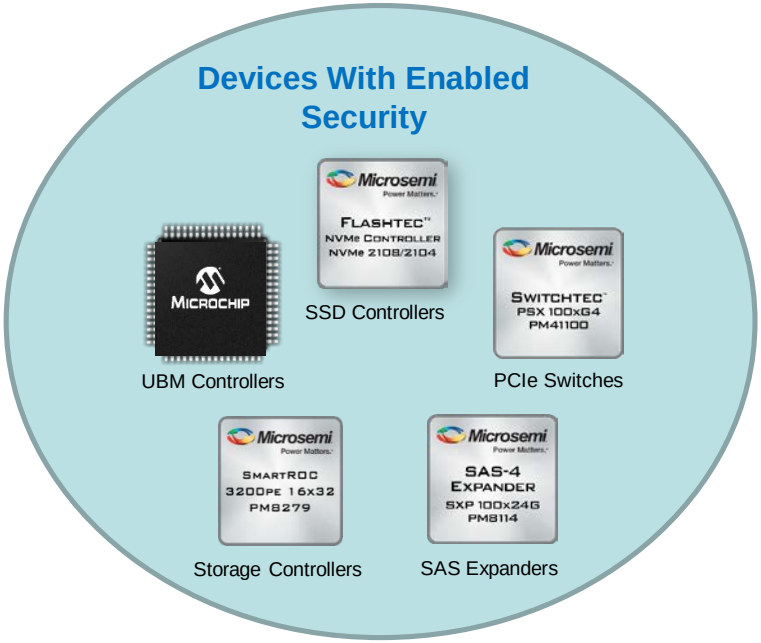
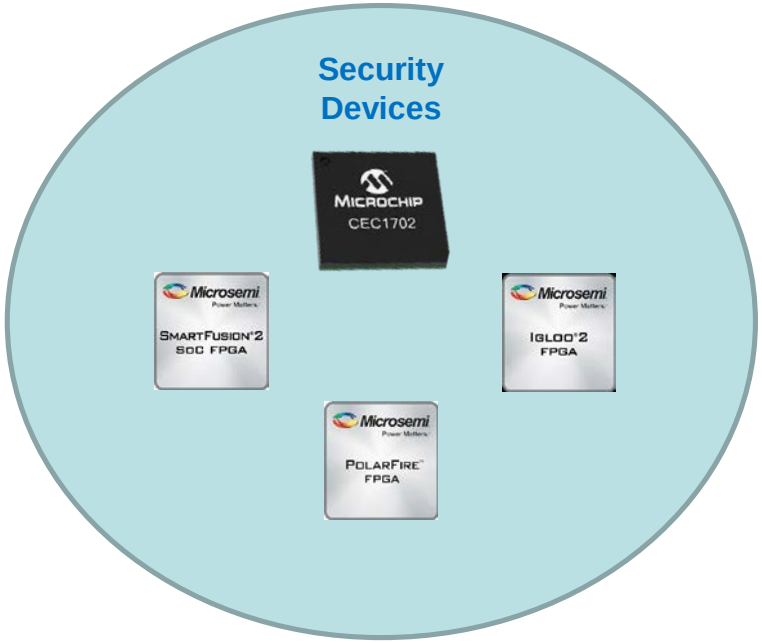
Microchip Products





Thank You

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