Layered Architecture

by

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Outline of the Lecture

- Why Layered Approach?
- What is Layered Approach?

- Basic Principles of Layered Approach

- Layers and Interfaces
- Entity and Protocols
- Services and Service Access Points
- Types of Services
- Service primitives

- ISO's OSI Reference Model
- Functions of different layers of OSI Model

Basic Concepts

- For successful communication, two systems must follow a common set of rules for generating and interpreting messages
- The set of rules to be followed is very complex
- Layered approach provides a viable approach to deal with a complex problem

Layered Approach

- A complex problem is divided into a number of pieces of manageable and comprehensible size
- It provides structured modular approach
- Each module can be developed and tested independently
- Allows easy enhancement and implementation of the functions of particular layer without affecting other layers

Basic Principles of Layering

- Use optimum number of layers
- Put similar functions in the same layer
- Create a layer where we need different levels of abstraction
- Allow changes of functions to be made within a layer without affecting others
- Create layer boundaries for each layer with its upper and lower layers
- Choose layer boundaries to minimize information flow across the boundaries

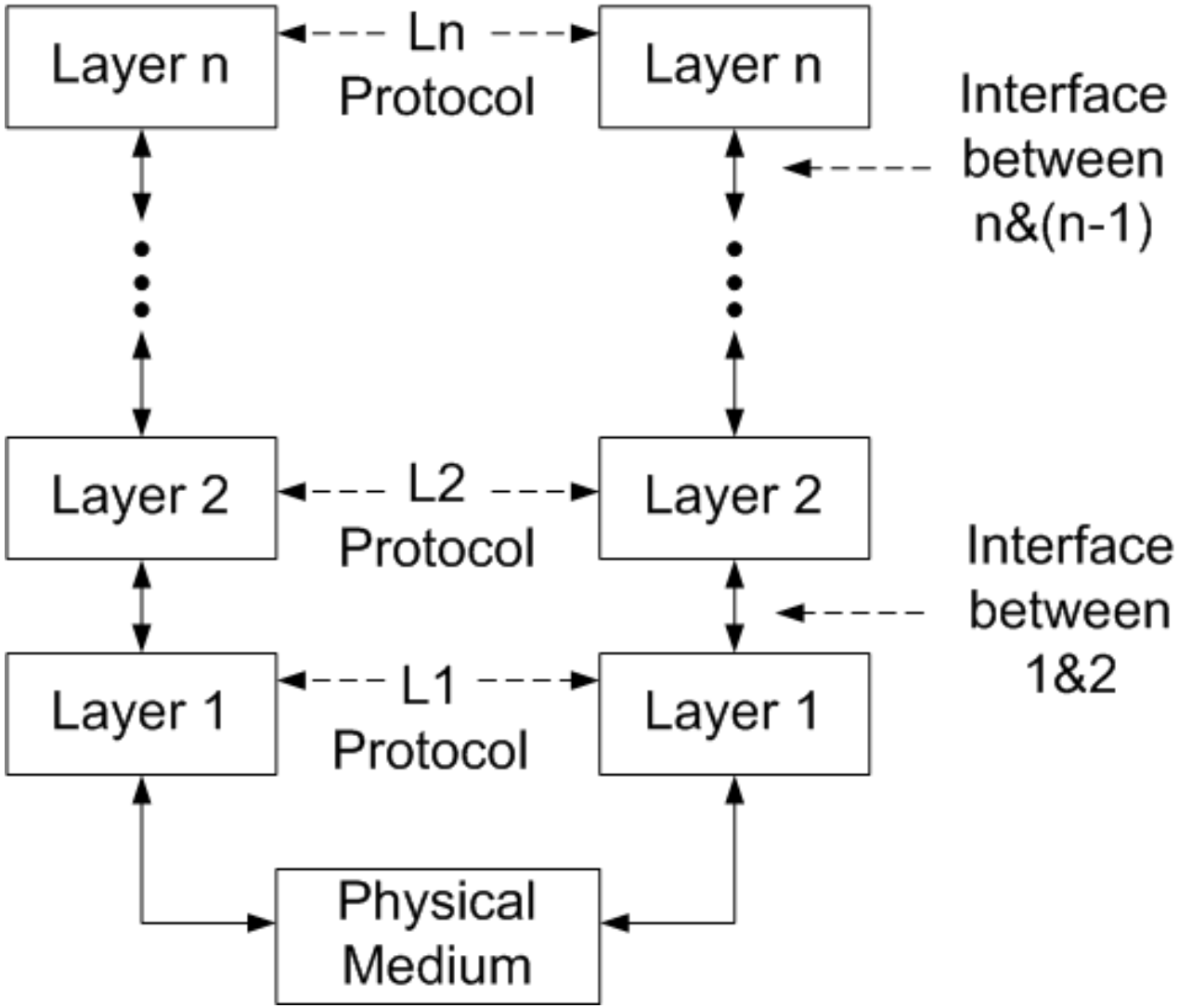
Layers and Interfaces

- System interconnection rules and modularized in terms of series of layers of functions, say N layers
- Each layer contains a group of related functions
- A layer below Layer n and a layer above Layer n are Layers (n-1) and (n+1), respectively
- Between each pair of adjacent layers, there is an interface

Cont…

- Interface defines which primitives services the lower layer offers to the upper layer
- Layer n provides services to Layer (n+1) through service access points
- Each layer adds value to the services provided by lower layers

Example


Layer n
Ln
Protocol
Layer n
Interface
between
n&(n-1)
Layer 2
L2
Protocol
Layer 2
Interface
between
1&2
Layer 1
L1
Protocol
Layer 1
Physical
Medium

Entity and Protocol

- Data communication occurs between two entities in different systems
- Entity is something which is capable of sensing, processing, and receiving information
- For communication to take place the entities should follow an agreed upon protocols

Cont…

- A protocol is a set of rules that govern data communication
- It defines -- What, How, When
- Syntax: Refers to the structure or format of data
- Semantics: The way the bit patterns are interpreted and the actions taken based on interpretation
- Timing: Specifies when data can be sent and how fast it can be sent

Services

- Connection-oriented / Connection-less
- Quality-of-Services
- Few examples:
  - Sequence arrival of pages
  - Remote Log-in
  - Digitized voice

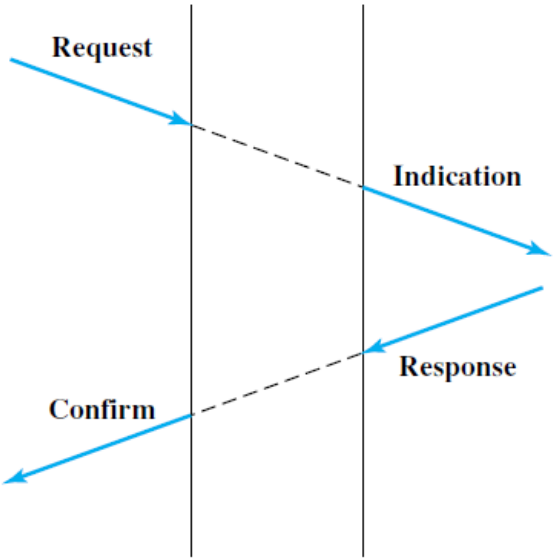
  } Connection-oriented

  - Registered mail
  - Electronic Junk mail
  - Database enquiry

  } Connection-less

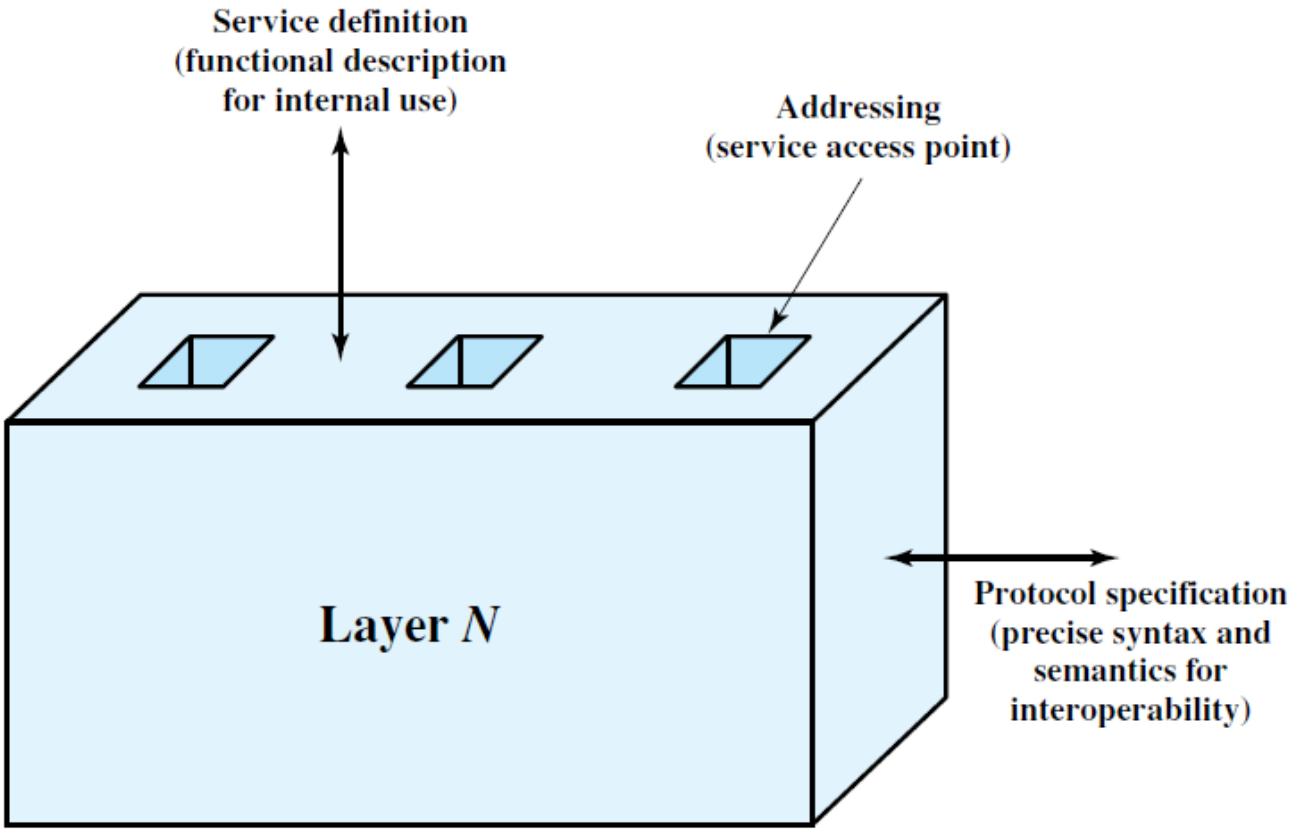
Service Primitives

- Request: A primitive issued by a service user to invoke some service
- Indication: A primitive issued by a service provider to signal the called party
- Response: A primitive issued by a service user to acknowledge **or** complete some procedure previously invoked by an indication to that user
- Confirm: A primitive issued by a service provider to acknowledge **or** complete some procedure previously invoked by the service user



(a) Confirmed service

Service Access Points



Information Flow in Layered Architecture

- Layer n on one machine carries on conversion with Layer n on another machine
- Rules and conventions used in this conversation are collectively known as Layer-n Protocols
- List of protocols used by certain system is called protocol stack
- Set of Layers and Protocols is the Network Architecture

What is Architecture?

- Architecture is a set of rules and conventions used to build something
- It does not specify implementation details
- It is a model – a framework of standard
- A standard based on model can be implemented

OSI Model

- The Open Systems Interconnection (OSI) reference model was developed by the International Organization for Standardization (ISO) as a model for a computer protocol architecture and as a framework for developing protocol standards.

- The OSI model consists of seven layers

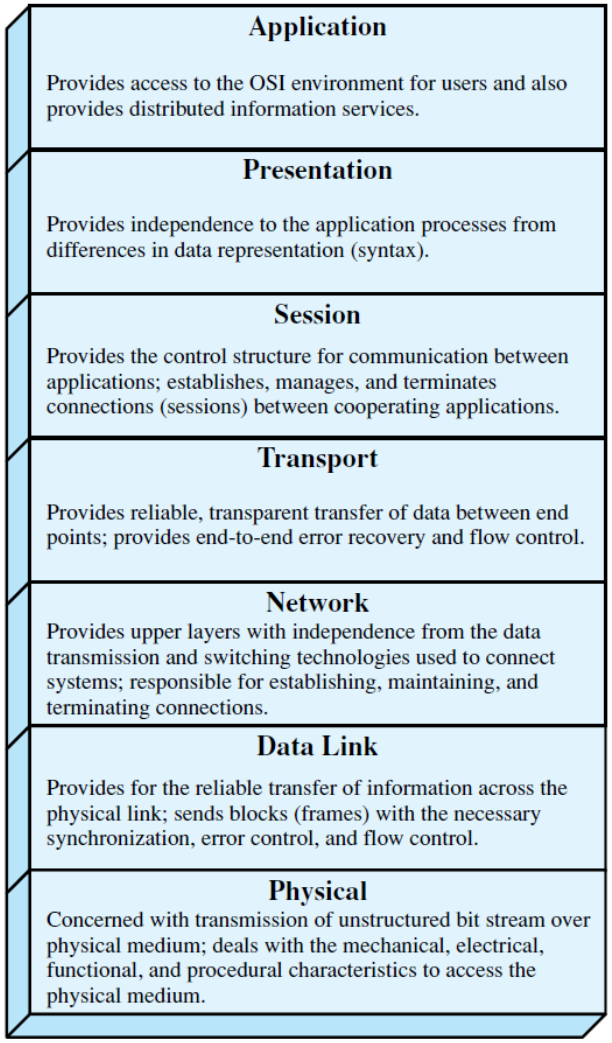


Figure 2.6 The OSI Layers

Physical Layer

- Concerned with transmission of raw bits over a communication channel
  - Number of pins and functions of each pin of the network connector (Mechanical)
  - Signal level, Data rate (Electrical)
  - Whether simultaneous transmission in both directions
  - Establishing and breaking of physical connection
  - Deals with physical transmission medium

Datalink Layer

- This layer transforms the physical layer to a reliable transmission/reception of a structured stream.
  - Framing
  - Physical addressing
  - Synchronization
  - Error control
  - Flow control
  - Character / Bit orientation
  - Medium access control – e.g, ALOHA, CSMA, etc.

Network Layer

- Responsible for source-to-destination delivery by establishing, maintaining, and terminating connections.
  - Packet
  - Logical addressing
  - Routing
    - Virtual Circuits
    - Datagram Services
  - Assembly / disassembly of messages
  - Message priorities
  - Internetworking

Transport Layer

- Responsible for true end-to-end communication
  - QoS requirement
  - Port addressing
  - Multiplexing
  - Segmentation and Reassembly
  - Connection control
  - End-to-end error detection and recovery
  - Flow control

Session Layer

- Establishes connection and termination
- Perform dialog management
  - Who speaks, when, how long
  - Simplex / Half-duplex / Full-duplex
- Recovery using check pointing
- Token Management

Presentation Layer

- Syntax and semantics of information
- Data types
- Character codes
- Data compression / decompression
- Encryption / decryption

Application Layer

- Concerned with user applications
- Common Application Service Element (CASE) – login, password checks
- Specific Application Service Element (SASE) –
  - File transfer, access, and management
  - Job transfer, and manipulation
  - E-mail
  - Teletex, Telefax, etc.
  - Message handling
  - Document transfer

Thanks!

Figure and slide materials are taken from two main sources:

1. Data and Computer Communications, by W. Stallings
2. NPTL lecture on Data Communication, by Prof. A. K. Pal, IIT Kharagpur