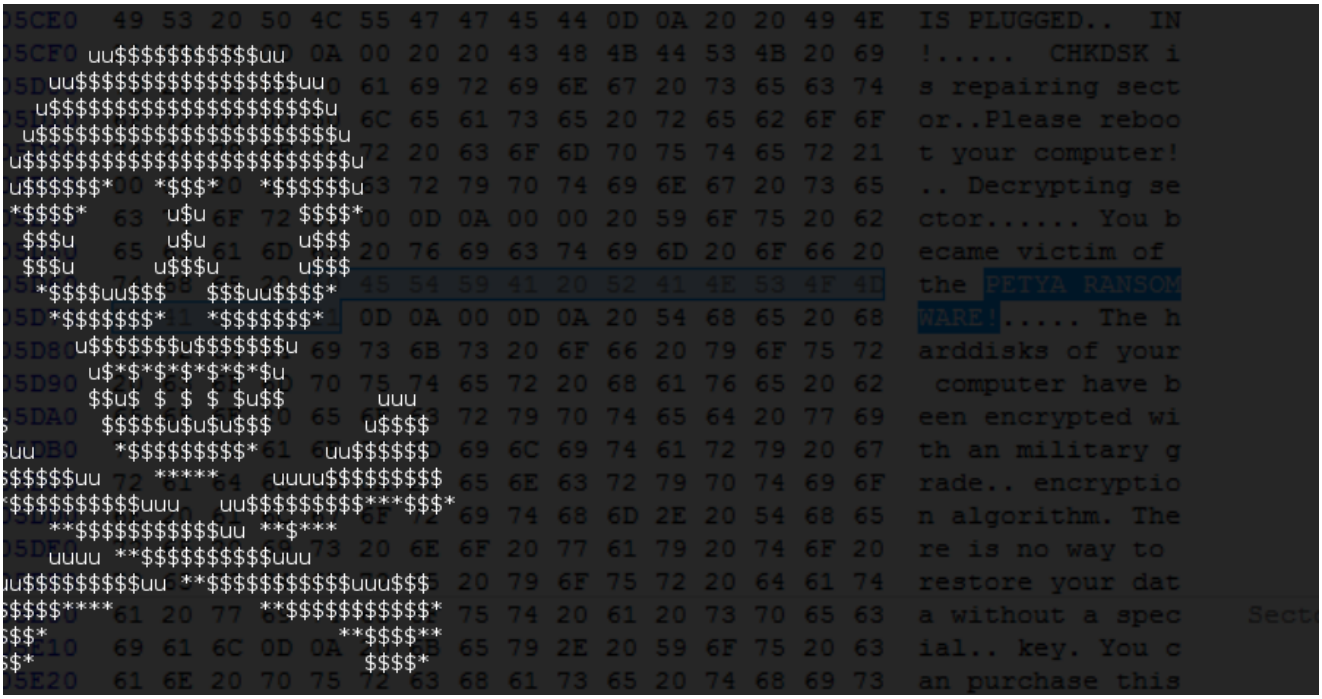
# Third time (un)lucky – improved Petya is out

blog.malwarebytes.com/threat-analysis/2016/07/third-time-unlucky-improved-petya-is-out/

Malwarebytes Labs July 18, 2016




So far we dedicated several articles to the interesting, low-level ransomware called Petya, hijacking the boot sector. You can read about it here:

- https://blog.malwarebytes.com/threat-analysis/2016/05/petya-and-mischa-ransomware-duet-p1/ – Green Petya (version 2)
- https://blog.malwarebytes.com/threat-analysis/2016/04/petya-ransomware/ – Red Petya (version 1)

Each of those versions was using Salsa20 algorithm to encrypt Master File Table and make disk inaccessible. However, due to the implementation bugs the intended algorithm was weakened – giving a chance to recover data.

Unfortunately, as always in such cases, it is just a matter of time when cybercriminals get their cryptography fixed. Petya's authors got it right at the third attempt. The currently launched wave of this ransomware finally seems to have the proper Salsa20.

*sample: c8623aaa00f82b941122edef3b1852e3*

## Behavioral analysis

Behavior of Petya didn't changed – we can see exactly the same UI like in the previous green edition:


## Inside

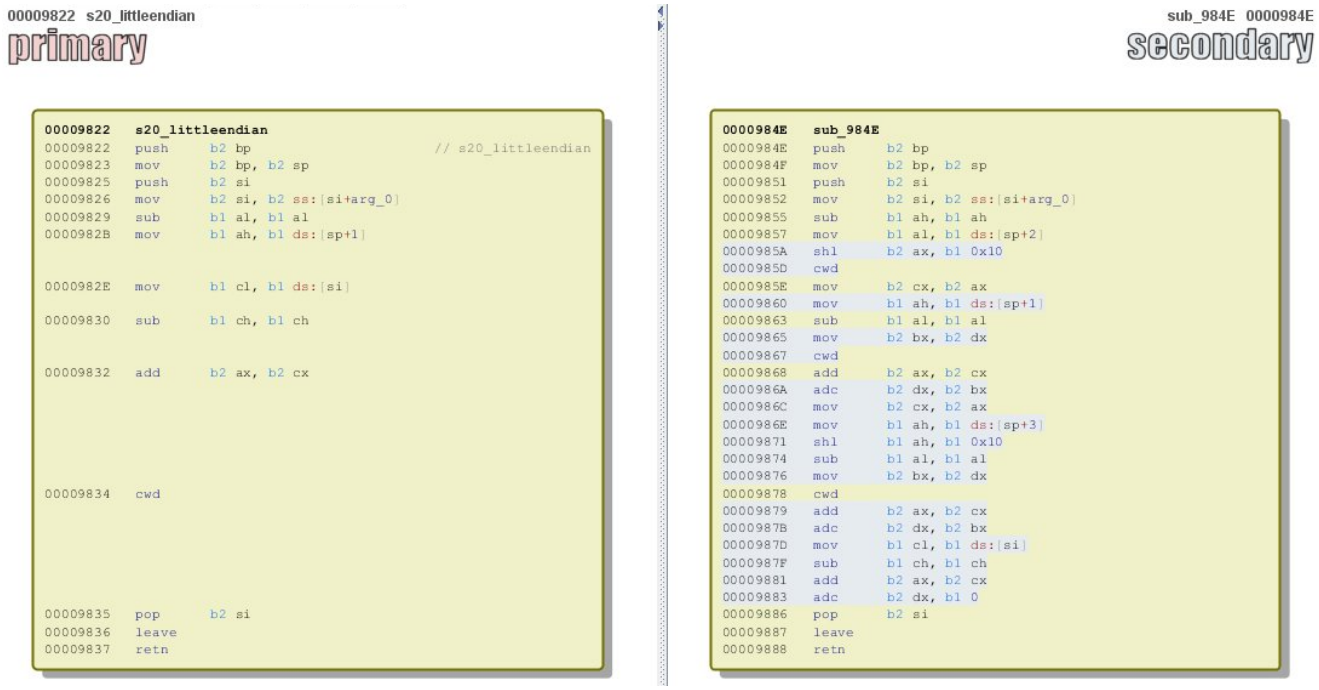
Let's take a look at differences in the code. Using BinDiff we can spot, that not many functions have changed. However, those that were giving weak points to the previous edition are modified.

| | | | | | | |
|---|---|---|---|---|---|---|
| 0.95 | 0.99 | G------ | 0000844E | check_key | 0000844E | check_key |
| 0.66 | 0.95 | -I--E-- | 00009822 | s20_littleendian | 0000984E | sub_984E_74 |
| 0.65 | 0.90 | -I--E-- | 00008AAC | reboot_disk | 00008ADA | sub_8ADA_51 |

### Salsa20

First of all, let's take a look the function **s20_littleendian** that was causing the major bug in the last release. Due to it's invalid implementation, only 8 out of 16 characters of the key were meaningful and brutforcing the key was easier (working solution has been implemented by procrash). Detailed explanation of this bug you can find in the updated post about the previous Petya – under the section "New Petya, new bug".

On the left – you can see the implementation of the buggy function (from the previous edition). On the right – current, fixed implementation:




### Explanation

The old implementation was truncated – it didn't used 32 bit values as it should – only added a sign bit expansion to the 16 bit value:

```
static int16_t s20_littleendian(uint8_t *b)
{
  return b[0] +
         (b[1] << 8);
}
```

Now, authors got the proper implementation, using 32 bits. So, the last bug in Salsa20 got finally fixed, making implementation complete.

## Key

In the first (red) version of Petya  authors used 32 byte long Salsa key – that was, however, generated from the 16 byte long key, using a custom function to pre-process it and extend.

In the second – green edition, they gave up this idea and applied the original 16 byte long key, without any modification.

This time, they changed mind and went back to the first solution of using 32 byte long key, yet with some improvements. Again we can see ***expand32*** in the code (instead of ***expand16*** known from the previous edition):

```
00009936 enter   16h, 0
0000993A push    di
0000993B push    si
0000993C mov     [bp+var_11], 78h ; 'x'
00009940 mov     [bp+var_10], 70h ; 'p'
00009944 mov     [bp+var_F], 61h ; 'a'
00009948 mov     [bp+var_E], 6Eh ; 'n'
0000994C mov     [bp+var_D], 64h ; 'd'
00009950 mov     [bp+var_B], 33h ; '3'
00009954 mov     [bp+var_A], 32h ; '2'
00009958 mov     [bp+var_9], 2Dh ; '-'
0000995C mov     [bp+var_8], 62h ; 'b'
00009960 mov     [bp+var_7], 79h ; 'y'
00009964 mov     [bp+var_6], 74h ; 't'
00009968 mov     al, 65h ; 'e'
0000996A mov     [bp+var_12], al
0000996D mov     [bp+var_5], al
00009970 mov     al, 20h ; ' '
00009972 mov     [bp+var_C], al
00009975 mov     [bp+var_4], al
00009978 mov     [bp+var_3], 6Bh ; 'k'
0000997C xor     di, di
```

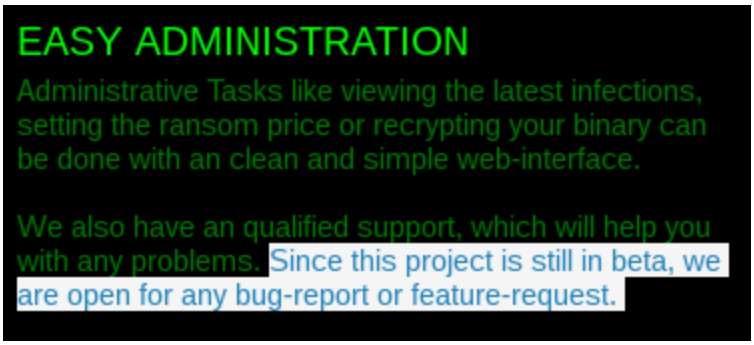
When the victim insert the key for the verification, before using it as a Salsa20 key, it is preprocessed by a new algorithm (more complex than  in case of Red Petya):

```
000084D8
000084D8 loc_84D8:
000084D8 push    0
000084DA push    16              ; size
000084DC lea     ax, [bp+initial_key]
000084DF push    ax
000084E0 lea     ax, [bp+modified_key]
000084E3 push    ax
000084E4 call    process_key
000084E7 add     sp, 8
000084EA mov     byte ptr [bp+counter+2], 0
```

```
000084EE
000084EE process_key_loop_top:
000084EE push    0
000084F0 push    32              ; size
000084F2 lea     ax, [bp+modified_key]
000084F5 push    ax
000084F6 push    ax              ; key_buffer
000084F7 call    process_key
000084FA add     sp, 8
000084FD inc     byte ptr [bp+counter+2]
00008500 cmp     byte ptr [bp+counter+2], 128
00008504 jb      short process_key_loop_top
```

## Conclusion

New edition shows that the project is reaching maturity – however, as we can read on the associated onion page – it is still a beta version and we can expect that it will keep evolving. Below – fragment of Petya's RaaS website:




We are not yet sure about the distribution method, but probability is high, that also this time it is spam with a link leading to cloud storage. We strongly advise to be extra vigilant for the job applications coming this days – it proven to be a common cover for Petya/Mischa dropper. More information about it you can find in our previous articles about Petya.

## Appendix

> Petya and Mischa – Ransomware Duet (Part 1)



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*This was a guest post written by Hasherezade, an independent researcher and programmer with a strong interest in InfoSec. She loves going in details about malware and sharing threat information with the community. Check her out on Twitter @hasherezade and her personal blog: https://hshrzd.wordpress.com.*