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UEFI Test Tools For Linux Developers

Brian Richardson – Intel Corporation
Alex Hung – Canonical, Ltd.

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Agenda

- UEFI & Linux Interoperability
- Using FWTS with UEFI
- Using CHIPSEC with UEFI
- Using LuvOS with UEFI
- Next Steps

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UEFI & Linux Interoperability

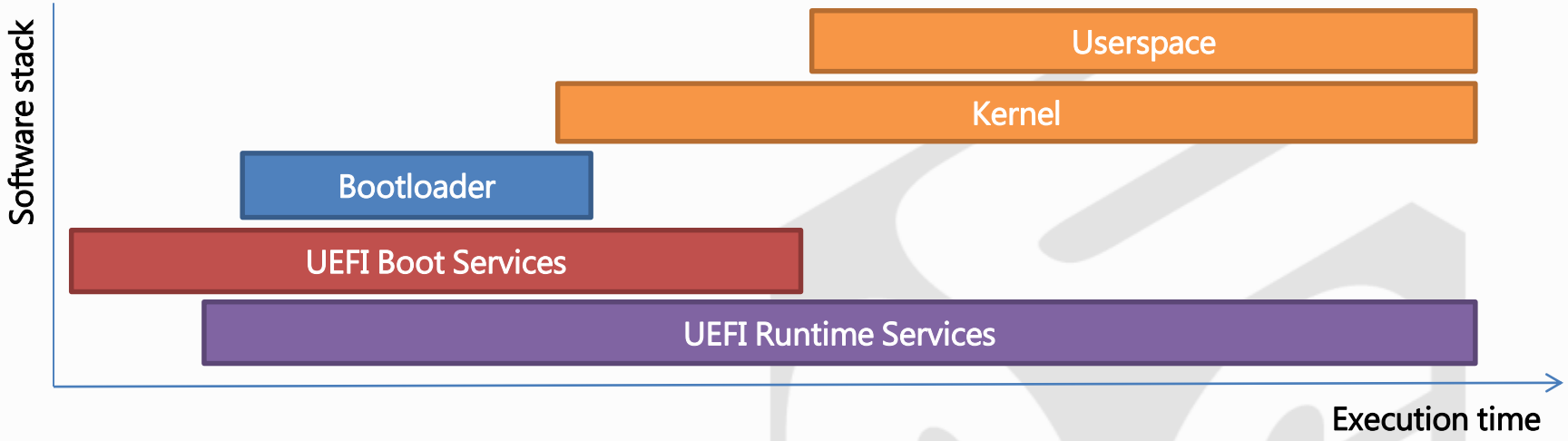
Improvements can be made in UEFI/Linux testing

- Look for UEFI problems prior to distro releases
- Tests are too focused on UEFI boot services
- Improve coverage for UEFI runtime services

Quality of firmware implementations varies

- Can open up new attack surfaces
- Example: “Samsung bricking” http://mjg59.dreamwidth.org/22855.html

UEFI & Linux Software Stack



Used by bootloader and pre-OS applications (test, provision, etc.)

Large surface, terminated at boot

Traditionally tested using the UEFI Self-Certification Test (SCT)

Used by OS after boot services are terminated by bootloader

Small surface, resident at runtime

Traditionally tested/exercised by OS vendor validation plan

UEFI Runtime Needs More Attention

Many UEFI features are available at OS runtime

- Boot Order (**`efibootmgr`**)
- Capsule (system & peripheral firmware)
- Certificate Revocation (Secure Boot dbx)

Runtime variable access can have major issues

- Samsung bricking, Capsule buffer overflow, …

UEFI Runtime Services Need to be Tested with Linux

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Firmware Test Suite

What is Firmware Test Suite (FWTS)?

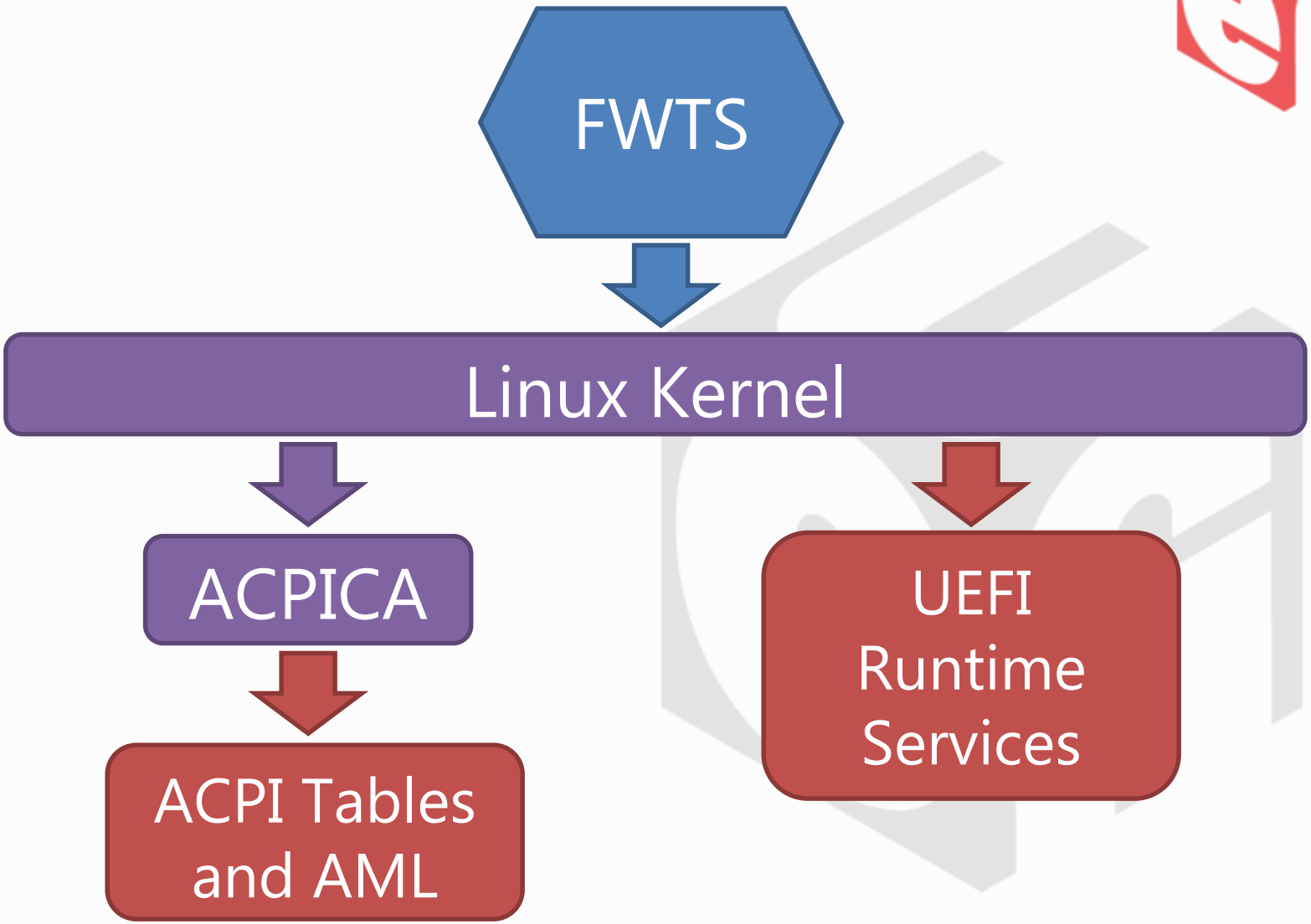
- Open-source Linux tool that automates firmware checking
- Detect bugs and advise firmware engineers
  - Test interactions between Linux & firmware
  - Gather firmware data for debug

What Does FWTS Test?

- Firmware Standards: ACPI, SMBIOS, UEFI, …
- Hardware Standards: PCI/PCIe, x86 CPU
- System Level: Sleep and hibernate, interrupt configuration, and kernel log
- … and many others

A complete list is available @ https://wiki.ubuntu.com/Kernel/Reference/fwts

FWTS Architecture



UEFI Test Items

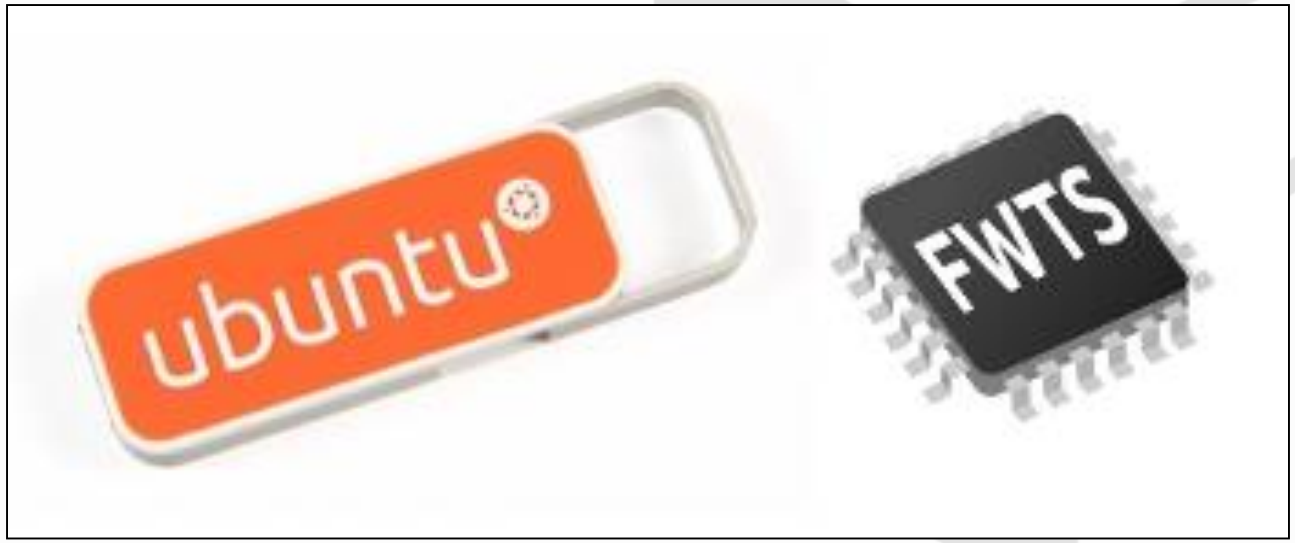
Tests	Descriptions
securebootcert	UEFI **secure boot**
uefirtmisc	UEFI **miscellaneous** runtime service interface
uefirttime	UEFI Runtime service **time** interface
uefirtvariable	UEFI Runtime service **variable** interface

ACPI Test Items

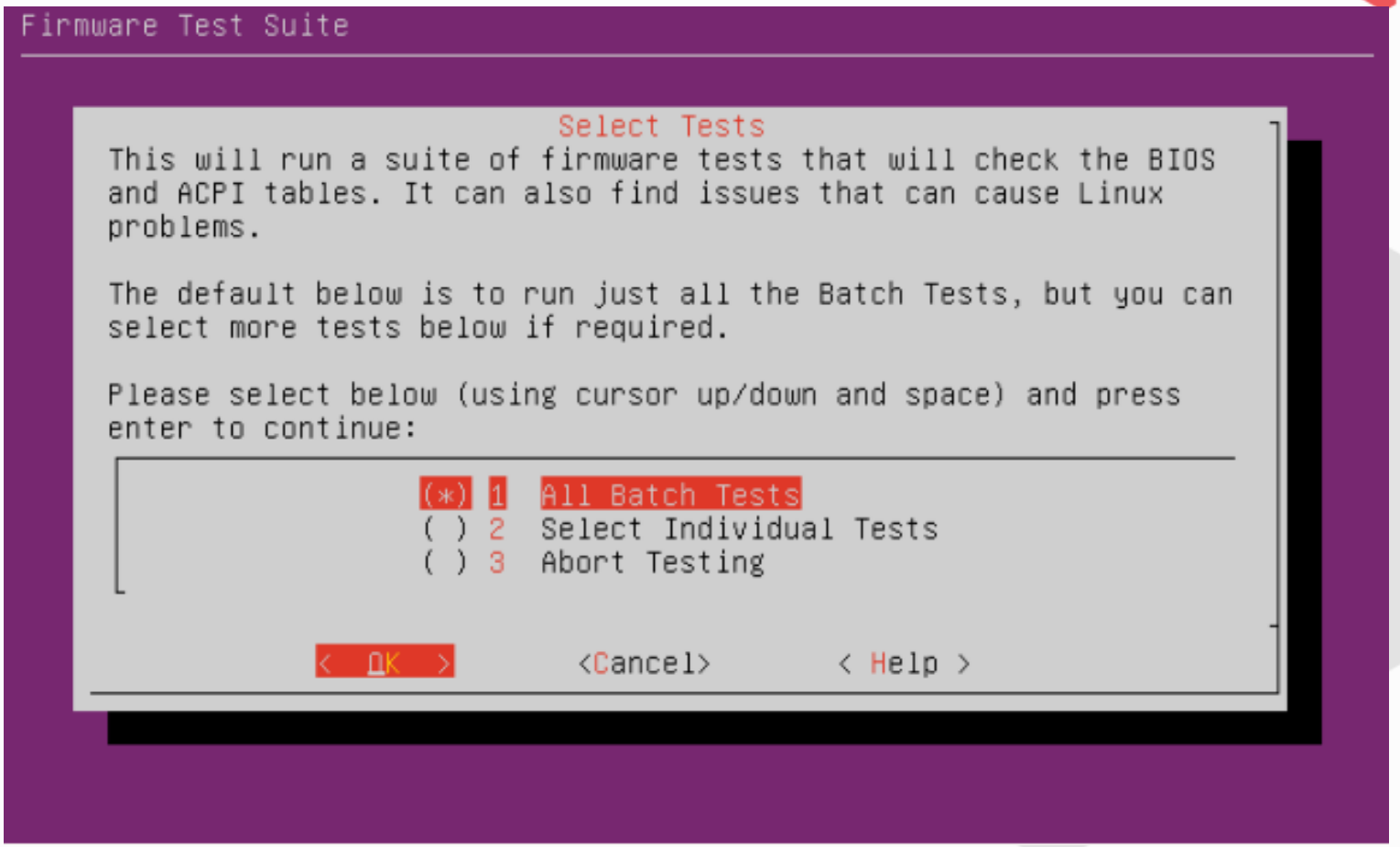
Tests	Descriptions
acpitables	Check ACPI table settings sanity
checksum	Check ACPI table checksum
fadt	Check FADT SCI_EN enabled
method	Check ACPI DSDT Method Semantic
dmar/mcfg etc.	Verifies corresponding ACPI tables
Others…	Fan, C-/P- states etc.

Firmware Test Suite Live

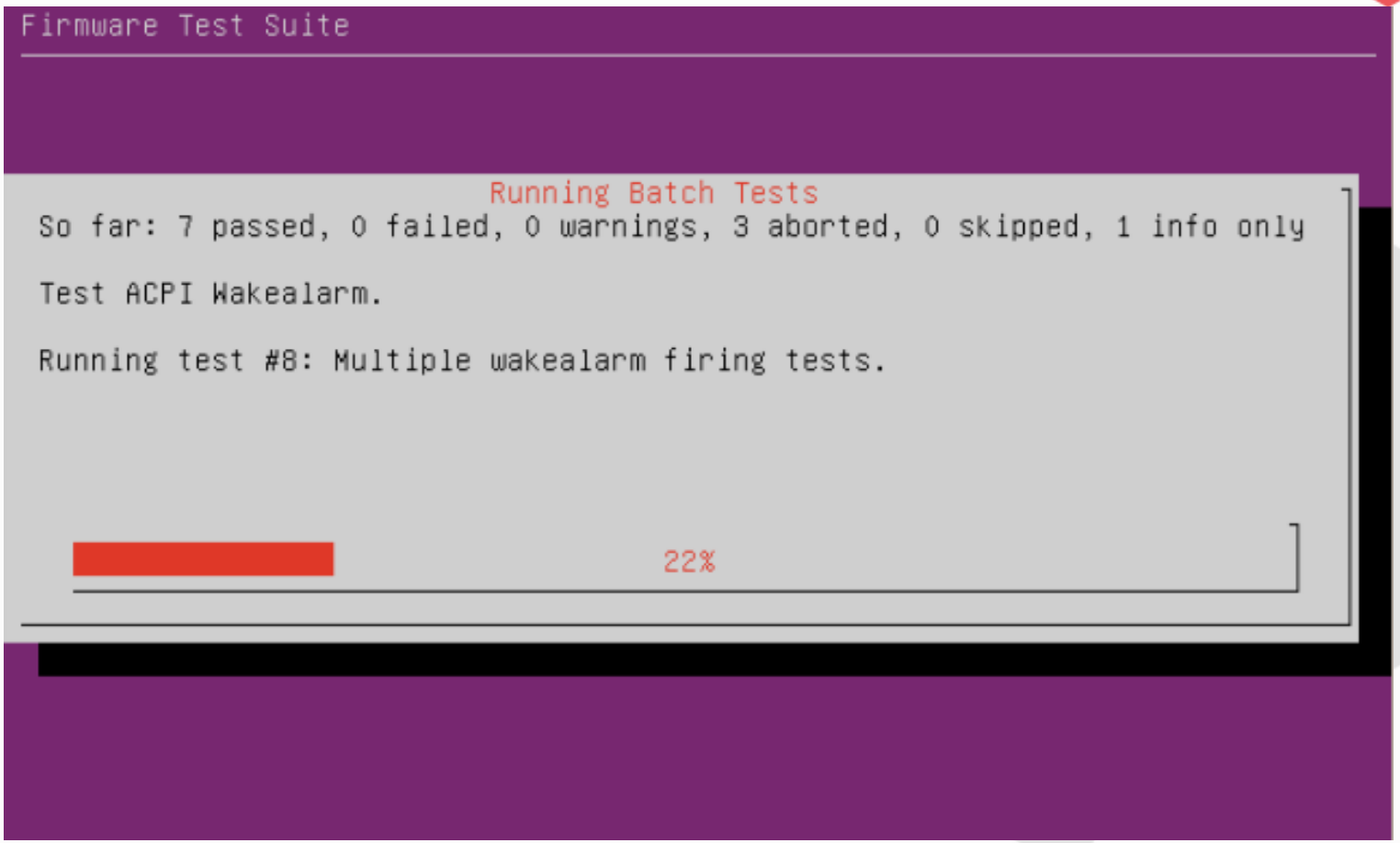
- FWTS-Live – Bootable USB image
- Boot and run FWTS w/o installation



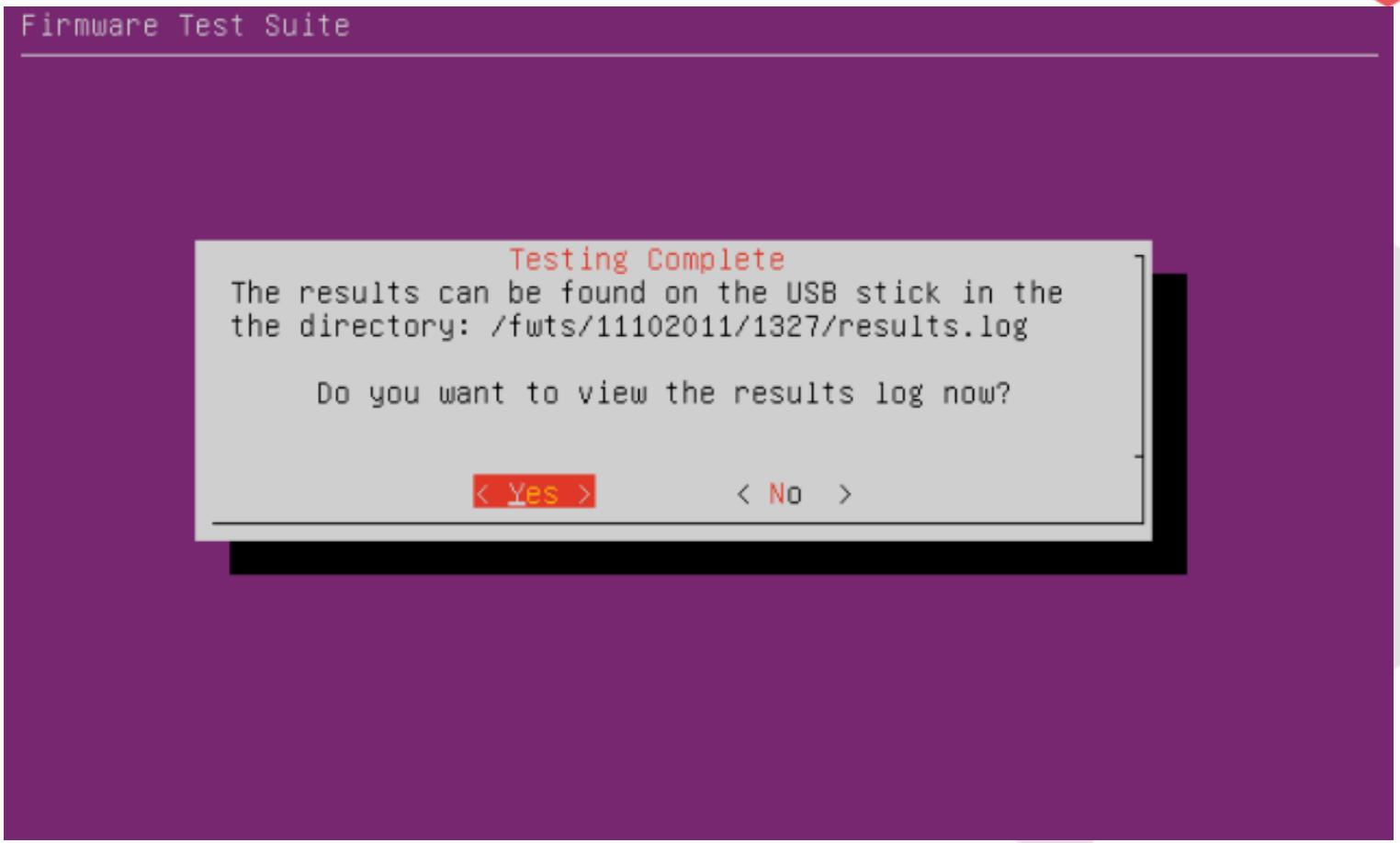
FWTS: Live In Action



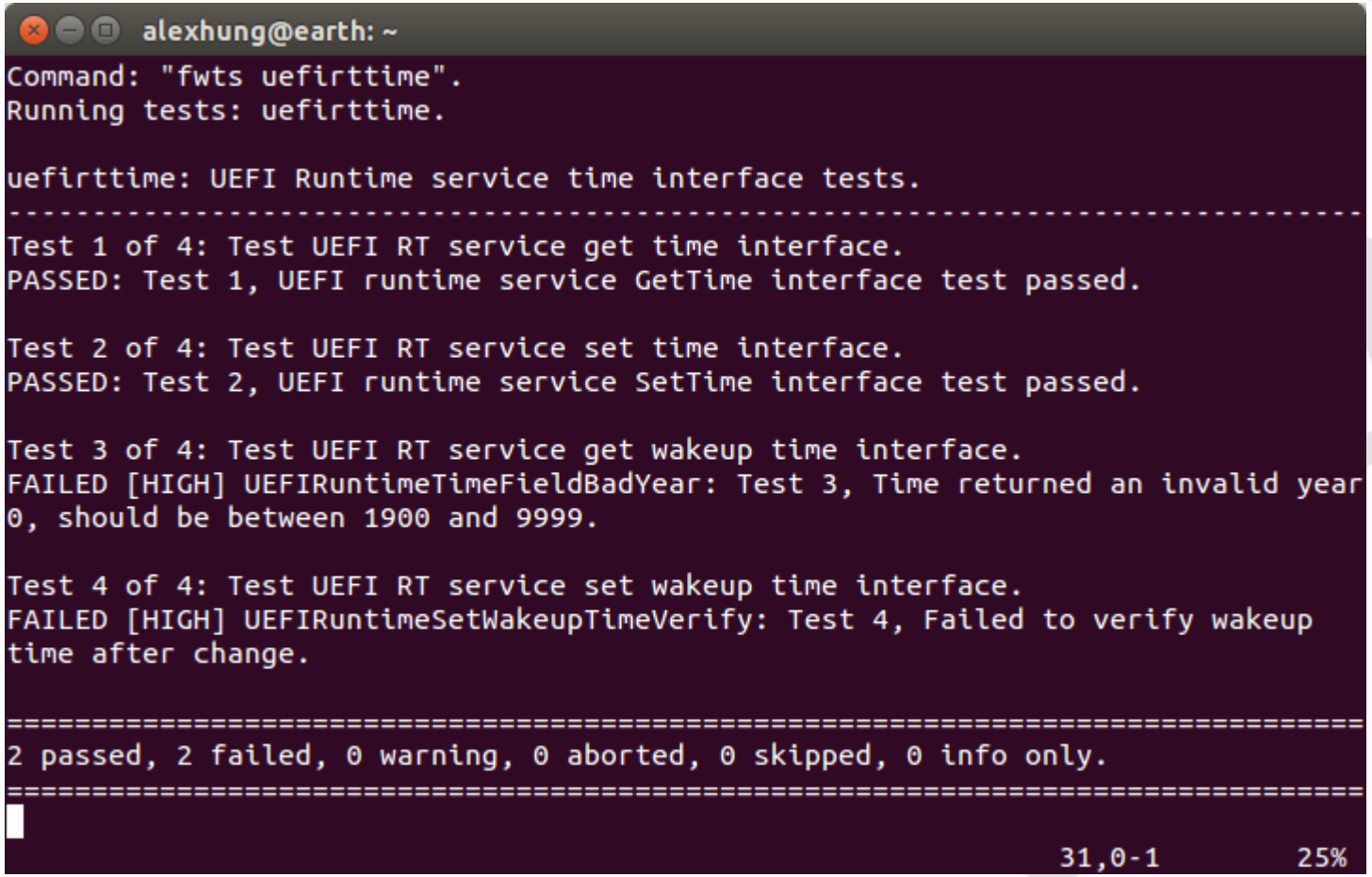
FWTS: Live In Action (Cont'd)



FWTS: Live In Action (Cont'd)



FWTS Result Log



FWTS Result Log (Cont'd)

```
alexhung@earth: ~
================================================================================

Critical failures: NONE

High failures: 2
 uefirttime: Time returned an invalid year 0, should be between 1900 and 9999.
 uefirttime: Failed to verify wakeup time after change.

Medium failures: NONE

Low failures: NONE

Other failures: NONE

Test           |Pass |Fail |Abort|Warn |Skip |Info |
---------------+-----+-----+-----+-----+-----+-----+
uefirttime     |    2|    2|     |     |     |     |
---------------+-----+-----+-----+-----+-----+-----+
Total:         |    2|    2|    0|    0|    0|    0|
---------------+-----+-----+-----+-----+-----+-----+
                                                55,1          Bot
```

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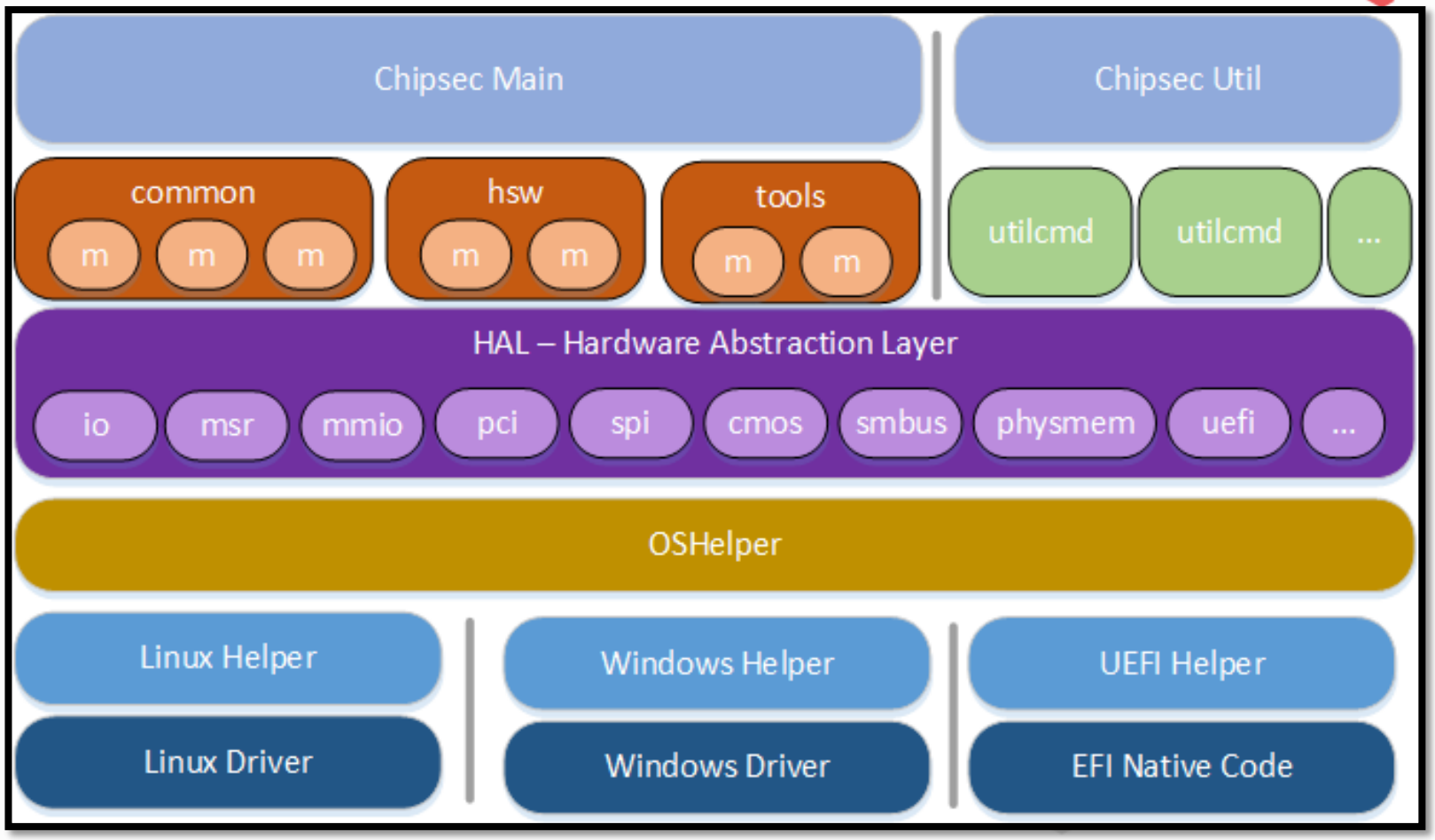
Testing Platform Security (CHIPSEC)

Platform Security Assessment Framework
https://github.com/chipsec/chipsec

Single test suite for Linux, Windows & UEFI

- Analyze hardware, firmware & components
- Extensible security test suite (Python)
- Security assessment tools for low level components/interfaces
- Forensic capabilities for firmware

CHIPSEC: Platform Security Assessment Framework



Examples Of Test Modules

Direct H/W Access for Manual Testing

```
chipsec_util msr 0x200
chipsec_util smi 0x01 0xFF
```

Forensics – Live firmware analysis

```
chipsec_util spi dump rom.bin
chipsec_util spi read 0x700000 0x100000 bios.bin
chipsec_util uefi var-list
```

Forensics – Offline firmware analysis

```
chipsec_util uefi keys PK.bin
chipsec_util uefi nvram vss bios.bin
chipsec_util uefi decode rom.bin
```

Ex: BIOS Write Protection

```
[+] imported chipsec.modules.common.bios_wp
[x][ ============================================================
[x][ Module: BIOS Region Write Protection
[x][ ============================================================
BIOS Control (BDF 0:31:0 + 0xDC) = 0x2A
[05]    SMM_BWP = 1 (SMM BIOS Write Protection)
[04]    TSS     = 0 (Top Swap Status)
[01]    BLE     = 1 (BIOS Lock Enable)
[00]    BIOSWE  = 0 (BIOS Write Enable)

[+] BIOS region write protection is enabled (writes restricted to SMM)

[*] BIOS Region: Base = 0x00500000, Limit = 0x00FFFFFF
SPI Protected Ranges
------------------------------------------------------------
PRx (offset) | Value    | Base     | Limit    | WP? | RP?
------------------------------------------------------------
PR0 (74)     | 00000000 | 00000000 | 00000000 | 0   | 0
PR1 (78)     | 8FFF0F40 | 00F40000 | 00FFF000 | 1   | 0
PR2 (7C)     | 8EDF0EB1 | 00EB1000 | 00EDF000 | 1   | 0
PR3 (80)     | 8EB00EB0 | 00EB0000 | 00EB0000 | 1   | 0
PR4 (84)     | 8EAF0C00 | 00C00000 | 00EAF000 | 1   | 0

[!] SPI protected ranges write-protect parts of BIOS region (other parts of BIOS can be
modified)

[+] PASSED: BIOS is write protected
```

Based on MITRE at *Black Hat USA 2013* and *NoSuchCon 2013*

Is BIOS correctly protected?

Testing Using Known Threats

Issue	CHIPSEC Module	Public Details
SMRAM Locking	common.smm	CanSecWest 2006
BIOS Keyboard Buffer Sanitization	common.bios_kbrd_buffer	DEFCON 16 2008
SMRR Configuration	common.smrr	ITL 2009 CanSecWest 2009
BIOS Protection	common.bios_wp	BlackHat USA 2009 CanSecWest 2013 Black Hat 2013 NoSuchCon 2013 Flashrom
SPI Controller Locking	common.spi_lock	Flashrom Copernicus
BIOS Interface Locking	common.bios_ts	PoC 2007
Access Control for Secure Boot Keys	common.secureboot.keys	UEFI 2.4 Spec
Access Control for Secure Boot Variables	common.secureboot.variables	UEFI 2.4 Spec

Leverage Community Knowledge for Firmware Testing

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01.org/linux-uefi-validation

- Common manager for existing UEFI test suites
- Focused on testing Linux with UEFI firmware
- Test new components prior to use in new distros
- Removes focus on UEFI pre-boot environment
- Distributed under MIT license

01.org/linux-uefi-validation

- New test suite
- Proprietary Intel tool
- Replacement for existing test suites
- Certification tool for Linux/UEFI compliance

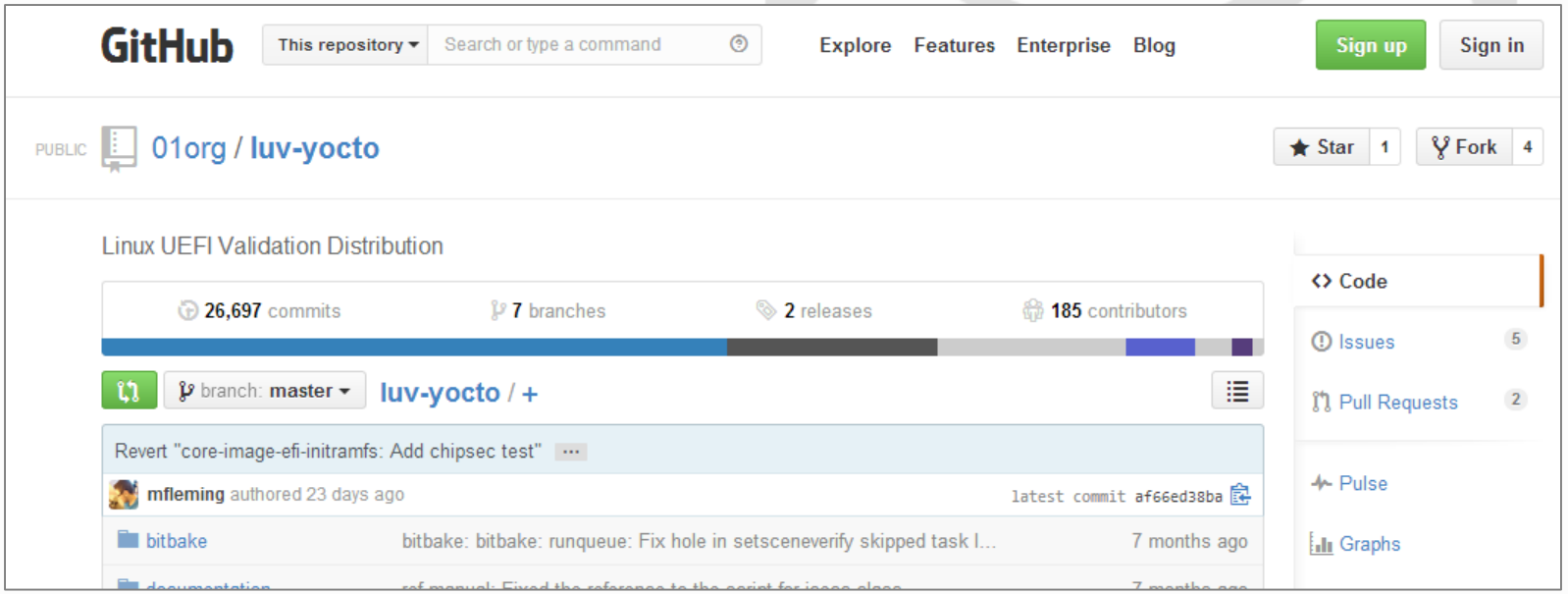
Hands-off Testing

1. Boot the USB image
2. LuvOS collects results.
3. There is no Step 3.

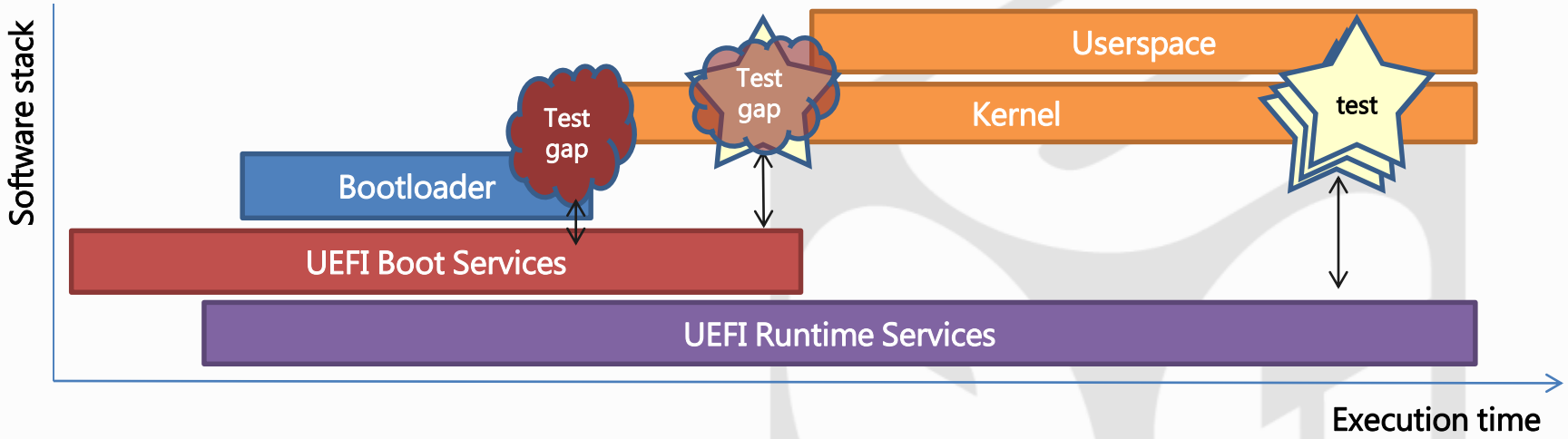
```
[-] efivarfs
  [+] test_create... passed
  [+] test_create_empty... passed
  [+] test_create_read... passed
  [+] test_delete... passed
  [+] test_zero_size_delete... passed
  [+] test_open_unlink... passed
  [+] test_valid_filenames... passed
  [+] test_invalid_filenames... passed
[-] fwts
  [+] bios_info... passed
  [+] version... passed
  [+] acpiinfo... passed
  [+] mtrr... 25 failures!
  [+] klog... 2 failures!
  [+] oops... passed
  [+] acpitables... passed
  [+] apicinstance... passed
  [+] autobrightness... passed
  [+] checksum... passed
  [+] cstates... passed
  [+] dmar... passed
  [+] fadt... passed
  [+] fan... passed
  [+] mcfg... 1 failures!
  [+] method... 29 failures!
  [+] osilinux... skipped
  [+] pcc... passed
  [+] syntaxcheck... 122 failures!
  [+] wakealarm... passed
  [+] wmi... passed
  [+] apicedge... passed
```

LuvOS Features

- Included test suites: FWTS, CHIPSEC, BITS & efivarfs
- Future UEFI tests: Capsule, Network Stack, Secure Boot and Linux bootloaders



LuvOS… Covers Entire Execution Cycle



Use LuvOS to Bridge Gaps in Linux/UEFI Validation

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Download and run the tools …

- FWTS - https://odm.ubuntu.com/
- CHIPSEC - https://github.com/chipsec/chipsec
- LuvOS - https://01.org/linux-uefi-validation

Questions? Contributions? Bugs?!?

- fwts-announce@lists.ubuntu.com
- chipsec@intel.com
- https://lists.01.org/mailman/listinfo/luv

For more information on the Unified EFI Forum and UEFI Specifications, visit http://www.uefi.org

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