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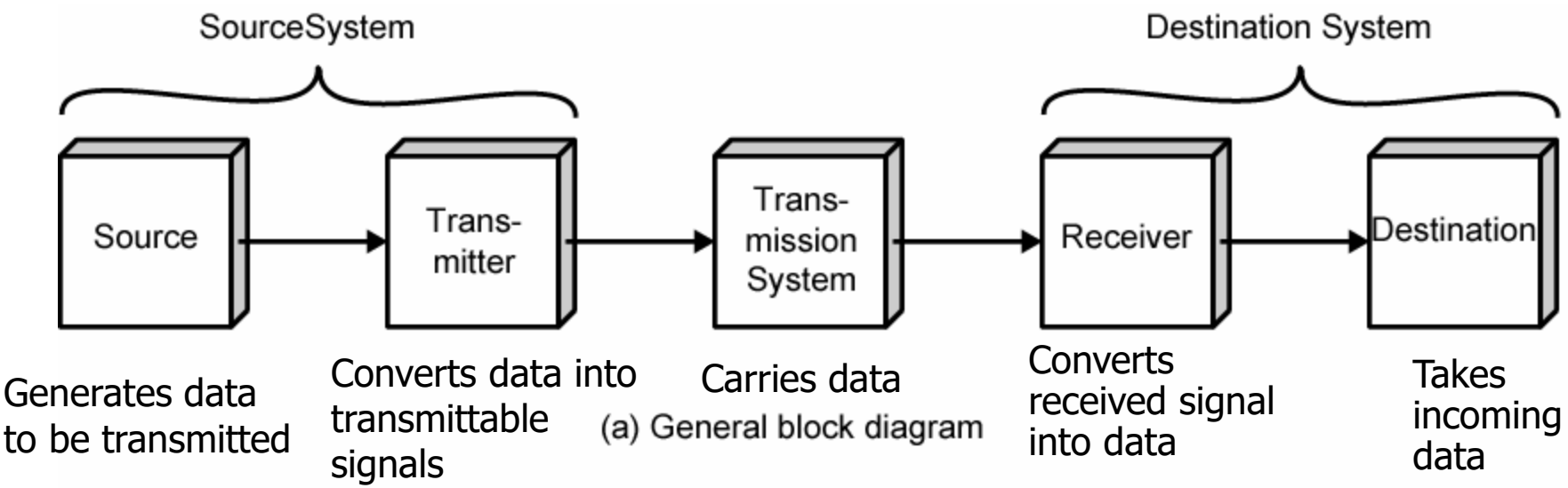
References

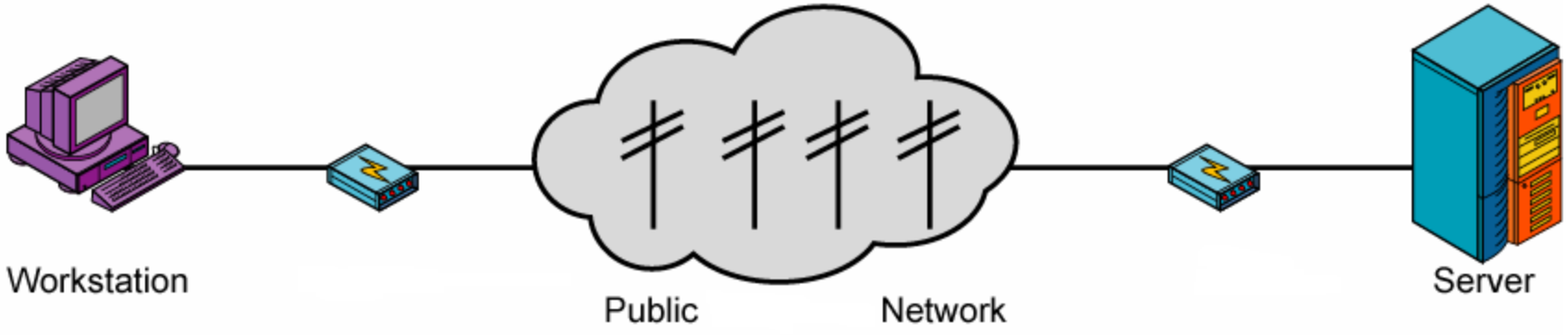
- *Behrouz A Forouzan*
  - *Data Communications and Networking*
    - *McGraw Hill*
  - *http://highered.mcgraw-hill.com/sites/0072515848/student_view0/*
- *William Stallings*
  - *Data and Computer Communication*
    - *Pearson Prentice Hall*
- *Andrew Tanenbaum*
  - *Retele de Calculatoare*
    - *Byblos*

Overview of Data Communications and Networking

Simplified Communications Model-Diagram



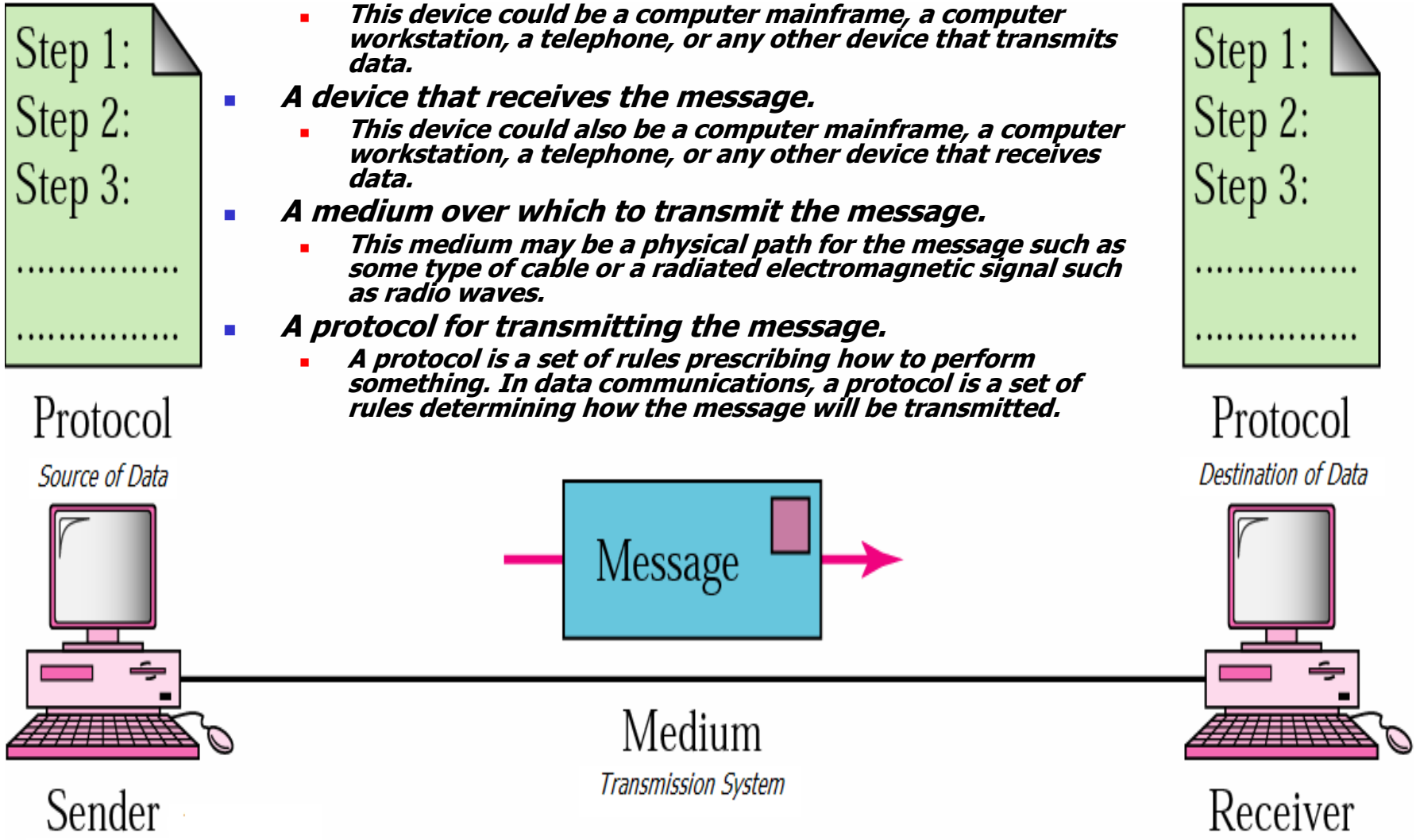
(a) General block diagram



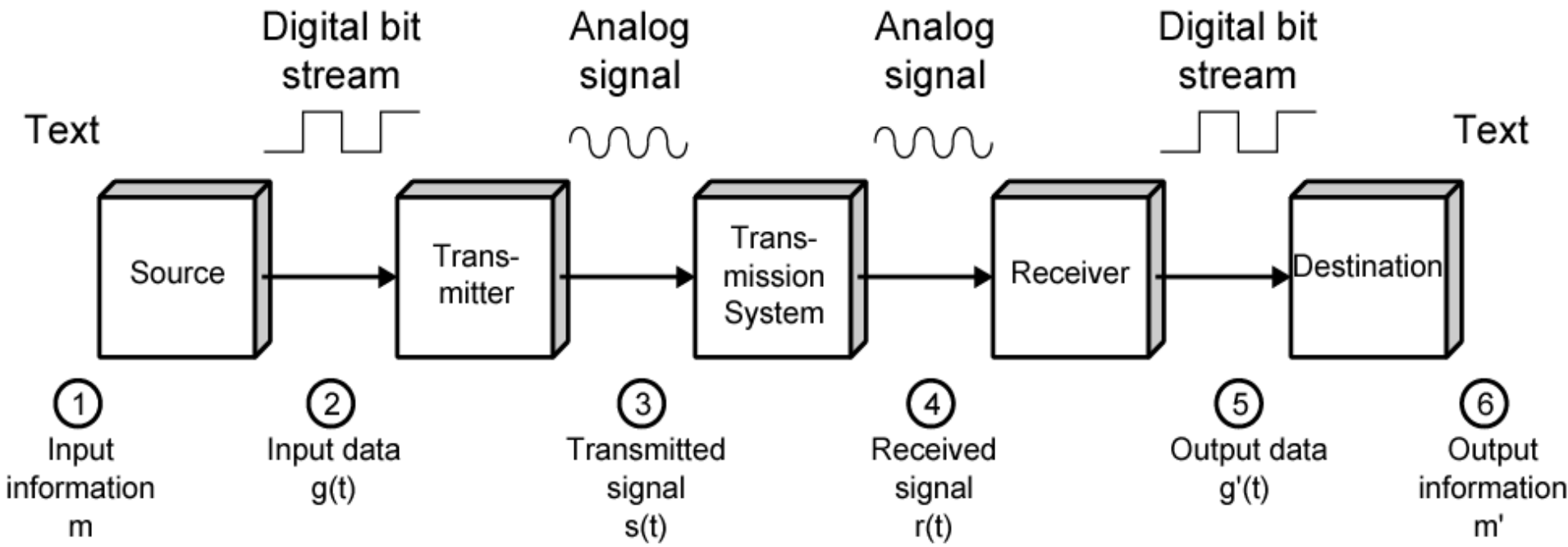
(b) Example

Five components of data communication

- ***A message to be communicated.***
  - ***This message may be data, text, audio, graphics, or video.***
- ***A device that sends the message.***
  - ***This device could be a computer mainframe, a computer workstation, a telephone, or any other device that transmits data.***
- ***A device that receives the message.***
  - ***This device could also be a computer mainframe, a computer workstation, a telephone, or any other device that receives data.***
- ***A medium over which to transmit the message.***
  - ***This medium may be a physical path for the message such as some type of cable or a radiated electromagnetic signal such as radio waves.***
- ***A protocol for transmitting the message.***
  - ***A protocol is a set of rules prescribing how to perform something. In data communications, a protocol is a set of rules determining how the message will be transmitted.***



Simplified Data Communications Model



Several terms that are often used

- A **line** is a physical connection between two points in a network.
- A **circuit** can be a single or multiple connection or a nonphysical connection such as a satellite or microwave transmission.
- A **link** is an unbroken circuit between two network nodes.
- A **channel** is either a whole circuit or part of a circuit.

Basic Concepts

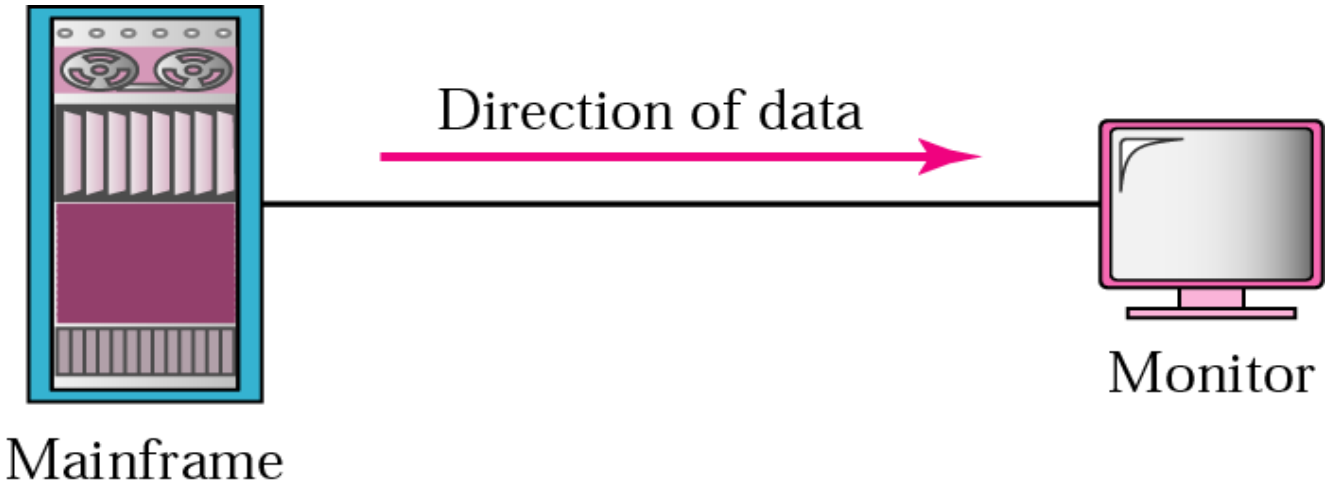
- The five basic concepts that describe the relationships between communicating devices are:
  - transmission mode
  - line configuration
  - topology
  - types of networks
  - internetworks

Transmission Mode

- The three types of data transmission
  - simplex,
  - half-duplex, and
  - full-duplex

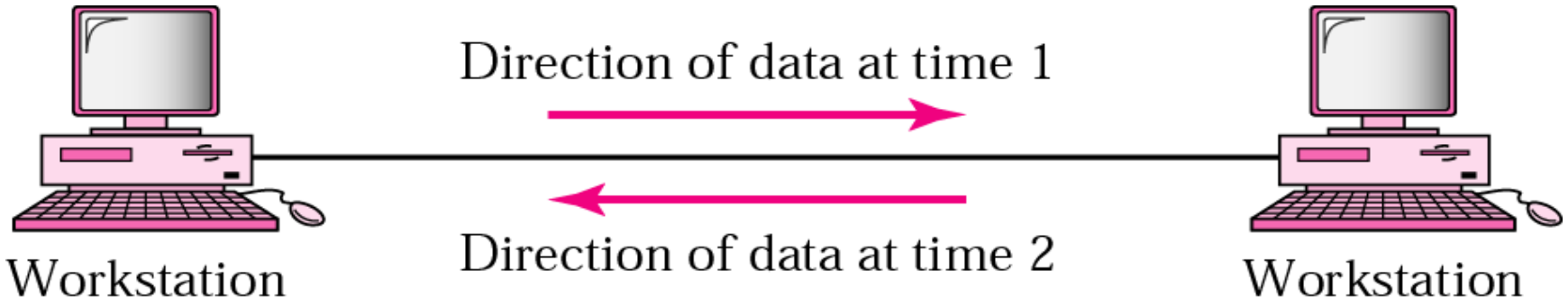
Simplex

Simplex data transmission: data can flow only in one direction



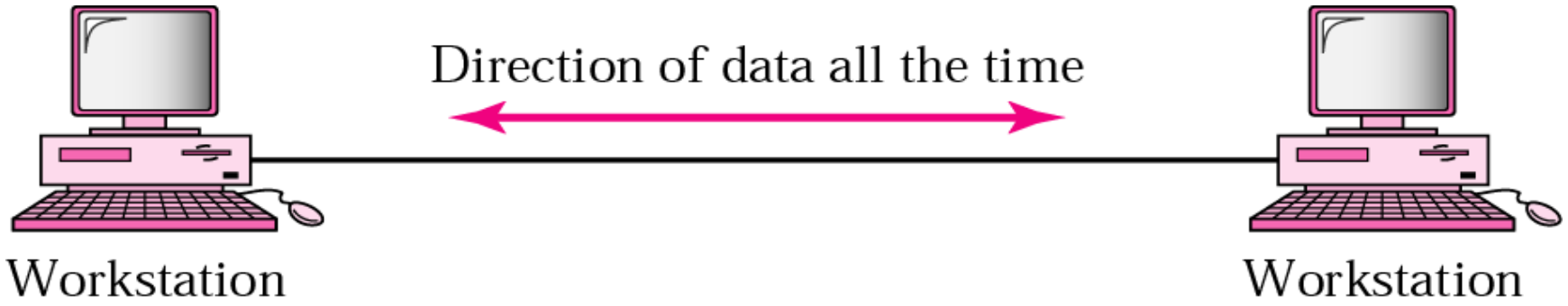
Half-duplex

Half-duplex data transmission: data can flow in both directions, but only in one direction at a time.



Full-duplex

Full-duplex data transmission: data can flow in both directions at the same time.

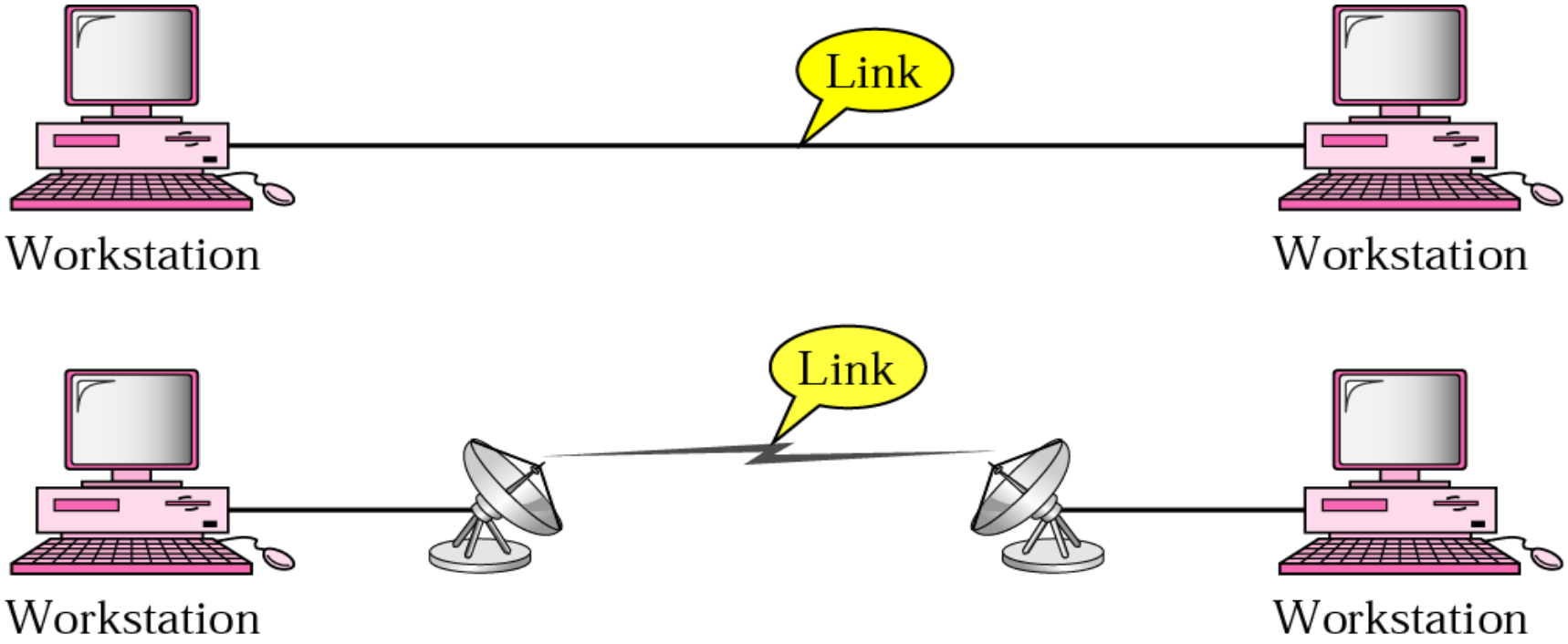


Line configurations

- Line configurations describe the way devices are connected.
- There are two configurations:
  - (1) point-to-point configuration and
  - (2) multipoint, or multidrop, configuration.

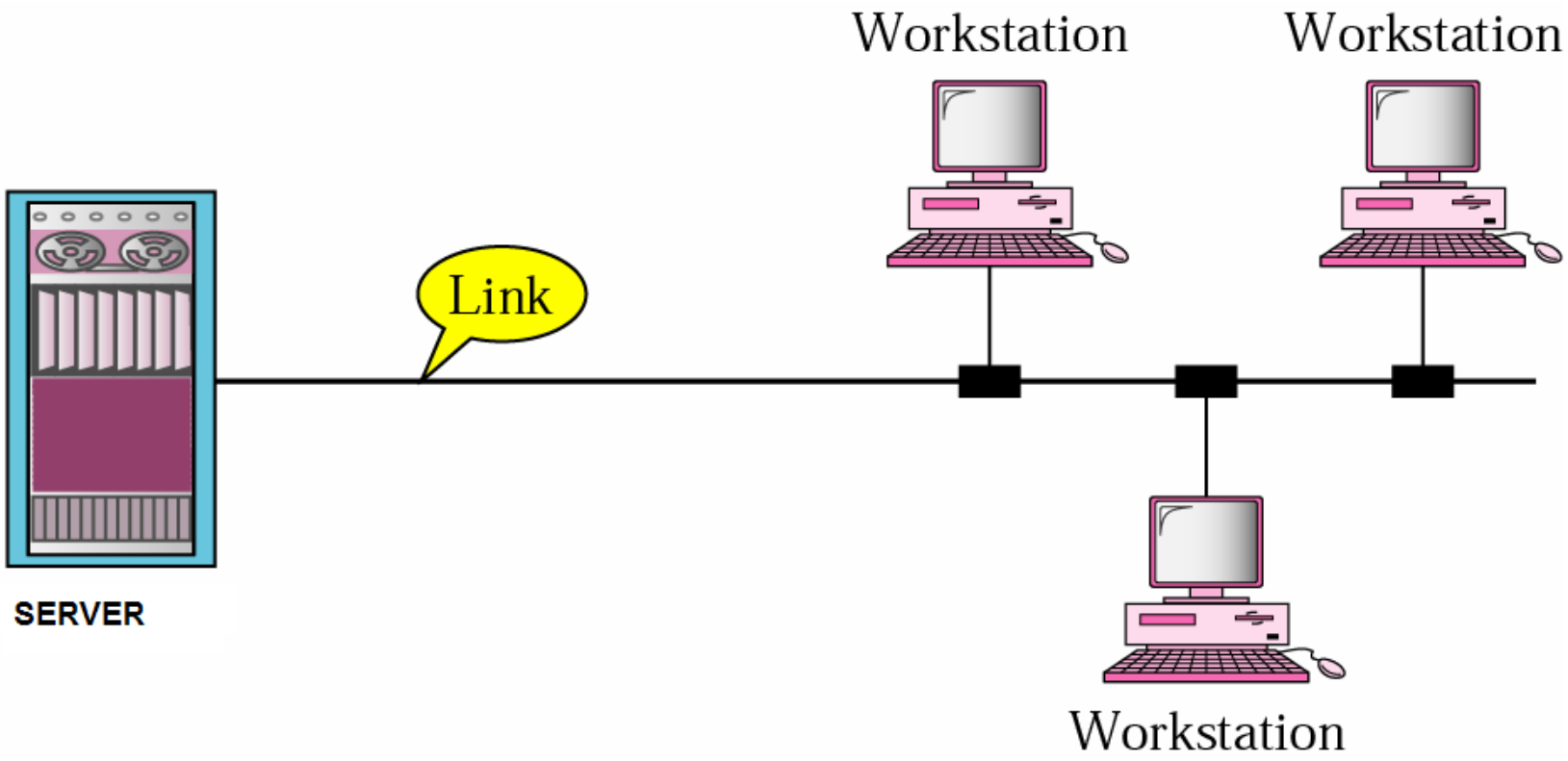
Line Configuration (1): Point-to-point connection

In the point-to-point configuration, the link is dedicated to communications between two devices.

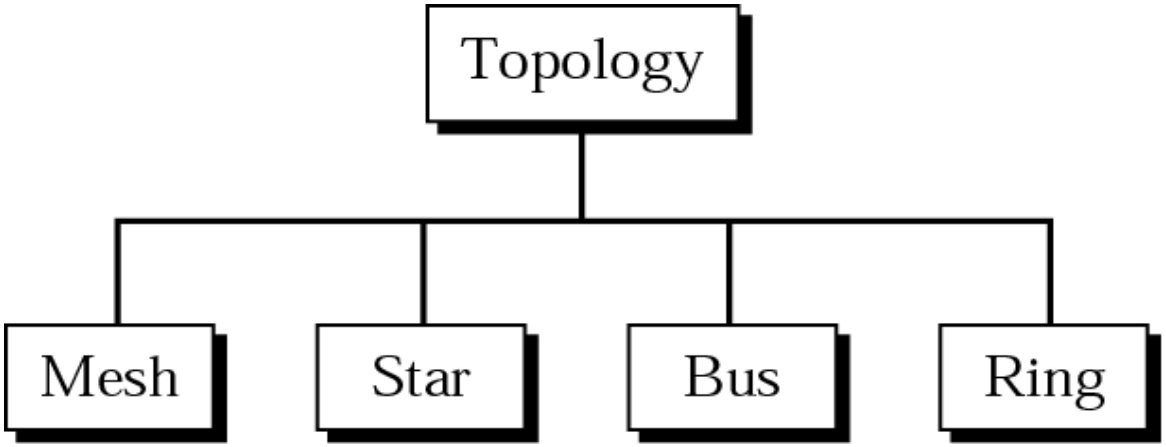


Line Configuration (2): Multipoint connection

In the multipoint configuration, the link is shared by multiple terminals.



Categories of topology

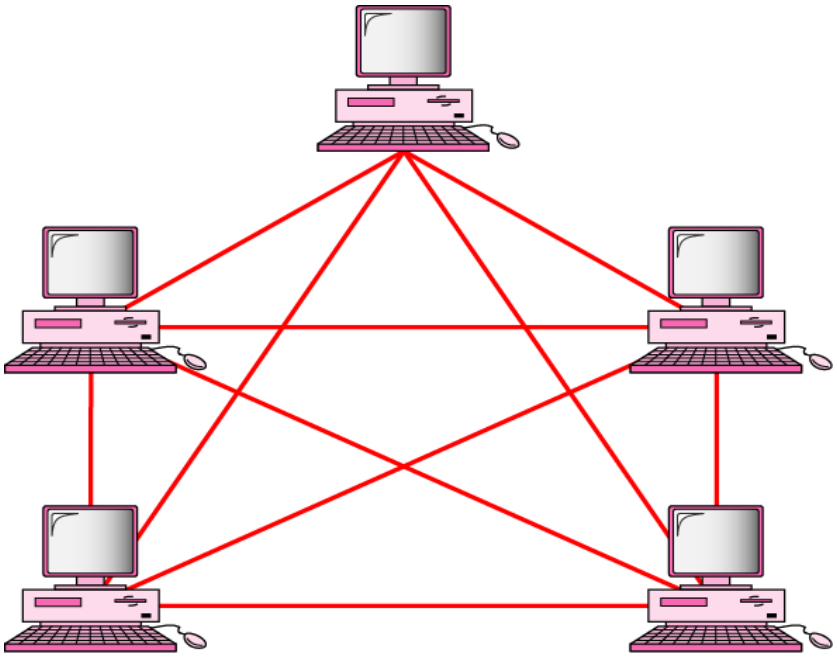


Fully connected mesh topology (for five devices)

In mesh topology, every node is connected by a dedicated point-to-point connection to all other nodes. A message will require only one hop no matter where the sending and receiving nodes are located in the network.

Number of connections = T × (T – 1)/2

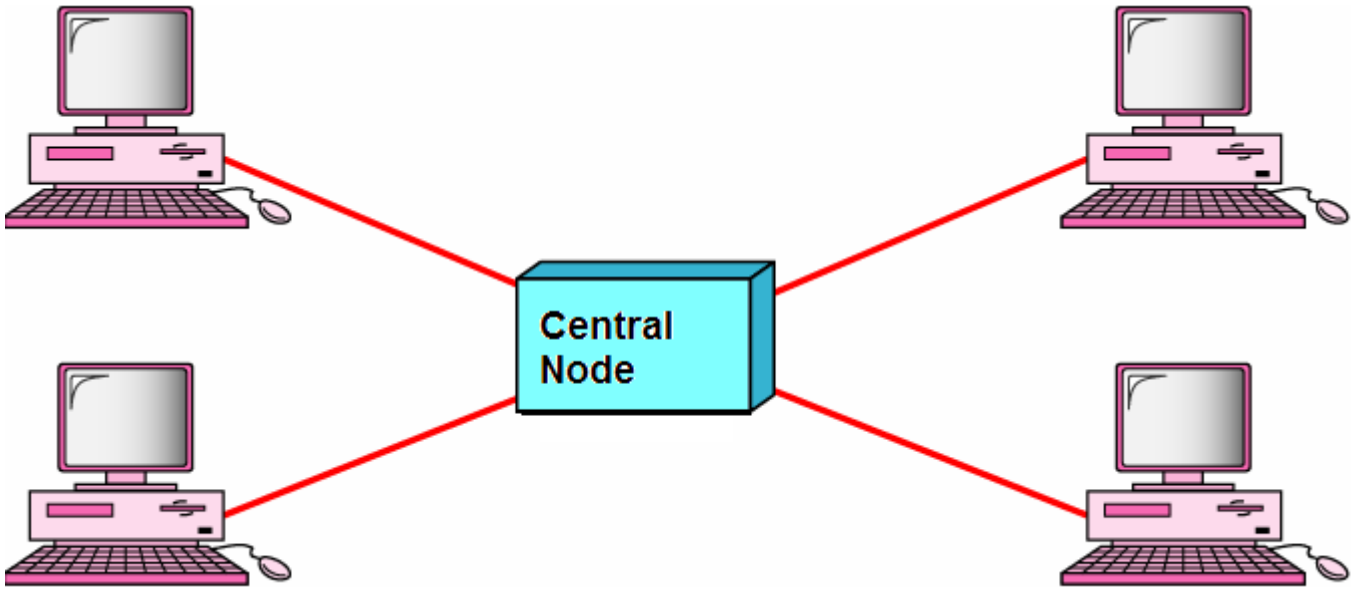
where T = the number of nodes or terminals.



Star topology

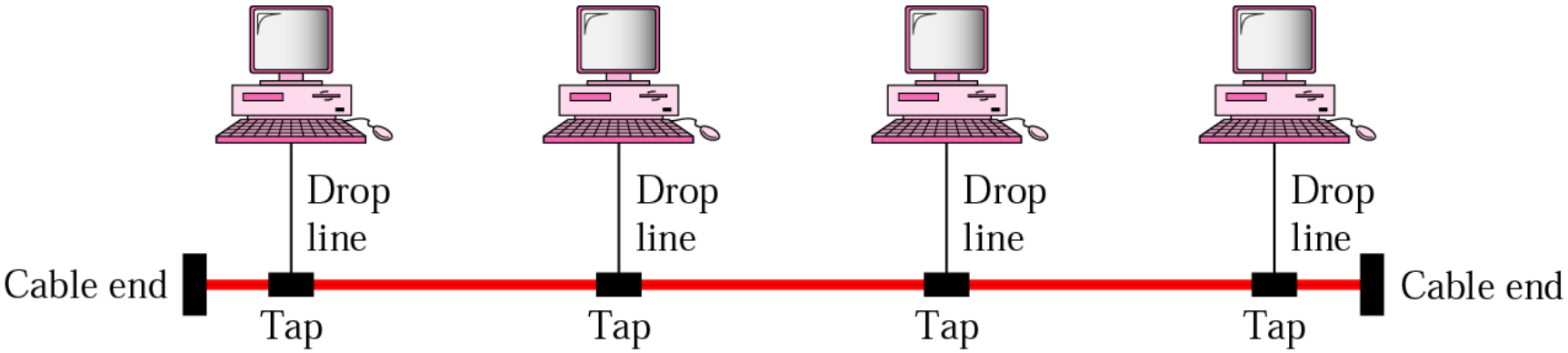
In the star topology, the central node is connected to every other node.

Messages between two nodes, where neither is the central node, always require two hops.



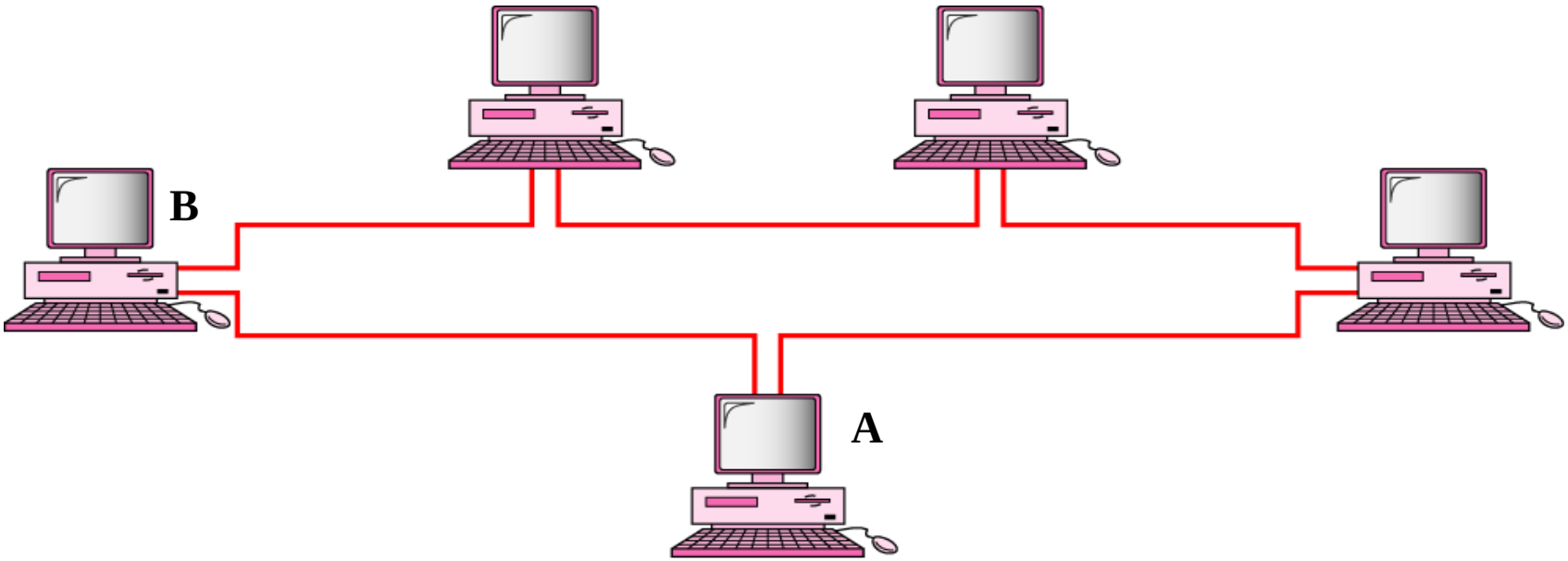
Bus topology

In the bus topology, a cable running the length of the network connects all nodes or workstations with a multipoint connection. The small solid rectangles at each end represent the cable ends. A message from node A to node B is put onto the bus and is received by all nodes on the bus, including node B.

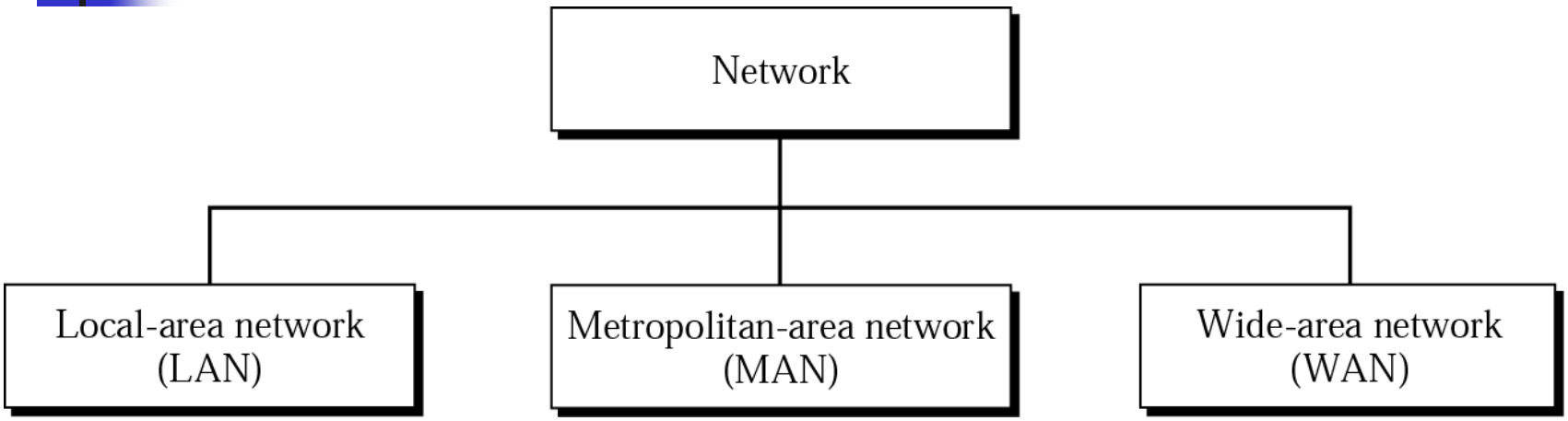


Ring topology

In the ring topology, a closed loop connects all of the workstations. Messages from A to B flow through the intervening nodes, in sequence, until they reach B. In our diagram, four hops are required if the traffic flows only in the counterclockwise direction.



Categories of networks



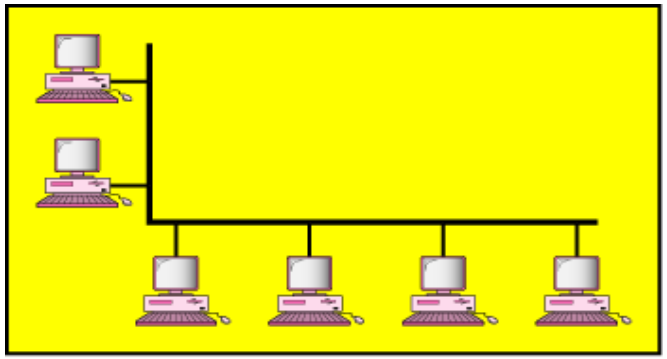
Local area networks (LANs), wide area networks (WANs), and metropolitan area networks (MANs) are the primary categories of networks.

In addition to these three categories, hybrid networks are created using internetworking devices. Hybrid networks often combine the best characteristics of pure LAN, WAN, or MAN networks. LANs, WANs, and MANs differ in the way they are used and in the technologies

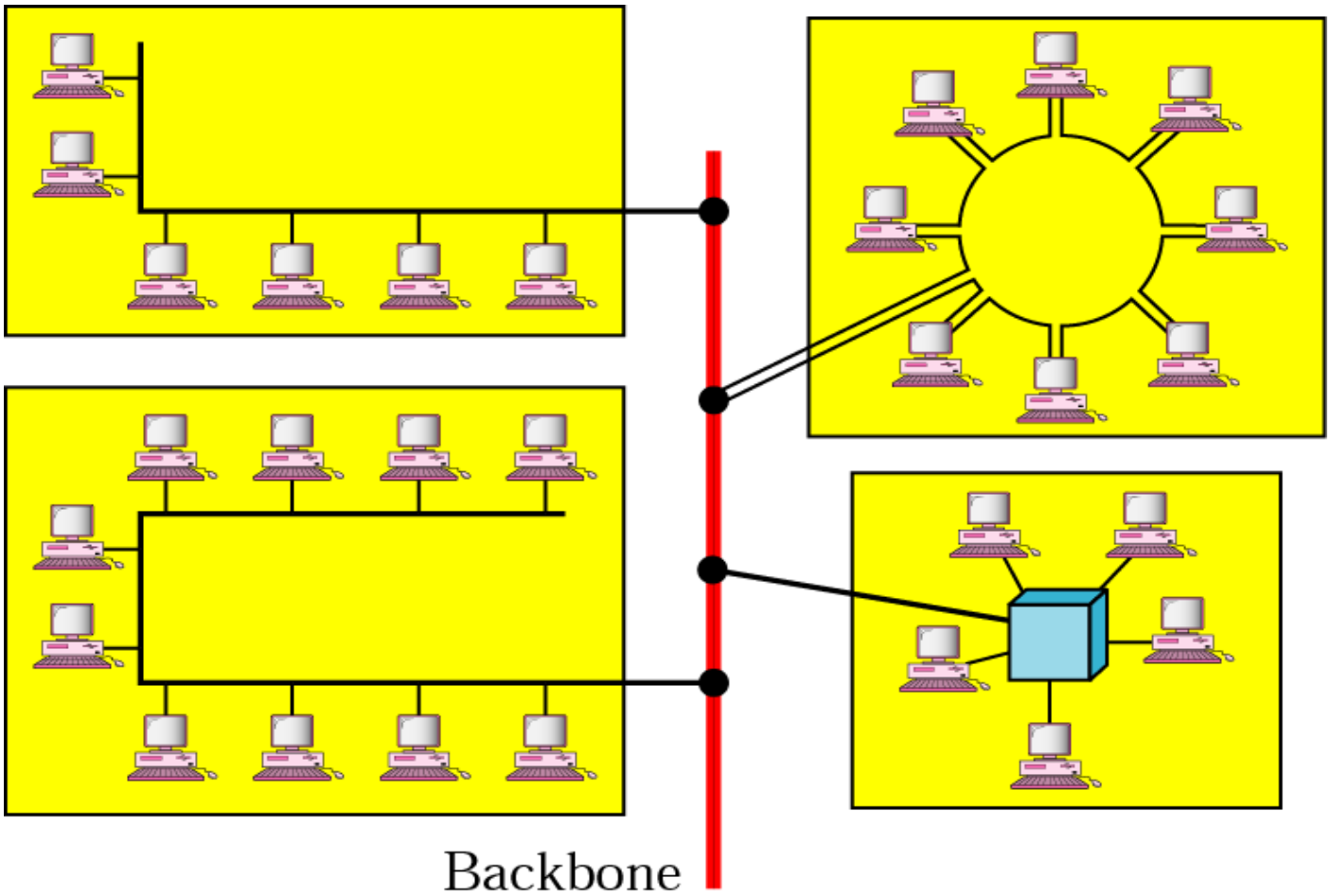
LAN- Local Area Network

LANs connects microcomputers and other workstation devices located in a single office, a single building, or on a campus.
The use of LANs allowed the sharing of resources, including hardware, software, and data.
LAN characteristics include:

- *a common transmission medium throughout the network*
- *bus, ring, or star topologies*
- *lengths of less than 10 km*
- *usually owned by their users*
- *typical data rates of 10 Mbps (Megabits per second) , 100 Mbps, 1Gbps, 10 Gbps and 100 Gbps systems in development*



a. Single-building LAN

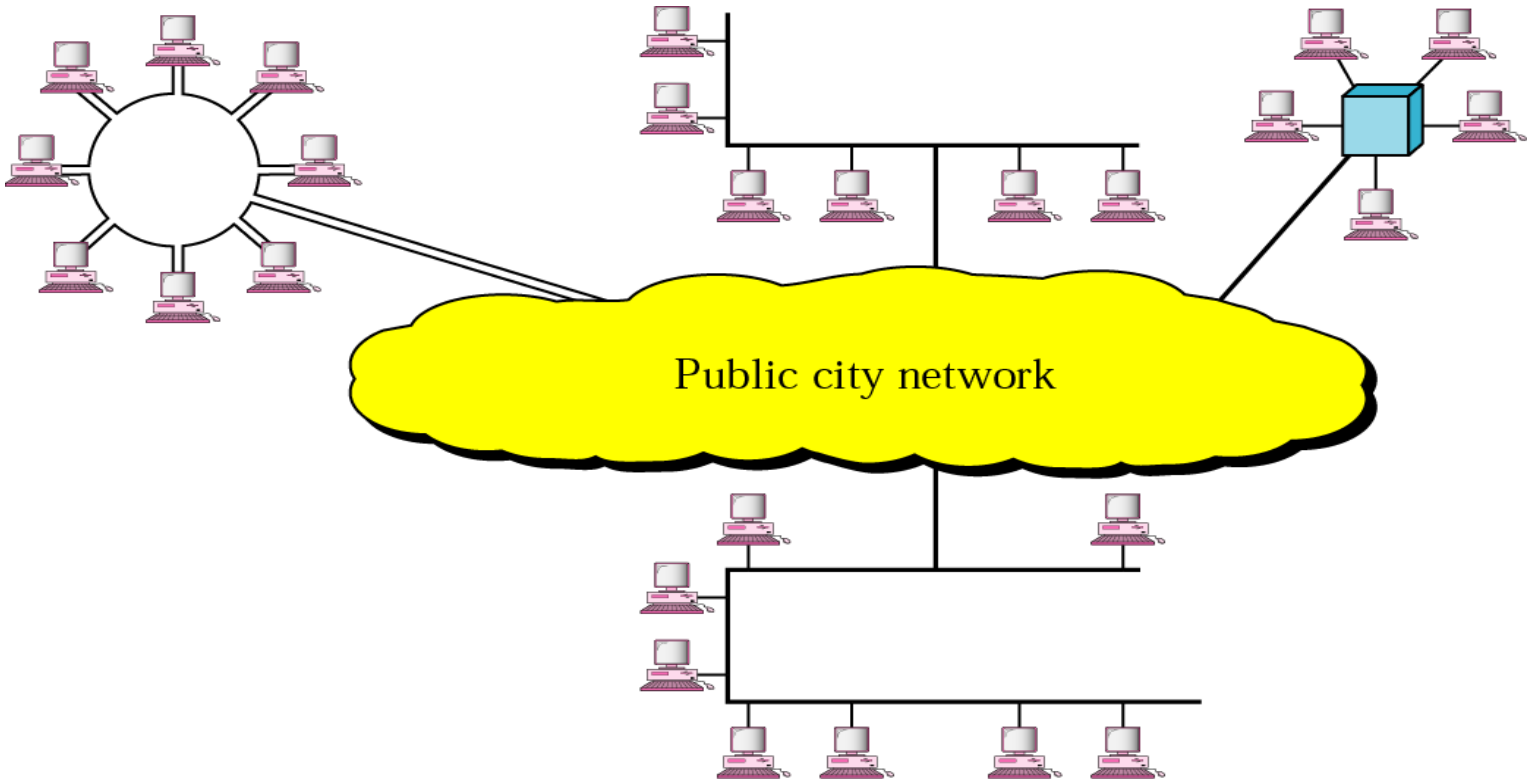


b. Multiple-building LAN

MAN – Metropolitan Area Network

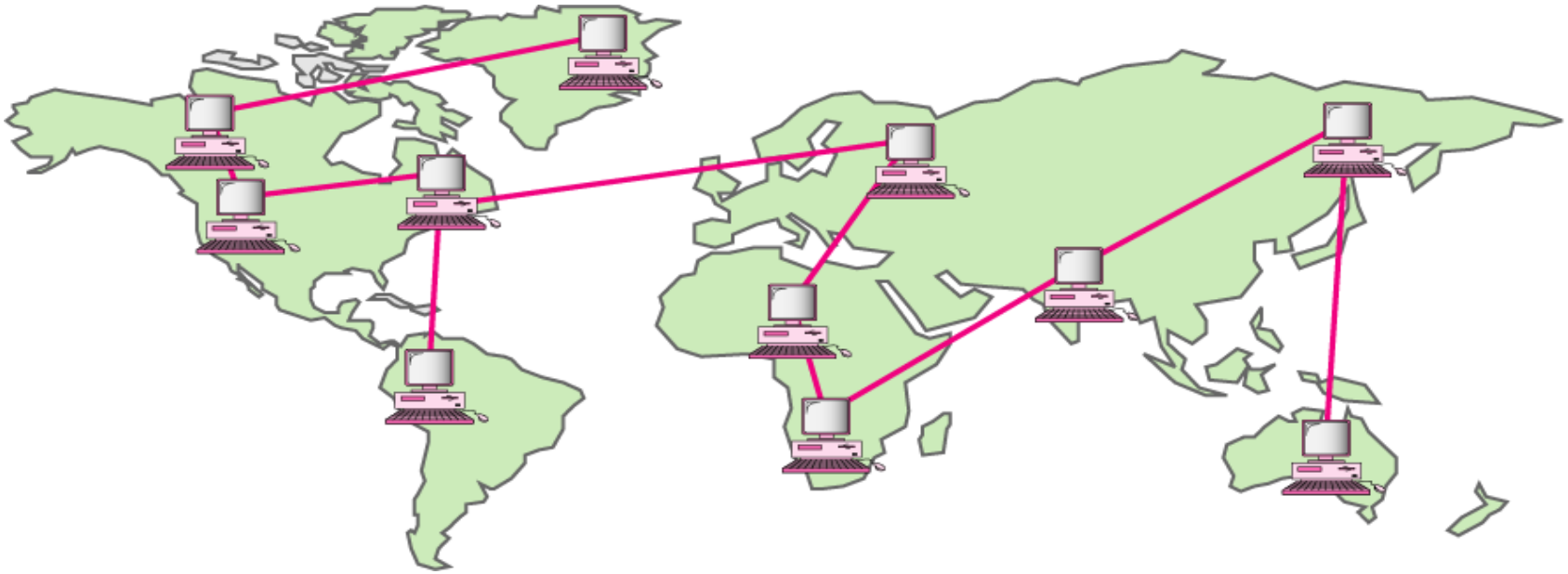
MANs, the newest of the three network types, span geographical areas that usually encompass a city or county and use digital technology similar to that used in LANs. MANs are often used to connect a series of LANs. Because of the larger area covered, MANs are usually owned by a public carrier or local government agency.

MANs may also be used as a backbone network to interconnect distributed LANs.



WAN- Wide Area Networks

WANs are centrally monitored and managed networks used to interconnect users over large geographical areas that may span cities, states, or countries.
A public carrier owns the communication circuits for most WANs. This makes sense for all but the largest corporations, because of the cost involved in establishing and maintaining the circuits over long distances.
When a single company owns a WAN, it is often called an enterprise network.



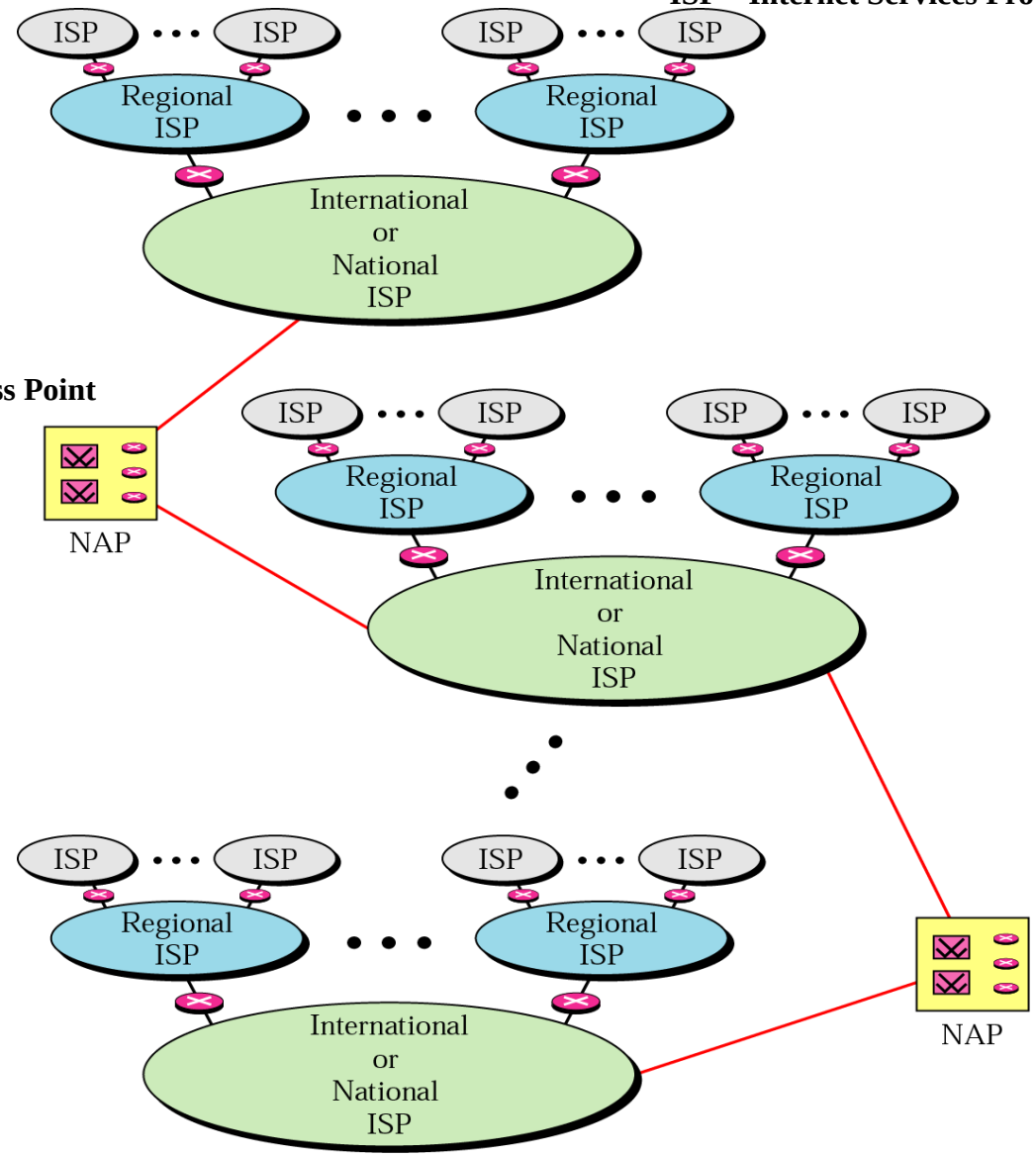
Internetworks

- It is often desirable to connect networks. The following terms are used to describe these types of connections:
- An **internet** or **internetwork** is the connection of two or more networks.
- The **Internet** is the worldwide network we all use.
- An **intranet** is a private network that uses Internet technologies.
- The devices used for network interconnections include bridges, routers, and gateways.

Internet today

ISP – Internet Services Provider

NAP- Network Access Point



Significant Events in Data Communications History

1837

- **Invention of the telegraph.**
- Samuel Morse invented the telegraph. By using a series of dots and dashes, people were able to send messages over long distances using telegraph wires.

- 1876
  - **Invention of the telephone.**
  - Antonio Meuci (Alexander Graham Bell) invented the telephone. It allowed people to talk to each other over telephone lines.
- 1885
  - **AT&T incorporated.**
  - By 1983, American Telephone and Telegraph (AT&T) controlled 90 percent of US nation's telephones and owned companies that provided most of the end-to-end telephone service (Fitzgerald 1993, 272). Because of its size and importance, AT&T was regulated by the FCC.

Significant Events in Data Communications History

- 1937
  - **ARINC case.**
  - The FCC granted Aeronautical Radio Inc. (ARINC) permission, over the objections of AT&T, to provide a communications network for the airline industry.
- 1940
  - **Bell Labs succeeded in data communication experiment.**
  - One of the first attempts to attach computer-related devices to communication devices occurred when Bell Labs (an AT&T company) at Dartmouth College communicated with an electronic calculator in New York City.
- 1956
  - **Hush-a-Phone case.**
  - Hush-a-Phone developed a rubber shield that could be placed over the telephone mouthpiece to provide privacy in a crowded room. AT&T sued to halt the sale of these devices and won, but then lost on an appeal. AT&T was concerned that any foreign attachment to its network could affect performance and strongly discouraged such attachments.

First proposal for the global operation of computer networks

- 1961: Leonard Kleinrock published the first proposal for the global operation of computer networks, "**Information Flow in Large Communication Nets**" laying down the fundamental principles of packet switching, message switching and communication in data networks.

- 1962: The first Telstar communication satellite was launched;

- 1962: J.C.R. Licklider from MIT (Massachusetts Institute of Technology) proposed the concept of **"Galactic Network"** being the first time launched the idea of global computer network; He envisioned a global interconnection of computers through which anyone could quickly access data and programs from any site.

Packet switching

- 1964, Paul Baran published a series of reports on distributed communication, ("Reports on Distributed Communications") in the care of one's own information about **information about being divided into blocks before a network was networked.**
- A former of the two independent inventors and concepts of package use, care and over time that can communicate data from the Internet

- 1964: Independent of Paul Baran, Donald Davies of the National Physical Laboratory-NPL, England, introduces the **concept of packet switching**, a concept that will be the basis of the development of computer networks in the next decade.

Significant Events in Data Communications History

- 1964
  - Rand Corporation introduced the concept of packet-switching networks.
  - The Arpanet was based on the concept of packet-switching networks, as was later the Internet.
- 1969
  - MCI case.
  - MCI (then known as Microwave Communications, Inc.) asked the FCC for approval to build a microwave service between St. Louis and Chicago, which implied that the local phone companies would provide local connectivity for users. AT&T contended that doing so would:
    - fragment the nation's communications because of differing standards and interface problems
    - construct duplicate systems the country didn't need
    - cause "cream skimming" of the best customers
    - MCI won a landmark decision that broke AT&T's monopoly of leased lines and required AT&T to provide local connections.

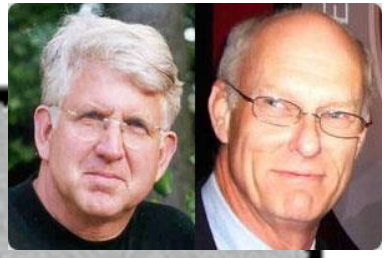
Significant Events in Data Communications History

- 1969
  - Arpanet implemented.
  - The Arpanet, a network funded by the U.S. Department of Defense's Advanced Research Projects Agency (ARPA), was implemented with four nodes. Arpanet was the forerunner of the Internet.
- 1970-1971:
  - *In the dept of Computers UPB the first multi-access conversational system in Romania called SISIF (P. Dimo, I. Athanasiu, V. Cristea). The system was based on the interconnection of the HP2116B and IBM1130 computer systems.*
  - *Redesign the connection channel between HP 2116 and IBM 1130 to allow additional Marian Dobre devices to be connected*

1971
University of Hawaii developed Alohanet.
The University of Hawaii developed the Alohanet, a radio network used to transmit data packets in the Hawaiian Islands. This network was the inspiration for Ethernet,

Conception of the Ethernet

1973 Xerox developed Ethernet.



Metcalfe's original conception of the Ethernet

Transmission Control Protocol

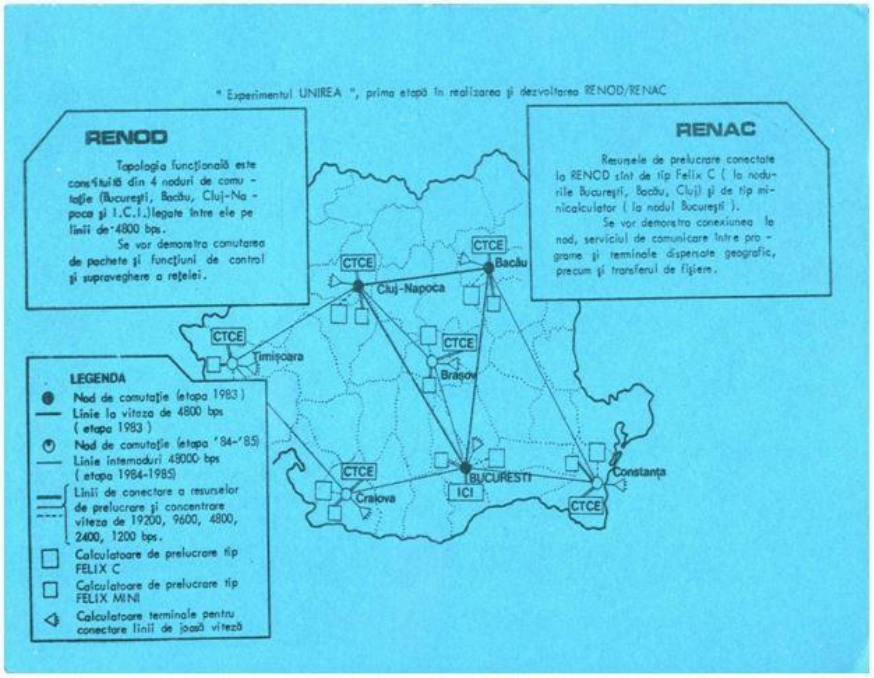
- 1974: Vinton Cerf and Robert Kahn proposed and implemented the Transmission Control Protocol (Internet Protocol) TCP / IP [Cerf 1974] [Kahn 1978]. Vinton G. Cerf and Robert E. Kahn received the AM Turing Award in 2004. Vint Cerf considered "the father of the Internet"
- 1975: manufacture of the first Romanian modems (IPA) and testing of the Romanian communication lines for data transmission (ICI and MTTc);
- 1979: the first Romanian prototype of LAN (Local Area Network) is made, hard and soft, at ICI by a team led by Dr. Florin Păunescu, of which Iulian Popa, Dan Petre Goleşteanu, Liana Dogaru and others were included.

F. Păunescu Iulian Popa

WAN in Romania

- *1984: The first WAN type network, of Romanian design and with Romanian equipment (UNIREA Experiment figure 3.), initially having three nodes, is realized by ICI and MTTc by a team led by Prof.* ***Marius Guran****, of which F. was part. Păunescu, E. Stăicuț, V. Papadopol, M. Grozavescu, S. Coman, L. Onulescu, V Tomescu*

1984: EXPERIMENTUL UNIREA



World Wide Web

- 1989
  - World Wide Web introduced.
  - The World Wide Web (WWW) was created, leading to a commercialization of the Internet.

Tim Berners-Lee

UPB first *international connectivity was achieved through dial-up*

- *1990: The Polytechnic University of Bucharest and the Technische Universitat Darmstadt started a project to establish an experimental electronic mail system and to develop a data communication infrastructure connected to the international data network; international connectivity was achieved through dial-up (coordination Nini Popovici). The project was developed in the computer department and the UPB Data Center.*
- *Computing center led by Prof. Mircea Petrescu, Computer Department led by Prof. Nicolae Tapus*
- *1990: The first courses of Local Networks are taught at the Polytechnic University of Bucharest (Prof. Nicolae Ţăpuş and Trandafir Moisa)*

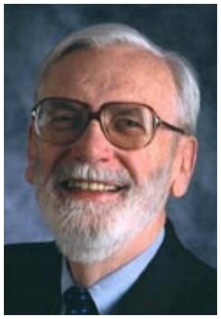
N Popovici

N Ţăpuş

T Moisa

Highly Probable Future

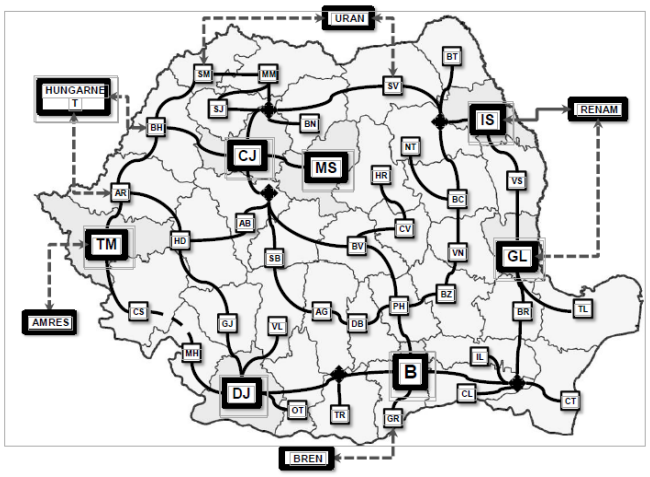
- 1994: Coates, J.F publică ”The Highly Probable Future 83 Assumptions About the Year 2025”, World Future Society [Coates 1994]. in which it lists 83 very probable events for the year 2025. These include: a single broadband network, based on fiber optics; complete fusion of computers with telecommunications; the emergence of a new vocabulary containing tele-voting, tele-work,…. tele-all; countless virtual communities on a global scale, based on electronic links; privatization of the INTERNET; about **40% of the work will be distributed, at a distance, and the service will become history for many** ”.



RoEduNet

- *1998: The official establishment of the management agency of RoEduNet by GD 515 / 21.08.1998. The full name is the Office for the Administration and Operation of RoEduNet Data Communications Infrastructure, abbreviated O.A.O.I.C.D. RoEduNet. The first director was Nicolae Popovici, and during the time RoEduNet was led by Eduard Andrei, Octavian Rusu and Gheorghe Dinu. The first national network of data communications for education and research at national level is created by establishing and equipping with communications equipment and servers the 6 regional nodes in Iasi - Alexandru Ioan Cuza University, Tg. Mureş - Petru Maior University, Cluj Napoca - Technical University, Timisoara - Technical University of Timişoara and Craiova - University of Craiova*

C. Enăchescu, E. Andrei, I. Jurca, A.V Marinescu, O. Rusu, K. Pusztai



CATC - International Training Center for Computer Networking Technology

N Țăpuș N Sandu R Rughiniș

- *1999: The CISCO Local Academy is set up at the UPB Computer Science Department, and subsequently the CATC - International Training Center for Computer Networking Technology was developed, which coordinated the activity of 43 regional Academies from 12 countries in Eastern Europe and East Asia. and the activity of 271 Local Academies in Romania (CATC Director Nicolae Țăpuș). Nicolai Sandu, academic manager at CISCO and Răzvan Rughiniș executive director of CATC from Politehnica University of Bucharest, played a very important role in setting up CATC Romania and coordinating the global training activities.*

MonaLisa (MONitoring Agents using a Large Integrated Services Architecture)

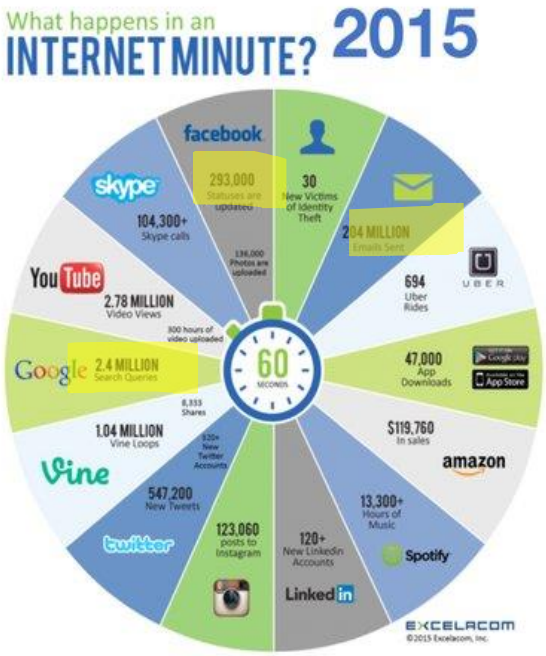
I Legrand H Newman N Țăpuș V Cristea

- *2006: Within the collaboration of CALTECH- CERN - Politehnica University of Bucharest, the MonaLisa system (MONitoring Agents using a Large Integrated Services Architecture) is designed, which is based on the dynamic distributed service architecture and is capable of providing comprehensive monitoring, control and global optimization services for widely distributed systems. It has become a monitoring tool for the systems distributed at CERN and within the laboratories that develop distributed applications. The design and implementation team was led by Iosif Legrand and Harvey Newman from Caltech respectively Nicolae Țăpuș and Valentin Cristea from the Polytechnic University of Bucharest who led the **PhD team from UPB**.*
- *In 2006 M.Toartă, N. Tăpuș, C. Stratan, C. Cirstoiu, C. Grigoraș, R. Voicu, A. Muraru, **C. Dobre**, L. Mușat, A. Costan**, F. Pop**, A. Herișanu de at UPB, I. Legrand, H. Newman from Caltech received the CENIC 2006 Innovation Award for High-Performance Applications • MonALISA • offered by the Corporation for Education Network Initiatives in California (CENIC)*

Internet every day

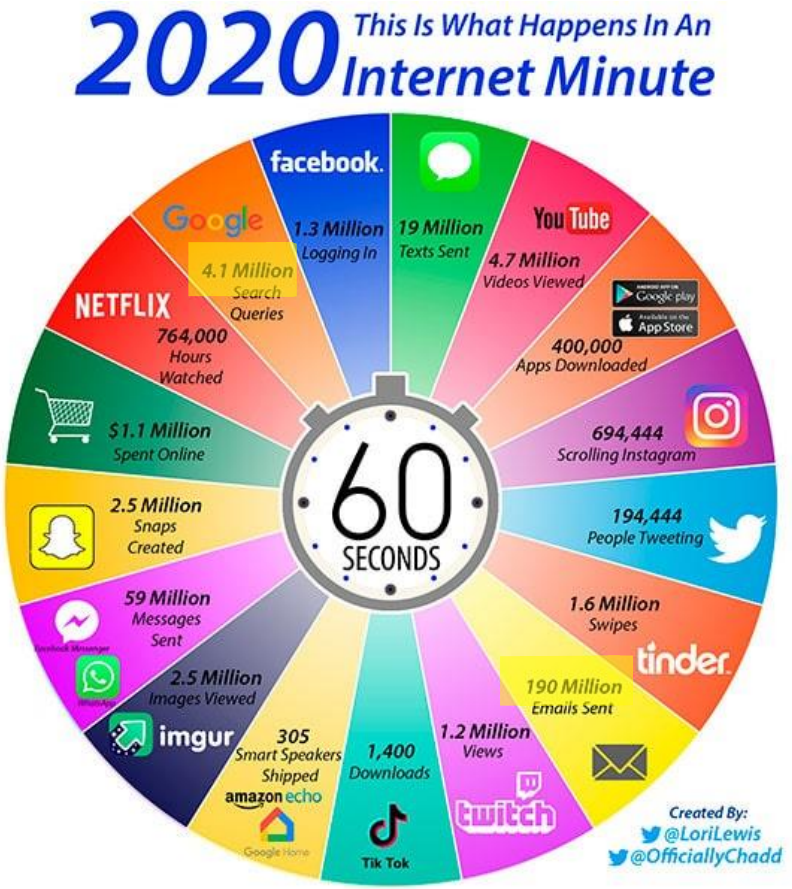
- In the EU, 71% of individuals use the Internet every day or almost every day. The share of daily users was highest in Luxembourg (93%), followed by Denmark (89%), the United Kingdom (88%), the Netherlands (86%), Sweden and Finland (85% each). Shares of less than 60% took place in Greece and Poland (57% each), Bulgaria (49%) and Romania (42%).
- (https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Archive:Internet_access_and_use_statistics_-_households_and_individuals&oldid=379591).
- Europe's academic research and education network, GEANT 2 comprises national academic networks from all countries in Europe. The connections are made through multiple connections of 10 Gbps and 100 Gbps

Internet Minute



@PetiotEric

- To see what is happening on the Internet, in real time, you can access the website
- www.webpagefx.com/internet-real-time/



Data communication speed in Romania

- The evolution of the Internet both in terms of infrastructure and access equipment and in terms of services offered has evolved unimaginably long. Data communication at the speed of 100 Gbps ensures the transfer of a text of about 1 billion characters (about 100,000 pages). in a second. The same is done on the Internet from classic computers but newer from tablets and mobile phones. In Romania, a very high-performance data network was developed in a very good dynamic.

- In 2016, Romania has reached the highest communication speed given at European level. According to Speedtest website (http://www.speedtest.net/global-index/),
- in April 2018, Romania ranks 5th in the world in terms of the Speedtest Global Index indicator regarding fixed broadband connections after Singapore , Iceland and Republic of Korea is ranked 35th on mobile communications
- (http://www.speedtest.net/global-index/romania#fixed).

https://worldpopulationreview.com/country-rankings/internet-speeds-by-country

Internet Speeds By Country 2020 by Population 2020

* Speed is in megabits per second. Speed is for downloading.

CSV JSON

Country	Broadband Speed	Mobile Speed	Population 2020
Singapore	191.93	50.43	5,850,342
South Korea	156.18	97.44	51,269,185
Taiwan	151.75	43.66	23,816,775
Hong Kong	151.02	31.24	7,496,981
Romania	130.79	36.68	19,237,691
Monaco	125.69		39,242
Andorra	115.88		77,265
United States	115.67	34.76	331,002,651
Switzerland	115.38	54.42	8,654,622

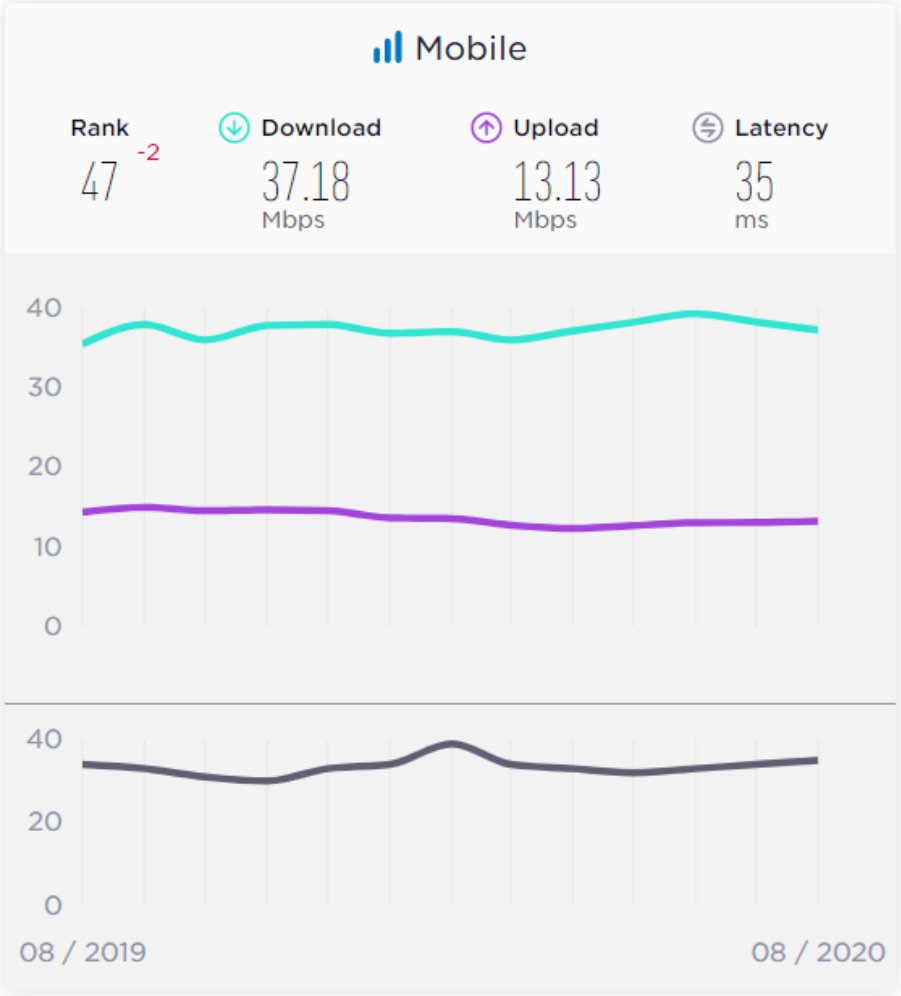
https://getinternet.com/which-countries-have-fastest-internet-in-world/

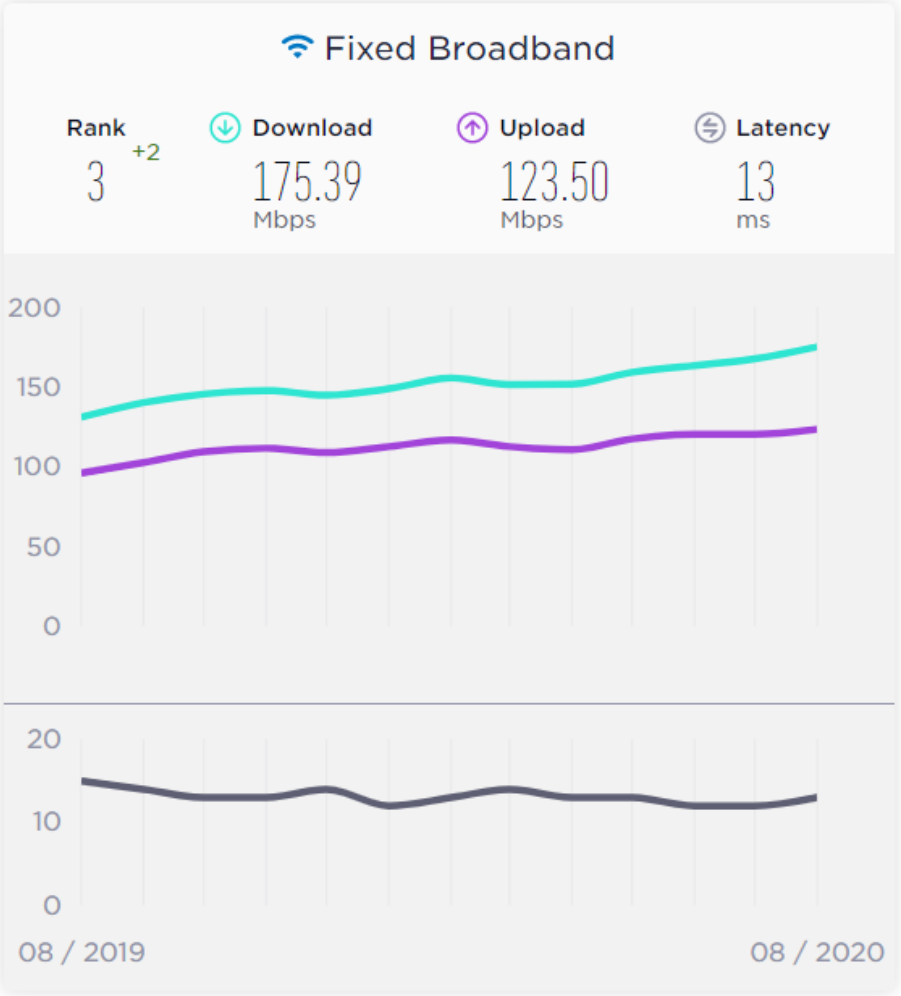
The Top 10 Countries with the Fastest Internet Speeds

1. Singapore
2. Sweden
3. Denmark
4. Norway
5. Romania
6. Belgium
7. Netherlands
8. Luxembourg
9. Hungary
10. Switzerland

https://www.speedtest.net/global-index/romania

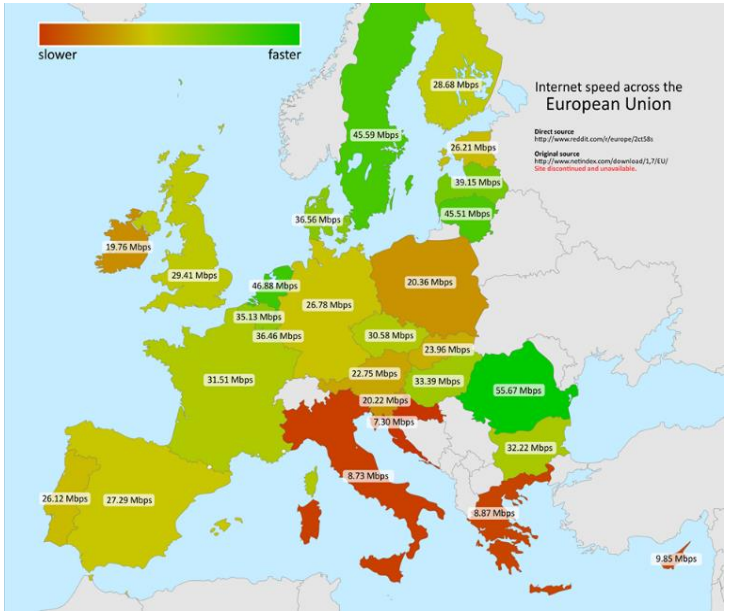
← Romania August 2020





Romania ranked 5th in the world.

- The academic research and education network along with the commercial networks in Romania provides Internet access for the entire scientific community but also for the population of the countries.
- Romania ranked 5th in the world.
- It should be noted that a number of five cities in Romania are in the top 10 cities in the world with the highest internet speed.
- The ranking is as follows:
- *Timişoara – România – 99.13 Mbps;*
- *Bucureşti – România – 81.86 Mbps*;
- Central District – Hong Kong – 77.24 Mbps;
- Kowloon – Hong Kong – 66.76 Mbps;
- *Braşov – România – 65.83 Mbps;*
- *Iaşi – România – 60.11 Mbps*;
- Paris – Franţa – 60.09 Mbps;
- Singapore – Singapore – 58.98 Mbps;
- *Cluj- Napoca – România – 55.86 Mbps*;
- Vilnius – Lituania – 54.52 Mbps; (Economica.net).



New genetation of conection (Piata Romana Bucharest !!!)

https://www.romaniajournal.ro/society-people/bucharest-revealed-as-best-city-for-remote-working/

The Top 10 Best Cities For Remote Working

Rank	City	Country
1	Bucharest	Romania
2	Houston	USA
3	Las Vegas	USA
4	Atlanta	USA
5	Budapest	Hungary
6	San Francisco	USA
7	Los Angeles	USA
8	Kiev	Ukraine
9	Chicago	USA
10	Warsaw	Poland

Bucharest came top overall as the best city for remote working, 4.33% of jobs in the city gave workers the opportunity for remote working, the highest of all the cities in the index. It also scored highly for internet speed, coming 4th in the ranking with internet speeds of 52 Mbps, and 7th for the cost of living £421 per month.