3. Cmds < $h_1 \to h_2$ >   tp_src   tp_dst   Openflow (2)   *

```
ovs-ofctl add-flow -O OpenFlow14 tcp:127.0.0.1:6654 arp, arp_op=1, actions=flood (1)
ovs-ofctl add-flow -O OpenFlow14 tcp:127.0.0.1:6654 arp, arp_op=2, eth_src=@MAC_H1, eth_dst=@MAC_H2, inport=1, actions=output:2 (2)
ovs-ofctl add-flow -O OpenFlow14 tcp:127.0.0.1:6654, arp, arp_op=2, eth_src=@MAC_H2 eth_dst=@MAC_H1, in_port=2, actions=output:1 (3)
ovs-ofctl add-flow -O OpenFlow14 tcp:127.0.0.1:6654, tcp, in_port=1, nw_src=@IP_H1, nw_dst=@IP_H2, tcp_flags=+Syn, actions=output:2 (4)
ovs-ofctl add-flow -O OpenFlow14 tcp:127.0.0.1:6654, tcp, in_port=2, nw_src=@IP_H2, nw_dst=@IP_H1, tcp_flags=+Syn+Ack, actions=output:1
ovs-ofctl add-flow -O OpenFlow14 tcp:127.0.0.1:6654, tcp, in_port=1, nw_src=@IP_H1, nw_dst=@IP_H2, tcp_flags=-Syn, actions=output:2
ovs-ofctl add-flow -O OpenFlow14 tcp:127.0.0.1:6654, tcp, in_port=2, nw_src=@IP_H2, nw_dst=@IP_H1, tcp_flags=-Syn, actions=output:1
```

(1) ARP request

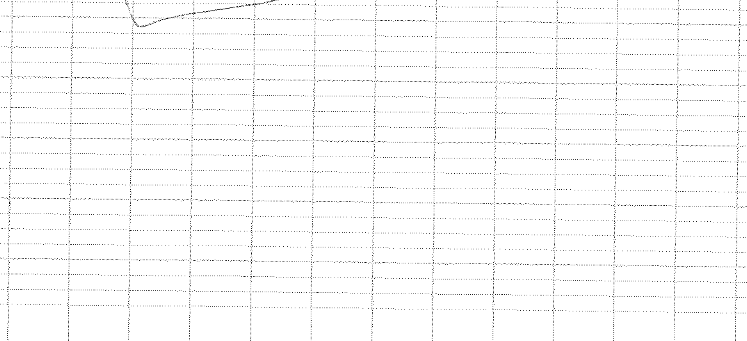
(2) ARP ~~request~~ = Reply   h1 → h2
                                h2 → h1

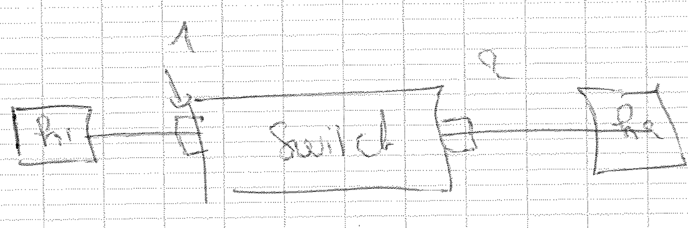
TCP
(3) } établir la conx
(4) }
(5) — communication → (+ Syn + Ack) conn
                       - Syn
(6) — Fin
(7)

-Syn

TCP → Syn
     ↘ Syn Ack
Fin

type de protocol   code de msg





ARP.

h1 ⟶ h2

(1) h1 ⟶ h2 (Request) broadcast

(2) h2 ⟶ h1 Reply (unicast)

- ovs_ofct add-flow o_openflow TCP: 127.0.0.1:6654, arp arp_op=1, action = flood
- ovs_ofct add-flow o_openflow TCP 127.0.0.1:665 arp arp_op=2, input=2, eth_src =(@MAC h2) eth_dest = h1 action = output: 1

arp_op = 1 ⟶ flood

arp_op = 2, S1 ⟶ output 2

⟶ output 1

Tab

Ping

ARP —

ICMP —

h1 ⟶ h2

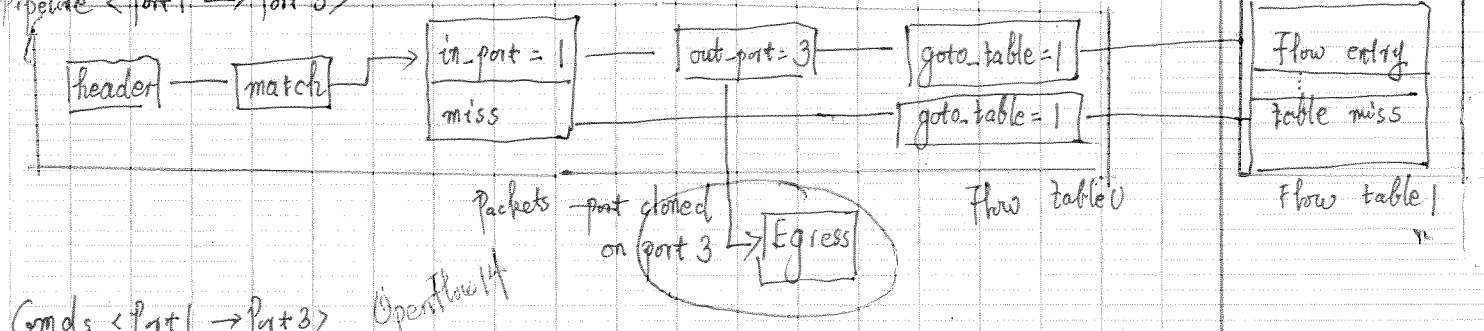
h1

ovs-ofct

Port mirroring

OpenFlow ①

Pipeline <Port 1 → Port 3>



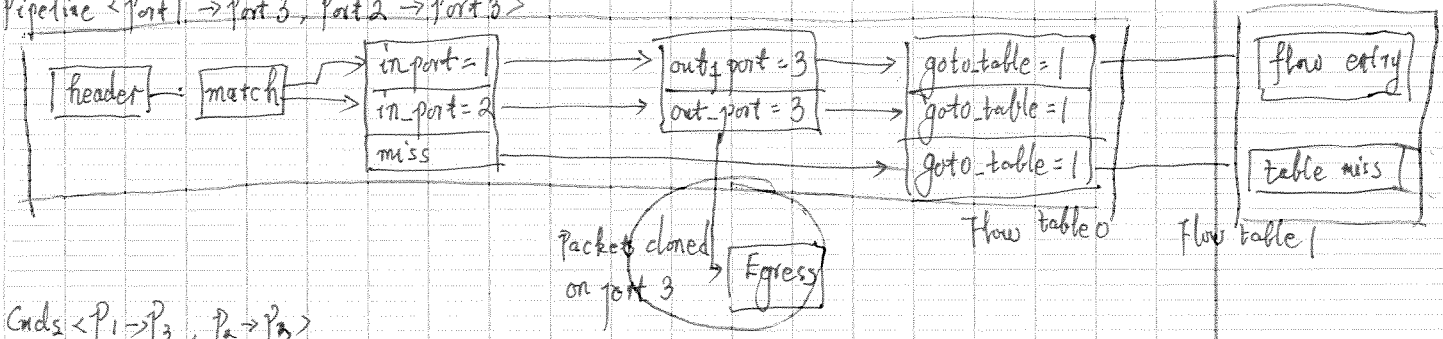
2. Cmds <Port 1 → Port 3>

OpenFlow 14

ovs-ofctl add-flow -O openflow14 tcp:127.0.0.1:6654 in_port=1, actions=output:3, goto_table:1

ovs-ofctl add-flow -O openflow14 tcp:127.0.0.1:6654 priority=0, actions=goto_table:1 ⇒ miss table

3. Pipeline <Port 1 → Port 3, Port 2 → Port 3>



4. Cmds <$P_1 \to P_3$, $P_2 \to P_3$>

ovs-ofctl add-flow -O openflow14 tcp:127.0.0.1:6654 in_port=1, actions=output:3, goto_table:1

ovs-ofctl add-flow -O openflow14 tcp:127.0.0.1:6654 in_port=2, actions=output:3, goto_table:1

ovs-ofctl add-flow -O openflow14 tcp:127.0.0.1:6654 in_priority=0, actions=goto_table:1 ⇒ miss table

ARP

1. Fonctionnement ARP:

Trame de requête avec le code arp_op=1 en diffusion [arp_op=1: request]

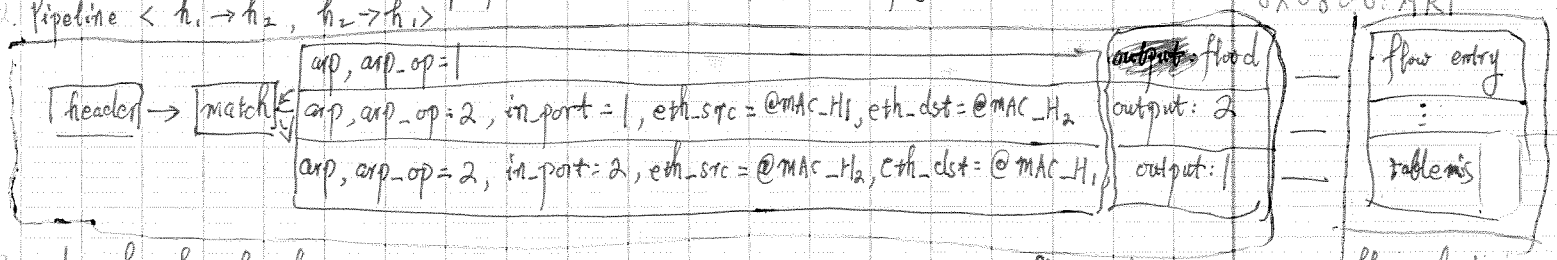
Trame de reponse avec le code arp_op=2 en unicast [arp_op=2: reply]

ethertype:

0x0800: IPv4

0x0806: ARP

2. Pipeline <$h_1 \to h_2$, $h_2 \to h_1$>



3. Cmds <$h_1 \to h_2$, $h_2 \to h_1$>.

① solution

ovs-ofctl add-flow -O openflow14 tcp:127.0.0.1:6654 arp, arp_op=1, actions=flood

ovs-ofctl add-flow -O openflow14 tcp:127.0.0.1:6654 arp, arp_op=2, in_port=1, eth_src=@MAC_H1, eth_dst=@MAC_H2, actions=output:2

ovs-ofctl add-flow -O openflow14 tcp:127.0.0.1:6654 arp, arp_op=2, in_port=2, eth_src=@MAC_H2, eth_dst=@MAC_H1, actions=output:1

② solution

arp, arp_op=1, in_port=1, dl_src=@MAC_H1, dl_dst=@MAC_H2, actions=output:2

arp, arp_op=1, in_port=2, dl_src=@MAC_H2, dl_dst=@MAC_H1, actions=output:1

arp, arp_op=2, in_port=1, dl_src=@MAC_H1, dl_dst=@MAC_H2, actions=output:2

arp, arp_op=2, in_port=2, dl_src=@MAC_H2, dl_dst=@MAC_H1, actions=output:1

Ping

1. Messages de Ping:

1ère trame <ARP request>: arp 0x0806, arp_op=1, SPA:@IP_H1, TPA:@IP_H2, SHA:@MAC_H1, THA:@FF:FF:FF:FF:FF:FF

2ère trame <ARP reply>: arp 0x0806, arp_op=2, SPA:@IP_H2, TPA:@IP_H1, SHA:@MAC_H2, THA:@MAC_H1

3ère trame <Icmp Echo Request>: Icmp, 0x0800, icmp_type=8, icmp_code=0, src:@IP_H1, dst:@IP_H2, IP_proto=1

4ère trame <Icmp Echo Reply>: Icmp, 0x0800, icmp_type=0, icmp_code=0, src:@IP_H2, dst:@IP_H1, IP_proto=1

2. Pipeline <$h_1 \to h_2$>

header – match →

match	Actions
arp, arp_op=1	flood
arp, arp_op=2, eth_src=@MAC_H1, eth_dst=@MAC_H2	output:2
arp, arp_op=2, eth_src=@MAC_H2, eth_dst=@MAC_H1	output:1
icmp, icmp_type=8, icmp_code=0, ip_src=@IP_H1, ip_dst=@IP_H2	output:2
icmp, icmp_type=0, icmp_code=0, ip_src=@IP_H2, ip_dst=@IP_H1	output:1

dl_src, dl_dst, nw_src, nw_dst

flow table 0

flow table 1: flow entry … table miss

$h_2 \to h_1$?

3. Cmds <$h_1 \to h_2$>

```
ovs-ofctl add-flow -O OpenFlow14 tcp:127.0.0.1:6654 arp,arp_op=1,actions=flood
ovs-ofctl add-flow -O OpenFlow14 tcp:127.0.0.1:6654 arp,arp_op=2,eth_src=@MAC_H1,eth_dst=@MAC_H2,in_port=1,actions=output:2
ovs-ofctl add-flow -O OpenFlow14 tcp:127.0.0.1:6654 arp,arp_op=2,eth_src=@MAC_H2,eth_dst=@MAC_H1,in_port=2,actions=output:1
ovs-ofctl add-flow -O OpenFlow14 tcp:127.0.0.1:6654 icmp,icmp_type=8,icmp_code=0,nw_src=@IP_H1,nw_dst=@IP_H2,in_port=1,
                                                                                    action=output:2
ovs-ofctl add-flow -O OpenFlow14 tcp:127.0.0.1:6654 icmp,icmp_type=0,icmp_code=0,nw_src=@IP_H2,
                                                    nw_dst=@IP_H1,in_port=2,actions=output:1
```

ip_src: 10.0.0.1 ?
ip_dst: 10.0.0.2

Tcp:

1. les messages Tcp:

1ère trame <ARP Request> arp, 0x0806, arp_op=1, SHA:@MAC_H1, THA:@77:77:77:77:77:77, SPA:@IP_H1, TPA:@IP_H2

2ème trame <ARP Reply> arp, 0x0806, arp_op=2, SHA:@MAC_H2, THA:@MAC_H1, SPA:@IP_H2, TPA:@IP_H1

3ème trame <Tcp Sync> tcp, ip_src=@IP_H1, ip_dst=@IP_H2, tcp_flags=+Syn

4ème trame <Tcp Sync+Ack> tcp, ip_src=@IP_H2, IP_dst=@IP_H1, tcp_flags=+Syn+Ack

5ème trame <Tcp Ack> tcp, ip_src=@IP_H1, IP_dst=@IP_H2, tcp_flags=-Syn+Ack

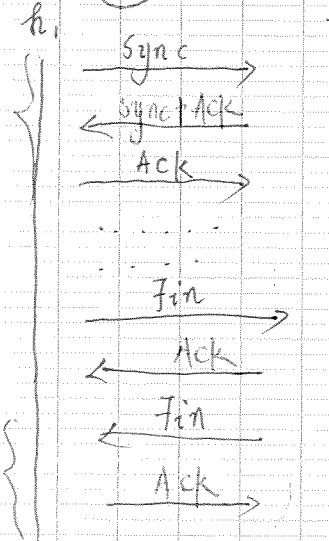
6ème trame <Tcp Fin> tcp, ip_src=@IP_H1, IP_dst=@IP_H2, tcp_flogs=+fin

7ème trame <Tcp Ack> tcp, ip_src=@IP_H2, IP_dst=@IP_H1, tcp_flags=-fin+Ack

8ème trame <Tcp Fin> tcp, ip_src=@IP_H2, IP_dst=@IP_H1, tcp_flags=+fin

9ème trame <Tcp Ack> tcp, ip_src=@IP_H1, IP_dst=@IP_H2, tcp_flags=-fin+Ack

tcp_flags:
0: fin
1: syn
4: Ack



6ème trame <Tcp. -Syn>
tcp, ip_src=@IP_H1, ip_dst=@IP_H2, tcp_flags=-Syn
7ème trame <Tcp - Syn>
tcp, ip_src=@IP_H2, ip_dst=@IP_H1, tcp_flags=-Syn

2. Pipeline <$h_1 \to h_2$>

header → match

match	flow table 0
arp, arp_op=1	flood
arp, arp_op=2, eth_src=@MAC_H1, eth_dst=@MAC_H2	output:2
arp, arp_op=2, eth_src=@MAC_H2, eth_dst=@MAC_H1	output:1
tcp, in_port=1, ip_src=@IP_H1, IP_dst=@IP_H2, tcp_flags=+Syn	output:2
tcp, in_port=2, ip_src=@IP_H2, IP_dst=@IP_H1, tcp_flags=+Syn+Ack	output:1
tcp, in_port=1, ip_src=@IP_H1, IP_dst=@IP_H2, tcp_flags=-Syn	output:2
tcp, in_port=2, ip_src=@IP_H2, IP_dst=@IP_H1, tcp_flags=-Syn	output:1

flow table 1: flow entry … table miss