KAPTOXA Point-of-Sale Compromise

Jan. 14, 2014
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Executive Summary

Since Dec. 18, 2013, the U.S. Secret Service (USSS), US-CERT and the cyber threat intelligence firm iSIGHT Partners have been working together to characterize newly identified malware associated with the KAPTOXA operation, which is behind a large-scale point-of-sale (POS) cyber crime breach. This characterization included determining malware functionality and scope, reverse engineering and proprietary research and analysis of threat marketplace activity before, during and after the breach.

The purpose of this release is to provide relevant and actionable technical indicators enabling the identification of additional victims. Since the USSS is actively investigating these breaches, the organizations working on the case are unable to disclose the full nature of the threat at this time, including external connection points, potential attribution or other known tactics, techniques and procedures (TTPs). However, threat updates will be released as appropriate and in coordination with the USSS so as to not interfere with active investigations.

USSS, US-CERT and iSIGHT Partners have confirmed that the high-profile KAPTOXA POS compromise involved the use of a new malware variant, dubbed "Trojan.POSRAM," which is designed to extract payment card details from POS systems. Multiple data points strongly suggest that Trojan.POSRAM was derived from another type of POS malware known as "BlackPOS." At the time of discovery and analysis, the malware had a zero percent anti-virus detection rate, which means that fully updated anti-virus engines on fully patched computers could not identify the malware as malicious.

The KAPTOXA operators also leveraged a variety of other tools to penetrate the targeted network, maintain access and exfiltrate stolen data. While some components of the breach operation were technically sophisticated, the operational sophistication of the compromise activity makes this case stand out. The intrusion operators displayed innovation and a high degree of skill in orchestrating the various components of the activity.

Financially motivated cyber criminals around the world have used POS malware at an accelerating pace for several years. Significantly, POS malware that includes memory scraping capabilities has been available in the Russian-language underground for some time. While Eastern Europe has been the focal point for POS malware development and use, cyber criminals in Brazil have used the technique since at least 2009. Globally, this trend will probably continue because malware offers important cost and risk advantages over hardware skimming techniques.

KAPTOXA Operation Uses Trojan.POSRAM in Sophisticated Retail Compromise

USSS, US-CERT and iSIGHT Partners have confirmed the use of a new Trojan, dubbed "Trojan.POSRAM," in a complex attack targeting payment card information and involving multiple other code types. Trojan.POSRAM is POS malware that monitors memory address spaces used by specific programs. Malware users can specify which programs should be monitored; specific versions of Trojan.POSRAM analyzed by USSS, US-CERT and iSIGHT Partners looked for pos.exe, pp.exe, PosW32.exe and epsenginesrv.exe.

Multiple data points strongly suggest that Trojan.POSRAM was derived from another type of POS malware known as "BlackPOS."

- Both malware types contained unique strings in the programming section of the code:
  - KAPTOXA
  - blocklen:
The structure of code is the same between both binaries. BinDiff, a commercial binary diffing tool, identified 875 functions as unchanged and 150 as changed. With a total of 1,294 functions in POSRAM, the BinDiff match rate is 79 percent. IDACompare, a free binary diffing utility, posts similar results. In particular, the Exact CRC match statistics are a very strong indicator. This method takes a CRC hash of the ordered base assembler instructions in a routine and hashes them into a 32-bit integer for comparison. Results are below showing how closely related the two samples are to one another.

- Decompiling both routines using HexRays for the MemMap routine reveals a close association:

```c
memset(&buf, -95899460, 0x1234);
lpAddress = 0;
wp = 1879048191;
dword_X4300C = 0;
do
   { VirtualQueryEx(hProcess, lpAddress, sBuffer, &tBuf);
     if ( w7 )
       { if ( Buffer.RegionSize )
          { u11 = (signed int)Buffer.BaseAddress;
            u10 = Buffer.RegionSize + ( DWORD )Buffer.BaseAddress;
           GetSize:
            (int)Buffer.BaseAddress,
            (int)Process,
            (int)RegionSize,
            Buffer.BaseAddress,
            Buffer.RegionSize + ( DWORD )Buffer.BaseAddress);
           *dword_X4300C;
          } lpAddress = (char *)lpAddress + Buffer.RegionSize;
        } while ( u7 & (unsigned int)lpAddress < w8 );
      
    _RTC_CheckStackTrace(a10, dword_X4200C);
      return unknown_libname_3Q(w5, w6);
   }
```

The malware is configured to "hook" into these payment application programs to monitor the information they process in memory. These programs are responsible for processing authorization data, which includes full magnetic stripe data (track data). When authorization data is processed, the payment application decrypts the transaction on the cash register system or BOH server and stores the authorization data in random access memory (RAM). The data must be decrypted for the authorization to be completed, so hackers are accessing full track data when it is stored in RAM and using the RAM-scraping malware to steal it.

When the malware identifies this information, it saves it to %windir%\system32\winxml.dll. Every seven hours the Trojan checks to see if the local time is between the hours of 10 a.m. and 5 p.m. If so, the Trojan attempts to send winxml.dll over a temporary NetBIOS share to an internal host (dump server) inside the compromised network over TCP port 139, 443 or 80. This step allows the intrusion operators to remotely steal data from POS terminals with no Internet access.

In addition to Trojan.POSRAM, the following types of code were also used:

- **ICMP Listener**: Listens for custom ICMP packets to log dump transfers from a POS scraper to an internal LAN dump server.
- **Shellcode Loader**: Receives raw commands across the network to be loaded and executed on a compromised host. This tactic is innovative and new to eCrime, able to covertly subvert network controls and common forensic tactics to conceal all data transfers and executions that may have been run through such a loader.
• **Data Manager:** Manages data on the dump server.
• **Exfiltrator:** Trojans that communicate with the centralized dump server to pull stolen data from a temporary DLL file, then exfiltrating it out of the network to a remote FTP server (by IP).
• **Hacking Tools:** The intrusion operators used a variety of admin and hacking tools for network discovery, credential compromise, database operations and port forwarding.

While some components of the breach operation were technically sophisticated, it is the operational orchestration of the KAPTOXA compromise activity that is remarkable.

**POS Malware and the Cyber Crime Landscape**

Widespread, "commercialized" POS malware is increasingly available on underground marketplaces, which we believe may lead to a demand for private and more specialized POS malware. For example, as banking malware became commercialized and highly visible to law enforcement (e.g., Zeus, Citadel and Carberp) we observed an increased demand for private Trojans. A similar phenomenon may result from the increasing popularity of POS malware.

Numerous types of available POS malware are being sold on the underground, which is making this type of malware increasingly available to cyber criminals. Some of the more popular POS malware is listed below:

• **BlackPOS** (aka "Memory Form Grabber"): POS malware that is easily available due to a leaked version of the source code; the original source code was authored by actor "ree[4]" (for more information and attribution, see iSIGHT Partners. "Analysis of 'Dump Memory Grabber' Point-of-Sale Malware," Malware Report #13-25113. April 8, 2013; and "Attribution for Russian Actor 'Ree[4],' Seller of a Credit Card RAM Memory Grabber," Intel-792666. April 11, 2013).
• **Dexter** (v2 called "Stardust"): POS malware that scans victim machines' process memory for credit card track data and exfiltrates it to a remote command and control (C&C) server (see iSIGHT Partners. "Dexter POS Malware," Malware Report #13-24091. Feb. 6, 2013; and "Publicity Surrounding Dexter Malware Will Probably Contribute to Actor Interest in This Malware in the Underground Marketplaces," Intel-981126. Oct. 30, 2013).

We believe there is a strong market for the development of POS malware, and evidence suggests there is a growing demand that will continue to drive increased prevalence and availability of POS malware.

• The abuse of online freelance IT marketplaces for the development of POS malware is common. In July 2013, on a popular online freelancing website, more than 20 percent of observed advertisements containing the keywords "POS" and "EMV" were malicious or suspicious, illustrating abuse by cyber criminals in outsourcing the development of POS malware (for more information, see iSIGHT Partners. "Freelancing Website Abuse for POS Compromise Development, Particularly EMV Compromise, Likely to Continue Over Next 6-12 Months," Intel-874657. July 8, 2013).
• This same phenomenon was also observed in September 2010. Average bids for observed, outsourced POS malware projects in 2010 spiked from $425-$2,500 in the first half of the year to $6,500 in the latter part of the year (see iSIGHT Partners. "Adversary Actors Using Global Freelancing Marketplaces to Develop Malware for POS Terminals, Likely Indicating Increased Threat to EMV Payment Systems," Intel-281120. Sept. 3, 2010).
• The market for POS malware is further exemplified by multiple cyber criminal advertisements interested in obtaining this type of malware. For example, there was an increase in observed interest in POS malware among French-speaking cyber criminals in late 2013.

We suggest that the spread of POS malware will primarily be enabled by further development of existing credential theft Trojans rather than the creation of entirely new malware families—particularly as there is evidence of this already occurring—although original development is also probable. For example, ProjectHook (RAM-scraping malware) is based on Zeus, and one actor has already claimed to have created a new builder and panel for vSkimmer, most likely based on the alleged leak of the original.

Leaked source code of credential theft malware could provide a starting block for actors who do not have the skill to create an entirely new type of malware from scratch, or for actors seeking to leverage previous work to optimize the efficiency of their scheme. Such lowered barriers to market entry could lead to more types of POS malware offered for sale and therefore eventually lead to cheaper prices and larger user bases (for a general outlook on POS malware, see iSIGHT Partners. "Command and Control Infrastructure Used for Three Types of POS Malware Demonstrates Growing Popularity and Availability of Such Cyber Crime Tools," Intel- 963893. Oct. 15, 2013).
Appendix 1: Initial Recommended Mitigation Strategies

Look for the following generic indicators, which may reveal a compromise:

- Audit networks for possible rogue PING messages that contain custom text messages.
- Audit hosts for a rogue "POSWDS" service.
- Look for rogue applications in memory that may attempt to masquerade as svchost and/or other programs on POS terminals.
- Look for data dumps within temporary DLL files stored on POS terminals, such as %windir%\system32\winxml.dll.
- Look for a rogue data manager application on internal LAN servers.
- Look for unauthorized FTP exfiltration on Internet-accessible hosts/servers.

Mitigation may be very complex and involve the immediate removal of known malware for the architecture of this attack, extensive audits and response work within the entire network, changes to accounts, passwords and other data that may have been compromised internally and coordination with iSIGHT Partners and law enforcement in an active investigation.
Appendix 2: Technical Malware Analysis

The following technical information is derived from malware analysis performed by iSIGHT Partners and is intended to allow those potentially affected by similar activity to check their systems for potentially malicious activity. Network indicators (and specifically, IPs) linked to this attack have been redacted due to ongoing law enforcement investigations.

POSWDS Service Created by Malware

When run, the Trojan creates a service called "POSWDS" and runs the code from the original location of execution.

Trojan monitors memory space for different programs (observed targeted programs include pos.exe, pp.exe, PosW32.exe and epsenginesrv.exe, depending on the variant) to steal sensitive information from memory, incrementally saving data to %windir%\system32\winxml.dll.

The Windows registry is modified to contain or modify keys to configure the service and disable proxy:

```
HKLM\SYSTEM\ControlSet001\Enum\Root\LEGACY_POSWDS\0000\Control
 *NewlyCreated* = 0x00000000
ActiveService = "POSWDS"

HKLM\SYSTEM\ControlSet001\Enum\Root\LEGACY_POSWDS\0000
Service = "POSWDS"
Legacy = 0x00000001
ConfigFlags = 0x00000000
Class = "LegacyDriver"
ClassGUID = "{8ECC055D-047F-11D1-A537-0000F8753ED1}"
DeviceDesc = "POSWDS"

HKLM\SYSTEM\ControlSet001\Enum\Root\LEGACY_POSWDS
NextInstance = 0x00000001

HKLM\SYSTEM\ControlSet001\Services\POSWDS\Enum
0 = "Root\LEGACY_POSWDS\0000"
Count = 0x00000001
NextInstance = 0x00000001

HKLM\SYSTEM\ControlSet001\Services\POSWDS\Security
Security = 01 00 14 80 90 00 00 00 00 9C 00 00 00 14 00 00 00 30 00 00 00 02 00 1C 00 01 00 00 00 02 80 14
00 FF 01 0F 00 01 01 00 00 00 00 01 00 00 00 00 02 00 60 00 04 00 00 00 00 01 04 00 00 00 00 14 00 FD 01 02 00 01
01 00 00 00 00 05 12 00 00 00 00 18 00 FF 01 0F 0

HKLM\SYSTEM\ControlSet001\Services\POSWDS
Type = 0x00000110
Start = 0x00000002
ErrorControl = 0x00000000
ImagePath = "file and pathname of the sample #1"
DisplayName = "POSWDS"
ObjectName = "LocalSystem"
```
FailureActions = FF FF FF FF 01 00 00 00 01 00 00 00 03 00 00 00 74 00 6D 00 01 00 00 00 A0 86 01 00 01 00 00 00 A0 86 01 00

HKLM\SYSTEM\CurrentControlSet\Enum\Root\LEGACY_POSWDS\0000\Control
*NewlyCreated* = 0x00000000
ActiveService = "POSWDS"

HKLM\SYSTEM\CurrentControlSet\Enum\Root\LEGACY_POSWDS\0000
Service = "POSWDS"
Legacy = 0x00000001
ConfigFlags = 0x00000000
Class = "LegacyDriver"
ClassGUID = "{8ECC055D-047F-11D1-A537-0000F8753ED1}"
DeviceDesc = "POSWDS"

HKLM\SYSTEM\CurrentControlSet\Enum\Root\LEGACY_POSWDS
NextInstance = 0x00000001

HKLM\SYSTEM\CurrentControlSet\Services\POSWDS\Enum
0 = "Root\LEGACY_POSWDS\0000"
Count = 0x00000001
NextInstance = 0x00000001

HKLM\SYSTEM\CurrentControlSet\Services\POSWDS\Security
Security = 01 00 14 80 90 00 00 00 9C 00 00 00 14 00 00 00 30 00 00 00 02 00 1C 00 01 00 00 00 02 80 14 00 FF 01 0F 00 01 01 00 00 00 00 01 00 00 00 00 02 00 60 00 04 00 00 00 00 14 00 FF 01 02 00 01 01 00 00 00 00 05 12 00 00 00 00 18 00 FF 01 0F 0

HKLM\SYSTEM\CurrentControlSet\Services\POSWDS
Type = 0x00000110
Start = 0x00000002
ErrorControl = 0x00000000
ImagePath = "file and pathname of the sample #1"
DisplayName = "POSWDS"
ObjectName = "LocalSystem"
FailureActions = FF FF FF FF 01 00 00 00 01 00 00 00 03 00 00 00 74 00 6D 00 01 00 00 00 A0 86 01 00 01 00 00 00 A0 86 01 00

HKEY_USERS\DEFAULT\Software\Microsoft\Windows\CurrentVersion\Internet Settings ProxyEnable = 0x00000000

HKLM\SYSTEM\ControlSet001\Control\ServiceCurrent
(Default) =

HKLM\SYSTEM\CurrentControlSet\Control\ServiceCurrent
(Default) =

Every seven hours the Trojan checks to see if the local time is between the hours of 10 a.m. and 5 p.m. If the local time is during the time range specified, the Trojan attempts to exfiltrate winxml.dll over a temporary NetBIOS share to a host on the internal network. This most likely occurs over TCP port 139; however, NetBIOS can also fall back upon the WebDav transport, which uses ports 443 or 80. In a
common networked environment the Trojan can easily communicate via NetBIOS over the network using the aforementioned ports.

Three commands are used to move data from a collections host to the internal LAN dump server. The commands are used to mount a drive, move data to the remote host, and then the mapped network share is removed as a way to conceal communications.

**ICMP Listener**

Several executables in this incident are designed to listen for ICMP (ping) messages across the LAN, with embedded status updates about dumps transferred to the internal dump server. This is done as a way to log dumps sent to a dump server, covertly across the LAN, prior to exfiltration.

A POS scraper transfers stolen data to an internal dump server. It sends a status update (via an embedded string with an ICMP packet) across the network, which is then picked up by an ICMP listener, which logs the event to a file at the file log.txt in the applications home directory and displays the text message to a console window. Early analysis strongly suggests that this specific sample was likely used as a way to test functionality on an internal platform server and ICMP logging of dumps, prior to rolling out an attack on another internal LAN dump server seen in this attack.

**Data Manager**

A data management Trojan that runs on a compromised internal C&C server, this program is managed by remote Exfiltrator code. It is responsible for copying all stolen log data to a temporary storage file. All log files found within the folder c:\windows\twain_32\ will be copied into the file c:\windows\twain_32a.dll. As seen with POS scraper Trojans in this attack, the DLL is only a temporary storage file for stolen data, and the file is deleted once a transfer has been completed.

**Exfiltrator**

Similar to POS Terminal Trojans in this attack, Exfiltrator Trojans communicate with a C&C that receives aggregate stolen data, ready for exfiltration:

Each Exfiltrator is designed to send stolen log data to a remote computer.

Functionality for the code is as follows:

**COMMAND:** `ftp -s: [Application Path]\cmd.txt`

- start data management utility XXX on remote dump server to conglomerate log files
- sleep for four minutes
- killing the executable again
- copying over stolen data from dump server
- generate an FTP upload script to upload to `omitted_IP\public_html\cgi-bin`
- execute the FTP script (Windows FTP client) for exfiltration

This sample PULLs data from the internal drop server for FTP exfiltration.
Shellcode Loader

Shellcode Loader binaries can easily appear to be legitimate tools due to strings included within the binaries to trick responders and forensic experts. They are all designed to download second-stage shellcode and execute it, covertly, without leaving tracks/logs behind of what was run on a host.

Network traffic of an executable code being transferred to the Shellcode Loader would just look like a binary blob with high entropy. There is no NOP slide to trigger shellcode detections, no MZ header of an executable and probably no strings because it is traditional to encode shellcode and prefix it with its own encoder. Additionally, no files are necessary for the loaders to run code. In addition, this technique leaves no traces in memory, making it very difficult to identify what might have been transferred to and run on the compromised host.

These loader applications include the publicly available Harmony API hasher written by Stephen Fewer. The specific application of this technique for running shellcode appears to be innovative and unique to the architecture of this attack, for covert operations.

Various Hacking Tools

There are a significant number of various hacking tools used in this attack for network discovery, credential compromise, database operations and port forwarding. Specific details on these files have been omitted due to the ongoing law enforcement investigations.

File Details

**Note:** A multi-scanner of all samples at the time of analysis revealed a zero percent detection (undetected, formerly unknown family of code). Various hacking tools are generally detected at various rates, as they are potentially unwanted programs in most instances. It appears likely that codes for this attack were customized to avoid detection and to communicate to an internal LAN dump server for exfiltration, as demanded by the network architecture.

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Identifier: attacker
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Name: 4b9b36800db395d8a95f331c4608e947
Identifier: attacker
Extension: exe
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Sha1: 608a63f8a6d981196303164bd09623366aa6a86c5
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Identifier: attacker
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Type: PE32 executable for MS Windows (DLL) (console) Intel 80386 32-bit
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Name: 814b88ca4ef695f6a3fa11912a1c807
Identifier: attacker
Extension: exe
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Size: 53248
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Identifier: attacker
Extension: exe
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Size: 45056
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Identifier: attacker
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Identifier: attacker
Extension: exe
Type: PE32 executable for MS Windows (GUI) Intel 80386 32-bit Mono/.Net assembly
Size: 126976
Md5sum: a109c617ecc92c27e9dab972c8964cb4
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Sha256: e25e75196fcef1991fbd17db4413662e9189ee5f3d8b91dd11e58a7ae2a38a
Fuzzy: 1536:3Bd/UgCokjhSYywQz8QeUhRnHcwV3atrossRLCzmsg8cxg+1GnNZ+WhVPkQV/dVUI:Rd/UtpVWsRLMmsg8cXC8l/3UI

Name: f6877447d2bd0199ad2f073a391aadce
Identifier: attacker
Extension: exe
Type: PE32 executable for MS Windows (console) Intel 80386 32-bit
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Anti-Virus Scan Results