Security: IPsec

Software installation

Install ipsec-tools and strongswan

Commands to install ipsec:

```
wget http://launchpadlibrarian.net/234435245/ipsec-
tools_0.8.2+20140711-5_amd64.deb
sudo apt install ./ipsec-tools_0.8.2+20140711-5_amd64.deb
```

Command to install strongswan:

```
sudo apt install strongswan
```

IPSec configuration via setkey

Modification of configuration files

setkey.conf_a_

```
#!/usr/sbin/setkey -f

## konfiguracja dla maszyny A

## flush SAD and SPD
flush;
spdflush;

## add SAs in SAD
add 172.20.253.237 172.20.252.198 esp 0x1000 -E aes-cbc
0xaa223344556677889900aabbccddeeff;
add 172.20.252.198 172.20.253.237 esp 0x2000 -E aes-cbc
0xbb223344556677889900aabbccddeeff;

## add SPs in SPD
spdadd 172.20.253.237 172.20.252.198 any -P out ipsec
esp/transport//require;
spdadd 172.20.252.198 172.20.253.237 any -P in  ipsec
esp/transport//require;
```

setkey.conf_b_

```
#!/usr/sbin/setkey -f

## konfiguracja dla maszyny B

## flush SAD i SPD
flush;
spdflush;

## add SAs in SAD
add 172.20.253.237 172.20.252.198 esp 0x1000 -E aes-cbc
0xaa223344556677889900aabbccddeeff;
add 172.20.252.198 172.20.253.237 esp 0x2000 -E aes-cbc
0xbb223344556677889900aabbccddeeff;

## add SPs in SPD
spdadd 172.20.253.237 172.20.252.198 any -P in  ipsec
esp/transport//require;
spdadd 172.20.252.198 172.20.253.237 any -P out ipsec
esp/transport//require;
```

Configuration loading

On the machine a:

```
administrator@ipsec-A:~$ sudo setkey -f setkey.conf_a_
administrator@ipsec-A:~$ sudo setkey -D
172.20.252.198 172.20.253.237
        esp mode=transport spi=8192(0x00002000) reqid=0(0x00000000)
        E: aes-cbc  bb223344 55667788 9900aabb ccddeeff
        seq=0x00000000 replay=0 flags=0x00000000 state=mature
        created: Jun 14 19:29:57 2025   current: Jun 14 19:30:01 2025
        diff: 4(s)      hard: 0(s)      soft: 0(s)
        last:                           hard: 0(s)      soft: 0(s)
        current: 0(bytes)       hard: 0(bytes)  soft: 0(bytes)
        allocated: 0    hard: 0 soft: 0
        sadb_seq=1 pid=13464 refcnt=0
172.20.253.237 172.20.252.198
        esp mode=transport spi=4096(0x00001000) reqid=0(0x00000000)
        E: aes-cbc  aa223344 55667788 9900aabb ccddeeff
        seq=0x00000000 replay=0 flags=0x00000000 state=mature
        created: Jun 14 19:29:57 2025   current: Jun 14 19:30:01 2025
        diff: 4(s)      hard: 0(s)      soft: 0(s)
        last:                           hard: 0(s)      soft: 0(s)
        current: 0(bytes)       hard: 0(bytes)  soft: 0(bytes)
        allocated: 0    hard: 0 soft: 0
        sadb_seq=0 pid=13464 refcnt=0
administrator@ipsec-A:~$ sudo setkey -DP
172.20.252.198[any] 172.20.253.237[any] 255
```

```
        fwd prio def ipsec
        esp/transport//require
        created: Jun 14 19:29:57 2025  lastused:
        lifetime: 0(s) validtime: 0(s)
        spid=82 seq=1 pid=13511
        refcnt=1
172.20.252.198[any] 172.20.253.237[any] 255
        in prio def ipsec
        esp/transport//require
        created: Jun 14 19:29:57 2025  lastused:
        lifetime: 0(s) validtime: 0(s)
        spid=72 seq=2 pid=13511
        refcnt=1
172.20.253.237[any] 172.20.252.198[any] 255
        out prio def ipsec
        esp/transport//require
        created: Jun 14 19:29:57 2025  lastused:
        lifetime: 0(s) validtime: 0(s)
        spid=65 seq=3 pid=13511
        refcnt=1
(per-socket policy)
        in(socket) none
        created: Jun 14 19:18:30 2025  lastused:
        lifetime: 0(s) validtime: 0(s)
        spid=59 seq=4 pid=13511
        refcnt=1
(per-socket policy)
        out(socket) none
        created: Jun 14 19:18:30 2025  lastused:
        lifetime: 0(s) validtime: 0(s)
        spid=52 seq=5 pid=13511
        refcnt=1
(per-socket policy)
        in(socket) none
        created: Jun 14 19:18:30 2025  lastused:
        lifetime: 0(s) validtime: 0(s)
        spid=43 seq=6 pid=13511
        refcnt=1
(per-socket policy)
        out(socket) none
        created: Jun 14 19:18:30 2025  lastused:
        lifetime: 0(s) validtime: 0(s)
        spid=36 seq=7 pid=13511
        refcnt=1
(per-socket policy)
        in(socket) none
        created: Jun 14 19:18:30 2025  lastused:
        lifetime: 0(s) validtime: 0(s)
        spid=27 seq=8 pid=13511
        refcnt=1
(per-socket policy)
```

```
        out(socket) none
        created: Jun 14 19:18:30 2025  lastused:
        lifetime: 0(s) validtime: 0(s)
        spid=20 seq=9 pid=13511
        refcnt=1
(per-socket policy)
        in(socket) none
        created: Jun 14 19:18:30 2025  lastused:
        lifetime: 0(s) validtime: 0(s)
        spid=11 seq=10 pid=13511
        refcnt=1
(per-socket policy)
        out(socket) none
        created: Jun 14 19:18:30 2025  lastused:
        lifetime: 0(s) validtime: 0(s)
        spid=4 seq=0 pid=13511
        refcnt=1
administrator@ipsec-A:~$
```

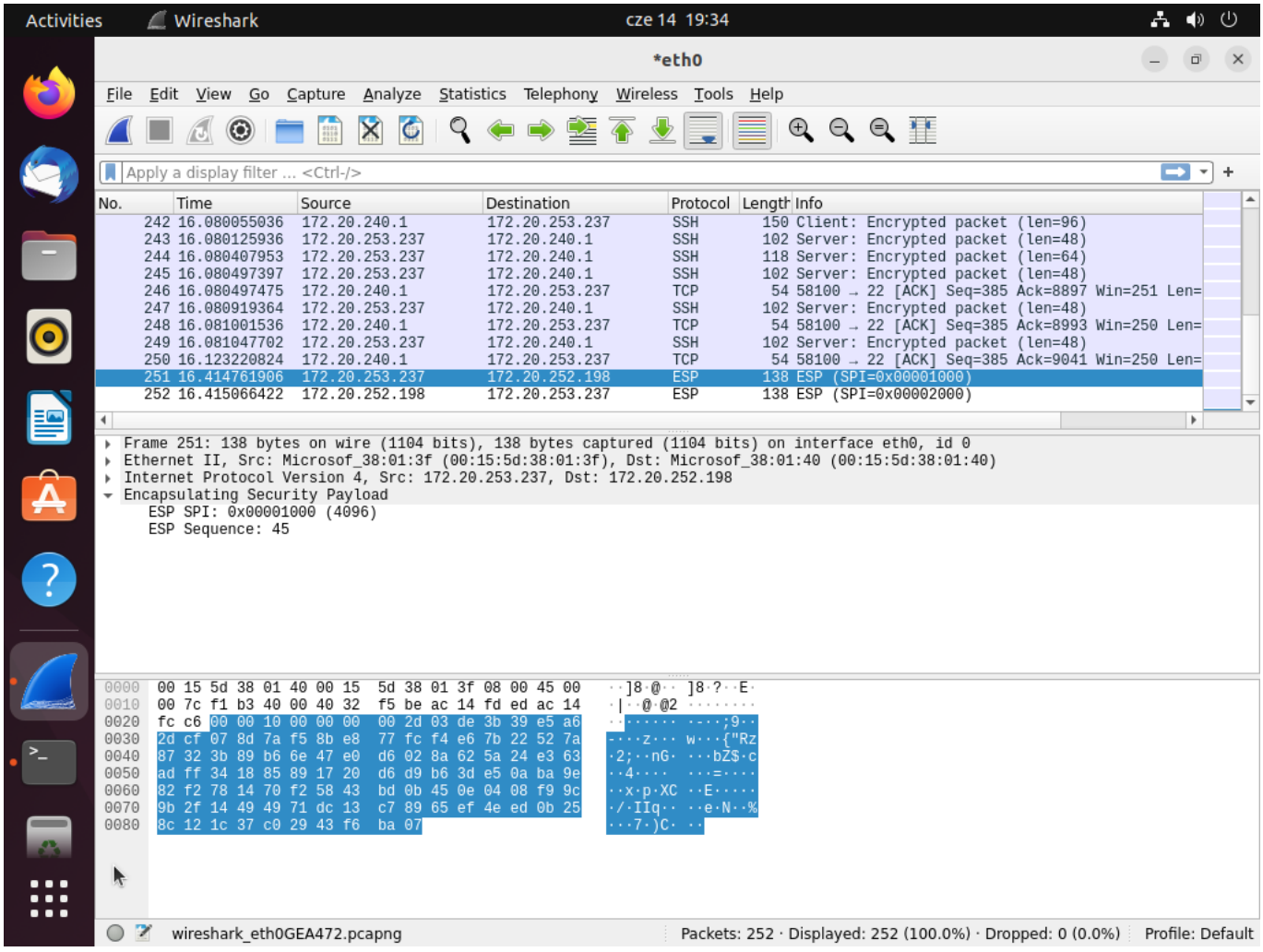
On machine b:

```
administrator@ipsec-B:~$ sudo setkey -f setkey.conf_b_
administrator@ipsec-B:~$ sudo setkey -D
172.20.252.198 172.20.253.237
        esp mode=transport spi=8192(0x00002000) reqid=0(0x00000000)
        E: aes-cbc  bb223344 55667788 9900aabb ccddeeff
        seq=0x00000000 replay=0 flags=0x00000000 state=mature
        created: Jun 14 19:31:00 2025   current: Jun 14 19:31:15 2025
        diff: 15(s)     hard: 0(s)      soft: 0(s)
        last:                           hard: 0(s)      soft: 0(s)
        current: 0(bytes)       hard: 0(bytes)  soft: 0(bytes)
        allocated: 0    hard: 0 soft: 0
        sadb_seq=1 pid=32009 refcnt=0
172.20.253.237 172.20.252.198
        esp mode=transport spi=4096(0x00001000) reqid=0(0x00000000)
        E: aes-cbc  aa223344 55667788 9900aabb ccddeeff
        seq=0x00000000 replay=0 flags=0x00000000 state=mature
        created: Jun 14 19:31:00 2025   current: Jun 14 19:31:15 2025
        diff: 15(s)     hard: 0(s)      soft: 0(s)
        last:                           hard: 0(s)      soft: 0(s)
        current: 0(bytes)       hard: 0(bytes)  soft: 0(bytes)
        allocated: 0    hard: 0 soft: 0
        sadb_seq=0 pid=32009 refcnt=0
administrator@ipsec-B:~$ sudo setkey -DP
172.20.252.198[any] 172.20.253.237[any] 255
        out prio def ipsec
        esp/transport//require
        created: Jun 14 19:31:00 2025  lastused:
        lifetime: 0(s) validtime: 0(s)
        spid=17 seq=1 pid=32078
        refcnt=1
```

```
172.20.253.237[any] 172.20.252.198[any] 255
        fwd prio def ipsec
        esp/transport//require
        created: Jun 14 19:31:00 2025  lastused:
        lifetime: 0(s) validtime: 0(s)
        spid=10 seq=2 pid=32078
        refcnt=1
172.20.253.237[any] 172.20.252.198[any] 255
        in prio def ipsec
        esp/transport//require
        created: Jun 14 19:31:00 2025  lastused:
        lifetime: 0(s) validtime: 0(s)
        spid=8 seq=0 pid=32078
        refcnt=1
administrator@ipsec-B:~$
```

Tunnel Action Test

Performing a ping from machine A to B and observing the ESP header



Questions

What traffic is secured by an IPSec tunnel?

IP traffic between machines A (172.20.253.237) and B (172.20.252.198) - any protocol (any) defined in the SPD.

What IPSec protocol is used? Which algorithms?

- Protocol: ESP
- Encryption algorithm: AES-CBC
- Services: Encryption (no authentication in this example)

Role of SAD and SPD:

- SAD: Stores SA parameters (keys, algorithms, SPI).
- SPD: Stores the security policies (which traffic is to be secured and how)

Which commands are processed for outbound/inbound traffic?

- For outgoing packets -. `spdadd … -P out`
- For incoming packets - `spdadd … -P in`

Why do you need two SAs?

SAs are unidirectional - one for A → B, the other for B → A to secure a two-way channel.

Meaning of commands ''setkey -D'' i ''setkey -DP''

- `-D` - shows active security associations (SA)
- `-DP` - shows active safety policies (SPD)

What is the purpose of the SPI field in the IPSec header?

The SPI (Security Parameter Index) is a unique security association (SA) identifier that allows the recipient to identify which parameters to use to decrypt and authenticate the packet.

What is the purpose of the Sequence Number field in the IPSec header?

The Sequence Number is used to prevent replay attacks. The number increases monotonically for each packet, allowing you to check that packets have not been replayed.

Modifying IPSec and SA policies

ESP with AES-CBC + HMAC-SHA1

setkey.conf_a_

```
#!/usr/sbin/setkey -f

## maszyna A (172.20.253.237)
flush;
spdflush;

## SA: A->B
add 172.20.253.237 172.20.252.198 esp 0x1000 -E aes-cbc
0xaa223344556677889900aabbccddeeff -A hmac-sha1
0x00112233445566778899aabbccddeeff00112233;
## SA: B->A
add 172.20.252.198 172.20.253.237 esp 0x2000 -E aes-cbc
0xbb223344556677889900aabbccddeeff -A hmac-sha1
0x11223344556677889900aabbccddeeff00112233;

## SPD: zabezpiecz wszystkie pakiety ESP w trybie transportowym
spdadd 172.20.253.237 172.20.252.198 any -P out ipsec
esp/transport//require;
spdadd 172.20.252.198 172.20.253.237 any -P in ipsec
esp/transport//require;
```

setkey.conf_b_

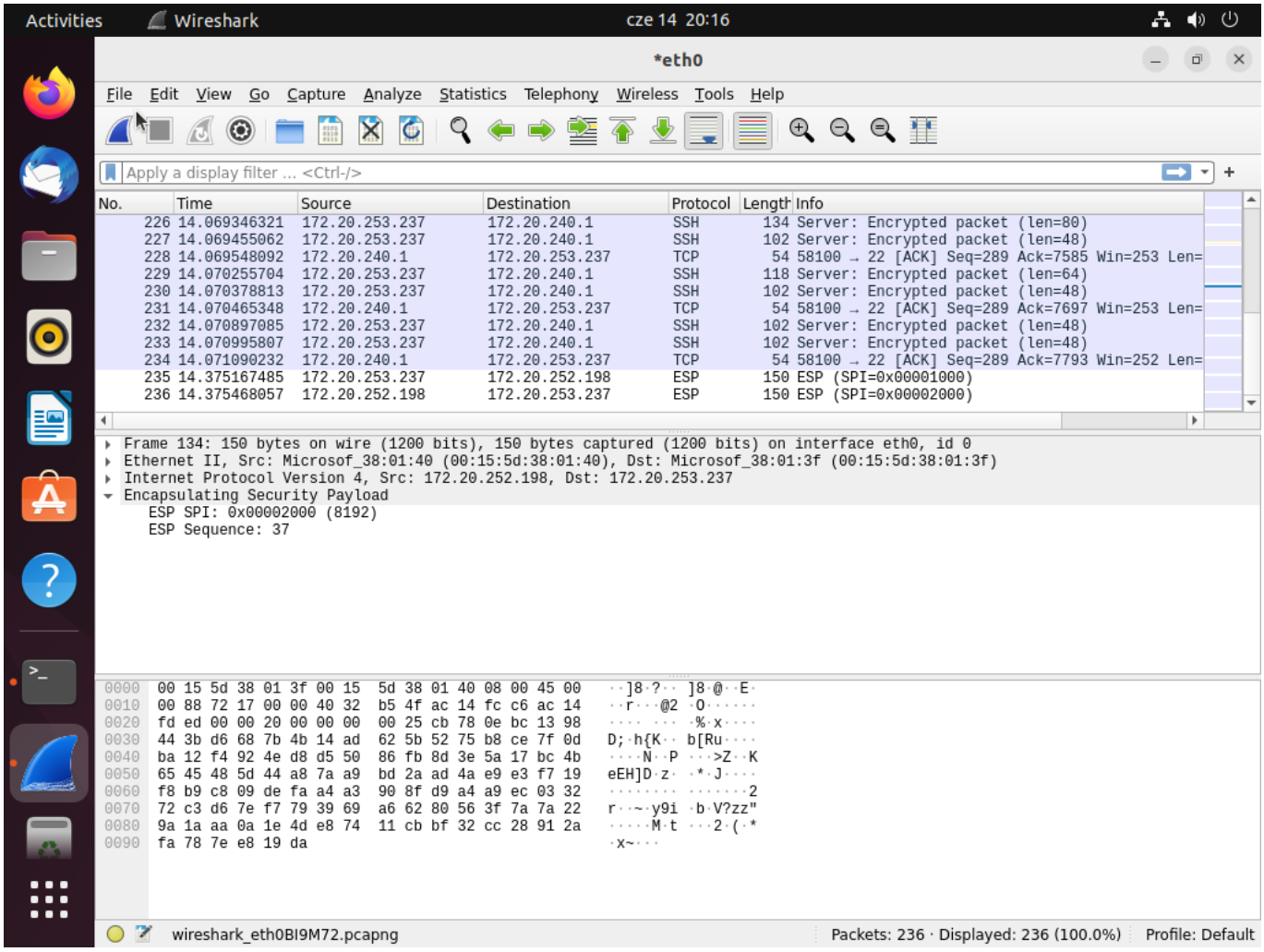
```
#!/usr/sbin/setkey -f

## maszyna B (172.20.252.198)
flush;
spdflush;

## SA: B->A
add 172.20.252.198 172.20.253.237 esp 0x2000 -E aes-cbc
0xbb223344556677889900aabbccddeeff -A hmac-sha1
0x00112233445566778899aabbccddeeff00112233;
## SA: A->B
add 172.20.253.237 172.20.252.198 esp 0x1000 -E aes-cbc
0xaa223344556677889900aabbccddeeff -A hmac-sha1
0x00112233445566778899aabbccddeeff00112233;

## SPD: zabezpiecz wszystkie pakiety ESP w trybie transportowym
spdadd 172.20.252.198 172.20.253.237 any -P out ipsec
esp/transport//require;
spdadd 172.20.253.237 172.20.252.198 any -P in ipsec
```

```
esp/transport//require;
```



AH with HMAC-SHA1

setkey.conf_a_

```
#!/usr/sbin/setkey -f

## maszyna A (172.20.253.237)
flush;
spdflush;

## SA: A->B
add 172.20.253.237 172.20.252.198 ah 0x1000 -A hmac-sha1
0x00112233445566778899aabbccddeeff00112233;
## SA: B->A
add 172.20.252.198 172.20.253.237 ah 0x2000 -A hmac-sha1
0x11223344556677889900aabbccddeeff00112233;

## SPD: zabezpiecz wszystkie pakiety AH w trybie transportowym
spdadd 172.20.253.237 172.20.252.198 any -P out ipsec
```

```
ah/transport//require;
spdadd 172.20.252.198 172.20.253.237 any -P in ipsec
ah/transport//require;
```

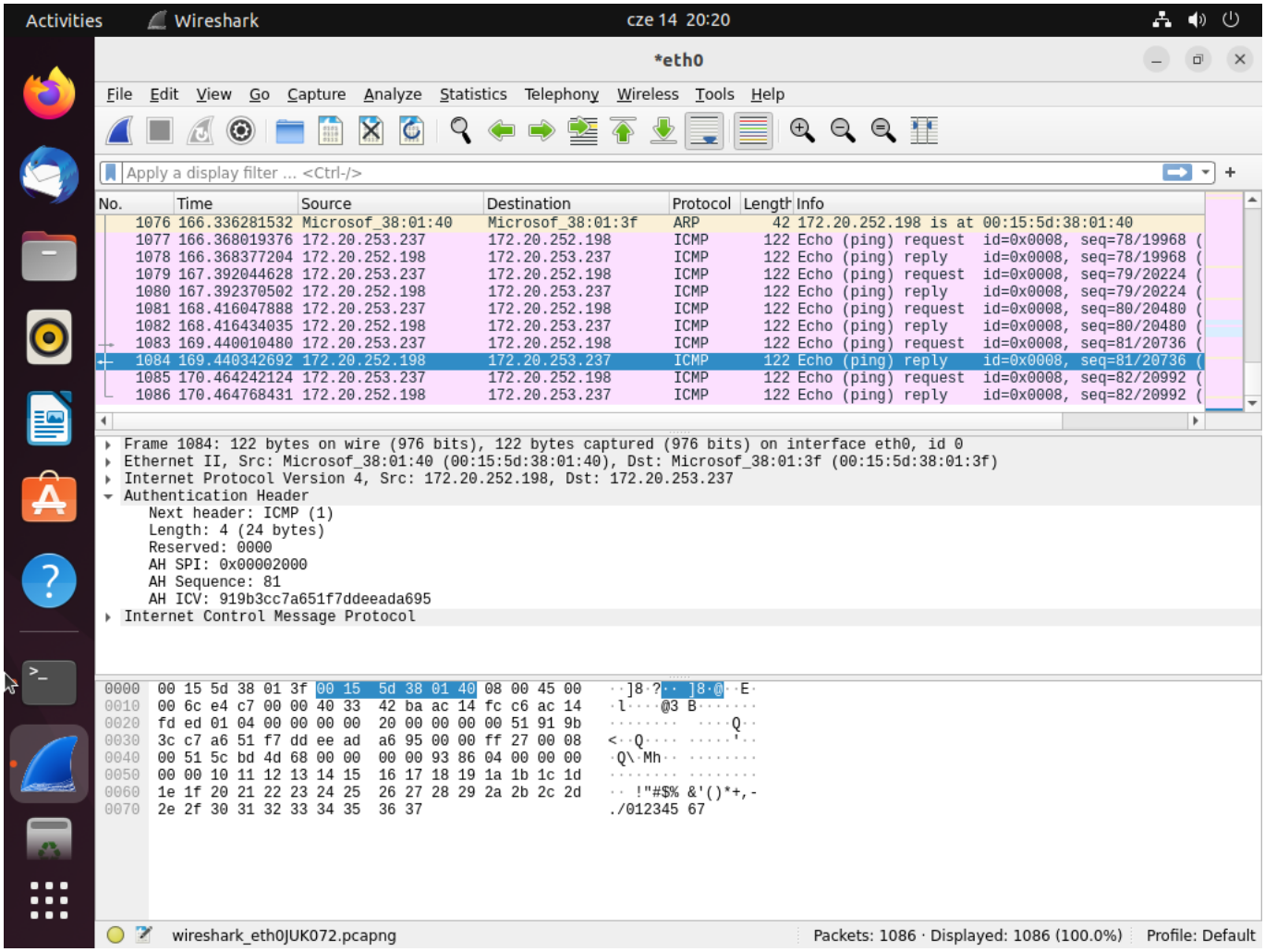
setkey.conf_b_

```
#!/usr/sbin/setkey -f

## maszyna B (172.20.252.198)
flush;
spdflush;

## SA: B->A
add 172.20.252.198 172.20.253.237 ah 0x2000 -A hmac-sha1
0x11223344556677889900aabbccddeeff00112233;
## SA: A->B
add 172.20.253.237 172.20.252.198 ah 0x1000 -A hmac-sha1
0x00112233445566778899aabbccddeeff00112233;

## SPD: zabezpiecz wszystkie pakiety AH w trybie transportowym
spdadd 172.20.252.198 172.20.253.237 any -P out ipsec
ah/transport//require;
spdadd 172.20.253.237 172.20.252.198 any -P in ipsec
ah/transport//require;
```



ESP (AES-CBC) + AH (HMAC-SHA1)

setkey.conf_a_

```
#!/usr/sbin/setkey -f

## maszyna A (172.20.253.237)
flush;
spdflush;

## SA ESP: A->B
add 172.20.253.237 172.20.252.198 esp 0x3000 -E aes-cbc
0xaa223344556677889900aabbccddeeff;
## SA ESP: B->A
add 172.20.252.198 172.20.253.237 esp 0x4000 -E aes-cbc
0xbb223344556677889900aabbccddeeff;

## SA AH: A->B
add 172.20.253.237 172.20.252.198 ah 0x5000 -A hmac-sha1
0x00112233445566778899aabbccddeeff00112233;
## SA AH: B->A
add 172.20.252.198 172.20.253.237 ah 0x6000 -A hmac-sha1
```

```
0x00112233445566778899aabbccddeeff00112233;

## SPD: zabezpiecz pakiety ESP i AH w trybie transportowym
spdadd 172.20.253.237 172.20.252.198 any -P out ipsec
esp/transport//require ah/transport//require;
spdadd 172.20.252.198 172.20.253.237 any -P in ipsec
esp/transport//require ah/transport//require;
```

setkey.conf_b_

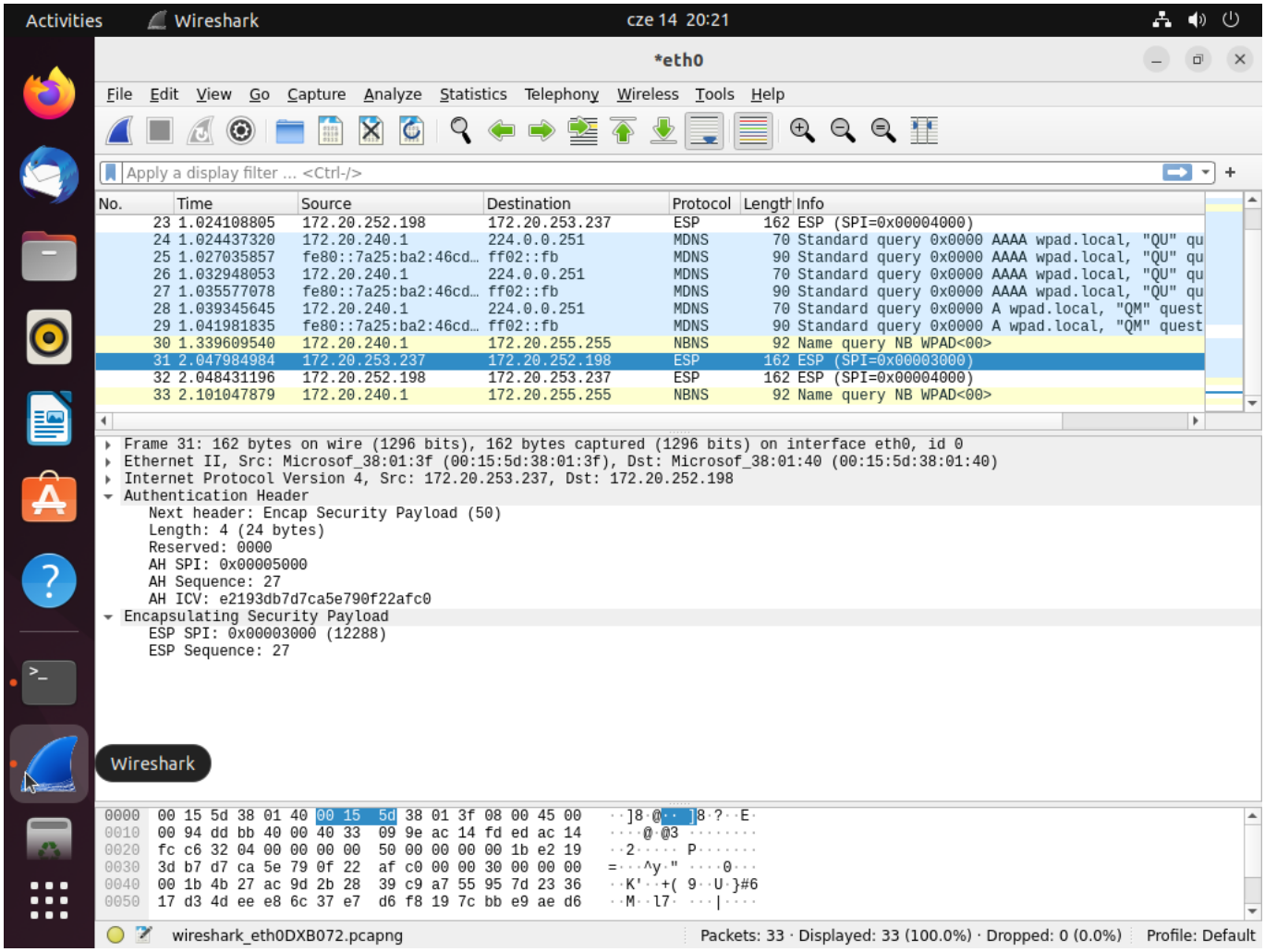
```
#!/usr/sbin/setkey -f

## maszyna B (172.20.252.198)
flush;
spdflush;

## SA ESP: B->A
add 172.20.252.198 172.20.253.237 esp 0x4000 -E aes-cbc
0xbb223344556677889900aabbccddeeff;
## SA ESP: A->B
add 172.20.253.237 172.20.252.198 esp 0x3000 -E aes-cbc
0xaa223344556677889900aabbccddeeff;

## SA AH: B->A
add 172.20.252.198 172.20.253.237 ah 0x6000 -A hmac-sha1
0x00112233445566778899aabbccddeeff00112233;
## SA AH: A->B
add 172.20.253.237 172.20.252.198 ah 0x5000 -A hmac-sha1
0x00112233445566778899aabbccddeeff00112233;

## SPD: zabezpiecz pakiety ESP i AH w trybie transportowym
spdadd 172.20.252.198 172.20.253.237 any -P out ipsec
esp/transport//require ah/transport//require;
spdadd 172.20.253.237 172.20.252.198 any -P in ipsec
esp/transport//require ah/transport//require;
```



Questions

Difference between ESP and ESP+AH configurations

- ESP protects the data (encrypts), but does not protect the entire IP header.
- AH does not encrypt, but protects the integrity of the entire IP packet (with header).
- ESP+AH ensures the confidentiality and integrity of the header and data.

Application of AH

For connections where the integrity of the entire IP header is important (e.g. for auditing systems or where it is not possible to use encryption).

IKE and strongSwan protocol (PSK)

SAD and SPD cleansing

On bush A and B:

```
sudo setkey -F    # usuń wszystkie SA
sudo setkey -FP   # usuń wszystkie SP
```

Configurations

Machine A

/etc/ipsec.conf:

```
config setup
    charondebug = "ike 1, knl 1, cfg 1"

conn host-host
    keyexchange=ikev2
    authby=psk
    left=172.20.253.237       # lokalny endpoint
    leftsubnet=172.20.253.237/32
    right=172.20.252.198      # zdalny endpoint
    rightsubnet=172.20.252.198/32
    ike=aes256-sha1-modp1024
    esp=aes256-sha1
    auto=add
```

/etc/ipsec.secrets:

```
172.20.253.237 172.20.252.198 : PSK "SuperTajnyPSK"
```

Machine B

/etc/ipsec.conf:

```
config setup
    charondebug = "ike 1, knl 1, cfg 1"

conn host-host
    keyexchange=ikev2
    authby=psk
    left=172.20.252.198
    leftsubnet=172.20.252.198/32
    right=172.20.253.237
    rightsubnet=172.20.253.237/32
    ike=aes256-sha1-modp1024
    esp=aes256-sha1
    auto=add
```

/etc/ipsec.secrets:

```
172.20.252.198 172.20.253.237 : PSK "SuperTajnyPSK"
```

Starting strongSwan and establishing a tunnel

```
administrator@ipsec-A:~$ sudo ipsec restart
Stopping strongSwan IPsec...
Starting strongSwan 5.9.5 IPsec [starter]...
administrator@ipsec-A:~$ sudo ipsec up host-host
initiating IKE_SA host-host[1] to 172.20.252.198
generating IKE_SA_INIT request 0 [ SA KE No N(NATD_S_IP) N(NATD_D_IP)
N(FRAG_SUP) N(HASH_ALG) N(REDIR_SUP) ]
sending packet: from 172.20.253.237[500] to 172.20.252.198[500] (1044 bytes)
received packet: from 172.20.252.198[500] to 172.20.253.237[500] (344 bytes)
parsed IKE_SA_INIT response 0 [ SA KE No N(NATD_S_IP) N(NATD_D_IP)
N(FRAG_SUP) N(HASH_ALG) N(CHDLESS_SUP) N(MULT_AUTH) ]
selected proposal: IKE:AES_CBC_256/HMAC_SHA1_96/PRF_HMAC_SHA1/MODP_1024
authentication of '172.20.253.237' (myself) with pre-shared key
establishing CHILD_SA host-host{1}
generating IKE_AUTH request 1 [ IDi N(INIT_CONTACT) IDr AUTH SA TSi TSr
N(MOBIKE_SUP) N(NO_ADD_ADDR) N(MULT_AUTH) N(EAP_ONLY) N(MSG_ID_SYN_SUP) ]
sending packet: from 172.20.253.237[4500] to 172.20.252.198[4500] (412
bytes)
received packet: from 172.20.252.198[4500] to 172.20.253.237[4500] (220
bytes)
parsed IKE_AUTH response 1 [ IDr AUTH SA TSi TSr N(MOBIKE_SUP)
N(NO_ADD_ADDR) ]
authentication of '172.20.252.198' with pre-shared key successful
IKE_SA host-host[1] established between
172.20.253.237[172.20.253.237]...172.20.252.198[172.20.252.198]
scheduling reauthentication in 9788s
maximum IKE_SA lifetime 10328s
selected proposal: ESP:AES_CBC_256/HMAC_SHA1_96/NO_EXT_SEQ
CHILD_SA host-host{1} established with SPIs c4b20310_i c04d47dc_o and TS
172.20.253.237/32 === 172.20.252.198/32
peer supports MOBIKE
connection 'host-host' established successfully
administrator@ipsec-A:~$ sudo setkey -D
172.20.253.237 172.20.252.198
        esp mode=tunnel spi=3226290140(0xc04d47dc) reqid=1(0x00000001)
        E: aes-cbc  7ed41201 e80a0bf4 fb871600 4cfcbfab 1e6e4fb3 c346376a
429d1575 1d58fc17
        A: hmac-sha1  7a7a8e7d 7beaad8e 5f045ba1 45b42d7f bcc4de08
        seq=0x00000000 replay=0 flags=0x00000000 state=mature
        created: Jun 14 20:37:14 2025   current: Jun 14 20:37:52 2025
        diff: 38(s)     hard: 3600(s)   soft: 2765(s)
        last: Jun 14 20:37:14 2025      hard: 0(s)      soft: 0(s)
        current: 3192(bytes)    hard: 0(bytes)  soft: 0(bytes)
        allocated: 38   hard: 0 soft: 0
        sadb_seq=1 pid=28477 refcnt=0
```

```
172.20.252.198 172.20.253.237
        esp mode=tunnel spi=3300000528(0xc4b20310) reqid=1(0x00000001)
        E: aes-cbc  b834b5fd 2412b9cf 9e4ac726 29160d9e afbb91b0 7b2aafd5
07fc4c67 052b7958
        A: hmac-sha1  31564ba0 bfdb79ff 872d5e0b fc3079d4 ea43a976
        seq=0x00000000 replay=32 flags=0x00000000 state=mature
        created: Jun 14 20:37:14 2025   current: Jun 14 20:37:52 2025
        diff: 38(s)     hard: 3600(s)   soft: 2819(s)
        last: Jun 14 20:37:14 2025      hard: 0(s)      soft: 0(s)
        current: 3192(bytes)    hard: 0(bytes)  soft: 0(bytes)
        allocated: 38   hard: 0 soft: 0
        sadb_seq=0 pid=28477 refcnt=0
administrator@ipsec-A:~$ sudo setkey -DP
172.20.253.237[any] 172.20.252.198[any] 255
        out prio high + 1073374593 ipsec
        esp/tunnel/172.20.253.237-172.20.252.198/unique:1
        created: Jun 14 20:37:14 2025  lastused: Jun 14 20:37:56 2025
        lifetime: 0(s) validtime: 0(s)
        spid=265 seq=1 pid=28510
        refcnt=1
172.20.252.198[any] 172.20.253.237[any] 255
        fwd prio high + 1073374593 ipsec
        esp/tunnel/172.20.252.198-172.20.253.237/unique:1
        created: Jun 14 20:37:14 2025  lastused:
        lifetime: 0(s) validtime: 0(s)
        spid=258 seq=2 pid=28510
        refcnt=1
172.20.252.198[any] 172.20.253.237[any] 255
        in prio high + 1073374593 ipsec
        esp/tunnel/172.20.252.198-172.20.253.237/unique:1
        created: Jun 14 20:37:14 2025  lastused: Jun 14 20:37:56 2025
        lifetime: 0(s) validtime: 0(s)
        spid=248 seq=3 pid=28510
        refcnt=1
(per-socket policy)
        in(socket) none
        created: Jun 14 20:34:15 2025  lastused: Jun 14 20:37:14 2025
        lifetime: 0(s) validtime: 0(s)
        spid=243 seq=4 pid=28510
        refcnt=1
(per-socket policy)
        out(socket) none
        created: Jun 14 20:34:15 2025  lastused: Jun 14 20:37:14 2025
        lifetime: 0(s) validtime: 0(s)
        spid=236 seq=5 pid=28510
        refcnt=1
(per-socket policy)
        in(socket) none
        created: Jun 14 20:34:15 2025  lastused: Jun 14 20:37:14 2025
        lifetime: 0(s) validtime: 0(s)
        spid=227 seq=6 pid=28510
```

```
        refcnt=1
(per-socket policy)
        out(socket) none
        created: Jun 14 20:34:15 2025  lastused: Jun 14 20:37:14 2025
        lifetime: 0(s) validtime: 0(s)
        spid=220 seq=7 pid=28510
        refcnt=1
(per-socket policy)
        in(socket) none
        created: Jun 14 20:34:15 2025  lastused:
        lifetime: 0(s) validtime: 0(s)
        spid=211 seq=8 pid=28510
        refcnt=1
(per-socket policy)
        out(socket) none
        created: Jun 14 20:34:15 2025  lastused:
        lifetime: 0(s) validtime: 0(s)
        spid=204 seq=9 pid=28510
        refcnt=1
(per-socket policy)
        in(socket) none
        created: Jun 14 20:34:15 2025  lastused:
        lifetime: 0(s) validtime: 0(s)
        spid=195 seq=10 pid=28510
        refcnt=1
(per-socket policy)
        out(socket) none
        created: Jun 14 20:34:15 2025  lastused:
        lifetime: 0(s) validtime: 0(s)
        spid=188 seq=0 pid=28510
        refcnt=1
administrator@ipsec-A:~$
```

Questions

How many SA associations have been negotiated?

The setkey -D result shows two ESP associations in the SAD database (SPI 0xc04d47dc and 0xc4b20310) - one for each direction of movement.

What type of IPSec header and mode was used for the SA associations created? What algorithms were used?

According to the ipsec log up host-host, ESP was negotiated in tunnel mode (ESP:AES_CBC_256/HMAC_SHA1_96/NO_EXT_SEQ).

Algorithms: AES-CBC 256-bit for encryption and HMAC-SHA1-96 (96-bit tag) for authentication.

What is the key length used for each algorithm?

AES-CBC-256 uses a key length of 256 bits.

HMAC-SHA1-96 uses a tag of 96 bits (12 bytes), although the HMAC key itself can be longer (typically 160 bits), in the log we see 20 bytes of key, but the tag is truncated to 12 bytes.

In which phase of the IKE protocol was the shared PSK key used?

The PSK key was used in phase 1 (IKE_SA_INIT and IKE_AUTH) to authenticate the endpoints.

What SPD policies were created by the IKE process?

setkey -DP shows four entries:

two out and in entries for ESP tunnel mode (one each for A→B and B→A traffic) with reqid = 1 and unique flag.

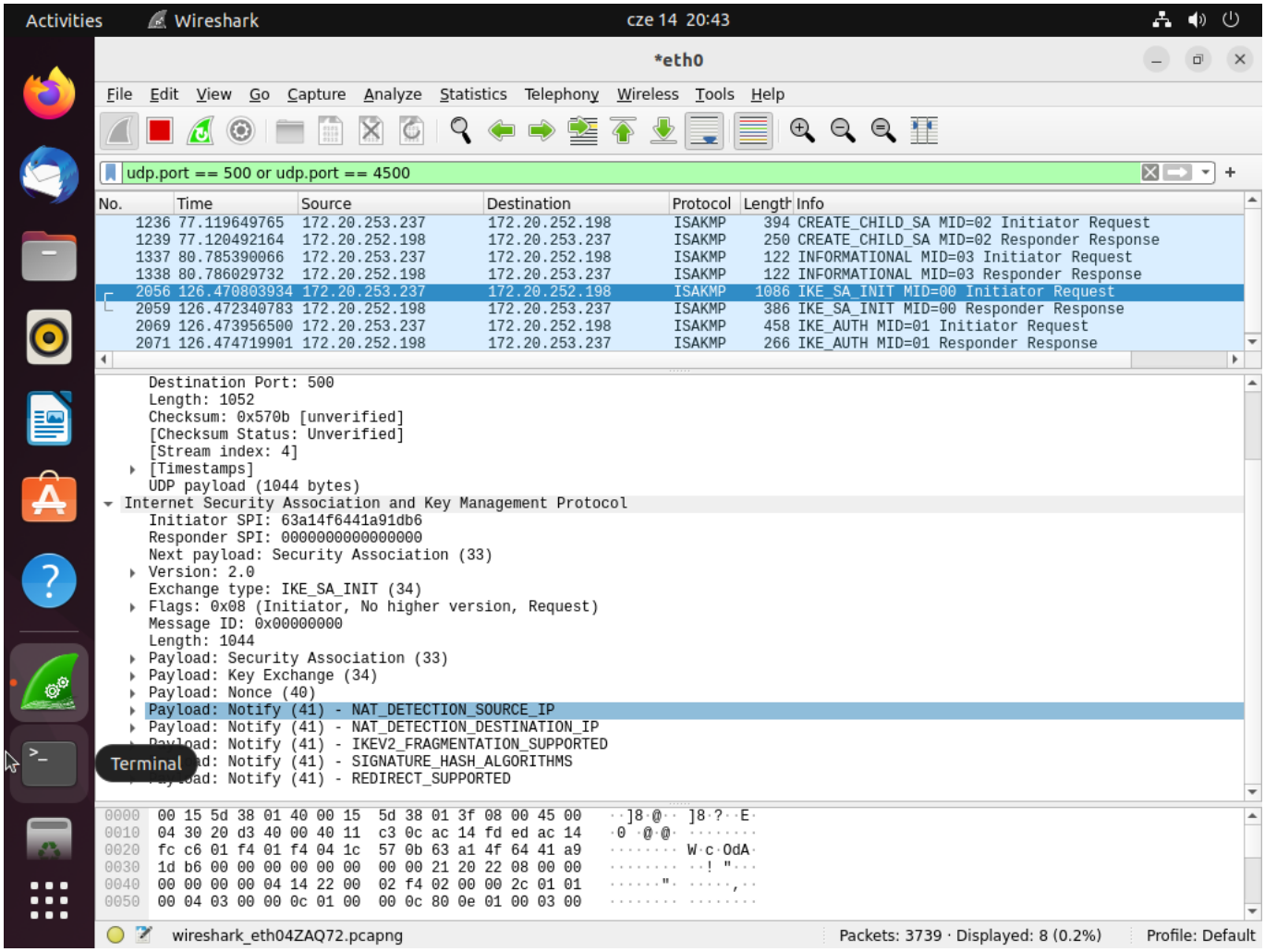
an additional fwd entry related to packet forwarding.

Policies apply to traffic 172.20.253.237[any]. ↔ 172.20.252.198[any] and have priority 'high', operation ipsec esp/tunnel/…/unique:1.

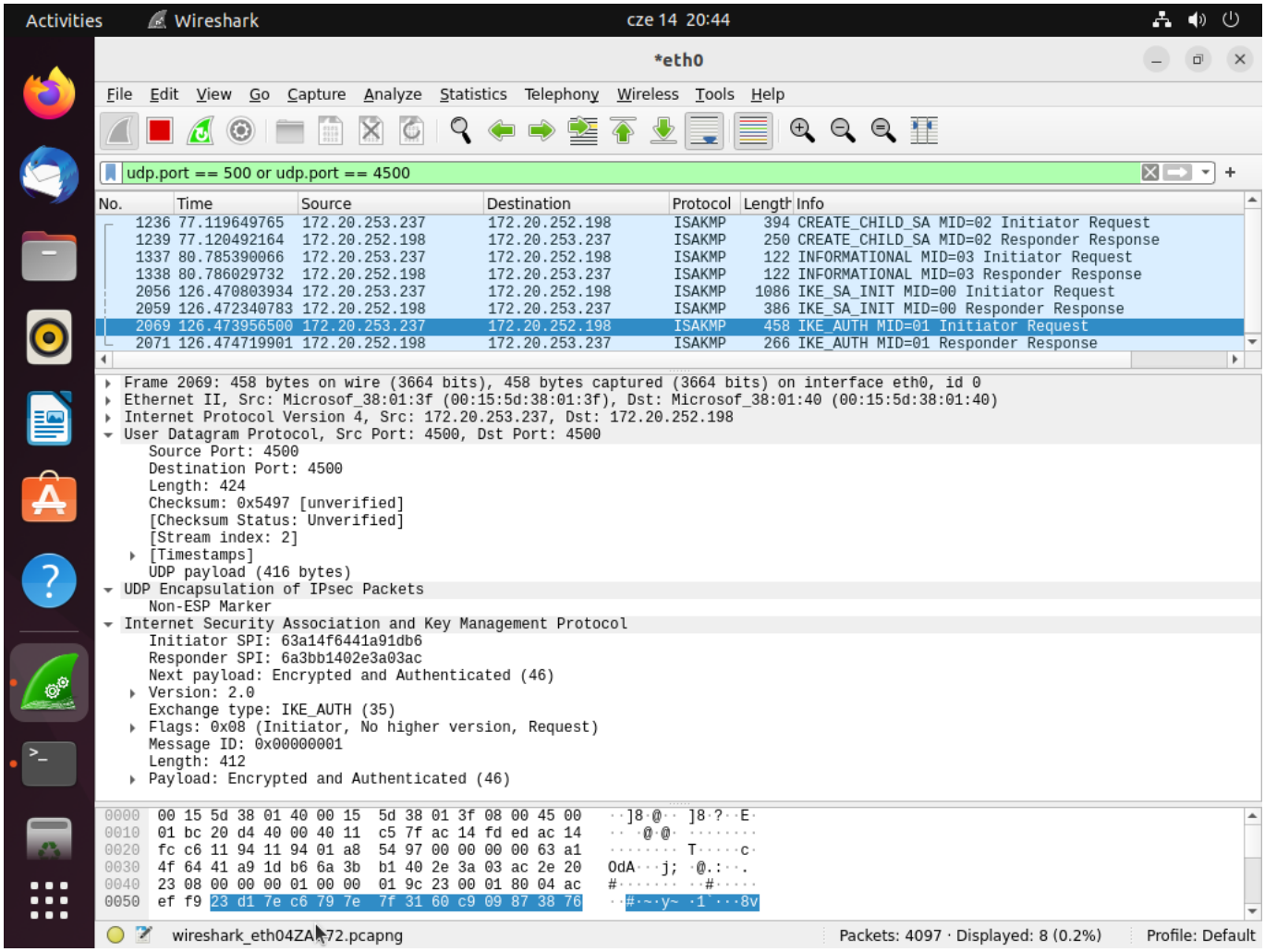
Analysis of IKE traffic in Wireshark

Filter: `udp.port == 500 or udp.port == 4500`.

The IKE_SA_INIT packets show the exchange of SA offers (AES_CBC_256/HMAC_SHA1_96/PRF_HMAC_SHA1/MODP_1024) and DH keys.



In IKE_AUTH, IDi, IDr and AUTH payload with PSK authentication appear.


Activities
Wireshark
cze 14 20:44
*eth0
File Edit View Go Capture Analyze Statistics Telephony Wireless Tools Help
udp.port == 500 or udp.port == 4500
No. Time Source Destination Protocol Length Info
1236 77.119649765 172.20.253.237 172.20.252.198 ISAKMP 394 CREATE_CHILD_SA MID=02 Initiator Request
1239 77.120492164 172.20.252.198 172.20.253.237 ISAKMP 250 CREATE_CHILD_SA MID=02 Responder Response
1337 80.785390066 172.20.253.237 172.20.252.198 ISAKMP 122 INFORMATIONAL MID=03 Initiator Request
1338 80.786029732 172.20.252.198 172.20.253.237 ISAKMP 122 INFORMATIONAL MID=03 Responder Response
2056 126.470803934 172.20.253.237 172.20.252.198 ISAKMP 1086 IKE_SA_INIT MID=00 Initiator Request
2059 126.472340783 172.20.252.198 172.20.253.237 ISAKMP 386 IKE_SA_INIT MID=00 Responder Response
2069 126.473956500 172.20.253.237 172.20.252.198 ISAKMP 458 IKE_AUTH MID=01 Initiator Request
2071 126.474719901 172.20.252.198 172.20.253.237 ISAKMP 266 IKE_AUTH MID=01 Responder Response
Frame 2069: 458 bytes on wire (3664 bits), 458 bytes captured (3664 bits) on interface eth0, id 0
Ethernet II, Src: Microsof_38:01:3f (00:15:5d:38:01:3f), Dst: Microsof_38:01:40 (00:15:5d:38:01:40)
Internet Protocol Version 4, Src: 172.20.253.237, Dst: 172.20.252.198
User Datagram Protocol, Src Port: 4500, Dst Port: 4500
Source Port: 4500
Destination Port: 4500
Length: 424
Checksum: 0x5497 [unverified]
[Checksum Status: Unverified]
[Stream index: 2]
[Timestamps]
UDP payload (416 bytes)
UDP Encapsulation of IPsec Packets
Non-ESP Marker
Internet Security Association and Key Management Protocol
Initiator SPI: 63a14f6441a91db6
Responder SPI: 6a3bb1402e3a03ac
Next payload: Encrypted and Authenticated (46)
Version: 2.0
Exchange type: IKE_AUTH (35)
Flags: 0x08 (Initiator, No higher version, Request)
Message ID: 0x00000001
Length: 412
Payload: Encrypted and Authenticated (46)
0000 00 15 5d 38 01 40 00 15 5d 38 01 3f 08 00 45 00
0010 01 bc 20 d4 40 00 40 11 c5 7f ac 14 fd ed ac 14
0020 fc c6 11 94 11 94 01 a8 54 97 00 00 00 00 63 a1
0030 4f 64 41 a9 1d b6 6a 3b b1 40 2e 3a 03 ac 2e 20
0040 23 08 00 00 00 01 00 00 01 9c 23 00 01 80 04 ac
0050 ef f9 23 d1 7e c6 79 7e 7f 31 60 c9 09 87 38 76
wireshark_eth04ZA72.pcapng
Packets: 4097 · Displayed: 8 (0.2%)
Profile: Default