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UEFI & EDK II Training

How to Write a UEFI Application w/ Windows Lab

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See also LabGuide.md for Copy & Paste examples in labs

Lesson Objective

- UEFI Application with PCDs
- Simple UEFI Application
- Add functionality to UEFI Application
- Using EADK with UEFI Application

UEFI APPLICATION W/ PCDS

EDK II PCD's Purpose and Goals

Review

Documentaton : MdeModulePkg/Universal/PCD/Dxe/Pcd.inf

Purpose

- Establishes platform common definitions
- Build-time/Run-time aspects
- Binary Editing Capabilities

Goals

- Simplify porting
- Easy to associate with a module or platform

PCD Syntax

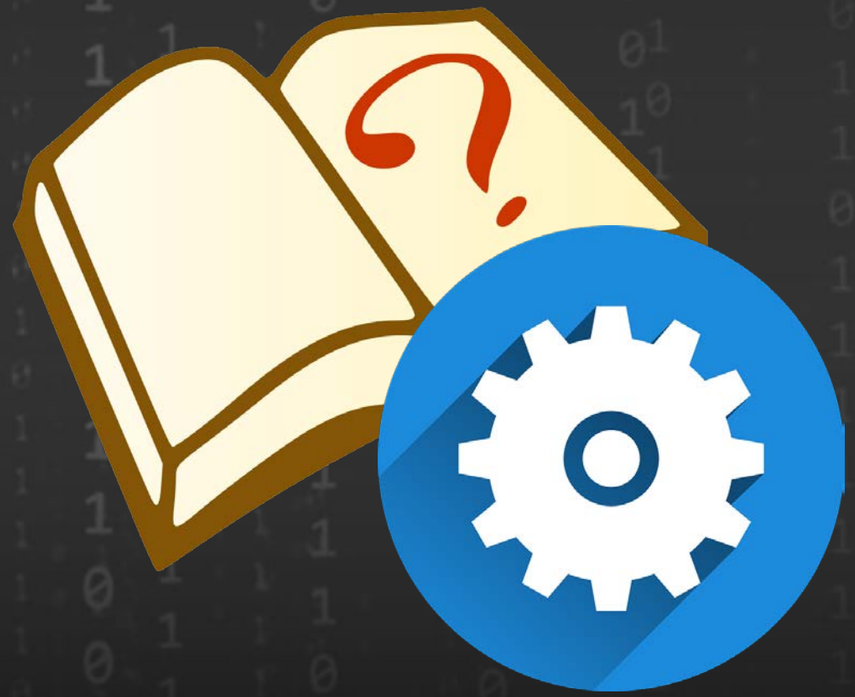
Review

PCDs can be located anywhere within the Workspace even though a different package will use those PCDs for a given project

.DEC	.INF	.DSC
Define PCD	Reference PCD	Modify PCD
Package	Module	Platform

Lab 1: Writing UEFI Applications with PCDs

In this lab, you'll learn how to write UEFI applications with PCDs.



EDK II HelloWorld App Lab

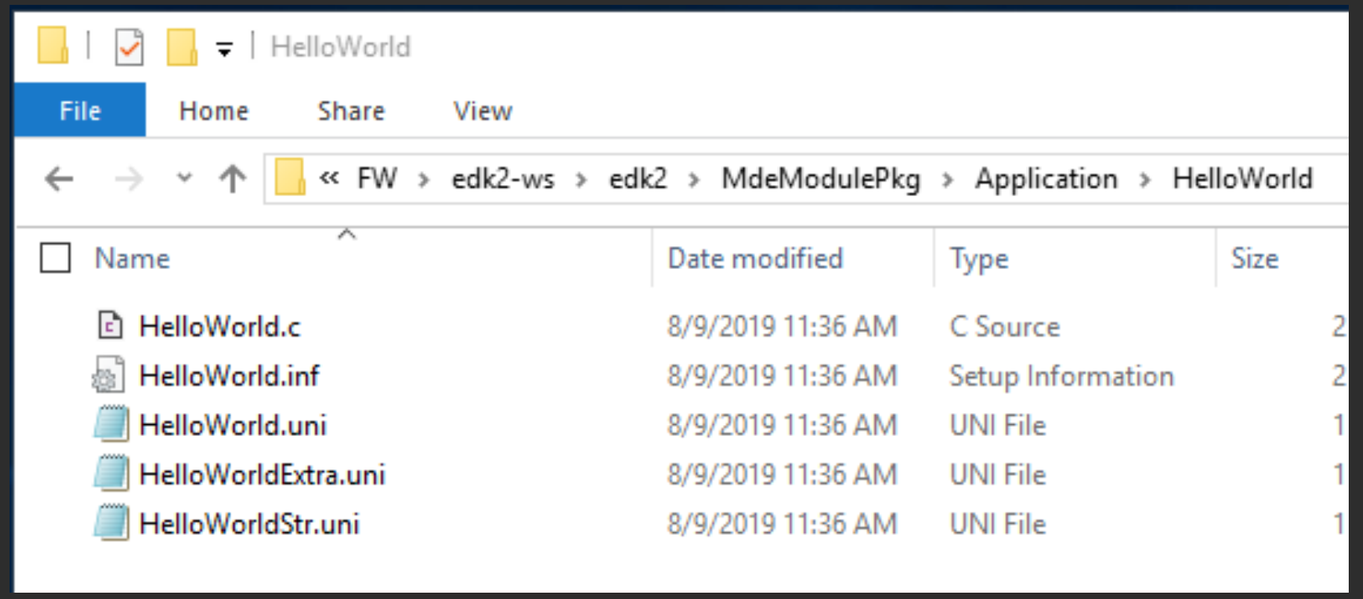
First Setup for Building EDK II for EmulatorPkg, See Lab Setup

Locate and Open edk2\MdeModulePkg\Application\HelloWorld\HelloWorld.c

Notice the PCD values

Build Emulation Package

Then Run HelloWorld



-D WIN_SEC_BUILD -a X64

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EDK II HelloWorld App Lab

Open a VS Command Prompt and type: `cd C:/FW/edk2-ws` then

```
$> Setenv.bat
$> cd edk2
$> edksetup
```

Build EmulatorPkg for Windows X64 (run WinHost.exe from `Build/EmulatorX64/ . . ./X64`)

```
$> Build –D ADD_SHELL_STRING
$> RunEmulator.bat
```

At the UEFI Shell prompt

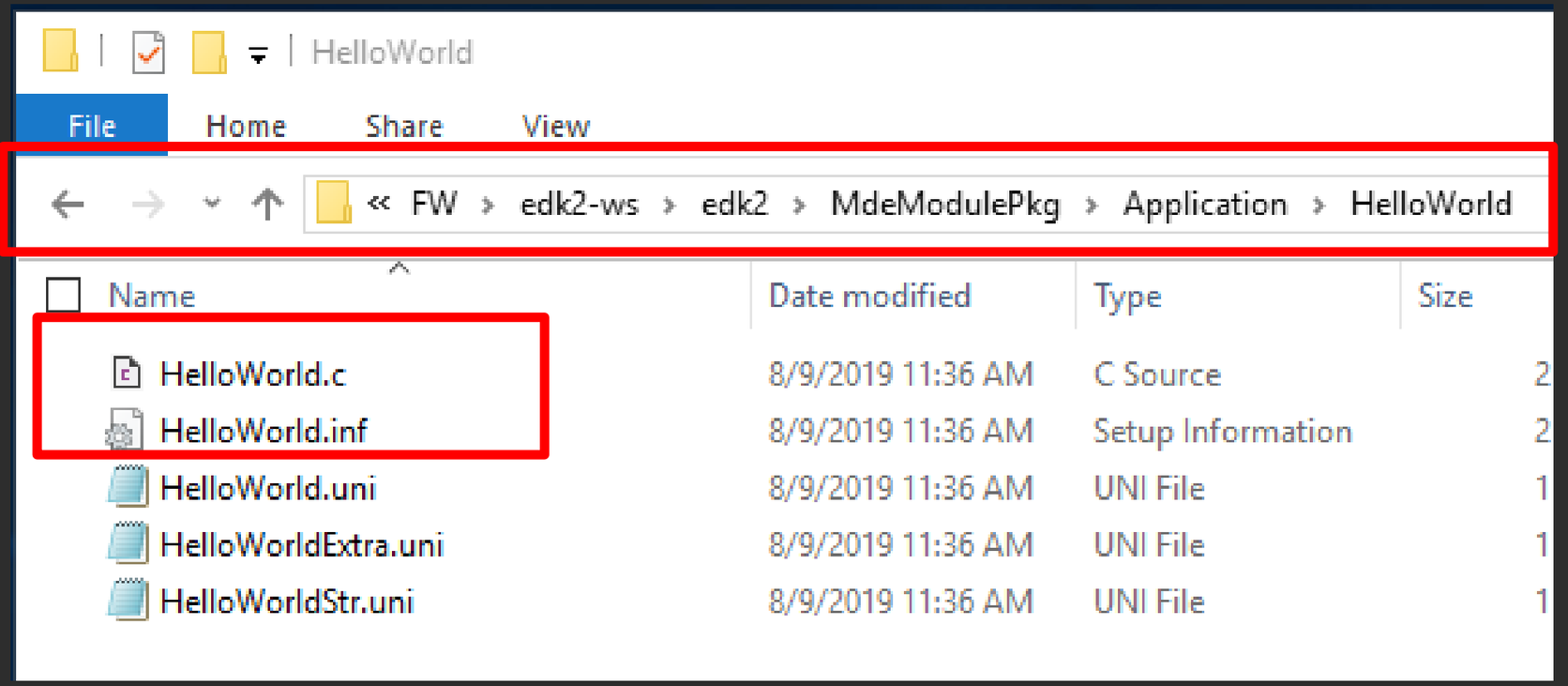
```
Shell> Helloworld
UEFI Hello World!
Shell>
```

How can we force the HelloWorld application to print out 3 times ?

Note: RunEmulator.bat will run WinHost.exe from `Build/EmulatorX64/DEBUG_TAG/X64`

EDK II HelloWorld App Lab

MdeModulePkg/Application/HelloWorld



EDK II HelloWorld App

Source HelloWorld.c

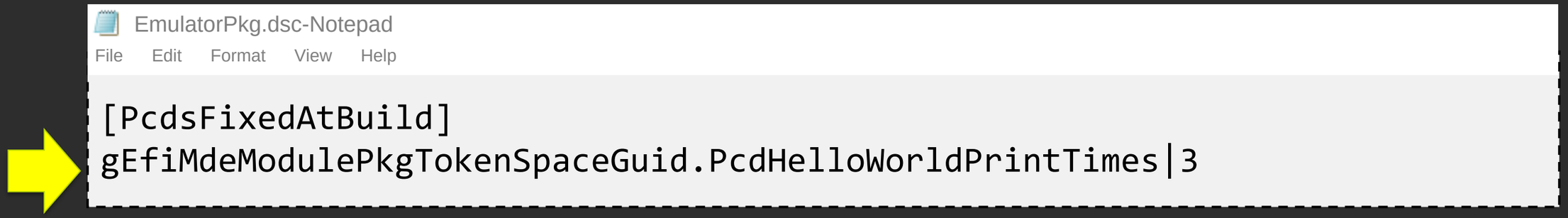
```
EFI_STATUS
EFIAPI
UefiMain (
  IN EFI_HANDLE        ImageHandle,
  IN EFI_SYSTEM_TABLE  *SystemTable
  )
{
  UINT32 Index;
  Index = 0;
  // Three PCD type (FeatureFlag, UINT32
  // and String) are used as the sample.
  if (FeaturePcdGet (PcdHelloWorldPrintEnable)) {
  for (Index = 0; Index < PcdGet32   (PcdHelloWorldPrintTimes); Index ++) {

    // Use UefiLib Print API to print
      // string to UEFI console

      Print ((CHAR16*)PcdGetPtr (PcdHelloWorldPrintString));
    }
  }

  return EFI_SUCCESS;
}
```

Notice the 3 PCDs

EDK II HelloWorld App Solution

1. Edit the file C:/FW/edk2-ws/edk2/EmulatorPkg/EmulatorPkg.dsc

After the section `[PcdsFixedAtBuild]` (search for **"PcdsFixedAtBuild"** or **"Hello")**



2. Re-Build – Cd to C:/FW/edk2-ws/edk2

```
$> Build –D ADD_SHELL_STRING
```

EDK II HelloWorld App Solution

3. Run Emulation (run WinHost.exe from `Build/EmulatorX64/ . . ./X64`)

```
C:/FW/edk2-ws/edk2> RunEmulator.bat
```

4. At the Shell prompt

```
Shell> Helloworld
UEFI Hello World!
UEFI Hello World!
UEFI Hello World!
Shell>
```

5: Exit Emulation

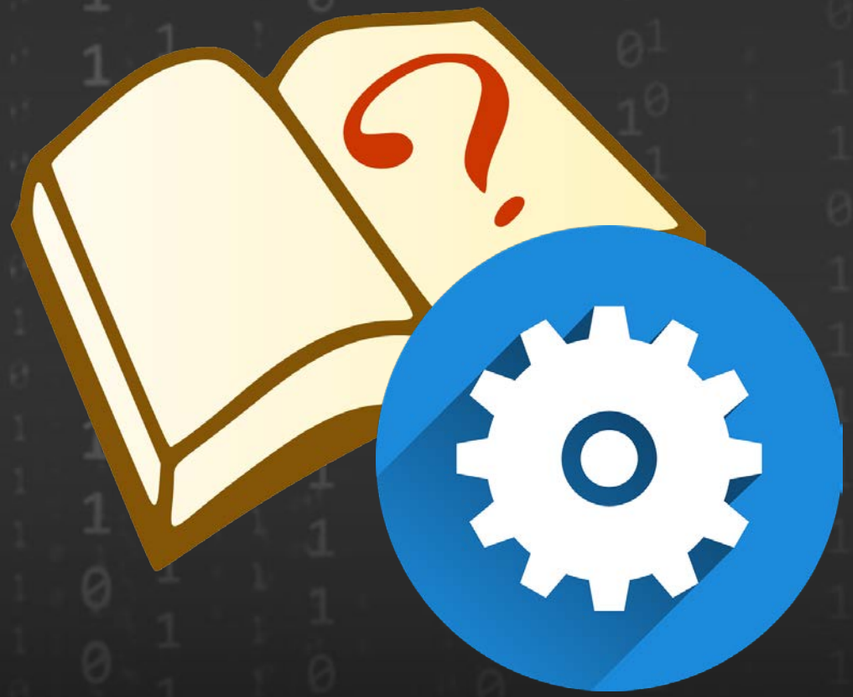
```
Shell> Reset
```

How can we change the **string** of the HelloWorld application?

Also see ../edk2/MdeModulePkg/MdeModulePkg.Dec

Lab 2: Write a Simple UEFI Applications

In this lab, you'll learn how to write simple UEFI applications.



LAB 2 Writing a Simple UEFI Application

In this lab, you'll learn how to write simple UEFI applications.

"C" file

```
EFI_STATUS
EFIAPI
UefiMain (
  IN EFI_HANDLE        ImageHandle,
  IN EFI_SYSTEM_TABLE  *SystemTable
  )
{
  return EFI_SUCCESS;
}
```

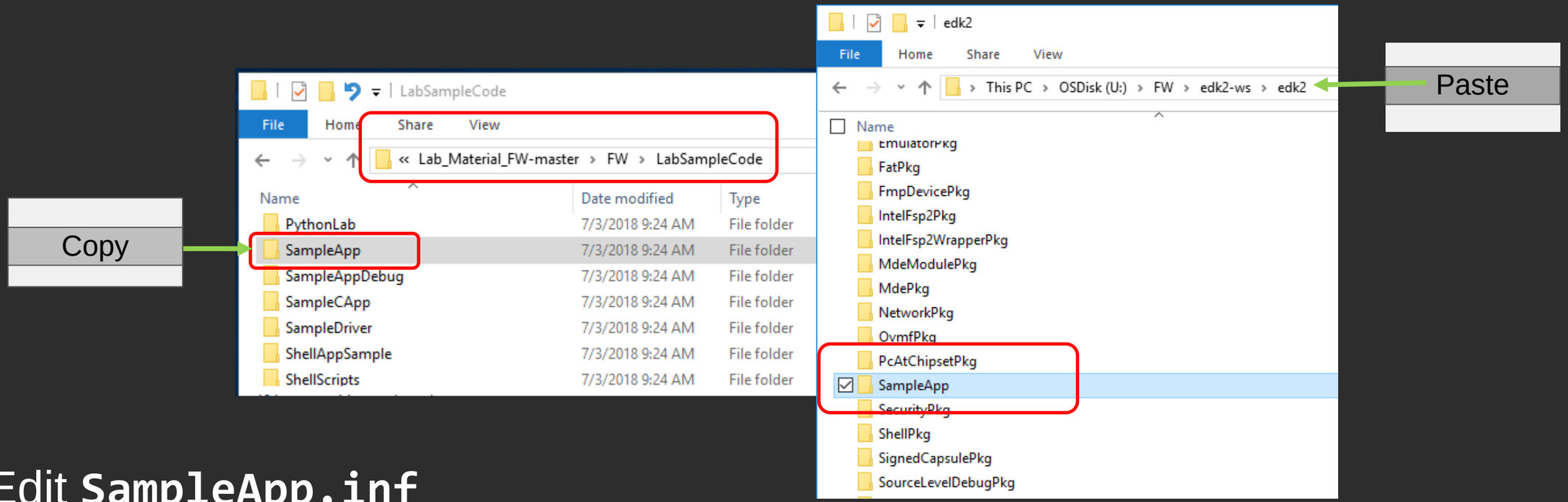
.inf file

```
[Defines]
  INF_VERSION        =
  BASE_NAME          =
  FILE_GUID          =
  MODULE_TYPE        =
  VERSION_STRING     =
  ENTRY_POINT        =

[Sources]

[Packages]

[LibraryClasses]
```

- What goes into a Simplest "C"
- Start with what should go into the Simplest .INF file

Application Lab –start with .c and .inf template

Copy the `LabSampleCode/SampleApp` directory to `C:/FW/edk2-ws/edk2`



Edit **`SampleApp.inf`**

- Look in the INF for **"XXXXXXXXXXX"** sections that will need information
- Create Name & GUID, and then fill in the MODULE_TYPE

Lab 2: Sample Application INF file

SampleApp.inf - Notepad

File Edit Format View Help

```
[Defines]
  INF_VERSION                    = 0x00010005
  BASE_NAME                      = XXXXXXXXXXXX
  FILE_GUID                      = XXXXXXXXXXXX
  MODULE_TYPE                    = XXXXXXXXXXXX
  VERSION_STRING                 = 1.0
  ENTRY_POINT                    = UefiMain

[Sources]
  XXXXXXXXX
[Packages]
  #XXXXXXXX

[LibraryClasses]
  #XXXXXXXXXXXXX

[Guids]
 # . . .
```

SampleApp

Get a GUID

UEFI_APPLICATION

SampleApp.c

Get a GUID guidgenerator.com/ or https://www.guidgen.com/

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Lab 2: Sample Application ‘C’ file

SampleApp.c - Notepad

File Edit Format View Help

```
/** @file
  This is a simple shell application
**/
EFI_STATUS
EFIAPI
UefiMain (
  IN EFI_HANDLE        ImageHandle,
  IN EFI_SYSTEM_TABLE  *SystemTable
  )
{
  return EFI_SUCCESS;
}
```

Does not do anything but return Success

Lab 2: Will it compile now?

Not yet …

1. Need to add headers to the .C file
2. Need to add a reference to INF from the platform DSC
3. Need to add a few Package dependencies and libraries to the .INF

Application Lab – Update Files

1. .DSC (EmulatorPkg/EmulatorPkg.dsc)

[Components . . .]

Add INF to components section, before build options

Hint: add after comment: `# Add new modules here`

```
SampleApp/SampleApp.inf
```

2. .INF File (**SampleApp/SampleApp.inf**)

Packages (all depend on MdePkg)

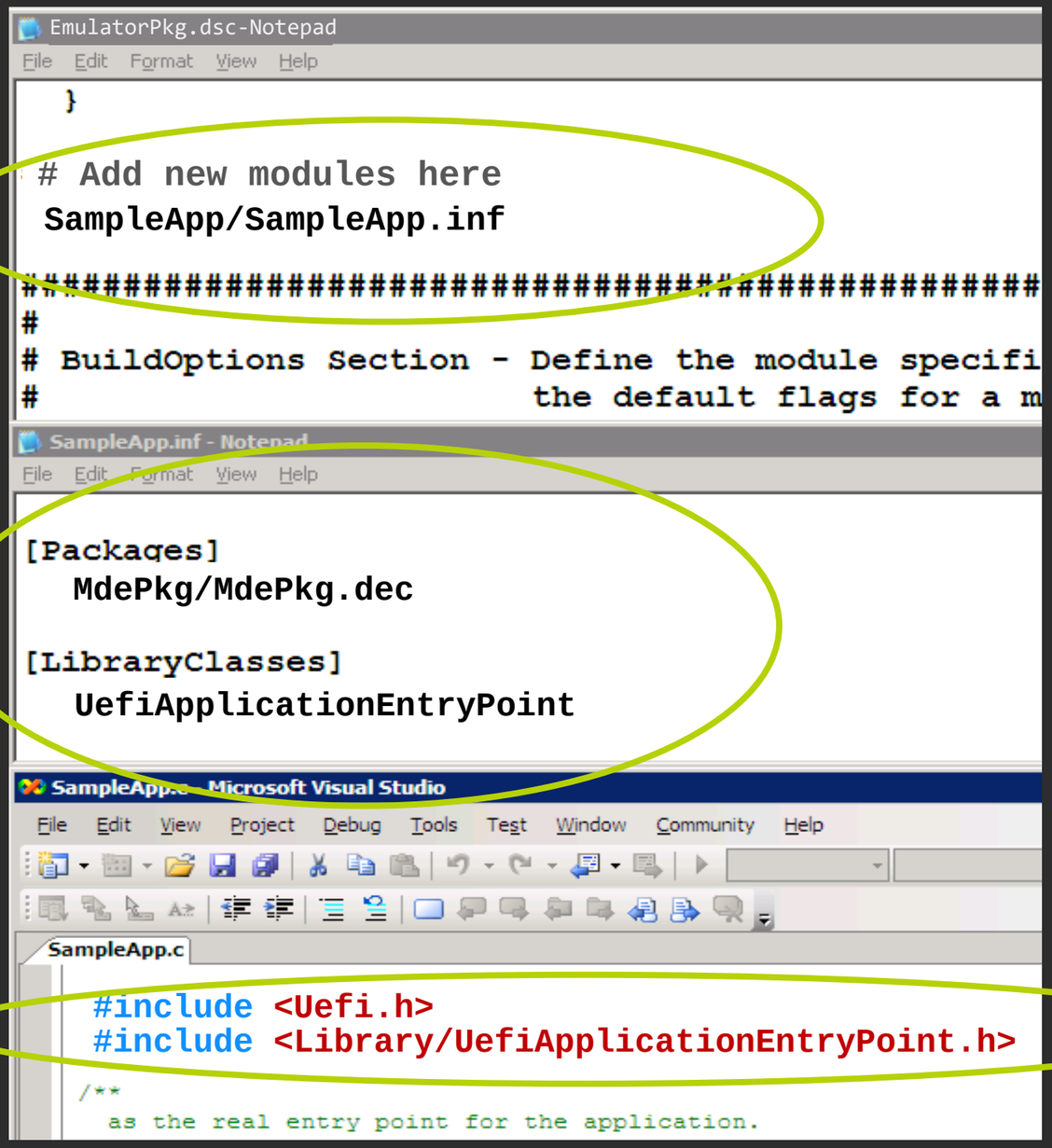
```
[Packages]
    MdePkg/MdePkg.dec
[LibraryClasses]
    UefiApplicationEntryPoint
```

3. .C file - Header references File (**SampleApp/SampleApp.c**)

```
#include <Uefi.h>
#include <Library/UefiApplicationEntryPoint.h>
```

Copy and paste LabGuide.md

Lab 2: cont. Solution



EmulatorPkg/EmulatorPkg.dsc

SampleApp/SampleApp.inf

SampleApp/SampleApp.c

Copy and paste LabGuide.md

Lab 2 : Will it compile now?

At the VS Command Prompt

```
$> Build –D ADD_SHELL_STRING
$> RunEmulator.bat
```

Run the application from the shell

```
Shell> SampleApp
Shell>
```

Notice that the program will immediately unload because the main function is empty

Exit

```
Shell> Reset
```

Possible Build Errors

Error on SampleApp.inf

Developer Command Prompt for VS2015

```
Processing meta-data ..

build...
c:\fw\edk2\SampleApp\SampleApp.inf(21): error 3000: No value specified
        FILE_GUID                      =


- Failed -
Build end time: 09:11:30, Jul.25 2018
Build total time: 00:00:03


C:\fw\edk2>
```

This failure if FILE_GUID blank

Developer Command Prompt for VS2015

```
Processing meta-data .
Architecture(s)  = X64
Build target     = DEBUG
Toolchain        = VS2015x86

Active Platform          = c:\fw\edk2-ws\edk2\EmulatorPkg\EmulatorPkg.dsc
...........

- Failed -
Build end time: 10:31:17, Feb.02 2022
Build total time: 00:00:13
```

Developer Command Prompt for VS2015

```
Processing meta-data .....................


build...
 : error C0DE: Unknown fatal error when processing [c:\fw\edk2\SampleApp\SampleApp.inf]

(Please send email to edk2-devel@lists.01.org for help, attaching following call stack trace!)

(Python 2.7.14 on win32) Traceback (most recent call last):
  File "build\build.py", line 2493, in Main
  File "build\build.py", line 2226, in Launch
  File "build\build.py", line 2047, in _MultiThreadBuildPlatform
  File "c:\Users\Public\Documents\BuildPool\BaseTools\build\Source\Python\AutoGen\AutoGen.py",
line 4391, in CreateCodeFile
  File "c:\Users\Public\Documents\BuildPool\BaseTools\build\Source\Python\AutoGen\AutoGen.py",
line 3604, in _GetAutoGenFileList
  File "c:\Users\Public\Documents\BuildPool\BaseTools\build\Source\Python\AutoGen\GenC.py", lin
e 2075, in CreateCode
  File "c:\Users\Public\Documents\BuildPool\BaseTools\build\Source\Python\AutoGen\GenC.py", lin
e 2033, in CreateHeaderCode
  File "c:\Users\Public\Documents\BuildPool\BaseTools\build\Source\Python\Common\Misc.py", line
 308, in GuidStringToGuidStructureString
IndexError: list index out of range


- Failed -
Build end time: 09:15:55, Jul.25 2018
Build total time: 00:00:24
```

This failure if “XXXX. . .” are left or other improper format of the GUID

The FILE_GUID was invalid or not updated from “XXX…” to a proper formatted GUID in INF

Possible Build Errors

Error on SampleApp.inf

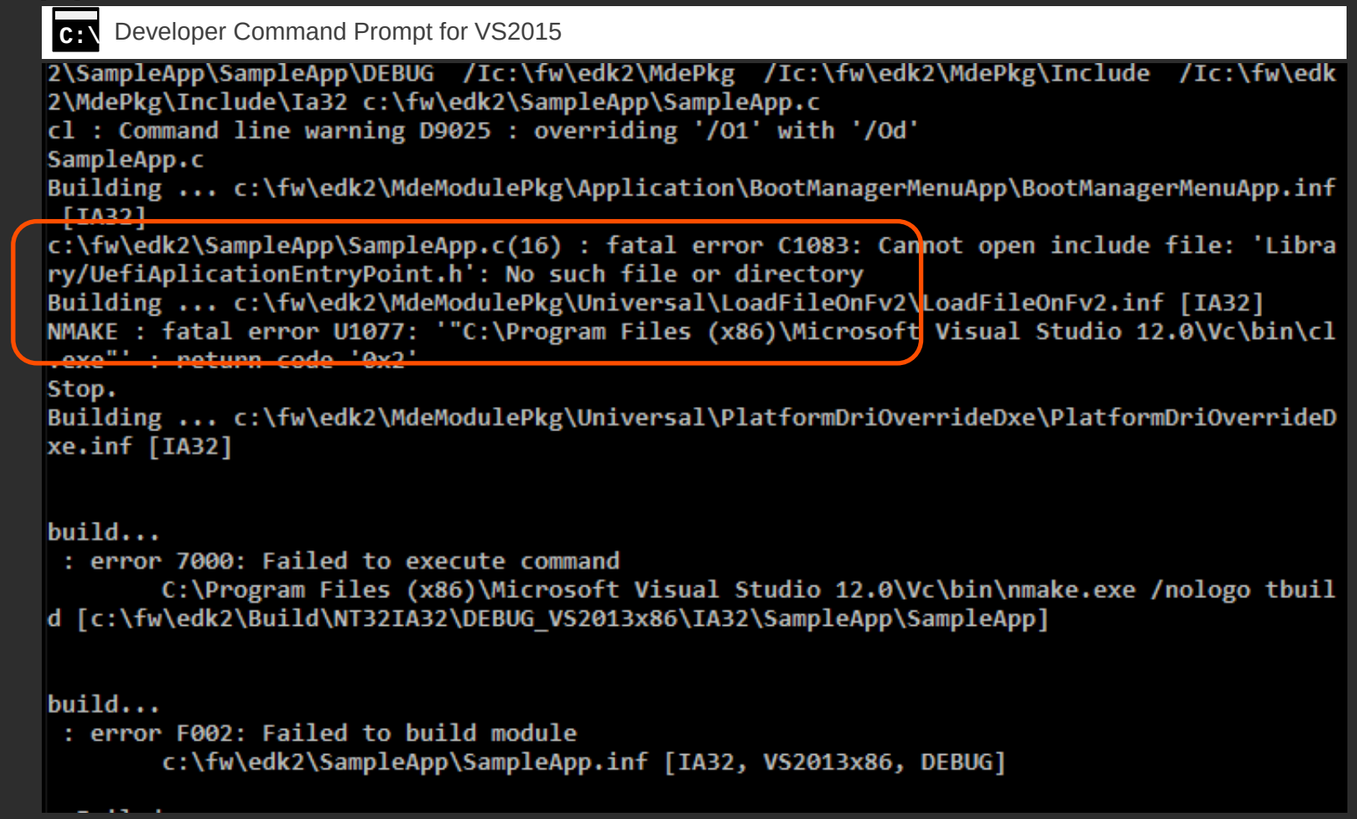
Developer Command Prompt for VS2015

```
Building ... c:\fw\edk2\MdeModulePkg\Universal\LoadFileOnFv2\LoadFileOnFv2.inf [IA32]
SampleApp.c
 B  Creating library c:\fw\edk2\Build\NT32IA32\DEBUG_VS2013x86\IA32\SecMain.lib and object c:\f
w\edk2\Build\NT32IA32\DEBUG_VS2013x86\IA32\SecMain.exp
uilding ... c:\fw\edk2\MdeModulePkg\Universal\PlatformDriOverrideDxe\PlatformDriOverrideDxe.inf
 [IA32]
Generating code
Building ... c:\fw\edk2\MdeModulePkg\Application\VariableInfo\VariableInfo.inf [IA32]
c:\fw\edk2\Build\NT32IA32\DEBUG_VS2013x86\IA32\SampleApp\SampleApp\DEBUG\AutoGen.h(16) : fatal
error C1083: Cannot open include file: 'Base.h': No such file or directory
NMAKE : fatal error U1077: '"C:\Program Files (x86)\Microsoft Visual Studio 12.0\Vc\bin\cl.exe"
' : return code '0x2'
Stop.


build...
 : error 7000: Failed to execute command
        C:\Program Files (x86)\Microsoft Visual Studio 12.0\Vc\bin\nmake.exe /nologo tbuild [c:
\fw\edk2\Build\NT32IA32\DEBUG_VS2013x86\IA32\SampleApp\SampleApp]


build...
 : error F002: Failed to build module
        c:\fw\edk2\SampleApp\SampleApp.inf [IA32, VS2013x86, DEBUG]

- Failed -
Build end time: 09:23:56, Jul.25 2018
Build total time: 00:00:41
```

The [Packages] was invalid or did not specify MdePkg/MdePkg.dec properly

Possible Build Errors

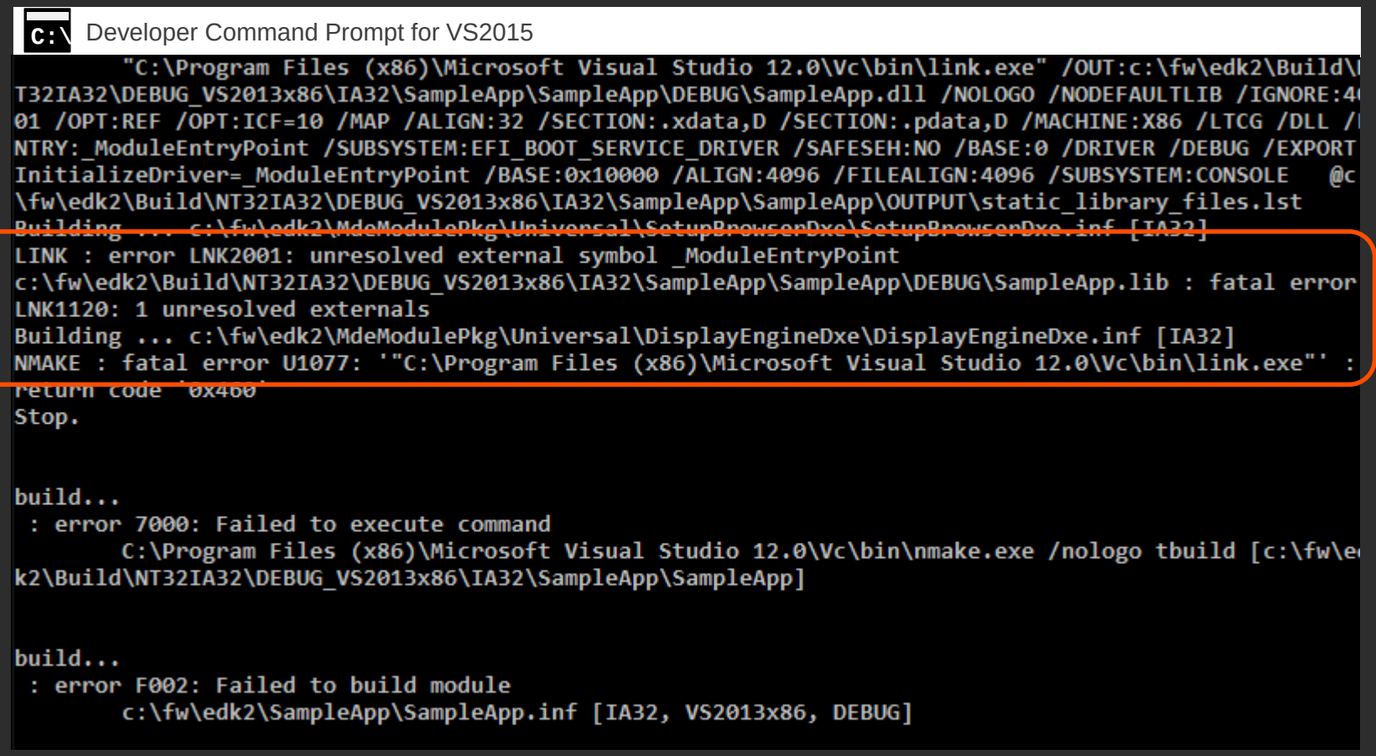
Compiler Error on SampleApp.c



The #include <Library/UefiApplicationEntryPoint.h> has a typo (“Application” not “Aplication”)

Possible Build Errors

Compile Linker Error on unresolved reference



The SampleApp.inf section `[LibraryClasses]` did not reference `UefiApplicationEntryPoint`

Possible Build Errors

Error at the Shell prompt

```
Press ESC in 4 seconds to skip startup.nsh or any other key to continue.
2.0 Shell> SampleApp
'SampleApp' is not recognized as an internal or external command, operable progr
am, or script file.
2.0 Shell> FS0:
2.0 FS0:\> LS SampleApp.efi
Error. No matching files were found.
2.0 FS0:\> _
```

Ensure the SampleApp.inf BaseName is SampleApp

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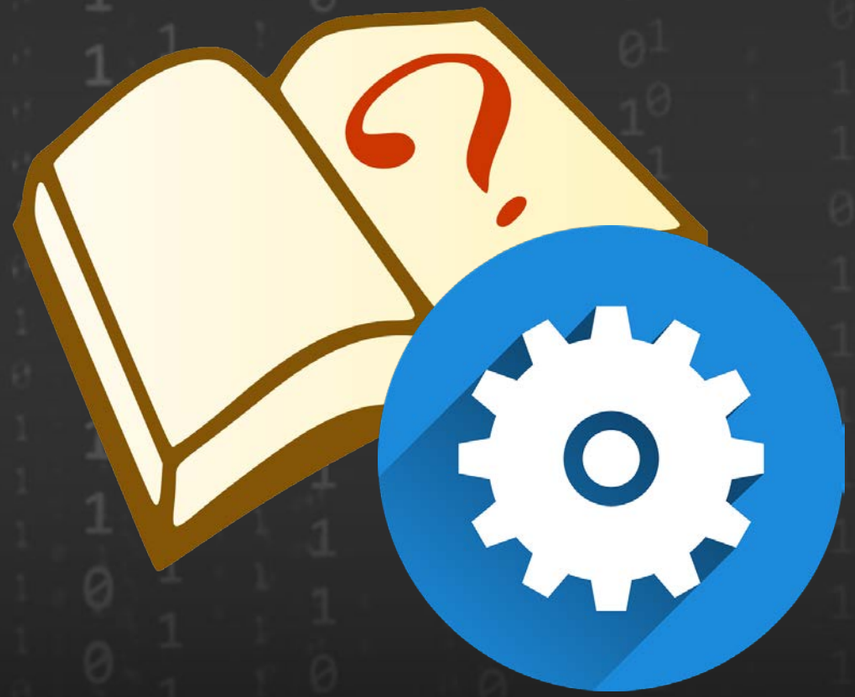
Lab 2.1: Build Switches

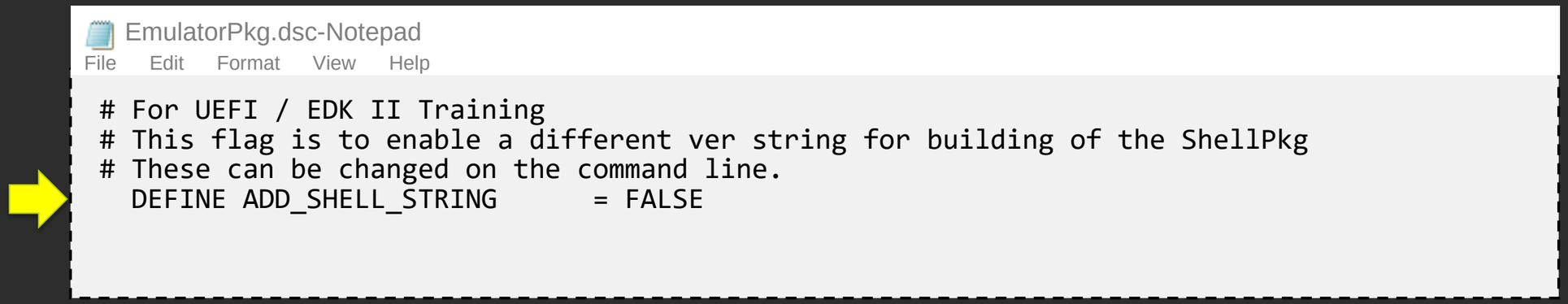
In this lab, you'll remove the build switches to be always TRUE



Build MACRO Switches

The build for `EmulatorPkg` is using build MACRO Switch:

`-D ADD_SHELL_STRING` – used to change a string in the UEFI Shell application, only used for EDK II Training (requires ShellPkg be re-built on a change of this switch)



First delete directory Build/EmulatorX64/DEBUG_*tag*/X64/ShellPkg

Lab 2.1: Compiling w/ Build Switch

At the VS Command Prompt build without the "-D ADD_SHELL_STRING" switch

```
Delete Build/EmulatorX64/DEBUG_tag/X64/ShellPkg
$> Build
$> RunEmulator.bat
```

Check the Shell version with "Ver" command

```
Shell> ver
UEFI Interactive Shell v2.2
EDK II
UEFI v2.70 (EDK II, 0x00010000)
Shell> _
```

Build with the –D ADD_SHELL_STRING

```
Delete Build/EmulatorX64/DEBUG_tag/X64/ShellPkg
$> Build -D ADD_SHELL_STRING
$> RunEmulator.bat
```

Check the Shell version with "Ver" command

```
Shell> ver
UEFI Interactive Shell v2.2 -From ADD_SHELL_STRING Switch
EDK II
UEFI v2.70 (EDK II, 0x00010000)
Shell> _
```

NOTE: You may need to Delete directory: Build/EmulatorX64/DEBUG_*tag*/X64/ShellPkg Between each build

Lab 2.1: Compiling w/out Build Switch

Edit the file C:/FW/edk2-ws/edk2/EmulatorPkg/EmulatorPkg.dsc

Change:

```
DEFINE ADD_SHELL_STRING = TRUE
```

(save the file)

Delete directory Build\ . . .\ Shellpkg

Re-Build – Cd to C:/FW/edk2-ws/edk2

```
$> Build
$> RunEmulator.bat
```

```
Shell> ver
UEFI Interactive Shell v2.2 -From ADD_SHELL_STRING Switch
EDK II
UEFI v2.70 (EDK II, 0x00010000)
Shell> _
```

Check the Shell version with “Ver” command

Copy and paste LabGuide.md

Knowledge Check from LAB 2

1. How to write a simple native UEFI Application
2. Each module requires a .inf file with a unique GUID (use http://www.guidgenerator.com/)
3. The module created will be the base name defined in the .inf file
4. The module's .inf file is required to be included in the platform .dsc file
5. The [Packages] section is required at minimum to include MdePkg/MdePkg.dec
6. When using a Build Switch (-D) on the command line it overrides the value in the .DSC file

Lab 2: If there are build errors …

See class files for the solution

- `. . .FW/LabSampleCode/LabSolutions/LessonB.2`
- Copy the .inf and .c files to `C:/FW/edk2-ws/edk2/SampleApp`
- Search sample DSC for reference to `SampleApp.inf` and add this line to your workspace DSC file `C:/FW/edk2-ws/edk2/EmulatorPkg/EmulatorPkg.dsc`

```
  SampleApp/SampleApp.inf
```

Invoke “ `build`” again and check the solution

ADD FUNCTIONALITY

Add Functionality to the Simple UEFI Application :

Next 3 Labs

Lab 3: Print the UEFI System Table

Lab 4: Wait for an Event

Lab 5: Create a Simple Typewriter function

Solutions in .../FW/LabSampleCode/LabSolutions/LessonB.n

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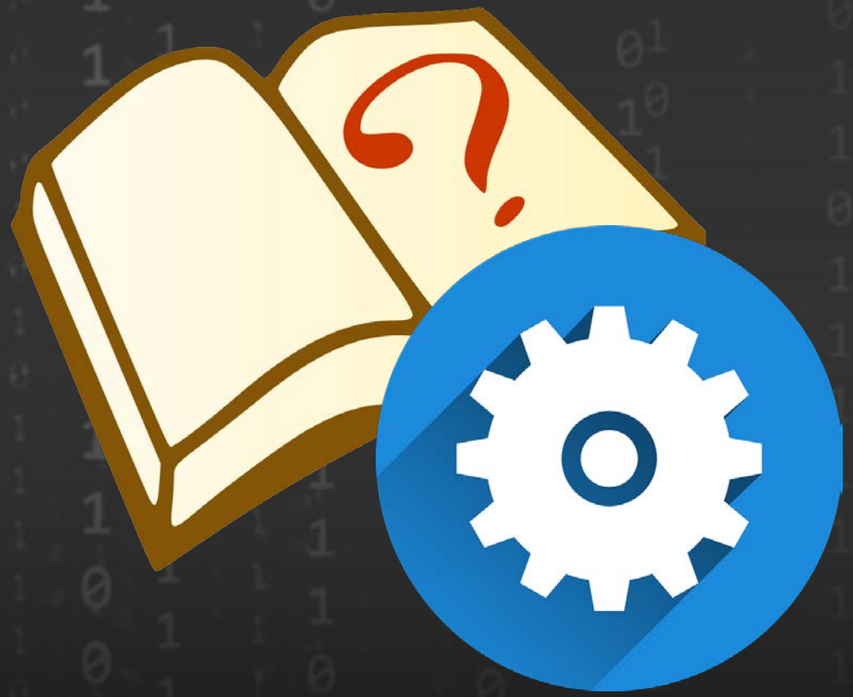
Lab 3: Print the UEFI System Table

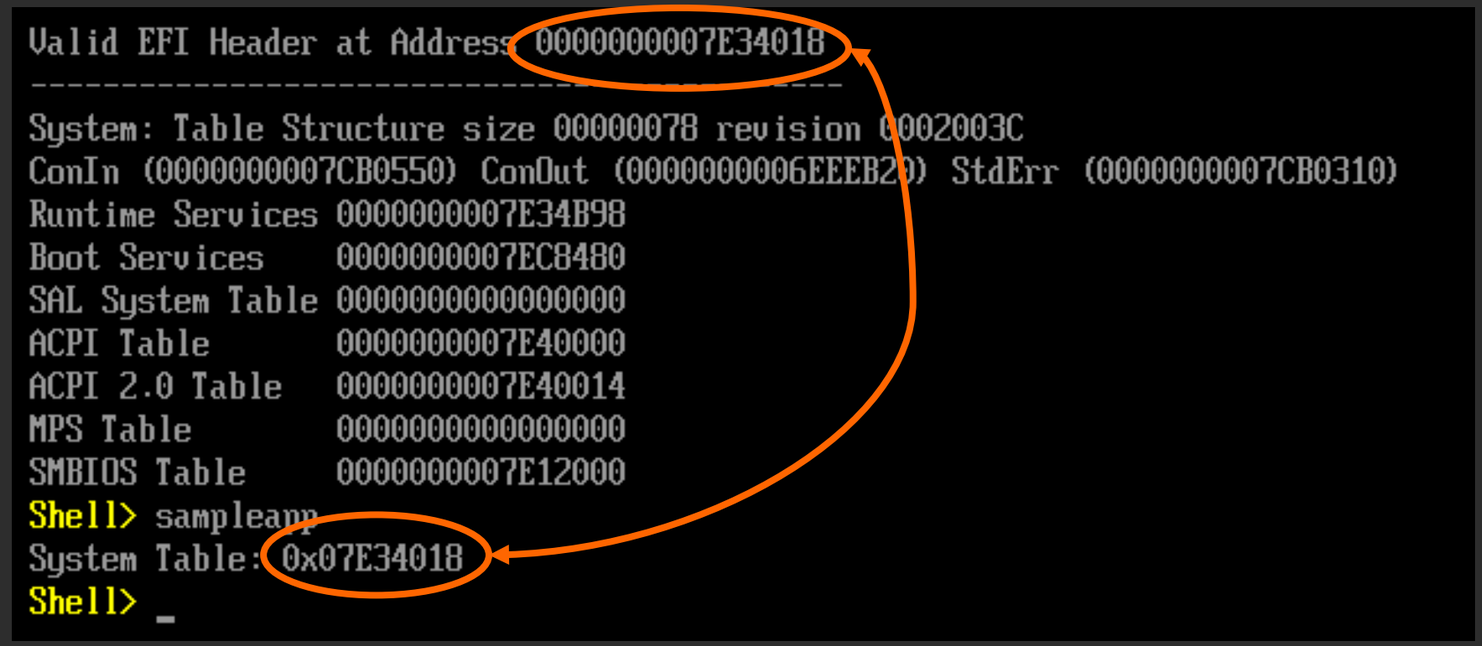
Add code to print the hex address of the EFI System Table pointer to the console.



Lab 3 : Add System Table Code

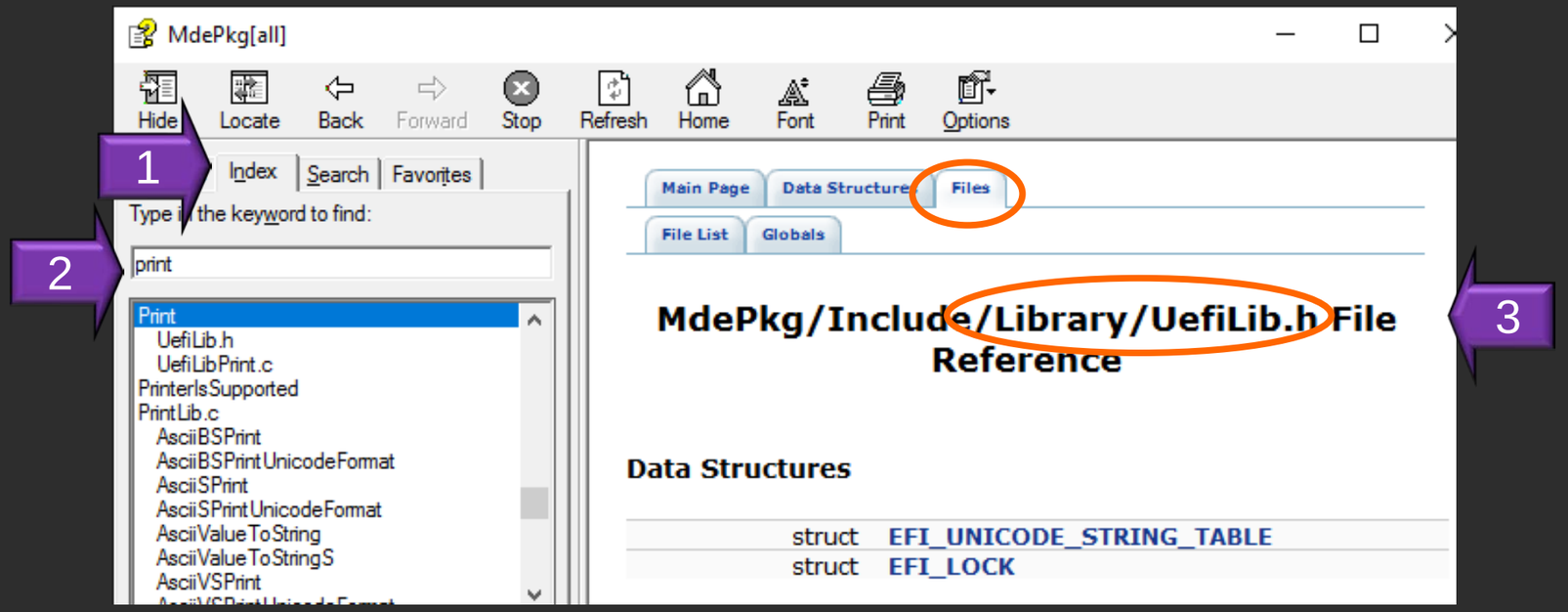
Add code to print to the console the hex address of the system table pointer

- Where is the “print” function?
- Where does the app get the pointer value?
  (compared to **`mem`** command below)



Lab 3 : Locating the Print() Function

1. Search the MdePkg.chm and find that the Print function by clicking on the “Index” tab
2. Type “Print” and double click
3. Scroll to the top in the right window to see that the print function is in the UefiLib.h file



Lab 3 : Modifying .C & .INF Files

SampleApp.c - Notepad

File Edit Format View Help

SampleApp.c

```
#include <Uefi.h>
#include <Library/UefiApplicationEntryPoint.h>
#include <Library/UefiLib.h>

EFI_STATUS
EFIAPI
UefiMain (
  IN EFI_HANDLE        ImageHandle,
  IN EFI_SYSTEM_TABLE  *SystemTable
  )
{
  Print(L"System Table: 0x%p\n“, SystemTable);
  return EFI_SUCCESS;
}
```

SampleApp.inf - Notepad

File Edit Format View Help

SampleApp.inf

```
[LibraryClasses]
  UefiApplicationEntryPoint
  UefiLib
```

Note: Solution files are in the lab materials directory

Copy and paste LabGuide.md

Lab 3 : Build and Test SampleApp

At the VS Command Prompt

```
$> Build
$> RunEmulator.bat
```

Run the application from the shell

```
Shell> SampleApp
System Table: 0x07E34018
Shell>
```

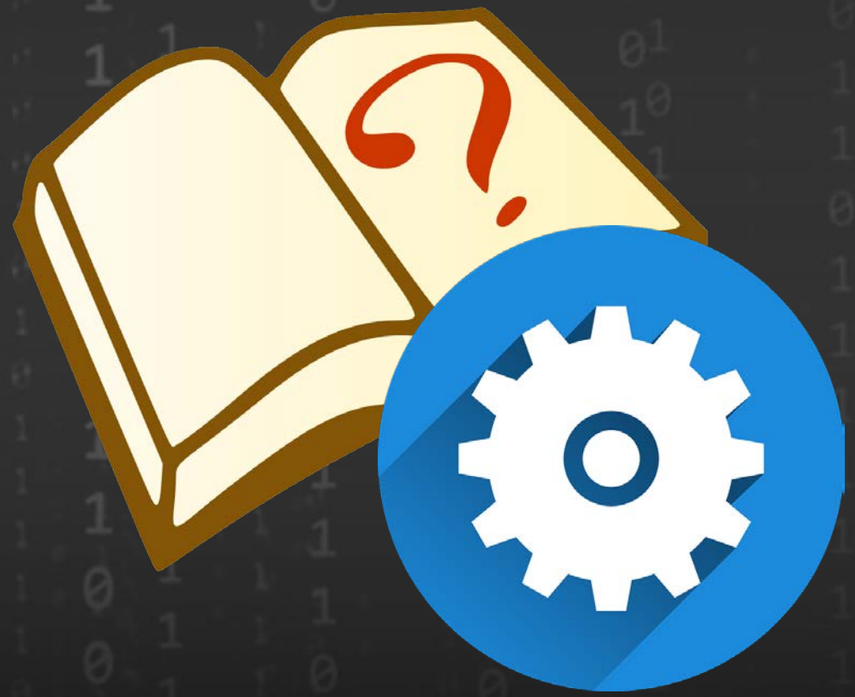
Verify by using the “mem” command

Exit

```
Shell> Reset
```

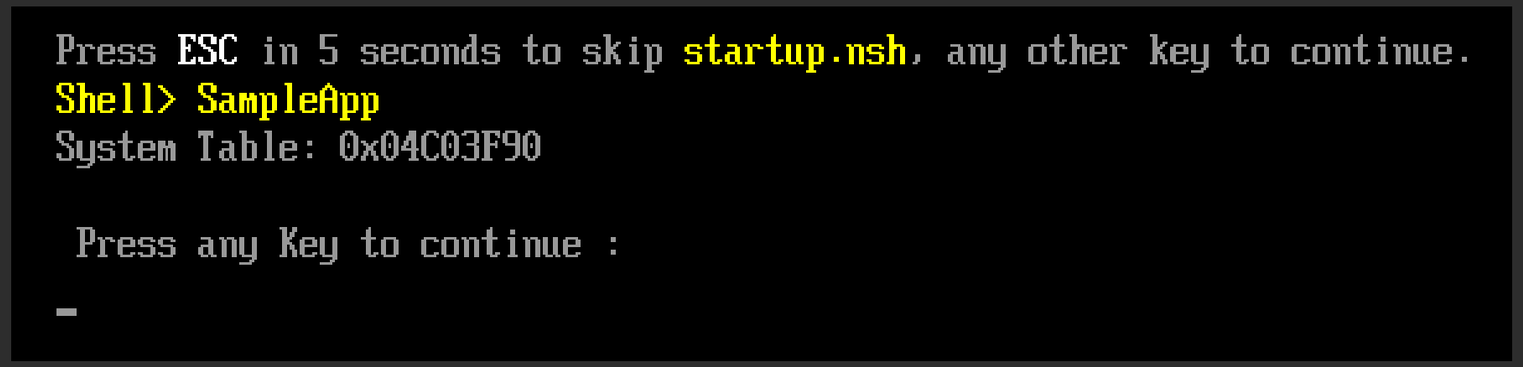
Lab 4: Waiting for an Event

In this lab, you'll learn how to locate code and .chm files to help write EFI code for waiting for an event



Lab 4 : Add Wait for Event

Add code to make your application wait for a key press event (`WaitForEvent / WaitForKey`)



- Where are these functions located?
- What else can you do with the key press?

Lab 4: HOW?

Locate Functions: `WaitForEvent / WaitForKey`

- Search MdePkg.chm- "MdePkg Document With Libraries.chm" located in ... Lab_Material_FW/FW/Documentation
  - Locate `WaitForEvent` in Boot Services
  - Locate `WaitForKey` and find (`EFI_SIMPLE_TEXT_INPUT_PROTOCOL` will be part of ConIn)
- Check the UEFI Spec for parameters needed:
  - `WaitForEvent` is referenced via Boot Services pointer, which is referenced via EFI System Table
  - `WaitForKey` can be referenced through the EFI System Table passed into the application
- **OR** Search the working space for `WaitForEvent` for an example
- One can be found in MdePkg/Library/UefiLib/Console.c ~ ln 569:

Lab 4 : Update the C File for `WaitForKey`

Search the work space and find the following MdePkg/Library/UefiLib/Console.c ~ ln 563:

Console.c - Notepad

File Edit Format View Help

```
  UINTN                     EventIndex;

  // If we encounter error, continue to read another key in.
  //
    if (Status != EFI_NOT_READY) {
      continue;
    }
    gBS->WaitForEvent (1, &gST->ConIn->WaitForKey, &EventIndex);
  }
```

Line 410

Line 563

Add the following to `SampleApp.c`

SampleApp.c - Notepad

File Edit Format View Help

```
UINTN                         EventIndex;
Print(L"System Table: 0x%p\n",SystemTable);
Print(L"\nPress any Key to continue : \n");
gBS->WaitForEvent (1, &gST->ConIn->WaitForKey, &EventIndex);
```

Copy and Paste

Lab 4: Test Compile

However, this won't compile … `gBS` and `gST` are not defined.

```
Building ... c:\fw\edk2\MdeModulePkg\Application\BootManagerMenuApp\BootManagerMenuApp.inf [IA32]
c:\fw\edk2\SampleApp\SampleApp.c(42) : error C2065: 'gBS' : undeclared identifier
c:\fw\edk2\SampleApp\SampleApp.c(42) : error C2223: left of '->WaitForEvent' must point to struct/unio
n
c:\fw\edk2\SampleApp\SampleApp.c(42) : error C2065: 'gST' : undeclared identifier
c:\fw\edk2\SampleApp\SampleApp.c(42) : error C2223: left of '->ConIn' must point to struct/union
Building ... c:\fw\edk2\MdeModulePkg\Universal\LoadFileOnFv2\LoadFileOnFv2.inf [IA32]
NMAKE : fatal error U1077: '"C:\Program Files (x86)\Microsoft Visual Studio 12.0\Vc\bin\cl.exe"' : ret
urn code '0x2'
Stop.
Building ... c:\fw\edk2\MdeModulePkg\Universal\PlatformDriOverrideDxe\PlatformDriOverrideDxe.inf [IA32
]


build...
 : error 7000: Failed to execute command
        C:\Program Files (x86)\Microsoft Visual Studio 12.0\Vc\bin\nmake.exe /nologo tbuild [c:\fw\edk
2\Build\NT32IA32\DEBUG_VS2013x86\IA32\SampleApp\SampleApp]
```

Search the `MdePkg.chm` for "**gBS**" and "**gST**" – they are located in `UefiBootServicesTableLib.h`

Add the boot services lib to `SampleApp.c . . .`

```
#include <Library/UefiBootServicesTableLib.h>
```

(hint: **`Lesson B.4`** has the solution)

Lab 4: Update for gBS & gST

SampleApp.c - Notepad

File Edit Format View Help

```
#include <Uefi.h>
#include <Library/UefiApplicationEntryPoint.h>
#include <Library/UefiLib.h>
#include <Library/UefiBootServicesTableLib.h>
// . . .
EFI_STATUS
EFIAPI
UefiMain (
  IN EFI_HANDLE        ImageHandle,
  IN EFI_SYSTEM_TABLE  *SystemTable
  )
{
  UINTN                EventIndex;
  Print(L"System Table: 0x%p\n“, SystemTable);
  Print(L"\nPress any Key to  continue :\n");
  gBS->WaitForEvent (1, &gST->ConIn->WaitForKey, &EventIndex);
  return EFI_SUCCESS;
}
```

Copy and paste LabGuide.md

Lab 4 : Build and Test SampleApp

At the VS Command Prompt

```
$> Build
$> RunEmulator.bat
```

Run the application from the shell

```
Shell> SampleApp
System Table: 0x07E34018
Press any key to continue:
Shell>
```

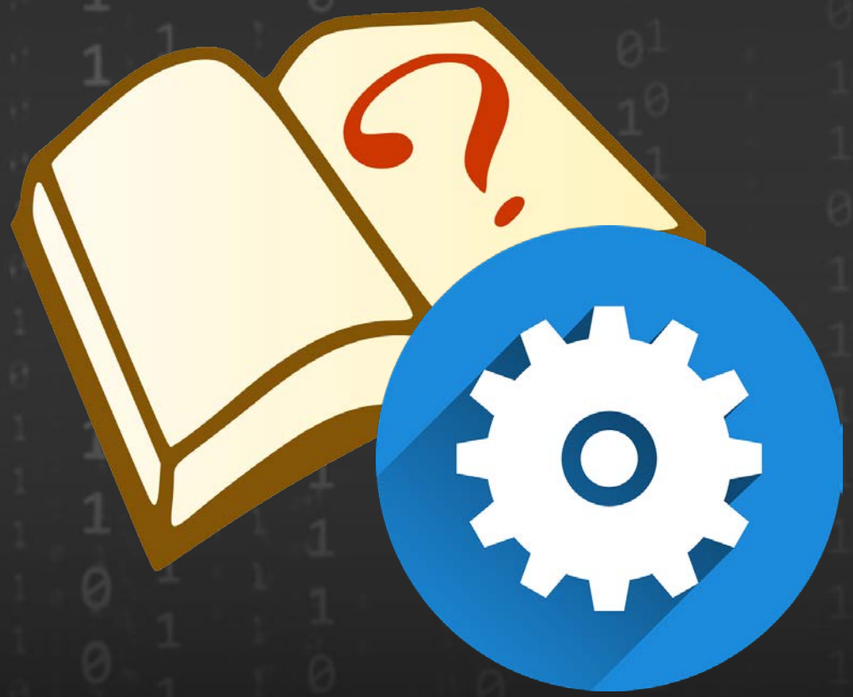
Notice that the SampleApp will wait until a key press to continue

Exit

```
Shell> Reset
```

Lab 5: Creating a Simple Typewriter Function

In this lab, you'll learn how to create a simple typewriter function that retrieves the keys you type and subsequently prints each one back to the console

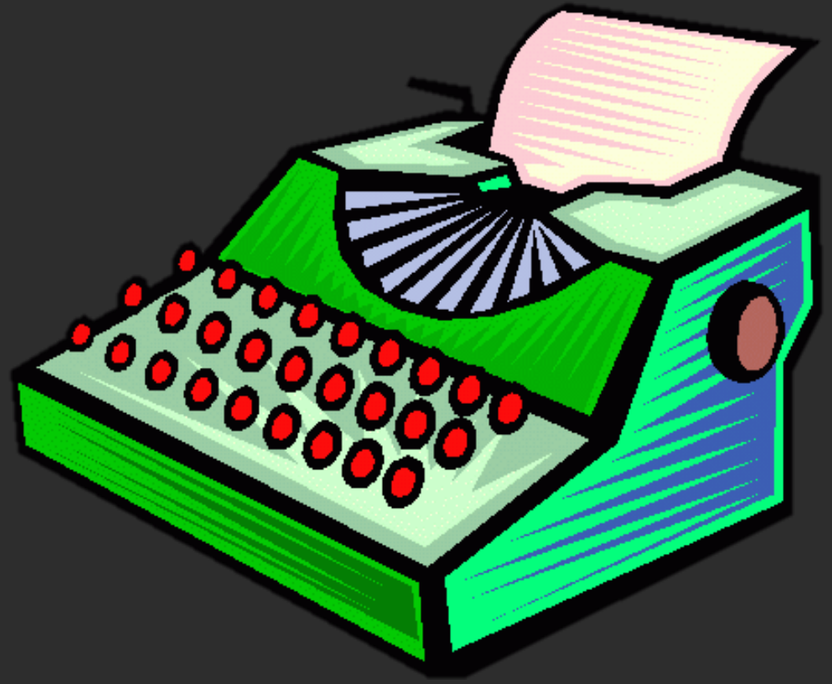


Lab 5 : Typewriter Function

Create a Simple Typewriter Function using the SampleApp from Lab 4

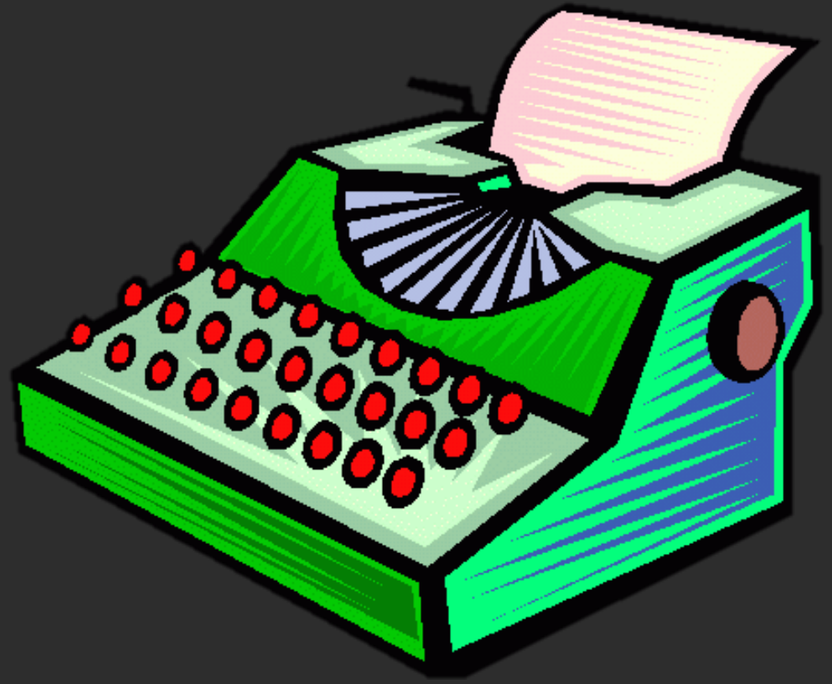
Requirements:

- Retrieve keys entered from keyboard (*Like* Lab 4)
- Print back each key entered to the console
- To exit, press “.” (DOT) and then <Enter>



Lab 5 : Typewriter Function

Create a Simple Typewriter Function using the SampleApp from Lab 4



How:

1. Add a Loop using `WaitForEvent` with `WaitForKey`
2. Use the `ReadKeyStroke` function from `ConIn`
3. Print back each key to console
4. Exit when DOT “.” character is followed by an <Enter> key

Lab 5: How Process (Hints)

- Use the same procedure as with Lab 4 to find "ReadKeyStroke" in the workspace: MdePkg/Library/UefiLib/Console.c ~ ln 552

```
Status = gST->ConIn->ReadKeyStroke (gST->ConIn, Key);
```

- ReadKeyStroke uses buffer called EFI_INPUT_KEY ~ ln 393

```
OUT EFI_INPUT_KEY  *Key,
```

- TIP: Good Idea to zero out a buffer in your function –
  - Use MdePkg.chm to find ZeroMem function
  - Use ZeroMem on your variable buffer "Key" of type EFI_INPUT_KEY
- Use Boolean flag "ExitLoop" to exit your loop once the user enters a DOT "." character.

Lab 5: Solution

SampleApp.c - Notepad

File Edit Format View Help

```
#include <Uefi.h>
#include <Library/UefiApplicationEntryPoint.h>
#include <Library/UefiLib.h>
#include <Library/BaseMemoryLib.h>
#include <Library/UefiBootServicesTableLib.h>
#define CHAR_DOT  0x002E    // '.' in Unicode

EFI_STATUS
EFIAPI
UefiMain (
  IN EFI_HANDLE        ImageHandle,
  IN EFI_SYSTEM_TABLE  *SystemTable
  )
{
  UINTN          EventIndex;
  BOOLEAN        ExitLoop;
  EFI_INPUT_KEY  Key;

// Lab 3
 Print(L"System Table: 0xp\n",SystemTable);

//Lab 4
 Print( L"\nPress any Key to continue : \n\n");
 gBS->WaitForEvent (1, &gST->ConIn->WaitForKey,EventIndex);
```

(hint: Lesson B.5 has the solution)

```
// Lab 5
 Print(L"Enter text. Include a dot ('.') in a \
     sentence then <Enter> to exit:\n\n”);
 ZeroMem (&Key, sizeof (EFI_INPUT_KEY));
 gST->ConIn->ReadKeyStroke (gST->ConIn, &Key);
 ExitLoop = FALSE;
 do {
        gBS->WaitForEvent (1, &gST->ConIn->WaitForKey,
              &EventIndex);
        gST->ConIn->ReadKeyStroke (gST->ConIn, &Key);
        Print(L"%c", Key.UnicodeChar);
        if (Key.UnicodeChar == CHAR_DOT){
              ExitLoop = TRUE;
        }
    } while (!(Key.UnicodeChar == CHAR_LINEFEED  ||
       Key.UnicodeChar == CHAR_CARRIAGE_RETURN) ||
       !(ExitLoop) );

 Print(L"\n");
 return EFI_SUCCESS;
}
```

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Lab 5: Solution

SampleApp.c Should have the following for Lab 5:

```
#include <Uefi.h>
#include <Library/UefiApplicationEntryPoint.h>
#include <Library/UefiLib.h>
#include <Library/UefiBootServicesTableLib.h>
#include <Library/BaseMemoryLib.h>
#define CHAR_DOT  0x002E    // '.' in Unicode

EFI_STATUS
EFIAPI
UefiMain (
  IN EFI_HANDLE        ImageHandle,
  IN EFI_SYSTEM_TABLE  *SystemTable
  )
{
  UINTN          EventIndex;
  BOOLEAN        ExitLoop;
  EFI_INPUT_KEY  Key;

// Lab 3
 Print(L"System Table: 0x%p\n",SystemTable);

//Lab 4
 Print( L"\nPress any Key to continue : \n\n");
 gBS->WaitForEvent (1, &gST->ConIn->WaitForKey,
```

```
// Lab 5
 Print(L"Enter text. Include a dot ('.') in a sentence then
<Enter> to exit:\n\n”);
 ZeroMem (&Key, sizeof (EFI_INPUT_KEY));
 gST->ConIn->ReadKeyStroke (gST->ConIn, &Key);
 ExitLoop = FALSE;
 do {
        gBS->WaitForEvent (1, &gST->ConIn->WaitForKey,&EventIndex);
        gST->ConIn->ReadKeyStroke (gST->ConIn, &Key);
        Print(L"%c", Key.UnicodeChar);
        if (Key.UnicodeChar == CHAR_DOT){
             ExitLoop = TRUE;
        }
    } while (!(Key.UnicodeChar == CHAR_LINEFEED  ||
        Key.UnicodeChar == CHAR_CARRIAGE_RETURN) ||
        !(ExitLoop) );
}
 Print(L"\n");
 return EFI_SUCCESS;
}
```


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Lab 5 :Build and Test SampleApp

At the VS Command Prompt

```
$> Build
$> RunEmulator.bat
```

Run the application from the shell

```
Shell> sampleapp
System Table: 0x061CBF90


 Press any Key to continue :
Enter text. Include a dot ('.') in a sentence then <Enter> to exit:

This is text from the type writer function.
Shell> _
```

Exit

```
Shell> Reset
```

Bonus Exercise: Open Protocol Example

Write an Application using **`argv, argc`** parameters

- Captures command line parameters using Open Protocol
- Need to open SHELL_INTERFACE_PROTOCOL
- Note: Requires ShellPkg

Build SampleApp

```
$> Build
$> RunEmulator.bat
```

Run the application form the shell

```
Shell> SampleApp  test1 test2
```

(hint: ~FW/LabSampleCode/ShellAppSample has the solution)

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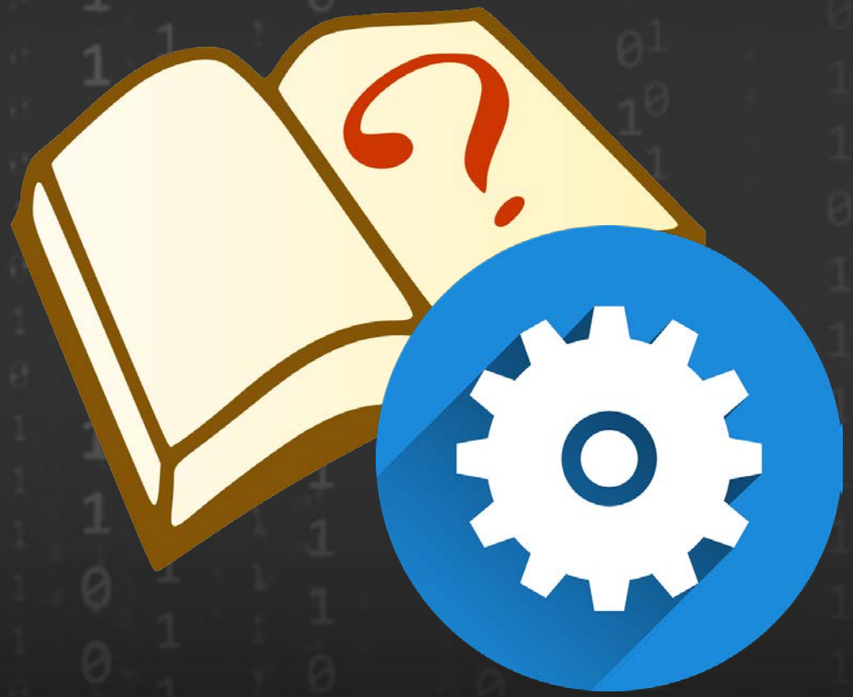
USING EADK

Using EADK with UEFI Application

Labs 6-7 are Optional

Lab 6: Writing UEFI Applications with EADK

In this lab, you'll write an application with the same functionality as SampleApp.c using LibC from the EDK II Application Development Kit (EADK)



Lab 6: With EDK II EADK

Write the same application with the same functionality as SampleApp.c using the LibC from the EADK

```
Shell> fs0:
FS0:\> SampleCApp
System Table: 0x631bf90

Press any Key and then <Enter> to continue :


Enter text. Include a dot ('.') in a sentence then <Enter> to exit:

This is a sentence using my UEFI Application using the C library.


FS0:\> _
```

What libraries are needed

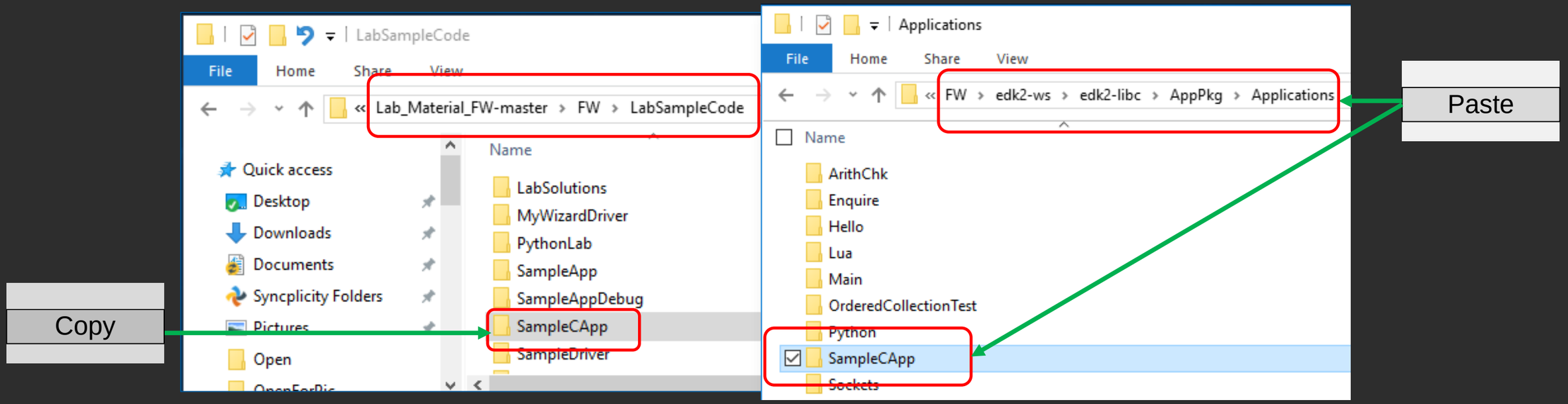
What differences are there using the LibC

Lab 6: EDK II using EADK

Start with the packages for EADK from `edk2-libc`

- /edk2-libc - `AppPkg` - has directory Applications
- /edk2-libc - `StdLib` - contains the LibC libraries

- Copy and paste directory `../FW/LabSampleCode/SampleCApp` to
  `C:/FW/edk2-ws/edk2-libc/AppPkg/Applications/SampleCApp`



Lab 6: EDK II using EADK

Check out AppPkg/Applications/SampleCApp

SampleCApp.c and SampleCApp.inf

SampleCApp.c - Notepad

File Edit Format View Help

```
#include <stdio.h>
// . .
int
main (
  IN int Argc,
  IN char **Argv
)
{
   return 0;
}
```

SampleCApp.inf - Notepad

File Edit Format View Help

```
[Defines]
  INF_VERSION          = 1.25
  BASE_NAME            = SampleCApp
  FILE_GUID            = 4ea9…
  MODULE_TYPE          = UEFI_APPLICATION
  VERSION_STRING       = 0.1
  ENTRY_POINT          = ShellCEntryLib

[Sources]
  SampleCApp.c

[Packages]
  StdLib/StdLib.dec
  MdePkg/MdePkg.dec
  ShellPkg/ShellPkg.dec

[LibraryClasses]
  LibC
  LibStdio
```

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Lab 6 : Update AppPkg.dsc

Edit the C:/fw/edk2-ws/edk2-libc/AppPkg/AppPkg/AppPkg.dsc and add SampleCApp.inf at the end

of the components section

- (hint: search for "#### Sample Applications")
- AppPkg/Applications/SampleCApp/SampleCApp.inf

```
[Components]
#### Sample Applications.
AppPkg/Applications/Hello/Hello.inf             # No LibC includes or functions.
AppPkg/Applications/Main/Main.inf               # Simple invocation. No other LibC function
AppPkg/Applications/Enquire/Enquire.inf         #
AppPkg/Applications/ArithChk/ArithChk.inf       #

AppPkg/Applications/SampleCApp/SampleCApp.inf  # LAB 6
```

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Lab 6 :Build and Test SampleCApp

Build the AppPkg at the VS Command Prompt

```
$> build -p AppPkg/AppPkg.dsc –m AppPkg/Applications/SampleCApp/SampleCApp.inf
```

Copy the built application to the Emulator runtime directory (note VS Tool)

```
$> copy ..\Build\AppPkg\DEBUG_VS2015x86\X64\SampleCApp.efi
                        ..\Build\EmulatorX64\DEBUG_VS2015x86\X64
```

Run Emulator emulation

```
$> RunEmulator.bat
```

Run the application SampleCApp from the Shell

```
Shell> SampleCApp
Shell>
```

Notice that the program will immediately unload because the main function is empty

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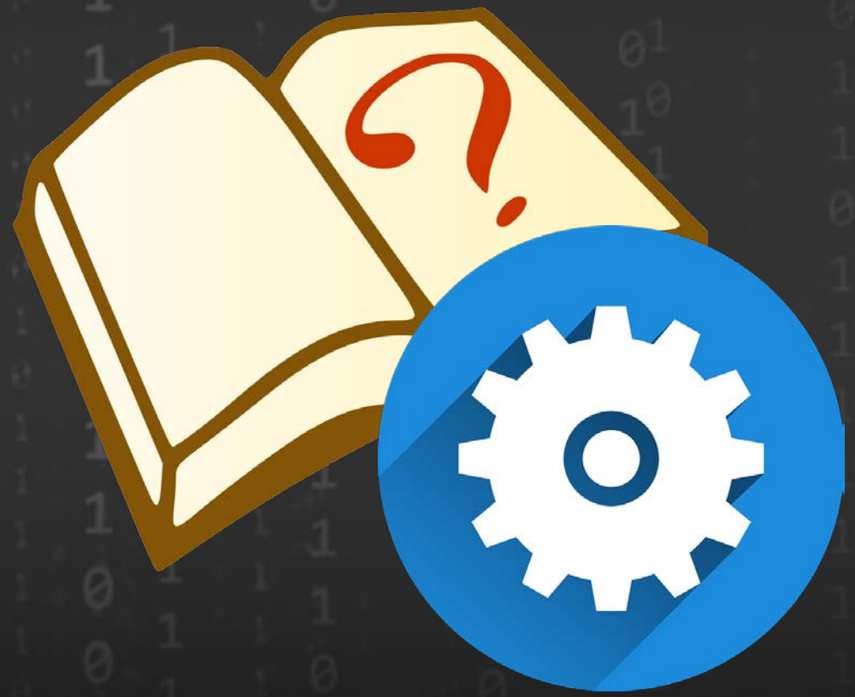
Lab 7: Adding Functionality to SampleCApp

In this lab, you'll add functionality to SampleCApp the same as in Lab 5. This lab will use EADK libraries, so the coding style is similar to standard C.



Lab 7: Add the same functionally from Lab 5

SampleCApp.c and SampleCApp.inf

SampleCApp.c - Notepad

File Edit Format View Help

```
#include <stdio.h>
#include <Library/UefiBootServicesTableLib.h>
// . . .
   char c;

   printf("System Table: %p \n", gST) ;
   puts("Press any Key and then <Enter>
         to continue : ");
   c=(char)getchar();
   puts ("Enter text. Include a dot ('.') in a
         sentence then <Enter> to exit:");
   do {
      c=(char)getchar();
      } while (c != '.');
   puts ("\n");

   return 0;
 }
```

SampleCApp.inf - Notepad

File Edit Format View Help

```
[Defines]
  INF_VERSION         = 1.25
  BASE_NAME           = SampleCApp
  FILE_GUID           = 4ea9…
  MODULE_TYPE         = UEFI_APPLICATION
  VERSION_STRING      = 0.1
  ENTRY_POINT         = ShellCEntryLib

[Sources]
  SampleCApp.c

[Packages]
  StdLib/StdLib.dec
  MdePkg/MdePkg.dec
  ShellPkg/ShellPkg.dec

[LibraryClasses]
  LibC
  LibStdio
  UefiBootServicesTableLib
```

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Lab 7: Add the same functionally from Lab 5

SampleCApp.c and SampleCApp.inf

SampleCApp.c - Notepad

File Edit Format View Help

```
#include <stdio.h>
#include <Library/UefiBootServicesTableLib.h>
// . . .
   char c;

   printf("System Table: %p \n", gST) ;
   puts("Press any Key and then <Enter>
         to continue : ");
   c=(char)getchar();
   puts ("Enter text. Include a dot ('.') in a
         sentence then <Enter> to exit:");
   do {
      c=(char)getchar();
      } while (c != '.');
   puts ("\n");

   return 0;
 }
```

3

SampleCApp.inf - Notepad

File Edit Format View Help

```
[Defines]
  INF_VERSION         = 1.25
  BASE_NAME           = SampleCApp
  FILE_GUID           = 4ea9…
  MODULE_TYPE         = UEFI_APPLICATION
  VERSION_STRING      = 0.1
  ENTRY_POINT         = ShellCEntryLib

[Sources]
  SampleCApp.c

[Packages]
  StdLib/StdLib.dec
  MdePkg/MdePkg.dec
  ShellPkg/ShellPkg.dec

[LibraryClasses]
  LibC
  LibStdio
  UefiBootServicesTableLib
```

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Lab 7: Add the same functionally from Lab 5

SampleCApp.c and SampleCApp.inf

SampleCApp.c - Notepad

File Edit Format View Help

```
#include <stdio.h>
#include <Library/UefiBootServicesTableLib.h>
// . . .
   char c;

   printf("System Table: %p \n", gST) ;
   puts("Press any Key and then <Enter>
         to continue : ");
   c=(char)getchar();
   puts ("Enter text. Include a dot ('.') in a
         sentence then <Enter> to exit:");
   do {
      c=(char)getchar();
      } while (c != '.');
   puts ("\n");

   return 0;
 }
```

3

4

SampleCApp.inf - Notepad

File Edit Format View Help

```
[Defines]
  INF_VERSION         = 1.25
  BASE_NAME           = SampleCApp
  FILE_GUID           = 4ea9…
  MODULE_TYPE         = UEFI_APPLICATION
  VERSION_STRING      = 0.1
  ENTRY_POINT         = ShellCEntryLib

[Sources]
  SampleCApp.c

[Packages]
  StdLib/StdLib.dec
  MdePkg/MdePkg.dec
  ShellPkg/ShellPkg.dec

[LibraryClasses]
  LibC
  LibStdio
  UefiBootServicesTableLib
```

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Lab 7: Add the same functionally from Lab 5

SampleCApp.c and SampleCApp.inf

SampleCApp.c - Notepad

File Edit Format View Help

```
#include <stdio.h>
#include <Library/UefiBootServicesTableLib.h>
// . . .
   char c;

   printf("System Table: %p \n", gST) ;
   puts("Press any Key and then <Enter>
         to continue : ");
   c=(char)getchar();
   puts ("Enter text. Include a dot ('.') in a
         sentence then <Enter> to exit:");
   do {
      c=(char)getchar();
      } while (c != '.');
   puts ("\n");

   return 0;
}
```

3

4

5

SampleCApp.inf - Notepad

File Edit Format View Help

```
[Defines]
  INF_VERSION          = 1.25
  BASE_NAME            = SampleCApp
  FILE_GUID            = 4ea9…
  MODULE_TYPE          = UEFI_APPLICATION
  VERSION_STRING       = 0.1
  ENTRY_POINT          = ShellCEntryLib

[Sources]
  SampleCApp.c

[Packages]
  StdLib/StdLib.dec
  MdePkg/MdePkg.dec
  ShellPkg/ShellPkg.dec

[LibraryClasses]
  LibC
  LibStdio
  UefiBootServicesTableLib
```

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Lab 7: Solution

SampleCApp.c and SampleCApp.inf

“C” file

```
#include <stdio.h>
#include <Library/UefiBootServicesTable
// . . .
   char c;

   printf("System Table: %p \n", gST) ;
   puts("Press any Key and then <Enter> to continue :
   c=(char)getchar();
   puts ("Enter text. Include a dot ('.') in a
   do {
      c=(char)getchar();
      } while (c != '.');
   puts ("\n");

   return 0;
 }
```

.inf file

```
[Defines]
  INF_VERSION    = 1.25
  BASE_NAME      = SampleCApp
  FILE_GUID      = 4ea9…
  MODULE_TYPE    = UEFI_APPLICATION
  VERSION_STRING = 0.1
  ENTRY_POINT    = ShellCEntryLib

[Sources]
  SampleCApp.c

[Packages]
  StdLib/StdLib.dec
  MdePkg/MdePkg.dec
  ShellPkg/ShellPkg.dec

[LibraryClasses]
  LibC
  LibStdio
  UefiBootServicesTableLib
```

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Lab 7 :Build and Test SampleCApp

Build the AppPkg at the VS Command Prompt

```
$> build -p AppPkg/AppPkg.dsc –m AppPkg/Applications/SampleCApp/SampleCApp.inf
```

Copy the built application to the Emulator runtime directory (note VS Tool)

```
$> copy ..\Build\AppPkg\DEBUG_VS2015x86\X64\SampleCApp.efi
                        ..\Build\EmulatorX64\DEBUG_VS2015x86\X64
```

Run Emulator emulation

```
$> RunEmulator.bat
```

Run the application SampleCApp from the Shell

```
Shell> SampleCApp
Press any Key and then <Enter> to Continue :

Enter text. Include a dot (‘.’) in a sentence then <Enter> to exit:
This is sample text.
Shell>
```

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Summary

- UEFI Application with PCDs
- Simple UEFI Application
- Add functionality to UEFI Application
- Using EADK with UEFI Application

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Questions?

Return to Main Training Page

Return to Training Table of contents for next presentation link

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ACKNOWLEDGEMENTS