Filling UEFI/FW Gaps in the Cloud

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Agenda

• Cloud Server Firmware Challenges
• Intro to UEFI
• Firmware Update
• Provisioning
• Tools & Diagnostics
• Security
• Conclusion
Introduction
Firmware Challenges in the Cloud

- Design constraints for the Compute –
  - Physics challenge?
  - How to deploy the compute engine?
  - How to manage the compute?

- Key Cloud Firmware Challenges
  - Firmware Updates
  - Bare Metal Provisioning
  - Security
  - Tools & Diagnostics
Why UEFI?

- Mostly written in C. High code re-use.
- Better platform scaling. For e.g. removes shadow ROM limits.
- Storage. GPT removes 2.2 TB MBR restriction.
- CPU Architecture independent. Platform design flexibility.
- Secure boot solves “trust” related system integration challenges.
- Pre-boot Networking. Ipv4, Ipv6, PXE, VLAN, iSCSI etc.
- UEFI shell improves pre-boot testing & diagnostics experience.
All products, dates, and programs are based on current expectations and subject to change without notice.
# Building UEFI

## Industry Standards Compliance
- UEFI 2.0, UEFI 2.1, UEFI 2.2, UEFI 2.3, UEFI 2.4; PI 1.0, PI 1.1, PI 1.2, PI 1.3; ACPI 5.1

## Extensible Foundation for Advanced Capabilities
- Pre-OS Security
- Rich Networking
- Manageability

## Support for UEFI Packages
- Import/export modules source/binaries to many build systems

## Maximize Re-use of Source Code**
- Platform Configuration Database (PCD) provides “knobs” for binaries
- ECP provides for reuse of EDK1117 (EDK I) modules
- Improved modularity, library classes and instances
- Optimize for size or speed

## Multiple Development Environments and Tool Chains**
- Windows, Linux, OSX
- VS2003, VS2005, WinDDK, Intel, GCC

## Fast and Flexible Build Infrastructure**
- 4X+ Build Performance Improvement (vs EDK I)
- Targeted Module Build Flexibility

Maximize the open source at [www.tianocore.org](http://www.tianocore.org)
Firmware Updates
Firmware Update Challenges

- Components from multiples vendors
- Delivering firmware
- Different types of devices
- Recovery from failures
- Node equivalence across datacenter
- Security, security, security……

Note: BMC based FW updates not covered here
Solving Firmware Update

- Reliable update story
  - Fault tolerant
  - Scalable & repeatable

- How can UEFI Help?
  - Capsule model for binary delivery
  - Bus / Device Enumeration
  - Managing updates via
    - EFI System Resource Table
    - Firmware Management Protocol
    - Capsule Signing
Delivering Firmware Binaries

- UEFI supports Capsule format
  - Tools for capsule generation
  - Core logic for capsule handling

- Extensible Capsule format
  - Self-contained
  - Discrete updates
  - Composite updates

- Firmware Management Protocol allows
  - Reading / updating firmware
  - Integrity checks
EFI System Resource Table

- **Update types**
  - Largely OS assisted
  - Largely BIOS assisted

- **FW updateability rules can be encoded into the capsule**
  - Least version
  - Signing

- **Describe various updateable components on the platform**
Bare Metal Provisioning
Bare Metal Provisioning Challenges

• Hardware Detection

• Installation
  - Local / Remote

• Configuration
  - Local / Remote / Scriptable

• Cloning
  - Automated

• Backup / Recovery
  - Local / Remote / Automated
Bare Metal Provisioning Solutions

• Need a ‘no-touch’, automated installation mechanism
  • Repurpose / Configure / Recover

• HII and IFR for consistent & scriptable configuration

• Non-blocking local disk and networking services for high throughput image delivery and recovery

• UEFI Variables for booting and Authenticated Variables for safe storage of settings, like UEFI secure boot database
Networking in UEFI

- UEFI offers rich set of Networking Features during pre-boot
  - PXE boot support for network boot, OS installations, provisioning etc.
  - Native support for IPv4 as well as IPv6
  - Network file system support
  - Virtual LAN support, iSCSI
  - IpSec for supporting secure communication

- Evolution of networking –
  - RFC 5970 allows for ‘boot from URI’
    - HTTP, NFS,…
Security
Attacks on Firmware

Stephen Cobb, senior security researcher at ESET North America, says that hacking firmware can be particularly effective because it is so hard to eliminate. It's also particularly challenging to do, says Jean Taggart, security researcher at Malwarebytes. “Doing this on just one brand of hard drive would be an almost Herculean task,” he says. “You have to understand the hardware as well— if not more— than the original manufacturer.”

Stan Alcorn, Marketplace, Feb 17, 2015
Security Challenges

• Different elements in platform from many vendors
• How to establish trust anchor in the hardware
• How to protect elements
• How to protect the platform
• How to allow platform scaling
Security Solutions

- Signed capsule updates
- UEFI Secure boot
  - local / network
- TPM on the platform
  - Measured boot
  - Root of Trust for Reporting
  - Storage
- Protect machine configuration & UEFI Secure boot trust anchors

In-band and out-of-band network security
Guarding & Verifying in Pre-boot

- PI & UEFI complement each other to impart **platform security** through guarding and verification during pre-boot.

- PI facilitates **platform hardening** by guarding internal firmware ingredients that consume reset vector, initialization of CPU, Memory, Chipset etc.

- UEFI signing allows **robust platform scaling** through verified inclusion of external firmware ingredients such as OPROMS into the trust chain.
Recommended UEFI Boot Flow

1. **CPU Reset**

2. **SEC**
   - S-CRTM; Init caches/MTRRs; Cache-as-RAM (NEM); Recovery; TPM Init

3. **Pre-EFI Init (PEI)**
   - S-CRTM: Measure DXE/BDS
   - Early CPU/PCH Init
   - Memory (DIMMs, DRAM) Init, SMM Init

4. **Driver Exec Env (DXE)**
   - Continue initialization of platform & devices
   - Enum FV, dispatch drivers (network, I/O, service...)
   - Produce Boot and Runtime Services
   - ACPI, UEFI SystemTable, SMBIOS table

5. **Boot Dev Select (BDS)**
   - Boot Manager (Select Boot Device)
   - EFI Shell/Apps; OS Boot Loader(s)
   - ExitBootServices. Minimal UEFI services (Variable)

6. **Runtime / OS**
Tools & Diagnostics
Tools & Diagnostic Challenges

- Platform ingredients from many vendors
- How to assess health, security, compliance of the elements
- Consistent environment to run diagnostics
  - Log / Report / Journal results
- Recovery agent considerations
  - Local / Remote / In-band / Out-of-band
Tools Solutions

- Environment for hosting tools
  - UEFI Shell
  - Linux UEFI Validation project

- Tools for deployment
  - UEFI SCT
  - PI SCT
  - ACPI Compliance
  - SMBIOS Compliance
  - Security
    - Chipsec
    - Copernicus
    - Selftest
chipsec Tool

- Essentially a platform security assessment framework for risk assessment
- Can be extended to meet specific platform security concerns
- Open sourced
  - [https://github.com/chipsec/chipsec](https://github.com/chipsec/chipsec)
- Supported Environments
  - Windows
  - Linux
  - UEFI (over Python)
Diagnostics Solutions

- Once in UEFI, how to assess, probe, and prod the system
  - Type15 SMBIOS Records
  - Dmpstore for UEFI variables, incl WHEA variable
  - ACPI CA for executing/dumping/viewing namespace
- UEFI shell to run above, redirect output to file or 'virtual file' (e.g., volatile variable)
- PCI command to read/write/assess hardware state. Scriptable too
- Results can be installed in UEFI system table like other hand-off info, or variable, or file on ESP, or sent across the network using UEFI network stack
Conclusions & Next Steps
Call to actions

Get involved in the standards

If you’re an IHV, implement FMP, Capsules, Security reviews of code

If you’re an OSV, build UEFI loader and boot agent

If you’re middle ware, leverage HII and shell scripting/config
Conclusion
Cloud has challenges for platform
UEFI for interop
Evolve updates
Provisioning
Diagnostics
Security
More information

www.opencompute.org – OCP specs
www.uefi.org – UEFI, ACPI, Shell, PI Specifications
www.Tianocore.org – open source UEFI
http://firmware.intel.com – white papers, training
UEFI Industry Resources

**UEFI Forum**
- www.uefi.org

**UEFI Open Source**
- www.tianocore.org

**Intel UEFI Resources**
- Firmware.intel.com

**Open Compute Resources**
- www.opencompute.org

**Intel EBC Compiler**

**UEFI Books/ Collateral**
- www.intel.com/intelpress
- http://www.apress.com/apressopen

**Microsoft UEFI Resources**