UEFI Development and Innovations for System-On-Chip (SoC)

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EFIS002
Agenda

- Why use Intel® UEFI Development Kit 2010 (Intel® UDK2010) in System-On-Chip (SoC)
- Enable Intel® Atom™ Processor E6xx with Intel® UDK2010
- Byosoft* SoC Boot Loader Development
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System-On-Chip (SoC) & SoC Firmware

- **What is SoC**
  - SoC is a single chip which integrates a complete set of system components
  - Usually contains a processor core, utilizes standard interconnects & busses and requires software components for full operation

- **What is SoC firmware?**
  - SoC firmware is coded instructions that are stored permanently in read-only memory
  - When the device starts up, the SoC firmware is to initialize and identify system devices. The primary function of the firmware is to load and start an operating system.
The Requirements of SoC Firmware

**Perspective of Product**
- Stable
  - Stability is essential for industry control devices
- Performance
  - Like in IVI devices, boot speed is one of the key indicators

**Perspective of Development**
- Low Technical Threshold
  - Easy to learn, easy to use
- Customization
  - Meet the requirements of time to market for different segment devices

**Need a Firmware Solution for SoC**

IVI: In-Vehicle Infotainment
SoC: System-on-Chip
The Intel® UDK2010 is an open source build environment and tools that supports the development of UEFI Firmware, drivers and applications.
Intel® UDK2010 is a Good Option for SoC

**Perspective of Product**

- **Stable**
  - Like in some industry control devices
  - The core of Intel UDK2010 has been verified on server, desktop, laptop...

- **Performance**
  - Like in IVI devices, boot speed is one of the key indicators
  - Intel UDK2010 has a leading boot performance

**Perspective of Development**

- **Low Technical Threshold**
  - Intel UDK2010 is C language and development environments are Windows*/Linux*/Ios*

- **Customization**
  - Meet the requirements of time to market for different segment devices
  - Intel UDK2010 naturally supports customization with its special features, like modular packages...

*Intel® UDK2010 meets the requirements of SoC firmware*
Other Reasons to Choose Intel® UDK2010 for SoC Firmware

- Compatible with Industry standards, like UEFI spec, PI spec
- Bundle of complex features, like ACPI
- Open source community contribution
- Support by ecosystem, IBVs/ISVs/OSVs/IHVss

Intel® UDK2010 is on http://www.tianocore.sourceforge.net
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Intel® Atom™ Processor E6xx Series Architecture

**North complex**

**Single Intel® Atom™ Processor Core**
- 45nm Hi-K process
- Max 512K L2 cache
- 0.6 to 1.6GHz Low power core

**Memory controller**
- 32-bit DDR2 667/800
- Max 1GB
- Single Memory Channel

**Graphics**
- 2D and 3D HW accelerator

**Integrated High Definition Video Decoder & Encoder**

**Display**
- LVDS & SDVO interface

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**South complex**

**LPC**
- 8254
- HPET
- Watch Dog
- RTC & CMOS
- 14-pins GPIO
- 8259

**SPI Interface**

**SMBUS1.0**

**Intel® High Definition Audio**

- 4 x1 PCI Express* Gen1.0 Ports

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**Intel® Atom™ E6xx Series integrates Processor, GMCH and ICH**

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PCIe: PCI Express* Technology
Build Single Chip System with Intel® Atom™ Processor E6xx Series

Intel® Atom™ Processor E6xx Series are a complete system by itself
CRB Diagram of Intel® Atom™ Processor E6xx Series with Intel® PCH EG20T

Intel® Atom™ Processor E6xx Series-based Platform for General Embedded Purposes
Firmware requirements of the CRB

- Support all SKUs of the Intel® Atom™ processor E6xx series
- Support updating the firmware image on the SPI flash
- Support loading EFI Option Rom on devices connected to the PCI/PCIe ports
- Support the ACPI 3.0 states
- Support Booting from SPI flash, USB, SATA, SD, PXE, CD/DVD
- Support booting to Windows* CE 6.0, MeeGo* 1.1 and Fedora* 13
- Support to scale to other system
- Support feature configuration
- Support to boot to the OS loader within 2000 milliseconds
- Support to present the splash screen within 1.0 second

Use Intel® UDK2010 to achieve these goals

CRB: Customer Reference Board; PCIe: PCI Express* Technology; Intel® UDK2010: Intel® UEFI Development Kit 2010
Develop the SoC Advanced Features

**Scalable**

Scale firmware for fragment Intel® Atom™ E6xx based platforms

**Configurability**

Customize the platform with PCD

**Performance**

How make Intel Atom E6xx based platform boot fast

**Splash Screen**

How to present splash screen earlier
SoC Firmware Flash Layout Organization

- FD (Flash Device image) sections can be customized
- The PCH drivers are gathered in a FV, PCH FV
- Drivers in other FVs have no dependency to drivers in PCH FV

Easy to scale to different Intel® Atom™ E600 platforms
Develop the SoC Advanced Features

**Scalable**
Scale firmware for fragment Intel® Atom™ E6xx based platforms

**Configurability**
Customize the platform with PCD

**Performance**
How make Intel Atom E6xx based platform boot fast

**Splash Screen**
How to present splash screen earlier
Configurable - PCD Introduction

- Platform Configuration Database (PCD) is an important feature of Intel® UDK2010
- Platform level PCD file describes the content of the build for a specific platform
- PCDs can be used to store Platform Information
  - Vital Produce Data (VPD)
  - Setup Options
  - Serial Number
  - ...

Using PCD can centralize platform configuration items
PCD Implementation for CRB

- More than 400 PCDs are exposed
  - Pre-allocated memory for IGD
  - Internal Device Enable
  - PCI Express* Root Port Configuration
  - Processor Power Management
  - SMBIOS configurations
  - BDS related configuration including boot order
  - ACPI PCI Routing
  - ACPI MADT
  - Process features switch
  - Others

- The PCD setting can be changed in either source code or binary image

*PCD configuration makes the firmware workable on similar platforms*
Develop the SoC Advanced Features

- **Scalable**
  - Scale firmware for fragment Intel® Atom™ E6xx based platforms

- **Configurability**
  - Customize the platform with PCD

- **Performance**
  - How make Intel Atom E6xx based platform boot fast

- **Splash Screen**
  - How to present splash screen earlier
Boot Performance Enhancement for SoC

Some tips to tune boot performance

- Minimize code/data access without cache
- Minimize flash region access, organize flash layout effectively
- Hardcode some parameters (i.e. memory solder down)
- Remove interaction UI
- Connect less devices
- Cooperate with OSV, reduce duplicate work between firmware and Operation System

Develop the SoC Advanced Features

**Scalable**
Scale firmware for fragment Intel® Atom™ E6xx based platforms

**Configurability**
Customize the platform with PCD

**Performance**
How make Intel Atom E6xx based platform boot fast

**Splash Screen**
How to present splash screen earlier
Splash Screen

- Change the boot flow to make splash screen present earlier
- Move part of drivers to another FV to reach this goal

Time Comparison

<table>
<thead>
<tr>
<th>Normal Boot</th>
<th>Early Splash Screen</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time(^1)</td>
<td>1200 ms</td>
</tr>
<tr>
<td>Time(^1)</td>
<td>980 ms</td>
</tr>
</tbody>
</table>

\(^1\)The Time is from power on to showing screen
Agenda

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- Enable Intel® Atom™ Processor E6xx with Intel® UDK2010
- Byosoft* SoC Boot Loader Development
Byosoft* SoC Boot Loader Development

• For Byosoft*, the boot loader solution for Intel® Architecture (IA) based SoC design is a key business area

• Leverage the advantages of Intel® UDK2010 for SoC designs
  – Reuse the function modules of other platforms
  – Develop new features based on the Intel UDK2010
    ▪ IPv6 Network Stack
    ▪ Security Framework
    ▪ Library instances
    ▪ Platform Configuration Database (PCD)

Intel® UDK2010 can accelerate the SoC boot loader development
Byosoft* SoC Boot Loader Development

- For different market requirements, Byosoft has different solutions

Identity Authentication Solution

Error report & recovery solution

Fast Boot Solution

Intel® Atom™ Processor E6xx Series based on Intel® UDK2010
Identity Authentication Solution

- Byosoft* Identity Authentication Solution is to solve pirated designs

  - Encrypt customer information to generate license key
  - Authenticate the license status
  - Automatically lock the non-licensed products to stop the infringement
Identity Authentication Solution

Work flow of the initial phase in the boot loader

- Assign license key
- Based on license key to generate a new key through encryption module
- Save the new key into flash
Identity Authentication Solution

Work flow of the execution phase in the boot loader

- Check the information of hardware & boot loader
- Check the license key through the decryption module
- Pass the authentication and boot the system normally
- Or, lock the non-licensed products and notice the customer
Identity Authentication Solution

- License Check Module - Customized credential provider under standard UEFI/UDK PBA Framework for platform authentication and identification
- Flexible key deployment & Derivation mechanism based on UEFI Key Management Service Protocol

Take full advantage of Intel® UDK2010 Security Infrastructure
Error Report & Recovery Solution

- Byosoft* Error Report & Recovery Solution is used in Industry Control system

  Report the error info through network in security way

  Recovery the system if detects errors

  Keep the system stable
Error Report & Recovery Solution

Work flow of error handling

- Boot to OS
- Monitor System Status
- System meets error
- Recover the system
- Upload error information to the server
- Back to the normal state
Error Report & Recovery Solution

- Error Info Transfer Module - Leverage Intel® UDK2010 IPV4/IPV6 stack to transfer error report.
- Error Report Module - The error report is encrypted by Intel® UDK2010 IP Sec module.
- Use UEFI Runtime service to communicate between OS and firmware.

Develop advanced features based on Intel® UDK2010 network fundamental components.
Fast Boot Solution

- Byosoft* Fast Boot Solution is used in the devices which have strict boot performance requirements

- Only enable necessary devices

- Improve the efficiency of code execution by making full use of cache

- Use the fixed boot mode according the usages of the device
Fast Boot Solution

• The core of Intel® UDK2010 is modular making it more efficient to optimize
• Intel® UDK2010 supports to integrate all required drivers into one FV image to save decompressing time
• It is easy to save and reuse data to avoid long time enumeration and hardware training in Intel® UDK2010
• Byosoft* can customize the boot loader to satisfy different requirements from customers

The architecture of Intel® UDK2010 supports performance tuning
Fast Boot Solution

• Boot performance comparison between Normal Boot and Fast Boot

<table>
<thead>
<tr>
<th>Boot Phase</th>
<th>Normal Boot Performance</th>
<th>Fast Boot Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>SEC</td>
<td>12 ms</td>
<td>16 ms</td>
</tr>
<tr>
<td>PEI</td>
<td>1592 ms</td>
<td>516 ms</td>
</tr>
<tr>
<td>DXE</td>
<td>594 ms</td>
<td>207 ms</td>
</tr>
<tr>
<td>BDS</td>
<td>13594 ms</td>
<td>1623 ms</td>
</tr>
<tr>
<td>Total Time</td>
<td>15792 ms</td>
<td>2362 ms</td>
</tr>
</tbody>
</table>
Summary

- Intel® UDK2010 naturally supports SoC boot loader development
- Based on Intel® UDK2010, Byosoft makes the innovation for SoC boot loader
- Byosoft* will continue to commit itself on SoC boot loader service and development
Additional resources on UEFI:

- Other UEFI Sessions – Next slide
- More web based info:
  - EDK II Open Source Implementation: [www.tianocore.org](http://www.tianocore.org)

# EFI Track Sessions

<table>
<thead>
<tr>
<th>Session ID</th>
<th>Title</th>
<th>Day/Time</th>
<th>Room</th>
</tr>
</thead>
<tbody>
<tr>
<td>EFIS001</td>
<td>Microsoft* Windows* Platform Evolution and UEFI</td>
<td>Tuesday 11:10</td>
<td>306A</td>
</tr>
<tr>
<td>EFIS002</td>
<td>UEFI Development and Innovations for System-On-Chip (SoC)</td>
<td>Tuesday 14:05</td>
<td>306A</td>
</tr>
<tr>
<td>EFIS003</td>
<td>UEFI and Transparent Computing Technology</td>
<td>Tuesday 15:10</td>
<td>306A</td>
</tr>
<tr>
<td>EFIS004</td>
<td>Intel® UEFI Development Kit 2010 and Intel® Boot Loader Development Kit: Foundations for Advanced Embedded Development</td>
<td>Tuesday 16:10</td>
<td>306A</td>
</tr>
<tr>
<td>SPCQ001</td>
<td>Hot Topic Q&amp;A: Intel® Boot Loader Development Kit (Intel® BLDK)</td>
<td>Tuesday 17:00</td>
<td>306A</td>
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<tr>
<td>EFIS005</td>
<td>Security and Networking Advancements Today’s UEFI and Intel® UEFI Development Kit 2010 (Intel® UDK2010)</td>
<td>Wednesday 11:10</td>
<td>306A</td>
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