tianocore

UEFI & EDK II TRAINING

How to Write a UEFI Driver- Port Lab with Linux

tianocore.org

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

tianocore

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

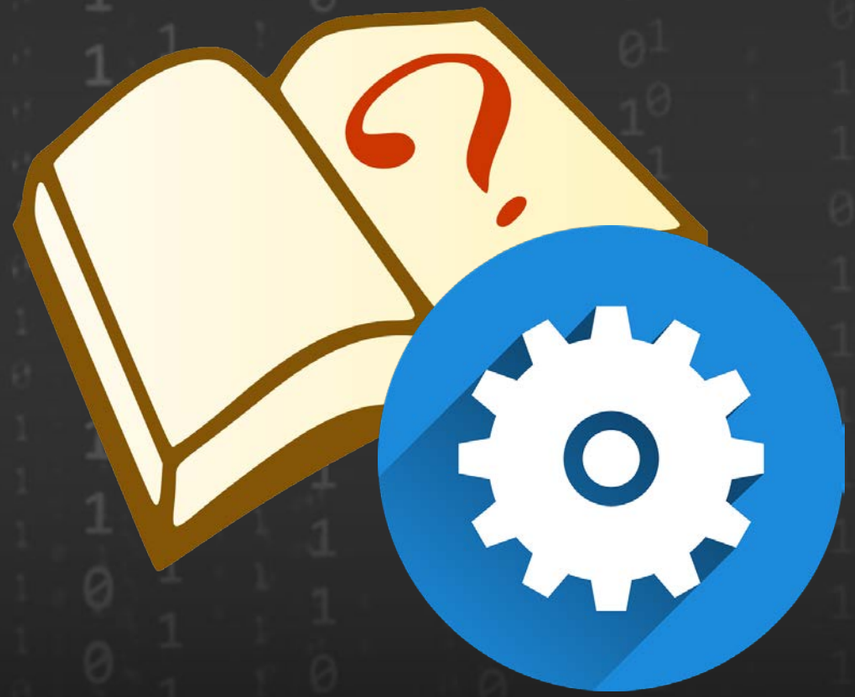
Note: Since this is a lab, to follow examples for copy & paste, use the following Markdown link LabGuide.md

tianocore

LAB 1: UEFI DRIVER TEMPLATE

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

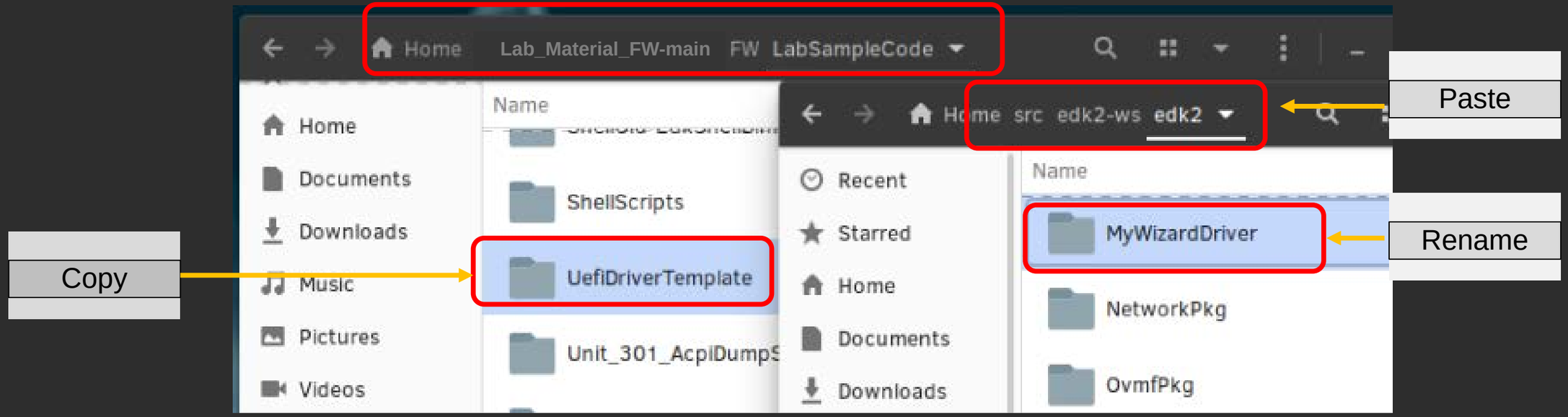
Skip if LAB 1 UEFI Driver Wizard completed successfully



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`

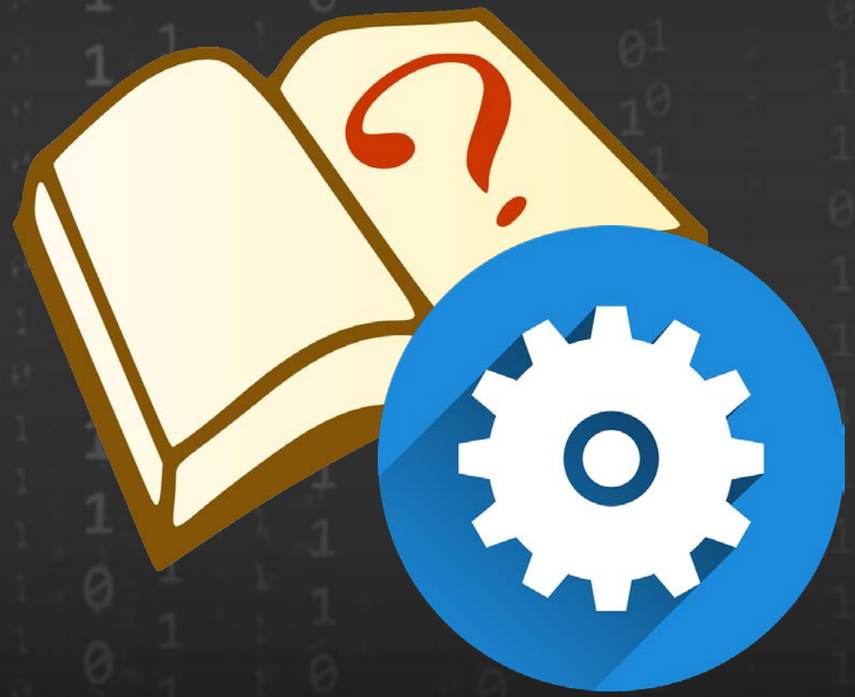


Review UEFI Driver Wizard Lab for protocols produced and which are being consumed

tianocore

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



tianocore

Compile a UEFI Driver

Two Ways to Compile a Driver	
Standalone	*In a Project*
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

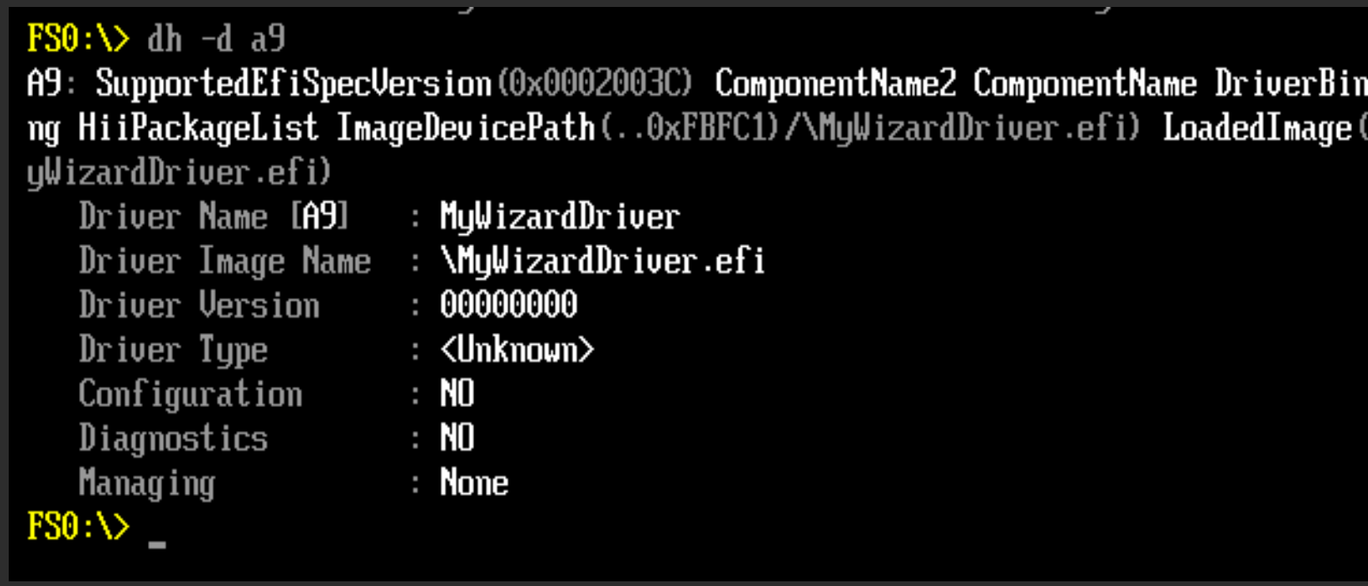
At the shell prompt Type: `drivers`

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)

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)



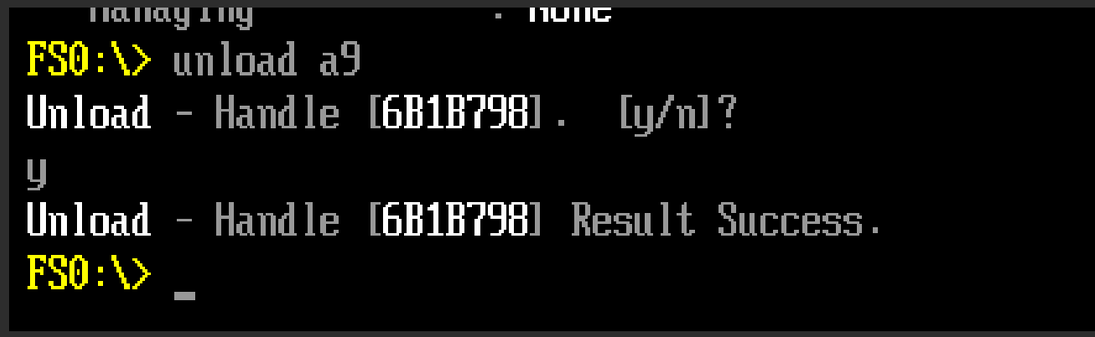
Lab 2: Test Driver

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

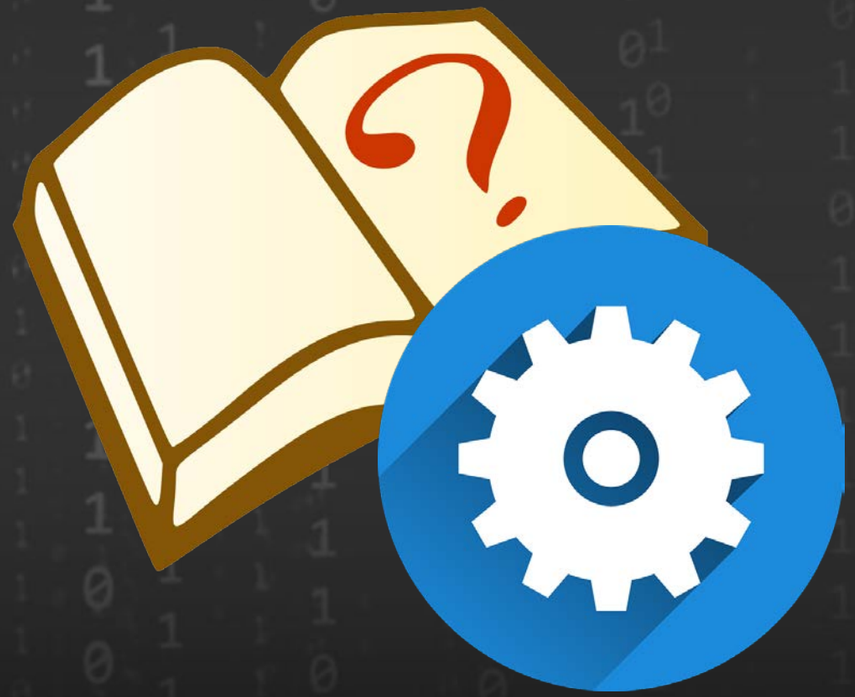
Exit QEMU



tianocore

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`

tianocore

Lab 3: Build and Test Driver

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

```
bash$ build
```

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
```

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

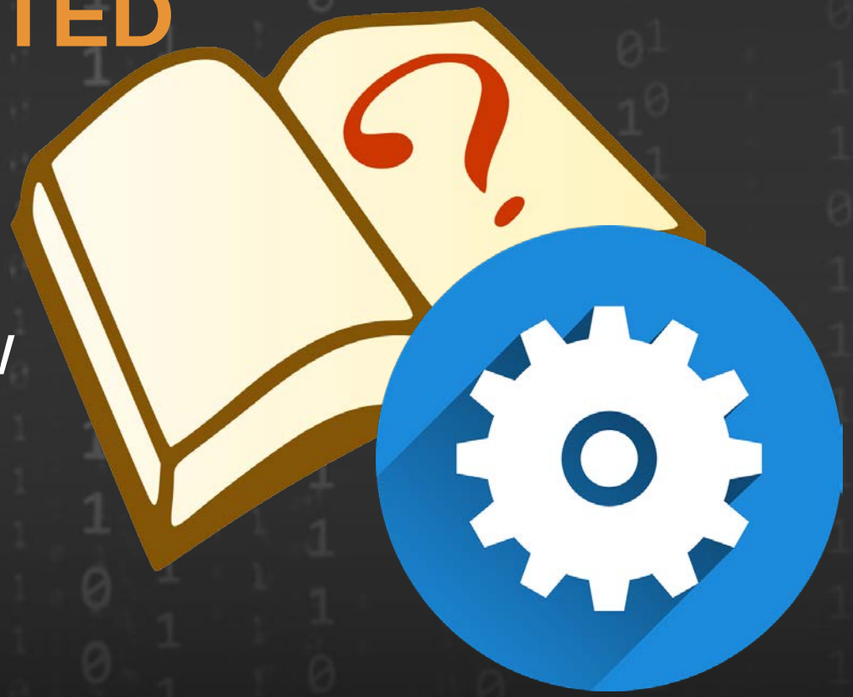
Exit QEMU

```
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`

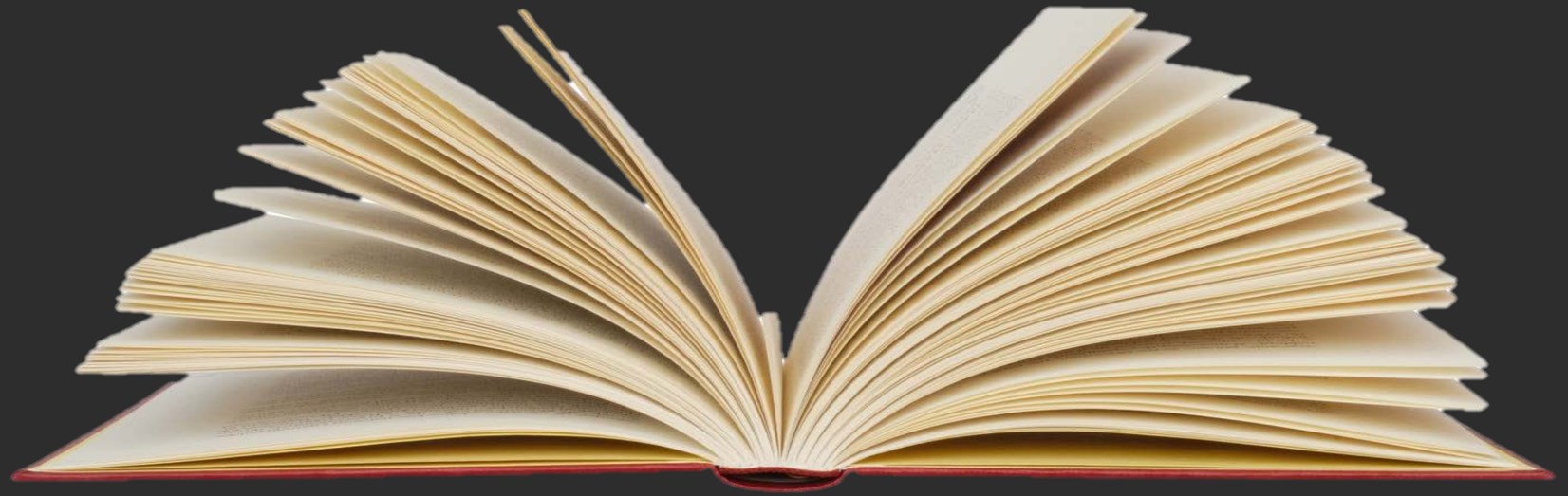
Supported Goals:

- 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;
```

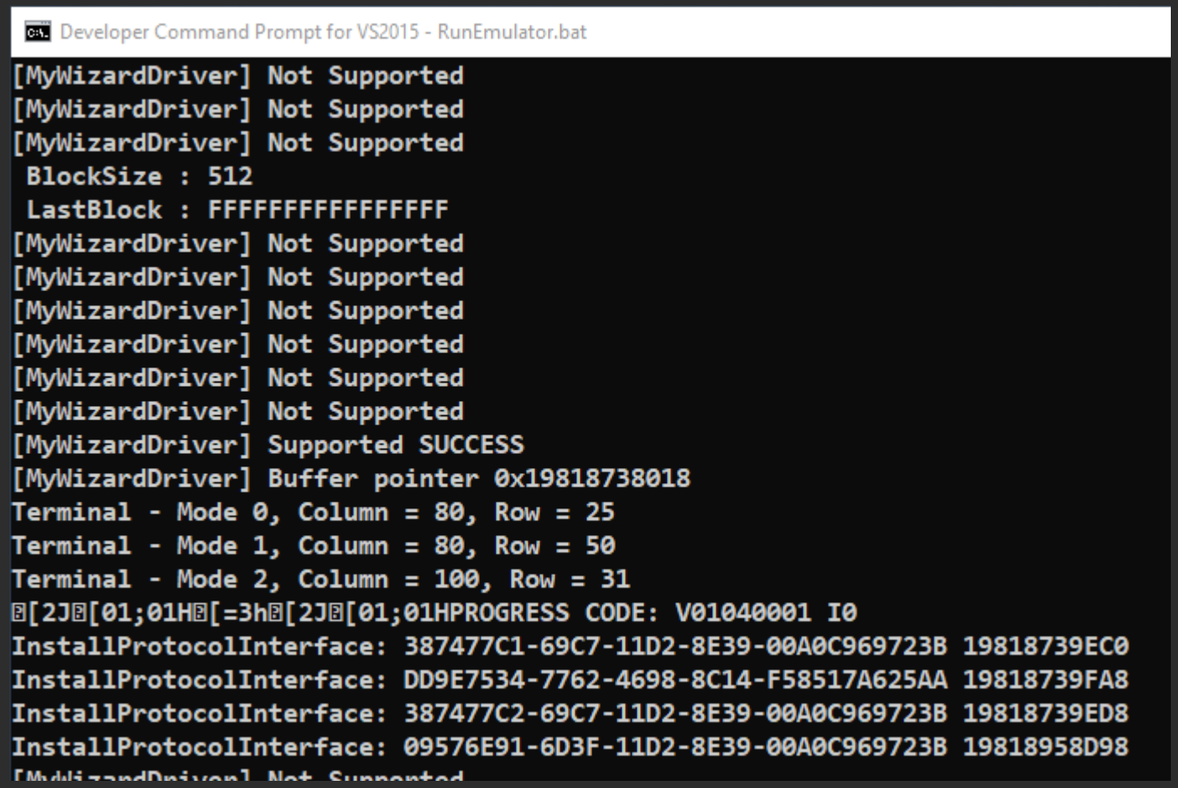
- Notice the Library calls to `AllocateZeroPool()` and `SetMem16()`
- The `Start()` function is where there would be calls to "`gBS-InstallMultipleProtocolInterfaces()`"

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



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`

tianocore

Lab 4: Build and Test Driver

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

```
bash$ build
```

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
```

Lab 4: Build and Test Driver

Load the UEFI Driver from the shell

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

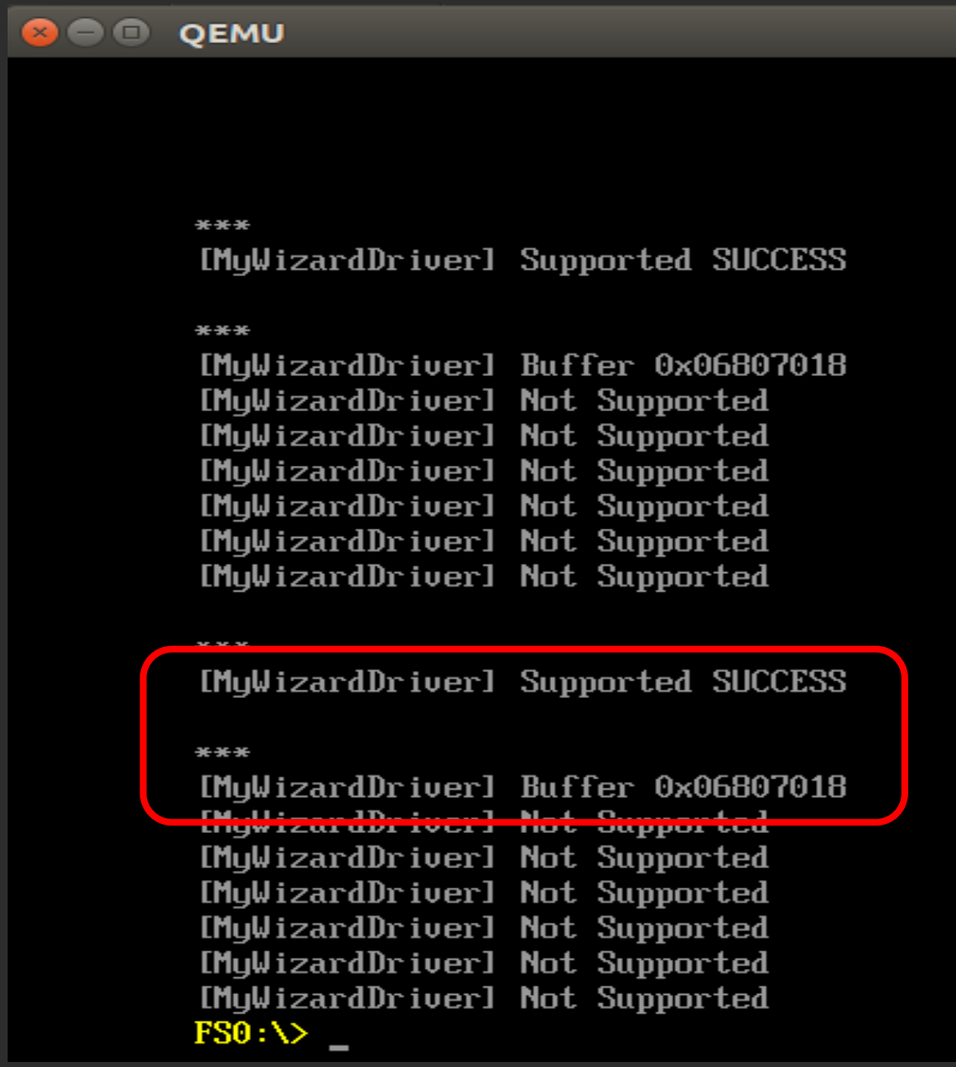
Type: `FS0:\> load MyWizardDriver.efi`

```
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

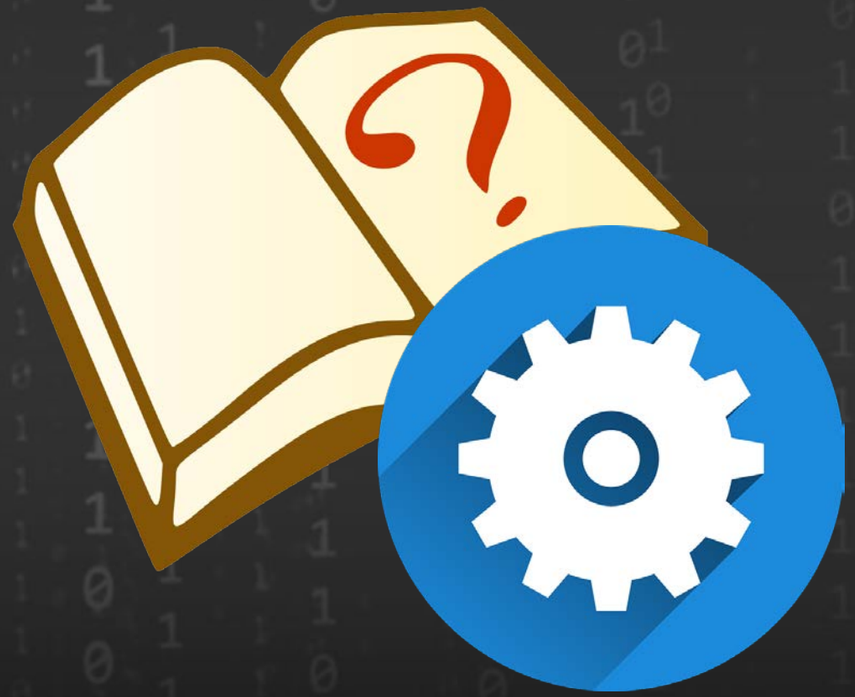


tianocore

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
EFIAPI
CreateNVVariable()
{
    EFI_STATUS                Status;
    UINTN                  BufferSize;

    BufferSize = sizeof (MYWIZARDDRIVER_CONFIGURATION);
    Status = gRT->GetVariable(
        mVariableName,
        &mMyWizardDriverVarGuid,
        NULL,
        &BufferSize,
        mMyWizDrv_Conf
        );
    if (EFI_ERROR(Status)) {  // Not definded 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"

tianocore

Lab 5: Build and Test Driver

Build MyWizardDriver – Cd to ~/src/edk2 dir

```
bash$ build
```

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
```

tianocore

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
```

tianocore

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

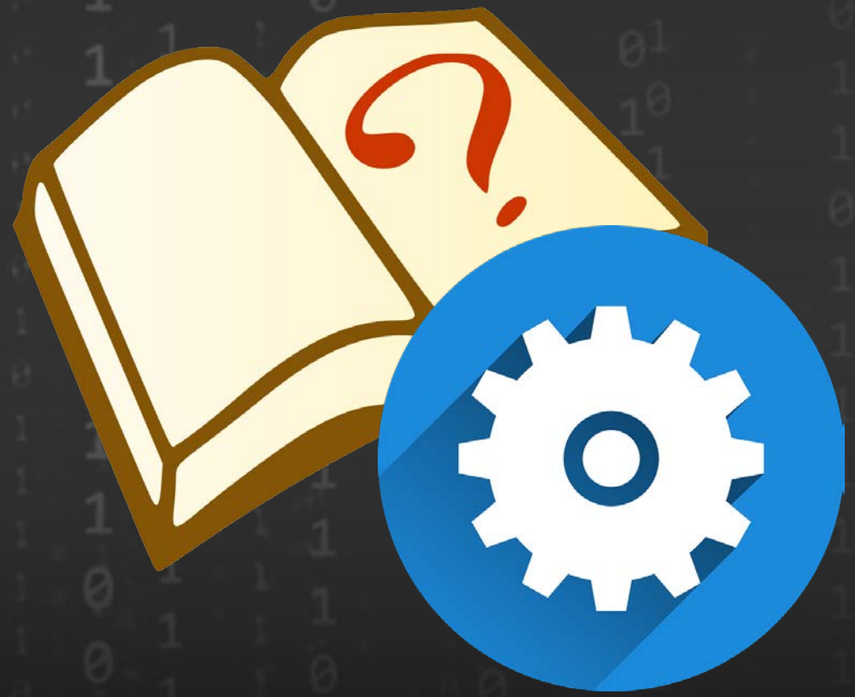
```
FS0:\> dmpstore -all -b
Variable NV+BS '363729F9-35FC-40A6-AFC8-E8F54911F1D6:MWD_NVData' DataSize = 0x2B

  00000000: 00 00 00 00 00 00 00 00-00 00 00 00 00 00 00 00  *................*
  00000010: 00 00 00 00 00 00 00 00-00 00 00 00 00 00 00 00  *................*
  00000020: 00 00 00 00 00 00 00 00-00 00 00                 *...........*
```

Exit QEMU

tianocore

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"

tianocore

Lab 6: Build and Test Driver

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

```
bash$ build
```

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
```

tianocore

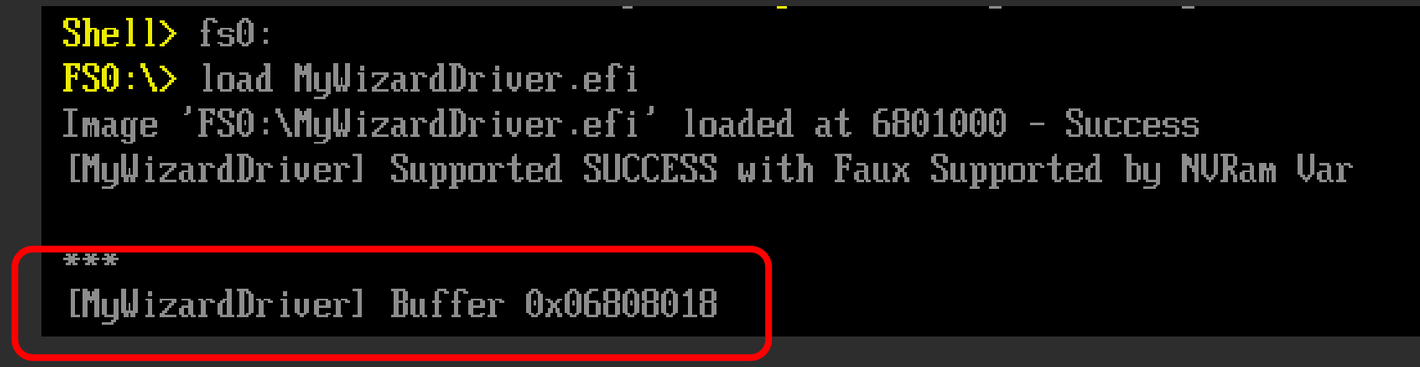
Lab 6: Test Driver

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



tianocore

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

```
FS0:\> unload a9
Unload - Handle [6B1B798].  [y/n]?
y
Unload - Handle [6B1B798] Result Success.
FS0:\> _
```

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

tianocore

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

tianocore

Additional Porting

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?

Return to Main Training Page

Return to Training Table of contents for next presentation link

tianocore

ACKNOWLEDGEMENTS