Chapter I
Layered Protocol Architectures
Layered protocol architectures

- 1 - Motivation, concepts and design issues
- 2 - Reference models
Motivation, concepts and design issues

Figure 1.13 (Reference [1])
Motivation, concepts and design issues

Figure 1.15 (Reference [1])
Motivation, concepts and design issues

• Why organize network software/firmware/hardware in a stack of layers?
  – A layer N provides a service to its user (Layer N+1) but keeps the details of its internal state and algorithms hidden
    • Hierarchisation
    • Modularization
    • Information hiding
    • Data encapsulation
    • Abstract data types
    • Object oriented programming
Motivation, concepts and design issues

• The key concepts
  – Protocol, protocol stack
  – Interfaces and services
  – Network architecture
Motivation, concepts and design issues

• Protocol
  – Rules governing the exchange of messages between peer layers (or entities in general)
    • Syntax
    • Semantics
    • Sequencing

• Protocol stack
  – List of protocol used by a given system, one per layer
Motivation, concepts and design issues

- Interface and services
  - Between adjacent layers
    - Primitive operations and services made available by the lower layer to the upper layer
  - Service specification
    - Set of primitives operations available to a user process to access the service
      - Connection – oriented services
      - Connection-less services
Motivation, concepts and design issues

- Interfaces and services
  - Example of 5 service primitives for implementing a simple connection oriented service (figure 1.17 – reference [1])

<table>
<thead>
<tr>
<th>Primitive</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>LISTEN</td>
<td>Block waiting for an incoming connection</td>
</tr>
<tr>
<td>CONNECT</td>
<td>Establish a connection with a waiting peer</td>
</tr>
<tr>
<td>RECEIVE</td>
<td>Block waiting for an incoming message</td>
</tr>
<tr>
<td>SEND</td>
<td>Send a message to the peer</td>
</tr>
<tr>
<td>DISCONNECT</td>
<td>Terminate a connection</td>
</tr>
</tbody>
</table>
Motivation, concepts and design issues

- Relationship between services and protocols
  - Figure 1.19 – reference [1]
Motivation, concepts and design issues

• Design issues for the layers
  – Addressing
  – Error control
  – Flow control
  – Routing
Motivation, concepts and design issues

• Network architecture
  – Set of layers and protocols
  – Examples
    • OSI reference model
    • TCP/IP reference model
Reference model

OSI reference model

– Figure 1.20 – reference [1]
Reference model

- OSI Reference model
  - The 7 layers
    - Application
    - Presentation
    - Session
    - Transport
    - Network
    - Data link
    - Physical
Reference model

- OSI Reference model
  - Application Data Unit (APDU)
  - Session Data Unit (SPDU)
  - Transport Data Unit (TDU)
  - Packet
  - Frame
  - Bit
Reference model

- OSI Reference model
  - Key issues
    - Bad timing
    - Bad technology
    - Complexity leading to bad implementations
Reference model

- TCP / IP reference model
  - Figure 1.21 (Reference [1])

<table>
<thead>
<tr>
<th>OSI</th>
<th>TCP/IP</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Physical</td>
</tr>
<tr>
<td>2</td>
<td>Data link</td>
</tr>
<tr>
<td>3</td>
<td>Network</td>
</tr>
<tr>
<td>4</td>
<td>Transport</td>
</tr>
<tr>
<td>5</td>
<td>Session</td>
</tr>
<tr>
<td>6</td>
<td>Presentation</td>
</tr>
<tr>
<td>7</td>
<td>Application</td>
</tr>
</tbody>
</table>

TCP/IP:
- Application
- Transport
- Internet
- Host-to-network
Reference model

- TCP/IP reference model
  - Figure 1.22 (Reference [1]) – Protocols and networks in the TCP/IP model initially
## Reference model

- Hybrid model
  - Figure 1.24 (Reference [1])

<table>
<thead>
<tr>
<th>Layer</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Application layer</td>
</tr>
<tr>
<td>4</td>
<td>Transport layer</td>
</tr>
<tr>
<td>3</td>
<td>Network layer</td>
</tr>
<tr>
<td>2</td>
<td>Data link layer</td>
</tr>
<tr>
<td>1</td>
<td>Physical layer</td>
</tr>
</tbody>
</table>
References