

UEFI & EDK II TRAINING

How to Write a UEFI Driver- Port Lab with Linux

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See also [LabGuide.md](#) for Copy & Paste examples in labs

Lesson Objective

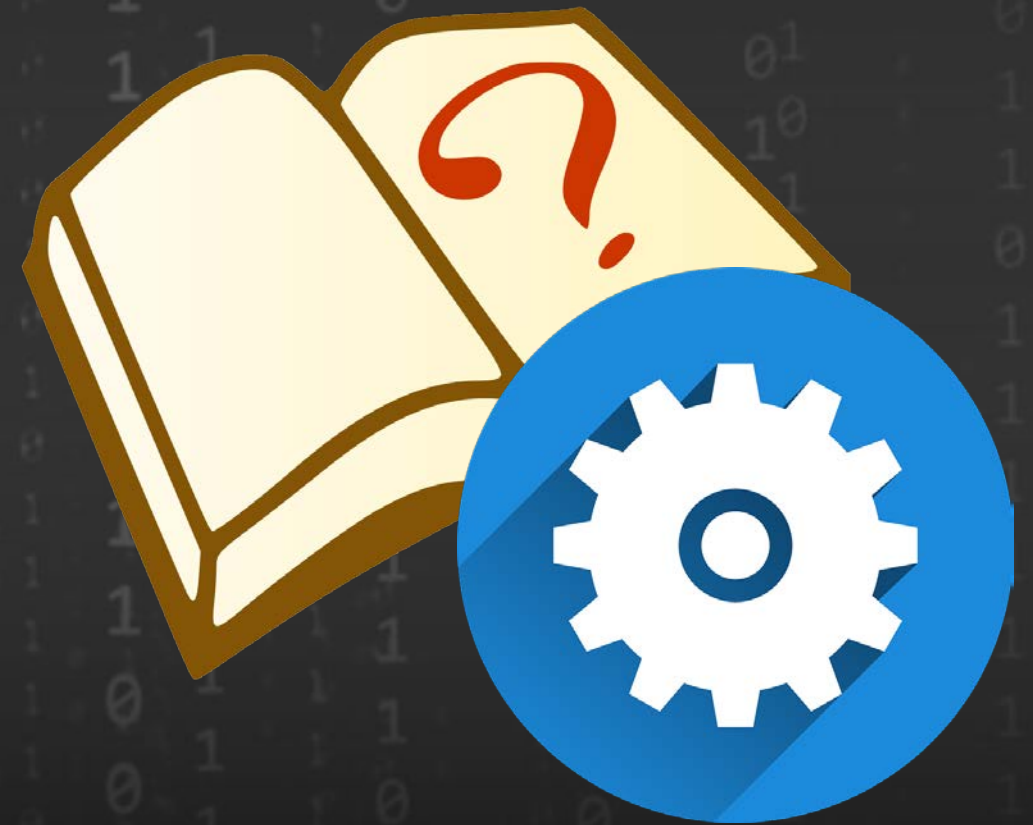
- ★ Compile a UEFI driver template created from UEFI Driver Wizard
- ★ Test driver in QEMU using UEFI Shell 2.0
- ★ Port code in the template driver

Note: Since this is a lab, to follow examples for copy & paste, use the following Markdown link [LabGuide.md](#)

LAB 1: UEFI DRIVER TEMPLATE

Use this lab, if you're not able to create a UEFI Driver Template using the UEFI Driver Wizard.

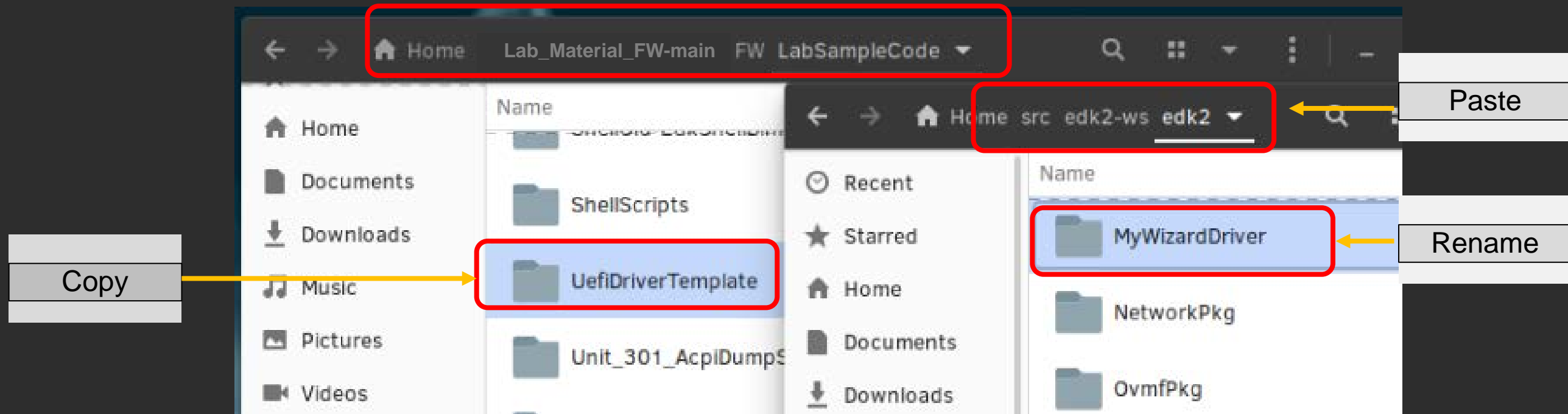
Skip if LAB 1 UEFI Driver Wizard completed successfully



Lab 1: Get UEFI Driver Template

Non-Ubuntu Linux users or Python UEFI Driver Wizard does not work:

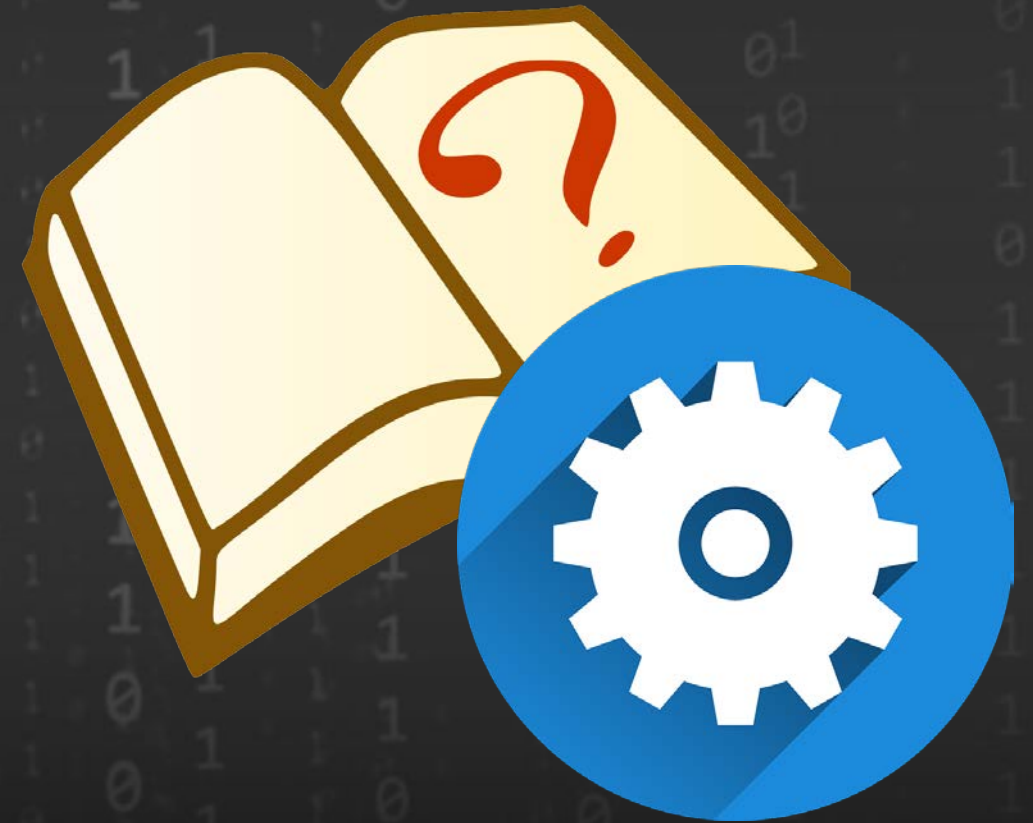
1. Copy the directory UefiDriverTemplate from
 `~. . ./FW/LabSampleCode/` to `~/src/edk2-ws/edk2`
2. Rename Directory UefiDriverTemplate to MyWizardDriver



Review [UEFI Driver Wizard Lab](#) for protocols produced and which are being consumed

LAB 2: BUILDING A UEFI DRIVER

In this lab, you'll build a UEFI Driver created by the UEFI Driver Wizard. You will include the driver in the OVMF project. Build the UEFI Driver from the Driver Wizard



Compile a UEFI Driver

Two Ways to Compile a Driver	
<i>Standalone</i>	<i>In a Project</i>
The build command directly compiles the .INF file	Include the .INF file in the project's .DSC file
Results: The driver's .EFI file is located in the Build directory	Results: The driver's .EFI file is a part of the project in the Build directory

Lab 2: Build the UEFI Driver

- Perform [Lab Setup](#) from previous Labs
- Open `~src/edk2-ws/edk2/OvmfPkg/OvmfPkgX64.dsc`
- Add the following to the [Components] section:

Hint: add to the last module in the [Components] section

```
# Add new modules here
  MyWizardDriver/MyWizardDriver.inf{
    <LibraryClasses>      DebugLib|MdePkg/Library/UefiDebugLibConOut/UefiDebugLibConOut.inf
  }
```

- Save and close the file `~src/edk2-ws/edk2/OvmfPkg/OvmfPkgX64.dsc`

Lab 2: Build and Test Driver

Build MyWizardDriver – Cd to ~/src/edk2-ws/edk2 dir

```
bash$ . edksetup.sh  
bash$ build
```

Build error Known issue from UEFI Driver Wizard:
ComponentName.c Line 148 col 74 needs “//” in front of “## TO_START”

```
bash$ build
```

Build ERRORS: Copy the solution files from
~/. . . /FW/LabSampleCode/LabSolutions/LessonC.1 to ~/src/edk2-
ws/edk2/MyWizardDriver

Lab 2: Build and Test Driver

Copy MyWizardDriver.efi to hda-contents

```
bash$ cd ~/run-ovmf/hda-contents
bash$ cp ~/src/edk2-ws/Build/OvmfX64/DEBUG_GCC5/X64/MyWizardDriver.efi .
```

Test by Invoking Qemu

```
bash$ cd ~/run-ovmf
bash$ . RunQemu.sh
```

Load the UEFI Driver from the shell

At the Shell prompt, type **Shell> fs0:**

Type: **FS0:\> load MyWizardDriver.efi**

```
Shell> fs0:
FS0:\> load MyWizardDriver.efi
Image 'FS0:\MyWizardDriver.efi' loaded at 5E7F000 - Success
FS0:\> _
```

Lab 2: Test Driver

At the shell prompt Type: `drivers`

Verify the UEFI Shell loaded the new driver. The drivers command will display the driver information and a driver handle number ("a9" in the example screenshot)

```
92 00000011 ? - - - - Usb Mass Storage Driver      UsbMassStorageDxe
93 00000010 B - - 1 1 QEMU Video Driver             QemuVideoDxe
94 00000010 ? - - - - Virtio GPU Driver             VirtioGpuDxe
A9 00000000 ? - - - - MyWizardDriver                \MyWizardDriver.efi
FS0:\>
```

Lab 2: Test Driver

At the shell prompt using the handle from the drivers command,
Type: `dh -d a9`

Note: The value a9 is the driver handle for MyWizardDriver. The handle value may change based on your system configuration.(see example screenshot - right)

```
FS0:\> dh -d a9
A9: SupportedEfiSpecVersion(0x0002003C) ComponentName2 ComponentName DriverBin
ng HiiPackageList ImageDevicePath(..0xFBFC1)\MyWizardDriver.efi) LoadedImage(
yWizardDriver.efi)
  Driver Name [A9]      : MyWizardDriver
  Driver Image Name    : \MyWizardDriver.efi
  Driver Version       : 00000000
  Driver Type          : <Unknown>
  Configuration        : NO
  Diagnostics           : NO
  Managing              : None
FS0:\> _
```

Lab 2: Test Driver

At the shell prompt using the handle from the drivers command, Type: `unload a9`

See example screenshot - below
Type: `drivers` again

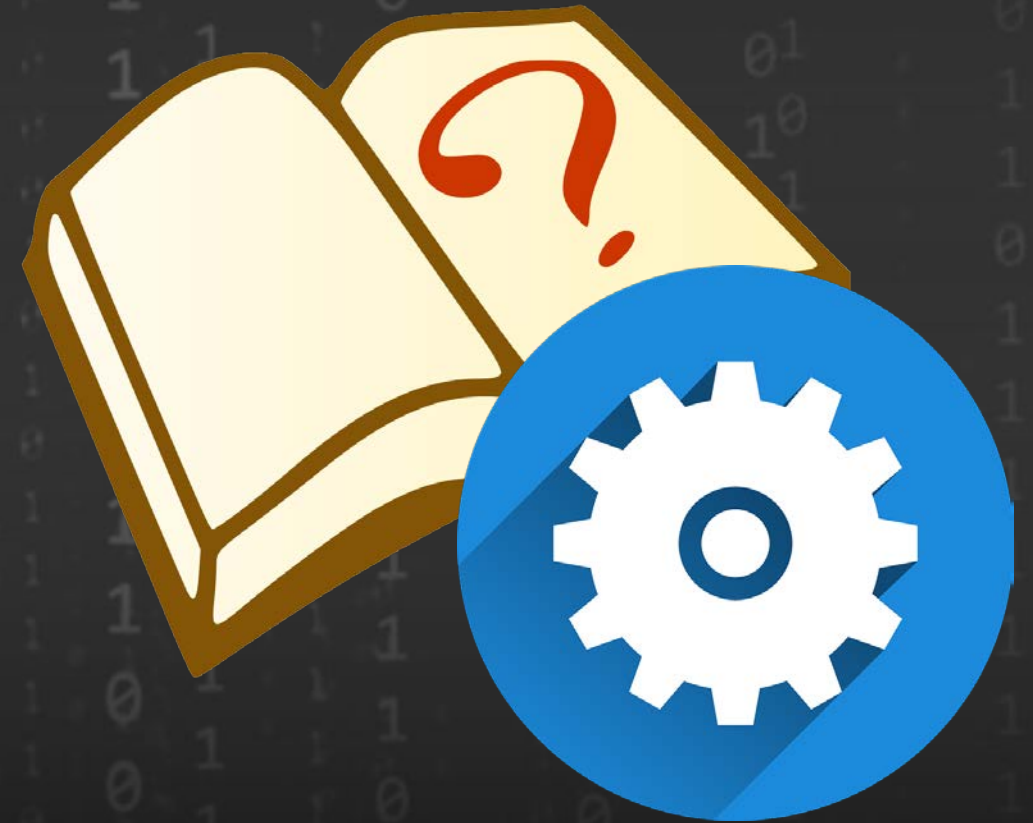
Notice results of unload command

Exit QEMU

```
managing - none
FS0:\> unload a9
Unload - Handle [6B1B798] . [y/n]?
y
Unload - Handle [6B1B798] Result Success.
FS0:\> _
```

LAB 3: COMPONENT NAME

In this lab, you'll change the information reported to the drivers command using the ComponentName and ComponentName2 protocols.



Lab 3: Component Name

- Open `~/src/edk2-ws/edk2/MyWizardDriver/ComponentName.c`
- Change the string returned by the driver from MyWizardDriver to:
UEFI Sample Driver

```
/// Table of driver names
///
GLOBAL_REMOVE_IF_UNREFERENCED
EFI_UNICODE_STRING_TABLE mMyWizardDriverDriverNameTable[] = {
    { "eng;en", (CHAR16 *)L"UEFI Sample Driver" },
    { NULL, NULL }
};
```

- Save and close the file: `~/src/edk2-ws/edk2/MyWizardDriver/ComponentName.c`

Lab 3: Build and Test Driver

Build MyWizardDriver – Cd to ~/src/edk2-ws/edk2 dir

```
bash$ build
```

Copy MyWizardDriver.efi to hda-content

```
bash$ cd ~/run-ovmf/hda-content
```

```
bash$ cp ~/src/edk2-ws/Build/OvmfX64/DEBUG_GCC5/X64/MyWizardDriver.efi .
```

Test by Invoking Qemu

```
bash$ cd ~/run-ovmf
```

```
bash$ . RunQemu.sh
```

Lab 3: Build and Test Driver

Load the UEFI Driver from the shell

At the Shell prompt, type `Shell> fs0:`

Type: `FS0:\> load MyWizardDriver.efi`

Type: `drivers`

Observe the change in the string
that the driver returned

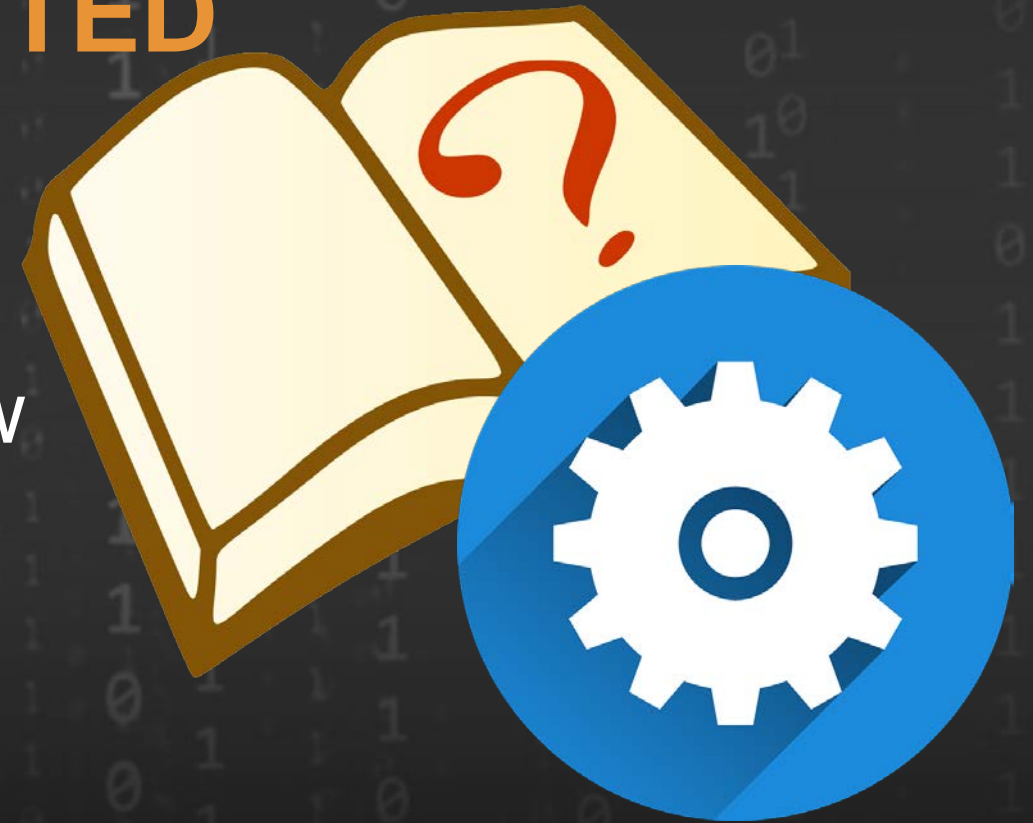
Exit QEMU

```
92 00000011 ? - - - - Usb Mass Storage Driver      UsbMassStorageDxe
93 00000010 B - - 1 1 QEMU Video Driver             QemuVideoDxe
94 00000010 ? - - - - Virtio GPU Driver             VirtioGpuDxe
A9 00000000 ? - - - - - UEFI Sample Driver         \MyWizardDriver.efi
FS0:\> _
```

LAB 4: PORTING THE SUPPORTED & START FUNCTIONS

The UEFI Driver Wizard produced a starting point for driver porting ... so now what?

In this lab, you'll port the “Supported” and “Start” functions for the UEFI driver





Lab 4: Porting Supported and Start

Review the Driver Binding Protocol



Supported()

Determines if a driver supports a controller



Start()

Starts a driver on a controller & Installs Protocols



Stop()

Stops a driver from managing a controller

Lab 4: The Supported() Port

The UEFI Driver Wizard produced a Supported() function but it only returns EFI_UNSUPPORTED

Supported Goals:

- Checks if the driver supports the device for the specified controller handle
- Associates the driver with the Serial I/O protocol
- Helps locate a protocol's specific GUID through UEFI Boot Services' function

Lab 4: Help from Robust Libraries

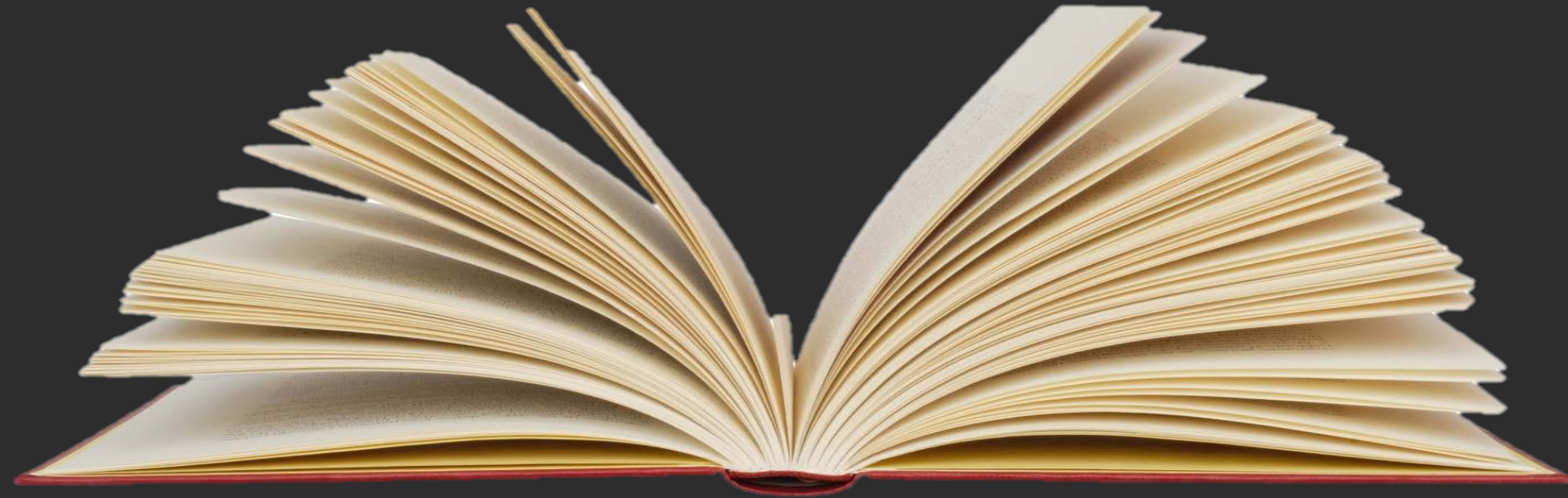
EDK II has libraries to help with porting UEFI Drivers



AllocateZeroPool() include - [MemoryAllocationLib.h]



SetMem16() include - [BaseMemoryLib.h]



Check the MdePkg with libraries help file (.chm format)

Lab 4: Update Supported

- Open `~/src/edk2-ws/edk2/MyWizardDriver/MyWizardDriver.c`
- Locate `MyWizardDriverDriverBindingSupported()`, the supported function for this driver and comment out the `"/"` in the line: `"return EFI_UNSUPPORTED; "`

```
EFI_STATUS
EFIAPI
MyWizardDriverDriverBindingSupported (
    IN EFI_DRIVER_BINDING_PROTOCOL *This,
    IN EFI_HANDLE                  ControllerHandle,
    IN EFI_DEVICE_PATH_PROTOCOL    *RemainingDevicePath OPTIONAL
)
{
    // return EFI_UNSUPPORTED;
}
```

- copy and past (next slide)

Lab 4: Update Supported Add Code

Copy & Paste the following code for the supported function

MyWizardDriverDriverBindingSupported():

```
EFI_STATUS Status;
EFI_SERIAL_IO_PROTOCOL *SerialIo;
Status = gBS->OpenProtocol (
    ControllerHandle,
    &gEfiSerialIoProtocolGuid,
    (VOID **) &SerialIo,
    This->DriverBindingHandle,
    ControllerHandle,
    EFI_OPEN_PROTOCOL_BY_DRIVER | EFI_OPEN_PROTOCOL_EXCLUSIVE
);

if (EFI_ERROR (Status)) {
    return Status; // Bail out if OpenProtocol returns an error
}

// We're here because OpenProtocol was a success, so clean up
gBS->CloseProtocol (
    ControllerHandle,
    &gEfiSerialIoProtocolGuid,
    This->DriverBindingHandle,
    ControllerHandle
);

return EFI_SUCCESS;
```

Lab 4: Notice UEFI Driver Wizard Includes

- Open `~/src/edk2-ws/edk2/MyWizardDriver/MyWizardDriver.h`
- Notice the following include statement is already added by the driver wizard:

```
// Produced Protocols
//
#include <Protocol/SerialIo.h>
```

- Review the Libraries section and see that UEFI Driver Wizard automatically includes library headers based on the form information. Also, other common library headers were included

```
// Libraries
//
#include <Library/UefiBootServicesTableLib.h>
#include <Library/MemoryAllocationLib.h>
#include <Library/BaseMemoryLib.h>
#include <Library/BaseLib.h>
#include <Library/UefiLib.h>
#include <Library/DevicePathLib.h>
#include <Library/DebugLib.h>
```

Lab 4: Update the Start()

- **Copy & Paste** the following in MyWizardDriver.c after the #include "MyWizardDriver.h" line:

```
#define DUMMY_SIZE 100*16 // Dummy buffer
CHAR16 *DummyBufferfromStart = NULL;
```

Locate MyWizardDriverDriverBindingStart(), the start function for this driver and comment out the "//" in the line "return EFI_UNSUPPORTED; "

```
EFI_STATUS
EFIAPI
MyWizardDriverDriverBindingStart (
    IN EFI_DRIVER_BINDING_PROTOCOL *This,
    IN EFI_HANDLE ControllerHandle,
    IN EFI_DEVICE_PATH_PROTOCOL *RemainingDevicePath OPTIONAL
)
{
    // return EFI_UNSUPPORTED;
}
```

Lab 4: Update Start Add Code

Copy & Paste the following code for the start function

MyWizardDriverDriverBindingStart():

```
if (DummyBufferfromStart == NULL) {      // was buffer already allocated?
    DummyBufferfromStart = (CHAR16*)AllocateZeroPool (DUMMY_SIZE * sizeof(CHAR16));
}

if (DummyBufferfromStart == NULL) {
    return EFI_OUT_OF_RESOURCES;          // Exit if the buffer isn't there
}

SetMem16 (DummyBufferfromStart, (DUMMY_SIZE * sizeof(CHAR16)), 0x0042); // Fill buffer

return EFI_SUCCESS;
```

- Notice the Library calls to `AllocateZeroPool()` and `SetMem16()`
- The `start()` function is where there would be calls to `"gBS-InstallMultipleProtocolInterfaces()"`

Lab 4: Debugging before Testing the Driver

UEFI drivers can use the EDK II debug library



DEBUG() include - [DebugLib.h]

DEBUG() Macro statements can show status progress interest points throughout the driver code

```

Developer Command Prompt for VS2015 - RunEmulator.bat
[MyWizardDriver] Not Supported
[MyWizardDriver] Not Supported
[MyWizardDriver] Not Supported
BlockSize : 512
LastBlock : FFFFFFFFFFFFFFFF
[MyWizardDriver] Not Supported
[MyWizardDriver] Not Supported
[MyWizardDriver] Not Supported
[MyWizardDriver] Not Supported
[MyWizardDriver] Not Supported
[MyWizardDriver] Not Supported
[MyWizardDriver] Supported SUCCESS
[MyWizardDriver] Buffer pointer 0x19818738018
Terminal - Mode 0, Column = 80, Row = 25
Terminal - Mode 1, Column = 80, Row = 50
Terminal - Mode 2, Column = 100, Row = 31
[2J][01;01H][=3h[2J][01;01HPROGRESS CODE: V01040001 I0
InstallProtocolInterface: 387477C1-69C7-11D2-8E39-00A0C969723B 19818739EC0
InstallProtocolInterface: DD9E7534-7762-4698-8C14-F58517A625AA 19818739FA8
InstallProtocolInterface: 387477C2-69C7-11D2-8E39-00A0C969723B 19818739ED8
InstallProtocolInterface: 09576E91-6D3F-11D2-8E39-00A0C969723B 19818958D98
[MyWizardDriver] Not Supported

```


Lab 4: Add Debug Statements Supported()

Copy & Paste the following DEBUG() macros for the supported function:

```
Status = gBS->OpenProtocol(
    ControllerHandle,
    &gEfiSerialIoProtocolGuid,
    (VOID **)&SerialIo,
    This->DriverBindingHandle,
    ControllerHandle,
    EFI_OPEN_PROTOCOL_BY_DRIVER | EFI_OPEN_PROTOCOL_EXCLUSIVE
);

if (EFI_ERROR(Status)) {
    DEBUG((EFI_D_INFO, "[MyWizardDriver] Not Supported \r\n"));
    return Status; // Bail out if OpenProtocol returns an error
}

// We're here because OpenProtocol was a success, so clean up
gBS->CloseProtocol(
    ControllerHandle,
    &gEfiSerialIoProtocolGuid,
    This->DriverBindingHandle,
    ControllerHandle
);
DEBUG((EFI_D_INFO, "[MyWizardDriver] Supported SUCCESS\r\n"));
return EFI_SUCCESS;
```

Lab 4: Add Debug Statements Start()

Copy & Paste the following DEBUG macro for the Start function just before the `return EFI_SUCCESS;` statement

```
DEBUG ((EFI_D_INFO, "\r\n***\r\n[MyWizardDriver] Buffer 0x%p\r\n", DummyBufferfromStart));  
return EFI_SUCCESS;
```

Note: This debug macro displays the memory address of the allocated buffer on the debug console

Save `~/src/edk2-ws/edk2/MyWizardDriver/MyWizardDriver.c`

Lab 4: Build and Test Driver

Build MyWizardDriver – Cd to ~/src/edk2-ws/edk2 dir

```
bash$ build
```

Copy MyWizardDriver.efi to hda-content

```
bash$ cd ~/run-ovmf/hda-content
```

```
bash$ cp ~/src/edk2-ws/Build/OvmfX64/DEBUG_GCC5/X64/MyWizardDriver.efi .
```

Test by Invoking Qemu

```
bash$ cd ~/run-ovmf
```

```
bash$ . RunQemu.sh
```

Lab 4: Build and Test Driver

Load the UEFI Driver from the shell

At the Shell prompt, type **Shell> fs0:**

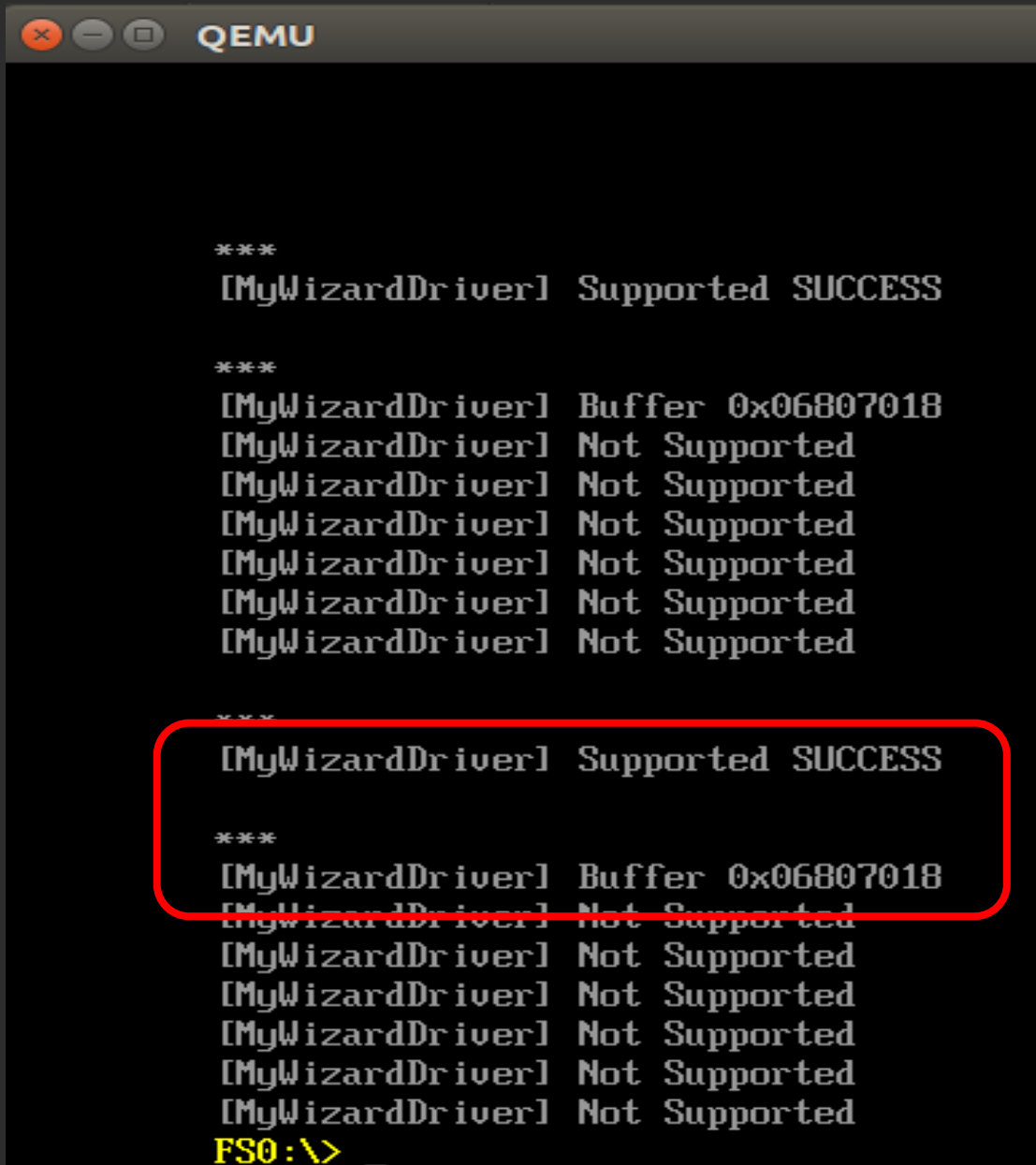
Type: **FS0:\> load MyWizardDriver.efi**

```
Shell> fs0:
FS0:\> load MyWizardDriver.efi
Image 'FS0:\MyWizardDriver.efi' loaded at 5E7F000 - Success
FS0:\> _
```

Lab 4: Build and Test Driver

- Check the QEMU debug console output.
- Notice Debug messages indicate the driver did not return `EFI_SUCCESS` from the "Supported()" function most of the time.
- See that the "Start()" function did get called and a Buffer was allocated.

Exit QEMU



```
***
[MyWizardDriver] Supported SUCCESS

***
[MyWizardDriver] Buffer 0x06807018
[MyWizardDriver] Not Supported
[MyWizardDriver] Not Supported
[MyWizardDriver] Not Supported
[MyWizardDriver] Not Supported
[MyWizardDriver] Not Supported
[MyWizardDriver] Not Supported

***
[MyWizardDriver] Supported SUCCESS

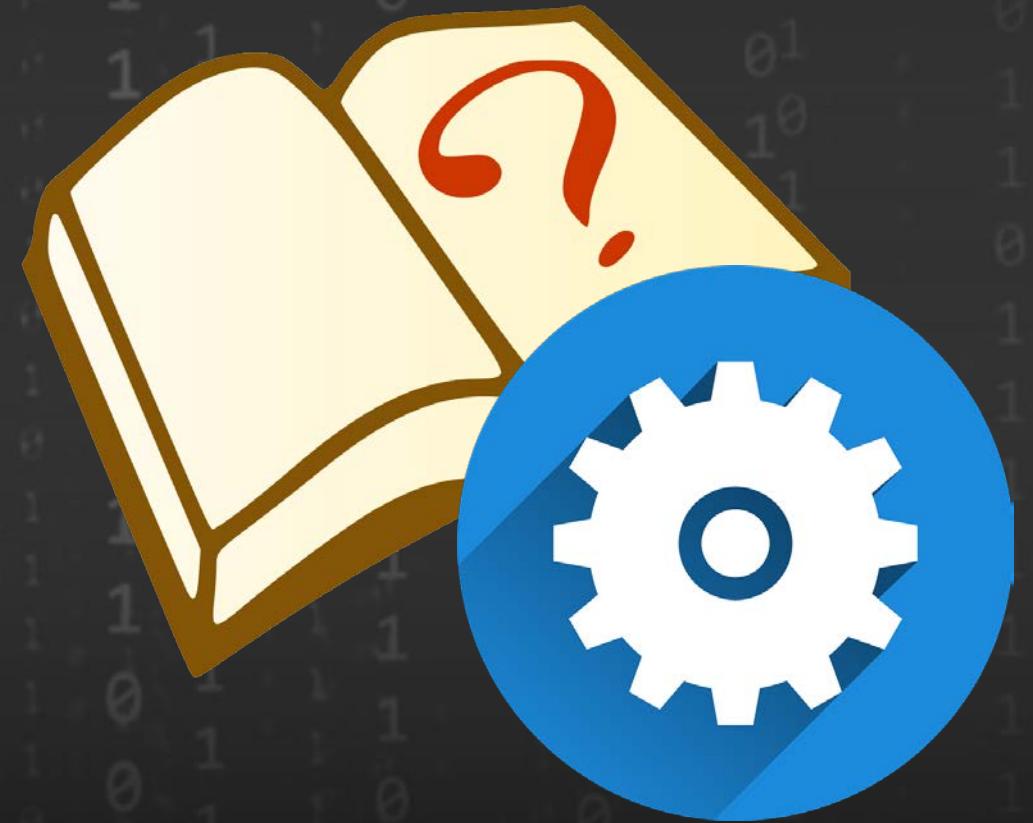
***
[MyWizardDriver] Buffer 0x06807018
[MyWizardDriver] Not Supported
[MyWizardDriver] Not Supported
[MyWizardDriver] Not Supported
[MyWizardDriver] Not Supported
[MyWizardDriver] Not Supported
[MyWizardDriver] Not Supported
FS0:\> _
```

The screenshot shows a QEMU window with a dark background and white text. The text represents debug output from a driver named 'MyWizardDriver'. It shows a sequence of 'Supported' and 'Not Supported' messages, along with a 'Buffer' allocation. A red rectangle highlights the second 'Supported SUCCESS' message and the subsequent 'Buffer' allocation message.

LAB 5: CREATE A NVRAM VARIABLE

In this lab you'll create a non-volatile UEFI variable (NVRAM), and set and get the variable to return a successful supported function

Use Runtime services to
"SetVariable()" and "GetVariable()"



Lab 5: Adding a NVRAM Variable Steps

1. Create .h file with new `typedef` definition and its own GUID
2. Include the new .h file in the driver's top .h file
3. In the `Start()` make a call to a new function to set/get the new NVRam Variable
4. Before `EntryPoint()` add the new function `CreateNVVariable()` to the driver.c file.

Lab 5: Create a new .h file

Create a new file in your editor called: "MyWizardDriverNVDataStruc.h"

Copy, Paste and then **Save** this file

```
#ifndef _MYWIZARDDRIVERNVDATASTRUC_H_
#define _MYWIZARDDRIVERNVDATASTRUC_H_
#include <Guid/HiiPlatformSetupFormset.h>
#include <Guid/HiiFormMapMethodGuid.h>

#define MYWIZARDDRIVER_VAR_GUID \
{ \
    0x363729f9, 0x35fc, 0x40a6, 0xaf, 0xc8, 0xe8, 0xf5, 0x49, 0x11, 0xf1, 0xd6 \
}

#pragma pack(1)
typedef struct {

    UINT16    MyWizardDriverStringData[20];
    UINT8     MyWizardDriverHexData;
    UINT8     MyWizardDriverBaseAddress;
    UINT8     MyWizardDriverChooseToEnable;

} MYWIZARDDRIVER_CONFIGURATION;

#pragma pack()
#endif
```

Lab 5: Update MyWizardDriver.c

Open `"~/src/edk2-ws/edk2/MyWizardDriver/MyWizardDriver.c"`

Copy & Paste the following 4 lines after the `#include "MyWizardDriver.h"` statement:

```
#include "MyWizardDriver.h"

EFI_GUID    mMyWizardDriverVarGuid = MYWIZARDDRIVER_VAR_GUID;

CHAR16      mVariableName[] = L"MWD_NVData"; // Use Shell "Dmpstore" to see
MYWIZARDDRIVER_CONFIGURATION mMyWizDrv_Conf_buffer;
MYWIZARDDRIVER_CONFIGURATION *mMyWizDrv_Conf = &mMyWizDrv_Conf_buffer; //use the pointer
```

Lab 5: Update MyWizardDriver.c

Locate "MyWizardDriverDriverBindingStart ()" function

Copy & Paste at the beginning of the start function to declare a local variable

```
EFI_STATUS Status; // Declare a local variable Status
```

Copy & Paste the 6 lines: 1) new call to "CreateNVVariable();" , 2-6) if statement with DEBUG just before the line "return EFI_SUPPORTED" as below:

```
Status = CreateNVVariable();
if (EFI_ERROR(Status)) {
    DEBUG((EFI_D_ERROR, "[MyWizardDriver] NV Variable already created \r\n"));
}
else {
    DEBUG((EFI_D_ERROR, "[MyWizardDriver] Created NV Variable in the Start \r\n"));
}

return EFI_SUCCESS;
```

Lab 5: Update MyWizardDriver.c

Copy & Paste the new function before the call to "MyWizardDriverDriverEntryPoint()"

```
EFI_STATUS
EFI_API
CreateNVVariable()
{
    EFI_STATUS      Status;
    UINTN           BufferSize;

    BufferSize = sizeof (MYWIZARDDRIVER_CONFIGURATION);
    Status = gRT->GetVariable(
        mVariableName,
        &mMyWizardDriverVarGuid,
        NULL,
        &BufferSize,
        mMyWizDrv_Conf
    );
    if (EFI_ERROR(Status)) { // Not defined yet so add it to the NV Variables.
        if (Status == EFI_NOT_FOUND) {
            Status = gRT->SetVariable(
                mVariableName,
                &mMyWizardDriverVarGuid,
                EFI_VARIABLE_NON_VOLATILE | EFI_VARIABLE_BOOTSERVICE_ACCESS,
                sizeof (MYWIZARDDRIVER_CONFIGURATION),
                mMyWizDrv_Conf // buffer is 000000 now for first time set
            );
            DEBUG((EFI_D_INFO, "[MyWizardDriver] Variable %s created in NVRam Var\r\n", mVariableName));
            return EFI_SUCCESS;
        }
    }
    // already defined once
    return EFI_UNSUPPORTED;
}
```

- Note: the `gRT->GetVariable` and `gRT->SetVariable` use Runtime services table
- The Runtime Services Table was not automatically included with the Driver Wizard

Lab 5: Update MyWizardDriver.h

Open "~/src/edk2/MyWizardDriver/MyWizardDriver.h"

Copy & Paste the following "#include" after the list of library include statements:

```
// Libraries
// . . .
#include <Library/UefiRuntimeServicesTableLib.h>
```

Copy & Paste the following "#include" after the list of protocol include statements:

```
// Produced Protocols
// . . .
#include "MyWizardDriverNVDataStruc.h"
```

Save "~/src/edk2-ws/edk2/MyWizardDriver/MyWizardDriver.h"

Save "~/src/edk2-ws/edk2/MyWizardDriver/MyWizardDriver.c"

Lab 5: Build and Test Driver

Build MyWizardDriver – Cd to ~/src/edk2 dir

```
bash$ build
```

Copy MyWizardDriver.efi to hda-content

```
bash$ cd ~/run-ovmf/hda-content
```

```
bash$ cp ~/src/edk2-ws/Build/OvmfX64/DEBUG_GCC5/X64/MyWizardDriver.efi .
```

Test by Invoking Qemu

```
bash$ cd ~/run-ovmf
```

```
bash$ . RunQemu.sh
```

Lab 5: Test Driver

Load the UEFI Driver from the shell

At the Shell prompt, type `Shell> fs0:`

Type: `FS0:\> load MyWizardDriver.efi`

Observe the Buffer address
returned by the debug statement

```
Shell> fs0:
FS0:\> load MyWizardDriver.efi
Image 'FS0:\MyWizardDriver.efi' loaded at 6801000 - Success
[MyWizardDriver] Supported SUCCESS with Faux Supported by NVRam Var

***
[MyWizardDriver] Buffer 0x06808018
```


Lab 5: Verify Driver

At the Shell prompt, type **FS0:\> mem 0x6808018**

Observe the Buffer is filled with the letter "B" or 0x0042

```
[MyWizardDriver] Buffer 0x06808018
```

```
FS0:\>
```

```
FS0:\> mem 0x6808018
```

```
Memory Address 0000000006808018 200 Bytes
```

```
06808018: 42 00 42 00 42 00 42 00-42 00 42 00 42 00 42 00 *B.B.B.B.B.B.B.B.*
06808028: 42 00 42 00 42 00 42 00-42 00 42 00 42 00 42 00 *B.B.B.B.B.B.B.B.*
06808038: 42 00 42 00 42 00 42 00-42 00 42 00 42 00 42 00 *B.B.B.B.B.B.B.B.*
06808048: 42 00 42 00 42 00 42 00-42 00 42 00 42 00 42 00 *B.B.B.B.B.B.B.B.*
06808058: 42 00 42 00 42 00 42 00-42 00 42 00 42 00 42 00 *B.B.B.B.B.B.B.B.*
06808068: 42 00 42 00 42 00 42 00-42 00 42 00 42 00 42 00 *B.B.B.B.B.B.B.B.*
```

Lab 5: Verify NVRAM Created by Driver

At the Shell prompt, type `FS0:\> dmpstore -all -b`

Observe now the NVRAM variable "MWD_NVData" was created and filled with 0x00s

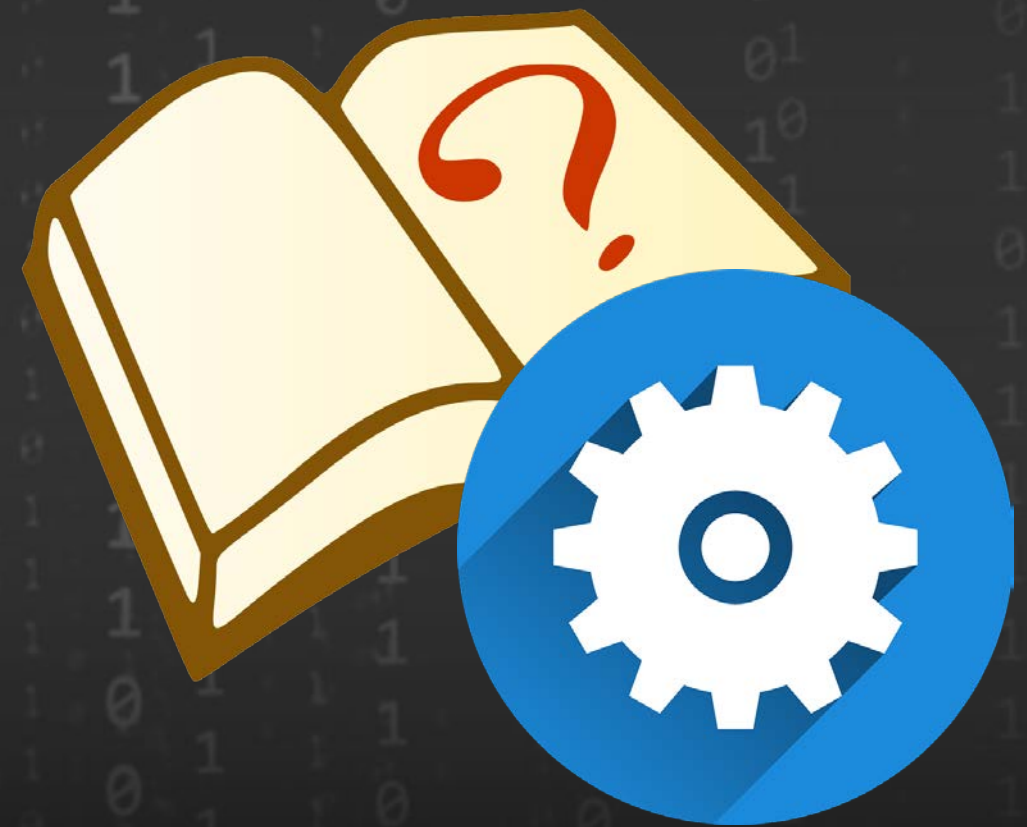
```
FS0:\> dmpstore -all -b
Variable NV+BS '363729F9-35FC-40A6-AFC8-EBF54911F1D6:MWD_NVData' DataSize = 0x2B

000000000: 00 00 00 00 00 00 00 00 00-00 00 00 00 00 00 00 00  *.....*
000000010: 00 00 00 00 00 00 00 00 00-00 00 00 00 00 00 00 00  *.....*
000000020: 00 00 00 00 00 00 00 00 00-00 00 00                    *.....*
```

Exit QEMU

LAB 6: PORT STOP AND UNLOAD

In this lab, you'll port the driver's "Unload" and "Stop" functions to free any resources the driver allocated when it was loaded and started.



Lab 6: Port the Unload function

Open `"~/src/edk2-ws/edk2/MyWizardDriver/MyWizardDriver.c"`

Locate `"MyWizardDriverUnload ()"` function

Copy & Paste the following `"if"` and `"DEBUG"` statements before the `"return EFI_SUCCESS;"` statement.

```
// Do any additional cleanup that is required for this driver
//
if (DummyBufferfromStart != NULL) {
    FreePool(DummyBufferfromStart);
    DEBUG((EFI_D_INFO, "[MyWizardDriver] Unload, clear buffer\r\n"));
}
DEBUG((EFI_D_INFO, "[MyWizardDriver] Unload success\r\n"));

return EFI_SUCCESS;
```

Lab 6: Port the Stop function

Locate "MyWizardDriverDriverBindingStop ()" function

Comment out with "//" before the "return EFI_UNSUPPORTED;" statement.

Copy & Paste the following "if" and "DEBUG" statements before the "return EFI_SUCCESS;" statement.

```
if (DummyBufferfromStart != NULL) {
    FreePool(DummyBufferfromStart);
    DEBUG((EFI_D_INFO, "[MyWizardDriver] Stop, clear buffer\r\n"));
}
DEBUG((EFI_D_INFO, "[MyWizardDriver] Stop, EFI_SUCCESS\r\n"));

return EFI_SUCCESS;
// return EFI_UNSUPPORTED;
}
```

Save & Close "MyWizardDriverDriver.c"

Lab 6: Build and Test Driver

Build MyWizardDriver – Cd to ~/src/edk2-ws/edk2 dir

```
bash$ build
```

Copy MyWizardDriver.efi to hda-content

```
bash$ cd ~/run-ovmf/hda-content
```

```
bash$ cp ~/src/edk2-ws/Build/OvmfX64/DEBUG_GCC5/X64/MyWizardDriver.efi .
```

Test by Invoking Qemu

```
bash$ cd ~/run-ovmf
```

```
bash$ . RunQemu.sh
```

Lab 6: Test Driver

Load the UEFI Driver from the shell

At the Shell prompt, type **Shell> fs0:**

Type: **FS0:\> load MyWizardDriver.efi**

Observe the Buffer address is at
0x06808018 as this slide example

```
Shell> fs0:
FS0:\> load MyWizardDriver.efi
Image 'FS0:\MyWizardDriver.efi' loaded at 6801000 - Success
[MyWizardDriver] Supported SUCCESS with Faux Supported by NVRam Var

***
[MyWizardDriver] Buffer 0x06808018
```

Lab 6: Verify Driver

At the Shell prompt, type **FS0:\> drivers**

Observe the handle is "A9" as this slide example

Type: **mem 0x06808018**

Observe the buffer was filled with the "0x0042"

```
92 00000011 ? - - - - Usb Mass Storage Driver      UsbMassSt
93 00000010 B - - 1 1 QEMU Video Driver             QemuVideo
94 00000010 ? - - - - Virtio GPU Driver             VirtioGpu
A9 00000000 ? - - - - UEFI Sample Driver            \MyWizard
FS0:\> _
```

```
[MyWizardDriver] Buffer 0x06808018
```

```
FS0:\>
```

```
FS0:\> mem 0x6808018
```

```
Memory Address 0000000006808018 200 Bytes
```

```
06808018: 42 00 42 00 42 00 42 00-42 00 42 00 42 00 42 00 *B.B.
06808028: 42 00 42 00 42 00 42 00-42 00 42 00 42 00 42 00 *B.B.
06808038: 42 00 42 00 42 00 42 00-42 00 42 00 42 00 42 00 *B.B.
06808048: 42 00 42 00 42 00 42 00-42 00 42 00 42 00 42 00 *B.B.
06808058: 42 00 42 00 42 00 42 00-42 00 42 00 42 00 42 00 *B.B.
06808068: 42 00 42 00 42 00 42 00-42 00 42 00 42 00 42 00 *B.B.
```


Lab 6: Verify Unload

At the Shell prompt, type `FS0:\> unload a9`

Observe the DEBUG messages from the Unload

```
Managing ... none
FS0:\> unload a9
Unload - Handle [6B1B798]. [y/n]?
y
Unload - Handle [6B1B798] Result Success.
FS0:\> _
```

```
[MyWizardDriver] Unload, clear buffer
[MyWizardDriver] Unload success
```

Lab 6: Verify Unload

At the Shell prompt, type `FS0:\> mem 0x06808018 -b`

Observe the buffer is now NOT filled

```
FS0:\> mem 6808018
Memory Address 0000000006808018 200 Bytes
06808018: AF AF AF AF AF AF AF AF-AF AF AF AF AF AF AF AF *.....*
06808028: AF AF AF AF AF AF AF AF-AF AF AF AF AF AF AF AF *.....*
06808038: AF AF AF AF AF AF AF AF-AF AF AF AF AF AF AF AF *.....*
06808048: AF AF AF AF AF AF AF AF-AF AF AF AF AF AF AF AF *.....*
```

Exit QEMU


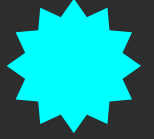

Adding strings and forms to setup (HII)

Publish & consume protocols

Hardware initialization

Refer to the UEFI Drivers Writer's Guide for more tips— [Pdf link](#)

Lesson Objective

-  Compile a UEFI driver template created from UEFI Driver Wizard
-  Test driver in QEMU using UEFI Shell 2.2
-  Port code into the template driver

Questions?



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ACKNOWLEDGEMENTS

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