

# UEFI & EDK II Training

**EDK II Modules: Libraries, Drivers & Applications**

[tianocore.org](https://tianocore.org)



# LESSON OBJECTIVE

- What is a EDK II Module
- Use EDK II libraries to write UEFI apps/drivers
- How to Define a UEFI application
- Differences between UEFI App / Drivers INF file

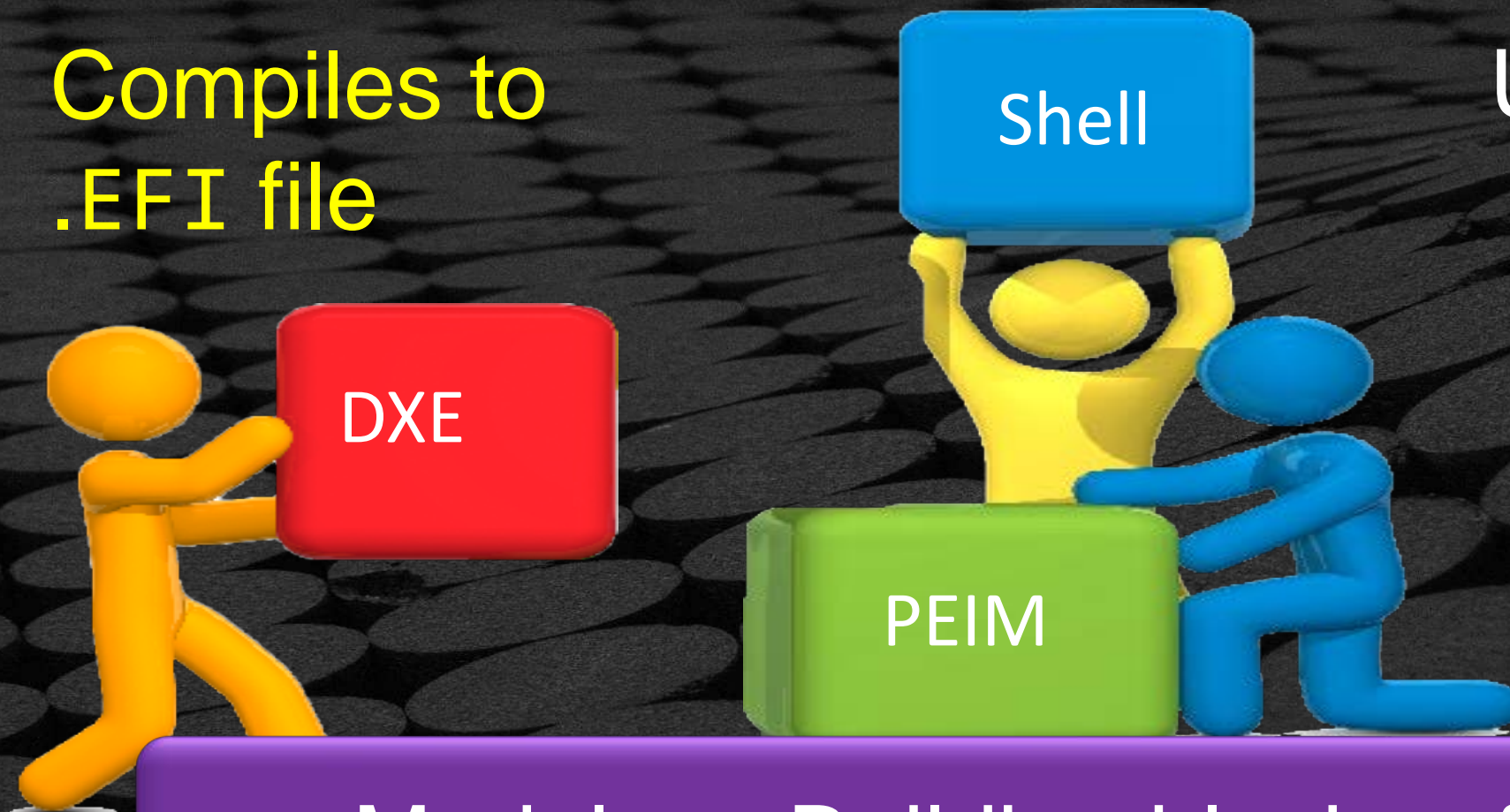
# EDK II MODULES OVERVIEW

What are EDK II Modules



Smallest separate object compiled in EDK II

Compiles to  
.EFI file



UEFI/DXE Driver

PEIM

UEFI App. or  
Library

Modules: Building blocks of EDK II



## Most Used Module Types



Syntax:

```
<ModuleTypes> ::= <ModuleType> [<Space> <ModuleType>]
```



# Module Source Contents - minimum file

MODULE_TYPE	Example Source files
UEFI_APPLICATION	Foo.c, Foo.inf
UEFI_DRIVER	FooDriver.c, FooDriver.h, FooDriver.vfr, FooDriver.uni, FooDriver.inf
DXE_DRIVER	Foo.c, Foo.h, Foo.inf
DXE, UEFI or PEIM Library	FooLib.c, FooLib.h, fooLib.inf (w/ LIBRARY_CLASS=)

**Complexity - Greater number of source files**

**.INF file - One file is required per module**

**.EFI file - Sources compiled to a single .EFI file**

# EDK II LIBRARY MODULES



## *Syntax:*

```
[LibraryClasses.common]
```

```
<LibraryClassName> | <LibraryInstancePathToInf/Name.inf>
```

```
DebugLib|MdePkg/Library/BaseDebugLibNull/BaseDebugLibNull.inf
```

**Name**

**Implementation<sup>3</sup>**

**Consistent set of interfaces**

**Does not describe implementation of the interfaces**



# “NULL” Library Class

## Constructors

## Special Cases

NOT “. . . LibNull” instance

### Syntax

```
Pkg/MyModule/MyModule.inf {  
  <LibraryClasses>  
    NULL|Pkg/Library/LibName/LibName.inf  
    NULL|Pkg/Library/LibName2/LibName2.inf  
}
```

## Open Source Example

DxeCrc32GuidedSectionExtractLib  
ShellPkg as used with Profiles

### UEFI Shell example:

```
ShellPkg/Application/Shell/Shell.inf {  
  <LibraryClasses>  
    NULL|ShellPkg/Library/UefiShellDriver1CommandsLib/UefiShellDriver1CommandsLib.inf  
    NULL|ShellPkg/Library/UefiShellNetwork1CommandsLib/UefiShellNetwork1CommandsLib.inf  
    . . .  
}
```

# Locating Library Classes

Library based upon

1. Industry specs (UEFI, etc.)

**MdePkg/MdeModulePkg**

2. Features

**NetworkPkg/SecurityPkg**

Use the package help files (.CHM) to find a library or function

*Example: MdePkg.chm*

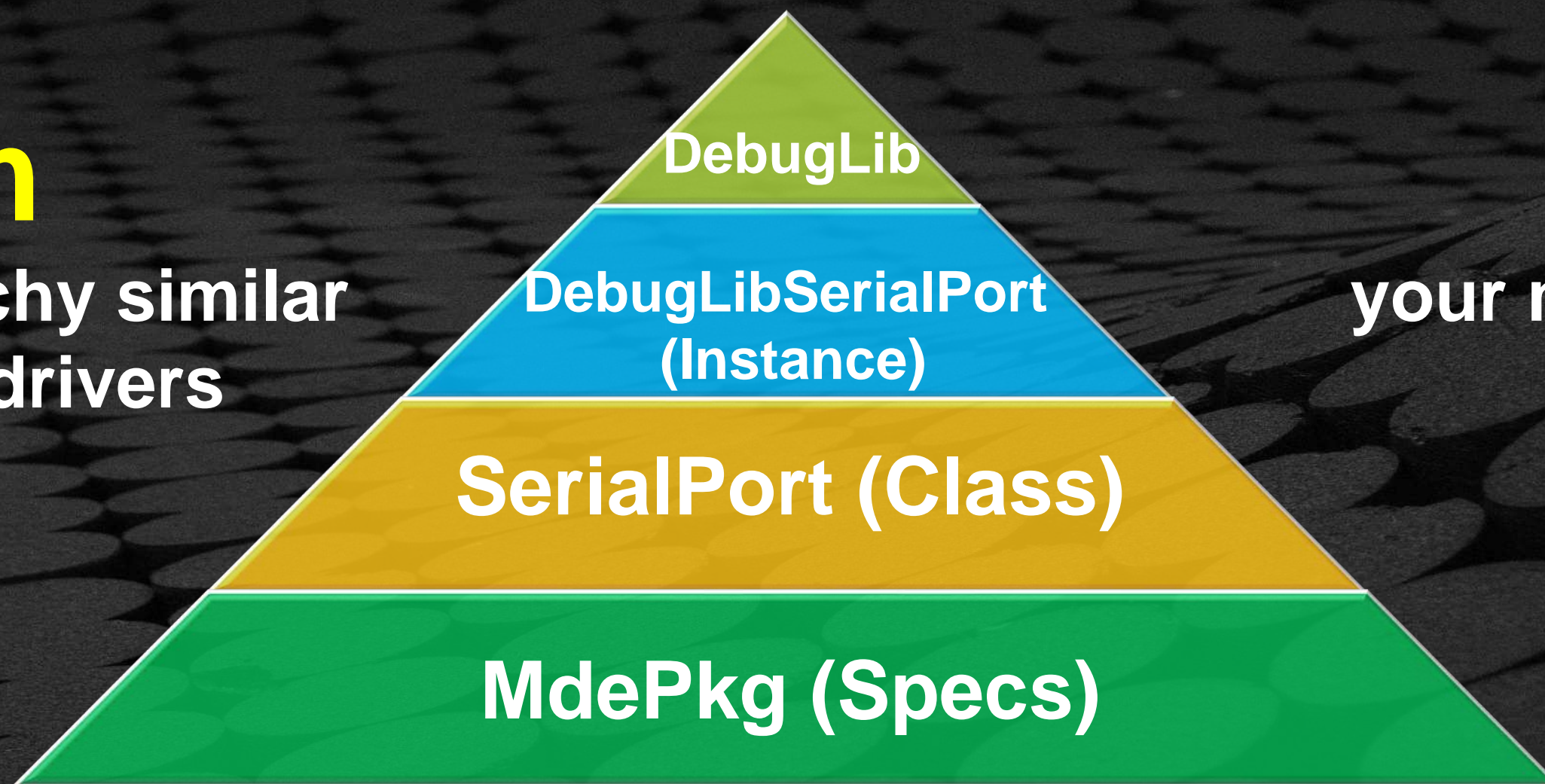
Search Workspace (.INF) "LIBRARY\_CLASS"



# Library Instance Hierarchy

## Form

a hierarchy similar  
to UEFI drivers



## Link

your module to  
another

**Build error** : Instance of Library class [*Foo...Lib*] is not found ....  
Consumed by module [*My Module.inf*]



# Commonly Used Base Library Classes

BaseLib    DebugLib    UefiDriverEntryPoint  
UefiLib    UefiBootServicesTableLib  
UefiApplicationEntryPoint    DxeCoreEntryPoint  
CpuLib    UefiUsbLib    PciLib    DevicePathLib    IoLib  
MemoryAllocationLib    PrintLib    PeimEntryPoint  
PeiCoreEntryPoint    UefiScsiLib    BaseMemoryLib  
UefiRuntimeLib    SmmMemLib  
DxeServicesLib    SynchronizationLib    PciExpressLib  
DxePcdLib    UefiRuntimeServicesTableLib  
PciSegmentLibLib    PeiServicesLib  
PeiPcdLib    DxeHobLib    UefiFileHandleLib

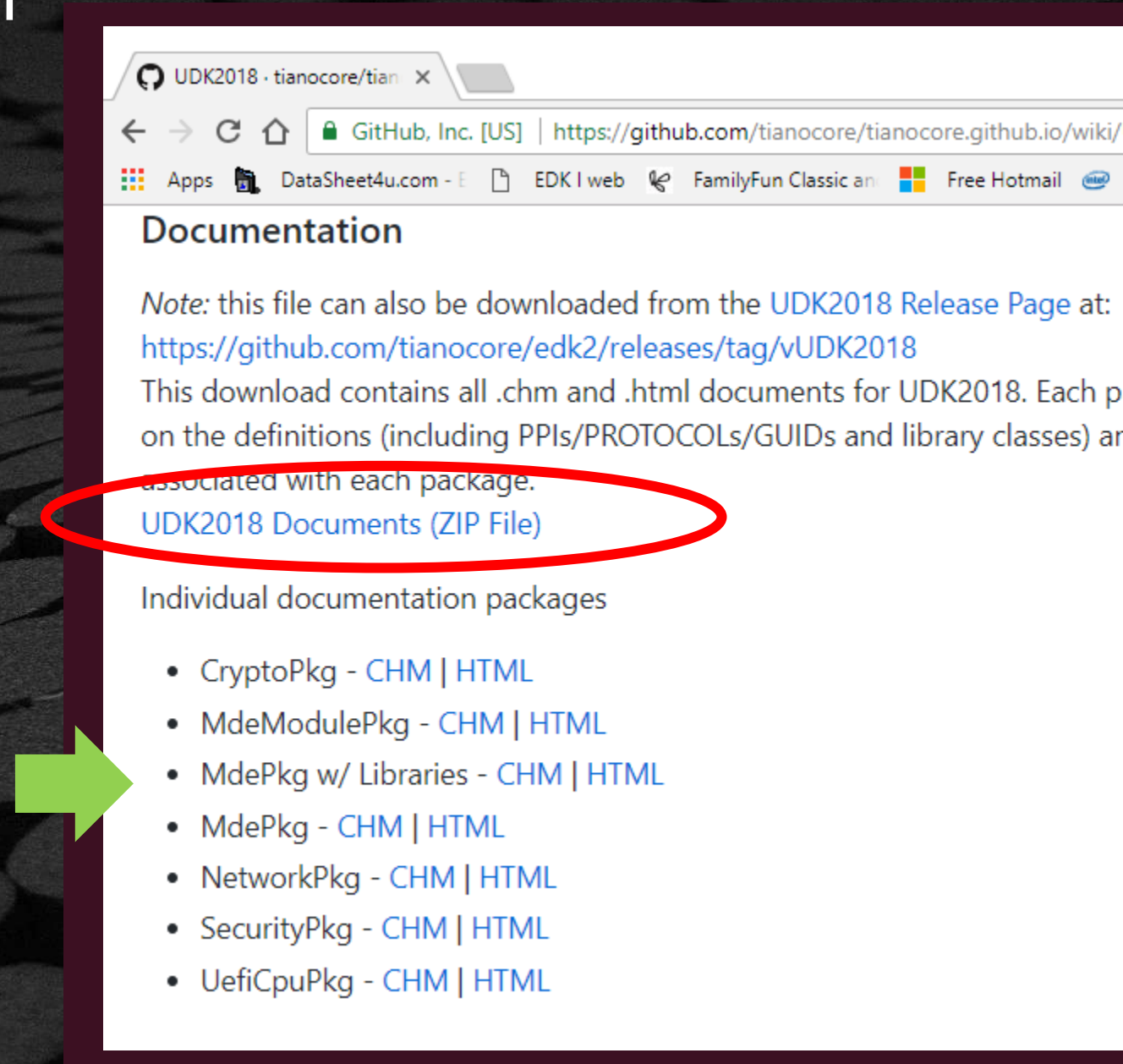


# MdePkg Library .CHM file Location

[tianocore.org](https://tianocore.org) UDK2018 documentation on

 [Latest UDK Release](#)

 [UDK2018](#)



UDK2018 · tianocore/tianocore.github.io/wiki/

← → ↻ 🏠 🔒 GitHub, Inc. [US] | <https://github.com/tianocore/tianocore.github.io/wiki/>

Apps 📁 DataSheet4u.com - E 📄 EDK I web 🖱️ FamilyFun Classic an 🌐 Free Hotmail 🍏

## Documentation

Note: this file can also be downloaded from the [UDK2018 Release Page](https://github.com/tianocore/edk2/releases/tag/vUDK2018) at: <https://github.com/tianocore/edk2/releases/tag/vUDK2018>

This download contains all .chm and .html documents for UDK2018. Each package contains documentation on the definitions (including PPIs/PROTOCOLs/GUIDs and library classes) and the associated with each package.

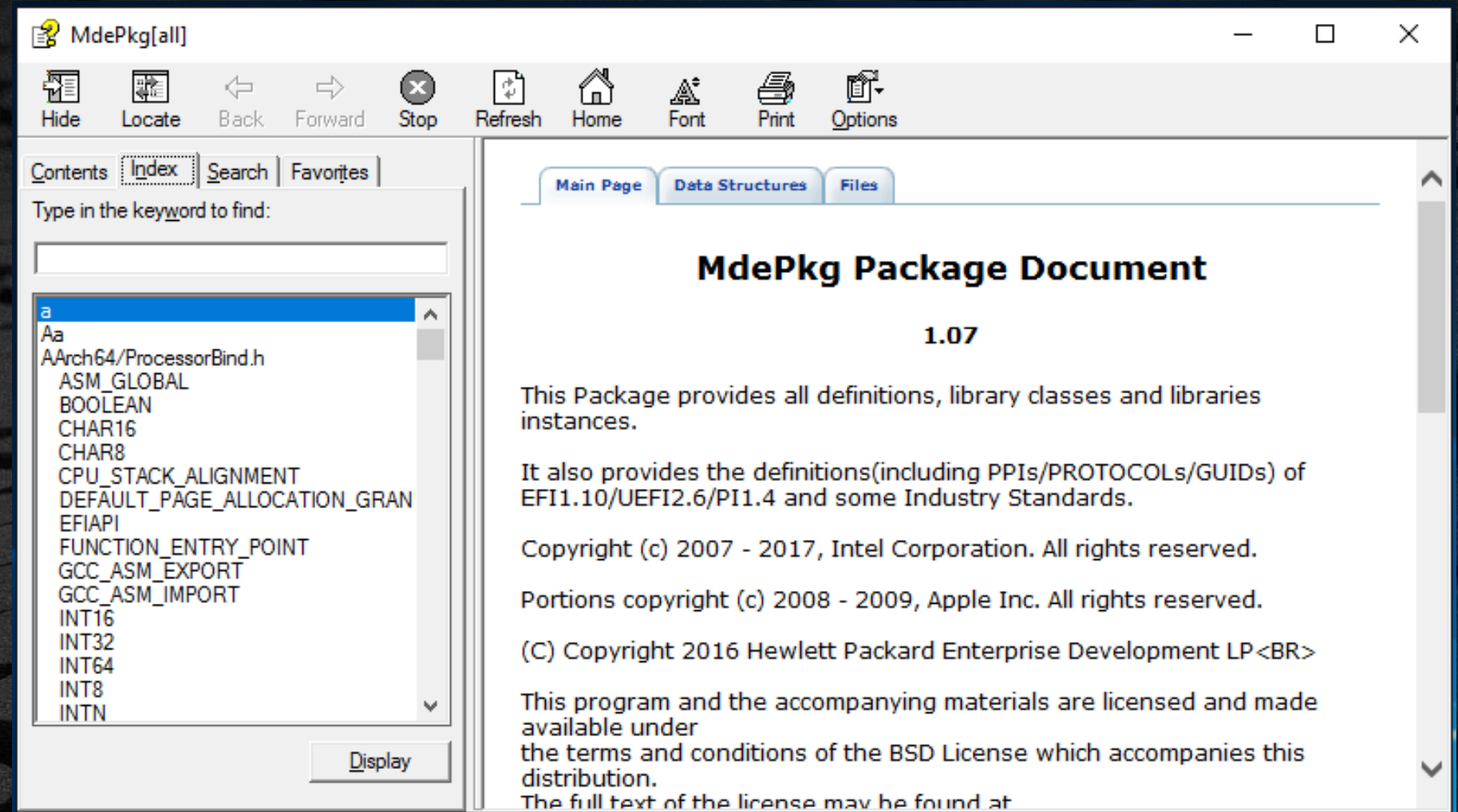
[UDK2018 Documents \(ZIP File\)](#)

### Individual documentation packages

- CryptoPkg - [CHM](#) | [HTML](#)
- MdeModulePkg - [CHM](#) | [HTML](#)
- MdePkg w/ Libraries - [CHM](#) | [HTML](#)
- MdePkg - [CHM](#) | [HTML](#)
- NetworkPkg - [CHM](#) | [HTML](#)
- SecurityPkg - [CHM](#) | [HTML](#)
- UefiCpuPkg - [CHM](#) | [HTML](#)



# Library Navigation Demonstration



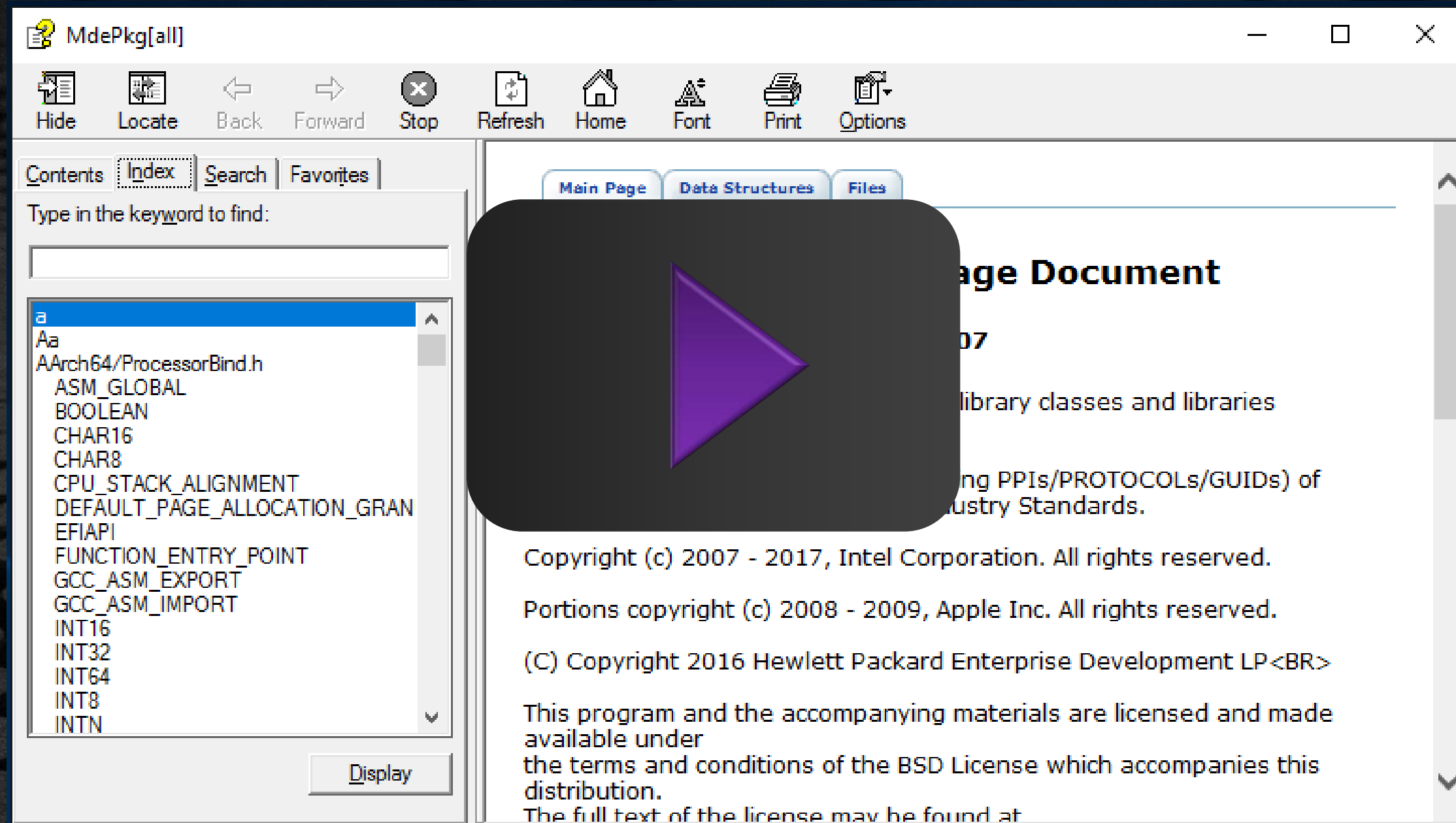
Open file: /FW/Documentation/"MdePkg Document With LibrariesMdePkg.chm"

**NOTE:** Install a CHM Viewer for Ubuntu

```
bash$ sudo aptitude install kchmviewer
```



# Library Navigation Demonstration



<https://youtu.be/s8Zw1w1iQS4>

# EDK II UEFI APPLICATION



# Defining a UEFI Application

## Characteristics of a UEFI Application

- ✱ Loaded by UEFI loader, just like drivers
- ✱ Does not register protocols
- ✱ Consumes protocols
- ✱ Typically exits when completed (user driven )
- ✱ Same set of interfaces as drivers available

# Defining a UEFI Application

## UEFI Application Usages

- ✱ Platform Diagnostics
- ✱ Factory Diagnostics
- ✱ Utilities
- ✱ Driver Prototyping
- ✱ “Platform” Applications
- ✱ Portable Across Platforms (IA32, X64, ARM, Itanium, etc.)



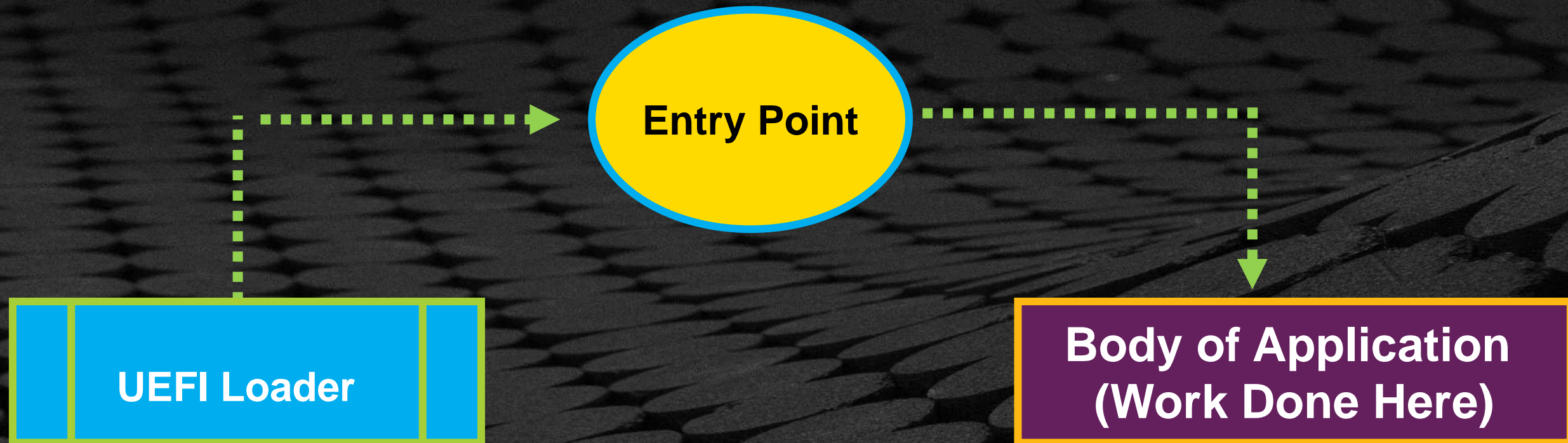
# Executing Applications



UEFI Loader

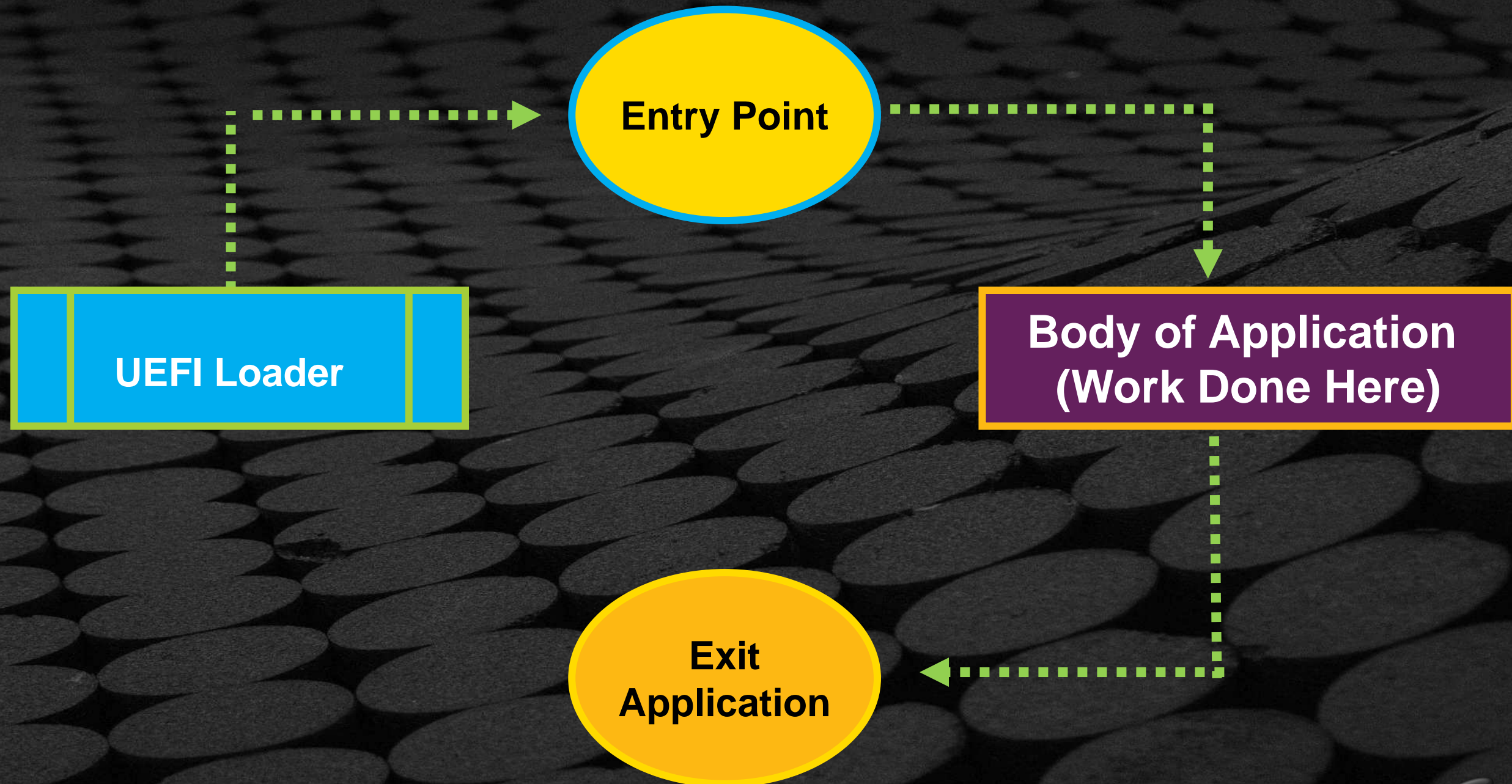


# Executing Applications



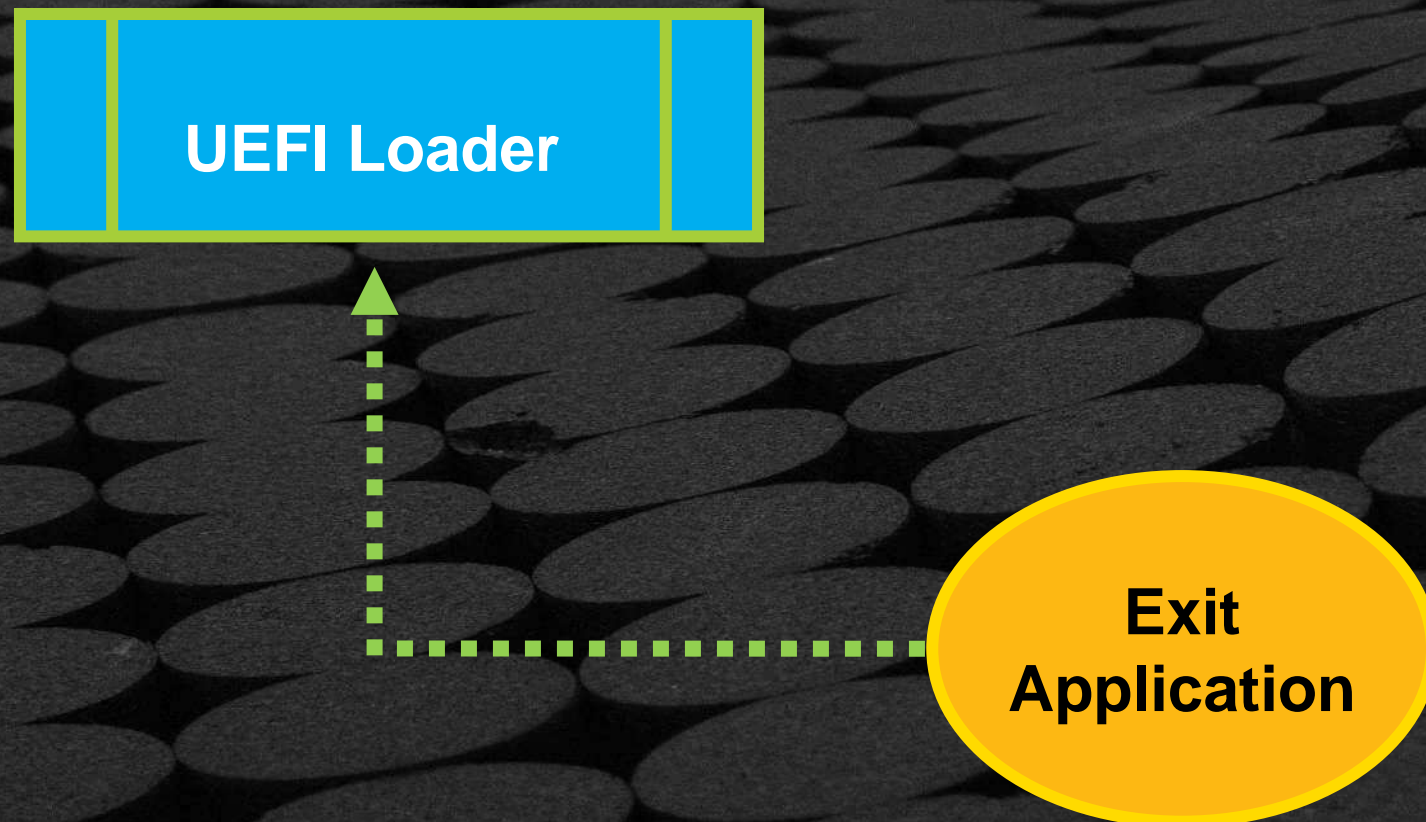


# Executing Applications





# Executing Applications





# Executing Applications



UEFI Loader



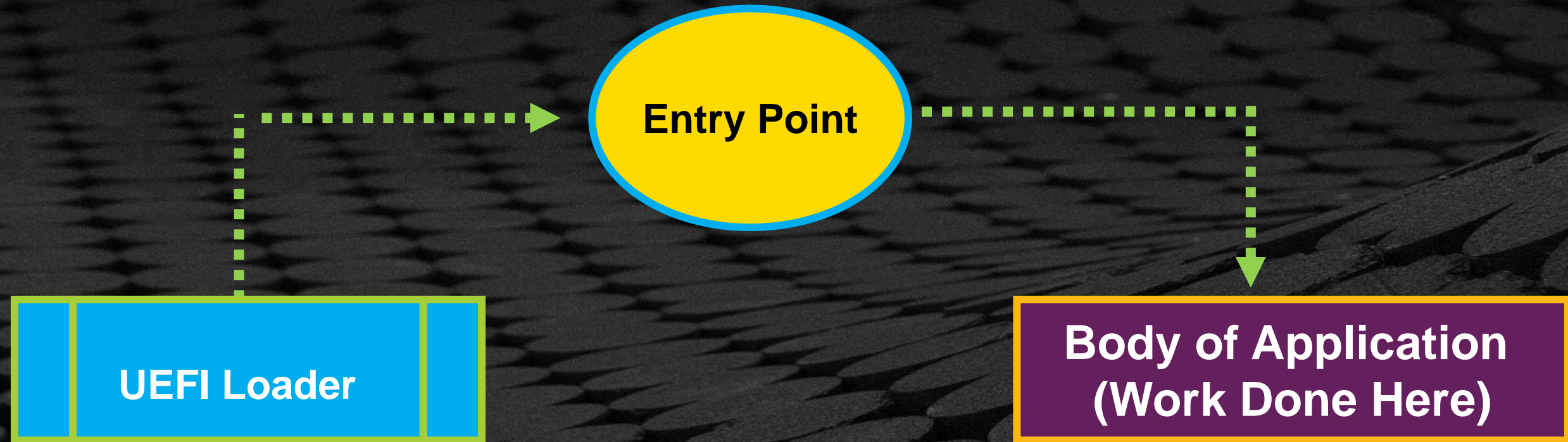
# Executing Applications



**OS Loader**



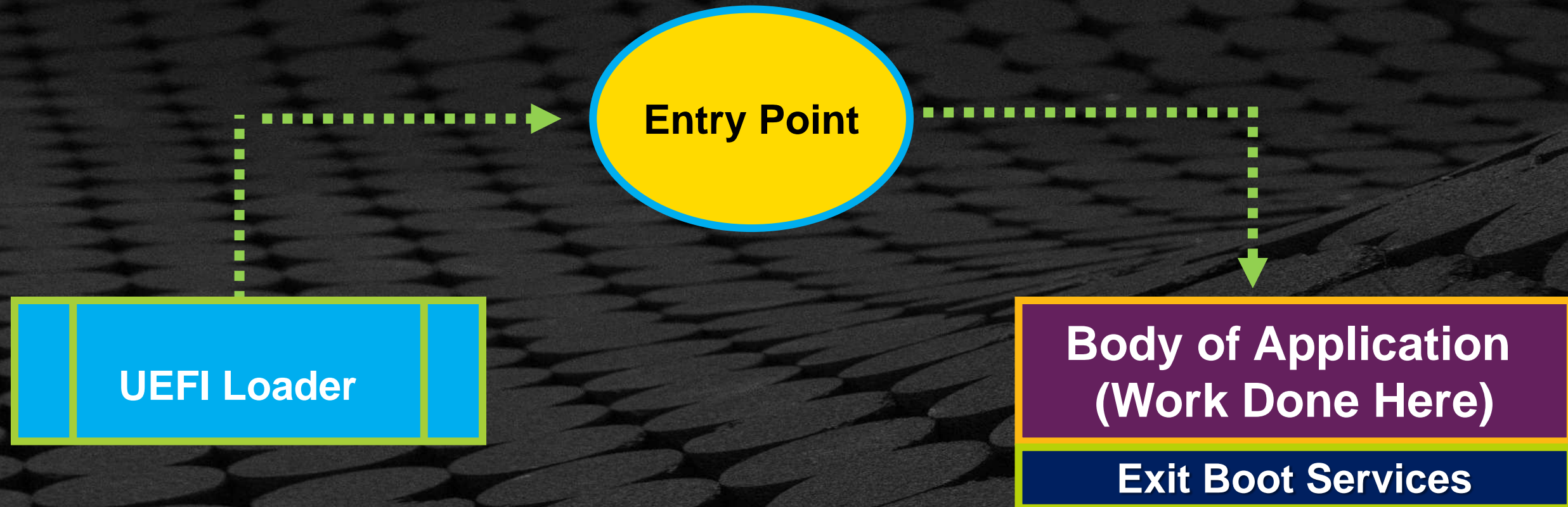
# Executing Applications



**OS Loader**



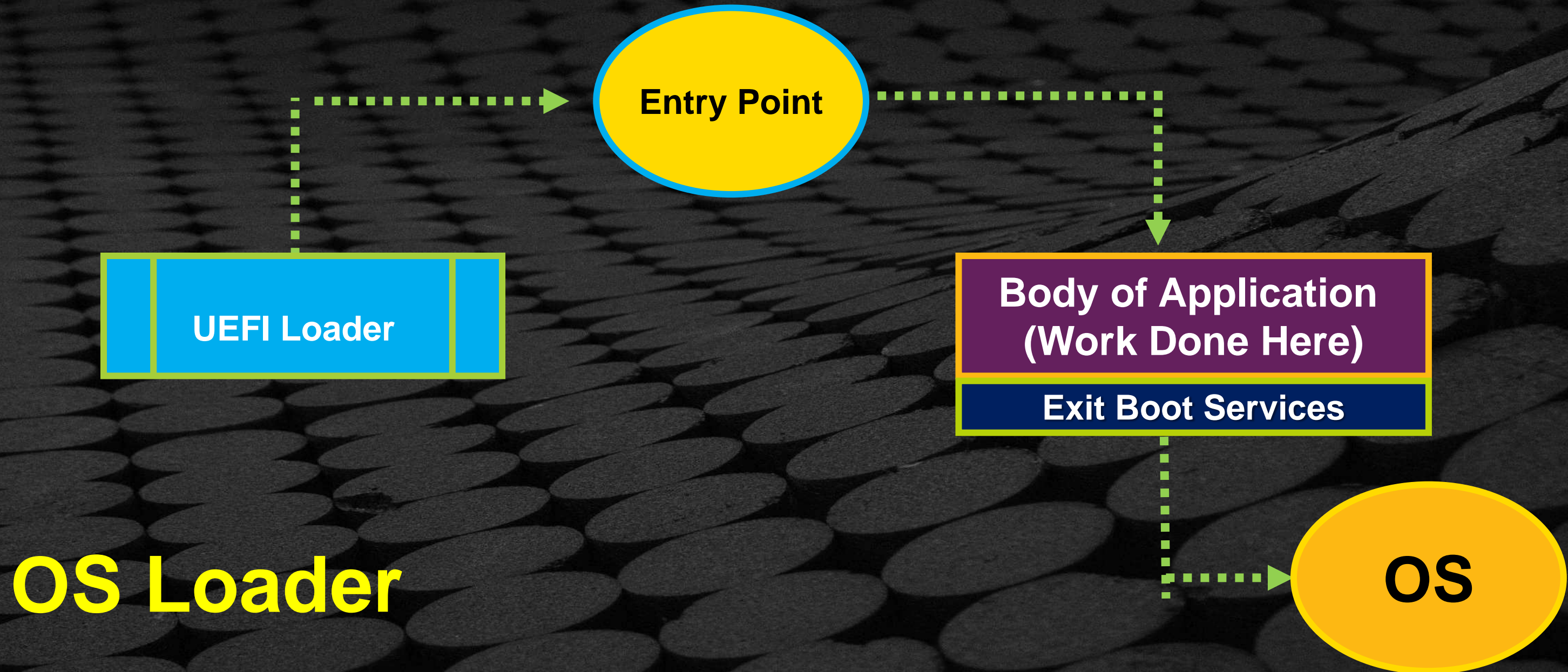
# Executing Applications



**OS Loader**

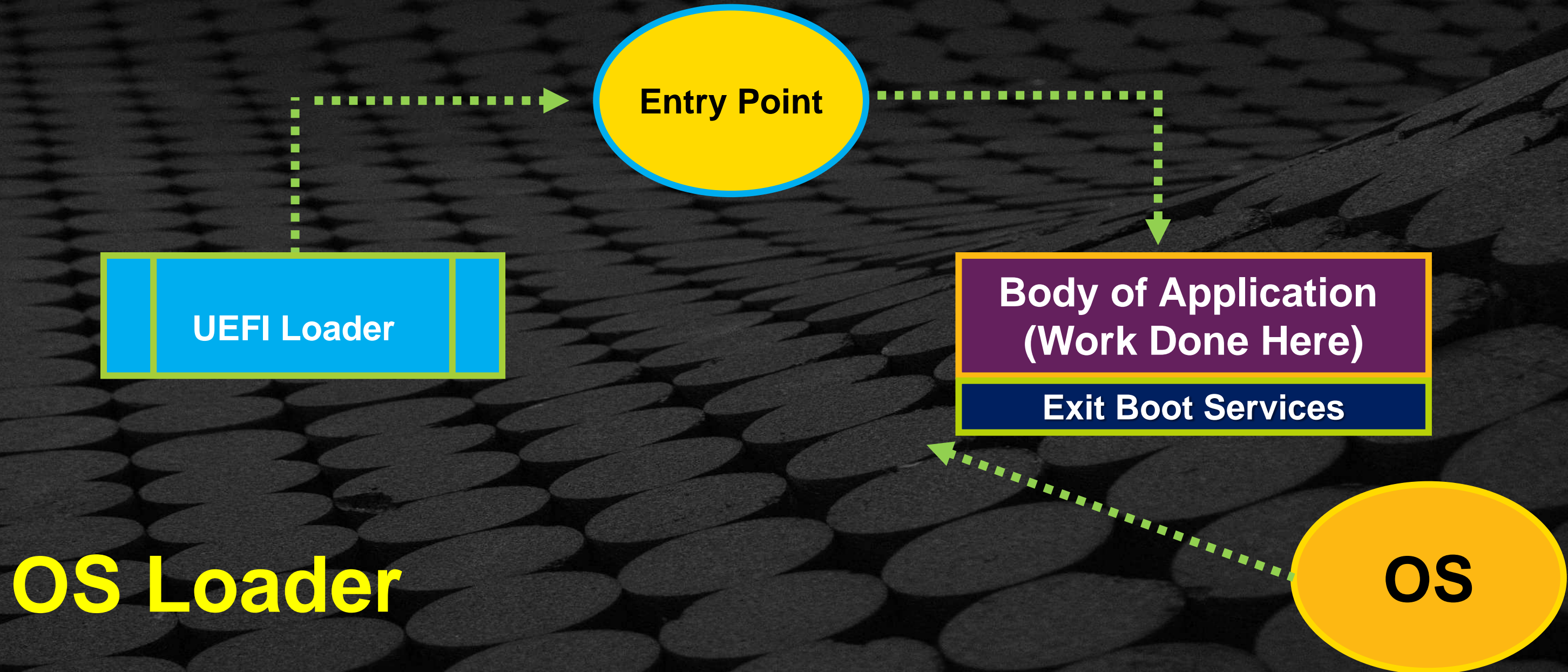


# Executing Applications





# Executing Applications





# Executing Applications



OS

OS Loader



# Driver Vs. Application

	Driver	Application
Loaded by:	UEFI Loader	UEFI Loader
Interfaces available:	ALL	ALL
Consume protocols?	YES	YES
Produce protocols?		
Typically driven by?		
Typical use		



# Driver Vs. Application

	Driver	Application
Loaded by:	UEFI Loader	UEFI Loader
Interfaces available:	ALL	ALL
Consume protocols?	YES	YES
Produce protocols?	YES	NO
Typically driven by?	System	User
Typical use	Support Hardware	Any



# EDK II UEFI APPLICATIONS

## How to Write a EDK II UEFI Application




# Application Files Placement

- Application source files can be located anywhere in the EDK II workspace including PACKAGES\_PATH
- All code and include files go under a single directory containing the driver INF
- EDK II Sample Applications can be found here:

`edk2/MdeModulePkg/Application`

- Typically, modules reside within a package:

```
MyWorkSpace/  
  edk2/  
    MyPkg/  
      Application/  
        MyApp/
```



`MyApp.c`  
`MyApp.inf`



## Syntax

```
INFfile ::= [<Header>  
            <Defines>  
            [<BuildOptions>]  
            [<Sources>]  
            [<Binaries>]  
            [<Guids>]  
            [<Protocols>]  
            [<Ppis>]  
            [<Packages>]  
            [<LibraryClasses>]  
            [<Pcds>]  
            [<UserExtensions>]  
            [<Depex>]
```

PreMake

INF text file example



# Application INF Files [DEFINES]

Field	Description
<b>INF_VERSION</b>	1.25* - Version of the INF spec.
<b>BASE_NAME</b>	What's the name of the application
<b>FILE_GUID</b>	Create a GUID for your module
<b>MODULE_UNI_FILE</b>	Meta-data - localization for Description & Abstract
<b>VERSION_STRING</b>	Version number
<b>ENTRY_POINT</b>	Name of the function to call
<b>MODULE_TYPE</b>	UEFI_APPLICATION

\* EDK II Specifications: <https://github.com/tianocore/tianocore.github.io/wiki/EDK-II-Specifications>



# Sample INF file

```
[Defines]
  INF_VERSION           = 0x00010005
  BASE_NAME             = MyApplication
  MODULE_UNI_FILE       = MyFile.uni
  FILE_GUID             = 10C75C00-30 . . .
  MODULE_TYPE           = UEFI_APPLICATION
  VERSION_STRING        = 1.0
  ENTRY_POINT           = UefiMain
[Sources]
  MyFile.c

[Packages]
  MdePkg/MdePkg.dec

[LibraryClasses]
  UefiApplicationEntryPoint

[Guids]

[Ppis]

[Protocols]
```



# Sample INF file

```
[Defines]
  INF_VERSION           = 0x00010005
  BASE_NAME             = MyApplication
  MODULE_UNI_FILE       = MyFile.uni
  FILE_GUID             = 10C75C00-30 . . .
  MODULE_TYPE           = UEFI_APPLICATION
  VERSION_STRING        = 1.0
  ENTRY_POINT           = UefiMain
```

```
[Sources]
  MyFile.c
```

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

```
[LibraryClasses]
  UefiApplicationEntryPoint
```

```
[Guids]
```

```
[Ppis]
```



# BUILDING AN APPLICATION

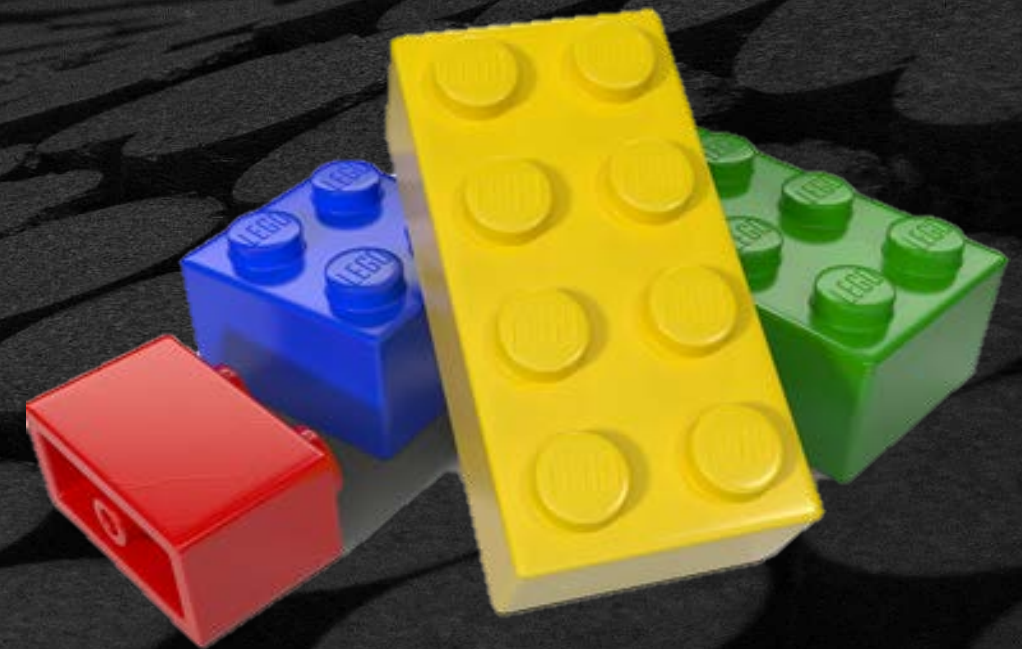
Platform .DSC references .INF

Runs:

“Build” for the entire platform

OR

“Build” in the application’s directory





# Sample Application 'C' file

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

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



# Sample Application 'C' file

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

```
EFI_STATUS
```

```
EFI_API
```

```
UefiMain (
```

```
    IN EFI_HANDLE
```

```
    IN EFI_SYSTEM_TABLE
```

```
)
```

```
{
```

```
    return EFI_SUCCESS;
```

```
}
```

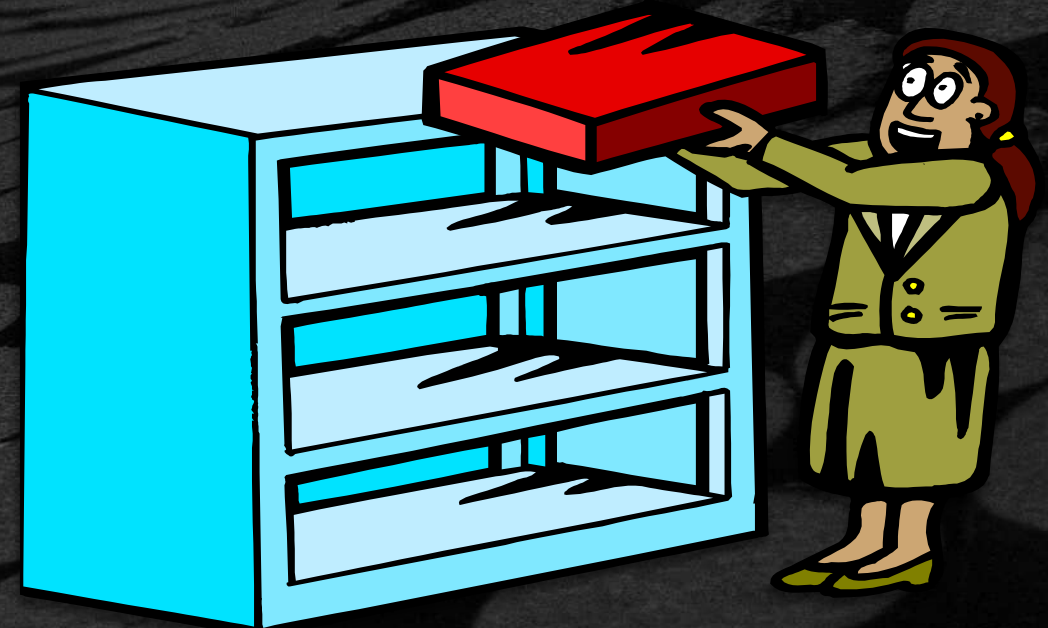
```
    ImageHandle,  
    *SystemTable
```



# UEFI Application Vs. EADK Application

EDK II Application Development Kit includes the Standard C Libraries in UEFI Shell Applications

*Off the shelf* “C” application  
Converted to UEFI application





# Sample INF file using EDK II EADK

```
[Defines]
  INF_VERSION           = 0x00010005
  BASE_NAME             = MyApplication
  FILE_GUID             = 10C75C00-30 . . .
  MODULE_TYPE           = UEFI_APPLICATION
  VERSION_STRING        = 1.0
  ENTRY_POINT           = ShellCEntryLib
[Sources]
  MyFile.c

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

[LibraryClasses]
  LibC
  LibStdio
```



# Sample INF file using EDK II EADK

```
[Defines]
  INF_VERSION           = 0x00010005
  BASE_NAME             = MyApplication
  FILE_GUID             = 10C75C00-30 . . .
  MODULE_TYPE           = UEFI_APPLICATION
  VERSION_STRING        = 1.0
  ENTRY_POINT           = ShellCEntryLib
```

```
[Sources]
  MyFile.c
```

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

```
[LibraryClasses]
  LibC
  LibStdio
```



# Sample Application 'C' file Using EDK II EADK

This sample looks a lot like actual "C" source.

```
#include <stdio.h>
```

```
int  
Main (  
    IN int Argc,  
    IN char **Argv  
)  
{  
    return 0;  
}
```



# Driver Files Placement

- ★ Driver source code can go anywhere in the EDK II workspace
- ★ All code and include files go under a single directory containing an INF
- ★ Good example of UEFI Drivers can be found here:  
`edk2/MdeModulePkg/Bus/ScsiDiskDxe`
- ★ Typically, Driver modules reside within a package:

```
MyWorkSpace/  
  edk2/  
    MyPkg/  
      Include/  
        MyDriver/
```

```
MyDriver.c  
MyDriver.h  
MyDriver.inf
```





# Driver INF Files: [DEFINES]

Field	Description
<b>INF_VERSION</b>	1.25* - Version of the INF spec.
<b>BASE_NAME</b>	What's the name of the driver
<b>FILE_GUID</b>	Create a GUID for your module
<b>MODULE_UNI_FILE</b>	Meta-data - localization for Description & Abstract
<b>VERSION_STRING</b>	Version number
<b>ENTRY_POINT</b>	Name of the function to call
<b>MODULE_TYPE</b>	UEFI_DRIVER, DXE_DRIVER, PEIM, or others



# Changes for a UEFI Driver Module

Applications can be converted to a driver

**But** ...It remains in memory after it runs

UEFI Driver Module requirements:

- Driver Binding Protocol
- Component Name2 Protocol (recommended

DXE/PEIM/other Driver requirements





# Sample Driver INF file

```
[Defines]
  INF_VERSION          = 0x00010005
  BASE_NAME            = MyDriver
  FILE_GUID            = 10C75C00-30 . . .
  MODULE_TYPE          = UEFI_DRIVER
  VERSION_STRING       = 1.0
  ENTRY_POINT          = UefiMain
```

```
[Sources]
  MyDriverFile.c
```

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

```
[LibraryClasses]
  UefiDriverEntryPoint
  . . .
```

```
[Guids]
  . . .
[Protocols]
  . . .
```



# INF Usage Fields – DIST files

## **Optional** UEFI Spec – Package Distribution

Usage Fields used by Build tools for creating the .Dist files for binary modules

[GUID]

[PCD]

[PROTOCOL]

[PPIS]

1 Usage Block – “##” After the entry

*n* Usage Blocks – “##” Precede the entry

### Usage Key Word

## UNDEFINED

## CONSUMES

## SOMETIMES\_CONSUMES

## PRODUCES

## SOMETIMES\_PRODUCES

## TO\_START

## BY\_START

## NOTIFY

} UEFI Protocol





# INF File Usage Block examples

[Guids]

```
## SOMETIMES_PRODUCES ## Variable:L"ConInDev"  
## SOMETIMES_CONSUMES ## Variable:L"ConInDev"  
## SOMETIMES_PRODUCES ## Variable:L"ConOutDev"  
## SOMETIMES_CONSUMES ## Variable:L"ConOutDev"  
## SOMETIMES_PRODUCES ## Variable:L"ErrOutDev"  
## SOMETIMES_CONSUMES ## Variable:L"ErrOutDev"  
gEfiGlobalVariableGuid
```

```
gEfiVTUTF8Guid          ## SOMETIMES_CONSUMES ## GUID # used with a Vendor-Defined  
gEfiVT100Guid           ## SOMETIMES_CONSUMES ## GUID # used with a Vendor-Defined  
gEfiVT100PlusGuid       ## SOMETIMES_CONSUMES ## GUID # used with a Vendor-Defined  
gEfiPcAnsiGuid          ## SOMETIMES_CONSUMES ## GUID # used with a Vendor-Defined  
gEfiTtyTermGuid         ## SOMETIMES_CONSUMES ## GUID # used with a Vendor-Defined  
gEdkiiStatusCodeDataTypeVariableGuid ## SOMETIMES_CONSUMES ## GUID
```

Example: [TerminalDxe.inf](#)



# INF File Usage Block examples

[Protocols]

gEfiSerialIoProtocolGuid                      ## TO\_START

## BY\_START

## TO\_START

gEfiDevicePathProtocolGuid

gEfiSimpleTextInProtocolGuid                ## BY\_START

gEfiSimpleTextInputExProtocolGuid          ## BY\_START

gEfiSimpleTextOutProtocolGuid               ## BY\_START

[Pcd]

gEfiMdePkgTokenSpaceGuid.PcdDefaultTerminalType                ## SOMETIMES\_CONSUMES

gEfiMdeModulePkgTokenSpaceGuid.PcdErrorCodeSetVariable        ## CONSUMES

Example: [TerminalDxe.inf](#)





# Driver Binding

- Supported
- Start
- Stop



# UEFI Driver Example – Disk I/O

 <https://github.com/tianocore/edk2/.../Disk/DiskIoDxe>

## Entry Point

### “C” File

```
EFI_STATUS
EFI_API
InitializeDiskIo (
    IN EFI_HANDLE      ImageHandle,
    IN EFI_SYSTEM_TABLE *SystemTable
)
{
    // ...
    Status = EfiLibInstallDriverBindingComponentName2 (
        ImageHandle,
        SystemTable,
        &gDiskIoDriverBinding,
        ImageHandle,
        &gDiskIoComponentName,
        &gDiskIoComponentName2
    );
    ASSERT_EFI_ERROR (Status);
    return Status;
}
```

### INF File

```
[Defines]

ENTRY_POINT = InitializeDiskIo
```



# UEFI Driver Example – Disk I/O

 <https://github.com/tianocore/edk2/.../Disk/DiskIoDxe>

## Supported

### “C” File

```
EFI_STATUS
EFI_API
DiskIoDriverBindingSupported (
    IN EFI_DRIVER_BINDING_PROTOCOL *This,
    IN EFI_HANDLE
    IN EFI_DEVICE_PATH_PROTOCOL *RemainingDevicePath
    OPTIONAL
)
{
    Status = gBS->OpenProtocol (
        ControllerHandle,
        &gEfiBlockIoProtocolGuid,
        (VOID **) &BlockIo,
        This->DriverBindingHandle,
        ControllerHandle,
        EFI_OPEN_PROTOCOL_BY_DRIVER
    );
}
```

### INF File

[Protocols]

```
gEfiBlockIoProtocolGuid  ## TO_START
```



# UEFI Driver Example – Disk I/O

 <https://github.com/tianocore/edk2/.../Disk/DiskIoDxe>

Start

## “C” File

```
EFI_STATUS
EFI_API
DiskIoDriverBindingStart (
    IN EFI_DRIVER_BINDING_PROTOCOL *This,
    IN EFI_HANDLE
    IN EFI_DEVICE_PATH_PROTOCOL *RemainingDevicePath
    OPTIONAL
)
{
    if (Instance->BlockIo2 != NULL) {
        Status = gBS->InstallMultipleProtocolInterfaces (
            &ControllerHandle,
            &gEfiDiskIoProtocolGuid, &Instance->DiskIo,
            &gEfiDiskIo2ProtocolGuid, &Instance->DiskIo2,
            NULL
        );
    }
}
```

## INF File

[Protocols]

```
gEfiDiskIoProtocolGuid ## BY_START
gEfiDiskIo2ProtocolGuid ## BY_START
```



# DXE Driver Example - PlatformInfoDxe



<https://github.com/tianocore/edk2-platforms/. . ./Vlv2TbItDevicePkg/PlatformInfoDxe>

tianocore / edk2-platforms

Code Pull requests 0 Projects 0 Security Insights

Branch: master edk2-platforms / Platform / Intel / Vlv2TbItDevicePkg / PlatformInfoDxe /

mdkinney Platform/Vlv2TbItDevicePkg: Import Vlv2TbItDevicePkg from edk2

PlatformInfoDxe.c	Platform/Vlv2TbItDevicePkg: Import Vlv2TbItDevicePkg from edk2
PlatformInfoDxe.h	Platform/Vlv2TbItDevicePkg: Import Vlv2TbItDevicePkg from edk2
PlatformInfoDxe.inf	Platform/Vlv2TbItDevicePkg: Import Vlv2TbItDevicePkg from edk2



# DXE Driver Example – PlatformInfoDxe

 <https://github.com/tianocore/edk2-platforms/PlatformInfoDxe>

## Entry Point

### “C” File

```
#include "PlatformInfoDxe.h"
...
EFI_STATUS
EFIAPI
PlatformInfoInit (
    IN EFI_HANDLE      ImageHandle,
    IN EFI_SYSTEM_TABLE *SystemTable
)
/*++
{
// ...
    return Status;
}
```

### INF File

```
[Defines]
...
MODULE_TYPE           = DXE_DRIVER
VERSION_STRING        = 1.0
ENTRY_POINT           = PlatformInfoInit
...

[Depex]
gEfiVariableArchProtocolGuid AND
gEfiVariableWriteArchProtocolGuid
```

Notice the MODULE TYPE, C function Entry point and the [Depex] differences in the INF file



# PEI Driver (PEIM) Example - CpuloPei



<https://github.com/tianocore/edk2/UefiCpuPkg/CpuloPei>

tianocore / edk2

Code

Pull requests 0

Projects 0

Insights

Branch: master

edk2 / UefiCpuPkg / CpuloPei /

LeoAtAmd and Igao4 UefiCpuPkg: Modify CpuloPei to support new IoLib library

..	
CpuloPei.c	UefiCpuPkg: Modify CpuloPei to support
CpuloPei.h	Code refinement.
CpuloPei.inf	UefiCpuPkg: INF/DEC file updates to EDK
CpuloPei.uni	UefiCpuPkg: Convert all .uni files to utf-8
CpuloPeiExtra.uni	UefiCpuPkg: Convert all .uni files to utf-8



# PEI Driver (PEIM) Example – CpuIoPei

 <https://github.com/tianocore/edk2/UefiCpuPkg/CpuIoPei>

## Entry Point

### “C” File

```
#include "CpuIoPei.h"
//...
EFI_STATUS
EFIAPI
CpuIoInitialize (
    IN EFI_PEI_FILE_HANDLE FileHandle,
    IN CONST EFI_PEI_SERVICES **PeiServices
)
{
    EFI_STATUS Status;
    //...
    return EFI_SUCCESS;
}
```

### INF File

```
[Defines]
...
MODULE_TYPE           = PEIM
VERSION_STRING        = 1.0
ENTRY_POINT           = CpuIoInitialize
...

[Depex]
TRUE
```



# LESSON OBJECTIVE

- What is a EDK II Module
- Use EDK II libraries to write UEFI apps/drivers
- How to Define a UEFI application
- Differences between UEFI App / Drivers INF file



# Questions?





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