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

Management
- Graceful Shutdown Clarifications
- Wireless Power Calibration Device

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

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

```python
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"

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

**Resources**
- Processors
- Disks
- NICs
- Storage
- Oem.HPE
- 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

- **LAN / WAN / Cloud**
- **DHCP Server**
- **DNS Server**
- **HTTP Server**
- **FTP Server**
- **HPE Embedded UEFI Shell**
- **HPE UEFI Pre-Boot UI**

**Management Network**

- **Console and Virtual Media** (USB, Keyboard, Mouse)
- **In-band RESTful API**
- **Out-of-band RESTful API (HTTPS)**

**RAM Disk**

- **Tools & Scripts**
- **UEFI Shell startup script**

**Deployment Assets**

- **Boot ISO**
- **Tools & Scripts**

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

**API**
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)

```json
{
  "Name": "SecureBoot",
  "ResetAllKeys": false,
  "ResetToDefaultKeys": false,
  "SecureBootCurrentState": false,
  "SecureBootEnable": false,
  "Type": "HpSecureBoot.0.9.5"
}
```
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

```
"AdminName": "",
"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": "Boot Mode",
    "DisplayName": "Boot Mode",
    "HelpText": "Use this option to select the boot mode of the system. Selecting the "uefi" option will boot the system in UEFI Mode. Selecting the "legacybios" option will boot the system in Legacy BIOS Mode."
    "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"
        }
    ]
}
```
# Create FAT32 RAM Disk
ramdisk -c -s 512 -v MYRAMDISK -t F32
FS0:

# Download provisioning OS files from HTTP to RAM Disk
webclient -g http://repo.hpe.com/deploy/efilinux.efi
webclient -g http://repo.hpe.com/deploy/deploy.kernel
webclient -g http://repo.hpe.com/deploy/deploy.ramdisk

# Start provisioning OS
efilinux.efi -f deploy.kernel initrd=deploy.ramdisk

A use case of accelerating firmware development with UEFI advanced features
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Apply Key Features to UEFI Development

System Startup

System Configuration

System Advanced Features

Secure Boot to OS

Firmware Update

Boot Recovery

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

Deployment

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

Benefits

- No specific solution
- Higher utilization
- Verification status

Customized UEFI Secure Boot reduces the security risk introduced by platform specific solutions. Working w/ OS vendors on interoperability and readiness.
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

UEFI Firmware Resource Table (ESRT)

```
{ Camera GUID1, VersionInfo }
{ G-Sensor GUID2, VersionInfo }
{ System Firmware GUID3, VersionInfo }
......
```

UEFI Firmware Resource Table

```
FMP Capsule
RoutingInfo
Updated Data (Optional)
Update UEFI driver (Optional)
```

UPDATE

Camera
G-Sensor
System firmware
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
- System Advanced Features
- x-UEFI Configuration
- HII New Protocols
- 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
x-UEFI Usage Example

iSCSIInitiatorName

VFR file

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

UNI file

```plaintext
#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

System Startup

System Configuration

System Advanced Features

System Distribution & Validation

UEFI HTTP Stack

UEFI Wireless Stack

UEFI Bluetooth®
UEFI HTTP Stack

New Modules

<table>
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<th>Driver</th>
<th>Library</th>
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<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
- System Distribution & Validation
- Intel® Firmware Engine
- Intel® Intelligent Test System
Intel® Firmware Engine

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

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- Application, SDK and open hardware platforms available for download at [intel.com/firmwareengine](http://intel.com/firmwareengine)
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- Updated SDK due April 2016
- Additional platforms from the Intel IoT roadmap are under development
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Scalable hardware/software test framework

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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_6lJbxG5BYFFMPSI&Sourc e=IDF
## Other Technical Sessions

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<tr>
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<td>STTS002</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
Sample Configuration Script Using HPREST Tool

# 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