
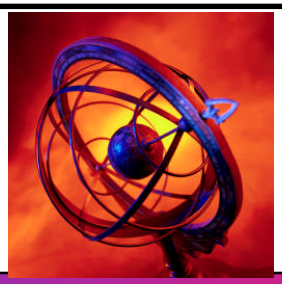


Introduction to the OSI Model and the Physical Layer

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Learning Objectives

You will be able to:

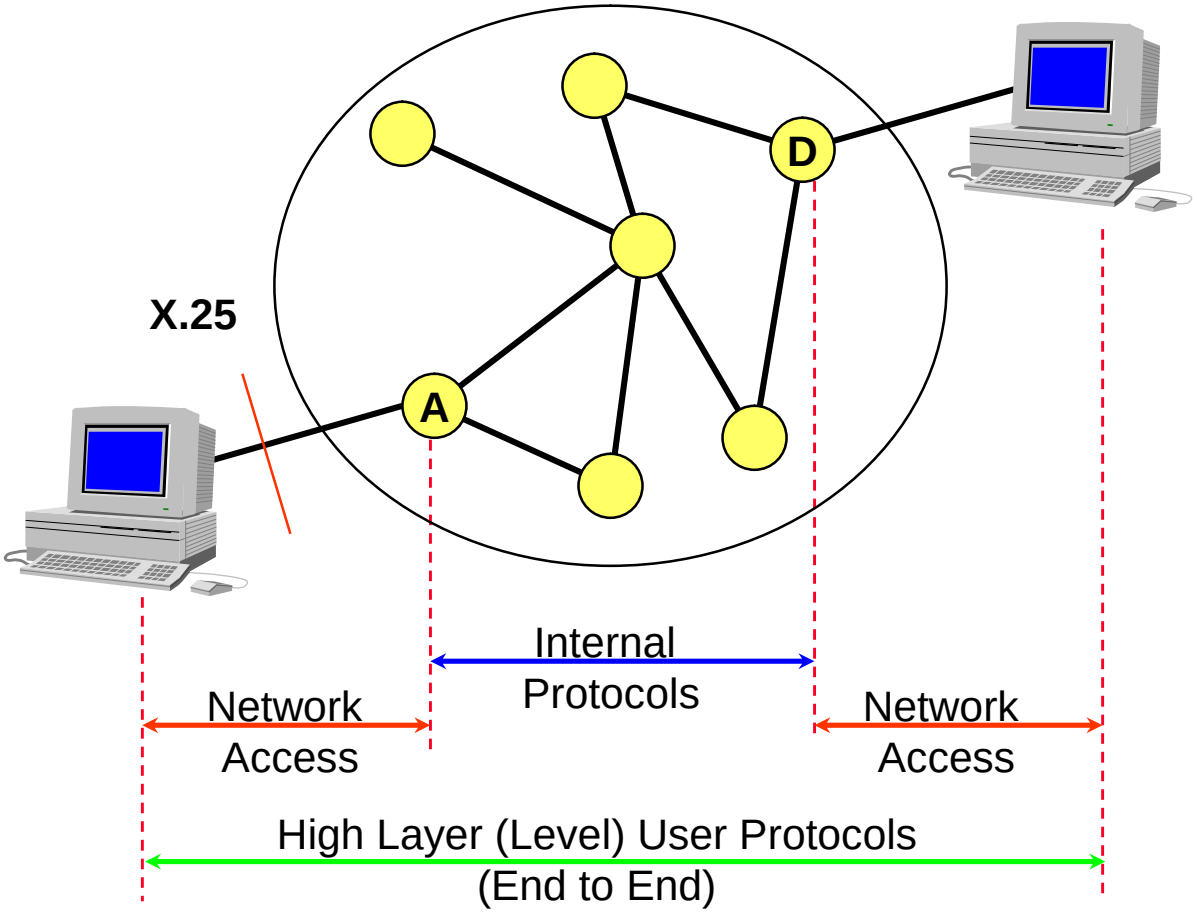
- **Describe the concept of Layering as it applies to communication protocols**
- **Identify and describe the basic components in the OSI Reference Model such as:**
  - the N+1, N and N-1 Layers,
  - Layer Entities,
  - the Service Access Point (SAP),
  - the role of primitives,
  - the difference between Inter-Layer and peer communication,
  - the basic functions of the various Layers of the OSIRM
- **Identify and describe the layered components of a TCP/IP network**

References

- Forouzan, “Data Communications and Networking”, 4th Edition
- Tanenbaum, “Computer Networks”, 4th Edition
- Cisco CCNA1 Module 10 - part 1
- Stallings, William 2000 ‘Data and Computer Communications’, Prentice Hall, Sixth Edition
- Russell, Travis 1997 ‘Telecommunications Protocols’, McGraw Hill

Introducing Protocols

(Protocols in a Data Network)

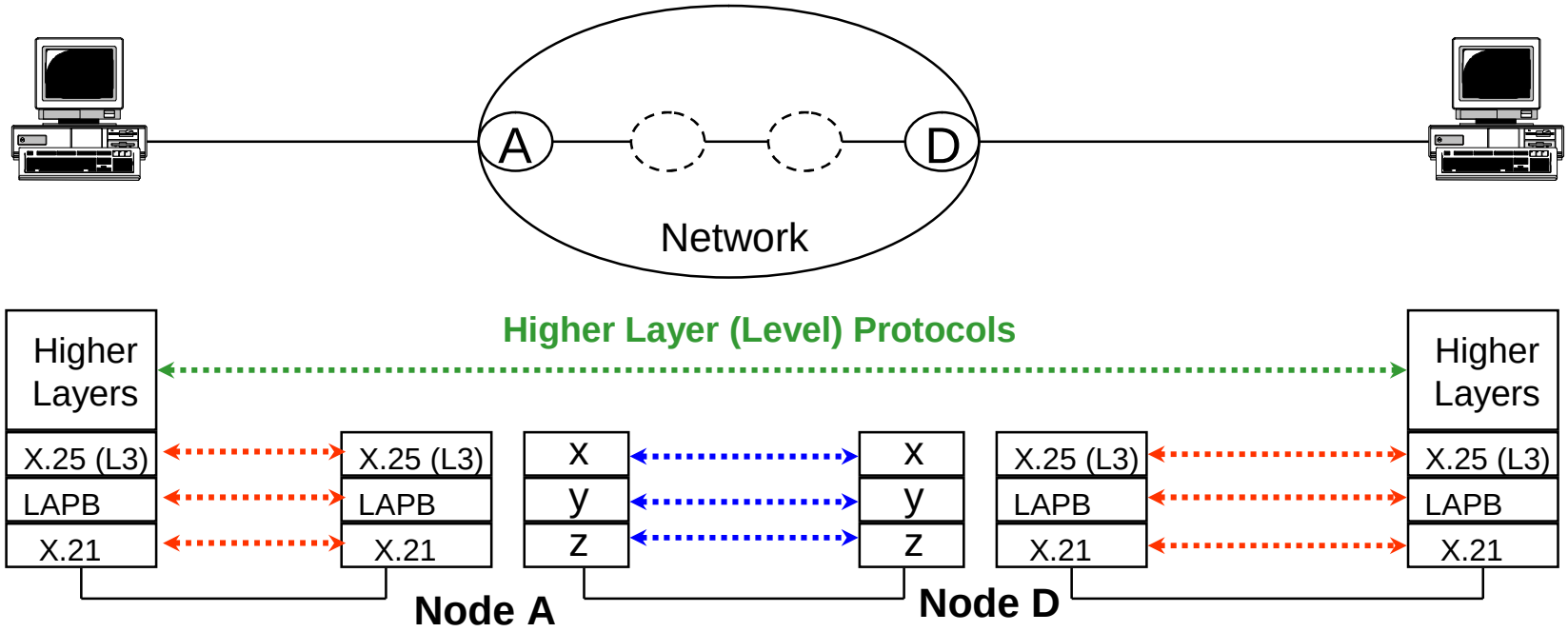


- Network Access Protocols
  - Highly standardised
  - Describe how to use a network
  - Specified as if each user is the only network user.
- Internal Protocols

Introducing Protocols

(A Protocol Model for a Data Network)

- **The Packet Switching Network of the Previous Slide can be viewed in terms of a Layered Model**



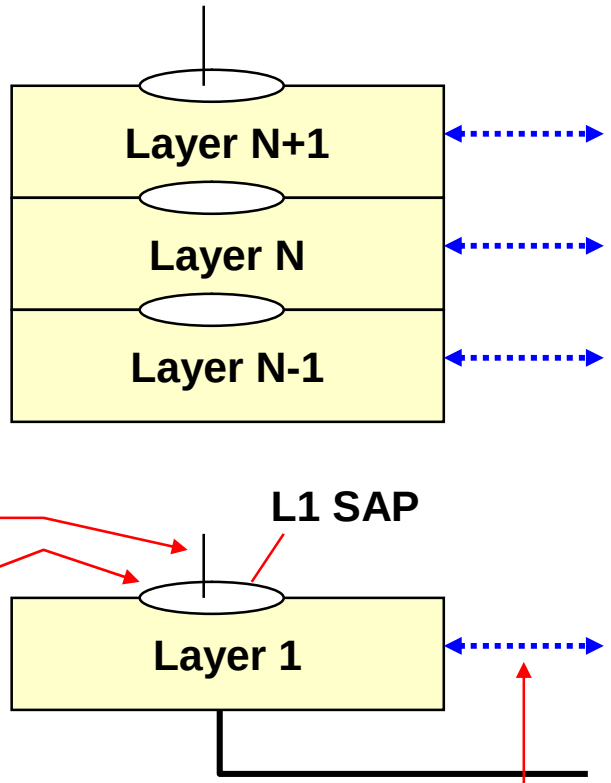
Introducing Protocols
(A Definition)

- **According to the "Webster's New World Dictionary "**
  - A protocol is .. "a set of rules governing the communications and the transfer of data between machines, as in computer systems".
- **Other dictionaries will talk about the "rules of interaction" between organisations, countries, people or machines**

The point here is that for two entities to interact / communicate / co-operate there must be a set of rules that describe how the communication is to take place (including definitions of the semantics and syntaxes involved)

Introducing Protocols
(A Definition - 1)

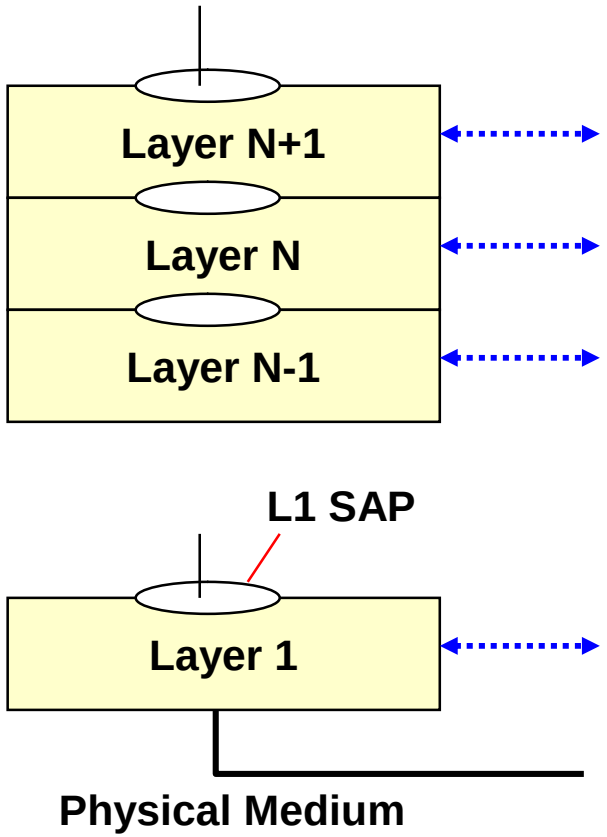
- To “handle” complex protocols designers “compartmentalised” communication protocols into Layers
- Communications and data transfer between machines takes place at many "layers".
- Each layer provides a Service (via InterLayer Communication) to it’s higher Layer through the SAP
- And communicates with its peer in the remote system



Introducing Protocols

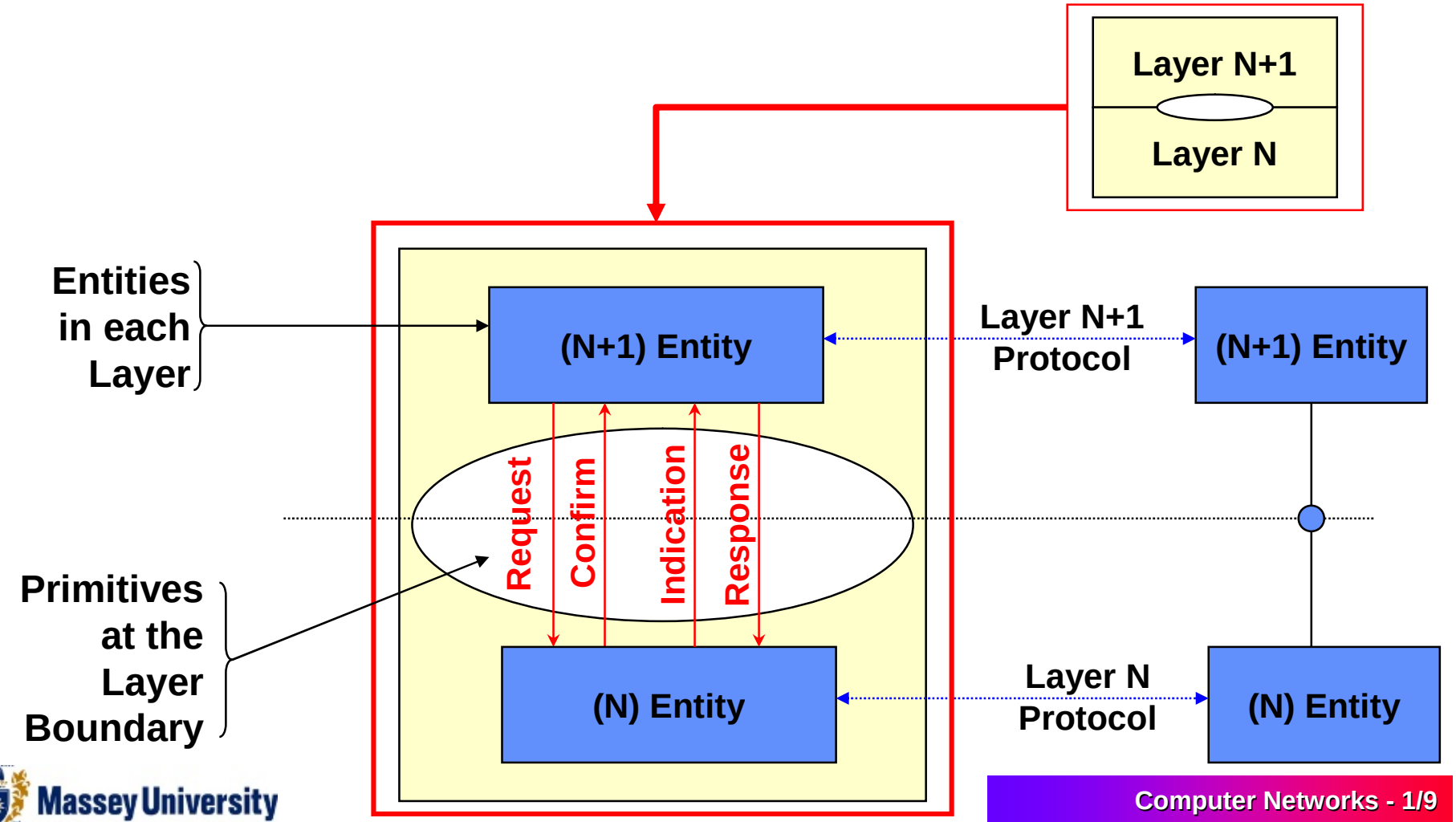
(A Definition - 2)

- These layers can be implemented as software, hardware or a combination of both
- InterLayer Communications can be anything from software messages to the raising or lowering of voltage levels
- Peer Communication is always in terms of abstract Protocol Data Units (PDUs).
- The only actual communication is on the Physical Medium



Introducing Protocols

(Entities and Primitives)



Introducing Protocols
(Goals of the OSIRM)

- The Open Systems Interconnection Reference Model (OSIRM) effort strove to define the functions and protocols necessary for any computer system to connect to any other computer system, regardless of the manufacturer.

- In 1977, the International Organisation for Standardisation (ISO) started work on the OSIRM. The Basic reference model was documented in 1983 as ISO standard 7498.

OSI has standardized many of these protocols, but only a few are in widespread use.

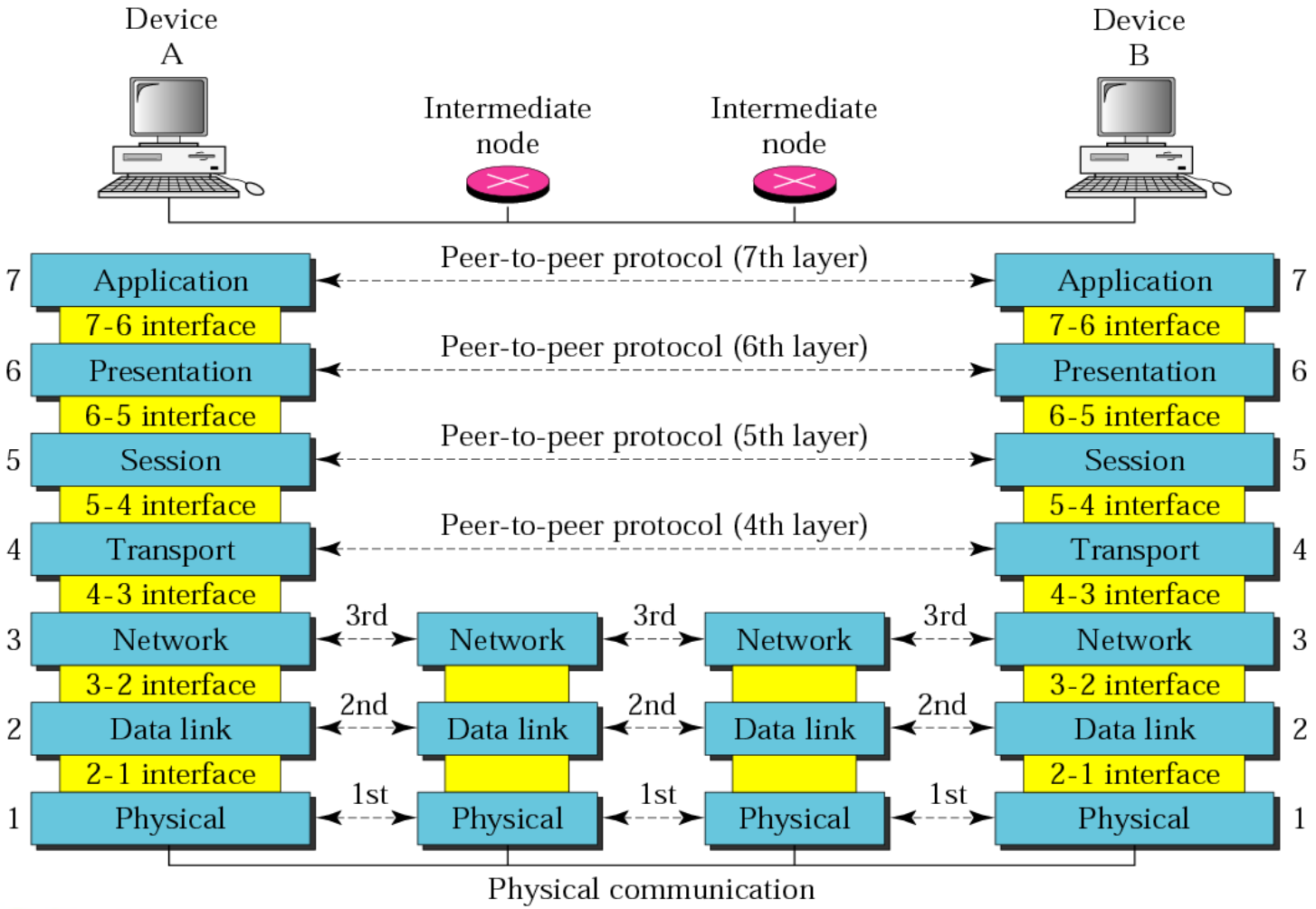
The layering concept, however, has been widely adopted by every major computer and communications standards body and most proprietary implementations as well.

Introducing Protocols
(OSIRM and the Future)

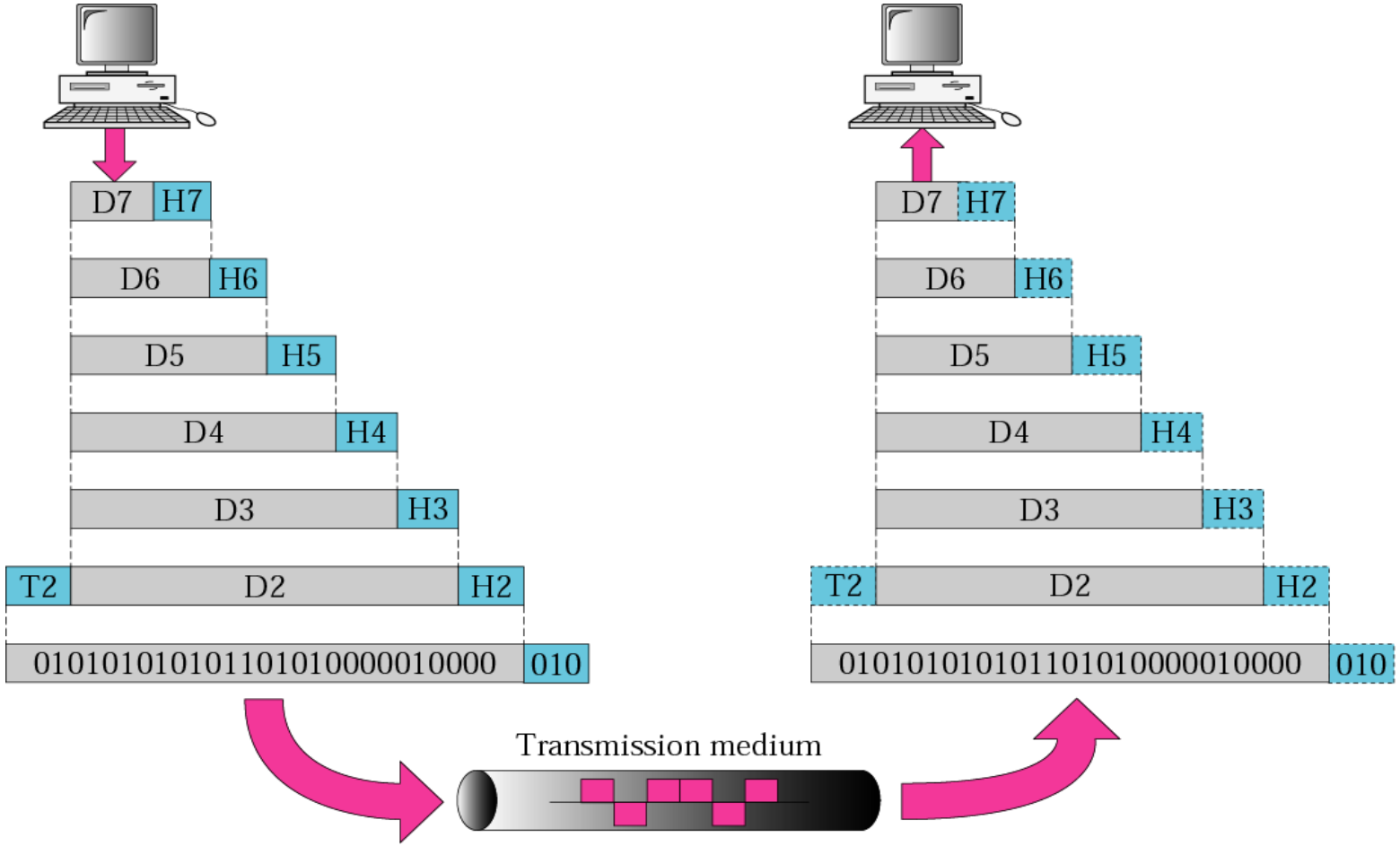
- Whilst ISO defined protocols for the OSIRM may not be in wide use. Communication product vendors relate their commercial offerings to the OSIRM.
- That is…… Protocol X is a Transport Layer Protocol, or Protocol Y is a Session Layer Protocol
- It is, and will continue to grow to be the framework for modelling of communication systems

While “Internet” protocols (i.e. those developed by the IETF) will be commercially dominant.

OSI Layered Model



Communication between layers

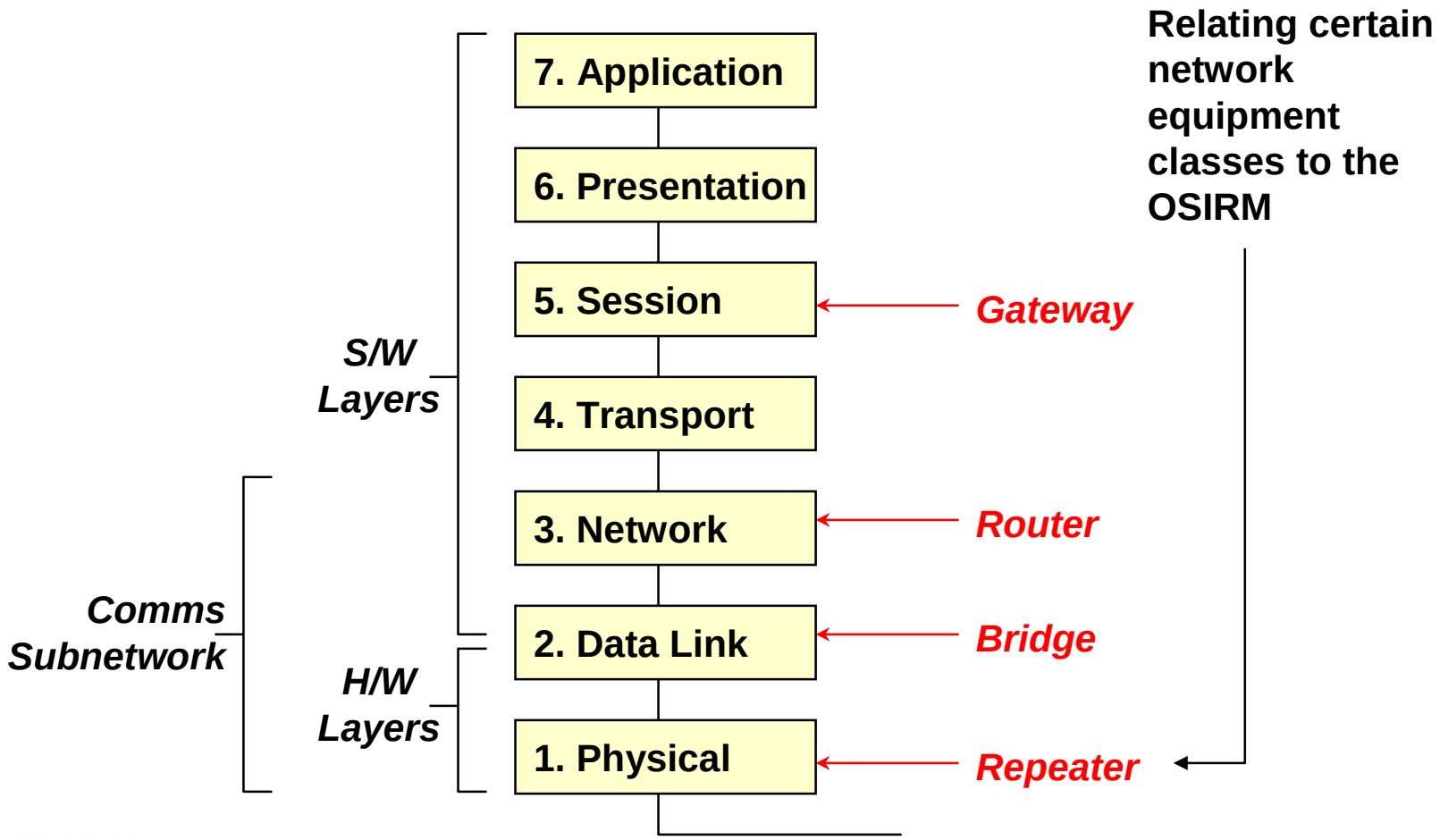


Overview of the Layers

Application	To allow access to network resources
To translate, encrypt and compress data	**Presentation**
Session	To establish, manage and terminate sessions
To provide reliable process to process message delivery and recovery	**Transport**
Network	To move packets from source to destination; to provide internetworking
To organise bits into frames; to provide hop-to-hop delivery	**Data Link**
Physical	To transmit bits over a medium; to provide mechanical and electrical specifications

Introducing Protocols

(The Basic OSI Reference Model - 1)



Introducing Protocols

(The Basic Reference Model - 2)

- **7. Application**
- **6. Presentation**
- **5. Session**
- **4. Transport**
- **3. Network**
- **2. Data Link**
- **1. Physical**

Defines network segmentation and network address scheme. *Connectivity over multiple network segments* Cornerstone on which all upper layers are based.
Units is "Packets"

Creates packet headers & checksum trailers. Packages datagrams into frames. Detects errors. Regulates data flow. Maps hardware *addresses. (FDDI,* Ethernet, T1)
Units **is "Frames"**

Defines physical and electrical *specifications for* transmission. Defines connector types and pin-outs, voltage and current. (e.g., RS-232, V.35)
Units is "Bits"

Introducing Protocols

(The Basic Reference Model - 3)

- **7. Application**
- **6. Presentation**
- **5. Session**
- **4. Transport**
- **3. Network**
- **2. Data Link**
- **1. Physical**

Connection negotiation, establishes and maintains connection, and synchronises dialog. (RPC, Nethios, service 'ports')
Unit is "Message"

Assures end-to-end reliability. Translates & manages message communication through subnetwork. Insure data integrity and deals with packet sequencing. (e.g. TCP)
Unit is "Segment"

Introducing Protocols

(The Basic Reference Model - 4)

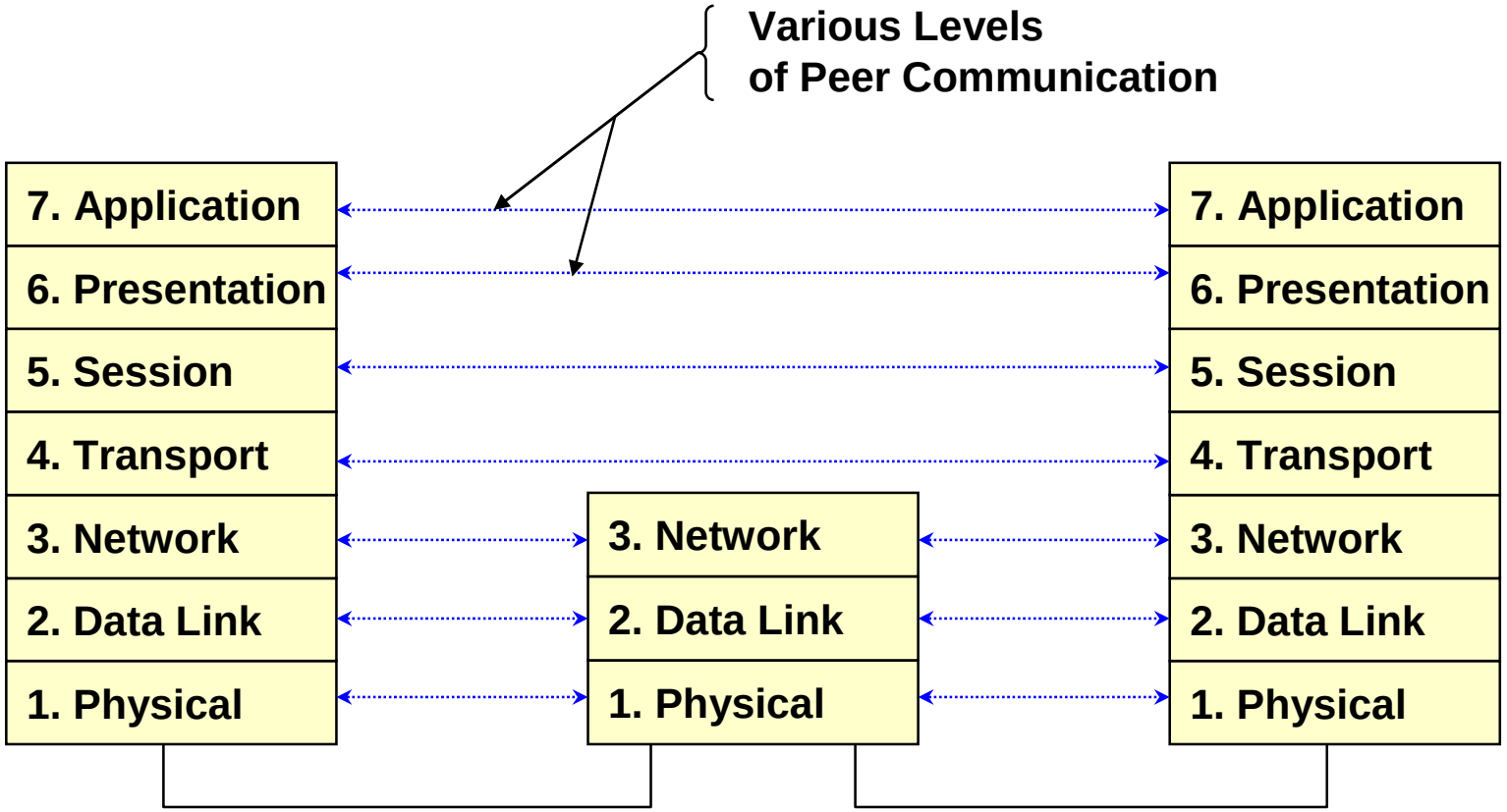
- **7. Application**
- **6. Presentation**
- **5. Session**
- **4. Transport**
- **3. Network**
- **2. Data Link**
- **1. Physical**

Manages program requests that require access to services provided by a remote system.(FFP, NFS, MHS, Netware requester)
Unit is "Message"

Translates data format of sender to data format of receiver. Also performs encryption. Provides data compression, translation and *encryption.*
Unit is "Message"

Introducing Protocols

(End and Intermediate Systems - 1)



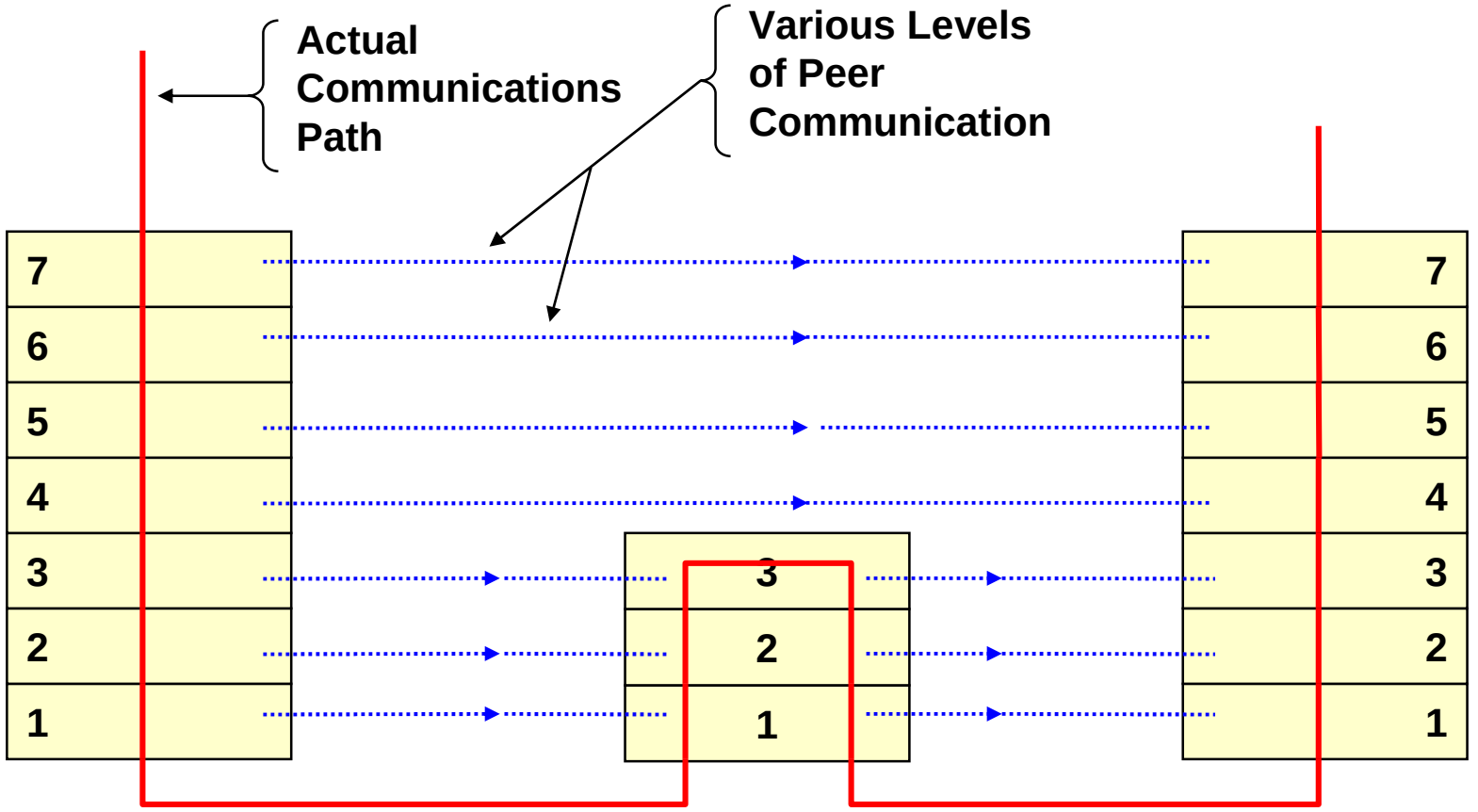
Introducing Protocols

(End and Intermediate Systems - 2)

- Each of the seven layers represents one or more protocols that define the functional operation of communications between user and network elements.

- All protocol communications between layers are "peer-to-peer" - depicted as horizontal arrows between the layers. Standards span all seven layers of the model.

Introducing Protocols
(Following Interlayer & Peer Communication)



Connection-oriented and connectionless services

- The service each layer provides to the layer above can be classified into two different types,
- Connection oriented service requires a pair of processes in the two computers to establish a connection before sending data.
- In connectionless service, data packets are independent of each other and they may not arrive at the destination in the proper order.

Connection-oriented service over a single link

- In connection-oriented service, a logical connection is established by having both sides initialize variables and counters needed to keep track of which frames have been received and which ones have not
- In connectionless service, this connection does not need to be established, therefore data frames can get lost, corrupted, duplicated, and out of order.

Connection-oriented service over multiple links

- In connection-oriented service, a path from the source to the destination must be established before any data packets can be sent. This connection is called a VC (virtual circuit).
- In connectionless service, no advance setup is needed. In this context, the packets are called datagrams. The datagrams carries the full destination address, and each is routed through the system independent of all the others.

Application layer

- Provides the user interface, application programs, access to distributed information services
  - ex.
  - File Transfer Protocol (FTP), E-Mail
- Other important tasks
  - Identification and checking the availability of the called party
  - Agreement on encryption mechanisms and responsibility for error recovery
  - Procedures for initiation and release of a dialog

Presentation Layer

- Concerned with the representation of syntax of data during transfer of information between two application processes
- Performs the necessary conversion if two application processes use different syntaxes
  - ex. Two people who speak different languages communicating with each other. The PL does the job of the interpreter. The PL at each end translate the message to English before handing it to SL
- Performs encryption using a secured key if requested by the AL

Session Layer

- Sets up and clear the dialog between two PL protocol entities
- In the case of half duplex (two way alternate) mode of dialog, it controls the exchange of data (dialog units)
- Token management- in case both sides are not supposed to attempt the same operation at the same time, users are issued with tokens. Only the user who has the token at a given time can perform the critical operation
- Can establish synchronization points during lengthy transactions as requested by the user via SL
- Reports of non-recoverable data to higher layers.

Transport Layer

- Provides higher layers with a message transfer facility which is efficient, reliable and cost-effective and independent of the network layer
- Can offer various classes of service because of the varied quality of service (QOS) provided by different networks - ranging from basic functions needed for connection establishment and data transfer to full error control and flow control

Network Layer

- Concerns with routing messages from the source to the destination through the network. This may require making multiple hops at various nodes in the network
- The main tasks of the NL are
  - Providing services to the TL, such as connection oriented or connection less, explicit confirmation of delivery and priority schemes
  - Routing of packets
  - Congestion control
  - compatibility issues associated with internetworking

Data Link Layer

- DLL converts a raw transmission media (coaxial cable, satellite channel) into a line that appears free of transmission errors to the network layer and it concerns about the link established between two ends of a single transmission facility, i.e. no nodes or switching centres in the middle
- The main tasks are
  - Services provided to the NL,such as unacknowledged connectionless service, acknowledged connectionless service and connection oriented service
  - framing
  - error control
  - flow control

Physical Layer

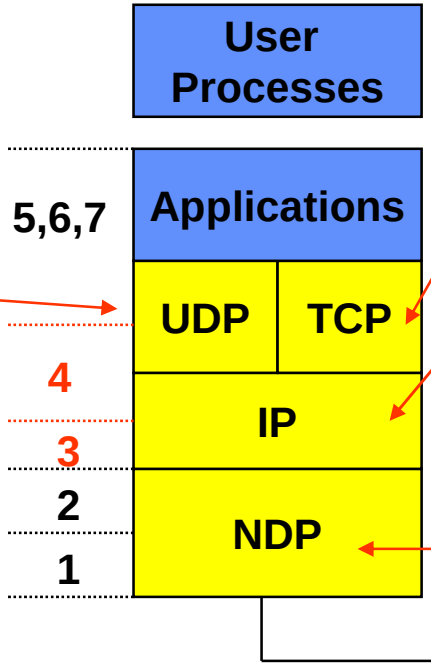
- The physical layer concerns with issues related to the utilisation of a given physical medium (copper wire, optical fiber, free space) for digital data transmission
- The main tasks of the physical layer are
  - defining voltage levels of various signals and bit rates
  - analogue to digital and digital to analogue conversion
  - error control coding
  - multiplexing schemes
  - modulation and demodulation

Some Revision on TCP/IP Networks

- Nodes in a TCP/IP network are modelled using a 5 layer model.
- They can also be modelled using the OSI 7 layer model.. It is just that the TCP/IP community use a 5 layer model
- Note that in the past they have used a three layered model…. So their model complexity is growing

A TCP/IP Node and a Rough Equivalence to OSI Layering

An element of the communications stack



Transport Control Protocol

- Provision of a reliable connection oriented service

User Datagram Protocol

- Unreliable Datagram service but supports the ability to find multiple Applications on the target machine

InterNet Protocol Layer

- Routing on IP Addresses
- Provision of an unreliable Datagram service over multiple networks

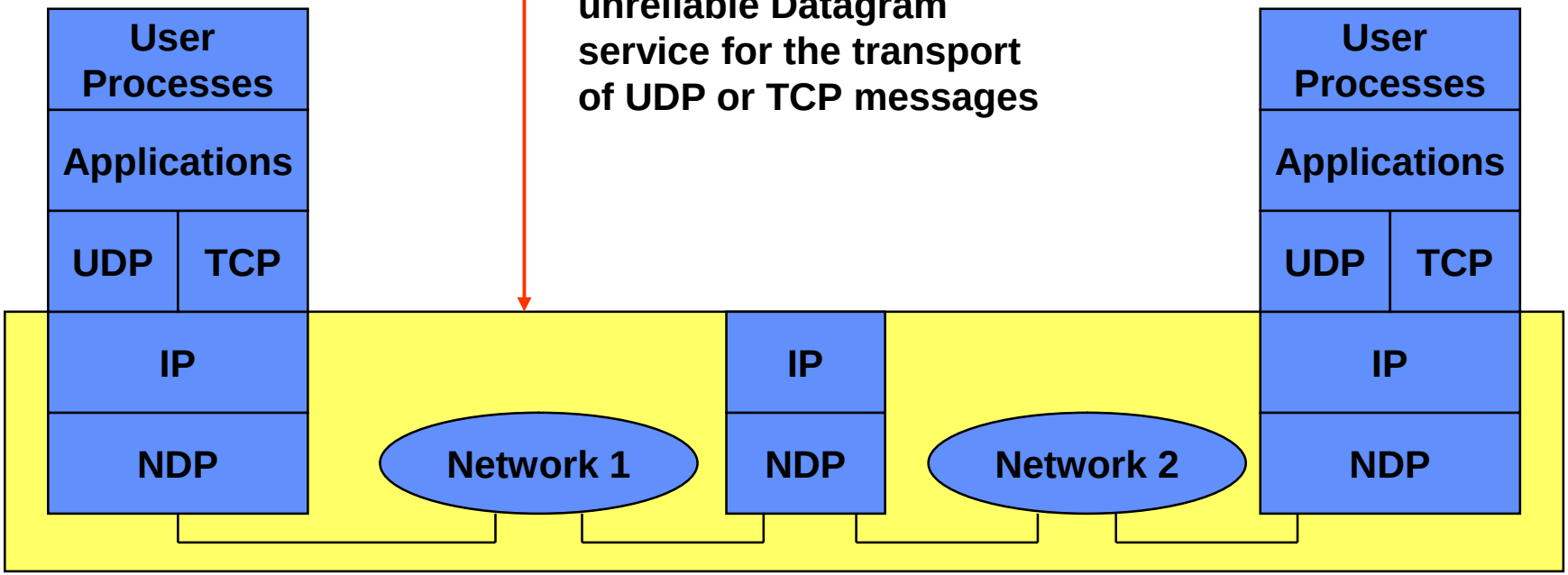
Network Dependent Protocols

- Those protocols necessary to connect to a network

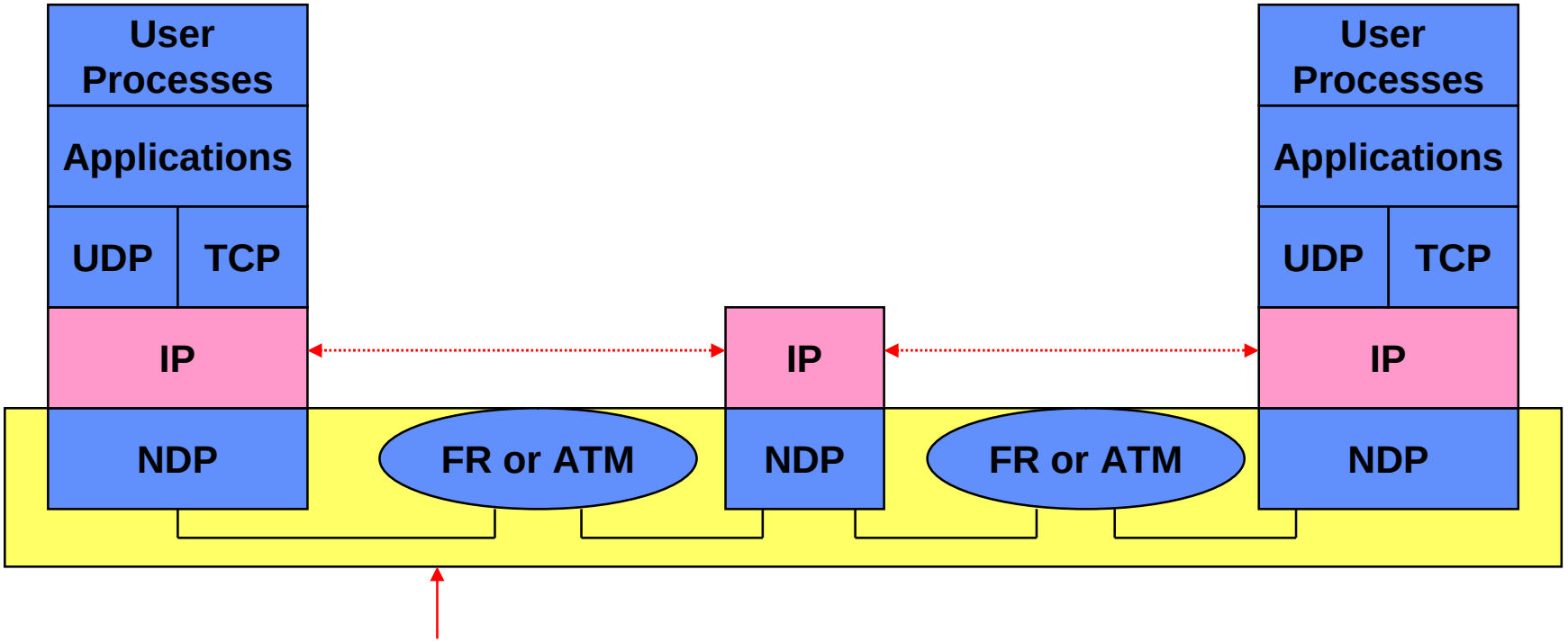
A TCP/IP Network Model

The Internetwork

- A collection of networks that provide an unreliable Datagram service for the transport of UDP or TCP messages

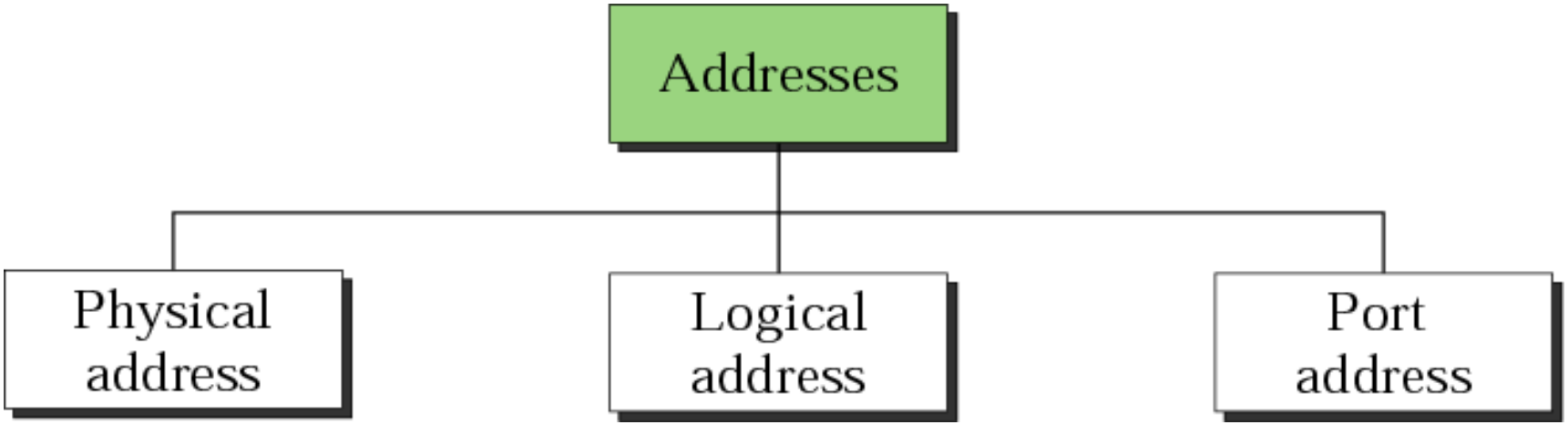


A TCP/IP Network Model

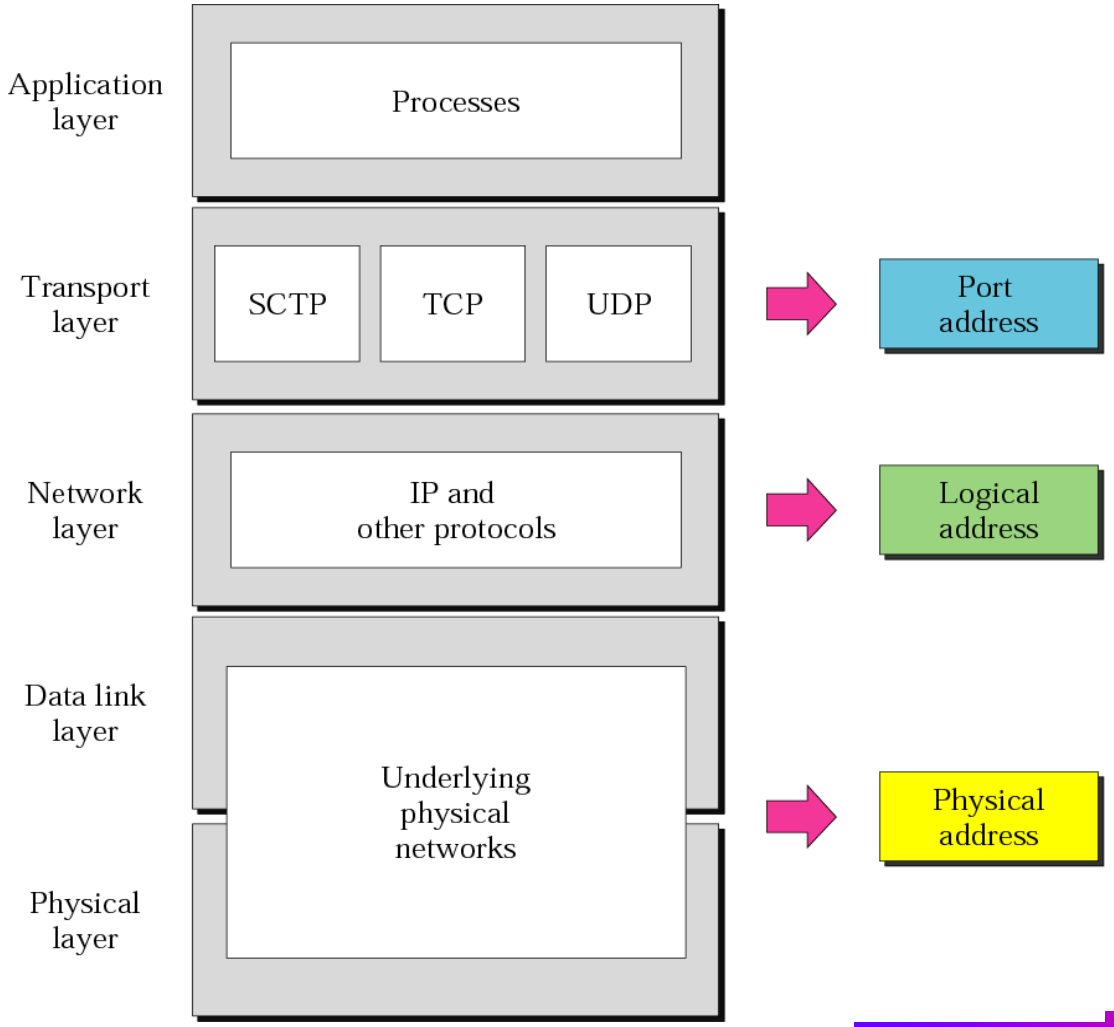


- A collection of networks that can carry an IP Datagram (e.g. Frame Relay or ATM)

Addresses in TCP/IP



Relationship of layers and addresses in TCP/IP



Physical addresses