

Exercise Sheet 5

Exercise 1 (IPv4 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?	---.---.---.---	-----.-----.-----.-----	

Exercise 2 (Inter-Networking)

1. Calculate for the **subnet ID of sender and receiver** and specify whether the IP packet **leaves the subnet during transmission** or not for the following two examples.

a)	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]?

```
b) 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]?

2. The forwarding table of a computer (Windows or Unix) can be queried with the command `netstat -rn`. An exemplary output may look like this:

Kernel IP routing table

Destination	Gateway	Genmask	Flags	MSS	Window	irtt	Iface
0.0.0.0	10.2.0.1	0.0.0.0	UG	0	0	0	eth0
10.2.0.0	0.0.0.0	255.255.255.0	U	0	0	0	eth1
10.204.0.0	0.0.0.0	255.252.0.0	U	0	0	0	wlan0
10.200.0.0	0.0.0.0	255.248.0.0	U	0	0	0	eth2
172.17.8.15	0.0.0.0	255.255.255.255	UH	0	0	0	eth2
192.168.23.0	0.0.0.0	255.255.255.0	U	0	0	0	wlan1
192.168.42.0	0.0.0.0	255.255.255.240	U	0	0	0	eth3

Specify the particular interface the kernel will choose for each destinations with following IPv4 addresses and explain why:

- 192.168.23.14
- 192.168.42.17
- 192.168.42.15
- 10.2.0.255
- 10.207.51.4
- 172.17.8.18
- 172.17.8.15
- 10.202.4.3
- 10.216.168.23

Exercise 3 (Subnetting)

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.

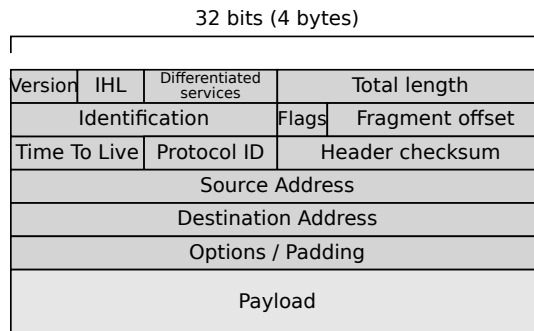
Network ID: 11000011.00000011.10000000.00000000 195.3.128.0
Number of bits for host IDs?
Number of bits for subnet IDs?
Number of possible subnets?
Subnet mask: _____·_____·_____·_____ ---·---·---·---

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: _____·_____·_____·_____ ---·---·---·---

Exercise 4 (Checksums in IP Packets)

The figure shows the structure of IPv4 packets as discussed in the computer networks course.



The given data in hexadecimal notation is a truncated excerpt of an IP packet:

4500 0034 B612 4000 4006 6F80 0A00 008B 5BC6 AEE0

The data contains the values of the fields of the IP packet header.

- 4 = Version
- 5 = IHL = IP Header Length ($\implies 5 * 4$ Byte words = 20 bytes)
- 00 = Differentiated services
- 0034 = Total length ($\implies 52$ bytes)
- B612 = Identification
- 4000 = Flags + Fragment offset
- 40 = Time To live ($\implies 62$ hops)
- 06 = Protocol ID (\implies TCP)
- 6F80 = Header Checksum
- 0A00 008B = IP address (sender)
- 5BC6 AEE0 = IP address (destination)

1. **Calculate** the checksum for each IP header:

- 4500 0034 4C22 4000 F706 ????? C163 9055 0A00 008B
- 4500 0034 671E 4000 4006 ????? 0A00 008b C163 9055
- 4500 00F2 0000 4000 4011 ????? 0A00 008b 0A00 00FF

2. **Verify** the checksum of each IP header:

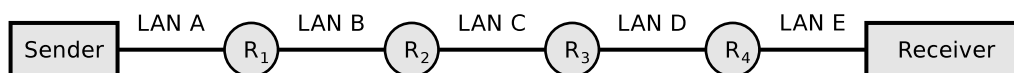
- 4500 0034 02FD 4000 3606 276C 6CA0 A330 0A00 008B
- 4500 00E7 02FC 4000 3606 37BC 6CA0 A330 0A00 008B
- 4500 0034 A9D5 4000 4006 814E 0A00 008B adC2 4613

Exercise 5 (Address Types and Spaces)

1. Name the three private IPv4 address spaces.
2. What is the prefix for a link-local address in IPv4 and IPv6 networks?
3. Which of the following IPv4 addresses are multicast addresses?
 - 222.1.2.3
 - 224.1.2.3
 - 242.0.0.0
 - 234.23.23.23
4. How can an IPv6 anycast address be distinguished from a unicast or a multicast address?
5. Which IPv6 address can you use in order to *ping* all stations in a local network?
6. What type of address is given with `fd04:2342:0815:1:6770:37ca:7a5c:f408/64`? What is its purpose?
7. What type of address is given with `ff02::1:ff5c:f408`? What is its purpose?

Exercise 6 (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.

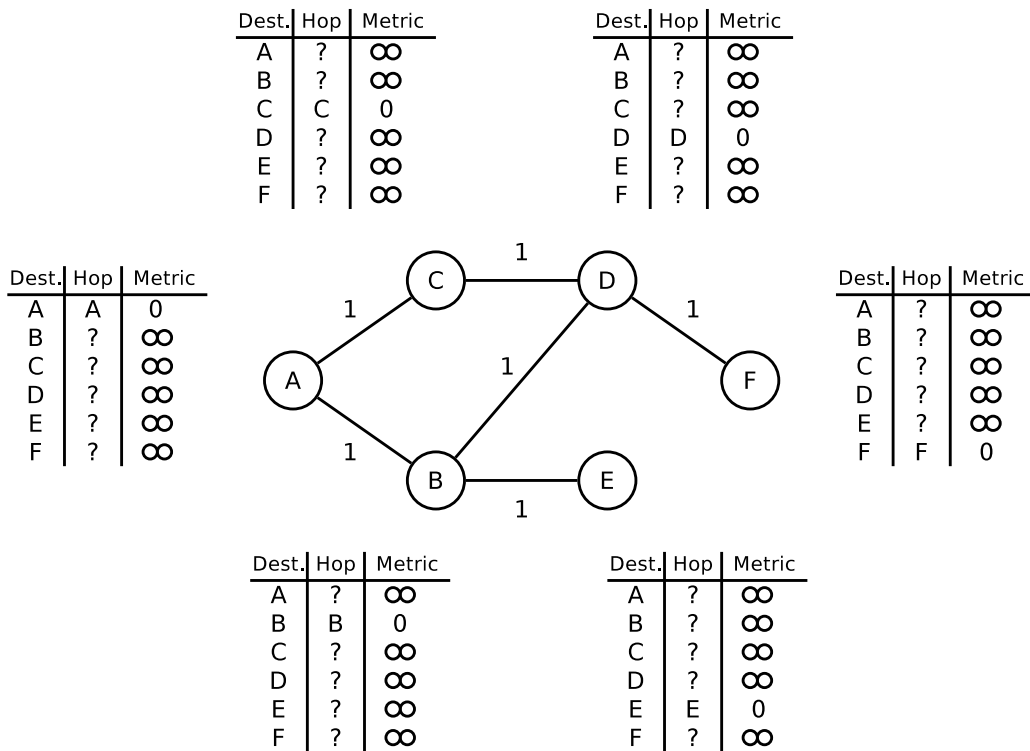
Exercise 7 (Forwarding and Path Calculation)

1. What is an **autonomous system**?
2. Which two major classes for **adaptive, dynamic routing protocols** exist?
3. Which **algorithms** are implemented by each of the routing protocol classes from subtask 2?
4. The **Border Gateway Protocol** (BGP) is a protocol for...
 Intra-AS routing Inter-AS routing
5. Which **routing protocol class** from subtask 2 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 2 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 2 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?

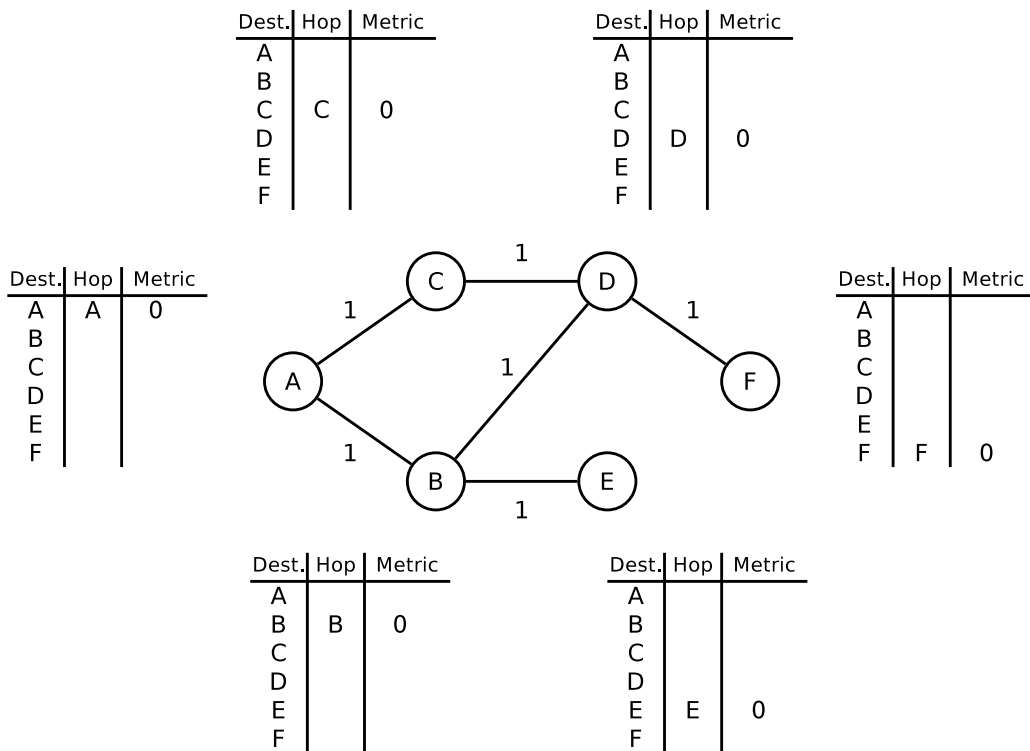
Exercise 8 (Bellman-Ford Algorithm)

1. **Calculate** the entries of the routing tables for each advertisement round of the Routing Information Protocol (RIP).
 (The hop metric is used.)

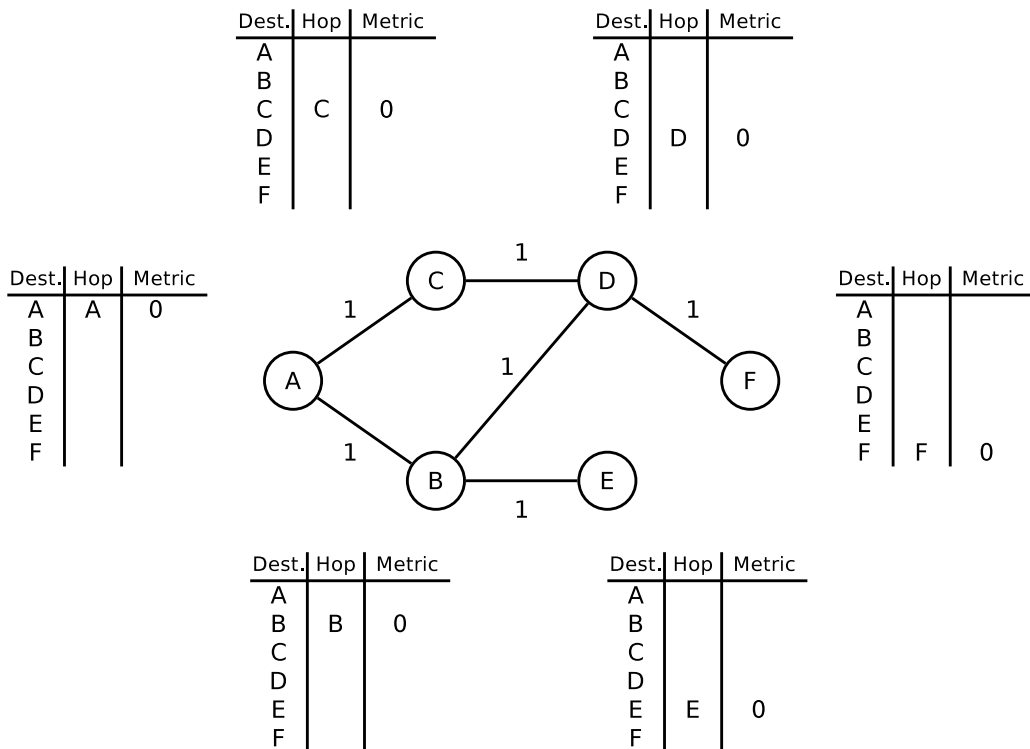
Step 1



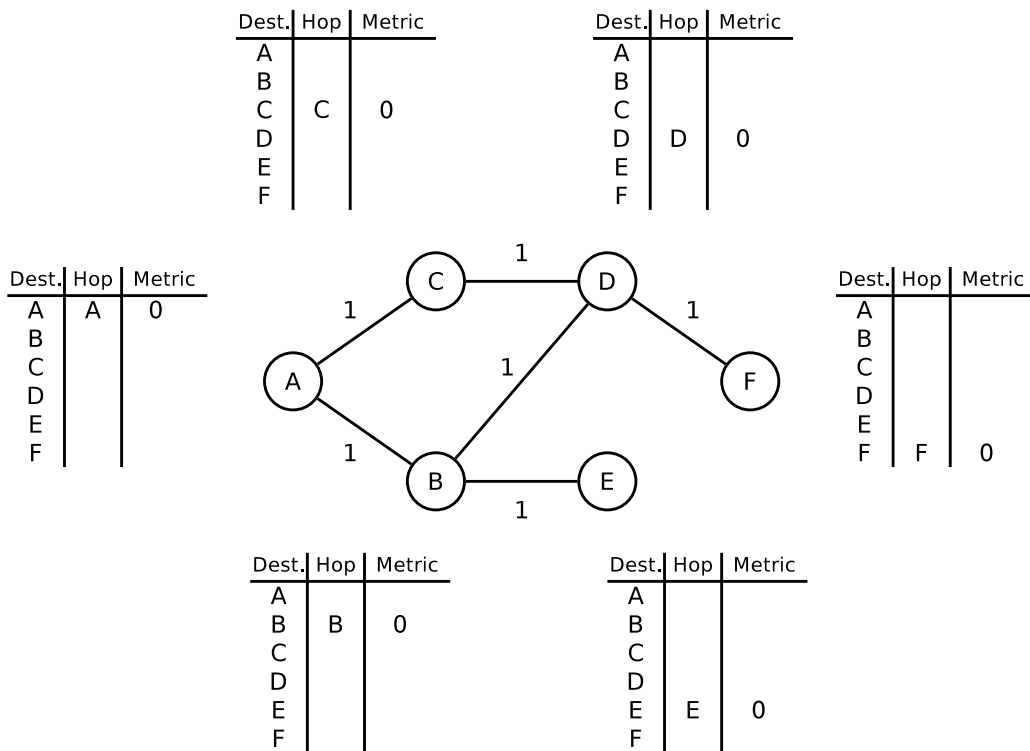
Step 2



Step 3



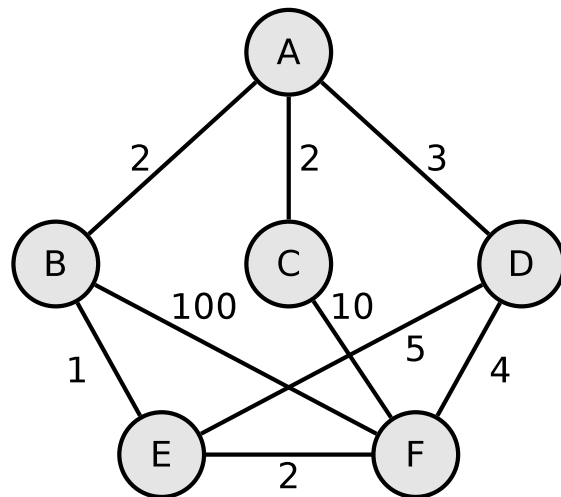
Step 4



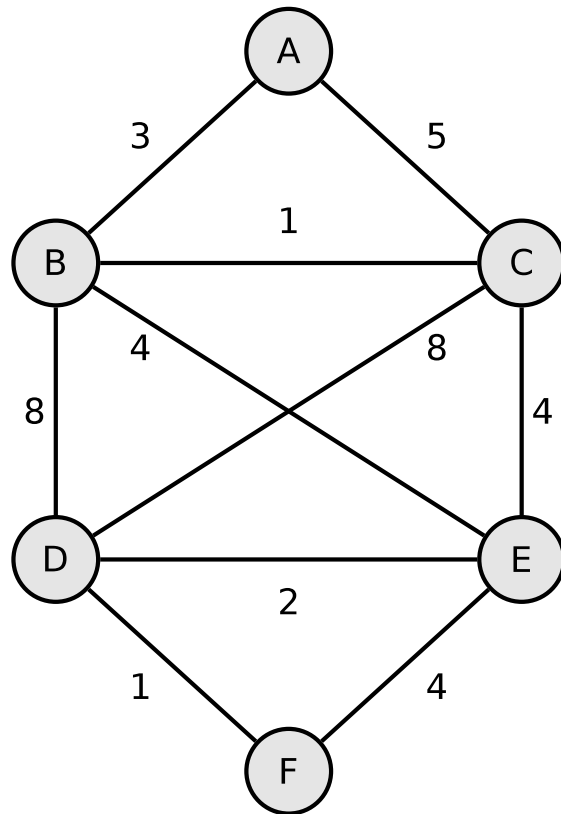
Exercise 9 (Dijkstra's Algorithm)

- 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 10 (IPv6 Address Representation)

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: ____:____:____:____:____:____:____:____

Exercise 11 (Do some research)

1. The transition from IPv4 to IPv6 may indicate that one IP version number has been skipped. What happened to **IPv5**?
2. Explain the meaning of the fields **Flags**, **MSS**, **Window**, and **irrt** in the forwarding table as shown in task 2.
3. Explain what **BGP hijacking** is and list two popular incidents where it was used and why.
4. What is the **ASN** our university's network reside in?