HACETTEPE UNIVERSITY
COMPUTER ENGINEERING DEPARTMENT
COMPUTER NETWORKS LABORATORY

EXPERIMENT

Static Routing

AIM

Aim of this experiment is to create a wide area network (WAN) as shown in Figure-2. You will connect all LANs and configure your devices such that all subnet PCs should ping each other. You will learn static routing configuration on Routers.

INTRODUCTION

You should read Chapter 4 - Network Layer from the course textbook.

General Information about DTE and DCE

Data terminal equipment (DTE) is an end instrument that converts user information into signals or reconverts received signals. These can also be called tail circuits. A DTE device communicates with the data circuit-terminating equipment (DCE). The DTE/DCE classification was introduced by IBM.

V.35 is a high-speed serial interface designed to support both higher data rates and connectivity between DTEs (data-terminal equipment) or DCEs (data-communication equipment) over digital lines.

Two different types of devices are assumed on each end of the interconnecting cable for a case of simply adding DTE to the topology (e.g. to a hub, DCE), which also brings a less trivial case of interconnection of devices of the same type: DTE-DTE or DCE-DCE. Such cases need crossover cables, such as for the Ethernet or null modem for RS-232.

A DTE is the functional unit of a data station that serves as a data source or a data sink and provides for the data communication control function to be performed in accordance with the link protocol.

The data terminal equipment may be a single piece of equipment or an interconnected subsystem of multiple pieces of equipment that perform all the required functions necessary to permit users to communicate. A user interacts with the DTE (e.g. through a human-machine interface), or the DTE may be the user.

Usually, the DTE device is the terminal (or a computer emulating a terminal), and the DCE is a modem or another carrier-owned device.

A general rule is that DCE devices provide the clock signal (internal clocking) and the DTE device synchronizes on the provided clock (external clocking). D-sub connectors follow another rule for pin assignment.

- 25 pin DTE devices transmit on pin 2 and receive on pin 3.
- 25 pin DCE devices transmit on pin 3 and receive on pin 2.
- 9 pin DTE devices transmit on pin 3 and receive on pin 2.
- 9 pin DCE devices transmit on pin 2 and receive on pin 3.

This term is also generally used in the Telco and Cisco equipment context to designate a network device, such as terminals, personal computers but also routers and bridges, that's unable or configured not to generate clock signals. Hence a PC to PC Ethernet connection can also be called a DTE to DTE communication. This communication is done via an Ethernet crossover cable as opposed to a PC to DCE (hub, switch, or bridge) communication which is done via an Ethernet straight cable.

A **data circuit-terminating equipment(DCE)** is a device that sits between the data terminal equipment (DTE) and a data transmission circuit. It is also called data communication(s) equipment and data carrier equipment.[citation needed] Usually, the DTE device is the terminal (or computer), and the DCE is a modem.

In a data station, the DCE performs functions such as signal conversion, coding, and line clocking and may be a part of the DTE or intermediate equipment. Interfacing equipment may be required to couple the data terminal equipment (DTE) into a transmission circuit or channel and from a transmission circuit or channel into the DTE.

Although the terms are most commonly used with RS-232, several data communication standards define different types of interfaces between a DCE and a DTE. The DCE is a device that communicates with a DTE device in these standards. Standards that use this nomenclature include:

- Federal Standard 1037C, MIL-STD-188
- RS-232
- Certain ITU-T standards in the V series (notably V.24 and V.35)
- Certain ITU-T standards in the X series (notably X.21 and X.25)

A general rule is that DCE devices provide the clock signal (internal clocking) and the DTE device synchronizes on the provided clock (external clocking). D-sub connectors follow another rule for pin assignment. DTE devices usually transmit on pin connector number 2 and receive on pin connector number 3. DCE devices are just the opposite: pin connector number 2 receives and pin connector number 3 transmits the signals.

When two devices, that are both DTE or both DCE, must be connected together without a modem or a similar media translator between them, a crossover cable must be used, e.g. a null modem for RS-232 or an Ethernet crossover cable.

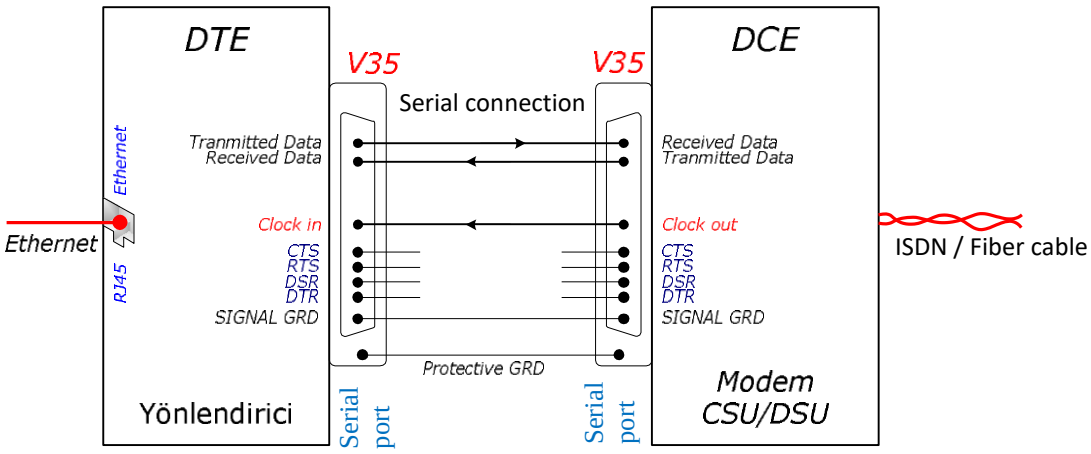

Figure 1- DTE vs DCE

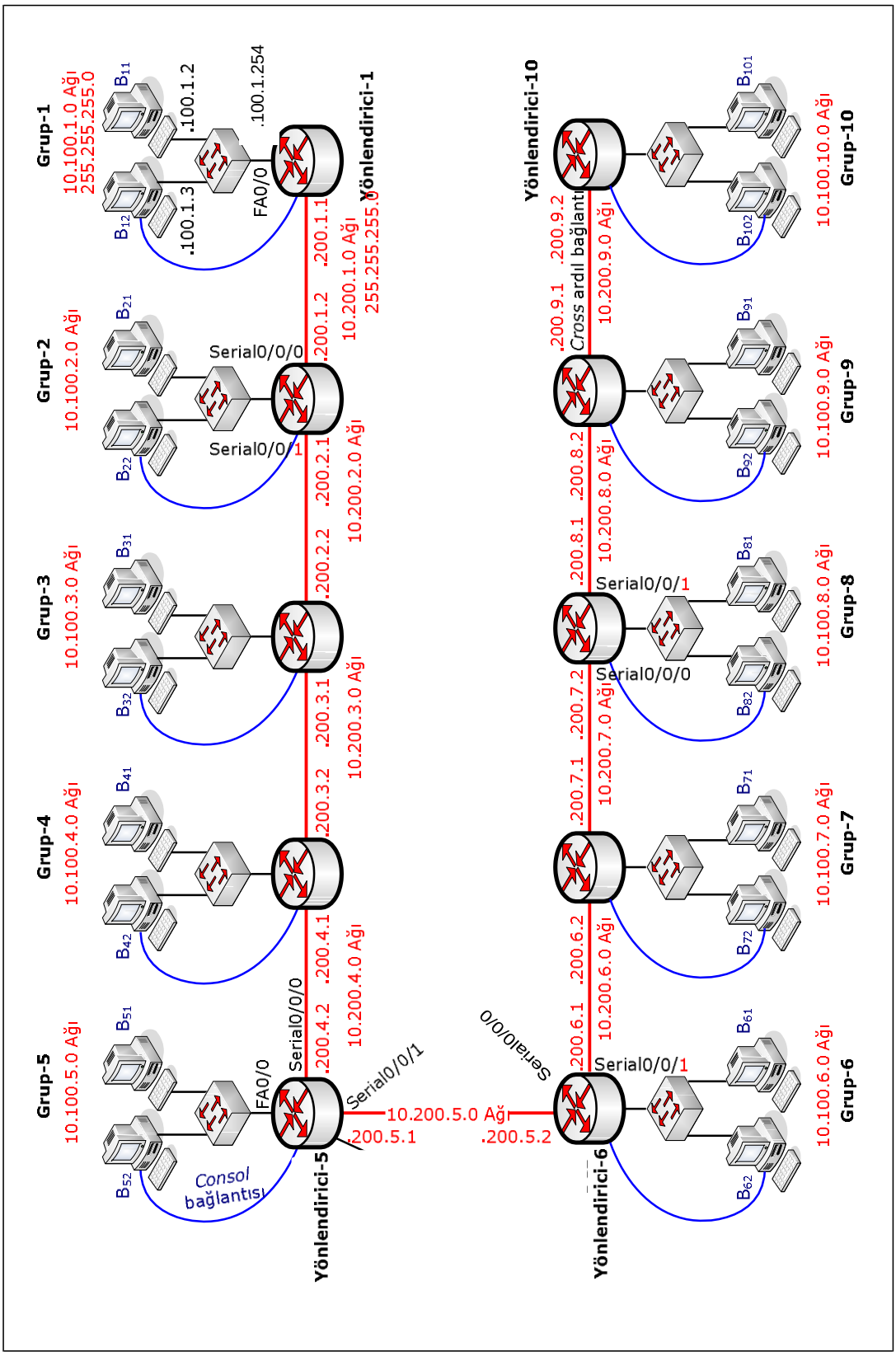

Figure2 – Lab Topology

EXPERIMENT STEPS

Aim of this experiment is to create a wide area network (WAN) as shown in Figure-2

Configuring interfaces

→ Setting IP address of the interface.

```
Router1(config-if)# ip address <IP@> <mask>
```

→ Configuring communication protocol for serial interfaces

```
Router1(config-if)# encapsulation <protocol name>
```

You can use `encapsulation ?` command for supported protocols. These protocols are related with Data Link Layer. You're going to use HDLC in this step.

→ Determining serial cable property that is attached to your routers serial interface whether DCE of DTE

```
router_1# show controllers serial 0/0/<port number>
```

Table 1- Example outputs of show commands

```
... ...
router_1# show controllers serial 0/0/0
Interface Serial 0/0/0
Hardware is PowerQUICC MPC860
DCE V.35, no clock
... ...
router_2# show controllers serial 0/0/0
Interface Serial 0/0/0
Hardware is PowerQUICC MPC860
DTE V.35, clock stopped
... ...
router_1# show controllers serial 0/0/1
Interface Serial 0/0/1
Hardware is PowerQUICC MPC860
No serial cable attached
... ...
```

→ You have to configure clock rate to your serial interface which has a cable attached with DCE end.

```
Router1(config-if)# clock rate 64000
```

With this command, clock generation is performed over the clock output of the corresponding V35 connection.

→ `no shutdown` command is used to put an interface into the active state.

→ After all configurations completed, check your interface settings using show command

```
router_1# show ip interface brief
```

During the configuration process, you can see that some connections that need to work does not work. The reason for this may be that the necessary settings on the neighbored router have not yet been completed. Wait for the other groups (your right and your left) to complete the configurations. If the problem continues, investigate the source of the problem with the other groups concerned.

Configuring routings

Routers are systems that contain one or more Ethernet (local area network) and Serial (wide area network) type connections. Because of these features, they are capable of both protocol conversion and inter-gate routing.

Routers use tables called "routing table" to determine a packet to coming through an interface, which link to route to. The routing tables maintain the destination IP address & routing interface relationships.

→ `show ip route` command is used for displaying the routing table.

Beginning of the routing lines, there exists some letter codes like `S, D, C, R, B`, etc.

`S` means static. Indicates entries that configured by user.

`D` means dynamic, which will be discussed in Dynamic Routing experiment, that obtained automatically using dynamic routing algorithms.

`C` shows routing entries about networks directly connected to router's interfaces.

Networks that are directly connected to the router are automatically processed by the router to its table. In order to be able to access networks that are not directly connected to the router, the relevant entries (connections) must be manually added to the routing table.

→ Static routing command used for networks that are not directly connected to the router (in config mode):

```
ip route <destination network> <dest netmask> <gateway>/<nexthop IP>
```

```
Router_1# ip route 193.140.236.0 255.255.255.0 Serial0/0/0
```

After this command, an entry will be displayed like this:

```
S 193.140.236.0/24 [90/2172416] via 10.200.1.2, 16:39:12, Serial0/0/0
```

Default route is used for unknown networks or internet gateway:

```
ip route 0.0.0.0 0.0.0.0 <gateway>/<next hop IP>
```

Testing all connections

- You should be able to ping from your router to all directly connected neighbors.
- You should be able to ping from your computer to all other groups computers.
- After that, use `traceroute <IP address>` command to discuss the route and hop count of your packet.

REFERENCES

- Computer Networks: A top-down approach, Kurose and Ross, 6th Edition, Addison-Wesley
- DTE https://en.wikipedia.org/wiki/Data_terminal_equipment
- DCE https://en.wikipedia.org/wiki/Data_circuit-terminating_equipment
- Serial cable connections http://www.cisco.com/c/en/us/support/docs/routers/7200-series-routers/12219-17.html