



---

# Computer Networks 1

## (Mạng Máy Tính 1)

Lectured by: Dr. Phạm Trần Vũ

[cuu duong than cong . com](http://cuuduongthancong.com)



# Course details

---

- Number of credits: 4
- Study time allocation per week:
  - 3 lecture hours for theory
  - 2 lecture hours for exercises and lab work
  - 8 hours for self-study
- Website:
  - <http://www.cse.hcmut.edu.vn/~ptvu/net1/>



# Course outline (1)

---

- Fundamental concepts in the design and implementation of computer networks
  - Protocols, standards and applications
  - Introduction to network programming.

cuu duong than cong . com



# Course outline (2)

---

- The topics to be covered include:
  - Introduction to network architecture, OSI and the TCP/IP reference models.
  - Network technologies, especially LAN technologies (Ethernet, wireless networks and Bluetooth).
  - Issues related to routing and internetworking, Internet addressing and routing.
  - Internet transport protocols (UDP and TCP)
  - Network-programming interface
  - Application layer protocols and applications such as DNS, E-mail, and WWW.



# References

---

- ❑ “*Computer Networks*”, Andrew S. Tanenbaum, 4th Edition, Prentice Hall, 2003.
- ❑ “*TCP/IP Protocol Suite*”, B. A. Forouzan, Mc Graw-Hill, 1st ed., 2000.



# Assessment

---

- ❑ Assignment 20%
  - Two assignments, 10% each
- ❑ Midterm exam: 20%
- ❑ Final exam: 60%
- ❑ Laboratory work is compulsory
  - No lab work = No assignment mark



---

# Lecture 1: Introduction to Computer Networks

## ***Reference:***

Chapter 1 - “*Computer Networks*”,  
Andrew S. Tanenbaum, 4th Edition, Prentice Hall, 2003.



# Uses of Computer Networks

---

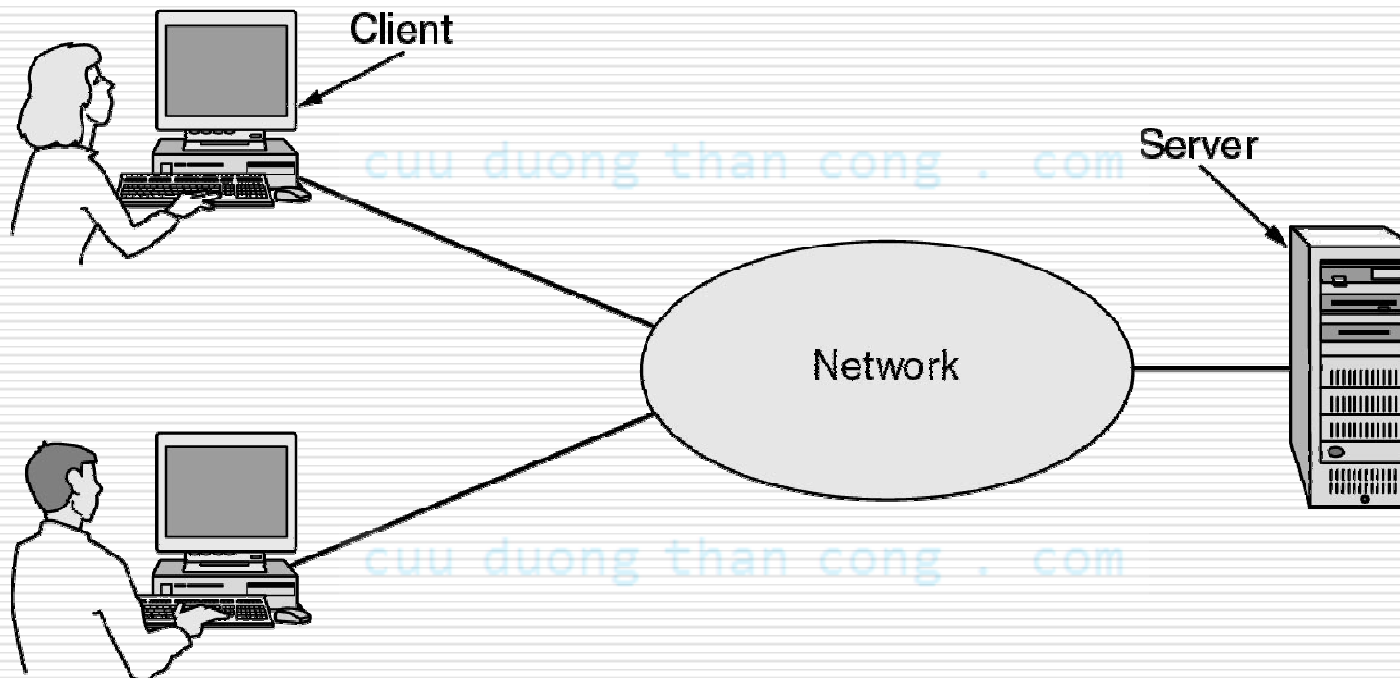
- ❑ Business Applications
- ❑ Scientific Applications
- ❑ Home Applications
- ❑ Mobile Users



# Business Applications of Networks (1)

---

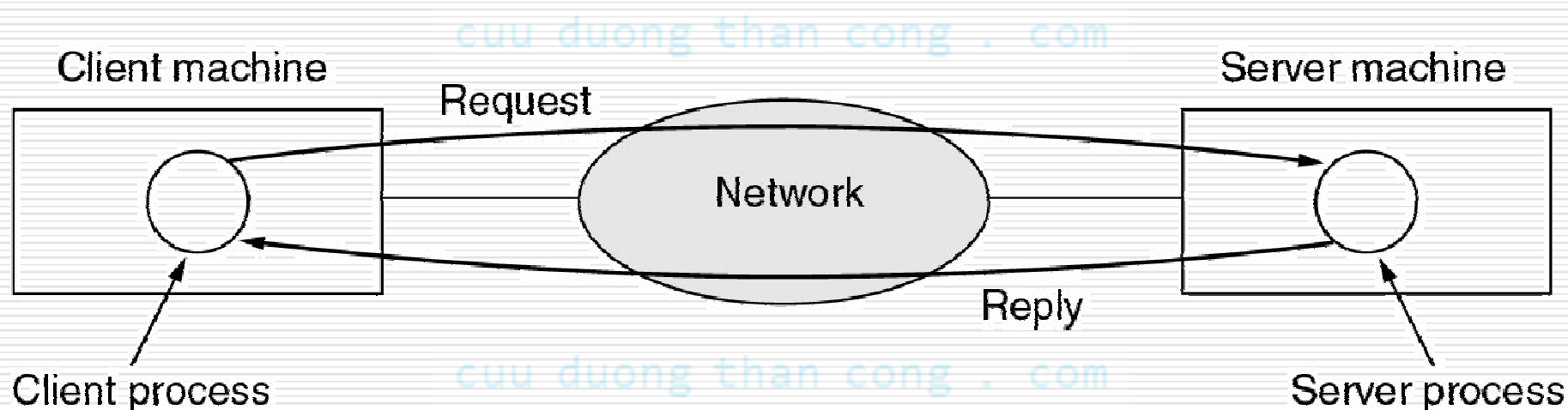
- ❑ A network with two clients and one server.





## Business Applications of Networks (2)

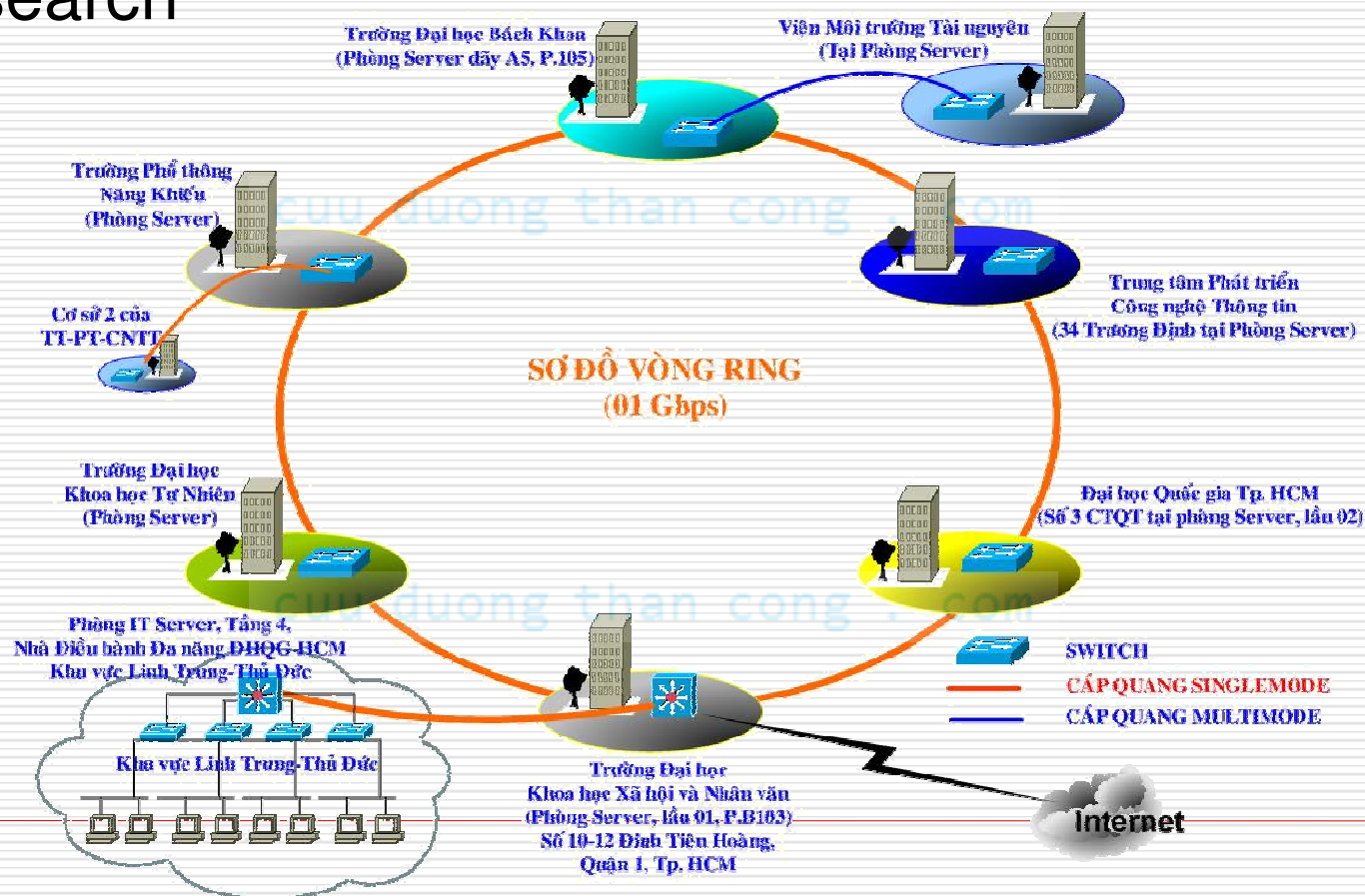
- ❑ The client-server model involves requests and replies.





# Scientific Applications

- Grid computing infrastructure to support scientific research





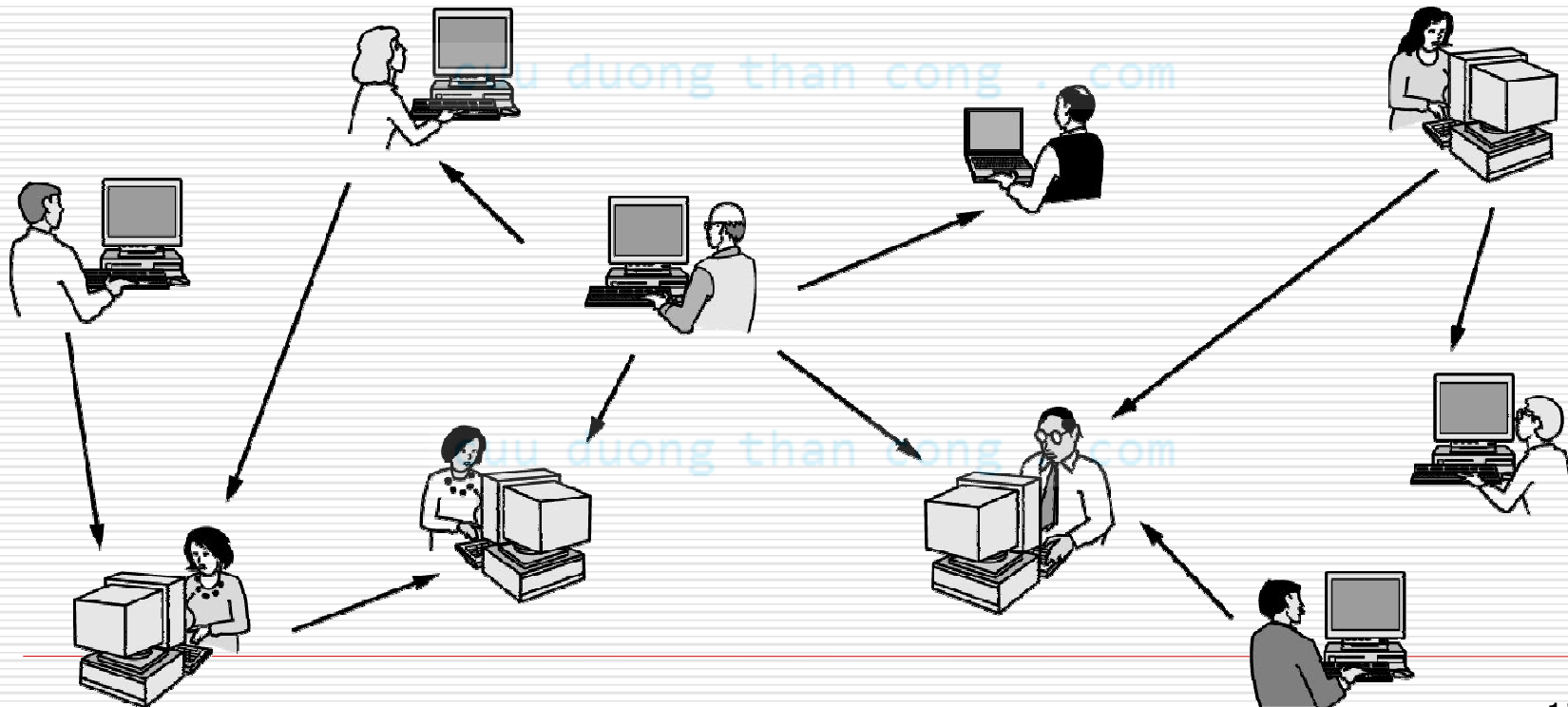
# Home Network Applications (1)

---

- ❑ Access to remote information
- ❑ Person-to-person communication
- ❑ Interactive entertainment
- ❑ Electronic commerce

# Home Network Applications (2)

- ❑ In peer-to-peer system there are no fixed clients and servers.





# Home Network Applications (3)

---

- ❑ Some forms of e-commerce.

| Tag | Full name              | Example                                          |
|-----|------------------------|--------------------------------------------------|
| B2C | Business-to-consumer   | Ordering books on-line                           |
| B2B | Business-to-business   | Car manufacturer ordering tires from supplier    |
| G2C | Government-to-consumer | Government distributing tax forms electronically |
| C2C | Consumer-to-consumer   | Auctioning second-hand products on-line          |
| P2P | Peer-to-peer           | File sharing                                     |



# Mobile Network Users

---

- ❑ Combinations of wireless networks and mobile computing.

| Wireless | Mobile | Applications                             |
|----------|--------|------------------------------------------|
| No       | No     | Desktop computers in offices             |
| No       | Yes    | A notebook computer used in a hotel room |
| Yes      | No     | Networks in older, unwired buildings     |
| Yes      | Yes    | Portable office; PDA for store inventory |



# Network Hardware

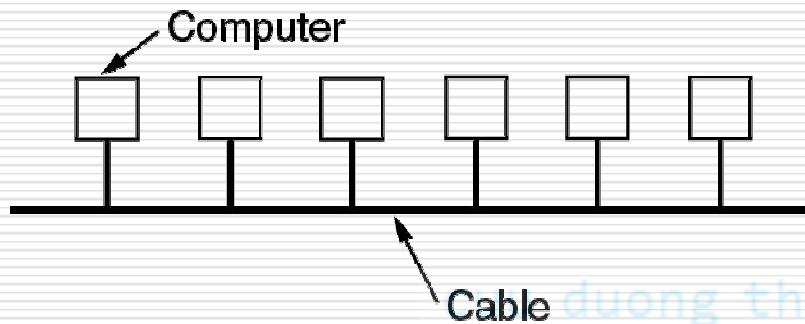
---

- ❑ Local Area Networks
- ❑ Metropolitan Area Networks
- ❑ Wide Area Networks
- ❑ Wireless Networks
- ❑ Home Networks
- ❑ Internetworks

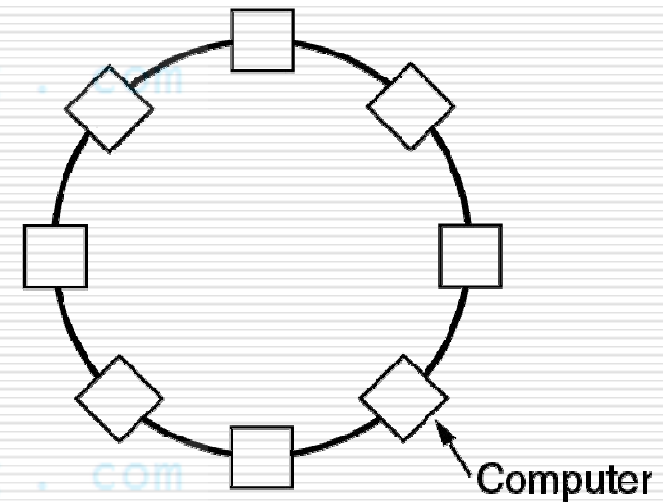


# Local Area Networks

- ❑ Two broadcast networks
- ❑ (a) Bus
- ❑ (b) Ring



(a)

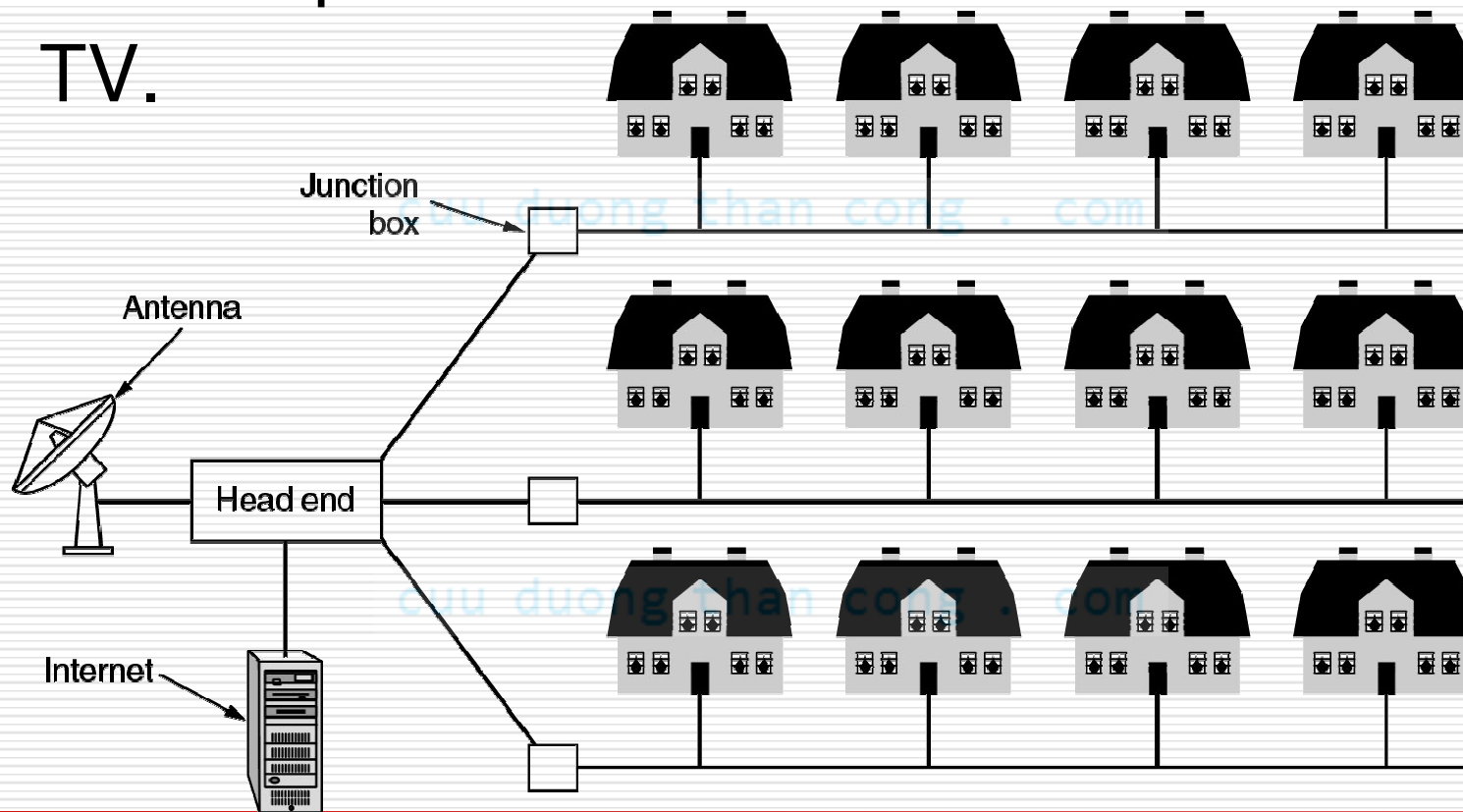


(b)



# Metropolitan Area Networks

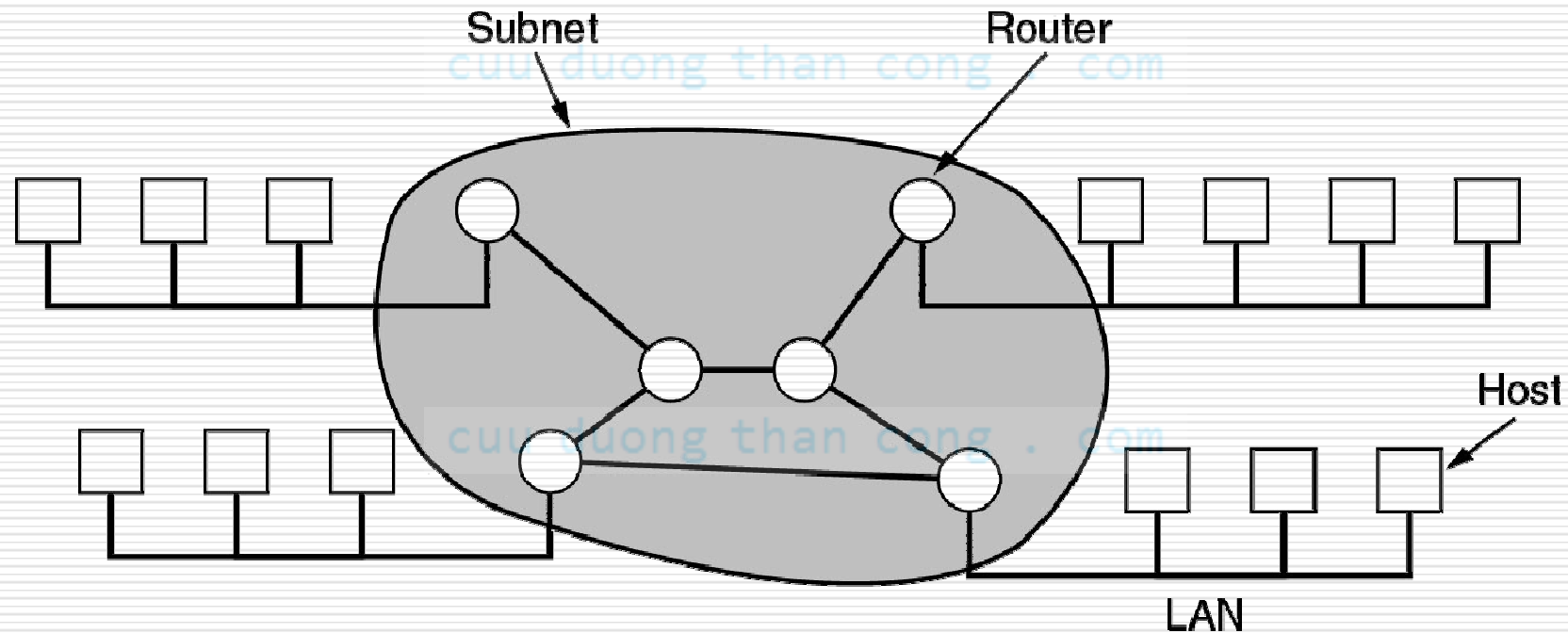
- A metropolitan area network based on cable TV.





# Wide Area Networks (1)

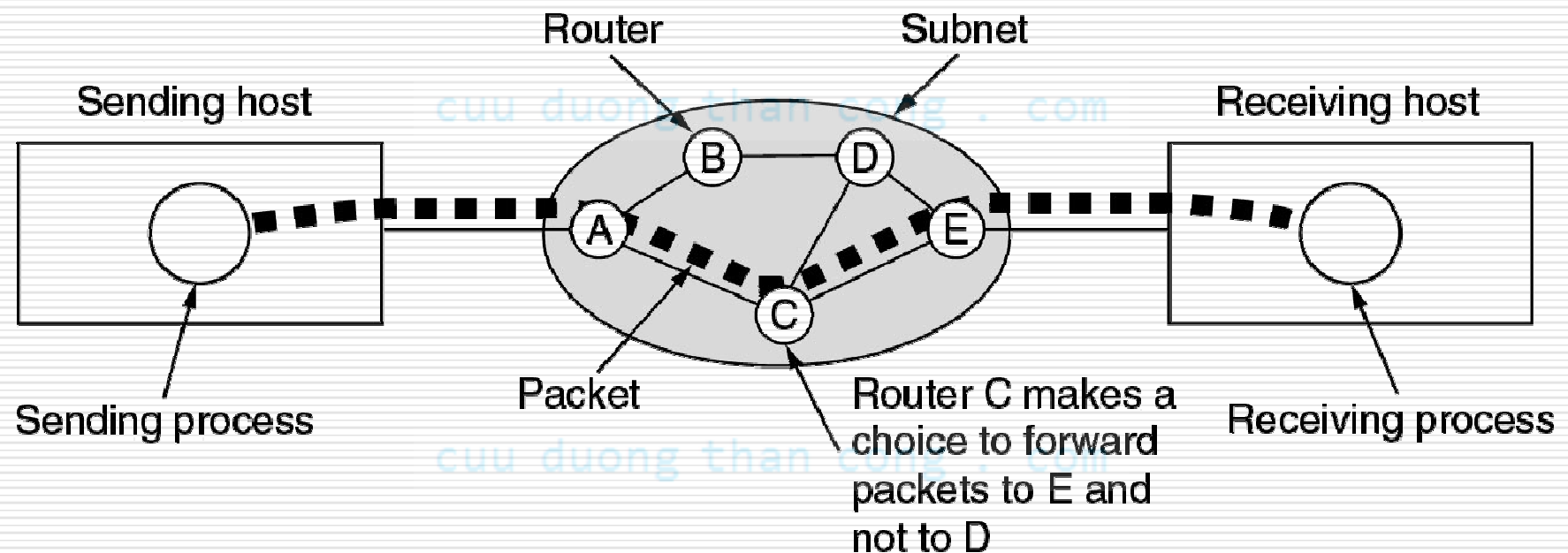
- ❑ Relation between hosts on LANs and the subnet.





## Wide Area Networks (2)

- A stream of packets from sender to receiver.





# Wireless Networks (1)

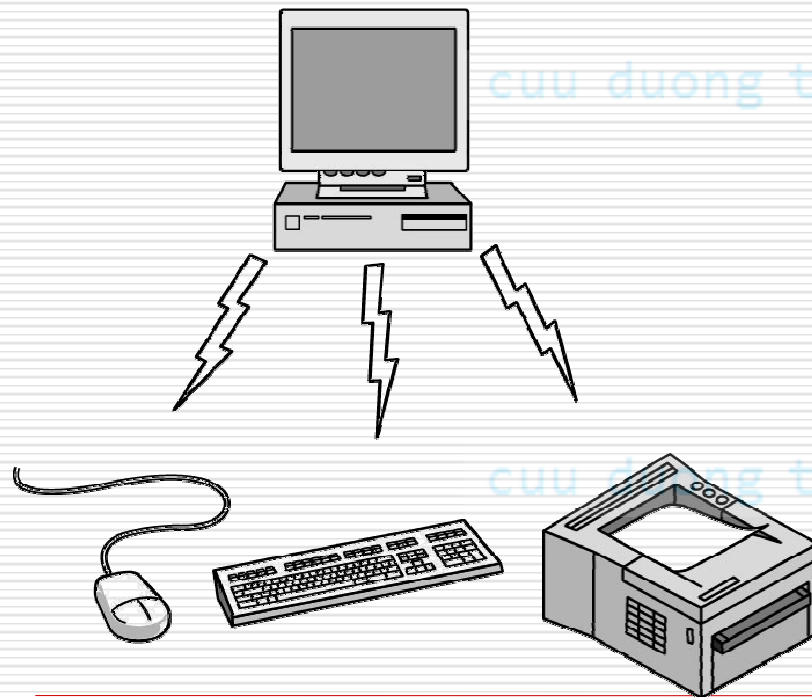
---

- Categories of Wireless Networks
  - System interconnections
  - Wireless LANs
  - Wireless WANs

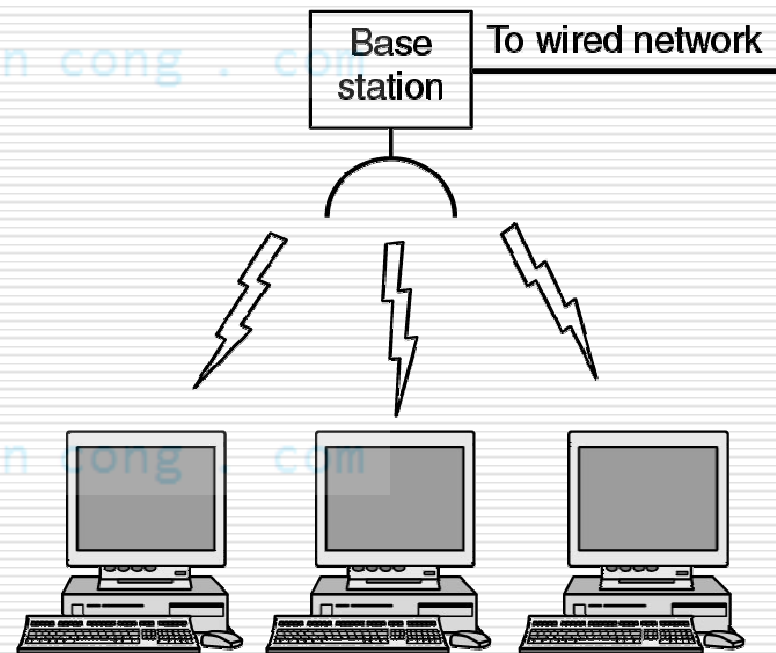


# Wireless Networks (2)

- ❑ (a) Bluetooth configuration
- ❑ (b) Wireless LAN



(a)

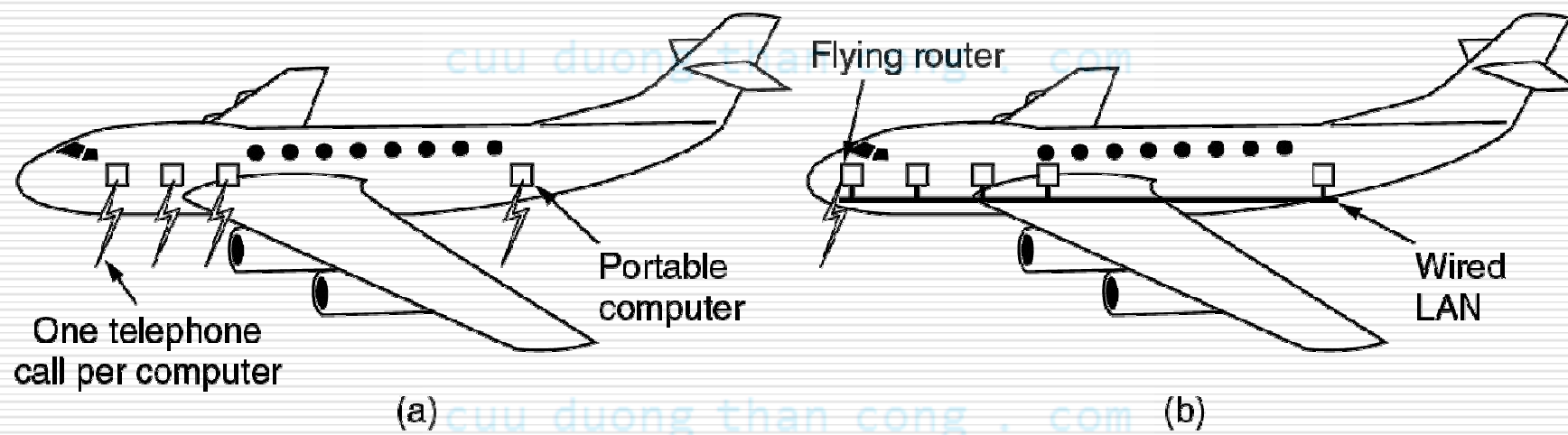


(b)



# Wireless Networks (3)

- (a) Individual mobile computers
- (b) A flying LAN





# Home Network Categories

---

- ❑ Computers: desktop PC, PDA, shared peripherals
- ❑ Entertainment: TV, DVD, VCR, camera, MP3
- ❑ Telecomm: telephone, cell phone, intercom, fax
- ❑ Appliances: microwave, fridge, clock, aircon
- ❑ Telemetry: utility meter, burglar alarm, babycam

cuu duong than cong . com



# Network Software

---

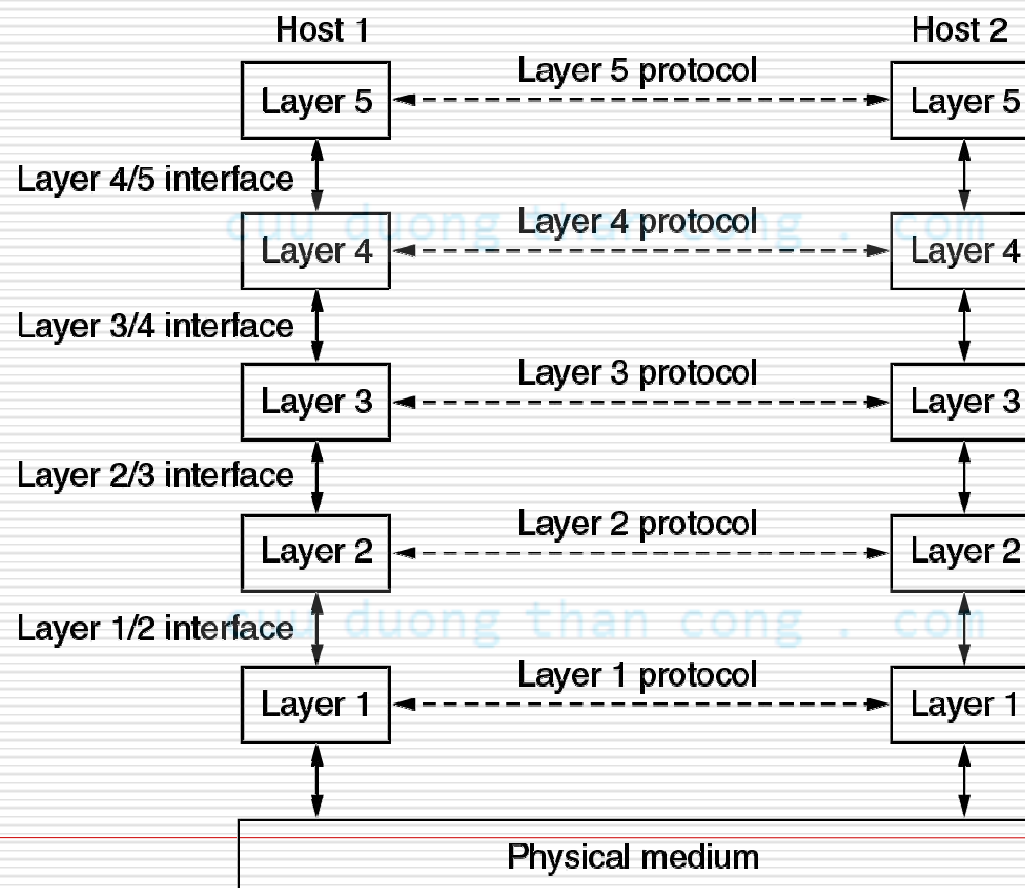
- ❑ Protocol Hierarchies
- ❑ Design Issues for the Layers
- ❑ Connection-Oriented and Connectionless Services
- ❑ Service Primitives
- ❑ The Relationship of Services to Protocols



# Network Software

## Protocol Hierarchies

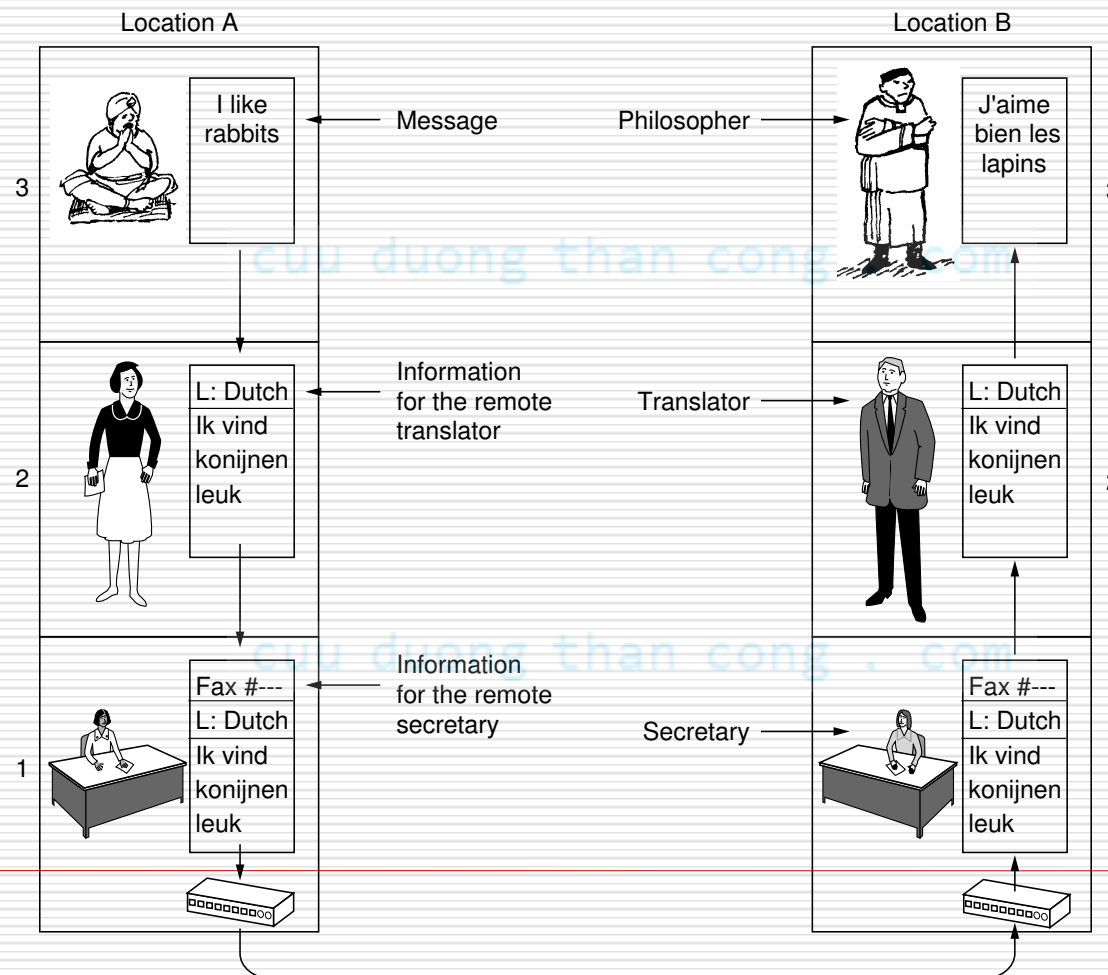
- Layers, protocols, and interfaces.





# Protocol Hierarchies (2)

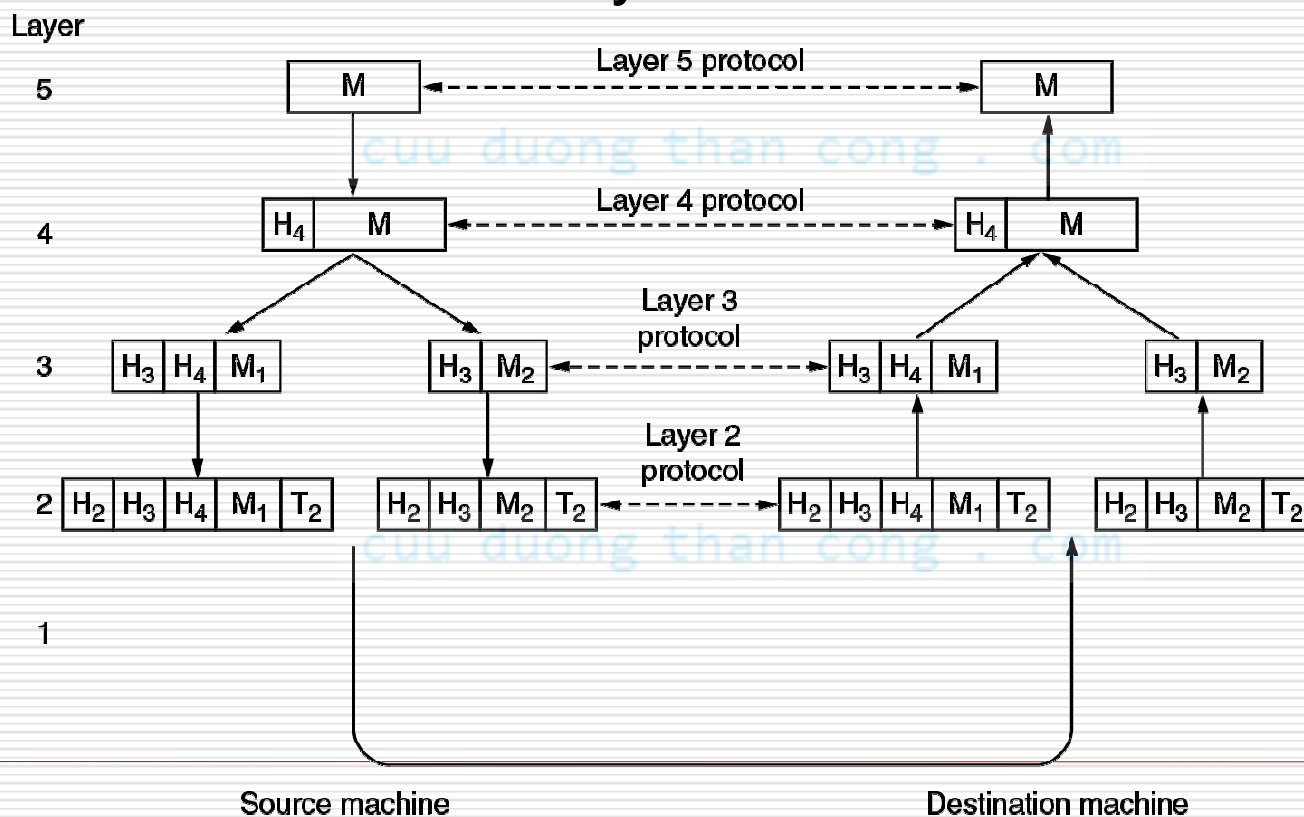
- The philosopher-translator-secretary architecture.





# Protocol Hierarchies (3)

- Example information flow supporting virtual communication in layer 5.





# Design Issues for the Layers

---

- ❑ Addressing
- ❑ Error Control
- ❑ Flow Control
- ❑ Multiplexing
- ❑ Routing



# Connection-Oriented and Connectionless Services

---

- ❑ Six different types of service.

|                     |   | Service                 | Example              |
|---------------------|---|-------------------------|----------------------|
| Connection-oriented | { | Reliable message stream | Sequence of pages    |
|                     |   | Reliable byte stream    | Remote login         |
|                     |   | Unreliable connection   | Digitized voice      |
| Connection-less     | { | Unreliable datagram     | Electronic junk mail |
|                     |   | Acknowledged datagram   | Registered mail      |
|                     |   | Request-reply           | Database query       |



# Service Primitives

---

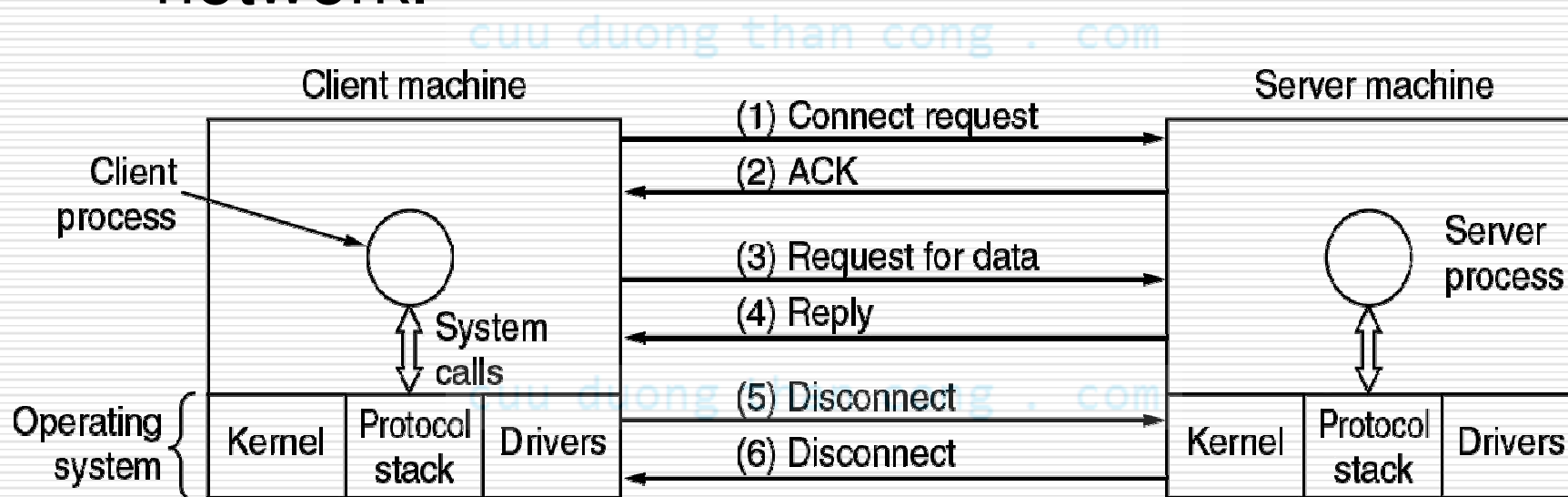
- Five service primitives for implementing a simple connection-oriented service.

| Primitive  | Meaning                                    |
|------------|--------------------------------------------|
| LISTEN     | Block waiting for an incoming connection   |
| CONNECT    | Establish a connection with a waiting peer |
| RECEIVE    | Block waiting for an incoming message      |
| SEND       | Send a message to the peer                 |
| DISCONNECT | Terminate a connection                     |



## Service Primitives (2)

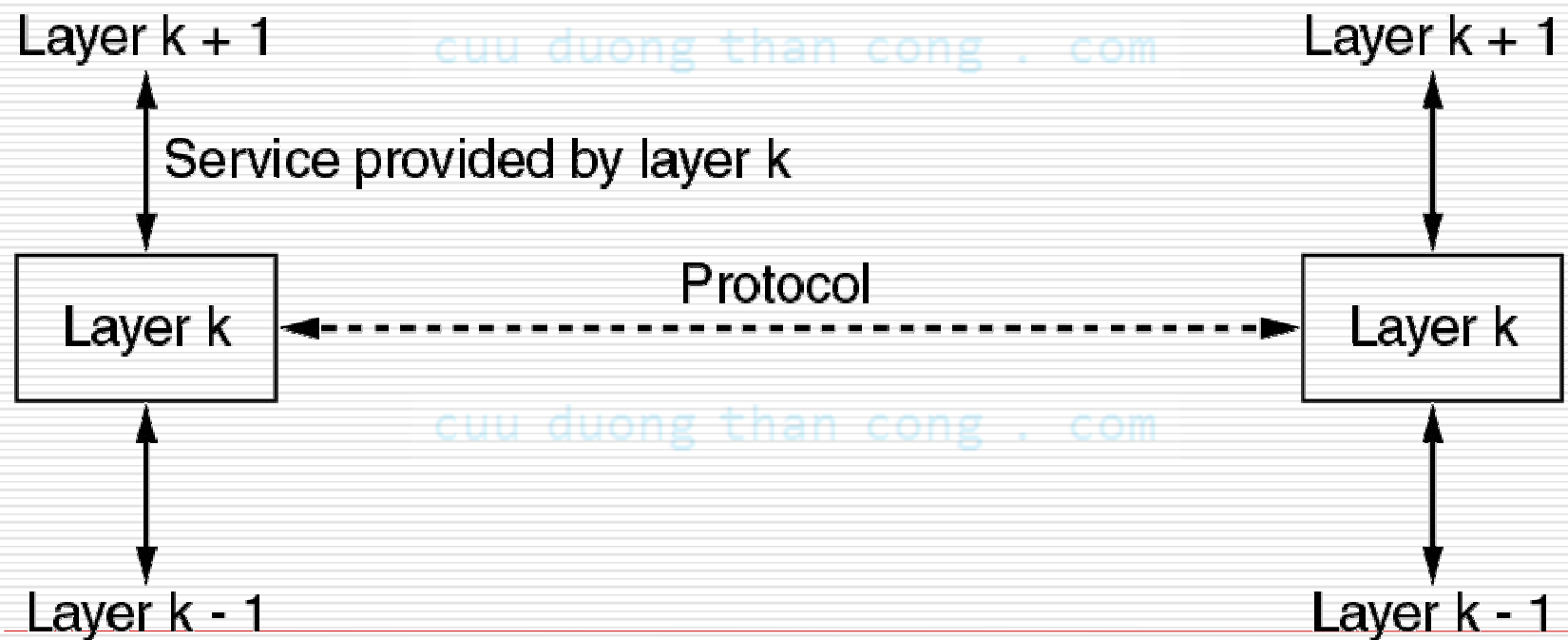
- ❑ Packets sent in a simple client-server interaction on a connection-oriented network.





# Services to Protocols Relationship

- The relationship between a service and a protocol.





# Reference Models

---

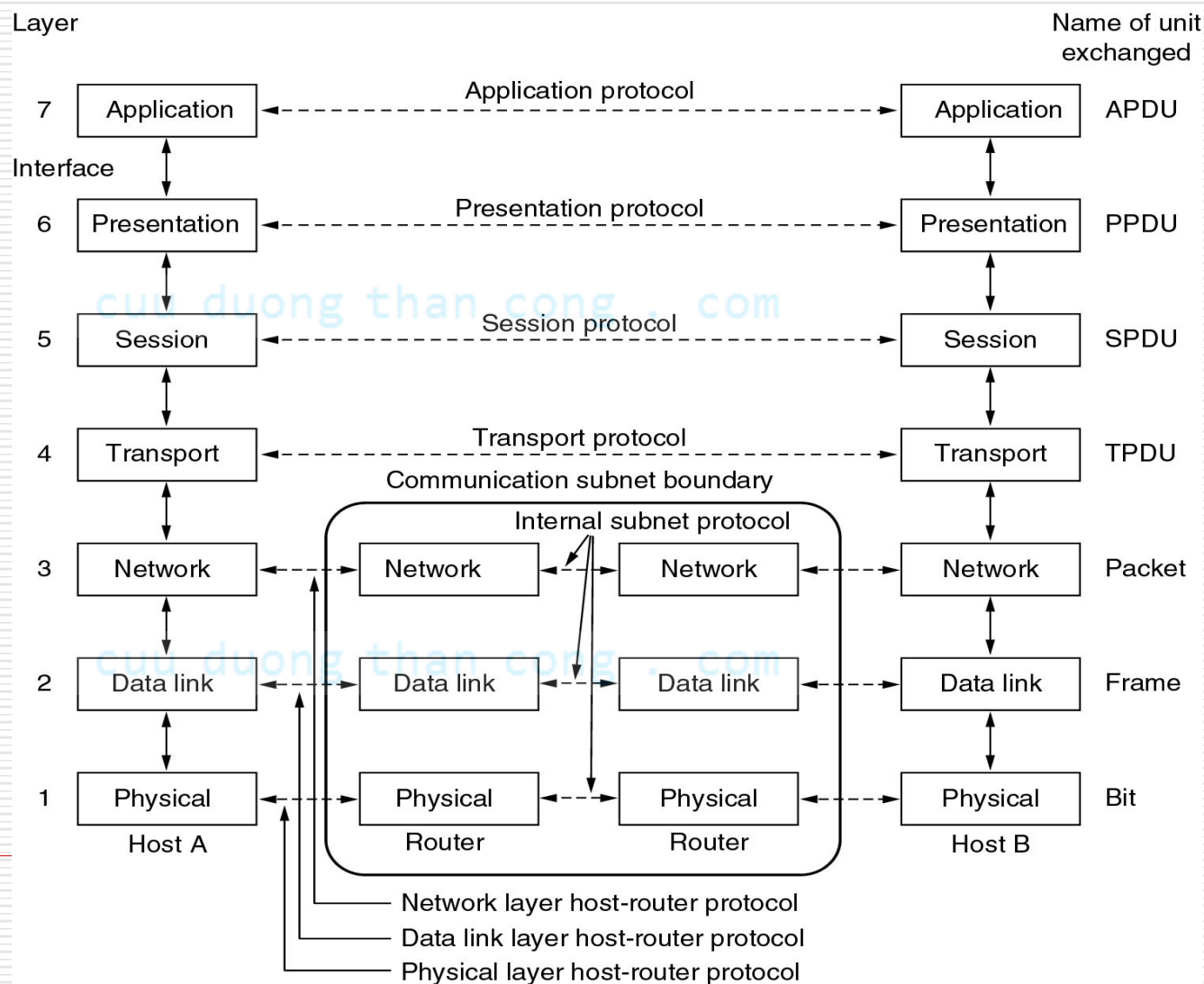
- ❑ The OSI Reference Model
- ❑ The TCP/IP Reference Model
- ❑ A Comparison of OSI and TCP/IP
- ❑ A Critique of the OSI Model and Protocols
- ❑ A Critique of the TCP/IP Reference Model

cuu duong than cong . com



# OSI Reference Model

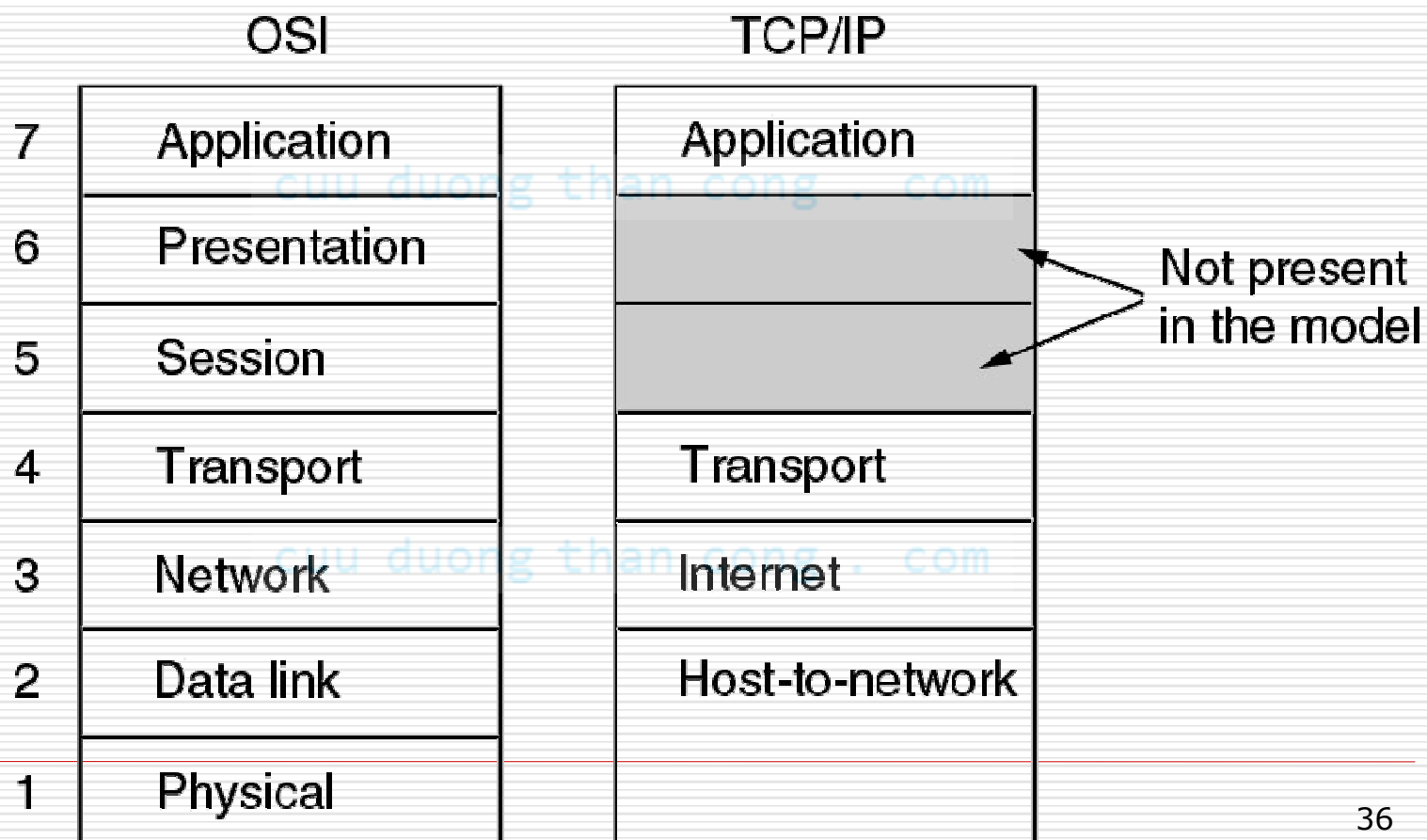
The OSI reference model.





# TCP/IP Reference Models (1)

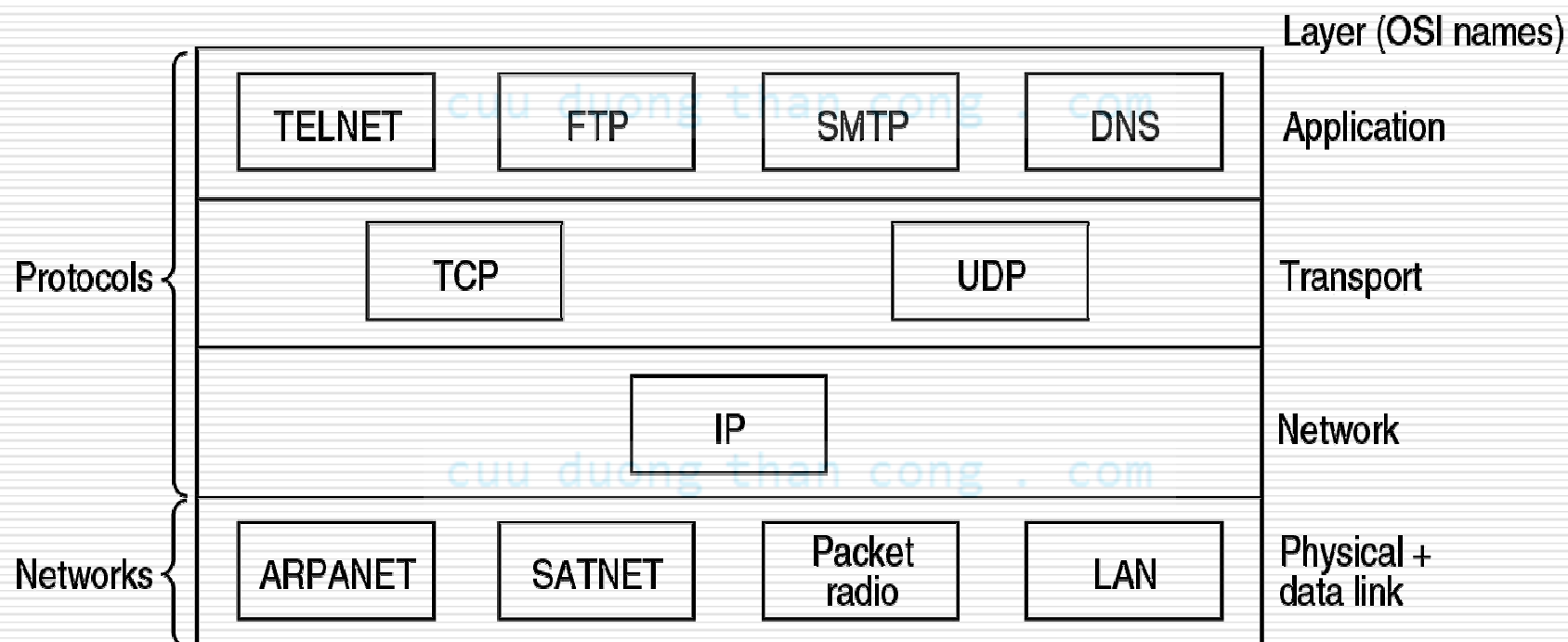
- The TCP/IP reference model.





# TCP/IP Reference Model (2)

- Protocols and networks in the TCP/IP model initially.





# Comparing OSI and TCP/IP Models

---

- ❑ Concepts central to the OSI model
- ❑ Services
- ❑ Interfaces
- ❑ Protocols



# A Critique of the OSI Model and Protocols

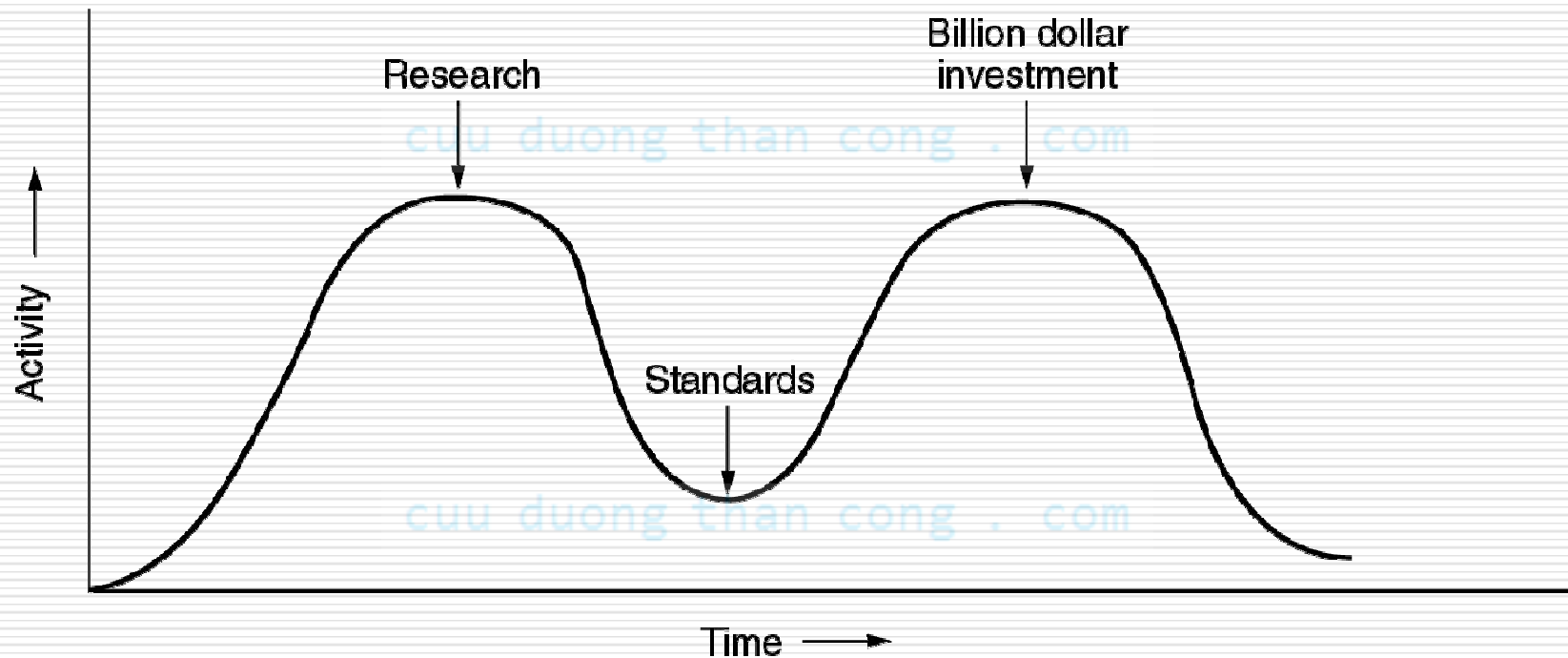
---

- Why OSI did not take over the world
  - Bad timing
  - Bad technology
  - Bad implementations
  - Bad politics



# Bad Timing

- ❑ The apocalypse of the two elephants.





# A Critique of the TCP/IP Reference Model

---

## □ Problems:

- Service, interface, and protocol not distinguished
- Not a general model
- Host-to-network “layer” not really a layer
- No mention of physical and data link layers
- Minor protocols deeply entrenched, hard to replace



# Hybrid Model

---

- ❑ The hybrid reference model to be used in this book.

|   |                   |
|---|-------------------|
| 5 | Application layer |
| 4 | Transport layer   |
| 3 | Network layer     |
| 2 | Data link layer   |
| 1 | Physical layer    |



# Example Networks

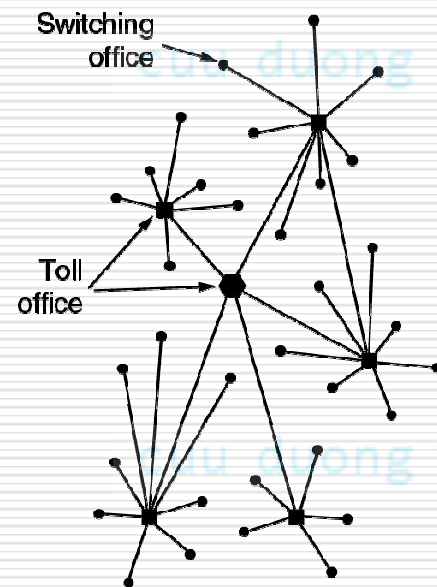
---

- ❑ The Internet
- ❑ Connection-Oriented Networks:  
X.25, Frame Relay, and ATM
- ❑ Ethernet
- ❑ Wireless LANs: 802.11

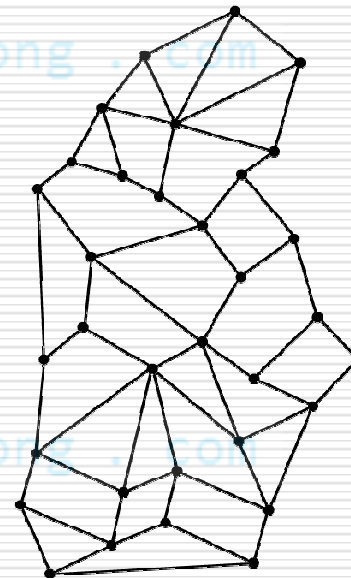


# The ARPANET (1)

- (a) Structure of the telephone system.
- (b) Baran's proposed distributed switching system.



(a)

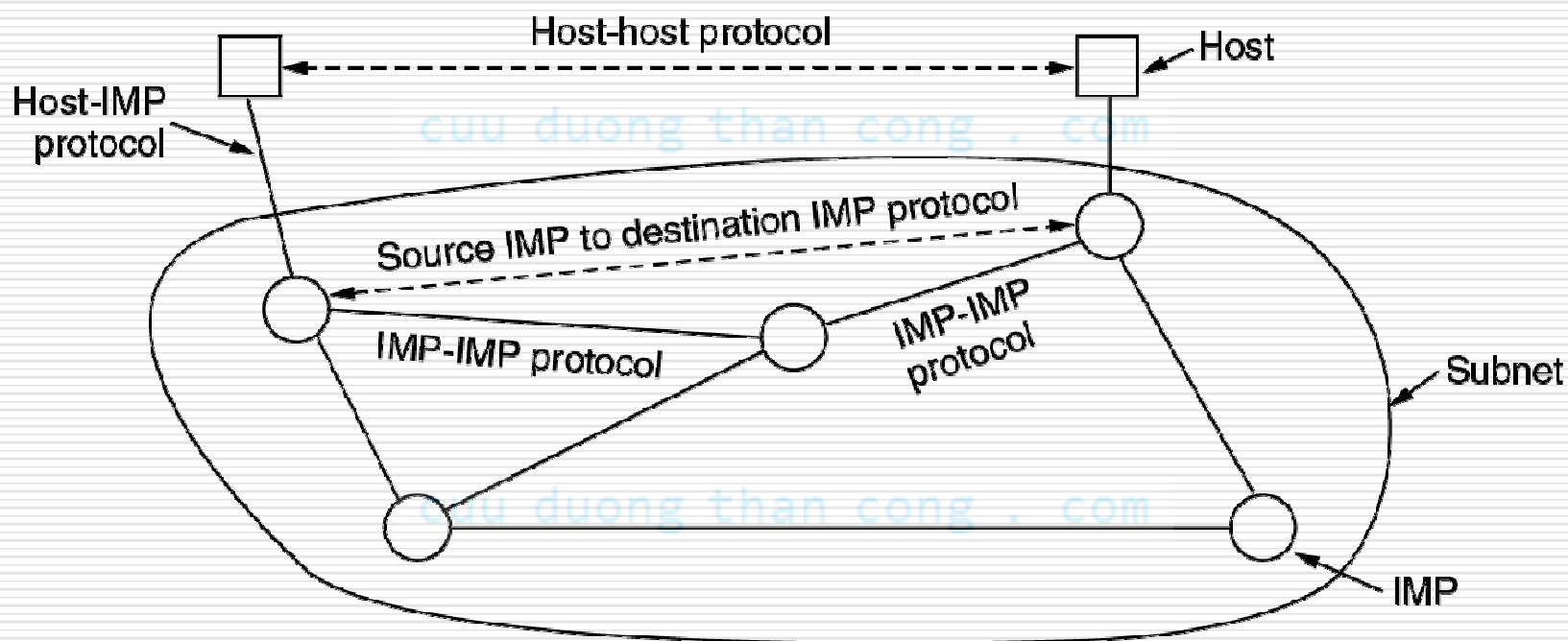


(b)



# The ARPANET (2)

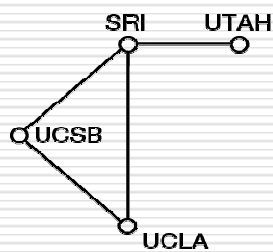
- The original ARPANET design.



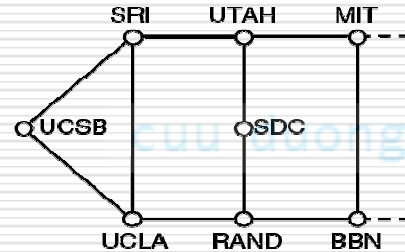


# The ARPANET (3)

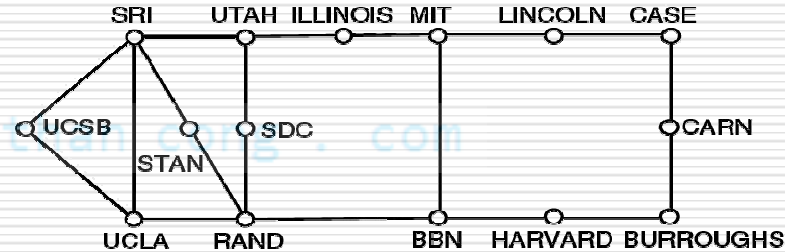
- Growth of the ARPANET (a) December 1969. (b) July 1970.
- (c) March 1971. (d) April 1972. (e) September 1972.



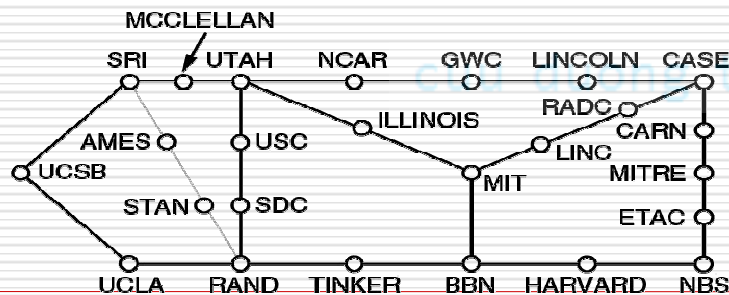
(a)



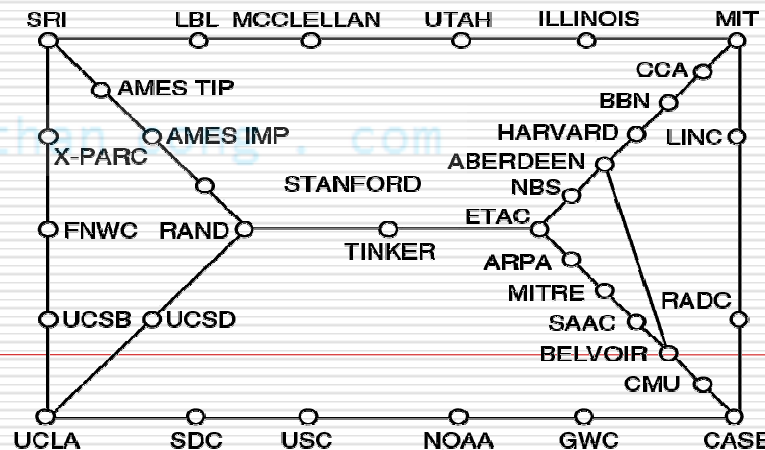
(b)



(c)



(d)

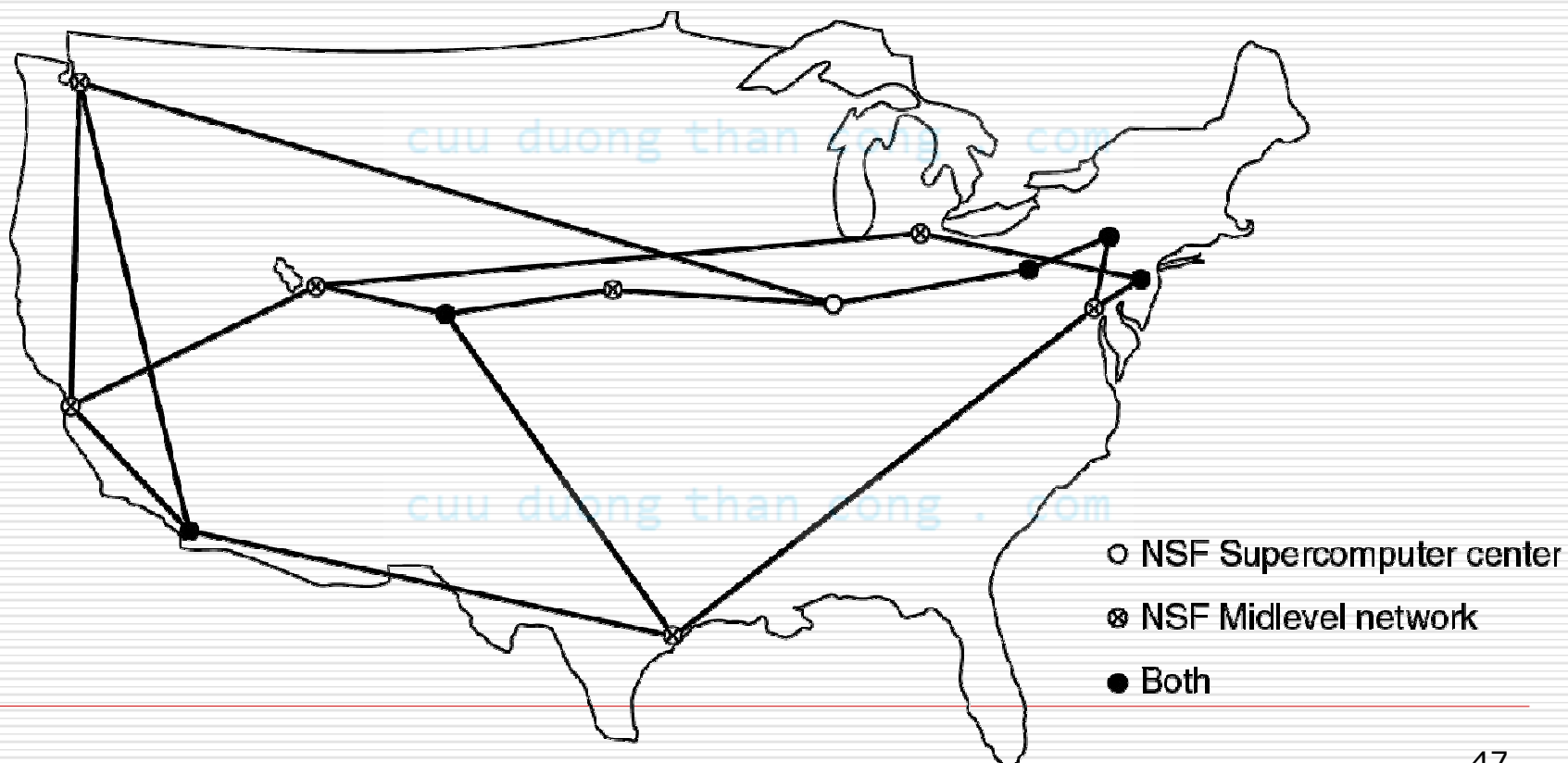


(e)



# NSFNET

- The NSFNET backbone in 1988.





# Internet Usage

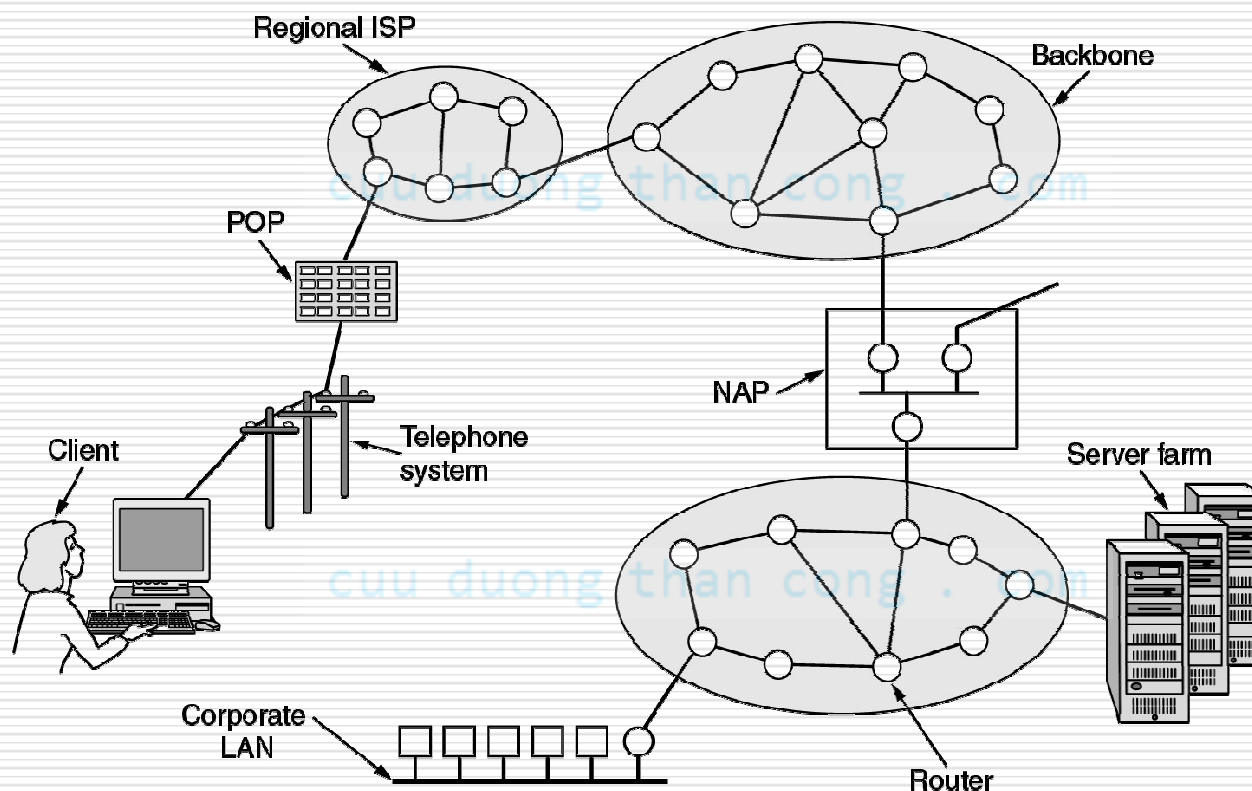
---

- Traditional applications (1970 – 1990)
  - E-mail
  - News
  - Remote login
  - File transfer



# Architecture of the Internet

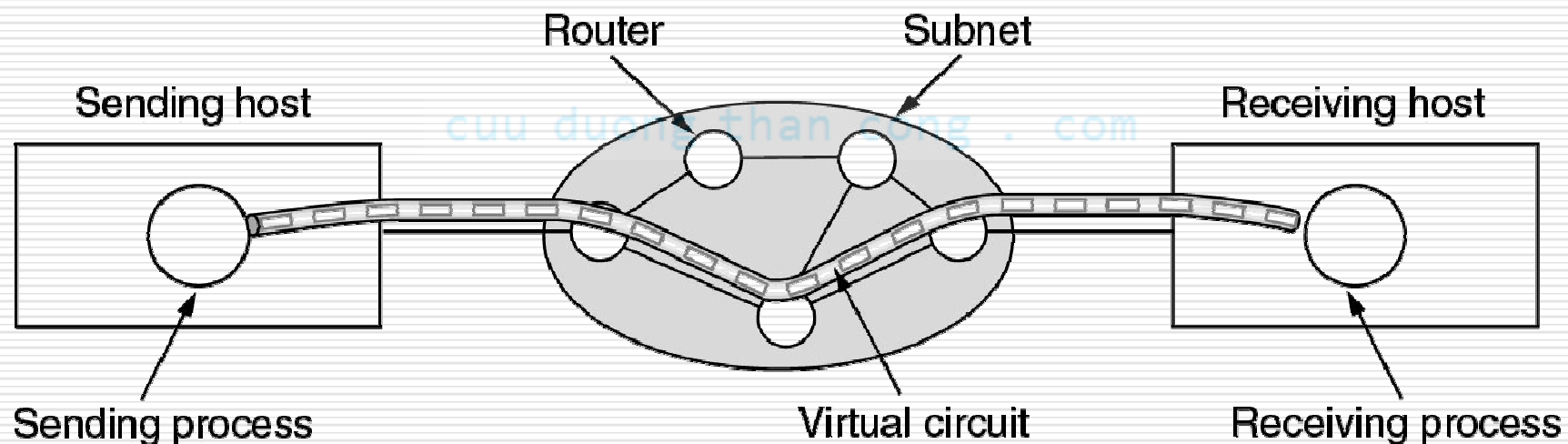
## □ Overview of the Internet.





# ATM Virtual Circuits

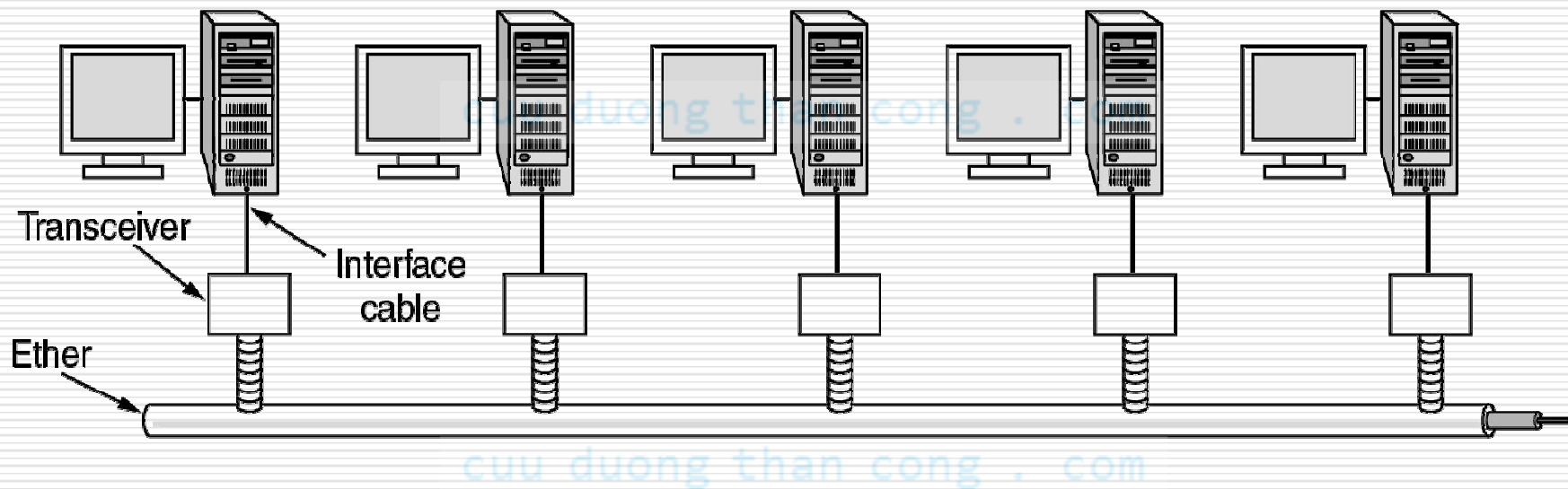
- A virtual circuit.





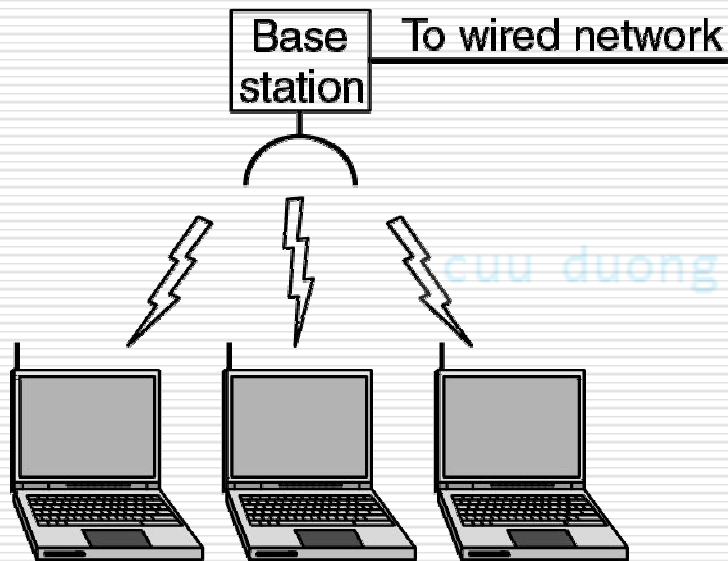
# Ethernet

## □ Architecture of the original Ethernet.

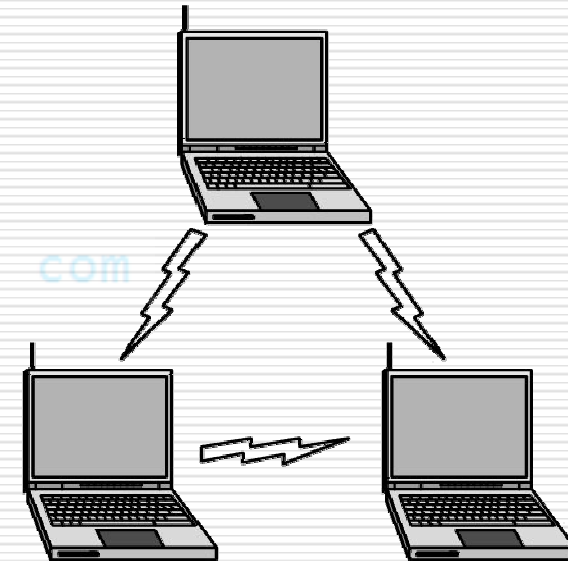




# Wireless LANs (1)



(a)



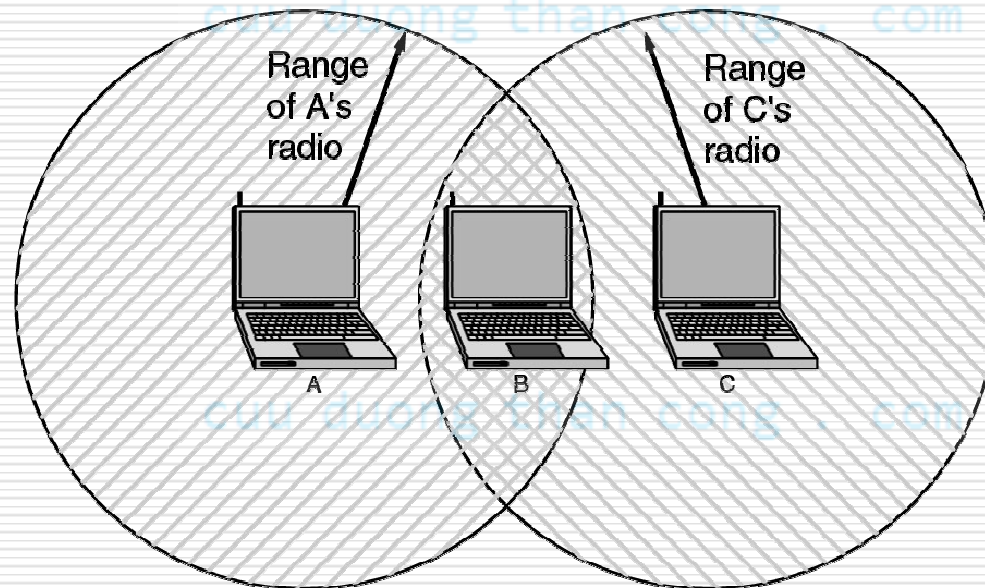
(b)

- ❑ (a) Wireless networking with a base station.
- ❑ (b) Ad hoc networking.



## Wireless LANs (2)

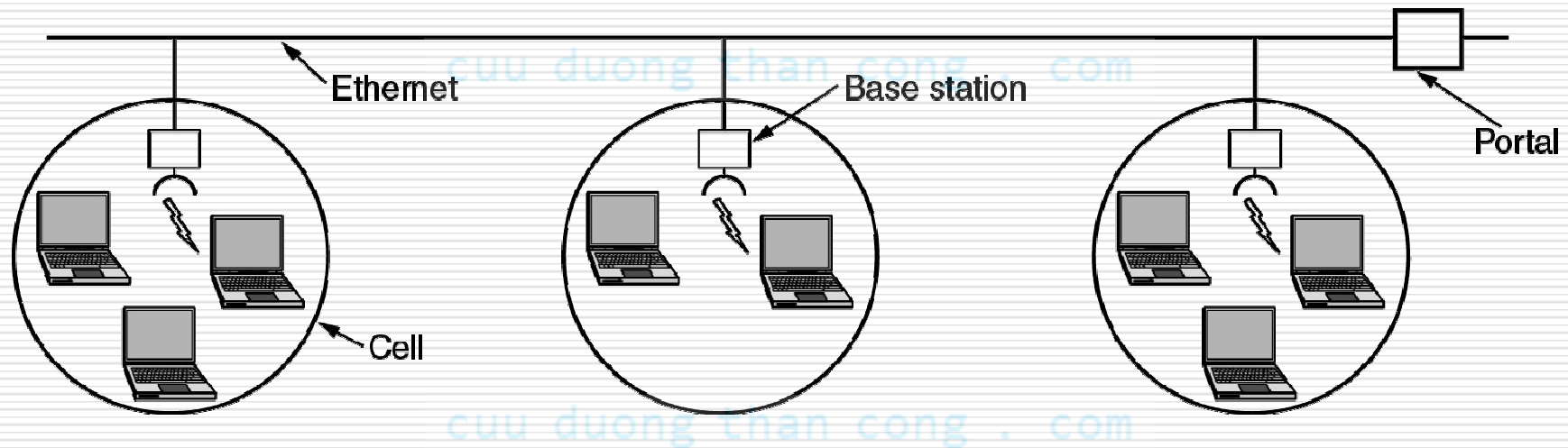
- ❑ The range of a single radio may not cover the entire system.





# Wireless LANs (3)

- ❑ A multicell 802.11 network.





# Network Standardization

---

- ❑ Who's Who in the Telecommunications World
- ❑ Who's Who in the International Standards World
- ❑ Who's Who in the Internet Standards World

[cuu duong than cong . com](http://cuuduongthancong.com)

[cuu duong than cong . com](http://cuuduongthancong.com)



# ITU

---

## □ Main sectors

- Radiocommunications
- Telecommunications Standardization
- Development

## □ Classes of Members

- National governments
- Sector members
- Associate members
- Regulatory agencies



# IEEE 802 Standards

| Number   | Topic                                                          |
|----------|----------------------------------------------------------------|
| 802.1    | Overview and architecture of LANs                              |
| 802.2 ↓  | Logical link control                                           |
| 802.3 *  | Ethernet                                                       |
| 802.4 ↓  | Token bus (was briefly used in manufacturing plants)           |
| 802.5    | Token ring (IBM's entry into the LAN world)                    |
| 802.6 ↓  | Dual queue dual bus (early metropolitan area network)          |
| 802.7 ↓  | Technical advisory group on broadband technologies             |
| 802.8 †  | Technical advisory group on fiber optic technologies           |
| 802.9 ↓  | Isochronous LANs (for real-time applications)                  |
| 802.10 ↓ | Virtual LANs and security                                      |
| 802.11 * | Wireless LANs                                                  |
| 802.12 ↓ | Demand priority (Hewlett-Packard's AnyLAN)                     |
| 802.13   | Unlucky number. Nobody wanted it                               |
| 802.14 ↓ | Cable modems (defunct: an industry consortium got there first) |
| 802.15 * | Personal area networks (Bluetooth)                             |
| 802.16 * | Broadband wireless                                             |
| 802.17   | Resilient packet ring                                          |

The 802 working groups. The important ones are marked with \*. The ones marked with ↓ are hibernating. The one marked with † gave up.



# Metric Units

| Exp.       | Explicit                    | Prefix | Exp.      | Explicit                          | Prefix |
|------------|-----------------------------|--------|-----------|-----------------------------------|--------|
| $10^{-3}$  | 0.001                       | milli  | $10^3$    | 1,000                             | Kilo   |
| $10^{-6}$  | 0.000001                    | micro  | $10^6$    | 1,000,000                         | Mega   |
| $10^{-9}$  | 0.000000001                 | nano   | $10^9$    | 1,000,000,000                     | Giga   |
| $10^{-12}$ | 0.0000000000001             | pico   | $10^{12}$ | 1,000,000,000,000                 | Tera   |
| $10^{-15}$ | 0.0000000000000001          | femto  | $10^{15}$ | 1,000,000,000,000,000             | Peta   |
| $10^{-18}$ | 0.0000000000000000001       | atto   | $10^{18}$ | 1,000,000,000,000,000,000         | Exa    |
| $10^{-21}$ | 0.00000000000000000000001   | zepto  | $10^{21}$ | 1,000,000,000,000,000,000,000     | Zetta  |
| $10^{-24}$ | 0.0000000000000000000000001 | yocto  | $10^{24}$ | 1,000,000,000,000,000,000,000,000 | Yotta  |

- The principal metric prefixes.