Accelerating Firmware Development With UEFI Advanced Features

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STTS001
Agenda

• Latest UEFI & ACPI Specifications

• Redfish RESTful Use Case in Data Center

• Apply Key Features to UEFI Development

• Summary
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Latest UEFI & ACPI Specifications

- UEFI 2.6
- ACPI 6.1
- UEFI Shell 2.2
- UEFI PI 1.4
- UEFI PI Packaging 1.1

http://uefi.org/specifications
UEFI 2.5 Networking

- Boot from HTTP(S) (HTTP API, HTTP Helper API, DNS v4/v6, RAMDISK, ...)
- Wi-Fi (EAP, Extensible Authentication Protocol, Support)
- TLS, Transport Layer Security
- Bluetooth®
- Redfish REST Protocol

www.uefi.org
What's New – UEFI 2.6

Network Enhancements
- Wireless MAC Connection II Protocol
- RAMDISK Protocol

RAS
- Common Platform Error Record (CPER) Extension for ARM*

User Interface
- Human Interface Infrastructure (HII) Font Ex, Glyph Generator, Image Ex and Image Generator Protocols

I/O
- SD/eMMC Pass Thru Protocol
- Non-identity Mapped Address Translations in PCI Root Bridge and I/O Protocols

www.uefi.org
What's New – ACPI 6.1

Persistent Memory
- NFIT Updates
- NFIT Root Device _DSM

RAS
- APEI Extension for ARM*
- ERST/EINJ max wait time

Management
- Graceful Shutdown Clarifications
- Wireless Power Calibration Device

I/O
- Interrupt-signaled Events

UEFI & ACPI specification updates help in accelerating firmware development

www.uefi.org
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Redfish RESTful Use Case in Data Center

What is Redfish?
- Industry standard - [www.dmtf.org/standards/redfish](http://www.dmtf.org/standards/redfish)
- DMTF* Scalable Platforms Management Forum (SPMF) provides specification, schema, mockup, whitepaper, FAQ & resource browser

Managing multi-code servers via a RESTful API
- Built on modern tool chain (HTTPS, JSON, OData)

Client Python* code
```
rawData = urllib.urlopen('https://192.168.0.1/redfish/v1/Systems/1')
jsonData = json.loads(rawData)
print( jsonData['SerialNumber'] )
```

Output
0AB8012GQ0
Redfish Resource Map

Service Root

/redfish/v1
    Root
    Links to all content

Collection

/redfish/v1/Systems
    Collection of Systems
    "Logical view"

/redfish/v1/Chassis
    Collection of Chassis
    "Physical view"

/redfish/v1/Managers
    Collection of Managers
    "BMC"

Singleton

/redfish/v1/Systems/<id>
    Server System
    "Logical computer system"

Processors
Disks
NICs
Storage
Oem.HPE

Tasks
Sessions
Accounts
Events
Registries
Schemas

SecureBoot
UEFI Boot Order
UEFI iSCSI Boot
UEFI BIOS HII Settings

Hewlett Packard Enterprise *
UEFI REST Protocol

• New in UEFI v2.5
• Standard pre-boot in-band access to a RESTful API, like Redfish
• Abstracts BMC-specific access methods (proprietary)
UEFI Firmware Development Process

- System Startup
- System Configuration
- System Advanced Features
- System Distribution & Validation
UEFI Deployment Solution on HPE* Servers

**Hewlett Packard Enterprise**
HPE* ProLiant* Gen9 Servers with UEFI Network Deployment

UEFI network stack

LAN / WAN / Cloud

Management Network

Management Clients (Remote Console, RESTful tools, etc...)

Boot ISO

Config

Management Clients (Remote Console, RESTful tools, etc...)

HTTPs

Tools & Scripts

Deployment Assets

**Tools** & **Scripts**

**HPE Embedded UEFI Shell**

**HPE UEFI Pre-Boot UI**

**HPE UEFI Shell** startup script

**RAM Disk**

**UEFI Shell startup script**

**Boot ISO**

**HTTPs**

**HTTP**

**HTTP Server**

**FTP**

**FTP Server**

**Out-of-band RESTful API (HTTPs)**

**In-band RESTful API**

**Console and Virtual Media (USB, Keyboard, Mouse)**

**Deployment**

**System Utilities**

**DHCP Server**

**DNS Server**

**HTTP Server**

**FTP Server**

**Administration Network**

**HPE ProLiant DL380 Gen9 Servers with UEFI Network Deployment**

**HPE ProLiant DL360 Gen9 Servers with UEFI Network Deployment**

**HPE ProLiant DL180 Gen9 Servers with UEFI Network Deployment**

**Management Clients**

**Remote Console**

**RESTful tools**

**etc...**
Hewlett Packard Enterprise* Redfish Example: Secure Boot

GET @ /redfish/v1/systems/1/secureboot

- Enable/Disable Secure Boot
- Reset all Secure Boot variables to defaults
- Clear all keys (Setup Mode)
Hewlett Packard Enterprise* Redfish Example: UEFI BIOS HII Settings

GET @ /redfish/v1/systems/1/bios

- All UEFI BIOS settings HII (name/values)
- HII meta-data in Attribute Registry
- Name/value pairs used to lookup meta-data in Attribute Registry

```
"AttributeName": "",
"AdminOtherInfo": "",
"AdminPassword": null,
"AdminPhone": "5555555",
"AdvancedMemProtection": "AdvancedEcc",
"AsrStatus": "Enabled",
"AsrTimeoutMinutes": "10",
"AssetTagProtection": "Unlocked",
"AttributeRegistry": "HpBiosAttributeRegistryP89.1.0.40",
"AutoPowerOn": "RestoreLastState",
"BootMode": "Uefi",
```
Hewlett Packard Enterprise* Redfish Example: UEFI BIOS HII Settings

GET @ /redfish/v1/registries/HpBiosAttributeRegistryP89.1.0.40

```
{
  "AttributeName": "BootMode",
  "DisplayName": "Boot Mode",
  "HelpText": "Use this option to select the boot mode of the system. Selection(s) are applied to the next boot.",
  "WarningText": "Boot Mode changes require a system reboot in order to take effect",
  "ReadOnly": false,
  "GrayOut": false,
  "Type": "Enumeration",
  "MenuPath": ".:/BootOptions",
  "DisplayOrder": 81,
  "CurrentValue": null,
  "Value": [
    {
      "ValueName": "Uefi",
      "ValueDisplayName": "UEFI Mode"
    },
    {
      "ValueName": "LegacyBios",
      "ValueDisplayName": "Legacy BIOS Mode"
    }
  ]
}
```
Sample UEFI Shell Deployment Script (startup)

A use case of accelerating firmware development with UEFI advanced features
Agenda

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• Apply Key Features to UEFI Development

• Summary
Apply Key Features to UEFI Development

- System Startup
  - Secure Boot to OS
  - Firmware Update
  - Boot Recovery
- System Configuration
- System Advanced Features
- System Distribution & Validation
Initial - UEFI Secure Boot

SECURED boot path example:

- Boot loader (bootx64.efi) protected by UEFI secure boot
- Early Launch Anti-Malware (ELAM) protected by Boot loader
- Rootkit malware can no longer bypass anti-malware inspection
Advanced – Customized UEFI Secure Boot

<table>
<thead>
<tr>
<th>Deployment</th>
<th>Initial</th>
<th>Advanced</th>
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<tbody>
<tr>
<td>Platform Specific PK \textsubscript{pub} Clear</td>
<td>Standardized solution to customize the secure boot keys</td>
<td></td>
</tr>
<tr>
<td>Setup Mode User Mode</td>
<td>Setup Mode User Mode</td>
<td>Audit Mode Deployed Mode</td>
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</table>

<table>
<thead>
<tr>
<th>Benefits</th>
<th>Security</th>
<th>Flexibility</th>
<th>Extensibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>• No specific solution</td>
<td>• Higher utilization</td>
<td>• Verification status</td>
<td></td>
</tr>
</tbody>
</table>
Secure Firmware Update

• Firmware update **protected** by:
  - OS verify the update driver when creating capsule
  - UEFI secure boot verify capsule payload before performing update
• What’s new:
  - ESRT
  - FMPv3
  - FMP capsule
Boot Recovery

- What’s new
  - OS defined recovery
  - Platform defined recovery
  - Recovery policy protected by authentication
    - OsRecoveryOrder
    - dbrDefault, dbr
  - Default platform recovery supported

Security enhancements help in accelerating the system startup stage
Apply Key Features to UEFI Development

System Startup

System Configuration

x-UEFI Configuration

HII New Protocols

......

System Advanced Features

System Distribution & Validation
x-UEFI Scriptable Configuration

- Based on keywords defined in different namespaces
- Leverages existing UEFI HII infrastructure

- Key elements:
  - x-UEFI language
  - Keyword Handler Protocol
iSCSIInitiatorName

VFR file

```
string varid = ISCSI_CONFIG_IFR_NVadata.InitiatorName,
prompt = STRING_TOKEN(STR_ISCSI_CONFIG_INIT_NAME),
```

UNI file

```
#string STR_ISCSI_CONFIG_INIT_NAME   #language en-US "iSCSI_Initiator_Name"
#string STR_ISCSI_CONFIG_INIT_NAME   #language x-UEFI "iSCSIInitiatorName"
```

Script file

```
IScsiScript -i iqn.edkii.intel.com
```
How to Implement x-UEFI?

• OEMs ...
  - Get keywords definition from [http://www.uefi.org/confignamespace](http://www.uefi.org/confignamespace)
  - Use KeywordHandler.GetData/SetData

• Firmware vendors ...
  - Get HII updates from Intel® UEFI Development Kit (Intel® UDK) 2015

• IHVs ...
  - Define and register x-UEFI keywords
  - Support keyword setting in ConfigAccess.RouteConfig

Configuration enhancements help in accelerating the in-band startup during the system configuration stage.
Apply Key Features to UEFI Development
UEFI HTTP Stack

New Modules

<table>
<thead>
<tr>
<th>Driver</th>
<th>Library</th>
</tr>
</thead>
<tbody>
<tr>
<td>HTTP Boot Driver</td>
<td>HTTP Library</td>
</tr>
<tr>
<td>HTTP Driver</td>
<td>TLSLib Library</td>
</tr>
<tr>
<td>HTTP Utilities Driver</td>
<td>OpenslTLSLib Library</td>
</tr>
<tr>
<td>TLS Driver</td>
<td></td>
</tr>
</tbody>
</table>

- Flexible Network Deployment
- Home Environment Support
- Corporate Environment Support
HTTP(S) Boot Flow

EFI HTTPBoot Client

DHCP Server

DNS Server

HTTP(S) Server

DHCP: address config

DNS: Host name resolution

HTTP: 1). Get NBP file size 2). Download NBP file

Booted!
DEMO - UEFI HTTP(S) Boot

• STEP 0: Configure TLS certificate
  - For HTTPS
• STEP 1: Configure Boot URI
  - Enter Device Manager
  - Select a particular NIC
  - Enter HTTP boot Configuration
  - Enter Boot URI and save changes
• STEP 2: Find boot option
  - Enter Boot Manager
  - Select new added boot option
• STEP 3: Boot to Windows* Pre-installation Environment image

TLS is still a patch. Cert management is not secured so far. Want to work w/ the community to harden and OS vendors for interoperability.
UEFI Wireless Stack

- 802.11 compliant wireless stack:
  - Connection manager using HII
  - Generic supplicant capability includes
    - PSK authentication
    - EAP 802.1x authentication
  - CCMP encryption
**UEFI Bluetooth®**

- Produce generic I/O interface:
  - UEFI device drivers can easily deliver rich services

- UEFI Bluetooth® Stack Layer:
  - Bluetooth® host controller
  - Bluetooth® bus
  - Bluetooth® service

**Leverage the connectivity enhancement during the stage of enabling advanced feature**
Apply Key Features to UEFI Development

System Startup

System Configuration

System Advanced Features

Intel® Firmware Engine

Intel® Intelligent Test System

System Distribution & Validation
Quickly generate royalty-free firmware for IoT devices without source code

Extensible binary firmware framework
Start from validated reference designs
GUI development for faster time to market

Available now at intel.com/firmwareengine
Intel® Firmware Engine

• Application, SDK and open hardware platforms available for download at intel.com/firmwareengine

• Intel® Firmware Engine 2.0 just released

• Updated SDK due April 2016

• Additional platforms from the Intel IoT roadmap are under development
Intel® Intelligent Test System (Intel® ITS)

Scalable hardware/software test framework

Test automation, device control & UEFI code coverage

Reduce costs & improve validation efficiency

Intel® Firmware Engine and Intel® ITS simplify firmware distribution and validation

Available now at intel.com/intel-its
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Summary and Next Steps

- UEFI & ACPI specification updates help in accelerating firmware development
- Redfish used RESTful management in modern data center is a good use case of accelerating firmware development with UEFI advanced features
- More enhancements in security, configuration, networking are ready to be adopted
- Intel® Firmware Engine and Intel® Intelligent Test System simplify firmware distribution and validation

Next Steps:

- Adopt UEFI 2.6 implementations with UEFI advanced features
- Adopt Redfish implementations in servers and management software
- Working with the community more deeply to continue improving security, interoperability and readiness of UEFI advanced features
Additional Sources of Information

• A PDF of this presentation is available from our Technical Session Catalog: www.intel.com/idfsessionsSZ
• This URL is also printed on the top of Session Agenda Pages in the Pocket Guide.

• More web-based info:
  - Intel® Architecture Firmware Resource Center: firmware.intel.com
  - UEFI Forum Learning Center: uefi.org/learning_center
  - UEFI and ACPI Specifications: www.uefi.org/specs/
  - Redfish Specification: www.dmtf.org/standards/redfish
Intel EDK II & UEFI Developer Survey

Intel Software is conducting a survey to improve EDK II & UEFI development tools. We want to know about your compiler preferences, debug methods, and what we can do for the future of firmware.

http://intelcustomer.az1.qualtrics.com/SE/?SID=SV_6IJbxG5BYFFMPSl&Sourc=IDF
Other Technical Sessions

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<td>STTS001</td>
<td>Accelerating Firmware Development With UEFI Advanced Features</td>
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✓ = DONE
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Backup
What's New – UEFI Shell 2.2

• Network updates
• Allow `Execute()` to not nest new shells
• Add command line parameter to auto exit

• `setvar` command re-factor
• New command features
  `dh`, `disconnect`, `comp`, `dmem`, `cls`, `reset`, `pci`, `bcfg`, `dmpstore`
What's New - PI Packaging 1.1

- Convey PCD settings with discrete sub-settings
- Localized name to a package
- Convey detailed Protocol/PPI/GUIDs produces information
- Convey usage for PCDs from binary modules
- Convey detailed Protocol/PPI/GUIDs consumes information

- Convey PCD display information
- Convey enumeration-like information for PCD (allow string)
- Abstract type support
- Convey detailed BY_START/TO_START interaction
- Convey install/produce limit information about Protocol/PPI/GUIDs
# Login to iLO
hprest login https://clientilo.domain.com -u username -p password

# Configure UEFI network settings (Use Auto and DHCP defaults)
hprest set PreBootNetwork=AUTO --selector HpBios.
hprest set Dhcpv4=Enabled

# Configure UEFI Shell startup script from URL
hprest set UefiShellStartup=Enabled
hprest set UefiShellStartupLocation=NetworkLocation
hprest set UefiShellStartupUrl=http://192.168.1.1/deploy/startup.nsh

# Set one-time-boot to Embedded UEFI Shell
hprest set Boot/BootSourceOverrideEnabled=Once --selector ComputerSystem.
hprest set Boot/BootSourceOverrideTarget=UefiShell

# Save and reboot server
hprest commit --reboot=ON