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Threat Report:
PonyFinal Ransomware

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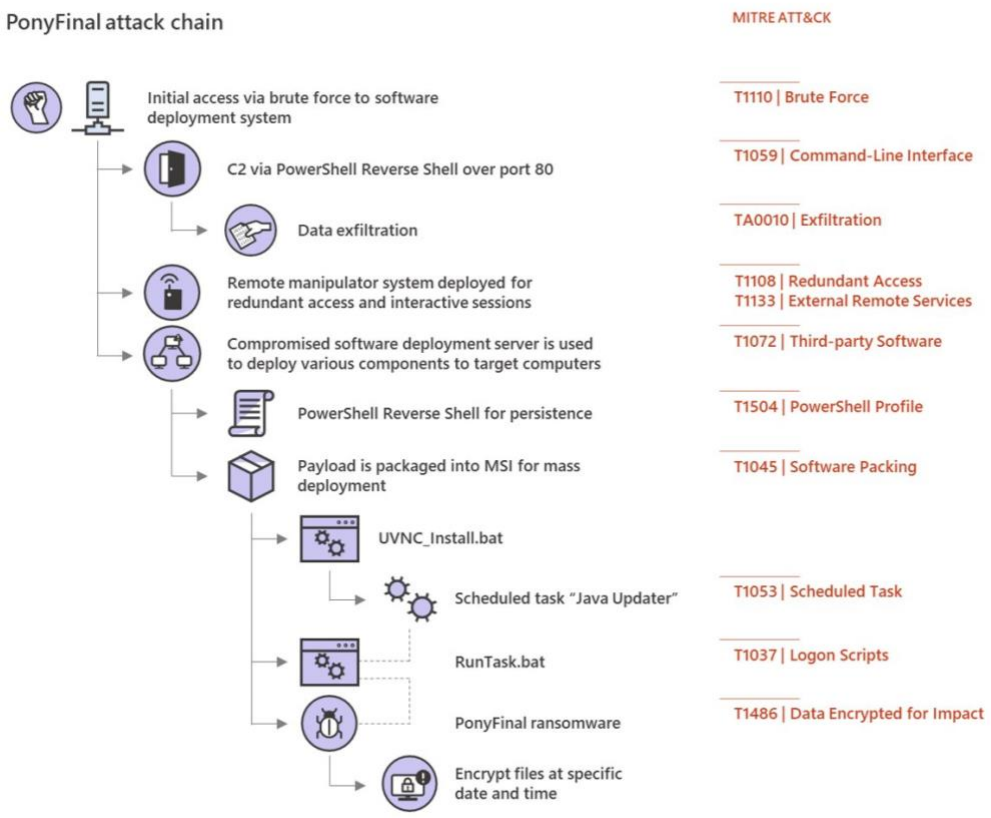
1 EXECUTIVE SUMMARY

On May 27, Microsoft's security team issued an advisory warning about PonyFinal, a Java-based ransomware that was developed to target large organizations. The attack chain of PonyFinal ransomware is described in Figure 1.

Figure 1 - PonyFinal Ransomware: Attack Chain

Source: Microsoft



Because of the variety of techniques PonyFinal ransomware uses, the growing number of PonyFinal attacks and the lack of more detailed available information, SecureMisr has analyzed it in detail. This research will improve our ability to detect and prevent this attack.

The obtained sample of PonyFinal ransomware uses different techniques including self-replication, persistence, and kill switch. Ponyfinal can also be classified as a logic bomb as it is programmed to start its encryption process at *2020-04-10 13:00:00*.

PonyFinal ransomware uses both symmetric and asymmetric encryption, which includes Advanced Encryption Standard (AES) and RSA algorithms. It is also worth noting that the malware authors use strong encryption configurations and keys to prevent brute-forcing. After being encrypted, the files will also be overwritten with randomly generated data, before being deleted. After encryption, the file name will be appended by the extension "*.enc*"

The variant of PonyFinal ransomware was built to target Adani Group, an Indian multinational conglomerate, headquartered in Ahmedabad, Gujarat. However, it can be used to target any other company. The attackers currently demand 300 bitcoins (within 72 hours) for the RSA private key.

As a final note, the sample itself does not delete the local backup on the victim's system, including, for example, the Volume Shadow Copy on Windows. Therefore, it is possible to restore the encrypted files from the local backup. However, there is no guarantee that other variants of PonyFinal will not delete the local backups.

2 ANALYSIS

2.1 Self-Replication and Persistence Mechanism

Malware authors often employ persistence mechanisms to be able to launch their malware across restarts. To achieve this, PonyFinal ransomware starts its execution by replicating itself to *%PUBLIC%\tmp.jar* and then dropping the file *%PUBLIC%\RunTask.bat* to setup persistence, as shown in Figure 2 and Figure 3. The file *RunTask.bat* will be scheduled to run when the computer starts.

Figure 2 - Persistence Setup

```
try {
    duplicate(new File(System.getProperty("java.class.path")), new File(System.getenv("PUBLIC") + "\\tmp.jar"));
    setup_persistence();
}
catch (IOException thrown) {
    Logger.getLogger(PonyFinal.class.getName()).log(Level.SEVERE, null, thrown);
}
```

Figure 3 - RunTask.bat

```
final File file = new File(System.getenv("PUBLIC") + "\\RunTask.bat");
final byte[] decode = Base64.getDecoder().decode("
    QEVDSE8gT0ZGDQpqYXZhdyAgLVhtczJnIC1YbXg1ZyAtamFyICVSZXBsYWNlJQ0K".getBytes(StandardCharsets.UTF_8));
final String replace = new String(decode).replace("%Replace%", System.getenv("PUBLIC") + "\\tmp.jar");
System.out.println(new String(replace));
try {
    if (!file.exists()) {
        file.createNewFile();
        final FileOutputStream fileOutputStream = new FileOutputStream(file);
        System.out.println(decode);
        fileOutputStream.write(replace.getBytes(StandardCharsets.UTF_8));
        fileOutputStream.close();
    }
}
catch (IOException ex) {
    ex.printStackTrace();
}
```

The content of the bat file is generated at run time by following the steps:

- Base64-decode the string "*QEVDSE8gT0ZGDQpqYXZhdyAgLVhtczJnIC1YbXg1ZyAtamFyICVSZXBsYWNlJQ0K*". The result is shown below:

```
@ECHO OFF
javaw  -Xms2g -Xmx5g -jar %Replace%
```

- Replace the sub-string "%Replace%" by the path to the replicated *tmp.jar* file.

2.2 Kill Switches

It is not uncommon to see malware authors use kill switches in their malware, as they can be used to stop the execution and hide the malicious behaviour from analysis if the malware detects that it is running in a sandbox. In some cases, malware authors also use a kill switch as a safety mechanism, which will prevent the malware from infecting the malware authors' systems.

PonyFinal ransomware contains kill switches that check for computer name or host name. If the names belong to a list of predefined names, it will terminate the execution. These checks happen after the ransomware establishes persistence on the victims' system. The related code is shown in

Figure 4.

Figure 4 - Kill Switches

```
final String computer_name = System.getenv("COMPUTERNAME");
final String host_name;
if ((host_name = System.getenv("HOSTNAME")) != null && is_excluded_name(host_name)) {
    System.exit(0);
}
if (computer_name != null && is_excluded_name(computer_name)) {
    System.exit(0);
}
```

The list of the predefined names include: *AUN-B0BHLH2, DT-0206-802RWQL, DT-0206-802RWQZ, DT-0105-J5PTH32, CSLAB3, DT-1301-6DCY7Q2, DT-1102-PGD8881, DT-0802-2ZPSDV2, DT-0105-5BZJ7BS, APMUL-FS, AUN-2Z4W7Y2, sapphireapp1, adsap*.

2.3 Predefined Launch Time

PonyFinal ransomware only encrypts files on the victims' system at, or after, a predefined launch time. As shown in Figure 5, the launch time was *2020-04-10 13:00:00*. Because of this behavior, Ponyfinal ransomware can also be classified as a Logic Bomb. This technique, when applied to ransomware, can help the infection remain stealthy before the launch and surprise its victims when all the systems are encrypted at once.

Figure 5 - Predefined Launch Time

```
System.out.println("Waiting until launchtime..");
try {
    Thread.sleep(5000L);
    while (true) {
        final Date date = new Date();
        final SimpleDateFormat simpleDateFormat;
        final Date parse = (simpleDateFormat = new SimpleDateFormat("yyyy-MM-dd HH:mm:ss")).parse("2020-04-10
            13:00:00");
        System.out.println(simpleDateFormat.format(date));
        if (date.after(parse)) {
            break;
        }
        Thread.sleep(300000L);
    }
}
catch (Exception ex) {
    ex.printStackTrace();
}
```

2.4 Encryption Mechanism and The Ransom Note

PonyFinal ransomware employs both symmetric and asymmetric encryption, which includes Advanced Encryption Standard (AES) and RSA algorithms. The AES encryption configurations include Cipher block chaining (CBC) for block cipher mode of operation, and PKCS5 for padding. Meanwhile, the RSA encryption configurations include Cipher block chaining (CBC) for block cipher mode of operation, and PKCS1 for padding.

If infected by PonyFinal ransomware, each file on the victim's machine will be encrypted with a pair of randomly generated AES keys and initialization vector. Each folder on the victim's machine will contains a "keys.enc" file, which stores AES keys and initialization vector (encrypted by a hard-coded RSA public key) to decrypt all files in that folder. Decryption processes require a private RSA key from the attacker(s) to decrypt the AES keys.

The structure of the "keys.enc" files is as follows:

- *<Full path to encrypted file>:<RSA encrypted data>* (multiple lines)

The <RSA encrypted data>, when decrypted, will have the following structure:

- *<Initialization vector>:<Base64-encoded key>*

After being encrypted, the files (See Figure 6) will also be deleted securely by overwriting them with randomly generated data before they're deleted. This action is done to prevent the victims from recovering the files, since the file contents are overwritten on the disk.

Figure 6 - Securely Delete File

```
if (file.exists()) {
    final long length = file.length();
    final SecureRandom secureRandom = new SecureRandom();
    final RandomAccessFile randomAccessFile;
    (randomAccessFile = new RandomAccessFile(file, "rws")).seek(0L);
    randomAccessFile.getFilePointer();
    final byte[] array = new byte[64];
    for (int n = 0; n < length; n += 64) {
        secureRandom.nextBytes(array);
        randomAccessFile.write(array);
    }
    randomAccessFile.close();
    file.delete();
}
```

It is also worth noting that the malware authors use strong encryption keys to prevent brute-forcing. The hard-coded public RSA key is 4096 bits in length, and its modulus is:

*8854954836021407729844923307699462804198469282658130154642560211514670400968358467497188308837416842351706954771950266359942589821215152162029791665841390987182041265571598451161999775924914828868320530124720772690150465193838604484887956402426335393246880462356896316521830843183163861480928893015183915084121935446776970025697388983435322336124911977050270430927810573628718070343858973590533023172916120264691173894954680504036168167191661206428107561392793613526968280512156365038677782514836662073174271002300181777893756768542288084173335912792245083191226740326348784854322136145429889344875699151070761818427011638521034788116895065553008462745469466551613548533659841118294621704391120394834439161167506091311606891532597469454831682010630437823255208096345802147732608355421142255867844889712275991501089022663270130035414334945224516250017840594395515088140507924547717224571455448332690353924469270785159099520694084292062864392744677814394030344867879630944062708581946189730218728935967913511215469908033889250333653551855740789396313854889542903437308479496688988789220928128977914723708826218512096540429325081839222388613221141479391632915792296503076975601376784802512879915306819885852318548861530679977160875654275, *

Its pubic exponent is *65537*. Finally, the randomly generated AES keys are 128 bits in length.

This variant of PonyFinal ransomware scans all files and folders on the victim's machine but only encrypts files with the following extensions:

php, .asp, .aspx, .config, .html, .ost, .pst, .doc, .dot, .wbk, .docx, .docm, .dotx, .dotm, .docb, .xls, .xlt, .xlm, .xlsx, .xlsm, .xltx, .xltm, .xlsb, .xla, .xlam, .xll, .xlw, .ppt, .pot, .pps, .900, .TSF, .001, .7z, .arj, .deb, .pkg, .rar, .rpm, .tar.gz, .z, .zip, .csv, .dat, .db, .dbf, .log, .mdb, .sav, .sql, .tar, .xml, .ai, .bmp, .gif, .ico, .jpeg, .jpg, .png, .ps, .psd, .svg, .tif, .tiff, .sql, .mp4, .7z, .rar, .m4a, .wma, .avi, .wmv, .csv, .d3dbsp, .zip, .sie, .sum, .ibank, .t13, .t12, .qdf, .gdb, .tax, .pkpass, .bc6, .bc7, .bkp, .qic, .bkf, .sidn, .sidd, .mddata, .itl, .itdb, .icxs, .hvpl, .hplg, .hkdb, .mdbackup, .syncdb, .gho, .cas, .svg, .map, .wmo, .itm, .sb, .fos, .mov, .vdf, .ztmp, .sis, .sid, .ncf, .menu, .layout, .dmp, .blob, .esm, .vcf, .vtf, .dazip, .fpk, .mlx, .kf, .iwd, .vpk, .tor, .psk, .rim, .w3x, .fsh, .ntl, .arch00, .lvl, .snx, .cfr, .ff, .vpp_pc, .lrf, .m2, .mcmeta, .vfs0, .mpqge, .kdb, .db0, .dba, .rofl, .hkx, .bar, .upk, .das, .iwi, .litemod, .asset, .forge, .ltx, .bsa, .apk, .re4, .sav, .lbf, .slm, .bik, .epk, .rgss3a, .pak, .big,wallet, .wotreplay, .xxx, .desc, .py, .m3u, .flv, .js, .css, .rb, .png, .jpeg, .txt, .p7c, .p7b, .p12, .pfx, .pem, .crt, .cer, .der, .x3f, .srw, .pef, .ptx, .r3d, .rw2, .rwl, .raw, .raf, .orf, .nrw, .mrwref, .mef, .erf, .kdc, .dcr, .cr2, .crw, .bay, .sr2, .srf, .arw, .3fr, .dng, .jpe, .jpg, .cdr, .indd, .ai, .eps, .pdf, .pdd, .psd, .dbf, .mdf, .wb2, .rtf, .wpd, .dxg, .xf, .dwg, .pst, .accdb, .mdb, .pptm, .pptx, .ppt, .xlk, .xlsb, .xlsm, .xlsx, .xls, .wps, .docm, .docx, .doc, .odb, .odc, .odm, .odp, .ods, .odt, .mp3, .mpa, .ogg, .wav, .wma, .wpl, .cda, .ldf

After encryption, the file name will be appended by the extension "*.enc*"

Similar to the “keys.enc” files, the ransom note is dropped in each folder to demand the ransom. The content of the ransom note is shown in Figure 7.

Figure 7 - Ransom Note

```
Dear ADANI GROUP,

All your important files were encrypted on all computers.
You can verify this by click on see files an try open them.

Encryption was produced using unique KEY generated for this computer.

To decrypted files, you need to obtain private key.
The single copy of the private key, with will allow you to decrypt the files, is locate on a secret server on the internet;
The server will destroy the key within 72 hours after encryption completed.
Pay us 300 BTC , and we will decode upto 3 sample files you send us via email for verification to prove we deliver master key,
send file sample to: thecurelegion@protonmail.com
Bitcoins have to be sent to this address: 3JKX3VWDPW7gvVaXFVv3UazY29pE2LGV7b

After you've sent the payment send us an email to : thecurelegion@protonmail.com with subject : Decryption of files

If you are    not familiar with bitcoin you can buy it from here :

SITE : www.localbitcoin.com

After we confirm the payment , we send the private key so you can decrypt your system.
```

The note above shows that this variant of was built to target Adani Group, an Indian multinational conglomerate, headquartered in Ahmedabad, Gujarat. The attackers demand 300 bitcoin for the RSA private key. As a final note, the sample itself does not delete the local backup on the victim’s system. For example, the Volume Shadow Copy on Windows. Therefore, it is possible to restore the encrypted files from the local backup.

2.5 IOCs

List of IOCs related to this miner has been provided on PonyFinal.

Figure 8 - IOCs List

IOC Type	IOC Value	Comments
MD5	e94b18674b8336461c12a2ed48541956	PonyFinal Ransomware
MD5	05b90b2c63743b26099668f97201cd52	RunTask.bat
MD5	1bc975c4e0504493433b6926c3edc5b4	Ransom note
File Name	keys.enc	Encrypted decryption keys
File Name	*.enc	Encrypted file
File Name	README_files.txt	Ransom note
Email Address	thecurelegion[@]protonmail[.]com	Attackers’ email address
Bitcoin Address	3JKX3VWDPW7gvVaXFVv3UazY29pE2LGV7b	Attackers’ Bitcoin address