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UEFI & EDK II TRAINING

EDK II Debugging through UEFI Boot Flow

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LESSON OBJECTIVE

- Debugging commands similar to all debuggers
- Debugging UEFI Platform Initialization Boot Flow

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DEBUGGING COMMANDS

`CpuBreakpoint()` added to Source

Source Level Debugging

View call stack

Go

Insert CpuBreakpoint()

View and edit local/global variables

Set breakpoint

Step into/over routines

Go till

View disassembled code

View/edit general purpose register values

CpuBreakpoint Vs. CpuDeadLoop

CpuBreakpoint

When using a Software debugger:

- Visual Studio
- GDB (ovmf with qemu)
- Intel® UDK Debugger
- Windriver* Simics
- Debug agent –`SourceLevelDebugPkg`

CpuDeadLoop

When using a Hardware debugger:

- In-Target Probe (ITP)
- Intel® SVT DCI cable
- Intel® SVT Closed Chassis Adapter (CCA)
- other 3rd Party Hardware (i.e. Lauterbach w/ JTAG)

The functions `CpuBreakpoint()` and `CpuDeadLoop()` are part of the EDK II Base Libraries and can be compiled with any UEFI or PI Module at any phase of the boot flow (SEC, PEI, DXE, BDS, TSL)

Special DCI Breakpoint with HW Debugger

`CpuIceBreakpoint`

The Intel Architecture has a special op-code for a breakpoint: `int1`
Better than a `CpuDeadLoop()` since it halts the processor. Better trace information
Downside:

- Requires a Hardware Debugger with DCI capabilities to intercept the int1 op code
- There is no “C” equivalent – needs to be assembly code

Example of this code is the downloaded Lab Material : .

`. . . /LabSampleCode/CpuIceBreakpoint_Code`

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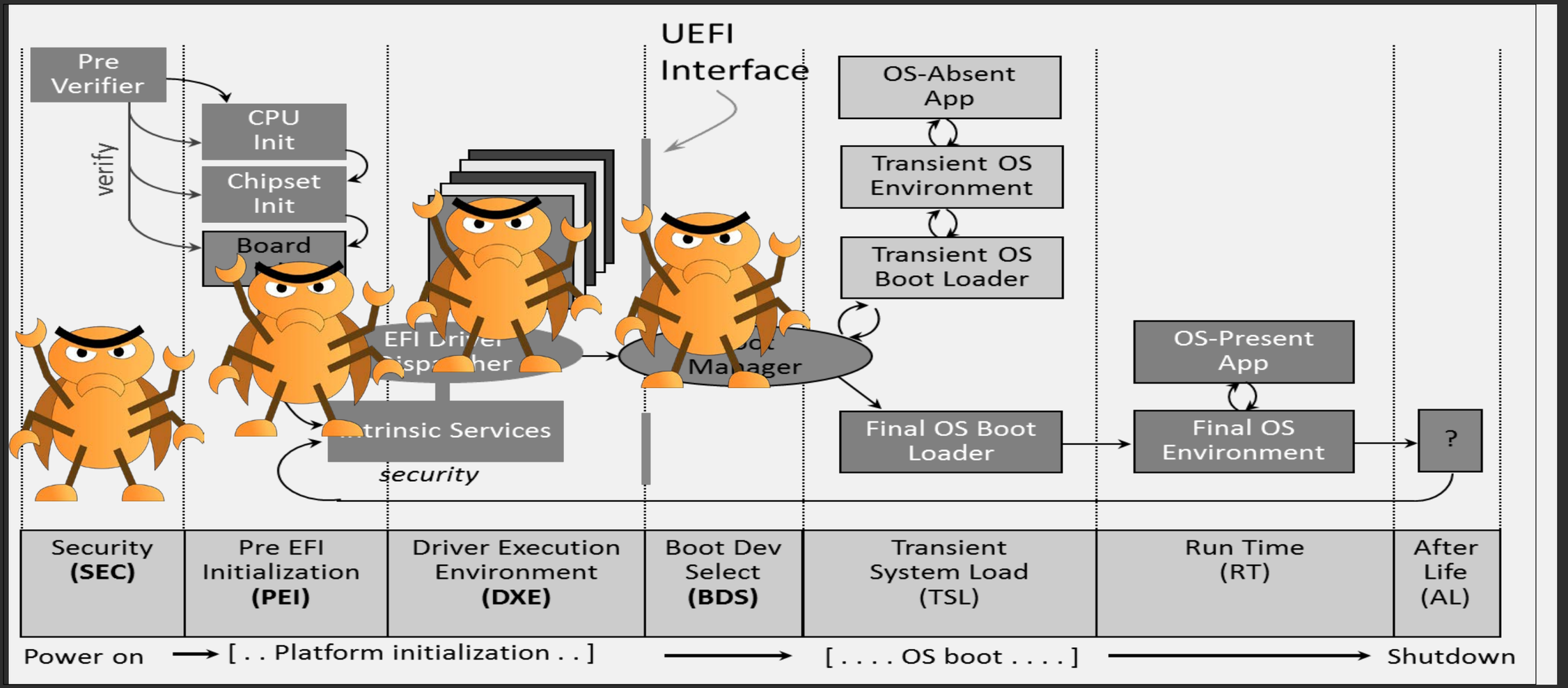
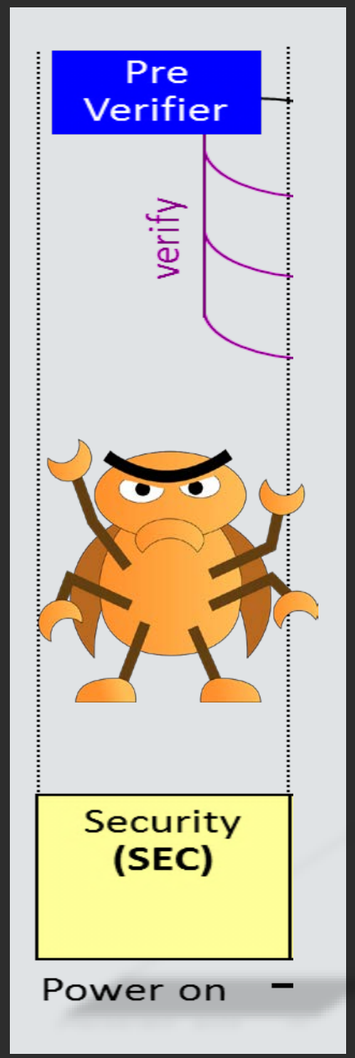
DEBUGGING THRU BOOT FLOW

Add Breakpoints to the Compiled BIOS / Firmware Source Code

Debugging the Boot Phases



Debugging the Boot Phases - SEC

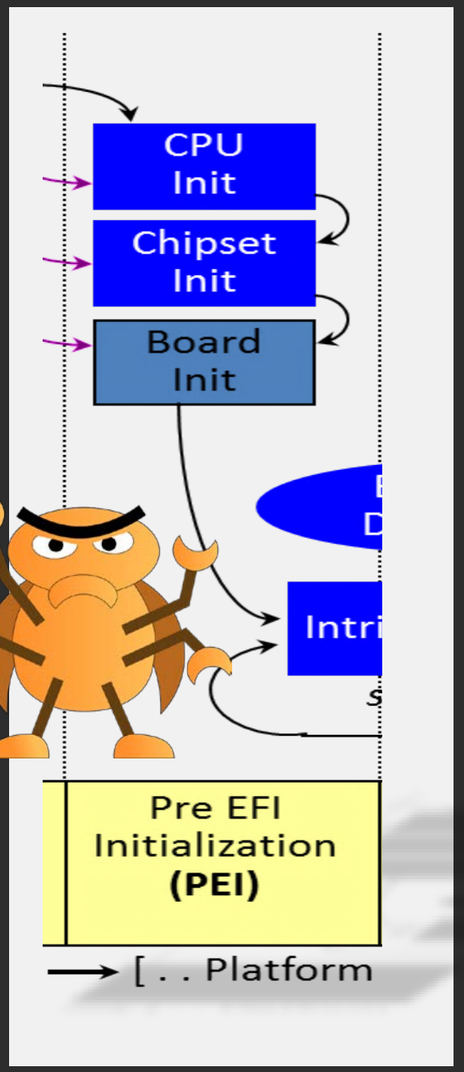


Debugging Sec Phase

Hardware debugger capable only

- Break at the Reset Vector
- Check temporary memory – CAR NEM
- Enable the “C” Code
- Transfer control to PEI

Debugging the Boot Phases - PEI



- Use debugger prior to PEI Main
- Check proper execution of PEI drivers
- Execute basic chipset & Memory init.
- Check memory availability
- Complete flash accessibility
- Execute recovery driver
- Detect DXE IPL

PEI Phase: Trace Each PEIM

There is a loop function in :

MdeModulePkg/Core/Pei/Dispatcher/Dispatcher.c

Add CpuBreakpoint(); before launching each PEIM

```
VOID
PeiDispatcher (
  IN CONST EFI_SEC_PEI_HAND_OFF  *SecCoreData,
  IN PEI_CORE_INSTANCE           *Private
  )
{ // ...
        // Call the PEIM entry point
        //
        PeimEntryPoint = (EFI_PEIM_ENTRY_POINT2)(UINTN)EntryPoint;
        PERF_START (PeimFileHandle, "PEIM", NULL, 0);
// Add a call to CpuBreakpoint();  approx. line 1460
        CpuBreakpoint();
        PeimEntryPoint(PeimFileHandle, (const EFI_PEI_SERVICES **) &Private->Ps);
```

Check for transition from PEI to DXE

Critical point before calling DXE in:

MdeModulePkg/Core/Pei/PeiMain.c

Add CpuBreakpoint(); before entering DxeIpl

```
VOID
EFIAPI
PeiCore (
  IN CONST EFI_SEC_PEI_HAND_OFF        *SecCoreDataPtr,
  IN CONST EFI_PEI_PPI_DESCRIPTOR      *PpiList,
  IN VOID                              *Data
  )
{ // ...
  // Enter DxeIpl to load Dxe core.
  //
  DEBUG ((EFI_D_INFO, "DXE IPL Entry\n"));
// Add a call to CpuBreakpoint();  approx. line 512
  CpuBreakpoint();
  Status = TempPtr.DxeIpl->Entry (
                             TempPtr.DxeIpl,
                             &PrivateData.Ps,
                             PrivateData.HobList
```

Check for transition from DxeIpl to DXE

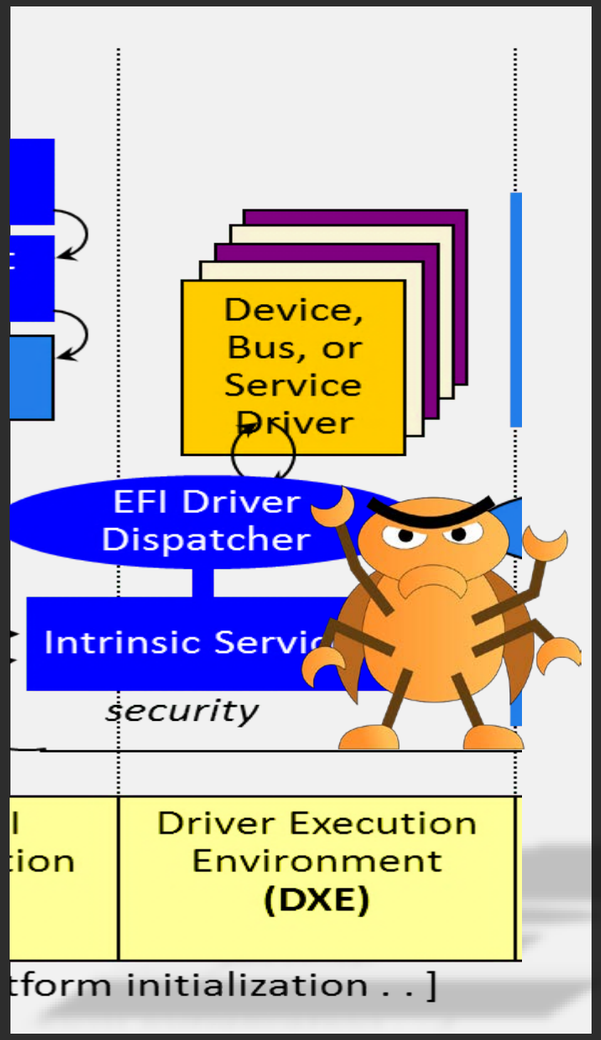
Critical point before calling DXE Core in:

MdeModulePkg/Core/DxeIplPeim/DxeLoad.c

Before entering Dxe Core (Notice also this is a standalone module - DxeIpl.efi)

```
EFI_STATUS
EFIAPI
DxeLoadCore (
  IN CONST EFI_DXE_IPL_PPI *This,
  IN EFI_PEI_SERVICES      **PeiServices,
  IN EFI_PEI_HOB_POINTERS  HobList
  )
{ // ...
  // Transfer control to the DXE Core
  // The hand off state is simply a pointer to the HOB list
  //
// Add a call to CpuBreakpoint();  approx. line 448
  CpuBreakpoint();
  HandOffToDxeCore (DxeCoreEntryPoint, HobList);
  //
  // If we get here, then the DXE Core returned.  This is an error
```

Debugging the Boot Phases - DXE



- Search for cyclic dependency check
- Trace ASSERTs caused during DXE execution
- Debug individual DXE drivers
- Check for architectural protocol failure
- Ensure BDS entry call

DXE: Trace Each Driver Load

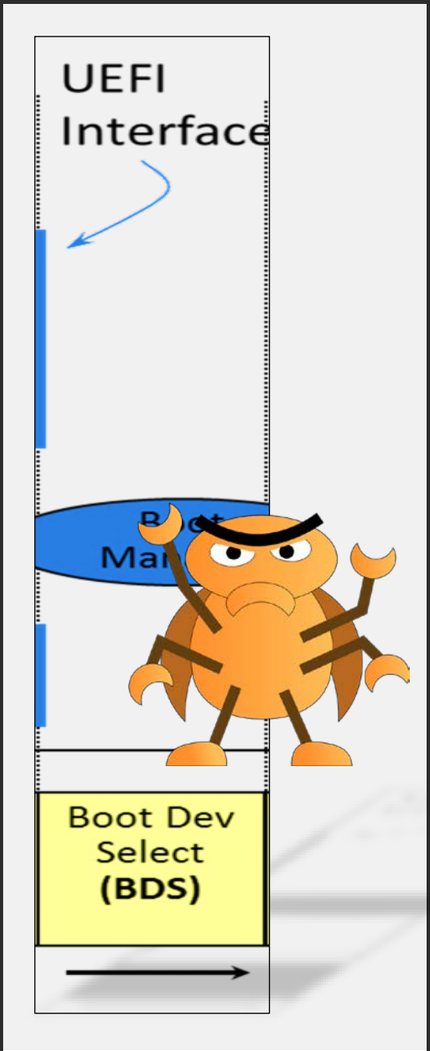
DXE Dispatcher calls to each driver's entry point in:

MdeModulePkg/Core/Dxe/Image/Image.c

Break every time a DXE driver is loaded.

```
EFI_STATUS
EFIAPI
CoreStartImage (
  IN EFI_HANDLE  ImageHandle,
  OUT UINTN      *ExitDataSize,
  OUT CHAR16     **ExitData  OPTIONAL
  )
{ // ...
    //
    // Call the image's entry point
    //
    Image->Started = TRUE;
// Add a call to CpuBreakpoint();  approx. line 1650
    CpuBreakpoint();
    Image->Status = Image->EntryPoint (ImageHandle, Image->Info.SystemTable);
```

Debugging the Boot Phases - BDS



- Detect console devices (input and output)
- Check enumeration of all devices' preset
- Detect boot policy
- Ensure BIOS "front page" is loaded

BDS Phase – Entry Point

DXE call to BDS entry point in:

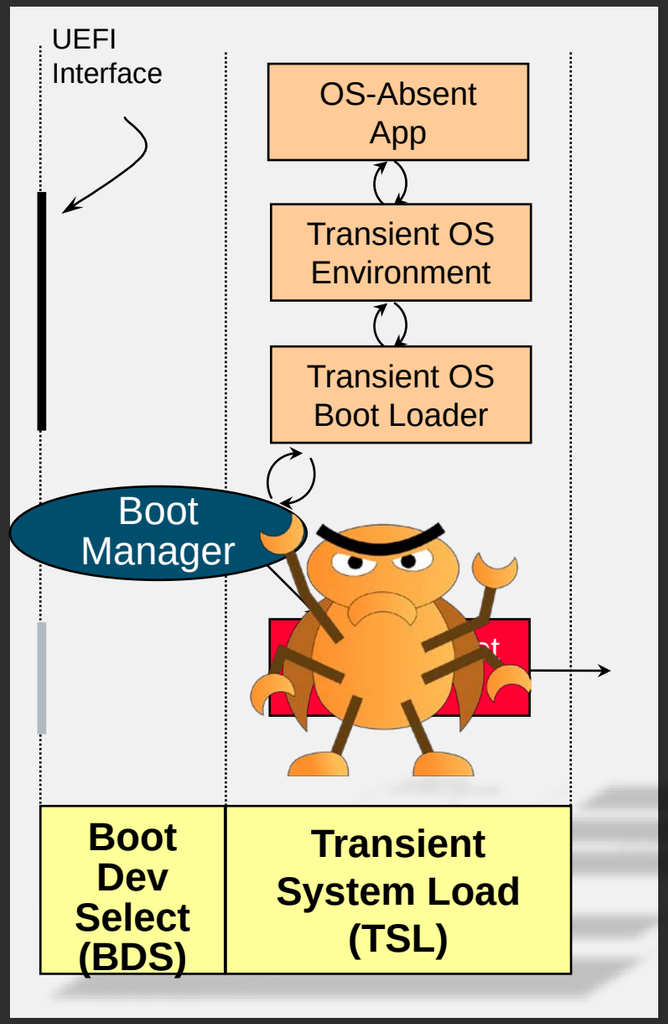
MdeModulePkg/Core/Dxe/DxeMain/DxeMain.c

Add CpuBreakpoint(); to break before BDS.

```
VOID
EFIAPI
DxeMain (
  IN  VOID *HobStart
  )
{ // ...
  // Transfer control to the BDS Architectural Protocol
  //
// Add a call to CpuBreakpoint();  approx. line 550
  CpuBreakpoint();
  gBds->Entry (gBds);

  //
  // BDS should never return
  //
  ASSERT (FALSE);
  CpuDeadLoop ();
```

Debugging the Boot Phases - Pre-Boot



- "C" source debugging
- UEFI Drivers
  - Init
  - Start
  - Supported
- UEFI Shell Applications
  - Entry point
  - Local variables
- **`CpuBreakpoint()`**

Debug in Pre-Boot – UEFI Shell Application

Add CpuBreakpoint() to SampleApp.c near the entry point

Add SampleApp.inf to the platform .dsc file

```
bash$ cd <edk2 workspace directory>
bash$ . edksetup.sh
bash$ build -m SampleApp/SampleApp.inf
```

Copy the binary SampleApp.efi to USB drive

SampleApp.c(~/src/edk2-ws/edk2/SampleApp) - gedit

Save

```
EFI_STATUS
EFIAPI
UefiMain (
  IN EFI_HANDLE        ImageHandle,
  IN EFI_SYSTEM_TABLE  *SystemTable
  )
{
        UINTN             EventIndex;
        BOOLEAN           ExitLoop;
        EFI_INPUT_KEY     Key;
        DEBUG((0xffffffff, "\n\nUEFI Base Training DEBUG DEMO\n"));
        DEBUG((0xffffffff, "0xffffffff USING DEBUG ALL Mask Bits Se

        CpuBreakpoint();
```

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SUMMARY

- Debugging commands similar to all debuggers
- Debugging UEFI Platform Initialization Boot Flow

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Questions?

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ACKNOWLEDGEMENTS