UEFI Secure Boot in Linux*

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Agenda

• Problem Statement
• What is UEFI Secure Boot
• Introduction to Machine Owner Key
• Secure Boot in SUSE Linux
• Demo
Problem Statement
Secure Boot Problem

• Malware moving more into the platform
• UEFI extensibility can be exploited by unauthorized parties
• Attacks increasingly targeting the platform firmware
  – Black Hat 2007, 2009, 2013, CanSecWest 2013...
• Need to balance UEFI code loading controls and maintain platform owner and user choice
  – Maintain ability to have several operating systems on the platform
  – Provide platform owner a choice for software
What is UEFI Secure Boot
UEFI Secure Boot

1. Enroll

Authenticated Variables
- PEI FV
- KEK
- PK
- db
- dbx

DXE FV
- Image Verify

Certificate
SignInfo

2A. Signed Image Discover
- Certificate + SignInfo
- OpRom.efi

2B. Signature Verification

3. Post ship update DB

Load

2C. Signed Image Load

OsLoader.efi
- Certificate + SignInfo

Cloud

Update DB
The full solution

Intel® Device Protection Technology with Boot Guard – Secure Boot Policy Enforcement

End to end platform integrity
Secure Boot Challenges for Linux*

• Dual OS deployment challenge
  – Users can disable UEFI Secure Boot to install Linux* but this isn’t the best deployment plan
  – Users must have an option to install Linux alongside an OS, even when UEFI Secure Boot is enabled

• Linux can benefit from UEFI Secure Boot, if...
  – Customers can install Linux without disabling the feature
  – Platform owner can set security policy and customize system

• Different roles interact with UEFI Secure Boot
  – Kernel hacker – disable or enroll own keys w/firmware screens
  – Consumer – just want it to work, seamless boot of live images
  – Managed IT machine – IT is the ‘owner.’ Control end user actions.

Linux distributions have several options to implement secure boot
Introduction to Machine Owner Key
Machine Owner Key (MOK)

• To support UEFI Secure Boot in Linux*, there are two challenges to overcome
  – Coexist with other operating systems
  – Avoid the potential General Public License (GPL) copyright issues caused by the UEFI image signature

• MOK gives back the key management control to users or security admin
SUSE Solution

MOK comprised of 4 parts

1. **shim**
   - A BSD licensed preloader of the OS loader (grub2) signed with the db key
   - All involved components are signed

2. **MOK database** - The key database implemented in a UEFI nvram variable, MOKList

3. **MokManager**
   - The UEFI program to manipulate the MOK database

4. **mokutil**
   - The Linux* utility program to issue requests to MokManager
MOK Database

- The MOK database is used as a boot service non-volatile variable
- UEFI Boot Service non-volatile variables are immune from threats from OS
- MOKList is not the db and does not need to be controlled by KEK

<table>
<thead>
<tr>
<th></th>
<th>Boot Service</th>
<th>Runtime Service</th>
<th>Authenticated</th>
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<tbody>
<tr>
<td>UEFI - Read</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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<tr>
<td>UEFI - Write</td>
<td>Yes</td>
<td>Yes</td>
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<td>Yes</td>
<td>Yes</td>
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<tr>
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<td>Restricted</td>
</tr>
</tbody>
</table>

'MOKList is not accessible at OS runtime'
UEFI Secure Boot With MOK

shim is loaded before other UEFI images
Multi-boot with MOK

Load the UEFI image as long as it is trusted
Enroll A New MOK Key

1. request

Reboot

mokutil --import

Password Hash

2. detect

shim

3. verify

MokManager

4. enroll

MOKList

RT Var

5. reboot

custom boot path

RT: Runtime

Password Hash

User

User

Password Hash

User
Secure Boot in SUSE Linux*
Either the UEFI CA key or SUSE key will let the shim boot with UEFI secure boot
**Linux* Driver Verification**

- All kernel drivers have to be signed with the SUSE key
- Linux* kernel verifies drivers with the built-in SUSE key or MOK keys
- SUSE will NOT sign any binary driver that is incompatible with GPLv2
- The user is free to enroll the key for the third party binary driver
- SUSE's Partner Linux Driver Program (PLDP) - simplifies MOK implementation

*Users can get their 3rd party drivers included in the secure boot with MOK*
Third Party Driver Verification

Boot Service
- shim

Runtime
- kernel
  - verify
- copy
- MOKListRT (User)

3rd Party Driver
- User
- Signature
**SUSE Summary and Call to Action**

- UEFI Secure Boot no longer an issue to the Linux* World
- With MOK, users select the keys they trust
- Linux systems benefit from MOK to ensure the integrity of the drivers

**Call to action:**

- Use MOK in your Linux deployments
- Put SUSE key in UEFI database to test multi-signed shim
- Utilize SUSE's Partner Linux Driver Program for delivering kernel drivers compatible with SUSE Linux Enterprise and Secure Boot
  - [https://www.suse.com/partners/linux-driver-program/](https://www.suse.com/partners/linux-driver-program/)
Summary

• Attacks against the platform will most likely continue
• Deploy UEFI Secure Boot to address pre-OS malware
• Design a robust platform implementation
• Avoid ‘restricted boot’ & continue to enable platform owner choice of UEFI Secure Booted code
• Emergent tools for choice include multi-signed images, the Shim Loader, and Machine Owner Key
• Machine Owner Key provides practical solution for implementing key management
Updates from Linux* Distributions

- **Ubuntu** 12.10 – 64-bit version of Ubuntu 12.10 shipped with Shim to support secure boot
- **Fedora** 19 – included Shim with MOK (Machine Owned Key) functionality
- **OpenSUSE** 12.3 release supports MOK manager and multisigned Shim loader
- **SUSE SLES 11 SP3** - included multisigned Shim with MOK functionality and runtime Mokutil
- **Linux Foundation Secure Boot System Released**
- **UEFI Technology Adopted by Linux Community†**

Intel UEFI Community Resource Center

Welcome to Intel UEFI Community Resource Center
Your gateway for developing UEFI firmware, drivers, and applications for use on Intel® architecture platforms.

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Communicate. Forum for discussions with Intel engineers and other developers »

Share. Upload and download files for sharing with the community »

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Find solutions. Get conforming devices, BIDS, and drivers from participating vendors »

Central resource for UEFI on Intel® Architecture
Additional Sources of Information

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

Visit the Unified EFI Forum for the latest specifications.

The EDK II project is hosted at http://tianocore.org.

Latest updates to SUSE* UEFI secure boot:
OpenSUSE tools UEFI:

http://download.opensuse.org/repositories/home:/jejb1:/UEFI/
http://build.opensuse.org/project/show/home:jejb1:UEFI

Related Articles/Whitepapers at tianocore.org:
- “A Tour Beyond BIOS into UEFI Secure Boot”
- Images with Multiple Signatures
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See also
Technical Showcase Booths 408, 409, 410
“Intel® Device Protection Technology with Boot Guard - Secure Boot Policy Enforcement, booth #318”

✓ = DONE
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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!
Additional Linux Resources

IDF 2012 – Developing UEFI Support for Linux*  

For more information on Ubuntu* ...  
Secure Boot Tools - git://kernel.ubuntu.com/jk/sbsigntool  
https://github.com/vathpela/pesign

Summary of secure bootloaders  
http://www.rodsbooks.com/efi-bootloaders/secureboot.html

Matthew Garrett  http://mjg59.dreamwidth.org/  
Shim https://github.com/mjg59/
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Backup
Authenticated Variables (AT):
Small signed named data containers
• Managed, protected by the system BIOS
• Read by BIOS, OS.
• Modified by BIOS, OS only if signature verifies (or local user on Intel® Architecture platforms)

PK: Platform Key: AT containing OEM’s keys.
Party who can edit the KEK via s/w

KEK: Key Exchange Key: List of certificates of owners allowed to update white list (db), black list (dbx)

db: Authorization Database: AT containing authorized certs / hashes

dbx: Exclusion Database: AT containing excluded certs / hashes

Signed PE/COFF executables
• Op ROMs
• Boot loaders
• Applications
Authenticode signing format

Option ROM
OS Loader
Option ROM
The Full Solution

Signed Firmware Update 800-147

OS Secure Boot

UEFI Secure Boot

HDD

UEFI DXE Core / Dispatcher

Silicon initialization (SEC/PEI)

Hardware
- I/O
- Memory
- Network
- Graphics

OS Driver

OS Kernel

UEFI OS Loaders (SecondStageLoader.efi)

UEFI Boot Loaders (OSLoader1.efi, OSLoader2.efi, OSLoader3.efi)

Signed Firmware Update 800-147

End to end platform integrity