OSI REFERENCE MODEL - Open Systems Interconnection/Reference Model

The OSI/RM sometimes just called the OSI provides standards to be used and referenced by vendors and developers so the network and its various systems all speak the same language. This language comes in the form of protocols and provided systems are all using the same protocols, regardless of whether it is a UNIX/Linux or Windows server 2008 operating system being run on a server, they can all be interoperable.

The OSI describes the process of packet creation known as encapsulation and also describes how a packet is de-capsulated after delivery. The OSI consists of seven layers and each layer corresponds to certain protocols, most networking equipment manufacture's adhere to this protocol- layered model, but may deviate to a degree.

When you send data from a computer it begins with the top layer of the OSI/RM model, it then travels down through the model from layer 7 down to layer 1, this process is then reversed when it reaches the receiving computer.

Data is packaged as is passes down through the model, it is then unpackaged when it arrives at the destination as it then moves up through the model. At each layer of the model a process takes place that prepares the data to be sent to its destination.

When data enters the top three layers of the model, it remains relatively unchanged and is essentially still data, it is called a **PDU** or *protocol datagram unit* at this point. When it reaches layer 4 it is known as a **Segment**, at layer 3 it becomes a **Packet** and at layer 2 it becomes a **Frame**. The bottom layer converts the frame into **Bits** or (ones and zeros) for transport across the network medium.

Below describes the model and its functions.

THE SEVEN LAYERS OF THE OSI MODEL

LAYER 7	FUNCTION
APPLICATION **PDU**	The application layer is the interface to the user, file transfers, email and application layer protocols work at this layer, it is also the first part of packet creation. At this point and down through the next two layers the data is known as a ***PDU*** or *protocol data unit*. **PDU – PROTOCOL DATA UNIT**

LAYER 6	FUNCTION
PRESENTATION **PDU**	The presentation layer is responsible for three things, data presentation, data compression and data encryption. Data presentation is achieved by converting **ASCII** code (*American Standard Code for Information Interchange*) into **EBCDIC** (*Extended Binary Coded Decimal Interchange Code*). This way almost any computer or system will be able to read and understand the code. This layer also compresses, encrypts and formats the data. **Presentation, compression and encryption**.

ASCII– AMERICAN STANDARD CODE FOR INFORMATION INTERCHANGE

EBCDIC –EXTENDED BINARY CODED DECIMAL INTERCHANGE CODE

LAYER 5	FUNCTION
SESSION **PDU**	As it implies, it has a degree of control over a network session, it establishes, maintains and also terminates communication between computers or devices on the network. This layer also takes care of synchronising and regulating the flow of data, it controls the transmission of data.

LAYER 4	FUNCTION
TRANSPORT **SEGMENTS**	Provides error detection and correction, handles the reliability of data delivery, it uses flow control and segmentation, it ***segments*** data into smaller chunks before transmission. If the flow of data is too fast for the receiving device, it slows the flow. It is responsible for data disassembly and reassembly, it breaks it down before transmission and builds it up at the destination. The transport layer uses two primary protocols, **UDP** (*connectionless*) and **TCP** (*connection-oriented*) for the delivery of data. UDP only sends the data using the best effort mode of delivery, it does not guarantee its delivery. TCP uses acknowledgments from the receiving computer letting the sending device know it has received the expected packets. It is this layer and TCP that guarantees the delivery of data ensuring the data has arrived complete and intact. **UDP – USER DATAGRAM PROTOCOL** The **T** in **T**ransport is for **TCP**. **TCP – TRANSMISSION CONTROL PROTOCOL**

LAYER 3	FUNCTION
NETWORK **PACKETS**	Handles the discovery of destination systems and logical addressing. Organises data into appropriate datagram's or packets and uses **RIP** (*Routing Information Protocol*) and **OSPF** (*Open Shortest Path First*) in dynamic routing. It tells the packets where to go and how to get there. It uses logical addressing unlike the data-link layer which uses MAC addressing. This layer uses **IP – INTERNET PROTOCOL** **RIP –ROUTING INFORMATION PROTOCOL** **OSPF – OPEN SHORTEST PATH FIRST**

LAYER 2	FUNCTION
DATA LINK **FRAMES**	The data link layer is responsible for the formation and transmission of data, it formats the data into frames to be sent to the next layer. It synchronises and controls the flow of data, it provides error control and also prepares the data to be placed on the wire. The data link layer use two sub-layers, the **LLC** (*Logical Link Control*) and the **MAC** (*Media Access Control*.)
LLC (802.2) **FRAMES**	***Logical Link Control*** (LLC) is the top part of the data link layer and talks directly to the network layer. It provides error control and flow control and identifies the protocols that are to be used. It provides **SAP's** (*Service Access Points*) that operate between the MAC sub-layer and the network layer.
MAC (802.1) **FRAMES**	***Media Access Control*** (MAC) defines how frames are placed on the wire or transmission media. Being the lower part of the data link layer, it resides below the LLC and talks directly to the physical layer, it is basically responsible for putting data on the wire and is responsible for the physical MAC addresses of each NIC.

LAYER 1	FUNCTION
PHYSICAL **BITS**	Defines the media by which signals (*ones and zeros*) or bits can travel, it may be copper wire where they travel as electrical pulses, or fibre-optic (*glass fibre- light pulses*) or radio waves for wireless transmissions. This layer defines the topology of a network including all its cables and connectors, repeaters and hubs. This includes modems and NIC's and is where digital signals become analog and vice versa. It is this layer that is responsible for placing the bits on the wire, it communicates directly with the MAC sublayer of the data link layer where frames are converted into bits ready for transmission.

The data encapsulation process adds headers to the data as it travels down through the OSI model, it is also de-encapsulated at the receiving end and the additions are stripped away in reverse order to finally reveal the original data. At each layer a new header is added providing the packet with information relevant to that layer, or 'peer layer' at the receiving end. The data also changes state as is it is passed down.

Application, Presentation and Session Layers: PDU

The data at these layers receives its first headers and is known as a **PDU** or **Protocol Data Unit**.

Transport Layer: Segment

When the data reaches the transport layer it is encapsulated with source and destination port numbers that identify the application the data is expected to use. It may be port 125 (SMTP) or 69(TFP), the data is also segmented into smaller chunks and becomes a segment at this layer.

Network Layer: Packet

When a segment is passed down from the transport layer it becomes a packet and is further encapsulated with source and destination IP addresses.

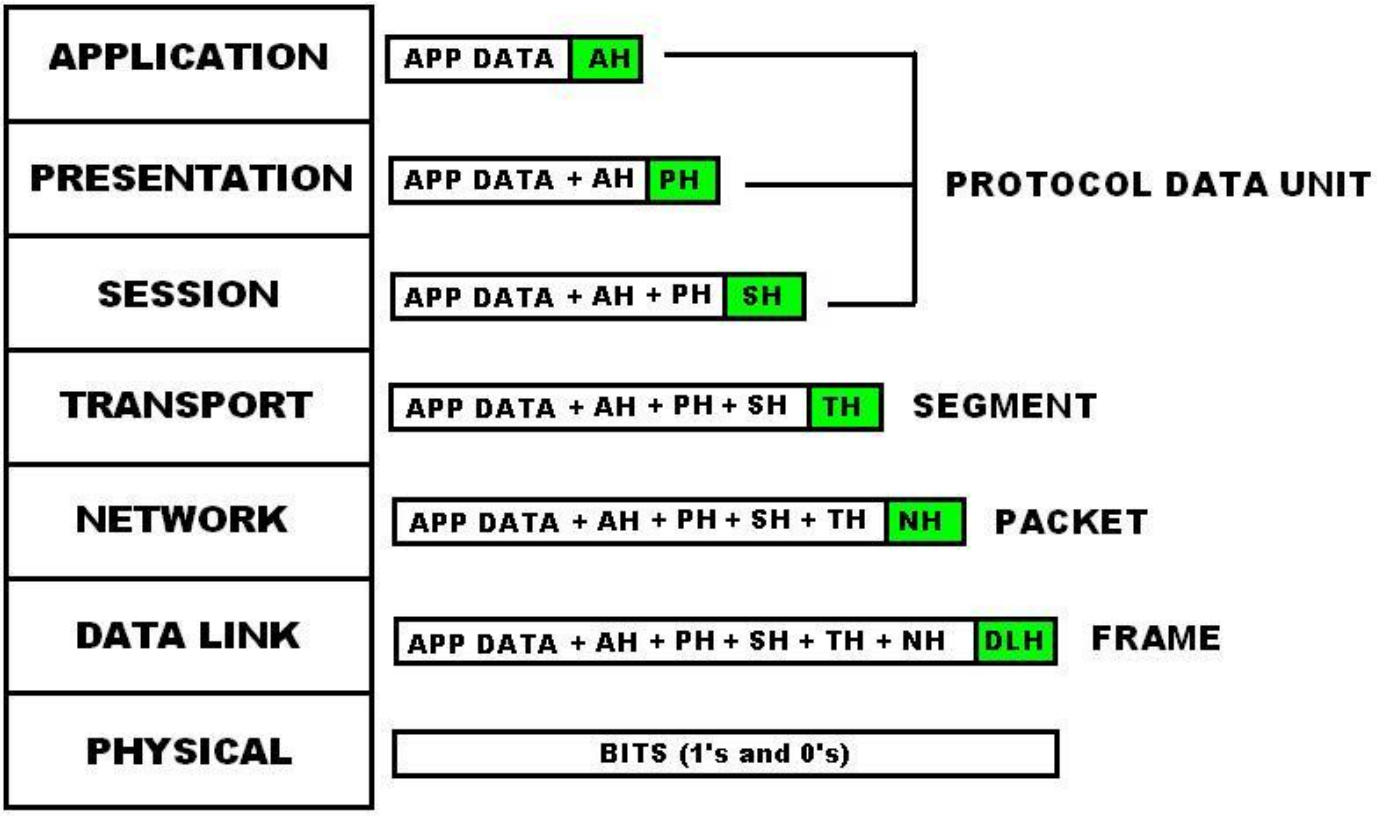
Data Link Layer: Frame

The packet is passed down to the data link layer where it is encapsulated with source and destination MAC addresses, a **CRC** or *cyclical redundancy check* is also added at this point, this uses a metric (counts the number of one's) that matches the data at the receiving end to ensure the successful delivery of data. The CRC is added as a trailer to the end of the frame. If the CRC does not match the entire packet is discarded. At this point the packet becomes a frame.

Physical Layer: Bits

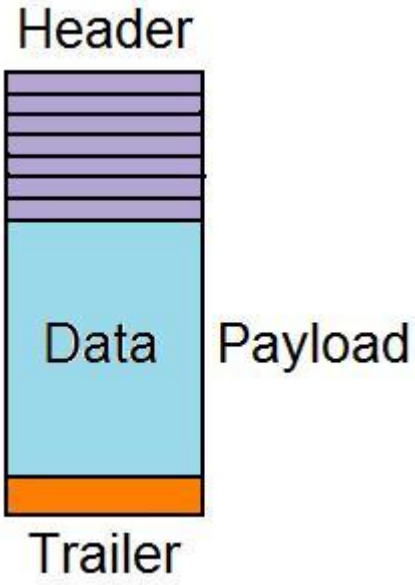
Frames are passed down to the physical layer where they are converted into bits ready for transmission.

THE PACKET CREATION PROCESS



As data is processed first down through the model a packet is built, eventually it contains several headers and the original data resides in the middle known as the payload and the end of the packet has a trailer which may contain information that validates the packet. The trailer often contains a CRC and if the CRC is not matched at the destination end, the entire packet will be discarded and a request for a new one is sent.

Right shows the basic construction of a packet:



Several protocols are mapped to specific layers of the OSI, some overlap and others pertain just to one specific layer, below tables some protocols mapped to layers. Many application protocols also map to the presentation and session layers.

OSI PROTOCOLS AND LAYERS

Layer	Protocols
Application **Presentation** **Session**	**SMTP POP3 IMAP** **HTTP SMB NFS** **DNS FTP TFTP**
Transport	**TCP UDP**
Network	**IP RIP OSPF**
Data Link	**ARP Ethernet Token Ring**

ROUTABLE AND NON-ROUTABLE PROTOCOLS

A protocol is a set of rules that network devices use to enable successful communication with each other. It is like a set of rules used for network devices and how they should package and send data across the network.

It is very much like road rules where traffic is concerned, and if everyone follows the same set of rules you reduce the chance of collisions, however just like drivers, networks also have mishaps occasionally even though they are following the same set of rules.

Some protocols are non-routable and use static routes and do not use the ***network*** layer of the OSI.

Non-routable protocols are **LAT** (*local Area Transport*) and **DLC** (*Data Link Control*).

Non-routable protocols can be encapsulated in a routable protocol such as TCP/IP making them routable.

Routable protocols can be vectored via routers and include **TCP**.

The TCP <Transport> operates at layer 4.

IP <network addressing> operates at layer 3

TCP/IP is a set of protocols known as a protocol suite, it includes IP and UDP.

TCP:

- Ensures Reliable Comminication
- Connection-Oriented
- Dropped or lost packets are resen
- Operates at the Transport Layer
- Dissasembles and reassembles packets
- Uses the handshaking process
- Uses ports to deliver packets

IP:

- Connectionless protocol
- Used for Addressing (IP address)
- Used ofr troubleshooting networks (ICMP)
- Operates at the Network Layer

UDP:

- Connectionless delivery (best effort)
- No handshaking process
- Used ofr video and ausio streaming

IPX: (NWLink – legacy model used on UNIX systems)

- Works like IP inTCP/IP and is responsible for routing
- Connectionless protocol
- Operates on the Nwtoek Layer
- Forwards packets to destination

SPX:

- Works like TCP in TCP/IP
- Connection-Oriented Protocol
- Guarantees delivery