Link State Routing and OSPF

Link State Routing and OSPF

Topics Covered:

1. Link State Routing :
2. OSPF :
    1. Areas
    2. Types of Links

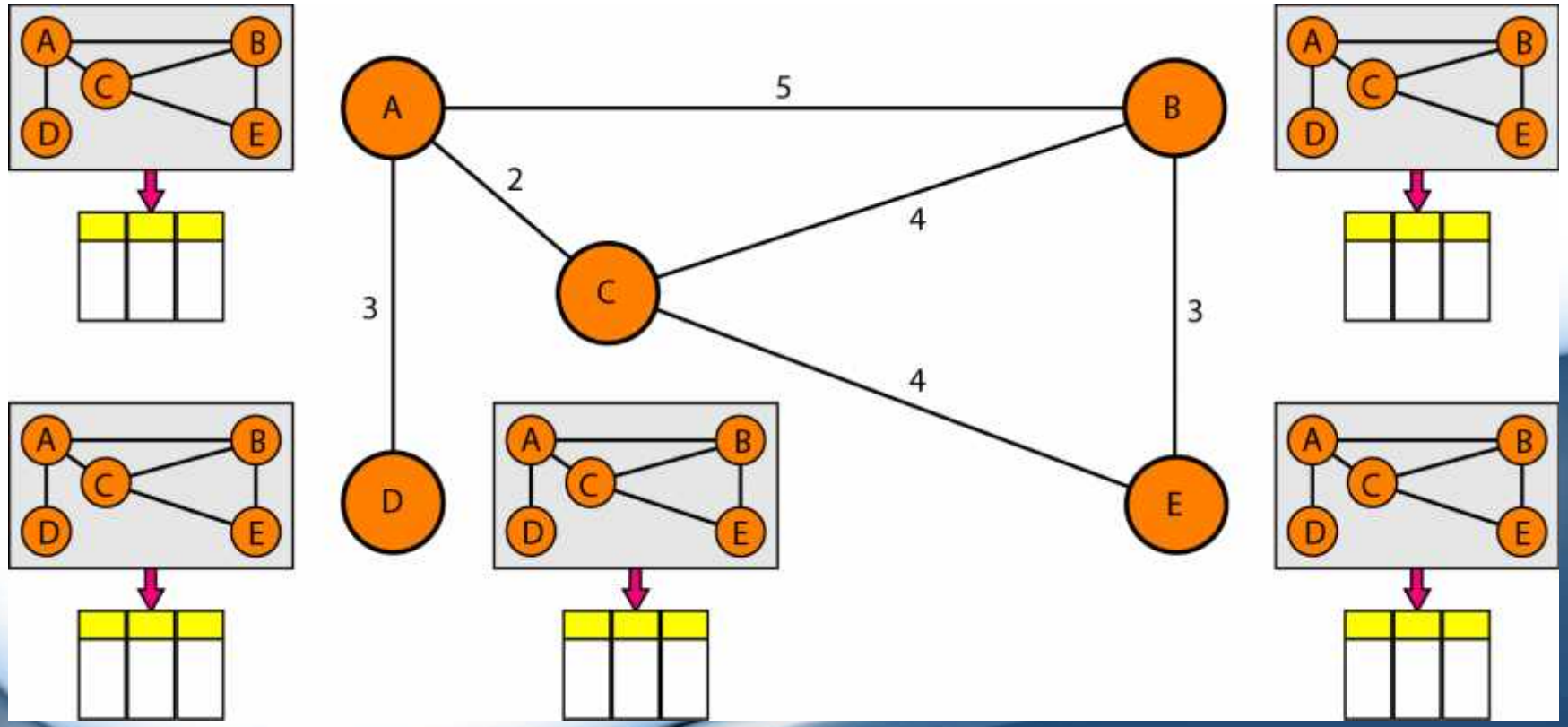
Link State Routing :

- Link state routing has a different philosophy from that of distance vector routing.

- In link state routing, if each node in the domain has the entire topology of the domain
  - the list of nodes and links
  - how they are connected including the type
  - cost (metric)
  - condition of the links (up or down)

- The node can use Dijkstra's algorithm to build a routing table

Link State Routing



Link State Routing

- The figure shows a simple domain with five nodes. Each node uses the same topology to create a routing table, but the routing table for each node is unique because the calculations are based on different interpretations of the topology.

- The topology must be dynamic, representing the latest state of each node and each link. If there are changes in any point in the network (a link is down, for example), the topology must be updated for each node.

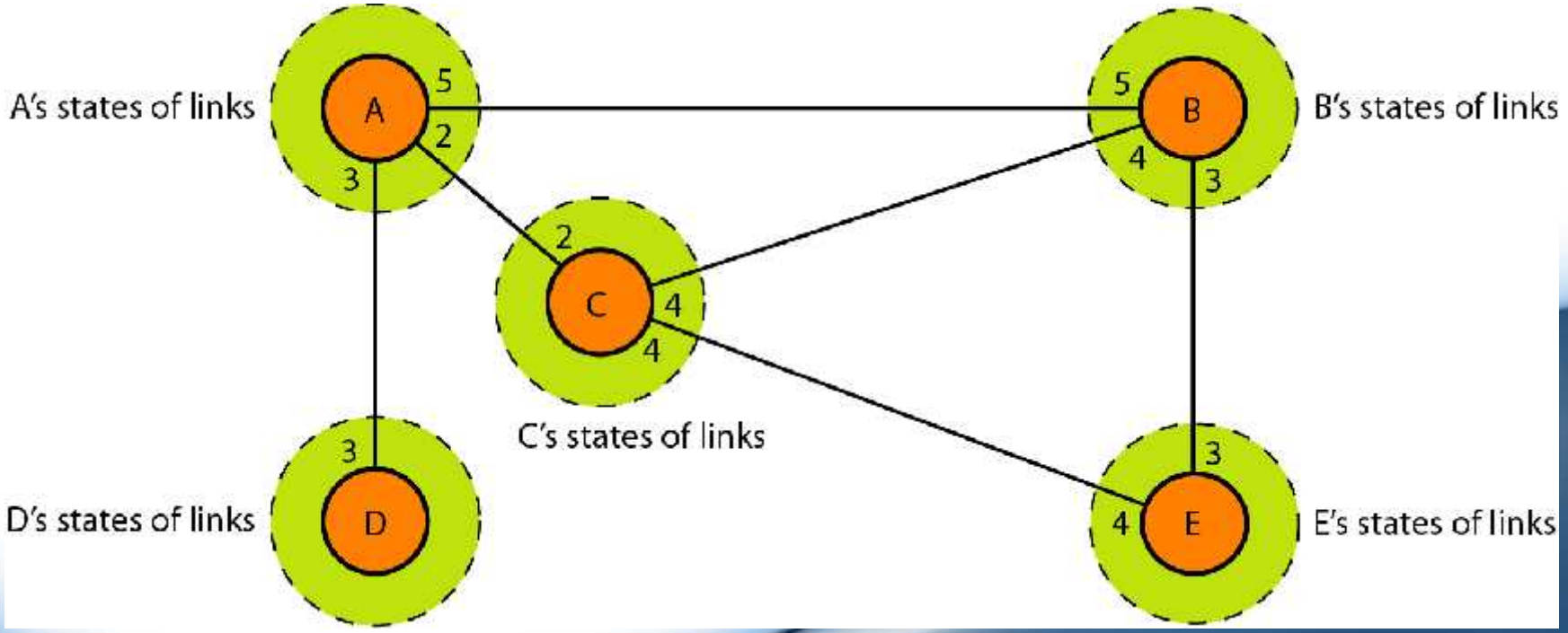
- How can a common topology be dynamic and stored in each node? No node can know the topology at the beginning or after a change somewhere in the network.

Link State Routing

- Link state routing is based on the assumption that, although the global knowledge about the topology is not clear, each node has partial knowledge: it knows the state (type, condition, and cost) of its links.

- In other words, the whole topology can be compiled from the partial knowledge of each node.

Link State Routing



Building Routing Tables :

- In link state routing, four sets of actions are required to ensure that each node has routing table showing the least-cost node to every other node.
  - Creation of the states of the links by each node, called the link state packet (LSP).
  - Dissemination of LSPs to every other router, called flooding, in an efficient and reliable way.
  - Formation of a shortest path tree for each node.
  - Calculation of a routing table based on the shortest path tree.

OSPF :

- The Open Shortest Path First or OSPF protocol is an intradomain routing protocol based on link state routing. Its domain is also an autonomous system.
  - What is an Area?
  - What is a Metric?
  - What is a Link?

Areas

- To handle routing efficiently and in a timely manner, OSPF divides an autonomous system into areas. An area is a collection of networks, hosts, and routers all contained within an autonomous system.

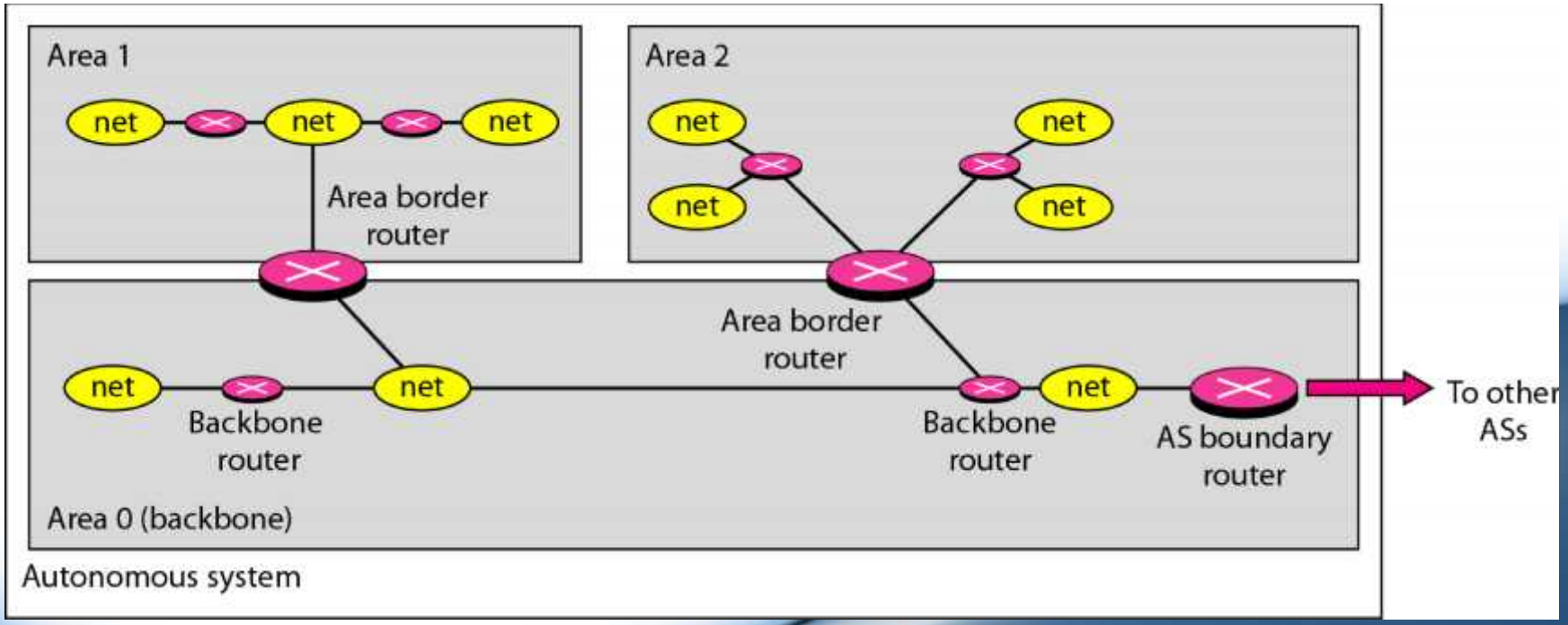
- An autonomous system can be divided into many different areas. All networks inside an area must be connected.
  - Routers inside an area flood the area with routing information.
  - At the border of an area, special routers called area border routers summarize the information about the area and send it to other areas.

Areas

- Among the areas inside an autonomous system is a special area called the *backbone;* all the areas inside an autonomous system must be connected to the backbone. In other words, the backbone serves as a primary area and the other areas as secondary areas. This does not mean that the routers within areas cannot be connected to each other, however.
- The routers inside the backbone are called the backbone routers. Note that a backbone router can also be an area border router.

- If, because of some problem, the connectivity between a backbone and an area is broken, a virtual link between routers must be created by an administrator to allow continuity of the functions of the backbone as the primary area. Each area has an area identification.

Areas

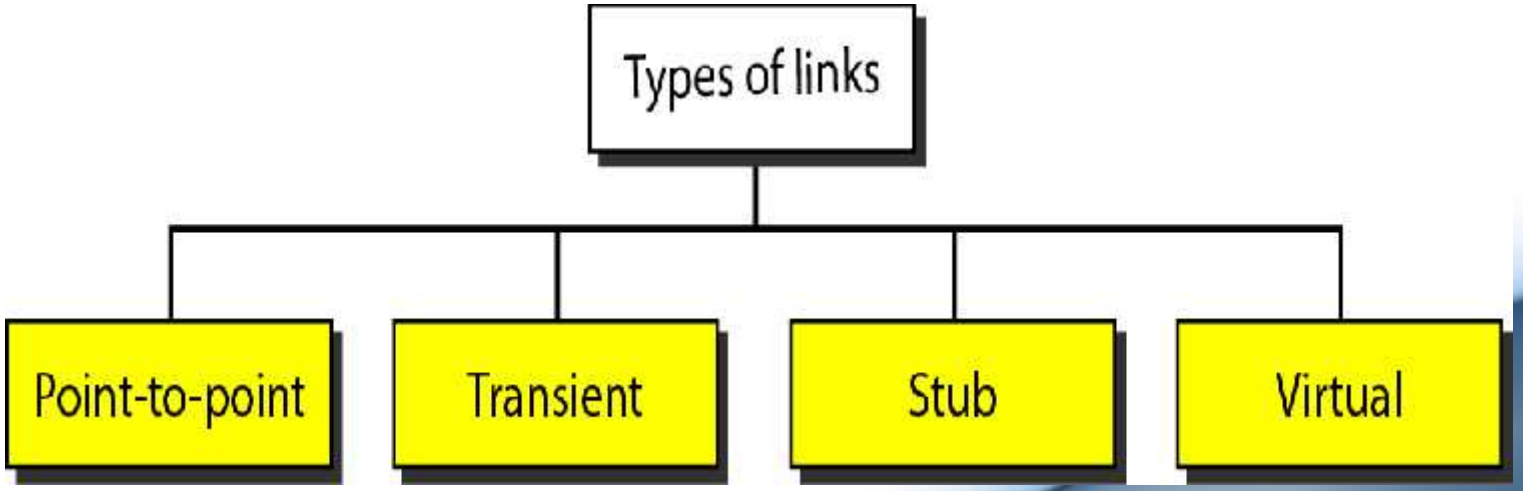

Area 1
net
net
net
Area border router
Area 2
net
net
net
net
Area border router
net
Backbone router
net
Backbone router
net
AS boundary router
To other ASs
Area 0 (backbone)
Autonomous system

Metric:

- The OSPF protocol allows the administrator to assign a cost, called the metric, to each route.
- The metric can be based on a type of service
  - minimum delay
  - maximum throughput
- As a matter of fact, a router can have multiple routing tables, each based on a different type of service.

Types of Links

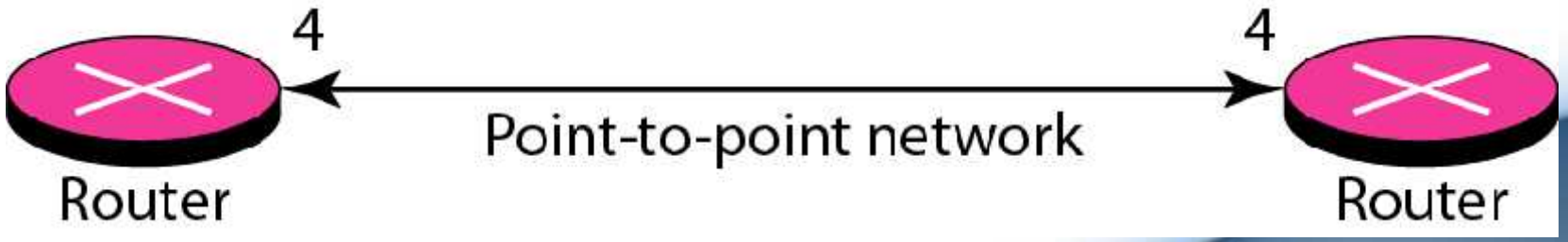
- In OSPF terminology, a connection is called a *link.* Four types of links have been defined: point-to-point, transient, stub, and virtual



Point - to - Point

- A point-to-point link connects two routers without any other host or router in between. In other words, the purpose of the link (network) is just to connect the two routers.
- An example of this type of link is two routers connected by a telephone line or a T line. There is no need to assign a network address to this type of link.
- Graphically, the routers are represented by nodes, and the link is represented by a bidirectional edge connecting the nodes.
- The metrics, which are usually the same, are shown at the two ends, one for each direction. In other words, each router has only one neighbor at the other side of the link

Point - to - Point



A transient link

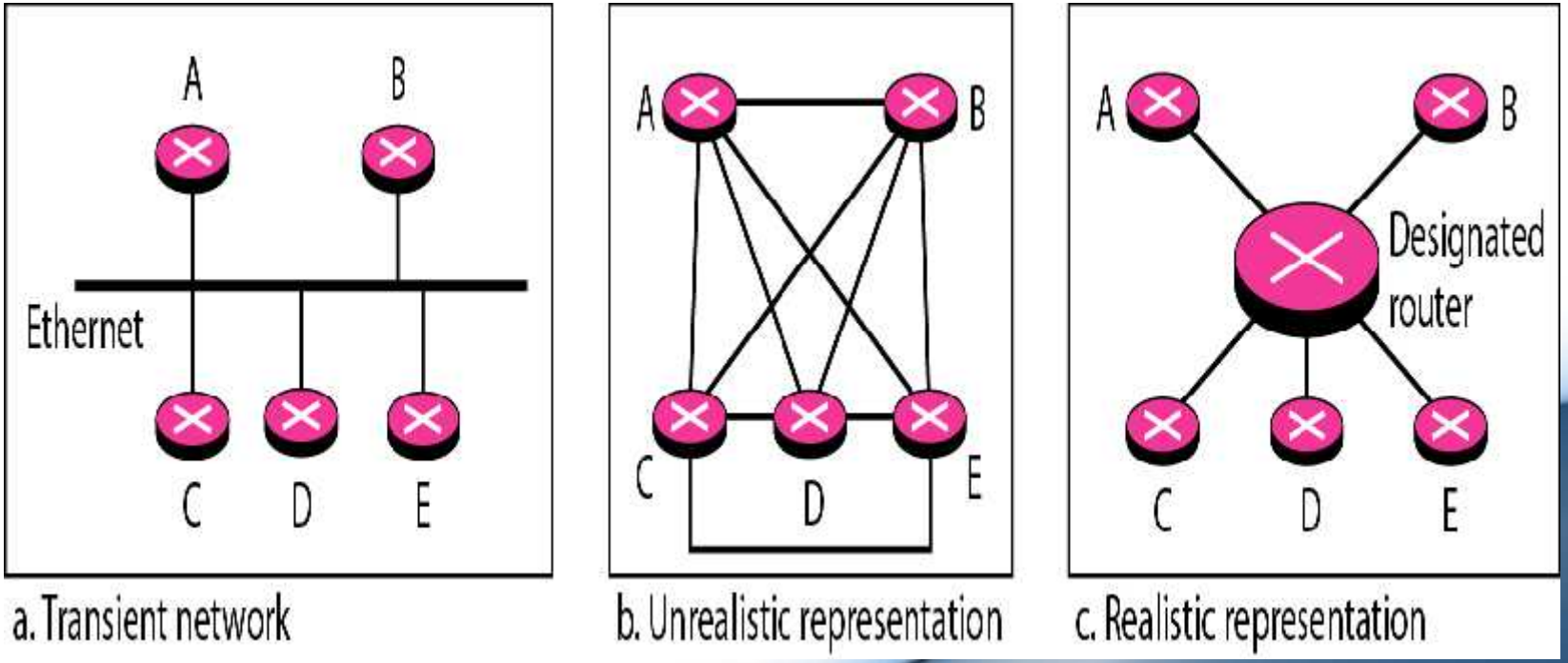
- A transient link is a network with several routers attached to it. The data can enter through any of the routers and leave through any router. All LANs and some WANs with two or more routers are of this type. In this case, each router has many neighbors.
- This is neither efficient nor realistic.
  - It is not efficient because each router needs to advertise the neighborhood to four other routers, for a total of 20 advertisements.
  - It is not realistic because there is no single network (link) between each pair of routers; there is only one network that serves as a crossroad between all five routers.
- To show that each router is connected to every other router through one single network, the network itself is represented by a node. However, because a network is not a machine, it cannot function as a router. One of the routers in the network takes this responsibility. It is assigned a dual purpose; it is a true router and a designated router.

A transient link

- Now each router has only one neighbor, the designated router (network). On the other hand, the designated router (the network) has five neighbors. We see that the number of neighbor announcements is reduced from 20 to 10. Still, the link is represented as a bidirectional edge between the nodes.

- However, while there is a metric from each node to the designated router, there is no metric from the designated router to any other node. The reason is that the designated router represents the network. We can only assign a cost to a packet that is passing through the network. We cannot charge for this twice. When a packet enters a network, we assign a cost; when a packet leaves the network to go to the router, there is no charge.

A transient link



a. Transient network

b. Unrealistic representation

c. Realistic representation

A stub link

- A stub link is a network that is connected to only one router. The data packets enter the network through this single router and leave the network through this same router. This is a special case of the transient network.

- We can show this situation using the router as a node and using the designated router for the network. However, the link is only one-directional, from the router to the network (see Figure 22.28).

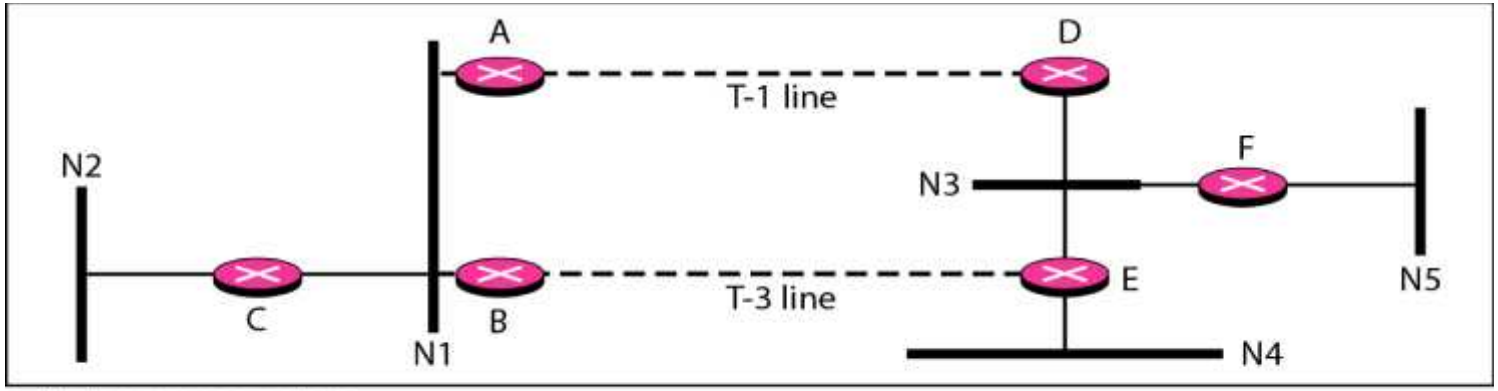
- When the link between two routers is broken, the administration may create a virtual link between them, using a longer path that probably goes through several routers.

A stub link

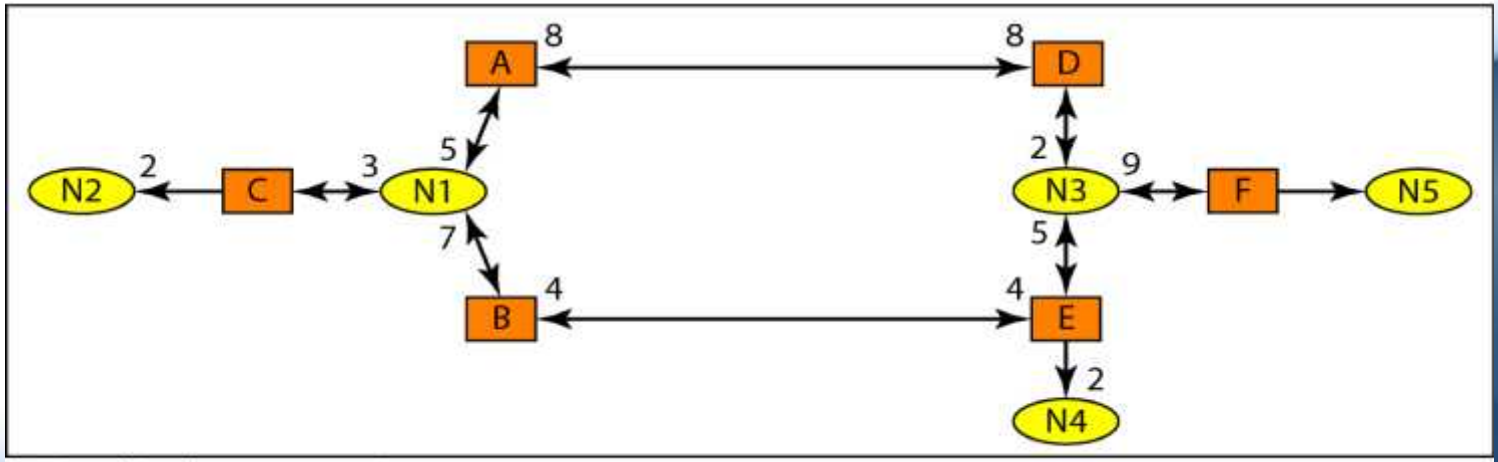
- **Graphical Representation:** Let us now examine how an AS can be represented graphically. Figure 22.29 shows a small AS with seven networks and six routers.

- Two of the networks are point-to-point networks. We use symbols such as Nl and N2 for transient and stub networks. There is no need to assign an identity to a point-to-point network. The figure also shows the graphical representation of the AS as seen by OSPF. We have used square nodes for the routers and ovals for the networks (represented by designated routers). However, OSPF sees both as nodes. Note that we have three stub networks.

A Stub Link



a. Autonomous system



b. Graphical representation

Thank You