Beyond DOS: The UEFI Shell – a Modern Pre-boot Application Environment

Mike Rothman, Sr. Staff BIOS Software Engineer, Intel
Jaben Carsey, Staff BIOS Engineer, Intel
Nathan C Skalsky, Staff Firmware Engineer, IBM
Jeff Bobzin, UEFI Architect, Insyde

EFIS005
Agenda

• Shells – History and Standardization
• Applications and Scripts
• UEFI Shell 2.0 Unique Features
• IBM Shell Innovations
• Insyde Shell Innovations
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• **Shells – History and Standardization**
  • Applications and Scripts
  • UEFI Shell 2.0 Unique Features
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  • Insyde Shell Innovations
Shells – History and Standardization

• History of Command-lines
  – Early 1970’s – Unix arrives
  – Early 1980’s – DOS arrives
  – Today – Most O/Ses expose a command-line

• Command-line uses
  – Scripting
  – Program Launching
  – Abstraction to underlying system
  – Bring-up Target

PC DOS 1.1

Modern version of DOS

UEFI Shell

EFI Shell version 2.10 (6486.11)
Current running mode 1.1.2
Device mapping table
  Press ESC in 4 seconds to skip startup.PSH. any other key to continue.
  Shell 1
The presence of standards enables interoperability
Shells – History and Standardization

• Reusable code regardless of UEFI implementation.
  - Due to scripting and programmable methods being standardized.

Shell Applications

Shell Interfaces (EFI_SHELL_PROTOCOL)

Shell Interfaces

Platform/Hardware Interfaces

UEFI / PI Interfaces

UEFI Driver

UEFI Driver

UEFI Driver

UEFI Driver

UEFI Driver

CPU Modules

Chipset Modules

Hardware
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A UEFI Shell 2.0 Architecture

- Shell Library
- Shell Applications
- Shell Scripts

- Command-line Parser
- Shell Protocol
- Shell Console Parser

Shell Core

- Command Launcher
- Shell Console

- Script Processor
- Profile Command Set
- Level 3 Command Set

Optional Features

- UEFI / PI Interfaces
- Console Driver(s)
- UEFI Driver
- UEFI Driver
- UEFI Driver

UEFI Driver

- CPU Modules
- Chipset Modules

Hardware
Shell Applications

- UEFI Shell 2.0 applications are compiled C code binaries that:
  - Use a Shell protocol
    - EfiShellProtocol – provides APIs for file IO and Shell Environment IO
    - EfiShellParametersProtocol – provides Std I/O and Argc/Argv
  - Optionally use UEFI protocols
  - Are launched from command line, script, or in startup parameters to the shell itself

Shell Applications replace EFI Shell Extensions
Shell Scripts

- Shell Scripts (.nsh files) provide automated execution of sequences of shell commands, shell or UEFI applications, and other shell scripts
- Support complex logic via For, If, and Goto
- Route human readable commands to correct hardware

```plaintext
“COPY F12:\Source.txt
FS12:\Destination.txt”
```

```
UEFI Shell
Environment
```

```
EFI_SHELL_PROTOCOL
EFI_SHELL_PARAMETERS_PROTOCOL
```

```
EFI_SIMPLE_FILE_SYSTEM_PROTOCOL
Interface #0
```

```
EFI_BLOCK_IO_PROTOCOL
Interface #0
```

```
“BLK0”
```

```
“F12”
```
What’s Changed?

- EFI Shell scripts remain compatible
- UEFI 2.0 Scripts have additional capabilities
  - Query for command availability
  - Consistent Command feature sets

- Old Shell Protocols deprecated
- UEFI Shell Protocols added
  - EFI Shell extensions require porting
  - UEFI applications will work
- New UDK Shell Lib supports both Protocols
Agenda

• Shells – History and Standardization
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• **UEFI Shell 2.0 Unique Features**
• IBM Shell Innovations
• Insyde Shell Innovations
Key UEFI Shell 2.0 Features

New features provided by UEFI Shell are:
- Configure command sets available to end users configured at built time
- Provide backwards compatibility with existing shell scripts
- Manage firmware image size

```
[PcdsFixedAtBuild]

gEfiShellPkgTokenSpaceGuid.PcdShellSupportLevel | 3
### bit 0 = Drivers1, bit 1 = Debug1, bit 2 = Install1, bit 3 = Network1

gEfiShellPkgTokenSpaceGuid.PcdShellProfileMask   | 0xF
```
UEFI Shell Command Sets

• Shell Levels manage main features
  Level 0 – Launching a single application
  Level 1 – Adds scripting
  Level 2 – Adds file manipulation
  Level 3 – Adds UI and information retrieval

• Shell Profiles manage additional commands
  Install – Adds OS loader configuration
  Debug – Adds debug
  Driver – Adds driver manipulation
  Network – Adds network configuration & test

Unique ability to balance required features and commands against desired binary size
Shell.EFI Image Size Management

• Maximum Image Size
  – Level 3 shell with all 4 defined profiles
  – Supports all standard commands and a UI for interaction with an user

• Minimum Image Size
  – Level 0 shell with no profiles
  – Supports launching a single application

• Additional extra profiles possible

64 size combinations available!
Agenda

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Nathan C. Skalsky
Advisory Firmware Engineer, IBM
September 13th, 2010

Agenda

• IBM’s UEFI Shell 2.0 roadmap
• Key Features of UEFI Shell
• Running the UEFI Shell on IBM System x
• Example Uses of UEFI Shell
  • Bring Up
  • Development
  • System Manufacturing
  • Deployment/Provisioning
  • Maintenance
  • Debug
• Conclusion
UEFI Shell 2.0 Roadmap

• **Compatibility:** All UEFI-compliant System x Servers and Blades.

• **Integrated Shell:** a built-in level 3 UEFI Shell 2.0 is planned to be available via x86 IBM eX5 firmware updates within the next year.
  – Available as a Boot Item
  – Launch-able via UEFI Shell

• **Tools/CLI Strategy:** Current direction is to continue to use OS-based pre-boot deployments environments for flashing/in-band configuration updates. Shell is considered a supplementary command-line environment.
Key Features UEFI Shell 2.0

• “Common-Denominator” Preboot CLI
  – No dependencies on OS load / deployment
  – Direct-hardware environment
• Embeddable and flexible foot-print
• Scripting
  – Automating Configuration/deployment tasks
  – Automating Testing (reset tests, verify OS interfaces, run UEFI standards compliance tool (SCT))
• Shell Libraries enable ease of development and portability of applications
• Execute UEFI binaries
• Load/Unload Pre-Boot UEFI/DXE Drivers
Key Application Areas of UEFI Shell 2.0

• Early Hardware “Bring-up” Milestone
• Development and Testing
• Manufacturing
• Deployment/Provisioning
• Maintenance
• Debug / Product Support Investigations
Launching and Using UEFI Shell 2.0

- **One-Time**
  - F1 Setup ➔ Boot Manager ➔ Boot From File

- **As a Boot Option**
  - F1 Setup ➔ Boot Manager ➔ Add Boot Option
Using UEFI Shell during Development

- Scripting: Startup.nsh (think “Autoexec.bat”)
- Commands: DumpVariable/PCI/IbmHiiParse
Conclusion

• UEFI Shell 2.0 is a powerful “common denominator” environment and set of IO/console libraries

• IBM and IBM vendors heavily leverage the shell for bring-up, development, and debug activities

• Future is bright for automated and interactive configuration, deployment and update use-cases
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- **Insyde Shell Innovations**
Using the Pre-Boot Application Environment

- Network Browsing
- Complex Testing
Riding on top of a Network Capable Shell...

- Extends pre-boot space onto Internet
- Network Browsing Examples:
  - IT department support page
    - Help pages
    - Http download client
    - Access to OS recovery images
  - Remote assist system
    - System drivers download from OEM service site
    - Remote system diagnostic
    - Hardware support page
Demo of Network Browsing
Networking sets applications free in the pre-boot space
Complex Testing in a shell application

- Test hardware features not supported in OS
- Accelerate hardware feature development
  - Simpler debug environment than OS
  - More control for probing error conditions
- Enable efficient testing of features
  - Rapid test cycles booting just to UEFI Shell
  - Specific error cases can be validated
RAS Feature development and testing...

• OSes have limited support
  – Processor offline
  – Memory offline

• Need “live” ACPI environment
  – Methods and events supported
  – ACPI Component Architecture (ACPI) is candidate
    ▪ Designed for OS integration
    ▪ Open source code base
    ▪ Used in Linux and other Oses
    ▪ Excellent APIs for OS abstraction

• Why port ACPIA subsystem to UEFI shell?
  – UEFI is good fit for rapid testing and prototyping
  – UEFI protocols suitable to provide needed APIs
ACPICA Internals

- Internal Modules of the ACPICA Core Subsystem
Porting ACPICA

- Use standard C libs
- Use UEFI API to provide hardware access
- Use UEFI periodic timer events to monitor

```c
ACPI_STATUS AcpiOsReadPciConfiguration (ACPI_PCI_ID *PciId, UINT32 Register,
void *Value, UINT32 Width)
{
   UINT64 Pciex_Address=0;

    Pciex_Address = CALC_EFI_PCIEX_ADDRESS (PciId->Bus,
PciId->Device,PciId->Function, Register);
switch (Width)    {
    case 8:
        Status = gRootBridgeIo->Pci.Read (gRootBridgeIo,
        EfiPciWidthUint8, Pciex_Address, 1, Value);
    ...
```
Demo ACPICA running on

Intel 4-socket platform

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<th>StepOver</th>
<th>StepOut</th>
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South FPGA ver: 3.4
North FPGA ver: 3.4
IO FPGA ver: 3.4

[P31]-
[P31]?offline("CPU",3)

Mod: <Unknown> Address: 0x0000000000000000 slot 0

Telnet 192.168.100.1
fs0:localefx> acpica -t -f -v -x 0xf200000f
Summary

- Shell 2.0 implementation fully compliant to UEFI Shell Specification now available on tianocore.org
- Configure your shell to meet feature set and image size sweet spot
- Network profile sets applications free in the pre-boot space
- UEFI Application environment is great test harness
Additional sources of information on this topic:

• Other Sessions – Next Slide
• Demos in the showcase – EFI Booth, #160
• More web based info:
  – *UEFI Specifications* - [http://www.uefi.org](http://www.uefi.org)
• Book on topic:
  – Beyond BIOS 2nd edition - Intel Press
• Get the UEFI Shell 2.0 specification – www.uefi.org.
• Get the UDK ShellPkg with all the source code from www.tianocore.org
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Vouchers available in session room and UEFI Tech showcase booth #160
Intel® UDK2010 Available on tianocore.org

Intel® UDK2010
Open Source
UEFI Development Kit


http://www.tianocore.Sourceforge.net
UEFI PLUGFEST in Taiwan Oct 12-15, 2010

Save the date!

Visit www.uefi.org/events for Event Info and Registration
## IDF 2010 UEFI Fall Sessions
Sept. 13, 2010 Moscone Room 2006

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Backup Slides
1) This item illustrates what the standard entry point for any UEFI compatible binary application or driver looks like. This is the fundamental starting point for all UEFI compatible programs which exposes the underlying UEFI firmware services.

2) During the initialization of a UEFI program, the standard entry point would be used to access the standard runtime and boot services that the UEFI compatible firmware provides.

3) In most shell-aware applications, there would be either a library or macro which would be used to provide access to the underlying shell protocol interfaces. This library/macro isn’t required by the UEFI shell specification, but would commonly be found in many of the available shell-aware programs.

4) In shell-aware applications, the availability of the functions defined in the EFI_SHELL_PROTOCOL can be leveraged.