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Part 1

1.

```
soulr@soulr-VirtualBox:~/Desktop/share_folder/network$ sudo ovs-appctl fdb/flush s1
table successfully flushed
soulr@soulr-VirtualBox:~/Desktop/share_folder/network$ sudo ovs-appctl fdb/show s1
 port  VLAN  MAC                Age
soulr@soulr-VirtualBox:~/Desktop/share_folder/network$ sudo ovs-appctl fdb/flush s2
table successfully flushed
soulr@soulr-VirtualBox:~/Desktop/share_folder/network$ sudo ovs-appctl fdb/show s2
 port  VLAN  MAC                Age
soulr@soulr-VirtualBox:~/Desktop/share_folder/network$ sudo ovs-appctl fdb/flush s3
table successfully flushed
soulr@soulr-VirtualBox:~/Desktop/share_folder/network$ sudo ovs-appctl fdb/show s3
 port  VLAN  MAC                Age
soulr@soulr-VirtualBox:~/Desktop/share_folder/network$
```

2.

h4 uses ARP unicast to h1 and wait for h1 send back its MAC address.

37	57.952205049	10.0.0.4	10.0.0.1	ICMP	98	Echo (ping) reply id=0x0cb7, seq=3/768, ttl=64 (request in 36)
38	58.976461035	10.0.0.1	10.0.0.4	ICMP	98	Echo (ping) request id=0x0cb7, seq=4/1024, ttl=64 (reply in 39)
39	58.976487107	10.0.0.4	10.0.0.1	ICMP	98	Echo (ping) reply id=0x0cb7, seq=4/1024, ttl=64 (request in 38)
40	59.904143314	fe80::9472:d8ff:fe6…	ff02::2	ICMPv6	70	Router Solicitation from 96:72:d8:6a:a5:12
41	60.000150269	10.0.0.1	10.0.0.4	ICMP	98	Echo (ping) request id=0x0cb7, seq=5/1280, ttl=64 (reply in 42)
42	60.000175718	10.0.0.4	10.0.0.1	ICMP	98	Echo (ping) reply id=0x0cb7, seq=5/1280, ttl=64 (request in 41)
43	60.928157810	e6:7e:b2:ff:6d:13	56:bd:e4:86:26:9e	ARP	42	Who has 10.0.0.1? Tell 10.0.0.4
44	60.928165894	56:bd:e4:86:26:9e	e6:7e:b2:ff:6d:13	ARP	42	10.0.0.1 is at 56:bd:e4:86:26:9e
45	100.863957520	fe80::54bd:e4ff:fe8…	ff02::2	ICMPv6	70	Router Solicitation from 56:bd:e4:86:26:9e
46	104.961367556	fe80::648c:5fff:fe8…	ff02::2	ICMPv6	70	Router Solicitation from 66:8c:5f:82:ae:8c
47	107.008055188	fe80::6037:1eff:fe9…	ff02::2	ICMPv6	70	Router Solicitation from 62:37:1e:93:31:44
48	109.056896898	fe80::a891:eeff:fe6…	ff02::2	ICMPv6	70	Router Solicitation from aa:91:ee:6e:fc:0e
49	113.152513735	fe80::180d:e8ff:fe1…	ff02::2	ICMPv6	70	Router Solicitation from 1a:0d:e8:1c:05:c6

3.

h1 uses ARP broadcast and wait for h4 send back its MAC address.

No.	Time	Source	Destination	Protocol	Length	Info
25	49.664536840	fe80::180d:e8ff:fe1…	ff02::2	ICMPv6	70	Router Solicitation from 1a:0d:e8:1c:05:c6
26	51.235217742	fe80::9472:d8ff:fe6…	ff02::fb	MDNS	107	Standard query 0x0000 PTR _ipps._tcp.local, "QM" question PTR _ipp._…
27	51.818019704	fe80::180d:e8ff:fe1…	ff02::fb	MDNS	107	Standard query 0x0000 PTR _ipps._tcp.local, "QM" question PTR _ipp._…
28	51.939818481	fe80::a891:eeff:fe6…	ff02::fb	MDNS	107	Standard query 0x0000 PTR _ipps._tcp.local, "QM" question PTR _ipp._…
29	53.760737811	fe80::e47e:b2ff:fef…	ff02::2	ICMPv6	70	Router Solicitation from e6:7e:b2:ff:6d:13
30	55.921037562	56:bd:e4:86:26:9e	Broadcast	ARP	42	Who has 10.0.0.4? Tell 10.0.0.1
31	55.921259738	e6:7e:b2:ff:6d:13	56:bd:e4:86:26:9e	ARP	42	10.0.0.4 is at e6:7e:b2:ff:6d:13
32	55.921261921	10.0.0.1	10.0.0.4	ICMP	98	Echo (ping) request id=0x0cb7, seq=1/256, ttl=64 (reply in 33)
33	55.921406952	10.0.0.4	10.0.0.1	ICMP	98	Echo (ping) reply id=0x0cb7, seq=1/256, ttl=64 (request in 32)
34	56.928582197	10.0.0.1	10.0.0.4	ICMP	98	Echo (ping) request id=0x0cb7, seq=2/512, ttl=64 (reply in 35)
35	56.928618685	10.0.0.4	10.0.0.1	ICMP	98	Echo (ping) reply id=0x0cb7, seq=2/512, ttl=64 (request in 34)
36	57.952177970	10.0.0.1	10.0.0.4	ICMP	98	Echo (ping) request id=0x0cb7, seq=3/768, ttl=64 (reply in 37)
37	57.952205049	10.0.0.4	10.0.0.1	ICMP	98	Echo (ping) reply id=0x0cb7, seq=3/768, ttl=64 (request in 36)
38	58.976461035	10.0.0.1	10.0.0.4	ICMP	98	Echo (ping) request id=0x0cb7, seq=4/1024, ttl=64 (reply in 39)
39	58.976487107	10.0.0.4	10.0.0.1	ICMP	98	Echo (ping) reply id=0x0cb7, seq=4/1024, ttl=64 (request in 38)

4.

The switch needs to learn MAC address of the other device.

5.

MAC address

56:… is h1

E6:… is h4

H1 connects s1

H4 connects s3

S2 connects s1 and s3

Path of ping: h1, s1, s2, s3, h4

```
soulr@soulr-VirtualBox:~/Desktop/share_folder/network$ sudo ovs-appctl fdb/show s1
 port  VLAN  MAC                Age
    1     0  56:bd:e4:86:26:9e   87
    3     0  66:8c:5f:82:ae:8c   83
    2     0  62:37:1e:93:31:44   77
    3     0  1a:0d:e8:1c:05:c6   59
    3     0  e6:7e:b2:ff:6d:13   36
    3     0  96:72:d8:6a:a5:12   19
soulr@soulr-VirtualBox:~/Desktop/share_folder/network$ sudo ovs-appctl fdb/show s2
 port  VLAN  MAC                Age
    1     0  56:bd:e4:86:26:9e   89
    2     0  66:8c:5f:82:ae:8c   85
    1     0  62:37:1e:93:31:44   79
    2     0  1a:0d:e8:1c:05:c6   61
    1     0  8e:ea:e0:f1:a5:d8   38
    2     0  e6:7e:b2:ff:6d:13   38
soulr@soulr-VirtualBox:~/Desktop/share_folder/network$ sudo ovs-appctl fdb/show s3
 port  VLAN  MAC                Age
    3     0  56:bd:e4:86:26:9e   91
    1     0  66:8c:5f:82:ae:8c   87
    3     0  62:37:1e:93:31:44   81
    3     0  46:2d:56:3a:43:8a   63
    2     0  e6:7e:b2:ff:6d:13   40
    3     0  8e:ea:e0:f1:a5:d8   40
soulr@soulr-VirtualBox:~/Desktop/share_folder/network$
```

Part 2

1. No

```
mininet> h1 ping h4 -c 5
QStandardPaths: XDG_RUNTIME_DIR not set, defaulting to '/tm
p/runtime-root'
PING 10.0.0.4 (10.0.0.4) 56(84) bytes of data.
From 10.0.0.1 icmp_seq=1 Destination Host Unreachable
From 10.0.0.1 icmp_seq=2 Destination Host Unreachable
From 10.0.0.1 icmp_seq=3 Destination Host Unreachable
From 10.0.0.1 icmp_seq=4 Destination Host Unreachable
From 10.0.0.1 icmp_seq=5 Destination Host Unreachable

--- 10.0.0.4 ping statistics ---
5 packets transmitted, 0 received, +5 errors, 100% packet l
oss, time 4059ms
pipe 4
```

2. Yes

```
mininet> h1 ping h4 -c 5
PING 10.0.0.4 (10.0.0.4) 56(84) bytes of data.
64 bytes from 10.0.0.4: icmp_seq=1 ttl=64 time=0.043 ms
64 bytes from 10.0.0.4: icmp_seq=2 ttl=64 time=0.047 ms
64 bytes from 10.0.0.4: icmp_seq=3 ttl=64 time=0.060 ms
64 bytes from 10.0.0.4: icmp_seq=4 ttl=64 time=0.043 ms
64 bytes from 10.0.0.4: icmp_seq=5 ttl=64 time=0.082 ms

--- 10.0.0.4 ping statistics ---
5 packets transmitted, 5 received, 0% packet loss, time 4084ms
rtt min/avg/max/mdev = 0.043/0.055/0.082/0.014 ms
```

3.

Before enable STP

```
soulr@ubuntu:~$ sudo ovs-appctl fdb/show s1
 port  VLAN  MAC                Age
    4     0  7e:f8:78:ee:a7:fb    0
    4     0  0e:fb:6d:b8:ef:42    0
    4     0  0a:95:43:de:06:34    0
    3     0  e2:82:e8:5f:7c:6f    0
    3     0  a6:46:48:a4:c2:22    0
    4     0  92:37:04:73:e2:35    0
    3     0  ae:6b:0b:0c:e9:7e    0
    3     0  26:87:6a:da:75:4d    0
    4     0  72:a7:bf:63:9e:72    0
    4     0  1a:be:15:9a:52:a7    0
    3     0  1a:1b:1e:0e:c3:28    0
    3     0  02:52:ae:11:a8:17    0
```

After enable STP

```
soulr@ubuntu:~$ sudo ovs-appctl fdb/show s1
 port  VLAN  MAC                Age
    1     0  02:52:ae:11:a8:17    4
    4     0  72:a7:bf:63:9e:72    3
```

After enable STP, the s1 MAC address table know the path to h4.

4.

I learned that STP must enable when switches connect to loop, also know how the MAC address table works.