COMMUNICATION in DISTRIBUTED SYSTEMS

References [Col94], [Gos91], [Tan95]

INTERPROCESS COMMUNICATION

- **Communication modes**
- **Channel**
- **Communication structure**
- **Communication systems for distributed systems**

INTERPROCESS PRIMITIVES: MESSAGE PASSING

MESSAGE PASSING

- **Message passing primitives**
- **Adressing in message passing**

CLIENT-SERVER COMMUNICATION

- **Addressing in client-server communication**

GROUP COMMUNICATION

- **Group**
- **Types of groups**
- **Group membership**
- **Group addressing**
- **Properties of group communication**

INTERPROCESS PRIMITIVES: REMOTE PROCEDURE CALL

- **Goals of RPC**
- **Types of RPC**
- **Problems of RPC**
- **Advantages of RPC**

FEATURES and PROPERTIES of RPC

PRIMITIVES of RPC

- **Procedures of RPC**

ACTIVITIES of RPC

RPC for ONE CLIENT and ONE SERVER

- **Caller and callee**
- **Parameters and results in RPC**
- **Marshalling**
- **Client-server binding**

RPC for MANY CLIENTS and MANY SERVERS

- **Server kernel + many clients**

RPC and FAILURE HANDLING

- **Faults in RPC**
- **Exception handling**
- **Failure handling in RPCs by troupe and replicated RPCs**

INTERPROCESS COMMUNICATION

INTERPROCESS COMMUNICATION = provides access to resources distributed over a computer network by policies and strategies that effect local and remote communication between processes and between processes and resources

-types of interprocess communication:

a. local communication

- **processes are located on the same computer,**

b. remote communication

- **processes are located on different computers,**

- parts of interprocess communication:

a. interprocess communication primitives,

b. transport protocols that support these primitives

- interprocess communication primitives:

a. message exchange

- **is based on client-server model and is an extension of interprocess communication for centralised systems**

b. remote procedure call

- **is a type-checked mechanism that permits a language-level call on one computer to be automatically turned into a corresponding language-level call on another computer**

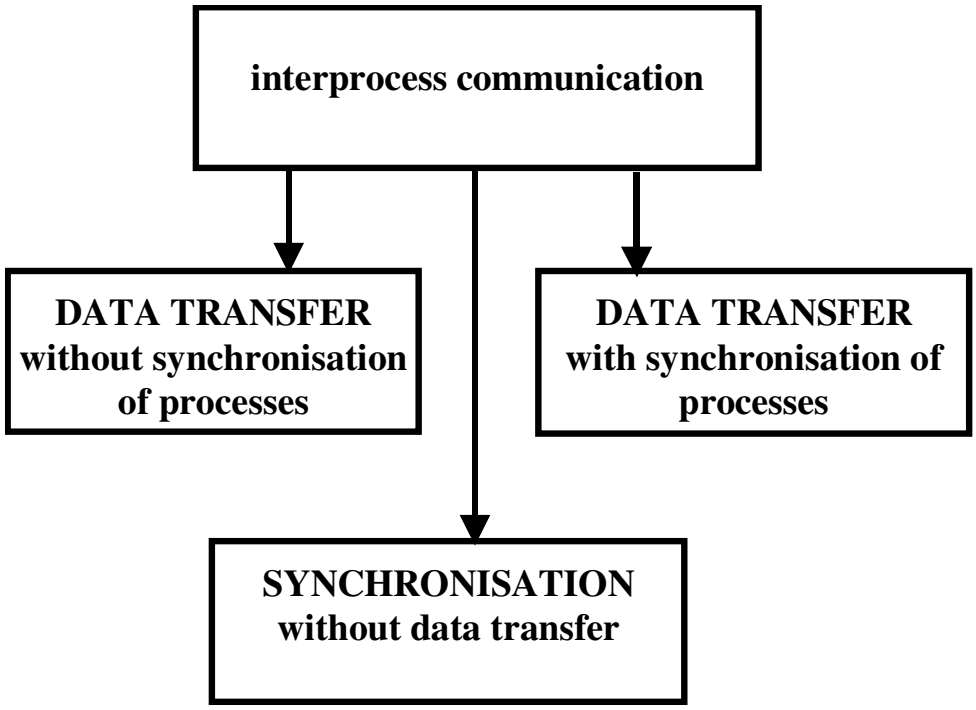
c. transactions

- **provide uniform support for invoking and synchronising operations on shared data object, assurance of serializability of transactions with one another, and atomic behaviour**

Communication levels:

interprocess communication	**transactions** **RPC** **message passing**
network operating systems	**transport connection**
communication network	**packet switching**

Communication modes:



Data transfer without process synchronisation

Processes exchange information either randomly or periodicaly, without any need for synchronization.

Data transfer with process synchronisation

Processes not only wait for events, but also use data associated with those events

Process synchronisation without data transfer, using signals.

Processes are linked by events, not data. They only wait for events.

Channel

CHANNEL = an abstraction of a physical communication network that provides communication path between processes

- channels are accessed by means of the following two basic primitives:

- **send**
- **receive**

- channels are provided in communication as;

- **global to processes (shared) or local to processes i.e. associated with processes (dedicated),**
- **one-way or two-way channels,**
- **buffered or non-buffered channels,**
- **reliable or unreliable channels,**

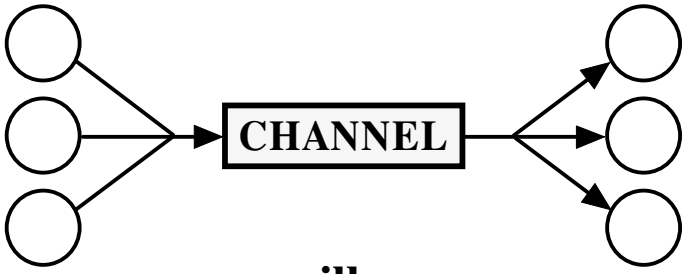
- channels are named using the following methods:

- **direct or indirect,**
- **static or dynamic,**

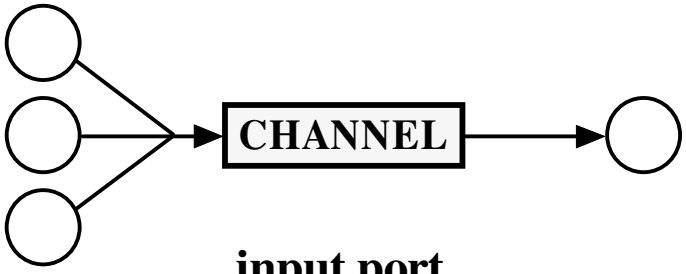
- channels are implemented in communication as:

- **mailboxes or ports,**
- **links**

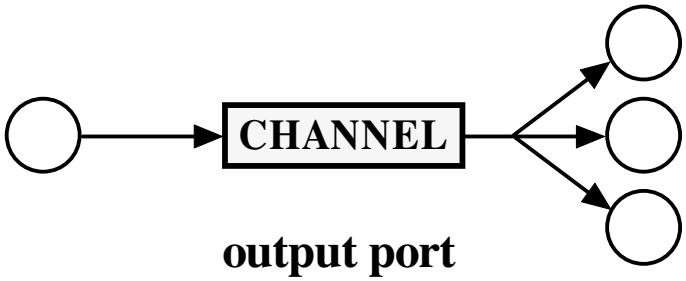
- the following channel types have proved the most popular since each is especially well suited to solving some programming problems and each can be implemented with reasonable efficiency:



mailbox



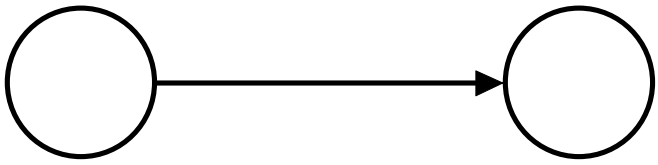
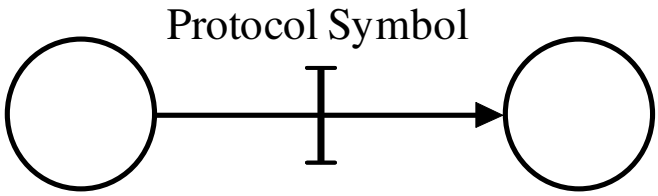
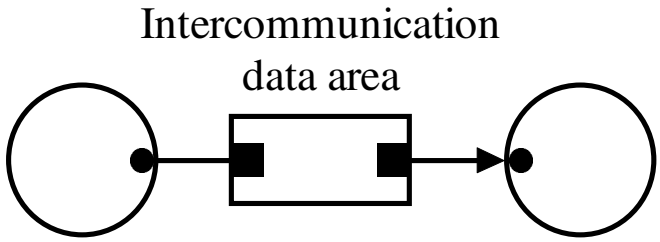
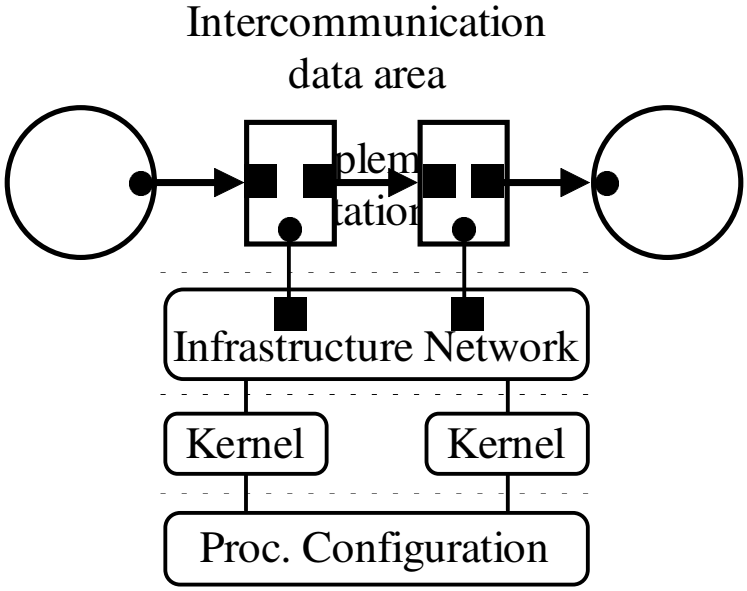
input port



output port

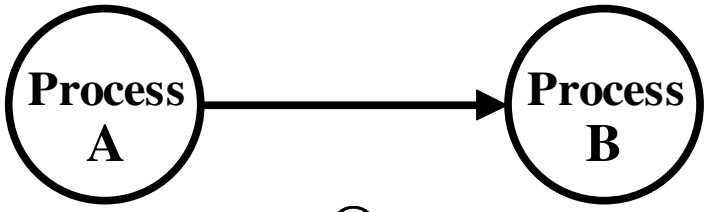
link

- channel description:

Level	Representation	Emphasis
Concep-tional		Path
Functional definition		Shared information
Design		Shared data
		Shared memory

Communication structure

- communication between two processes, assigned to the same processor, is a direct interaction between these processes :



①

- two processes in a distributed system communicate via some subsystem providing a communication service:

②

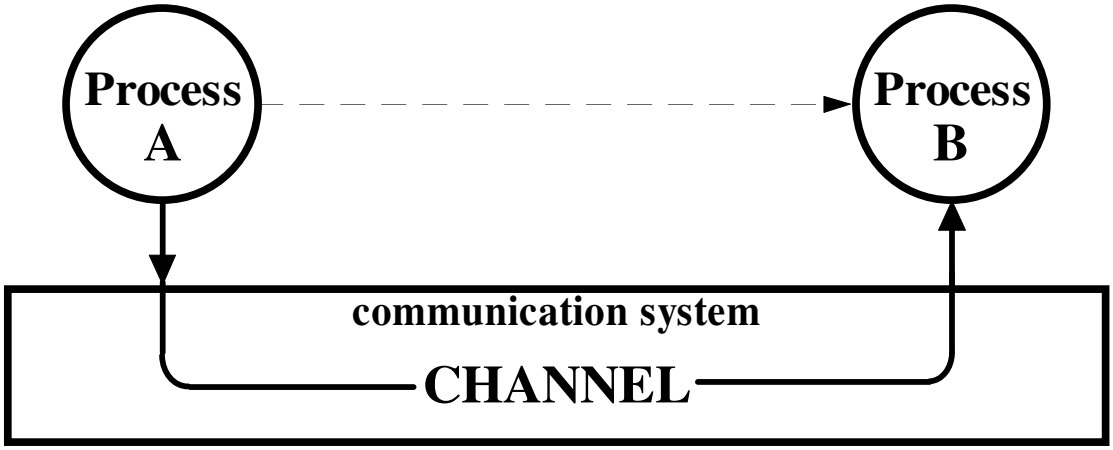
- the communication system is "*transparent*" as much as the direct interaction between one process and the communication subsystem appears, to the process, as a direct interaction with the other process.

- possible limitations to the transparency may be due to:

- **throughput limitations,**
- **delay,**
- **limitations of the available interaction primitives,**
- **transmission errors,**
- **loss or duplication of messages,**
- **loss or message sequencing,**
- **complicated interfaces to the communication subsystem, etc.**

- the communication subsystem provides a service which is used by the two processes, and

- two processes are in the higher layer within the architecture of the system:



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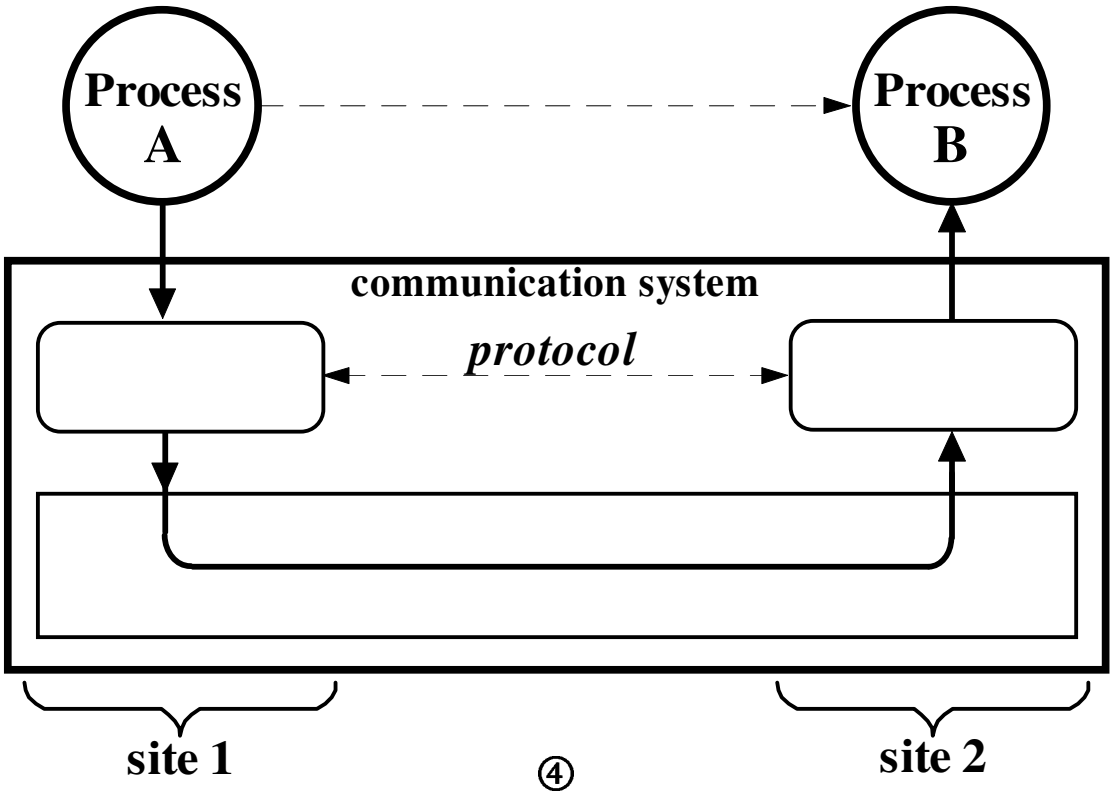
- the communication subsystem itself is usually built as a hierarchical and layered system:



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Communication systems for distributed systems

- computers in the DSs are interconnected through a computer communication network that are either Wide Area Networks (WANs) or Local Area Networks (LANs),

WAN = interconnects heterogeneous devices located over a wide geographic area

LAN = interconnects heterogeneous devices located over a small geographic area

ISO OSI:

- provides a framework for communication protocols containing seven layers with particular functions and services

- the communication network includes only three of the seven layers: the network layer, the data link layer and the physical layer,

services and protocols:

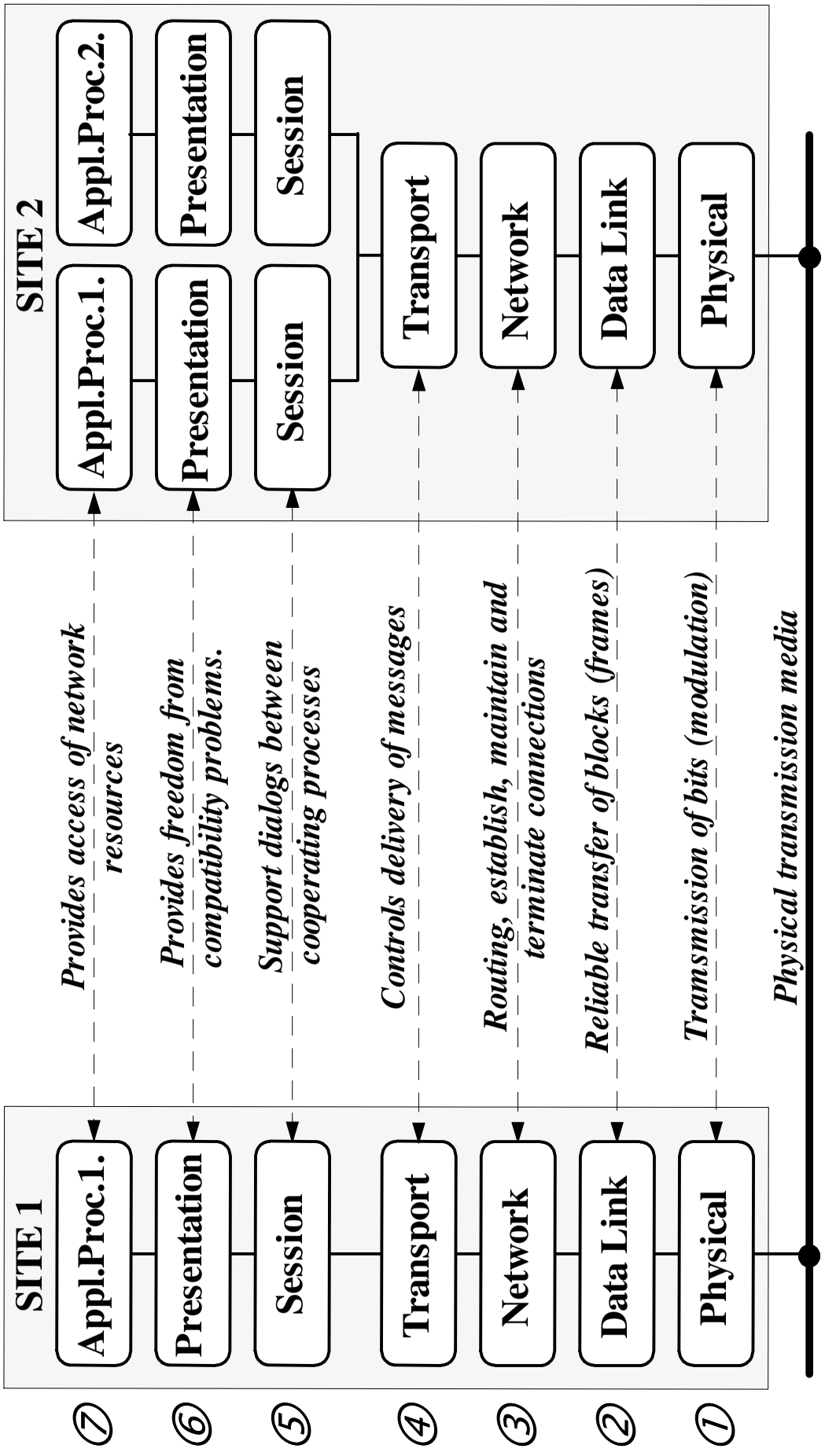
- the Open System Interface consists of several *layers* within the hierarchical structure,

- each layer consists of two components to provide the level "n" *service* to the next higher system layer and to use the level "n-1" communication service provided by the next lower system layer. Both of them follow the "level n" *protocol* to perform the communication between interacting entities,

bottlenecks of the hierarchical communication system:

- **In a distributed system, consisting of heterogeneous computers, connected by slow communication lines, the overhead might be tolerable. Plenty of computing capacity would be available for running complex protocols, but the narrow communication bandwidth constraints the closely-coupling between computers.**

- **On the other hand, in a distributed system consisting of identical computers connected by high speed local network, the price of the ISO model is generally too high.**



Layering in cooperating open systems

To meet the demand that sites have the mutual ability to transfer files and to invoke remote procedures across diverse networks, DOSes must contain higher level communications protocols, particularly Open System Interconnection (OSI) layers four and five.

Cross-networking