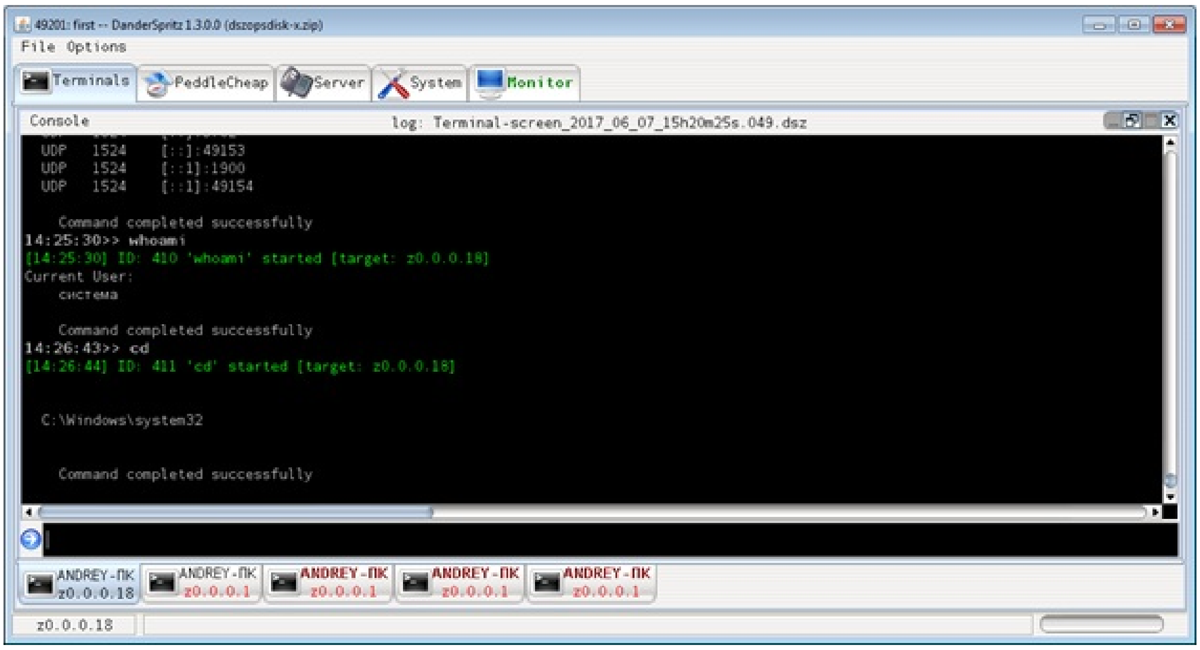
# DarkPulsar

securelist.com/darkpulsar/88199/

By Andrey Dolgushev , Dmitry Tarakanov , Vasily Berdnikov on October 19, 2018. 10:00 am

In March 2017, the ShadowBrokers published a chunk of stolen data that included two frameworks: DanderSpritz and FuzzBunch.

DanderSpritz consists entirely of plugins to gather intelligence, use exploits and examine already controlled machines. It is written in Java and provides a graphical windows interface similar to botnets administrative panels as well as a Metasploit-like console interface. It also includes its own backdoors and plugins for not-FuzzBunch-controlled victims.



```
  UDP   1524    [::]:49153
  UDP   1524    [::1]:1900
  UDP   1524    [::1]:49154

    Command completed successfully
14:25:30>> whoami
[14:25:30] ID: 410 'whoami' started [target: z0.0.0.18]
Current User:
    система

    Command completed successfully
14:26:43>> cd
[14:26:44] ID: 411 'cd' started [target: z0.0.0.18]


  C:\Windows\system32


    Command completed successfully
```

*DanderSprit interface*

Fuzzbunch on the other hand provides a framework for different utilities to interact and work together. It contains various types of plugins designed to analyze victims, exploit vulnerabilities, schedule tasks, etc. There are three files in the plugin set from the FuzzBunch framework:

%pluginName%-version.fb

This is the utility file of the framework. It duplicates the header from XML and includes the plugin's ID.

%pluginName%-version.exe

This executable file is launched when FuZZbuNch receives the command to do so.

%pluginName%-version.xml

This configuration file describes the plugin's input and output parameters – the parameter name, its type and description of what it's responsible for; all of these can be shown in FuzzBunch as a prompt. This file also contributes a lot to the framework's usability, as it supports the specification of default parameters.

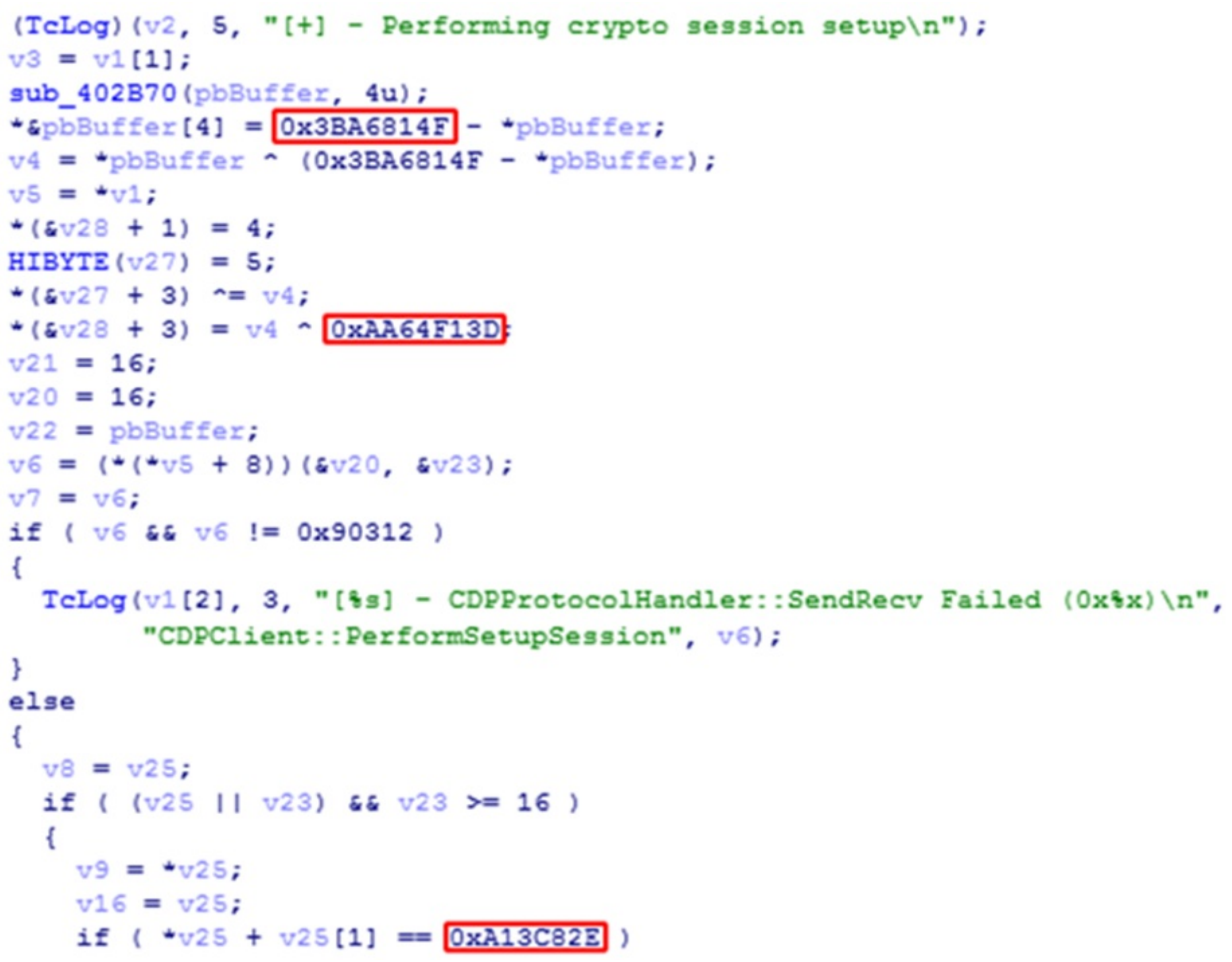
One of the most interesting Fuzzbunch's categories is called ImplantConfig and includes plugins designed to control the infected machines via an implant at the post-exploitation stage. **DarkPulsar** is a very interesting administrative module for controlling a passive backdoor named 'sipauth32.tsp' that provides remote control, belonging to this category.

It supports the following commands:

- Burn
- RawShellcode
- EDFStagedUpload
- DisableSecurity
- EnableSecurity
- UpgradeImplant
- PingPong

*Burn, RawShellcode, UpgradeImplant,* and *PingPong* remove the implant, run arbitrary code, upgrade the implant and check if the backdoor is installed on a remote machine, respectively. The purpose of the other commands is not that obvious and, to make it worse, the leaked framework contained only the administrative module to work with DarkPulsar's backdoor, but not the backdoor itself.

While analyzing the administrative module, we noticed several constants that are used to encrypt the traffic between the C&C and the implant:



```
(TcLog)(v2, 5, "[+] - Performing crypto session setup\n");
v3 = v1[1];
sub_402B70(pbBuffer, 4u);
*&pbBuffer[4] = 0x3BA6814F - *pbBuffer;
v4 = *pbBuffer ^ (0x3BA6814F - *pbBuffer);
v5 = *v1;
*(&v28 + 1) = 4;
HIBYTE(v27) = 5;
*(&v27 + 3) ^= v4;
*(&v28 + 3) = v4 ^ 0xAA64F13D;
v21 = 16;
v20 = 16;
v22 = pbBuffer;
v6 = (*(*v5 + 8))(&v20, &v23);
v7 = v6;
if ( v6 && v6 != 0x90312 )
{
  TcLog(v1[2], 3, "[%s] - CDPProtocolHandler::SendRecv Failed (0x%x)\n",
        "CDPClient::PerformSetupSession", v6);
}
else
{
  v8 = v25;
  if ( (v25 || v23) && v23 >= 16 )
  {
    v9 = *v25;
    v16 = v25;
    if ( *v25 + v25[1] == 0xA13C82E )
```

We thought that probably these constants should also appear in the backdoor, so we created a detection for them. Several months later we found our mysterious DarkPulsar backdoor. We later were able to find both 32- and 64-bit versions.

We found around 50 victims located in Russia, Iran and Egypt, typically infecting Windows 2003/2008 Server. Targets were related to nuclear energy, telecommunications, IT, aerospace and R&D.

## DarkPulsar technical highlights

The DarkPulsar implant is a dynamic library whose payload is implemented in exported functions. These functions can be grouped as follows:

1. Two nameless functions used to install the backdoor in the system.
2. Functions with names related to TSPI (Telephony Service Provider Interface) operations that ensure the backdoor is in the autorun list and launched automatically.
3. A function with a name related to SSPI (Security Support Provider Interface) operations. It implements the main malicious payload.

The implementations of the SSPI and TSPI interfaces are minimalistic: the functions that are exported by DarkPulsar have the same names as the interface functions; however, they include malicious code instead of the phone service.

The implant is installed in the system by the nameless exported function. The backdoor is launched by calling Secur32.AddSecurityPackage with administrator privileges with the

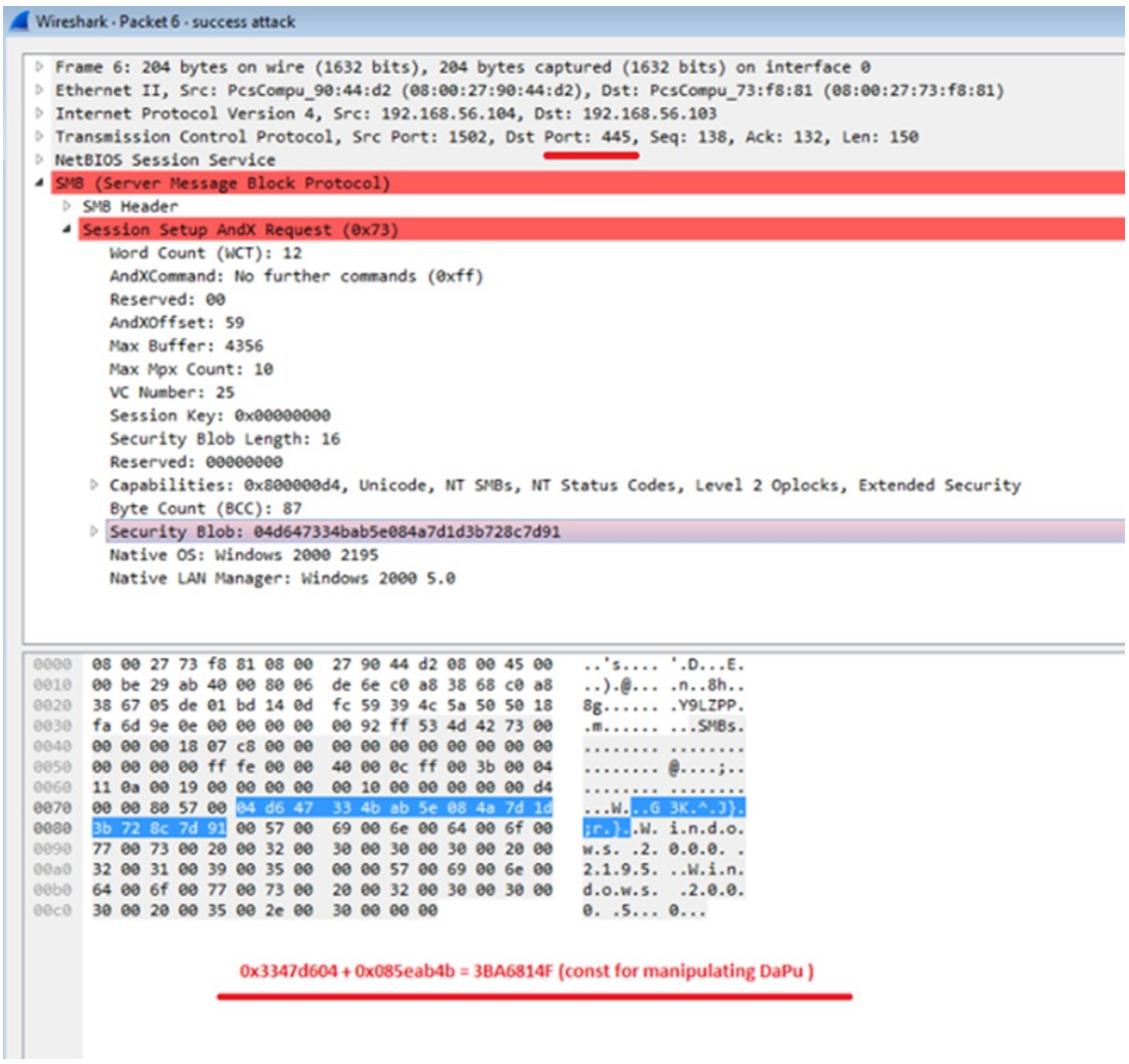
path to its own library in the parameter, causing lsass.exe to load DarkPulsar as SSP/AP and to call its exported function *SpLsaModeInitialize* used by DarkPulsar to initialize the backdoor. In this way AddSecurityPackage is used to inject code into lsass.exe. It also adds its library name at
HKLM\Software\Microsoft\Windows\CurrentVersion\Telephony\Providers

This is loaded at start by the Telephony API (TapiSrv) launched alongside the Remote Access Connection Manager (RasMan) service, setting startup type as “Automatic”. When loading the telephony service provider’s library, TapiSrv calls *TSPI_lineNegotiateTSPIVersion* which contains the AddSecurityPackage call to make the inject into lsass.exe.

DarkPulsar implements its payload by installing hooks for the SpAcceptLsaModeContext – function responsible for authentication. Such injects are made in several system authentication packets within the process lsass.exe and allow Darkpulsar to control authentication process based on the following protocols:

- Msv1_0.dll – for the NTLM protocol,
- Kerberos.dll – for the Kerberos protocol,
- Schannel.dll – for the TLS/SSL protocols,
- Wdigest.dll – for the Digest protocol, and
- Lsasrv.dll –for the Negotiate protocol.

After this, Darkpulsar gets ability to embed malware traffic into system protocols. Since this network activity takes place according to standard system charts, it will only be reflected in the System process – it uses the system ports reserved for the above protocols without hindering their normal operation.



```
Frame 6: 204 bytes on wire (1632 bits), 204 bytes captured (1632 bits) on interface 0
Ethernet II, Src: PcsCompu_90:44:d2 (08:00:27:90:44:d2), Dst: PcsCompu_73:f8:81 (08:00:27:73:f8:81)
Internet Protocol Version 4, Src: 192.168.56.104, Dst: 192.168.56.103
Transmission Control Protocol, Src Port: 1502, Dst Port: 445, Seq: 138, Ack: 132, Len: 150
NetBIOS Session Service
SMB (Server Message Block Protocol)
  SMB Header
  Session Setup AndX Request (0x73)
      Word Count (WCT): 12
      AndXCommand: No further commands (0xff)
      Reserved: 00
      AndXOffset: 59
      Max Buffer: 4356
      Max Mpx Count: 10
      VC Number: 25
      Session Key: 0x00000000
      Security Blob Length: 16
      Reserved: 00000000
    Capabilities: 0x800000d4, Unicode, NT SMBs, NT Status Codes, Level 2 Oplocks, Extended Security
      Byte Count (BCC): 87
    Security Blob: 04d647334bab5e084a7d1d3b728c7d91
      Native OS: Windows 2000 2195
      Native LAN Manager: Windows 2000 5.0

0000  08 00 27 73 f8 81 08 00  27 90 44 d2 08 00 45 00   ..'s.... '.D...E.
0010  00 be 29 ab 40 00 80 06  de 6e c0 a8 38 68 c0 a8   ..).@... .n..8h..
0020  38 67 05 de 01 bd 14 0d  fc 59 39 4c 5a 50 50 18   8g...... .Y9LZPP.
0030  fa 6d 9e 0e 00 00 00 00  00 92 ff 53 4d 42 73 00   .m...... ...SMBs.
0040  00 00 00 18 07 c8 00 00  00 00 00 00 00 00 00 00   ........ ........
0050  00 00 00 00 ff fe 00 00  40 00 0c ff 00 3b 00 04   ........ @....;..
0060  11 0a 00 19 00 00 00 00  00 10 00 00 00 00 00 d4   ........ ........
0070  00 00 80 57 00 04 d6 47  33 4b ab 5e 08 4a 7d 1d   ...W...G 3K.^.J}.
0080  3b 72 8c 7d 91 00 57 00  69 00 6e 00 64 00 6f 00   ;r.}..W. i.n.d.o.
0090  77 00 73 00 20 00 32 00  30 00 30 00 30 00 20 00   w.s. .2. 0.0.0. .
00a0  32 00 31 00 39 00 35 00  00 00 57 00 69 00 6e 00   2.1.9.5. ..W.i.n.
00b0  64 00 6f 00 77 00 73 00  20 00 32 00 30 00 30 00   d.o.w.s.  .2.0.0.
00c0  30 00 20 00 35 00 2e 00  30 00 00 00               0. .5... 0...
```

0x3347d604 + 0x085eab4b = 3BA6814F (const for manipulating DaPu )

*Network traffic during successful connection to DarkPulsar implant*

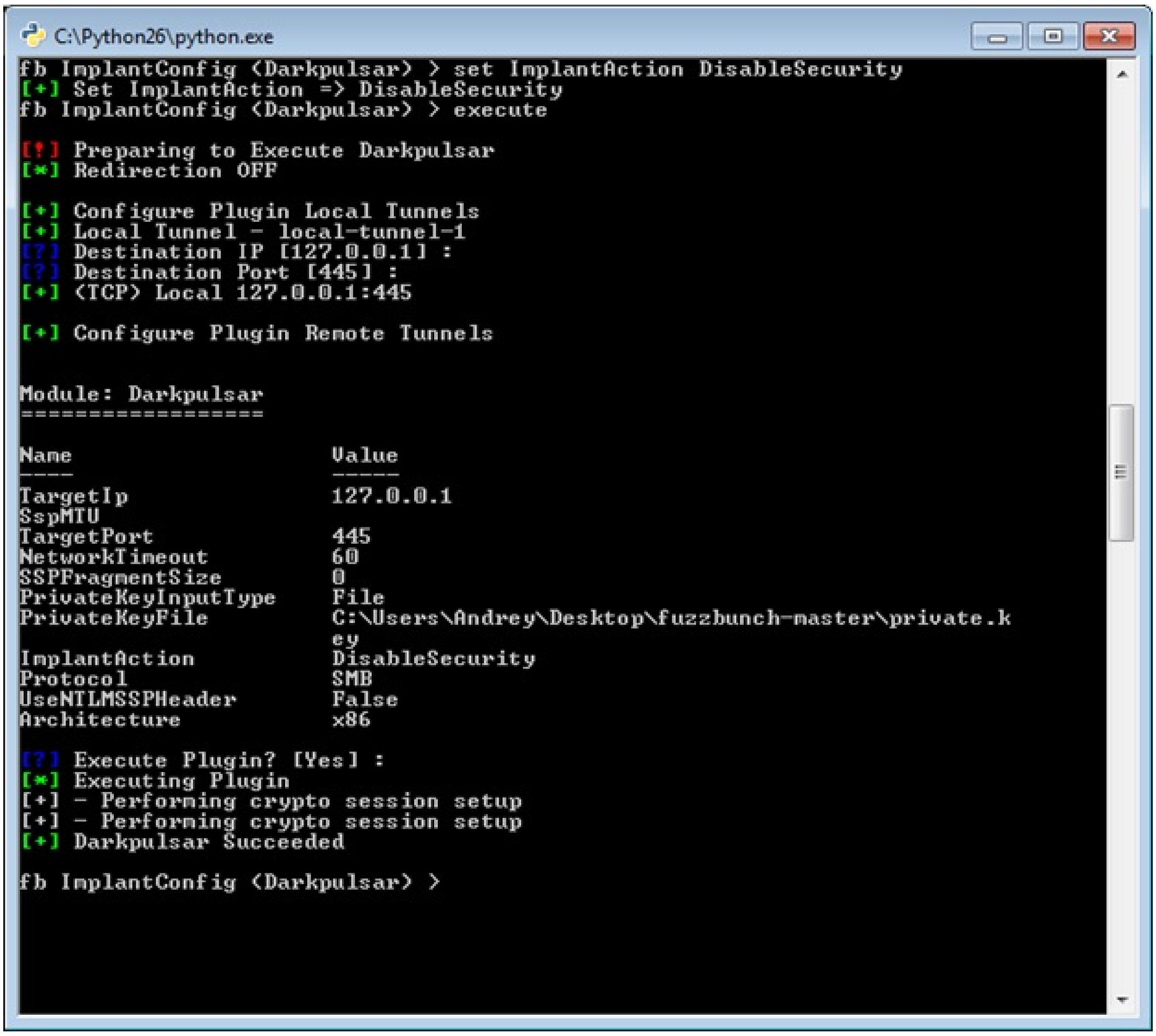
The second advantage of controlling authentication processes is ability to bypass entering a valid username and password for obtaining access to objects that require authentication such as processes list, remote registry, file system through SMB. After Darkpulsar's DisableSecurity command is sent, backdoor's hooks on the victim side will always returns in the SpAcceptLsaModeContext function that passed credentials are valid. Getting that, system will provide access to protected objects to client.

## Working with DarkPulsar

Darkpulsar-1.1.0.exe is the administrative interface working under the principle of "one command – one launch". The command to be executed must be specified either in the configuration file Darkpulsar-1.1.0.9.xml or as command line arguments, detailing at least:

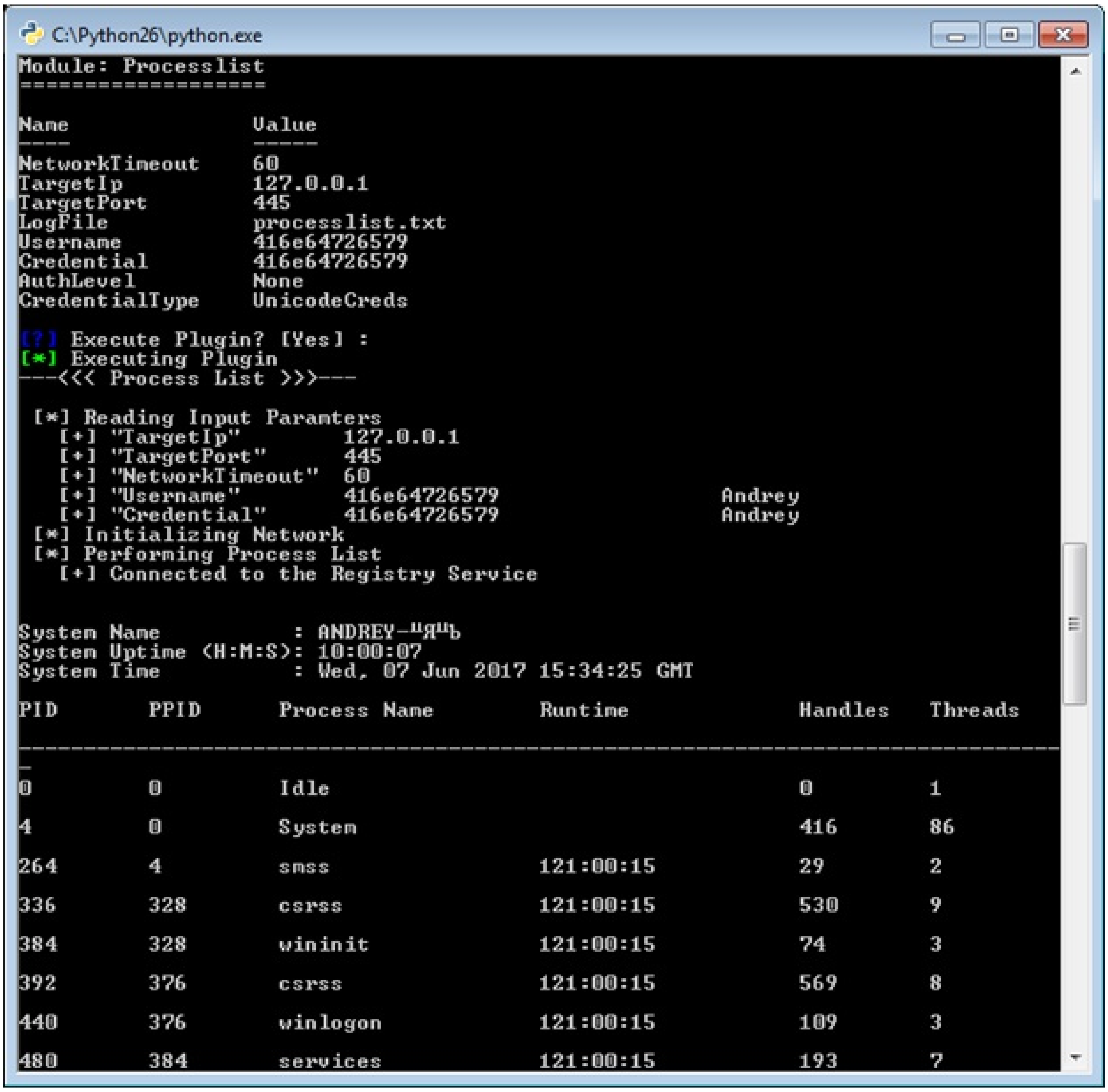
- whether the target machine uses a 32-bit or 64-bit system;
- protocol (SMB, NBT, SSL, RDP protocols are supported) to deliver the command and port number
- private RSA key to decrypt the session AES key

Darkpulsar-1.1.0 was not designed as a standalone program for managing infected machines. This utility is a plugin of the Fuzzbunch framework that can manage parameters and coordinate different components. Here is how DisableSecurity command in Fuzzbunch looks like:



```
fb ImplantConfig (Darkpulsar) > set ImplantAction DisableSecurity
[+] Set ImplantAction => DisableSecurity
fb ImplantConfig (Darkpulsar) > execute

[!] Preparing to Execute Darkpulsar
[*] Redirection OFF

[+] Configure Plugin Local Tunnels
[+] Local Tunnel - local-tunnel-1
[?] Destination IP [127.0.0.1] :
[?] Destination Port [445] :
[+] (TCP) Local 127.0.0.1:445

[+] Configure Plugin Remote Tunnels


Module: Darkpulsar
==================

Name                      Value
----                      -----
TargetIp                  127.0.0.1
SspMTU
TargetPort                445
NetworkTimeout            60
SSPFragmentSize           0
PrivateKeyInputType       File
PrivateKeyFile            C:\Users\Andrey\Desktop\fuzzbunch-master\private.k
                          ey
ImplantAction             DisableSecurity
Protocol                  SMB
UseNTLMSSPHeader          False
Architecture              x86

[?] Execute Plugin? [Yes] :
[*] Executing Plugin
[+] - Performing crypto session setup
[+] - Performing crypto session setup
[+] Darkpulsar Succeeded

fb ImplantConfig (Darkpulsar) >
```

Below is an example of Processlist after DisableSecurity, allowing to execute any plugin without valid credentials and operating via regular system functions (remote registry service):



```
Module: Processlist
===================

Name                Value
----                -----
NetworkTimeout      60
TargetIp            127.0.0.1
TargetPort          445
LogFile             processlist.txt
Username            416e64726579
Credential          416e64726579
AuthLevel           None
CredentialType      UnicodeCreds

[?] Execute Plugin? [Yes] :
[*] Executing Plugin
---<<< Process List >>>---

 [*] Reading Input Paranters
   [+] "TargetIp"        127.0.0.1
   [+] "TargetPort"      445
   [+] "NetworkTimeout"  60
   [+] "Username"        416e64726579                   Andrey
   [+] "Credential"      416e64726579                   Andrey
 [*] Initializing Network
 [*] Performing Process List
   [+] Connected to the Registry Service


System Name          : ANDREY-ЧЯЧЬ
System Uptime (H:M:S): 10:00:07
System Time          : Wed, 07 Jun 2017 15:34:25 GMT

PID       PPID      Process Name        Runtime             Handles   Threads

--------------------------------------------------------------------------------
-
0         0         Idle                                    0         1

4         0         System                                  416       86

264       4         smss                121:00:15           29        2

336       328       csrss               121:00:15           530       9

384       328       wininit             121:00:15           74        3

392       376       csrss               121:00:15           569       8

440       376       winlogon            121:00:15           109       3

480       384       services            121:00:15           193       7
```

## DanderSpritz

DanderSpritz is the framework for controlling infected machines, different from FuZZbuNch as the latter provides a limited toolkit for the post-exploitation stage with specific functions such as DisableSecurity and EnableSecurity for DarkPulsar.

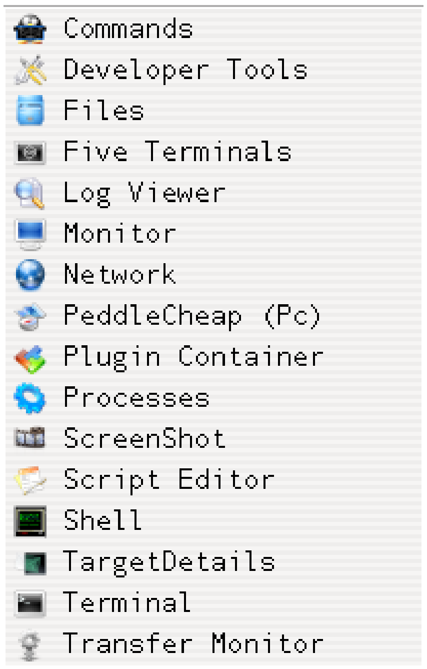
For DanderSpritz works for a larger range of backdoors, using PeedleCheap in the victim to enable operators launching plugins. PeddleCheap is a plugin of DanderSpritz which can be used to configure implants and connect to infected machines. Once a connection is established all DanderSpritz post-exploitation features become available.

This is how DarkPulsar in EDFStagedUpload mode provides the opportunity to infect the victim with a more functional implant: PCDllLauncher (Fuzzbunch's plugin) deploys the PeddleCheap implant on the victim side, and DanderSpritz provides a user-friendly post-exploitation interface. Hence, the full name of PCDllLauncher is 'PeddleCheap DLL Launcher'.

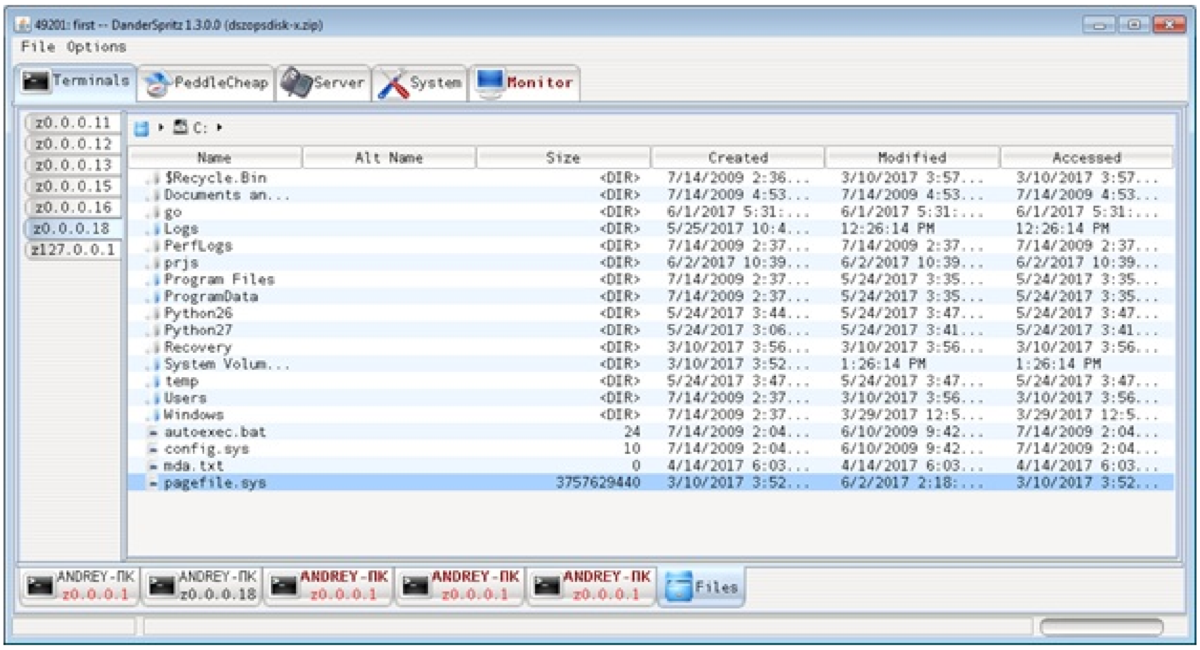
The complete DanderSpritz usage scheme with the plugin PeddleCheap via FuZZbuNch with the plugins DarkPulsar and PCDllLauncher consists of four steps:

- Via FuZZbuNch, run command EDFStagedUpload to launch DarkPulsar.
- In DanderSpritz, run command pc_prep (PeedelCheap Preparation) to prepare the payload and the library to be launched on the implant side.
- In DanderSpritz, run command pc_old (which is the alias of command pc_listen -reuse -nolisten -key Default) – this sets it to wait for a socket from Pcdlllauncher.
- Launch Pcdlllauncher via FuZZbuNch and specify the path to the payload that has been prepared with the command pc_prep in the ImplantFilename parameter.

/ol>



*DanderSpritz*



| Name | Alt Name | Size | Created | Modified | Accessed |
|---|---|---|---|---|---|
| $Recycle.Bin | | <DIR> | 7/14/2009 2:36... | 3/10/2017 3:57... | 3/10/2017 3:57... |
| Documents an... | | <DIR> | 7/14/2009 4:53... | 7/14/2009 4:53... | 7/14/2009 4:53... |
| go | | <DIR> | 6/1/2017 5:31:... | 6/1/2017 5:31:... | 6/1/2017 5:31:... |
| Logs | | <DIR> | 5/25/2017 10:4... | 12:26:14 PM | 12:26:14 PM |
| PerfLogs | | <DIR> | 7/14/2009 2:37... | 7/14/2009 2:37... | 7/14/2009 2:37... |
| prjs | | <DIR> | 6/2/2017 10:39... | 6/2/2017 10:39... | 6/2/2017 10:39... |
| Program Files | | <DIR> | 7/14/2009 2:37... | 5/24/2017 3:35... | 5/24/2017 3:35... |
| ProgramData | | <DIR> | 7/14/2009 2:37... | 5/24/2017 3:35... | 5/24/2017 3:35... |
| Python26 | | <DIR> | 5/24/2017 3:44... | 5/24/2017 3:47... | 5/24/2017 3:47... |
| Python27 | | <DIR> | 5/24/2017 3:06... | 5/24/2017 3:41... | 5/24/2017 3:41... |
| Recovery | | <DIR> | 3/10/2017 3:56... | 3/10/2017 3:56... | 3/10/2017 3:56... |
| System Volum... | | <DIR> | 3/10/2017 3:52... | 1:26:14 PM | 1:26:14 PM |
| temp | | <DIR> | 5/24/2017 3:47... | 5/24/2017 3:47... | 5/24/2017 3:47... |
| Users | | <DIR> | 7/14/2009 2:37... | 3/10/2017 3:56... | 3/10/2017 3:56... |
| Windows | | <DIR> | 7/14/2009 2:37... | 3/29/2017 12:5... | 3/29/2017 12:5... |
| autoexec.bat | | 24 | 7/14/2009 2:04... | 6/10/2009 9:42... | 7/14/2009 2:04... |
| config.sys | | 10 | 7/14/2009 2:04... | 6/10/2009 9:42... | 7/14/2009 2:04... |
| mda.txt | | 0 | 4/14/2017 6:03... | 4/14/2017 6:03... | 4/14/2017 6:03... |
| pagefile.sys | | 3757629440 | 3/10/2017 3:52... | 6/2/2017 2:18:... | 3/10/2017 3:52... |

*File System plugin*

## Conclusions

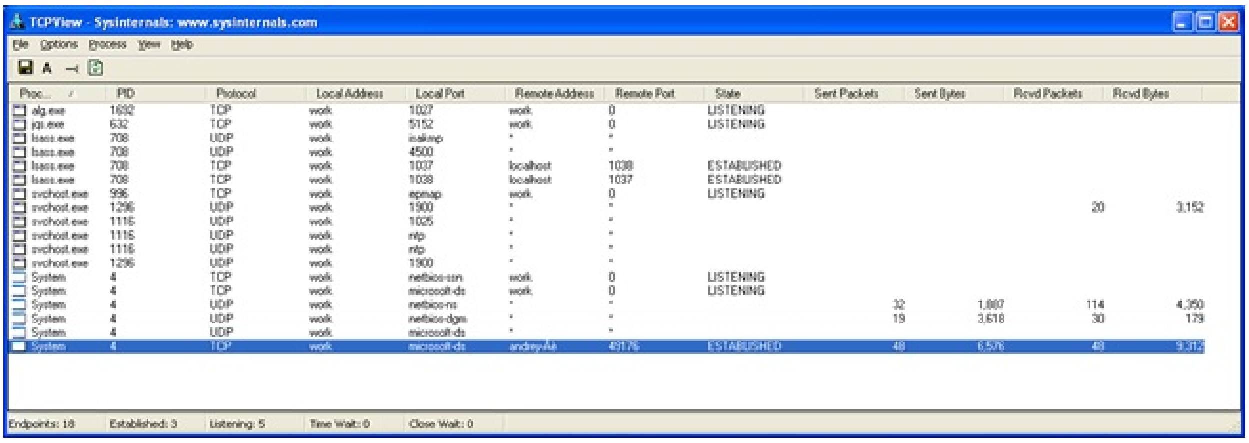
The FuzzBunch and DanderSpritz frameworks are designed to be flexible and to extend functionality and compatibility with other tools. Each of them consists of a set of plugins designed for different tasks: while FuzzBunch plugins are responsible for reconnaissance and attacking a victim, plugins in the DanderSpritz framework are developed for managing already infected victims.

The discovery of the DarkPulsar backdoor helped in understanding its role as a bridge between the two leaked frameworks, and how they are part of the same attacking platform designed for long-term compromise, based on DarkPulsar's advanced abilities for persistence and stealthiness. The implementation of these capabilities, such as encapsulating its traffic into legitimate protocols and bypassing entering credentials to pass authentication, are highly professional.

Our product can completely remove the related to this attack malware.

## Detecting malicious network activity

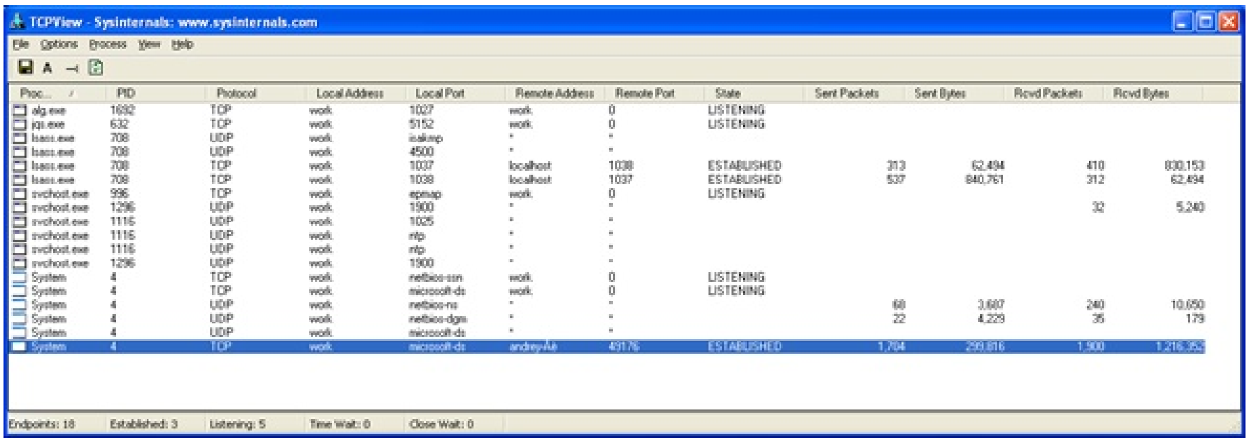
When EDFStagedUpload is executed in an infected machine, a permanent connection is established, which is why traffic via port 445 appears. A pair of bound sockets also appears in lsass.exe:


TCPView - Sysinternals: www.sysinternals.com

| Proc... | PID | Protocol | Local Address | Local Port | Remote Address | Remote Port | State | Sent Packets | Sent Bytes | Rcvd Packets | Rcvd Bytes |
|---|---|---|---|---|---|---|---|---|---|---|---|
| alg.exe | 1692 | TCP | work | 1027 | work | 0 | LISTENING | | | | |
| jqs.exe | 632 | TCP | work | 5152 | work | 0 | LISTENING | | | | |
| lsass.exe | 708 | UDP | work | isakmp | * | * | | | | | |
| lsass.exe | 708 | UDP | work | 4500 | * | * | | | | | |
| lsass.exe | 708 | TCP | work | 1037 | localhost | 1038 | ESTABLISHED | | | | |
| lsass.exe | 708 | TCP | work | 1038 | localhost | 1037 | ESTABLISHED | | | | |
| svchost.exe | 996 | TCP | work | epmap | work | 0 | LISTENING | | | | |
| svchost.exe | 1296 | UDP | work | 1900 | * | * | | | | 20 | 3,152 |
| svchost.exe | 1116 | UDP | work | 1025 | * | * | | | | | |
| svchost.exe | 1116 | UDP | work | ntp | * | * | | | | | |
| svchost.exe | 1116 | UDP | work | ntp | * | * | | | | | |
| svchost.exe | 1296 | UDP | work | 1900 | * | * | | | | | |
| System | 4 | TCP | work | netbios-ssn | work | 0 | LISTENING | | | | |
| System | 4 | TCP | work | microsoft-ds | work | 0 | LISTENING | | | | |
| System | 4 | UDP | work | netbios-ns | * | * | | 32 | 1,807 | 114 | 4,350 |
| System | 4 | UDP | work | netbios-dgm | * | * | | 19 | 3,618 | 30 | 179 |
| System | 4 | UDP | work | microsoft-ds | * | * | | | | | |
| System | 4 | TCP | work | microsoft-ds | andrey-Ae | 49176 | ESTABLISHED | 48 | 6,576 | 48 | 9,312 |

Endpoints: 18 Established: 3 Listening: 5 Time Wait: 0 Close Wait: 0

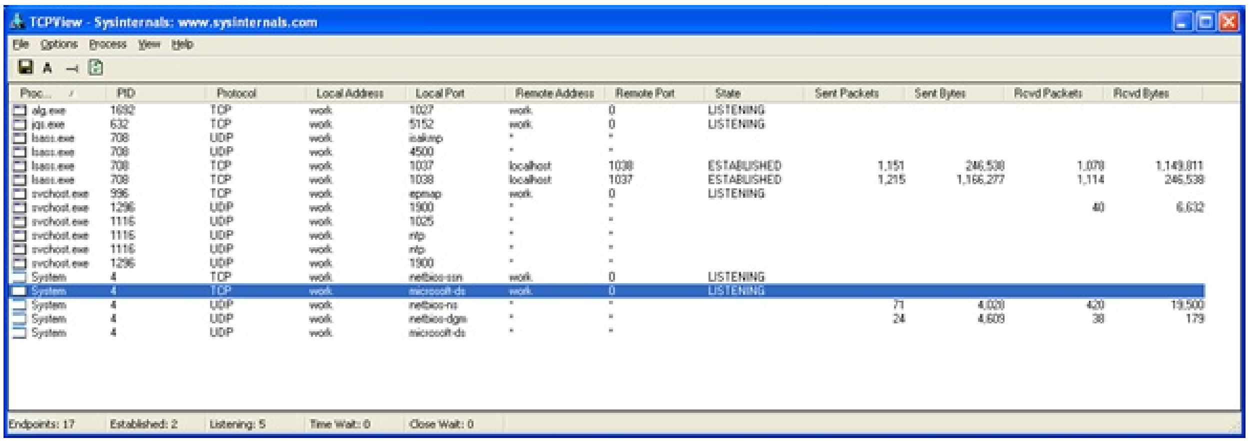
When DanderSpritz deploys PeddleCheap's payload via the PcDllLauncher plugin, network activity increases dramatically:


TCPView - Sysinternals: www.sysinternals.com

| Proc... | PID | Protocol | Local Address | Local Port | Remote Address | Remote Port | State | Sent Packets | Sent Bytes | Rcvd Packets | Rcvd Bytes |
|---|---|---|---|---|---|---|---|---|---|---|---|
| alg.exe | 1692 | TCP | work | 1027 | work | 0 | LISTENING | | | | |
| jqs.exe | 632 | TCP | work | 5152 | work | 0 | LISTENING | | | | |
| lsass.exe | 708 | UDP | work | isakmp | * | * | | | | | |
| lsass.exe | 708 | UDP | work | 4500 | * | * | | | | | |
| lsass.exe | 708 | TCP | work | 1037 | localhost | 1038 | ESTABLISHED | 313 | 62,494 | 410 | 830,153 |
| lsass.exe | 708 | TCP | work | 1038 | localhost | 1037 | ESTABLISHED | 537 | 840,761 | 312 | 62,494 |
| svchost.exe | 996 | TCP | work | epmap | work | 0 | LISTENING | | | | |
| svchost.exe | 1296 | UDP | work | 1900 | * | * | | | | 32 | 5,240 |
| svchost.exe | 1116 | UDP | work | 1025 | * | * | | | | | |
| svchost.exe | 1116 | UDP | work | ntp | * | * | | | | | |
| svchost.exe | 1116 | UDP | work | ntp | * | * | | | | | |
| svchost.exe | 1296 | UDP | work | 1900 | * | * | | | | | |
| System | 4 | TCP | work | netbios-ssn | work | 0 | LISTENING | | | | |
| System | 4 | TCP | work | microsoft-ds | work | 0 | LISTENING | | | | |
| System | 4 | UDP | work | netbios-ns | * | * | | 68 | 3,607 | 240 | 10,050 |
| System | 4 | UDP | work | netbios-dgm | * | * | | 22 | 4,229 | 35 | 179 |
| System | 4 | UDP | work | microsoft-ds | * | * | | | | | |
| System | 4 | TCP | work | microsoft-ds | andrey-Ae | 49176 | ESTABLISHED | 1,704 | 299,816 | 1,900 | 1,216,355 |

Endpoints: 18 Established: 3 Listening: 5 Time Wait: 0 Close Wait: 0

When a connection to the infected machine is terminated, network activity ceases, and only traces of the two bound sockets in lsass.exe remain:



```
TCPView - Sysinternals: www.sysinternals.com
File  Options  Process  View  Help

Proc...       PID    Protocol  Local Address  Local Port     Remote Address  Remote Port  State        Sent Packets  Sent Bytes  Rcvd Packets  Rcvd Bytes
alg.exe       1692   TCP       work           1027           work            0            LISTENING
jqs.exe       632    TCP       work           5152           work            0            LISTENING
lsass.exe     708    UDP       work           isakmp         *               *
lsass.exe     708    UDP       work           4500           *               *
lsass.exe     708    TCP       work           1037           localhost       1038         ESTABLISHED         1,151     246,538         1,070   1,149,811
lsass.exe     708    TCP       work           1038           localhost       1037         ESTABLISHED         1,215   1,166,277         1,114     246,538
svchost.exe   996    TCP       work           epmap          work            0            LISTENING
svchost.exe   1296   UDP       work           1900           *               *                                                             40       6,632
svchost.exe   1116   UDP       work           1025           *               *
svchost.exe   1116   UDP       work           ntp            *               *
svchost.exe   1116   UDP       work           ntp            *               *
svchost.exe   1296   UDP       work           1900           *               *
System        4      TCP       work           netbios-ssn    work            0            LISTENING
System        4      TCP       work           microsoft-ds   work            0            LISTENING
System        4      UDP       work           netbios-ns     *               *                                   71       4,020           420      19,500
System        4      UDP       work           netbios-dgm    *               *                                   24       4,609            38         179
System        4      UDP       work           microsoft-ds   *               *

Endpoints: 17   Established: 2   Listening: 5   Time Wait: 0   Close Wait: 0
```

## IOCs

implant – 96f10cfa6ba24c9ecd08aa6d37993fe4
File path – %SystemRoot%\System32\sipauth32.tsp
Registry – HKLM\Software\Microsoft\Windows\CurrentVersion\Telephony\Providers