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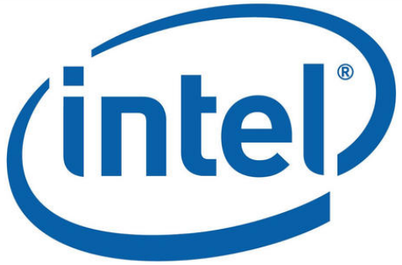

Using Python 3 in the UEFI Shell for Platform Security Analysis

UEFI 2022 Virtual Summit

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Meet the Presenters

Aaron Frinzell security research

Nathaniel Mitchell security research

Sara Batllori security research

Dan Scott security research

More Questions?

Following today's webinar, join the live, interactive WebEx Q&A for the opportunity to chat with the presenters

- **Visit this link to attend:** https://bit.ly/3OnTLCr
- **Meeting number:** 2558 523 4281
  Password: uefiforum (83343678 from phones and video systems)

Agenda

- EFI Shell Python 3.6.8 Implementation
- CHIPSEC in the EFI Shell

CHIPSEC

Python based framework for analyzing the security of PC platforms including hardware, system firmware (BIOS/UEFI), and platform components. It includes a security test suite, tools for accessing various low-level interfaces, and forensic capabilities.

Source: https://github.com/chipsec/chipsec

Our First Try…

- Python 2.7
- Based on the EDK2 implementation
- Support two Python versions
- EOL'd January 1, 2020 (PEP 373)

Python 2.7 EDK2: https://github.com/tianocore/edk2-archive/blob/master/AppPkg/Applications/Python/PythonReadMe.txt

Python 2 EOL: https://www.python.org/doc/sunset-python-2/

EDK2-LIBC Python Implementation

- Python 3.6.8 support added Sept 2, 2021
- https://github.com/tianocore/edk2-libc
- /AppPkg/Applications/Python/Python-3.6.8/

Source: https://github.com/tianocore/edk2-libc/commit/7769ee0af3429ca650b651a7894308ae09906302

Py2 to Py3 Migration

- Decoupled text and binary data
  - str, bytes, & Unicode
  - Py2 could use str type for both text and binary data
  - Py3 str now always Unicode
- Class and Syntax changes
- cpython changes
  - Parsing arguments and format specifier deprecation
    - u# - old style Py_UNICODE API
  - Method Calling convention:
    - METH_OLDARGS deprecated
    - METH_VARARGS, function type PyCFunction

Source: https://docs.python.org/3/howto/pyporting.html

CHIPSEC edk2module.c Changes

```
// -- Access to CPU MSRs
extern void _rdmsr( unsigned int msr_num, unsigned int* msr_lo, unsigned int* msr_hi );
extern void _wrmsr( unsigned int msr_num, unsigned int  msr_hi, unsigned int  msr_lo );
extern void _swsmi( unsigned int smi_code_data, unsigned int rax_value, unsigned int rbx_value, unsigned int rcx_value, unsigned int rdx_value, unsigne
extern unsigned int  AsmCpuidEx( unsigned int  RegisterInEax, unsigned int  RegisterInEcx, unsigned int* RegisterOutEax, unsigned int* RegisterOutEbx,
// -- Access to PCI CFG space
extern void WritePCIByte          ( unsigned int pci_reg, unsigned short cfg_data_port, unsigned char  byte_value );
extern void WritePCIWord          ( unsigned int pci_reg, unsigned short cfg_data_port, unsigned short word_value );
extern void WritePCIDword         ( unsigned int pci_reg, unsigned short cfg_data_port, unsigned int   dword_value );
extern unsigned char  ReadPCIByte ( unsigned int pci_reg, unsigned short cfg_data_port );
extern unsigned short ReadPCIWord ( unsigned int pci_reg, unsigned short cfg_data_port );
extern unsigned int   ReadPCIDword( unsigned int pci_reg, unsigned short cfg_data_port );
// -- Access to Port I/O
extern unsigned int   ReadPortDword ( unsigned short port_num );
extern unsigned short ReadPortWord  ( unsigned short port_num );
extern unsigned char  ReadPortByte  ( unsigned short port_num );
extern void           WritePortDword( unsigned int   out_value, unsigned short port_num );
extern void           WritePortWord ( unsigned short out_value, unsigned short port_num );
extern void           WritePortByte ( unsigned char  out_value, unsigned short port_num );
// -- Access to CPU Descriptor tables
extern void _store_idtr( void* desc_address );
extern void _load_idtr ( void* desc_address );
extern void _store_gdtr( void* desc_address );
extern void _store_ldtr( void* desc_address );

// -- Support routines
EFI_STATUS GuidToStr( IN EFI_GUID *guid, IN OUT UINT8 *str_buffer );
```

edk2module.c

Source: https://github.com/chipsec/chipsec/tree/main/chipsec_tools/edk2/PythonEFI

Build Prep

- Latest EDK2
  - https://github.com/tianocore/edk2
    - git clone git@github.com:tianocore/edk2.git
  - Update submodules
    - cd edk2
    - git submodule update --init
- Latest EDK2-LIBC
  - https://github.com/tianocore/edk2-libc
    - git clone git@github.com:tianocore/edk2-libc.git

Source: https://github.com/tianocore/edk2/blob/master/ReadMe.rst

CHIPSEC Source Code

- Files to copy/overwrite:
  - https://github.com/chipsec/chipsec/tree/main/chipsec_tools/edk2/PythonEFI
  - edk2module.c - all CHIPSEC related functions (#ifdef CHIPSEC)
  - cpu.asm – asm functions

Python Updates

- AppPkg/Applications/Python/Python-3.6.8
  - Execute srcprep.py
  - Overwrite:
    - /PyMod-3.6.8/Modules/edk2module.c
  - Add:
    - /PyMod-3.6.8/Modules/cpu.asm
  - Update:
    - /Python368.inf
    - Add ‘PyMod-$(PYTHON_VERSION)/Modules/cpu.asm’ under [Sources.X64] section

```
[Sources.X64]
  PyMod-$(PYTHON_VERSION)/Modules/cpu.asm   #
```

Source: https://chipsec.github.io/installation/USB%20with%20UEFI%20Shell.html

Build python368.efi

- Build efi
  - build -a X64 -p AppPkg\AppPkg.dsc
- Build Python package
  - cd AppPkg\Applications\Python\Python-3.6.8
  - create_python368_pkg.bat (.sh)
    - Switches: <tool_chain> <target> <arch> <out_folder>
    - Example:

```
create_python368_pkg.bat VS2019 RELEASE X64 d:\
```

Source: https://chipsec.github.io/installation/USB%20with%20UEFI%20Shell.html

It Works, But…

- Most platforms ‘worked’ but a handful exhibited GP
- Enter uuid.py library
  - Uses environmental specific calls to generate random UUID
  - Defaulted to Linux routines for reading Unix timestamp and MAC address

```
!!!! X64 Exception Type - 0D(#GP - General Protection)  CPU Apic ID - 00000008 !!!!
ExceptionData - 0000000000000000
RIP  - 00000000622C17BE, CS  - 0000000000000038, RFLAGS - 0000000000010202
RAX  - AFAFAFAFAFAFAFAF, RCX - 000000006288BF38, RDX - 0000000000000000
```

Source: https://github.com/tianocore/edk2-libc/commit/c32222fed9927420fc46da503dea1ebb874698b6

EFI Shell Python Setup

1. https://github.com/chipsec/chipsec
2. /__install__/UEFI/chipsec_py368_uefi_x64.zip
3. FAT32 media
4. Extract to /EFI
5. Boot to Shell

```
Boot Override
UEFI: Built-in EFI Shell
```

```
fs0:
├──efi
│   ├──StdLib
│   │   └──lib
│   │       └──python36.8
│   │           └──[lots of python files and directories]
│   └──Tools
│       └──python368.efi
└──chipsec
    ├──chipsec
    │   └── ...
    ├──chipsec_main.py
    ├──chipsec_util.py
    └── ...
```

Source: https://github.com/chipsec/chipsec/blob/main/__install__/UEFI/chipsec_py368_uefi_x64.zip

Using EFI Shell Python

- fs0:> python368.efi
- >>> import edk2

```
fs0:\> python368
Python 3.6.8 (default, Feb 23 2022, 17:43:18) [C] on uefi
Type "help", "copyright", "credits" or "license" for more information.
>>> import edk2
>>> hex(edk2.rdmsr(0x1f2)[0])
'0x88400006'
>>> _
```

CHIPSEC EDK2 Library

```
edk2.readmem(phys_address_lo, phys_address_hi, length)
edk2.readmem_dword(phys_address_lo, phys_address_hi)
edk2.writemem(phys_address_lo, phys_address_hi, buffer, length)
edk2.writemem_dword(phys_address_lo, phys_address_hi, value)
edk2.allocphysmem(length, max_pa)[0]
edk2.readio(io_port, size)
edk2.writeio(io_port, size, value)
edk2.readpci(bus, device, function, address, size)
edk2.writepci(bus, device, function, address, value, size)
edk2.swsmi(SMI_code_data, _rax, _rbx, _rcx, _rdx, _rsi, _rdi)
edk2.rdmsr(msr_addr)
edk2.wrmsr(msr_addr, eax, edx)
edk2.cpuid(eax, ecx)
edk2.GetVariable(name, guidstr, size)
edk2.GetNextVariableName(size, name, guid)
edk2.SetVariable(name, guidstr, int(attrs), data, datasize)
```

CHIPSEC Release

- Python 2 is EOL'd in CHIPSEC
- CHIPSEC v1.8.0 introduced Python 3.6.8 support, released Dec 2021

```
#
# Python 2/3 compatible input
#
def cs_input(msg):
    if sys.version[0] == '2':
        return raw_input(msg)
    else:
        return input(msg)
```

Source: https://github.com/chipsec/chipsec/releases/tag/1.8.0

Running CHIPSEC

- Shell> fs0:
- FS0:\> cd chipsec
- FS0:\chipsec\> python368 chipsec_main.py

Or

- FS0:\chipsec\> python368 chipsec_util.py

Demo

Chipsec_main Log

```
################################################################
##                                                            ##
##  CHIPSEC: Platform Hardware Security Assessment Framework  ##
##                                                            ##
################################################################
[CHIPSEC] Version 1.8.7
[CHIPSEC] Arguments: -l cml_nuc.txt

[CHIPSEC] API mode: using CHIPSEC kernel module API
[CHIPSEC] OS      : uefi
[CHIPSEC] Python  : 3.6.8 (64-bit)
[CHIPSEC] Helper  : EfiHelper (None)
[CHIPSEC] Platform: CometLake U
[CHIPSEC]      VID: 8086
[CHIPSEC]      DID: 9B61
[CHIPSEC]      RID: 0C
[CHIPSEC] PCH     : Intel 400 series PCH-LP Prem-U
[CHIPSEC]      VID: 8086
[CHIPSEC]      DID: 0284
[CHIPSEC]      RID: 00
```

Log Module

```
137 [*] Running module: chipsec.modules.common.cpu.spectre_v2
138 [x][ ================================================================
139 [x][ Module: Checks for Branch Target Injection / Spectre v2 (CVE-2017-5715)
140 [x][ ================================================================
141 [*] CPUID.7H:EDX[26] = 1 Indirect Branch Restricted Speculation (IBRS) & Predictor Barrier (IBPB)
142 [*] CPUID.7H:EDX[27] = 1 Single Thread Indirect Branch Predictors (STIBP)
143 [*] CPUID.7H:EDX[29] = 1 IA32_ARCH_CAPABILITIES
144 [+] CPU supports IBRS and IBPB
145 [+] CPU supports STIBP
146 [*] Checking enhanced IBRS support in IA32_ARCH_CAPABILITIES...
147 [*]   cpu0: IBRS_ALL = 1
148 [+] CPU supports enhanced IBRS (on all logical CPU)
149 [*] Checking if OS is using Enhanced IBRS...
150 [*]   cpu0: IA32_SPEC_CTRL[IBRS] = 0
151 [*]   cpu0: IA32_SPEC_CTRL[STIBP] = 0
152 [-] OS doesn't seem to use Enhanced IBRS
153 [#] INFORMATION: Unable to determine if the OS uses STIBP
154 [!] WARNING: CPU supports mitigation (enhanced IBRS) but OS is not using it
155 [!] OS may be using software based mitigation (eg. retpoline)
156 [!] WARNING: Retpoline check not implemented in current environment
```

Log Summary

```
660 [CHIPSEC] **************************  SUMMARY  **************************
661 [CHIPSEC] Time elapsed            1.000
662 [CHIPSEC] Modules total           27
663 [CHIPSEC] Modules failed to run   0:
664 [CHIPSEC] Modules passed          19:
665 [+] PASSED: chipsec.modules.common.bios_kbrd_buffer
666 [+] PASSED: chipsec.modules.common.bios_smi
667 [+] PASSED: chipsec.modules.common.bios_ts
668 [+] PASSED: chipsec.modules.common.bios_wp
669 [+] PASSED: chipsec.modules.common.debugenabled
670 [+] PASSED: chipsec.modules.common.ia32cfg
671 [+] PASSED: chipsec.modules.common.me_mfg_mode
672 [+] PASSED: chipsec.modules.common.memlock
673 [+] PASSED: chipsec.modules.common.remap
674 [+] PASSED: chipsec.modules.common.secureboot.variables
675 [+] PASSED: chipsec.modules.common.smm
676 [+] PASSED: chipsec.modules.common.smm_code_chk
677 [+] PASSED: chipsec.modules.common.smm_dma
678 [+] PASSED: chipsec.modules.common.smrr
679 [+] PASSED: chipsec.modules.common.spd_wd
680 [+] PASSED: chipsec.modules.common.spi_desc
681 [+] PASSED: chipsec.modules.common.spi_fdopss
682 [+] PASSED: chipsec.modules.common.spi_lock
683 [+] PASSED: chipsec.modules.common.uefi.access_uefispec
684 [CHIPSEC] Modules information     1:
685 [#] INFORMATION: chipsec.modules.common.cpu.cpu_info
686 [CHIPSEC] Modules failed          0:
687 [CHIPSEC] Modules with warnings   4:
688 [!] WARNING: chipsec.modules.common.cpu.spectre_v2
689 [!] WARNING: chipsec.modules.common.rtclock
690 [!] WARNING: chipsec.modules.common.spi_access
691 [!] WARNING: chipsec.modules.common.uefi.s3bootscript
692 [CHIPSEC] Modules skipped         0:
693 [CHIPSEC] Modules not applicable  3:
694 [*] NOT APPLICABLE: chipsec.modules.common.cpu.ia_untrusted
695 [*] NOT APPLICABLE: chipsec.modules.common.memconfig
696 [*] NOT APPLICABLE: chipsec.modules.common.sgx_check
697 [CHIPSEC] ****************************************************************
```

What's Next?

CHIPSEC's Discord

- See for yourself
  - Run Python 3 in the shell
    - Use CHIPSEC's pre-compiled version [github.com]
    - Build it yourself from EDK2 [github.com]
  - Join the CHIPSEC community
    - CHIPSEC's latest release [github.com]
    - Join the Discord Channel [discord.gg]
    - Quarterly Community Meetings [github.com]
- If you are an Intel customer with an CNDA in place, contact chipsec@intel.com for additional tests and platform support.

Questions?

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