## COMPUTER NETWORKS, MULTIMEDIA - LAB

006

Subject:
Cisco IOS - IP multicast.
IP multicast tunneling over networks not supporting the IP multicast

Task A: Unicast routing.

1. The aim is to implement a solution that enables transfer of IP multicast datagrams over a network where IP multicast is not supported. This situation happens often, when IP Multicast networks are dispersed geographically (Internet connections often do not support IP multicast).

2. The test installation will use three routers. The center router will simulate a part of the network that does not support multicast IP traffic. Two others - will be connected respectively to the source and IP multicast stream (on a computer) an do a multicast player application (on another computer). The aim is to build a tunnel enabling transmission of IP multicast traffic from the source to the player despite the lack of functionality of the IP multicast router in the middle.

3. Prepare an installation consisting of three Cisco routers and two computers - as in is shown below:
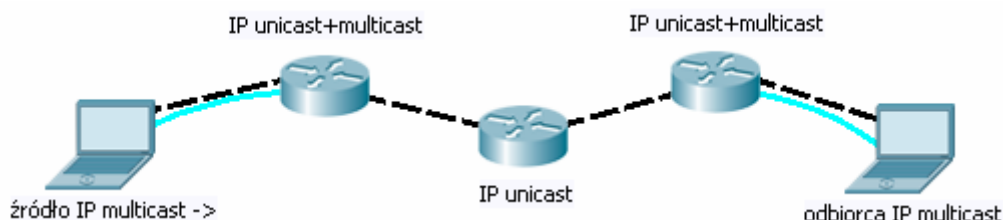
4. Then to prepare a complete IP addressable infrastructure in all network segments in accordance with generally known rules, for instance - as the following figure shows. When configuring addressing, remember to define the addresses of default gateways for both computers connected to the system:
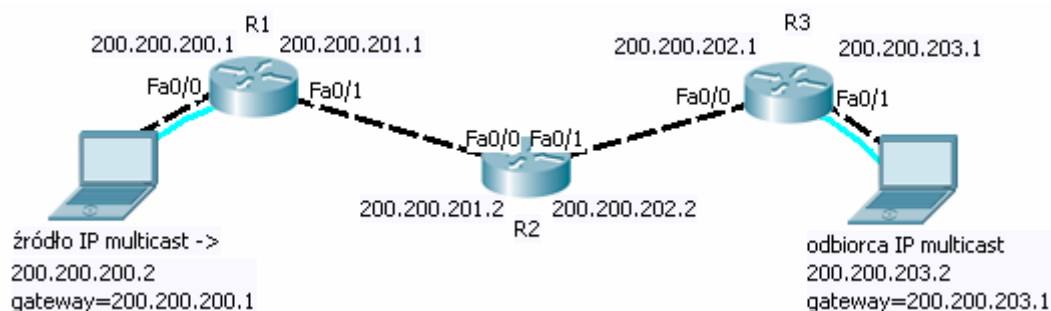
Instructions for configuring routers with addressing visible in the picture will be as follows:

R1 (config) #interface FastEthernet0/0
R1 (config-if) #ip address 200.200.200.1 255.255.255.0
R1 (config-if) #no shut
R1 (config) #interface FastEthernet0/1
R1 (config-if) #ip address 200.200.201.1 255.255.255.0
R1 (config-if) #no shut

R2 (config) #interface FastEthernet0/0
R2 (config-if) #ip address 200.200.201.2 255.255.255.0
R2 (config-if) #no shut
R2 (config) #interface FastEthernet0/1
R2 (config-if) #ip address 200.200.202.2 255.255.255.0
R2 (config-if) #no shut

R3 (config) #interface FastEthernet0/0
R3 (config-if) #ip address 200.200.202.1 255.255.255.0
R3 (config-if) #no shut
R3 (config) #interface FastEthernet0/1
R3 (config-if) #ip address 200.200.203.1 255.255.255.0
R3 (config-if) #no shut

The next step is to run a dynamic routing system to enable IP unicast traffic (IP unicast communication is necessary to start IP multicast).
Use an EIGRP:

R1 (config) #router eigrp 100
R1 (config) #network 0.0.0.0
R2 (config) #router eigrp 100
R2 (config) #network 0.0.0.0
R3 (config) #router eigrp 100
R3 (config) #network 0.0.0.0

5. After you run a dynamic routing system, check the functioning of the system at the current stage of construction (IPv4 unicast communication):

R1 # sh ip eigrp neighbor
R1 # sh ip eigrp topology
R1 # show ip route
R2 # sh ip eigrp neighbor
R2 # sh ip eigrp topology
R2 # show ip route
R3 # sh ip eigrp neighbor
*R3 # sh ip eigrp topology*
R3 # show ip route

Computer on the right> ping 200.200.200.2
Computer on the left> ping 200.200.203.2

Task B: The tunnel for IP multicast traffic

1. The tunnel will be set between routers R1 and R3, which will be transmitting multicast IP traffic over it (without processing of the IP multicast in router R2, hence it does not support IP multicast). In addition, it is necessary to define another segment of IP network - which is formed in the interior of a tunnel:

   R1 (config)#interface Tunnel1
   R1 (config-if)#ip address 200.200.204.1 255.255.255.0
   R1 (config-if)#tunnel source 200.200.201.1
   R1 (config-if)#tunnel destination 200.200.202.1
   R1 (config-if)#no shut

   R3 (config)#interface Tunnel1
   R3 (config-if)#ip address 200.200.204.2 255.255.255.0
   R3 (config-if)#tunnel source 200.200.202.1
   R3 (config-if)#tunnel destination 200.200.201.1
   R3 (config-if)#no shut
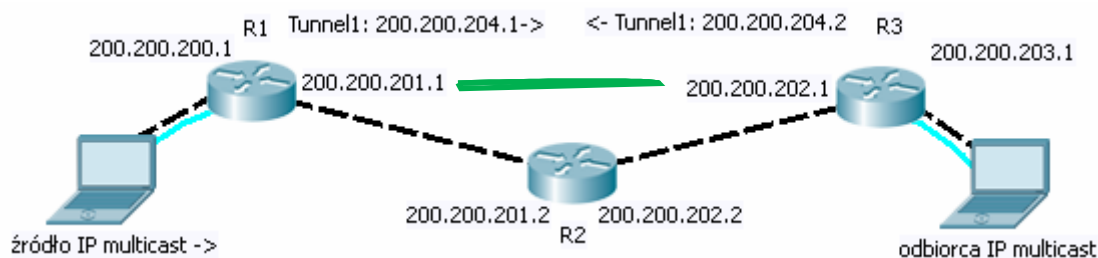
2. After the has started there will be a problem of alternative IP routes between router R1 and R3 (additional route goes through the tunnel now). The information about this route should not be placed in the global IP routing tables of R1 and R3. It must only be used to support IP multicast traffic, not unicast. If it happens – that inter tunnel route will be better then normal one (leading physically through the router R2) and will be chosen to build the tunnel itself. It will cause a temporary routing loop (tunnel depends on a route it creates). To avoid that – exclude the interface Tunnel from eigrp route learning procedure:

   R1 (config)#router EIGRP 100
   R1 (config-router)#passive-interface Tunnel1

   R3 (config)#router EIGRP 100
   R3 (config-router)#passive-interface Tunnel1

   After that, unicast IP traffic between the computers will not run through the tunnel (tunnel is reserved for IP multicast only).

Task C: Starting of IP Multicast

1. Sufficient variant of IP PIM for streaming will be a dense mode. PIM dense mode (i.e. push mode) assumes automaticall broadcast of multicast IP traffic from all sources to routers. When the routers do not need IP multicast traffic of some group – they prune (hold) it.

2. Start the IP mode multicast routing only in router R1 and R3:

   R1 (config)#ip multicast-routing
   R3 (config)#ip multicast-routing

   Activate the IP multicast functionality only on tunnel interfaces and interfaces directly connected to the computers:
   :

   R1 (config)#int fa 0/0
   R1 (config-if)#ip pim dense-mode
   R1 (config)#int tunnel 1
   R1 (config-if)#ip pim dense-mode

   R3(config)#int fa 0/1
   R3(config-if)#ip pim dense-mode
   R3(config)#int tunnel 1
   R3(config-if)#ip pim dense-mode

   Note, that the multicast IP mode is not activated interfaces fa0/1 in the router R1 and fa0/0 router R3. These interfaces are physically connected with router R2, which does not support IP multicast. Instead, the routers R1 and R3 will be passing the IP multicast communication through the tunnel (tunnel interface 1). After such configuration, a DVMRP (Distance Vector Multicast Routing Protocol) will be carried out only in the routers R1 and R3.
   DVMRP adjacency occurs directly between R1 and R3:
   R1#show ip pim neighbor
   R3#show ip pim neighbor

3. Start an IP multicast transition on source computer (as shown in figure: computer on the left), using a VideoLAN - VLC Player application. For this particular app use the command:
   vlc.exe file :sout=#rtp{dst=224.1.1.1,port=5004,mux=ts,ttl=10} :sout-all :sout-keep --repeat

   where *file* is the path to a media file, dst=224.1.1.1 is an IP multicast group number used for the transmission, port=5004 is used UDP port number (UDP datagrams will be uses in fourth layer of the ISO OSI), mux (muxer) indicates the type of formatting in multimedia stream. "ts" here means MPEG Transport Stream - a variant designed for streaming MPEG (including the extension of the Session Description Protocol format for describing the content of the media stream).

   Note: it is necessary to emit an IP multicast datagrams with a TTL greater than the number of routers planned to go through (to reach the destination).

4. At the computer intended for the recipient of IP multicast (computer on the right) turn the VLC Player application on the IP to receive a stream (it wont work for
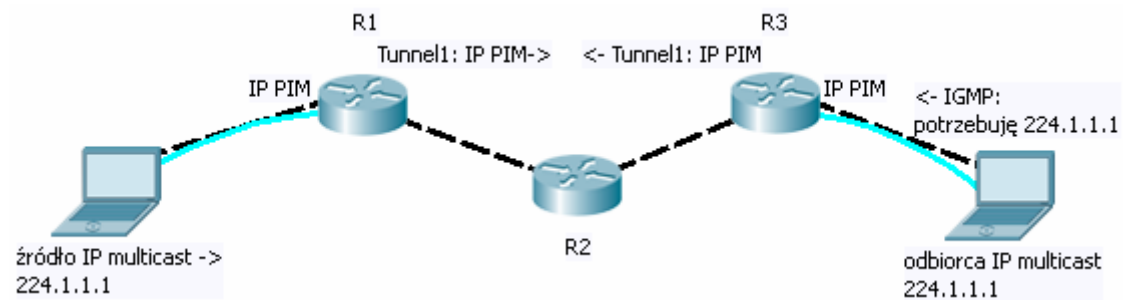
now, cost configuration of the IP multicast transmission is not ready yet):

vlc.exe rtp://224.1.1.1:5004

5. After starting the receiving app, check whether it is registered or not in a directly connected router (R3):
R3#show ip igmp groups
R3#show ip igmp membership

Check if the DVMRP processes have found a unicast address of IP multicast source desired by the player:
R1#show ip mroute
R3#show ip mroute

The resulting reports should include entry such as:
...
(200.200.200.2, 224.1.1.1), 00: 00: 04/00: 02: 55, flags:
...
indicating unicast IP address (200.200.200.2) of multicast group 224.1.1.1

6. As you know, to start the multicast transmission an IP unicast path is needed. It is used by a router to ask for the IP multicast stream in proper direction. R3 router should send such request to R1 (saying "send me a copy of the stream of 224.1.1.1").
Current state is not yet operational, because the router R3 (checking the route to 200.200.200.2 and wanting to ask to enable IP multicast stream 224.1.1.1) will send the request to router R2 (R2 carries a router IP Unicast route):
R3 # show ip route.
Since R2 does not support IP multicast the multicast route must be set over the tunnel. Currently, the the request will be sent to address 200.200.202.2 (that's the address of R2):
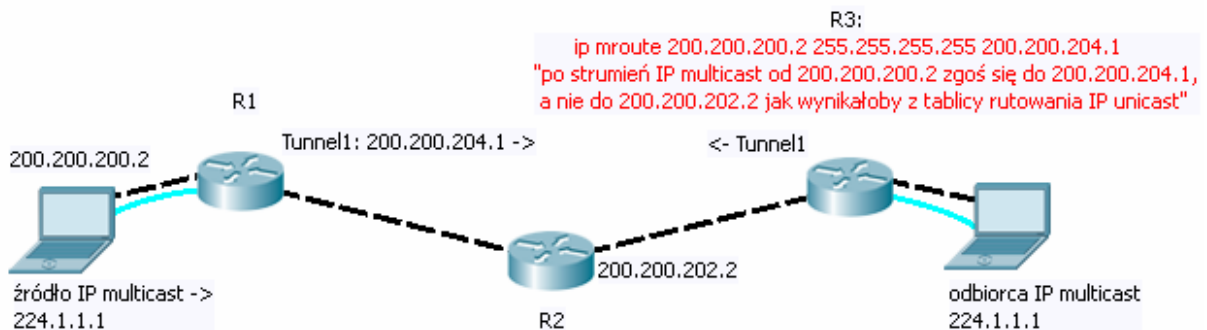*R3# show ip mroute.*

...
(200.200.200.2, 224.1.1.1), 00: 00: 04/00: 02: 55, flags:
 Incoming interface: Null, RPF nbr 200.200.202.2
 Outgoing interface list:
 FastEthernet0 / 0, Forward / Dense, 00: 00: 04/00: 00: 00
...

Therefore a traffic redirection must be configured to bypass the traffic thru a tunnel:

R3(config)#ip mroute 200.200.200.2 255.255.255.255 200.200.204.1

where 200.200.204.1 is an address of opposite tunnel end (see figure below).

It could also be configured with that command:
R3(config)#ip mroute 200.200.200.2 255.255.255.255 Tunnel 1

Check the rule:
R3#show ip mroute static

After that change the contents of IP multicast routing table should look like this:

R3#show ip mroute
...
(200.200.200.2, 224.1.1.1), 00: 00: 48/00: 02: 11, flags T
 Incoming interface: Tunnel1, RPF nbr 200.200.204.1, Mroute
 Outgoing interface list:
    FastEthernet0 / 0, Forward / Dense, 00: 00: 48/00: 00: 00

Right now a request will be sent to the tunnel.

R3#show ip summary mroute
R3#show ip active mroute
R3#show ip count mroute
R3#show interfaces summary

Full configuration:

Router 1 (connected to the source IP multicast)

```
IP multicast-routing

interface FastEthernet0/0
 ip address 200.200.201.1 255.255.255.0
 no shut
exit

interface FastEthernet0/1
 ip address 200.200.200.1 255.255.255.0
 ip pim dense-mode
 no shut
exit

interface Tunnel1
 ip address 200.200.204.1 255.255.255.0
 ip pim dense-mode
 tunnel source 200.200.201.1
 tunnel destination 200.200.202.1
 no shut
exit

router eigrp 100
 passive-interface Tunnel1
 network 0.0.0.0
exit
```

Router 2 (middle)

```
interface FastEthernet0/0
 ip address 200.200.202.2 255.255.255.0
 no shut
exit

interface FastEthernet0/1
 ip address 200.200.201.2 255.255.255.0
 no shut
exit

router eigrp 100
 net 0.0.0.0
exit
```

3 router (connected to IP Multicast receiver)

```
IP multicast-routing

interface FastEthernet0/0
 ip address 200.200.203.1 255.255.255.0
 ip pim dense-mode
 no shut
exit

interface FastEthernet0/1
 ip address 200.200.202.1 255.255.255.0
 no shut
exit

interface Tunnel1
 ip address 200.200.204.2 255.255.255.0
 ip pim dense-mode
 tunnel source 200.200.202.1
 tunnel destination 200.200.201.1
 no shut
exit

router eigrp 100
 passive-interface Tunnel1
 net 0.0.0.0
exit

ip mroute 200.200.200.2 255.255.255.255 Tunnel 1
```