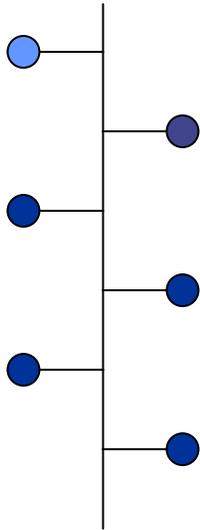


## Unit 1 (Very Short) History of Telecommunication Networks



# History of Telecommunication

- Communication: essential for activity coordination...
  - Early milestones
    - Visual signals
    - Telegraph
    - Telephones
  - Further milestones - computer networks
  - What is (and what isn't) a computer network?
- 

## *Acknowledgments:*

Several historical slides have been taken from the book:

A. Michael Noll: “Introduction to Telephones & Telephone Systems”, Artech House, 1986

# Some examples (1)

- The three army problem



- Principles

- The bigger force wins.  
Each orange army is smaller than the black army but the black army is smaller than the joint orange force. The two orange forces may communicate to synchronize their attack.
- For this communication they need:
  - A common language (possibly not understood by the black army)
  - A communication path - a messenger - who has to pass through the land occupied by the enemy (and could be intercepted with a given probability  $p$ ).
  - The march from one headquarters to the other one takes half an hour.
  - An agreed principle: Attack only if each of the orange units is sure that both will attack on time.
- How can this be assured?

# Some examples (2)

- Some possible problems
  - Both commanders of the orange armies send a messenger to the counterpart with different suggested time for an attack. Afterwards both agree for the suggestion of the partner.  
The play goes on....
  - The commander of the orange army A is the commanding officer. He sends a messenger with an order. Did the commander of the other orange army receive the message? When?
  - The commander of the orange army B has to acknowledge his readiness to follow the orders. Is the victory sure ?
- Let us use multiple acknowledgements...

# Some examples (3)

## – The Send and Wait protocol

- Sender:  
Send the information. If no acknowledgment has been received within an hour, send again.
- Receiver:  
Wait for an information. Acknowledge the received information.
- Comment:  
Let  $N$  be the number of hours since starting the procedure.  
The probability of failure is:  $p^N$  (should be compared to the case of multiple acknowledgements). Which approach is better?

# Some examples (4)

- Let us consider a bank
  - Client: Has 5000 \$ on his account. Asks for 1000 \$ to be paid.
  - Clerk 1: Uses a communication system, operating according to the Send-and-Wait procedure, in order to communicate with the headquarters.
  - A message “Check the account. If there is more than 1000 \$ **then** (subtract 1000 \$ and acknowledge), **otherwise** ask the police to arrest the crook”.
  - Clerk 2 (at the headquarters): Acts according to the request. Will this approach always work? Always?
  - Consider the different assurances you would like to have in communication:
    - Sending a post card from holidays ?
    - Returning per post goods to the shop ?
    - Asking somebody to attend a session of the court of justice?
    - Transferring money?

# Early Milestones (1)

---

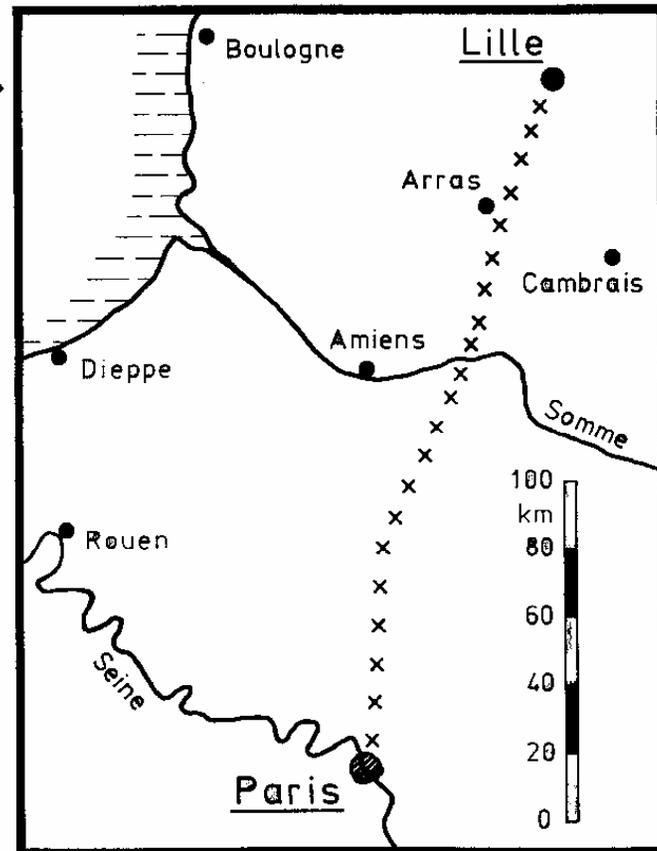
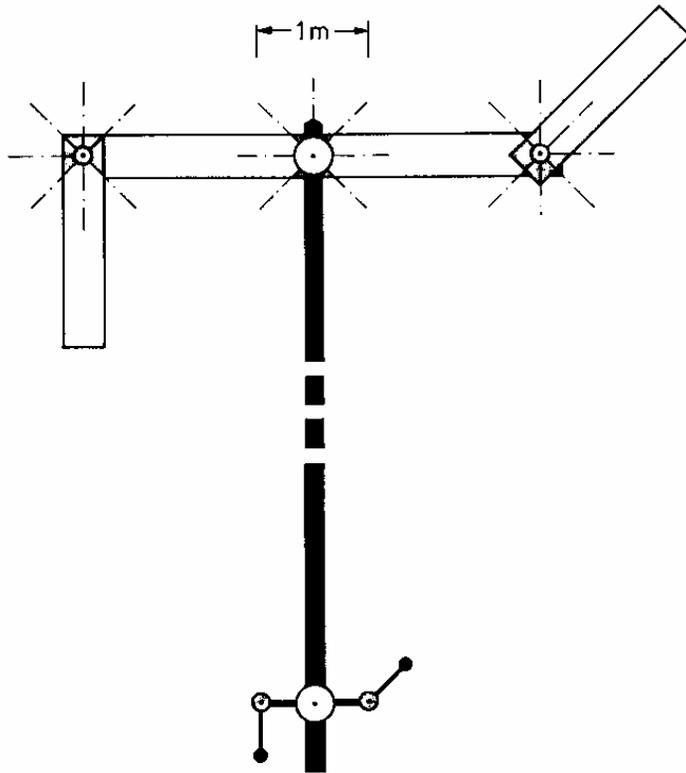
- Telecommunication = moving information over long distances
  - Basic question: how to move information quicker than people can move? Essential for activity coordination!
  
- Visual signals (limit is LOS :Line of sight)
  - Light (fire, mirrors), smoke
  - Signaling conventions (e.g. seamen flags)
  - First working optical Telegraph (Chappe, 1793)

# Visual Signals

- Optical Telegraph

- Need for fast information flow in time of French Revolution

- Claude Chappe installed the first optical telegraph line in summer 1794

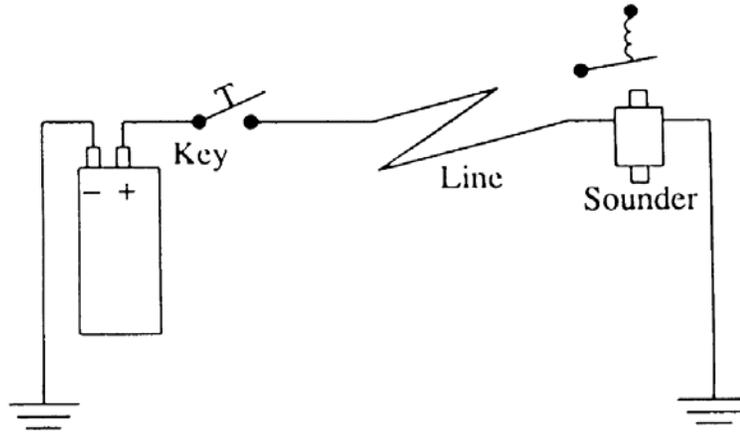


# Early Milestones (2)

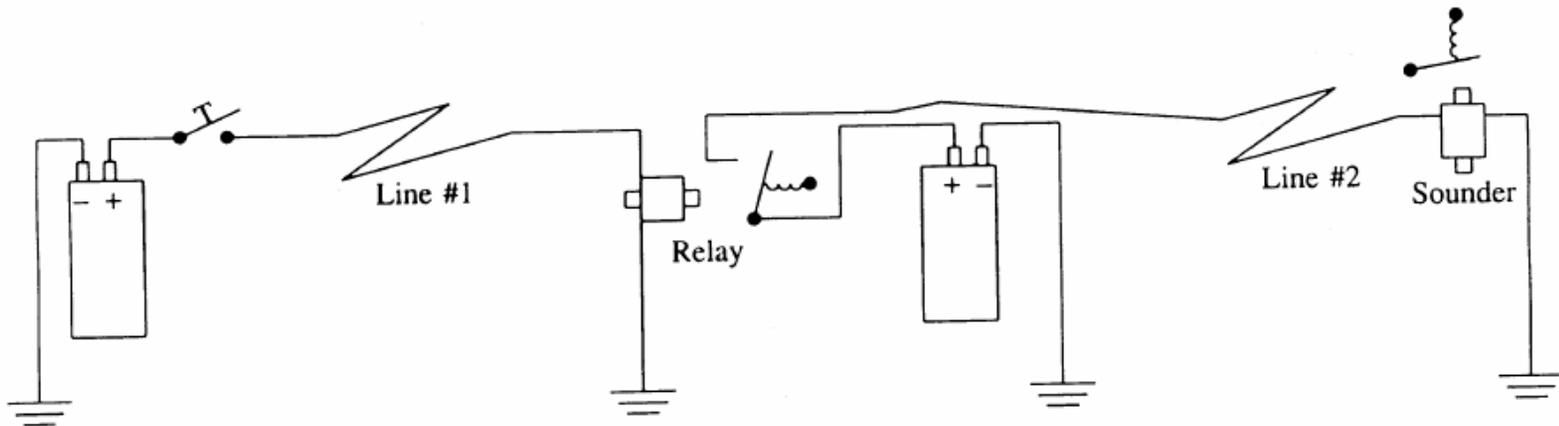
- Telegraph (Morse, 1837)
  - Digitally coded text information, hard copy option
  - Large distance covered with constant quality
  - Low speed, rather public than individual use
  
- Telephone (Reis 1861, Bell, 1876)
  - Transmission of voice (analog information)
  - Analog (later digital information)
  - Individual use, end-system (not person) addressed
  - Data transmission by telephone is possible
  - World's largest unified technical system!

# Telegraph (1)

- Diagram of Simplex Electromagnetic Telegraph



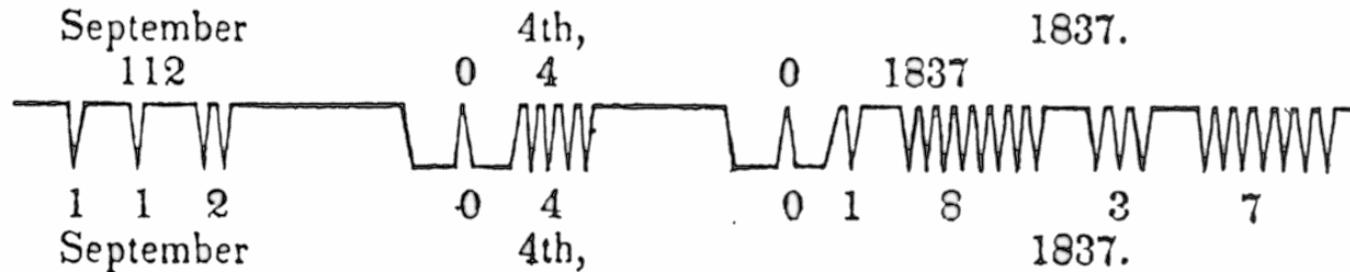
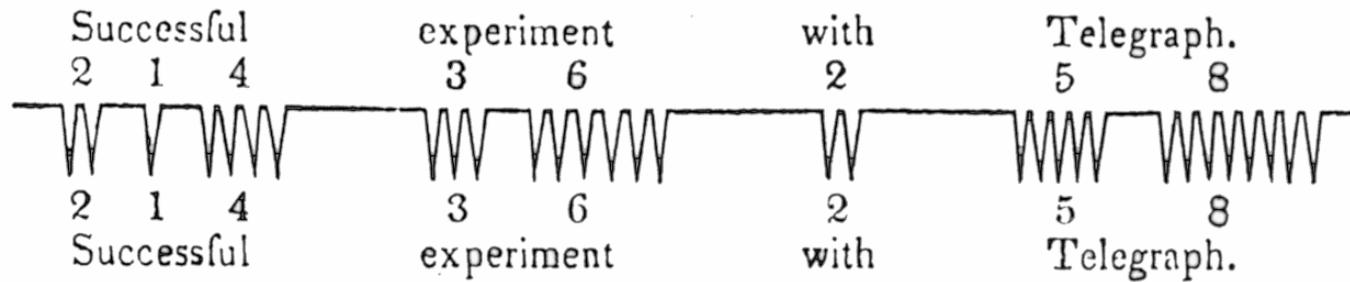
- a) Single simplex link



- b) Two simplex links cascaded by repeater

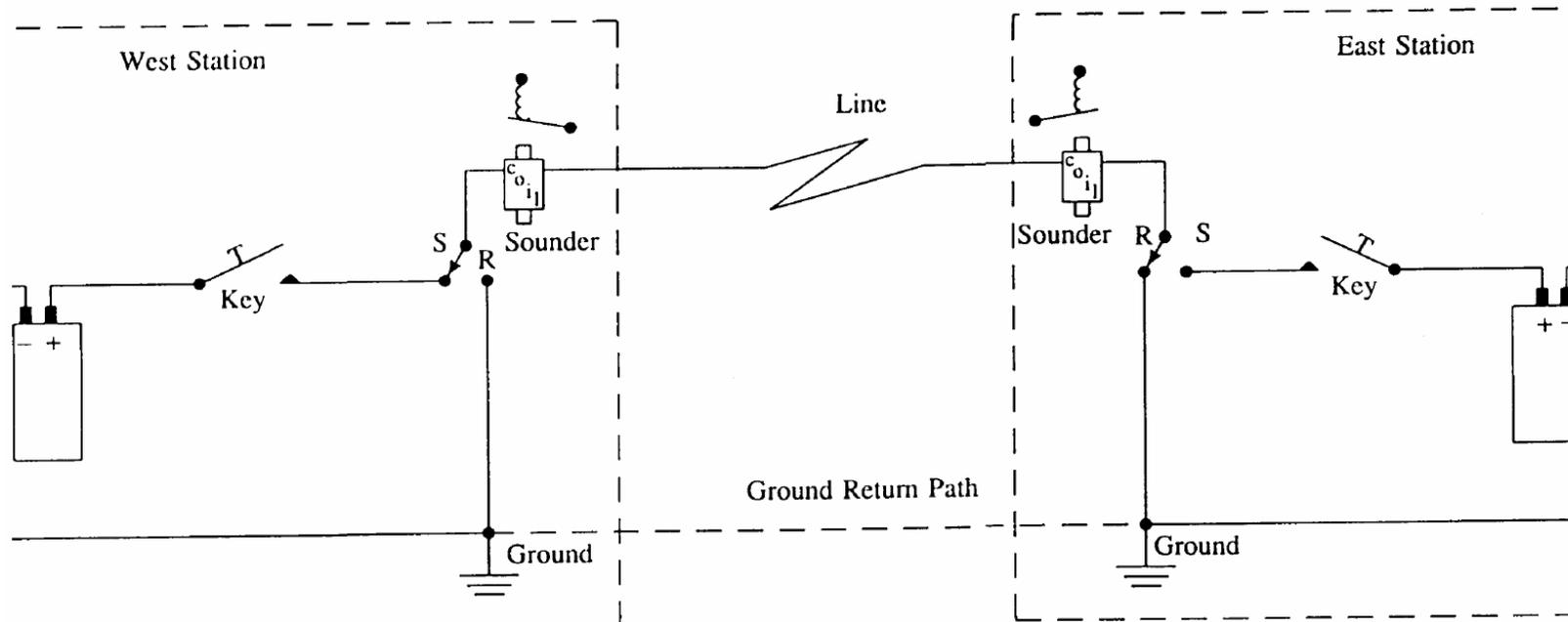
# Telegraph (2)

*Specimen of Telegraphic writing made by means of electricity at the distance of one third of a mile.*



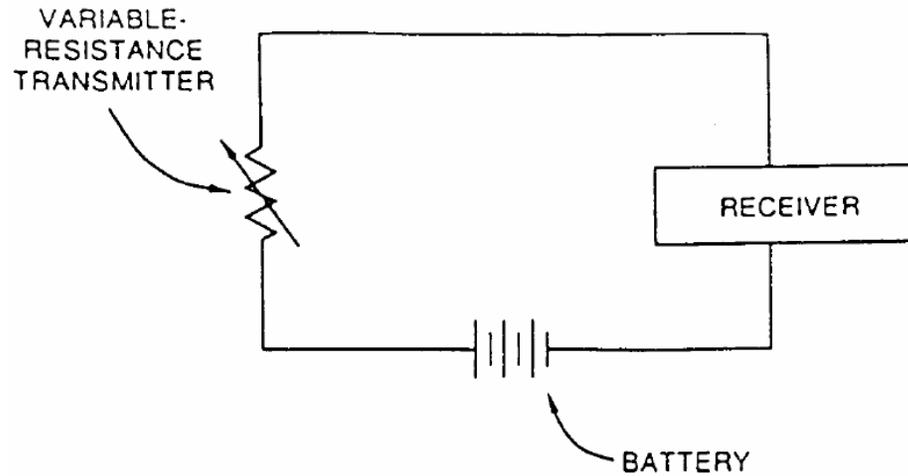
# Telegraph (3)

- Simplified diagram of Morse's half-duplex telegraph

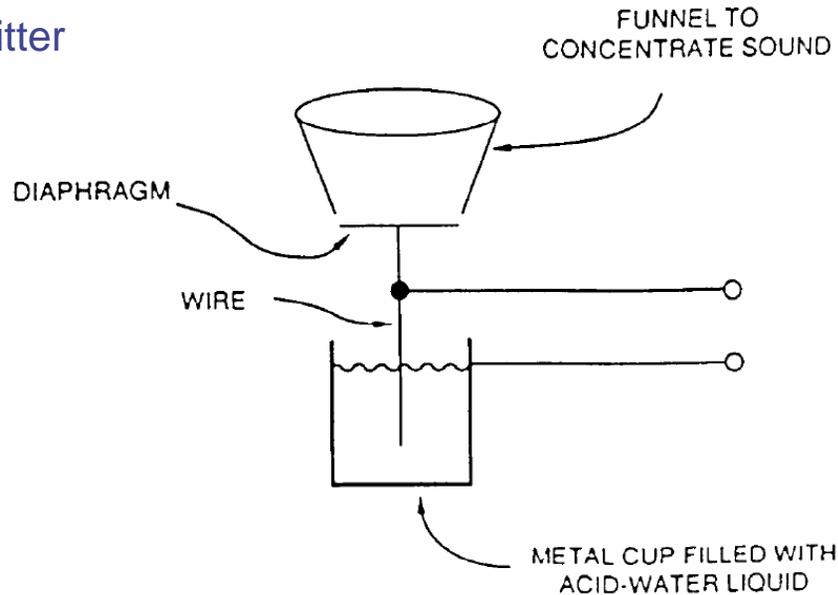


# Telephones - The basic Idea (1)

## Variable-resistance transmitter

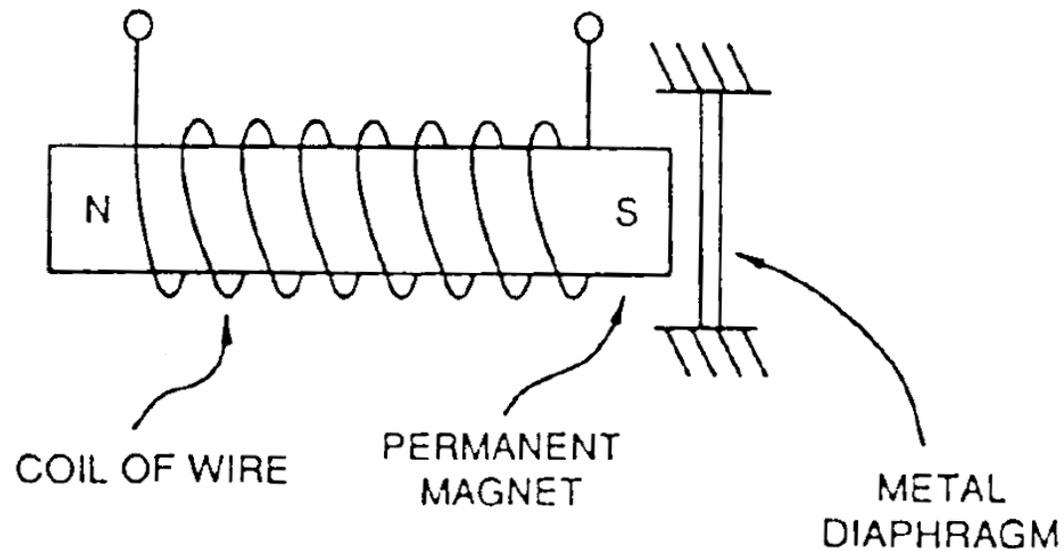


## Bell's liquid transmitter

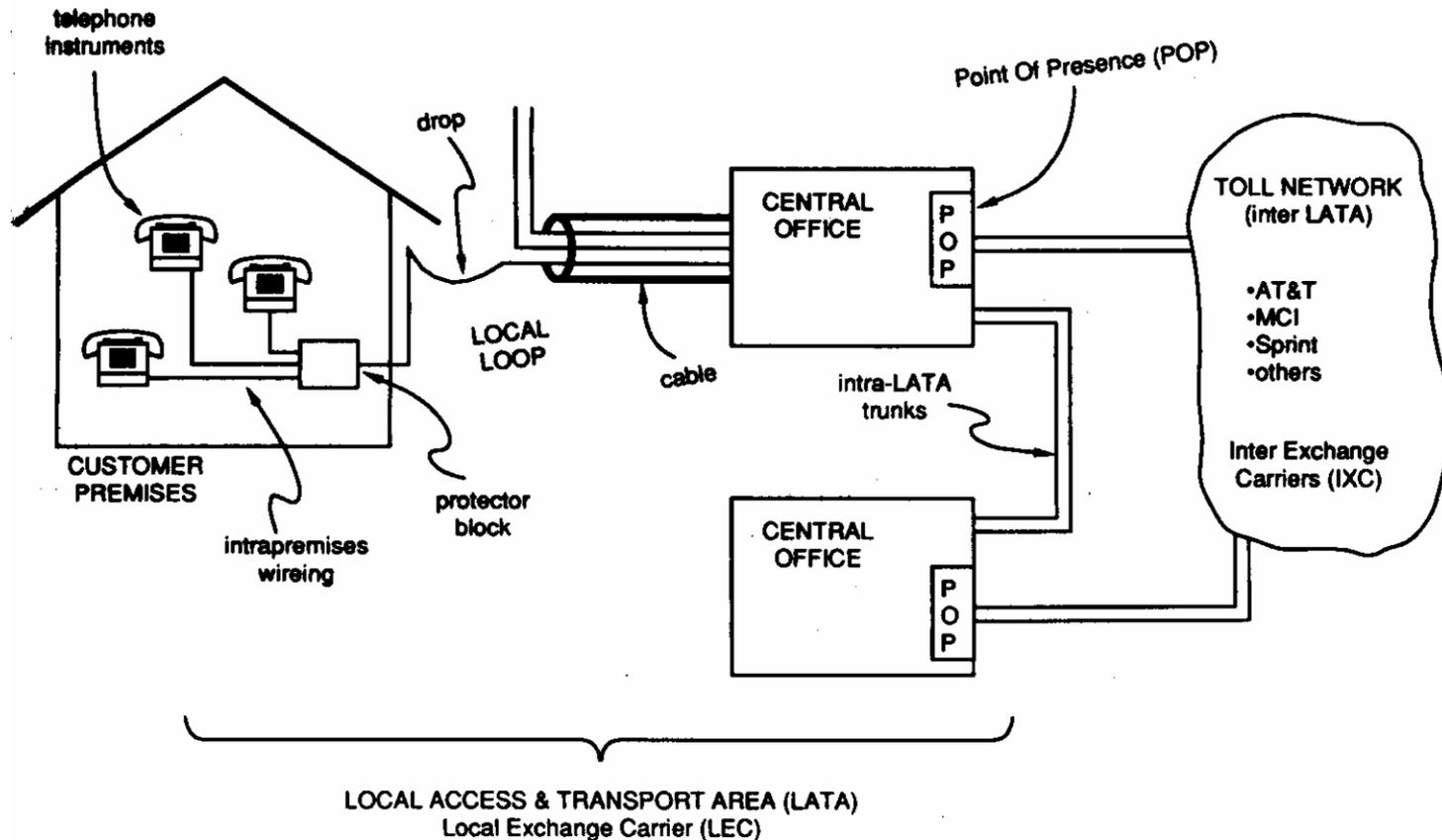


# Telephones - The basic Idea (2)

Watson's electromagnetic receiver



# Components of the Telephone Network



- A telephone call involves much switching and transmission equipment “beyond the dial”. Each telephone is connected to a central office by a pair of wires called the local loop. The first stage of switching occurs at the serving central office. Calls to another office within the local access and transport area (LATA) are carried over interoffice trunks. Calls outside the LATA are handled by interexchange carriers over their own transmission and switching facilities. The point of presence is the place where the IXC connects to the facilities of the local exchange carrier.

# Further Milestones - Computer Networks (1)

- Computer networks (ARPANET in service, 1971)

Transmission of digital information among processes running on individual computers

- Phase 1: how to achieve universal connectivity?
- Phase 2: how to improve speed?
  - selected steps:
    - Classical WANs: 56-64 kbit/s
    - LANs: 10 Mbit/s (local area)
    - LAN connection: 1,5-2 Mbits/s (over T1/E1)
    - FDDI: 100 Mbit/s (local/campus)
    - ATM: 155+ Mbit/s (universal)
    - Gigabit Networking (local/campus)
- Phase 3: how to support heterogeneity of networks?
- Phase 4: how to support multimedia communication
- Phase 5: how to allow mobility?
- Phase 6: how to allow personalization?

# Computer Networks (2)

- What is (and what isn't) a Computer Network
  - Traditional Modes of Computer Usage:
    - Single-programming/single operator
      - A single thread of execution
    - Multiprogramming/single operator
      - Multiple threads of execution
    - Multi-access
      - Multiple threads of execution, controlled by multiple persons using individual terminals
    - Remote multi-access
      - The possibility to access remote computers and use them like local ones.  
Necessary conditions:
        - Telecommunication facilities.
        - A proper type of terminal, connectable to the selected computer
        - Access rights
        - Familiarity with the local operating system (commands!)
        - Local availability of programs and data
        - Only peripherals connected to the target computer and to the own terminal may be used

# Computer Networks (3)

- Computer Network

- The user logged into a single computer (or a process started by this user!) may:

- Access any of the machines using a single, common authorization (additional security can be enforced!)
    - Cause moving data (e.g. files) among interconnected machines
    - Use resources (processors, peripherals, files) connected to anyone of the machines

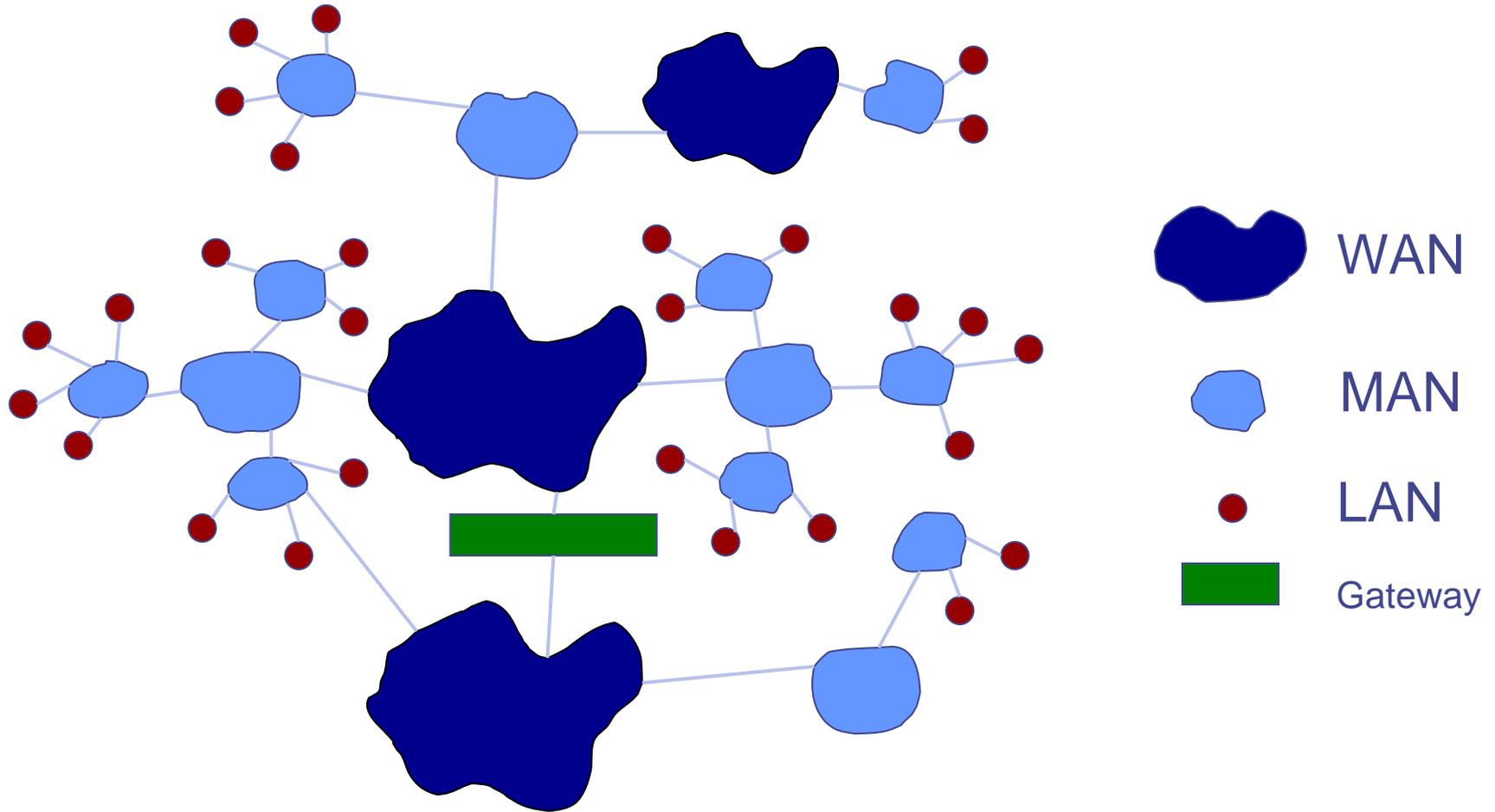
- Some important gains

- The economy of resource utilization (e.g. printers of different type, data banks, specialized programs)
    - The centralized management of data (software versions, backups)
    - Potential for collaborative work
    - Support for different qualities of service (QoS)

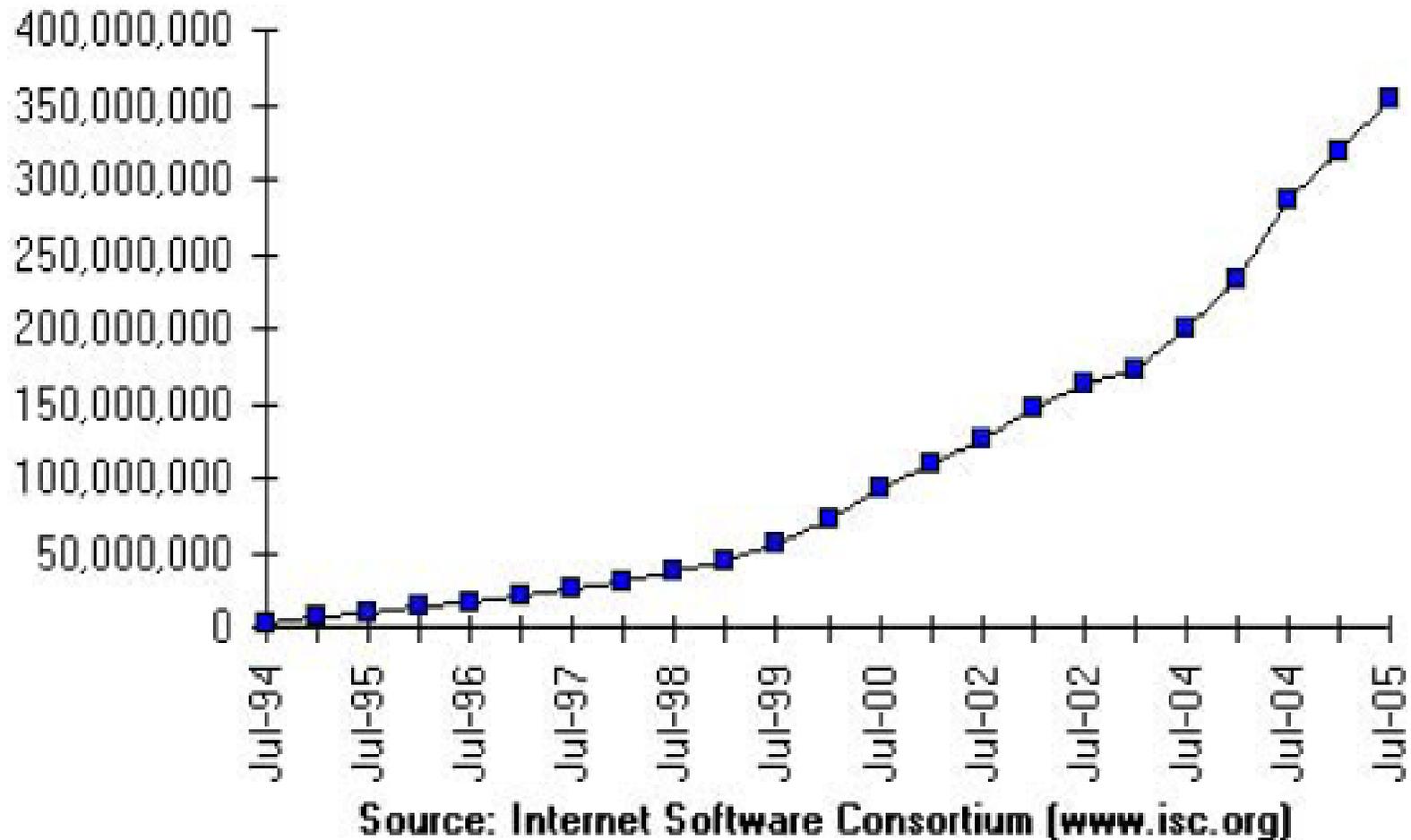
# Computer Networks (4)

- Network Types
  - LAN - Local Area Network
    - Less than approx. 3 km in distance
    - Provides local connectivity typically within a building
  - MAN - Metropolitan Area Network
    - Less than approx. 100 km
    - Provides regional connectivity typically within a campus or small area
  - WAN - Wide Area Network
    - No limit in distance
    - Provides national and international connectivity
- Interconnection of these different technologies?
- Distributed Systems
  - Computations are distributed among the connected computers transparently to the user, perhaps in a dynamic way (user has a view of a virtual multiprocessor)
- Broadband Access...

# Computer Networks Example



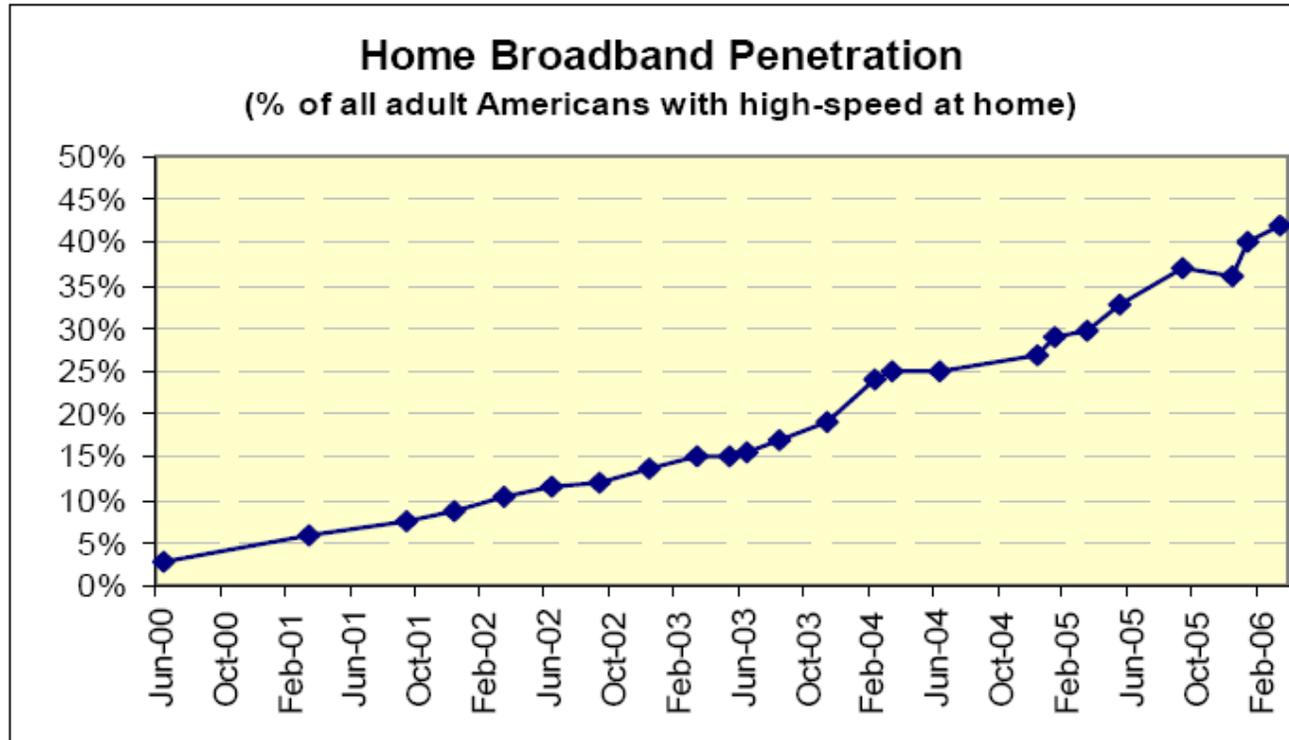
# Internet host count



Most recent count: 439,286,364 hosts have been discovered in July 2006

# Broadband Access

- How to get access from home/small office?  
Go broadband...



Source (this and following page):

[http://www.pewinternet.org/pdfs/PIP\\_Broadband\\_trends2006.pdf](http://www.pewinternet.org/pdfs/PIP_Broadband_trends2006.pdf)

# How Broadband Access is used?

User-generated online content						
	All internet users	All home users	Broadband at home	Dial-up at home	Millions of Americans with <u>home</u> internet access who do activity	Millions with internet access <u>only</u> at places other than home or work
Create or work on your own online journal or blog	8%	8%	11%	4%	9 million	2 million
Create or work on your own webpage	14	15	17	11	18 million	2 million
Create or work on webpages or blogs for others including friends, groups you belong to, or work	13	13	16	9	16 million	2 million
Share something online that you created yourself, such as your own artwork, photos, stories, or videos	26	28	32	20	32 million	4 million
Percent who have done at least one the above "content" activities	35	36	42	27	43 million	5 million
Source: Pew Internet & American Life Project December 2005 survey. Margin of error for internet users is $\pm 2\%$ .						

# Computer networks (5)

- Multimedia Communication
  - Integrated services digital network (ISDN)
  - Unified digital access for voice/data/image
  - Evolution from narrowband to broadband
- Mobility
  - Cordless Telephone
  - Satellite communication
  - Mobile telephone (the concept of cellular network)
  - Wireless LANs/MANs
- Exploring the reality/creating personal space?
  - Sensor networks
  - Location based services
  - Ambient Intelligence?