Network Hardware

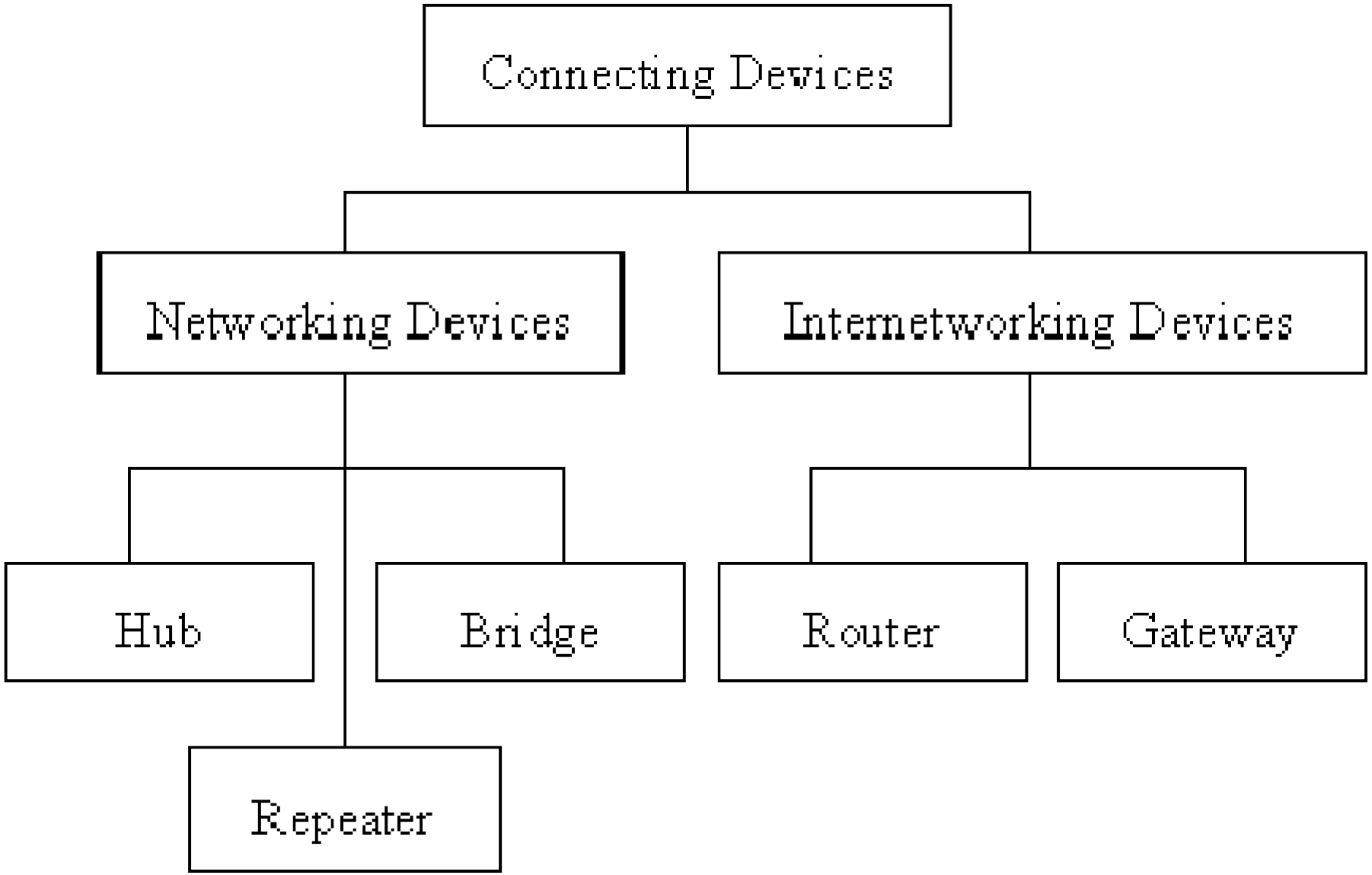
Introduction

- Networking means connecting two or more devices for the purpose of sharing data and resources. Setting a small network is fairly simple task but once the network start to grow and become a local area network it may need to cover more distance than its media can handle effectively. Or the number of station may be too great for efficient communication or management of the network, and the network may need to be subdivided.
- When two or more separate networks are connected for exchanging data or resources, they become an internetwork (or internet). The devices required to link number of LANs into an Internet are known as internetworking devices.

Introduction cont...d

- There is several ways that you can expand network capability such as:
  - Physically expanding to support additional computers
  - Segmenting to filter network traffic
  - Extending to connect separate LANs
  - Connecting two separate computing environments
- There are many devices available to accomplish these tasks. Following diagram will help to understand different types of connective devices.

Devices


Connecting Devices
Networking Devices
Internetworking Devices
Hub
Bridge
Router
Gateway
Repeater

Devices cont...d

Networking Devices

- Expansion within a single network, called *network connectivity.* And to expand a single network the following networking devices can be used.

♦ Hub
♦ Repeaters
♦ Bridges

Internetworking Devices

- Expansion that involves and joins two separate networks called *internetworking connectivity.* Following devices can be used for internetworking.

♦ Routers
♦ Brouters
♦ Gateways

Hub

- All networks require a central location to bring media segments together. These central locations are called **hubs**. The easiest way to understand this concept is to think of the necessity of connecting multiple cables. If you just connected the media segment together by soldering them, the signals would interfere with each other and create problem. A hub organizes the cables and relays signals to the other media segments.
- There are three main types of hub: Passive, active and intelligent.
    1. Passive Hub
    2. Active Hub
    3. Intelligent Hub

Types of Hub

Passive Hub

- A passive hub, simply *combines the signals of network segments*.
- There is no *signal processing or regeneration*. Because it does not boost the signals and in fact, absorbs some of the signal, a passive hub reduces by half the maximum cabling distance permitted.
- For example, if a segment normally allows a reliable transmission distance of 200 meters, the distance between a passive hub and a device can be only 100 meters. Passive hub merely ***acts as a connection point*** and does not amplify or regenerate the signal. Passive hubs do not require electrical power to run.

Types of Hub

Active Hub

- Active hubs are like passive hubs expect that *they have electronic components that regenerate or amplify signals* (depending of type of hub). Because of this, the distance between devices can be increased. The hub that regenerates the electrical signal and sends it to all the computers connected to it, is often called a *multiport repeater*. Active hub requires electrical power to run.

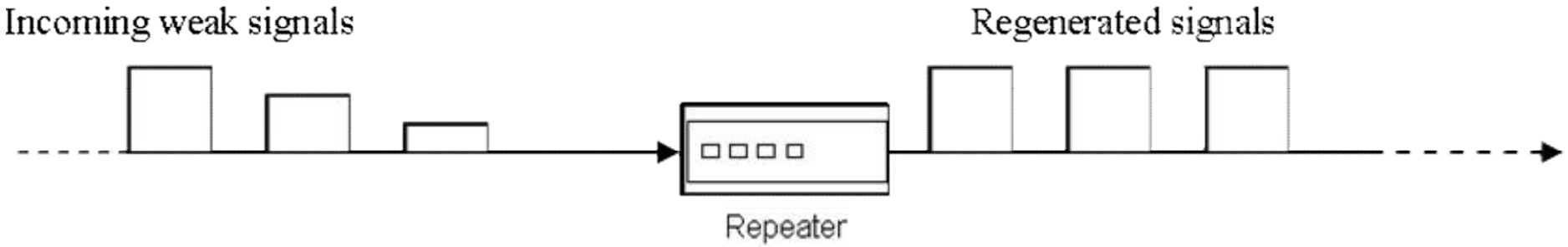
Types of Hub

Intelligent Hub

- In addition to *signal regeneration*, intelligent hubs perform some n*etwork management and intelligent path selection*. A switching hub chooses only the port of the device where the signal needs to go, rather than sending the signal along all paths.

Repeater

- Because of the electrical and mechanical limitations of any wiring system a network has physical limitations such as :
    - **Attenuation**: Loss of signal strength as the signal travels along a medium.
    - **Segment length:** longest successful data transmission through a continuous single cable.
    - **Node capacity per segment:** number of nodes can be connected on a media



Repeater cont...d

- Signal that carry information within a network can travel a fixed distance before attenuation or other interference from noise endangers the integrity of the data.
- A repeater installed on a link to receive the signal before it becomes too weak or corrupted, *regenerates the original bit pattern, and puts the refreshed signals back onto the link*. A repeater allows it to extend only physical length of the network.
- Repeaters operate at the *physical layers* of the OSI model and have no concern for the type of data being transmitted, the packet address, or the protocol being used. They are *unintelligent electronic device* unable to perform any filtering or translation on the actual data.

Repeater cont...d

- Repeaters retransmit the data at the same speed as the network. However there is a slight delay as the repeater regenerate the signal. If there are a number of repeaters in a row, a significant propagation delay can be created. Therefore, many network architectures limits the number of repeaters on the network.
- The location of a repeater on a link is vital. A repeater must be placed so that a signal reaches it before any noise changes the meaning of any of its bits. A little noise can alter the precision of a bit's voltage without destroying its identity. If the corrupted bit travels much farther, however, accumulated noise can change its meaning completely. At that point the original voltage become unrecoverable and the error can be corrected only by retransmission.

Repeater cont...d

Strengths and Limitations of Repeaters

Strength:

- Allows easy expansion of the network over large distance.
- Has very little impact on the speed of the network.
- Allows connection between different media.

Limitations:

- Provide no addressing information.
- Can not connect two different architectures.
- Does not help ease congestion problem.
- The number of repeaters in a network is limited.

Bridge

- Bridges operate in both the *physical and data link layer* of OSI model. Like repeaters, bridges also can *be used to connect two network segments and can connect dissimilar physical media*. However, bridges can also limit the traffic on each segment and eliminate bottlenecks.

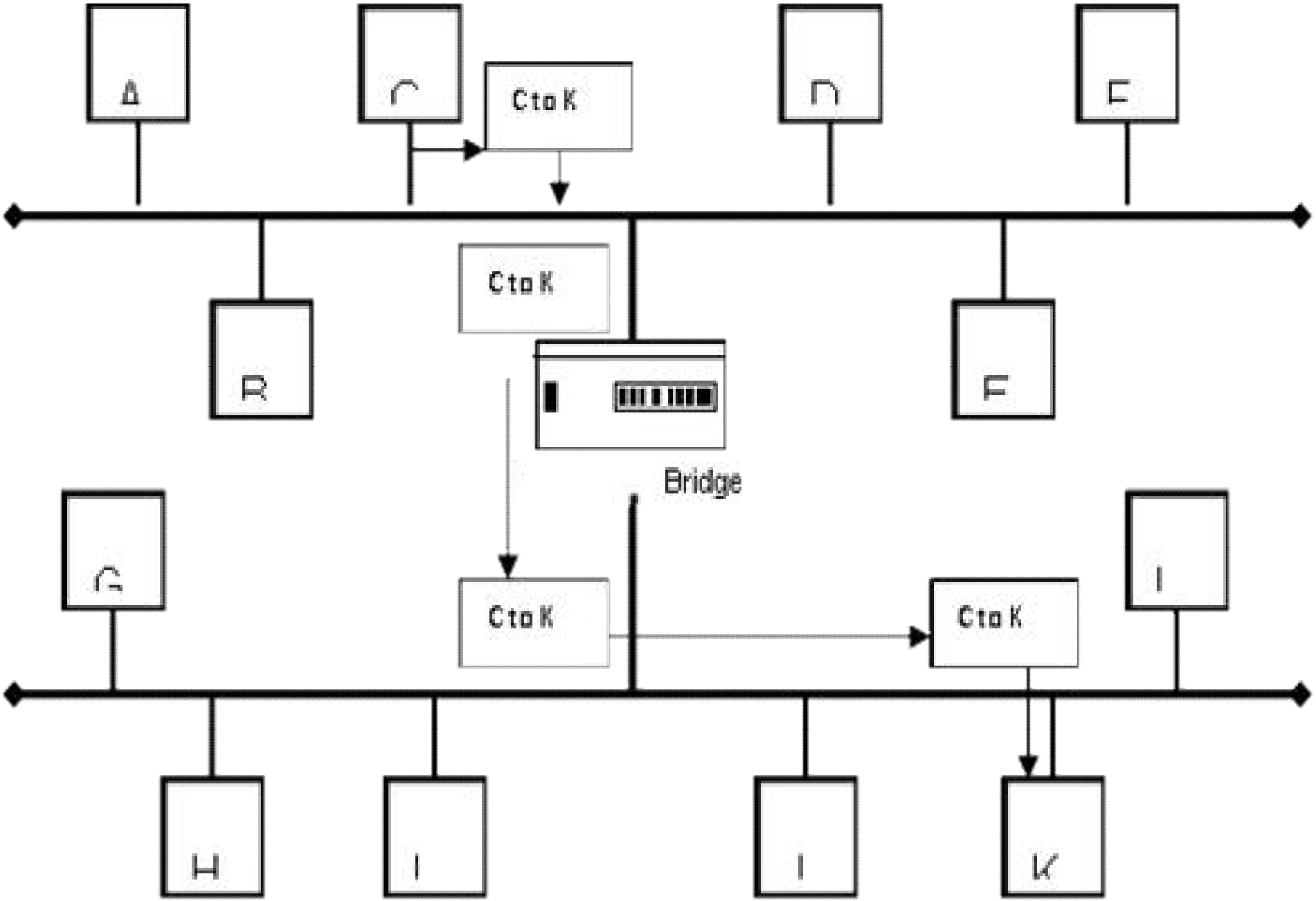
How Does Bridge Works?

- A bridge's primary function is to filter traffic between network segments. As a packet is received from a network segment, the bridge looks at the physical destination address of the packet before forwarding the packet on to other segments. If the packet's destination is on another network segment, the bridge retransmits the packet. However, if the destination is on the same network segment, on which the packet was received, the bridge assumes the packet has already reached its destination and the packet is discarded. As a result, network traffic is greatly reduced.

Bridge cont...d

- Bridges work at the *data link layer* of the OSI model. At this layer the hardware address, both source and destination, is added to the packet. Because bridges function at this layer, they have access to this address information. Each computer in the network is given a unique address. *Bridges analyse these address to determine whether on not to forward a packet*.

Bridge cont...d



Bridge cont...d

- In above figure, the packet generated by computer C is intended for computer K. The bridge allows the packet to cross and relay it to the entire lower segment where it is received by computer K. IF a packet is destined on a same segment (for example from computer A to computer F) the bridge will block the packet from crossing into lower segment to reduce the traffic.

Types of Bridges:

There are four type of bridges: simple, learning, multiport, and translation

1. Simple Bridges
2. Learning Bridges
3. Multiport Bridges
4. Translation Bridges

Bridge cont...d

Types of Bridges

- To select between segments, a bridge must have a look-up table that contains the physical addresses of every station connected to it. The table indicates to which segment each station belongs. How this table is generated and how many segments are connected by a single bridge determine the type and cost of the bridge.

Simple Bridges

- Simple bridges are the *least expensive types of bridge*. A simple bridge links two segments and *contains a table that lists the address of all the stations included in each segment*. *Before a simple bridge can be used, operator must program the addresses of every station*. Whenever a new station is added or removed, the table must be updated. *Installation and maintenance of simple bridges are time consuming and in long run more trouble than the cost savings are worth*.

Bridge cont...d

Learning Bridges

- A bridge *build its table of station addresses on its own*, as it performs its bridging function. When the learning bridge is first installed, its table is empty. As it encounters each packet, it looks at both the destination and the source addresses. It checks the destination to decide where to send the packet. If it does not yet recognise the destination address, it relays the packet to all of the station on both segments. *It uses the source address to build its table*. As it reads the source address, it notes which side the packet came from and associates that address with the segment to which it belongs.
- Using the same algorithm, the learning bridge is also *self-updating.*

Bridge cont...d

Multiport Bridges

- A multiport bridge can be either simple or learning, and is used to interconnect more than two same type segments.

Translation Bridges

- Translation bridges are available that can connect different types of networks. For example a translation bridge can be used to connect an *Ethernet network* to a *token ring network.*

Bridge cont...d

Strengths and Limitations of Bridges

Strength:

- Easy to extend network distances
- Can filter traffic to ease congestion
- Can connect network with different media
- Translation bridges can connect different network architectures

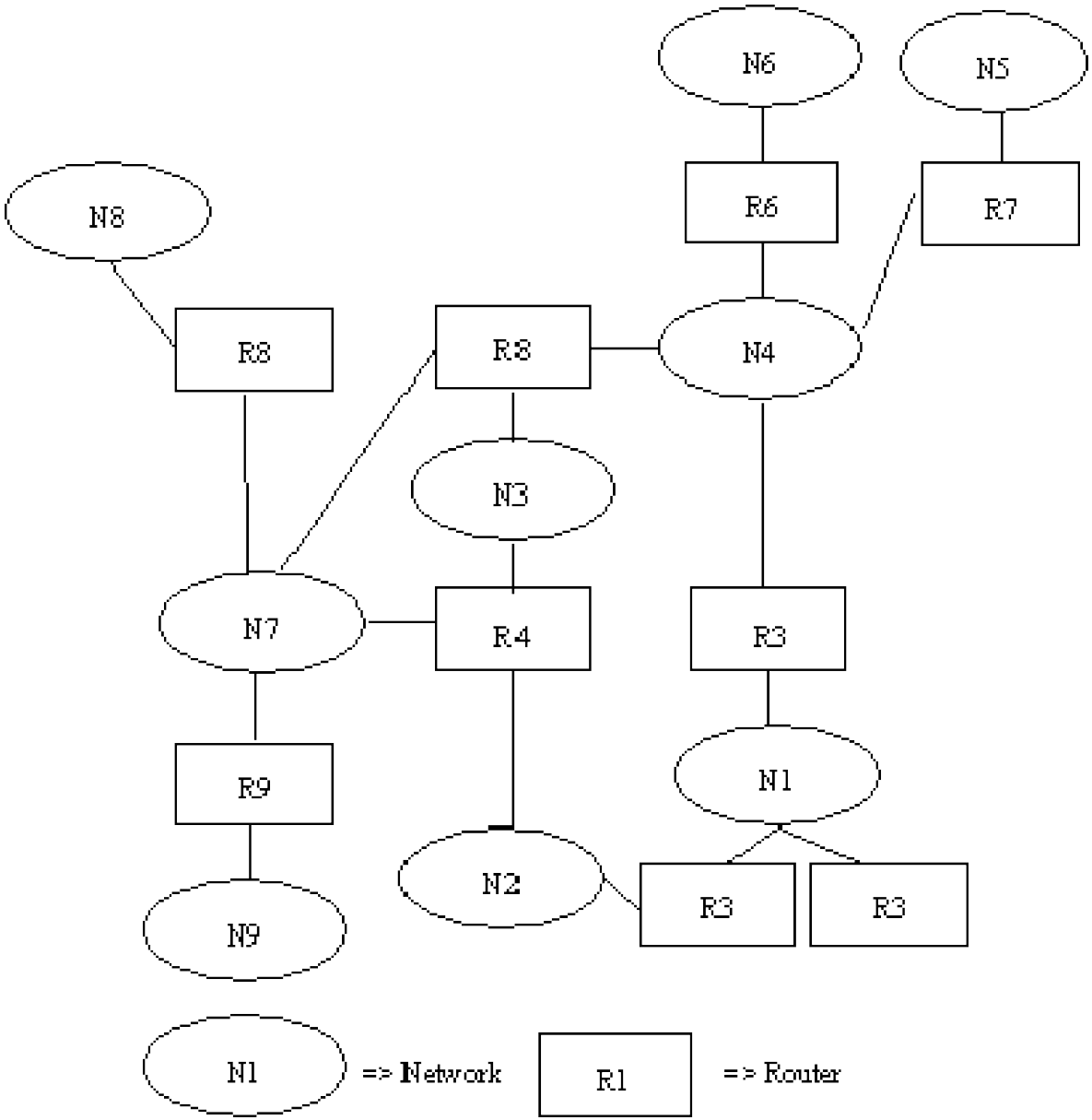
Limitation:

- Slower than repeaters
- More expensive than repeaters
- Can not handle multiple paths

Router

- Routers are *combination of hardware and software and used to connect separate networks to form an internetwork*. Router can *be used like bridges to connect multiple network segments and filter traffic*. Also, unlike bridges, routers can be used to connect two or more *independent* networks. For example a *FDDI networks* and an *Ethernet network* can interconnected so that users on each network can share resources on the other network and still both network continue to function separately.
- Routers can *connect complex networks with multiple paths between network segments*. Each network segment, also called a *subnetwork*, is assigned a network address. Each node on a subset is assigned an address as well. *Using a combination of the network and node address, the router can route a packet from the source to a destination address somewhere else on the network.*

Router cont...d



Router cont...d

- Router has access to first three layers(physical, data link, and network). To successfully route a packet through the internetwork, a router must determine packet's path. When the router receives a packet, it analyses the packet's destination network address and look up that address in its *routing table.* The router then repackages the data and sends it to the next router in the path.
- *Because it operates at the higher layers of the OSI model than bridges do, routers can easily send information over different network architectures*. For example, a packet received from a *token ring network* can be sent over an *Ethernet network*. The router removes the token ring frame, examines the packet to determine the network address, repackages the data into Ethernet frames, and sends the data out onto the Ethernet networks.

Router cont...d

- With this kind of translation, however, network speed is affected. As an example, Ethernet frames have a maximum data frame size of approximately 1,500 bytes, whereas token ring frames range in size from 4,000 to 18,000 bytes. So, for a single token ring frame of maximum size (18,000 bytes), 12 Ethernet frames must be created. Although routers are very fast, this type of translation does affect the network's speed.
- Unlike bridges routers have ability to select the best path that is *faster and economical*. When a router receives a packet whose destination address is unknown, it simply discards the packet but if the same packet is received by a bridge, the bridge will forward it to all connected network segments.

Router cont...d

- **Routing Table**
- Routing has a routing table that contains network addresses and the address of the routers that handle those networks. Following table shows a sample routing table for router A. it includes the next hope (i.e., where transmission will go next) and cost (i.e., number of hops the packet must take).

Network	Next Hope	Cost in Hopes
1	Directly Connected	0
2	Directly Connected	0
3	Router 4	1
4	Router 3	1
5	Router 3	2
6	Router 3	2
7	Router 4	1
8	Router 4	2
9	Router 4	2

Router cont...d

Static Routing

- If router uses static routing, the routing table must be updated manually by the network administrator. Each individual route must be added by manually. The router will always use the same path to a destination, even if it is not necessarily the shortest or most efficient route.

Dynamic Routing

- Dynamic routers communicate with each other and are constantly receiving and are constantly receiving updated routing tables from other routers. If multiple routes are available to a particular network, the router will decide which route is the best and enter that route into its routing table.

Router cont...d

Strengths and Limitations of Routers

Strength:

- Can connect networks of different physical media and network architectures
- Can choose the best path for a packet through an internetwork
- reduces network traffic by not forwarding corrupt packets

Limitation:

- More expensive a more complex than bridges or repeaters.
- Slower than bridge because they perform more complex calculations on the packet
- Only work with routable protocols (TCP/IP, IPX/SPX, DECnet, OSI, XNS).

Brouters

- Brouters combines the best of both bridges and routers. When brouters receive packets that are routable, they will operate as a router by choosing the best path for the packet and forwarding it to its destination. However, when a nonroutable packet is received, the brouter functions as a bridge, forwarding the packet based on hardware address. To do this brouters maintain both bridging table, which contains *hardware address*, and a routing table, which contains *network address*.

Gateway

- A gateway is generally software installed within a router. The gateway understands the protocol used by each network linked into the router and is therefore able to translate from one to another.
- Gateways operate in all seven layers of OSI model. A gateway is a protocol converter. A router itself transfers, accepts, and relays packets only across network using similar protocols. A gateway on the other hand, can accept a packet formatted for one protocol (e.g. AppleTalk) and convert it to a packet formatted for another protocol (e.g. TCP/IP) before forwarding it.

Gateway cont...d

Strengths and limitations of Gateway

Strength:

- Can connect completely different system.
- Dedicated to one task and perform that task well.

Limitation:

- More expensive than other devices.
- More difficult to install and configure.
- Greater processing requirements and they are slower than other devices.