



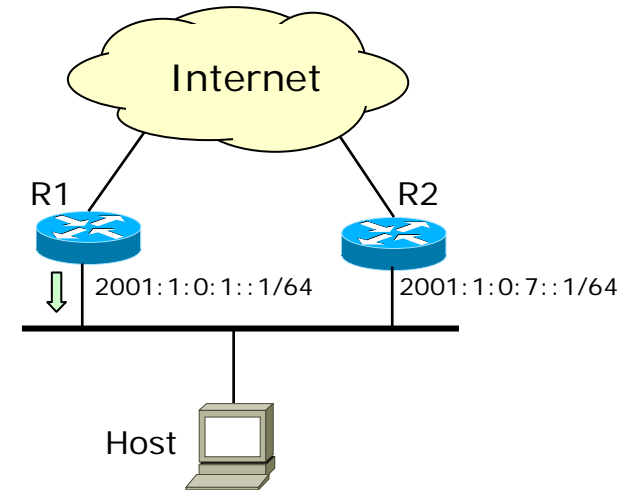
# Exercises

## IPv6: addressing and routing



## Esercizio 1: Stateless configuration

Given the configuration in the figure, assuming that Router Advertisement is enabled only in R1, which IPv6 addresses are obtained by the host interface with stateless configuration?



Possible answers:

- A) 2001:1:0:1:20b:5dff:fe4c:3a6b, 2001:1:0:7:20b:5dff:fe4c:3a6b, fe80::20b:5dff:fe4c:3a6b
- B) 2001:1:0:1:20b:5dff:fe4c:3a6b, fe80:1::20b:5dff:fe4c:3a6b
- C) 2001:1:0:7:20b:5dff:fe4c:3a6b, fe80::20b:5dff:fe4c:3a6b
- D) 2001:1:0:1:20b:5dfe:ff4c:3a6b, fe80::20b:5dff:fe4c:3a6b
- E) 2001:1:0:1:20b:5dff:fe4c:3a6b, fe80::20b:5dff:fe4c:3a6b



## Answer

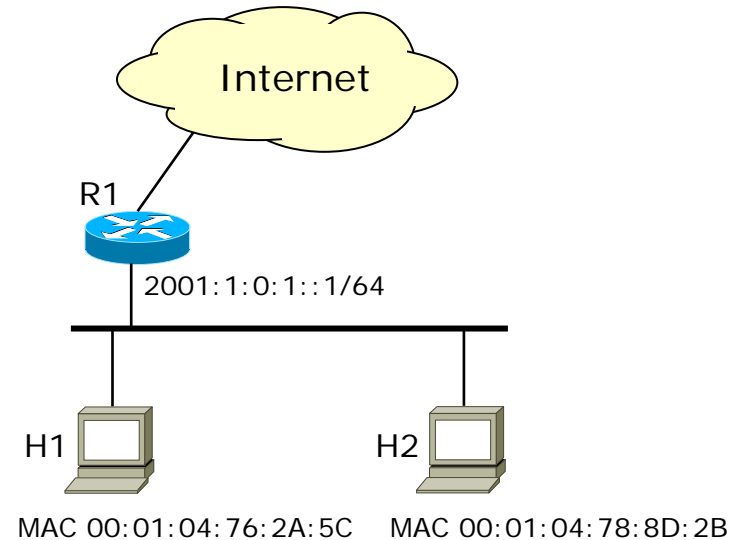
- A) Wrong, because R2 does not send Router Advertisement messages, and the prefix 2001:1:0:7::/64 cannot be configured in the host.
- B) Wrong, because the link local prefix is wrong (FE80:1::/64, while it should be FE80::/64)
- C) Wrong, because the global address has a prefix derived from R2, which does not advertize it.
- D) Wrong. The public IPv6 address is valid, but the interface ID is incorrectly obtained from the MAC address (note that the two bytes FF and FE are misplaced). Since we assume stateless configuration, the address is wrong.
- E) Correct.



## Exercise 2: Stateless configuration

Given the network depicted in the figure.  
Assuming that R1 is not enabled to send Router Advertisement messages, indicate:

- 1) the addresses configured in H1
- 2) the packets generated by H1 at bootstrap
- 3) the packets generated by H1 when the latter executes a **ping** addressed to H2, assuming that it knows the destination IPv6 address
- 4) the packets generated by H1 when it starts a TCP connection with an host in Internet





## Answer 1: H1 addresses

The only type of address is the link-local.

Interface ID:

MAC 00:01:04:76:2A:5C => IF\_ID 0201:04FF:FE76:2A5C

=> link local address: FC80::0201:04FF:FE76:2A5C





## Answer 2: packets generated at boot

Before assuming valid its link-local address, H1 should execute a Duplicate Address Detection (2 packets) procedure, then it sends a packet to the group “all routers” to verify that a router exists. Note that the latter packet is not sent as a default in all the operating systems.

Packet 1:

[Eth] 000104-762A5C => 3333FF-762A5C

[IPv6] :: => FF02::1:FF76:2A5C (Len 64)

[ICMP6] Neighbor Solicitation: who has FE80::0201:04FF:FE76:2A5C?

Packet 2:

[Eth] 000104-762A5C => 3333FF-762A5C

[IPv6] FE80::0201:04FF:FE76:2A5C => FF02::1:FF76:2A5C (Len 72)

[ICMP6] Group Membership Report (FF02::1:FF76:2A5C)

Packet 3:

[Eth] 000104-762A5C => 3333FF-0000002

[IPv6] FE80::0201:04FF:FE76:2A5C => FF02::2 (Len 56)

[ICMP6] Router solicitation



## Answer 3: ping to H2

First of all, it is necessary to compute the IPv6 link-local address of H2. Then, two packets are generated for the neighbor solicitation mechanism, followed by ICMP echo request/reply packets.

IPv6 address of H2: FE80::0201:04FF:FE78:8D2B (MAC: 00:01:04:78:8D:2B)

Packet 1:

[Eth] 000104-762A5C => 3333FF-788D2B  
[IPv6] FE80::0201:04FF:FE76:2A5C => FF02::1:FF78:8D2B (Len 72)  
[ICMP6] Neighbor Solicitation: who has FE80::0201:04FF:FE78:8D2B?

Packet 2:

[Eth] 000104-788D2B => 000104-762A5C  
[IPv6] FE80::0201:04FF:FE78:8D2B => FE80::0201:04FF:FE76:2A5C (Len 72)  
[ICMP6] Neighbor Advertisement: I am FE80::0201:04FF:FE78:8D2B at 000104-788D2B

Packet 3:

[Eth] 000104-762A5C => 000104-788D2B  
[IPv6] FE80::0201:04FF:FE76:2A5C => FE80::0201:04FF:FE78:8D2B (Len 72)  
[ICMP6] Echo Request

Packet 4:

[Eth] 000104-788D2B => 000104-762A5C  
[IPv6] FE80::0201:04FF:FE78:8D2B => FE80::0201:04FF:FE76:2A5C (Len 72)  
[ICMP6] Echo Reply



## Answer 4: TCP connection over Internet

Sending packets to an host in Internet is **impossible**, because H1 has no default gateway configured.

H1 is only able to communicate with hosts in its same subnet, by using the link-local address.

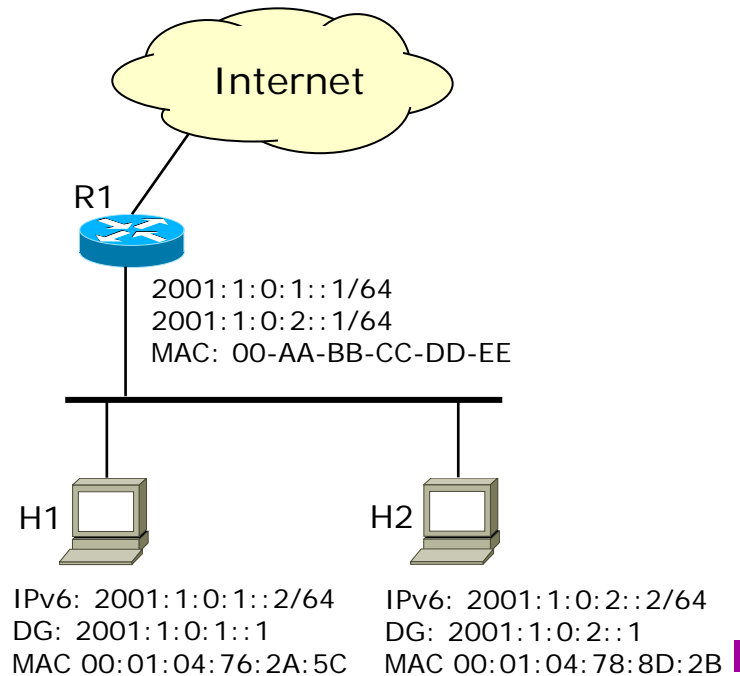




## Exercise 3 : PING

Given the configuration shown in the figure.  
Assuming that R1 is not enabled to send Router Advertisement messages, indicate what is the flow of packets when, in H1, the user types the command "PING 2001:1:0:2::2".

Assume that the neighbor cache is empty.





## Answer: Ping to H2 (1)

Packet 1 (ICMPv6 Neighbor Solicitation from H1 to R1):

[Eth] 000104-762A5C => 3333FF-000001

[IPv6] 2001:1:0:1::2 => FF02::1:FF00:1 (Len 72)

[ICMP6] Neighbor Solicitation: who has 2001:1:0:1::1 ?

Packet2 (ICMPv6 Neighbor Advertisement from R1 to H1):

[Eth] 00AABB-CCDDEE => 000104-762A5C

[IPv6] 2001:1:0:1::1 => 2001:1:0:1::2 (Len 72)

[ICMP6] Neighbor Advertisement: I am 2001:1:0:1::1 at 00AABB-CCDDEE

Packet 3 (ICMPv6 Echo Request to R1):

[Eth] 000104-762A5C => 00AABB-CCDDEE

[IPv6] 2001:1:0:1::2 => 2001:1:0:2::2 (Len 72)

[ICMP6] Echo Request

Packet 4 (ICMPv6 Neighbor Solicitation from R1 to H2):

[Eth] 00AABB-CCDDEE => 3333FF-000002

[IPv6] 2001:1:0:2::1 => FF02::1:FF00:2 (Len 72)

[ICMP6] Neighbor Solicitation: who has 2001:1:0:2::2 ?

Packet 5 (ICMPv6 Neighbor Advertisement from H2 to R1):

[Eth] 000104-788D2B=> 00AABB-CCDDEE

[IPv6] 2001:1:0:2::2 => 2001:1:0:2::1 (Len 72)

[ICMP6] Neighbor Advertisement: I am 2001:1:0:2::2 at 000104-788D2B

Packet 6 (ICMPv6 Echo Request from R1 to H2):

[Eth] 00AABB-CCDDEE => 000104-788D2B

[IPv6] 2001:1:0:1::2 => 2001:1:0:2::2 (Len 72)

[ICMP6] Echo Request

Packet 7: (ICMPv6 Echo Reply from H2 to R1):

[Eth] 000104-788D2B => 00AABB-CCDDEE

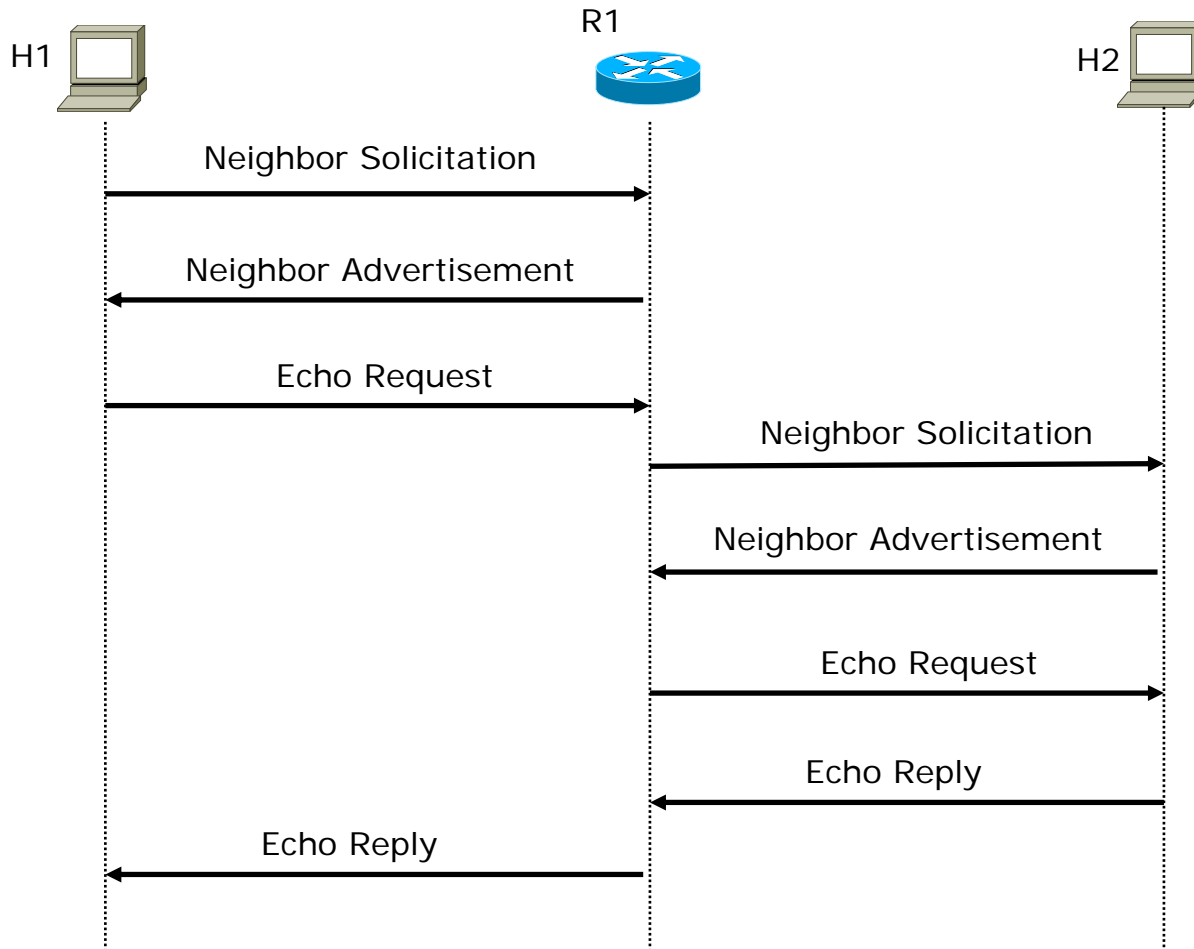
[IPv6] 2001:1:0:2::2 => 2001:1:0:1::2 (Len 72)

[ICMP6] Echo Reply

...



## Answer: Ping to H2 (2)





## Exercise 4

It is given the capture file (listed below) of a PING command between two hosts. What is the reason of the missing response to the ICMP Echo Request packet.

[Eth] 001121-3AF4D2 => 3333FF-030001	[IPv6] 2001:1A60:1:1::3:2 => FF02::1:FF03:1 (Len 72)	[ICMP6] Neighbor Solicitation: who has 2001:1A60:1:1::3:1?
[Eth] 001121-3B0726 => 001121-3AF4D2	[IPv6] 2001:1A60:1:1::3:1 => 2001:1A60:1:1::3:1 (Len 72)	[ICMP6] Neighbor Adv.: I am 2001:1A60:1:1::3:1 at 001121-3B0726
[Eth] 001121-3AF4D2 => 001121-3B0726	[IPv6] 2001:1A60:1:1::3:2 => 2001:1A60:1:2::16:2 (Len 72)	[ICMP6] Echo Request
[Eth] 001121-3B0726 => 3333FF-160002	[IPv6] FE80::0211:21FF:FE3B:0726 => FF02::1:FF16:2 (Len 72)	[ICMP6] Neighbor Solicitation: who has 2001:1A60:1:2::16:2?
[Eth] 001121-3B01F8 => 001121-3B0726	[IPv6] 2001:1A60:1:2::16:2 => FE80::0211:21FF:FE3B:0726 (Len 72)	[ICMP6] Neighbor Adv.: I am 2001:1A60:1:2::16:2 at 001121-3B01F8
[Eth] 001121-3B0726 => 001121-3B01F8	[IPv6] 2001:1A60:1:1::3:2 => 2001:1A60:1:2::16:2 (Len 72)	[ICMP6] Echo Request
[Eth] 001121-3B01F8 => 3333FF-300001	[IPv6] FE80::0211:21FF:FE3B:01F8 => FF02::1:FF30:1 (Len 72)	[ICMP6] Neighbor Solicitation: who has 2001:1A60:1:2::30:1?
[Eth] 001121-3B01F8 => 3333FF-300001	[IPv6] FE80::0211:21FF:FE3B:01F8 => FF02::1:FF30:1 (Len 72)	[ICMP6] Neighbor Solicitation: who has 2001:1A60:1:2::30:1?
[Eth] 001121-3AF4D2 => 001121-3B0726	[IPv6] 2001:1A60:1:1::3:2 => 2001:1A60:1:2::16:2 (Len 72)	[ICMP6] Echo Request
[Eth] 001121-3B0726 => 001121-3B01F8	[IPv6] 2001:1A60:1:1::3:2 => 2001:1A60:1:2::16:2 (Len 72)	[ICMP6] Echo Request

...

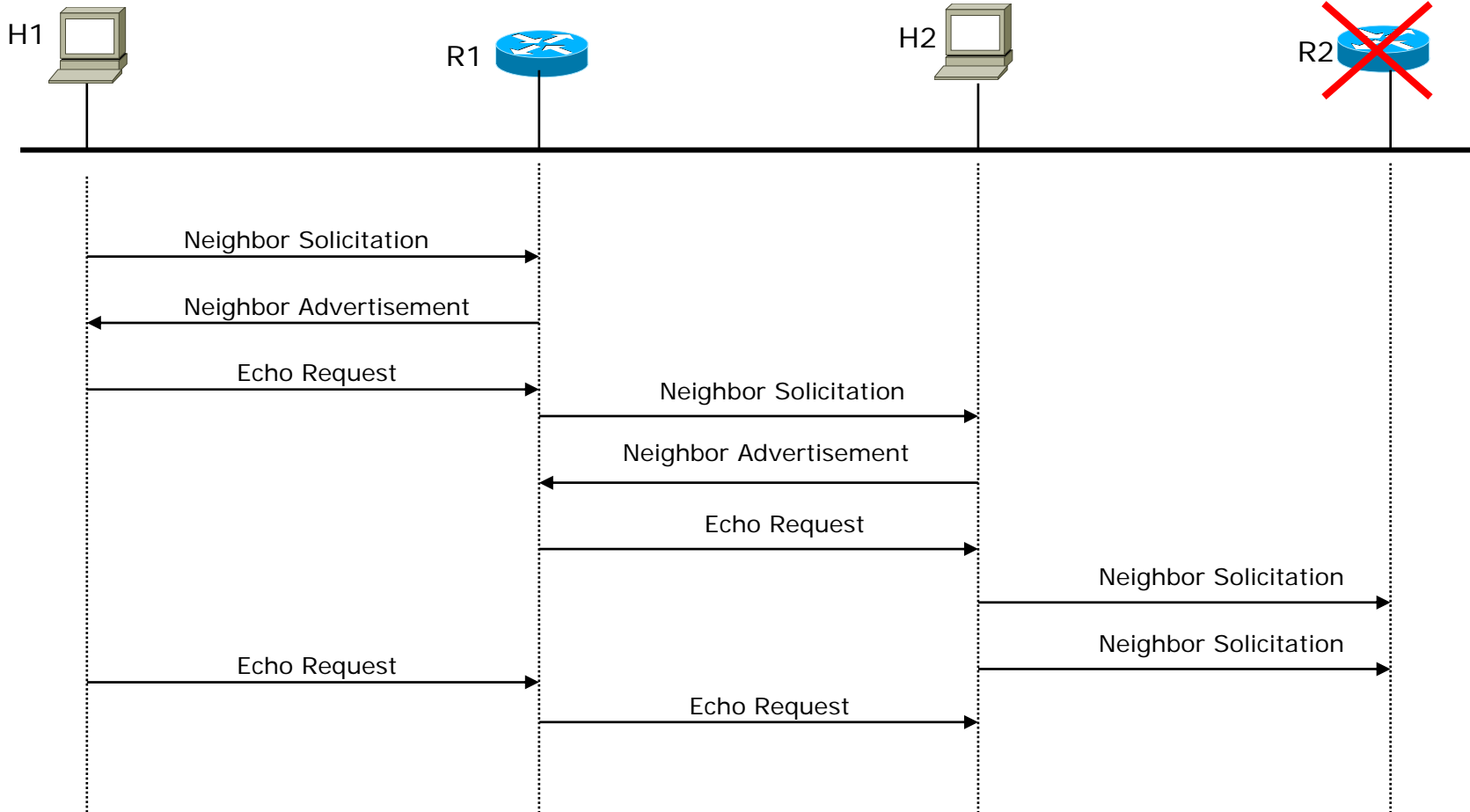
# Answer

IP: 2001:1A60:1:1::3:2  
DG: 2001:1A60:1:1::3:1

IP1: 2001:1A60:1:1::3:1  
IP2: 2001:1A60:1:2:[????]  
IP3: FE80::0211:21FF:FE3B:0726

IP1: 2001:1A60:1:2::16:2  
IP2: FE80::0211:21FF:FE3B:01F8  
DG: 2001:1A60:1:2::30:1

IP: 2001:1A60:1:2::30:1



## Exercise 5: addressing plan

Define an IPv6 addressing plan for the network shown in the figure.  
Define also the static routes that should be configured in the two routers, in order to have a correctly working system.



## Answer

The network is not connected to Internet. Hence, only link-local addresses are sufficient.

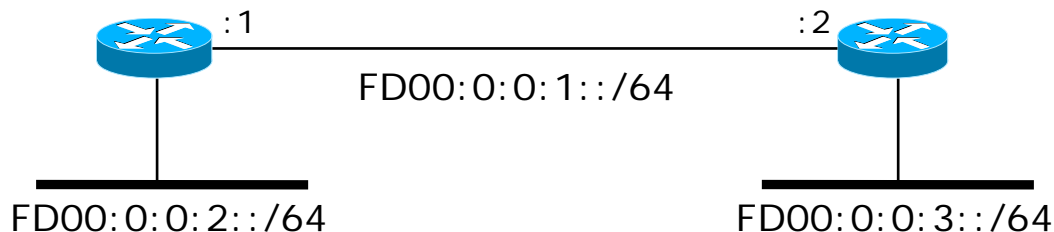
For sake of simplicity, it is possible to use /64 networks, even if this leads to huge waste of addresses (in the point-to-point link, in particular).

Static Route:

S FD00:0:0:3::/64 FD00:0:0:1::2

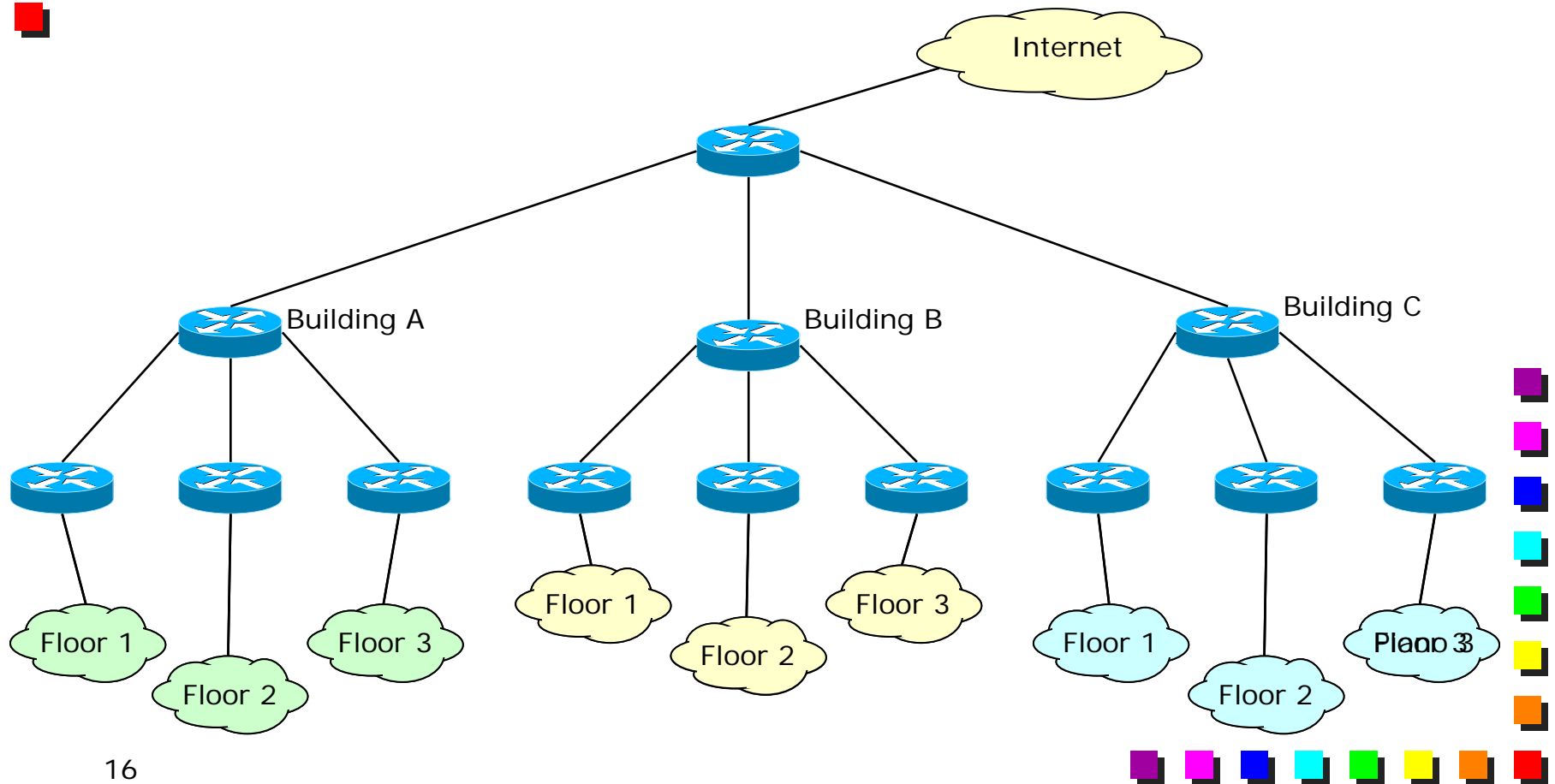
Static Route:

S FD00:0:0:2::/64 FD00:0:0:1::1



## Exercise 6: addressing plan

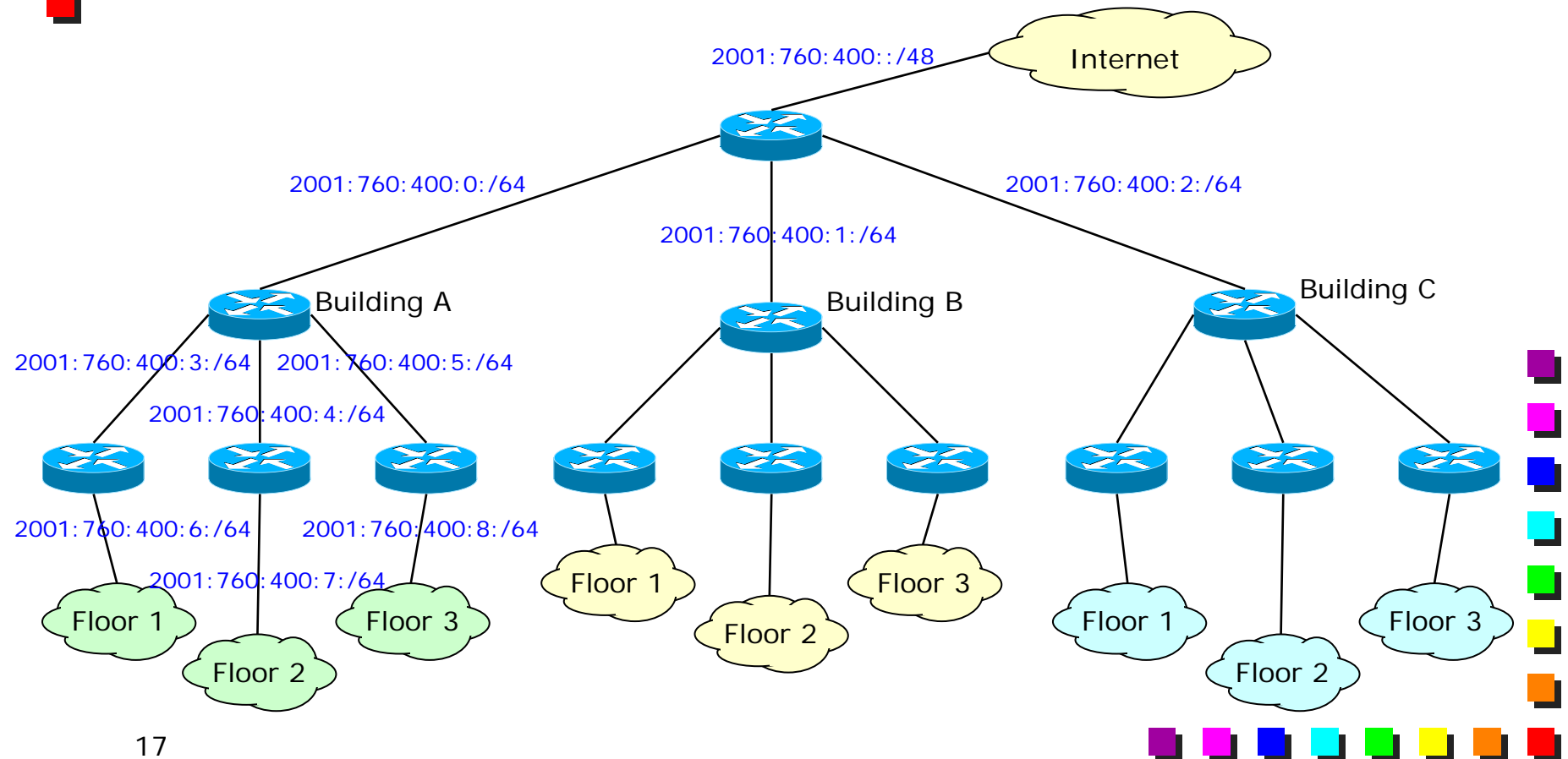
Define an IPv6 addressing plan for the network shown in the figure, and the interfaces where it makes sense to enable the router advertising process.





## Answer (1)

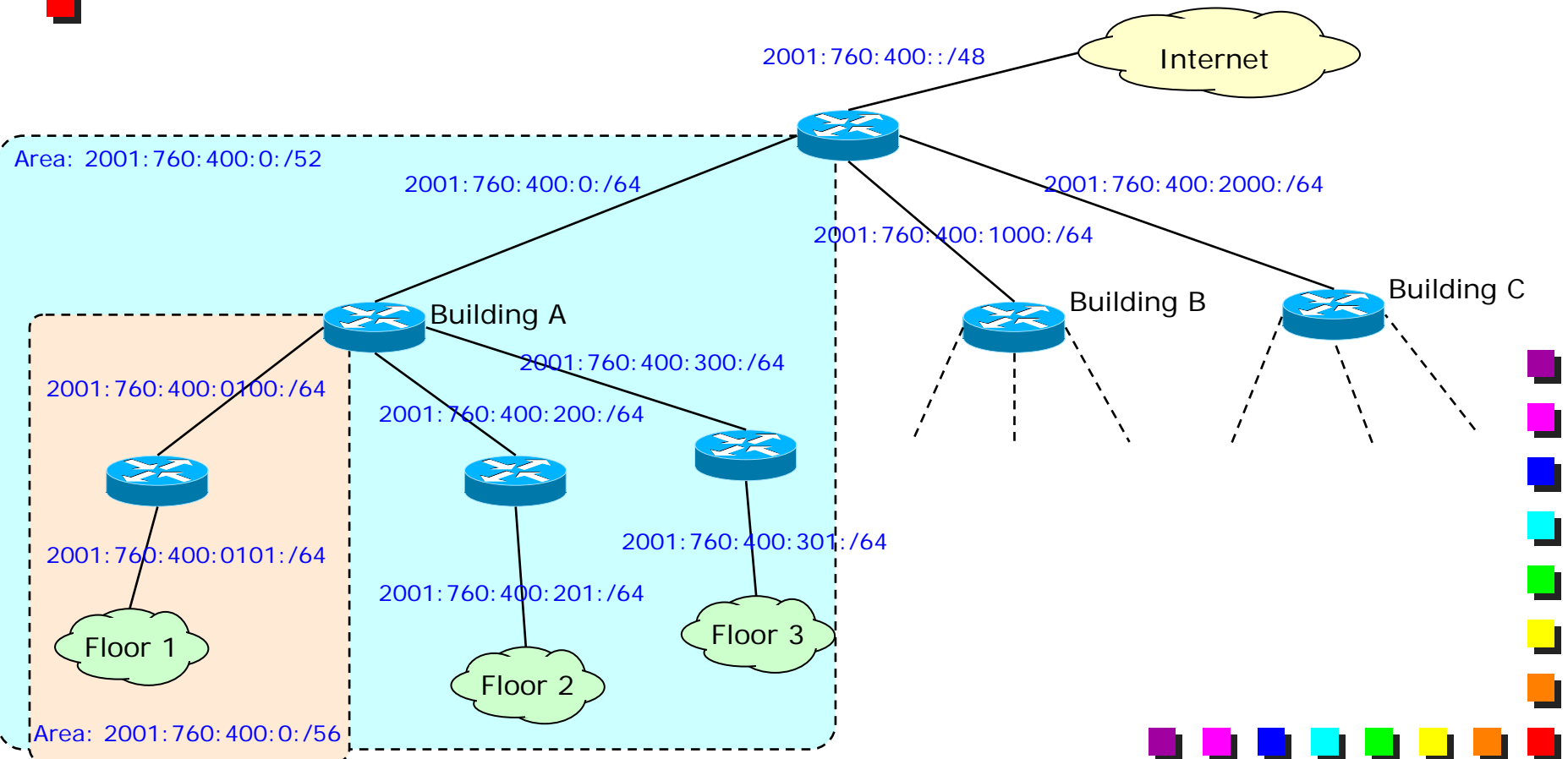
It is a network with limited size. It is possible to distribute addresses in non hierarchical way, leaving to the internal router the task of propagating reachability information.



## Answer(2)

Alternatively, it is possible to use a hierarchical addressing.

Router Advertisement should be enabled only in the lower interfaces of routers in the lowest level.





## Answer (2) - Addendum

- Strictly hierarchical addressing may be difficult to manage over a long period
  - Addresses to be assigned to point-to-point link is a problem, because they waste a non negligible amount of addresses
  - Normally, the hierarchical is used when the same organization is located in different sites, so that it is possible to know immediately the site of an host from a simple inspection of its IPv6 address
    - Inside each site, the solution is usually "anarchist"
    - Often, it is possible to use a specific range for point-to-point links between routers
- The "anachist" solution scales also for medium-large networks (few hundreds routes)
- The solution in the previuos slide is only one among several possible
- Note the partitioning at /52 and /56: why?



## Exercise 7: multiple choice question

At reboot, which address an IPv6 host will acquire?

- A) It is not possible to know exactly the address, because the IPv6 address is re-generated each time using a random number to define the Interface ID
  - B) A FE80::/32 address
  - C) As for the link-local, it will asseme the same address as before
  - D) The address is completely dependent from the information acquired by the router
- 