THREAT HUNTING VIA NETWORK TRAFFIC ANALYSIS
(EXAMINING LIVE MALWARE TRAFFIC SAMPLES)

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A persistent, detail-oriented cyber security specialist with 6 years of hands-on experience in the service provider industry.

Hassan has had a privilege to develop and lead critical security projects at one of the largest Fortune groups in Pakistan, Lakson Group of Companies, security advisor to Yottabyte Ltd and currently is serving as a Principal Threat Researcher at Point0Labs UK.
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<th>Section 2: ------ 30 mins --------</th>
<th>Section 3: --------20 mins------</th>
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Threat hunting is a proactive offense approach that security professionals use with the aid of Intel Threat. It consists of iteratively scanning through networks to detect compromise indicators (IoCs) and threats such as Advanced Persistent Threats (APTs) which bypass your existing security framework.
A threat hunter is a security professional who is skilled to recognize, isolate and defuse APTs by using manual or AI-based techniques because such threats can not be detected by network security monitoring tools.

They hunt for insider provocations or outside intruders to uncover risks posed by malicious actor typically employees, or outsiders, including a criminal organization which have been slipping through the cracks by security devices.
The cyber threat hunting team should be answerable to these questions before planning for the operation.

1. What is it that you hunt? You have to select exactly which adversaries you’re chasing for.

2. Where are you going to find the opponent/adversaries/IOC?

3. How would you consider an opponent/adversaries/IOC?

4. When will you find it?
Cyber Kill Chain

1. Recon
2. Weaponization
3. Delivery
4. Exploitation
5. Installation
6. Command & Control
7. Exfiltration
**Socio-Political Axis**
To further strategic Chinese foreign policy objectives in the South China Sea

**Adversary**
- People's Liberation Army Chengdu Military Region
- Second Technical Reconnaissance Bureau
- Military Unit Cover Designator 78020
- Ge Xing aka GreenSky27

**Capabilities**
- Families of Unique Custom Malware
- Specific Post-Infection, Second-Stage Tools & Utilities
- Use of an Exploit Kit Leveraged by Asian Hackers

**Technical Axis**
- CVE-2012-015
- Spear Phishing
- Right-to-Left Character Override
- Self-Extracting Executables

**Infrastructure**
- Global Command & Control Infrastructure
- Chinese Dynamic DNS Infrastructure Providers
- Attacker-Registered Domains

**Victims**
- Governments in Southeast Asia
- International organizations such as the Association of Southeast Asian Nations
- Public and private energy organizations
Network Traffic Analysis

Network traffic analysis (NTA) is a method of monitoring network availability and activity to identify anomalies, including security and operational issues.

Collecting a real-time and historical record of what's happening on your network.

Caveats

Sophisticated attackers frequently go undetected in a victim network for an extended period of time.

Attackers know how to blend their traffic with legitimate traffic and only the skilled network traffic analyst
How do we perform network monitoring?

Span ports
SNMP
Syslog
Flow data
SDEE etc
Benefits of Malware Traffic Analysis

- Deeper insights into malware behavior and rightly trace technical indicators
- Rightly trace the gaps and holes in existing security control layers
- Establish clarity in current standing with respect to detection capability
- Address existing security holes and gaps
- Greater ROI
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<th>APT</th>
<th>Malware</th>
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<td>The APT is well funded, organized groups that are systematically developed to compromise government and commercial entities.</td>
<td>Malware is any malicious software or program designed to damage or disable computers or networks.</td>
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<td>APT is a broad term used to describe a prolonged, more strategic and targeted attack.</td>
<td>Most malware attacks are target-specific, quick damaging attacks.</td>
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<td>APTs can stay undetected for a prolonged period.</td>
<td>Anti-malware can detect and eradicate malware.</td>
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<td>APTs are targeted attack on sensitive, corporate, banking networks to maintain access to their networks and infiltrate intellectual property data.</td>
<td>Most malware attacks are aimed at a specific user, company, or organization to gain access to their sensitive or personal data in a stealthy manner.</td>
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APT Case Studies

- Project Sauron
- Plead APT
Tools for Network Traffic Analysis

- Project Sauron
- Plead APT
Analyzing Trickot – Live Malware Traffic Sample
Trickbot Archeology

Figure 1: Flowchart from a Trickbot infection from malspam in September 2019.
Trickbot Pcap. Analysis

Review the traffic, and you will find the following activity common in recent Trickbot infections:

- An IP address check by the infected Windows host
- HTTPS/SSL/TLS traffic over TCP ports 447 and 449
- HTTP traffic over TCP port 8082
- HTTP requests ending in .png that return Windows executable files

Figure 2: Pcap of the Trickbot infection viewed in Wireshark.
Unique to this Trickbot infection is an HTTP request to www.dchristjan[.]com that returned a zip archive and an HTTP request to 144.91.69.195 that returned a Windows executable file.

Follow the HTTP stream for the request to www.dchristjan.com as shown in Figure 3 to review the traffic.
Trickbot Pcap. Analysis

In the HTTP stream, you can find indicators that a zip archive was returned as shown in Figure 4.

In Figure 4, you can also see the name of the file contained in the zip archive, **InvoiceAndStatement.lnk**.
You can export the zip archive from the traffic using Wireshark as shown in Figure 5 and Figure 6 using the following path:

File → Export Objects → HTTP…

Figure 5: Exporting HTTP objects from the pcap.
In a BSD, Linux, or Mac environment, you can easily confirm the extracted file is a zip archive.

Figure 6: Exporting the zip archive from the pcap.
Get the SHA256 hash of the file, and extract the contents of the archive in a command line environment. In this case, the content is a Windows shortcut file, which you can also confirm and get the SHA256 hash as shown in Figure 7.

Figure 7: Checking the extracted zip archive and its contents.
Trickbot Pcap. Analysis

An HTTP request to **144.91.69.195** returned a Windows executable file.

This is the initial Windows executable for Trickbot.

You can follow the HTTP stream for this HTTP request and find indicators this is an executable file as shown in Figure 8 and Figure 9.

*Figure 8: Following the HTTP stream for the HTTP request to 144.91.69.195.*
Trickbot Pcap. Analysis

Figure 9: Indicators the returned file is a Windows executable or DLL file.
You can extract the executable file from the pcap as shown in Figure 10.
Post infection traffic initially consists of HTTPS/SSL/TLS traffic over TCP port 443, 447, or 449 and an IP address check by the infected Windows host. In this infection, shortly after the HTTP request for the Trickbot executable, we can see several attempted TCP connections over port 443 to different IP addresses before the successful TCP connection to 187.58.56[.]26 over TCP port 449.

If you use your **basic+** filter, you can see these attempted connections as shown in Figure 11 and Figure 12.

*Figure 11: Attempted TCP connections over port 443 by the infected Windows host.*
Figure 12: Scrolling down to see more TCP connections over port 443 before a successful connection to 187.58.56[.]26 over TCP port 449.
The HTTPS/SSL/TLS traffic to various IP addresses over TCP port 447 and TCP port 449 has unusual certificate data. We can review the certificate issuer by filtering on `ssl.handshake.type == 11` when using Wireshark 2.x or `tls.handshake.type == 11` when using Wireshark 3.x.

Then go to the frame details section and expand the information, finding your way to the certificate issuer data as seen in Figure 13 and Figure 14.

Figure 13: Filtering for the certificate data in the HTTPS/SSL/TLS traffic, then expanding lines the frame details for the first result under TCP port 449.
In Figure 14, we see the following certificate issuer data used in HTTPS/SSL/TLS traffic to 187.58.56.26 over TCP port 449:

id-at-countryName=AU

id-at-stateOrProvinceName=Some-State

id-at-organizationName=Internet Widgits Pty Ltd

The state or province name (Some-State) and the organization name (Internet Widgits Pty Ltd) are not used for legitimate HTTPS/SSL/TLS traffic. This is an indicator of malicious traffic, and this type of unusual certificate issuer data is not limited to Trickbot.

What does a normal certificate issuer look like in legitimate HTTPS/SSL/TLS traffic?
Trickbot Pcap Analysis

If we look at earlier traffic to Microsoft domains at 72.21.81.200 over TCP port 443, we find the following as seen in Figure 15.

id-at-countryName=US
id-at-stateOrProvinceName=Washington
id-at-localityName=Redmond
id-at-organizationName=Microsoft Corporation
id-at-organizationUnitName=Microsoft IT
id-at-commonName=Microsoft IT TLS CA 2

Figure 15: Certificate data from legitimate HTTPS traffic to a Microsoft domain.
The Trickbot-infected Windows host will check its IP address using a number of different IP address checking sites. These sites are not malicious, and the traffic is not inherently malicious.

However, this type of IP address check is common with Trickbot and other families of malware. Various legitimate IP address checking services used by Trickbot include:

- api.ip.sb
- checkip.amazonaws.com
- icanhazip.com
- ident.me
- ip.anysrc.net
- ipcho.net
- ipinfo.io
- myexternalip.com
- wtfismyip.com

Figure 16: IP address check by the infected Windows host, right after HTTPS/SSL/TLS traffic over TCP port 449. Not inherently malicious, but this is part of a Trickbot infection.
A Trickbot infection currently generates HTTP traffic over TCP port 8082. This traffic sends information from the infected host like system information and passwords from the browser cache and email clients. This information is sent from the infected host to command and control servers used by Trickbot.

To review this traffic, use the following Wireshark filter:

```
http.request and tcp.port eq 8082
```

This reveals the following HTTP requests as seen in Figure 17:

```
```

Figure 16: IP address check by the infected Windows host, right after HTTPS/SSL/TLS traffic over TCP port 449. Not inherently malicious, but this is part of a Trickbot infection.
Trickbot Pcap Analysis

Figure 17: HTTP traffic over TCP port 8082 caused by Trickbot.
Trickbot Pcap. Analysis

Figure 18: Login credentials stolen by Trickbot from the Chrome web browser. This data was sent by the Trickbot-infected host using HTTP traffic over TCP port 8082.
Trickbot Pcap. Analysis

Figure 19: System data sent by a Trickbot-infected host using HTTP traffic over TCP port 8082. It starts with a list of running processes.
Trickbot Pcap. Analysis

Figure 20: More system data sent by a Trickbot-infected host using HTTP traffic over TCP port 8082
Trickbot Pcap. Analysis

Figure 22: Windows executable sent through URL ending in .png.

Content type listed as `image/png` even though this is actually an EXE file.

First 2 bytes of an EXE or DLL show as ASCII characters `MZ`.

Often seen in EXE or DLL files.
Trickbot Archealogy

Figure 23: Simplified flow chart for Emotet with Trickbot activity.
Trickbot Pcap. Analysis

Figure 25: The differences in Emotet and Trickbot traffic.
Lessons Learned — to help prevent trickbot infections

- Never click on unsolicited emails.
- Implement a centrally-managed, up-to-date anti-malware solution
- Ensure that systems are hardened with industry-accepted guidelines
- Keep un-necessary task automations disabled — Windows Script Host
- Enable CMD and PowerShell Command Line logging and forward logs on SIEM for audit trails
- Consider using application whitelisting
- Disable the use of SMBv1 across the network and require at least SMBv2 to harden systems against Network Propagation modules used by TrickBot.
- Adhere to the principal of least privilege, limit administrative credentials to designated administrators.
Incident Response — if a trickbot infection is identified

- Disable Internet access at the affected site to help minimize the extent of exfiltration of credentials associated with external, third-party resources.

- Review impacted subnets to identify multi-homed systems which may adversely impact containment efforts. Also, consider temporarily taking the network offline to perform identification, prevent reinfections, and stop the spread of the malware.

- Identify, shutdown, and take the infected machines off the network.

- Heighten monitoring of SMB communication or outright block it between workstations, and configure firewall rules to only allow access from known administrative servers.

- Assess the need to have ports 445 (SMB) open on systems and, if required, consider limiting connections to only specific, trusted hosts.

- Start with remediation of multi-homed systems (e.g. Domain Controller, File Server) as these can communicate across Virtual Local Area Networks (VLANs) and can be a potential means for spreading malware.

- Create clean VLANs that do not have access to infected VLANs. After the systems have been reimaged or restored from a known good backup, place them on the clean VLAN.
• Do not login to infected systems with domain or shared local administrator accounts. This is the best remediation strategy since TrickBot has several ways of gaining access to credentials.

• As TrickBot is known for scraping both domain and local credentials, it is recommended that a network-wide password reset take place. This is best done after the systems have been cleaned and moved to the new VLAN. This is recommended so new passwords are not scraped by the malware.

• Apply host-based isolation via Windows Firewall Group Policy Objects (GPOs), host-based intrusion detection system/network intrusion detection system (HIDS/NIDS) products, a Private Virtual Local Area Network (pVLAN), or similar means to help mitigate propagation.

• Determine the infection vector (patient zero) to determine the root cause of the incident.
Analyzing Qakbot Malware – Live Malware Traffic Sample
Analyzing XM Rig Miner – Live Malware Traffic Sample
18 Biggest Data Breaches of the 21st Century

- Yahoo! 3 billion (Yahoo! 2013)
- Adobe 38 million (Adobe Inc. 2013)
- TD Ameritrade 94 million (The TD Ameritrade 2000)
- RSA 40 million (RSA Security LLC 2013)
- Heartland 134 million (Heartland Payment Systems, Inc. 2008)
- Target 110 million (Target Corporation 2013)
- Equifax 143 million (Equifax Inc. 2017)
- U.S. Office of Personnel Management 22 million (OPM 2015)
- JPMorgan Chase 76 million (JP Morgan Chase & Co. 2014)
- Marriott International 500 million (Marriott International 2018)
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<th>Breach Impact</th>
<th>How Hacked?</th>
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<td>Yahoo</td>
<td>3 billion</td>
<td>Employees were targeted via spear-phishing attacks</td>
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<td>Marriott</td>
<td>500 million</td>
<td>Vulnerable third party services acquired</td>
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<td>Ebay</td>
<td>145 million</td>
<td>Employee`s credentials were compromised via spear-phishing attack.</td>
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<tr>
<td>Equifax</td>
<td>143 million</td>
<td>Lackings in patch management of Apache</td>
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<tr>
<td>Target</td>
<td>110 million</td>
<td>Vendor infected via email phishing campaign to pivot into the network.</td>
</tr>
<tr>
<td>Sony PlayStation</td>
<td>77 million</td>
<td>System administrator<code>s PC was compromised to steal the sensitive info. System</code>s were running on obsolete and outdated versions.</td>
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<tr>
<td>JB Morgan Chase Bank</td>
<td>76 million</td>
<td>An employee`s personal computer was compromised, who used VPN accesses to connect to corporate network from home.</td>
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On Sunday, December 13, SolarWinds announced that updates to its leading network management software Orion, shipped to customers from March 2020, contained malware.

Malware, distributed by SolarWinds Orion software updates, infected the networks of the following: White House, the DOJ, the State Department, NASA, NSA, the military, the top IT and telecommunications companies, and most of the Fortune 500 companies. In total, up to 18,000 large entities have been infected by the malware.

The perpetrators of this malware attack were SolarWinds employees, not any outside party.

The call that he alleged nation-state is Russia was made by the media without any evidence.

The suspicions against Russia within the cyber security circles are strong. Russia has relatively little leverage over the tech companies in the US.

Additionally, SolarWinds develops its products and/or provides support from countries, which are difficult for Russia to infiltrate (including Singapore and Philippines). The Russian government denies any involvement.
SUPPLY CHAIN ATTACK
Attacks insert malicious code into a DLL component of legitimate software. The compromised DLL is distributed to organizations that use the related software.

EXECUTION PERSISTENCE
When the software starts, the compromised DLL loads, and the inserted malicious code calls the function that contains the backdoor capabilities.

DEFENSE EVASION
The backdoor has a lengthy list of checks to make sure it's running in an actual compromised network.

RECON
The backdoor gathers system info

INITIAL C2
The backdoor connects to a command-and-control server. The domain it connects to is partly based on info gathered from system, making each subdomain unique. The backdoor may receive an additional C2 address to connect to.

EXFILTRATION
The backdoor sends gathered information to the attacker.

HANDS-ON-KEYBOARD ATTACK
The backdoor runs commands it receives from attackers. The wide range of backdoor capabilities allow attackers to perform additional activities, such as credential theft, progressive privilege escalation, and lateral movement.
UNC2452 APT Capabilities

- Attacker Hostnames Match Victim Environment
- TEARDROP and BEACON Malware Used
- IP Addresses located in Victim’s Country
- Password Guessing Used
 UNC2452/ SolarStorm Attack Kill Chain

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<th>Execution 5 techniques</th>
<th>Persistence 7 techniques</th>
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<th>Lateral Movement 9 techniques</th>
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How to protect yourself from SunBurst?

• Determine if your organization uses the SolarWinds Orion software.

• Isolate the traffic external accesses to and from software winds Orion system, keeping it limited to internal environments only.

• Limit privileges of logging accounts and possibilities of lateral movement.

• Have an incident response plan emplaced.

• Review Your Logging from June 2020 till date and perform Indicators of Compromise (IoCs) sweeps against SunBurst Breach.

• Implement SunBurst detection rules e.g. Yara, Snort etc. on your security devices i.e. IDS, SIEM, Endpoint protection and EDR.

• Perform a user access right review exercise and reduce privileges.

  I. Most users don’t need administrative privileges on their laptops.
  II. Most software does not need administrative access to your network to function.
Backdoor discovered in ZyXel Firewalls

• Hardcoded admin-level backdoor account in more than 100,000 Zyxel Firewalls.

• Root accesses to devices via ssh or gui admin panel.

• User account ‘zyfwp’ with a password ‘PrOw!aN_fXp’ in the latest firmware version (4.60 patch 0)

• The plaintext password was visible in one of the binaries on the system

• According to Zyxel, the account was designed to deliver automatic firmware updates for access points via FTP.

• Affected Version

• ATP, USG, ZyWALL, USG FLEX and VPN firewalls running firmware 4.60 Patch 0 version is effected only.
`zyfwp` account after listing the current users in the 4.60 (Patch 0) Image of ZyXel firewall.
Zyxel removed the vulnerable firmware

Vulnerable firmware of Patch 0 has been removed from Zyxel site and replaced with Patch 1.
You to protect yourself from CVE-240-29583?

- Apply patch 4.60 (Patch 1) immediately or remove the ‘zyfwp’ account from your firmware.
- Perform your access rights review on quarterly basis, revoking unused accounts.
- Make sure, generic user IDs and passwords are not used by any means.
Cyber Threat Landscape In COVID-19

The latest development adds to a long list of cyberattacks against hospitals and testing centers, phishing campaigns that distribute malware such as AZORult, Emotet, Nanocore RAT and TrickBot via malicious links and attachments, and execute malware and ransomware attacks that aimed to profit off the global health concern.
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1. The computer trying to connect needs to be protected with an advanced protection solution.

2. Ensure only authorized devices are being used for official work purposes.

3. The connection between the computer and the corporate network must be secured by a VPN (Virtual Private Network) at all times.

4. Passwords used to access corporate services, and those we use in general, must be complex and difficult to decipher in order to avoid being compromised. Preferably use MFA.

5. Configure and test host based firewalls on each endpoint and harden systems.

6. Monitoring services for systems, networks, applications and users, and services to respond to and remedy the setbacks that may arise, are totally necessary to monitor and ensure business continuity when working remotely.

6. Provide security awareness session towards ensuring digital hygiene to users, and taking written acknowledgement on Acceptable Use Policy of organizational assets.
THANKYOU

ANY QUESTIONS?