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UEFI & EDK II Training

EDK II Build Process and Environment

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LESSON OBJECTIVE

- Define EDK II
- Describe EDK II's elements including file extensions, directories, modules, packages, and libraries
- Explain the EDK II build process
- Explain the Build tools

EDK II OVERVIEW

The EDK II Infrastructure

PHILOSOPHY OF EDK II

Support UEFI & PI needs

Separate tool & source code – added CI[1]

Package Definition file: DEC

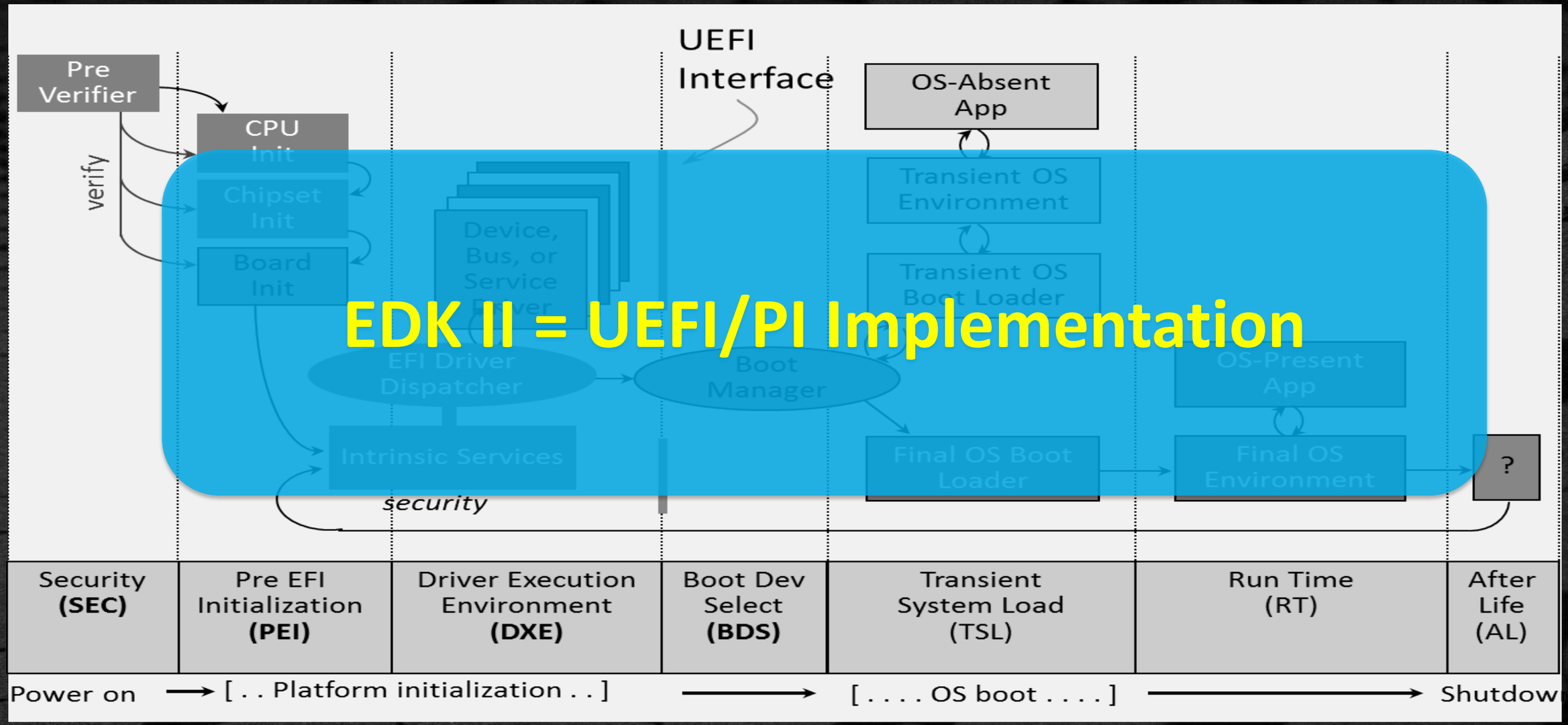
Flash Mapping Tool

Move as much Code to C

Open source EDK II on tianocore.org

[1] Continuous Integration (CI)

IMPLEMENTATION OF EDK II



EDK II File Extensions

- Located on tianocore.org project edk2

.DSC .DEC .INF .FDF	- Platform Description - Package Declaration - Module Definition *define a component* - Flash Description

EDK II File Extensions

- Located on tianocore.org project edk2

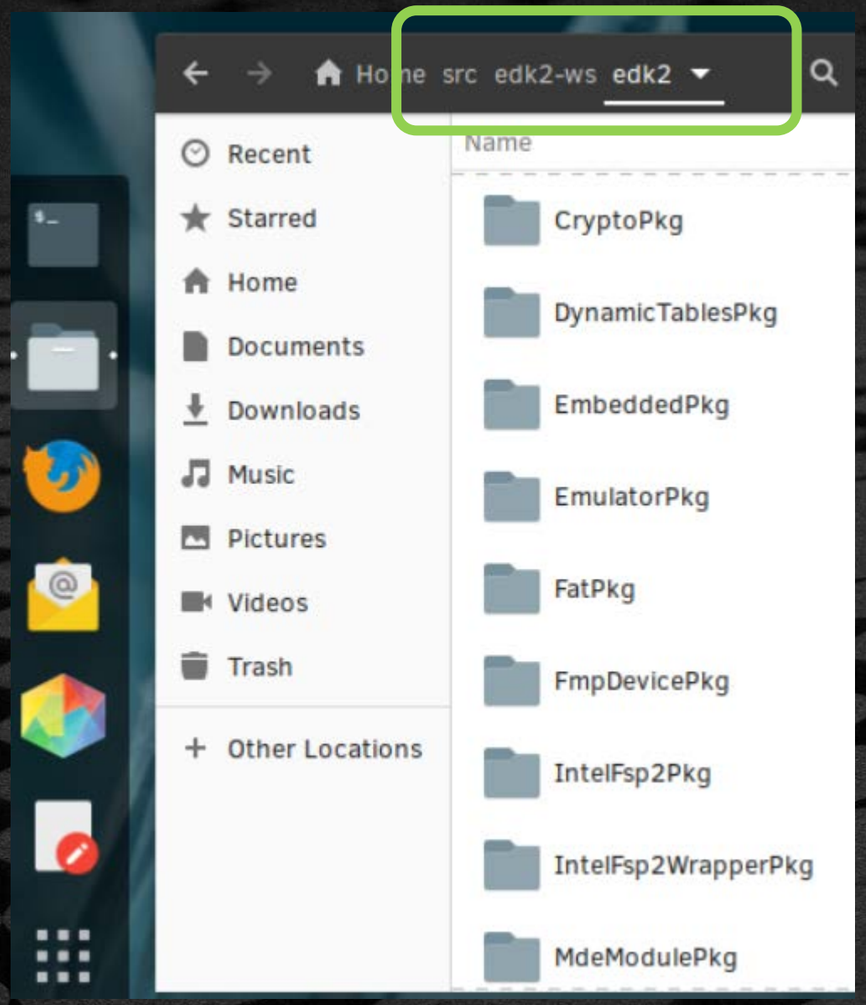
.DSC	**- Platform Description**
.DEC	**- Package Declaration**
.INF	**- Module Definition *define a component***
.FDF	**- Flash Description**
.VFR	- Visual Forms Representation for User interface
.UNI	- Unicode String text files w/ ease of localization
.c & .h	- Source code files
.FD	- Final Flash Device Image
.FV	- Firmware Volume File

EDK II Spec

Source

Output

EDK II Directory Structure



- Package concept for each EDK II sub-directory
- Platforms are contained in an EDK II package
- EDK II build process reflects the package
- Concept of “Work Space” :

  `$HOME/src/edk2-ws`

```
bash$  cd $HOME/src/edk2-ws/edk2
bash$  . edksetup.sh
bash$  make -C BaseTools/
bash$  build
```

Organization Directory Structure

Common	• No direct HW requirements, Features, Interface defs
Platform	• Enable a specific platform's capabilities.
Board	• Board specific code
Silicon	• Hardware specific code
Features	• Advanced features of platform functionality that is non-essential for "basic OS boot"

EDK II Open Board Directory Structure

- KabyLake w/ Intel® FSP

```
edk2/ https://github.com/tianocore/edk2                    ← Common
  . . .
edk2-platforms/ https://github.com/tianocore/edk2-platforms
  Platform/
      Intel/
          BoardModulePkg                                   ← Common (sharable)
          KabylakeOpenBoardPkg                             ← Platform (family)
             KabylakeRvp3                                  ← Board (instance)
          MinPlatformPkg                                   ← Platform (common)
          UserInterfaceFeaturePkg                          ← Advanced Feature
  Silicon/
      Intel/
          KabylakeSiliconPkg                               ← Silicon
          . . .
edk2-non-osi/ https://github.com/tianocore/edk2-non-osi
    Silicon/
      Intel/
          KabylakeSiliconBinPkg                            ← Silicon
          PurleySiliconBinPkg
FSP/  https://github.com/IntelFsp/FSP
      KabylakeFspBinPkg                                    ← Silicon
```

Key

Silicon/Chipset
Platform
Repository

MinPlatformPkg Example

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

PACKAGES

- EDK II projects are made up of packages
- Make your own packages
- Package contains only the necessities
- Remove packages from projects when not required
- Contain Multiple Modules

EDK II PACKAGE EXAMPLES: SPECS

MdePkg

Include files and libraries for Industry Standard Specifications

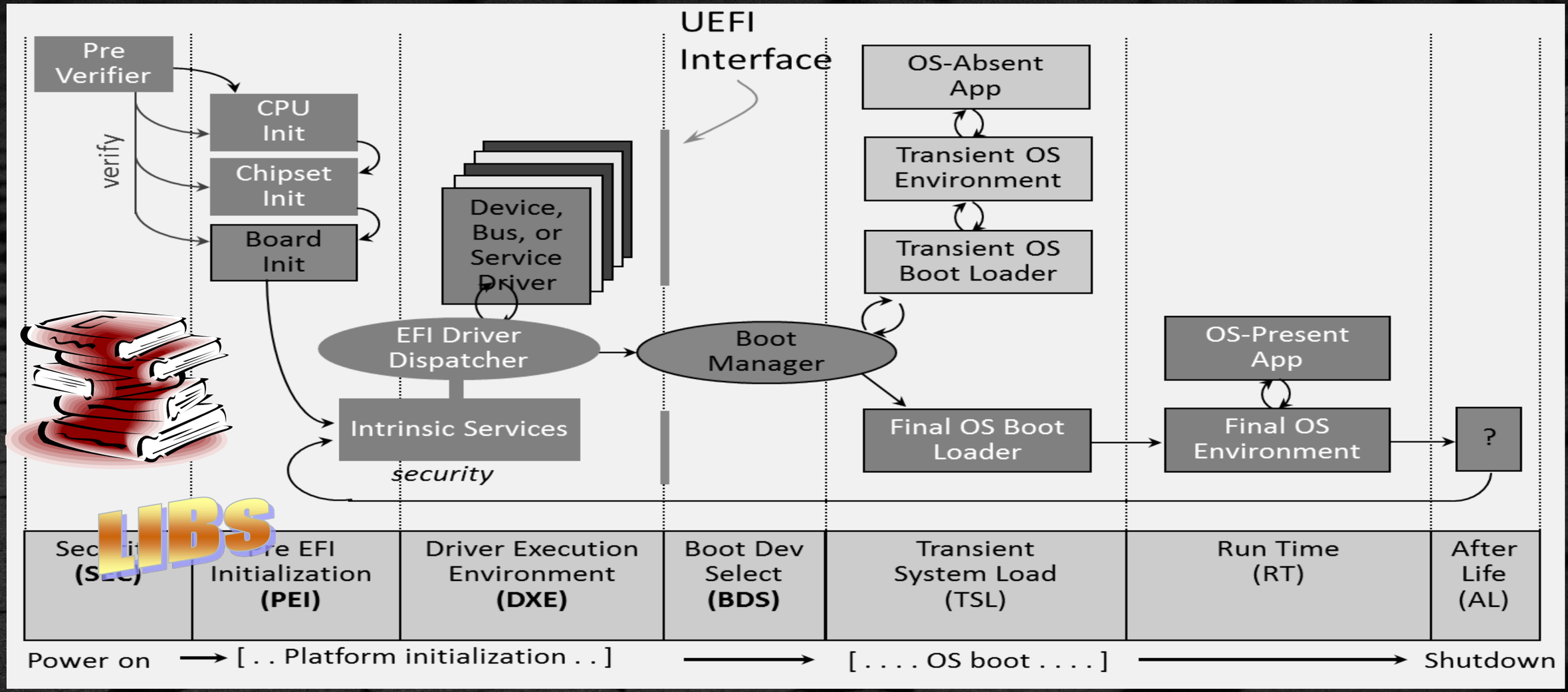
MdeModulePkg

Modules only definitions from the Industry Standard Specification are defined in the MdePkg

ADDITIONAL EDK II PACKAGE EXAMPLES:

- Platforms — `EmulatorPkg` & `OvmfPkg`
- Chipset/Processor — `IntelSiliconPkg` `KabylakeSiliconPkg` `KabylakeFspBinPkg`
- Functionality — `ShellPkg` & `NetworkPkg`

LIBRARIES


UEFI
Interface
Pre
Verifier
verify
CPU
Init
Chipset
Init
Board
Init
Device,
Bus, or
Service
Driver
EFI Driver
Dispatcher
Intrinsic Services
security
Boot
Manager
OS-Absent
App
Transient OS
Environment
Transient OS
Boot Loader
Final OS Boot
Loader
OS-Present
App
Final OS
Environment
?
LIBS
Driver Execution
Environment
(DXE)
Boot Dev
Select
(BDS)
Transient
System Load
(TSL)
Run Time
(RT)
After
Life
(AL)
Initialization
(PEI)
Power on
[. . Platform initialization . .]
[. . . . OS boot . . . .]
Shutdown

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LIBRARIES

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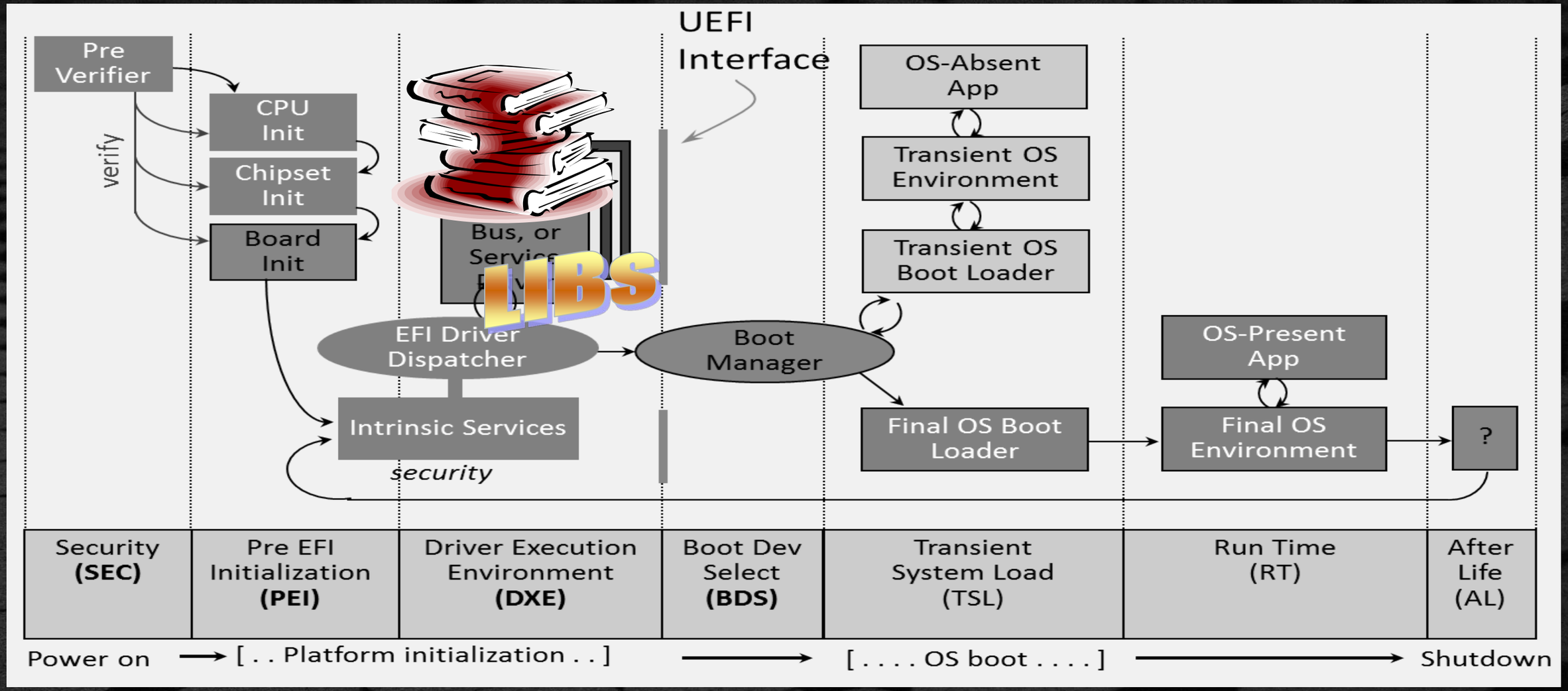
LIBRARIES



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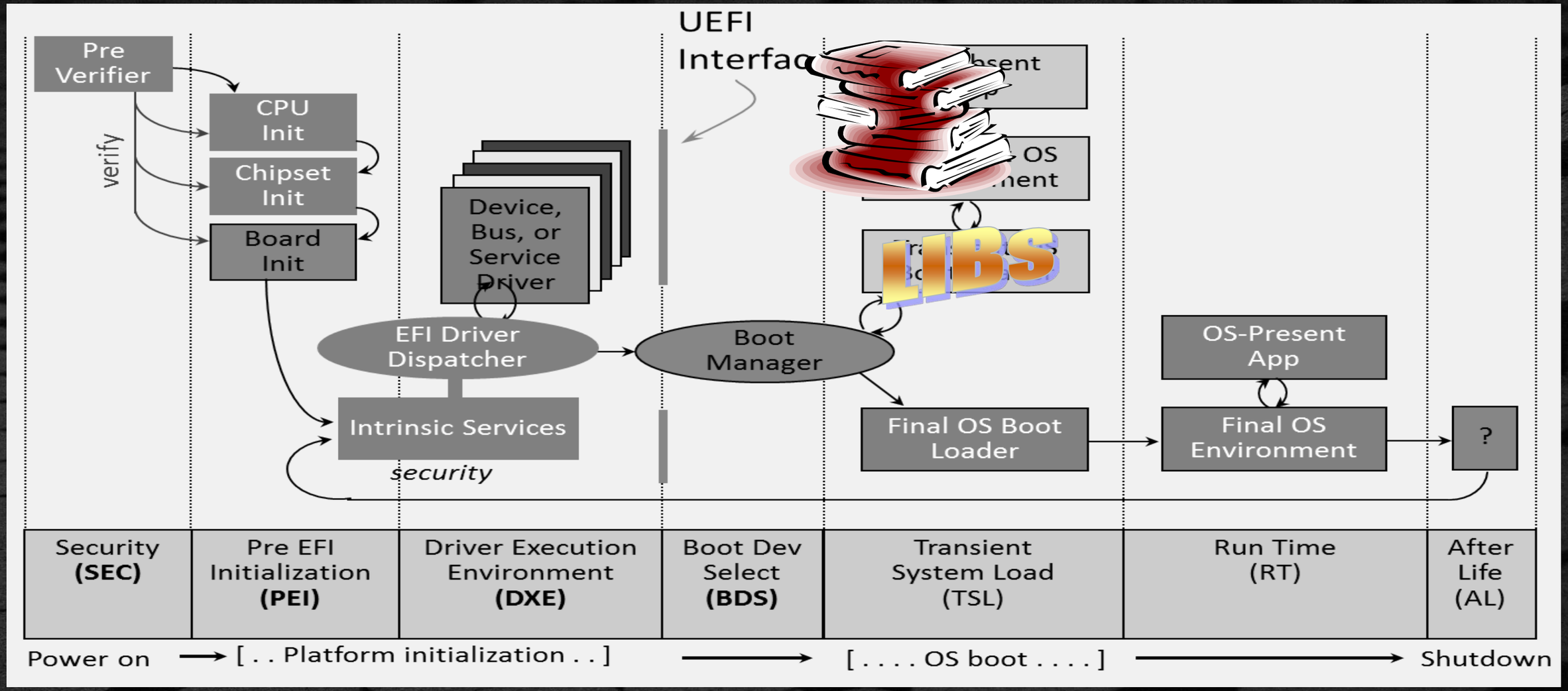
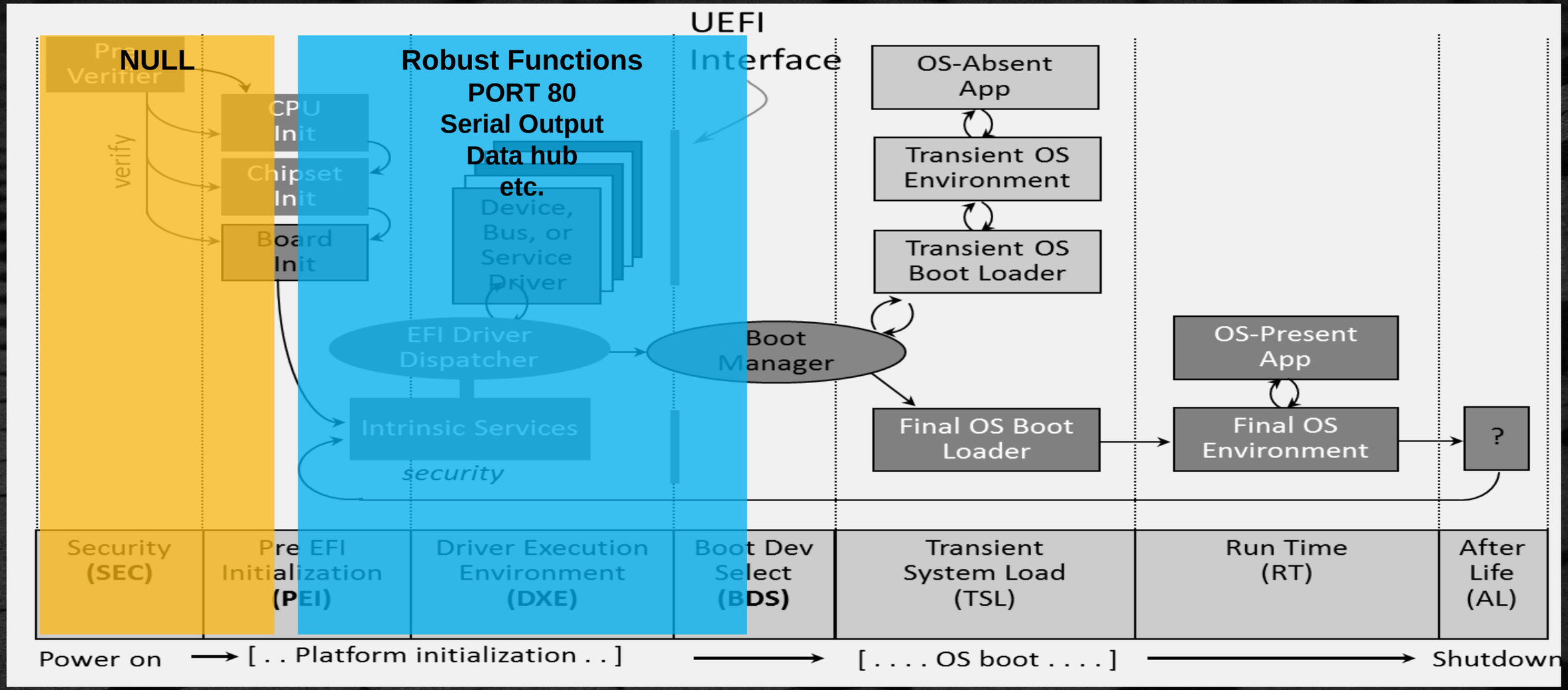
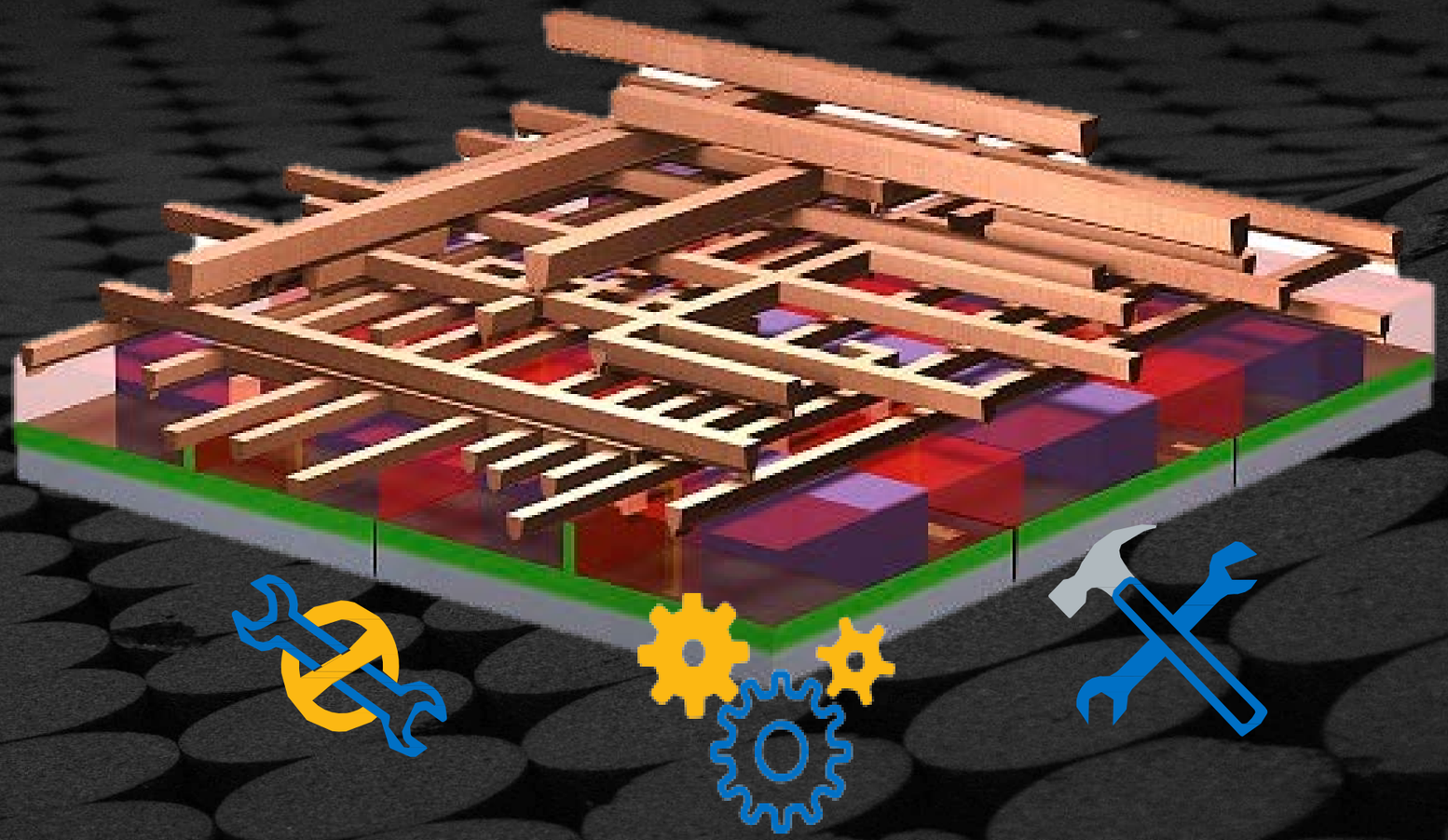
LIBRARIES



EXAMPLE – LIBRARY "DEBUGLIB"



PLATFORM CONFIGURATION DATABASE (PCD)



PLATFORM CONFIGURATION DATABASE (PCD)

Goals

Define module parameters

Store module / platform configurations

Reduce source edits

Maximize module reuse across platforms

Remove `#define`

No searching for “*magic*” `#define` statements

API functions

Get and Set functions for access to PCD variable DB

PLATFORM CONFIGURATION DATABASE (PCD)

Advantages

Binary Modularity

Configure firmware settings in binaries without building

Configure

Provide for options to configure firmware features

Patching

Simplify the binary patching process

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EDK II INFRASTRUCTURE SUMMARY

Packages
List of related modules

+

Libraries
Same name & interface

+

PCDs
Platform Config. DB

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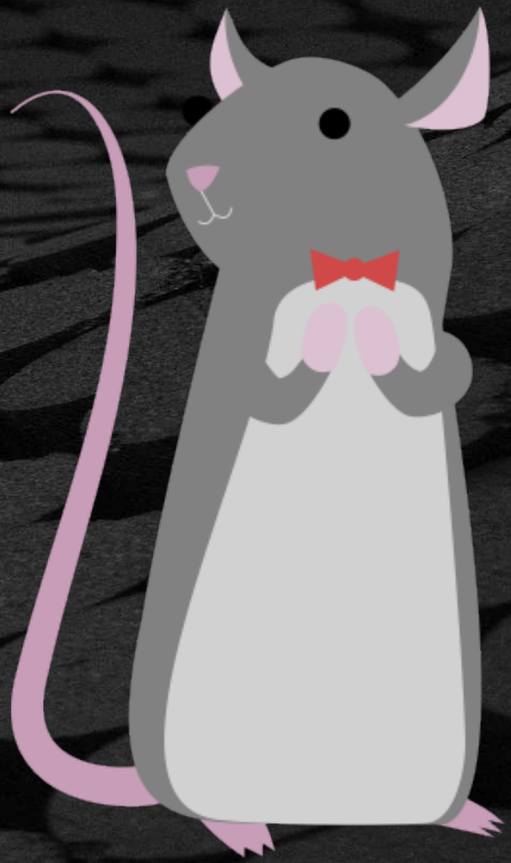
BUILD TOOLS

EDK II Build Tools and Configuration Files

EDK II With Continuous Integration (CI) Tools

- Python tools (pytool) and extensions for building and maintaining an EDK II based UEFI firmware code
- Designed to easily and consistently support running locally and in a cloud CI environment
- Uses a dynamic Python module to customize a global configuration file
- Documentation: pytool CI Tools



Stuart

Stuart CI Development Environment

- Windows 10:
  - Visual Studio VS2017 or VS2019
  - Windows SDK (for rc)
- Ubuntu 18.04 or Fedora
  - GCC5 or greater
- Python 3.7.x or greater on Path
- Git on Path

Typical Stuart CI Commands

```
$ pip install pip-requirements
$ stuart_setup
$ stuart_update
$ python BaseTools\Edk2ToolsBuild.py
$ stuart_ci_build
$ stuart_build
```

To Pass macros to build use:

```
BLD_*_[Macro-to-pass]=[Value]
```

Example Output From Stuart CI Build

```
INFO - Cmd to run is: build -p EmulatorPkg/EmulatorPkg.dsc -b DEBUG -t VS2019 -a X64
       -D WIN_HOST_BUILD=TRUE -D BUILD_X64=TRUE
INFO -
INFO - --------------Cmd Output Starting---------------
INFO - ------------------------------------------------
INFO - Build environment: Windows-10-10.0.18362-SP0
INFO - Build start time: 10:30:55, Aug.27 2020

                                  . . .
PROGRESS - Running Post Build
DEBUG - Plugin Success: Windows RC Path Support
DEBUG - Plugin Success: Windows Visual Studio Tool Chain Support
INFO - Writing BuildToolsReports to
               D:\FW\edk2-ws\edk2\Build\EmulatorX64\DEBUG_VS2019\BUILD_TOOLS_REPORT
DEBUG - Plugin Success: Build Tools Report Generator
PROGRESS - End time: 2020-08-27 10:17:41.147836  Total time Elapsed: 0:01:42
SECTION - Log file is located at: D:\FW\edk2-ws\edk2\Build\BUILDLOG_EmulatorPkg.txt
SECTION - Summary
PROGRESS - Success
```

ERROR – Red
WARNING - Yellow

Non-Stuart CI Development Environment

Compiler Tool Chains

- Microsoft Visual Studio (VS2019,VS2017, VS2015, VS2013, VS2012, etc.)
- Microsoft WDK
- Intel C/C++ compiler
- Intel C EFI Byte Code (EBC) compiler
- GCC V5.x or later

Python 3.7.*n* & Nasm & IASL

Operating Systems

- Microsoft Windows XP/7/8/10
- Apple Mac OS X
- RedHat Enterprise Linux
- Novell SuSE Linux
- Ubuntu 18.04
- Fedora
- Clear Linux* Project

ENVIRONMENT VARIABLES

Set by
`edksetup`
Windows = .bat
Linux = .sh

1. EDK_TOOLS_PATH
2. PATH
3. WORKSPACE
4. EFI_SOURCE / EDK_SOURCE
   Outside `edksetup`

* PACKAGES_PATH *(optional)*

CONFIGURATION FILES - SCRIPTS

- **edksetup.bat** or **edksetup.sh**

```
bash@usid:~/src/edk2
bash@usid:~/src/edk2$ . edksetup.sh
```

- First time use will set up configuration files:
  - Conf/build_rule.txt
  - Conf/target.txt
  - Conf/tools_def.txt
- Setup & verify a developer's workspace

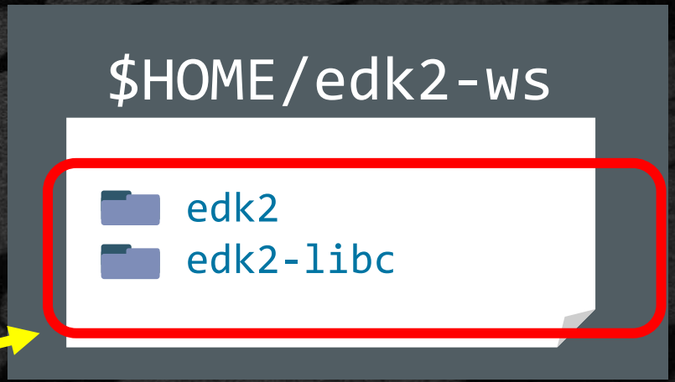
Multiple Workspace Environment Variable

PACKAGES_PATH

WORKSPACE

PACKAGES_PATH – *Optional*
Multiple paths that will be searched when attempting to resolve the location of packages.

- Highest search Priority / Build Directory
- Additional Paths in priority order. Must be set before **edksetup** and ***NOT*** set by **edksetup**



Example:

```
$> set WORKSPACE=%CWD%
$> set PACKAGES_PATH=%WORKSPACE%/edk2;%WORKSPACE%/edk2-libc
```

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USING TARGET.TXT

Tag	Description
ACTIVE_PLATFORM	Pointer to DSC file being built
TARGET	Build mode: DEBUG or RELEASE
TARGET_ARCH	Build architecture (IA32, IPF, X64, EBC, ARM)
TOOL_CHAIN_CONF	Path to `tools_def.txt`
TOOL_CHAIN_TAG	Compiler/tool set to use, based on definitions in `tools_def.txt`
MAX_CONCURRENT_THREAD_NUMBER	Number of threads available to the build process (multi-threaded build)

Using `tools_def.txt`

- Paths for compilers, assemblers, and linkers
  - Comes with definitions for all compilers
- Only modify this file when …
  - Tools are installed in a non-default location
  - Different compilers/tools need to be added
- Default values are set by `edksetup` script
  - Default values will cover most compiler needs
  - If there are problems with the file after editing, just delete and re-run `edksetup` (restores default)

First Make BaseTools

BaseTools

The first step is to make / “nmake” the “BaseTools” with the host OS & compiler environment.

For  Linux GCC5 the command is:

```
bash$ make -C BaseTools
```

For  Windows Visual Studio w/ Python 3.7 the command is:

```
> edksetup.bat Rebuild
```

Building BaseTools only needs to be done once

BUILD PROCESS

EDK II Process and Build Text Files

BUILD PROCESS OVERVIEW

tools_def.txt
target.txt

Source Files

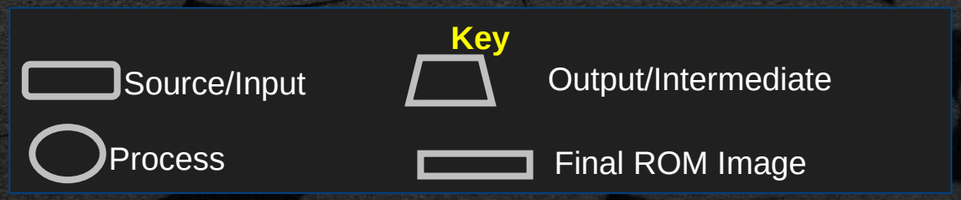
INF Files

DEC Files

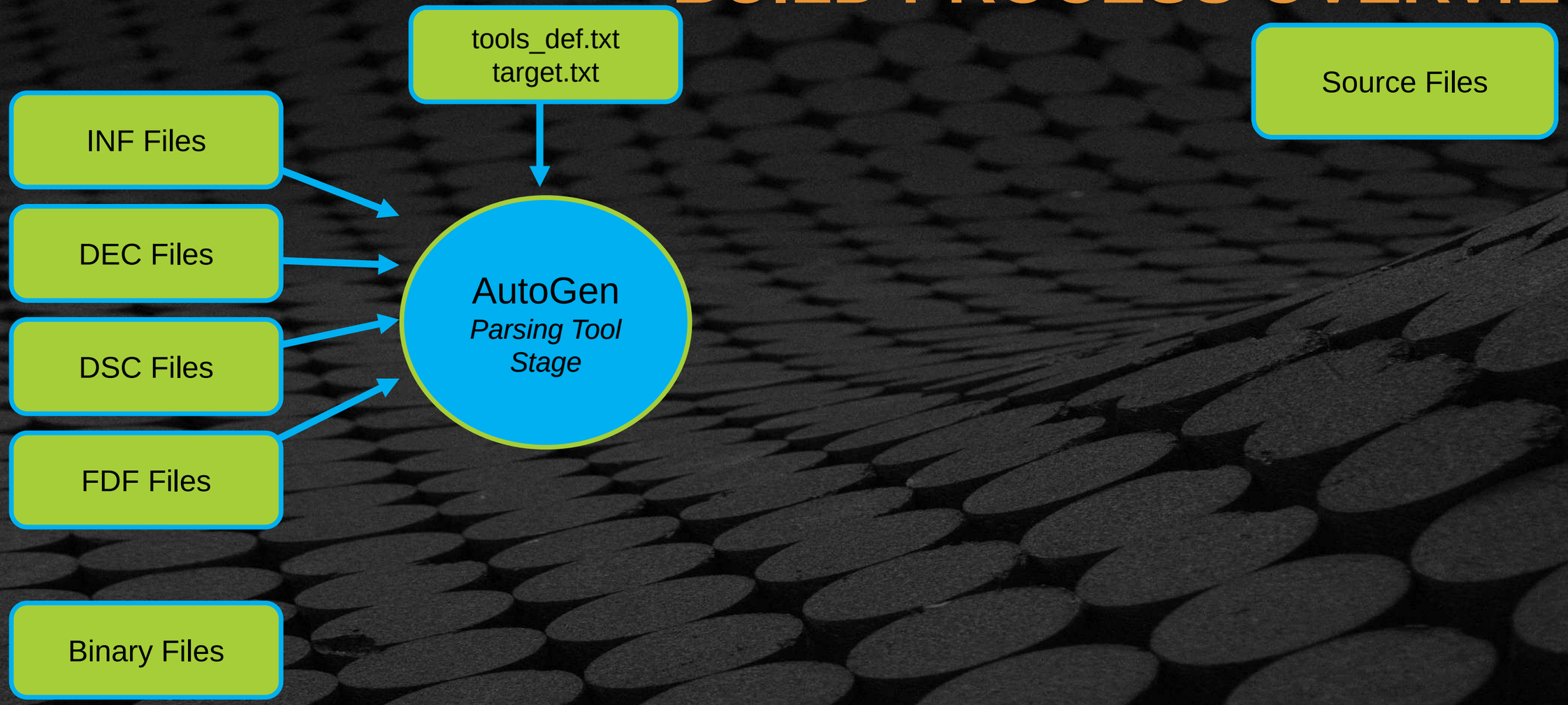
DSC Files

FDF Files

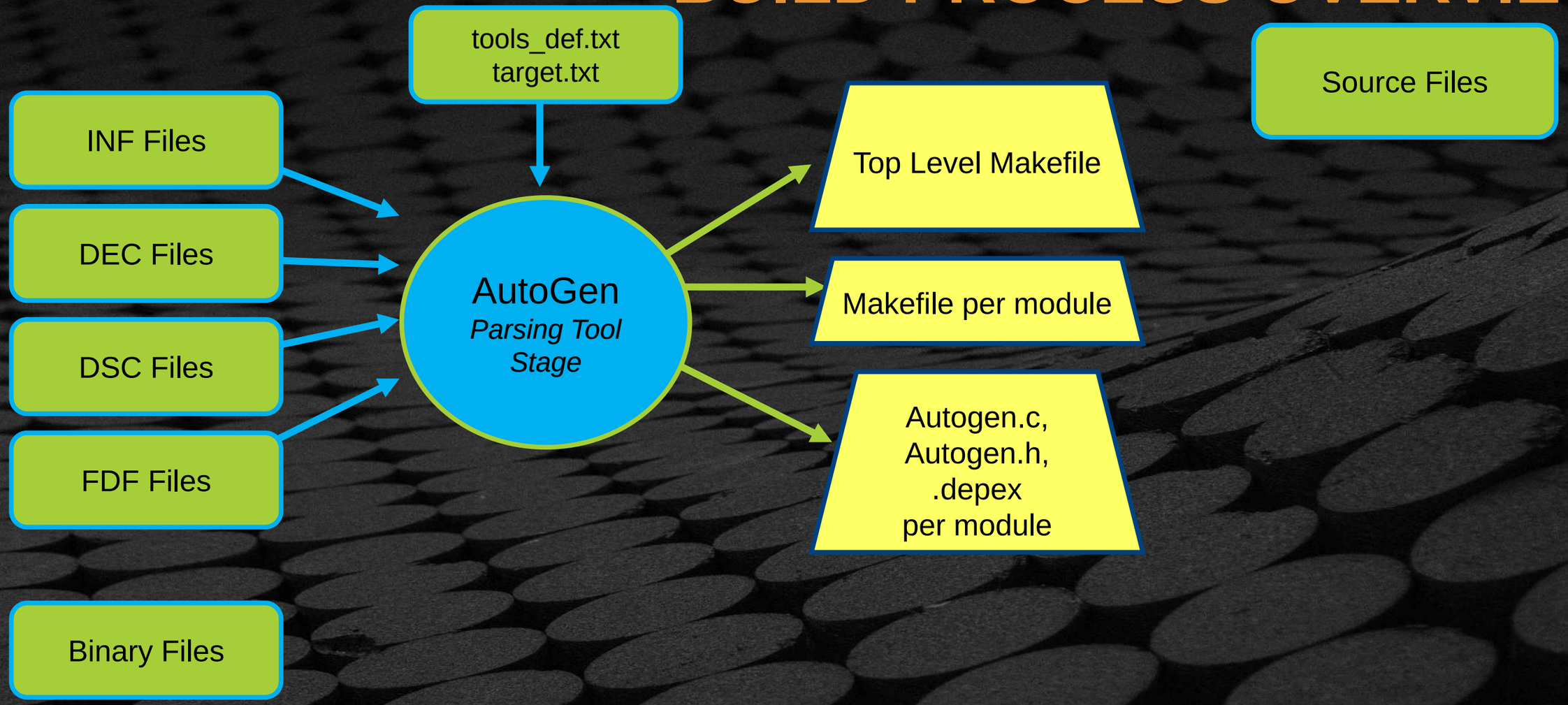
Binary Files



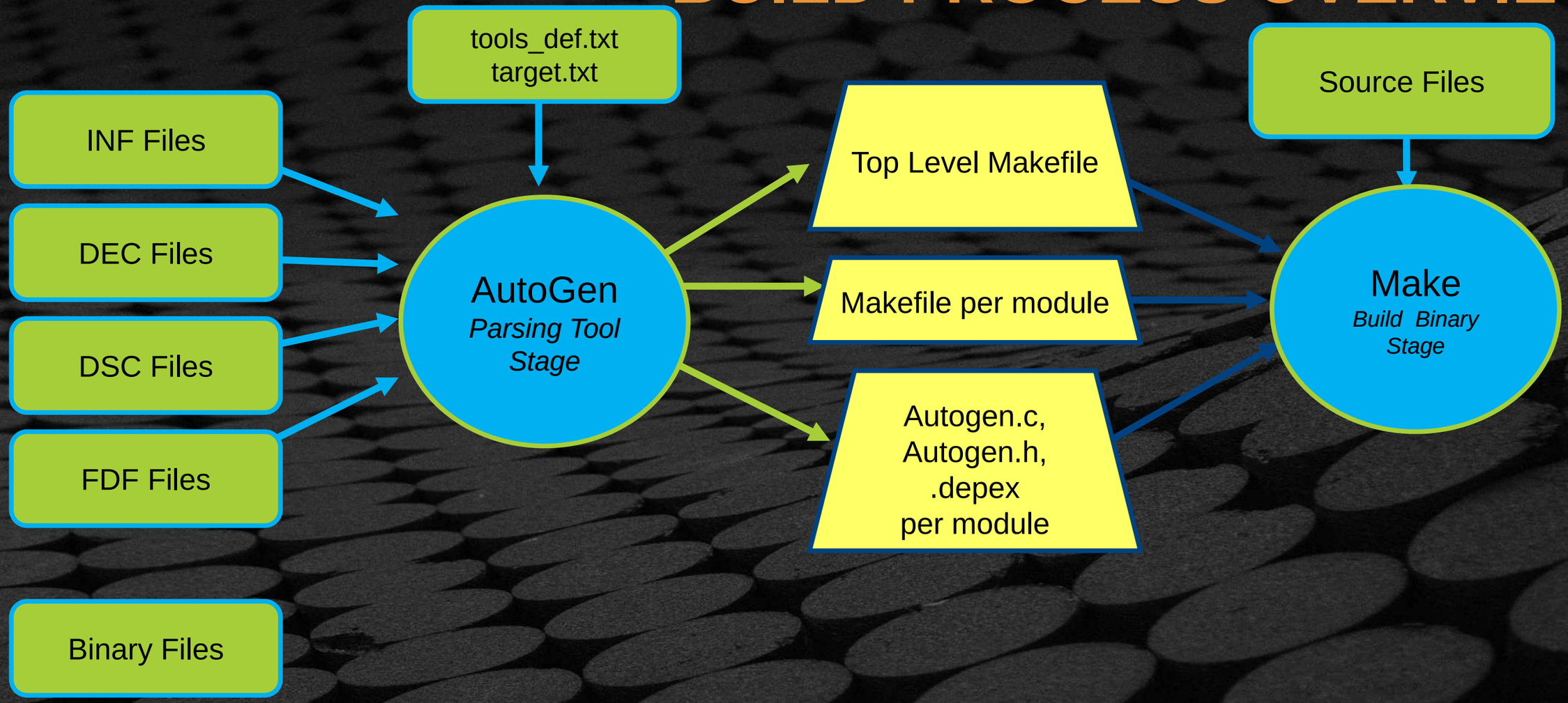
BUILD PROCESS OVERVIEW



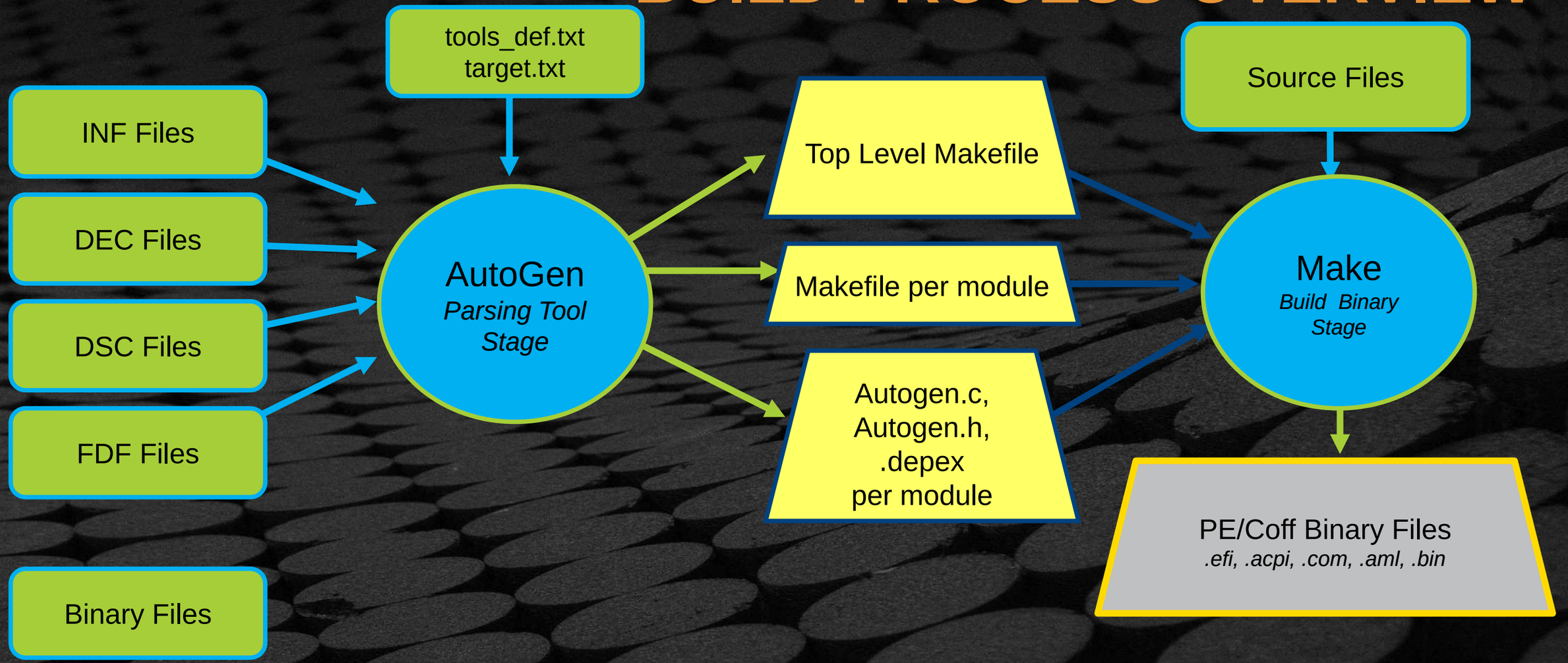
BUILD PROCESS OVERVIEW



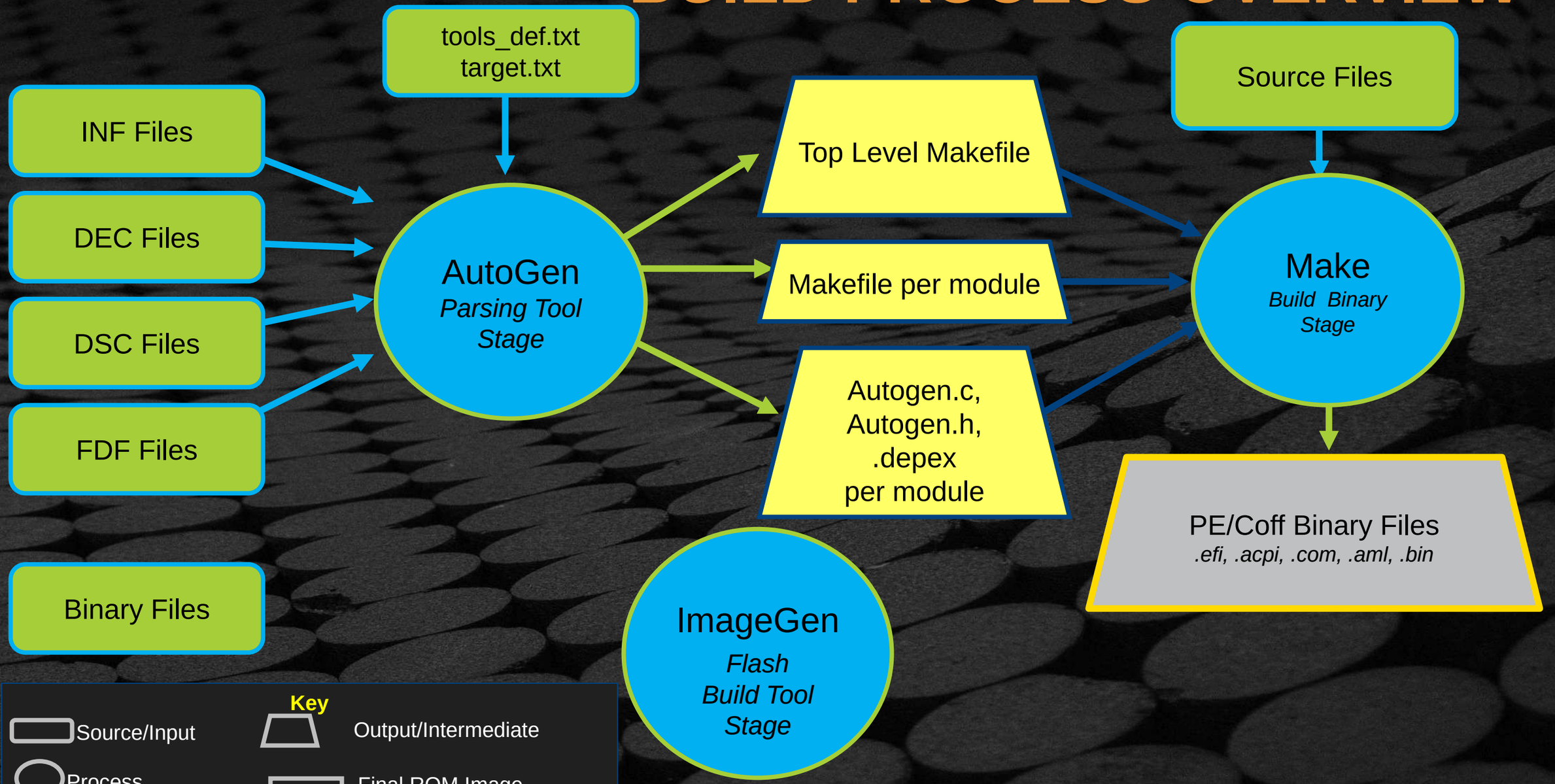
BUILD PROCESS OVERVIEW



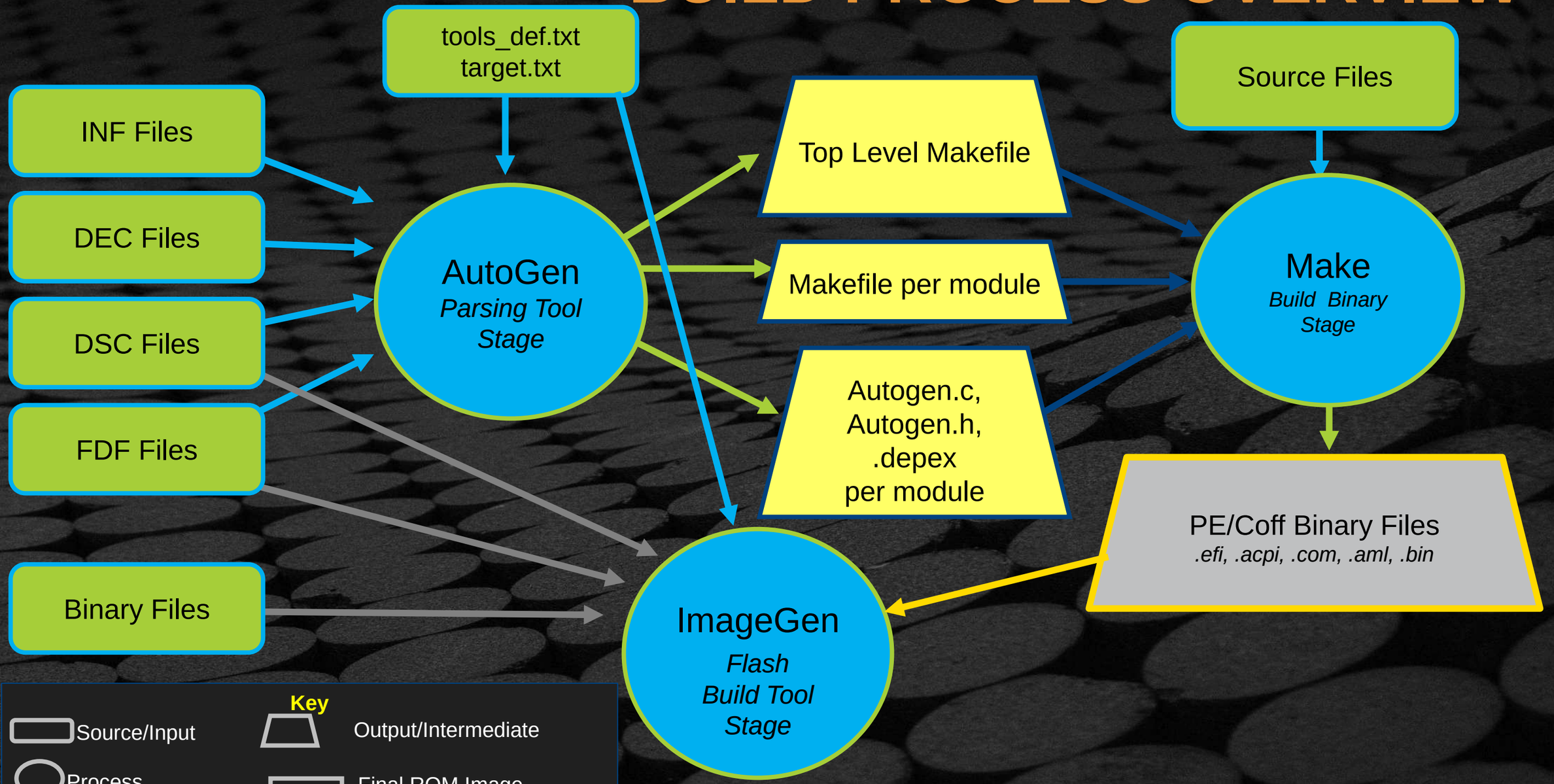
BUILD PROCESS OVERVIEW



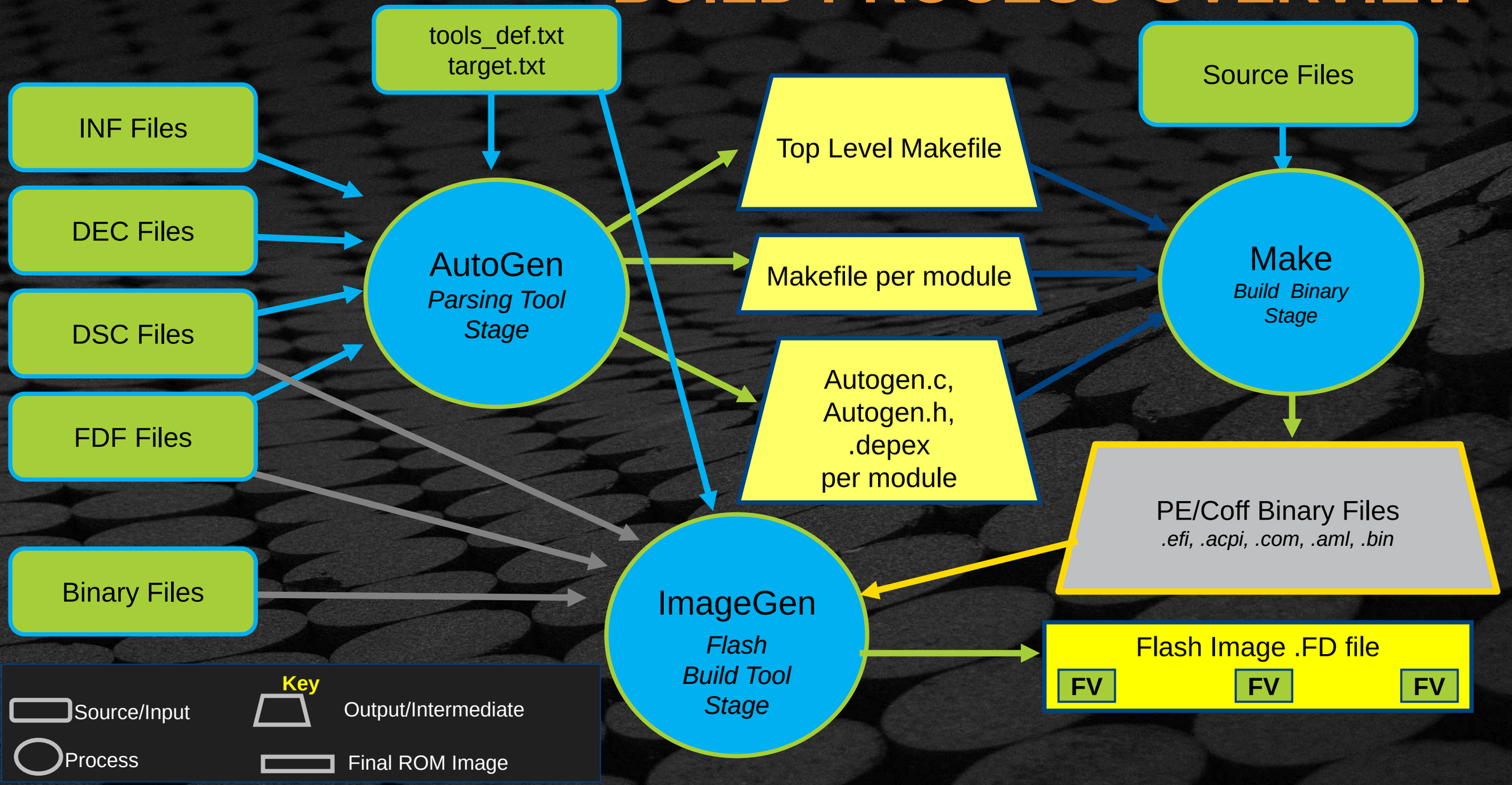
BUILD PROCESS OVERVIEW



BUILD PROCESS OVERVIEW



BUILD PROCESS OVERVIEW



BASIC BUILD STEPS

Platform

1. Navigate to root of EDK II workspace
2. Make the `BaseTools`
3. Run **`edksetup`**
4. Run **`build`**
5. Output: firmware image (FD) file under **`Build`** directory

Module

1. Navigate to root of EDK II workspace
2. Make the `BaseTools`
3. Run **`edksetup`**
4. Change to a directory with the proper INF
5. Run **`build`**
6. Output: .EFI files under **`Build`** directory

Note: Module .inf must be in .dsc components

BUILD OUTPUT LOCATION

```
Build
Build
Build
```

Path Element	Description	Notes
Build	Build directory	This is default.
Ovmfpkg	platform being used	
DEBUG_MYTOOLS	build mode and tool chain	From target.txt
FV	contains final image	Both FV and FD images
IA32 | X64	processor architecture	Contains platform makefile
Pkg/ModuleName	path to INF file	One for each INF
Foo	name of INF file (Module)	Contains module makefile
OUTPUT	.EFI file location	
DEBUG	Autogen files	

BUILD OUTPUT LOCATION

```
Build /OvmfX64
Build /Ovmf[1]
Build  /Ovmf[1]
```

Path Element	Description	Notes
Build	Build directory	This is default.
Ovmfpkg	platform being used	
DEBUG_MYTOOLS	build mode and tool chain	From target.txt
FV	contains final image	Both FV and FD images
IA32 | X64	processor architecture	Contains platform makefile
Pkg/ModuleName	path to INF file	One for each INF
Foo	name of INF file (Module)	Contains module makefile
OUTPUT	.EFI file location	
DEBUG	Autogen files	

[1] IA32 or X64

BUILD OUTPUT LOCATION

```
Build /OvmfX64  /DEBUG_MYTOOLS
Build /Ovmf[1] /DEBUG_MYTOOLS
Build  /Ovmf[1]  /DEBUG_MYTOOLS
```

Path Element	Description	Notes
Build	Build directory	This is default.
Ovmfpkg	platform being used	
DEBUG_MYTOOLS	build mode and tool chain	From target.txt
FV	contains final image	Both FV and FD images
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[1] IA32 or X64

BUILD OUTPUT LOCATION

```
Build /OvmfX64 /DEBUG_MYTOOLS /FV
Build /Ovmf[1] /DEBUG_MYTOOLS
Build /Ovmf[1] /DEBUG_MYTOOLS
```

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[1] IA32 or X64

BUILD OUTPUT LOCATION

```
Build /OvmfX64  /DEBUG_MYTOOLS  /FV
Build /Ovmf[1] /DEBUG_MYTOOLS  /IA32[1]
Build  /Ovmf[1]  /DEBUG_MYTOOLS    /IA32[1]
```

Path Element	Description	Notes
Build	Build directory	This is default.
Ovmfpkg	platform being used	
DEBUG_MYTOOLS	build mode and tool chain	From target.txt
FV	contains final image	Both FV and FD images
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[1] IA32 or X64

BUILD OUTPUT LOCATION

```
Build /OvmfX64 /DEBUG_MYTOOLS /FV
Build /Ovmf[1] /DEBUG_MYTOOLS /IA32[1] /Pkg /ModuleName
Build /Ovmf[1] /DEBUG_MYTOOLS /IA32[1] /Pkg /ModuleName
```

Path Element	Description	Notes
Build	Build directory	This is default.
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OUTPUT	.EFI file location	
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[1] IA32 or X64

BUILD OUTPUT LOCATION

```
Build /OvmfX64  /DEBUG_MYTOOLS  /FV
Build /Ovmf[1] /DEBUG_MYTOOLS  /IA32[1]/Pkg /ModuleName /Foo
```

```
Build  /Ovmf[1]  /DEBUG_MYTOOLS     /IA32[1]  /Pkg  /ModuleName    /Foo
```

Path Element	Description	Notes
Build	Build directory	This is default.
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DEBUG_MYTOOLS	build mode and tool chain	From target.txt
FV	contains final image	Both FV and FD images
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[1] IA32 or X64

BUILD OUTPUT LOCATION

```
Build /OvmfX64 /DEBUG_MYTOOLS /FV
Build /Ovmf[1] /DEBUG_MYTOOLS /IA32[1] /Pkg /ModuleName /Foo
Build /Ovmf[1] /DEBUG_MYTOOLS /IA32[1] /Pkg /ModuleName /Foo /OUTPUT
```

Path Element	Description	Notes
Build	Build directory	This is default.
Ovmfpkg	platform being used	
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[1] IA32 or X64

BUILD OUTPUT LOCATION

```
Build /OvmfX64 /DEBUG_MYTOOLS /FV
Build /Ovmf[1] /DEBUG_MYTOOLS /IA32[1] /Pkg /ModuleName /Foo /DEBUG
Build /Ovmf[1] /DEBUG_MYTOOLS /IA32[1] /Pkg /ModuleName /Foo /OUTPUT
                                                          /DEBUG
```

Path Element	Description	Notes
Build	Build directory	This is default.
Ovmfpkg	platform being used	
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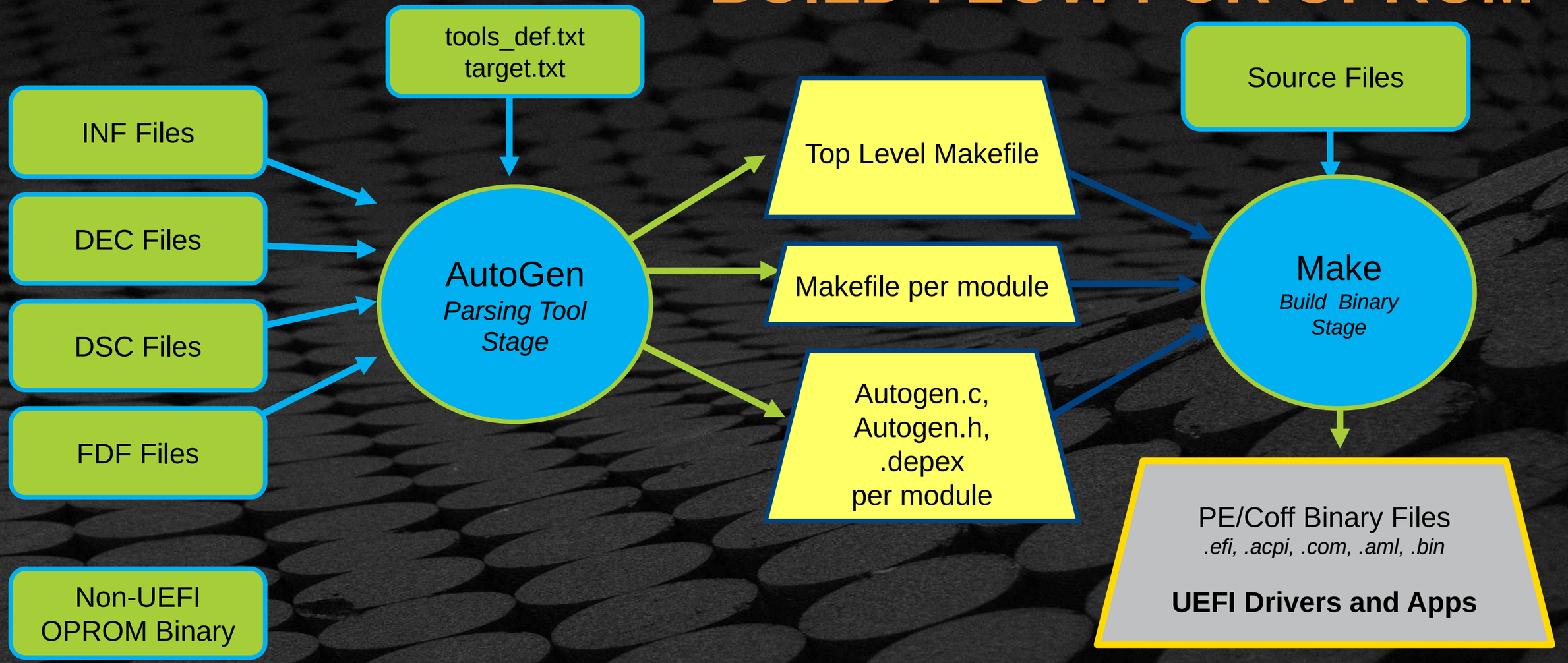
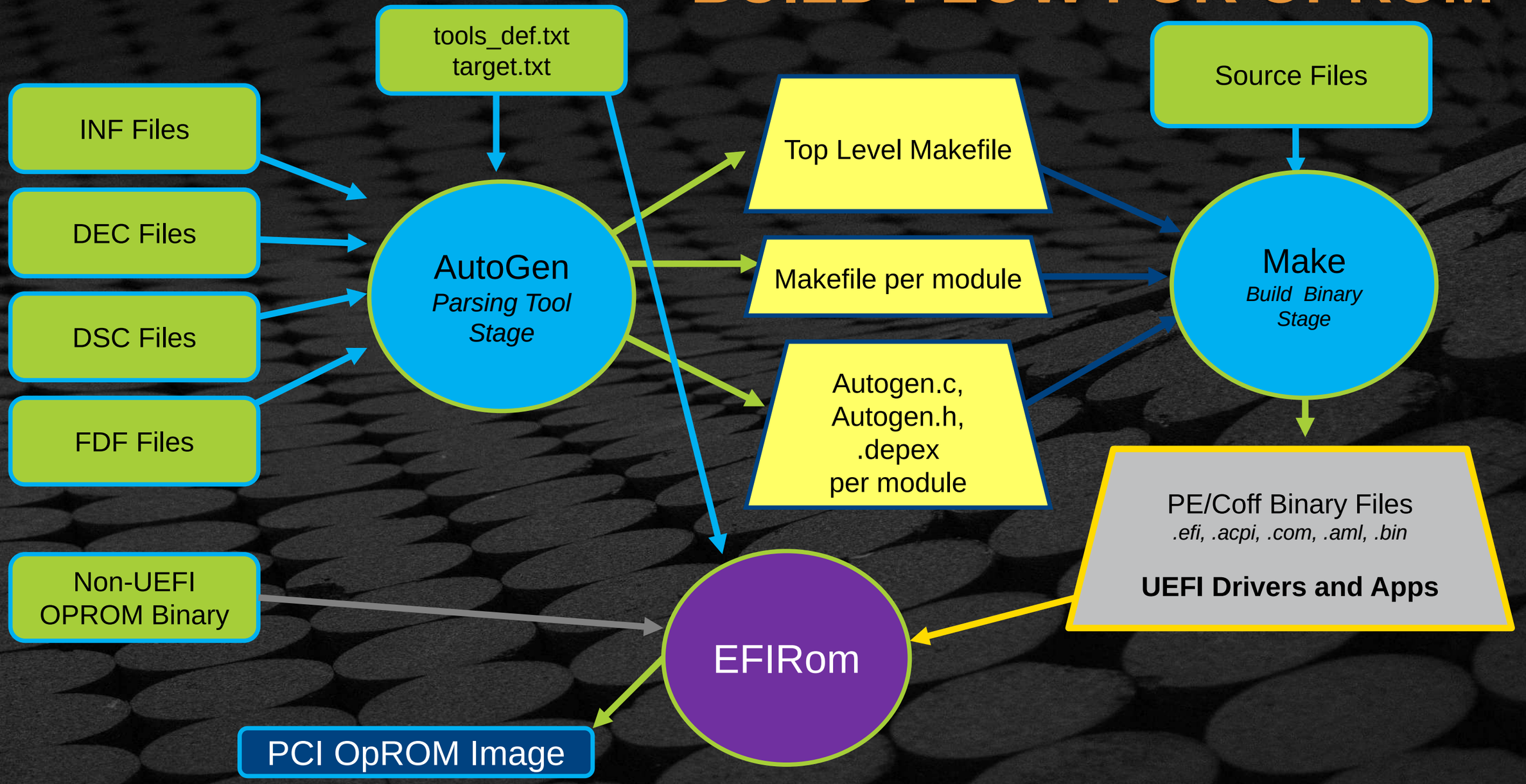
OUTPUT	.EFI file location	
DEBUG	Autogen files	

[1] IA32 or X64

BUILD FLOW FOR OPROM



BUILD FLOW FOR OPROM



The `build` Command

- Accepts command line arguments to support scripted builds
- Overrides most settings found in `target.txt`
- Overrides DSC with a minimal INF build
- Overrides some settings in DSC file (.FDF)
- Choose settings from the FDF file `(ROMIMAGE, FVIMAGE)`
- Choose `$(make)` options (silent, verbose, quiet)

Using EDK II build Command

```
Usage: build.exe [options] [all|fds|genc|genmake|clean|cleanall|cleanlib|modules|libraries|run]

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Options:
  --version             show program's version number and exit
  -h, --help            show this help message and exit
  -a TARGETARCH, --arch=TARGETARCH
                        ARCHS is one of list: IA32, X64, IPF, ARM or EBC,
                        which overrides target.txt's TARGET_ARCH definition
                        To specify more archs, please repeat this option.
  -p PLATFORMFILE, --platform=PLATFORMFILE
                        Build the platform specified by the DSC file name
                        argument, overriding target.txt's ACTIVE_PLATFORM
                        definition.
  -m MODULEFILE, --module=MODULEFILE
                        Build the module specified by the INF file name
                        argument.
```

• • •

bash$ build -h

Using EDK II build Command

```
Usage: build.exe [options] [all|fds|genc|genmake|clean|cleanall|cleanlib|modules|libraries|run]

Copyright (c) 2007 - 2017, Intel Corporation  All rights reserved.

Options:
  --version             show program's version number and exit
  -h, --help            show this help message and exit
  -a TARGETARCH, --arch=TARGETARCH
                        ARCHS is one of list: IA32, X64, IPF, ARM or EBC,
                        which overrides target.txt's TARGET_ARCH definition
                        To specify more archs, please repeat this option.
  -p PLATFORMFILE, --platform=PLATFORMFILE
                        Build the platform specified by the DSC file name
                        argument, overriding target.txt's ACTIVE_PLATFORM
                        definition.
  -m MODULEFILE, --module=MODULEFILE
                        Build the module specified by the INF file name
                        argument.
```

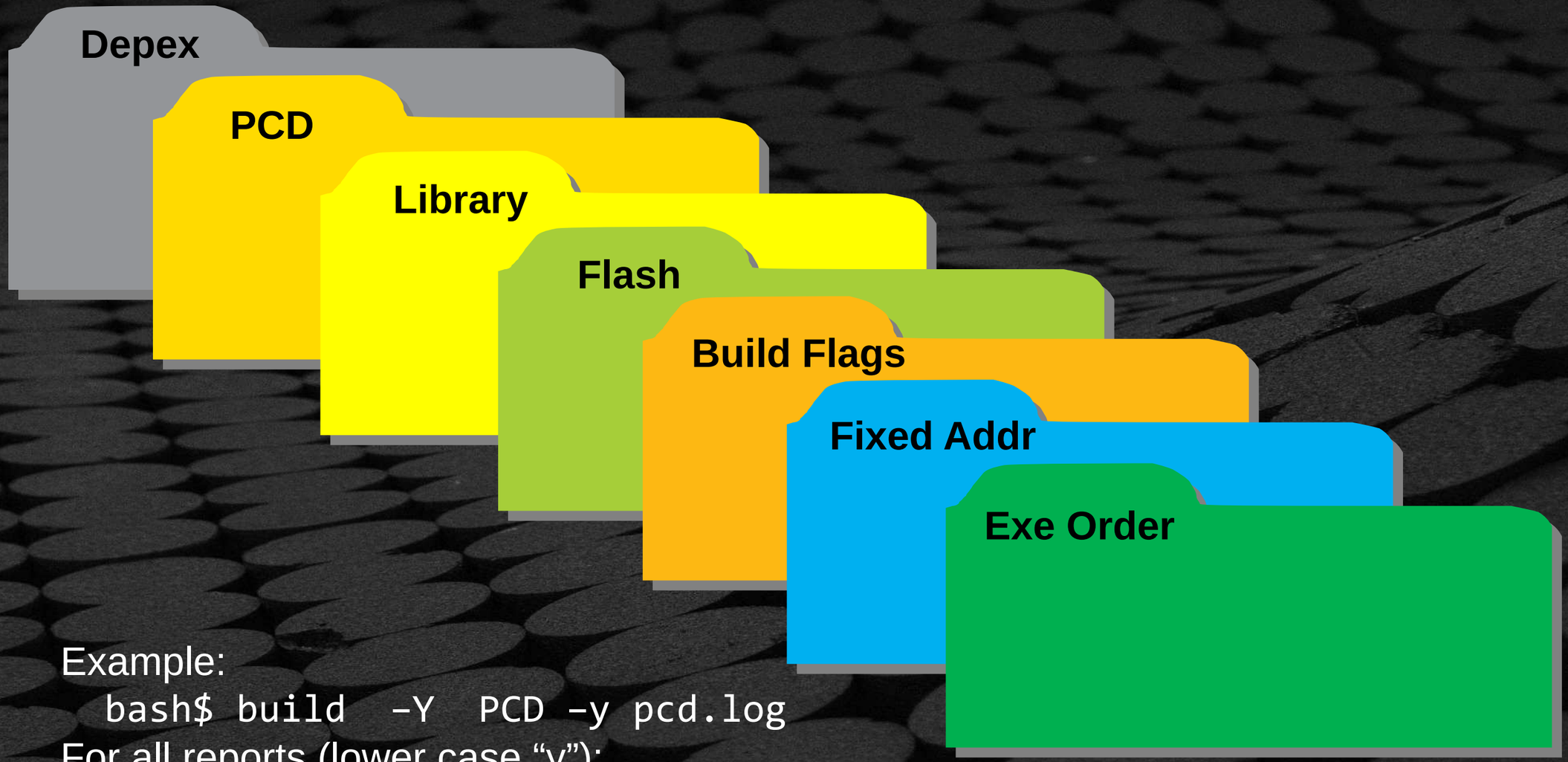
• • •

bash$ build -h

build -h

https://gitpitch.com/tianocore-training/EDK_II_Build_Process_Pres/master#/39/2

USING BUILD -Y COMMAND



Example:

```
bash$ build  -Y  PCD -y pcd.log
```

For all reports (lower case “y”):

```
bash$ build -y MyReport.log
```

USING BUILD -Y FOR REPORTS

- Scroll through examples of reports from the Build -Y commands
- Link to on line presentation

build -Y DEPEX

https://gitpitch.com/tianocore-training/EDK_II_Build_Process_Pres/master#/40/2

build -Y PCD

https://gitpitch.com/tianocore-training/EDK_II_Build_Process_Pres/master#/40/3

build -Y LIBRARY

https://gitpitch.com/tianocore-training/EDK_II_Build_Process_Pres/master#/40/4

build -Y FLASH

https://gitpitch.com/tianocore-training/EDK_II_Build_Process_Pres/master#/40/5

build -Y BUILD_FLAGS

https://gitpitch.com/tianocore-training/EDK_II_Build_Process_Pres/master#/40/6

build -Y FIXED_ADDRESS

https://gitpitch.com/tianocore-training/EDK_II_Build_Process_Pres/master#/40/7

build -Y EXECUTION_ORDER

https://gitpitch.com/tianocore-training/EDK_II_Build_Process_Pres/master#/40/8

Local Report.html is generated on the host build machine - pop up this in the Browser window.

Link: Link to Report.html on local machine

build -y MyReport.log

https://gitpitch.com/tianocore-training/EDK_II_Build_Process_Pres/master#/40/9

Build Tool Binaries

Utility	Description
Build.exe	Tool is written in Python and calls AutoGen.exe, then it calls $(MAKE) –f Makefile.out, and finally, it calls GenFds.exe
EfiRom.exe	used to build an option ROM image
GenPatchPcdTable	Tool works together with PatchPcdValue tool to set the specific value of a patchable PCD into the binary EFI image
PatchPcdValue	used to Patch the specific value into the binary

SUMMARY

- Define EDK II
- Describe EDK II's elements including file extensions, rectories, modules, packages, and libraries
- Explain the EDK II build process
- Explain the Build tools

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Questions?

Return to Main Training Page

Return to Training Table of contents for next presentation

Link


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ACKNOWLEDGEMENTS

BACKUP

EDK II VS. UDK (2010| 2017 .. 2018)

UEFI Developer's Kit 2018 (UDK2018)

Stable build of the EDK II project

Neither contain Intel silicon or platform code

wiki on tianocore.org Differences between UDK - EDK II

EDK II BUILD PROCESS STAGES

AutoGen
Parsing Tool Stage

Parse meta-data files to generate some C source code files and the make files

Make
Build Binary Stage

Process source code files to create PE32/PE32+/COFF images processed to UEFI format using $(MAKE) tool

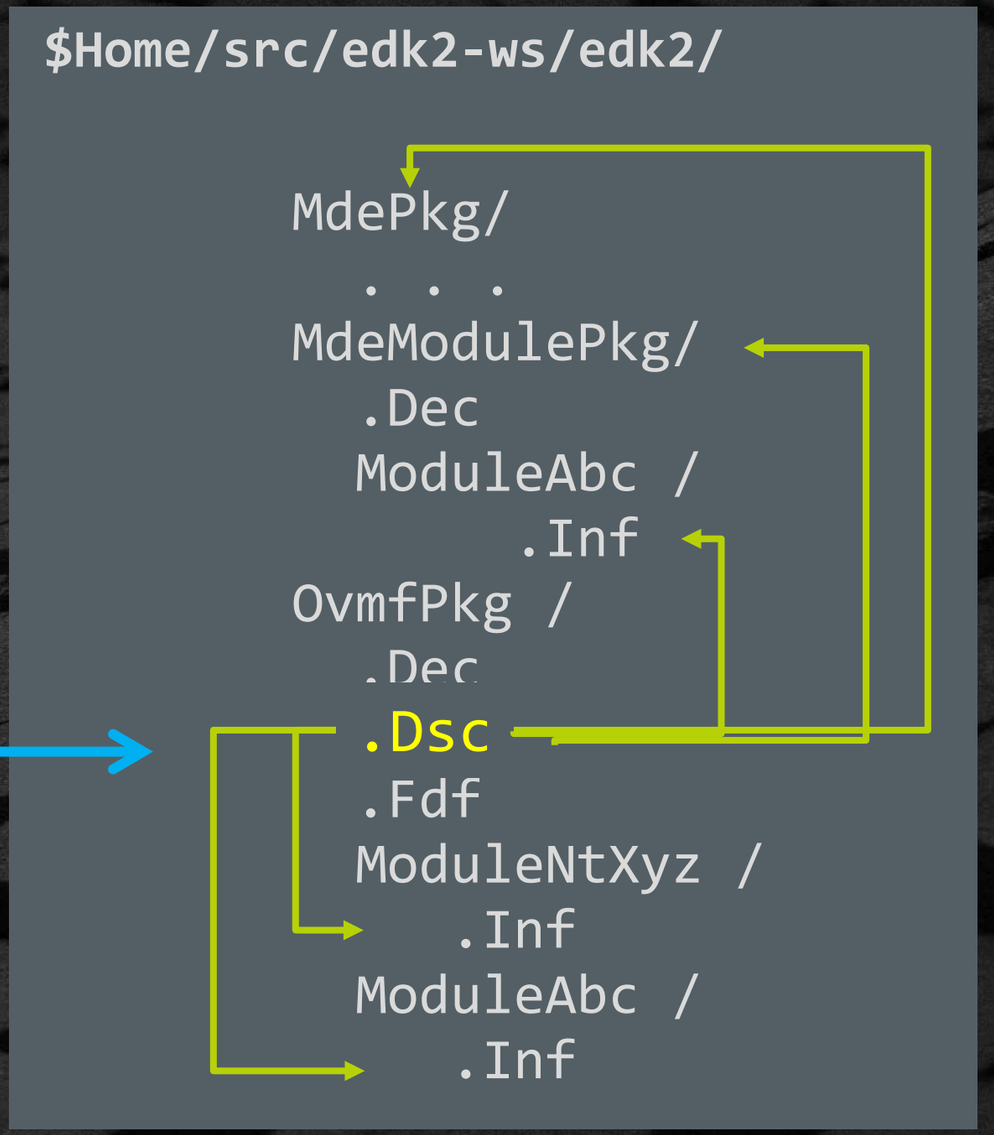
ImageGen
Flash Build Tool Stage

Takes the UEFI format files, creates UEFI “FLASH” images, UEFI apps, or UEFI PCI option ROMs

EDK II BUILD: AUTOGEN STAGE

EDK II Open Source

```
build –p OvmfPkg/OvmfX64Pkg.dsc
```



EDK II BUILD: MAKE STAGE

Uses assemblers/compilers/linkers to generate PE32/PE32+ COFF image file

Uses ImageGen tools to modify PE32/PE32+/COFF image file; Creates UEFI file (EFI_IMAGE_SECTION_HEADER structure)

GenFW

GenFds

EDK II BUILD: IMAGEGEN STAGE

- Builds one image for each specified firmware volume (FV)
- The FDF file supports all syntax available in the PI Specification Vol. 3