UEFI AND EDK II BASE TRAINING

Lab and Reference Guide

Assumes Linux Ubuntu 16.04

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LAB

UEFI DRIVER - ADDING HII

1. Adding Strings and Forms to Setup HII for User Configuration

In this lab, you'll learn how to use HII to add strings and forms to a firmware setup menu for user configuration. Once you've complete this lab, your end result will match Figure 1.

Figure 1 My Wizard Driver menu with strings and forms

a. Setup for Lab adding HII

Step	Action
1	Complete Lab Setup configure for building OvmfPkg with QEMU.
2	Start with LAB 6 solution from UEFI Driver Wizard Porting Lab and **create** a folder called **MyWizardDriver** in the ~/src/edk2 workspace
3	Now**, locate** and **open**: ~/SRC/LabSampleCode\MyWizardDriver

Step	Action
4	Copy the following Files to ~/SRC/edk2/MyWizardDriver ComponentName.c ComponentName DriverBinding.h HiiConfigAccess.c HiiConfigAccess.h MyWizardDriver.c MyWizardDriver.h MyWizardDriver.inf MyWizardDriver.uni MyWizardDriver.vfr MyWizardDriverNVDataStruc.h SimpleTextOutput.c SimpleTextOutput.h
5	**Open Terminal Command Prompt** `bash$ cd ~/src/edk2`

b. Edit Driver for adding HII

Step	Action
1	**Open** ~/src/edk2/MyWizardDriver
2	**Open** the following files for updating: 1) MyWizardDriverNVDataStruc.h 2) MyWizardDriver.vfr 3) MyWizardDriver.uni 4) MyWizardDriver.h 5) MyWizardDriver.c 6) MyWizardDriver.inf
3	**Update** the MyWizardDriverNVDataStruc.h file by copying and pasting the following GUID as shown below: This GUID is used to communicate to the HII Database and Browser Engine

```
#define MYWIZARDDRIVER_FORMSET_GUID \
  { \
0x5481db09, 0xe5f7, 0x4158, 0xa5, 0xc5, 0x2d, 0xbe, 0xa4,
0x95, 0x34, 0xff \
}
```

```
6
7  #define MYWIZARDDRIVER_VAR_GUID \
8    { \
9          0x363729f9, 0x35fc, 0x40a6, 0xaf, 0xc8, 0xe8, 0xf5, 0x49, 0x11, 0xf1, 0xd6 \
10   }
11
12 #define MYWIZARDDRIVER_FORMSET_GUID \
13   { \
14         0x5481db09, 0xe5f7, 0x4158, 0xa5, 0xc5, 0x2d, 0xbe, 0xa4, 0x95, 0x34, 0xff \
15  }
16
17
18 #pragma pack(1)
19 typedef struct {
20
21     UINT16  MyWizardDriverStringData[20];
22     UINT8   MyWizardDriverHexData;
23     UINT8   MyWizardDriverBaseAddress;
```

4	**Save** MyWizardDriverNVDataStruc.h

5

Update the **MyWizardDriver.vfr** file. **Delete** its contents and **replace** it with the following by copying and pasting:

You're adding a reference to the GUID and to the NVRAM storage where the configuration will be saved. In fact, you're replacing most of the original .vfr.

```
#include "MyWizardDriverNVDataStruc.h"
formset
  guid     = MYWIZARDDRIVER_FORMSET_GUID,
  title    = STRING_TOKEN(STR_SAMPLE_FORM_SET_TITLE),
  help     = STRING_TOKEN(STR_SAMPLE_FORM_SET_HELP),
  classguid = EFI_HII_PLATFORM_SETUP_FORMSET_GUID,

  //
  // Define a Buffer Storage (EFI_IFR_VARSTORE)
  //
    varstore MYWIZARDDRIVER_CONFIGURATION,  // This is the
data structure type
    //varid = CONFIGURATION_VARSTORE_ID,      // Optional
VarStore ID
    name  = MWD_IfrNVData,                  // Define
referenced name in vfr
    guid  = MYWIZARDDRIVER_FORMSET_GUID;    // GUID of this
buffer storage
```

6

Continue **adding** the remaining code to MyWizardDriver.vfr.

This is a Enable/ Disable question for the setup menu in the form of a Check box.

```
  form formid = 1, title =
STRING_TOKEN(STR_SAMPLE_FORM1_TITLE);
    subtitle text = STRING_TOKEN(STR_SUBTITLE_TEXT);

    subtitle text = STRING_TOKEN(STR_SUBTITLE_TEXT2);

  //
  // Define a checkbox to enable / disable the device
  //
      checkbox varid   =
MWD_IfrNVData.MyWizardDriverChooseToEnable,
                 prompt   =
STRING_TOKEN(STR_CHECK_BOX_PROMPT),
                 help     = STRING_TOKEN(STR_CHECK_BOX_HELP),
                 //
                 // CHECKBOX_DEFAULT indicate this checkbox is
marked with
           //   EFI_IFR_CHECKBOX_DEFAULT
                 //
                 flags    = CHECKBOX_DEFAULT ,
```

```
                    key       = 0,
                    default   = 1,
      endcheckbox;
   endform;

endformset;
```

7

Save MyWizardDriver.vfr

8

Now onto the MyWizardDriver.uni file. You'll add new strings to support the forms. **Delete** the file's content and **replace** it with the following by copying and pasting:

```
#langdef en "English"

#string STR_SAMPLE_FORM_SET_TITLE      #language en  "My Wizard Driver
Sample Formset"
#string STR_SAMPLE_FORM_SET_HELP       #language en  "Help for Sample
Formset"
#string STR_SAMPLE_FORM1_TITLE         #language en  "My Wizard Driver"

#string STR_SUBTITLE_TEXT              #language en "My Wizard Driver
Configuration"
#string STR_SUBTITLE_TEXT2             #language en "Device XYZ
Configuration"
#string STR_CHECK_BOX_PROMPT           #language en "Enable My XYZ
Device"


#string STR_CHECK_BOX_HELP             #language en "This is the help
message for the enable My XYZ device. Check this box to enable this
device."
```

9

Save MyWizardDriver.uni

10

Now update the MyWizardDriver.h file. **Add** the following HII libraries starting at approximately line 41 (as shown below) by copying and pasting:

By adding this code, now your driver will be consuming the HII Protocols and producing the CONFIG ACCESS PROTOCOL:

```
// Added for HII
#include <Protocol/HiiConfigRouting.h>
#include <Protocol/FormBrowser2.h>
#include <Protocol/HiiString.h>
#include <Library/DevicePathLib.h>
```

```
41
42  // Added for HII
43  #include <Protocol/HiiConfigRouting.h>
44  #include <Protocol/FormBrowser2.h>
45  #include <Protocol/HiiString.h>
46  #include <Library/DevicePathLib.h>
47
48  //
49  // Consumed Protocols
```

11	To add a data structure for HII routing and access, **add** the following code at approximately line 75 by copying and pasting after the "extern" statements:
11	

```
#define MYWIZARDDRIVER_DEV_SIGNATURE SIGNATURE_32 ('m', 'w',
'd', 'r')

// Need a Data structure for HII routing and accessing
typedef struct {
  UINT32                            Signature;

  EFI_HANDLE                        Handle;
  MYWIZARDDRIVER_CONFIGURATION     Configuration;

  EFI_HANDLE                        DriverHandle[2];
  EFI_HII_HANDLE                    HiiHandle[2];
  //
  // Consumed protocol
  //
  EFI_HII_DATABASE_PROTOCOL         *HiiDatabase;
  EFI_HII_STRING_PROTOCOL           *HiiString;
  EFI_HII_CONFIG_ROUTING_PROTOCOL   *HiiConfigRouting;
  EFI_FORM_BROWSER2_PROTOCOL        *FormBrowser2;

  //
  // Produced protocol
  //
  EFI_HII_CONFIG_ACCESS_PROTOCOL    ConfigAccess;

} MYWIZARDDRIVER_DEV;

#define MYWIZARDDRIVER_DEV_FROM_THIS(a)  CR (a,
MYWIZARDDRIVER_DEV, ConfigAccess,
MYWIZARDDRIVER_DEV_SIGNATURE)

#pragma pack(1)
///
/// HII specific Vendor Device Path definition.
///
typedef struct {
  VENDOR_DEVICE_PATH              VendorDevicePath;
  EFI_DEVICE_PATH_PROTOCOL        End;
} HII_VENDOR_DEVICE_PATH;


#pragma pack()
```

11	

```
73  extern EFI_HII_CONFIG_ACCESS_PROTOCOL  gMyWizardDriverHiiConfigAccess;
74
75  #define MYWIZARDDRIVER_DEV_SIGNATURE SIGNATURE_32 ('m', 'w', 'd', 'r')
76
77  // Need a Data structure for HII routing and accessing
78  typedef struct {
79    UINT32                          Signature;
80
81    EFI_HANDLE                      Handle;
82    MYWIZARDDRIVER_CONFIGURATION    Configuration;
83
84    EFI_HANDLE                      DriverHandle[2];
85    EFI_HII_HANDLE                  HiiHandle[2];
86    //
87    // Consumed protocol
88    //
89    EFI_HII_DATABASE_PROTOCOL       *HiiDatabase;
90    EFI_HII_STRING_PROTOCOL         *HiiString;
91    EFI_HII_CONFIG_ROUTING_PROTOCOL *HiiConfigRouting;
92    EFI_FORM_BROWSER2_PROTOCOL      *FormBrowser2;
93
94    //
95    // Produced protocol
96    //
97    EFI_HII_CONFIG_ACCESS_PROTOCOL  ConfigAccess;
98
99  } MYWIZARDDRIVER_DEV;
100
101 #define MYWIZARDDRIVER_DEV_FROM_THIS(a)  CR (a, MYWIZARDDRIVER_DEV, Config
102
103 #pragma pack(1)
104 ///
105 /// HII specific Vendor Device Path definition.
106 ///
107 typedef struct {
108   VENDOR_DEVICE_PATH            VendorDevicePath;
109   EFI_DEVICE_PATH_PROTOCOL      End;
110 } HII_VENDOR_DEVICE_PATH;
111
112 #pragma pack()
113 //
114 // Include files with function prototypes
```

12

Save MyWizardDriver.h

13

Now onto the MyWizardDriver.c file.
Add local definitions for the form GUID, variable name, and device path for HII at approximately line 13 after the #include "MyWizardDriver.h" by coping and pasting the following code.
In this step, you declare a local (to the module “m”) variable for the GUID we declared; the NVRAM variable name; driver handles; our configuration data; and the device path support.

13

```
//HII support
```

```
EFI_GUID   mMyWizardDriverFormSetGuid =
MYWIZARDDRIVER_FORMSET_GUID;

CHAR16     mIfrVariableName[] = L"MWD_IfrNVData";
EFI_HANDLE                     mDriverHandle[2] = {NULL,
NULL};
MYWIZARDDRIVER_DEV                 *PrivateData = NULL;

// HII support for Device Path
HII_VENDOR_DEVICE_PATH  mHiiVendorDevicePath = {
  {
    {
      HARDWARE_DEVICE_PATH,
      HW_VENDOR_DP,
      {
        (UINT8) (sizeof (VENDOR_DEVICE_PATH)),
        (UINT8) ((sizeof (VENDOR_DEVICE_PATH)) >> 8)
      }
    },
    MYWIZARDDRIVER_FORMSET_GUID
  },
  {
    END_DEVICE_PATH_TYPE,
    END_ENTIRE_DEVICE_PATH_SUBTYPE,
    {
      (UINT8) (END_DEVICE_PATH_LENGTH),
      (UINT8) ((END_DEVICE_PATH_LENGTH) >> 8)
    }
  }
};
```

14 **Locate** EFI_STATUS within the function `MyWizardDriverDriverEntryPoint` in the MyWizardDriver.c file (approx. Line 184) and **add** HII local definitions by copying and pasting (as shown below):

14

```
// HII Locals
EFI_HII_PACKAGE_LIST_HEADER     *PackageListHeader;
EFI_HII_DATABASE_PROTOCOL       *HiiDatabase;
EFI_HII_HANDLE                   HiiHandle[2];
EFI_STRING                       ConfigRequestHdr;
UINTN                            BufferSize;
```

14

```
178 {
179   EFI_STATUS  Status;
180
181   // HII Locals
182   EFI_HII_PACKAGE_LIST_HEADER     *PackageListHeader;
183   EFI_HII_DATABASE_PROTOCOL       *HiiDatabase;
184   EFI_HII_HANDLE                   HiiHandle[2];
185   EFI_STRING                       ConfigRequestHdr;
186   UINTN                            BufferSize;
187
188   Status = EFI_SUCCESS;
189
```

15	**Locate** the **ASSERT_EFI_ERROR (Status);** statement and the line: **// Retrieve HII Package List Header on ImageHandle** (approximately line 202). Now, **add** the following code to install the configuration access protocol (produced) by copying and pasting (as shown below) before the line:**// Retrieve HII Package List Header on ImageHandle**

15

```
//
//Now do HII Stuff
// Initialize the local variables.
  ConfigRequestHdr = NULL;

// Initialize driver private data
  PrivateData = AllocateZeroPool (sizeof
(MYWIZARDDRIVER_DEV));
  if (PrivateData == NULL) {
    return EFI_OUT_OF_RESOURCES;
  }

  PrivateData->Signature = MYWIZARDDRIVER_DEV_SIGNATURE;

  PrivateData->ConfigAccess.ExtractConfig =
MyWizardDriverHiiConfigAccessExtractConfig;
  PrivateData->ConfigAccess.RouteConfig =
MyWizardDriverHiiConfigAccessRouteConfig;
  PrivateData->ConfigAccess.Callback =
MyWizardDriverHiiConfigAccessCallback;

  //
  // Publish sample Fromset and config access
  //
  Status = gBS->InstallMultipleProtocolInterfaces (
                 &mDriverHandle[0],
                 &gEfiDevicePathProtocolGuid,
                 &mHiiVendorDevicePath,
                 &gEfiHiiConfigAccessProtocolGuid,
                 &PrivateData->ConfigAccess,
                 NULL
                 );
  ASSERT_EFI_ERROR (Status);

  PrivateData->DriverHandle[0] = mDriverHandle[0];
```

15

```
201   ASSERT_EFI_ERROR (Status);
202
203   //
204   //Now do HII Stuff
205   //
206
207   // Initialize the local variables.
208   ConfigRequestHdr = NULL;
209   //
210   // Initialize driver private data
211   //
212   PrivateData = AllocateZeroPool (sizeof (MYWIZARDDRIVER_DEV));
213   if (PrivateData == NULL) {
214     return EFI_OUT_OF_RESOURCES;
215   }
216
217   PrivateData->Signature = MYWIZARDDRIVER_DEV_SIGNATURE;
218
219   PrivateData->ConfigAccess.ExtractConfig = MyWizardDriverHiiConfigAccess
220   PrivateData->ConfigAccess.RouteConfig = MyWizardDriverHiiConfigAccessRc
221   PrivateData->ConfigAccess.Callback = MyWizardDriverHiiConfigAccessCallb
222
223
224   //
225   // Publish sample Fromset and config access
226   //
227   Status = gBS->InstallMultipleProtocolInterfaces (
228                   &mDriverHandle[0],
229                   &gEfiDevicePathProtocolGuid,
230                   &mHiiVendorDevicePath,
231                   &gEfiHiiConfigAccessProtocolGuid,
232                   &PrivateData->ConfigAccess,
233                   NULL
234                   );
235   ASSERT_EFI_ERROR (Status);
236
237   PrivateData->DriverHandle[0] = mDriverHandle[0];
238   //
239   // Retrieve HII Package List Header on ImageHandle
240   //
241   Status = gBS->OpenProtocol (
```

16

Next, add code to register a list of HII packages in the HII Database with the HII device path. This requires you to **replace** existing code (see below) by copying and pasting the new code at approx. line 265.

Find: `// Register list of HII packages in the HII Database` and replace

```
NULL,
&HiiHandle
```

The HII Browser will need to find your HII Package and it does this when the call is made to NewPackageList with the device path of your driver's HII packages. The mDriverHandle is your Driver's Device path. Use this in the call to NewPackageList instead of the NULL parameter used before.

16

Old Code

```
190                     );
191     if (!EFI_ERROR (Status)) {
192       //
193       // Register list of HII packages in the HII Database
194       //
195       Status = HiiDatabase->NewPackageList (
196                                 HiiDatabase,
197                                 PackageListHeader,
198                                 NULL,
199                                 &HiiHandle
200                                 );
201       ASSERT_EFI_ERROR (Status);
202     }
203   }
204   Status = EFI_SUCCESS;
205
206   //
```

16

```
mDriverHandle[0],
&HiiHandle[0]
```

16

New Code

```
257                     );
258     if (!EFI_ERROR (Status)) {
259       //
260       // Register list of HII packages in the HII Database
261       //
262       Status = HiiDatabase->NewPackageList (
263                                 HiiDatabase,
264                                 PackageListHeader,
265                                 mDriverHandle[0],
266                                 &HiiHandle[0]
267                                 );
268       ASSERT_EFI_ERROR (Status);
269     }
270   }
271   Status = EFI_SUCCESS;
```

17

Next, you'll **add** code to initialize the My Wizard Driver NVRAM variable by copying and pasting the following code **before** the `// Install Driver Supported EFI Version Protocol onto ImageHandle` comment (as shown below at approximately line 273):

17

```
  PrivateData->HiiHandle[0] = HiiHandle[0];

  BufferSize = sizeof (MYWIZARDDRIVER_CONFIGURATION);

  // IF driver is not part of the Platform then need to
get/set defaults for the NVRAM configuration that the driver
will use.
  Status = gRT->GetVariable (
            mIfrVariableName,
```

```
            &mMyWizardDriverFormSetGuid,
            NULL,
            &BufferSize,
            &PrivateData->Configuration
            );
  if (EFI_ERROR (Status)) {  // Not definded yet so add it to
the NV Variables.
         // zero out buffer
        ZeroMem (&PrivateData->Configuration, sizeof
(MYWIZARDDRIVER_CONFIGURATION));
        Status = gRT->SetVariable(
                  mIfrVariableName,
                  &mMyWizardDriverFormSetGuid,
                  EFI_VARIABLE_NON_VOLATILE |
EFI_VARIABLE_BOOTSERVICE_ACCESS,
                  sizeof (MYWIZARDDRIVER_CONFIGURATION),
                  &PrivateData->Configuration   //  buffer is
000000  now
                  );
  }
```

17

```
270   }
271   Status = EFI_SUCCESS;
272
273   PrivateData->HiiHandle[0] = HiiHandle[0];
274
275   BufferSize = sizeof (MYWIZARDDRIVER_CONFIGURATION);
276
277   // IF driver is not part of the Platform then need to get/set defaults for t
278   Status = gRT->GetVariable (
279             mIfrVariableName,
280             &mMyWizardDriverFormSetGuid,
281             NULL,
282             &BufferSize,
283             &PrivateData->Configuration
284             );
285   if (EFI_ERROR (Status)) {  // Not definded yet so add it to the NV Variables
286             // zero out buffer
287         ZeroMem (&PrivateData->Configuration, sizeof (MYWIZARDDRIVER_CONFIGURA
288         Status = gRT->SetVariable(
289                   mIfrVariableName,
290                   &mMyWizardDriverFormSetGuid,
291                   EFI_VARIABLE_NON_VOLATILE | EFI_VARIABLE_BOOTSERVICE_ACCESS,
292                   sizeof (MYWIZARDDRIVER_CONFIGURATION),
293                   &PrivateData->Configuration   //  buffer is 000000  now
294                   );
295   }
296   //
297   // Install Driver Supported EFI Version Protocol onto ImageHandle
```

18

Save MyWizardDriver.c

19

Now onto the final file, MyWizardDriver.inf. **Add** the following protocols in the [protocols] section that are being used by copying and pasting (as shown below):

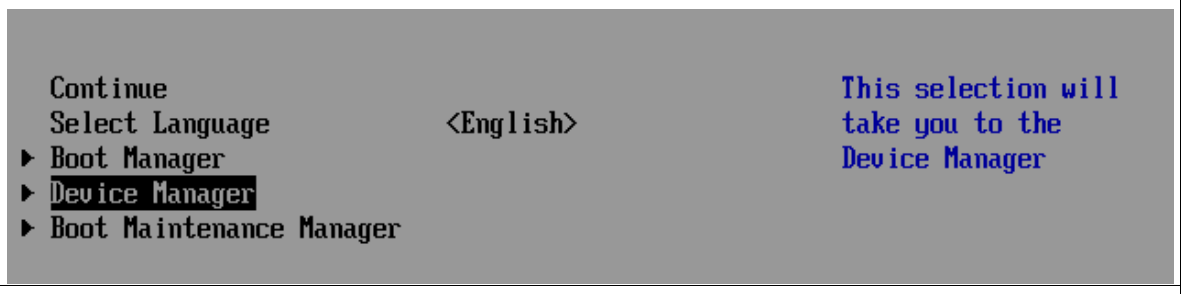
19	`gEfiHiiStringProtocolGuid ## CONSUMES`
	`gEfiHiiConfigRoutingProtocolGuid ## CONSUMES`
	`gEfiFormBrowser2ProtocolGuid ## CONSUMES`
	`gEfiHiiDatabaseProtocolGuid ## CONSUMES`

19	`55 gEfiComponentNameProtocolGuid`
	`56 gEfiHiiConfigAccessProtocolGuid`
	`57 gEfiSimpleTextOutProtocolGuid`
	`58`
	`59`
	`60 gEfiHiiStringProtocolGuid`
	`61 gEfiHiiConfigRoutingProtocolGuid`
	`62 gEfiFormBrowser2ProtocolGuid`
	`63 gEfiHiiDatabaseProtocolGuid`
	`64`

20	**Save** the MyWizardDriver.inf file. All the files should be saved at this point.
21	**Add** MyWizardDriver.inf to the OvmnPkgX64.dsc (See Lab 2 UEFI Driver Porting Lab)
22	In the Terminal Command Prompt (Cntl-Alt-T), **`bash$ cd ~/src/edk2`**
23	**`bash$ build`**
24	**Copy MyWizardDriver.efi to hda-contents** **`bash$ cd ~/run-ovmf/hda-contents`** **`bash$ cp ~/src/edk2/Build/OvmfX64/DEBUG_GCC5/X64/MyWizardDriver.efi .`**
25	**Invoke Qemu** **`bash$ cd ~/run-ovmf`** **`bash$ . RunQemu.sh`**
26	**Load the UEFI Driver from the shell** At the Shell 2.0 prompt, **type `fs0:`**
27	Type **`load MyWizardDriver.efi`**

28	`FS0:\> load MyWizardDriver.efi`
	`Image 'FS0:\MyWizardDriver.efi' loaded at 5EB9000 - Success`
	`FS0:\> exit_`
	
	Type exit

29	**Press** "Enter"
30	Now at the setup front page menu, **select** "Device Manager"



31

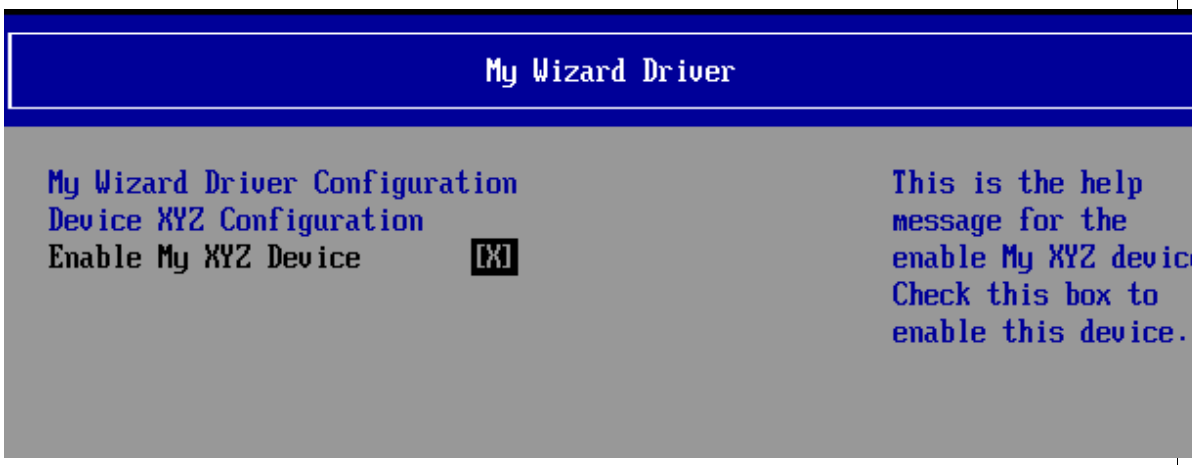
Press "Enter"

32

Inside the Device Manager menu **press** the down to "My Wizard Driver Sample Formset"

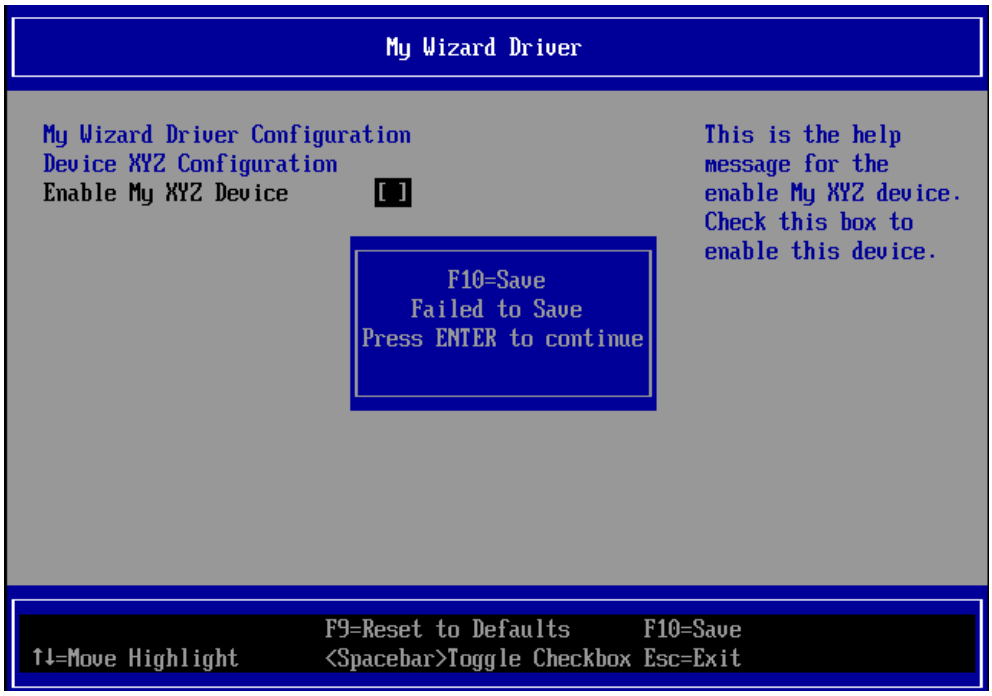
Press "Enter".

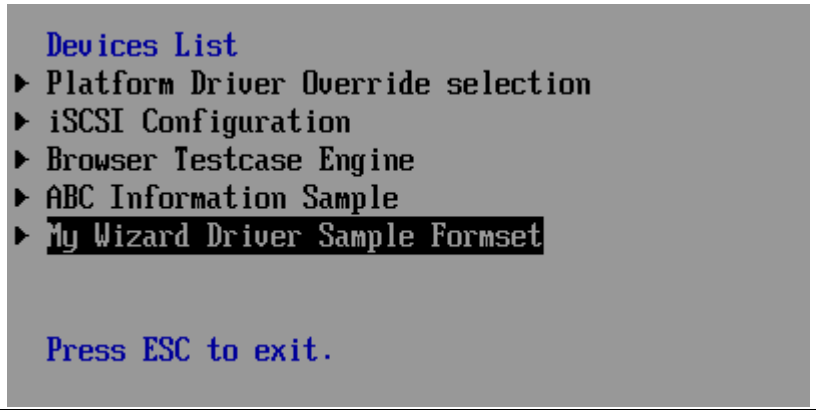
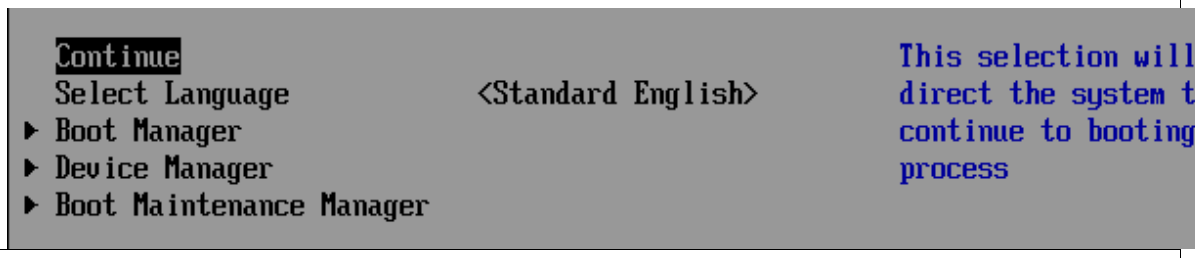
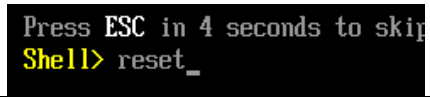
33



Note: Notice that your form is now displayed with a choice to enable your device. Also notice the titles and help strings that are in the .UNI file you edited.

At this point since the HII configuration routing functions are not functional the values (Enable/ Disable) will not be saved to NVRAM. The next lab will update the HII Extract,

	Route, and call back functions for the HII configuration routing protocol your driver will produce.
34	**Press** the space bar to Enable and Disable the “Enable My XYZ Device”
35	**Press** F10 to attempt to save   ***Note***: You’re not able to save the data changes at this point.
36	**Press** “Enter”
37	**Press** “Escape”, and then “Y” to exit
38	To Exit the “Device Manager” Page: Press “Escape”

	
39	**Press** Up Arrow to "Continue" 
40	**Press** "Enter"
41	At the Shell prompt **type** Reset 
42	**Exit QEMU**

You've completed the first lab and added strings and forms to setup HII for user configuration. However, **the data is not saved to NVRAM**. In the next lab, you'll learn how to update HII to save data to NVRAM.

For any build issues copy the solution files from ~/FW/LabSolutions/LessonE.1

2. Updating HII to Save Data Settings

In this lab, you'll learn how to modify and update your driver's HII code to save the users settings into NVRAM. The UEFI Driver Wizard created the protocols for your driver to update and interface with the HII browser engine and database. The HII configuration access Protocol functions for MyWizardDriver are in the file ~/src/edk2/MyWizardDriver/HiiConfigAccess.c. This next lab will install these protocols and update them to save the user data from the HII menus into NVRAM.

Step	Action
1	**Update** the MyWizardDriver.c file Your driver will need to keep track of the consumed protocols in it's own data structure so it will need to declare local pointers to these and then store them in its own private context data structure.
2	**Add** the following local variable declarations in the function `MyWizardDriverDriverEntryPoint` Entry Point (as shown below Approx. line 185):

```
EFI_HII_STRING_PROTOCOL          *HiiString;
EFI_FORM_BROWSER2_PROTOCOL       *FormBrowser2;
EFI_HII_CONFIG_ROUTING_PROTOCOL  *HiiConfigRouting;
```

```
179   EFI_STATUS  Status;
180
181   // HII Locals
182   EFI_HII_PACKAGE_LIST_HEADER     *PackageListHeader;
183   EFI_HII_DATABASE_PROTOCOL       *HiiDatabase;
184   EFI_HII_HANDLE                   HiiHandle[2];
185   EFI_HII_STRING_PROTOCOL         *HiiString;
186   EFI_FORM_BROWSER2_PROTOCOL      *FormBrowser2;
187   EFI_HII_CONFIG_ROUTING_PROTOCOL *HiiConfigRouting;
188   EFI_STRING                       ConfigRequestHdr;
189   UINTN                            BufferSize;
190
191   Status = EFI_SUCCESS;
192
```

3	**Add** the following code to locate and store consumed protocols **before** the `// Publish sample Fromset and config access` comment (as shown below Approx. line 227): The reason is to Locate the Hii Database, Hii String, Hii Form browser and config routing protocols and store their pointers into the Private context data structure for your driver to access.

Step	Action

	``
	  //
	  // Locate Hii Database protocol
	  //
	  Status = gBS->LocateProtocol (&gEfiHiiDatabaseProtocolGuid, NULL, (VOID **) &HiiDatabase);
	  if (EFI_ERROR (Status)) {
	  return Status;
	  }
	  PrivateData->HiiDatabase = HiiDatabase;
	
	  //
	  // Locate HiiString protocol
	  //
	  Status = gBS->LocateProtocol (&gEfiHiiStringProtocolGuid, NULL, (VOID **) &HiiString);
	  if (EFI_ERROR (Status)) {
	  return Status;
	  }
	  PrivateData->HiiString = HiiString;
	
	  //
	  // Locate Formbrowser2 protocol
	  //
	  Status = gBS->LocateProtocol (&gEfiFormBrowser2ProtocolGuid, NULL, (VOID **) &FormBrowser2);
	  if (EFI_ERROR (Status)) {
	  return Status;
	  }
	  PrivateData->FormBrowser2 = FormBrowser2;
	
	  //
	  // Locate ConfigRouting protocol
	  //
	  Status = gBS->LocateProtocol (&gEfiHiiConfigRoutingProtocolGuid, NULL, (VOID **)
	&HiiConfigRouting);
	  if (EFI_ERROR (Status)) {
	  return Status;
	  }
	  PrivateData->HiiConfigRouting = HiiConfigRouting;
	``

Step	Action

```
225
226
227   //
228   // Locate Hii Database protocol
229   //
230   Status = gBS->LocateProtocol (&gEfiHiiDatabaseProtocolGuid, NULL
231   if (EFI_ERROR (Status)) {
232     return Status;
233   }
234   PrivateData->HiiDatabase = HiiDatabase;
235
236   //
237   // Locate HiiString protocol
238   //
239   Status = gBS->LocateProtocol (&gEfiHiiStringProtocolGuid, NULL,
240   if (EFI_ERROR (Status)) {
241     return Status;
242   }
243   PrivateData->HiiString = HiiString;
244
245   //
246   // Locate Formbrowser2 protocol
247   //
248   Status = gBS->LocateProtocol (&gEfiFormBrowser2ProtocolGuid, NU
249   if (EFI_ERROR (Status)) {
250     return Status;
251   }
252   PrivateData->FormBrowser2 = FormBrowser2;
253
254   //
255   // Locate ConfigRouting protocol
256   //
257   Status = gBS->LocateProtocol (&gEfiHiiConfigRoutingProtocolGuid
258   if (EFI_ERROR (Status)) {
259     return Status;
260   }
261   PrivateData->HiiConfigRouting = HiiConfigRouting;
262
263
264   //
265   // Publish sample Fromset and config access
266   //
267   Status = gBS->InstallMultipleProtocolInterfaces (
```

Step	Action

4	Since the Hii Database Protocol was located earlier in the code with the previous code insertion and is no longer necessary, **comment out** the old `OpenProtocol` code with the "//" (approx. lines 289-298, as shown below) and **add the comment** // Done above
	Make sure not to comment out the second " `if (!EFI_ERROR (Status)) {`"
	
	`281 Status = gBS->OpenProtocol (`
	`282 ImageHandle,`
	`283 &gEfiHiiPackageListProtocolGuid,`
	`284 (VOID **)&PackageListHeader,`
	`285 ImageHandle,`
	`286 NULL,`
	`287 EFI_OPEN_PROTOCOL_GET_PROTOCOL`
	`288 );`
	`289 // Done above`
	`290 // if (!EFI_ERROR (Status)) {`
	`291 //  //`
	`292 //  // Retrieve the pointer to the UEFI HII Database Protocol`
	`293 //  //`
	`294 //  Status = gBS->LocateProtocol (`
	`295 //  &gEfiHiiDatabaseProtocolGuid,`
	`296 //  NULL,`
	`297 //  (VOID **)&HiiDatabase`
	`298 //  );`
	`299  if (!EFI_ERROR (Status)) {`
	
	Note: The earlier `LocateProtocol` code already found the pointer to the Hii Database protocol and stored it to the local pointer variable `HiiDatabase`.
	When we added the driver-consumed protocols, we searched via `LocateProtocol` for the Hii Database pointer function. Since we did it above we're now commenting out this code.

Step	Action
5	**Comment out** the **matching "}" with "//"** to the if statement (as shown below at approx. line 310): 299 if (!EFI_ERROR (Status)) { 300 // 301 // Register list of HII packages in the HII Database 302 // 303 Status = HiiDatabase->NewPackageList (304 HiiDatabase, 305 PackageListHeader, 306 mDriverHandle[0], 307 &HiiHandle[0] 308); 309 ASSERT_EFI_ERROR (Status); 310 // } 311 } 312 Status = EFI_SUCCESS; 313
6	**Save** MyWizardDriver.c
7	**Open** ~/src/edk2/MyWizardDriver/HiiConfigAccess.c**.** The Driver Wizard only made dummy functions for the extract, route and callback functions. In order to save the Data passed into the forms from the Hii Browser engine, you will need to port these functions to be functional.

8	**Add** the following extern statements for the form GUID and the NVRam variable (as shown below) these are global to the driver module only hence the beginning lower case "m" is the standard for a global for a module :
	
	`extern EFI_GUID mMyWizardDriverFormSetGuid;`
	`extern CHAR16 mIfrVariableName[];`
	
	12 #include "MyWizardDriver.h"
	13
	14 extern EFI_GUID mMyWizardDriverFormSetGuid;
	15 extern CHAR16 mIfrVariableName[];
	16
	17
	18 ///
	19 /// HII Config Access Protocol instance

9	**Locate** `MyWizardDriverHiiConfigAccessExtractConfig` and **replace** line 108, **"`return EFI_NOT_FOUND`"**, with the following code spread over **two** pages:

Step	Action

FROM:

```
EFI_STATUS
EFIAPI
MyWizardDriverHiiConfigAccessExtractConfig (
  IN CONST  EFI_HII_CONFIG_ACCESS_PROTOCOL  *This,
  IN CONST  EFI_STRING                      Request,
  OUT       EFI_STRING                      *Progress,
  OUT       EFI_STRING                      *Results
  )
{
  return EFI_NOT_FOUND;
}

/**
```

TO:

```
EFI_STATUS
EFIAPI
MyWizardDriverHiiConfigAccessExtractConfig (
  IN CONST  EFI_HII_CONFIG_ACCESS_PROTOCOL  *This,
  IN CONST  EFI_STRING                      Request,
  OUT       EFI_STRING                      *Progress,
  OUT       EFI_STRING                      *Results
  )
{
  EFI_STATUS                      Status;
  UINTN                           BufferSize;
  MYWIZARDDRIVER_DEV                  *PrivateData;
  EFI_HII_CONFIG_ROUTING_PROTOCOL *HiiConfigRouting;
```

```
EFI_STATUS                      Status;
UINTN                           BufferSize;
MYWIZARDDRIVER_DEV                  *PrivateData;
EFI_HII_CONFIG_ROUTING_PROTOCOL *HiiConfigRouting;
EFI_STRING                      ConfigRequest;
EFI_STRING                      ConfigRequestHdr;
UINTN                           Size;
BOOLEAN                         AllocatedRequest;
if (Progress == NULL || Results == NULL) {
  return EFI_INVALID_PARAMETER;
}
//
// Initialize the local variables.
//
ConfigRequestHdr  = NULL;
ConfigRequest     = NULL;
Size              = 0;
*Progress         = Request;
AllocatedRequest  = FALSE;
PrivateData = MYWIZARDDRIVER_DEV_FROM_THIS (This);
HiiConfigRouting = PrivateData->HiiConfigRouting;
//
// Get Buffer Storage data from EFI variable.
// Try to get the current setting from variable.
//
BufferSize = sizeof (MYWIZARDDRIVER_CONFIGURATION);
Status = gRT->GetVariable (
          mIfrVariableName,
          &mMyWizardDriverFormSetGuid,
          NULL,
          &BufferSize,
          &PrivateData->Configuration

    );
```

Step	Action

	``
	if (EFI_ERROR (Status)) {
	  return EFI_NOT_FOUND;
	}
	  if (Request == NULL) {
	  DEBUG ((DEBUG_INFO, "\n:: Inside of Extract Config and Request ==
	Null "));
	  } else {
	  ConfigRequest = Request;
	  }
	  //
	  // Convert buffer data to <ConfigResp> by helper function BlockToConfig()
	  //
	  Status = HiiConfigRouting->BlockToConfig (
	  HiiConfigRouting,
	  ConfigRequest,
	  (UINT8 *) &PrivateData->Configuration,
	  BufferSize,
	  Results,
	  Progress
	  );
	  //
	  // Free the allocated config request string.
	  //
	  if (AllocatedRequest) {
	  FreePool (ConfigRequest);
	  }
	  //
	  // Set Progress string to the original request string.
	  //
	  if (Request == NULL) {
	  *Progress = NULL;
	  } else if (StrStr (Request, L"OFFSET") == NULL) {
	  *Progress = Request + StrLen (Request);
	  }
	  return Status;
	``
	
	10
	
	Now **locate** `MyWizardDriverHiiConfigAccessRouteConfig` and **replace** line at approx. 228, **“`return EFI_NOT_FOUND`”**, with the following code:

Step	Action

FROM:

```
146 **/
147 EFI_STATUS
148 EFIAPI
149 MyWizardDriverHiiConfigAccessRouteConfig (
150   IN CONST  EFI_HII_CONFIG_ACCESS_PROTOCOL  *This,
151   IN CONST  EFI_STRING                      Configuration,
152   OUT       EFI_STRING                      *Progress
153   )
154 {
155   return EFI_NOT_FOUND;
156 }
157
158 /**
159
160   This function is called to provide results data to the driver.
161   This data consists of a unique key that is used to identify
162   which data is either being passed back or being asked for.
```

TO:

```
227 **/
228 EFI_STATUS
229 EFIAPI
230 MyWizardDriverHiiConfigAccessRouteConfig (
231   IN CONST  EFI_HII_CONFIG_ACCESS_PROTOCOL  *This,
232   IN CONST  EFI_STRING                      Configuration,
233   OUT       EFI_STRING                      *Progress
234   )
235 {
236   EFI_STATUS                        Status;
237   UINTN                             BufferSize;
238   MYWIZARDDRIVER_DEV                    *PrivateData;
239   EFI_HII_CONFIG_ROUTING_PROTOCOL  *HiiConfigRouting;
240
241   if (Configuration == NULL || Progress == NULL) {
242     return EFI_INVALID_PARAMETER;
243   }
```

Step	Action

```
EFI_STATUS                        Status;
UINTN                             BufferSize;
MYWIZARDDRIVER_DEV                     *PrivateData;
EFI_HII_CONFIG_ROUTING_PROTOCOL  *HiiConfigRouting;

if (Configuration == NULL || Progress == NULL) {
  return EFI_INVALID_PARAMETER;
}

PrivateData = MYWIZARDDRIVER_DEV_FROM_THIS (This);
HiiConfigRouting = PrivateData->HiiConfigRouting;
*Progress = Configuration;

//
// Get Buffer Storage data from EFI variable
//
BufferSize = sizeof (MYWIZARDDRIVER_CONFIGURATION);
Status = gRT->GetVariable (
          mIfrVariableName,
          &mMyWizardDriverFormSetGuid,
          NULL,
          &BufferSize,
          &PrivateData->Configuration
          );
if (EFI_ERROR (Status)) {
  return Status;
}

//
// Convert <ConfigResp> to buffer data by helper function ConfigToBlock()
//
BufferSize = sizeof (MYWIZARDDRIVER_CONFIGURATION);
Status = HiiConfigRouting->ConfigToBlock (
                            HiiConfigRouting,
                            Configuration,
                            (UINT8 *) &PrivateData->Configuration,
                            &BufferSize,
                            Progress
                            );
if (EFI_ERROR (Status)) {
  return Status;
}

//
// Store Buffer Storage back to EFI variable
//
Status = gRT->SetVariable(
                mIfrVariableName,
                &mMyWizardDriverFormSetGuid,
                EFI_VARIABLE_NON_VOLATILE | EFI_VARIABLE_BOOTSERVICE_ACCESS,
                sizeof (MYWIZARDDRIVER_CONFIGURATION),
                &PrivateData->Configuration
                );
         DEBUG ((DEBUG_INFO, "\n:: ROUTE CONFIG Saving the configuration to NVRAM \n"));

return Status;


//return EFI_NOT_FOUND;
```

Step	Action
11	Lastly, **locate** `MyWizardDriverHiiConfigAccessCallback` and **replace** at approx. line 326, "**`return EFI_UNSUPPORTED;`**", with the following code:

FROM:

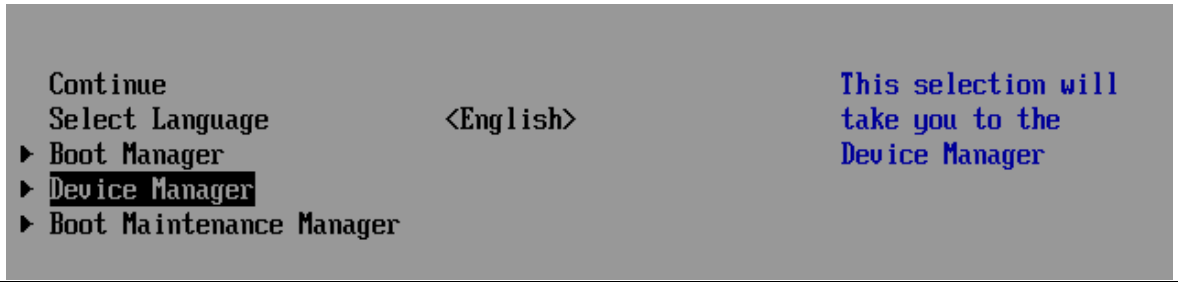
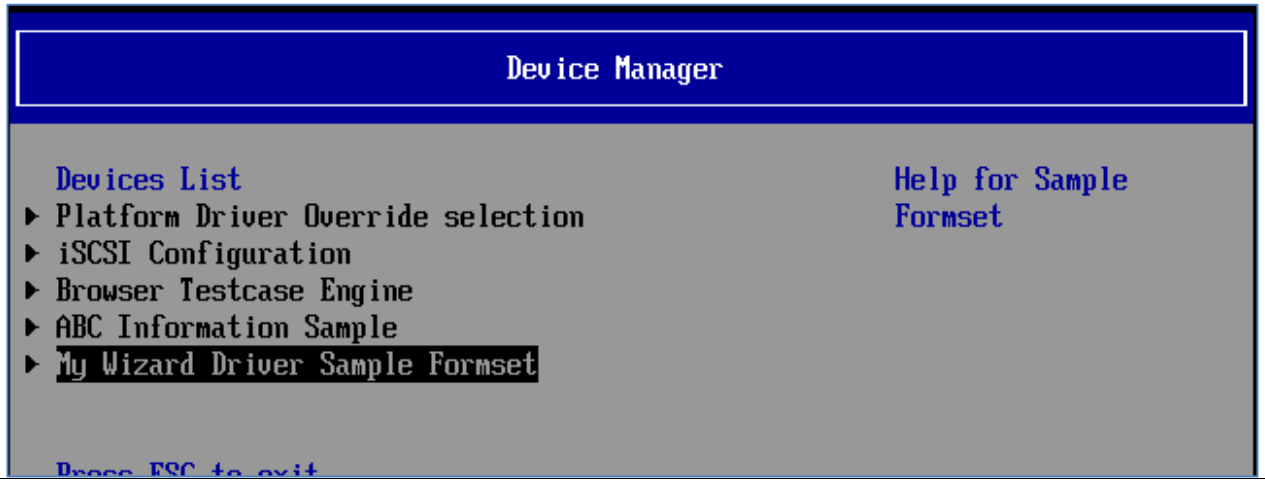
```
178                                     variable and its data.
179   @retval EFI_DEVICE_ERROR          The variable could not be saved.
180   @retval EFI_UNSUPPORTED           The specified Action is not suppo
181                                     callback.
182 **/
183 EFI_STATUS
184 EFIAPI
185 MyWizardDriverHiiConfigAccessCallback (
186   IN     CONST EFI_HII_CONFIG_ACCESS_PROTOCOL   *This,
187   IN     EFI_BROWSER_ACTION                     Action,
188   IN     EFI_QUESTION_ID                        QuestionId,
189   IN     UINT8                                  Type,
190   IN OUT EFI_IFR_TYPE_VALUE                     *Value,
191   OUT    EFI_BROWSER_ACTION_REQUEST             *ActionRequest
192   )
193 {
194   return EFI_UNSUPPORTED;
195 }
```

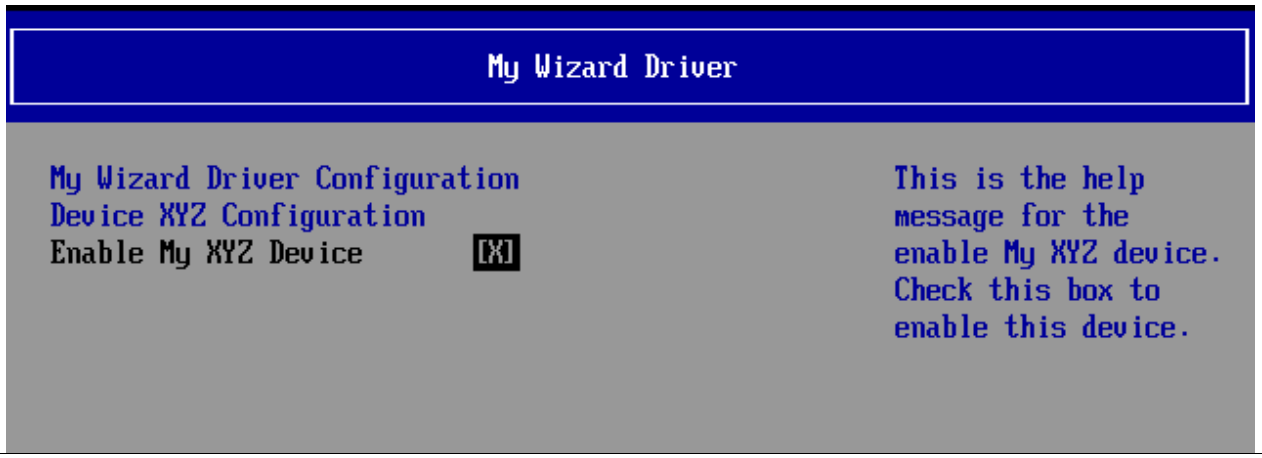
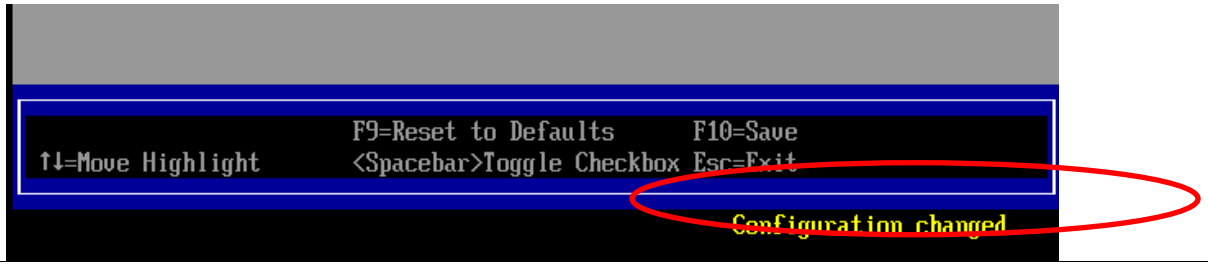
TO:

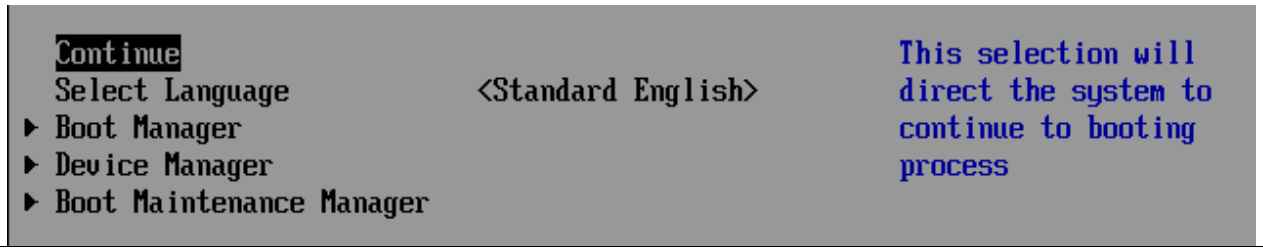
```
320                                     callback.
321 **/
322 EFI_STATUS
323 EFIAPI
324 MyWizardDriverHiiConfigAccessCallback (
325   IN     CONST EFI_HII_CONFIG_ACCESS_PROTOCOL   *This,
326   IN     EFI_BROWSER_ACTION                     Action,
327   IN     EFI_QUESTION_ID                        QuestionId,
328   IN     UINT8                                  Type,
329   IN OUT EFI_IFR_TYPE_VALUE                     *Value,
330   OUT    EFI_BROWSER_ACTION_REQUEST             *ActionRequest
331   )
332 {
333   MYWIZARDDRIVER_DEV       *PrivateData;
334   EFI_STATUS                        Status;
335   EFI_FORM_ID                       FormId;
336
337     DEBUG ((DEBUG_INFO, "\n:: START Call back ,Question ID=0x%08x
```

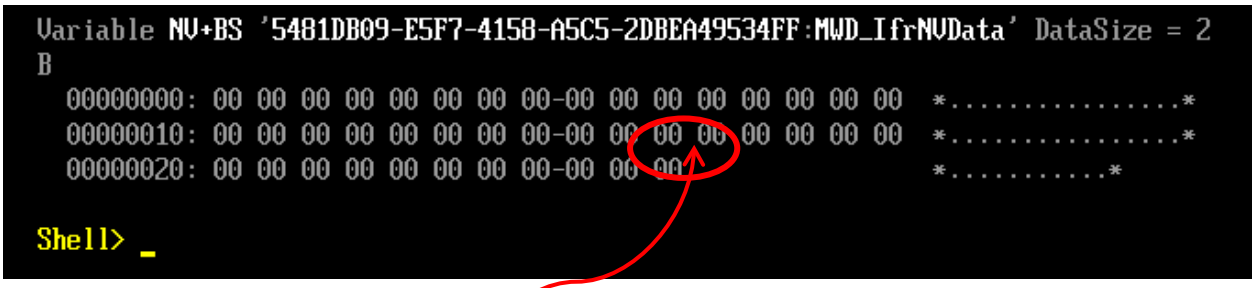
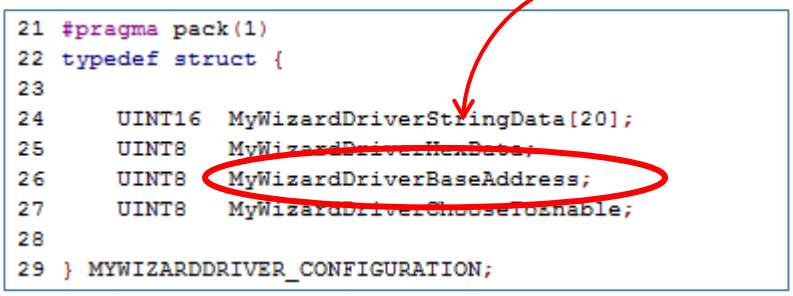
```
  MYWIZARDDRIVER_DEV       *PrivateData;
  EFI_STATUS                        Status;
  EFI_FORM_ID                       FormId;

    DEBUG ((DEBUG_INFO, "\n:: START Call back ,Question ID=0x%08x Type=0x%04x Action=0x%04x",
QuestionId, Type, Action));



  if (((Value == NULL) && (Action != EFI_BROWSER_ACTION_FORM_OPEN) && (Action !=
EFI_BROWSER_ACTION_FORM_CLOSE))||
    (ActionRequest == NULL)) {
    return EFI_INVALID_PARAMETER;
  }


  FormId = 0;
  Status = EFI_SUCCESS;
  PrivateData = MYWIZARDDRIVER_DEV_FROM_THIS (This);

  return Status;
```

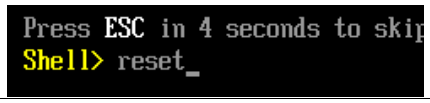
12	**Save** HiiConfigAccess.c

Step	Action
13	In the Terminal Command Prompt (Cntl-Alt-T), **bash$ cd ~/src/edk2**
	bash$ build
	Copy MyWizardDriver.efi to hda-contents **bash$ cd ~/run-ovmf/hda-contents** **bash$ cp ~/src/edk2/Build/OvmfX64/DEBUG_GCC5/X64/MyWizardDriver.efi .**
	Invoke Qemu **bash$ cd ~/run-ovmf** **bash$. RunQemu.sh**
	Load the UEFI Driver from the shell At the Shell 2.0 prompt, **type** fs0:
	Type load MyWizardDriver.efi
14	 **Type** exit
15	**Now at the setup front page menu press the down arrow to "Device Manager"** 
16	Inside the Device Manager menu **select** "My Wizard Driver Sample Formset" 

Step	Action
17	**Press** "Enter" . 
18	***Note***: Once you hit "Enter", notice that your form is now displayed with a choice to enable your Device. Also notice the titles and help strings that are in the .UNI file you edited.
	Test by **Press** the space bar to Enable and Disable the "Enable My XYZ Device" to change its value from: [X] to [ ]
19	**Note**: Notice the "Configuration changed" message at the menu bottom. 
20	**Press** "F10"
21	**Press** "Escape" to exit
22	**Press** "Escape" to exit the "Device Manager" Page

Step	Action
23	**Press** Up Arrow to "Continue" 
24	**Press** "Enter"
25	At the Shell Prompt **type** `dmpstore -all`

26	**Notice** that enable is selected and saved in NVRam as the value of 0x00:
	 
	
	 
	`#pragma pack(1)`
	`typedef struct {`
	`UINT16 MyWizardDriverStringData[20];`
	`UINT8 MyWizardDriverHexData;`
	`UINT8 MyWizardDriverBaseAddress;`
	`UINT8 MyWizardDriverChooseToEnable;`
	`} MYWIZARDDRIVER_CONFIGURATION;`
	
	Because our data structure in MyWizardDriverNVDataStruc.h is stored in NVRAM with the variable name `MWD_IfrNVData` of type `MYWIZARDDRIVER_CONFIGURATION`, we can see the changes from our menu accessing through our HII forms.
	
	Notice that the enable/disable byte is the last byte in data structure `MWD_IfrNVData.MyWizardDriverChooseToEnable` where `00` == disable and `01` == enable.

27	**Type** Reset 

Step	Action
28	**Exit QEMU**

For any build issues copy the solution files from ~/Fw/LabSolutions/LessonE.2
NOTE: Delete Directory ~/src/edk2/Build/OvmfX64/DEBUG_GCC5/X64/MyWizardDriver before the Build command to build the MyWizardDriver Clean

3. Updating your driver to initialize data from the VFR data to the HII Database

In this lab, you'll learn how to update your driver to initialize the data according to the defaults set in the .VFR file. Thus when the user enters your driver's menu for the first time, the values will display the defaults according to the .VFR file settings. You will also learn the rich set of HII function calls that are part of the MdeModulePkg in the HiiLib by reviewing the "MdeModulePkg Document.chm" From UDK2017.

a. Add HII Library Calls to Your Driver

For this lab you will update the following files: MyWizardDriver.inf, MyWizardDriver.h, and MyWizardDriver.c

Step	Action
1	**Update** the MyWizardDriver.inf file
2	**Add** the following package (as shown below): The HII Library in the MdeModulePkg has many functions to help with Communication to/from the Hii Database and Hii forms. One function call HiiSetToDefaults will compare the default settings from the .VFR file and update the driver's configuration buffer according to the settings in the .VFR file.
	`MdeModulePkg/MdeModulePkg.dec`

	`[Packages]`
	`  MdePkg/MdePkg.dec`
	`  MdeModulePkg/MdeModulePkg.dec`
	
	Note: For other functions from the HII Library, open the .chm file "MdeModulePkg Document.chm" and search for HiiLib.h.

3	**Add** the following library class (as shown below):
	`HiiLib`

	`[LibraryClasses]`
	`  UefiDriverEntryPoint`
	`  UefiBootServicesTableLib`
	`  MemoryAllocationLib`
	`  BaseMemoryLib`
	`  BaseLib`
	`  UefiLib`
	`  DevicePathLib`
	`  DebugLib`
	`  HiiLib`

Step	Action
4	**Save** MyWizardDriver.inf
5	**Update** the MyWizardDriver.h file
6	**Add** the following code (as shown below):

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

```
42  // Added for HII
43  #include <Protocol/HiiConfigRouting.h>
44  #include <Protocol/FormBrowser2.h>
45  #include <Protocol/HiiString.h>
46  #include <Library/DevicePathLib.h>
47  #include <Library/HiiLib.h>
```

7	**Save** MyWizardDriver.h
8	**Update** the MyWizardDriver.c file
9	**Add Locals:** first add 2 locals for your drivers configuration buffer and a boolean flag from the Hii Library calls Add the following at Approx. Line 190.

```
  MYWIZARDDRIVER_CONFIGURATION     *Configuration;
  BOOLEAN                          ActionFlag;
```

```
180
181   // HII Locals
182   EFI_HII_PACKAGE_LIST_HEADER     *PackageListHeader;
183   EFI_HII_DATABASE_PROTOCOL       *HiiDatabase;
184   EFI_HII_HANDLE                  HiiHandle[2];
185   EFI_HII_STRING_PROTOCOL         *HiiString;
186   EFI_FORM_BROWSER2_PROTOCOL      *FormBrowser2;
187   EFI_HII_CONFIG_ROUTING_PROTOCOL *HiiConfigRouting;
188   EFI_STRING                       ConfigRequestHdr;
189   UINTN                            BufferSize;
190   MYWIZARDDRIVER_CONFIGURATION     *Configuration;
191   BOOLEAN                          ActionFlag;
192
193   Status = EFI_SUCCESS;
194
```

10	**Add** the following to the MyWizardDriverDriverEntryPoint entry point funtion to line 319, approximately after “BufferSize =” as shown below

Step	Action

```
  //
  // Initialize configuration data
  //
  Configuration = &PrivateData->Configuration;
  ZeroMem (Configuration, sizeof (MYWIZARDDRIVER_CONFIGURATION));

  //
  // Try to read NV config EFI variable first
  //
  ConfigRequestHdr = HiiConstructConfigHdr (&mMyWizardDriverFormSetGuid,
mIfrVariableName, mDriverHandle[0]);
  ASSERT (ConfigRequestHdr != NULL);
```

```
317
318   BufferSize = sizeof (MYWIZARDDRIVER_CONFIGURATION);
319   //
320   // Initialize configuration data
321   //
322   Configuration = &PrivateData->Configuration;
323   ZeroMem (Configuration, sizeof (MYWIZARDDRIVER_CONFIGURATION));
324
325   //
326   // Try to read NV config EFI variable first
327   //
328   ConfigRequestHdr = HiiConstructConfigHdr (&mMyWizardDriverFormSetGuid, mIfrVa
329   ASSERT (ConfigRequestHdr != NULL);
330
331
332   // IF driver is not part of the Platform then need to get/set defaults for the
333   Status = gRT->GetVariable (
```

11 Modify the following lines:

@~338: remove: “&PrivateData->” from the “&PrivateData->Configuration”

@~342: remove line: ZeroMem (&PrivateData->Configuration, sizeof (MYWIZARDDRIVER_CONFIGURATION));

@~347: remove: “&PrivateData->” from the “&PrivateData->Configuration”

FROM **TO**

```
317
318   // IF driver is not part of the Platform then need to get/set defaults for the N
319   Status = gRT->GetVariable (
320             mIfrVariableName,
321             &mMyWizardDriverFormSetGuid,
322             NULL,
323             &BufferSize,
324             &PrivateData->Configuration
325             );
326   if (EFI_ERROR (Status)) {  // Not definded yet so add it to the NV Variables.
327             // zero out buffer
328         ZeroMem (&PrivateData->Configuration, sizeof (MYWIZARDDRIVER_CONFIGURAT
329                 Status = gRT->SetVariable(
330                   mIfrVariableName,
331                   &mMyWizardDriverFormSetGuid,
332                   EFI_VARIABLE_NON_VOLATILE | EFI_VARIABLE_BOOTSERVICE_ACCESS,
333                   sizeof (MYWIZARDDRIVER_CONFIGURATION),
334                   &PrivateData->Configuration   //  buffer is 000000  now
335                   );
336   }
337   //
```

```
330
331
332   // IF driver is not part of the Platform then need to get/set defaults for t
333   Status = gRT->GetVariable (
334             mIfrVariableName,
335             &mMyWizardDriverFormSetGuid,
336             NULL,
337             &BufferSize,
338             Configuration
339             );
340   if (EFI_ERROR (Status)) {  // Not definded yet so add it to the NV Variables
341             // zero out buffer
342                 Status = gRT->SetVariable(
343                   mIfrVariableName,
344                   &mMyWizardDriverFormSetGuid,
345                   EFI_VARIABLE_NON_VOLATILE | EFI_VARIABLE_BOOTSERVICE_ACCESS,
346                   sizeof (MYWIZARDDRIVER_CONFIGURATION),
347                   Configuration   //  buffer is 000000  now
348                   );
349     //
350     // EFI variable for NV config doesn't exist, we should build this variable
```

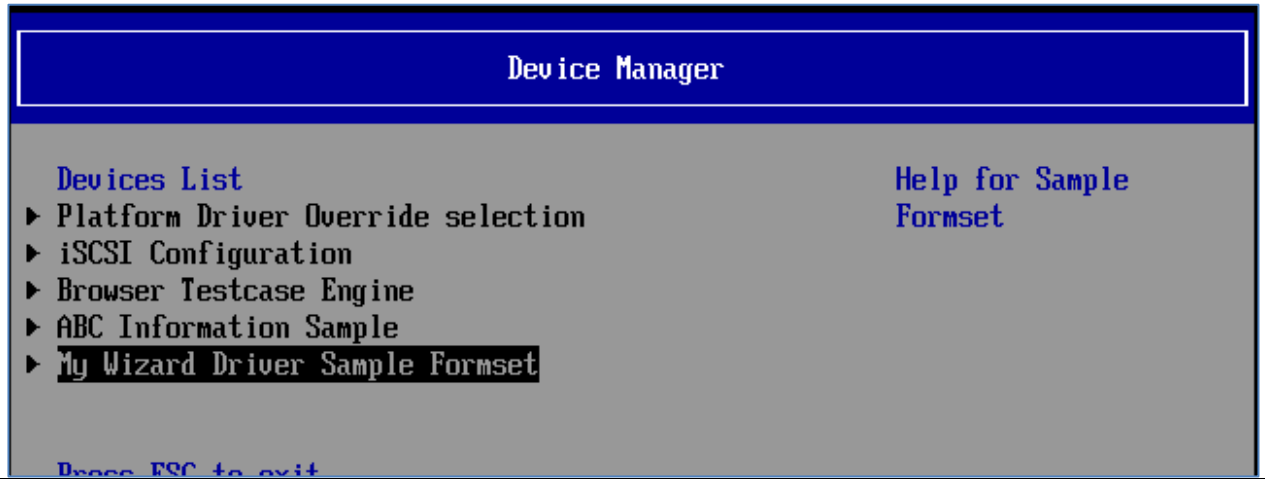
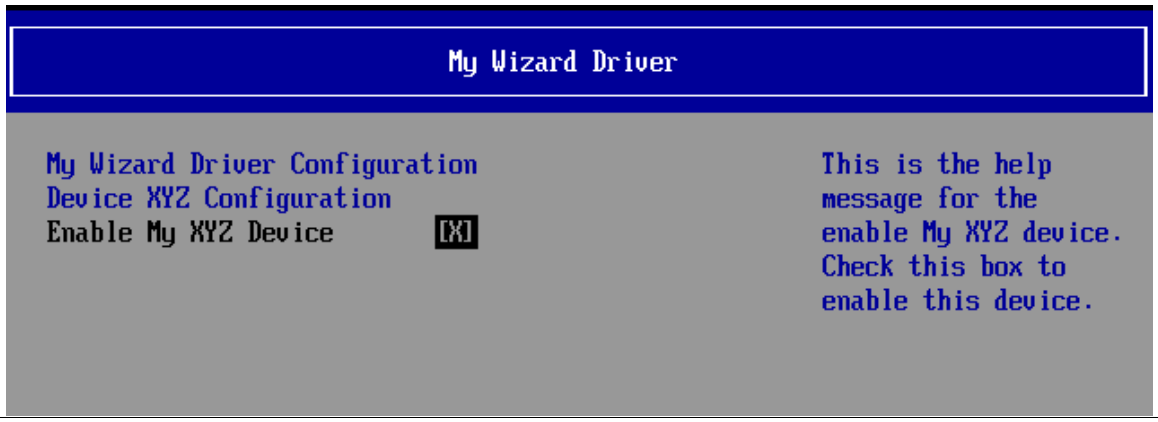
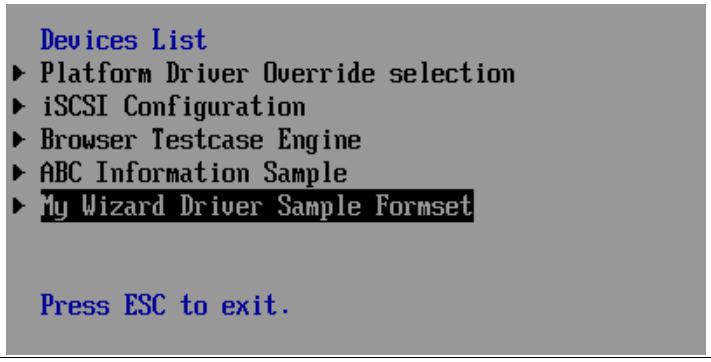
Step	Action

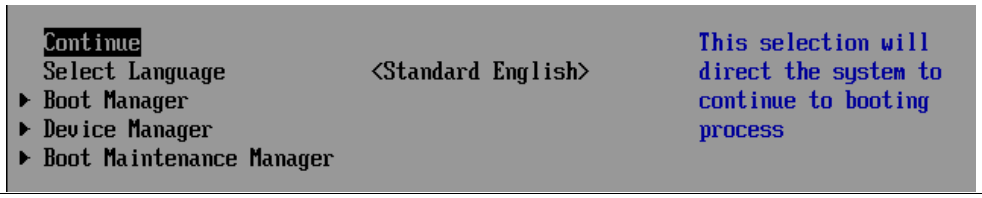
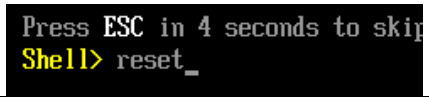
	Add the following code to the MyWizardDriverDriverEntryPoint entry point code at approximately line 349 before
	`//`
	`// Install Driver Supported EFI Version Protocol onto ImageHandle`
	`//`
	
	You're **deleting** the "}' and replacing it with the following code (as shown below). With this replacement we are adding an "else" to the "if" statement:

```
    //
    // EFI variable for NV config doesn't exist, we should build this
variable
    // based on default values stored in IFR
    //
    ActionFlag = HiiSetToDefaults (ConfigRequestHdr,
EFI_HII_DEFAULT_CLASS_STANDARD);
    ASSERT (ActionFlag);
  } else {
    //
    // EFI variable does exist and Validate Current Setting
    //
    ActionFlag = HiiValidateSettings (ConfigRequestHdr);
    ASSERT (ActionFlag);
  }  // Match if (EFI_ERROR (Status))
  FreePool (ConfigRequestHdr);

// end HII
```

```
347                     Configuration   //  buffer is 000000  now
348                     );
349     //
350     // EFI variable for NV config doesn't exist, we should build this variable
351     // based on default values stored in IFR
352     //
353     ActionFlag = HiiSetToDefaults (ConfigRequestHdr, EFI_HII_DEFAULT_CLASS_STANI
354     ASSERT (ActionFlag);
355   } else {
356     //
357     // EFI variable does exist and Validate Current Setting
358     //
359     ActionFlag = HiiValidateSettings (ConfigRequestHdr);
360     ASSERT (ActionFlag);
361   }  // Match if (EFI_ERROR (Status))
362   FreePool (ConfigRequestHdr);
363
364
365   // end HII
366   //
367   // Install Driver Supported EFI Version Protocol onto ImageHandle
368   //
369   Status = gBS->InstallMultipleProtocolInterfaces (
370                   &ImageHandle
```

Step	Action
	Note the "}" on line 361 is still matching the initial if statement. Make sure you do not have a duplicate "}"
13	**Save** the MyWizardDriver.c file
14	In the Terminal Command Prompt (Cntl-Alt-T), **bash$ cd ~/src/edk2**
15	**bash$ build**
16	**Copy MyWizardDriver.efi to hda-contents** **bash$ cd ~/run-ovmf/hda-contents** **bash$ cp ~/src/edk2/Build/OvmfX64/DEBUG_GCC5/X64/MyWizardDriver.efi .**
17	**Invoke Qemu** **bash$ cd ~/run-ovmf** **bash$. RunQemu.sh**
18	**Load the UEFI Driver from the shell** At the Shell 2.0 prompt, **type fs0:**
19	**Type load MyWizardDriver.efi**
22	**Type** exit FS0:\> load MyWizardDriver.efi Image 'FS0:\MyWizardDriver.efi' loaded at 5EB9000 - Success FS0:\> exit_
23	**Press** "Enter"
24	Now at the setup front page menu **select** "Device Manager" Continue Select Language <English> ▶ Boot Manager ▶ Device Manager ▶ Boot Maintenance Manager This selection will take you to the Device Manager
25	**Press** "Enter"

Step	Action
	Inside the Device Manager menu press the down arrow to **"My Wizard Driver Sample Formset"** 
26	**Press** "Enter" 
27	**Press** "Escape" to exit
28	To Exit the "Device Manager" Page: **Press** "Escape" 

Step	Action
29	**Press** Up Arrow to "Continue" 
30	**Type** Reset 
31	**Exit QEMU**

For any build issues copy the solution files from ~/FW/LbSolutions/LessonE.3
NOTE: Del Directory ~/src/edk2/Build/OvmfX64/DEBUG_GCC5/X64/MyWizardDriver before the Build command to build the MyWizardDriver Clean

b. Add your Driver to the platform

As of now, your driver needs to be soft loaded each time from the shell prompt. In this lab, you'll update the platform .FDF file to force your driver to load as part of the platform UEFI driver.

Step	
1	**Open** to update: ~/src/edk2/OvmfPkg/OvmfPkgX64.Fdf **Add** the following code (as shown below before "!if $(BUILD_NEW_SHELL) == TRUE"):

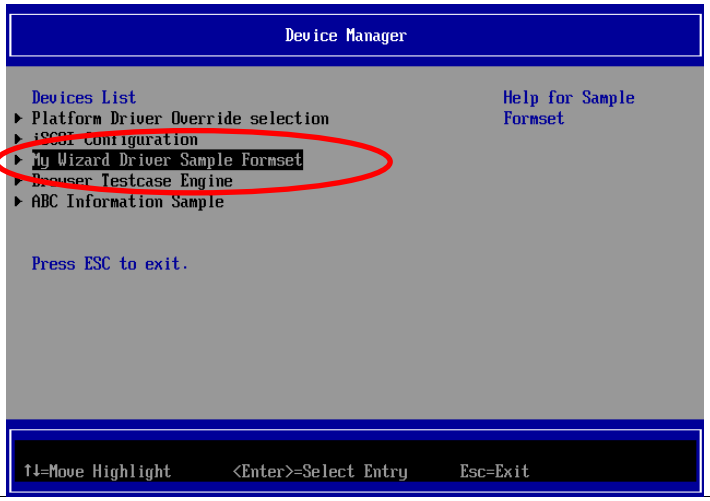
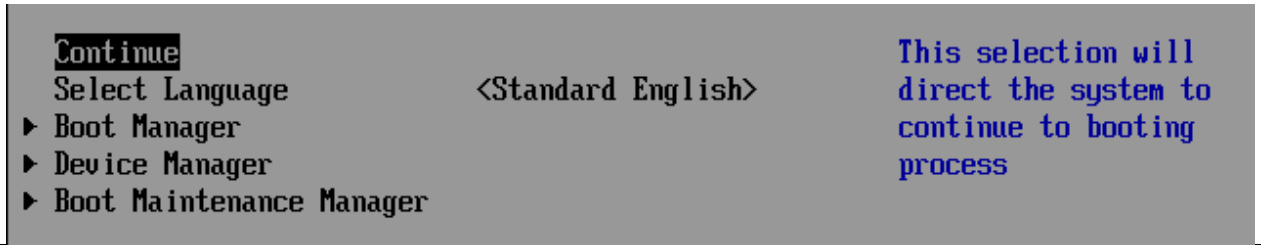
2	INF MyWizardDriver/MyWizardDriver.inf
	`INF MdeModulePkg/Universal/Network/IScsiDxe/IScsiDxe.inf`
	`INF MyWizardDriver/MyWizardDriver.inf`
	`!if $(BUILD_NEW_SHELL) == TRUE`
	`INF ShellPkg/Application/Shell/Shell.inf`
	`!endif`

3	**Save** OvmfPkgX64.Fdf
4	In the Terminal Command Prompt (Cntl-Alt-T), **`bash$ cd ~/src/edk2`**
5	**`bash$ build`**
6	**Copy MyWizardDriver.efi to hda-contents** **`bash$ cd ~/run-ovmf/`** **`bash$ cp ~/src/edk2/Build/OvmfX64/DEBUG_GCC5/FV/OVMF.fd bios.bin`**
7	**Invoke Qemu** **`bash$ . RunQemu.sh`**

8	**At the Shell prompt type:** `exit`
	
	`Press ESC in 1 seconds to skip`
	`Shell> exit_`

9	**Press** "Enter"

10	Now at the setup front page menu press the down arrow to **"Device Manager"**
	
	`Continue`
	`Select Language <English>`
	`▶ Boot Manager`
	`▶ Device Manager`
	`▶ Boot Maintenance Manager`
	
	`This selection will take you to the Device Manager`

11	**Press** "Enter"
11	**Notice** that the `My Wizard Driver Sample Formset` is added without having to issue the "Load" command from the shell prompt. 
12	**Press** "Escape"
13	**Press** Up arrow to "Continue" 
14	**Press "Enter"**
15	**Type** Reset
16	**Exit** QEMU

4. Updating the Menu: Reset Button

In this lab, you'll learn how to add a reset button to your driver's form menu. It's time to add more configuration fields to your menu, enabling users to modify more fields now that you've built a driver that 1) saves data from forms into NVRAM 2) updates data from the .VFR forms and 3) builds into the platform drivers.

The next set of labs will update .VFR, MyWizardDriver.vfr, and UNI MyWizardDriver.uni string files to incrementally add a reset button (4), pop-up box (5), string name (6), and numeric hex value (7) to your driver's form menu:

Step	Action
1	**Update** the MyWizardDriver.vfr file
2	**Add** the following code (as shown below after the "GUID" definition Apprx. Line 29): With this code you are created a VFR sub-function called "MyStandardDefault"

```
defaultstore MyStandardDefault,
    prompt      = STRING_TOKEN(STR_STANDARD_DEFAULT_PROMPT),
    attribute   = 0x0000;        // Default ID: 0000 standard
default
```

```
27     guid  = MYWIZARDDRIVER_FORMSET_GUID;    // GUID of this buffer storage
28
29 defaultstore MyStandardDefault,
30     prompt      = STRING_TOKEN(STR_STANDARD_DEFAULT_PROMPT),
31     attribute   = 0x0000;                        // Default ID: 0000 standard default
32
```

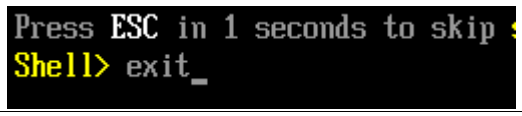
3	**Add** the folowing code before the "endform" (as shown below Approx. Line 55):

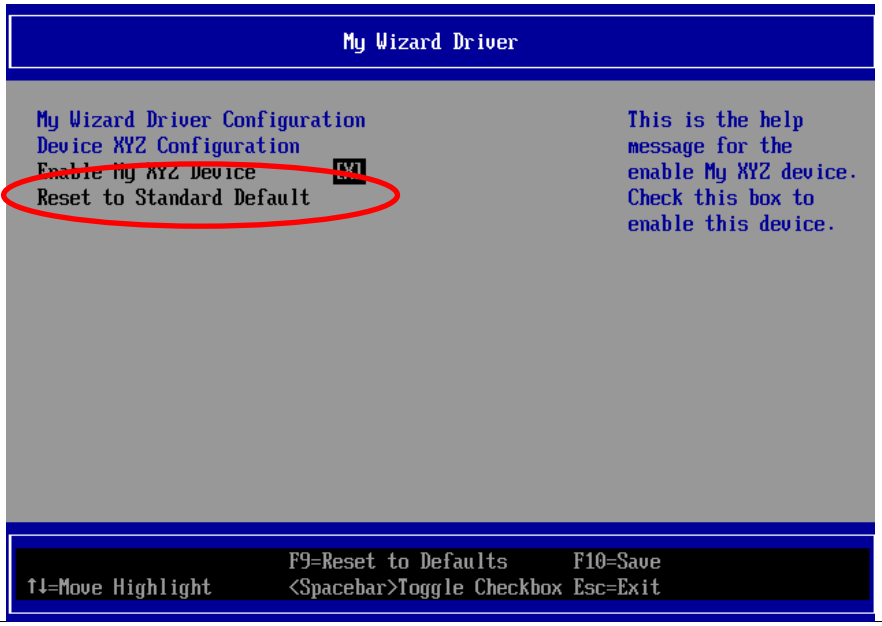
```
    resetbutton
      defaultstore = MyStandardDefault,
      prompt    = STRING_TOKEN(STR_STANDARD_DEFAULT_PROMPT_RESET),
      help      = STRING_TOKEN(STR_STANDARD_DEFAULT_HELP),
    endresetbutton;
```

```
52      endcheckbox;
53
54
55     resetbutton
56       defaultstore = MyStandardDefault,
57       prompt    = STRING_TOKEN(STR_STANDARD_DEFAULT_PROMPT_RESET),
58       help      = STRING_TOKEN(STR_STANDARD_DEFAULT_HELP),
59     endresetbutton;
60
61
62   endform;
63
64 endformset;
```

Step	Action
4	**Save** MyWizardDriver.vfr
5	**Update** the MyWizardDriver.uni file
6	**Add** the following strings at the end of the file to support the "**STR_**" referenced added in the .vfr file:

	`#string STR_STANDARD_DEFAULT_PROMPT #language en "Standard Default"`
	`#string STR_STANDARD_DEFAULT_PROMPT_RESET #language en "Reset to Standard Default"`
	`#string STR_STANDARD_DEFAULT_HELP #language en "This will reset all the Questions to their standard default value"`

7	**Save** MyWizardDriver.uni
8	In the Terminal Command Prompt (Cntl-Alt-T), **`bash$ cd ~/src/edk2`**
9	**`bash$ build`**
10	**Copy MyWizardDriver.efi to hda-contents** **`bash$ cd ~/run-ovmf/`** **`bash$ cp ~/src/edk2/Build/OvmfX64/DEBUG_GCC5/FV/OVMF.fd bios.bin`**
11	**Invoke Qemu** **`bash$ . RunQemu.sh`**
12	**At the Shell prompt type:** `exit` 
13	**Press** "Enter"
14	Now at the setup front page menu press the **down arrow** to **"Device Manager"**
15	**Press** "Enter"
16	Inside the Device Manager menu press the down arrow to **"My Wizard Driver Sample Formset"**

Step	Action
17	**Access** the My Wizard Driver menu and **notice** the item "Reset to Standard Default" 
18	**Press Down Arrow to "**Reset to Standard Default"
19	**Press** "Enter
20	**Notice** the **"Configuration changed"** message at the bottom of the menu
21	**To Exit Press** "Escape" then "Y"
22	**To Exit the "Device Manager" Page: Press** "Escape"
23	**Press** Up Arrow to **"**Continue**"**
24	**Observe:** Notice that since this change requires a reset, the shell will exit out completely. 
25	**Exit QEMU**

For any build issues copy the solution files from ~/FW/LabSolutions/LessonE.4
NOTE: Delete Directory ~/src/edk2/Build/OvmfX64/DEBUG_GCC5/X64/MyWizardDriver before the Build command to build the MyWizardDriver Clean

5. Updating the Menu: Pop-up Box

In this lab, you'll learn how to add a *pop-up box* to your driver's form menu by using the "**oneof**" VFR term. We will also only update the MyWizardDriver.vfr and MyWizardDriver.uni files.

Figure 5 My Wizard Driver with a pop-up box

Step	Action
	Background Information (not a step) The VFR term "`oneof`" will declare a pop-up menu. The user then selects one field that will dictate the value stored in the NVRAM variable. Looking at Figure 6 above, there are three values: **Value** / **Display** / **String token** **0** / 500 Hex / STR_ONE_OF_TEXT3 **1** / 480 Hex / STR_ONE_OF_TEXT2 **2** / 400 Hex / STR_ONE_OF_TEXT1 Add code to give your driver menu a pop-up menu item by defining a "`oneof`" item. Also, if the device is "`disabled`", then use the VFR term "`grayoutif`" statement so that the pop-up menu is not accessible and cannot be changed. The browser engine will use the configuration variable MWD_IfrNVData.MyWizardDriverChooseToEnable with a value of 0x0 to determine if the device is enabled or disabled
1	**Update** the MyWizardDriver.vfr file

Step	Action
2	**Add** the following code before the "resetbutton" statement (approximately line 53)

```
//
// Define oneof (EFI_IFR_ONE_OF)
//
grayoutif  ideqval MWD_IfrNVData.MyWizardDriverChooseToEnable == 0x0;

 oneof name = MyOneOf2,                          // Define reference name for Question
  varid   = MWD_IfrNVData.MyWizardDriverBaseAddress,
  // Use "DataStructure.Member" to reference Buffer Storage
  prompt  = STRING_TOKEN(STR_ONE_OF_PROMPT),
  help    = STRING_TOKEN(STR_ONE_OF_HELP),
  //
  // Define an option (EFI_IFR_ONE_OF_OPTION)
  //
  option text = STRING_TOKEN(STR_ONE_OF_TEXT3), value = 0x0, flags = 0;
  option text = STRING_TOKEN(STR_ONE_OF_TEXT2), value = 0x1, flags = 0;
  //
  // DEFAULT indicate this option will be marked with
  //  EFI_IFR_OPTION_DEFAULT
  //
  option text = STRING_TOKEN(STR_ONE_OF_TEXT1), value = 0x2,
     flags = DEFAULT;
 endoneof;
endif;
```

Step	Action

```
51                  default  = 1,
52      endcheckbox;
53    //
54     // Define oneof (EFI_IFR_ONE_OF)
55     //
56    grayoutif  ideqval MWD_IfrNVData.MyWizardDriverChooseToEnable == 0x0;
57
58     oneof name = MyOneOf2,                                  // Define referenc
59       varid   = MWD_IfrNVData.MyWizardDriverBaseAddress,
60       // Use "DataStructure.Member" to reference Buffer Storage
61       prompt  = STRING_TOKEN(STR_ONE_OF_PROMPT),
62       help    = STRING_TOKEN(STR_ONE_OF_HELP),
63       //
64       // Define an option (EFI_IFR_ONE_OF_OPTION)
65       //
66       option text = STRING_TOKEN(STR_ONE_OF_TEXT3), value = 0x0, flags = 0;
67       option text = STRING_TOKEN(STR_ONE_OF_TEXT2), value = 0x1, flags = 0;
68       //
69       // DEFAULT indicate this option will be marked with
70       //  EFI_IFR_OPTION_DEFAULT
71       //
72       option text = STRING_TOKEN(STR_ONE_OF_TEXT1), value = 0x2,
73           flags = DEFAULT;
74     endoneof;
75    endif;
76
77
78     resetbutton
79       defaultstore = MyStandardDefault,
```

3

Save the MyWizardDriver.vfr file

4

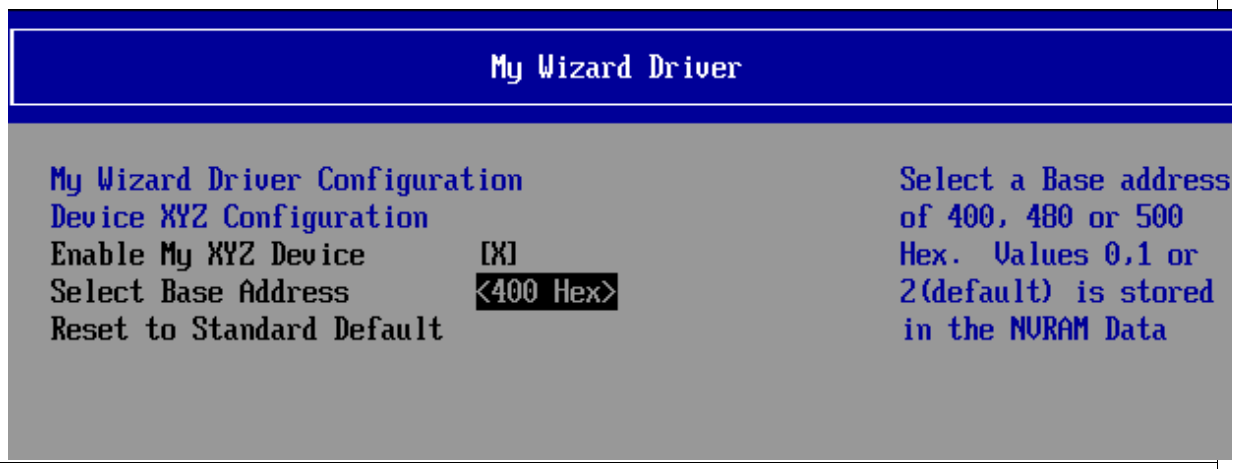
Update the MyWizardDriver.uni file

5

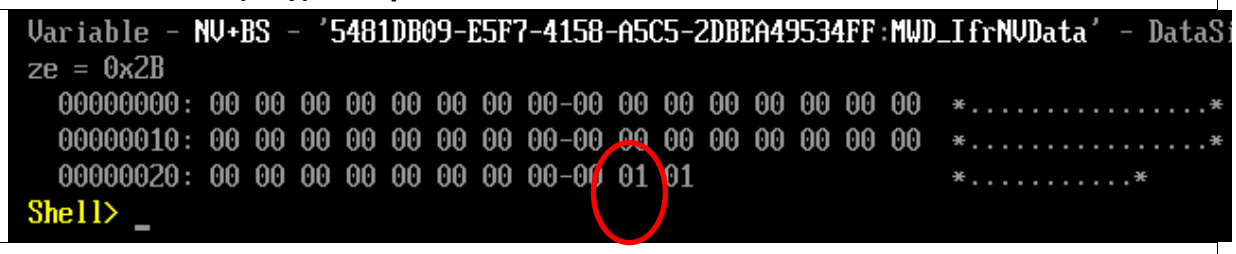
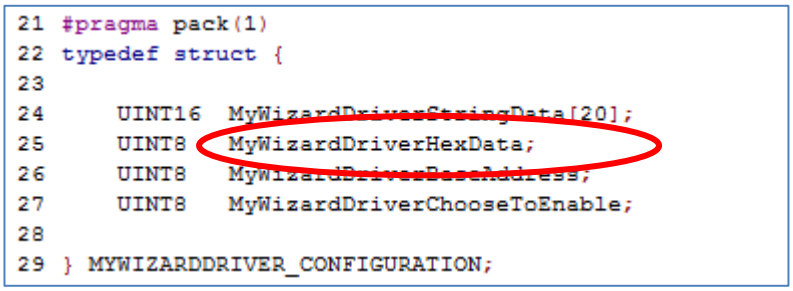
Add the following code to the end of the file (as shown below):

```
#string STR_ONE_OF_PROMPT                #language en "Select Base Address"

#string STR_ONE_OF_HELP                  #language en "Select a Base address of 400,
480 or 500 Hex.  Values 0,1 or 2(default) is stored in the NVRAM Data"

#string STR_ONE_OF_TEXT1                 #language en "400 Hex"

#string STR_ONE_OF_TEXT2                 #language en "480 Hex"

#string STR_ONE_OF_TEXT3                 #language en "500 Hex"
```

```
33 #string STR_STANDARD_DEFAULT_HELP      #language en "This will reset all the Questions to their
34
35 #string STR_ONE_OF_PROMPT              #language en "Select Base Address"
36
37 #string STR_ONE_OF_HELP                #language en "Select a Base address of 400, 480 or 500 H
38
39 #string STR_ONE_OF_TEXT1               #language en "400 Hex"
40
41 #string STR_ONE_OF_TEXT2               #language en "480 Hex"
42
43 #string STR_ONE_OF_TEXT3               #language en "500 Hex"
```

Step	Action
6	**Save** MyWizardDriver.uni
7	In the Terminal Command Prompt (Cntl-Alt-T), **`bash$ cd ~/src/edk2`**
8	**`bash$ build`**
9	**Copy MyWizardDriver.efi to hda-contents** **`bash$ cd ~/run-ovmf/`** **`bash$ cp ~/src/edk2/Build/OvmfX64/DEBUG_GCC5/FV/OVMF.fd bios.bin`**
10	**Invoke Qemu** **`bash$ . RunQemu.sh`**
11	**Type** `exit`
12	**Press** "Enter"
13	Now at the setup front page menu press the **down arrow** to **"Device Manager"**
14	**Press** "Enter"
15	Inside the Device Manager menu press the down arrow to **"My Wizard Driver Sample Formset"**
16	Down Arrow to "Select Base Address" 
17	**Press** "Enter" **Notice** the Pop up menu

Step	Action
18	**Select** “480 Hex” 
19	**Press** “Enter”
20	**Observe:** Notice the **“Configuration changed”** message at the bottom
21	Test the **“grayoutif”** by selecting “Enable My XYZ Device” then press the “Space” bar to toggle off or “Disabled”. 
22	**Notice** the “Select Base Address” is now grayed out and not selectable
23	**Press** “Space” again to Enable
24	**To Exit Press** “Escape” then “Y” or “F10” then “Escape”
25	**To Exit the “Device Manager” Page: Press** “Escape”

Step	Action
26	**Press Up Arrow to** "Continue"
27	**At the Shell Prompt type:** `dmpstore -all`
28	
28	 File MyWizardDriverNVDataStruc.h By updating MyWizardDriverNVDataStruc.h, our data structure stored in NVRAM is named MWD_IfrNVData of type MYWIZARDDRIVER_CONFIGURATION. Notice that the base address byte is the next to the last byte in the data structure **MWD_IfrNVData.MyWizardDriverBaseAddress** where 02 == 400H, 01 == 480H, 00 == 500H **Notice** the NVRAM Variable with the value of 480H will have a true value of 01.
29	**Type "`reset`"** at the Shell prompt
30	**Exit QEMU**

```
#pragma pack(1)
typedef struct {

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

} MYWIZARDDRIVER_CONFIGURATION;
```

For any build issues copy the solution files from ~/Fw/LabSolutions/LessonE.5
NOTE: Delete Directory ~/src/edk2/Build/OvmfX64/DEBUG_GCC5/X64/MyWizardDriver before the Build command to build the MyWizardDriver Clean

6. Updating the Menu: Creating a String to Name a Saved Configuration

In this lab, you'll create a string to name a saved configuration that will be stored into the NVRAM variable space. This lab uses the VFR term "`string`" to prompt the user to enter a string value. The VFR can determine the minimum and maximum number of characters of the string length with the terms "`minsize`" and "`maxsize`". Since there is also an enable/disable switch, the VFR can use the "`grayoutif`" term again to allow or disallow changes to this field.

Figure 6 : Menu with a string item

Step	Action
1	**Update** the MyWizardDriver.vfr file
2	**Add** the following code to the location at approx. line 77 and before the "resetbutton" item (as shown below):

Step	Action

	`//`
	`// Define a string (EFI_IFR_STRING) to name the configuration in the`
	`// NVRAM variable`
	`//`
	`  grayoutif  ideqval MWD_IfrNVData.MyWizardDriverChooseToEnable == 0x0;`
	`  string  varid  = MWD_IfrNVData.MyWizardDriverStringData,`
	`  prompt  = STRING_TOKEN(STR_MY_STRING_PROMPT),`
	`  help  = STRING_TOKEN(STR_MY_STRING_HELP),`
	`  minsize  = 3,`
	`  maxsize  = 20,`
	`  endstring;`
	`  endif;`

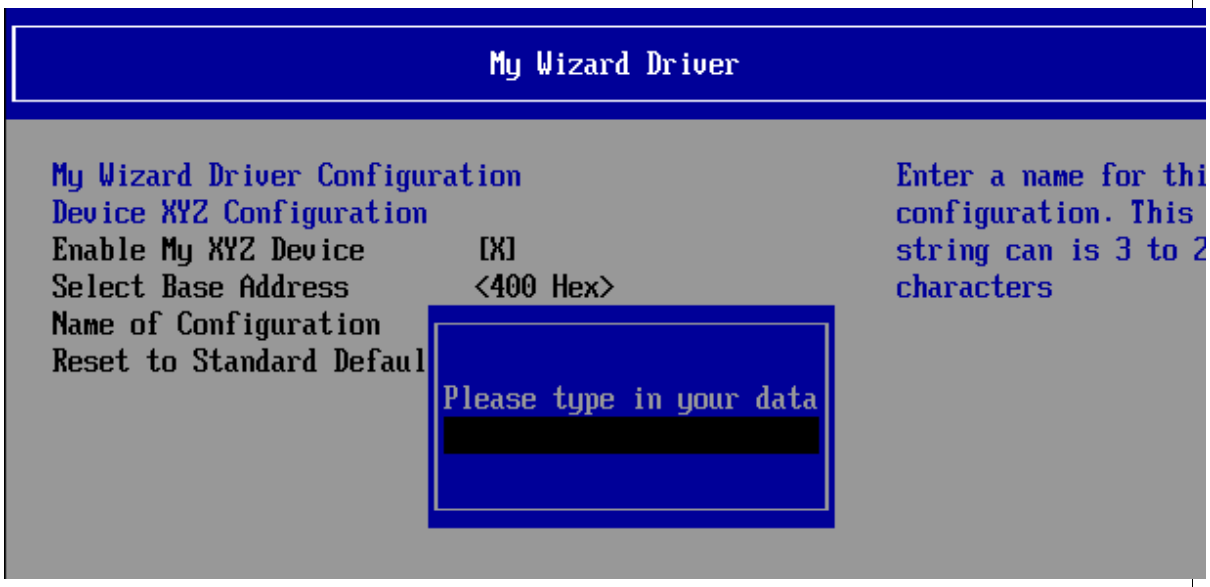
	`  endoneof;`
	`  endif;`
	
	`  //`
	`  // Define a string (EFI_IFR_STRING)to name the configuration in the`
	`  // NVRAM variable`
	`  //`
	
	`  //`
	`  grayoutif  ideqval MWD_IfrNVData.MyWizardDriverChooseToEnable == 0x0;`
	
	`  string  varid  = MWD_IfrNVData.MyWizardDriverStringData,`
	`  prompt  = STRING_TOKEN(STR_MY_STRING_PROMPT),`
	`  help  = STRING_TOKEN(STR_MY_STRING_HELP),`
	`  minsize  = 3,`
	`  maxsize  = 20,`
	
	`  endstring;`
	`  endif;`
	
	`  resetbutton`
	`  defaultstore = MyStandardDefault,`
	`  prompt  = STRING_TOKEN(STR_STANDARD_DEFAULT_PROMPT_RESET),`
	`  help  = STRING_TOKEN(STR_STANDARD_DEFAULT_HELP),`
	`  endresetbutton;`

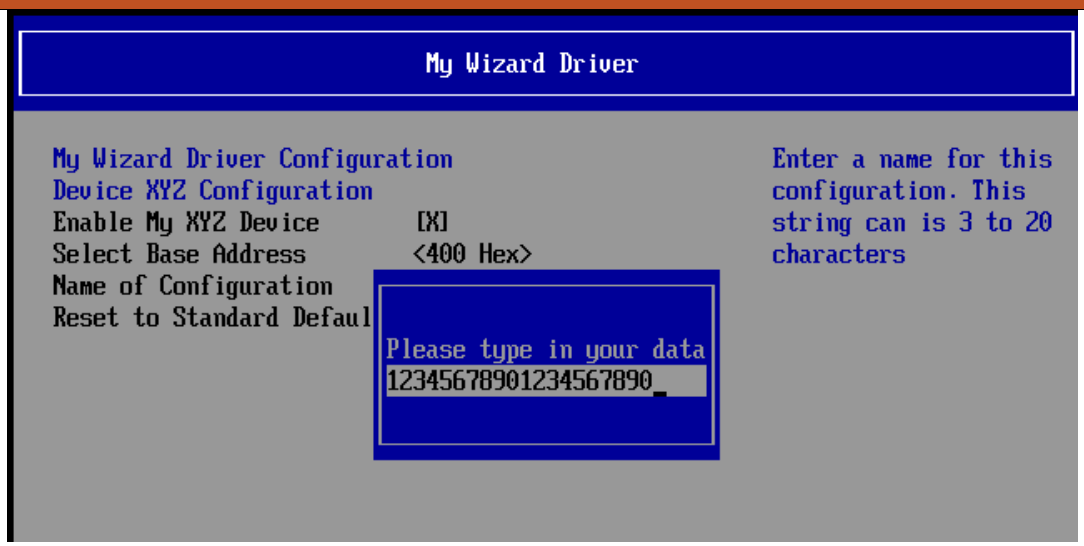
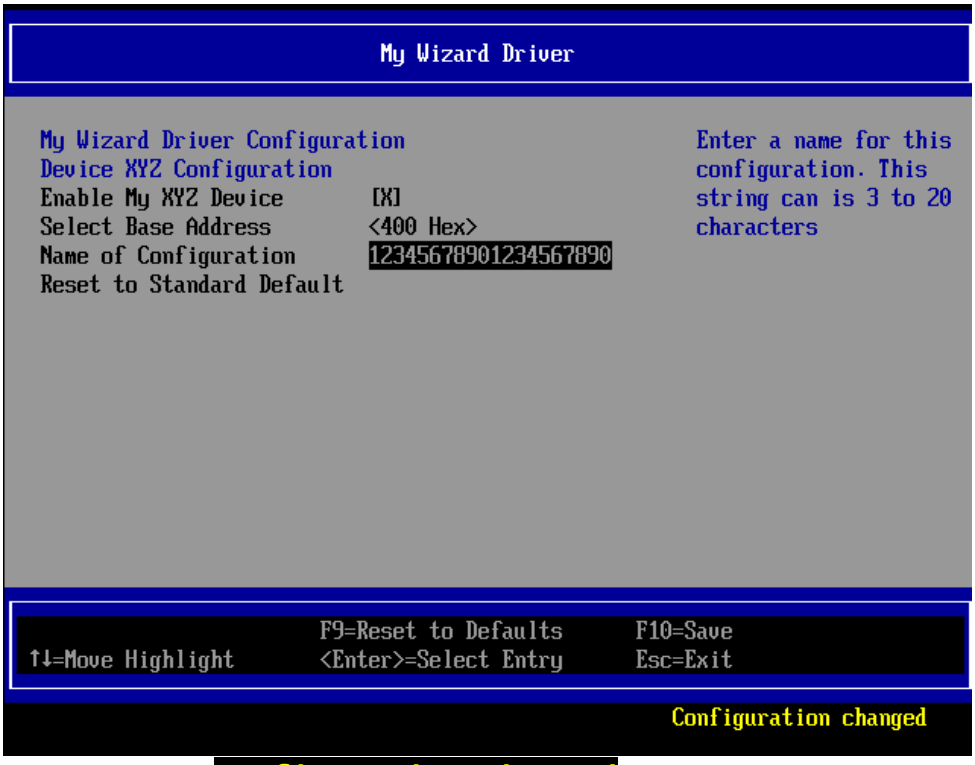
3	**Save** MyWizardDriver.vfr
4	**Update** MyWizardDriver.uni
5	**Add** the following code to the bottom of the file:

Step	Action

	`#string STR_MY_STRING_PROMPT #language en "Name of Configuration"`
	
	`#string STR_MY_STRING_HELP #language en "Enter a name for this configuration. This string can is 3 to 20 characters"`
	
	`#string STR_ONE_OF_TEXT1 #language en "400 Hex"`
	`#string STR_ONE_OF_TEXT2 #language en "480 Hex"`
	`#string STR_ONE_OF_TEXT3 #language en "500 Hex"`
	
	`#string STR_MY_STRING_PROMPT #language en "Name of Configuration"`
	
	`#string STR_MY_STRING_HELP #language en "Enter a name for this configuration. This`

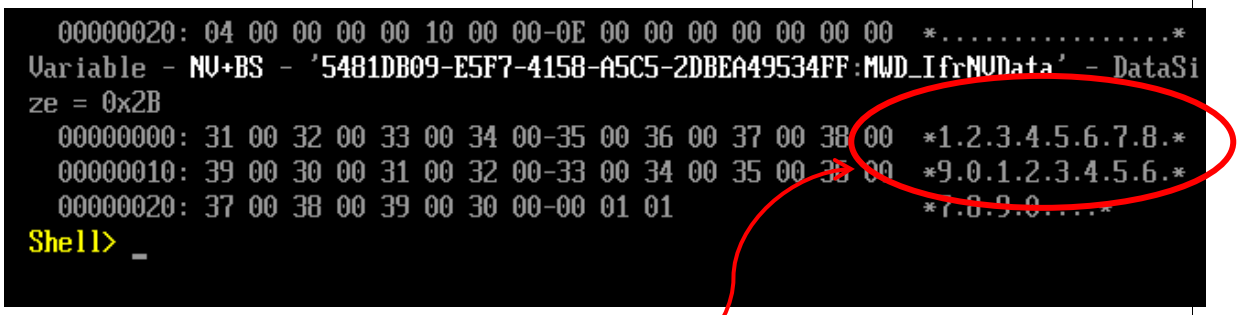
6	**Save** MyWizardDriver.uni
7	In the Terminal Command Prompt (Cntl-Alt-T), **`bash$ cd ~/src/edk2`**
8	**`bash$ build`**
9	**Copy MyWizardDriver.efi to hda-contents** **`bash$ cd ~/run-ovmf/`** **`bash$ cp ~/src/edk2/Build/OvmfX64/DEBUG_GCC5/FV/OVMF.fd bios.bin`**
10	**Invoke Qemu** **`bash$ . RunQemu.sh`**
11	**Type** `exit`
12	**Press** "Enter"
13	Now at the setup front page menu, **select "Device Manager"**
14	**Press** "Enter"
15	Inside the Device Manager menu, **select** "My Wizard Driver Sample Formset"
16	**Select** "Name of Configuration"
17	**Press** "Enter"

Step	Action
18	 **Notice** the string text pop up menu gets displayed
19	**Test** the "`minsize`" by only **typing** your choice of a two character string.
20	**Press** "Enter"  **Notice** the an error message validating that you need to enter three or more characters
21	**Press** "Enter" to clear the message
22	**Press** "Enter" again to re-enter pop up menu

Step	Action
23	 **Test** by **typing** more than "`maxsize`" of 20 characters **Notice** that the Browser only allows the maximum number of 20 characters to be entered with a forced stop. There is no error message but no more characters are allowed to be typed into the pop up menu.
24	**Press** "Enter"  **Notice** that the "**`Configuration changed`**" message is displayed
25	**Test** the `grayoutif` by **selecting** "Enable My XYZ Device"

Step	Action
26	Press the “Spacebar” to toggle off/disable **Notice** that the “Select Base Address” and “Name of Configruation” fields are now grayed out and not selectable 
27	**Press** “Space” again to Enable
28	**Press** “F10” to save
29	**Press** “Escape” to exit
30	**Press** “Escape” to exit the “Device Manager”
31	**Select “**Continue**”**
32	**Press** “Enter”
33	At the Shell Prompt, **type** `dmpstore -all` **Notice** the unicode string “12345678901234567890” is now stored because you entered those characters in the HII form menu. This is because the file WizardDriverNVDataStruc.h has the data structure stored in NVRAM with the GUID define name MWD_IfrNVData of type MYWIZARDDRIVER_CONFIGURATION. Notice that string data is the first 20 bytes in the data structure MWD_IfrNVData.MyWizardDriverStringData

Step	Action

34	
	`#pragma pack(1)`
	`typedef struct {`
	`  UINT16  MyWizardDriverStringData[20];`
	`  UINT8  MyWizardDriverHexData;`
	`  UINT8  MyWizardDriverBaseAddress;`
	`  UINT8  MyWizardDriverChooseToEnable;`
	`} MYWIZARDDRIVER_CONFIGURATION;`

35	**Type "`reset`"** at the Shell prompt
36	**Exit** QEMU

For any build issues copy the solution files from ~/Fw/LabSolutions/LessonE.6
NOTE: Delete Directory ~/src/edk2/Build/OvmfX64/DEBUG_GCC5/X64/MyWizardDriver before the Build command to build the MyWizardDriver Clean

7. Updating the Menu: Numeric Entry

In this lab, you'll learn how to add a numeric entry to your driver menu. This lab uses the VFR term "`numeric`" that prompts the user to enter a free-form numeric value. The VFR determines the minimum and maximum values with the terms "`minimum`" and "`maximum`". Since there is also an enable/disable switch, the VFR uses the "`suppressif`" term to display or hide this field when disabled. Also this field displays as decimal (default) or hexadecimal with the "`flags`" switch.

Figure 7 : Menu with Numeric item entry

Step	Action
1	**Update** the MyWizardDriver.vfr file
2	**Add** the following code in the location shown below at approx. Line 90 and before the "resetbutton" item:

```
//
// Define a numeric free form menu item
//
  suppressif  ideqval MWD_IfrNVData.MyWizardDriverChooseToEnable == 0x0;
   numeric varid   = MWD_IfrNVData.MyWizardDriverHexData,
            prompt  = STRING_TOKEN(STR_DATA_HEX_PROMPT),
            help    = STRING_TOKEN(STR_NUMERIC_HELP),
            flags   = DISPLAY_UINT_HEX ,     // Display in HEX format (if not
specified, default is in decimal format)
            minimum = 0,
```

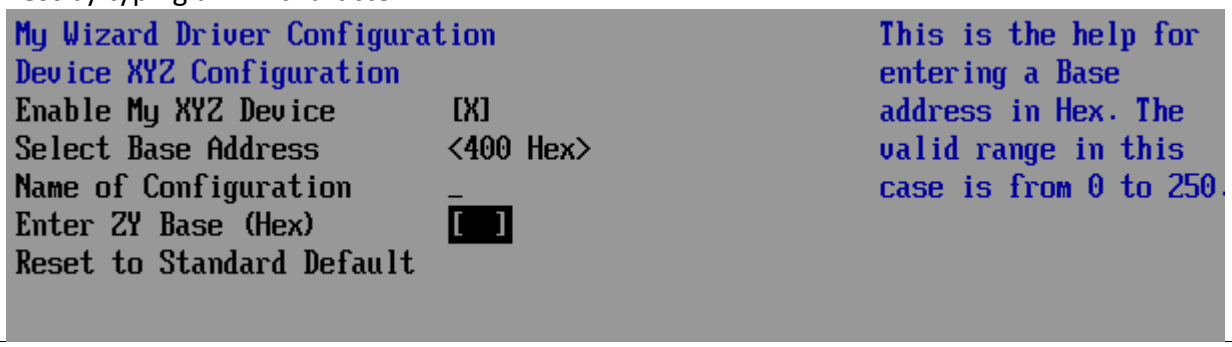
```
            maximum = 250,
          default = 0x22, defaultstore = MyStandardDefault,

    endnumeric;
  endif;
```

```
87      endstring;
88    endif;
89
90  //
91  // Define a numeric free form menu item
92  //
93    suppressif  ideqval MWD_IfrNVData.MyWizardDriverChooseToEnable == 0x0;
94     numeric varid   = MWD_IfrNVData.MyWizardDriverHexData,
95              prompt  = STRING_TOKEN(STR_DATA_HEX_PROMPT),
96              help    = STRING_TOKEN(STR_NUMERIC_HELP),
97              flags   = DISPLAY_UINT_HEX ,     // Display in HEX format (if
98              minimum = 0,
99              maximum = 250,
100             default = 0x22, defaultstore = MyStandardDefault,
101
102     endnumeric;
103   endif;
104
105
106     resetbutton
107       defaultstore = MyStandardDefault,
108       prompt   = STRING_TOKEN(STR_STANDARD_DEFAULT_PROMPT_RESET),
```

3	**Save** MyWizardDriver.vfr
4	**Update** the MyWizardDriver.uni file
5	**Add** the following code to the bottom of the file:

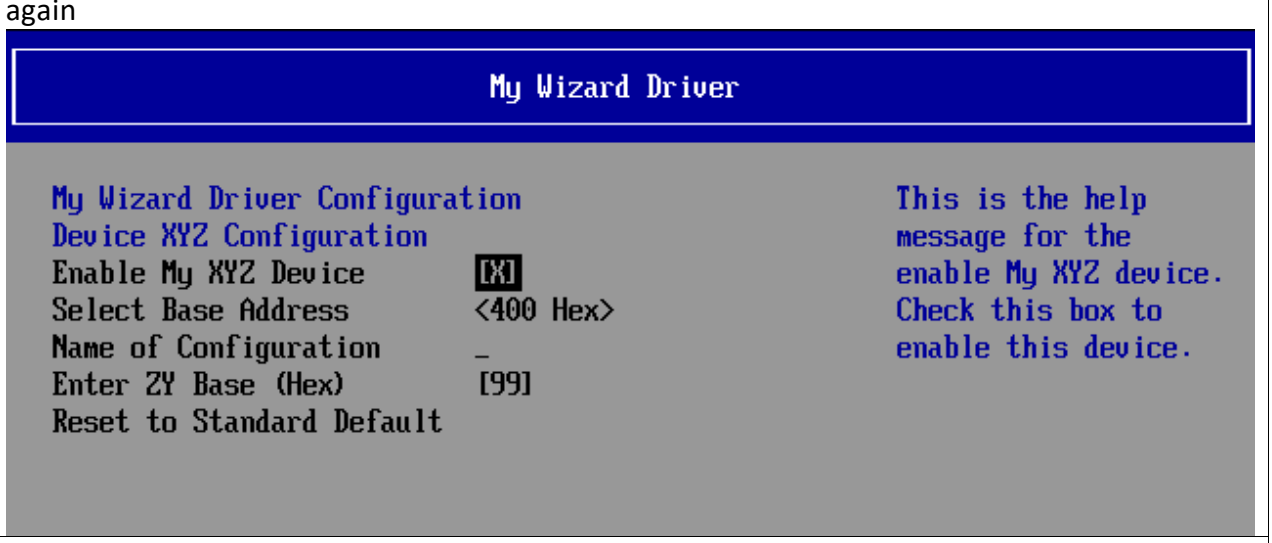
```
#string STR_DATA_HEX_PROMPT            #language en "Enter ZY Base
(Hex)"

#string STR_NUMERIC_HELP               #language en "This is the
help for entering a Base address in Hex. The valid range in this
case is from 0 to 250."
```

6	**Save** MyWizardDriver.uni
7	In the Terminal Command Prompt (Cntl-Alt-T), **bash$ cd ~/src/edk2**
8	**bash$ build**
9	**Copy OVMF.fd to run-ovmf** **bash$ cd ~/run-ovmf/** **bash$ cp ~/src/edk2/Build/OvmfX64/DEBUG_GCC5/FV/OVMF.fd bios.bin**

10	**Invoke Qemu** `bash$ . RunQemu.sh`
11	**Type** exit
12	**Press** "Enter"
13	Now at the setup front page menu, **select** "Device Manager"
14	**Press** "Enter"
15	Inside the Device Manager menu, **select** "My Wizard Driver Sample Formset" **Notice** the value for "Enter ZY Base(Hex)" is 022. Hex is the default because of the VFR field "`default = 0x22`"
16	**Select** "Enter ZY Base(Hex)"
17	**Press** "Enter"
18	**Test** by typing a "M" character 
18	**Notice** that only Numeric characters are allowed and also only values 00 to 0FA Hex. When values outside the range or none numeric characters are entered the red "!!" sting is displayed at the bottom of the menu. The string "!!" is part of the Browser engine : MdeModulePkg/Universal/SetupBrowserDxe/SetupBrowserStr.uni `#string INPUT_ERROR_MESSAGE #language en-US "!!"`

19	**Press** "Enter" again
20	**Test** by typing a value of '99' Hex
21	**Press** "Enter" **Notice** that the "**Configuration changed**" message is displayed
22	**Test the "surpressif"** by pressing the "spacebar" to "Enable My XYZ Device" then press the "Space" bar to toggle off or "Disabled".
23	**Notice the "Select Base Address" and "Name of Configuration"** fields are now grayed out and not selectable and the "**Enter ZY Base(Hex)**" does not appear at all.

24 **Press** "Space bar" again to "Enable My XYZ Device" and the "**Enter ZY Base(Hex)**" is displayed again



25 **Press** "F10" then "Escape" to exit

26 **Press** "Escape" to exit the "Device Manager"

27 **Select "**Continue**"**

28 **Press** "Enter"

29 At the Shell Prompt, **type** dmpstore –all

30

```
Variable - NV+BS - '5481DB09-E5F7-4158-A5C5-2DBEA49534FF:MWD_IfrNVData' - DataSi
ze = 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 00-99 02 01                 *...........*
Shell> _
```

```
21 #pragma pack(1)
22 typedef struct {
23
24     UINT16  MyWizardDriverStringData[20];
25     UINT8   MyWizardDriverHexData;
26     UINT8   MyWizardDriverBaseAddress;
27     UINT8   MyWizardDriverChooseToEnable;
28
29 } MYWIZARDDRIVER_CONFIGURATION;
```

Notice by modifying MyWizardDriverNVDataStruc.h our data structure stored in NVRAM is named **MWD_IfrNVData** of type MYWIZARDDRIVER_CONFIGURATION.

Notice that hex data is after the string data at the 21st byte in the data structure **MWD_IfrNVData.MyWizardDriverHexData**

31 **Type "reset"** at the Shell prompt

32 **Exit QEMU**

For any build issues copy the solution files from ~/FW/LabSolutions/LessonE.7
NOTE: Delete Directory ~/src/edk2/Build/OvmfX64/DEBUG_GCC5/X64/MyWizardDriver before the Build command to build the MyWizardDriver Clean

8. Updating your Driver for Interactive Call Backs

In this lab, you'll update your driver for interactive call backs. Call backs are a way to communicate changes the user is making in "real time" where your driver needs to intervene as the changes are made and before the user exits the current menu being displayed. These would be exception cases that the driver could interrupt the normal browser engine process.

To add call backs, the file HiiConfigAccess.c of your driver will be updated in the function MyWizardDriverHiiConfigAccessCallback. This function is called whenever any VFR items have a flag for INTERACTIVE set. So far, the previous labs did not have any call back items.

We can see this because there was a "Debug" call made in the MyWizardDriverHiiConfigAccessCallback function that never gets called:

HiiConfigAccess.c (line 331)

```
DEBUG ((DEBUG_INFO, "\n:: START Call back ,Question ID=0x%08x Type=0x%04x
Action=0x%04x", QuestionId, Type, Action));
```

a. Add the Case statements to the Call back routine

Step	Action
1	**Update** the HiiConfigAccess.c file
2	**Add** the following code before return status; to include a "case" statement in the call back routine for the "action" passed. Add the following code at approx. line 343 before: **`return status`**;

Step	Action

```
switch (Action) { // Start switch and passed param Action
case EFI_BROWSER_ACTION_FORM_OPEN:  // 3
  {
  }
  break;

case EFI_BROWSER_ACTION_FORM_CLOSE: // 4
  {
  }
  break;

case EFI_BROWSER_ACTION_RETRIEVE: // 2
  {
  }
  break;

case EFI_BROWSER_ACTION_DEFAULT_STANDARD: // 0x1000
  {
  }
  break;

case EFI_BROWSER_ACTION_DEFAULT_MANUFACTURING: // 0x1001
  {
  }
  break;
case EFI_BROWSER_ACTION_CHANGING:  // 0
  {
  }
  break;

case EFI_BROWSER_ACTION_CHANGED:  // 1
  {
  }
  break;

default:
  Status = EFI_UNSUPPORTED;
  break;
}  // end switch case on Action
```

Step	Action
3	**Save** HiiConfigAccess.c

```
340   FormId = 0;
341   Status = EFI_SUCCESS;
342   PrivateData = MYWIZARDDRIVER_DEV_FROM_THIS (This);
343
344
345   switch (Action) { // Start switch and passed param Action
346   case EFI_BROWSER_ACTION_FORM_OPEN:  // 3
347     {
348         }
349     break;
350
351   case EFI_BROWSER_ACTION_FORM_CLOSE: // 4
352     {
353         }
354         break;
355
356   case EFI_BROWSER_ACTION_RETRIEVE: // 2
357     {
358         }
359         break;
360
361   case EFI_BROWSER_ACTION_DEFAULT_STANDARD: // 0x1000
362     {
363         }
364         break;
365
366   case EFI_BROWSER_ACTION_DEFAULT_MANUFACTURING: // 0x1001
367     {
368         }
369         break;
370
371   case EFI_BROWSER_ACTION_CHANGING:  // 0
372     {
373         }
374     break;
375
376   case EFI_BROWSER_ACTION_CHANGED:  // 1
377     {
378         }
379     break;
380
381   default:
382     Status = EFI_UNSUPPORTED;
383     break;
384   }  // end switch case on Action
385
386   return Status;
387
388 //  return EFI_UNSUPPORTED;
389 }
```

Step	Action
4	In the Terminal Command Prompt (Cntl-Alt-T), **bash$ cd ~/src/edk2**
5	**bash$ build**
6	**Copy OVMF.fd to run-ovmf** **bash$ cd ~/run-ovmf/** **bash$ cp ~/src/edk2/Build/OvmfX64/DEBUG_GCC5/FV/OVMF.fd bios.bin**
7	**Invoke Qemu** **bash$. RunQemu.sh**
8	**Type** exit
9	**Press** "Enter"
10	Now at the setup front page menu, **select** "Device Manager"
11	**Press** "Enter"
12	Inside the Device Manager menu, **select** "My Wizard Driver Sample Formset"
13	**Press** "Enter"
14	**Notice** the debug messages in the Debug output (**No Debug messages for Call back**)
15	**Press** "Escape" to exit
16	**Press** "Escape" to exit the "Device Manager"
17	**Select "**Continue**"**
18	**Press** "Enter"
19	**Type** "reset" at the Shell prompt
20	Exit QEMU

b. Update the Menu for Interactive items

1	**Update** the MyWizardDriver.vfr file
2	Now, you'll add the flag characteristic `INTERACTIVE` to the string item's flags by using keyword `INTERACTIVE` and `questionid`. **Add** the following code in the location shown below: Approx. line 83 and line 86
	`questionid = 0x1001,`
	`flags = INTERACTIVE,`

```
76
77  //
78  // Define a string (EFI_IFR_STRING) to name the configuration in the
79  // NVRAM variable
80      //
81    grayoutif  ideqval MWD_IfrNVData.MyWizardDriverChooseToEnable == 0x0;
82      string     varid     = MWD_IfrNVData.MyWizardDriverStringData,
83             questionid  = 0x1001,
84                prompt    = STRING_TOKEN(STR_MY_STRING_PROMPT),
85                help      = STRING_TOKEN(STR_MY_STRING_HELP),
86                flags     = INTERACTIVE,
87                minsize   = 3,
88                maxsize   = 20,
89      endstring;
90    endif;
91
```

3

Include the numeric item by adding the following code in the location shown below, Approx. line 97 and line 100

```
questionid = 0x1111,
| INTERACTIVE
```

```
92  //
93  // Define a numeric free form menu item
94  //
95    suppressif  ideqval MWD_IfrNVData.MyWizardDriverChooseToEnable == 0x0;
96     numeric varid    = MWD_IfrNVData.MyWizardDriverHexData,
97             questionid  = 0x1111,
98              prompt   = STRING_TOKEN(STR_DATA_HEX_PROMPT),
99              help     = STRING_TOKEN(STR_NUMERIC_HELP),
100             flags    = DISPLAY_UINT_HEX | INTERACTIVE,     // Display in HEX
101             minimum = 0,
102             maximum = 250,
103             default = 0x22, defaultstore = MyStandardDefault,
104
105     endnumeric;
106   endif;
```

4

Save MyWizardDriver.vfr

5

In the Terminal Command Prompt (Cntl-Alt-T),

bash$ cd ~/src/edk2

6

bash$ build

7

Copy OVMF.fd to run-ovmf

bash$ cd ~/run-ovmf/

bash$ cp ~/src/edk2/Build/OvmfX64/DEBUG_GCC5/FV/OVMF.fd bios.bin

8

Invoke Qemu

bash$. RunQemu.sh

9

Type exit

10

Press "Enter"

11

Now at the setup front page menu, **select** "Device Manager"

12

Press "Enter"

13	Inside the Device Manager menu, **select** “My Wizard Driver Sample Formset”
14	**Press** “Enter”
15	
16	**click** on “Name of Configuration” and “Enter ZY Base(Hex)”

17

Notice the following in the Debug Output:
Every time the browser does anything with the interactive labeled fields there is a call made to your driver's call back function. We can determine which item by the quetionid and what action by the Action passed to your call back function. Your call back function can then add code to special case when these transitions occur.

Entering Form

```
:: START Call back ,Question ID=0x00001001 Type=0x0007 Action=0x0003
:: START Call back ,Question ID=0x00001111 Type=0x0000 Action=0x0003
:: START Call back ,Question ID=0x00001001 Type=0x0007 Action=0x0002
```

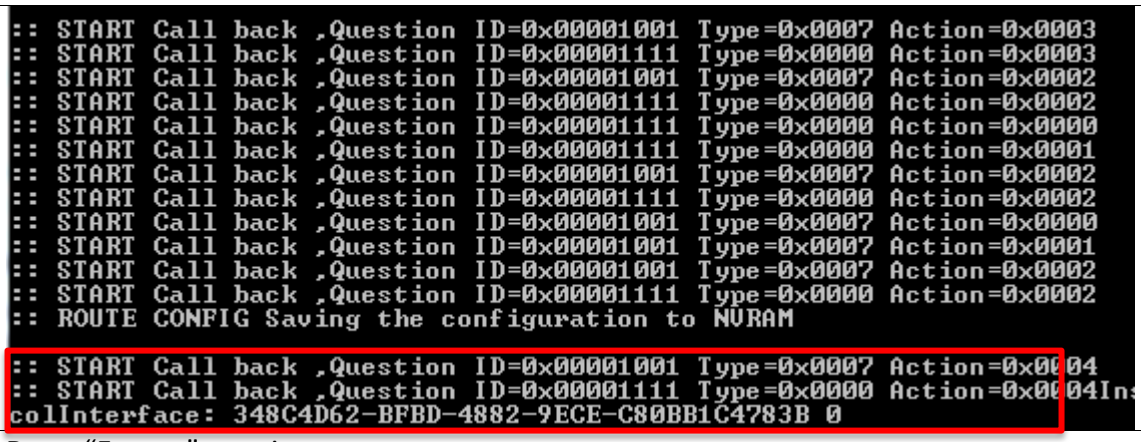
Changing a Value for Question ID 0x1111

```
:: START Call back ,Question ID=0x00001001 Type=0x0007 Action=0x0003
:: START Call back ,Question ID=0x00001111 Type=0x0000 Action=0x0003
:: START Call back ,Question ID=0x00001001 Type=0x0007 Action=0x0002
:: START Call back ,Question ID=0x00001111 Type=0x0000 Action=0x0002
:: START Call back ,Question ID=0x00001111 Type=0x0000 Action=0x0000
:: START Call back ,Question ID=0x00001111 Type=0x0000 Action=0x0001
:: START Call back ,Question ID=0x00001001 Type=0x0007 Action=0x0002
```

Changing a Value for Question ID 0x1001

```
:: START Call back ,Question ID=0x00001001 Type=0x0007 Action=0x0003
:: START Call back ,Question ID=0x00001111 Type=0x0000 Action=0x0003
:: START Call back ,Question ID=0x00001001 Type=0x0007 Action=0x0002
:: START Call back ,Question ID=0x00001111 Type=0x0000 Action=0x0002
:: START Call back ,Question ID=0x00001111 Type=0x0000 Action=0x0000
:: START Call back ,Question ID=0x00001111 Type=0x0000 Action=0x0001
:: START Call back ,Question ID=0x00001001 Type=0x0007 Action=0x0002
:: START Call back ,Question ID=0x00001111 Type=0x0000 Action=0x0002
:: START Call back ,Question ID=0x00001001 Type=0x0007 Action=0x0000
:: START Call back ,Question ID=0x00001001 Type=0x0007 Action=0x0001
:: START Call back ,Question ID=0x00001001 Type=0x0007 Action=0x0002
```

```
:: START Call back ,Question ID=0x00001001 Type=0x0007 Action=0x0003
:: START Call back ,Question ID=0x00001111 Type=0x0000 Action=0x0003
:: START Call back ,Question ID=0x00001001 Type=0x0007 Action=0x0002
:: START Call back ,Question ID=0x00001111 Type=0x0000 Action=0x0002
:: START Call back ,Question ID=0x00001111 Type=0x0000 Action=0x0000
:: START Call back ,Question ID=0x00001111 Type=0x0000 Action=0x0001
:: START Call back ,Question ID=0x00001001 Type=0x0007 Action=0x0002
:: START Call back ,Question ID=0x00001111 Type=0x0000 Action=0x0002
:: START Call back ,Question ID=0x00001001 Type=0x0007 Action=0x0000
:: START Call back ,Question ID=0x00001001 Type=0x0007 Action=0x0001
:: START Call back ,Question ID=0x00001001 Type=0x0007 Action=0x0002
:: START Call back ,Question ID=0x00001111 Type=0x0000 Action=0x0002
:: ROUTE CONFIG Saving the configuration to NVRAM
```

	
18	**Press** "Escape" to exit
19	**Press** "Escape" to exit the "Device Manager"
20	**Select "**Continue**"**
21	**Press** "Enter"
22	**Type** "`reset`" at the Shell prompt
23	Exit QEMU

For any build issues copy the solution files from ~/FW/LabSolutions/LessonE.8
NOTE: Delete Directory ~/src/edk2/Build/OvmfX64/DEBUG_GCC5/X64/MyWizardDriver before the Build command to build the MyWizardDriver Clean
.

9. Add code to your driver when Call Back events occur for Interactive Items

In this lab, you'll update your driver to print debug statements when the Hii browser engine calls back into your call back function. Every time the browser does anything with the interactive labeled fields there is a call made to your driver's call back function. We can determine the item by the quetionid and what action based on the action passed to your call back function. Your call back function can then add code to special case when these transitions occur.

For this lab we will simply add Debug print statements. However, the use of adding call backs to a driver's HII functions adds the capability of providing more manageability and flexibility for the interactions between the user, the browser engine, and your driver code. In a real driver firmware situation, it may be desired to implement more complex features and functionality based upon an item changing.

Step	Action
1	**Update** the HiiConfigAccess.c file

Step	Action
2	**Comment out** the DEBUG statement with "//" in the MyWizardDriverHiiConfigAccessCallback call back function approx. line 330: Because this will get called so many times that it will be hard to determine where your code is actually doing something
	//
	326 MYWIZARDDRIVER_DEV *PrivateData; 327 EFI_STATUS Status; 328 EFI_FORM_ID FormId; 329 330 // DEBUG ((DEBUG_INFO, "\n:: START Call back ,Question ID=0 331 332 333 334 if (((Value == NULL) && (Action != EFI_BROWSER_ACTION_FORM_O
3	**Add** a switch case statement of the question ID's to the "Action" switch case of EFI_BROWSER_ACTION_CHANGING in the call back function by **adding** a nested switch case code (as shown below at approx. line 372)

Step	Action

	switch (QuestionId) {
	case 0x1111:
	DEBUG ((DEBUG_INFO, "\n:: START Call back-Changing ,Question ID=0x%08x Type=0x%04x Action=0x%04x", QuestionId, Type, Action));
	break;
	case 0x1001:
	DEBUG ((DEBUG_INFO, "\n:: START Call back-Changing ,Question ID=0x%08x Type=0x%04x Action=0x%04x", QuestionId, Type, Action));
	break;
	default:
	Status = EFI_UNSUPPORTED;
	break;
	}

	369
	370 case EFI_BROWSER_ACTION_CHANGING: // 0
	371 {
	372 switch (QuestionId) {
	373 case 0x1111:
	374 DEBUG ((DEBUG_INFO, "\n:: START Call back- Chan
	375 break;
	376 case 0x1001:
	377 DEBUG ((DEBUG_INFO, "\n:: START Call back- Chan
	378 break;
	379 default:
	380 Status = EFI_UNSUPPORTED;
	381 break;
	382 }
	383 }
	384 break;
	385
	386 case EFI_BROWSER_ACTION_CHANGED: // 1

4	**Add** another nested switch case statement of the question ID's to the "Action" switch case of EFI_BROWSER_ACTION_CHANGED in the call back function (as show below at approx. line 388):

Step	Action

	switch (QuestionId) {
	case 0x1111:
	DEBUG ((DEBUG_INFO, "\n:: START Call back-Changed ,Question ID=0x%08x Type=0x%04x Action=0x%04x", QuestionId, Type, Action));
	break;
	case 0x1001:
	DEBUG ((DEBUG_INFO, "\n:: START Call back-Changed ,Question ID=0x%08x Type=0x%04x Action=0x%04x", QuestionId, Type, Action));
	break;
	default:
	Status = EFI_UNSUPPORTED;
	break;
	}

	385
	386 case EFI_BROWSER_ACTION_CHANGED: // 1
	387 {
	388 switch (QuestionId) {
	389 case 0x1111:
	390 DEBUG ((DEBUG_INFO, "\n:: START Call back- Changed
	391 break;
	392 case 0x1001:
	393 DEBUG ((DEBUG_INFO, "\n:: START Call back- Changed
	394 break;
	395 default:
	396 Status = EFI_UNSUPPORTED;
	397 break;
	398 }
	399 }
	400 break;
	401
	402 default:
	403 Status = EFI_UNSUPPORTED;
	404 break;
	405 } // end switch case on Action
	406
	407 return Status;
	408

5	**Save** MyWizardDriver.c

Step	Action
6	In the Terminal Command Prompt (Cntl-Alt-T), **`bash$ cd ~/src/edk2`**
7	**`bash$ build`**
8	**Copy OVMF.fd to run-ovmf** **`bash$ cd ~/run-ovmf/`** **`bash$ cp ~/src/edk2/Build/OvmfX64/DEBUG_GCC5/FV/OVMF.fd bios.bin`**
9	**Invoke Qemu** **`bash$ . RunQemu.sh`**
10	**Type** `exit`
11	**Press** "Enter"
12	Now at the setup front page menu, **select** "Device Manager"
13	**Press** "Enter"
14	Inside the Device Manager menu, **select** "My Wizard Driver Sample Formset"
15	**Press** "Enter"
16	**Observe** the Debug output **Test:** changing the **"Name of Configuration"** and the "**Enter ZY Base(Hex)**" fields while observing the Debug output
17	**Notice:** when changing the "**Name of Configuration**" field
18	**Notice:** when changing the "**Enter ZY Base(Hex)**" field
19	**Notice:** when Pressing "F10"
20	**Press** "Escape" to exit
21	**Press** "Escape" to exit the "Device Manager"
22	**Select "**Continue**"**
23	**Press** "Enter"
24	**Type** "`reset`" at the Shell prompt
25	**Exit QEMU**

For any build issues copy the solution files from ~/FW/LabSolutions/LessonE.9
NOTE: Delete Directory ~/src/edk2/Build/OvmfX64/DEBUG_GCC5/X64/MyWizardDriver before the Build command to build the MyWizardDriver Clean

10. Adding an Additional Form Page

In this lab, you'll learn how to add another form page to your My Wizard Driver menu by using the "`goto`" VFR term along with the "`form`" and "`formid`" VFR statements. Additionally, use "`surpressif`" or "`grayoutif`" to conditionally allow the user to enter your additional forms.

In addition, this lab will show how the "`time`" and "`date`" VFR terms are used within the VFR language to special case how the browser engine checks the time instead of your driver manually checking (e.g. leap year).

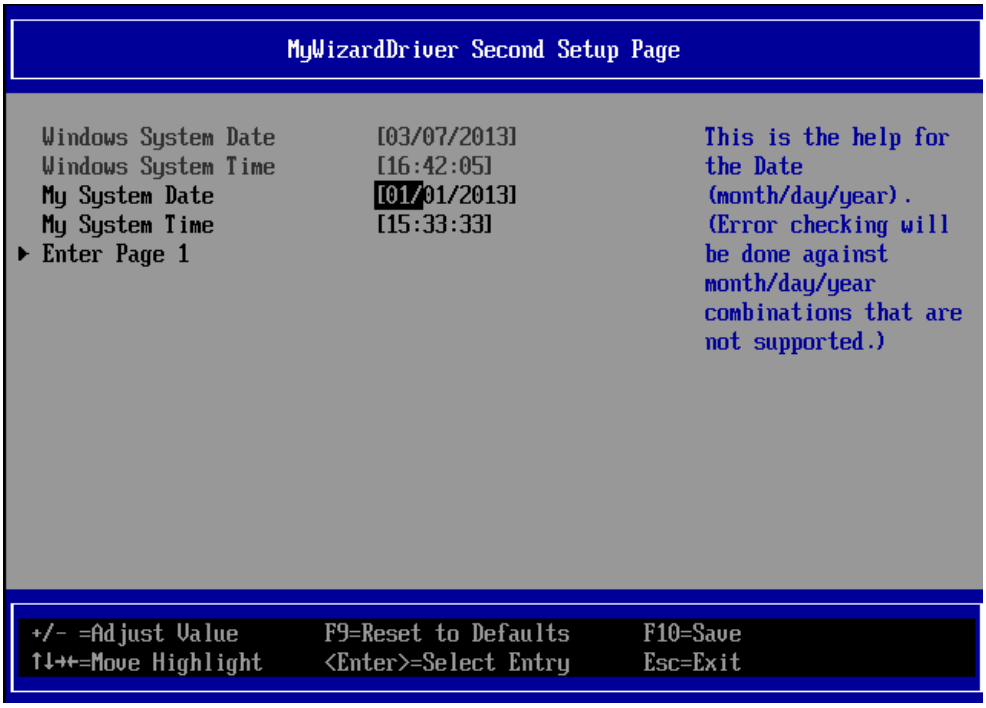
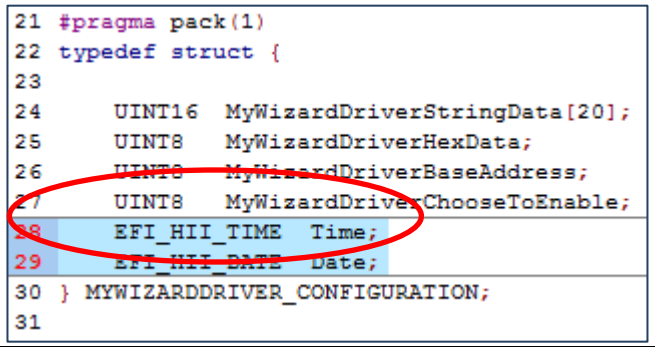


Figure 10: Second setup page

Step	Action
1	**Update** the MyWizardDriverNVDataStruc.h file
2	**Add** the following date and time fields to the configuration `typedef` (to to the location shown below):
	EFI_HII_TIME Time; EFI_HII_DATE Date;

Step	Action
	 21 #pragma pack(1) 22 typedef struct { 23 24 UINT16 MyWizardDriverStringData[20]; 25 UINT8 MyWizardDriverHexData; 26 UINT8 MyWizardDriverBaseAddress; 27 UINT8 MyWizardDriverChooseToEnable; 28 EFI_HII_TIME Time; 29 EFI_HII_DATE Date; 30 } MYWIZARDDRIVER_CONFIGURATION; 31
3	**Save** MyWizardDriverNVDataStruc.h
4	**Update** the MyWizardDriver.uni file

5	**Add** the following code to the end of the file to update the second page's string:
	`#string STR_FORM2_TITLE #language en "MyWizardDriver Second Setup Page"`
	`#string STR_DATE_PROMPT #language en "Windows System Date"`
	`#string STR_DATE_HELP #language en "This is the help for the Date (month/day/year). (Error checking will be done against month/day/year combinations that are not supported.)"`
	`#string STR_TIME_PROMPT #language en "Windows System Time"`
	`#string STR_TIME_HELP #language en "This is the help for the Time (hour/minute/second)."`
	`#string STR_ERROR_POPUP #language en "You typed in the wrong value!"`
	
	`#string STR_GOTO_FORM1 #language en "Enter Page 1"`
	`#string STR_GOTO_FORM2 #language en "Enter Page 2"`
	`#string STR_GOTO_HELP #language en "This is my goto help"`
	
	`#string STR_MY_DATE_PROMPT #language en "My System Date"`
	
	`#string STR_MY_TIME_PROMPT #language en "My System Time"`

6	**Save** MyWizardDriver.uni
7	**Update** the MyWizardDriver.vfr file
8	**Add** the "goto" VFR item to allow browser to ender another form by adding the following code before the "**endform"** at approx. line 114

Step	Action

	grayoutif ideqval MWD_IfrNVData.MyWizardDriverChooseToEnable == 0x0;
	goto 2,
	prompt = STRING_TOKEN(STR_GOTO_FORM2), //SecondSetupPage
	help = STRING_TOKEN(STR_GOTO_HELP);
	endif;

	108 resetbutton 109 defaultstore = MyStandardDefault, 110 prompt = STRING_TOKEN(STR_STANDARD_DEFAULT_PROMPT_RESET), 111 help = STRING_TOKEN(STR_STANDARD_DEFAULT_HELP), 112 endresetbutton; 113 114 grayoutif ideqval MWD_IfrNVData.MyWizardDriverChooseToEnable == 0x0; 115 goto 2, 116 prompt = STRING_TOKEN(STR_GOTO_FORM2), //SecondSetupPage 117 help = STRING_TOKEN(STR_GOTO_HELP); 118 endif; 119 120 endform; 121
9	**Add** the following code between "**endform"** `at approx. line 120` and "**endformset"** (the code continues for three pages in this lab guide):

```
form formid = 2,            // SecondSetupPage,
  title = STRING_TOKEN(STR_FORM2_TITLE);

  grayoutif TRUE; // DATE is the date of the Windows Host so can not change it.;
  date    year varid  = Date.Year, // Note that it is a member of NULL,
          //so the RTC will be the system resource to retrieve and save from
        prompt      = STRING_TOKEN(STR_DATE_PROMPT),
        help        = STRING_TOKEN(STR_DATE_HELP),
        minimum     = 1998,
        maximum     = 2099,
        step        = 1,
        default     = 2010,

        month varid = Date.Month, // Note that it is a member of NULL,
          //so the RTC will be the system resource to retrieve and save from
        prompt      = STRING_TOKEN(STR_DATE_PROMPT),
        help        = STRING_TOKEN(STR_DATE_HELP),
        minimum     = 1,
        maximum     = 12,
        step        = 1,
        default     = 1,

        day varid   = Date.Day, // Note that it is a member of NULL,
          //so the RTC will be the system resource to retrieve and save from
        prompt      = STRING_TOKEN(STR_DATE_PROMPT),
```

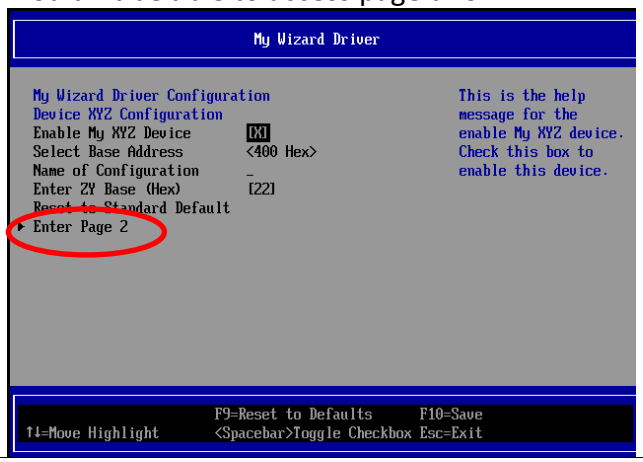
Step	Action
	help = STRING_TOKEN(STR_DATE_HELP), minimum = 1, maximum = 31, step = 0x1, default = 1, enddate; endif; //grayoutif TRUE DATE

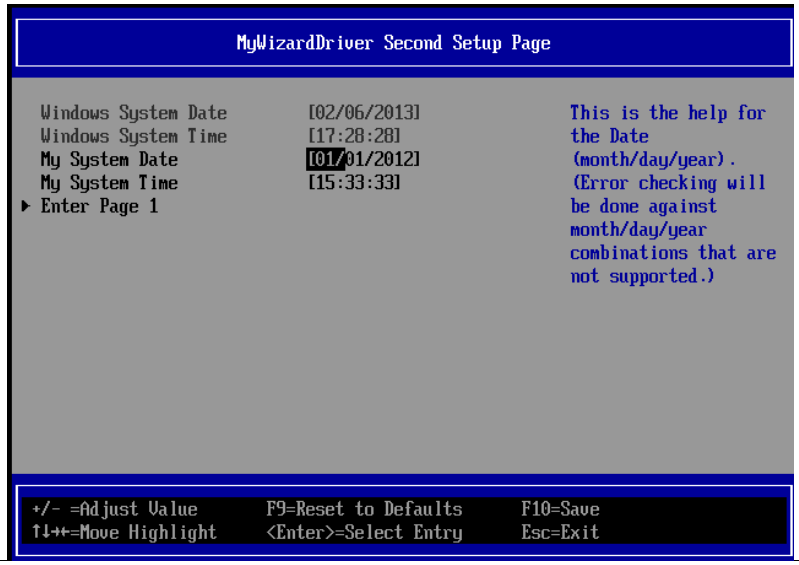
```
grayoutif TRUE;  // TIME – WINDOWS TIME
 time    hour varid  = Time.Hour, // Note that it is a member of NULL,
         //so the RTC will be the system resource to retrieve and save from
        prompt      = STRING_TOKEN(STR_TIME_PROMPT),
        help        = STRING_TOKEN(STR_TIME_HELP),
        minimum     = 0,
        maximum     = 23,
        step        = 1,
        default     = 0,

        minute varid  = Time.Minute, // Note that it is a member of NULL,
          //so the RTC will be the system resource to retrieve and save from
        prompt       = STRING_TOKEN(STR_TIME_PROMPT),
        help         = STRING_TOKEN(STR_TIME_HELP),
        minimum      = 0,
        maximum      = 59,
        step         = 1,
        default      = 0,

        second varid  = Time.Second, // Note that it is a member of NULL,
          //so the RTC will be the system resource to retrieve and save from
        prompt       = STRING_TOKEN(STR_TIME_PROMPT),
        help         = STRING_TOKEN(STR_TIME_HELP),
              minimum      = 0,
        maximum      = 59,
        step         = 1,
```

Step	Action
	default = 0, endtime; endif; //grayoutif TRUE TIME

Step	Action

	date // My Wizard Driver Date
	varid = MWD_IfrNVData.Date ,
	prompt = STRING_TOKEN(STR_MY_DATE_PROMPT),
	help = STRING_TOKEN(STR_DATE_HELP),
	flags = STORAGE_NORMAL,
	default = 2013/01/01,
	enddate;
	
	time // My Wizard Driver Time
	name = MyTimeMWD,
	varid = MWD_IfrNVData.Time,
	prompt = STRING_TOKEN(STR_MY_TIME_PROMPT),
	help = STRING_TOKEN(STR_TIME_HELP),
	flags = STORAGE_NORMAL ,
	default = 15:33:33,
	endtime;
	
	goto 1,
	prompt = STRING_TOKEN(STR_GOTO_FORM1), //MainSetupPage
	// this too has no end-op and basically it's a jump to a form ONLY
	help = STRING_TOKEN(STR_GOTO_HELP);
	
	endform;

Step	Action
10	**Save** MyWizardDriver.vfr
11	In the Terminal Command Prompt (Cntl-Alt-T), **`bash$ cd ~/src/edk2`**
12	**`bash$ build`**
13	**Copy OVMF.fd to run-ovmf** **`bash$ cd ~/run-ovmf/`** **`bash$ cp ~/src/edk2/Build/OvmfX64/DEBUG_GCC5/FV/OVMF.fd bios.bin`**
14	**Invoke Qemu** **`bash$ . RunQemu.sh`**
15	**Type** `exit`
16	Now at the setup front page menu, **select** "Device Manager"
17	**Press** "Enter"
18	Inside the Device Manager menu, **select** "My Wizard Driver Sample Formset"
19	**Press** "Enter" **Notice** the "Enter Page 2" option. Without `goto` in the MyWizardDriver.vfr file, you wouldn't be able to access page two. 
20	**Select** "Enter Page 2"

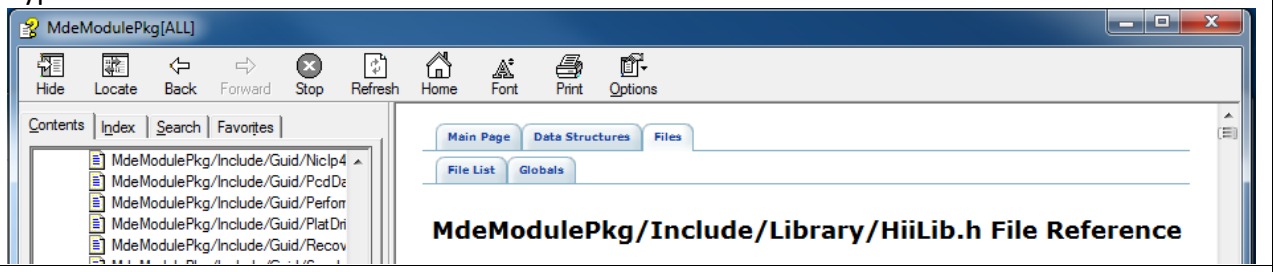
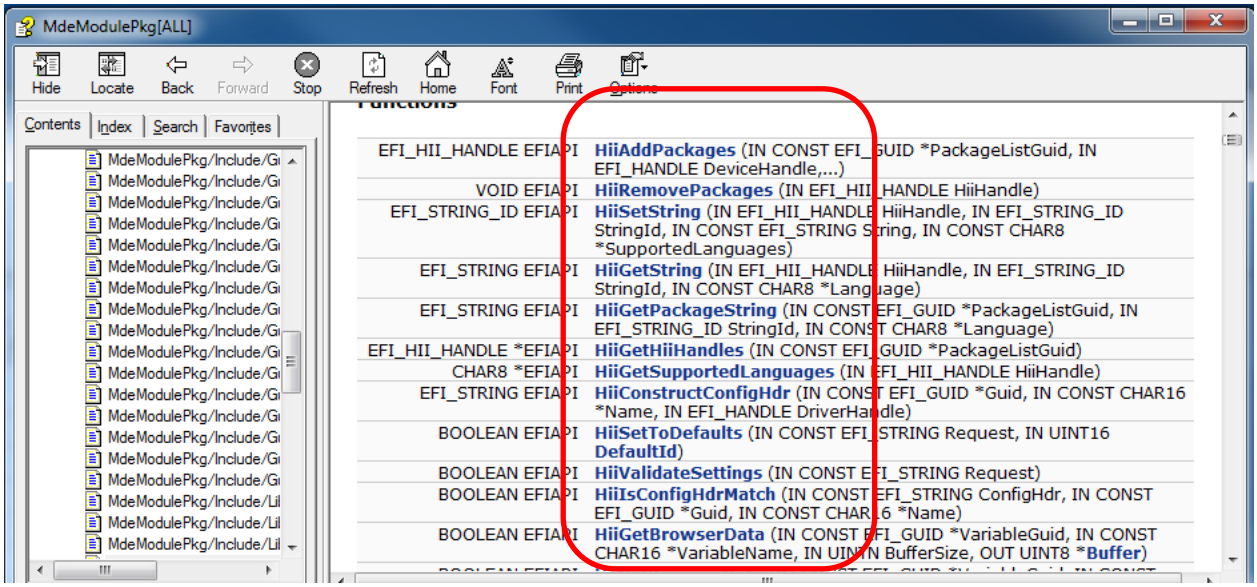
Step	Action
21	**Press** "Enter" **Notice** how the Windows System Date and Time cannot be modified to any other date/time and is grayed out: 
22	**Test** by trying to enter the date 02/30/2013, then try a valid leap year date: 02/29/2012.
23	**Press** "Down Arrow" to return to Page 1
24	Test the "`grayoutif`" by going to "Enable My XYZ Device"
25	Press the "Spacebar" to toggle off/disable

Step	Action
26	**Notice** the "Select Base Address" , "Name of Configuration" and the "Enter Page 2" fields are now grayed out and not selectable  **Note**: If you wanted to hide "**Enter Page 2**", you would simply replace the `grayoutif` code you entered with `suppressif` in the VFR file
27	**Press** "Space bar" again to Enable
28	**Press** "F10" then "Escape" to save and exit
29	**Press** "Escape" to exit "Device Manager"
30	**Select "**Continue**"**
31	**Press** "Enter"
32	**Type** "`reset`" `FS0:\> reset_`
33	**Exit QEMU**

For any build issues copy the solution files from ~/FW//LabSolutions/LessonE.10
NOTE: Delete Directory ~/src/edk2/Build/OvmfX64/DEBUG_GCC5/X64/MyWizardDriver before the Build command to build the MyWizardDriver Clean

11. Adding Communication from Driver to Console through HII

In this lab, you'll add communication from the driver to the console through HII. More specifically, you'll add code to retrieve a string from the HII database and print the string to the console. Then, you'll add the string in French, change the language, and test to ensure the correct language is displayed. The reason the driver should avoid direct string text to the console without the HII support is because there is no localization for text string inside the driver's source code. By using the HII database the strings are tokenized making localization easier.

Step	Action
1	For HII database library functions open the MdeModulePkg .Chm file and search on HiiLib.h functions
2	Select the Index tab
3	Type: HiiLib.h 
4	 ***Note***: Notice the list of Hii function calls available. To get Strings the `HiiGetString` function can be used.

Step	Action
5	**Update** the ~/src/edk2/OvmfPkg/OvmfPkgX64.fdf file
6	Make your driver stand alone. **Remove** (or comment out) the include statement in the OvmfPkgX64.fdf file:
	`#INF  MyWizardDriver/MyWizardDriver.inf`

	`INF  MdeModulePkg/Universal/Network/IScsiD`
	`#INF  MyWizardDriver/MyWizardDriver.inf`
	`!if $(BUILD_NEW_SHELL) == TRUE`
	`INF  ShellPkg/Application/Shell/Shell.inf`
	`!endif`

7	**Save** OvmfpkgX64.fdf
8	**Update** the MyWizardDriver.uni file
9	Add the following code to the top of the file at approx. line 14 as shown:
	`#langdef fr-FR  "Francais"`

	`12`
	`13 #langdef en "English"`
	`14 #langdef fr-FR  "Francais"`
	`15`
	`16 #string STR_SAMPLE_FORM_SET_TITLE  #language en  "My Wizard I`
	`17 #string STR_SAMPLE_FORM_SET_HELP  #language en  "Help for Sa`
	`18 #string STR_SAMPLE_FORM1_TITLE  #language en  "My Wizard I`
	`19`

10	Add the following code to the end of the file:
	`#string STR_LANGUAGE_TEST_STRING  #language en "Laurie's Test String"` `#language fr-FR "Chaîne de test de Laurie"`

	`75`
	`76 #string STR_MY_TIME_PROMPT  #language en "My System Time"`
	`77`
	`78 #string STR_LANGUAGE_TEST_STRING  #language en "Laurie's Test String"`
	`79  #language fr-FR "Chaîne de test de Laurie"`
	`80`

11	**Save** MyWizardDriver.uni
12	**Update** the MyWizardDriver.c file
13	**Add** the following local variable for `StringPtr` after "`BOOLEAN ActionFlag;`" and before "`Status = EFI_SUCCESS;`"(as shown below):

Step	Action
	`EFI_STRING StringPtr;`

	`189 UINTN BufferSize;`
	`190 MYWIZARDDRIVER_CONFIGURATION *Configuration;`
	`191 BOOLEAN ActionFlag;`
	`192 EFI_STRING StringPtr;`
	`193 Status = EFI_SUCCESS;`
	`194`

14	Add the following code after "`FreePool (ConfigRequestHdr);`" (as shown below) to edit the driver's entry point with a debug and print statement by making a call to the HiiGetString for the token to print (at approx line 364):

	`StringPtr = HiiGetString (HiiHandle[0], STRING_TOKEN (STR_LANGUAGE_TEST_STRING), NULL);`
	`DEBUG ((EFI_D_INFO,"[MyWizardDriver-Entrypoint] My String was: %s\n", StringPtr) );`
	`Print(L"%s\n", StringPtr );`

	`362 FreePool (ConfigRequestHdr);`
	`363`
	`364 StringPtr = HiiGetString (HiiHandle[0], STRING_TOKEN (STR_LANGUAGE_TEST_ST`
	`365 DEBUG ((EFI_D_INFO,"[MyWizardDriver-Entrypoint] My String was: %s\n", StringPtr)`
	`366 Print(L"%s\n", StringPtr );`
	`367`
	`368 // end HII`
	`369 //`
	`370 // Install Driver Supported EFI Version Protocol onto ImageHandle`

15	**Save** the MyWizardDriver.c
16	In the Terminal Command Prompt (Cntl-Alt-T), **`bash$ cd ~/src/edk2`**
17	**`bash$ build`**
18	**Copy MyWizardDriver.efi to hda-contents** **`bash$ cd ~/run-ovmf/hda-contents`** **`bash$ cp ~/src/edk2/Build/OvmfX64/DEBUG_GCC5/X64/MyWizardDriver.efi .`**
19	**Invoke Qemu** **`bash$ cd ~/run-ovmf`** **`bash$ . RunQemu.sh`**
20	**Load the UEFI Driver from the shell** At the Shell 2.0 prompt, **type `fs0:`**

Step	Action

21	**Type** `load MyWizardDriver.efi` and notice that the string's English version is displayed:
	`Shell> fs0:`
	`FS0:\> load MyWizardDriver.efi`
	`Laurie's Test String`
	`Image 'FS0:\MyWizardDriver.efi' loaded at 604A000 - Success`
	`FS0:\> _`

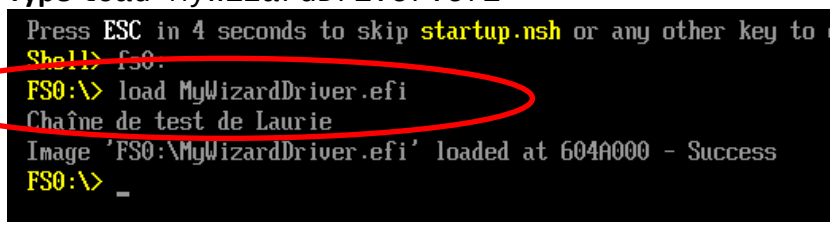
22	**Type** `Reset` `FS0:\> reset_`
23	**Press** "Enter"
24	**Type** `exit` at the shell prompt

25	**Select Language**
	`NT32 Emulation Environment`
	`NT32 Emulated Processor` `1.23 GHz`
	`R9 Prime` `128 MB RAM`
	`Continue`
	`Select Language` `<Standard English>`
	`▶ Boot Manager`
	`▶ Device Manager`
	`▶ Boot Maintenance Manager`
	`This is the option one adjusts to change the language for the current system`

26	**Press** "Enter"

27	`Français`
	`English`
	`Standard Français`
	`Standard English`
	Select "Français"

28	**Press** "Enter"

Step	Action
29	 **Select** "Continuer"
30	**Press** "Enter"
31	At the Shell Prompt, **type** `Fs0:`
32	**Type** `load MyWizardDriver.efi`  Notice that the string's French version is displayed:
33	**Type "reset"** 
34	**Exit QEMU**

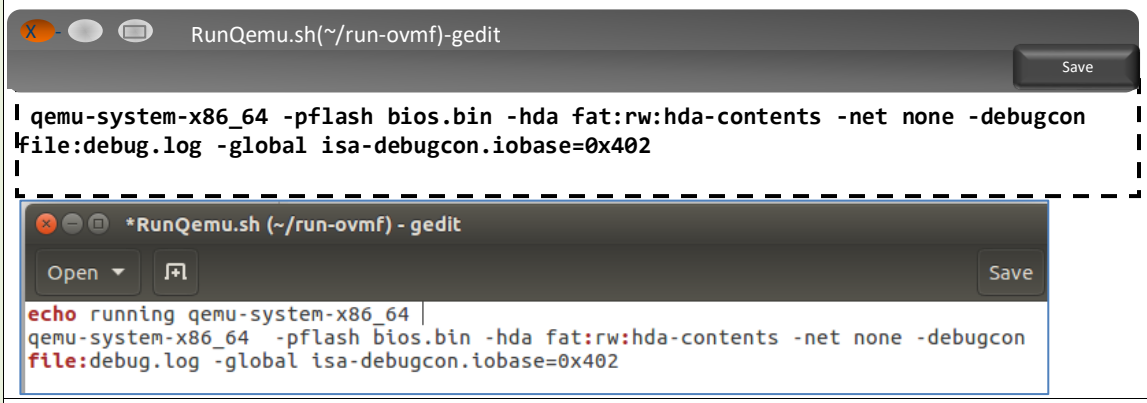
For any build issues copy the solution files from ~/FW/LabSolutions/LessonE.11
NOTE: Delete Directory ~/src/edk2/Build/OvmfX64/DEBUG_GCC5/X64/MyWizardDriver before the Build command to build the MyWizardDriver Clean.
Make sure you update OvmfPkgX64.fdf.

LAB SETUP

Setup OVMF Package for Edk II Build

Step		Action
1	**Skip if Lab Setup Done**	Download the training material first. UEFI Training Materials
2		Install the Ubuntu Linux tools **`bash$ sudo apt-get install build-essential uuid-dev iasl git`** **`bash$ sudo apt-get install gcc-5 nasm`** **`bash$ sudo apt-get install qemu`**
3		Extract the Downloaded **Lab_Material_FW.zip** to **$HOME** (this will create a directory ~FW)
4		Create a directory "src" **`bash$ mkdir ~src`**
5		From the ~FW folder, copy and paste folder "~FW/edk2" to ~src
6		Rename or mv the directory "**`~src/edk2/BaseTools`**" to something else **`bash$ cd ~src/edk2`** **`bash$ mv BaseTools BaseToolsX`**
7		Extract the file **~FW/edk2Linux/BaseTools.tar.gz** to **~src/edk2**
8		**`bash$ cd ~src/edk2`**
9		Make the BaseTools and setup the environment **`bash$ make –C BaseTools`** **`bash$ . edksetup.sh`**
10		Edit the file **Conf/target.txt** **`bash$ gedit Conf/target.txt`**
11		
12		Save and Exit
13		To Build OvmfPkg **`bash$ build`**

Invoke QEMU to run UEFI Shell

		Action
1	**Skip if Done**	Create a run-ovmf directory under the home directory **`bash$ cd ~`** **`bash$ mkdir ~run-ovmf`** **`bash$ cd run-ovmf`**
2		Create a directory to use as a hard disk image **`bash$ mkdir hda-contents`**
3		Copy the OVMF.fd BIOS image created from the build to the run-ovmf directory naming it bios.bin **`bash$ cp ~/src/edk2/Build/OvmfX64/DEBUG_GCC5/FV/OVMF.fd bios.bin`**
4		Create a Linux shell script to run the QEMU from the run-ovmf directory **`bash$ gedit RunQemu.sh`**
5		
6		Save and Exit
7		Run the RunQemu.sh Linux shell script **`bash$ . RunQemu.sh`**

Acknowledgements