Networking Lecture Notes

Matt Warner

1 Unit Overview

- Network concepts & terminology
- OSI reference model for protocols
  - Physical layer
  - Data Link layer
  - Network layer
  - Transport layer

2 Network Terminology

- Connected graph constructed from
  - node
  - link
- Nodes can reach others via path:
  - sequence of nodes and links

Note:-

In a network of computers, each computer becomes a node. The connection between nodes are called links.

3 Internet Terminology

- node
  - host or intermediary
- link
  - point-to-point or broadcast
- link medium
  - wired or wireless
- path
  - routed or switched

4 Networking Protocol

- communication in a network is governed by rules and conventions
- information is exchanged between nodes via messages
- messages use well-defined format
- each message has an exact meaning intended to provoke a defined response of the receiver

Note:-

A protocol describes the syntax, semantics, and synchronization of communication

5 OSI Model

- The OSI model divides rules of networking into 7 layers
  - Each layer serves a specific function
  - If all layers are functioning, hosts can share data

5.1 OSI reference model

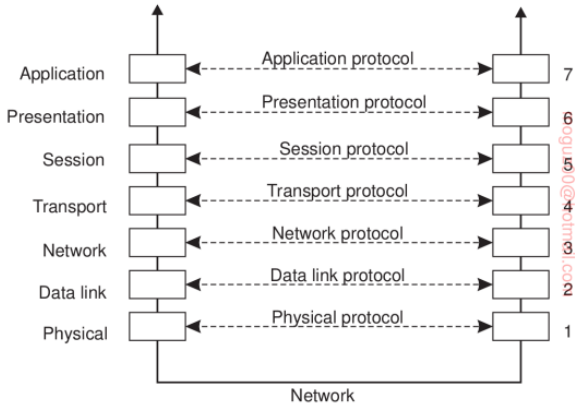

Figure 4.1: Layers, interfaces, and protocols in the OSI model.

6 Layered protocols

- complexities of communication organized into successive layers of protocols
  - lower-level layers: specific to medium
  - higher-level layers: specific to application
- standards achieve inter operability

7 OSI reference model layers

Each of the seven protocol layers are responsible for a share of the communications task between two nodes in the network.

- **Application**: provides services directly to user applications
- **Presentation**: performs data transformations to provide common interface for user applications
- **Session**: establishes, manages and ends user connection
- **Transport**: provides functions to guarantee reliable network link
- **Network**: establishes, maintains and terminates network connections
- **Data link**: ensures the reliability of link
- **Physical**: controls tranmission of the raw bit stream over the medium

7.1 More on Layers

Layer 1 - Physical - Transporting Bits

Computer data exists in the form of Bits (1's and 0's) Anything that contributes to moving bits from one computer to another, is considered layer 1 technology.

L1 Technologies:

Cables: Ethernet, Coaxial, Fiber.

Repeaters

Hubs

Wi-Fi is also considered to be a L1 technology. Wi-Fi solely exisits to cary 1's and 0's from one computer to the next.

Layer 2 - Data Link

Interacts with the Wire (i.e., Physical layer). Puts bits on the wire, and retrieves bits from the wire.

NIC - Network Interface Cards / Wi-FI Access Cards

Layer 2 uses an Addressing Scheme, known as a MAC address

- MAC addresses
    - 48 bits, represented as 12 hex digits
    - **94-65-9C-3B-8A-E5** (windows representation)
    - **94:65:9C:3B:8A:E5** (linux representation)
    - **9465.9C3B.8AE5** (cisco, routers, and switches)
    - Every NIC has a unique MAC address
- L2 Technologies: NICs, Switches

Layer 3 - Network - End to End delivery

Layer 3 uses its own Addressing Scheme, IP addresses

L3 Technologies: Routers, Hosts, (anything with an IP)

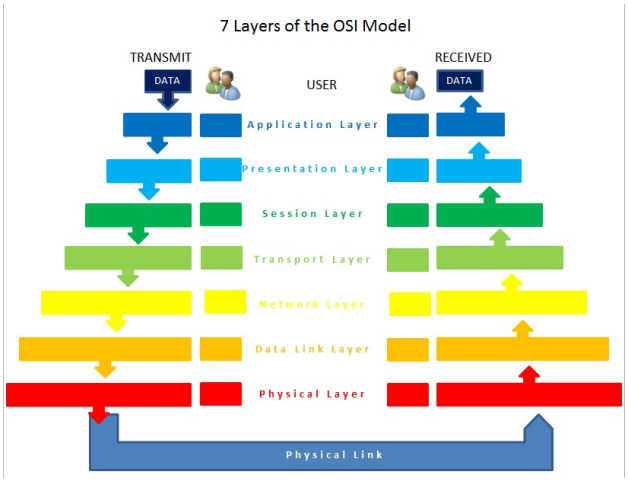

Figure 4.2 OSI reference model layers

8 Physical Layer: Wired Media

- Ethernet (grades below)
  - 10BASE-T, 100BASE-TX, 100BASE-T
  - 10Gbe, 40GbE, 100GbE
- Business/backbone
  - DS1(T1): 1.54Mbs to DS5: 400Mbs
  - **optical circuits:** OC-1: 50Mbs to OC-768: 40Gbs
- Last mile:
  - Modem
  - DSL
  - cable: DOCSIS
  - FiOS

8.1 Physical Layer: Wireless Media

- **Cellphone Data**
  - EDGE, GPRS, HSPA+
  - 4G LTE up to 100MBs
  - 5G over 100Mbs
- **Satellite**
  - Wildblue: 12Mbs
  - HughesNet: 15Mbs
  - Starlink: 200Mbs
- WiFi: 802.11
  - up to 150Mbs & MIMO
  - new: “ac” up to 1Gbs
- WiMax: 802.16
  - up to 40Mbs
- WPAN
  - BlueTooth up to 2Mbs
  - NFC up to 423Kbs
  - ZigBee up to 256Kbs

9 Data Link Layer: functionality

- Medium access control
  - arbitrate who transmits
- Addressing
  - address of recevier, address of sender
- Framing
  - delimited unit of transmission for data & control
- Error control and reliability
- Flow control

10 Network Layer

- also called: Internet Protocol Layer
  - provides host to host transmission service,
    where hosts are not necessarily adjacent
- layer provides services
  - addressing
    - hosts have global addresses: IPv4, IPv6
    - uses data link layer protocol to translate address: ARP
  - routing and forwarding
    find path from host to host

11 IPv4 Address

- IP address • 127.0.0.1
  - 32bit unique identifier, written as quad • 131.156.145.90
- network
  - first n bits of IP number, written as "\n" • 131.156.0.06
  - 8 -class A, 16 - class B, 24 - class C • 131.156.145.0/24
  - more than 24 - class D
- netmask
  - 32 bit number with first n bits all 1, rest 0 • 255.255.255.0
- broadcast
  - network number (first n bits), rest all 1 • 131.156.145.255
- gateway IP • 131.156.145.1
- name server IP • 131.156.145.2

12 IPv6 Address

13 Transport Layer

- Provides end-to-end communication services for applications
- byte format as abstraction on underlying system format
- raises reliability
- enables multiplexing
    - provides multiple endpoints on a single node: port