Kaunas University of Technology
Faculty of Informatics

Computer Networks and Internet Technologies

Engeneering Project

Student name, surname, academical group

Student **Zahi El Helou**, IFU-1

Position

Instructor **SANDONAVIČIUS Donatas**

Kaunas, 2024

1. Introduction:
The project:

configuration of schools' network					IP ranges			
Jpg No	1	2	3	4	5	Public networks	Administration networks	Server Relations
179	18v+10a	14v	8v+10v+R	31v+R	30v	172.16.40.0/23	192.168.11.64/27	10.10.12.192/27

We designed and modelled the network of 5 schools located in 5 different cities in the Cisco Packet Tracer environments.

The technical assignment is given in accordance with the MS Excel file, where the task description consists of one line containing 5 network configuration and IP address segments in the school. The line number XX corresponds to the **slide179.jpg** in the picture showing the location of the schools on the map and the optical cable connecting them.

1. The **„v“ letter indicates the subnets for public** use, and the letter **"a" indicates the subnetting for the administration**. If the letter "a" or "v" is written with "W", the wireless access device needs to be connected to the same subnet. The wireless connection must be secure.
2. Each school switches in with each other in a consistent manner.

3. If the school has both a public and an administrative subnet, they are connected through a router that connects to the school with the trunk network connecting to the district center. In the case of one subnet (only „v“), the school switcher is connected directly to the trunk network if the router is not set up in the school.
4. School computers connect to the switch by copper cable, 100 Mbps Ethernet UTP (Unshielded twisted pair) connections (Fast Ethernet). The switches are connected to the router by copper cable through a 1 Gbps UTP connection (Gigabit Ethernet). Devices connected to fiber optic cables are connected using 1 Gbps (Gigabit Ethernet) optical connectors.
5. Router Schools are also required in the following additional cases:
   - **"+ R"** is specified in school network configuration: compulsory school network separation through router;
   - The school sign in the diagram is placed in the middle of the cable or on the branch. This means that the school next to the same cable will not be connected by separate connection to the district center, but will be **connected sequentially** through the router of this school:

2. Network Topology:

configuration of schools' network						IP ranges		
Jpg No	1	2	3	4	5	Public networks	Administration networks	Server Relations
179	18v+10a	14v	8v+10v+R	31v+R	30v	172.16.40.0/23	192.168.11.64/27	10.10.12.192/27

- Sgarg-Rgarg

Type: Admin

Number of Subnets: 1

Number of Hosts per Subnet: 1

Total Hosts: 2

Subnet Mask: /30 (255.255.255.252)

- Rgarg-Rpri

Type: Server Relations

Number of Subnets: 1

Number of Hosts per Subnet: 1

Total Hosts: 2

Subnet Mask: /30 (255.255.255.252)

- School: Rgarg-Rdov

Type: Server Relations

Number of Subnets: 1

Number of Hosts per Subnet: 1

Total Hosts: 2

Subnet Mask: /30 (255.255.255.252)

- School: kre

Type: Public

Number of Subnets: 14

Number of Hosts per Subnet: 1

Total Hosts: 14

Subnet Mask: /27 (255.255.255.224)

- School: pri

Type: Public

Number of Subnets: 8

Number of Hosts per Subnet: 10

Total Hosts: 19

Subnet Mask: /27 (255.255.255.224)

- School: end

Type: Public

Number of Subnets: 30

Number of Hosts per Subnet: 1

Total Hosts: 30

Subnet Mask: /26 (255.255.255.192)

- School: agl

Type: Public

Number of Subnets: 31

Number of Hosts per Subnet: 1

Total Hosts: 31

Subnet Mask: /26 (255.255.255.192)

- School: dov-v

Type: Public

Number of Subnets: 18

Number of Hosts per Subnet: 1

Total Hosts: 18

Subnet Mask: /27 (255.255.255.224)

- School: dov-a

Type: Admin

Number of Subnets: 10

Number of Hosts per Subnet: 1

Total Hosts: 10

Subnet Mask: /28 (255.255.255.240)

Representing the data retrieved in a table for better visualization and understanding:

Name	Type	Number of Subnets	Number of Hosts per Subnet	Total Hosts	Subnet Mask
Sgarg-Rgarg	Admin	1	1	2	/30 (255.255.255.252)
Rgarg-Rpri	Server Relations	1	1	2	/30 (255.255.255.252)
Rgarg-Rdov	Server Relations	1	1	2	/30 (255.255.255.252)
kre	Public	14	1	14	/27 (255.255.255.224)
pri	Public	8	10	19	/27 (255.255.255.224)
end	Public	30	1	30	/26 (255.255.255.192)
agl	Public	31	1	31	/26 (255.255.255.192)
dov-v	Public	18	1	18	/27 (255.255.255.224)
dov-a	Admin	10	1	10	/28 (255.255.255.240)

Overall, these configurations specify the type of network, the number of subnets, the number of hosts per subnet, the total number of hosts, and the subnet mask for each school's network. The subnet mask is used to divide the IP address space into subnets. The notation "/30" or "/27" represents the number of bits used for the network portion of the IP address. The smaller the number, the fewer hosts can be accommodated in a subnet, but the more subnets can be created.

3. IP Distribution:

Documentation of the task

We create our LAN respective abbreviations, after that we calculate the number of interfaces, and we insert the correspondent Subnet types for each LAN.

In the network topology, we divide individual IP subnets and determine the number of addressable interfaces in them.

We first determine how many IP addresses are required for each subnet. We count the computers in the subnet and add one address to the router's connection and the wireless access device if it is provided in that subnet. We set the required address segments sizes; the segment sizes can be only 2^n.

LAN	Number of interfaces	Subnet type	Subnet size	Prefix	Mask	Address range from - to
Sgarg-Rgarg	1+1	Admin				
Rgarg-Rpri	1+1	Server Relations				
Rgarg-Rdov	1+1	Server Relations				
kre	14+1	Public				
pri	8+10+1	Public				
end	30+1	Public				
agl	31+1	Public				
dov-v	18+1	Public				
dov-a	10+1	Admin				

We select subnetworks from the given address segments by subnet type. The prefix and mask are counted or taken from this table:

Prefix	Mask	Address Segment Size
/30	255.255.255.252	4
/29	255.255.255.248	8
/28	255.255.255.240	16
/27	255.255.255.224	32
/26	255.255.255.192	64
/25	255.255.255.128	128
/24	255.255.255.0	256
/23	255.255.254.0	512
/22	255.255.252.0	1024

No we finally have our Subnet size, Prefix, and Mask IP addresses.

LAN	Number of interfaces	Subnet type	Subnet size	Prefix	Mask	Address range from - to
Sgarg-Rgarg	1+1	Admin	4	/30	255.255.255.252	
Rgarg-Rpri	1+1	Server Relations	4	/30	255.255.255.252	
Rgarg-Rdov	1+1	Server Relations	4	/30	255.255.255.252	
kre	14+1	Public	32	/27	255.255.255.224	
pri	8+10+1	Public	32	/27	255.255.255.224	
end	30+1	Public	64	/26	255.255.255.192	
agl	31+1	Public	64	/26	255.255.255.192	
dov-v	18+1	Public	32	/27	255.255.255.224	
dov-a	10+1	Admin	16	/28	255.255.255.240	

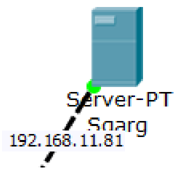
Problems could be avoided by placing the subnetting table in descending order:

LAN	Number of interfaces	Subnet type	Subnet size	Prefix	Mask	Address range from - to
Rgarg-Rpri	1+1	Server Relations	4	/30	255.255.255.252	10.10.12.192 - 10.10.12.195
Rgarg-Rdov	1+1	Server Relations	4	/30	255.255.255.252	10.10.12.196 - 10.10.12.199
Rdov-Ragl	1+1	Server Relations	4	/30	255.255.255.252	10.10.12.200 - 10.10.12.203
agl	31+1	Public	64	/26	255.255.255.192	172.16.40.0 - 172.16.40.63
end	30+1	Public	64	/26	255.255.255.192	172.16.40.64 - 172.16.40.127
pri	8+10+1	Public	32	/27	255.255.255.224	172.16.40.128 - 172.16.40.159
dov-v	18+1	Public	32	/27	255.255.255.224	172.16.40.160 - 172.16.40.191
kre	14+1	Public	32	/27	255.255.255.224	172.16.40.192 - 172.16.40.223
dov-a	10+1	Admin	16	/28	255.255.255.240	192.168.11.64 - 192.168.11.79
Sgarg-Rgarg	1+1	Admin	4	/30	255.255.255.252	192.168.11.80 - 192.168.11.83

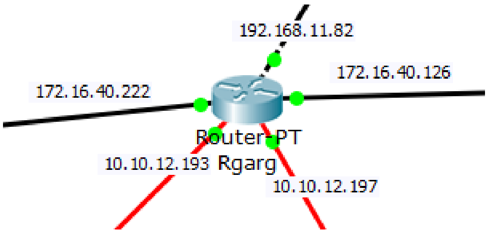
LAN	Number of interfaces	Mask	Address range from - to	Gateway (Router connection) address	Computer Addresses
agl	32	255.255.255.192	172.16.40.0-63	172.16.40.62	172.16.40.1-32
end	31	255.255.255.192	172.16.40.64-127	172.16.40.126	172.16.40.65-95
pri	19	255.255.255.224	172.16.40.128-159	172.16.40.158	172.16.40.129-147
dov-v	19	255.255.255.224	172.16.40.160-191	172.164.40.190	172.16.40.161-179
kre	15	255.255.255.224	172.16.40.192-223	172.16.40.222	172.16.40.193-207
dov-a	11	255.255.255.240	192.168.11.64-79	192.168.11.78	192.168.11.65-75
Sgarg-Rgarg	2	255.255.255.252	192.168.11.80-83	192.168.11.82	192.168.11.81

After completing all the necessary tables we can now start assigning the right IP addresses, subnet mask, as well as the gateway.

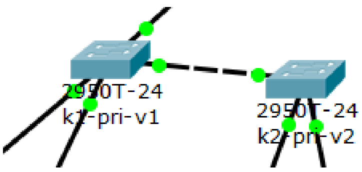
4. Network simulation



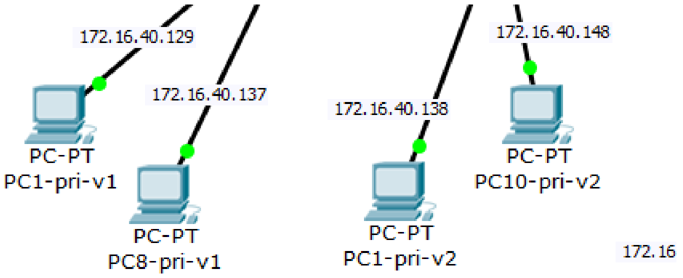
We will be using the Server-PT as only main Server.



That is the Router-PT that will be used routers.

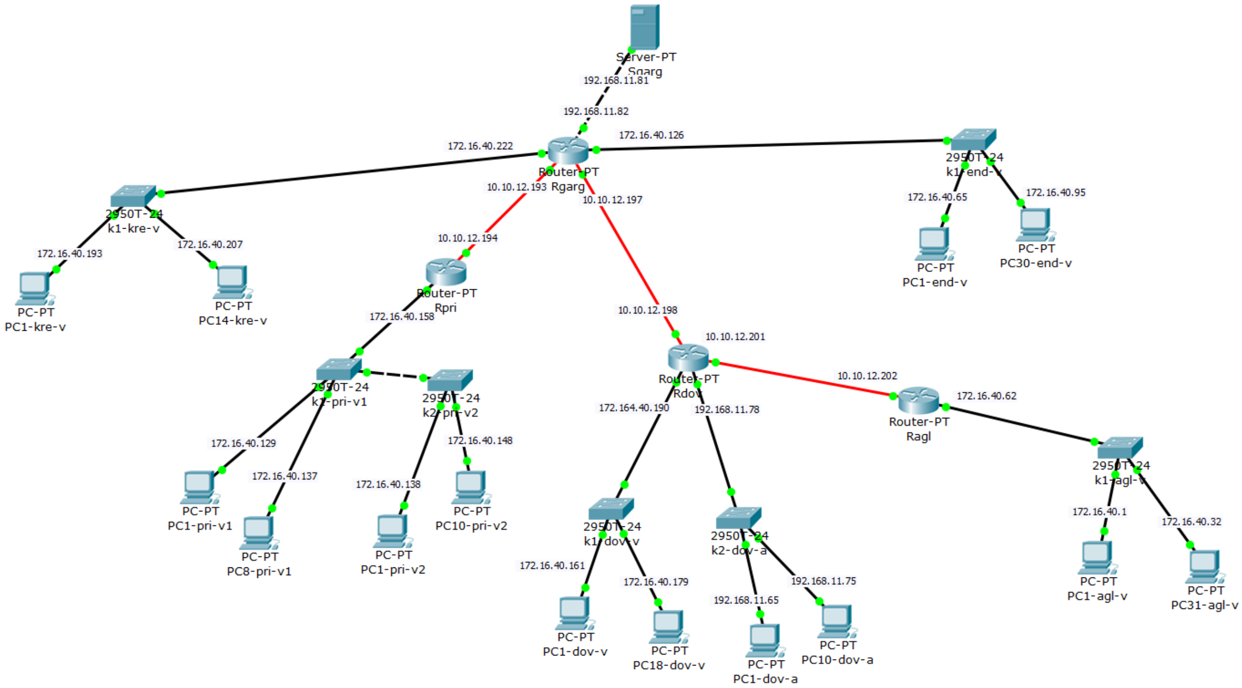


These are switches, we are using in that case the 2950T Switch



These are PC-PTs used as computers.

That is our final schematic:



5. <u>Creation of routing tables:</u>

After connecting all the schools and setting the IP numbers, we go to the next stage - the routing between the networks. Routers must ensure the transfer of data between all school networks and the server, as well as between school networks with each other.

1. Verifying the addresses of the router connections, aligning with the IP address table, verify that all required connections have specific IP addresses. It's worth knowing and marking the router interface numbers in the desktop schema.
2. We create routing tables for routers by indicating paths to those networks that are not directly connected to the router connections (the latter will automatically be included).

Rskuo

Marking	*Network IP Address*	*Network Mask*	*Through which router*	*The next hop address*
pri	*172.16.40.128*	255.255.255.224	*Rgarg*	*10.10.12.194*
agl	*172.16.40.0*	*255.255.255.192*	*Rdov*	*10.10.12.198*
dov-v	*172.16.40.160*	*255.255.255.224*	*Rdov*	*10.10.12.198*
dov-a	*192.168.11.64*	*255.255.255.240*	*Rdov*	*10.10.12.198*

*Similarly, we create routing tables for routers **Ragl, Rdov** and **Rpri***

Ragl:

Marking	*Network IP Address*	*Network Mask*	*Through which router*	*The next hop address*
agl	*192.168.0.8*	*255.255.255.252*	*Rdov*	*10.10.10.137*
end	*172.16.0.192*	*255.255.255.240*	*Rdov*	*10.10.10.137*
pri	*172.16.0.160*	*255.255.255.224*	*Rdov*	*10.10.10.137*
dov-v	*172.16.0.0*	*255.255.255.192*	*Rdov*	*10.10.10.137*
kre	*192.168.0.0*	*255.255.255.248*	*Rdov*	*10.10.10.137*
dov-a	*172.16.0.128*	*255.255.255.224*	*Rdov*	*10.10.10.137*

*In the schema, we see that the path for all the above networks is the same: via **Rskuo** the Gig4/0 connection.*

Rdov:

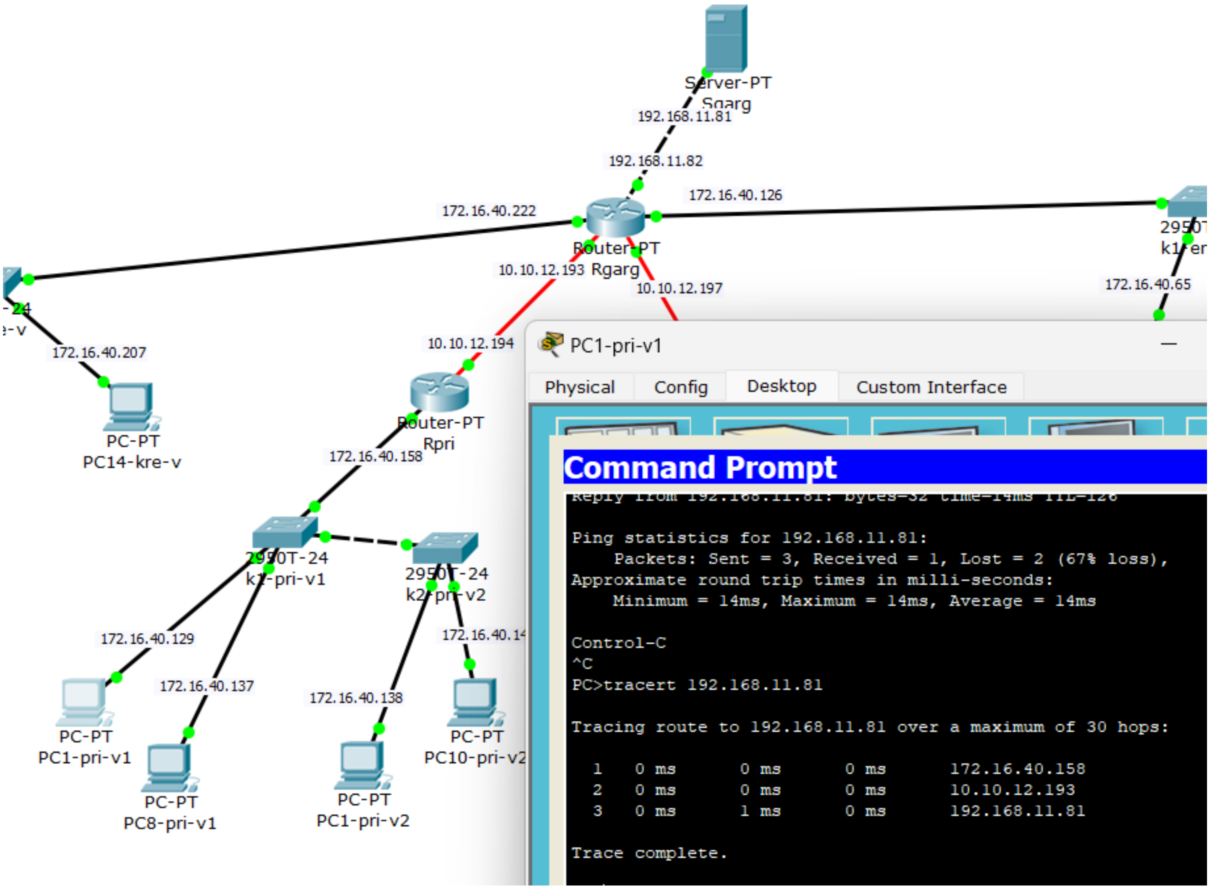
Marking	*Network IP Address*	*Network Mask*	*Through which router*	*The next hop address*
Sgarg-Rgarg	*192.168.0.8*	*255.255.255.252*	*Rgarg*	*10.10.10.134*
dov-v	*172.16.0.64*	*255.255.255.192*	*Rgarg*	*10.10.10.134*
kre	*172.16.0.0*	*255.255.255.192*	*Rgarg*	*10.10.10.134*
dov-a	*192.168.0.0*	*255.255.255.248*	*Rgarg*	*10.10.10.134*
pri	*172.16.0.128*	*255.255.255.224*	*Rgarg*	*10.10.10.134*

*The path to the listed networks goes through the **Rskuo** Gig1/0 connector, connecting the **sat** network and the **not** network directly.*

Rpri:

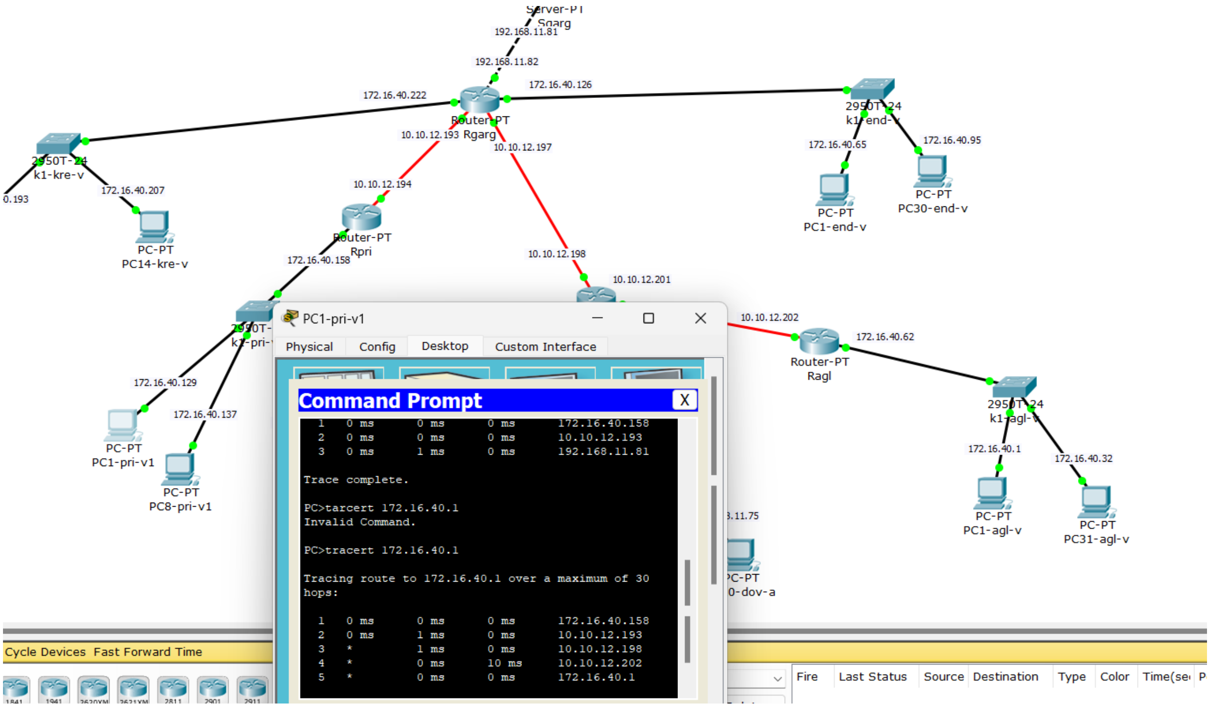
Marking	*Network IP Address*	*Network Mask*	*Through which router*	*The next hop address*
Sgarg-Rgarg	*192.168.0.8*	*255.255.255.252*	*Rgarg*	*10.10.10.129*
dov-v	*172.16.0.64*	*255.255.255.192*	*Rgarg*	*10.10.10.129*
kre	*172.16.0.192*	*255.255.255.240*	*Rgarg*	*10.10.10.129*
dov-a	*172.16.0.160*	*255.255.255.224*	*Rgarg*	*10.10.10.129*
pri	*172.16.0.128*	*255.255.255.224*	*Rgarg*	*10.10.10.129*

6. Network Configuration Testing



Here I am demonstrating the route from Pri to the Server, so we can see that the values are valid, and the route is correct.

Here is another example:



I am demonstrating the route starting from Pri to Agl, we can see that the static routing valid and the IP addresses printed are correct, which approves the simulation's workflow.

7. Conclusion

This project provides a comprehensive and detailed analysis and implementation of network configurations for schools located in different cities. The project employs Cisco Packet Tracer for modelling and simulating the networks, adhering to specific technical requirements provided by the academic instructor. It outlines a clear methodology for subnetting, IP distribution, and network simulation, ensuring secure and efficient connectivity among public, administrative, and server relation networks across the schools. The introduction sets the stage by describing the project's scope, including the configuration of school networks with designated IP ranges. The network topology section details the setup of various network types, demonstrating an understanding of subnetting and the significance of subnet masks in network segmentation.

The IP Distribution part of the project elaborates on the calculation of required interfaces and the allocation of appropriate subnet types, sizes, prefixes, and masks, ensuring an organized and efficient IP address scheme. This section also highlights the importance of proper subnetting to accommodate all necessary devices within the schools' networks while maintaining network security and performance. The Network Simulation and Creation of Routing Tables sections showcase the practical application of theoretical knowledge, with the use of specific networking hardware and software tools to simulate the designed networks.

The project concludes with Network Configuration Testing, demonstrating the effectiveness of the network setup through practical examples. These tests confirm the correct implementation of routing, adherence to the project's requirements, and the successful simulation of network connectivity scenarios.