Exercise Sheet 4

Exercise 1 (Routers, Layer-3-Switches, Gateways)

1. What is the purpose of **Routers** in computer networks?
   (*Also explain the difference to Layer-3-Switches.*)
2. What is the purpose of **Layer-3-Switches** in computer networks?
   (*Also explain the difference to Routers.*)
3. What is the purpose of **Gateways** in computer networks?
4. Why are **Gateways** in the network layer of computer networks seldom required nowadays?

Exercise 2 (Collision Domain, Broadcast Domain)

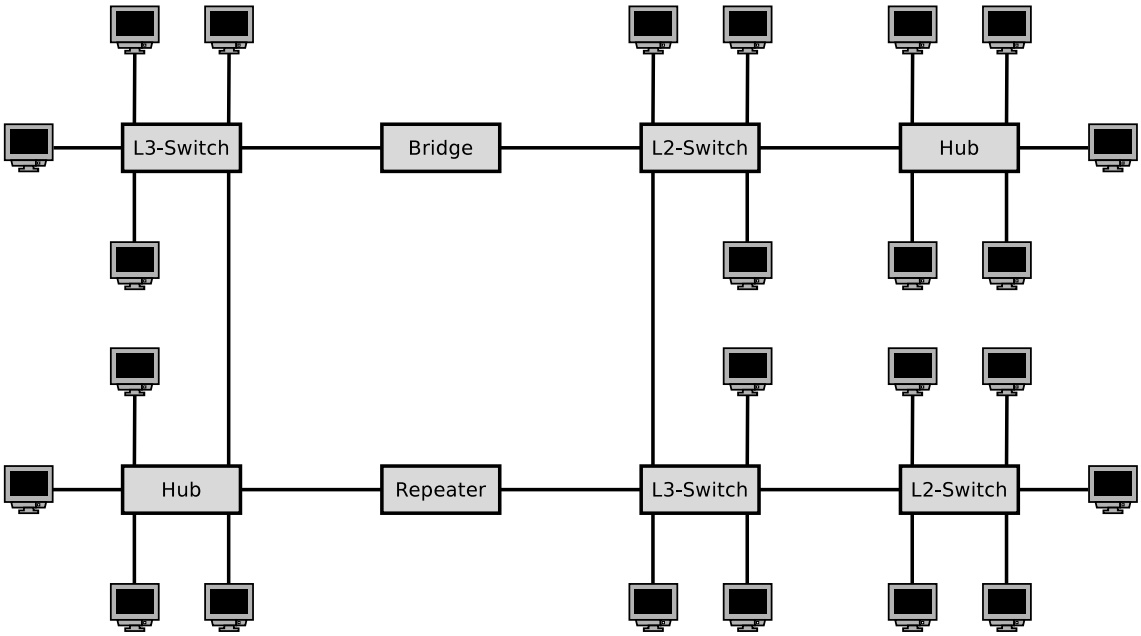
1. Which devices **divide the collision domain**?

   ☐ Repeater ☐ Bridge ☐ Router
   ☐ Hub ☐ Layer-2-Switch ☐ Layer-3-Switch

2. Which devices **divide the broadcast domain**?

   ☐ Repeater ☐ Bridge ☐ Router
   ☐ Hub ☐ Layer-2-Switch ☐ Layer-3-Switch

3. Sketch in the diagram all **collision domains** and all **broadcast domains**.



Exercise 3 (Addressing in the Network Layer)

1. What is the meaning of **Unicast** in the network layer of computer networks?
2. What is the meaning of **Broadcast** in the network layer of computer networks?
3. What is the meaning of **Anycast** in the network layer of computer networks?
4. What is the meaning of **Multicast** in the network layer of computer networks?
5. Why contains the IPv4 **address space** only 4,294,967,296 addresses?
6. Why was **Classless Interdomain Routing (CIDR)** introduced?
7. Describe in simple words the **functioning of CIDR**.
   Focus on the way, IP addresses are treated and subnets are created.

Exercise 4 (Addressing in the Network Layer)

Calculate for each subtask of this exercise the **first and last host addresses**, the **network address** and the **broadcast address** of the subnet.

```
IP Address:          151.175.31.100   10010111.10101111.00011111.01100100
Subnet mask:         255.255.254.0    11111111.11111111.11111110.00000000
Network address?     ___.___.___.___  ________.________.________.________
First host address?  ___.___.___.___  ________.________.________.________
Last host address?   ___.___.___.___  ________.________.________.________
Broadcast address?   ___.___.___.___  ________.________.________.________

IP Address:          151.175.31.100   10010111.10101111.00011111.01100100
Subnet mask:         255.255.255.240  11111111.11111111.11111111.11110000
Network address?     ___.___.___.___  ________.________.________.________
First host address?  ___.___.___.___  ________.________.________.________
Last host address?   ___.___.___.___  ________.________.________.________
Broadcast address?   ___.___.___.___  ________.________.________.________

IP Address:          151.175.31.100   10010111.10101111.00011111.01100100
Subnet mask:         255.255.255.128  11111111.11111111.11111111.10000000
Network address?     ___.___.___.___  ________.________.________.________
First host address?  ___.___.___.___  ________.________.________.________
Last host address?   ___.___.___.___  ________.________.________.________
Broadcast address?   ___.___.___.___  ________.________.________.________
```

binary representation	decimal representation	binary representation	decimal representation
10000000	128	11111000	248
11000000	192	11111100	252
11100000	224	11111110	254
11110000	240	11111111	255

Exercise 5 (Addressing in the Network Layer)

In each subtask of this exercise, a sender transmits an IP packet to a receiver. Calculate for each subtask the **subnet ID of sender and receiver** and specify whether the IP packet **leaves the subnet during transmission** or not.

```
Sender:        11001001.00010100.11011110.00001101    201.20.222.13
Subnet mask:   11111111.11111111.11111111.11110000    255.255.255.240


Receiver:      11001001.00010100.11011110.00010001    201.20.222.17
Subnet mask:   11111111.11111111.11111111.11110000    255.255.255.240



       Subnet ID of sender?

       Subnet ID of receiver?

       Does the IP packet leave the subnet [yes/no]?


Sender:      10000100.10011000.01010011.11111110    132.152.83.254
Subnet mask: 11111111.11111111.11111100.00000000    255.255.252.0


Receiver:    10000100.10011000.01010001.00000010    132.152.81.2
Subnet mask: 11111111.11111111.11111100.00000000    255.255.252.0



       Subnet ID of sender?

       Subnet ID of receiver?

       Does the IP packet leave the subnet [yes/no]?


Sender:        00001111.11001000.01100011.00010111    15.200.99.23
Subnet mask:   11111111.11000000.00000000.00000000    255.192.0.0


Receiver:      00001111.11101111.00000001.00000001    15.239.1.1
Subnet mask:   11111111.11000000.00000000.00000000    255.192.0.0



       Subnet ID of sender?

       Subnet ID of receiver?

       Does the IP packet leave the subnet [yes/no]?
```

Exercise 6 (Addressing in the Network Layer)

Calculate for each subtask of this exercise the **subnet masks** and answer the **questions**.

1. Split the class C network `195.1.31.0` for implementing 30 subnets.

```
Network ID:     11000011.00000001.00011111.00000000    195.1.31.0
Number of bits for subnet IDs?
Subnet mask:    ________.________.________.________    ___.___.___.___
Number of bits for host IDs?
Number of host IDs per subnet?
```

2. Split the class A network `15.0.0.0` for implementing 333 subnets.

```
Network ID:     00001111.00000000.00000000.00000000    15.0.0.0
Number of bits for subnet IDs?
Subnet mask:    ________.________.________.________    ___.___.___.___
Number of bits for host IDs?
Number of host IDs per subnet?
```

3. Split the class B network `189.23.0.0` for implementing 20 subnets.

```
Network ID:     10111101.00010111.00000000.00000000    189.23.0.0
Number of bits for subnet IDs?
Subnet mask:    ________.________.________.________    ___.___.___.___
Number of bits for host IDs?
Number of host IDs per subnet?
```

4. Split the class C network `195.3.128.0` into subnets, which contain 17 hosts each.

```
Network ID:     11000011.00000011.10000000.00000000    195.3.128.0
Number of bits for host IDs?
Number of bits for subnet IDs?
Number of possible subnets?
Subnet mask:    ________.________.________.________    ___.___.___.___
```

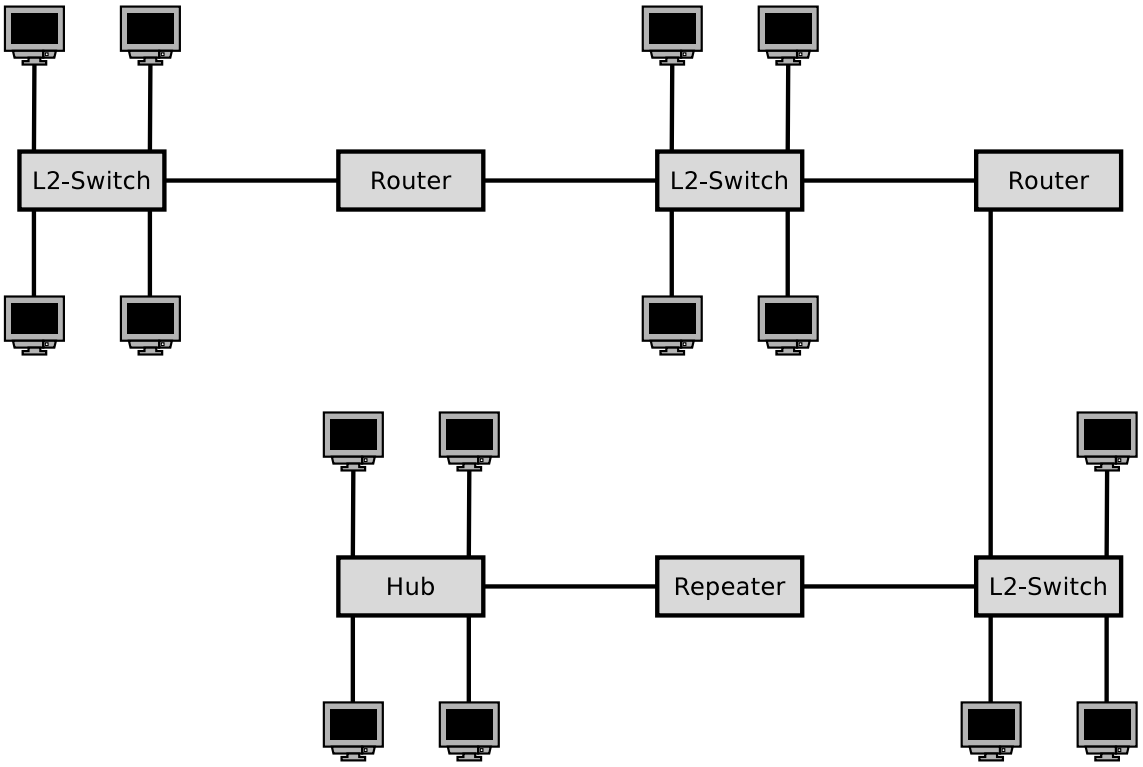
5. Split the class B network `129.15.0.0` into subnets, which contain 10 hosts each.

```
Network ID:     10000001.00001111.00000000.00000000    129.15.0.0
Number of bits for host IDs?
Number of bits for subnet IDs?
Number of possible subnets?
Subnet mask:    ________.________.________.________    ___.___.___.___
```

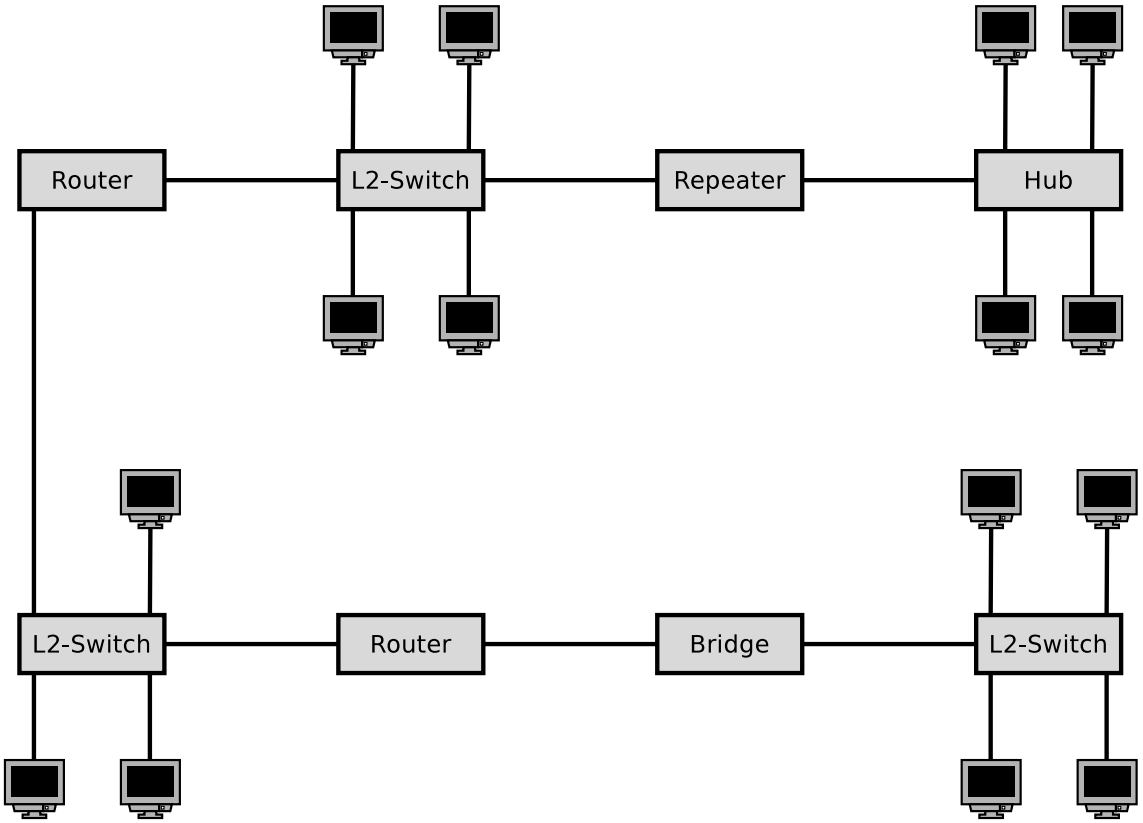
binary representation	decimal representation	binary representation	decimal representation
10000000	128	11111000	248
11000000	192	11111100	252
11100000	224	11111110	254
11110000	240	11111111	255

Exercise 7 (Collision Domain, Broadcast Domain)

1. Sketch in the diagram of the network topology all **collision domains** and all **broadcast domains**.

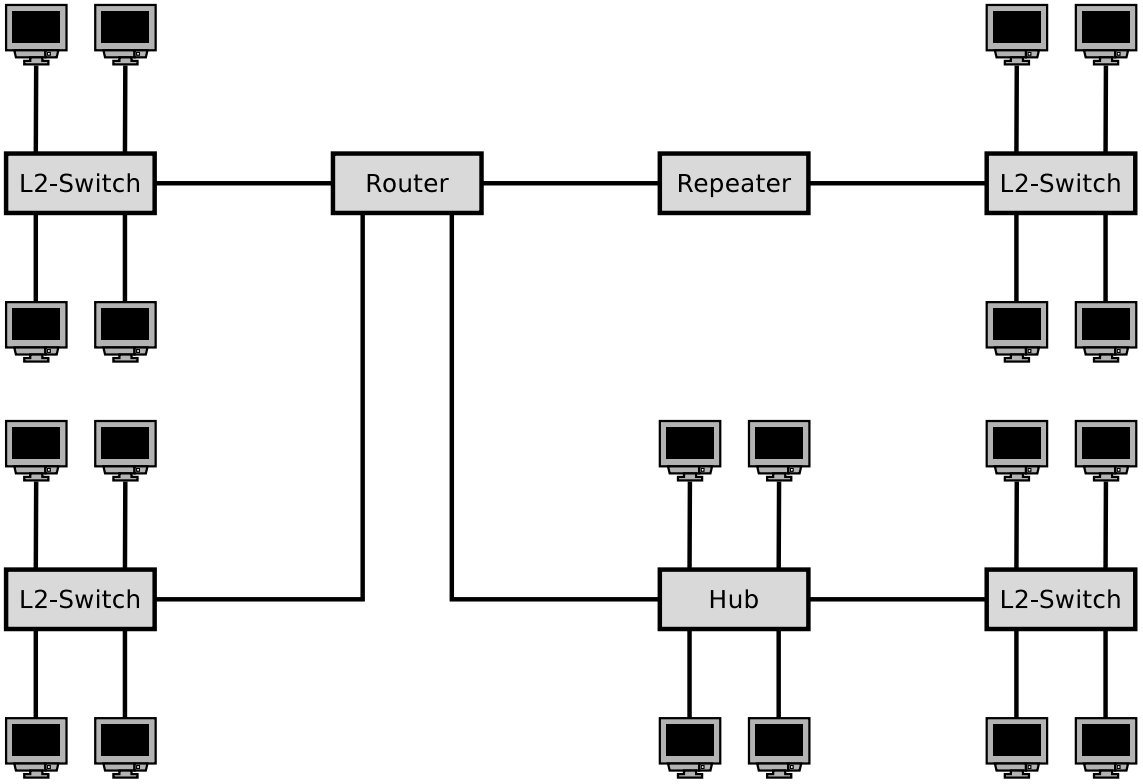


2. Sketch in the diagram of the network topology all **collision domains** and all **broadcast domains**.



Exercise 8 (Broadcast Domain)

1. Sketch in the diagram of the network topology all **broadcast domains**.
2. What is the **required number of subnets** for this network topology?



Exercise 9 (Private IP Address Spaces)

Name the three private IPv4 address spaces.

Exercise 10 (Addressing in the Network Layer)

Calculate for each network configuration in the table whether an IP packet, which is send from the given IP address to the destination address, **leaves the subnet during transmission** or not.

IP address	Subnet mask	Destination address	Leaves the subnet [yes/no]
201.20.222.13	255.255.255.240	201.20.222.17	
15.200.99.23	255.192.0.0	15.239.1.1	
172.21.23.14	255.255.255.0	172.21.24.14	
210.5.16.198	255.255.255.252	210.5.16.197	
210.5.16.198	255.255.255.252	210.5.16.201	
5.5.5.5	255.254.0.0	5.6.6.6	

(A part of the solution is the calculations performed. Where no calculation is required, you need to give a reason for your answer. Answering the question with just „yes“ or „no“ is not sufficient!)

Source: Jörg Roth. Prüfungstrainer Rechnernetze. Vieweg (2010)

Exercise 11 (Addressing in the Network Layer)

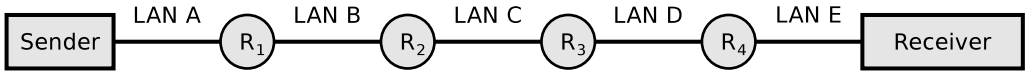
Specify for each subtask of this exercise the correct **subnet mask**.

1. A maximum number of subnets with 5 hosts each in a class B network.
2. 50 subnets with 999 hosts each in a class B network.
3. 12 subnets with 12 hosts each in a class C network.

Source: Jörg Roth. Prüfungstrainer Rechnernetze. Vieweg (2010)

Exercise 12 (Fragmenting IP Packets)

4,000 bytes payload need to be transmitted via the IP protocol. The payload must be fragmented, because it is transmitted over multiple physical networks, whose MTU is $< 4,000$ bytes. Display graphically the way, the payload is fragmented, and how many bytes of payload each fragment contains.



	LAN A	LAN B	LAN C	LAN D	LAN E
Network technology	Ethernet	PPPoE	ISDN	Ethernet	WLAN
MTU [bytes]	1,500	1,492	576	1,400	2,312
IP-Header [bytes]	20	20	20	20	20
maximum payload [bytes]	1,480	1,472	556	1,380	2,292

Display graphically the way, the payload is fragmented, and how many bytes of payload each fragment contains.

Exercise 13 (Forwarding and Path Calculation)

1. Which two major classes of **routing protocols** exist?
2. Which **algorithms for best path calculation** implement the routing protocol classes from subtask 1?
3. What is an **autonomous system**?

4. The **Border Gateway Protocol** (BGP) is a protocol for...

   ☐ Intra-AS routing ☐ Inter-AS routing

5. Which **routing protocol class** from subtask 1 implements the BGP?

6. **Open Shortest Path First** (OSPF) is a protocol for...

   ☐ Intra-AS routing ☐ Inter-AS routing

7. Which **routing protocol class** from subtask 1 implements OSPF?

8. The **Routing Information Protocol** (RIP) is a protocol for...

   ☐ Intra-AS routing ☐ Inter-AS routing

9. Which **routing protocol class** from subtask 1 implements the RIP?

10. When RIP is used, each Router communicates only with its **direct neighbors**. What are the **advantages** and **drawbacks** of method?

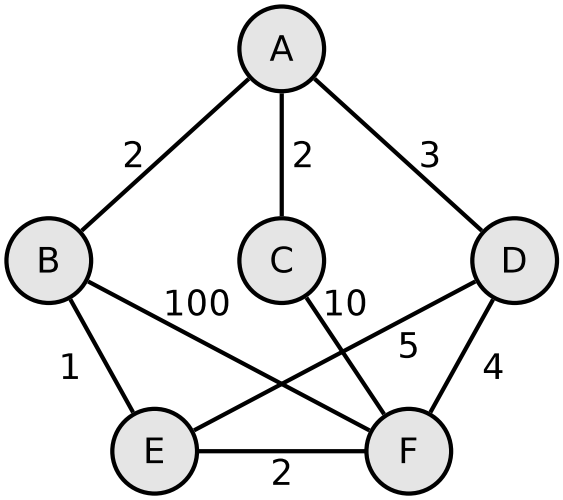
11. When RIP is used, the path cost (metric) depend only on the number of Routers (**hops**), which need to be passed on the way to the destination network. What is the **drawback** of this method?

12. When OSPF is used, **all Routers** communicate with each other. What are the **advantages** and **drawbacks** of method?

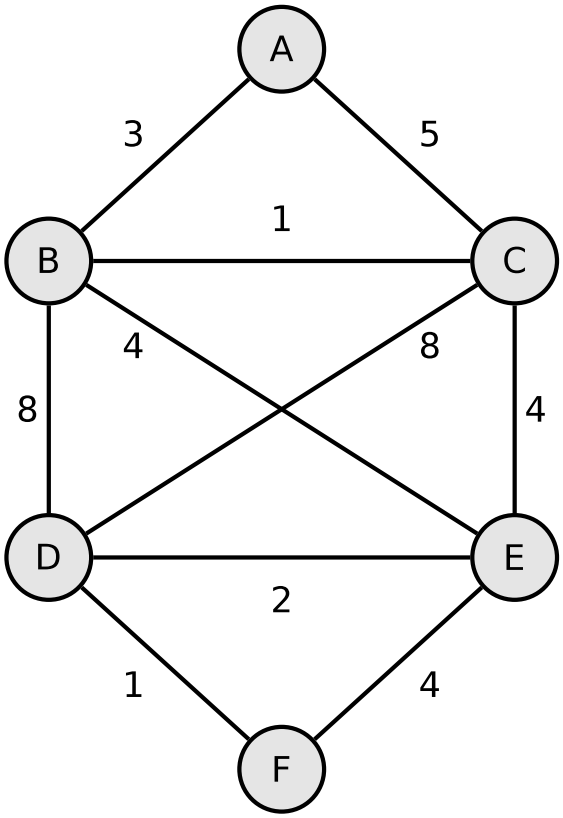
Exercise 14 (Dijkstra's Algorithm)

1. Calculate the shortest path from node A to all other nodes using Dijkstra's algorithm.

Source: Jörg Roth. Prüfungstrainer Rechnernetze. Vieweg (2010)



2. Calculate the shortest path from node A to all other nodes using Dijkstra's algorithm.



Exercise 15 (Internet Control Message Protocol)

1. Explain the purpose of the Internet Control Message Protocol (ICMP).
2. Give two examples for command line tools, which use ICMP.

Exercise 16 (IPv6)

1. Simplify these IPv6 addresses:
   - `1080:0000:0000:0000:0007:0700:0003:316b`

     Solution: _____
   - `2001:0db8:0000:0000:f065:00ff:0000:03ec`

     Solution: _____
   - `2001:0db8:3c4d:0016:0000:0000:2a3f:2a4d`

     Solution: _____
   - `2001:0c60:f0a1:0000:0000:0000:0000:0001`

Solution: _____

- `2111:00ab:0000:0004:0000:0000:0000:1234`

  Solution: _____

2. Provide all positions of these simplified IPv6 addresses:

   - `2001::2:0:0:1`

     Solution: `____:____:____:____:____:____:____:____`

   - `2001:db8:0:c::1c`

     Solution: `____:____:____:____:____:____:____:____`

   - `1080::9956:0:0:234`

     Solution: `____:____:____:____:____:____:____:____`

   - `2001:638:208:ef34::91ff:0:5424`

     Solution: `____:____:____:____:____:____:____:____`

   - `2001:0:85a4::4a1e:370:7112`

     Solution: `____:____:____:____:____:____:____:____`