Firmware Flexibility using Intel® Firmware Support Package

Vincent Zimmer – Senior Principal Engineer, Intel Corporation
Agenda

• Overview of the Intel® Firmware Support Package (Intel® FSP) to encapsulate Intel® silicon initialization

• Scaling platform initialization with the Intel FSP and open source Intel® Architecture (IA) firmware ecosystems

• Details on building an open source IA platform with Intel FSP

• Full openness

• Summary and next steps
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The Intel® Firmware Support Package (Intel® FSP)

Intel® Firmware Support Package (Intel® FSP) components

• CPU, memory controller, and chipset initialization functions as a binary package
• Provides silicon initialization ingredients
• Plugs into existing firmware frameworks
• Integration guide, includes API documentation

Intel FSP is currently available for the many Intel® hardware-producing divisions
From IDF 2013 Applying Intel® Firmware Support Package to Open Source EDK II

EDK II provides the framework ("Green H")

Intel® Firmware Support Package (Intel® FSP) provides low level of silicon initialization

OS

Pre-boot Tools

UEFI Specification

Platform Drivers

Intel FSP

Hardware

UEFI/PI Scope - Green “H”

PEI/DXE PI Foundation

Modular Components
Applying “Produced” Intel® Firmware Support Package (FSP) to “Consuming” IA firmware
Intel® FSP Producer

- Examples of binary instances on [http://www.intel.com/fsp](http://www.intel.com/fsp) with integration guides
- This includes hardware initialization code that is EFI Developer Kit II (EDK II)-based PEI Modules (PEIM’s)
- Modules are encapsulated as a UEFI PI firmware volume w/ extra header
- Configure w/Vital Product Data (VPD)-style Platform Configuration Data (PCD) externalized from the modules
- Resultant output state reported via UEFI Platform Initialization (PI) Hand Off Block (HOB)
- Present 1.0 specification at [FSP 1.0 External Architecture Specification (EAS)](http://www.intel.com)
The Source for the Intel® FSP Producer Code

- CPU and chipset-specific code for PEIM’s inside of the Intel FSP can be open or closed, added to...
- PEI core and infrastructure code at https://svn.code.sf.net/p/edk2/code/trunk/edk2/MdePkg and https://svn.code.sf.net/p/edk2/code/trunk/edk2/MdeModulePkg
- And the code to create the Intel FSP interfaces can be found at https://svn.code.sf.net/p/edk2/code/trunk/edk2/IntelFspPkg/

Intel FSP can encapsulate IP protected initialization code PRODUCED by Intel business units
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Intel® FSP Consumer

• Consumer Firmware can be bootloaders from board support packages, traditional BIOS, UEFI/PI based EDK II firmware, or other embedded software solutions

• Firmware to absorb, integrate, or ‘consume’ the Intel FSP binary

• Consistent consumer code in the open source Intel® Architecture firmware up streams

• Enables fully open work-flow of using Intel FSP and open source IA firmware code
Intel® FSP Boot Flow

1. **Reset Vector**
2. **Switch to 32-bit Mode**
3. **Find FSP Entry Point**
4. **Jump to FSPinit**

**Intel® Firmware Support Package (Intel® FSP)**

- **Load Microcode**
- **Temp Ram Init**
- **Mem Init**
- **Companion Chip Init**
- **Processor Init**
- **NotifyPhase Code**

**Parse Return Data**

**Platform Init**

**Bus and Device Init**

**NotifyPhase**

**Boot Device Init**

**Load OS or other payload**

**NotifyPhase**

**ReadyToBoot**

**PostPciEnum**

**Boot Loader or “FSP Consumer”**

**Intel FSP from “FSP Producer”**
Intel® FSP External Interfaces

APIs published by the Intel FSP Producer and invoked by the Consumer

- **TempRamInit** - Enables cache for using as temporary memory and code caching
- **FspInit** - Performs the processor and companion chipset initialization
- **NotifyPhase** - Hooks for certain phase during the platform initialization

Intel FSP Producer(binary) creates the UEFI PI Hand-off Blocks (Vol 3 of the UEFI PI spec)

- Contains basic platform information
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- Summary and next steps
## 2 Consumers: EDK II firmware and coreboot*

<table>
<thead>
<tr>
<th>Functionality</th>
<th>coreboot</th>
<th>UEFI / PI</th>
</tr>
</thead>
<tbody>
<tr>
<td>The reset vector and pre cache-as-ram setup</td>
<td>bootblock</td>
<td>Security Phase (SEC)</td>
</tr>
<tr>
<td>Cache as Ram setup, early silicon initialization, memory setup. Covered largely by Intel® Firmware Support Package</td>
<td>romstage</td>
<td>Pre-EFI Initialization (PEI) Create HOBs</td>
</tr>
<tr>
<td>Normal device setup and mainboard configuration. Publish SMBIOS/ACPI Tables</td>
<td>ramstage</td>
<td>Early Driver Execution Environment (DXE)</td>
</tr>
<tr>
<td>Memory map hand-off</td>
<td>CBMEM</td>
<td>UEFI Memory Map</td>
</tr>
<tr>
<td>The OS or application bootloader</td>
<td>payload</td>
<td>DXE BDS and UEFI Drivers</td>
</tr>
</tbody>
</table>
EDK II based Intel® FSP Consumer Details

Following discussion
EDK II based Intel® FSP Consumer Flow

- Generic EDK II code, the FSP Wrapper
- [https://svn.code.sf.net/p/edk2/code/trunk/edk2/IntelFspWrapperPkg/](https://svn.code.sf.net/p/edk2/code/trunk/edk2/IntelFspWrapperPkg/)
- Allows for integration of Intel® Firmware Support Package binary into EDK II-based platform code
- Some sample platform code at [http://uefidk.com](http://uefidk.com)
coreboot* based Intel® FSP Consumer Details

Following discussion

coreboot*

fsp driver

EDKII Pkg
IntelRcPkg
PlatformFspPkg
FspPkg

EDKII Pkg
PlatformPkg
FspWrapperPkg
<table>
<thead>
<tr>
<th>coreboot* driver</th>
<th>Functionality</th>
</tr>
</thead>
<tbody>
<tr>
<td>find_fsp</td>
<td>Function to find the FSP in memory</td>
</tr>
<tr>
<td>fsp_early_init</td>
<td>FSP memory and early device setup function. Called in romstage by the chipset driver</td>
</tr>
<tr>
<td>romstage_fsp_rt_buffer_callback</td>
<td>Callback from fsp_early_init for mainboard specific RT buffer customizations (soldered down memory timings, etc.)</td>
</tr>
<tr>
<td>FspNotify</td>
<td>There are two notify calls in ramstage. AfterPciEnumeration during device finalize and ReadyToBoot during chip finalize.</td>
</tr>
<tr>
<td>save_mrc_data</td>
<td>Called in romstage after fsp_early_init to save the memory configuration to CBMEM</td>
</tr>
<tr>
<td>update_mrc_cache</td>
<td>Moves the mrc data from CBMEM to NVRAM in late ramstage</td>
</tr>
</tbody>
</table>
coreboot* based Intel® FSP Consumer Flow

The EDK II and coreboot* open source ecosystems can CONSUME FSP’s with the upstreamed FSP wrapper package & driver
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• Summary and next steps
Many Paths for Enabling

• We’re moving into a world where it is easier to work with Intel® platforms
• Open platforms, open source
• Intel® Unified Binary Management System (Intel® UBMS)
• Development kits, Reference boards
• There is also a full open source EDK II option
  - See full platform sources for Intel® Quark™ SoC, including a feature rich UEFI build
Intel® Quark™ SoC – Hardware Overview

- 32 bit Intel® Pentium® ISA-class processor
- PCI
- USB
- I2C
- Single core
UEFI for Intel® Quark™ SoC

• First fully open source Intel-based platform

• Builds on Intel® UDK2010 packages like MdePkg, MdeModulePkg w/ a 32-bit build, adding
  - IA32FamilyCpuBasePkg
  - QuarkPlatformPkg
  - QuarkSocPkg

• Standard build is 1 Mbyte image w/full features
  - Capsule update, SMM, S3, PCI, recovery, full UEFI OS support, FAT OS support, UEFI variables
UEFI for Intel® Quark™ SoC

• A modular firmware architecture like UEFI PI and code-base like EDK II allows for scaling the technology

• Fixed function UEFI OS load experiences can scale in size

• Introducing “TinyQuark” open source example
  - 64 kbyte to boot
  - UEFI-aware
  - Yocto* image from SPI NOR flash

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<th>Module</th>
<th>Size (K)</th>
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<tr>
<td>Generic</td>
<td>34</td>
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</tr>
<tr>
<td>Silicon</td>
<td>10</td>
<td>14%</td>
</tr>
<tr>
<td>Platform</td>
<td>24</td>
<td>36%</td>
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Many paths for enabling, including full openness
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• Overview of the Intel® Firmware Support Package (Intel® FSP) to encapsulate Intel silicon initialization

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Summary

• Intel® Firmware Support Package (Intel® FSP) can encapsulate IP protected initialization code PRODUCED by Intel business units

• The EDK II and coreboot* open source Intel® Architecture (IA) firmware ecosystems can CONSUME FSP’s with the upstreamed FSP wrapper package and driver code

• Beyond mixing binary FSP and source, a full open source EDK II experience is possible, as noted by the Intel Quark Firmware
Next Steps

• Start to examine the Intel® Firmware Support Package (Intel® FSP) collection at intel.com/fsp, support code at tianocore.org, and sample projects at uefidk.com

• Provide Intel feedback as Intel FSP 1.0 EAS evolves going forward for new platform topologies FSP 1.0 External Architecture Specification (EAS) and whitepaper at FSP on EDKII Whitepaper

• Build more platforms with open source platform packages on www.tianocore.org and www.coreboot.org

• Evaluate the first fully-featured platforms on uefidk.com, like Intel® Quark™ SoC https://communities.intel.com/docs/DOC-22226 and Tiny Quark https://uefidk.com/content/get-started-intel-galileo-development-board and whitepaper at TinyQuark Whitepaper
Additional Sources of Information

- A PDF of this presentation is available from our Technical Session Catalog: [www.intel.com/idfsessionsSF](http://www.intel.com/idfsessionsSF). This URL is also printed on the top of Session Agenda Pages in the Pocket Guide.

- More web based info:
  - [www.tianocore.org](http://www.tianocore.org)
  - [www.intel.com/fsp](http://www.intel.com/fsp)
  - [www.uefidk.com](http://www.uefidk.com)
  - [www.coreboot.org](http://www.coreboot.org)

- More on topics discussed in this presentation:
  - see upcoming book
    - [Embedded Firmware Solutions](http://www.apress.com/9781484200711)
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  - Your own 3D avatar with 10 coins... Play the game, share with friends

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  - Talk with Intel experts about your development needs and plans
  - Tinker on your own time with self-run labs, source code, tools
  - Swipe your wristband on the Galileo Scan Stations to get coins

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  - Get 10 coins to get your 3D avatar... And enter daily drawing for tablets and 2-in-1s
  - Get 15 coins for your King Code t-shirt, and increase total game score potential

Don’t let the fun stop!
Daily lunch at food trucks
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<td>Intel® Firmware Support Package for Internet of Things</td>
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<td>2001</td>
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<td>Software Based System Power and Thermal Optimization Technology</td>
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<td>2008</td>
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**Day 2 Prize**
Win an Intel® Gigabyte* BRIX Pro-Ultra Compact PC

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