Passive SSH, a Fast-Lookup Database of SSH Key Materials to Support Incident Response

Team CIRCL
https://www.d4-project.org/

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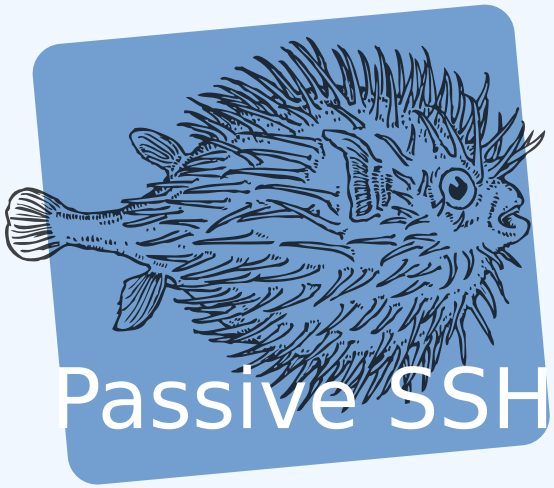

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Problem statement

- CIRCL (and other CSIRTs) have their own passive DNS[1] and passive SSL[2] database
- Historical data is a companion to incident response, infrastructure attribution and threat intelligence at large
- **SSH is a major protocol for remote management** (for normal users but also attackers)
- SSH protocol provides a significant **number of fingerprints** to track similar infrastructures (e.g. from banners to key fingerprints)

[1] https://www.circl.lu/services/passive-dns/
[2] https://www.circl.lu/services/passive-ssl/

Passive SSH design

- A fast-lookup database to find SSH key per IP, fingerprint or hassh[3]
- Supporting the storage of the key materials, key types and banners
- **Lightweight design** and supporting different kind of importers (scanner, network capture)
- The system can be used externally (for Internet-wide scan) or internally (for internal network ssh infrastructure scanning)
- Supporting IPv4, IPv6 but also Tor onion addresses or random TCP ports

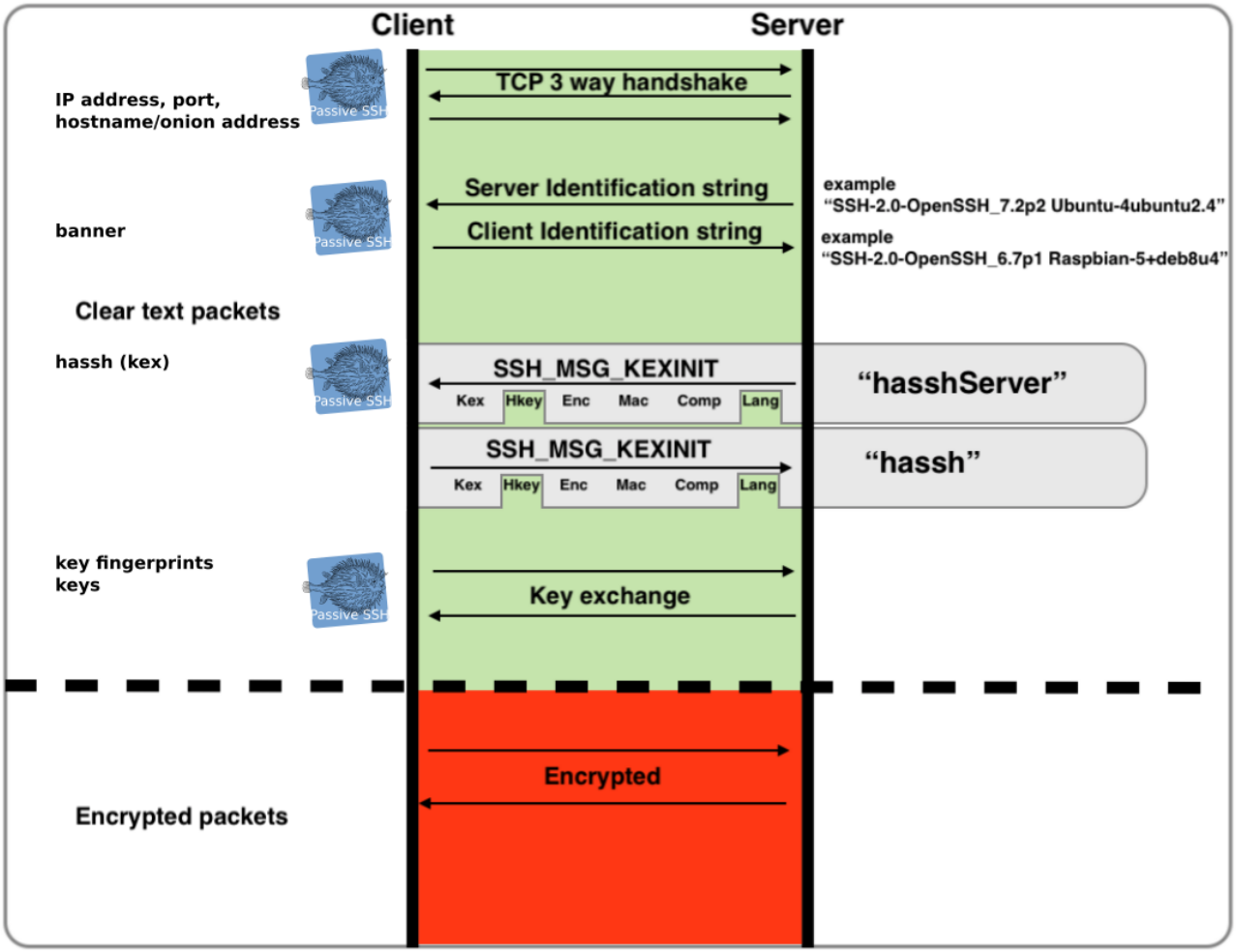
[3] https://github.com/salesforce/hassh

Passive SSH open source software

- Software written in Python 3 and released as an open source project[4]
- The database is a **Redis-compatible backend** (you can use Redis, kv-rocks or any compatible Redis backend)
- A sample SSH scanner is included to scan small networks or internal infrastructure
- CIRCL provides a **database from an Internet-wide scan** (access can be requested for FIRST, TF-CSIRT and CNW members)

[4] https://github.com/D4-project/passive-ssh

What do you store? or What can I lookup?



```
curl -s http://127.0.0.1:8500/banners | jq .
{
  "banners": {
    "SSH-2.0-OpenSSH_7.6p1 Ubuntu-4ubuntu0.3": 14522,
    "SSH-2.0-OpenSSH_7.4": 8036,
    "SSH-2.0-OpenSSH_7.9p1 Debian-10+deb10u2": 4563,
    "SSH-2.0-OpenSSH_7.2p2 Ubuntu-4ubuntu2.8": 4464,
    "SSH-2.0-OpenSSH_7.4p1 Debian-10+deb9u7": 4301,
    "SSH-2.0-OpenSSH_5.3": 2930,
    "SSH-2.0-OpenSSH_8.2p1 Ubuntu-4ubuntu0.1": 2901,
    "SSH-2.0-OpenSSH_7.2p2 Ubuntu-4ubuntu2.10": 2669,
    "SSH-2.0-OpenSSH_6.7p1 Debian-5+deb8u8": 2295,
    "SSH-2.0-OpenSSH_7.4p1 Debian-10+deb9u6": 1192,
    "SSH-2.0-OpenSSH_6.6.1p1 Ubuntu-2ubuntu2.13": 1107,
    "SSH-2.0-OpenSSH_6.7p1 Debian-5+deb8u3": 1024,
```

```
curl -s "http://127.0.0.1:8500/banner/hosts/SSH-2.0-
    OpenSSH_6.7p1%20OVH-rescue"  | jq .
{
  "banner": "SSH-2.0-OpenSSH_6.7p1 OVH-rescue",
  "hosts": [
    "188.165.216.153",
    "137.74.204.16",
    "188.165.233.197",
    "188.165.199.211",
    "188.165.192.121",
    "137.74.204.58",
    "188.165.224.149",
    "188.165.211.205",
    "188.165.216.162",
    "188.165.216.155",
    "188.165.194.193",
```

```
curl -s "http://127.0.0.1:8500/banner/hosts/SSH-2.0-lancom"
      | jq .
{
  "banner": "SSH-2.0-lancom",
  "hosts": [
    "89.1.181.237",
    "89.0.231.177",
    "91.0.158.6",
    "91.0.54.88",
    "91.0.146.13",
    "91.1.54.42",
    "91.1.23.189",
    "89.1.29.178",
    "91.0.184.142",
    "89.1.183.80",
    "89.1.142.156",
    "89.1.31.148",
```

```
curl -s "http://127.0.0.1:8500/host/ssh/89.1.181.237"  | jq .
{
  "first_seen": "20201116",
  "last_seen": "20201116",
  "port": 22,
  "banner": [
    "SSH-2.0-lancom"
  ],
  "hassh": {
    "deabc869d8b35c2fbef0831b838bf196": [
      "{\"key\": [\"rsa-sha2-512\", \"rsa-sha2-256\", \"ssh-rsa\", \"ssh-dss\"], \"
          encrypt\": [\"aes256-ctr\", \"aes192-ctr\", \"aes128-ctr\", \"aes256-cbc\",
          \"aes192-cbc\", \"aes128-cbc\", \"blowfish-ctr\", \"
blowfish-cbc\", \"arcfour256\", \"arcfour128\", \"arcfour\", \"3des-ctr\", \"3des-cbc\"],
       \"mac\": [\"hmac-sha2-512\", \"hmac-sha2-512-96\", \"hmac-sha2-256\", \"hmac-sha2
     -256-96\", \"hmac-sha1\", \"hmac-sha1-96
\", \"hmac-md5\", \"hmac-md5-96\"], \"compress\": [\"none\", \"zlib\"], \"lang\": []}"
    ]
  },
  "keys": [
    {
      "type": "ssh-rsa",
      "fingerprint": "af:80:1e:6f:5a:cf:f3:6e:7d:2a:aa:a5:f3:05:0e:1b"
    },
    {
      "type": "ssh-dss",
      "fingerprint": "8a:b9:c0:a6:b3:20:de:86:f6:10:97:8e:27:be:f1:ea"
    }
  ]
}
```

```
curl -s "http://127.0.0.1:8500/fingerprint/all/af:80:1e:6f:5a:cf:f3:6e:7d:2a:aa:a5:f3:05:0e:1b" | jq .
{
  "type": "ssh-rsa",
  "first_seen": "20201116",
  "last_seen": "20201116",
  "base64": "ssh-rsa AAAAB3NzaC1yc2EAAAABEQAAAQEAwe/8ooNGMyQCYTYcDlAAj1Da3e4uPbLNBA7zs/oKdeS9JhuJBO5oN0rwKk9B7Y429AL3OHHZUPVQMJ2Rt+fEfObYtLt+BI+289/DYdddUNxX3gU80rF4qiz1uQJ1FjcyW+LN1y219DE9rSshjY6aNPUshDhRuGnBxSNMJCl3pM6uxPnUhirccpobnHzO9C2cFAIMRGuy1/iJM/fwngGAlxYqtPJ8Pff7rTTcDrPF7YB7STSQXvBTgiwCHVEuxyQaX7Aik5BM0A+01W8j1b+lN+yzT4+EZbQJ4kQKfNb8aGWAcHacjs9VOfr4w79ynz/lPQ==",
  "fingerprint": "af:80:1e:6f:5a:cf:f3:6e:7d:2a:aa:a5:f3:05:0e:1b",
  "hosts": [
    "89.1.181.237"
  ]
}
```

Monitoring Attacker Infrastructure

- **Attackers are also system administrators** and use SSH to manage their infrastructure
- Some SSH installation are used as back-door on different ports
- **Understanding attacker infrastructure**[5] by looking at SSH banners, keys and fingerprints
- SSH cryptographic keys are renewed less often than TLS certificates

[5] A nice complement to Chapter 4 : Attack Infrastructure in Attribution of Advanced Persistent Threats, Timo Steffens

Uncloaking Tor hidden services with Passive SSH

- We collected a set of Tor onion addresses (60K) using the AIL framework
- Then we scanned for SSH on those onion addresses
- Finding **common set of fingerprints** between onion addresses and Internet-wide scan in Passive SSH
- Around 1.5% of Tor onion services are running SSH on a standard port

What's next?

- A MISP module to get Passive **SSH expansion and pivots in MISP project**
- Add SSH correlation in AIL framework for crawled Tor hidden services[6]
- Pcap feeder to Passive SSH
- Review of cryptographic materials[7] from existing Passive SSH database
- Improvement of the Passive SSH code base and release of version 1.0

[6] https://github.com/ail-project/ail-framework
[7] https://github.com/D4-project/snake-oil-crypto

Contact

- Get in touch if you want to get access to the **Passive SSH database** (you need to be a FIRST.org, TF-CSIRT or CNW member)
- Contact: info@circl.lu
- Source code: `https://github.com/D4-project/passive-ssh` - `https://twitter.com/d4_project`