n-1 and *n*-2:
Should we really trust in you?

(An examination of  macOS security updates)

Joshua Long

*with a few notes added to the slides for clarity

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% whoami

Joshua Long

- Chief Security Analyst at Intego
- 20+ years of cyber threat research
- Master of IT in Internet Security
- Discovered Apple ID password validation vulnerability
- Twitter: @theJoshMeister

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n-1 and *n*-2: Should we really trust in you?

- A brief history of macOS security updates
- Are new macOS versions inherently safer?
- Comparing patches for 400+ Big Sur-era vulns
- What about iOS?
- Takeaways

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Security update 2003-11-19 for 10.2.8

“It is Apple's policy to quickly address significant vulnerabilities in past releases of Mac OS X wherever feasible.”

* To date, this remains one of very few public statements Apple has made regarding its security update policies.

2003 2012 2021

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Security update 2003-11-19 for 10.2.8

“It is Apple's policy to quickly address significant vulnerabilities in past releases of Mac OS X wherever feasible.”

Security updates, 2003-12-19

“Note: The following fixes which appear in "Security Update 2003-12-19 for Panther" are not included in "Security Update 2003-12-19 for Jaguar" since the Jaguar versions of Mac OS X and Mac OS X Server are not vulnerable to these issues”

* Unfortunately, Apple no longer makes statements like these, which leaves open to speculation why some vulnerabilities don’t get patched for some macOS versions.

2003 2012 2021

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n and *n*-1

* Eventually Apple started patching a few apps (such as iTunes, QuickTime, and Safari) for the "n-2" Mac OS X version as well.

2003 2012 2021

September 2012:
Apple solidifies “n-2” support

* … when they started releasing security updates simultaneously for Mac OS X versions 10.6, 10.7, and 10.8.

Apple has followed similar practices ever since then.

2003 **2012** **2021**

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Why do Mac users sometimes not upgrade to the latest macOS?

- Don’t think they need the new features
- Concerned about something breaking
- Use legacy apps that won’t run on the latest OS
- Older Macs may not be compatible with the latest OS

Myth #1: New macOS versions are inherently safer.

Nope.

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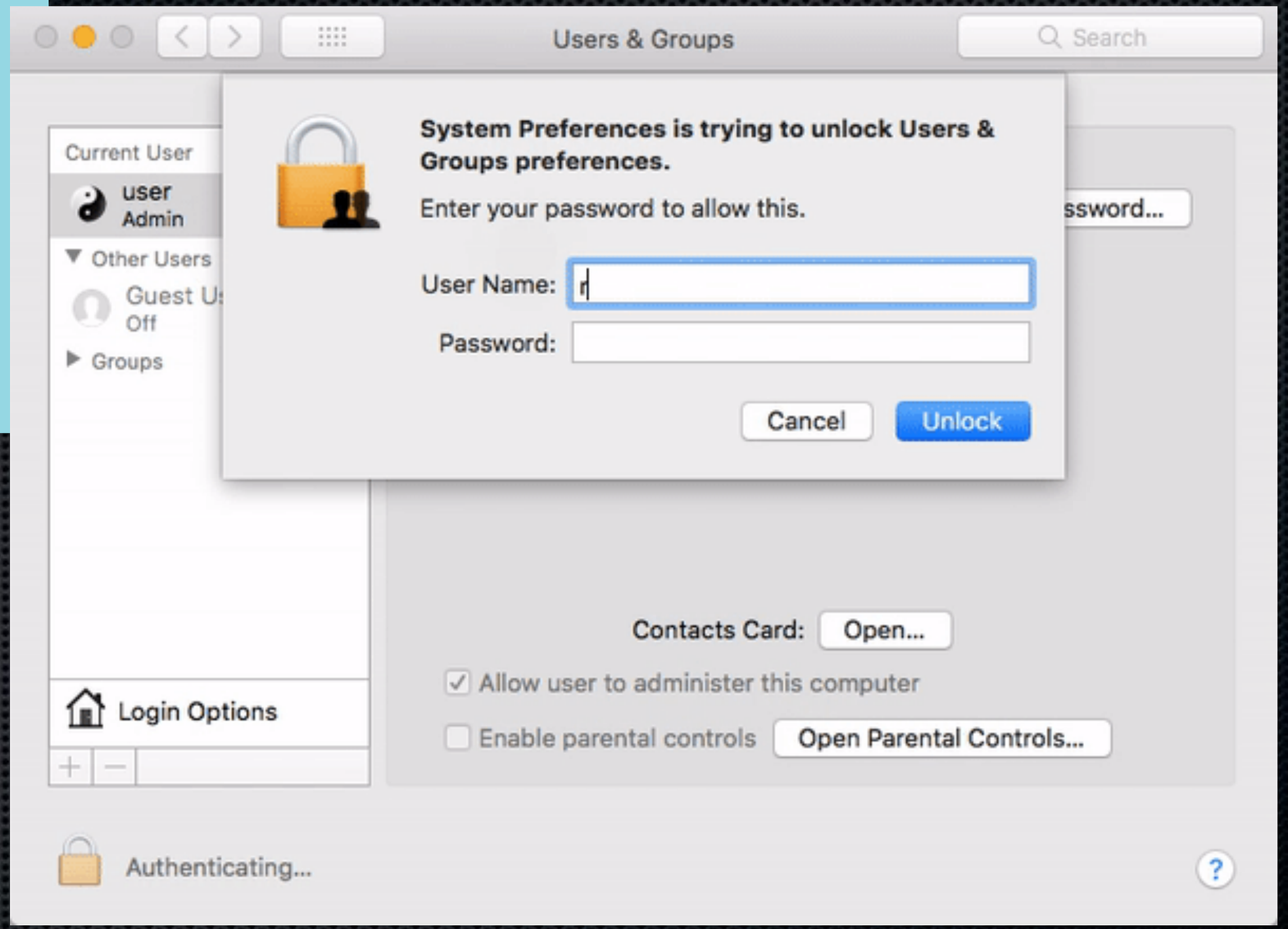
Remember this?



macOS High Sierra

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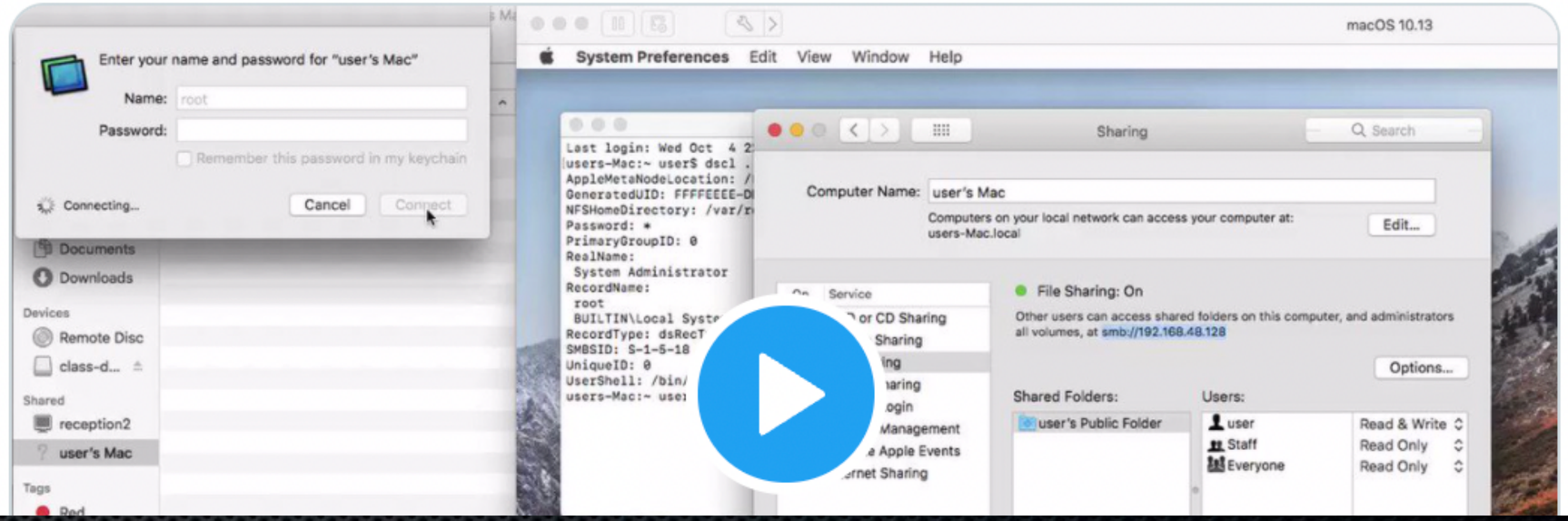
Remember this?

patrick wardle ✔
@patrickwardle

If certain sharing services enabled on target - this attack appears to work 💯 remote 🙈💀☠️ (the login attempt enables/creates the root account with blank pw) Oh Apple 🍎😷🤒🤕



macOS High Sierra

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```
((err = SSLHas
 goto fail;
 goto fail;
((err = SSLHas
 goto fail;
```

...and this?

```
static OSStatus
SSLVerifySignedServerKeyExchange(SSLContext *ctx, bool isRsa, SSLBuffer signedParams,
                                 uint8_t *signature, UInt16 signatureLen)
{
    OSStatus        err;
    SSLBuffer       hashOut, hashCtx, clientRandom, serverRandom;
    uint8_t         hashes[SSL_SHA1_DIGEST_LEN + SSL_MD5_DIGEST_LEN];
    SSLBuffer       signedHashes;
    uint8_t         *dataToSign;
    size_t          dataToSignLen;

    ...
    if ((err = ReadyHash(&SSLHashSHA1, &hashCtx)) != 0)
        goto ↓fail;
    if ((err = SSLHashSHA1.update(&hashCtx, &clientRandom)) != 0)
        goto ↓fail;
    if ((err = SSLHashSHA1.update(&hashCtx, &serverRandom)) != 0)
        goto ↓fail;
    if ((err = SSLHashSHA1.update(&hashCtx, &signedParams)) != 0)
        goto ↓fail;
        goto ↓fail;
    if ((err = SSLHashSHA1.final(&hashCtx, &hashOut)) != 0)
        goto ↓fail;

    err = sslRawVerify(ctx,
                       ctx->peerPubKey,
                       dataToSign,              /* plaintext */
                       dataToSignLen,           /* plaintext length */
                       signature,
                       signatureLen);
    if(err) {
        sslErrorLog("SSLDecodeSignedServerKeyExchange: sslRawVerify "
                    "returned %d\n", (int)err);
        goto ↓fail;
    }
```

OS X Mavericks

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Myth #2: All macOS security updates are created equal.

Uhh... No.

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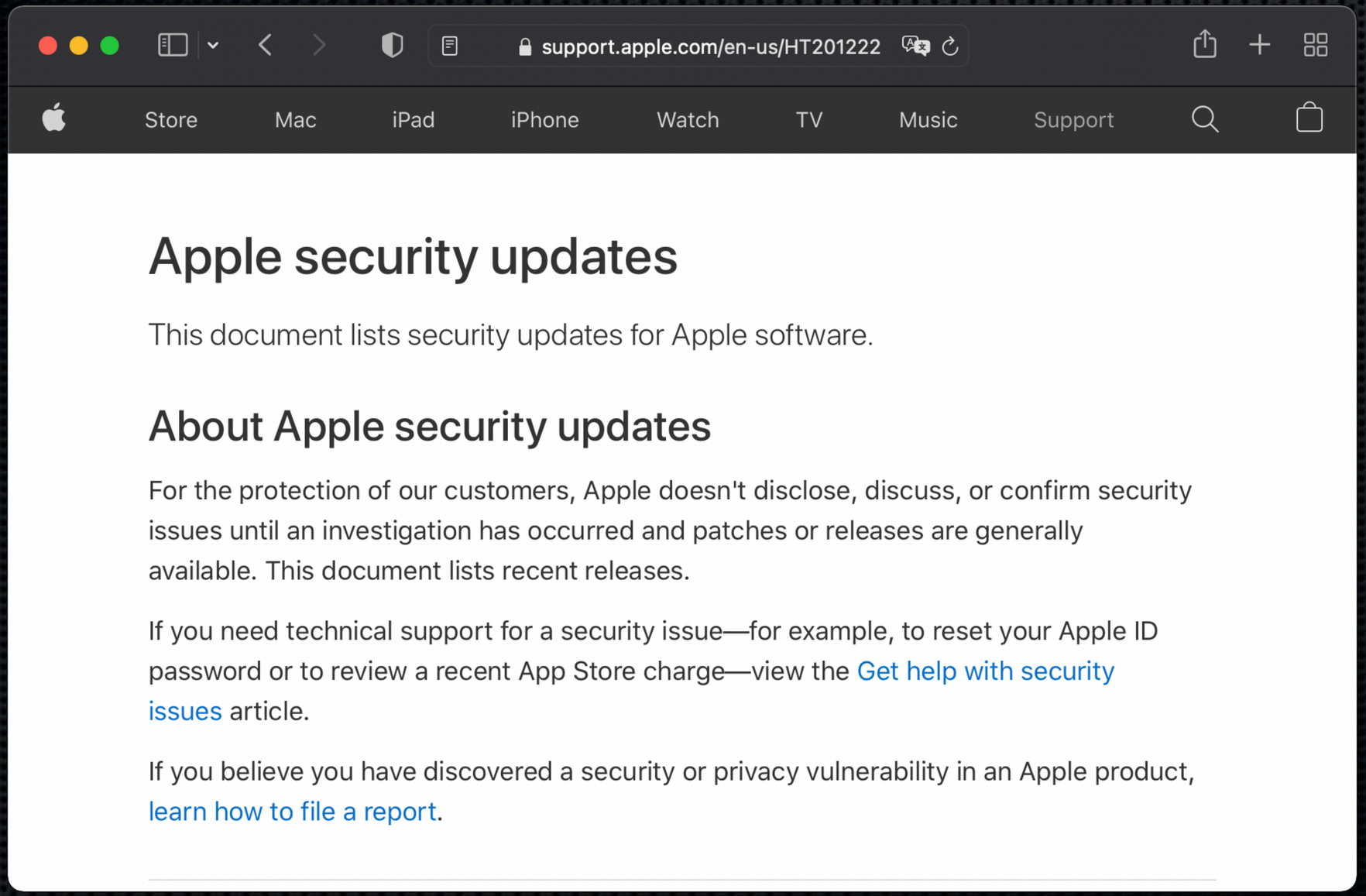
The Challenges

When Apple doesn't patch something for one or more OS…

- …is it because that vulnerability doesn't affect that OS for some reason?
- …did Apple in reality patch it, but just forgot to document it?

So we have to ask the vulnerability reporters?

- …but some are anonymous, hard to contact, or may be unwilling to discuss



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	#	Gen	11.x	10.15	10.14	CVE	Researcher	Component	ACE	RA	Pr	Term	DoS	MitM	Web	Oth	Wild	Rel	Rel2C	Rel2M	Add/Up	AdUpD8	AdUpDays
2	1	11.0.1	11.0.1	2020-001C	2020-007M	2020-27914	Yu Wang of Didi Research America	AMD	√S									11/12/20	32	32	√	12/14/20	32
3	2	11.0.1	11.0.1	2020-001C	2020-007M	2020-27915	Yu Wang of Didi Research America	AMD	√S									11/12/20	32	32	√	12/14/20	32
4	3	11.0.1	11.0.1	2020-001C	2020-007M	2020-27903	Zhipeng Huo (@R3dF09) of Tencent Security Xuanwu Lab	App Store			√							11/12/20	32	32			
5	4	11.0.1	11.0.1	2020-001C	2020-007M	2020-27910	JunDong Xie and XingWei Lin of Ant Security Light-Year Lab	Audio	√									11/12/20	32	32			
6	5	11.0.1	11.0.1	2020-001C	2020-007M	2020-27916	JunDong Xie of Ant Security Light-Year Lab	Audio	√									11/12/20	32	32			
7	6	11.0.1	11.0.1	2020-001C	2020-007M	2020-9943	JunDong Xie of Ant Group Light-Year Security Lab	Audio				√						11/12/20	32	32			
8	7	11.0.1	11.0.1	2020-001C	2020-007M	2020-9944	JunDong Xie of Ant Group Light-Year Security Lab	Audio				√						11/12/20	32	32			
9	8	11.0.1	11.0.1	2020-001C	2020-007M	2020-27906	Zuozhi Fan (@pattern_F_) of Ant Group Tianqiong Security Lab	Bluetooth		√			√					11/12/20	32	32			
10	9	11.0.1	11.0.1	2021-001C	2021-001M	2020-27945	Zhuo Liang of Qihoo 360 Vulcan Team	CFNetwork Cache	√									11/12/20	81	81	√	3/16/21	124
11	10	11.0.1	11.0.1	2020-001C	2020-007M	2020-27908	JunDong Xie and Xingwei Lin of Ant Security Light-Year Lab	CoreAudio	√									11/12/20	32	32	√	12/14/20	32
12	11	11.0.1	11.0.1			2020-27909	Anonymous working with Trend Micro Zero Day Initiative, JunDong Xie and Xingwei Lin of Ant Security Light	CoreAudio	√									11/12/20	∞	∞	√	12/14/20	32
13	12	11.0.1	11.0.1	2020-001C	2020-007M	2020-9960	JunDong Xie and Xingwei Lin of Ant Security Light-Year Lab	CoreAudio	√									11/12/20	32	32	√	12/14/20	32
14	13	11.0.1	11.0.1	2020-001C	2020-007M	2020-10017	Francis working with Trend Micro Zero Day Initiative, JunDong Xie of Ant Security Light-Year Lab	CoreAudio	√									11/12/20	32	32			
15	14	11.0.1	11.0.1		2020-004M	2020-9949	Proteas	CoreCapture	√K									11/12/20	∞	*			
16	15	11.0.1	11.0.1	10.15.6		2020-9883	an anonymous researcher, Mickey Jin of Trend Micro	CoreGraphics	√									11/12/20	*	∞			
17	16	11.0.1	11.0.1			2020-10003	Tim Michaud (@TimGMichaud) of Leviathan	Crash Reporter			√							11/12/20	∞	∞			
18	17	11.0.1	11.0.1	2020-001C	2020-007M	2020-27922	Mickey Jin of Trend Micro	CoreText	√									11/12/20	32	32	√	12/14/20	32
19	18	11.0.1	11.0.1			2020-9999	Apple	CoreText	√									11/12/20	∞	∞	√U	12/14/20	32
20	19	11.0.1	11.0.1	2021-001C		2020-27937	Wojciech Reguła (@_r3ggi) of SecuRing	Directory Utility				√						11/12/20	81	∞	√	3/16/21	124
21	20	11.0.1	11.0.1			2020-9965	Proteas	Disk Images	√K									11/12/20	∞	∞			
22	21	11.0.1	11.0.1			2020-9966	Proteas	Disk Images	√K									11/12/20	∞	∞			
23	22	11.0.1	11.0.1			2020-27894	Manuel Trezza of Shuggr (shuggr.com)	Finder								√		11/12/20	∞	∞			
24	23	11.0.1	11.0.1	2020-001C	2020-007M	2020-9962	Yiğit Can YILMAZ (@yilmazcanyigit)	FontParser	√									11/12/20	32	32	√	12/14/20	32
25	24	11.0.1	11.0.1	2020-001C	2020-007M	2020-27952	an anonymous researcher, Mickey Jin and Junzhi Lu of Trend Micro	FontParser	√									11/12/20	32	32	√	12/14/20	32
26	25	11.0.1	11.0.1	2020-001C	2020-007M	2020-9956	Mickey Jin and Junzhi Lu of Trend Micro Mobile Security Research Team working with Trend Micro's Zero Da	FontParser	√									11/12/20	32	32	√	12/14/20	32
27	26	11.0.1	11.0.1	2020-001C	2020-007M	2020-27931	Apple	FontParser	√									11/12/20	32	32	√	12/14/20	32
28	27	11.0.1	11.0.1	10.15.7		2020-27930	Google Project Zero	FontParser	√								√	11/12/20	*	∞			
29	28	11.0.1	11.0.1			2020-27927	Xingwei Lin of Ant Security Light-Year Lab	FontParser	√									11/12/20	∞	∞			
30	29	11.0.1	11.0.1			2020-29639	Mickey Jin & Qi Sun of Trend Micro working with Trend Micro's Zero Day Initiative	FontParser				√						11/12/20	∞	∞	√	7/21/21	251
31	30	11.0.1	11.0.1	2020-001C	2020-007M	2020-10002	James Hutchins	Foundation				√						11/12/20	32	32			
32	31	11.0.1	11.0.1	2020-001C	2020-007M	2020-9978	Luyi Xing, Dongfang Zhao, and Xiaofeng Wang of Indiana University Bloomington, Yan Jia of Xidian Universi	HomeKit						√				11/12/20	32	32	√	12/14/20	32
33	32	11.0.1	11.0.1			2020-9955	Mickey Jin of Trend Micro, Xingwei Lin of Ant Security Light-Year Lab	ImageIO	√									11/12/20	∞	∞	√	12/14/20	32
34	33	11.0.1	11.0.1	2020-001C	2020-007M	2020-27924	Lei Sun	ImageIO	√									11/12/20	32	32	√	12/14/20	32
35	34	11.0.1	11.0.1	2020-001C	2020-007M	2020-27912	Xingwei Lin of Ant Security Light-Year Lab	ImageIO	√									11/12/20	32	32	√U	12/14/20	32
36	35	11.0.1	11.0.1	2020-001C	2020-007M	2020-27923	Lei Sun	ImageIO	√									11/12/20	32	32	√U	12/14/20	32
37	36	11.0.1	11.0.1			2020-9876	Mickey Jin of Trend Micro	ImageIO	√			√						11/12/20	∞	∞			
38	37	11.0.1	11.0.1	2020-001C	2020-007M	2020-10015	ABC Research s.r.o. working with Trend Micro Zero Day Initiative	Intel Graphics Driver	√K									11/12/20	32	32	√	12/14/20	32
39	38	11.0.1	11.0.1	2020-001C	2020-007M	2020-27897	Xiaolong Bai and Min (Spark) Zheng of Alibaba Inc., and Luyi Xing of Indiana University Bloomington	Intel Graphics Driver	√K									11/12/20	32	32	√	12/14/20	32
40	39	11.0.1	11.0.1	2020-001C	2020-007M	2020-27907	ABC Research s.r.o. working with Trend Micro Zero Day Initiative, Liu Long of Ant Security Light-Year Lab	Intel Graphics Driver	√K									11/12/20	32	32	√+√U	12/14/20	32
41	40	11.0.1	11.0.1	2020-001C	2020-007M	2020-27919	Hou JingYi (@hjy79425575) of Qihoo 360 CERT, Xingwei Lin of Ant Security Light-Year Lab	Image Processing	√									11/12/20	32	32	√	12/14/20	32
42	41	11.0.1	11.0.1	2020-001C	2020-007M	2020-9967	Alex Plaskett (@alexjplaskett)	Kernel		√		√						11/12/20	32	32	√	12/14/20	32
43	42	11.0.1	11.0.1	2020-001C	2020-007M	2020-9975	Tielei Wang of Pangu Lab	Kernel	√K									11/12/20	32	32	√	12/14/20	32
44	43	11.0.1	11.0.1	2020-001C	2020-007M	2020-27921	Linus Henze (pinauten.de)	Kernel	√K									11/12/20	32	32	√	12/14/20	32
45	44	11.0.1	11.0.1	2021-001C	2021-001M	2020-27904	Zuozhi Fan (@pattern_F_) of Ant Group Tianqong Security Lab	Kernel	√K									11/12/20	81	81			
46	45	11.0.1	11.0.1	10.15.6		2019-14899	William J. Tolley, Beau Kujath, and Jedidiah R. Crandall	Kernel						√				11/12/20	∞	∞			
47	46	11.0.1	11.0.1			2020-27950	Google Project Zero	Kernel				√					√	11/12/20	∞	∞			

Some rough numbers

- 468 total Big Sur-era vulnerabilities

- 217 vulns patched for all 3 (BS, C, & M)
- 154 vulns patched only in Big Sur
- 74 vulns patched only in Big Sur & Catalina

- 11 vulns patched in only Catalina & Mojave
- 7 vulns patched in only Catalina
- 2 vulns patched in only Mojave
- 3 vulns patched in only Big Sur & Mojave??

There’s one more thing…

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“Apple is aware of a report that this issue may have been actively exploited.”

"Apple is aware of a report
that this issue may have been
actively exploited."

15 "actively exploited" vulns since Big Sur's release

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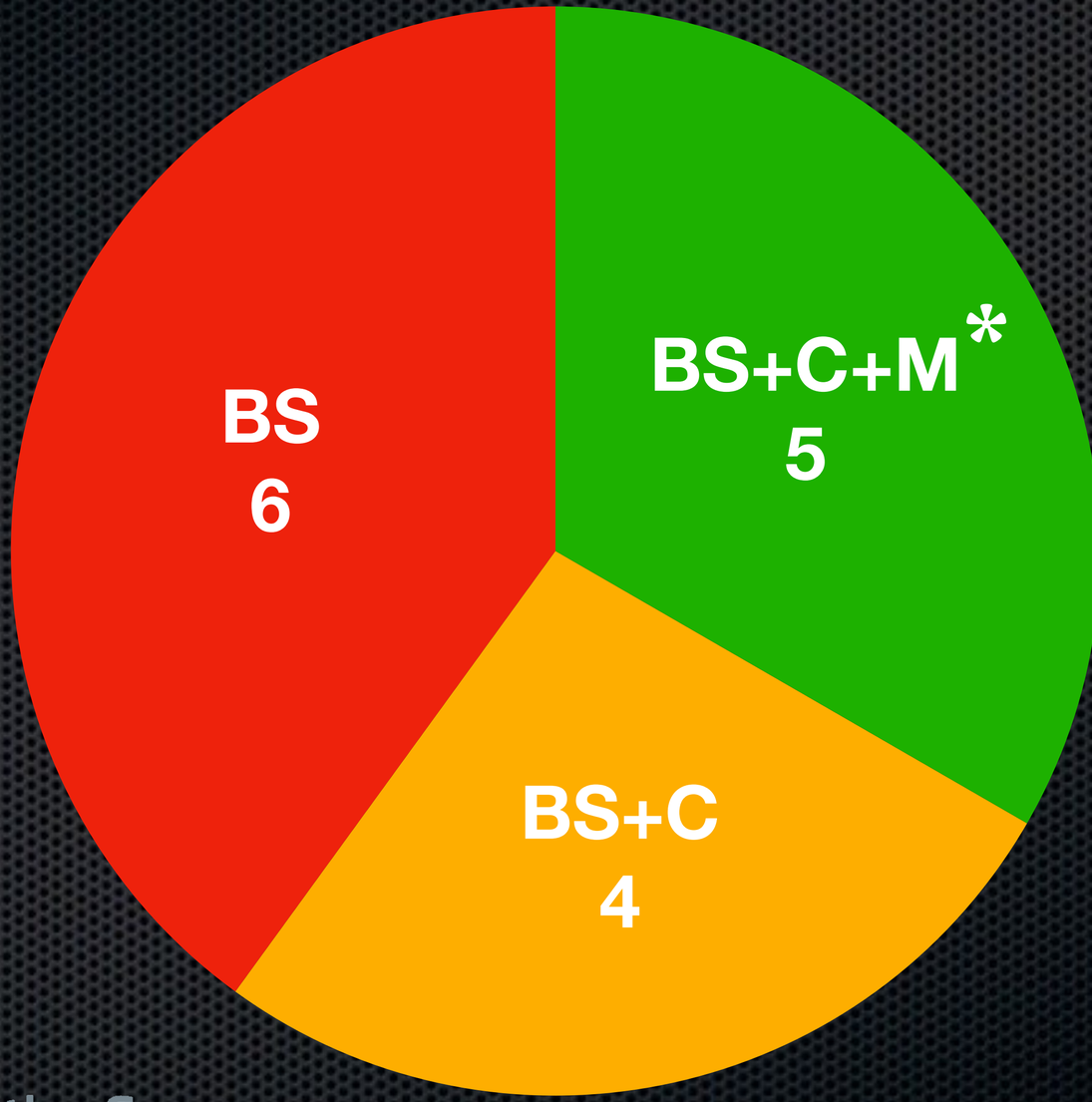
15 “actively exploited” vulns since Big Sur’s release



⬅️ * Asterisk because technically one of the 5 was only patched for BS & C but didn’t apply to M, so I counted it here because every affected OS was patched

11.x	10.15	10.14	CVE	Researcher	Component
11.2	2021-001C	2021-001M	2021-1782	an anonymous researcher	Kernel
11.3.1	Safari14.1	Safari14.1	2021-30665	yangkang (@dnpushme)&zerokeeper&bia	WebKit
11.3.1	Safari14.1	Safari14.1	2021-30663	an anonymous researcher	WebKit
11.6	Safari14.1.2*	Safari14.1.2*	2021-30858	an anonymous researcher	WebKit
11.3	2021-002C	N/A	2021-30657	Cedric Owens (@cedowens)	System Preferences
11.6	2021-005C		2021-30860	The Citizen Lab	CoreGraphics
11.2	2021-006C		2021-30869	Erye Hernandez of Google Threat Analysi	XNU
11.4	2021-005C		2021-30713	an anonymous researcher	TCC
11.0.1	10.15.7		2020-27930	Google Project Zero	FontParser
11.2			2021-1871	an anonymous researcher	WebKit
11.2			2021-1870	an anonymous researcher	WebKit
11.3			2021-30661	yangkang(@dnpushme) of 360 ATA	WebKit Storage
11.0.1			2020-27950	Google Project Zero	Kernel
11.0.1			2020-27932	Google Project Zero	Kernel
11.5.1			2021-30807	an anonymous researcher	IOMobileFrameBuffer

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* Many “actively exploited” vulns were reported anonymously

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11.x	10.15	10.14	CVE	Researcher	Component
11.2	2021-001C	2021-001M	2021-1782	an anonymous researcher	Kernel
11.3.1	Safari14.1	Safari14.1	2021-30665	yangkang (@dnpushme)&zerokeeper&bia	WebKit
11.3.1	Safari14.1	Safari14.1	2021-30663	an anonymous researcher	WebKit
11.6	Safari14.1.2*	Safari14.1.2*	2021-30858	an anonymous researcher	WebKit
11.3	2021-002C	N/A	2021-30657	Cedric Owens (@cedowens)	System Preferences
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11.4	2021-005C		2021-30713	an anonymous researcher	TCC
11.0.1	10.15.7		2020-27930	Google Project Zero	FontParser
11.2			2021-1871	an anonymous researcher	WebKit
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11.3			2021-30661	yangkang(@dnpushme) of 360 ATA	WebKit Storage
11.0.1			2020-27950	Google Project Zero	Kernel
11.0.1			2020-27932	Google Project Zero	Kernel
11.5.1			2021-30807	an anonymous researcher	IOMobileFrameBuffer

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*WebKit vulns presumably apply to all, so why weren't these actively exploited vulns patched?

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11.x	10.15	10.14	CVE	Researcher	Component
11.2	2021-001C	2021-001M	2021-1782	an anonymous researcher	Kernel
11.3.1	Safari14.1	Safari14.1	2021-30665	yangkang (@dnpushme)&zerokeeper&bia	WebKit
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11.6	Safari14.1.2*	Safari14.1.2*	2021-30858	an anonymous researcher	WebKit
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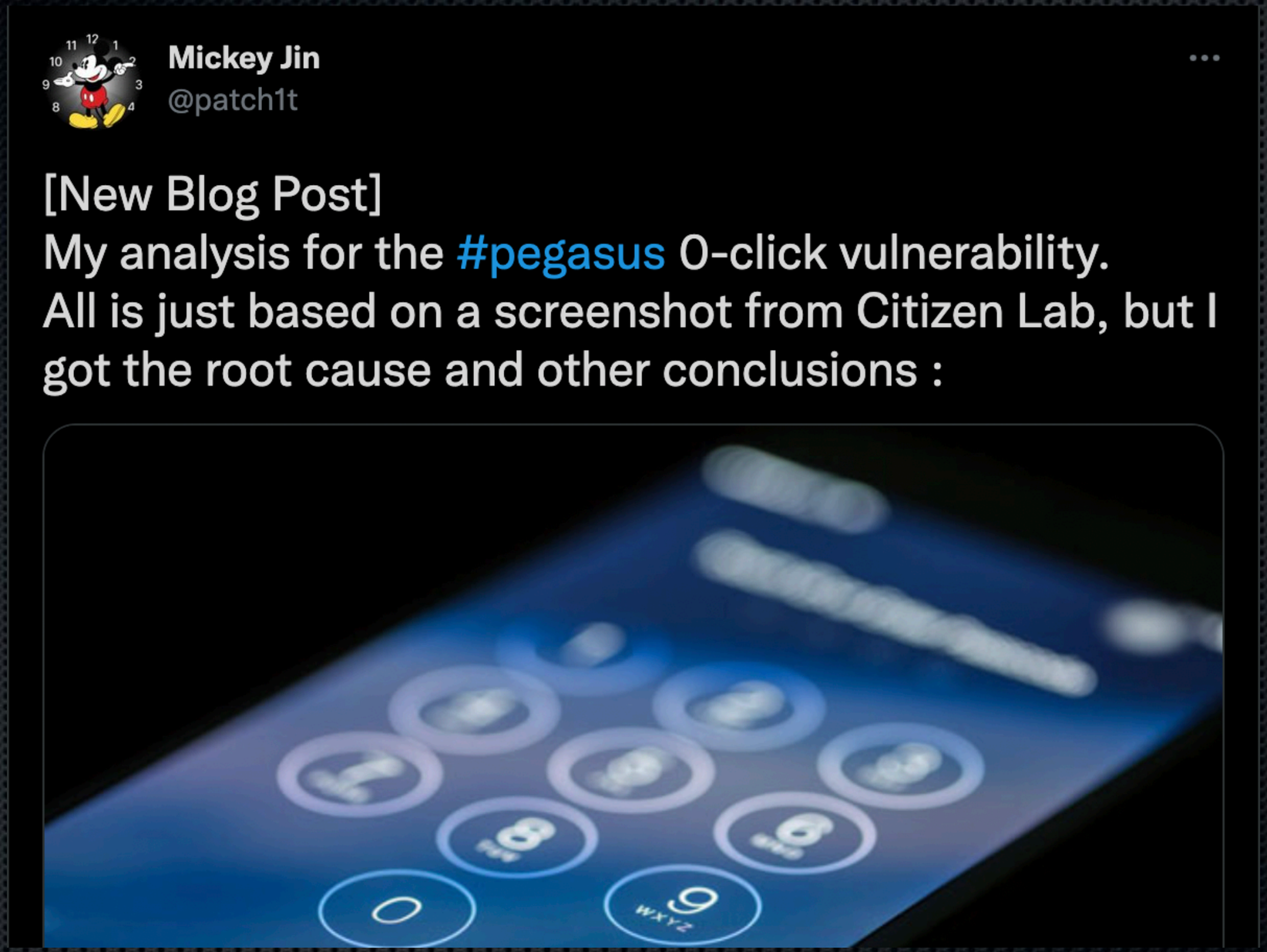
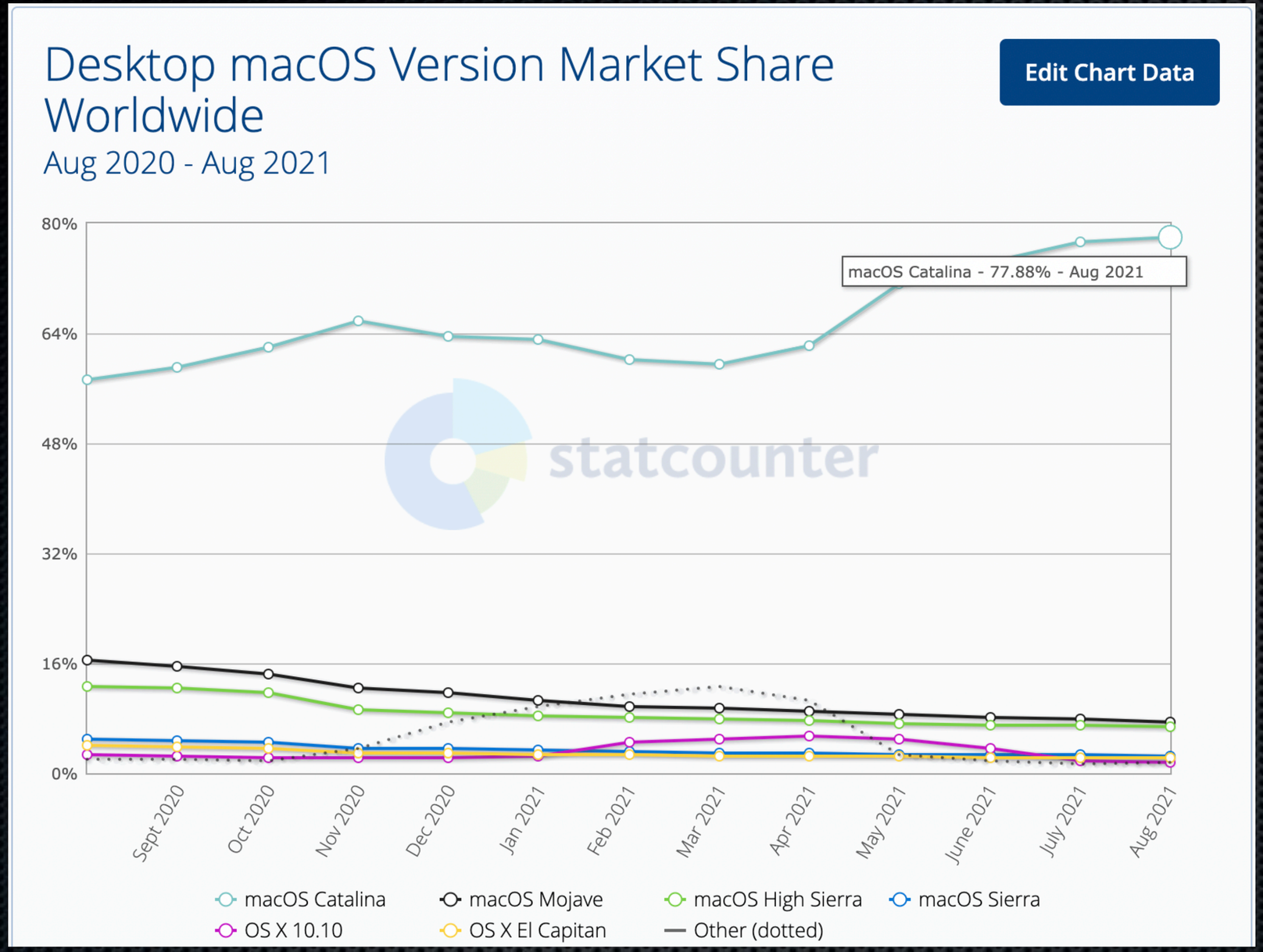
11.0.1	10.15.7		2020-27930	Google Project Zero	FontParser
11.2			2021-1871	an anonymous researcher	WebKit
11.2			2021-1870	an anonymous researcher	WebKit
11.3			2021-30661	yangkang(@dnpushme) of 360 ATA	WebKit Storage
11.0.1			2020-27950	Google Project Zero	Kernel
11.0.1			2020-27932	Google Project Zero	Kernel
11.5.1			2021-30807	an anonymous researcher	IOMobileFrameBuffer

* That CVE was leveraged by Pegasus. So why wasn't it patched for Mojave? Does it not affect Mojave?



* Mickey Jin confirmed to me privately that Mojave *is* affected!



Current macOS version market share:

Big Sur & Catalina: 78%

Mojave and older: 22%

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What about iOS?

- Some older iOS devices are stuck with iOS 12
- Apple is only patching “actively exploited” vulnerabilities for iOS 12
- iOS 13 isn’t getting any updates anymore
- iOS 14 is supposed to continue getting updates
- iOS 15 is the latest (but is missing two “actively exploited” iOS 14.8 patches)

* Currently, both iOS 14.8 and iOS 15 are not causing a red badge on the Settings app to prompt users to upgrade

Takeaways

- Generally speaking, the current macOS version is the safest one
  - it gets the most total patches, and the most important ones
- Avoid using *n*-1 or *n*-2 as your main macOS whenever possible

* in spite of the occasional new vulnerabilities that may be introduced, like goto fail and I Am Root

Resources

- White paper with additional details coming soon!
- The Mac Security Blog: blog.intego.com
- Follow @theJoshMeister and @IntegoSecurity

* Sign up to be notified when the white paper is available via the link at https://www.intego.com/mac-security-blog/integos-josh-long-speaking-at-obts-v4-0-mac-security-conference/ or follow @theJoshMeister and/or @IntegoSecurity & hit the bell icon to be alerted to new tweets—we'll share when the white paper is available.

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Thank you!

Each of these folks provided invaluable feedback—*thanks a million!*

08Tc3wBB • Aleksandar Nikolic • an anonymous researcher • Cedric Owens • Csaba Fitzl (theevilbit) • Gabe Kirkpatrick • gorelics • Jatayu Holznagel • Lauritz Holtmann • Linus Henze • Lior Halphon • Mickey Jin (patch1t) • Mikko Kenttälä (Turmio_) • Patrick Wardle • Prakash (1lastBr3ath) • Robert • Samy Kamkar • Shivam Kamboj Dattana (Sechunt3r) • Siguza • Steffen Klee • Thijs Alkemade • Tim Michaud • Wojciech Reguła (_r3ggi) • Yiğit Can Yılmaz • YoKo Kho • Yuebin Sun • Zhipeng Huo (R3dF09) • Zuozhi Fan (pattern_F_)

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Questions?

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- goto fail close-up from Goto Fail (Song) by James Dempsey and The Breakpoints
- goto fail larger screen shot by Synopsis
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