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isc.sans.edu/forums/diary/Sage+20+Ransomware/21959/

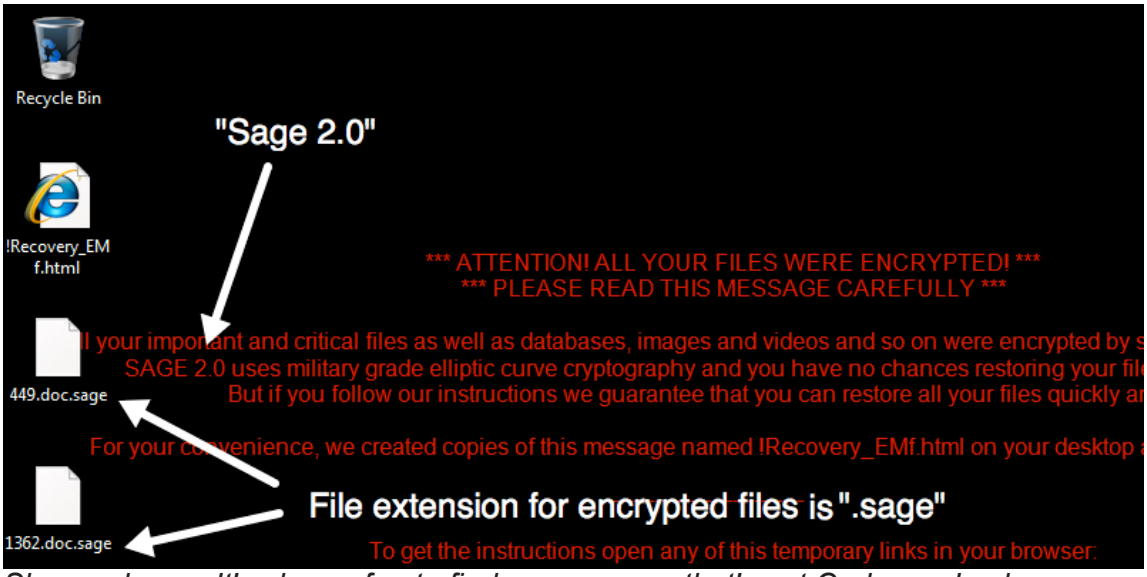
Sage 2.0 Ransomware

Brad

433 Posts
ISC Handler
Jan 21st 2017

Introduction

On Friday 2017-01-20, I checked a malicious spam (malspam) campaign that normally distributes Cerber ransomware. That Friday it delivered ransomware I'd never seen before called "Sage." More specifically, it was "Sage 2.0."



Shown above: It's always fun to find ransomawre that's not Cerber or Locky.

Sage is yet another family of ransomware in an already crowded field. It was noted on BleepingComputer forums back in December 2016 [1, 2], and Sage is a variant of CryLocker [3]. Unfortunately, I can't find an in-depth write-up on Sage that I like. With that in mind, this diary examines Sage 2.0.

The malspam

Emails from this particular campaign generally have no subject lines, and they always have no message text. The only content is a zip attachment containing a Word document with a malicious macro that downloads and installs ransomware. Sometimes, I'll see a .js file instead of a Word document, but it does the same thing.

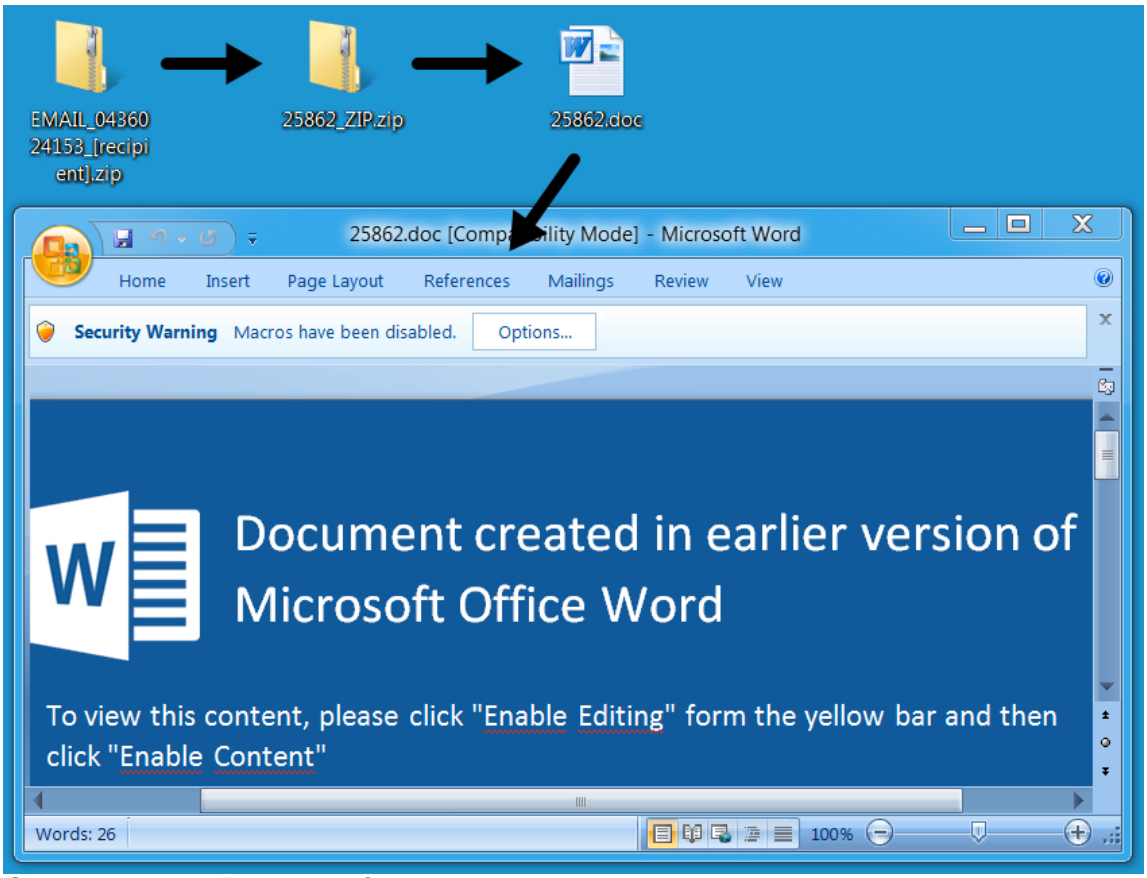
Date/Time	Sending mail server	Sending address (spoofed)	Subject	Attachment
2017-01-19 07:19 UTC	116.107.81.133	<dan_calkin@maysoft.com>	(none)	EMAIL_807388025533838_[recipient].zip
2017-01-19 07:51 UTC	colomna.net	<danny.h@post.cz>	(none)	EMAIL_42654088199_[recipient].zip
2017-01-19 08:13 UTC	vnpt.vn	<anna@monadance.org>	(none)	EMAIL_7281945_[recipient].zip
2017-01-19 14:35 UTC	hinet.net	<panakova@technicalmuseum.cz>	(none)	EMAIL_608170693_[recipient].zip
2017-01-19 15:53 UTC	dyn.bashtel.ru	<g_yorum35@windowslive.com>	(none)	EMAIL_6161214_[recipient].zip
2017-01-19 16:52 UTC	69.80.21.25	<jiggymovementbusiness@gmail.com>	(none)	EMAIL_327120_[recipient].zip
2017-01-19 16:57 UTC	ucom.am	<sherryloveless@gmail.com>	(none)	505635089.zip
2017-01-20 00:26 UTC	city-telekom.ru	<kasia_094@wp.pl>	(none)	EMAIL_77900715_[recipient].zip
2017-01-20 14:19 UTC	maxwifi.com.br	<highlandersboxingclub@live.com>	(none)	96676808070.zip
2017-01-20 16:36 UTC	c2h.no	<mmutchek@cox.net>	(none)	EMAIL_0436024153_[recipient].zip

Shown above: Data from a spreadsheet tracking the malspam (1 of 3).

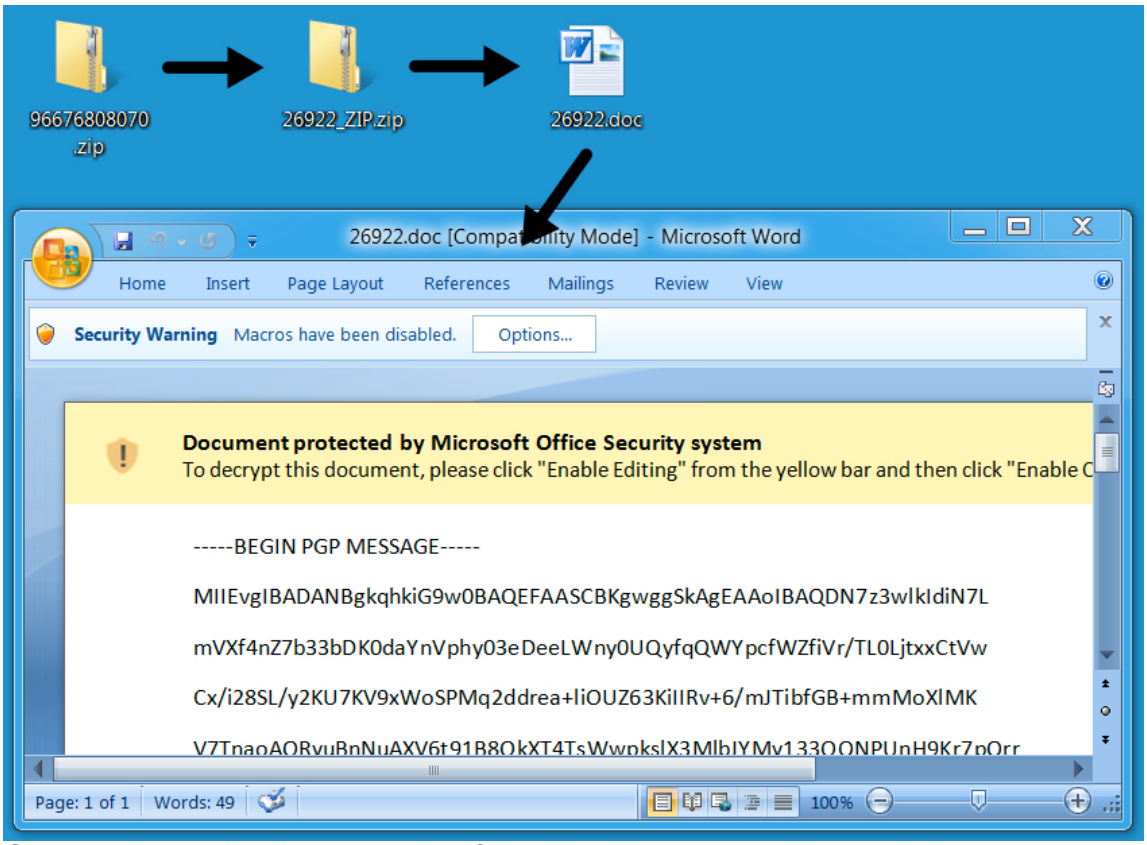
Often, the recipient's name is part of the attachment's file name. I replace those names with [recipient] before I share any info. A more interesting fact is the attachments are often double-zipped. They contain another zip archive before you get to the Word document or .js file.

Attachment	ZIP inside the ZIP	Extracted file
EMAIL_807388025533838_[recipient].zip	22044_ZIP.zip	22044.js
EMAIL_42654088199_[recipient].zip	380_ZIP.zip	380.js
EMAIL_7281945_[recipient].zip	12824_ZIP.zip	12824.js
EMAIL_608170693_[recipient].zip	13622_ZIP.zip	13622.doc
EMAIL_6161214_[recipient].zip	32449_ZIP.zip	32449.doc
EMAIL_327120_[recipient].zip	22230_ZIP.zip	22230.doc
505635089.zip	8970_ZIP.zip	8970.doc
EMAIL_77900715_[recipient].zip	20703_ZIP.zip	20703.doc
96676808070.zip	26922_ZIP.zip	26922.doc
EMAIL_0436024153_[recipient].zip	25862_ZIP.zip	25862.doc

Shown above: Data from a spreadsheet tracking the malspam (2 of 3).



Shown above: Example of a Word document with a malicious macro.



Shown above: Another example of the Word document with a malicious macro.

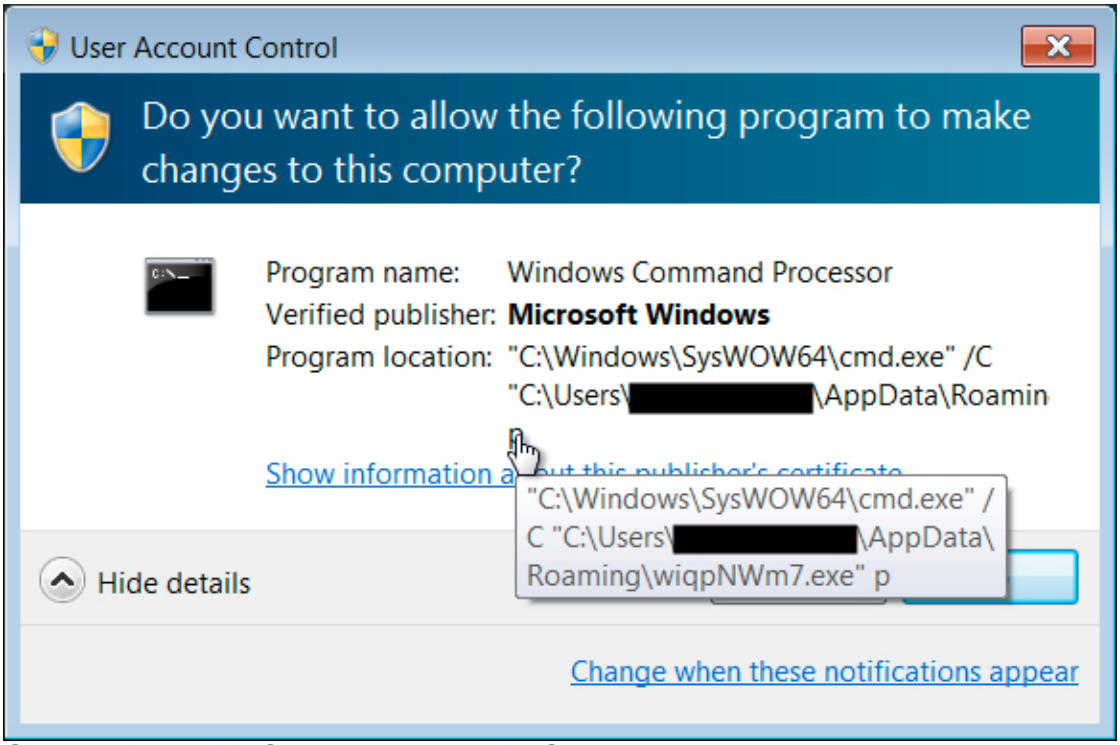
The Word document macros or .js files are designed to download and install ransomware. In most cases on Friday, the ransomware was Sage 2.0.

Extracted file	URL generated by extracted file	Ransomware on the local host	Ransomware
22044.js	fortycooola.top - GET /user.php?f=0.dat	C:\Users\[username]\AppData\Local\Tempequcuh.exe	Sage 2.0
380.js	fortycooola.top - GET /user.php?f=0.dat	C:\Users\[username]\AppData\Local\Temppmulwyqr.exe	Sage 2.0
12824.js	fortycooola.top - GET /user.php?f=0.dat	C:\Users\[username]\AppData\Local\Tempejmaxgo.exe	Sage 2.0
13622.doc	smoeroota.top - GET /read.php?f=0.dat	C:\Users\[username]\AppData\Local\Temp\Roaming.Exe	Sage 2.0
32449.doc	smoeroota.top - GET /read.php?f=0.dat	C:\Users\[username]\AppData\Local\Temp\Roaming.exe	Sage 2.0
22230.doc	smoeroota.top - GET /read.php?f=0.dat	C:\Users\[username]\AppData\Local\Temp\Roaming.exe	Sage 2.0
8970.doc	cocalolo.top - GET /search.php	C:\Users\[username]\AppData\Local\Temp\Roaming.exe	Cerber
20703.doc	smoeroota.top - GET /read.php?f=0.dat	C:\Users\[username]\AppData\Local\Temp\Roaming.EXE	Sage 2.0
26922.doc	truepokemonant.top - GET /search.php	C:\Users\[username]\AppData\Local\Temp\Roaming.eXe	Cerber
25862.doc	newfoodas.top - GET /read.php?f=0.dat	C:\Users\[username]\AppData\Local\Temp\Roaming.exe	Sage 2.0

Shown above: Data from a spreadsheet tracking the malspam (3 of 3), mostly Sage 2.0.

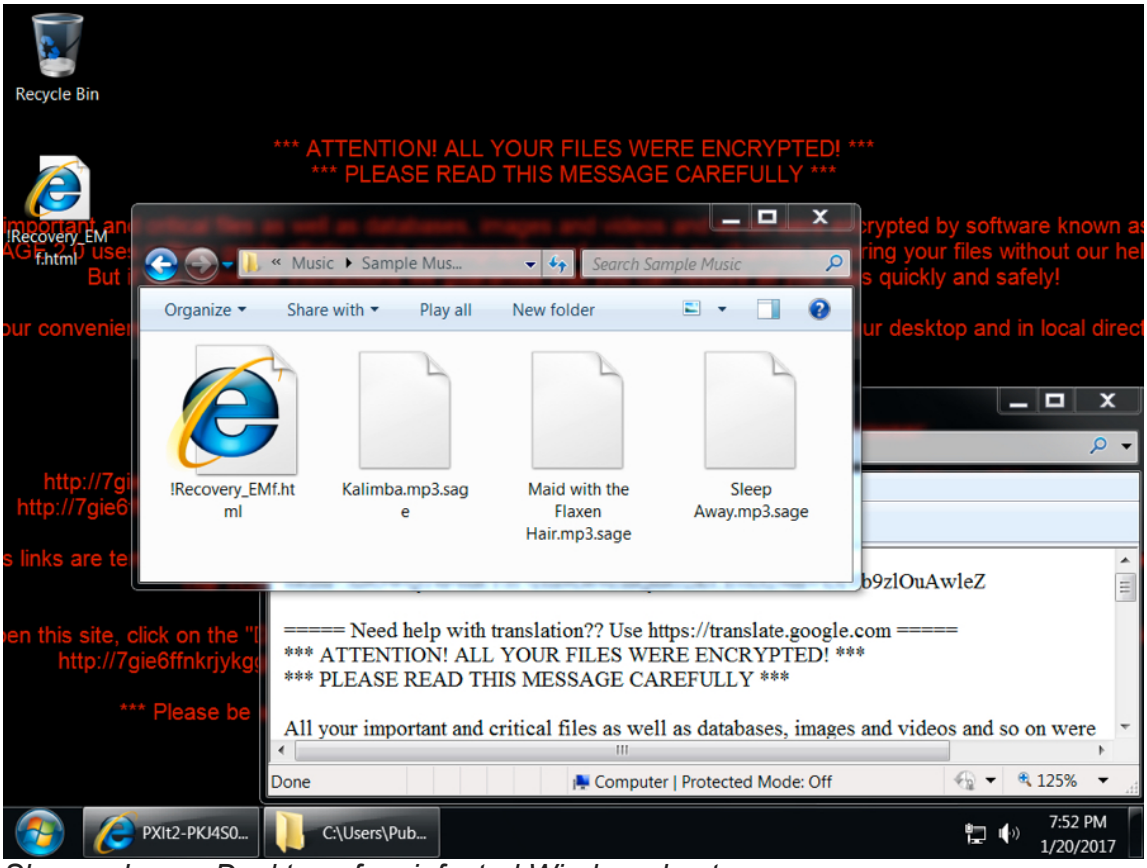
The infected host

Under default settings, an infected Windows 7 host will present a UAC window before Sage continues any further. It keeps appearing until you click yes.



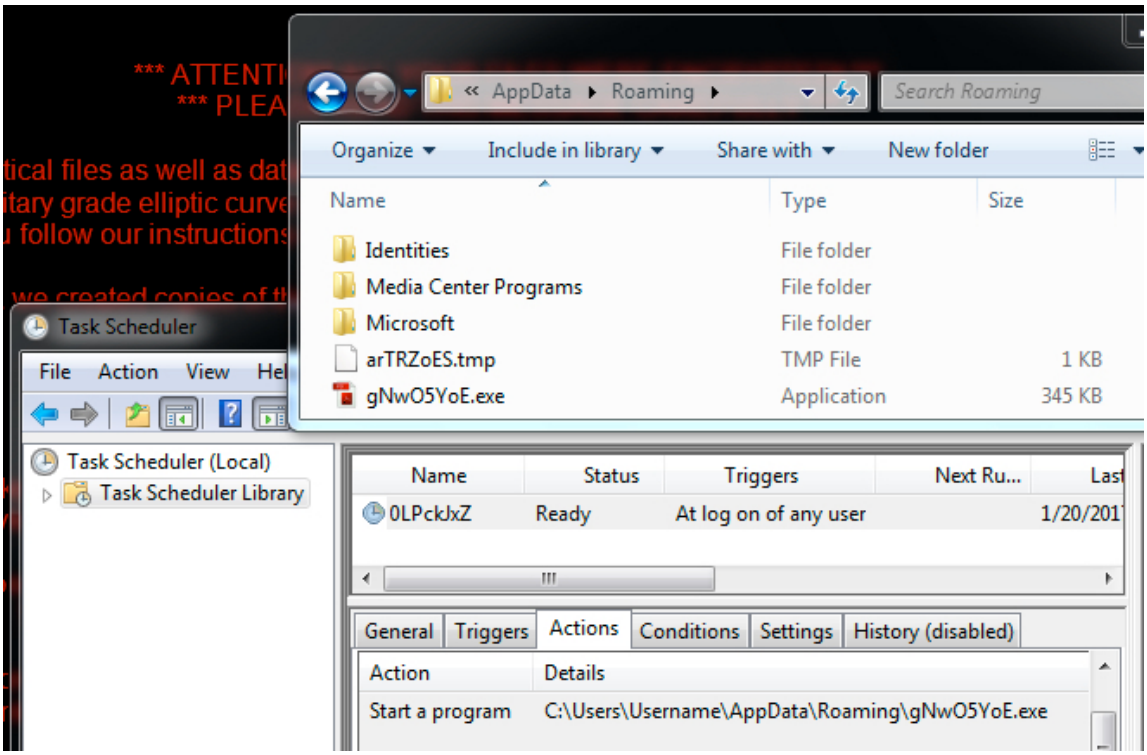
Shown above: UAC pop-up caused by Sage.

The infected Windows host has an image of the decryption instructions as the desktop background. There's also an HTML file with the same instructions dropped to the desktop. The same HTML file is also dropped to any directory with encrypted files. ".sage" is the suffix for all encrypted files.



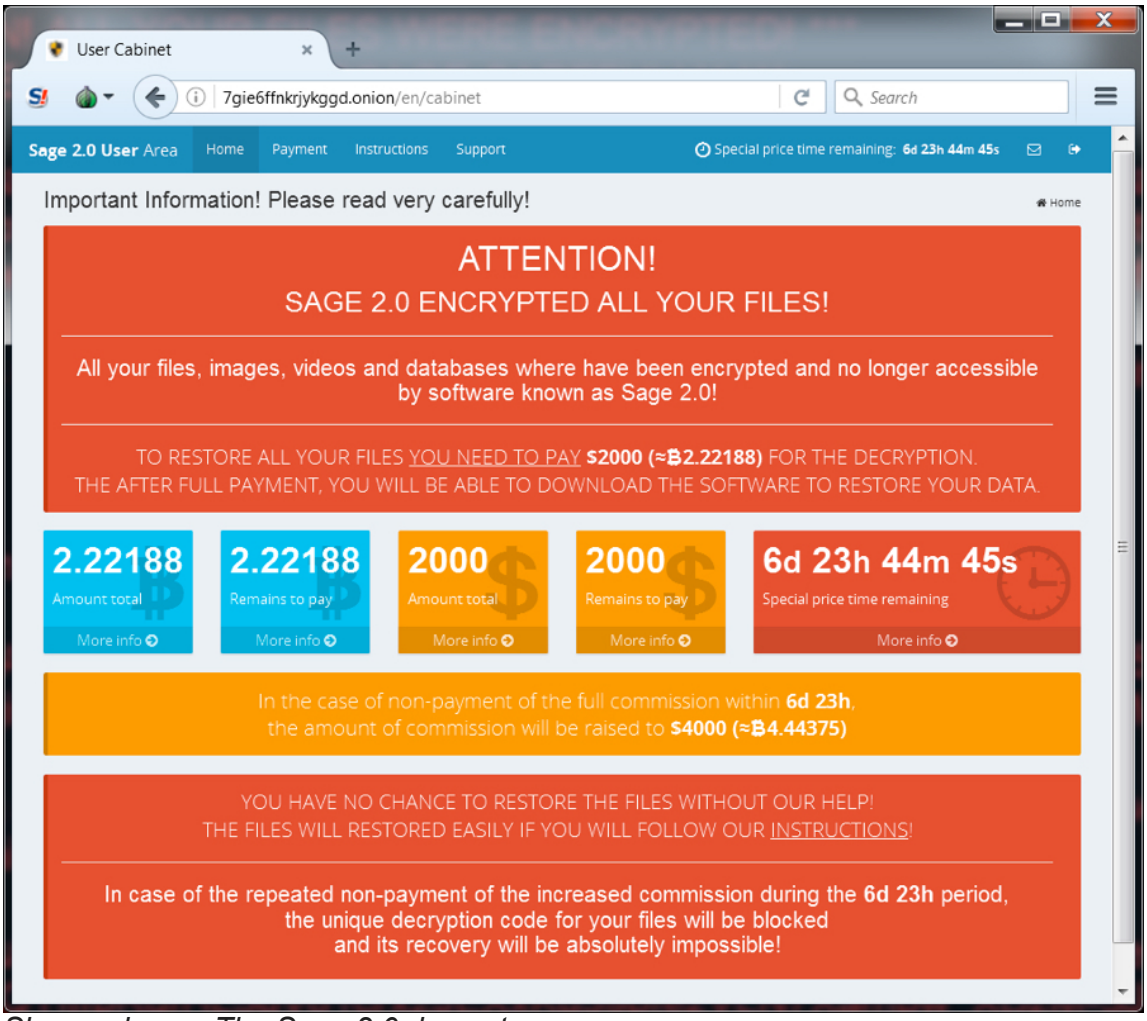
Shown above: Desktop of an infected Windows host.

Sage ransomware is kept persistent by a scheduled task, and it's stored as an executable in the user's ***AppData\Roaming*** directory.



Shown above: Sage ransomware and it's scheduled task for persistence.

Following the decryption instructions should take you to a Tor-based domain with a decryptor screen. On Friday, the cost to decrypt the files was $2,000 US dollars (or 2.22188 bitcoin).



Shown above: The Sage 2.0 decryptor.

Sage 2.0 traffic

Sage ransomware generates post-infection traffic. In the image below, an initial HTTP GET request to ***smoeroota.top*** was caused by a .js file retrieving the ransomware. The remaining HTTP POST requests are callback traffic generated by Sage 2.0 from the infected Windows host.

Filter: http.request Expression... Clear Apply Save Filter Filter Filt

Date/Time	Dst	port	Host	Info
2017-01-20 21:10:29	54.165.109.229	80	smoeroota.top	GET /read.php?f=0.dat HTTP/1.1
2017-01-20 21:10:38	66.23.246.239	80	mbfce24rgn65bx3g.er29sl.in	POST / HTTP/1.1
2017-01-20 21:10:45	54.146.39.22	80	mbfce24rgn65bx3g.er29sl.in	POST / HTTP/1.1
2017-01-20 21:11:03	66.23.246.239	80	mbfce24rgn65bx3g.er29sl.in	POST / HTTP/1.1
2017-01-20 21:11:05	66.23.246.239	80	mbfce24rgn65bx3g.er29sl.in	POST / HTTP/1.1
2017-01-20 21:11:17	54.146.39.22	80	mbfce24rgn65bx3g.er29sl.in	POST / HTTP/1.1
2017-01-20 21:12:18	66.23.246.239	80	mbfce24rgn65bx3g.er29sl.in	POST / HTTP/1.1

Shown above: Screenshot of the infection traffic, filtered in Wireshark.

```
POST / HTTP/1.1
Host: mbfce24rgn65bx3g.er29sl.in
Content-Length: 162
Connection: close

...j
....Zu.....A z_\j.j....G.nlr._0......
..,.j.c..B..eR.E.3.....]...
..4.7..x.j.'o3*.\...H...
.J...ECZ5o........ .b.....c.;.B...]8.yqJ.B&....Z..R.4.m[a.LK.P_E
.HTTP/1.1 200 OK
Server: nginx
Date: Fri, 20 Jan 2017 21:10:57 GMT
Content-Length: 1
Connection: close

k
```

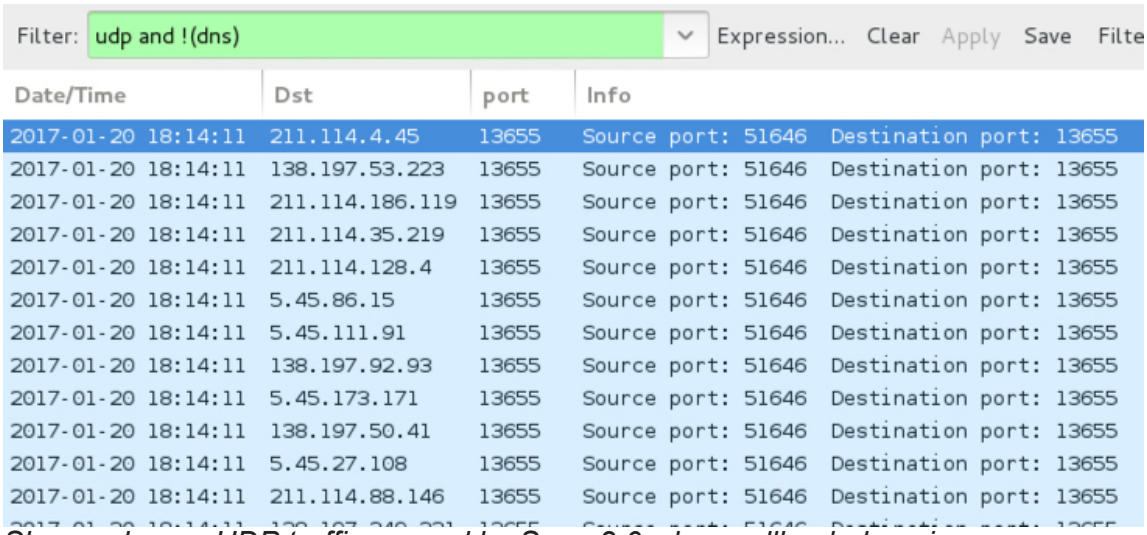
Shown above: TCP stream of an HTTP request for the post-infection traffic.

When the callback domains for Sage didn't resolve in DNS, the infected host sent UDP packets sent to over 7,000 IP addresses. I think this could be UDP-based peer-to-peer (P2P) traffic, and it appears to be somehow encoded or encrypted. BleepingComputer's September 2016 write-up on CryLocker shows the same type of UDP post-infection traffic, but CryLocker's traffic was not encrypted [4].

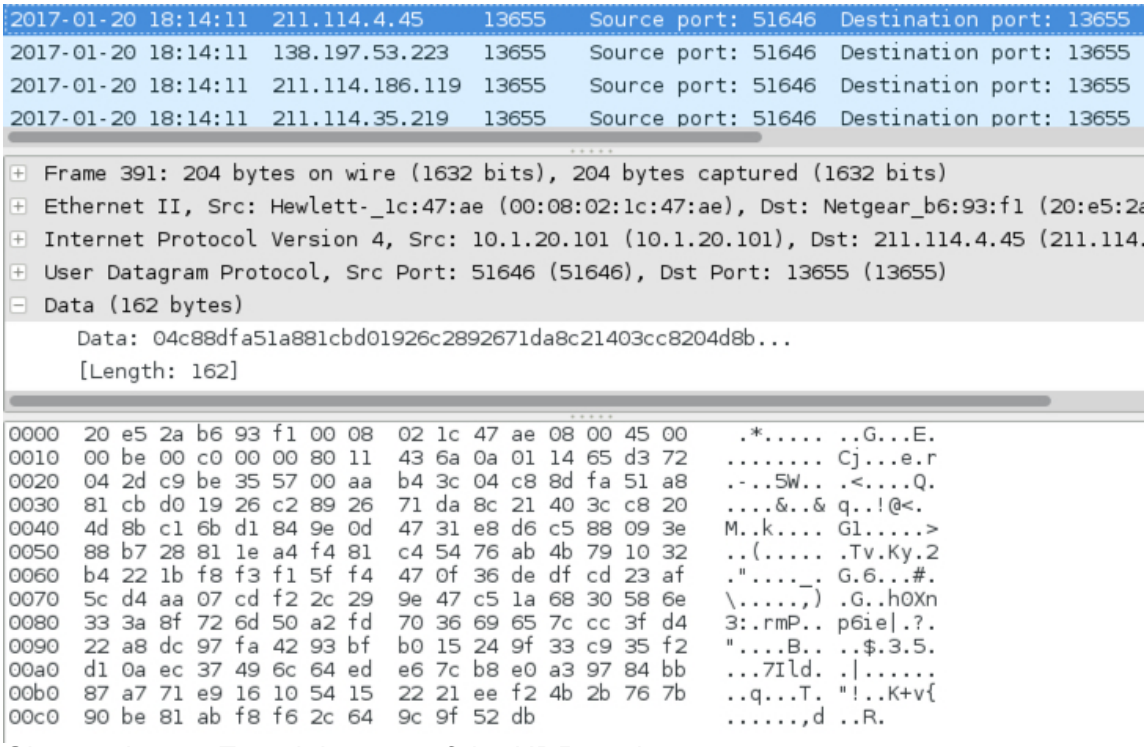
Filter: http.request or dns.qry.name — Expression... Clear Apply Save Filter Filter Filter

Date/Time	Dst	port	Host	Info
2017-01-20 18:13:09	84.200.34.99	80	fortycooola.top	GET /user.php?f=0.dat HTTP/1.1
2017-01-20 18:13:12	10.1.20.1	53		Standard query 0xced6 A mbfce24rgn65bx3g.er29sl.in
2017-01-20 18:13:13	10.1.20.1	53		Standard query 0xced6 A mbfce24rgn65bx3g.er29sl.in
2017-01-20 18:13:14	10.1.20.1	53		Standard query 0xced6 A mbfce24rgn65bx3g.er29sl.in
2017-01-20 18:13:17	10.1.20.1	53		Standard query 0xced6 A mbfce24rgn65bx3g.er29sl.in
2017-01-20 18:13:21	10.1.20.1	53		Standard query 0xced6 A mbfce24rgn65bx3g.er29sl.in
2017-01-20 18:13:25	10.1.20.1	53		Standard query 0x12a5 A mbfce24rgn65bx3g.er29sl.in
2017-01-20 18:13:26	10.1.20.1	53		Standard query 0x12a5 A mbfce24rgn65bx3g.er29sl.in
2017-01-20 18:13:27	10.1.20.1	53		Standard query 0x12a5 A mbfce24rgn65bx3g.er29sl.in
2017-01-20 18:13:29	10.1.20.1	53		Standard query 0x12a5 A mbfce24rgn65bx3g.er29sl.in
2017-01-20 18:13:33	10.1.20.1	53		Standard query 0x12a5 A mbfce24rgn65bx3g.er29sl.in
2017-01-20 18:13:36	10.1.20.101	54171		Standard query response 0x12a5 No such name
2017-01-20 18:13:36	10.1.20.101	65523		Standard query response 0xced6 No such name
2017-01-20 18:13:36	10.1.20.101	65523		Standard query response 0xced6 No such name
2017-01-20 18:13:36	10.1.20.101	65523		Standard query response 0xced6 No such name
2017-01-20 18:13:36	10.1.20.101	65523		Standard query response 0xced6 No such name
2017-01-20 18:13:36	10.1.20.1	53		Standard query 0xf48d A mbfce24rgn65bx3g.rzunt3u2.com
2017-01-20 18:13:36	10.1.20.101	54171		Standard query response 0x12a5 No such name

Shown above: An HTTP request for the Sage 2.0 binary, followed by callback domains not resolving in DNS.



Shown above: UDP traffic caused by Sage 2.0 when callback domains were unavailable.



Shown above: Examining one of the UDP packets.

Indicators of Compromise (IOCs)

Below are IOCs for Sage 2.0 from Friday 2017-01-20:

Ransomware downloads caused by Word document macros or .js files:

- 54.165.109.229 port 80 - ***smoeroota.top*** - GET /read.php?f=0.dat
- 54.165.109.229 port 80 - ***newfoodas.top*** - GET /read.php?f=0.dat
- 84.200.34.99 port 80 - ***fortycooola.top*** - GET /user.php?f=0.dat

Post-infection traffic:

- 54.146.39.22 port 80 - ***mbfce24rgn65bx3g.er29sl.in*** - POST /

- 66.23.246.239 port 80 - ***mbfce24rgn65bx3g.er29sl.in*** - POST /
- ***mbfce24rgn65bx3g.rzunt3u2.com*** (DNS queries did not resolve)
- Various IP addresses, UDP port 13655 - possible P2P traffic

Tor-based domains to view the decryption instructions:

- ***7gie6ffnkrjykggd.rzunt3u2.com***
- ***7gie6ffnkrjykggd.er29sl.in***
- ***7gie6ffnkrjykggd.onion***

SHA256 hashes for the Sage 2.0 ransomware samples:

- 0ecf3617c1d3313fdb41729c95215c4d2575b4b11666c1e9341f149d02405c05 (352,328 bytes)
- 362baeb80b854c201c4e7a1cfd3332fd58201e845f6aebe7def05ff0e00bf339 (352,328 bytes)
- 3b4e0460d4a5d876e7e64bb706f7fdbbc6934e2dea7fa06e34ce01de8b78934c (352,328 bytes)
- 8a0a191d055b4b4dd15c66bfb9df223b384abb75d4bb438594231788fb556bc2 (352,328 bytes)
- ccd6a495dfb2c5e26cd65e34c9569615428801e01fd89ead8d5ce1e70c680850 (352,328 bytes)

Examples of locations on the infected Windows host where Sage 2.0 was made persistent:

- C:\Users\[username]\AppData\Roaming\gNwO5YoE.exe
- C:\Users\[username]\AppData\Roaming\wiqpNWm7.exe
- NOTE: File names appear to consists 8 random alphabetic characters with an .exe suffix.

Final words

An important note: URLs for the ransomware download will send Cerber one day, but the same URLs can send something like Sage ransomware the next.

I'm not sure how widely-distributed Sage ransomware is. I've only seen it from this one malspam campaign, and I've only seen it one day so far. I'm also not sure how effective this particular campaign is. It seems these emails can easily be blocked, so few end users may have actually seen Sage 2.0.

Still, Sage is another name in the wide variety of existing ransomware families. This illustrates how profitable ransomware remains for cyber criminals.

Pcaps, emails, malware, and artifacts for this diary are available here.

Brad Duncan
brad [at] malware-traffic-analysis.net

References:

[1] https://www.bleepingcomputer.com/forums/t/634978/sage-file-sample-extension-sage/
[2] https://www.bleepingcomputer.com/forums/t/634747/sage-ransomware-sage-support-help-topic/

[3] https://www.pcrisk.com/removal-guides/10732-sage-ransomware
[4] https://www.bleepingcomputer.com/news/security/the-crylocker-ransomware-communicates-using-udp-and-stores-data-on-imgur-com/

Thread locked Subscribe	Jan 21st 2017 5 years ago
Thanks for sharing this, all the analysis is really good. Regards	Anonymous
Quote	Jan 23rd 2017 5 years ago
Hi, I am now investigating on this kind of Ransomware and it would be great if you could answer the following question: How are you able to differentiate the malspam campaigns and how are you able to say that this campaign normally distributes Cerber ransomware? The thing in this case is indeed an infection with Cerber at the first day, but executing it now, the payload for Sage 2.0 is downloaded and executed. The confusion in this thing is perfect because two different variants of Ransomware are distributed the same way ... Cheers	Anonymous
Quote	Jan 23rd 2017 5 years ago
Malspam campaigns are based on the characteristics of the traffic, URLs, emails, attachments, etc. I've been looking into this particular campaign since the beginning of the year. malware-traffic-analysis.net/2017/01/04/… malware-traffic-analysis.net/2017/01/05/… malware-traffic-analysis.net/2017/01/09/… malware-traffic-analysis.net/2017/01/13/… malware-traffic-analysis.net/2017/01/17/… malware-traffic-analysis.net/2017/01/18/… malware-traffic-analysis.net/2017/01/18/… Ultimately, ransomware is just another form of malware, and it can be distributed the same way any other malware is. This particular malspam campaign has a history of occasionally changing the ransomware sent from the URLs generated by those Word documents or JS file.	Brad  433 Posts ISC Handler
Quote	Jan 23rd 2017 5 years ago

Thank you for your reply. It is rather interesting in this case, because I recognized that the victim received on 29. November 2016, 18. January 2017 and 19. January 2017 eMails from the same sender containing the Downloader for Cerber. The first two times there was a Javascript file in it and the last time, when the victim actually opened the file (and got infected) it was a Word document. The problem is that we don't have any data to compare these campaigns. It is just possible investigating of the reports we have. Is there any open database or other resource we could compare and find out if it is the same campaign?

Anonymous

Quote

Jan 23rd 2017
5 years ago

Unfortunately, no I don't know of any databases. For what it's worth, if someone's email is publicly known (posted anywhere on the web), it'll get malspam from any number of campaigns.

This particular campaign that I'm tracking is not targeted, and it spreads a wide net. It's a botnet-based campaign from what I can tell, and it continues to spew massive amounts of malspam out on a daily basis. Once again, it's not targeting people. It's only using publicly-known email addresses that somehow get circulated on spammers' lists.

Sorry I can't be of more help.

Brad

433 Posts
ISC Handler

Quote

Jan 23rd 2017
5 years ago

Thank you, this is helping me to understand the structure a bit better (I am rather new to this topic). It is hard to learn about it if you just have a few reports and don't look behind the whole thing ;) That is the great thing about such blogs like this one or yours - getting a better overview!

Anonymous

Quote

Jan 24th 2017
5 years ago

I am currently under attack by this ransomware! So am I understanding that as of today the only option is, to pay the ransom so I can get my files back? I am not a computer specialist but have 5 that are computer specialists (all in different fields). They all seem to have different answers. How do I know who to go with, especially since my computer is on a time limit? $2,000 may not be a lot to some but it is to me, especially if I pay and it still doesn't work after. Anyone have any advice?

Thanks!
Cmlbalhll

Anonymous

Quote	Feb 3rd 2017 5 years ago
Hi, I understand you completely. Try to use the following methods described here. http://www.besttechtips.org/remove-sage-2-0-ransomware-and-decrypt-sage-files/	Anonymous
Quote	Feb 13th 2017 5 years ago
We got hit by Sage but managed to contain it. Out of three machines that were hit, only one was damaged, as the other two were running anti-ransomware technology with data protection & recovery (temasoft ranstop). Fortunately, the damaged machine shared important folders as mapped drives and those files were also protected by the anti-ransomware technology on the other two machines (actually I had two copies in the backup. But we lost the files on that machine that were not shared.	Anonymous
Quote	May 2nd 2017 5 years ago