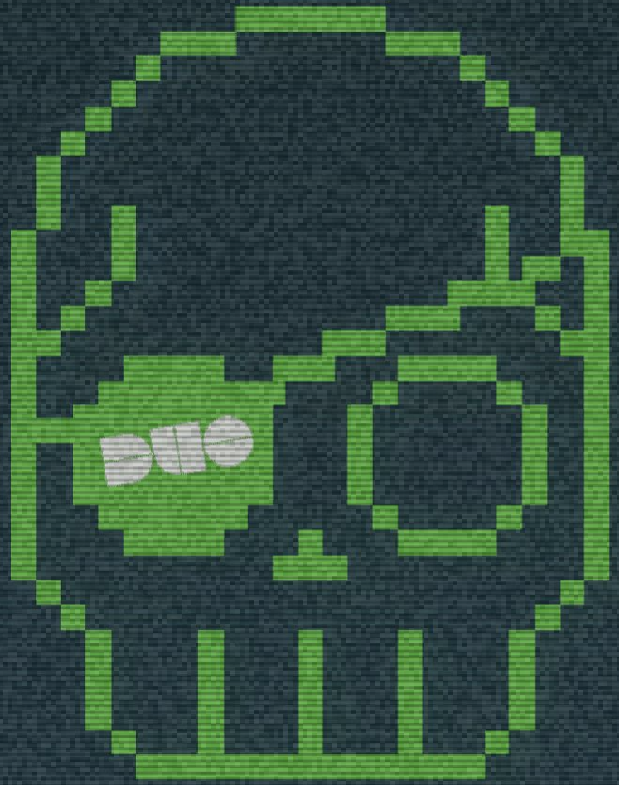
The Apple of Your EFI

An Updated Study of EFI Security



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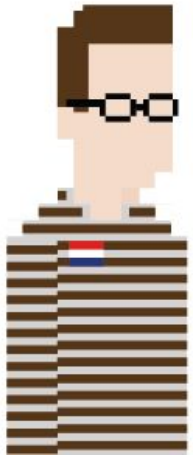
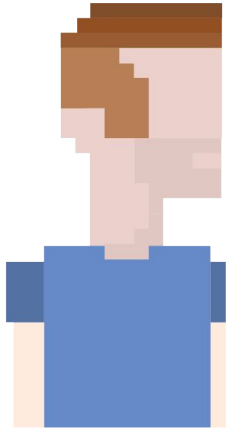
Black Hat Europe 2017

6/12/2017

About Us

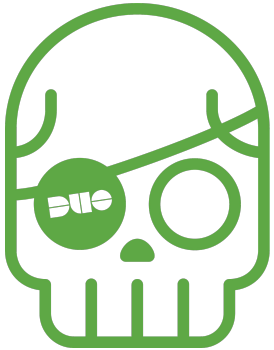
- **Pepijn Bruienne (@bruienne)**
  - R&D Engineer in Duo Labs
  - Focus on R&D, RE and further breaker of all things Apple
  - Recovering Mac Admin
  - OSS maintainer of some popular Mac Admin tools
- **Rich Smith (@iodboi)**
  - Director of R&D, Duo Labs
  - Enjoy researching at scale, post-exploitation, firmware & Python
  - Worked in security far too long now I think!





About Duo

- **We're with Duo Labs, Duo Security's research group**
- **We break things (or attempt to) and then:**
  - Write code to un-break it
  - Talk about it
  - Write papers & blogs about it



- **We build things:**
  - Prototype new security products & approaches for Duo
  - Think about what customers future security needs will be
  - Release open source code to share things we experiment with
    - Check out the recent releases of IsThisLegit? and Phinn

- **We're hiring!**

Research tl;dr

Shine some light onto firmware security as compared to software security

We analysed all OS, Security and EFI firmware release by Apple for 10.10/.11/.12/13

- This is all about what Apple is releasing EFI update wise
- About 3 years worth of update data, discovered many anomalies

We got data from >73K Mac systems to see the real-world state of EFI installs

- All about how well the EFI updates Apple released are being installed

We compared both datasets to see how well the real world matched the expected state of EFI versions running

?

Things We Will Cover Today

Context

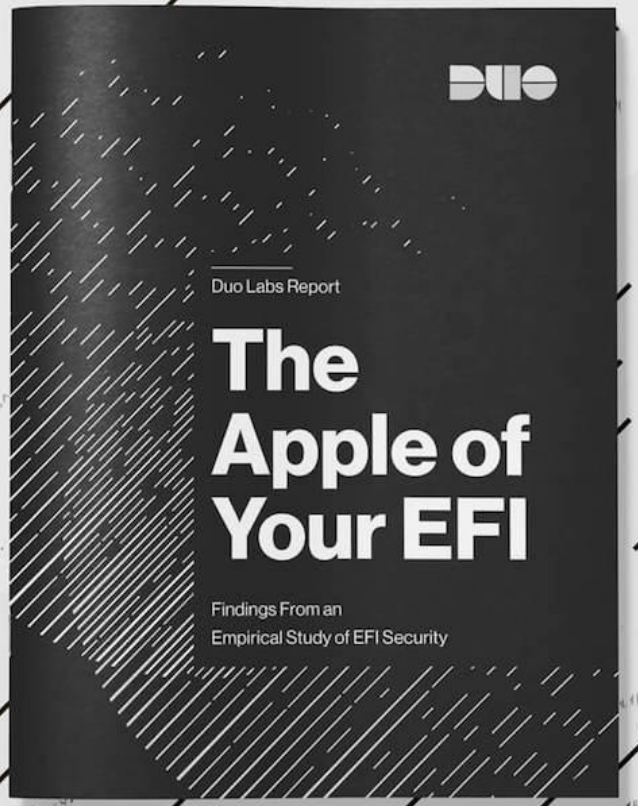
- History of existing Apple EFI security research
- How Apple Macs update their firmware

The New Work

- What we did
- What we found
- What you can do
- What we're releasing

Lots more information in our technical paper

http://duo.sc/2x1AA9R



EFI is Everywhere

Intel EFI - mid-1990s

UEFI standard - 2005

Apple EFI - 2006

EFI Killed the Open Firmware Star

- **Apple EFI**
  - Shipped in first-generation Intel Macs in early 2006
  - Intel switch = **no more Open Firmware** (PPC legacy)
  - First models shipped with EFI were iMac and MacBook Pro
  - Must support new Mac hardware and features
  - Supports platform-specific things like:
    - NetBoot
    - Internet Restore
  - Entirely invisible to end users

What Makes Attacking EFI Attractive?

- **Stealth**
  - It's very hard to detect if EFI / firmware is compromised
- **Persistence**
  - It's hard to remove implants from EFI
  - Reinstalling the OS or replacing HDD is not sufficient
- **Access to everything***
  - Running at Ring -2 means that security controls at higher layers can be circumvented
  - Pretty much arbitrary read/write to disk and memory

Protection Rings

- Ring 3 : Applications
- Ring 0 : OS / Kernel
- Ring -1 : Hypervisor
- Ring -2 : EFI

Who Wants to Attack EFI?

- Well-funded adversaries:
  - ‘Nation-states’
  - Industrial espionage
- This is <u>not</u> your script kiddie tool

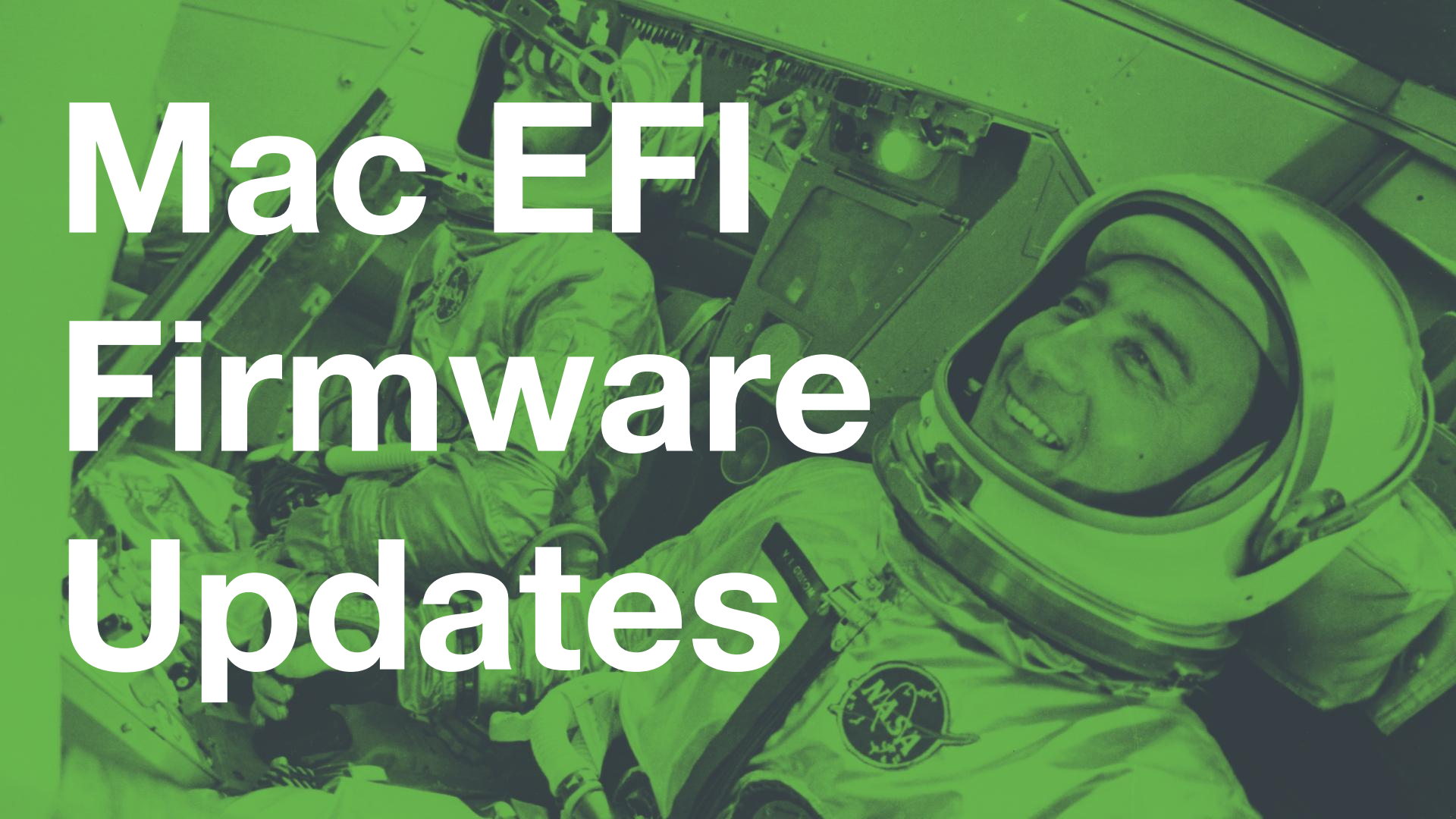
A Brief History Of Apple EFI Security

EFI Security Research in Brief

- ***'DE MYSTERIIS DOM JOBSIVS' -*** 2012 - snare - Black Hat 12
- **Sonic Screwdriver - 2012+** - Wikileaks 'Vault7' leaks - Sea Eye Aye?
- **ThunderStrike 1 - 2014** - Trammell Hudson @ 31c3
- **ThunderStrike 2 - 2015** - Trammell Hudson, Xeno Kovah,

  Corey Kallenberg @ Defcon 23
- **PCI DMA attack - 2016** - Ulf Frisk @Defcon24
- **Lots of other cool EFI research**
  - **Pedro Vilaça** - Is There an EFI Monster Inside Your EFI? @ 44Con/SyScan Beijing …
  - https://reverse.put.as

Mac EFI Firmware Updates



How Does EFI Get Updated?

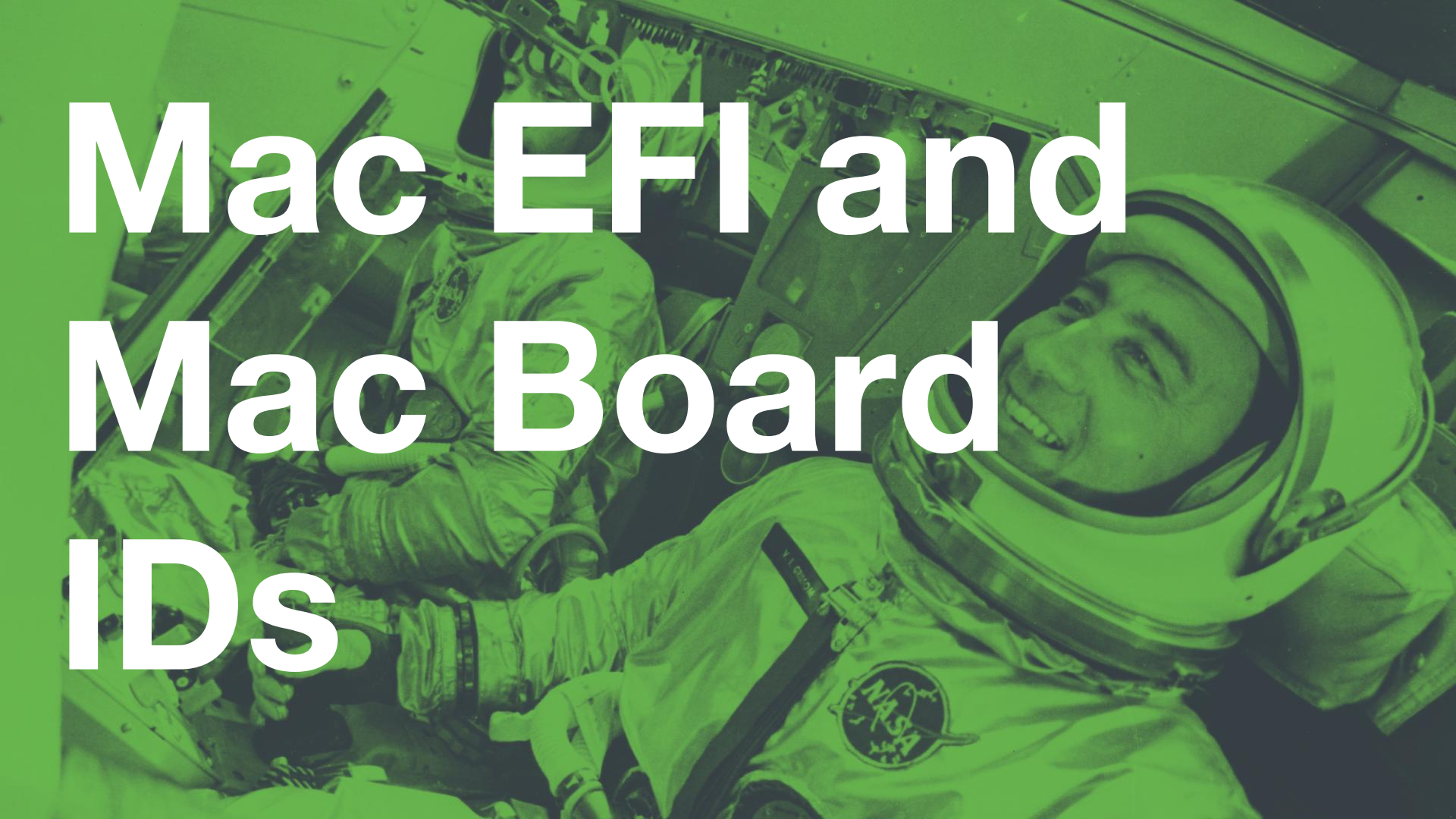
Prior to 2015 - manual

After ThunderStrike

The Apple EFI Update Process

- **As of late 2015 - ThunderStrike response**
  - Update is shipped as a standard Apple PKG installer
  - Payload-free PKG runs **`efiupdate`** to bootstrap EFI updater
  - Ships with complete set of current EFI **.scap** or **.fd** bundles
  - **`$MODEL_$MAJOR_$MINOR_`**`LOCKED`**`.$EXT`**
  - The postinstall script invokes **`efiupdate`**
  - The tool copies the correct firmware to the ESP (EFI System Partition)
  - The file is then blessed using the **`bless`** command:
    - **`bless -mount / -firmware MBP111_0138_B21_LOCKED.scap --verbose --recovery`**
  - EFI update gets one shot to get it right, will not run again until next OS update

Mac EFI and Mac Board IDs



Figuring Out Compatibility

Apple has to ship a lot of EFI payloads

Does every model have its own EFI payload?

Does the EFI payload contain the info?

How can the updater know?

Matching Specific Models With EFI

- **Apple uses various identifiers for Mac models**
  - **Model ID**: `<Model><major,minor>`
  - Example: **iMac17,1**
    - Minor version denotes different configs (21”, 27”)
    - Apple reuses these when spec bumps happen
    - In the past Apple shoved multiple configs into one single major,minor model ID

  - **Board ID**: `Mac-<8 or 16 character hex string>`
  - Unique for specific model and rev
  - Stored on logic board, get via `ioreg -l | grep -i board-id`
  - Example **iMac17,1** ==
    - `Mac-B809C3757DA9BB8D`
    - `Mac-DB15BD556843C820`
    - `Mac-65CE76090165799A`

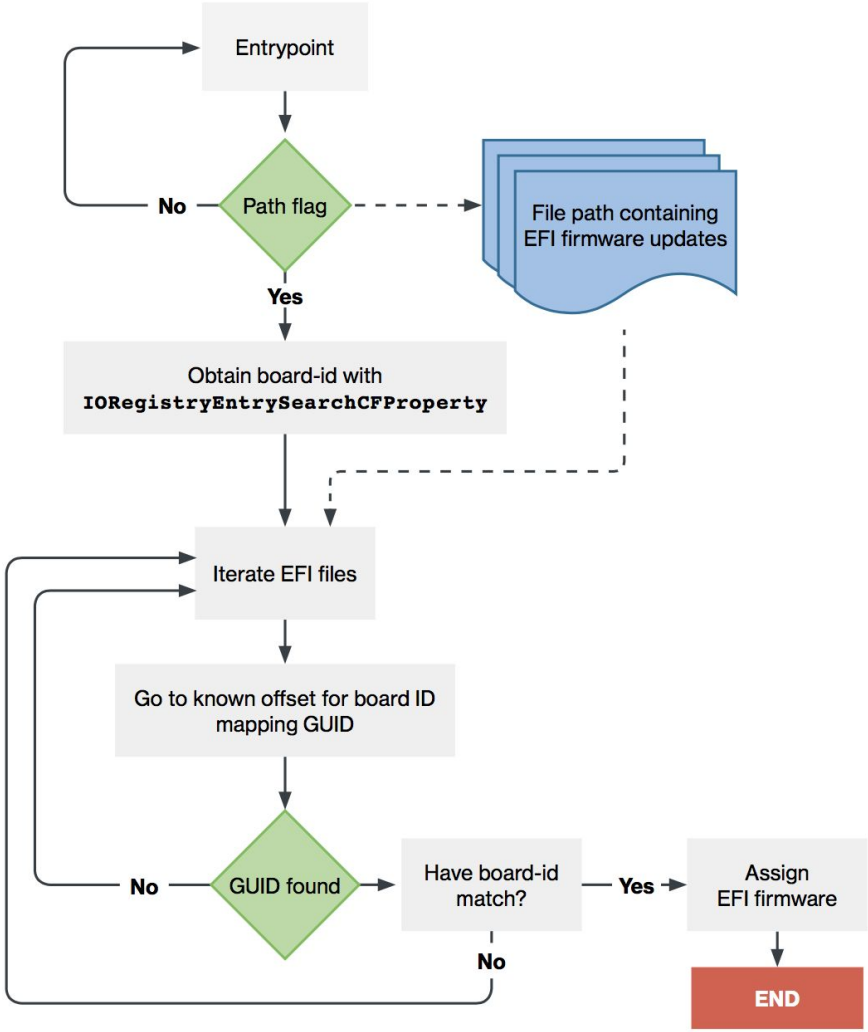
Matching Specific Models With EFI

- **How does the firmware updater match EFI and Mac model?**
  - The EFI payload contains board IDs with which it is compatible
  - Stored in GUID `781F254A-C457-5D13-9275-1BF5D56E0724`
  - Firmware updater looks for 4-byte header `0x7C000019`
  - 8 byte chunks are used for storing compatible board IDs, up to 120 bytes
  - Represents the hex string of the board ID `Mac-B809C3757DA9BB8D`
  - Grabs board ID of Mac via `IORegistry` API
  - If match is found == use this EFI firmware bundle

Does Every Model Get Its Own EFI Bundle?

- **Some models are rolled into a single EFI bundle**
  - Example: **MacBookAir7,1** and **MacBookAir7,2**
  - MBA 7,1 = **11”** model / MBA 7,2 = **13”** model
  - **MacBookAir7,2** EFI version string: `MBA71.0166.B26`
  - What does this mean?
  - Some EFI payloads contain multiple board ID entries
  - GUID `781F254A-C457-5D13-9275-1BF5D56E0724` holds up to 15
  - Apple uses this GUID to group compatible models, fewer files to maintain
    - ...thus fewer files to potentially mess up (more later)

EFI Upate Flowchart



Our Research Questions

What Did We Want To Find Out?

How well does EFI firmware security support compare to software security support?

Are all Mac systems treated equally in terms of EFI patches?

Are all OS versions treated equally in terms of EFI patches?

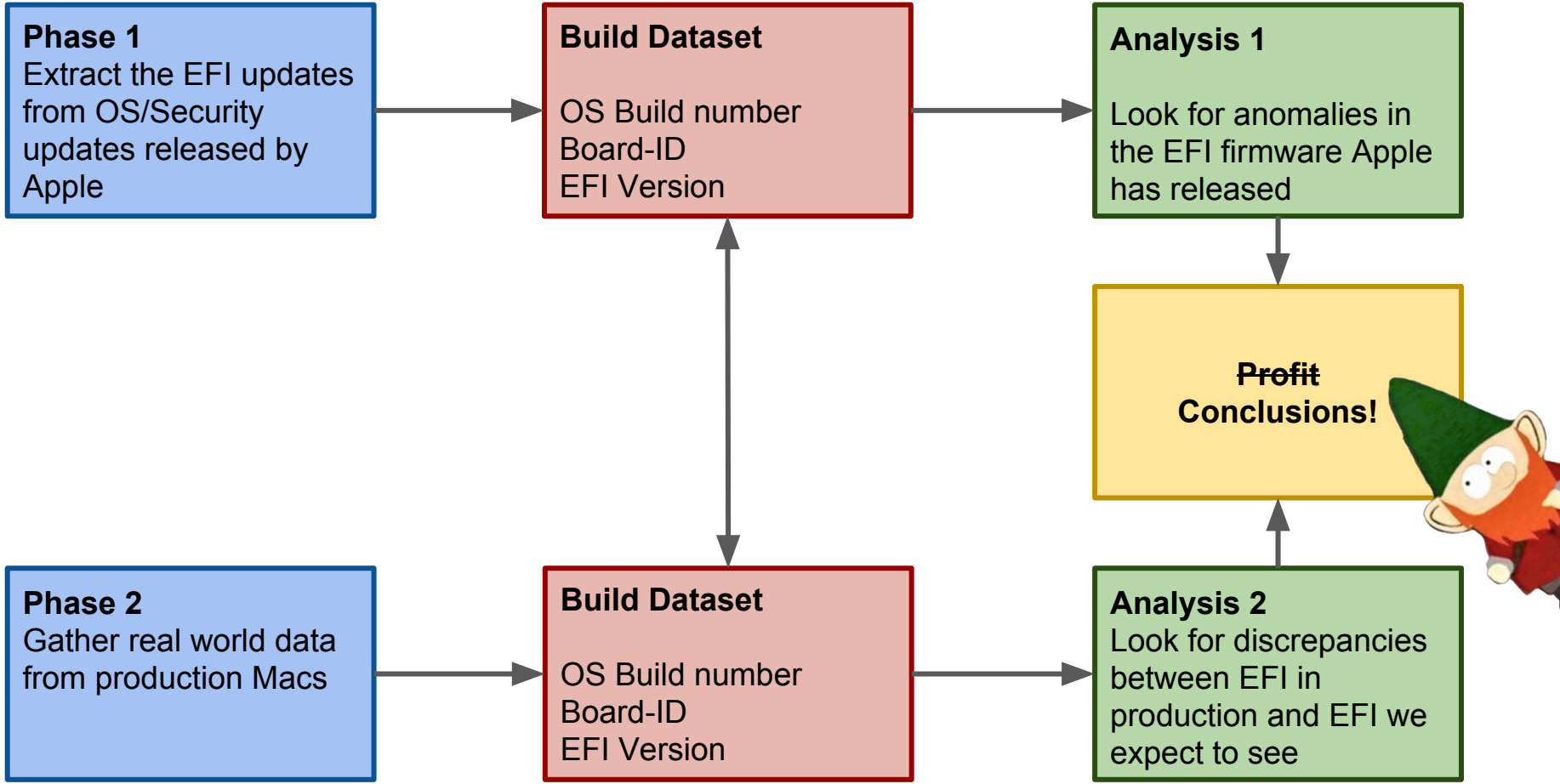
How well does the real world compare to what Apple released?

What is the visibility to EFI security support for admins & end users?

Common EFI Update Issues

- **Do EFI updates “just work”?**
  - EFI updates are hidden, slip-streamed with OS updates
  - This must mean they *always* work and have a robust fail mode, right?
- **Do same EFI updates ship for all “supported” OS versions?**
  - If the EFI support model matches the OS one they should be identical
- **Does the real world match the ideal world?**
  - A check in the field should come back with 100% match
- **If it does not, can Apple users find out easily?**
  - Spoiler alert: not quite that simple

The Analysis


Phase 1
Extract the EFI updates from OS/Security updates released by Apple
Build Dataset
OS Build number
Board-ID
EFI Version
Analysis 1
Look for anomalies in the EFI firmware Apple has released
~~Profit~~
Conclusions!
Phase 2
Gather real world data from production Macs
Build Dataset
OS Build number
Board-ID
EFI Version
Analysis 2
Look for discrepancies between EFI in production and EFI we expect to see

Phase 1 - Build a Picture of <u>What</u> Apple Released

- First we gathered all OS & Security updates released by Apple for 10.10, 10.11, 10.12 & 10.13
- Extracted all the EFI updates from them
- Built a dataset of triplicates, this formed an idealised <u>baseline</u> dataset

OS Build number	Mac Model/Board ID	EFI Version
16G29	IM151/ Mac-42FD25EABCABB274	IMI151-0207-B29
↓	↓	↓
10.12.6	iMac 27” 5K Late 2014	EFI Ver. 0207 Build 29

com.apple.pkg.update.security.2016-006Yosemite.14F2009	2016/10/24	0118 B12	0118 B12	0179 B12	0207 B05				
com.apple.pkg.update.os.10.12.1.16B2657	2016/10/24	0118 B13	0118 B13	0179 B13	0207 B07	0207 B03	0206 B01	0105 B09	
com.apple.pkg.update.security.2016-007Yosemite.14F2109	2016/12/13	0118 B14	0118 B14	0179 B14	0207 B08				
com.apple.pkg.update.os.SecUpd2016-003ElCapitan.15G1217	2016/12/13	0118 B14	0118 B14	0179 B14	0207 B08	0207 B04	0207 B04	0105 B08	
com.apple.pkg.update.os.10.12.2.16C67	2016/12/13	0118 B14	0118 B14	0179 B14	0207 B08	0207 B04	0207 B04	0105 B11	
com.apple.pkg.update.os.10.12.3.16D32	2017/01/23	0118 B17	0118 B17	0179 B17	0207 B11	0207 B07	0207 B07	0105 B15	
com.apple.pkg.update.security.2017-001Yosemite.14F2315	2017/03/27	0118 B12	0118 B12	0179 B12	0207 B05				
com.apple.pkg.update.os.SecUpd2017-001ElCapitan.15G1421	2017/03/27	0118 B13	0118 B13	0179 B13	0207 B06	0207 B03		0105 B08	
com.apple.pkg.update.os.10.12.4.16E195	2017/03/27	0118 B20	0118 B20	0179 B21	0207 B16	0207 B11	0207 B11	0105 B20	
com.apple.pkg.update.os.10.12.5.16F73	2017/05/15	0118 B44	0118 B43	0179 B21	0207 B16	0207 B11	0207 B11	0105 B20	0145 B06
com.apple.pkg.update.security.2017-002Yosemite.14F2411	2017/05/15								
com.apple.pkg.update.os.SecUpd2017-002ElCapitan.15G1510	2017/05/15	0118 B20	0118 B20	0179 B21	0207 B16	0207 B11	0207 B11	0105 B20	
com.apple.pkg.update.os.MacBookProUpdate.16F2104	2017/06/05	0118 B44	0118 B43	0179 B21	0207 B16	0207 B11	0207 B11	0105 B20	0145 B06
com.apple.pkg.update.security.2017-003Yosemite.14F2511	2017/07/19								
com.apple.pkg.update.os.SecUpd2017-003ElCapitan.15G1611	2017/07/19	0118 B20	0118 B20	0179 B21	0207 B16	0207 B11	0207 B11	0105 B20	
com.apple.pkg.update.os.10.12.6.16G29	2017/07/19	0118 B47	0118 B47	0179 B31	0207 B29	0207 B20	0207 B20	0105 B26	0145 B09

- Looked for anomalies & discrepancies in the EFI updates Apple released
  - Which Mac models saw EFI updates and when they saw them
  - Missing EFI updates
  - Differences between the updates released for 10.10, 10.11, 10.12, 10.13
  - EFI version anomalies

Phase 2 - Build a Picture of <u>How</u> EFI Looked in the Real Word

- Collected data from **73,383** Macs deployed in production
  - Same data triplicates of OS Build, Mac Model/Board-ID, and EFI version

- Of those we extracted **54,744** that were running 10.10, 10.11, 10.12
  - Older OS versions were no longer under security support by Apple
  - Old EFI is the least of their problems!!

- For any Mac model, on a specific OS version we could predict the EFI it *should* be running
- We then compared the datasets to see how well the <u>real world</u> matched the <u>perfect world</u> model built from the updates themselves

	Thunderstrike 1			Thunderstrike 2				CVE-2015-4860			DMA Attack (CVE-2016-7585)		
Model ID	**10.10.2**	**SecUpdate2015-001 (10.9)**	**SecUpdate2015-001 (10.8)**	**10.10.4**	**SecUpdate2015-005 (10.9)**	**SecUpdate2015-005 (10.8)**	**EFI Security Update 2015-001**	**10.11.1**	**SecUpdate2015-004 10.10**	**EFI Security Update 2015-002**	**10.12.4**	**SecUpdate2017-001 10.11**	**SecUpdate2017-001 10.10**
iMac7,1													
iMac8,1													
iMac8,1													
iMac9,1													
iMac10,1													
iMac11,1													
iMac11,2													
iMac11,3													
iMac12,1													
iMac12,2													
iMac13,1													
iMac13,2													
iMac14,1													
iMac14,2													
iMac14,3													
iMac14,4													
iMac15,1													
iMac16,1													
iMac16,2													
iMac17,1													
MacBook5,1													
MacBook5,2													
MacBook6,1													
MacBook7,1													
MacBook8,1													
MacBook9,1													
MacBookAir2,1													
MacBookAir3,1													
MacBookAir3,2													
MacBookAir4,1													
MacBookAir4,2													
MacBookAir5,1													
MacBookAir5,2													
MacBookAir6,1													
MacBookAir6,2													
MacBookAir7,1													
MacBookAir7,2													
MacBookPro3,1													
MacBookPro4,1													
MacBookPro5,1													
MacBookPro5,2													
MacBookPro5,3													
MacBookPro5,4													
MacBookPro5,5													
MacBookPro6,1													
MacBookPro6,2													
MacBookPro7,1													
MacBookPro8,1													
MacBookPro8,2													
MacBookPro8,3													

Research Findings

What Issues Exist?

Real world systems are out of date

Security Updates gradually drop EFI model support

Quiet failures and lack of visibility

Unexplained EFI update regressions

Succesful OS Update Does Not Mean Successful Firmware Update

Real world != perfect world

- **Data analysis reveals not all endpoints get EFI updates**
  - Gathered data from various Edu and Enterprise orgs
  - Anonymous data showing:
    - Model ID
    - OS version string
    - OS build string
    - EFI version string
  - Example: “MacBookPro10,1”,”10.12.4”,”16D25”,”MBP101.00EE.B12”
  - Compare against known-good lookup table
  - Measure non-compliant records

Which model X, with OS version Y, has EFI version older than it should be?

4.2%

Running incorrect EFI version

Average Across All Data

42.9%

Most out of date model

iMac16,2 / iMac 21” Late 2015

10%

Highest overall OS deviancy

macOS 10.12 Sierra

3.4%

OS X 10.10 Yosemite

Overall OS deviancy

2.1%

OS X 10.11 El Capitan

Overall OS deviancy

Mac Model	% Running Older-Than-Expected EFI Version	Raw Count of Systems Running Older EFI	Total Count of Systems Running Older EFI
iMac16,2	43.0%	941	2190
MacBookPro13,2	34.8%	114	328
MacBookPro13,1	28.5%	39	137
MacBookPro13,3	24.8%	78	314
MacBookPro8,2	14.9%	89	598
MacBookPro8,1	11.9%	59	498
Macmini3,1	11.5%	6	52
Macmini6,1	6.7%	13	194
iMac16,1	5.2%	15	287
MacBookAir6,1	5.0%	29	586
MacBook9,1	4.9%	10	206
Macmini7,1	4.8%	50	1035
MacBookAir4,1	4.4%	6	138
MacBookPro8,3	4.4%	3	69
iMac13,1	4.1%	86	2119
MacBookAir6,2	3.6%	81	2244

Software Secure But Firmware Vulnerable

Does “Supported OS” Mean “Supported EFI”?

- **Apple has a “soft” support deprecation schedule**
  - Only Apple truly knows what this schedule is exactly
  - Roughly “N-2” model
  - Security Updates (`SecUpd<20XX>-<YYY>`) are subsets of current OS update
    - As name implies security patches only + EFI updates
  - Some of this is because issues don’t affect older OS versions
  - But also because Apple just chose not to backport & QA (`ntp`, **Broadpwn**)
- **Security updates also quietly drop certain EFI updates in current OS updates**
  - Not current == Security updates == EFI quietly stops getting updates
  - Only way to be sure of broadest coverage: **run current OS and update immediately**

EFI coverage by update:

macOS Sierra 10.12.6 Update

El Capitan Security Update 2017-003

Yosemite Security Update 2017-003

43	31	1
EFI bundles	EFI bundles	EFI bundle
Sierra 10.12	**El Capitan 10.11**	**Yosemite 10.10**

A patch for one does not mean a patch for all

One patch to rule them all?

- **Apple states in their update notes when EFI vulnerabilities are fixed, but it does not give details for exactly which Mac models they patch**

- We looked at which models of Mac Apple released EFI updates for that addressed 4 high impact public EFI vulnerabilities
  - **CVE-2014-4498** - (Thunderstrike 1)
  - **CVE-2015-3692** - (Thunderstrike 2)
  - **CVE-2015-7035** - ("An attacker can exercise unused EFI functions")
  - **CVE-2016-7585** - (Ulf Frisk's DMA attack)

Mac models that did <u>not</u> have EFI updates released for each vulnerability

47	31	25	22
Thunderstrike 1	Thunderstrike 2	CVE-2015-7035	CVE-2016-7585

Some Models Are EFI Orphans

Do All OS Supported Models Get EFI Updates?

- **Apple has spotty coverage for certain “supported” models**
  - A number of models are supported by current OS and updates
  - The OS updates have not bundled EFI updates for these models
  - Other models were seen with only “factory” EFI, no further updates
    - Factory EFI: low-numbered <model>.<major>.BXX version
    - `MBPXXY.NNNN.B00`
  - This adds to the incorrect assumption that they are fully secure

Models Lacking EFI Updates

16

Models not receiving any EFI updates

18

Models with only factory EFI versions

EFI Firmware Factory

Mac Model	EFI Versions Observed in the Real World Data		
IM101	IM101.00CC.B00		
IM71	IM71.007A.B00	IM71.007A.B01	IM71.007A.B03
IM81	IM81.00C1.B00		
IM91	IM91.008D.B00	IM91.008D.B04	IM91.008D.B08
MB51	MB51.007D.B03	MB51.0073.B06	
MB52	MB52.0088.B06		
MB61	MB61.00C8.B00		
MBA21	MBA21.0075.B03	MBA21.0075.B05	
MBP31	MBP31.0070.B07		
MBP41	MBP41.00C1.B03		
MBP51	MBP51.007E.B05	MBP51.007E.B06	
MBP52	MBP52.008E.B05		
MBP53	MBP53.00AC.B03		
MBP55	MBP55.00AC.B03		
MM31	MM31.00AD.B00	MM31.0081.B06	
MP31	MP31.006C.B02	MP31.006C.B05	
MP41	MP41.0081.B04	MP41.0081.B07	MP41.0081.B08
MP51	MP51.007F.B00	MP51.007F.B01	MP51.007F.B03

This table lists Mac models from the real world dataset that have only been observed with one, two or three updates with low build numbers. This suggests they haven't been updated from the versions of firmware they were originally shipped with from the factory - making them likely to contain unpatched vulnerabilities.

Silent Updates Will Also Fail Silently

Do Failed Updates Generate Alerts?

- **Apple designed the process to be silent to end users**
  - This means it gets one shot to succeed
  - No retries outside of OS/Security updates until next version
  - No error logging or notification happens
  - User will not find out unless they know where to look for EFI version
  - Since EFI is an unknown system to users and many Mac admins it goes ignored
  - Result: EFI is often out of date

QA Failure? Incorrect EFI Firmwares Released

Are You Getting the EFI Updates You Should?

- **Apple sometimes has QA failures**
  - We identified EFI version regression issues with **OS X 10.10 & 10.11**
  - As part of the **Security Update 2017-001** (Mar 27, 2017)
  - For unexplained reasons included EFI bundles were:
    - **Older** than preceding SecUpd **2016-003**
    - **Same** as prior SecUpd **2016-002**
  - Example:
    - **MBP112**
      - SecUpd 2016-002 = `MBP112.0138.B17`
      - SecUpd 2016-003 = `MBP112.0138.B18`
      - SecUpd 2017-001 = `MBP112.0138.B17`

Mac Model	Security Update 2017-001 (10.11) [Released March 27, 2017]	Security Update 2016-003 (10.11) [Released Dec 13, 2016]	Security Update 2016-002 (10.11) [Released Oct 24, 2016]
IM121	0047 23B	0047 25B	0047 23B
IM131	010A B09	010A B0A	010A B09
IM141	0118 B13	0118 B14	0118 B13
IM142	0118 B13	0118 B14	0118 B13
IM143	0118 B13	0118 B14	0118 B13
IM144	0179 B13	0179 B14	0179 B13
IM151	0207 B06	0207 B08	0207 B06
IM161	0207 B03	0207 B04	0207 B03
MB81	0164 B14	0164 B19	0164 B14
MB91	0154 B05	0154 B09	0154 B05
MBA41	077 B14	077 B15	077 B14
MBA51	00EF B04	00EF B05	00EF B04
MBA61	0099 B22	0099 B23	0099 B22
MBA71	0166 B12	0166 B13	0166 B12
MBP81	0047 2CB	0047 2DB	0047 2CB
MBP91	00D3 B0D	00D3 B0E	00D3 B0D
MBP101	00EE B0A	00EE B0B	00EE B0A
MBP102	0106 B0A	0106 B0B	0106 B0A
MBP112	0138 B17	0138 B18	0138 B17
MM51	0077 B14	0077 B15	0077 B14
MM61	0106 B0A	0106 B0B	0106 B0A
MM71	0220 B07	0220 B08	0220 B07
MP61	0116 B17	0116 B21	0116 B17

Can You Downgrade EFI?

- **Firmware updates can not be downgraded**
  - In our testing we were unable to force older versions
  - The `efiupdater` binary only allows higher versions
    - There is a force flag but this just forces setup, not flash
  - If the version of the target EFI bundle is lower it exits
  - Unable to spoof by altering EFI bundle version due to signing
  - Unable to spoof by altering `efiupdater` due to signing
  - This made the EFI updates in SecUpd 2017-001 for 10.10/.11 just stale code

Mitigations

What Can We Do About It?

Upgrade to macOS 10.13

Logging and reporting

Run updates out of band

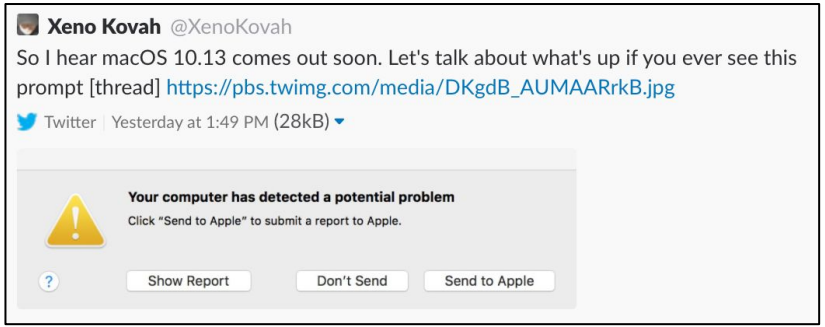
Apple is addressing some things

Update to macOS 10.13 High Sierra

- **macOS 10.13 includes EFI updates for supported models**
  - APFS requires EFI support - thus EFI updates
  - Includes Mac Pro tower models (MacPro5,1)
    - This model requires a manual update, special case in Install Assistant
  - Some older models saw their first-ever update since 2015
    - iMac (Late 2009) aka iMac10,1
    - MacBook (Late 2009) aka MacBook6,1
    - Mac Pro (Mid-2010) aka MacPro5,1
  - *Apple actually started shipping these EFI updates in 10.12.5*

What’s new with macOS 10.13 High Sierra?

- **macOS 10.13 High Sierra contains new tools**
  - Apple is focusing on EFI **integrity** with `eficheck`
  - No signs of actively updating out of date EFI versions (yet)
  - Combined standalone tool and daemon (runs once a week)
    - `/usr/libexec/firmwarecheckers/eficheck/eficheck`
  - Gets checksum of current EFI firmware
  - Compares to Apple-shipped and code signed whitelist
  - Apple ships partial whitelist with 10.13
  - Downloads full whitelist if needed
  - If checksum not found in whitelist: alert user
  - ...the UX is not great yet



Logging and Reporting

- **Since the OS does not log we must do it ourselves**
  - Use endpoint reporting tools
    - **osquery**: `/usr/local/bin/osqueryi "select version from platform_info"`
    - **Puppet**: `/usr/local/bin/facter system_profiler.boot_rom_version`
    - **Chef**: `/opt/chef/bin/ohai hardware/boot_rom_version`
    - **Shell script**:

      ```
      /usr/sbin/system_profiler SPHardwareDataType | awk '/ROM/{print $4}'
      ```
  - Once we have data we can move on to fixing divergent endpoints:
    - Re-install current OS or Security update to re-apply EFI
    - Use `efiupdater` as shown in paper to kick off EFI update
  - https://blog.kolide.com/check-the-efi-version-of-a-mac-with-osquery-f98c6e3beffa
  - https://github.com/trailofbits/osquery-pr/tree/alessandro/feature/macos_efigy_support

Apply Updates Out of Band

- **Don’t wait for next OS/Security Update**
  - Re-apply the update
  - Requires a restart in any case
  - If re-applying OS update: use Combo updater
    - Larger but considered best practice
    - Less chance of failures
  - Security Update is always Delta
  - Other option: create standalone installer for firmware updates only
    - Requires some custom work
    - Will always require a reboot, properly set user expectations
  - https://github.com/grahamgilbert/imagr/wiki/High-Sierra-Notes#firmware

Tool and API Releases

EFIgy - API and Tools to Help Visibility

- **As we discussed visibility to the state of your EFI and its security is hard**
- EFIgy is free RESTful API and open source client that gives you access to the data that we built up during our research
  - Identifies if you are running the most up-to-date EFI version for your Board-ID and OS Build combination
  - Highlight areas of security concern we have spoken about today such as Mac models that are not receiving EFI updates
  - CVE's that a particular EFI version may be vulnerable to
- Supports OS versions 10.10 through 10.13

EFIgy CLI App

efigy.io

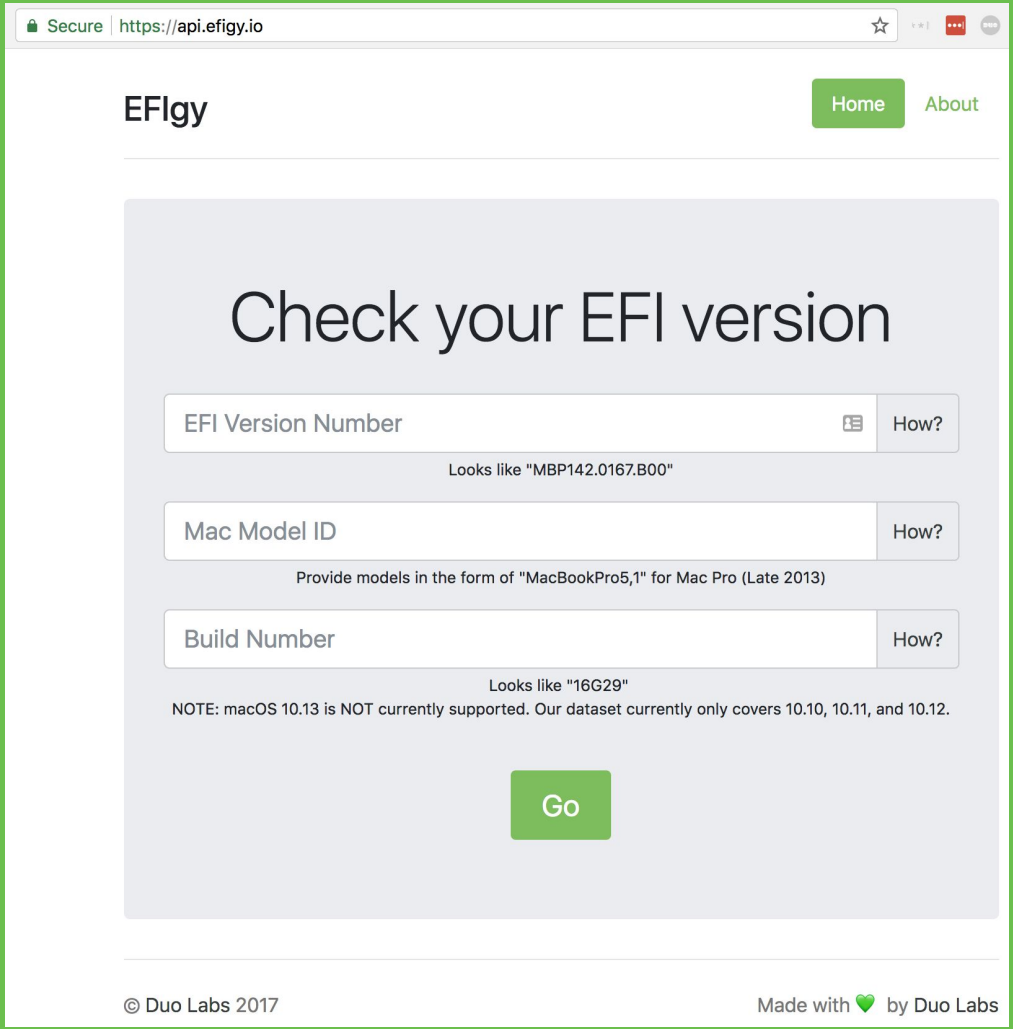
```
EFIgyLite API Information:
        API Version: 0.2
        Updated On: Oct 13 2017, 17:42


--------------------------------------------------------------------------------
Endpoint: 127.0.0.1
        # Enumerated system informaton (This data will be sent to the API in order to determi

        Hashed SysUUID   : 44c3cfc6f15da575636ebb88a78d7c88c54dabdb60ffaddcb8d7c02845955710
        Hardware Version : MacBookPro13,2
        EFI Version      : MBP132.0226.B25
        SMC Version      : 2.37f20
        Board-ID         : Mac-66E35819EE2D0D05
        OS Version       : 10.12.6
        Build Number     : 16G29

[?] Do you want to continue and submit this request? [Y/N]  y

        # Results:

        EFI firmware version check:
                [+] SUCCESS - The EFI Firmware you are running (None) is the expected versior

        Highest build number check:
                [+] SUCCESS - You are running the latest build number (16G29) of the OS versi

        Up-to-date OS check:
                [+] SUCCESS - You are running the latest major/minor/micro version of the OS
--------------------------------------------------------------------------------
```

EFIgy GUI App

github.com/duo-labs/EFIgy-GUI

EFIgy Web App

api.efigy.io



efigy.io
(github)

EFIgy API data

Up to date API data and graphs here

Demo Time

Conclusions

Conclusions

- Transparency is key - vendors should be clear with what they patch
- Systems can be '*software secure but firmware vulnerable*'
- Not all hardware may be treated equally
- QA is hard! Looking into the firmware being received is a good idea
- EFI is like a full OS in many ways:
  - It affects everything running above it (ring -2 remember!)
  - You should keep it up to date to not undermine the rest of your security
  - It needs to have notifications and alerts for updates like software does
- Apple is taking EFI security seriously and is continuing to lead the way

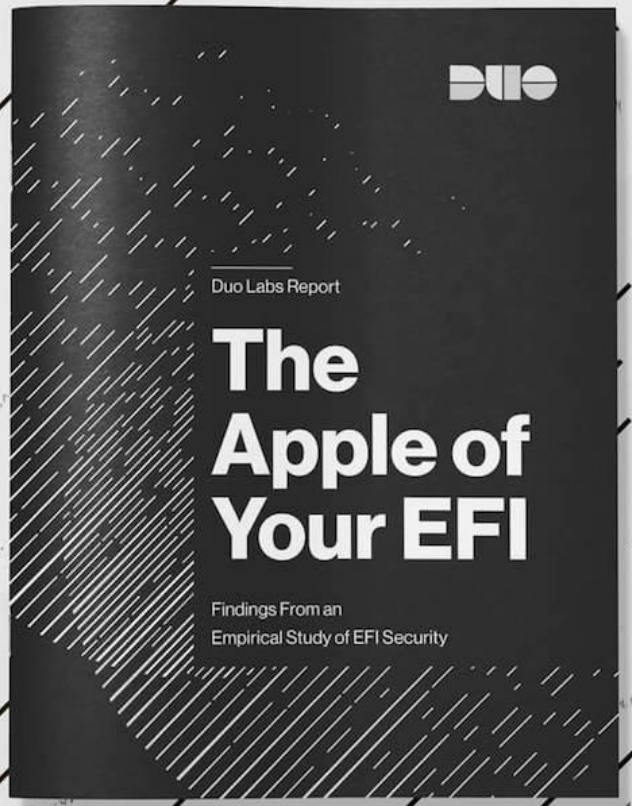
Lots more information in our technical paper

http://duo.sc/2x1AA9R

And Blogpost

http://duo.sc/2ychJhh

EFIgy Tools
https://efigy.io



Thanks!

If you've got Q's, we've got A's…*

Pepijn Bruienne (@bruienne)
Rich Smith (@iodboi)

* We hope!