

Numerical Communications

RICM3 – UGA Polytech

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Outline:

Numerical Communications

- **Lectures 9 séances**

Jan - April

- **Practical Sessions 4 séances**

Feb-April

- **Exam**

May

Bibliography

- **Mahé, « Communications Numériques »**
- Tannenbaum, « Computer networks »
- Kurose&Ross, « A top down approach to Networking »
- Forouzan, « data communication and networking »

Introduction

NB : most of the slides are from the Internet. Their authors are greatly thanked !!!

Among others : Forouzan, Garcia, Widjeja, Mahé, ...

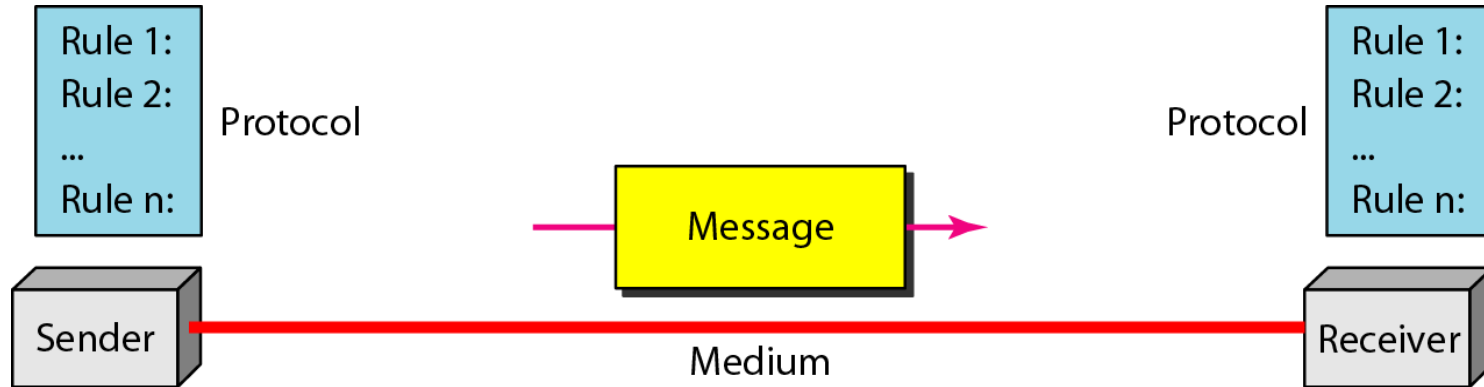
1-1 DATA COMMUNICATIONS

*The term **telecommunication** means communication at a distance. The word **data** refers to information presented in whatever form is agreed upon by the parties creating and using the data. **Data communications** are the exchange of data between two devices via some form of transmission medium such as a wire cable.*

Topics discussed in this section:

- **Components of a data communications system**
- **Data Flow**

Figure 1.1 *Components of a data communication system*



1-2 NETWORKS

*A **network** is a set of devices (often referred to as **nodes**) connected by communication **links**. A node can be a computer, printer, or any other device capable of sending and/or receiving data generated by other nodes on the network. A link can be a cable, air, optical fiber, or any medium which can transport a signal carrying information.*

Topics discussed in this section:

- Network Criteria
- Physical Structures
- Categories of Networks

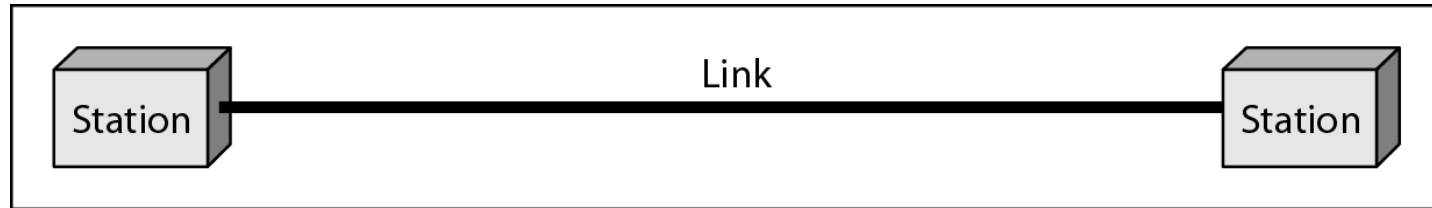
Network Criteria

- **Performance**
 - Depends on Network Elements
 - Measured in terms of Delay and Throughput
- **Reliability**
 - Failure rate of network components
 - Measured in terms of availability/robustness
- **Security**
 - Data protection against corruption/loss of data due to:
 - Errors
 - Malicious users

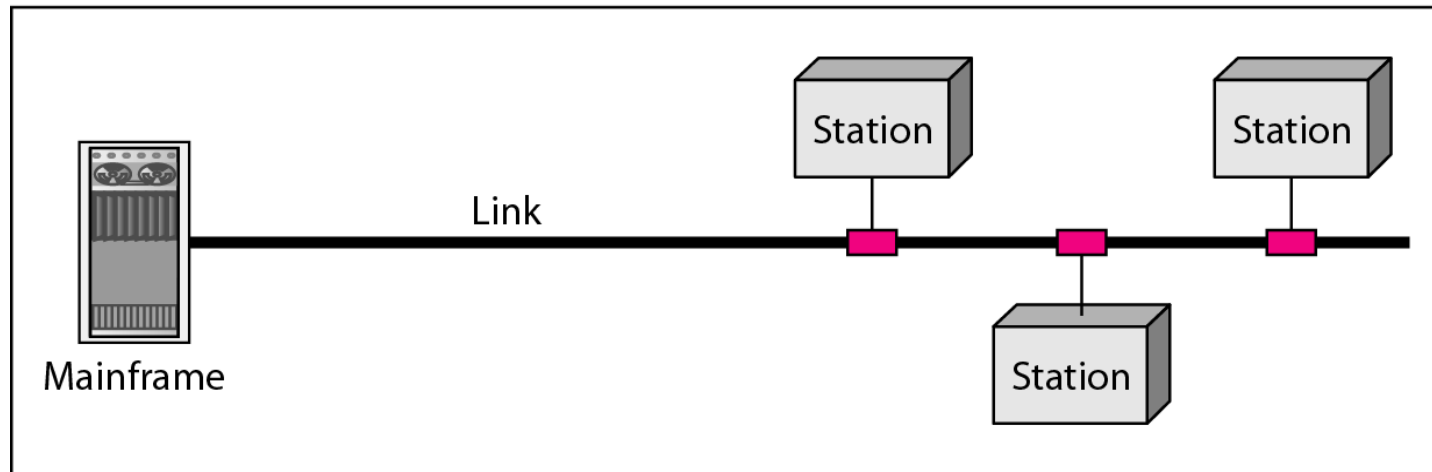
Physical Structures

- **Type of Connection**
 - Point to Point - single transmitter and receiver
 - Multipoint - multiple recipients of single transmission
- **Physical Topology**
 - Connection of devices
 - Type of transmission - unicast, multicast, broadcast

Figure 1.3 *Types of connections: point-to-point and multipoint*



a. Point-to-point



b. Multipoint

Figure 1.6 *A star topology connecting four stations*

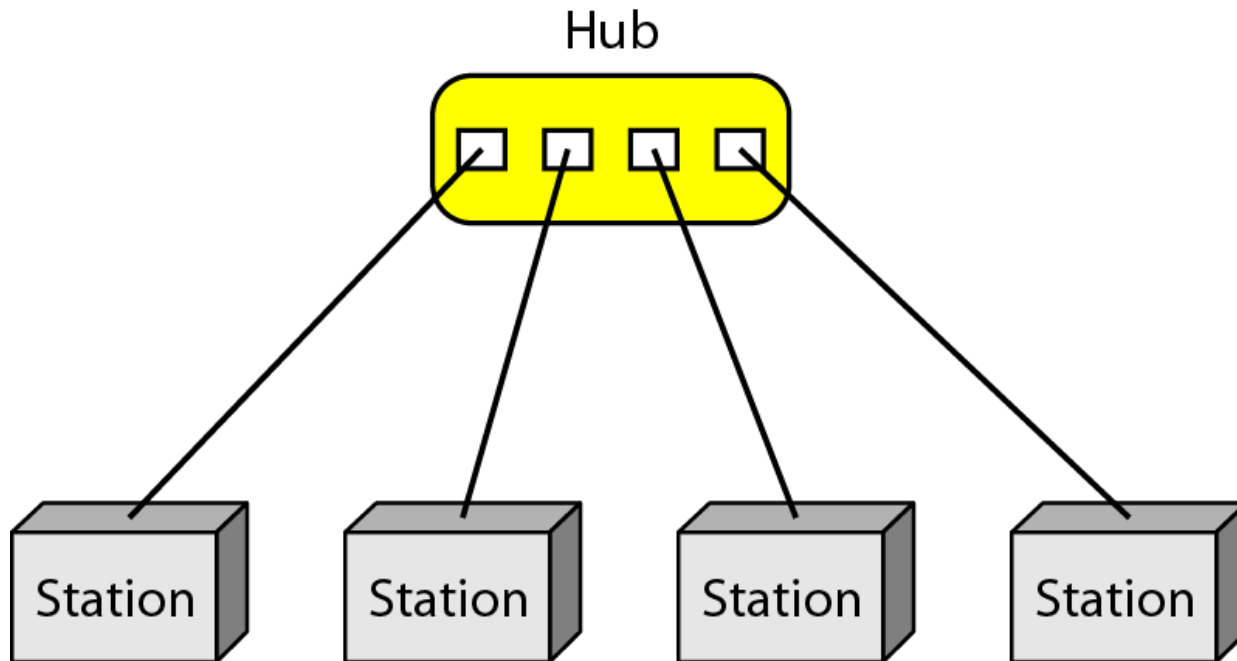


Figure 1.6 *A wireless network connecting four stations*

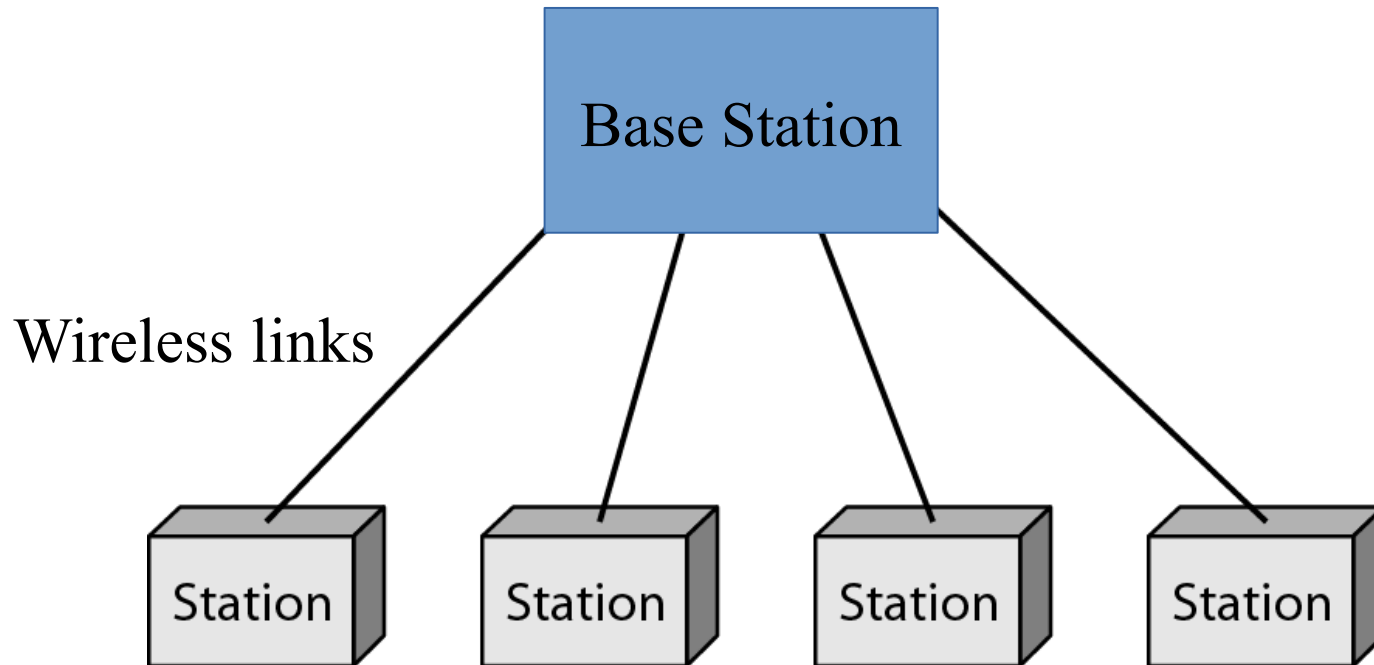
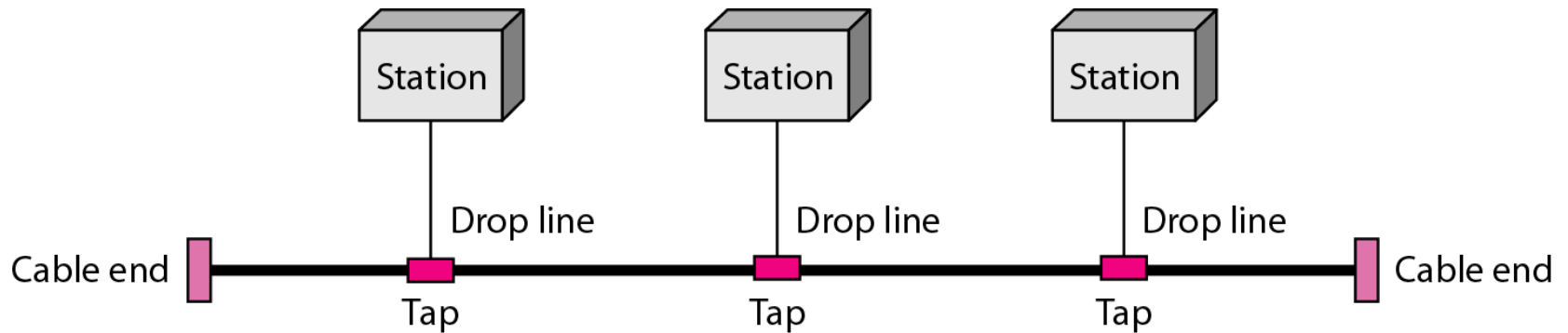


Figure 1.7 *A bus topology connecting three stations*



For instance, computer board, CPU chip, ...

Categories of Networks

- **System Area Networks (SANs)**
 - Very short distances ~nm-cm
- **Local Area Networks (LANs)**
 - Short distances ~100m
 - Designed to provide local interconnectivity
- **Wide Area Networks (WANs)**
 - Long distances ~km
 - Provide connectivity over large areas
- **Low Power WAN (LPWANs)**
 - Low Power for IoT
 - Provide connectivity over large areas ~km

1-3 THE INTERNET

*The **Internet** has revolutionized many aspects of our daily lives. It has affected the way we do business as well as the way we spend our leisure time. The Internet is a communication system that has brought a wealth of information to our fingertips and organized it for our use.*

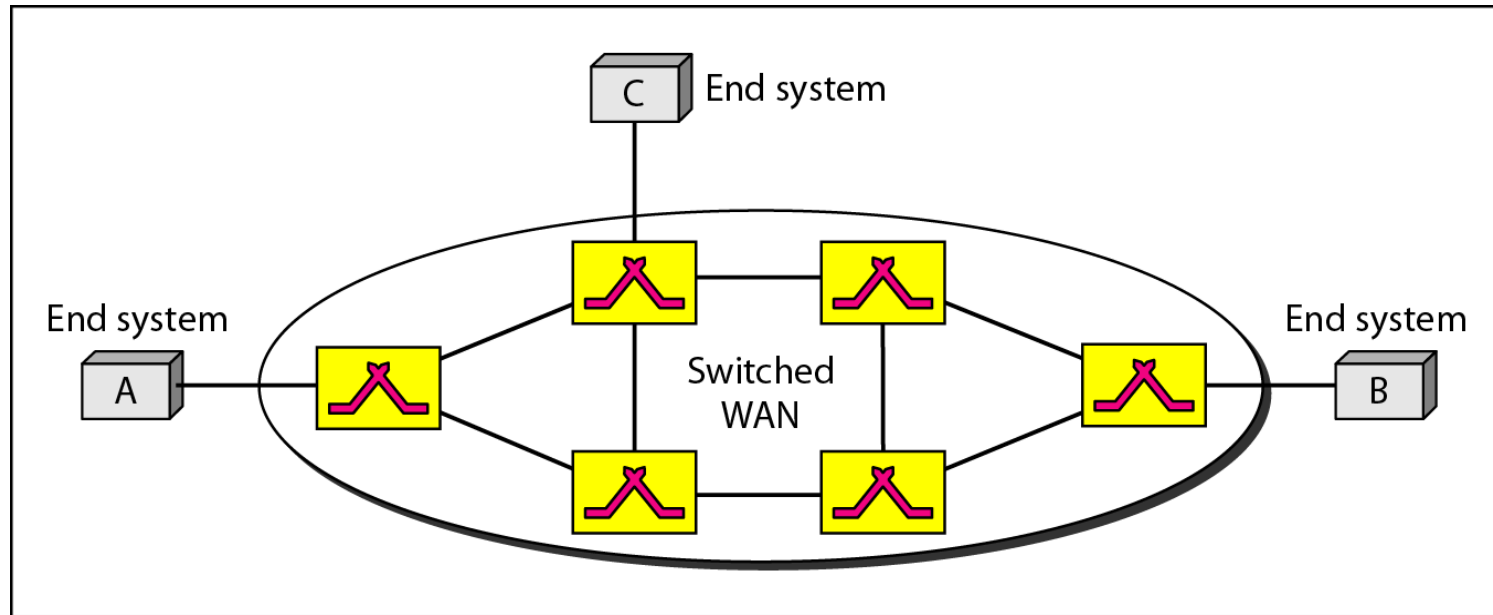
Topics discussed in this section:

Interconnection of networks

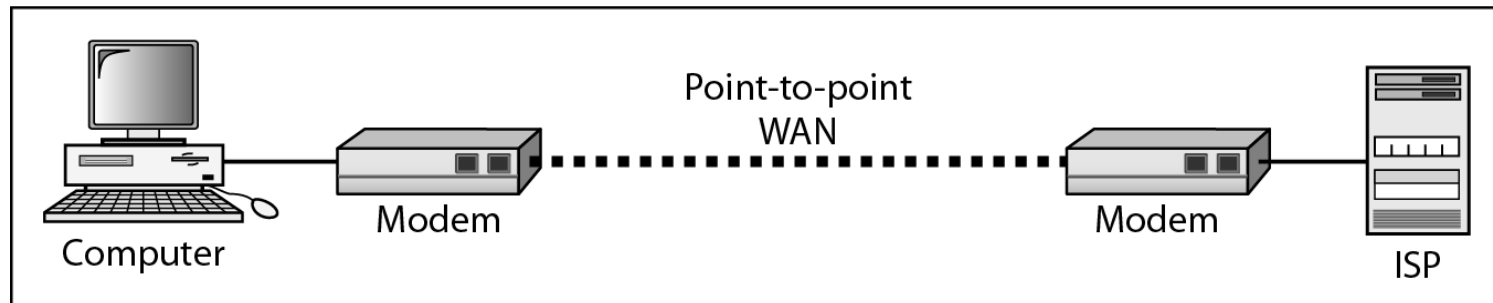
Organization of the Internet

Internet Service Providers (ISPs)

Figure 1.11 *WANs: a switched WAN and a point-to-point WAN*

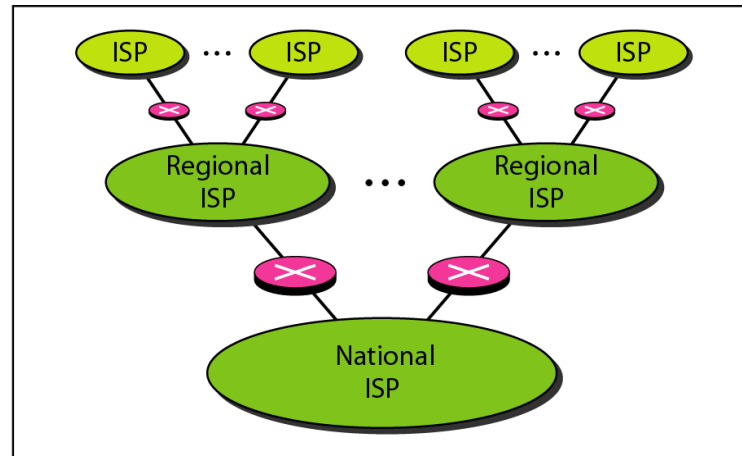


a. Switched WAN

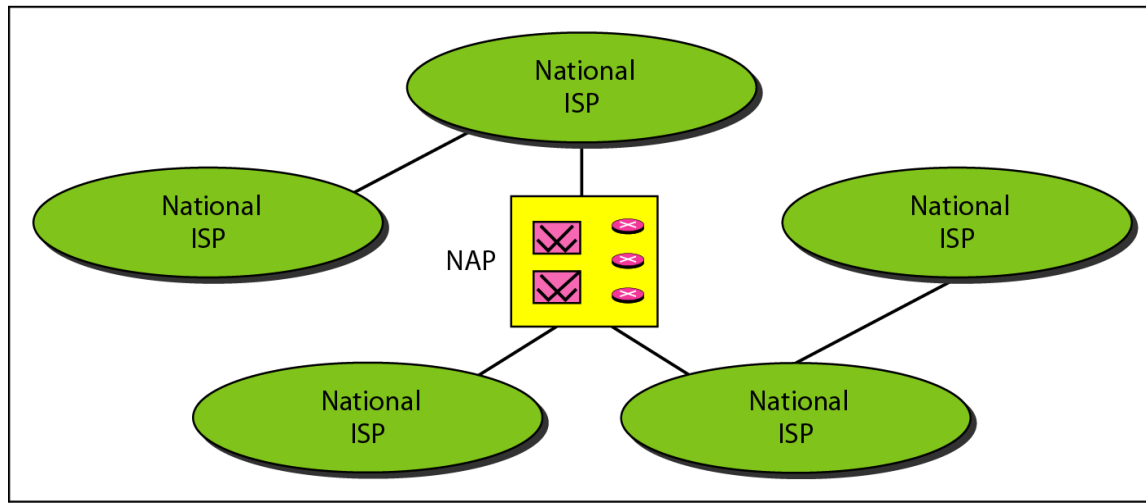


b. Point-to-point WAN

Figure 1.13 *Hierarchical organization of the Internet*

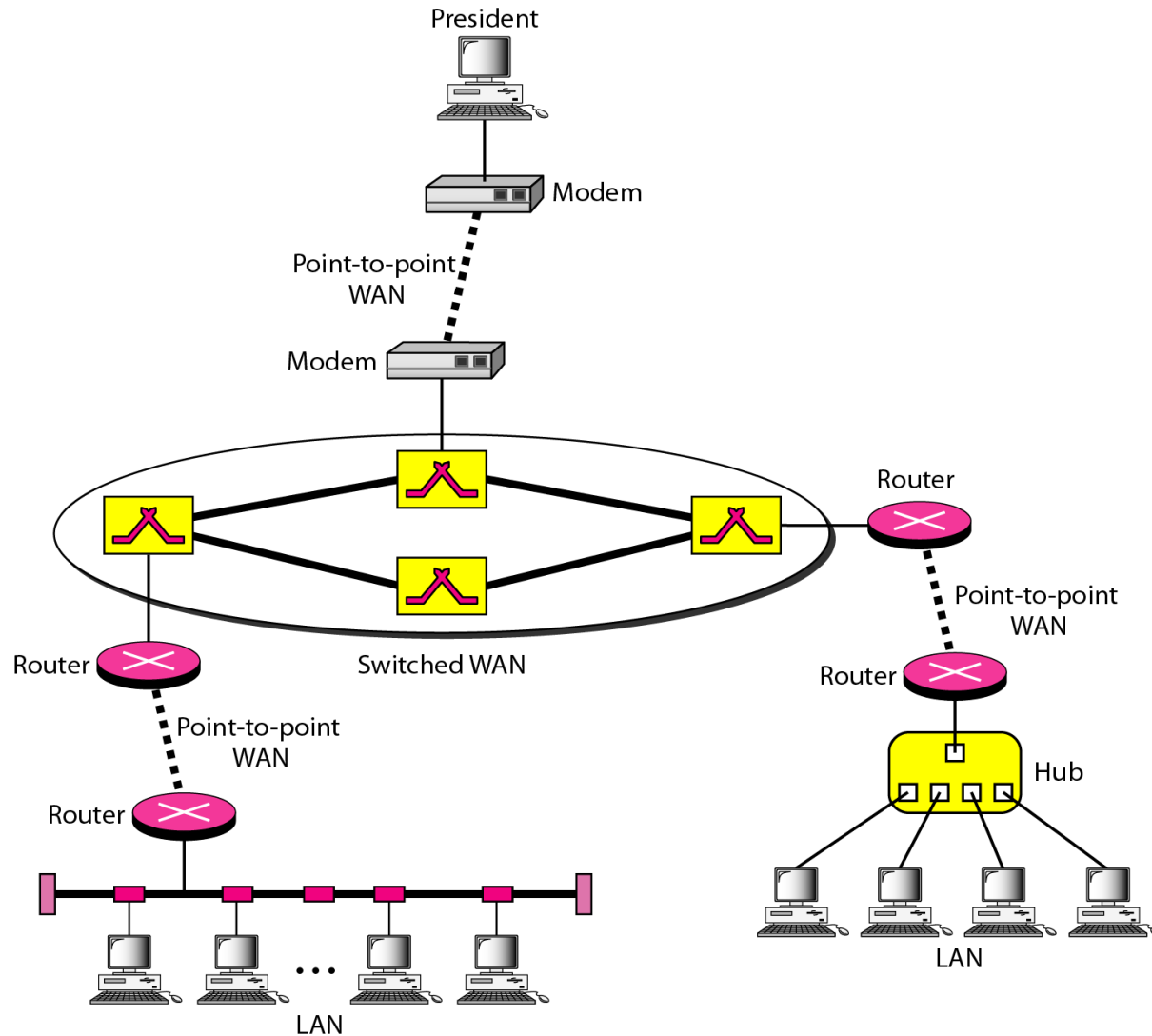


a. Structure of a national ISP



b. Interconnection of national ISPs

Figure 1.12 *A heterogeneous network made of four WANs and two LANs*



1-4 INFORMATION THEORY

*The theory that describes the quantity of information contained in a symbol. It is based on the decision that can be made on a particular event with the given symbol. Information is the resolution of uncertainty.
MIT slides lec01 pp04-21*

Topics discussed in this section:

- Entropy
- Shannon
- Huffman

1-4 PROTOCOLS

A protocol is synonymous with rule. It consists of a set of rules that govern data communications. It determines what is communicated, how it is communicated and when it is communicated. The key elements of a protocol are syntax, semantics and timing

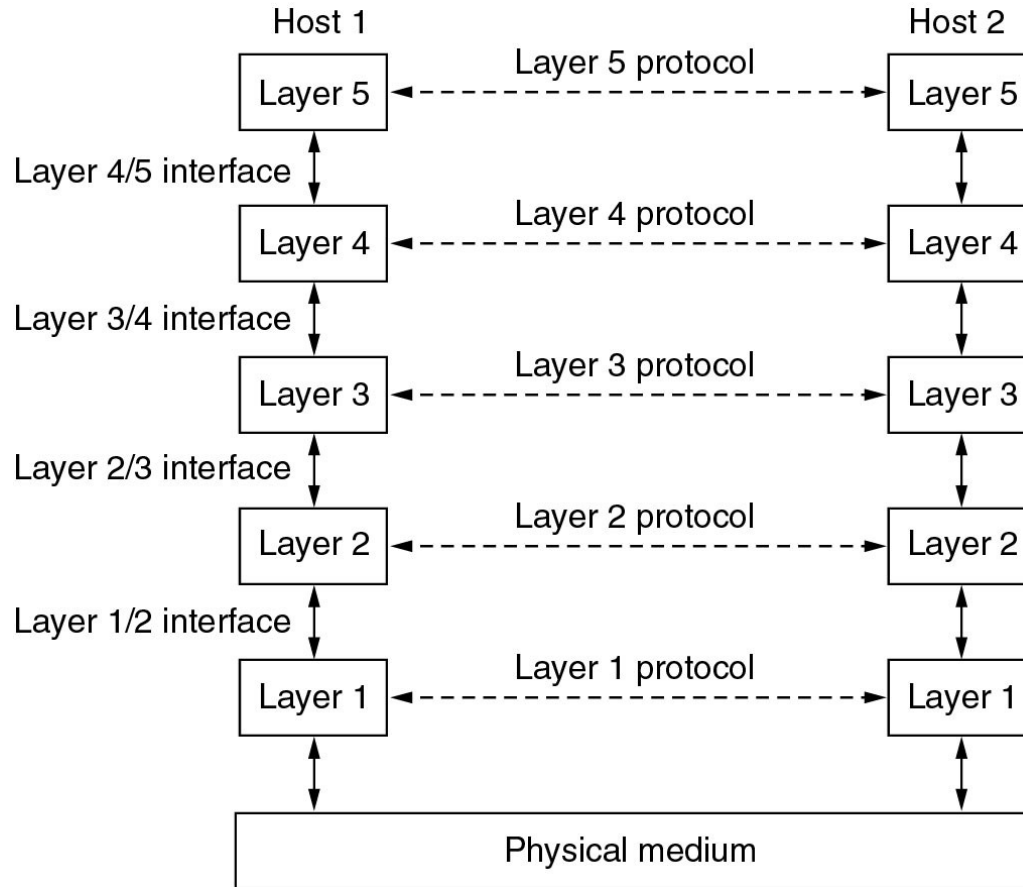
Topics discussed in this section:

- Syntax
- Semantics
- Timing
- Software Architecture

Elements of a Protocol

- **Syntax**
 - Structure or format of the data
 - Indicates how to read the bits - field delineation
- **Semantics**
 - Interprets the meaning of the bits
 - Knows which fields define what action
- **Timing**
 - When data should be sent and what
 - Speed at which data should be sent or speed at which it is being received.

Network Software Protocol Hierarchies



Layers, protocols, and interfaces.

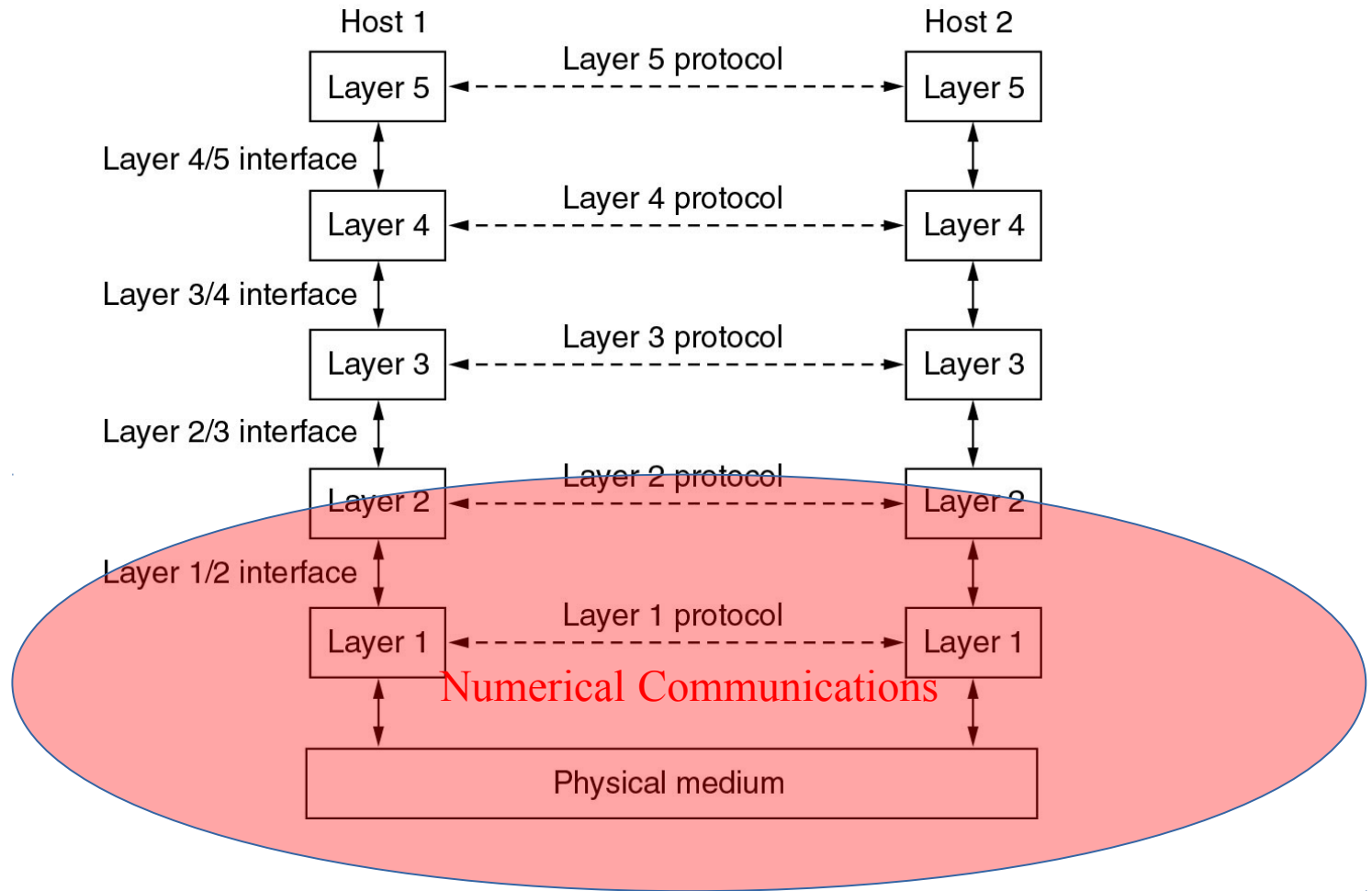
1-4 PHYSICAL LAYER PROTOCOL

A physical protocol manages transmission, data, communication channel adaptation. It consists of (sampling), digitalization, coding, (error detection, error correction), rules that govern data communications. It determines how raw data is communicated and recovered.

Topics discussed in this section:

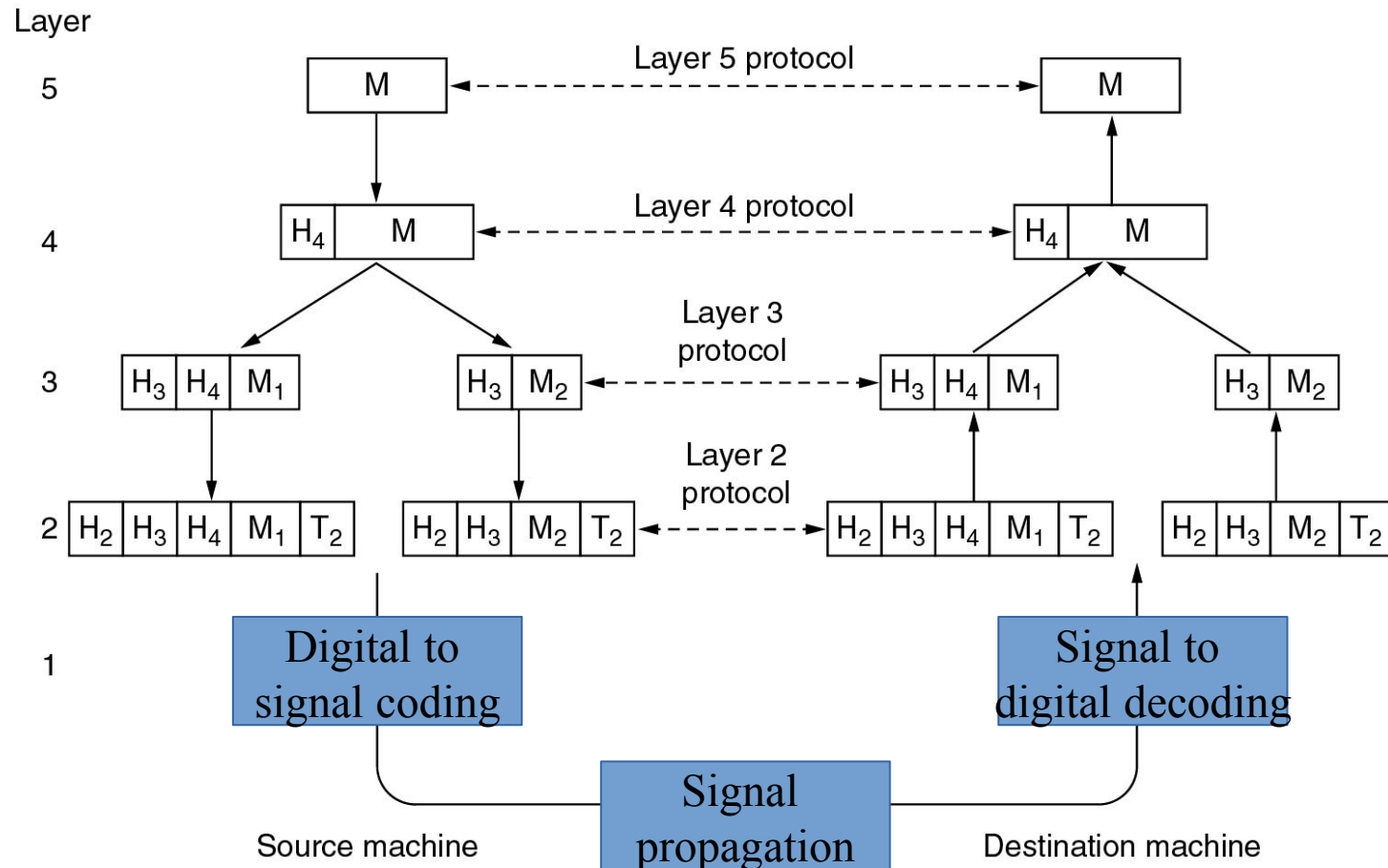
- Signal
- Coding
- Error

Network Software Protocol Hierarchies



Layers, protocols, and interfaces.

Protocol Hierarchies transformations



Application flow supporting virtual communication in layer 5.

1-4 INFORMATION THEORY

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Take away

Network

- Structured in layer

Digital Communications

- Information theory bits \neq binary digits
- Entropy is the limit of information bits for a representation
- Binary digits coding tries to reach the limit
- Huffman coding