Developing UEFI Support for Linux*

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EFIS001
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Agenda

• UEFI Considerations for Linux*
  – Overview of the UEFI Boot Process
  – Using UEFI Secure Boot with Linux
  – Other Implementation Issues
• Implementing UEFI in Ubuntu* 12.10
• Implementing UEFI in Fedora* 18
• Latest Updates to SUSE* Secure Boot Plans
• Summary / Next Steps / Q&A

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UEFI Considerations for Linux*

- Overview of the UEFI Boot Process
- Using UEFI Secure Boot with Linux*
- Other Implementation Issues
Overview of the UEFI Boot Process

OPERATING SYSTEM

UEFI OS LOADER

UEFI BOOT SERVICES

Protocols + Handlers

Timer

Memory

UEFI/PI Drivers

UEFI API

UEFI RUNTIME SERVICES

PLATFORM SPECIFIC Firmware

PLATFORM HARDWARE

System ROM (SPI)

Option ROM

UEFI SYSTEM PARTITION

OS PARTITION

UEFI Drivers

UEFI Drivers

UEFI Drivers

UEFI OS Loader
Typical OS Loader Scenario for UEFI

- One GPT disk partition is FAT32 (service partition)
- OS installer puts the loader on the service partition
  - Under `/EFI/BOOT` or `/EFI/osname` directory
  - Ex: `/efi/boot/bootx64.efi`, `/efi/ubuntu/grubx64.efi`
- NVRAM *(Bootxxxx)* has a device path to OS loader
  - Maps to specific device, GUID partition & filename
Advantages of UEFI Boot Process

• Extensible across multiple boot devices
  – SATA, SAS, USB, PXE/iSCSI (IPv4/IPv6), ...
• Supports multi-boot operations
  – Multi-boot loaders w/o MBR chain-loading
  – UEFI Forum reserves directories to avoid collisions
  – Use `/efi/boot` directory for removable media
• Device path stored in boot options (NVRAM)
  – Pointer to specific boot device
• Boot image can be validated when loaded
  – Allows firmware loader to perform security checks
Using UEFI Secure Boot with Linux

The key is in the keys ...
Signed images for the OS loader, UEFI Drivers & Option ROMs must reference some key in the db (and not be in the dbx)

1. Enroll
   - PEI FV
   - Authenticated Variable
     - PK
     - KEK
   - db
   - dbx
   - Variable
   - DXE FV
   - Image Verify

2A. Signed Image Discovery
   - OpRom.efi
     - Certificate
     - SignInfo

2B. Signature Verification

2C. Signed Image Load
   - OsLoader.efi
     - Certificate
     - SignInfo

Reference: Figure 11 from the “A Tour Beyond BIOS into UEFI Secure Boot” whitepaper at tianocore.org
Secure Boot Challenges for Linux*

• 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 & customize system

• Distributions have other considerations for UEFI
  – How the kernel handles signed & unsigned code
  – Migrating drivers from legacy BIOS calls (INTxx) to UEFI

*Linux distributions must determine how to implement secure boot
Implementing UEFI in Ubuntu* 12.10

• Secure Boot: Implementation Overview

• Ubuntu* Certification Requirements

• Demo
Secure Boot: Implementation Overview

UEFI Secure Boot can’t interfere with Ubuntu’s* value...

• Must allow user modification
  – Allow user-defined trust verification

• Must work on generic hardware
  – Without reconfiguration!

• Must work with Ubuntu infrastructure
Ubuntu* Implementation

Microsoft* UEFI CA certificate
Signature generated from Microsoft UEFI CA

Ubuntu* CA certificate
Signature generated from Ubuntu CA

Legend
- **cert**: Microsoft* UEFI CA certificate
- **sig**: Signature generated from Microsoft UEFI CA
- **cert**: Ubuntu* CA certificate
- **sig**: Signature generated from Ubuntu CA
Ubuntu* Implementation

Bootloader shim allows compatibility with Microsoft* UEFI CA

Code up to ExitBootServices() is signed

Bootloader images will be signed during build. No requirements for driver signing.
Ubuntu* Certification

System requirements for Ubuntu* preinstalls

UEFI requirements include:
• Initial key database configuration
• User key reconfiguration functionality
• Facility to enable/disable secure boot

For more information ...
• Ubuntu ODM Portal - http://odm.ubuntu.com/
• Secure Boot Signing Tools - git://kernel.ubuntu.com/jk/sbsigntool
Ubuntu* Demo with UEFI

- Key reconfiguration through standard firmware interfaces
- Ubuntu* images verified by firmware
- Key reconfiguration at OS level (with appropriate KEK installed)
Ubuntu* Implementation for UEFI

Ubuntu* 12.10 implements UEFI Secure Boot

- Boot loader shim signed by Microsoft* UEFI CA
- Ubuntu signed boot loader

Supports runtime key reconfiguration

- Using efivars interface to update PK, KEK, db, dbx

Certification requires user-modifiable keys

- User control of security policy

Ubuntu uses existing Linux* infrastructure to support UEFI with Secure Boot
Implementing UEFI in Fedora* 18

- Satisfying Enterprise Customers
- Changes to the Kernel
- Demo: Security Policy
Implementing UEFI in Fedora* 18

• Fedora* 18 implements full UEFI Secure Boot support
  – Due for release early November 2012

• Uses UEFI for new enterprise-level features
  – Use UEFI for new functionality, not the bare minimum

• Implementing UEFI requires a surprisingly large set of functional changes
Satisfying Enterprise Customers

- UEFI Secure Boot can bring value to servers
  - However, customer configuration & integration is vital
  - Vital that trust be determined by the customer
  - Functionality for self-signing is hugely important
  - Integration into update system is also a key factor

- IPv6 support in the firmware permits net installs
  - Next generation network infrastructure support

- UEFI offers persistent NVRAM storage
  - Perfect for crash dumps and back-traces
Increased Kernel Security

• Signed drivers
  – Kernel refuses to load drivers unless signed with trusted key
  – Support for key installation

• Controlled hardware access
  – No direct user space access to hardware resources
  – All access mediated via the kernel
  – Graphics processor command streams validated to prevent DMA attacks

• Some debugging features disabled
  – Must be impossible for users to programmatically override security policy
  – Debug support must involve physically-present end user enablement
The diagram illustrates the Fedora* implementation of UEFI firmware. The process begins with the UEFI firmware, which contains a Microsoft* UEFI CA certificate. This certificate is verified and executed to load the boot shim, which is signed with the Fedora CA certificate. The bootloader is then loaded, which is signed with the Fedora CA certificate. Finally, the kernel is loaded, which is signed with the Fedora CA certificate. The diagram also includes a legend for the symbols used:

- **cert**: Microsoft* UEFI CA certificate
- **sig**: Signature generated from Microsoft UEFI CA
- **cert**: Fedora* CA certificate
- **sig**: Signature generated from Fedora CA
Fedora* Implementation

Bootloader shim allows compatibility with Microsoft* UEFI CA

All kernel-level code is signed

boot shim
  sig
  cert

bootloader
  sig

kernel
  sig

Bootloader images will be signed during build. Will only boot signed kernels.
Hardware Enablement

• Kernel-mediated hardware access involves some new driver support
  – Added new kernel support for obsolescent graphics chipsets
  – Additional benefits in the form of power management
  – Server hardware environment very different to client
  – Still vital to provide full support

• The impact of UEFI & Secure Boot on the wider ecosystem will take time to determine
Demo: Security Policy in Fedora* 18

Use UEFI Secure Boot to enforce boot policy ...
*Fedora* 18 boot using only signed binaries and drivers
UEFI Support in Fedora* 18

Full system security

Designed to minimize impact on users

Available later this year

*Fedora uses UEFI Secure Boot as part of value-add for enterprise customers*
Latest updates to SUSE* UEFI secure boot plans
SUSE* Approach to UEFI Secure Boot

• SUSE has to balance two goals
  – Improving enterprise security by adopting UEFI Secure Boot
  – Reconcile UEFI Secure Boot with Linux developer’s need to run a custom boot loader & kernel

• Aiming to support Secure Boot in SLE11 SP3* and openSUSE*

• Working with Linux* community and other vendors
  – Building on the shim loader created by Matthew Garrett
  – Extending it to allow machine owner to securely boot other kernels
Summary

- Linux* distributions must determine how to implement Secure Boot
- Ubuntu* uses existing Linux infrastructure to support UEFI with Secure Boot
- Fedora* uses UEFI Secure Boot as part of value-add for enterprise customers
- SUSE* has plans to use UEFI Secure Boot
Call to action

• Evaluate platform support for UEFI
• Become familiar with UEFI Secure Boot and how it effects your platform
• Download and test the latest Linux* distributions with support for UEFI & Secure Boot
  – The link for Ubuntu* Secure boot resources is at: https://wiki.ubuntu.com/UEFI/SecureBoot
Get More Information

• Intel UEFI Community - http://intel.com/udk
• UEFI Forum Learning Center
  – http://www.uefi.org/learning_center/
• Use the TianoCore edm2-devel mailing_list for support from other UEFI developers
• Read the “A Tour Beyond BIOS into UEFI Secure Boot” whitepaper at tianocore.org
• For more information on Ubuntu* ...
• For more information on Fedora* ...
  – http://fedoraproject.org/
• Latest updates to SUSE* UEFI secure boot plans: https://www.suse.com/blogs/tag/secure-boot/

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Figure 11 from the “A Tour Beyond BIOS into UEFI Secure Boot” whitepaper at tianocore.org