tianocore

UEFI & EDK II Training

UEFI Aware Operating System

tianocore.org

LESSON OBJECTIVE

- Explain How the OS and UEFI Work together
- Explain the UEFI Requirements for UEFI aware OS
- Explain How Secure Boot Fits with UEFI
- What about coreboot?

tianocore

UEFI AWARE OS REQUIREMENTS

Common Requirements

tianocore

UEFI OPERATING SYSTEMS

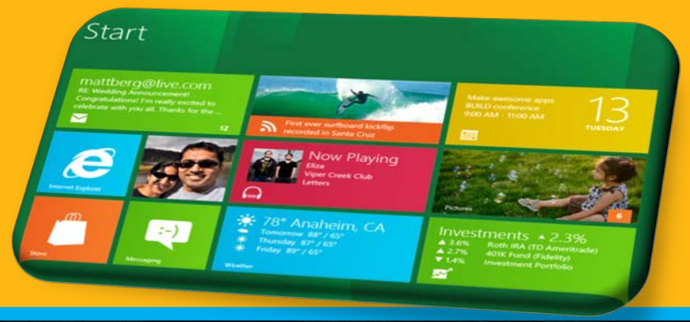
Windows Server 2008 R2

Windows 10

Windows 7

Windows Storage Server 2008 R2 Enterprise

Microsoft



CANONICAL

yocto PROJECT

ubuntu

debian

suse

Clear Linux* Project

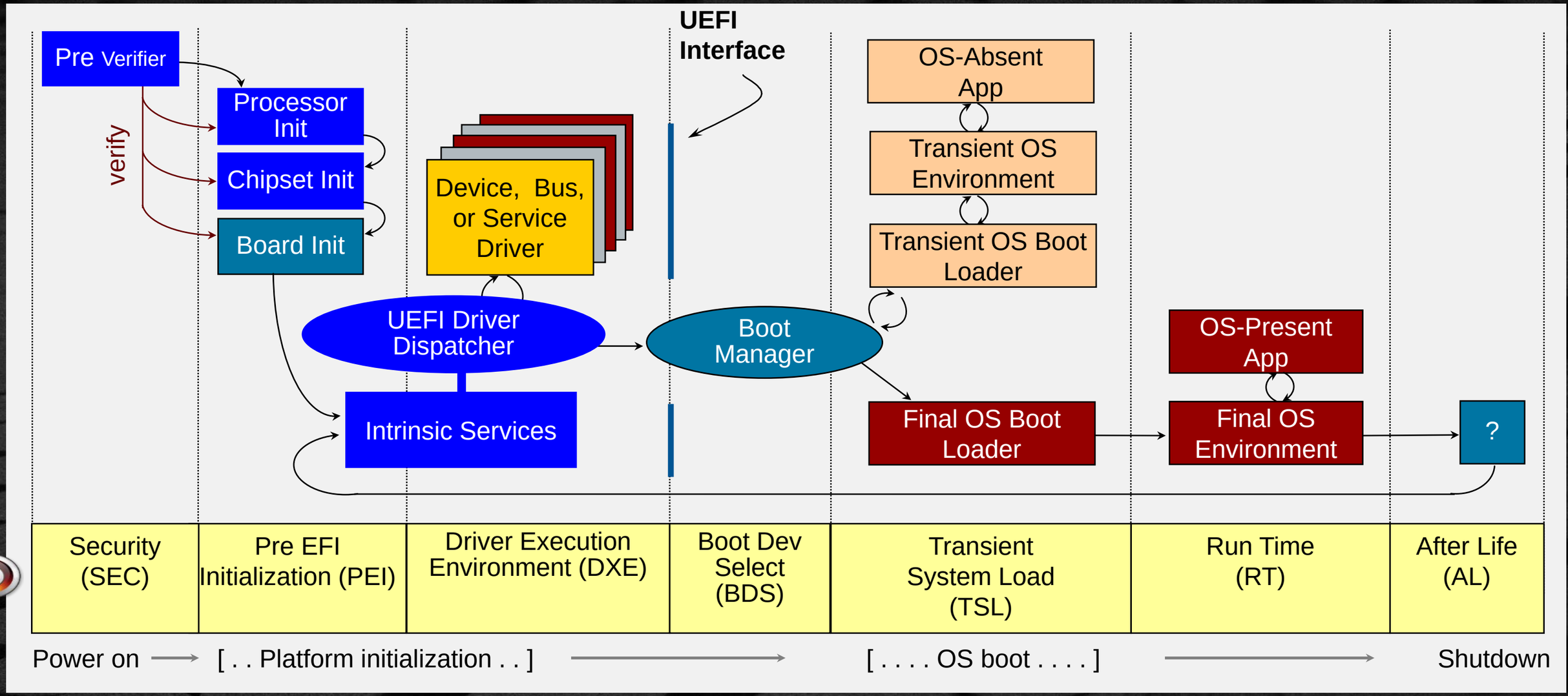
redhat.

Novell

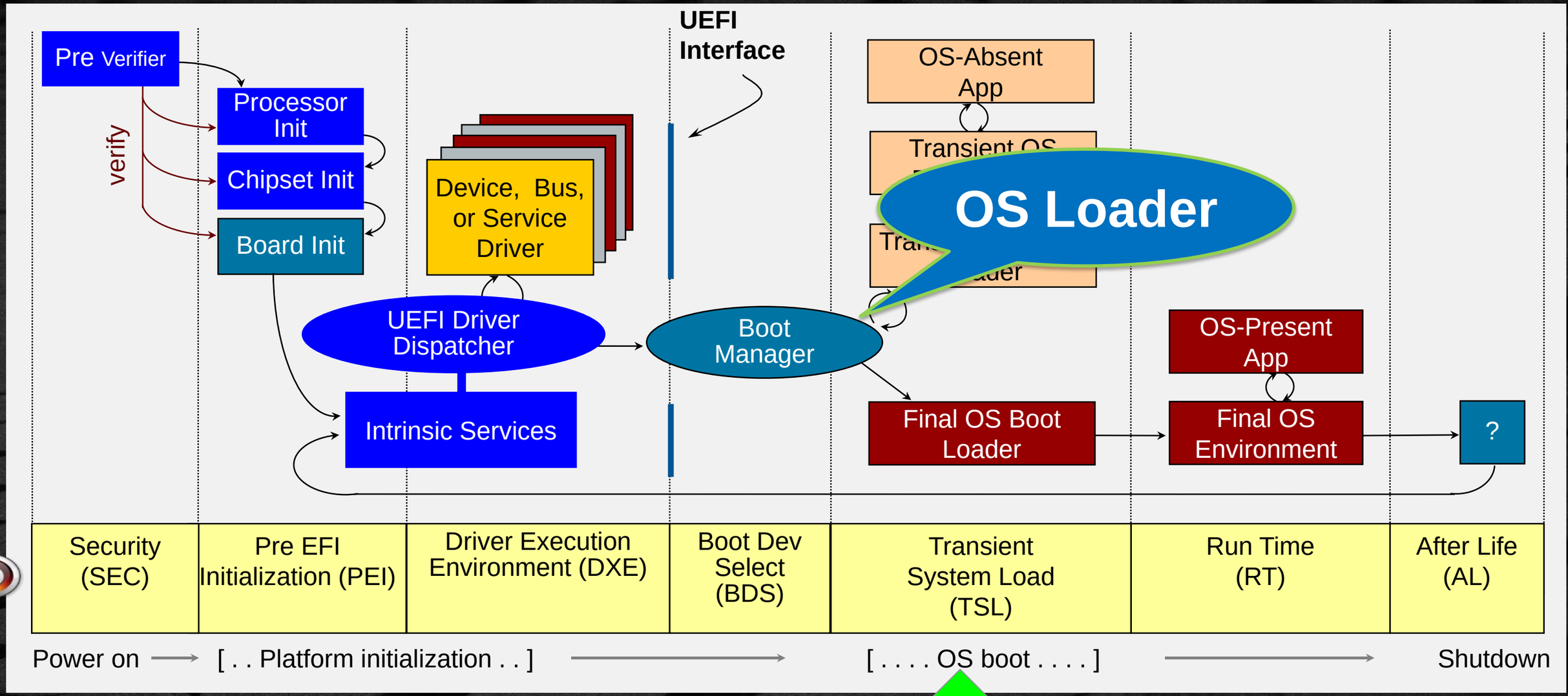
fedora

vmware

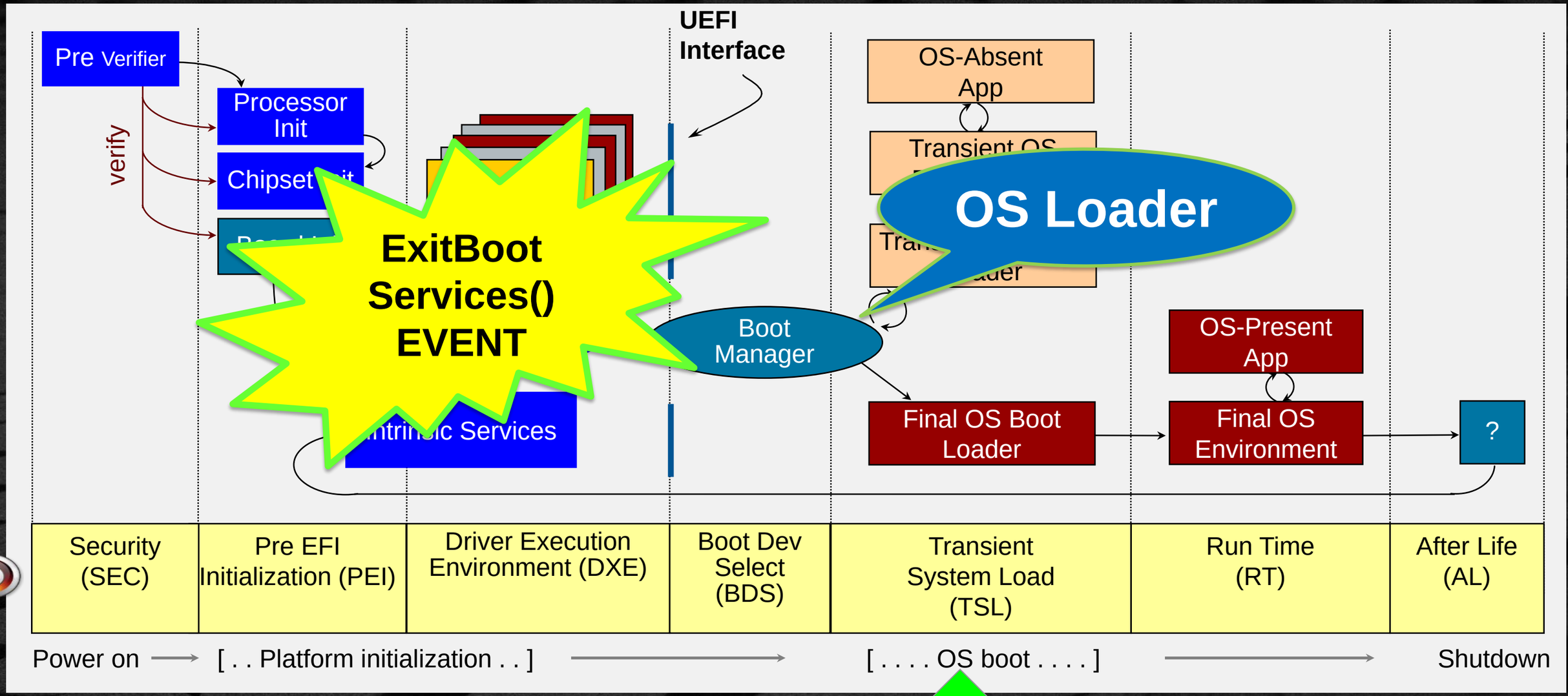
UEFI - PI & EDK II Boot Flow - Review



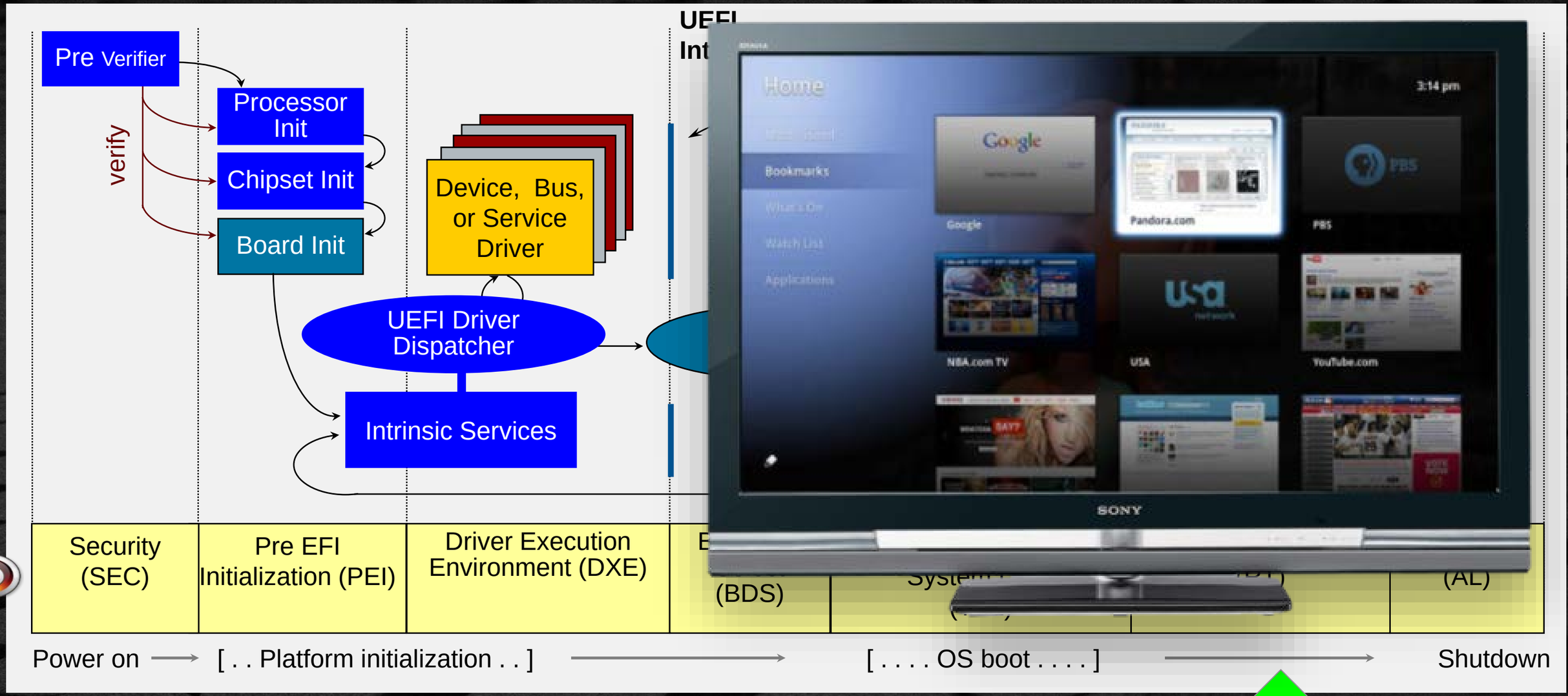
UEFI - PI & EDK II Boot Flow - Review



UEFI - PI & EDK II Boot Flow - Review



UEFI - PI & EDK II Boot Flow - Review



tianocore

UEFI OS REQUIREMENTS

UEFI Drivers:
Boot devices/console

UEFI OS installer

UEFI OS Loader

Disk
Partition/Formats

Firmware
Requirements

Set Boot Path to
Boot to UEFI OS

UEFI System Classes (based on firmware interfaces)

UEFI Class 0

- Boots Legacy - int 19 ONLY
- Legacy BIOS Only (16 bit)
- No UEFI or UEFI PI Interfaces

UEFI Class 1

- Boots Legacy - int 19 ONLY
- Uses UEFI / PI Interfaces
- Only legacy BIOS runtime Interfaces

UEFI Class 2

- Boots Legacy - int 19 or UEFI
- Uses UEFI / PI Interfaces
- Legacy BIOS runtime Interfaces w/ **CSM**

Limited Benefits

- ✓ OEMs / ODMs Internal
- ✓ Double code development
- ✓ Compromised security – MBR exposure

UEFI System Classes (based on firmware interfaces)

UEFI Class 0

- Boots Legacy - int 19 ONLY
- Legacy BIOS Only (16 bit)
- No UEFI or UEFI PI Interfaces

UEFI Class 1

- Boots Legacy - int 19 ONLY
- Uses UEFI / PI Interfaces
- Only legacy BIOS runtime Interfaces

UEFI Class 2

- Boots Legacy - int 19 or UEFI
- Uses UEFI / PI Interfaces
- Legacy BIOS runtime Interfaces w/ **CSM**

UEFI Class 3

- Boots **ONLY** UEFI
- Uses UEFI / PI Interfaces
- Runtime exposes only UEFI interfaces

UEFI System Classes (based on firmware interfaces)

Full Benefits

- ✓ UEFI Innovation
- ✓ Smaller code size/ Validation
- ✓ Extensibility

Only Class after 2020

Enabling *Secure Boot* creates another Class

UEFI Class 3 +

- Boots **ONLY** UEFI
- Uses UEFI / PI Interfaces
- Runtime exposes only UEFI interfaces

UEFI Secure Boot “ON”

Required UEFI Drivers: OS Install & Boot

Boot Device

Console Output

Console Input

NVRAM Driver

tianocore

UEFI OS LOADER

- OS install process includes UEFI loader

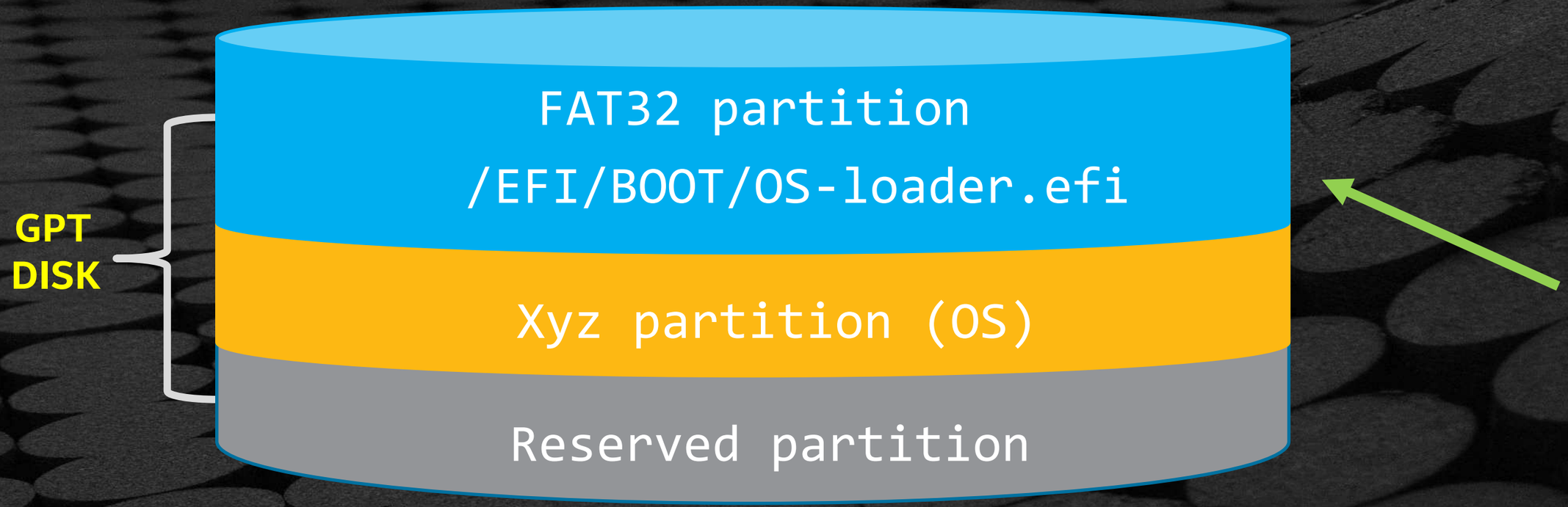
  `/efi/boot/bootx64.efi /efi/redhat/grub.efi`
- Call UEFI boot & runtime services to start OS
- Exit UEFI Boot Services
- Transfer control to native OS

UEFI OS INSTALLER

- Discover UEFI storage devices
- Setup storage device: GPT w/ FAT32 boot partition
- Create boot variable `BootXXXX`

tianocore

Disk Partition and Format

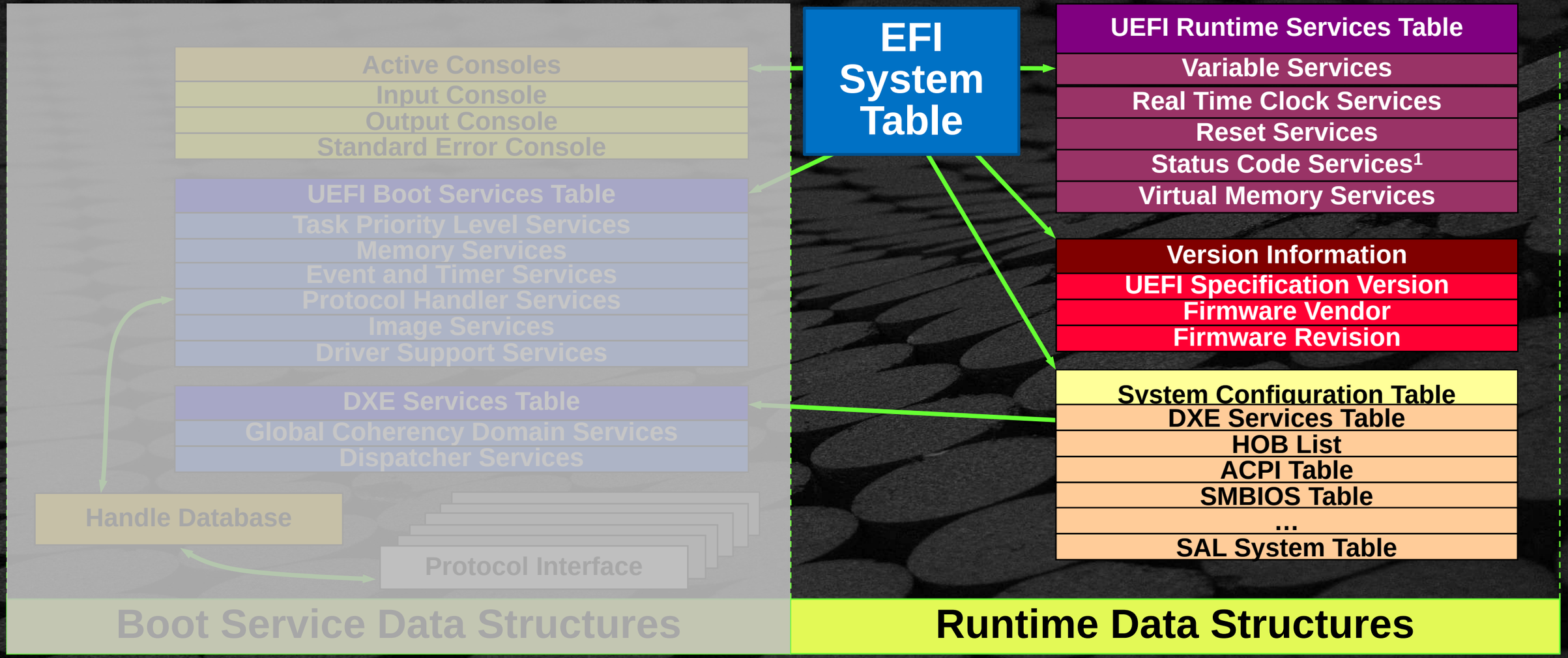


tianocore

INTERFACE INSIDE OS RUNTIME

UEFI Runtime Services

Runtime Services Available to the UEFI Aware OS



Accessing RT services from Windows API

- GetFirmwareEnvironmentVariable: MSDN Link
- SetFirmwareEnvironmentVariable: MSDN Link
- Example: (determine if UEFI or Legacy BIOS)

```
 int main(int argc, char*argv[])
{
        GetFirmwareEnvironmentVariableA("",
           "{00000000-0000-0000-0000-000000000000}",NULL,0);
        if (GetLastError() ==ERROR_INVALID_FUNCTION) {
              printf("Legacy"); // This.. is.. LEGACY BIOS....
              return 1;
        } else{
              printf("UEFI"); // This.. is.. UEFI
              return 0;
        }
        return 0;
}
```

ACCESSING RT SERVICES FROM LINUX OS

Firmware Test Suite, it includes a Linux kernel driver to help with it's interactions with UEFI. Note that this is a Linux-centric test suite, solution won't work for other OSes.

- http://kernel.ubuntu.com/git/hwe/fwts.git
- https://bugs.launchpad.net/ubuntu/+source/linux/+bug/1633506
- https://patchwork.kernel.org/patch/9323781/
- http://www.basicinputoutput.com/2016/03/introduction-to-firmware-test-suite-fwts.html

tianocore

SECURITY WITH UEFI

How does UEFI ensure the Operating System is trusted?

BOOT SECURITY TECHNOLOGIES

Hardware Root of Trust	Boot Guard, Intel® TXT
Measured Boot	Using TPM[1] to store hash values
Verified Boot	Boot Guard + UEFI Secure Boot

[1]TPM – Trusted Platform Module

Resources: https://firmwaresecurity.com/2015/07/29/survey-of-boot-security-technologies/

tianocore

HARDWARE ROOT OF TRUST

Boot Guard

CPU verifies signature

Verification occurs before system FW starts

Hash of public key is fused in CPU

Verification

Intel® TXT

Uses a Trusted Platform Module (TPM) & cryptographic

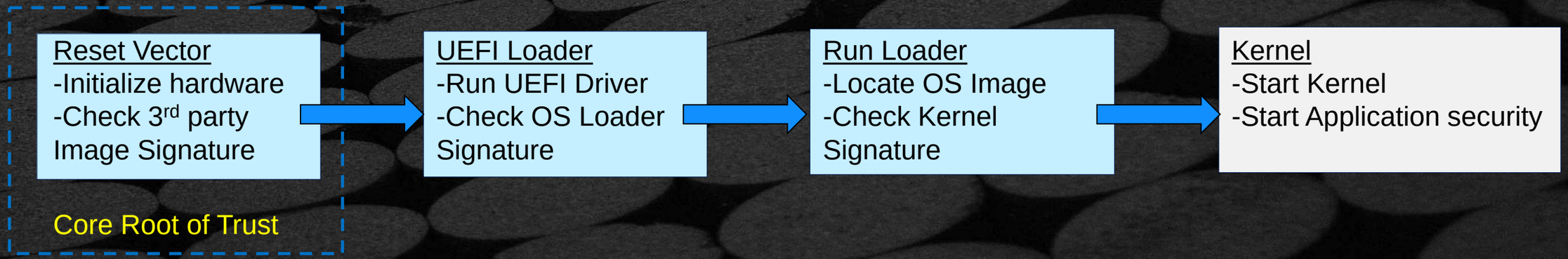
Provides Measurements

Measurements

UEFI SECURE BOOT

Software ID checking during every step of the boot flow:

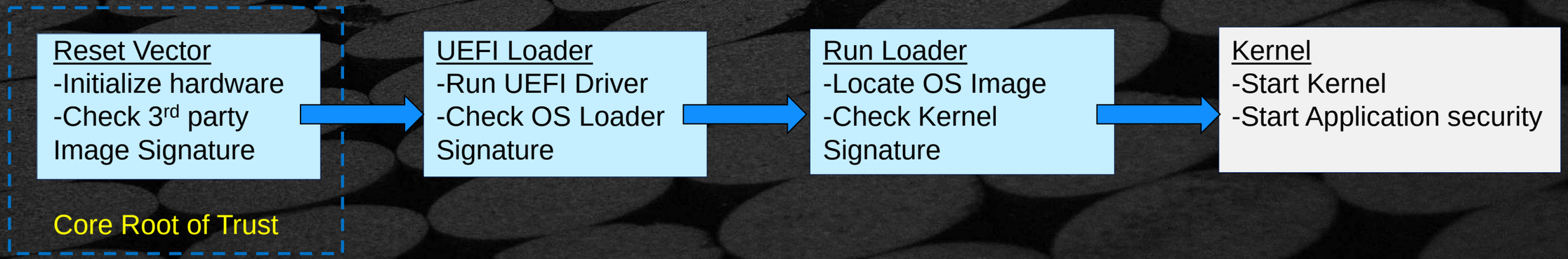
1. UEFI System FW (updated via secure process)



UEFI SECURE BOOT

Software ID checking during every step of the boot flow:

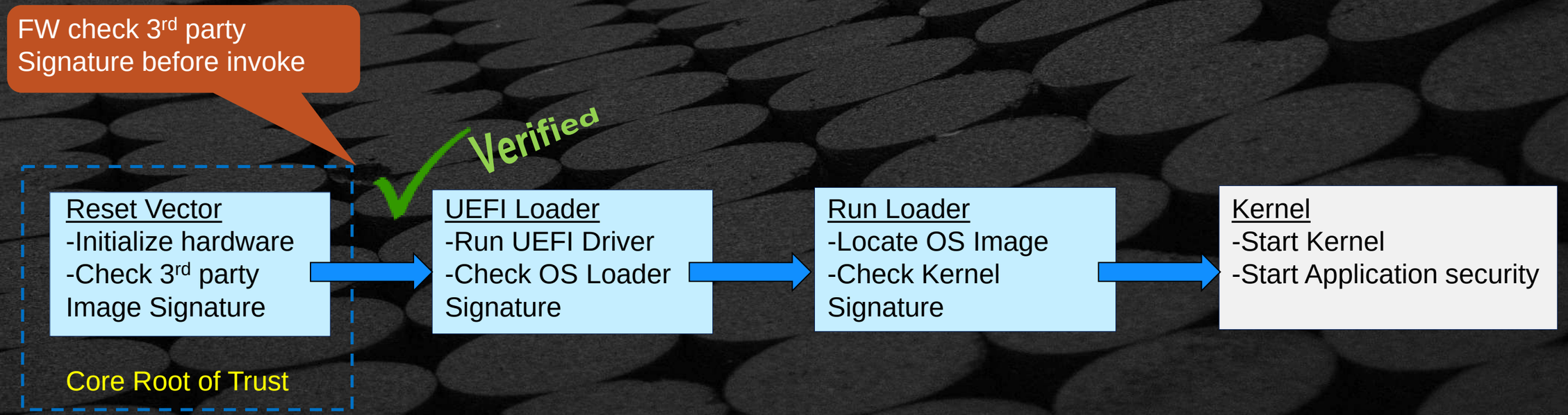
1. UEFI System FW (updated via secure process)
2. Add-In Cards (signed UEFI Option ROMs)



UEFI SECURE BOOT

Software ID checking during every step of the boot flow:

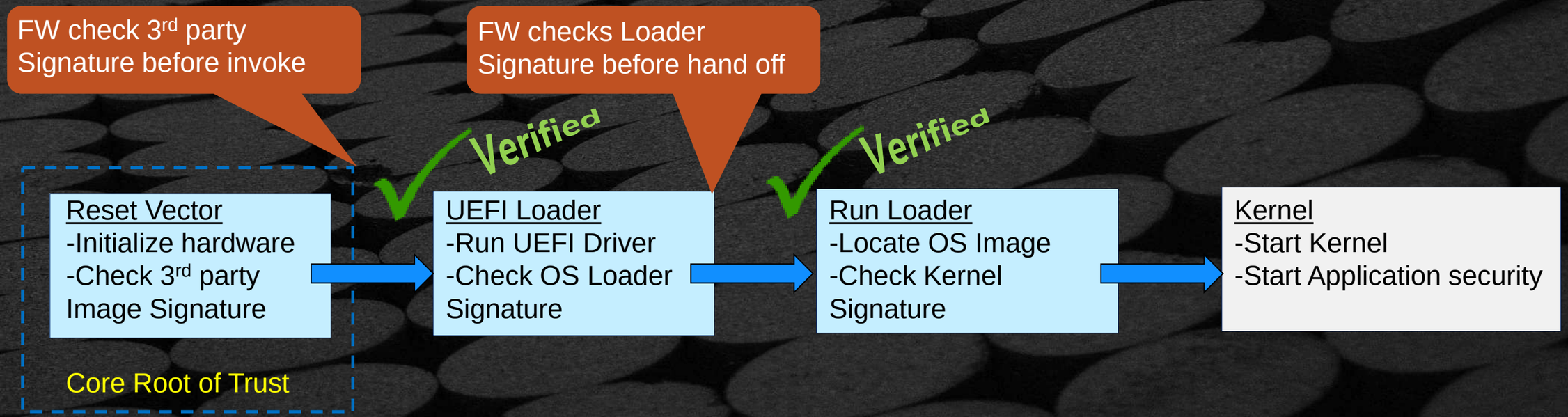
1. UEFI System FW (updated via secure process)
2. Add-In Cards (signed UEFI Option ROMs)



UEFI SECURE BOOT

Software ID checking during every step of the boot flow:

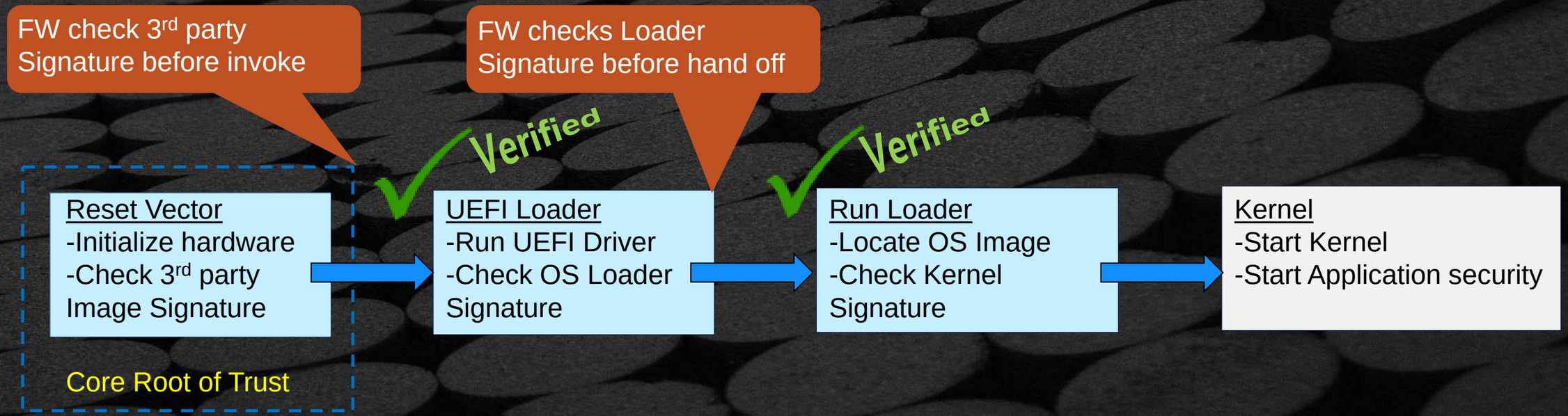
1. UEFI System FW (updated via secure process)
2. Add-In Cards (signed UEFI Option ROMs)



UEFI SECURE BOOT

Software ID checking during every step of the boot flow:

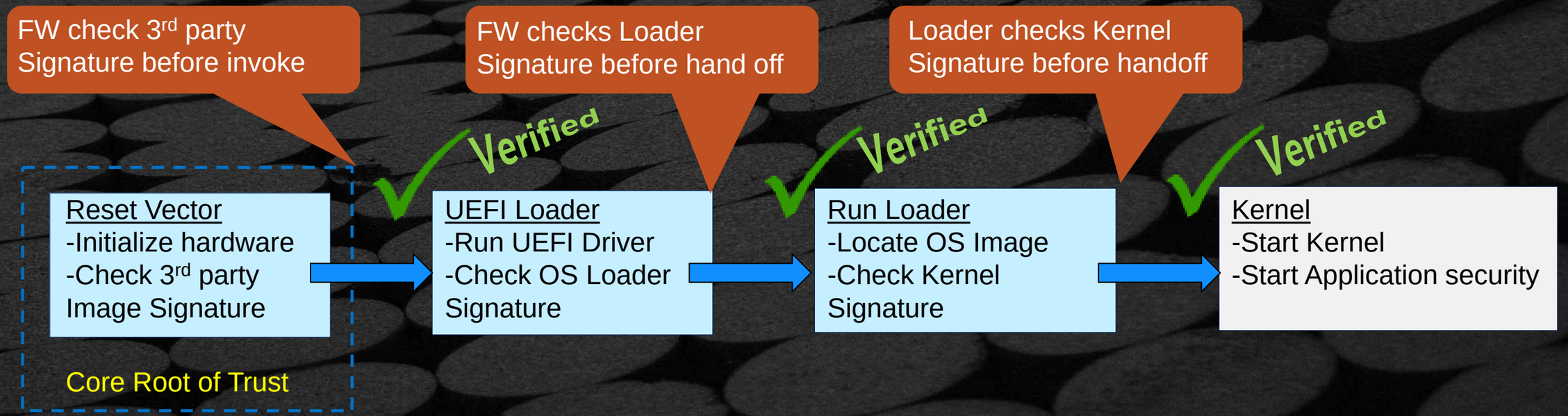
1. UEFI System FW (updated via secure process)
2. Add-In Cards (signed UEFI Option ROMs)
3. OS Boot Loader (checks for “secure mode” at boot)



UEFI SECURE BOOT

Software ID checking during every step of the boot flow:

1. UEFI System FW (updated via secure process)
2. Add-In Cards (signed UEFI Option ROMs)
3. OS Boot Loader (checks for “secure mode” at boot)



AUTHENTICATED VARIABLES

PK

KEK

DB

DBX

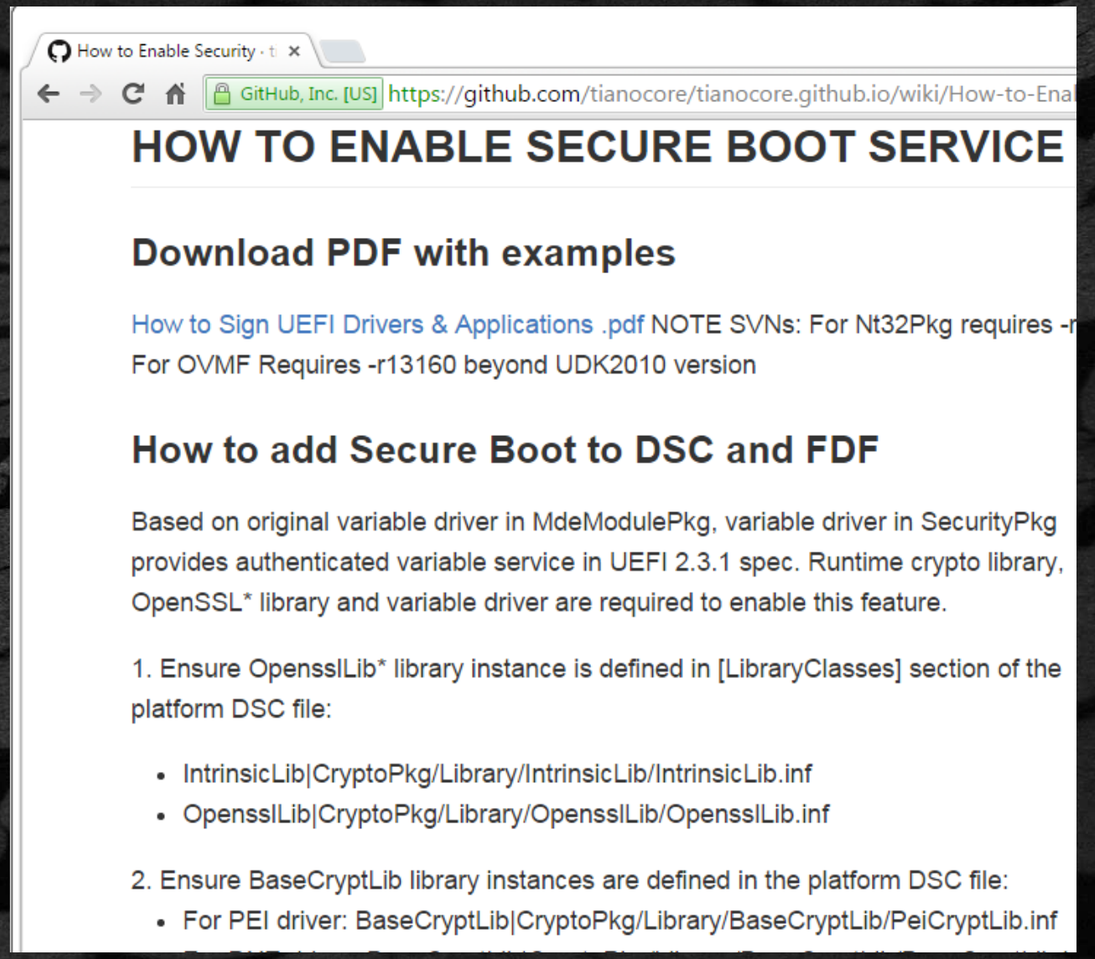
SetupMode

SecureBoot

```
2.0 Shell> dmpstore SecureBoot
Variable - RS+BS - '8BE4DF61-93CA-11D2-AA0D-00E098032B8C:SecureBoot' - DataSize
  = 0x01
    00:
                                                    00   *.*
```

Security Package Project Page Wiki Link

- Wiki Link: How-to-Enable-Security
- PDF: How to Sign UEFI Images V1.31
- Build command line switch -
  SECURE_BOOT_ENABLE = TRUE
- Install the OpensslLib CryptoPkg : OpenSSL-Howto.txt

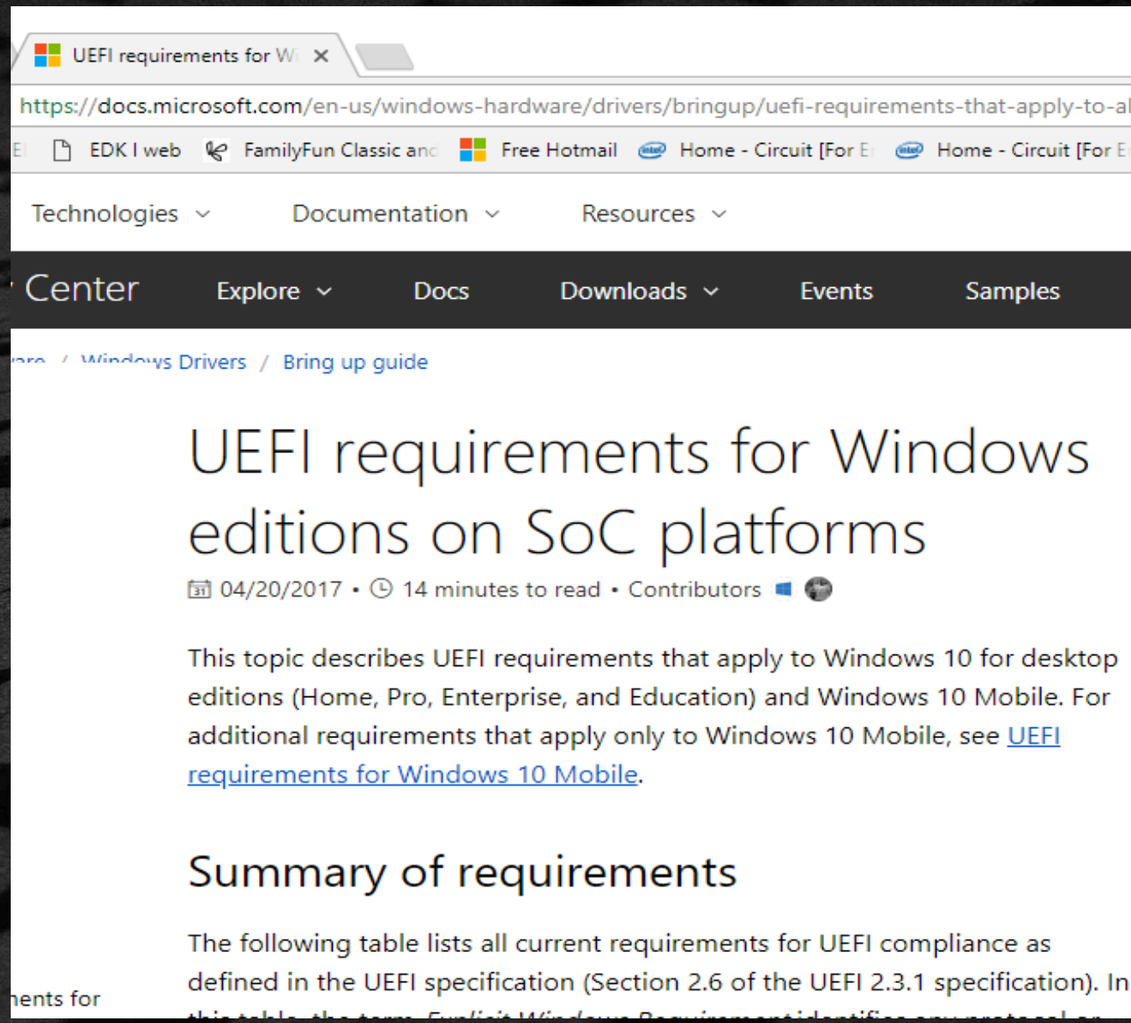


Windows Secure Boot Key Creation and Management Guidance

- Windows - Secure Boot Key Creation & Management Guide
- Creation and management of the Secure Boot keys and certificates in a manufacturing environment.
- Addresses questions related to creation, storage and retrieval of Platform Keys (PKs), secure firmware update keys, and third party Key Exchange Keys (KEKs).

Many Platforms are Requiring UEFI Secure Boot Enabled

- Secure Boot now mandated for specific platforms
- See “Security requirements” on UEFI requirements for Windows editions on SoC Platforms

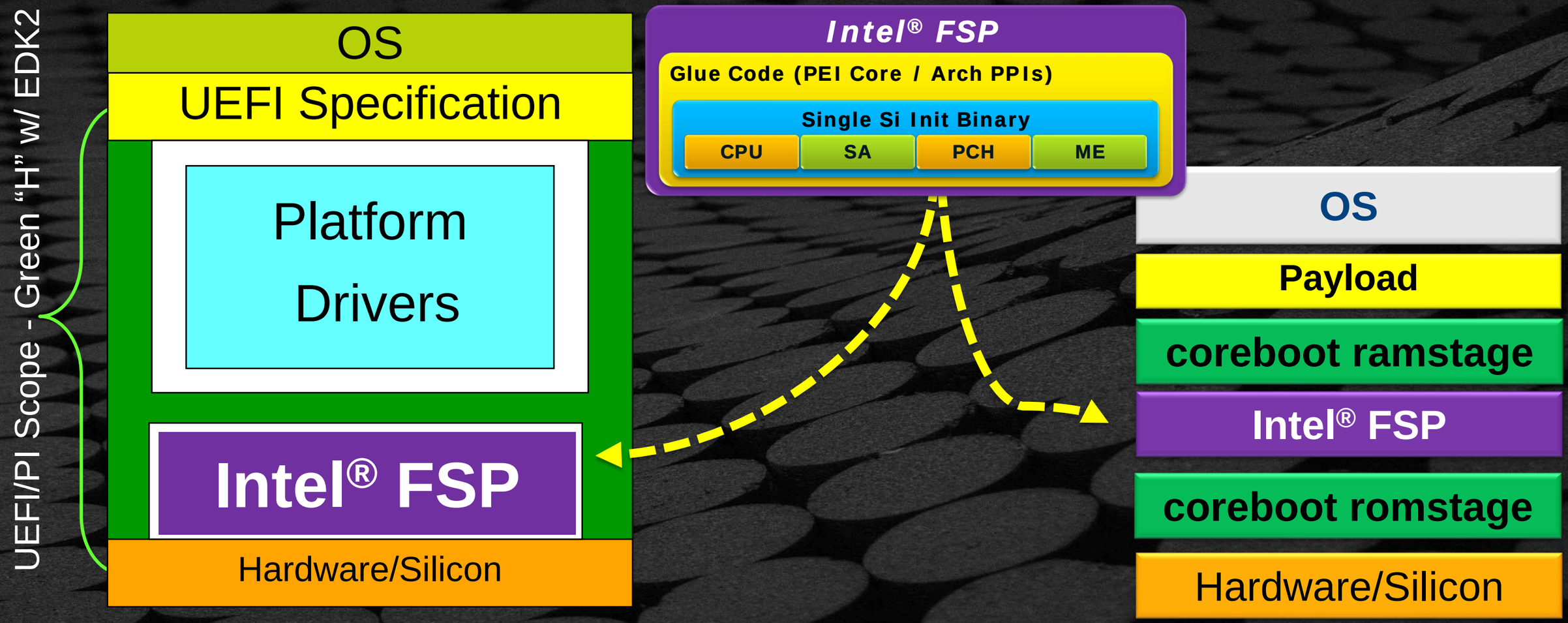


tianocore

COREBOOT

How does coreboot work with UEFI

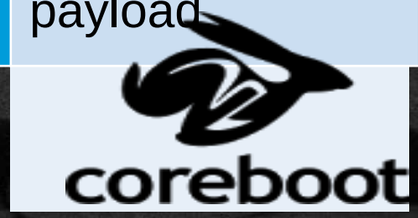
Intel® FSP "Produced" to "Consuming" Intel® Architecture Firmware



Intel FSP is independent of the bootloader solutions

Consumers: EDK II firmware and coreboot

Functionality	coreboot	UEFI / PI
The reset vector and pre cache-as-ram setup	bootblock	Security Phase (SEC)
Cache as Ram setup, early silicon initialization, memory setup. Covered largely by Intel® Firmware Support Package	romstage	Pre-EFI Initialization (PEI) Create HOBs
Normal device setup and mainboard configuration. Publish SMBIOS/ACPI Tables	ramstage	Early Driver Execution Environment (DXE)
Memory map hand-off	CBMEM	UEFI Memory Map
The OS or application bootloader	payload	DXE BDS and UEFI Drivers



tianocore

SUMMARY

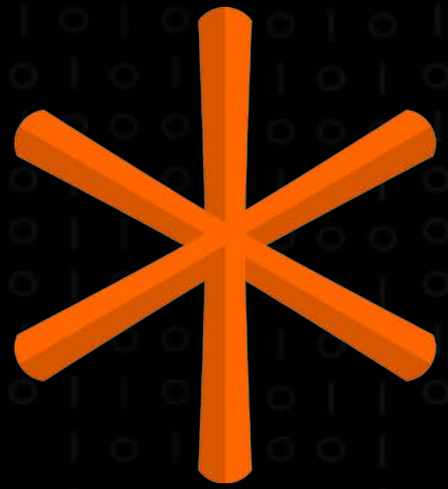
- Explain How the OS and UEFI Work together
- Explain the UEFI Requirements for UEFI aware OS
- Explain How Secure Boot Fits with UEFI
- What about coreboot?

tianocore

Questions?

Return to Main Training Page

Return to Training Table of contents for next presentation link



tianocore

Redistribution and use in source (original document form) and 'compiled‘ forms (converted to PDF, epub, HTML and other formats) with or without modification, are permitted provided that the following conditions are met:

Redistributions of source code (original document form) must retain the above copyright notice, this list of conditions and the following disclaimer as the first lines of this file unmodified.

Redistributions in compiled form (transformed to other DTDs, converted to PDF, epub, HTML and other formats) must reproduce the above copyright notice, this list of conditions and the following disclaimer in the documentation and/or other materials provided with the distribution.

THIS DOCUMENTATION IS PROVIDED BY TIANOCORE PROJECT "AS IS" AND ANY EXPRESS OR IMPLIED WARRANTIES, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE ARE DISCLAIMED. IN NO EVENT SHALL TIANOCORE PROJECT BE LIABLE FOR ANY DIRECT, INDIRECT, INCIDENTAL, SPECIAL, EXEMPLARY, OR CONSEQUENTIAL DAMAGES (INCLUDING, BUT NOT LIMITED TO, PROCUREMENT OF SUBSTITUTE GOODS OR SERVICES; LOSS OF USE, DATA, OR PROFITS; OR BUSINESS INTERRUPTION) HOWEVER CAUSED AND ON ANY THEORY OF LIABILITY, WHETHER IN CONTRACT, STRICT LIABILITY, OR TORT (INCLUDING NEGLIGENCE OR OTHERWISE) ARISING IN ANY WAY OUT OF THE USE OF THIS DOCUMENTATION, EVEN IF ADVISED OF THE POSSIBILITY OF SUCH DAMAGE.

Copyright (c) 2020, Intel Corporation. All rights reserved.

Backup

UEFI Secure Boot

- Deficiency: Boot path malware targets
- UEFI and Secure Boot harden the boot process
- Firmware/software in the boot process must be signed by a trusted Certificate Authority (CA)
- Firmware image is hardware-protected
- 3rd party drivers signed using CA-holding trusted keys
- Trusted signing key's database factory-initialized and OS-updated

WHY??? SECURE BOOT WITH UEFI

Without

Possible corrupted or destroyed data

- BootKit virus – MBR Rootkits
- Network boot attacks e.g. PXESPOILT
- Code Injection Attacks

With

- **Data integrity**
- **Trusted boot to OS**
- **Trusted drivers**
- **Trusted Applications**

UEFI Secure Boot Flow