Configuration of a computer network created on the basis of the nationwide PIONIER fiber optic network.

Signalling and Management Systems Project

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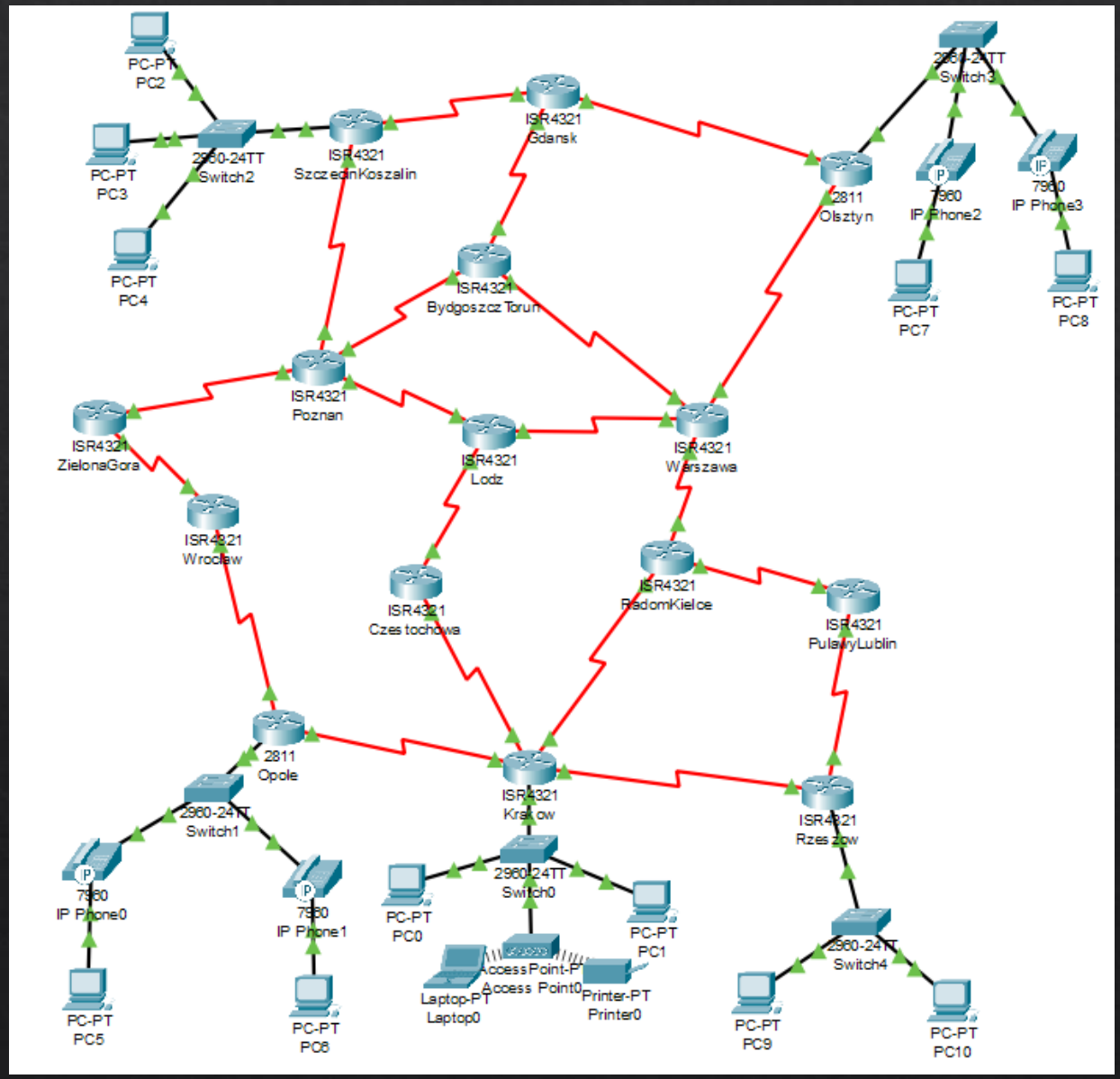
Tool selection

The tools that were used for the project were Cisco Packet Tracer, a network simulator from Cisco that has quite a large option of device models in its library. Most of the functions work just like on real hardware. VirtualBox and Free Range Routing for CLI simulation were used to run the simulation.

FRROUTING

Topology mapping in Cisco Packet Tracer

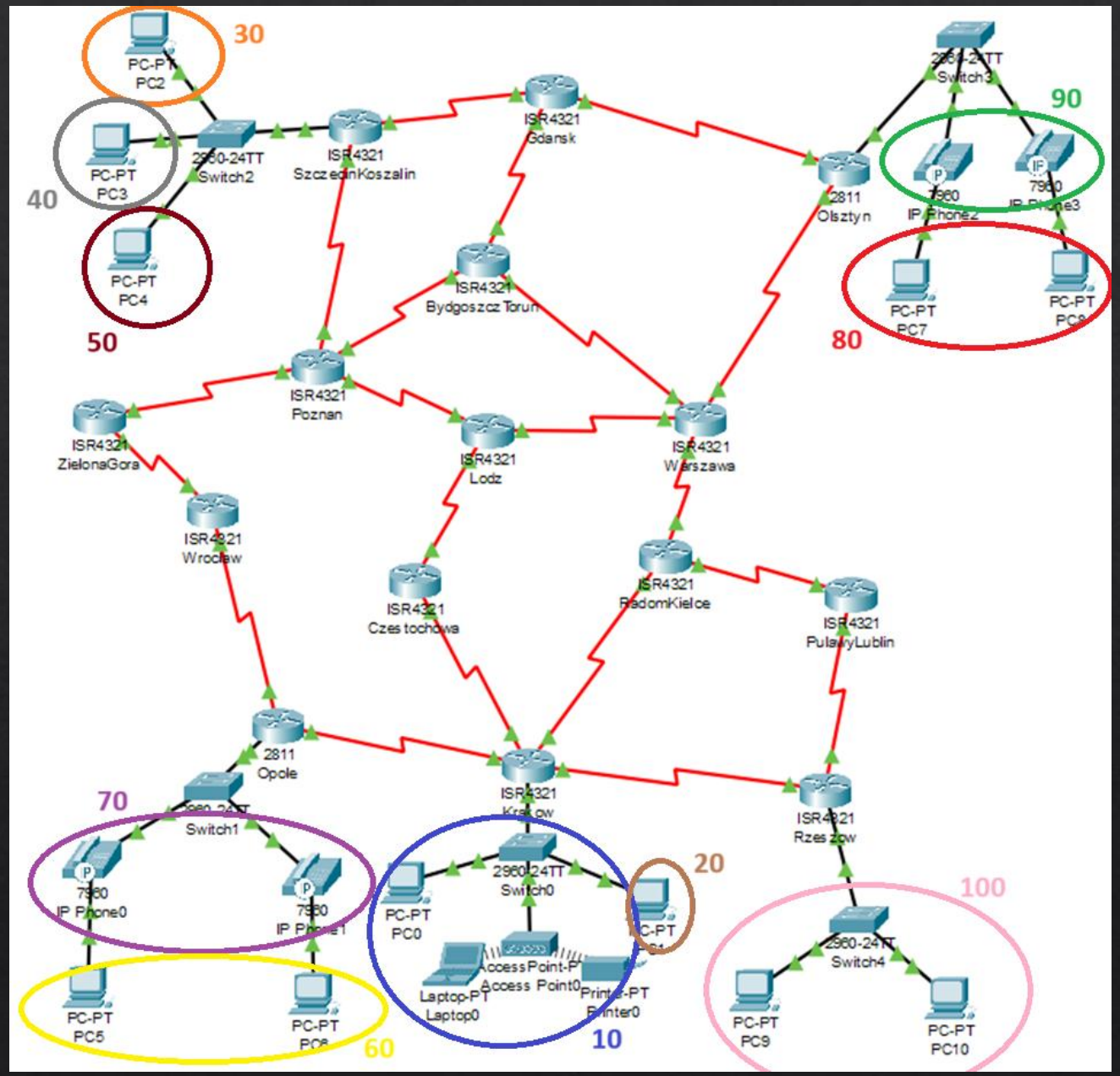


```
Device Name: Krakow
Device Model: ISR4321
Hostname: Krakow

Port                    Link   VLAN   IP Address          IPv6 Address
GigabitEthernet0/0/0    Up     --     <not set>           <not set>
GigabitEthernet0/0/0.10 Up     --     192.168.10.1/24     2001:DB8:1::1/64
GigabitEthernet0/0/0.20 Up     --     192.168.20.1/24     2001:DB8:2::1/64
GigabitEthernet0/0/1    Down   --     <not set>           <not set>
Serial0/1/0             Up     --     10.0.0.1/30         2001:0:0:1::1/64
Serial0/1/1             Up     --     10.0.10.1/30        2001:0:0:2::1/64
Serial0/2/0             Up     --     10.0.20.1/30        2001:0:0:3::1/64
Serial0/2/1             Up     --     10.0.30.1/30        2001:0:0:4::1/64
Vlan1                   Down   1      <not set>           <not set>
```

First, the topology was mapped based on the Pioneer network. Switches, computers, VoIP phones and an access point were added to increase the features that can be added to the project. Next, connections between routers were addressed using IPv4 and IPv6. For the network to function properly, a routing protocol had to be configured, and for this project OSPF was chosen, which allows for more accurate route planning than, for example, RIP. Later, vlans were added on the switches, and DHCP was run on the routers, which allowed automatic addressing of connected devices. Address translation (NAT) and the ability to make calls (VoIP) were also added to the computer network. Finally, a number of tests and simulations were carried out to confirm that the implemented functions worked correctly.

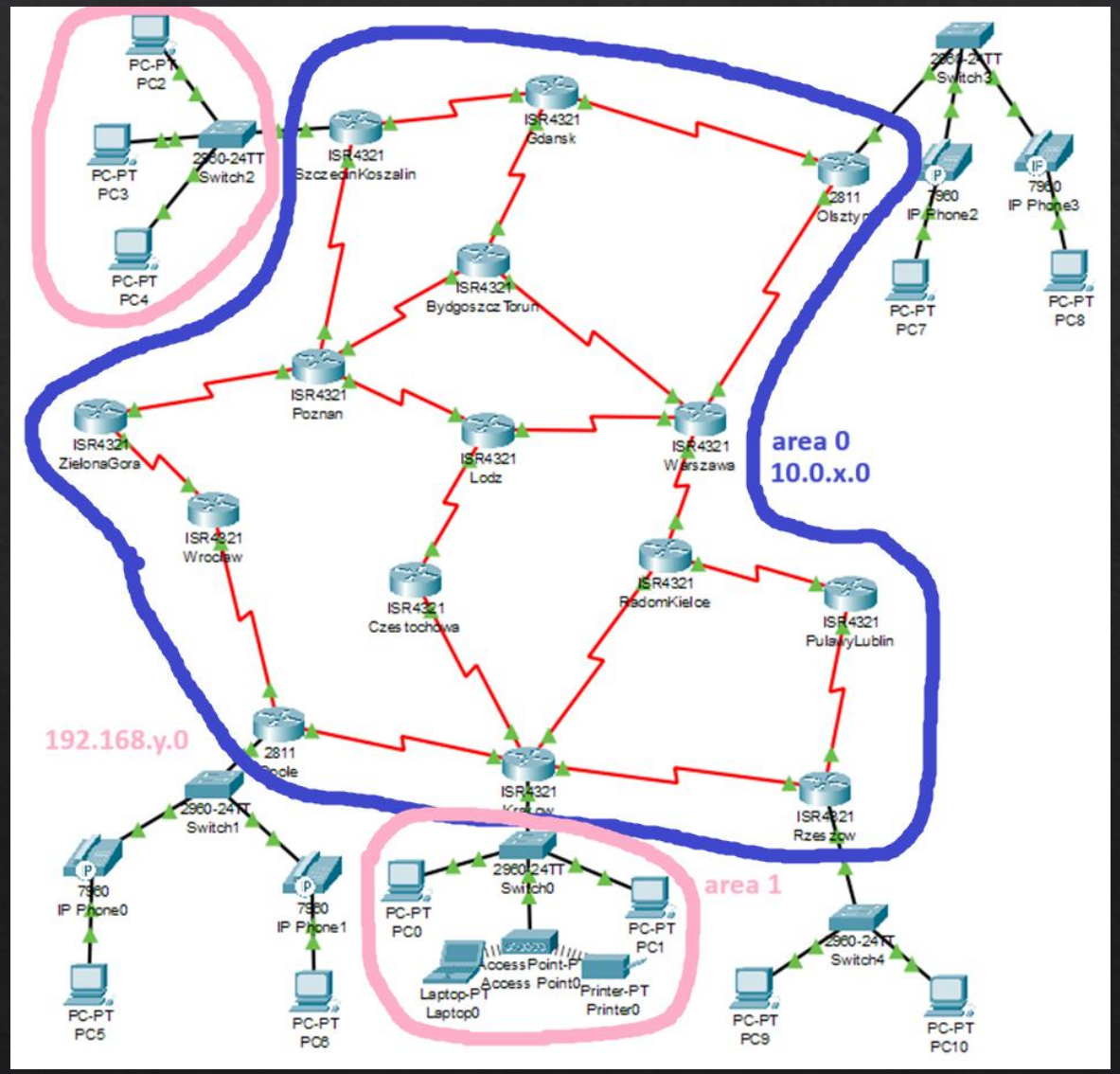
Thus, vlans were created in the computer network. In Cracow two vlans were created. Number 10 for ports 1-5 and number 20 for ports 6-10. Similarly, in Szczecin, only here another 3 vlan was added for ports 11-15. vlans were also created to support VoIP in Opole and Olsztyn.

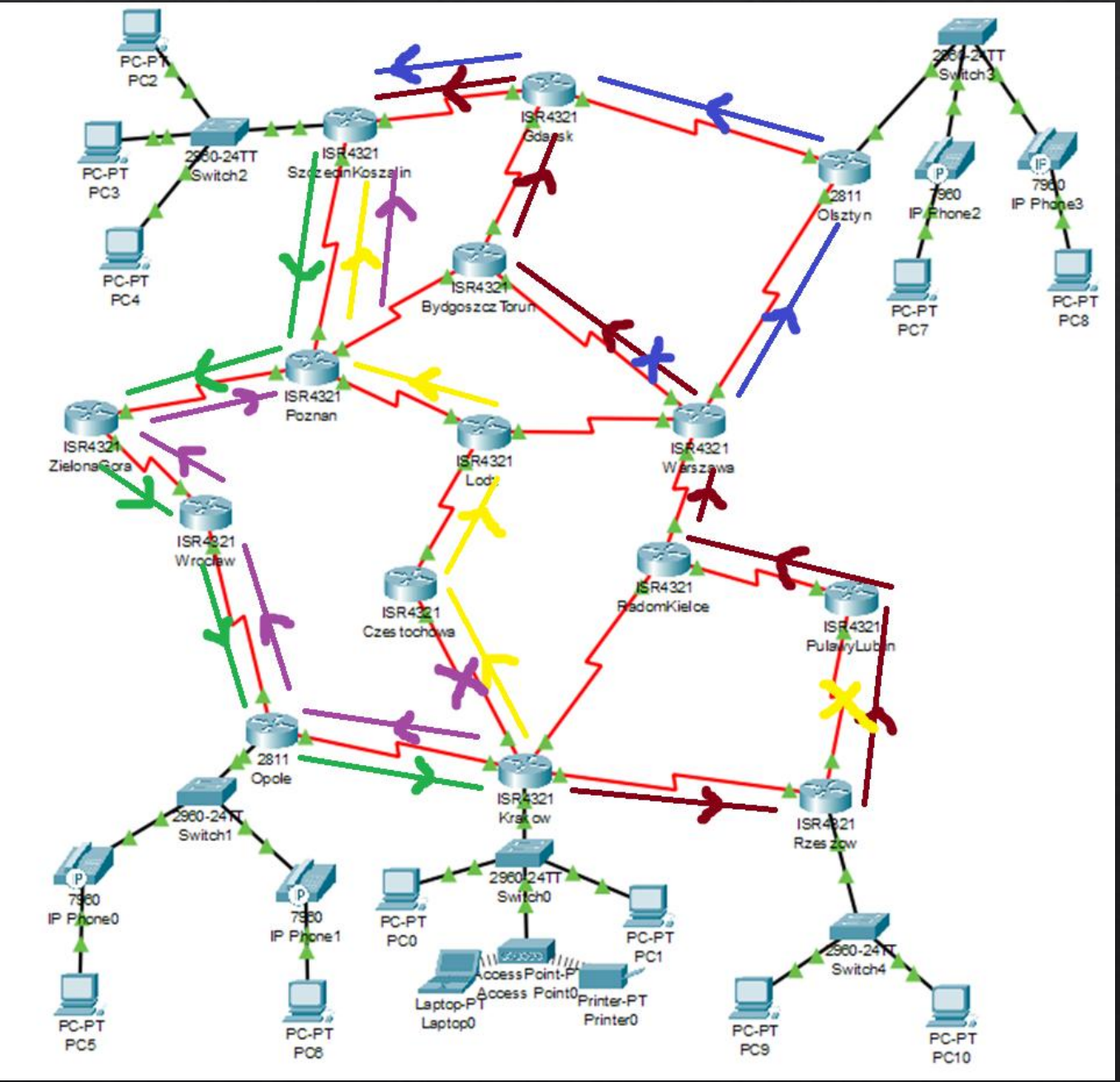


```
Krakow>en
Krakow#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
Krakow(config)#ip dhcp pool Krakow
Krakow(dhcp-config)#network 192.168.10.0 255.255.255.0
Krakow(dhcp-config)#def
Krakow(dhcp-config)#default-router 192.168.10.1
Krakow(dhcp-config)#dns
Krakow(dhcp-config)#dns-server 8.8.8.8
Krakow(dhcp-config)#ip dhcp e
Krakow(dhcp-config)#exit
Krakow(config)#ip dhcp ex
Krakow(config)#ip dhcp excluded-address 192.168.10.1 192.168.10.100
Krakow(config)#int gig0/0/0.10
Krakow(config-subif)#enca
Krakow(config-subif)#encapsulation dot1
Krakow(config-subif)#encapsulation dot1Q 10
Krakow(config-subif)#ip add 192.168.10.1 255.255.255.0
Krakow(config-subif)#def
Krakow(config-subif)#no sh
Krakow(config-subif)#exit
```

The slide shows the commands to configure one of the two DHCP servers in Krakow. Network 192.168.10.0. Default gateway 192.168.10.1. In addition, the first 100 addresses were excluded from use. And the subinterface was addressed. DHCP was also configured in Szczecin, Rzeszow, Opole and Olsztyn.

The slide shows how to configure OSPF. A zero area (backbone area) was created for devices from the 10.0.X.0 network. Devices from the 192.168.Y.0 network were assigned to area one. In addition, each device was assigned an ID, e.g. 4.4.4.4.





In OSPF, the cost of routes has been changed to maximize the use of the entire network and get the most fault tolerance, any of the routes or the device. The first route the packets will be sent is represented by the brown color. This is followed by the blue color in the case of damage to the Warsaw - BydgoszczToruń route or beyond. Then the yellow color, which uses the shortest route from Krakow to Szczecin. In the event of damage to this route, the next route by which packets will be sent is the purple route consisting of devices located to the west. In the other direction, a green route has been designated. In addition, I wanted to implement MPLS, but Cisco Packet Tracer does not simulate this function correctly.

In Rzeszow, NAT, or Network Address Translation, has been configured. The router translates addresses from the 192.168.100.0 network in such a way that from a subnet we can “get” to the rest of the network, but from elsewhere in the network we can't get to what's behind the NAT.

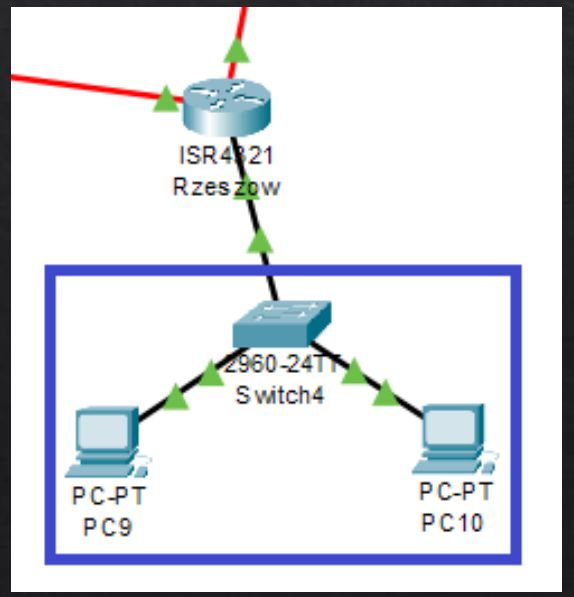
```
Rzeszow(config)#int gig0/0/0.100
Rzeszow(config-subif)#ip nat inside
Rzeszow(config-subif)#ex
Rzeszow(config)#acc
Rzeszow(config)#access-list 10 permit 192.168.100.0 0.0.0.255
Rzeszow(config)#access-list 20 permit 192.168.100.0 0.0.0.255
Rzeszow(config)#ip nat inside source list 10 int s0/1/0 overload
Rzeszow(config)#ip nat inside source list 20 int s0/1/1 overload
Rzeszow(config)#int gig0/0/0.100
Rzeszow(config-subif)#ip nat inside
Rzeszow(config-subif)#int s0/1/0
Rzeszow(config-if)#ip nat outside
Rzeszow(config-if)#int s0/1/1
Rzeszow(config-if)#ip nat outside
```

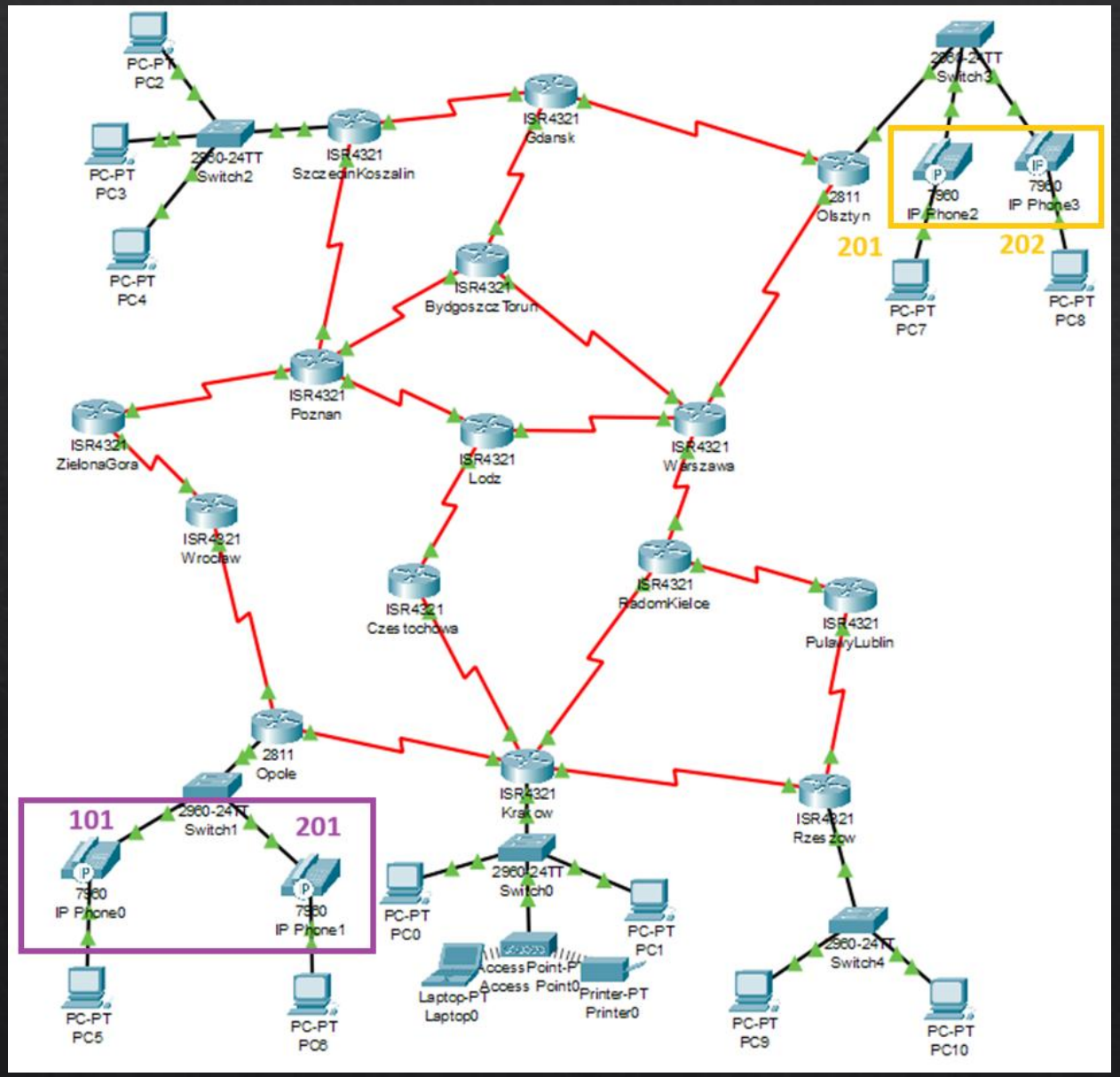
```
Pinging 192.168.100.3 with 32 bytes of data:

Reply from 192.168.30.1: Destination host unreachable.
```

```
Pinging 192.168.30.101 with 32 bytes of data:

Reply from 192.168.30.101: bytes=32 time=57ms TTL=121
```





VoIP phones have been configured in Opole and Olsztyn, which allows calls to be made over the network. In Opole, numbers 101 and 102 were assigned, and in Olsztyn numbers 201 and 202. In addition, using the policy map function, the priority for this type of traffic was increased to ensure trouble-free transmission.


```
Krakow#show policy-map
  Policy Map VOIP_P
    Class VOIP
      Strict Priority
      Bandwidth 512 (kbps) Burst 12800 (Bytes)
```

VirtualBox was used to run the simulations, in which virtual machines were created for each router and FRR was used to simulate the consoles from the routers and the functions that Cisco routers offer. A number of tests were conducted to confirm the correct operation of the implemented functions

```
Tracing route to 192.168.30.101 over a maximum of 30 hops:

  1    0 ms     0 ms     0 ms     192.168.10.1
  2    6 ms     0 ms     3 ms     10.0.0.2
  3   13 ms    23 ms    13 ms     10.0.40.2
  4   12 ms    23 ms    17 ms     10.0.50.2
  5   24 ms     6 ms     2 ms     10.0.60.2
  6   28 ms    18 ms    31 ms     10.0.130.1
  7   29 ms    33 ms    31 ms     10.0.120.1
  8   20 ms    13 ms    25 ms     10.0.140.1
  9   36 ms     6 ms    31 ms     192.168.30.101
```