

Threat Hunting SSH Keys – Bash Script Feature Pivoting

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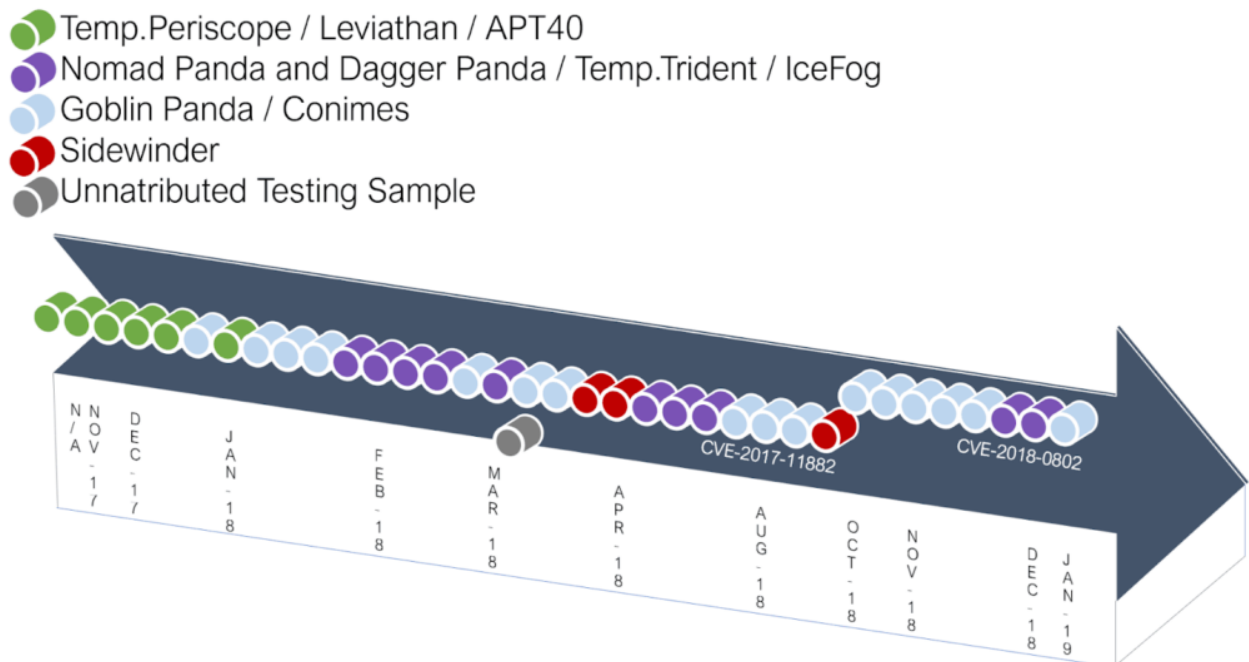
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Malicious actors often add SSH keys to victim hosts for persistence ([T1098.004](#)), in this blog we will show you how to hunt with that knowledge. The process of identifying malicious activity through threat intelligence pivoting is standard practice for any CTI analyst. For readers unfamiliar with the process, pivoting is the process of identifying similar or associated elements of data – such as network and host-based activity. For example, pivoting can be done through network characteristics such as unique C2 server configurations. Additionally, the process of pivoting can be applied to other areas, such as malware samples designed in similar ways or containing similar functionality. The process of pivoting has been written about extensively, and I recommend readers review the paper “[Formulating a Robust Pivoting Methodology](#)”. Ultimately, we want to pivot to discover new activity based on a relationship of many types.

Pivot Quality

When it comes to pivoting, it's important to avoid common mistakes. For example, an analyst could incorrectly associate a collection of domains through a bad pivot on a shared historical DNS record to a parked IP address. On the other hand, a malware sample could be related to others based on code reuse or functionality. A common opportunistic threat which we observe related to Linux and Cloud services are botnets of illicit cryptocurrency miners ([T1496](#)). A large majority of these ongoing attacks originate from the delivery and execution of scripts. Now, the scripts happen to reuse code from others on a large scale. For example, we've previously mentioned malicious scripts which uninstall monitoring agents for Tencent Host Security (YunJing) and the [Threat Detection Service \(Aegis\)](#) from Alibaba Cloud.

Lacework has observed this function being reused across various cloud targeting threats, such as the H2miner botnet, TeamTNT, and Rocke Group ([G0106](#)). In fact, it's almost a challenge to find similar scripts that do not contain this general function. In more capable and targeted adversary groups, the use of the [Royal Road](#), or "8.t" toolkit is an example of a potential pivot expanding your collection outside of your interests. Royal Road is a shared RTF weaponizer that has been observed in use across multiple seemingly unrelated APT groups such as Goblin Panda, APT40, and ICEFOG (China) [and then later with SideWinder](#) (India), later to be in use by various crimeware operators. If you were to pivot on the use of Royal Road alone, many incorrect conclusions could be made, which is a reason why attribution should be taken with caution. Nonetheless, it is important to challenge what is truly unique to your investigation interest and what could be shared widely among different actors.



Royal Road Use Timeline, Source: [Analyzing Digital Quartermasters in Asia – Anomali](#)

Malicious SSH Keys

Let's take a look at private SSH keys – a common, often unique, string we can observe in great quantities when searching for malware. A recent example of a malicious script that is easy to come across are Linux OS Raspberry Pi bots.

The script originally came to light in 2017 with the objective of installing an illicit miner. Today we continue to observe a new flood of the current-day version with the addition of many new features, including adding it to an IRC botnet, such as sample 65b4e03c1300eebf6823bb6834461960. At one point in the script, the actor's SSH key is added into `authorized_keys` for retaining access if the IRC bot is remediated by the victim.

```
39 rm -rf /root/.bashrc
40 rm -rf /home/pi/.bashrc
41
42 usermod -p \$6\$vGkGPKUr\$heqv0hUzvbQ66Nb0JGcIjh/81sG1WAccZgzPn8A0Wn58hHXWqy5y0gTLYJEb0jhkHD0MRsAkfJgjU/ioCYDeR1 pi
43
44 mkdir -p /root/.ssh
45 echo "ssh-rsa AAAAB3NzaC1yc2EAAAADAQABAAQCL0kIN33IJSIufmqpgg54D6s4J0L7XV2kep0rNzgy1S1IdE8HDef7z1ipBVuGTygGsq+x4yVnxveGshV
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zylUBp/XB6B" >> /root/.ssh/authorized_keys
46
```

SSH Key Addition Command

In this case, our working theory is the samples containing the same key are likely associated with the same operator and/or campaign. An SSH key is an interesting pivot because it is not only based on the uniqueness of a specific sample, it is also a unique identifier the attacker would have to manage as well. This means a pivot to all samples containing this key could be isolated to the same access manager/operator or a different actor reusing the code by accident (less likely). Of course, we must consider if any automated “builder” could include this at creation.

Yara Rules

So how do we pivot on this simple string? One can make use of their own sample telemetry or database if possible. The use of VirusTotal here can grant us access to samples as well. A very basic Yara could be:

```
rule pi_irc_botnet {
  strings:
    $a1 =
"AAAAB3NzaC1yc2EAAAADAQABAAQCL0kIN33IJSIufmqpgg54D6s4J0L7XV2kep0rNzgy1S1IdE8HDef7z

    $a2 = ">> /root/.ssh/authorized_keys"
  condition:
    all of them
}
```

That rule is based on a single file we observed maliciously dropping an IRC bot on a vulnerable Raspberry Pi, which leads us to over 550 samples on VirusTotal (IOCs below).

+ 1133 PRO

556 matches

VirusTotal Retro Results

Inspecting our hundreds of triggering files indicated this to be a strong link to associated malicious scripts – generally referenced as Backdoor:Linux/IRCbot. While this is a very simple and clear example, I hope it sheds some light on how to think about such a direct link to pivot on.

Technique Pivots

Now let's consider how we could widen our Yara rule for the purpose of finding samples not using this exact key, but the same technique of adding a key to `authorized_keys`. First, we can look for the echo of the key into `.ssh/authorized` keys based on ASCII strings. We must now consider legitimate files since we're not isolated to a specific key. Therefore, we should implement the rule with strings we could consider highly suspicious to be included in the same script.

```
rule sus_ssh_add {
  strings:
    $a1 = "echo \"ssh-rsa AAAA"
    $a2 = ">> /root/.ssh/authorized_keys"
    $b1 = "pkill -f"
    $b2 = "killall"
    $b3 = " >> /etc/hosts"
  condition:
    all of ($a*) and
    any of ($b*)
}
```

As you can see, we added the requirements for a few strings typically seen in malicious scripts. This includes process killing commands, and modifications to `etc/hosts`. What we're looking for here is not directly related to our original sample, so not a pivot on association, but a pivot on technique. This leads us to unassociated files which we can use for further research. When it comes to wide rules such as this, we need to be careful to consider how this could lead to false positives. My objective is to find the malicious with minimal false positives – so further tuning can be made based on the results of such a rule.

There are near endless possibilities for pivoting, and I hope this short post helps readers understand the value of some types over others. Our use of an actor unique and sample family unique string of an SSH key allows us to collect a few hundred associated samples. Additionally there are many things we can do to pivot on this technique to find other malicious activity in our telemetry.

In upcoming blogs we dive into further pivot techniques and make better use of the large influx of scripts reusing code and building off each other for improved infections. Please [follow us on Twitter](#) to keep up with our latest research. All IOCs from this blog are also [on our GitHub](#).

Associated indicators (IOCs)

1a903f084d90e57e95eb5656779a795b0a6895a65391bdc77d6056b9b54466af709074e10e839555e38c8439e4084038850a2ed2b99d2d5f8c8445672f2a14d7827cf5e018af83a5cc50bd02e80239c8a549f4874546244a00b2038796de1375aee5ab4a94f37843055005062bbf24939f16e9787f602fa7ba34b033fc417f5398022a72b7b5aae67d8c876365475b8931937a15d45d9ed0537b4f53e6d9af0d428ba78017d240f3ac3715a8f9647a2c9e8f3aedf93bb65d438152c67bc4ca5c86d00b441e314733a9111dc7598ce93da84e2254d6139f862f9075354a12b807cfc02c6b3eb4f7be05f7e440a9190e6bcd6df39a87422f71afed4ca603be0058a730da0e9129eea06a5a2d00845e3b15fd4db4d6ff15097e6a49383139f9d1ed4fe0224219c46e5efa6124aa3489f3fbe72b31c329ba77aa77ed0fb1d97784b8b612b0a357748bfad1e8dc52a4989d138a00239f191555bf124a8f023f85b559b8d3121d8b38d715278706c318829e17ca08277fe4db9398eccd21a9267e7da473f4c0986d0e2d3a366d0bd2d062c34dff480dfb5ef4b87ef8b0c3784dfb8fdde6cafe70ab02ca38a733866b3a26d118f05b5c1104e82fc994c5ebfe85a768e93291a4e24a30735c9ce6265de36dba979e6d9e7659857ace6b6e4425f170ac3ff315522d25f19891902cce2a602184a120cf69ff0d81600e05666accb3df5dbd45da696fcbab62463159cda9a3e402aa169d8325b33980689c8c728158b7b2656131c697deb7b4a0b9832351ef8361c69ba1ea78f922017654bf88ec59f8bec480acceaaa1b8484027d98e2b967d9beddd34f8ed1be4ad001e4eea7a46a83975ae639abf5466e0afb12ae8e6b24a7f1f3119c9b21e877742b46991d7329ef49a3a4e4202519a5804a866321f8017130bedcdc15e867d3d99d1b2de9f1609e783443f4e1d5460c2a5a6952e41e4ef9711bbeaa1bcc762a3747776c3feebb998bb8d1c9df10f4c464e3d204c653a9a8db1e5ada682e1a89629cda8b3dc36bba87a54850f875fc5c8abaaeffc754a1fc08f1082caeeeb518c44ae2d50aa57535e0cdd301ad2014bf9671bb85576081fe8cb7b244c99d037036e0a56c3621f45266a71ab0a1873a25a7bdfafca88a92e4ab1fe6dfa55b9fe141944709ccba5cbf1ea7f87ac1b9ed864b72b6976eaae94263f1b1aeeedaba1fc0af47f17d66f109605d616b5121e87d5cc57510ae9e1f26d4330df08efb9df86d39b2ad124f765dde9323105637a02a188326dec5759f0d6de1755353d43aa1f5b7ada609eb546c254c55e8a1183f9e96a5c475ed6c9ae2d3bf3892be604c4c40ea7bb65ac59a841f0c12f02518a428911ae94513e86ff36dfae7bb00ff829a6f1aec32f53a516ed60930ab2739db8dc6e73d58d813a7d13dce23c499b7766da3498dac02716333c87293ef77c0705706e51301894270a5a64e8c8f2e9c1180d532d4010c660f2fc2aa90dc35ad0b3b12331aa7b0918ad86a8d19715579282bbd978aaa7d6544a22e2857c231c9330eca8f3b65cbe563487b019fc62a0db0aa2bad84124b48656223cc1933416e6000744cc557713e3b9dc8f88c580b47091f0b8f211a3799d67

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