

TCP/IP

The language of the Internet

UNIX Network Administration
CIS 68C2-01

TCP/IP

- What is TCP/IP?
 - ✗ TCP/IP is a suite of protocols
 - ✗ Protocol: formal rules of behavior
 - ✗ A sampling of the protocols defined in TCP/IP
 - ✗ UDP, TCP, ARP, IPv4, IPv6, ICMP, RARP, ...
 - ✗ TCP/IP is TCP over IP
 - ✗ Transmission Control Protocol
 - ✗ Internet Protocol

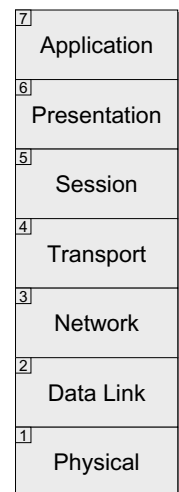
TCP/IP

- Features of TCP/IP

- ✗ Open protocol standards
 - ✗ Most defined in Request for Comments (RFCs)
 - ✗ Others defined in MIL STD and IEN (abandon)
- ✗ Hardware independent
 - ✗ TCP/IP can be carried over Ethernet, token ring, dial-up, serial lines, FDDI, etc.
- ✗ Common addressing scheme
 - ✗ Each host is uniquely identifiable worldwide
- ✗ Standardized high-level protocols
 - ✗ Allows user services

ISO's OSI Networking Model

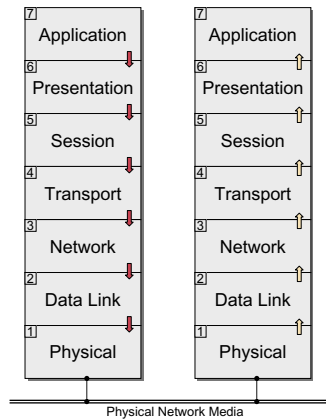
- OSI Reference Model
 - ✗ Open Systems Interconnect
 - ✗ Defined by International Standards Organization (ISO)
 - ✗ Defines 7 Functional Layers
 - ✗ Each layer defines a function performed when data is exchanged between cooperating applications across a network
 - ✗ Layers are data communication functions
 - ✗ Not individual protocols
 - ✗ A layer's function may be performed by many protocols



ISO's OSI Networking Model

□ The 7 Layer Stack

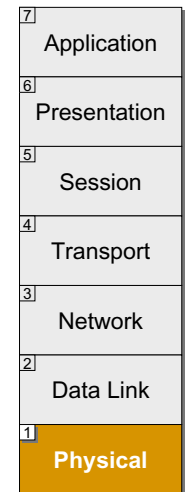
- ✗ Data travels...
 - ✗ ...down the stack to be transmitted to the network
 - ✗ ...up the stack when received from the network
- ✗ Each layer knows how to pass data to the layer above and below itself
- ✗ Each protocol communicates with its peer across network
 - ✗ Eg. session layer to session layer



ISO's OSI Networking Model

□ Layer 1 – Physical Layer

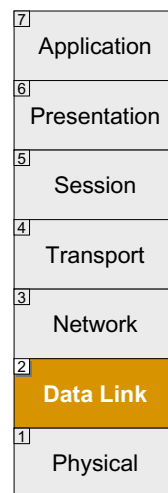
- ✗ Defines hardware characteristics of physical media
- ✗ Uses existing hardware media standards
 - ✗ IEEE 802.3
 - ✗ RS232C
 - ✗ V.35



ISO's OSI Networking Model

□ Layer 2 – Data Link Layer

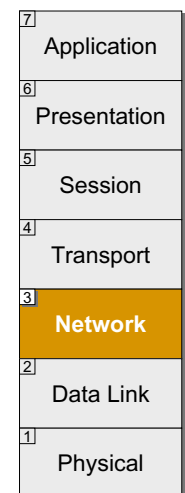
- ✗ Reliable delivery of data across physical network
 - ✗ *Reliable* does not mean *guaranteed*
- ✗ TCP/IP generally does not use this layer directly



ISO's OSI Networking Model

□ Layer 3 – Network Layer

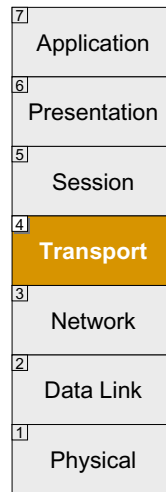
- ✗ Manages connections across network
- ✗ Performed in IP of TCP/IP
 - ✗ Isolates upper layers from underlying physical network
 - ✗ Handles addressing and data delivery
 - ✗ TCP/IP's Network Layer



ISO's OSI Networking Model

□ Layer 4 – Transport Layer

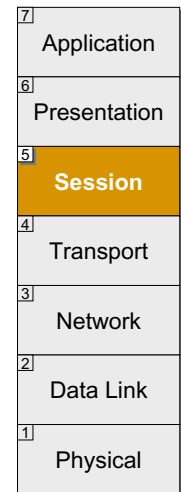
- ✗ Guarantees the accurate transmission of data across a network
- ✗ Performed in TCP of TCP/IP
- ✗ TCP/IP also has UDP
 - ✗ No reliability
 - ✗ Connectionless



ISO's OSI Networking Model

□ Layer 5 – Session Layer

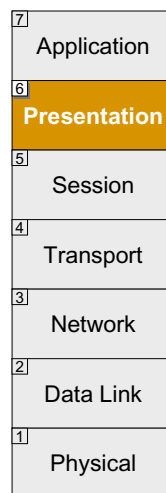
- ✗ Manages sessions (connections) between applications across network
- ✗ Implemented in TCP/IP in Transport Layer
 - ✗ Connections are called sockets and ports
 - ✗ Not sessions



ISO's OSI Networking Model

□ Layer 6 – Presentation Layer

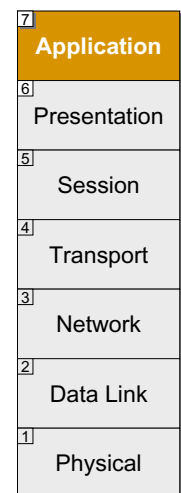
- ✗ Describes how data is represented between two applications
- ✗ Required to allow applications to exchange data
- ✗ Standard data presentation routines are defined
- ✗ Often handled within applications
 - ✗ Also handled via TCP protocols such as XDR or MIME



ISO's OSI Networking Model

□ Layer 7 – Application Layer

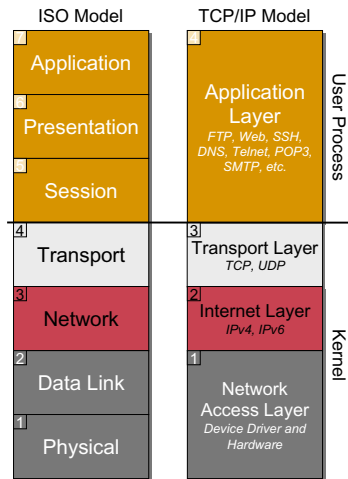
- ✗ Applications
 - ✗ Network applications and utilities
 - ✗ Daemons providing network services
- ✗ TCP/IP Application
 - ✗ Considered anything above Transport Layer



TCP/IP Protocol Architecture

TCP/IP Architecture

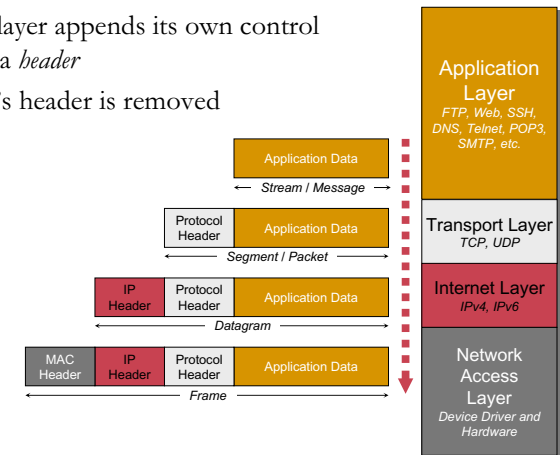
- ✗ OSI is considered overkill
 - ✗ Complex and inefficient
- ✗ TCP/IP is described with a simpler model
- ✗ TCP/IP has 3 to 5 layers
 - ✗ No universal agreement on exact layer definitions



TCP/IP Protocol Architecture

Data Encapsulation

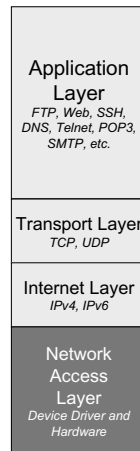
- ✗ On transmit, each layer appends its own control information called a *header*
- ✗ On receive, a layer's header is removed



TCP/IP Protocol Architecture

Network Access Layer

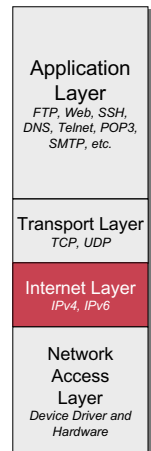
- ✗ Maps IP address into physical address
 - ✗ Physical address scheme depends on media
 - ✗ RFC 826: Address Resolution Protocol (ARP)
 - ✗ Specifies IP address to Ethernet address translation
- ✗ Encapsulates IP datagram
 - ✗ RFC 894: Specifies IP datagram encapsulation for Ethernet networks
 - ✗ MAC header
- ✗ Frame delivery to/from the physical network media



TCP/IP Protocol Architecture

Internet Layer

- ✗ RFC 791: Internet Protocol (IP)
 - ✗ Defines ...
 - ✗ The datagram
 - ✗ Contains the destination IP address
 - ✗ The internet addressing scheme
 - ✗ How data is moved between the network access and transport layers
 - ✗ Routing of datagrams to hosts
 - ✗ Datagram fragmentation and re-assembly
 - ✗ IP is a connectionless protocol



TCP/IP Protocol Architecture

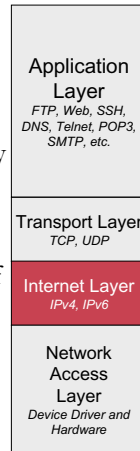
□ Internet Layer *(continued)*

✗ Routing

- ✗ Systems can only deliver packets to hosts directly attached to same physical network
- ✗ Packets are switched from one network to another by routers (also called gateways)

✗ Fragmentation and re-assembly

- ✗ IP ensures frames are sized according to the needs of the underlying physical media
- ✗ Frame sizes (Maximum Transmission Unit)
 - ✗ Ethernet: 1500 bytes
 - ✗ FDDI: 4500 bytes



TCP/IP Protocol Architecture

□ Transport Layer

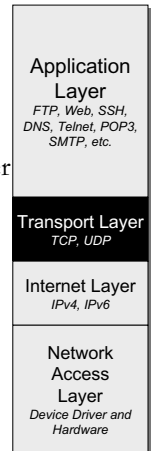
✗ Delivers data between Internet Layer and Application Layer

✗ Data delivered to a particular *service*

- ✗ Specified by the destination port in the transport layer header

✗ Two most common protocols

- ✗ UDP Protocol
 - ✗ Best-effort, connectionless datagrams
- ✗ TCP Protocol
 - ✗ Reliable, connection-oriented byte-stream



TCP/IP Protocol Architecture

□ Transport Layer *(continued)*

✗ RFC 768: UDP Protocol

- ✗ Minimal overhead
- ✗ Connectionless datagram delivery
 - ✗ Delivery is not guaranteed

✗ RFC 793: TCP Protocol

- ✗ Reliable
 - ✗ PAR – Positive Acknowledgment with Re-transmission
 - ✗ Checksums used to ensure correct data delivered
- ✗ Connection oriented (End-to-end connection)
 - ✗ Established with three-way handshake
- ✗ Byte Stream
 - ✗ TCP data is continuous stream of bytes



TCP/IP Protocol Architecture

□ Application Layer

✗ Many networking applications and *services*

- ✗ User programs: telnet, ftp, http, etc.
- ✗ Daemons: DNS, NFS, NIS, etc.

✗ Applications/servers listen to a particular TCP/UDP port number

- ✗ Packet directed using the destination port in Transport Layer's header

