TCP/IP

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TCP/IP is a suite of communication protocols that defines how data is transmitted & routed over the internet

It is a set of rules & procedures that govern data communication

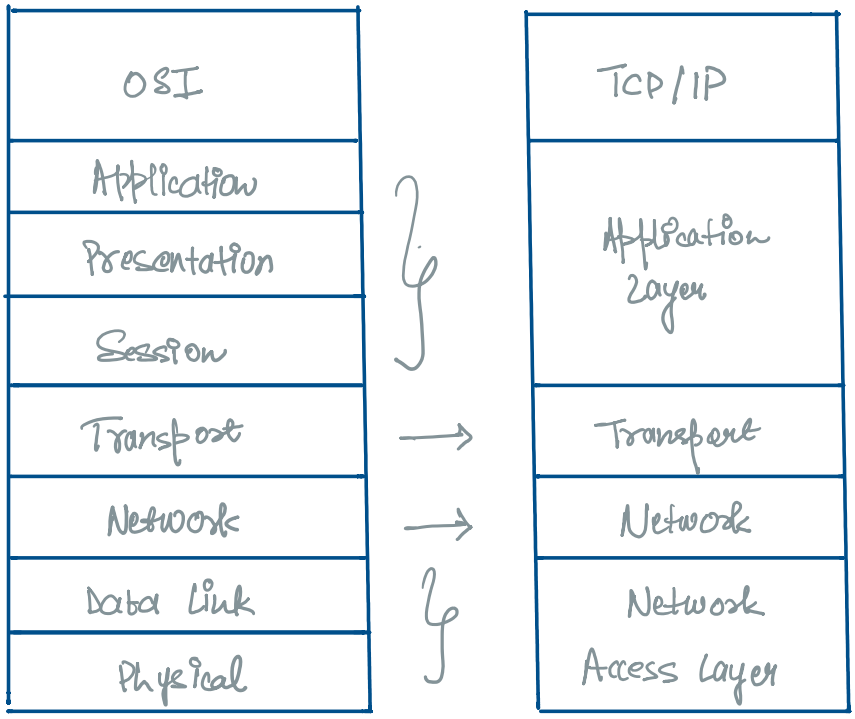
- Ensures reliable transmission of data btw devices (sent in order, without errors & are reassembled correctly at end)

- Responsible for Addressing & Routing packets of data

★ Key Characteristics

- Data Transfer
- Reliability (data delivery by recovering damaged, lost or duplicate data)
- Multiplexing (port nos allowing multiple applications to use the network)
- Connections (connection establish btw port nos of sender & receiver devices)
- Compatibility (designed to work with wide range of hardware & software)
- Scalability (suitable for network of all sizes)
- Open Standards (protocol standards are publicly available & can be implemented by anyone)
- Modular Architecture (add or remove protocols as needed)
- Reliability (error-checking & connection mechanisms)
- Flexibility
- End-to-End Connectivity (without intermediate routing)

★ OSI & TCP/IP



ISO in late 1970's
- Rigid & Strict
- Conceptual tool
- Used for teaching

US DoD in 1960's
- Flexible & Adaptable
- Foundation of modern internet
- Used for real-world network communication

① NETWORK ACCESS LAYER (LINK LAYER)

- Combines Physical & Data Link from OSI
- Primarily responsible for the transmission of data btw two devices on the same network
- Key functions are encapsulating IP datagrams into frames for transmission & mapping IP addresses to physical ones.
- Protocols: Ethernet (IEE 802.3)
  Wi-Fi (IEEE 802.11)
  Point-to-Point Protocol (PPP)
- Functions: Frame formatting & encapsulation
  Error detection & correction
  Flow control & congestion avoidance

② NETWORK LAYER / INTERNET LAYER

- Defines the protocols responsible for the logical transmission of data across

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- Primary Protocols: IP (Internet Protocol)
  ICMP (Internet Control Message Protocol)
  ARP (Address Resolution Protocol)

③ TRASPORT LAYER

- Role of Function: End-to-End Communication
  Segmentation of Reassembly (breaks down large data into segments)
  Error Detection & Correction
  Flow Control (prevent overwhelming the host)
- Key Concepts: Port Numbers
  Connection Establishment & Termination
  Segmentation
- Example: Web Browsing
  Streaming Media

④ APPLICATION LAYER

- Network Services directly to the end-user
- Key Concepts: Application Services (formatting, encryption)
  Data Representation (data translation & encoding)
  Session Management (interactions are correctly established & terminated)
- Roles of Functions: Protocol Support
  User Interaction
- Protocols: HTTP/HTTPS
  FTP
  SMTP (Simple Mail Transfer Protocol)
  IMAP (Internet Message Access Protocol)
  DNS
- Examples: Web Browsing
  Email Communication

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✯ TCP vs IP

Feature	TCP	IP
Purpose	Ensures reliable, ordered & error checked delivery of data	Provides addressing & routing of packets
Type	Connection-oriented	Connectionless
Error Handling	Yes	No
Flow Control	Yes	No
Congestion "	Yes	No
Data Segmentation	Breaks into segments & reassembles at end	Breaks & doesn't reassemble
Header Size	Larger, 20-60 Bytes	Smaller, typically 20 Bytes
Reliability	Reliable data transfer	No guarantee
Transmission Acknowledgement	Yes	No

✯ Port Number

- Operates at Transport layer of ~~TCP/IP~~ TCP/IP Model
- Ensures that data can be correctly routed & processed, allowing multiple applications to use network resources efficiently.
- Purpose & Function : Service Identification
  Multiple Applications
- Port Number Ranges : Well-known Ports - [0-1023]
  HTTP : Port 80
  HTTPS : Port 443
  FTP : Port 21
  SMTP : Port 25

DNS : Port 53

Registered Ports [1024 - 49151]

Dynamic / Private Ports [49152 - 65535]

- Port numbers are used in TCP & UDP Headers
- Examples : Web Server [HTTP(80) or HTTPS (443)]
  Email Client [SMTP(25) or IMAP(143)]
  FTP Client [FTP(21)]
- Port Number Assignment : Static (well-known)
  Dynamic (client applications)
- Why Temporary Ports ? : Multiple Simultaneous Connections
  Short-lived communication

★ 3-Way Handshake in TCP/IP

A fundamental process used in the TCP to establish a reliable connection btw a client & a server before data transfer begins.

Step 1 SYN (Synchronize)

Step 2 SYN-ACK (Synchronize-Acknowledgement)

Step 3 ACK (Acknowledgement)