Using UEFI for Secure Firmware Update of Expansion Cards

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STTS003
Agenda

• Protecting the Firmware Update Process
• Security Enhancements in UEFI 2.4
• Securing the Firmware Update Process
• Pre-OS UEFI Secure Firmware Update with FMP
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Attacking “Other” Firmware

Enterprise systems use multiple firmware images...

Problems:
• Mixed update tools (Legacy & UEFI)
• Staging updates across enterprise environment
• Multiple attack surfaces exist before OS loads

• UEFI & Baseboard Management Controller (BMC) Firmware
• UEFI Driver & Option ROM (OpROM)
• Storage Firmware
Areas for Improvement

• Microsoft defines *EFI System Resource Table* (ESRT) for Windows* 8 systems
  – Described in “*Windows UEFI Firmware Update Platform*”
  – Currently used for “connected standby” devices

*Is a similar method applicable to other OS?*

• Many vendors already use Firmware Management Protocol (FMP) for updates...
  *Can FMP be hardened to meet NIST¹ requirements?*

• UEFI provides an infrastructure for security...
  *How can this be utilized in the update process?*

¹National Institute of Standards Technology (NIST)
Agenda

- Current State of Firmware Security
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Industry Trend is for Increased Security

- System Manufacturers in Enterprise Segment must add security for
  - NIST Compliance
  - OS Requirements
  - Customer Demand
Added Security for Firmware Protection

• **All** firmware components must be protected from unauthorized alteration
  – System firmware
  – Option ROMs on expansion boards
• **Still need to allow authorized firmware updates!**
Secure Boot protects system but also blocks many current IHV update schemes:
- DOS
- EFI/UEFI Shell
How UEFI Secure Boot Protects

• UEFI Secure Boot is a technology to eliminate a major security hole during handoff from UEFI firmware to UEFI OS
• Option ROMs and OS boot-loaders need to be signed by private key corresponding to a certificate in the systems security database
• Database is always provisioned at factory and maintained by OS if required for revocation
Microsoft* hosts a CA for UEFI use

- UEFI Option ROMs need to be signed by a widely trusted Certificate Authority
- Microsoft* has CA experience and volunteered to host the first all-industry UEFI CA
- Manufacturers are encouraged to put MS CA certificate into “Allowed” database
- In addition to Signing Option ROM Images, MS CA can be used to sign Option ROM Secure Update Drivers
1. UEFI has Firmware Management Protocol (FMP)
   - UEFI Specification defines a rich Firmware Management Protocol with functions for
     - Get Current Version and Update ID
     - Validate Update
     - Install a new image
     - Maintain Package Information

2. UEFI has UpdateCapsule Interface
   - Interface to deliver Updates to Firmware
   - Boot Services and Run Time Support
   - But implementing Run Time Delivery has been challenging
UEFI 2.4 Spec Was Recently Released

New in UEFI 2.4 for Secure Firmware Update:

1. **Define capsule format containing FMP updates**
   
   *Clarifies usage of Capsule for FMP*

2. **Deliver capsule on boot disk**
   
   *Stage update in OS*
   
   *Process update in secure firmware state*

3. **Variable with capsule processing status**
   
   *Report results back to OS context*
New FMP Capsule Delivers - Optional Update Drivers and Multiple Payloads

EFI Capsule Header

Capsule Body

EFI_FIRMWARE_MANAGEMENT_CAPSULE_HEADER

Optional Driver 1
Offset Within Body == ItemOffset[0]

Optional Driver 2
Offset Within Body == ItemOffset[1]

Payload 1
Offset Within Body == ItemOffset[2]

Payload 2
Offset Within Body == ItemOffset[3]

Payload n
Offset Within Body == ItemOffset[EmbeddedDriverCount + PayloadItemCount - 1]
Using UEFI 2.4, Update is Delivered Added Security

1. Copy Update to Boot Disk
2. Reboot to BIOS
3. Find and Unpack
4. FMP Check and Apply
5. Report Results

Cloud → FMP Capsule On Disk → Secure Boot → ROM to be Updated
UEFI Responsive to Industry Needs

- Requirement for Secure Update for expansion cards
- UEFI WG brings together OS, OEM, IHV, and IBV
- Version 2.4 delivers workable solution

UEFI 2.4 Offers New Tools for Update
Agenda

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Requirement to Verify Update Image

• Chain of trust requires –
  1. Firmware checks signature of Option ROM and any Update Driver
  2. Trusted update code checks the signed update image

• Three examples follow to explain validation
  ① Protected. Signed driver downloaded with update.
  ② More Protected. Signed option ROM on card.
  ③ Most Protected. Device firmware.
Downloaded Driver Validation
(No FMP Available in the Card)

Update Driver is trusted

Capsule
- Update Driver
- Payload

Unpack

System Firmware

Update Driver

FMP

Validate

Onboard

Trusted Update Driver

Protected!

IDF13
Option ROM Does Validation (Secure FMP in Option ROM)

Validation Occurs in ROM Using Code from Factory to Auth

Capsule
Payload

Unpack

System Firmware

UEFI Option ROM

Validate

Onboard

MORE Protected!
Device Engine Does Validation

- Device Engine
- System Firmware
- UEFI Option ROM
- IHV Option ROM

Validation Occurs in Hardware

③ MOST Protected!

Capsule
- Payload 1
- Payload 2

Unpack → FMP → Onboard

System Firmware → UEFI Option ROM → Onboard

IDF13
SOFTWARE DEMO

Update of Emulex Controller Firmware Using Firmware Management Capsule
IHVs Feedback Needed

• Current design as reflected in UEFI 2.4 specification is powerful and flexible

• UEFI working group is looking for feedback from IHVs. For example, some ideas:
  – Platform firmware could expose generic validation routines to assist IHV code in authentication
  – Clarifications of methods for write-protecting firmware store before leaving root-of-trust environment
  – User Interface through DRIVER_HEALTH_PROTOCOL

• If your company is not a member – Join UEFI!
• IHVs – we need your input!

UEFI Offers Solutions for Security Requirements
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Non-Secure Legacy Firmware Update Methods

- Utility in DOS
- EFI Shell with shell DRVCFG application (direct or through FMP)
- OS Runtime Utility from IHV

Pros
- Simple delivery method

Cons
- Untrusted OS with weak security methods
- Rogue binary can be substituted
- Difficult to implement hardware write protect
System OEM Handles Update Delivery

IHVs

Raw Driver Image

System OEM

Datacenter/Servers

Pros

- Protected, but Chain of Trust is completely under OEM control
- Authentication doesn’t burden every adapter driver

Cons

- Business Risk - IHV is vulnerable if OEM process is ever compromised
Delivery and Authentication by Capsule

**Pros**
- Authentication is done by Capsule Driver and doesn’t burden every adapter driver’s FMP implementation

**Cons**
- Dependence upon Secure Boot leaves FMP vulnerable if Secure Boot is compromised
Authentication in UEFI Option ROM

**Pros**
- Protected – Authentication in factory image
- Eliminates need for IHV Update Driver
- Not dependent on OEM Secure Boot

**Cons**
- Requires every UEFI adapter driver to include the authentication logic
- Requires UEFI adapter driver to manage keys
Authentication on Adapter

Dependency:
- Requires additional local storage on adapter card
- Adapter firmware must manage keys

Pros:
- Only one point of challenge
- Signed components not required in stack
- Authentication in protected environment
IHV Recommendations

• Safeguard your firmware and hardware from Pre-OS attacks!

• You have multiple options

• Contribute to overall system security

• New market opportunities for security solutions

IHVs need to evolve to meet update security requirements
Summary

• Expansion board firmware security is a key element of platform security
• UEFI 2.4 offers new tools for update
• UEFI offers solutions for IHV security requirements
• IHVs need to evolve to meet update security requirements
Call to Action

• Evaluate the security of current update strategies

• For new designs, plan to include board resources that support strongest security

• Engage with your partners and the industry through participation in UEFI
Additional Sources of Information

PDF of this presentation is available from our Technical Session Catalog:
www.intel.com/idfsessionsSF
The URL is on top of Session Agenda Pages in Pocket Guide.

Visit the Unified EFI Forum for the latest UEFI Specification and the “UEFI Secure Boot in Modern Computer Security Solutions” whitepaper.

NIST Special Publications are available from http://csrc.nist.gov/publications/PubsSPs.html
Welcome to Intel UEFI Community Resource Center

Your gateway for developing UEFI firmware, drivers, and applications for use on Intel® architecture platforms.

Learn more about UEFI >

http://uefidx.com

Central resource for UEFI on Intel® Architecture
### Other Sessions at IDF
**Wednesday, Sept 11, Moscone Room 2008**

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<td>STTS004</td>
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See also

Technical Showcase Booths 409, 410, 411

✓ = DONE
Software Developers: Network & Have Fun!

Don’t miss out on some great IDF networking and social activities hosted by Intel Software & Services Group (SSG):

- **Day 1, Tuesday, Sept 10th, 7pm-10:30pm**
  - **Software Developer Networking Party**
    - Pick up your Software VIP lanyard at the Software and Services Pavilion Info Counter to get party access!

- **Day 2, Wednesday, Sept 11**
  - **SSG Inspiration Through Innovation Hour**
    - Location: Showcase Networking Plaza, 11am-12pm & 5pm-6pm
    - SSG/guests discuss how innovation has inspired their products

  - **Doug Fisher (Intel VP, GM SSG) Meet & Greet**
    - Software & Services Pavilion, 5-7pm

- Watch out for SSG Mobile Lunch Food and Dessert carts outside Moscone throughout the conference
- Visit SSG Pavilion Showcase for great demos and games!
Please Fill Out The Online Session Evaluation Form

Enter to win fabulous prizes!

You will receive an email with a link to the online session evaluation prior to the end of this session. Please submit the evaluation by 10am tomorrow to be entered to win.

Winners will be announced by email

Sweepstakes rules are available at the Help Desk on Level 2
All sessions evaluations must be submitted by Friday, September 13 at 5pm
Q&A
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