LESSON E3_EN. NETWORKING BASICS, STRUCTURES, ARHITECTURES. APPROACHING THE TCP/IP PROTOCOLS.

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After studying this lesson, you will acquire the following knowledge:
- Modern network types, their architectures and topologies,
- The concepts of LAN, End to End technology, broadcasting technology.
- The structure of the world networking systems and how you are involved in this architecture,
- Elements of LANs, MANs, WANs, Backbone networks and applied TCP elements,
- Elements of VPN, Intranet, Extranet and Internet networks and other.

CONTENT OF THE LESSON
1. NETWORK STRUCTURES. TYPES OF NETWORKS.
2. THE INTERNET NETWORK. OTHER NETWORKS.
3. PRACTICAL EXAMPLES OF NETWORK STRUCTURES.

LEARNING OBJECTIVES:
After studying this lesson you will accomplish the ability to:
- Use the essential topologies of the Data networks,
- Distinguish between different network technologies such as: the LAN, End to End technology, broadcasting technology.
- Explain networking systems and how you are involved in this architecture,
- Understand and explain LANs, MANs, WANs, Backbone networks,
- Understand and explain VPN, Intranet, Extranet and Internet networks.

1. NETWORK STRUCTURES. TYPES OF NETWORKS.

1.1. BASIC ELEMENTS.

1.) The steps of Internet development.

The research for creating the Internet network started in 1969 through the American military project meant to create a **packet switching network** and became operational in 1975.
The TCP/IP protocols were adopted as MIL STD (Military standard) 1983, and in 1983 the public was allowed civilian usage of part of this network. The initial maximum speed was of 56 Kbps.

The primary Internet Backbone network was achieved in 1985.
In 1985 the organization of the Internet network was formed from the three-tiered network topology:
- faster backbone (at the time),
- regional networks,
- local networks,

After this victory, the next steps were undertaken: navigation (with HTML, hyper-connections, browsers), search engines, multimedia through Internet, TV through Internet etc.
The primary and complete explanations about the Internet functioning are presented in the **RFCs – Requests for Comments: www.rfc-editor.org .**

2.) Basic motivation for good Internet functioning.
In the previous lessons, through real and environment tests, you have studied the basic elements of the TCP/IP range of protocols and the motivations for Internet functioning:
- using the packet switching technology,
- using the isolation of the each entity in order to be easily replaced,
- using the IP Addressing (IPs game) as the basis for finding the paths from source to destination,
- using the Physical Address for taking the data packets inside the NIC of each device,
- using the simple-to-manage, powerful tools for troubleshooting and maintenance and other.

The TCP/IP (Transmission Communication Protocol / Internet Protocol) is the family (suite) of protocols for transmissions through "the Network of the Networks": the Internet.
The TCP/IP protocol (and related standards) is so reliable (it comes from military fields) that many other networks, such as local area networks (LAN), often use it.

The previous lessons also analysed the main characteristics of the networks: units of basic measurement in digital communications, the Bandwidth and the Throughput.

1.2. TYPES OF NETWORKS.

The definition of the network: a collection of computers or other devices which communicate with each other.
Through networks, data are transmitted between the senders / sources and the receivers / destinations, and vice versa.

The Internet uses the sending of the Data under the form of the Data packets.

The principal criteria for network classification.

There are three main criteria which help the networks' classification:

- 1). - the network architecture
- 2). - the transmission technology,
- 3). - the scale on which the network operates.

Other criteria are generated by the type of protocols used by the respective network; for instance:

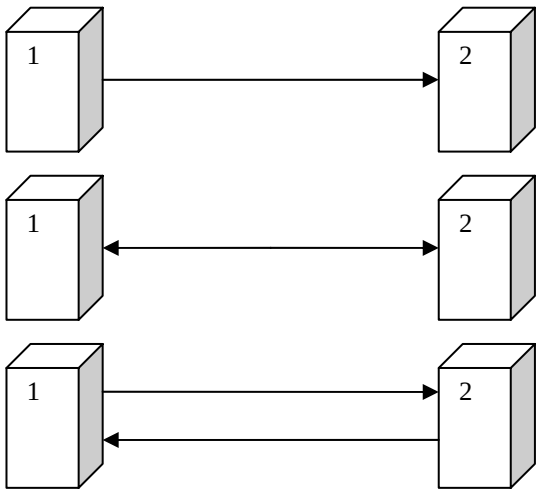
- 1).- proprietary based protocols, such as used by IBM networks, Novell networks, DECnet etc,
- 2).- non-proprietary based protocols, such as TCP / IP.

A network may be decomposed in three main elements:

- 1). - The physical connections: how the connections between partners are physically achieved; which the media of the transmission is,
- 2). - The protocols, which protocols are used for the transmission. It emphasises that the TCP/IP - the suite of protocols used by the Internet - is the winner among protocols,
- 3). - The applications. How the network is applied, for which transfers, at which speed, with which level/ features of reliability, control, fault tolerance, for which principal services / functions (HTTP- navigation, FTP- File Transfer Protocol, and many others).

The three basic types of transmission.

The three basic transmission modes [1.] are illustrated in figure 1.1.:



Simplex Communication
The simplex communication achieves one-way and unidirectional transmission.

Half-Duplex communication
The Half-Duplex communication allows two-way communication, but only one way at a time.

Full-Duplex communication
The Half-Duplex communication allows the simultaneous communication in both directions.

Fig. 1.1. The modes of transmission between two entities.

1).The simple architecture of the networks.

Networks may be of one of the principal types illustrated in: fig. 1.2., bus network; fig.1.3. the circle connection; fig.1.4. the mesh connection; fig.1.5. the star connection.

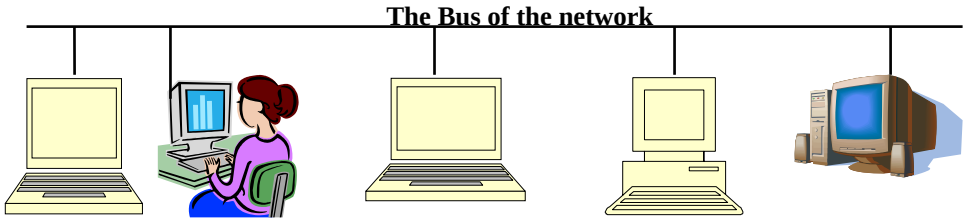


Fig.1.2. The computers connected at one bus. Frequently used configuration.

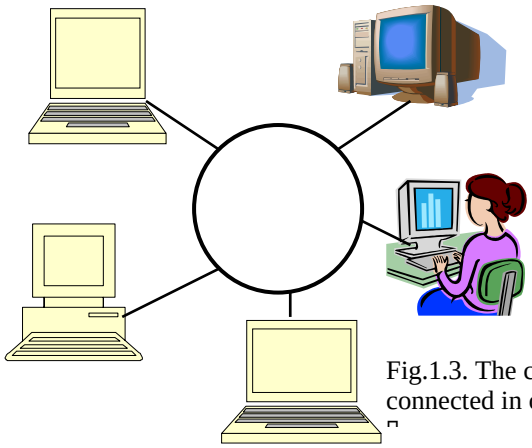


Fig.1.3. The computers connected in one ring, circle-bus

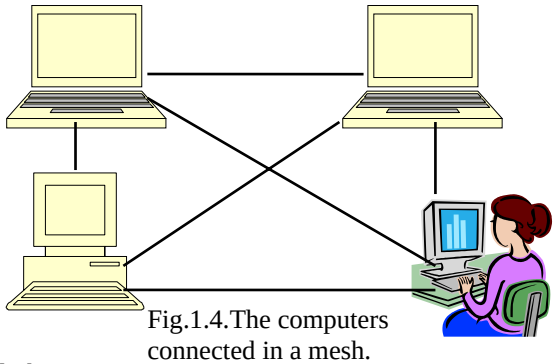


Fig.1.4.The computers connected in a mesh.

The LAN – Local Area Networks illustrated in fig. 1.2. and fig. 1.5. may be of the Ethernet type.
Ethernet is a protocol for LANs – Local Area Networks.

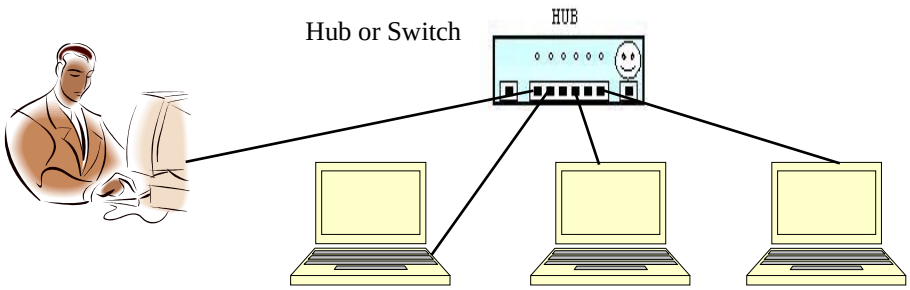


Fig.1.5. The computers connected in star formation.

The configuration illustrated in fig. 1.2. is similar to the configuration in fig. 1.5.

Use of the Hub in the configuration illustrated in fig. 1.5 is similar to the use of a Bus in the configuration illustrated in fig. 1.2.: the Data which come by one entry of the Hub is transferred, in parallel, to all the connections of the Hub, to all the hub's partners, respectively.
In addition, if one of the Hub's connections is short-circuited, the damage does not influence the other outputs of the Hub.

The hub is a device which puts the Data received at one entry of the Hub into all the other outputs of the Hub.
Actually, the Hub functions as a "concentrated" bus and replaces the bus configuration with the star configuration.

The cables illustrated in fig. 1.2., 1.3., 1.4., 1.5. are not simple cables, but special transmission cables with multiple, isolated wires.

The partners in networking may launch the following types of emissions:

- the **End-to-End** transfer of the encapsulated message (which may use the implicit broadcasting)
- the addressed broadcasting / spreading (which may use the implicit broadcasting) diffusion of the encapsulated message and, respectively, the simultaneous offering of the Data Packet to all or one part of the network partners

(devices), depending on the used Address. The Data Packet will be processed by the computer with the correspondent Address.

The following transmission technologies work in a similar way:

- **A. Technology with implicit spreading (broadcasting):**

Implicit broadcasting.

In the case of implicit broadcasting technology, the communication channel (such as one bus) is used for offering the Data Packet (generated by one computer) to the NICs from all the computers of the network (which is the case of the LAN).
The data Packets are implicitly broadcasted to all the computers of the respective bus.
The implicit broadcasting technology signifies that the Data Packet is simultaneously present at the points of entry of the NICs of all of the network's partners.

The Data Packet includes the address of the targeted computer, which constitutes the destination of the Data Packet.

The **implicit broadcasting** by putting the Data Packet on the bus (or on one Hop entry) is necessary in order not be confused with the **addressed broadcasting** (which may use implicit broadcasting), consisting in sending the Data Packet toward a group of addresses (IP Addresses or Physical Addresses).

In the End-to-End technology, the communication is between two computers (work stations, servers, hosts, other devices), (respectively **end-to-end)** frequently placed in different networks, maybe at thousands of kilometres apart.

In the broadcasting technology :

- **Implicit Broadcast** represents the sending of the tram (Data Packet) to all the computers of a network (usually LAN), for instance, by putting the Data Packet on the bus.
- **Addressed Broadcast** represents the sending of the tram towards a group of Addresses (and may include the Implicit Broadcast). In the **addressed broadcasting,** the communication is achieved by sending the Data Packet to all or part of the IP Addresses of one or multiple networks, or to all or part of the Physical Addresses of the LAN's partners.

Sending a Data Packet to a single destination (possibly through implicit broadcasting).

If the message sent by one Partner (device or equipment, respectively) includes the address of the other Partner of the respective network, then this second Partner (device) will take over the Data Packet through the NIC, will process it and - may be, will respond to that particular message.

Only the targeted machine takes and processes the Data Packet, because the address (part of address), placed in the header of the Data Packet, (normally) corresponds only to the address of the respective machine.
The machines having other network addresses will ignore the respective data Packet.

For instance, if the destination address (indicated in the header of the Data Packet) sent by the source will indicate the Physical Ethernet Address of destination inside the LAN-Local Area Network (in hexadecimal): 00 00 00 00 01 01
that corresponds to the binary address: 0000 0000 0000 0000 0000 0000 0000 0000 0000 0001 0000 0001), only the computer with the NIC address (hexadecimal) 00 00 00 10 01 01 will take the Data Packet.

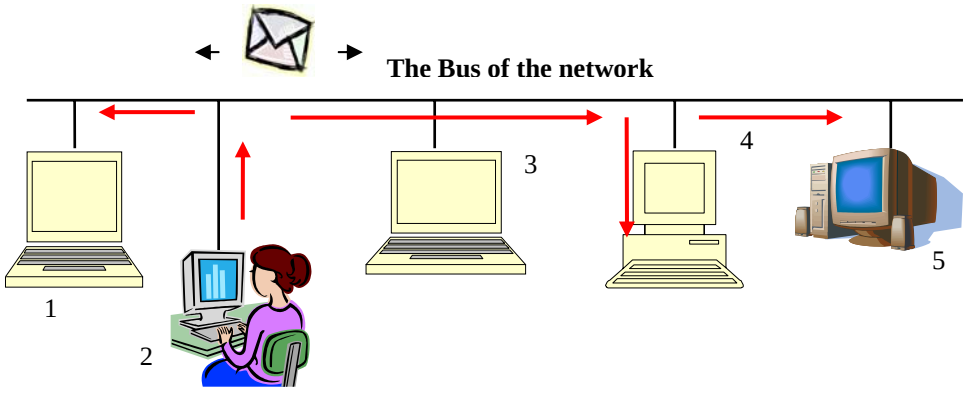


Fig.1.6. The Data Packet is sent by machine 1 through the bus. The Data Packet is present, simultaneously, at the entry points (the NICs) of all computers. The Data Packet is taken only by the computer which has the NIC's address identical with the destination address indicated in the header of the Data Packet. In this example, the data packet is taken by computer 4.

The **addressed broadcast**. The case when the Data Packet is taken over and processed by all the computers of the network.

By using of special addresses (of the form: 111111…) the bites of this address cover all the addressing possibilities of the network.
Consequently, one Data Packet sent toward this broadcasting address will be taken into consideration by all the computers of the network.

In this way, all the computers of the respective network may be simultaneously questioned or informed.

Also, the common address for a group of computers may be generated.

Example: if the broadcasting address is (hexadecimal) compared with the previous example:
00 00 00 00 FF FF (respectively, in binary form: 0000 0000 0000 0000 0000 0000 0000 0000 1111 1111 1111 1111),
then this broadcasting address includes the previous address:
(in binary form: 0000 0000 0000 0000 0000 0000 0000 0000 0000 0001 0000 0001), many other binary combinations and many other possible addresses, respectively. All these machines will read the Data Packet.

The **addressed broadcasting** toward all the addresses of the network is very important for the special tests inside the network.
These actions include:

- The arp or ARP (Address Resolution Protocol) test, for detecting Physical Address through broadcasting to all the IP Addresses of the LAN. The ARP is described in the RFC 826, http://www.freesoft.org/CIE/RFC/826/index.htm .
- The rarp or RARP (Reverse Address Resolution Protocol) test, for detecting the IP Address through broadcasting to all the Physical addresses of the LAN,
- Accomplishing the information about the network through the ARP and RARP procedures,
- Tests (arp, rarp) for eliminating the double IP Addressing.
- Other.

The small networks (small as geographical extension and local / LANs-Local Area Networks), respectively, such as the Ethernet usually work by sending the Data Packets to all the partners of the LAN network (implicit broadcast). The Data packet will be taken into consideration only by the machine with a corresponding address.
The Data Packets, which address Hosts from the same LAN, must not search and find the path. The Data Packets are already inside the network of the destination computer.

The Data Packet - helped by routers - must search and find the path from source to destination when travelling through many networks. In order to find the path, the Data Packet uses the virtual address called IP Address of the destination and the Directory tables placed in Routers.

One example of the application of the addressed broadcasting technology (including implicit broadcasting) is illustrated in fig. 1.7.

In the example illustrated in fig. 17., computer 2 sends data Packets to all the addresses of the network (because the destination address is in the form of Hexa and Physical: FF FF FF FF FF FF, which represents “1” on all positions and includes all the network physical addresses).
All the NICs read the Data Packet. Is responding, the computer which has one answer to the question launched by the first sender (computer 2).

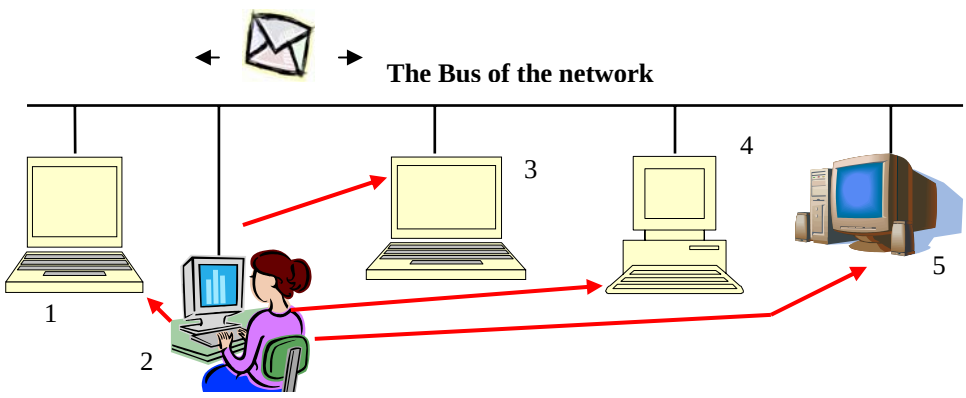


Fig.1.7. Example of the application of the addressed broadcasting technology

- **B. Technology with the End-to-End and Peer to Peer connections**:

There are two types of networking in use:

- Peer-to-Peer connections,
- Server(s)-based connections, connections which include End-to-End communications.

The End-to-End connections (not to be confused with Peer-to-Peer connection).
The End-to-End connections are based on the connections between two computers through a complex or simple network.

These connections may be through multiple physical channels, respectively, the Data Packets may use (in some cases) different paths to travel from source to destination.

The Data Packets must search and find the path toward the destination, based on the cooperation with the routers.

The End-to-End connection is a concept of communication that allows the transfer of the Data Packets from Source (one End) to Destination (the second End), irrespective of destination, media, distance.

These virtual channels are based on real channels. They are called "virtual" because:

- they are created ad-hoc from different portions of the real connecting ways, for the **End-to-End** Data transfer, and also
- they support finding the pathway by the search. The search is "achieved" by each Data Packet (based on the routers' decision).

In the End-to-End technology it is recommendable to allow the selection of the most favourable way - for instance, the short way.
The networks ensuring the End-to-End connections achieve the transmission by the passage of the Data Packets between intermediary computers, such as Gateways, Routers, Special Servers etc.

Obviously, End-to-End connections do not represent the simple connection between two neighbouring computers but the achievement of the connection between two points (two computers) placed at any distance, no matter how long.

To solve the communication between two points placed at a distance (maybe 10 000 Km or more), it is necessary that the Data Packet pass through intermediary machines called Hops (for instance Routers) in which the Data Packet sits and waits for some milliseconds or more.

The time consumed by the Data Packet inside each Hop is used for processing the Data Packet (integrity control, finding the direction of the pathway, processing the TTL-Time to Leaving etc).
Finding the direction of the Data Packet and of the pathway, respectively, consists in establishing, for instance in the Router, the NIC-Network Interface Card, through which the Data Packet will be sent to the destination.

In many instances, the pathway on which the Data Packet will travel is selected from multiple possibilities.

Usually, large networks – such as the Internet – use End-to-End technology.
The Data Packets search and find the pathway from source to the destination in cooperation with the routing devices.
The main elements through which the Data Packets cooperate with the devices placed on the path to the destination are the IP Addresses of Destination (also the IP Addresses of Source / Sender).

Peer-to-Peer networks.
Peer-to-Peer connections represent the low-cost connection between two individual pieces of equipment.
Peer-to-Peer connections are solved without a Server.
The PC connected through Peer-to-Peer normally uses NICs - Network Interface Cards.

The Networks participating in the End-to-End transfer.

Obviously, with the Internet the End-to-End connection supposes the transfer of the Data Packets through different networks.

The **uni-casting** network is an End-to-End network that ensures the communication between a single sender / source and a single destination. Also in the case of **uni-casting** networks, the Data Packet:

- may travel through many Hops,
- in this case, the path is found through the cooperation between the data Packet (which offers the Destination Address) and each Hop on the path. The hop gives the direction towards which next Hop is necessary to be sent the Data Packet.

One example of the point to point / End to End network is illustrated in fig. 1.7.
In the example illustrated in fig. 1.6. the End to End connection between machine 1 and Server 6. are presented .
Machine 1 is placed inside an Ethernet network and sent the TCP/IP data Packet through gateway 4 to Hop 5, Hop 6, to the server 7 (from which machine 1 takes over the navigation pages).

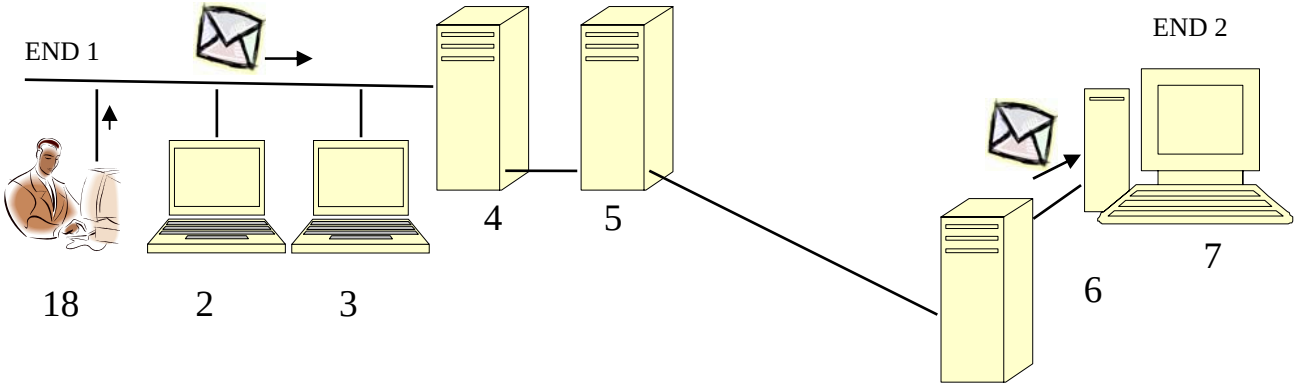


Fig.1.8.The End-to-End connection from machine 1 to machine 7. 4 is the gateway of the LAN formed by machines 1,2,3. 5 and 6 are Hops.

It is important to note that in the End-to-End communication, one partner may send Data Packets with a broadcasting character at a global level, for instance, with a view to question the world's Servers about special information.

The Server (or another machine) which has the correspondent Address (Destination Address) indicated in the Data Packet will respond if a Server or machine with this Address is in operation.

The mode of broadcasting is different according to the type of Addresses by which the broadcasting is achieved:

- to Physical Addresses inside one LAN,
- to IP Addresses: inside one LAN (to the IP Addresses of a LAN's partners) or to a group of IP Addresses, or toward the entire Internet world.

2.). Types of networks according to dimension.

- 2.1). - The PAN – Personal Area Network placed within few meters, usually in the same room.
- 2.2). - The LAN – Local Area Networks are networks which may cover a length (or radius) from about a few meters to 1 Km.
- 2.2). - The MAN – Metropolitan Area Networks are networks which may cover a length (or radius) of up to 10 Km.
- 2.3). - The WAN – Wide Area Networks are networks which may cover a length (or radius) of up to about 1000 Km
- 2.4). - The Internet Backbone Network represents the high-speed data ways and are the backbone of the Internet, the Network of the Networks. The covered distances reach more than 10000 Km. The backbone may be extended at a global level.

Fig. 1.9 and fig. 1.10 illustrate the hierarchical underlying of the world networks crossing the same geographic area and being divided into tree-like structures.
Based on the connections between the inter-networks (in fig.1.9. between the blue networks A,B, C, D and the black networks 1, 2, 3, 4), the Data Packets can use the most convenient path indicated by the Hops, in order to travel a shorter way between the source and the destination.

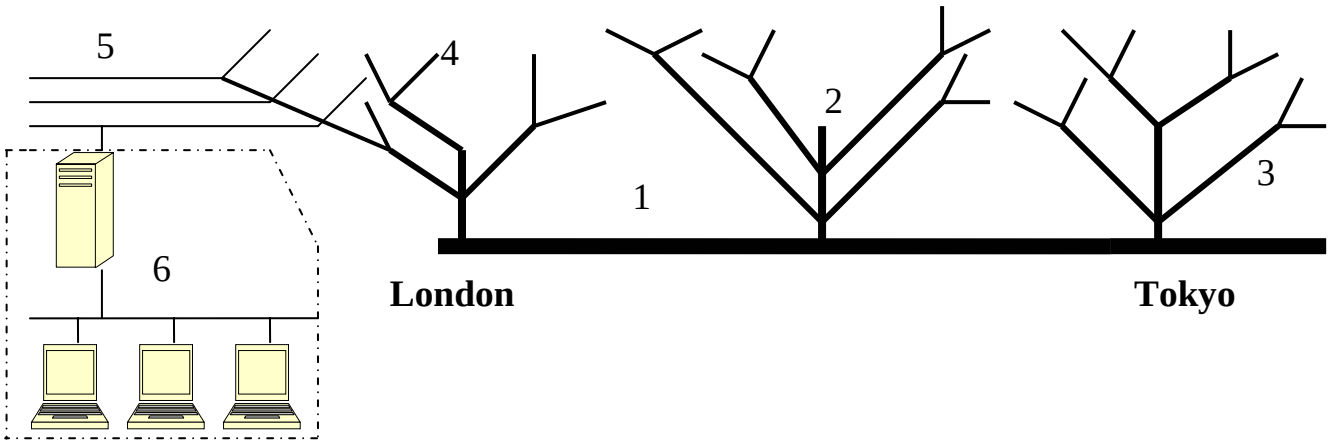
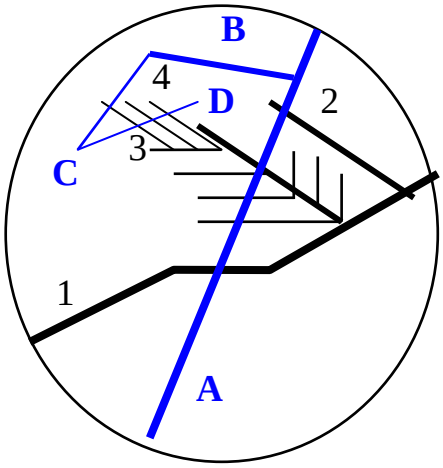


Fig 1.9. The hierarchy of the networks is disposed at a global level (example): Network 1: Backbone network; Network 2: WAN; Network 3: MAN; Network 4: Network of the ISP; Network 5: Building's networks; Network 6: Your LAN.

Fig 1.10. The simplified hierarchical mode in which the networks are disposed in the world (example):

Network: 1, A: Backbone networks,
Network: 2, B: WAN,
Network: 3, C: MAN
Network: 4, D: LAN

emphasising the intersection between Backbone networks.



The World

- 2.2).- LANs – Local Area Networks

The LANs are achieved for one building or group of buildings.
They have their own architecture, mainly buses and their own transmission technology, based on:

- Ethernet standard IEEE 802.3 or
- wireless IEEE 802.11 or
- hybrid solutions (partly Ethernet, partly wireless).

Examples of LANs are illustrated in fig 1.1. to 1.5.

The LAN, which may be also called Intranet, may be connected or may not be connected to the Internet.

The LAN becomes more important (and also more insecure) when it is connected to the Internet Network, respectively, to a hierarchically superior network, therefore one MAN or one WAN.
Fig. 1.11 illustrates a LAN with a star configuration by using a Hub, connected to the Internet through a Gateway.

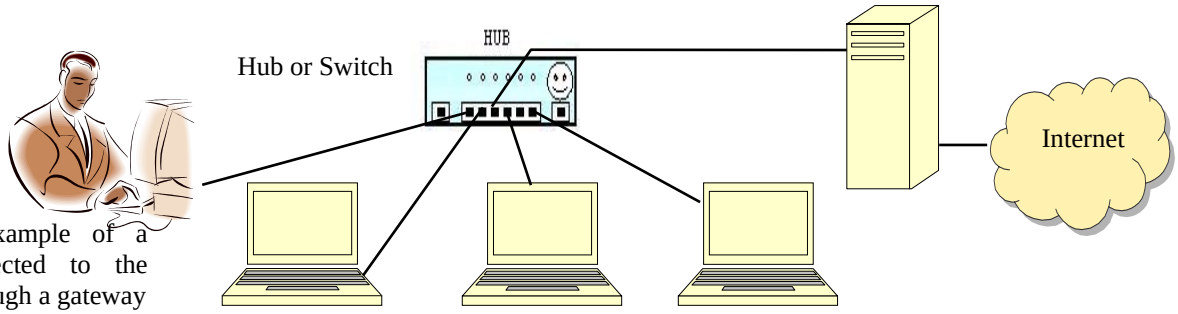


Fig.1.11. Example of a LAN connected to the Internet through a gateway

2.3.) The MAN-Metropolitan Area Network

The MAN is the network achieved for part of a city or for an entire city.
The MAN may be done with different technologies.

The solutions include: cable TV, Wireless connection with sub-Servers, ADSL connection up to the LAN, etc.

An example of MAN based on the connections through cable TV and TV cable sub-networks directed to different city districts is illustrated in fig. 1.12. .

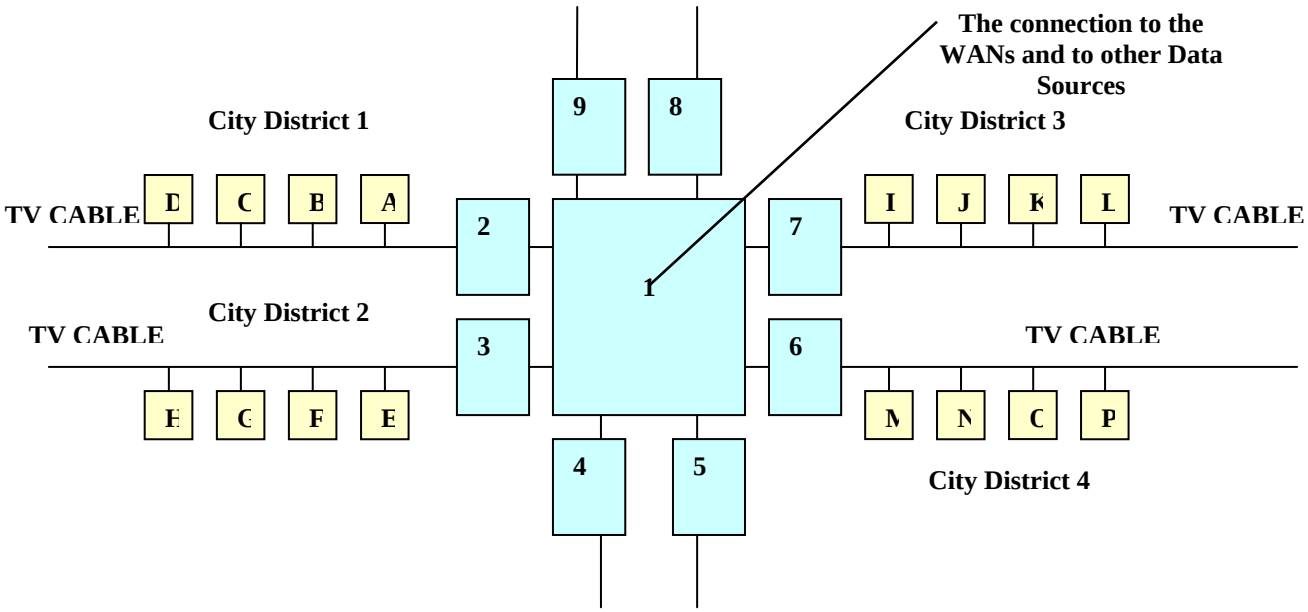


Fig. 1.12. MAN based on TV cable network:
1.- General monitoring stations 2, 3, 4, 5, 6, 7, 8,
9 –Servers and separators of the District;
A,B,C,D,E,F,G, H, I, J, K, L, M, N, O, P – Houses/Internet subscribers.

- 2.3.) The WAN – Wide Area Network – and the Backbone, high speed Networks.

The WAN may cover an entire country or part of a continent.
The WANs have two components:

- Transmission lines and
- Packets Switching elements (commutation elements) also called Routers or Hops.

The WAN may be considered as a collection of Routers.
The WANs works on the principle: **store and transmit**. This means that the Data Packets are received, stored as soon as possible and sent back to the destination. An example of WAN is illustrated in fig: 1.13.
In fact, the WAN is formed from path 3, 4, 5, 6.

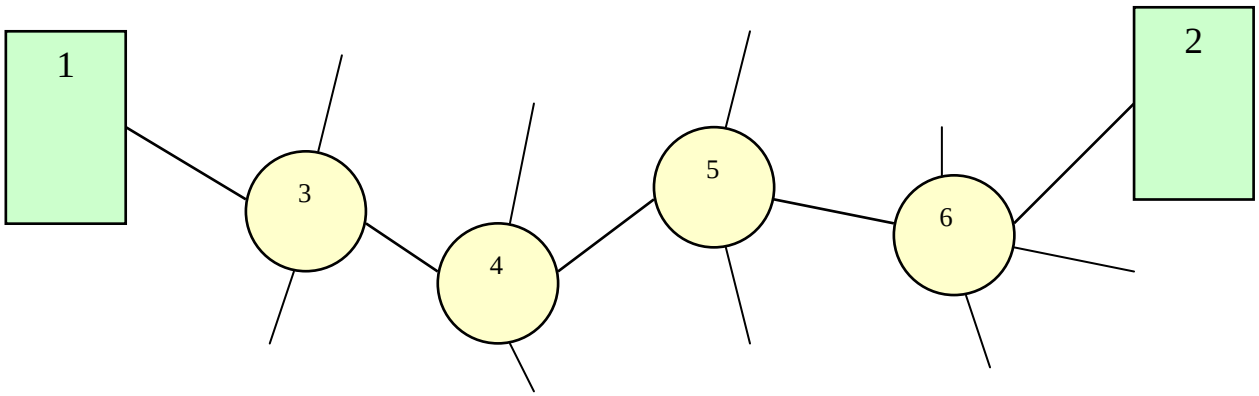


Fig.1.12 Example of WAN,
1, 2: Adaptors to MAN,

3, 4, 5: Routers

Most of the WANs work with the Data Packets switching. There is a part of WAN that works with the commutation in line (line switching).

The Backbones, which are high-speed networks, are big networks, owned by telecommunications companies, such as: MCI, WorldCom, Sprint and other.
Examples:

- the Abilene Backbone network covers over 10000 km at a data rate of about 10 Gigabits/second (Gbps),
- the GEANT network connects over 30 European countries at a speed of 10 Gbps (www.dante.net/geant or http://www.geant.net/upload/pdf/Topology_Oct_2004.pdf).

1.3. CONNECTION TYPES: PACKET-SWITCHED NETWORKS.

1.) Types of the WAN technology.

- 1.- Dedicated connections,

represent the only point-to-point connection between two devices.
Advantages:

- a permanent connection (7/24 connection),
- integral bandwidth,
- high speeds, for instance 45 Mbps with the T3 line and 30 Mbps with the E3 line [8.].
- extensible through the use of wireless options (for instance with Cisco Aironet up to 108 Mbps, according to the type and environment on pre-established distances: www.cisco.com/warp/public/44/jump/wireless.shtml).

Disadvantages:

- high cost, especially for multiple connections,
- connection is closed only to one site,
- mainly: no-connection to the world.

The connection is achieved through CSU / DSU (Channel Service Unit / Data Service Unit)

- 2.- Circuit-Switched Connections.

A dedicated connection (which may partly be replaced in time as the pathway between the source and destination) is established. It is the case of the normal phone, fax etc.
Between the Circuit Switched connections there are:

- Analogue [analogue modem (modulator/ demodulator) based] Modem Connections, theoretically of up to 53 Kbps (for instance, 56 Kbps are prohibited by FCC norms).
- ISDN Connections ISDN- Integrated Services digital network (from 128 Kbps to 1,5 Mbps). It functions only digitally for voice, data and video.

Types of ISDN:

- BRI – Basic Rate: also called 2B+D - formed from the channels: 2BX 64 Kbps + 1Dx16 KBps,
- PRI – Primary Rate: also called 23B+D - formed from the channels: 23Bx64 + 1Dx64 Kbps. By working on the T1 lines, PRI may reach 1,544 Mbps.

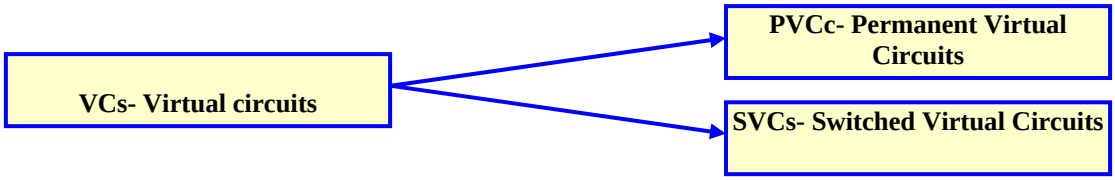
  - Advantages of Circuit-Switched Connections:
    - Connection when required,
    - Dedicated bandwidth (integrally consumed by the process),
    - Cheaper than dedicated lines, etc.

  - Disadvantages of Circuit-switched Connections:
    - Relative low speed (very low in the analogue systems),
    - As far as ISDN is concerned, it is considered by some sources to use complicated adaptors and interfaces,
    - Lack of efficiency regarding channel use (one ISDN consumes an entire bandwidth of the channel).

The ISDN requires specialised adapters and interfaces.

- Packet-Switched [8.].

It may be considered that - helped by the Routers and based on the IP Address of Destination (and on the Source for the incorrect or missed Data Packets retransmission) - the Data Packets search their own pathway.
Point-to-point, VCS Virtual circuits / connections are temporary, dynamically created (created only for the instantaneous purpose of the Data Packet passing to the Destination) for the Packet-Switched network.
VCS may to be:



- Advantages of Packet-Switched Networks:
  - Cheaper.
  - High-speed connections, including T3 line , E3 line, transport of Multimedia, voice, etc
  - Good use of the bandwidth.

- Disadvantages of Packed-Switched Networks:
  - The complexity of the networks, complex protocols, intensive software development and tests (solved).
  - The fact that the bandwidth is shared disputable: it has an advantage or a disadvantage.

2. THE INTERNET NETWORK. OTHER NETWORKS.

1.) The Internet.
The Internet Network, also called Information Superhighway, is a "network of networks" based of the TCP/IP protocol.

The Internet is made of a few principal, inter-connected Backbone networks, from which are disposed the networks of the different other ranks like the arms of a tree.
The Internet results as in the above fig.1.9 and fig. 1.10 by the hierarchy of the networks, from the basic networks - usually Ethernet networks - to the big, very fast networks, like the Backbone networks.

The Data packets.

The Internet functions with the technology of Data Packets switching and not with the technology of lines switching.

Therefore, the message transmitted via the Internet (more precise, parts of the messages) is presented as Data Packets.

Each packet includes:
- standard information such as the IP addresses of the source and destination,
- digital Data and
- digital indicators. The indicators are groups of digital bits inside the serialized train of bits.

These indicators inform about:
- the moment of starting the Data Packet,
- end indicators (which indicate the ending of the respective Data Packet), elements of control of data integrity and others.

The sender's machine generates the packet or the data packets based on rules, protocols and standards included inside the TCP/IP suite of protocols.

Switched networks.

The switched networks switch the Data Packets to different parts of the network. They do not broadcast the packets to the entire network, but direct the Data Packets only to the selected portion of the network, respectively, to an under-network.
One example in which the Data Packets are divided and sent only according to the Packets Addresses to the selected networks, Network A and, respective, Network B is illustrated in fig. 1.13.

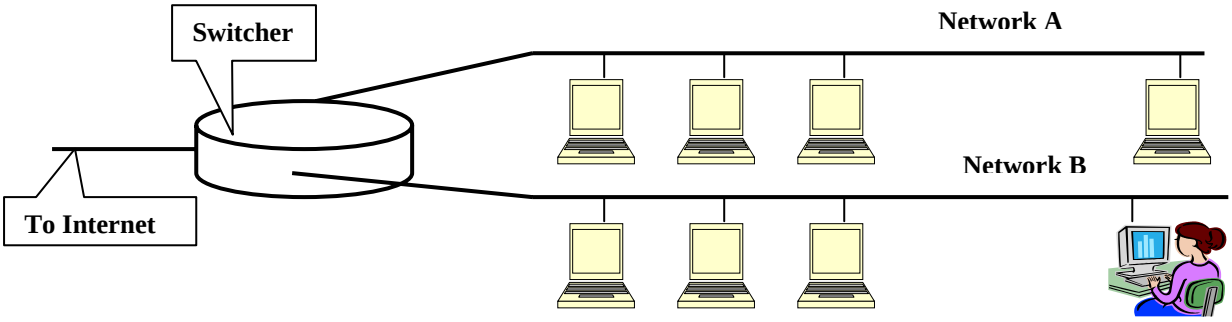


Fig. 1.13. The Switcher allows the distribution of data packets based on the IP Addresses only to the Network which contains machines with the respective addresses.

The switcher may be, for instance, a Router (in this case with 3 NICs- Network Interface Cards), a Server with 3 NICs etc.

2.) The Intranet. The Extranet.

The Intranet networks are **private** networks working for a specified entity.
Multiple Intranet networks may be inter-connected to create an Extranet.
The Extranet is the part of your Intranet that you share with the world outside your entity.

(The Intranet may work with other protocols than the TCP/IP. If the Intranet works based on the TCP/IP protocol, then the Intranet is also called internet, that is, internet with a small 'i').

The Internet includes both Intranets (which may not work based on the TCP/IP) and internets (which work only based on the TCP/IP protocol).

The Extranet may consist of a few intranets and internets which are usually interconnected through the Internet. .

3.) The VPN – Virtual Private Network
The VPN is a private network which uses public facilities, namely the Internet.
To may to work inside the public environment, the VPN is using:

- the tunnelling protocol (the creation of virtual direct connection over the Internet) and
- the encryption of Data.

The VPN may be a money saver. The motivation for cost cutting lies in the fact that the leasing private lines (which are not used in the VPN) are usually expensive compared with public telecommunications.

The VPNs work in both systems: Intranet networks and Extranet networks.

4.) The software as the engine which deals with Internet requirements.

All the works and operations achieved by the Internet are based on the hardware and software components.
The software components for solving the Internet functions are implemented in compliance with the TCP/IP protocols and are present – also encapsulated – in all the partners of the Internet network: Servers, Routers, Gateways, Work stations including your machine, PC, laptop or other.

The software deals with the treatment of messages, the encapsulation of message components, the creation of Data Packets, the monitoring of the Data Packets, the handling and monitoring of IP addresses and of other types of Addresses, the monitoring of the Data Packets transfer, the correction of transmission failures, the support of the troubleshooting tools, the measuring of the network behaviour, the adaptation to the network speed possibilities and many others.

All these functions and works are achieved by the software programs, based on protocol agreements of the TC/IP suite.

3. PRACTICAL EXAMPLES OF NETWORK STRUCTURES.

1.) The typical example of the LAN

Figure 3.1 presented below illustrates the configuration of 2 LANs, where in each LAN the machines are inter-connected through the hub of the respective LAN.

With the external networks (the Internet), the LANs communicate through one switch which improves the speed and functionality. This performance is accomplished following the fact that the Switch distributes the Data Packets to the Hubs according to the Data Packets addresses:

Each of the two LANs receives only the data Packets which are addressed to that specific LAN.

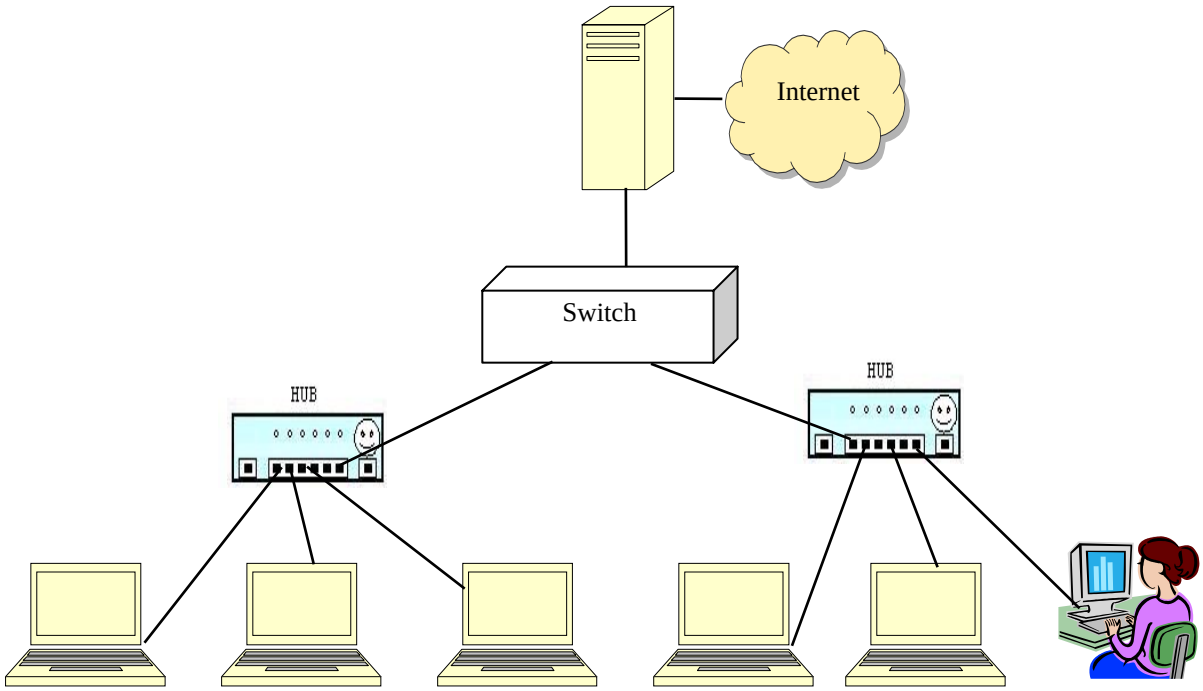


Fig.3.1. Example of achieving two star-shaped LANs (each LAN has their own Hub), and connected to the Internet through the use of a switch.

2.) The layers of one Cisco Network Design Model [1]

The Cisco Network Design Model is very important.

The layers of the Cisco Network Design Model are the following [1.]:

- The Access Layer represents the connection to the Internet through the Firewall and Router 1 (the Router distributes the Data Packets based on the IP Destination address of the data Packets).
- The Distribution Layer represented by the distributions achieved by Router 2
- The Core Layer includes the Switch and the Hubs which achieve the transfers with addresses filtered by Router 1, Router 2, and the Switch.
  The Switch is more intelligent than the Hub. The switch directs the Data only to the network segments in which the targeted IP addresses are present.
  Some Switches may learn from traffic the paths to the different addresses. The Switch plays a part in avoiding the elements of congestion.

The illustrated Cisco Model is a generic model, first applied to medium-sized and large networks.

For small networks, parts of the Cisco model are also used, with a reduced number of layers and with a reduced number of Routers.

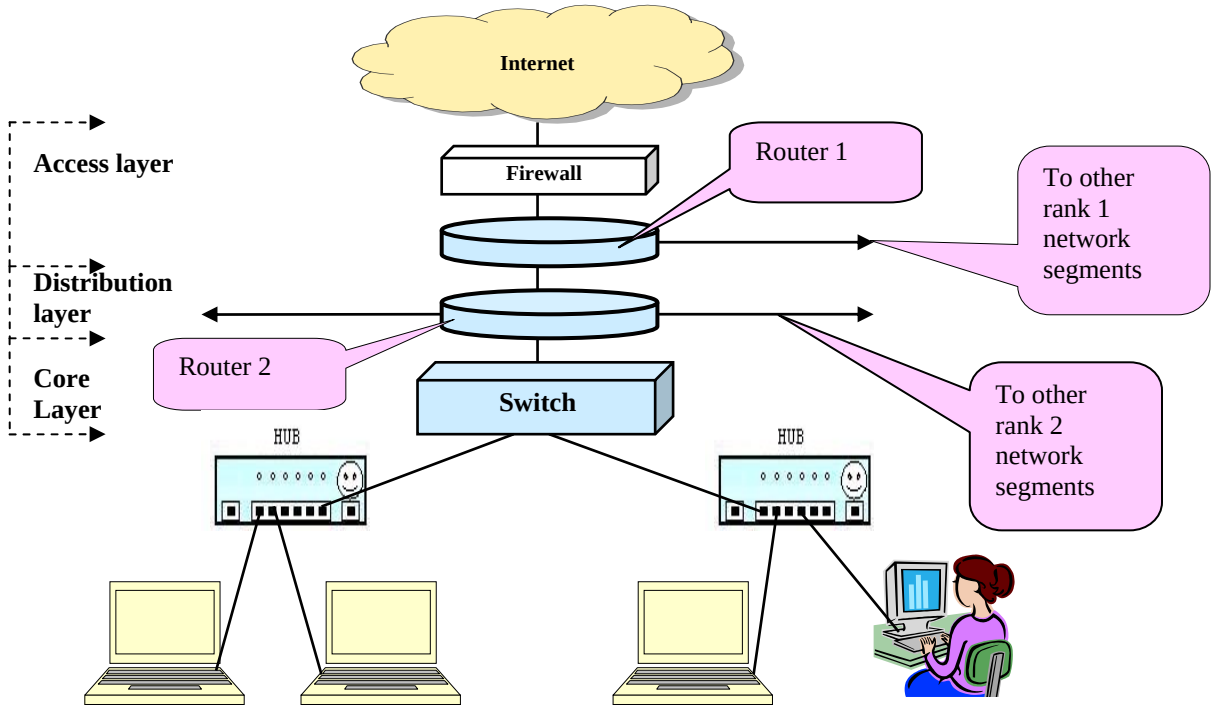


Fig.3.2. Example of the achievement of the Cisco Network Design Model.

Key Points Summary. Conclusions and Recommendations

In the fields of the networks and networking there have been two winners in the past years:

- the TCP/IP suite of protocols and
- the Ethernet protocol for LANs.

The main practical structures of the Internet's networks take into consideration the above aspects and achieve networks whose base are the Ethernet networks.

The networks includes toward the upper levels:

Firewalls (which may be also practiced on each machine),
Routers with different ranks separating the Data Packets based on the IP Address,
Switches which direct the Data Packets to the correspondent IP Addresses.

At a basic level, the Hubs (if the network use Hubs) and the machine itself with the own NIC. The Hubs are usually and frequently used. The Hubs may be replaced with Switches (more intelligent hubs).

Study Guide

ESSENTIAL QUESTIONS TO EVALUATE THE ACQUIRED KNOWLEDGE

1. What does broadcasting technology and End to End technology signify?
2. Which are the differences between the broadcasting in one LAN and broadcasting in the Internet?
3. Which are the principal four types of network topologies?
4. Which are the principal layers of the Cisco Design Architecture?
5. For the small systems all the layers indicated in the response to the previous question 4 must be used?
6. Which are the classical elements of a configuration through which one LAN is connected to the Internet?
7. Which are the principal functions of the Hubs?
8. Why is a Switch superior to a Hub?
9. Which is the normal IP Address for broadcasting in an End-to-End network? Why does this address have this form?
10. Which are the levels of the simplified hierarchical model of the network rank?

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[Supp. 3.] www.cramsession.com
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[Supp. 4.] www.ietf.org RFCs.
[Supp. 5.] www.rfc-editor.org RFCs.

SUPPLEMENTARY GUIDANCE ON THE CONTENTS OF THE LESSON

It is advisable to refer to: www.cisco.com; www.cramsession.com; http://www.freesoft.org/CIE/RFC/826/10.htm .

ANSWERS TO QUESTIONS

1. The broadcasting technology consists of sending the Data Packet to the network's partners, so as to accomplish the response from one of the entities. The End to End technology sends the Data Packet to the known IP Address of destination, IP Address which is usually placed in another network.
2. Broadcasting in a LAN is usually achieved inside the LAN addresses to the IP Addresses (arp, to identify the Physical addresses) or to Physical Addresses (rarp). The broadcasting on the Internet is achieved on IP addresses.
3. The four principal types of network are: bus, star, mesh and ring.
4. The principal layers of the Cisco Design Architecture are: Access Layer, Distribution Layer and Core Layer.
5. No.
6 The firewall (possible and recommended), the switch, the Hubs, the machines, each with its own NIC, cables.
7. The Hubs transforms the Bus configuration into a star configuration. It permits the separation of the connections to different machines. One short circuit on a pair of cables does not influence the overall functioning of the system. The Hub simultaneously applies the Data received on an input , on all the outputs.
8. The Switch is more intelligent than the Hub. The switch directs the Data only to the network segments in which the targeted IP addresses are present. Some Switches may learn the paths for the different addresses in traffic. The Switch contributes to avoiding the elements of congestion.
9. The IP Address serialized under the form 111111…, that is with the value 1 in all positions, have the feature of including all the possibilities of forming the addresses, that is all of the addresses used.
10. The simplified hierarchical levels are:
Network: 1 (high rank, high level and high speed), Backbone networks,
Network: 2, WAN, Wide Area Network, or regional,
Network: 3, MAN, Metropolitan area Network,
Network: 4, LAN

WORDS TO THE LEARNER: ***"Do not wait for opportunities. Create them."*** (After Bernard Shaw)