

A R&D report
on
OSI Model & Its Layers

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Week 1

in

Cloud Infra and Security

By

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Objective

This document aims to explain the OSI Model and its 7 layers simply and concisely. We intend to strip away the critical, foundational elements of networking, and be a reference for interns, engineers and other entities that are not technical.

This document will:

- Explain each of the 7 layers of the OSI model with enough detail, however, simple enough to allow people to begin cognitive thinking on a basis currently in networking terminology.
- Show how each layer occurs in real-time use in today's specific world of networks, and how protocols are processed at each of their layers.
- Use real-world examples to see how the OSI Model is leveraged during day-to-day networking operations, troubleshooting, and/or design of systems.
- Unbundle the process of transmitting the received data, providing a foundation of understanding of data encapsulation/decapsulation, and build on experiences of being able to clearly see data with different protocols flow across networks.
- It is a starting point for people looking to begin the process of improving their foundation knowledge of networking, enabling them in formal settings to problem-solve at a higher level in a technical environment.

Introduction

The OSI Model (Open System Interconnection) is used to help standardise the way networks and protocols communicate with one another. It was developed by the **International Organisation for Standardisation (ISO)**, and the OSI Model breaks network communication into 7 distinct layers (with roles) used for transmitting data from one device to another.

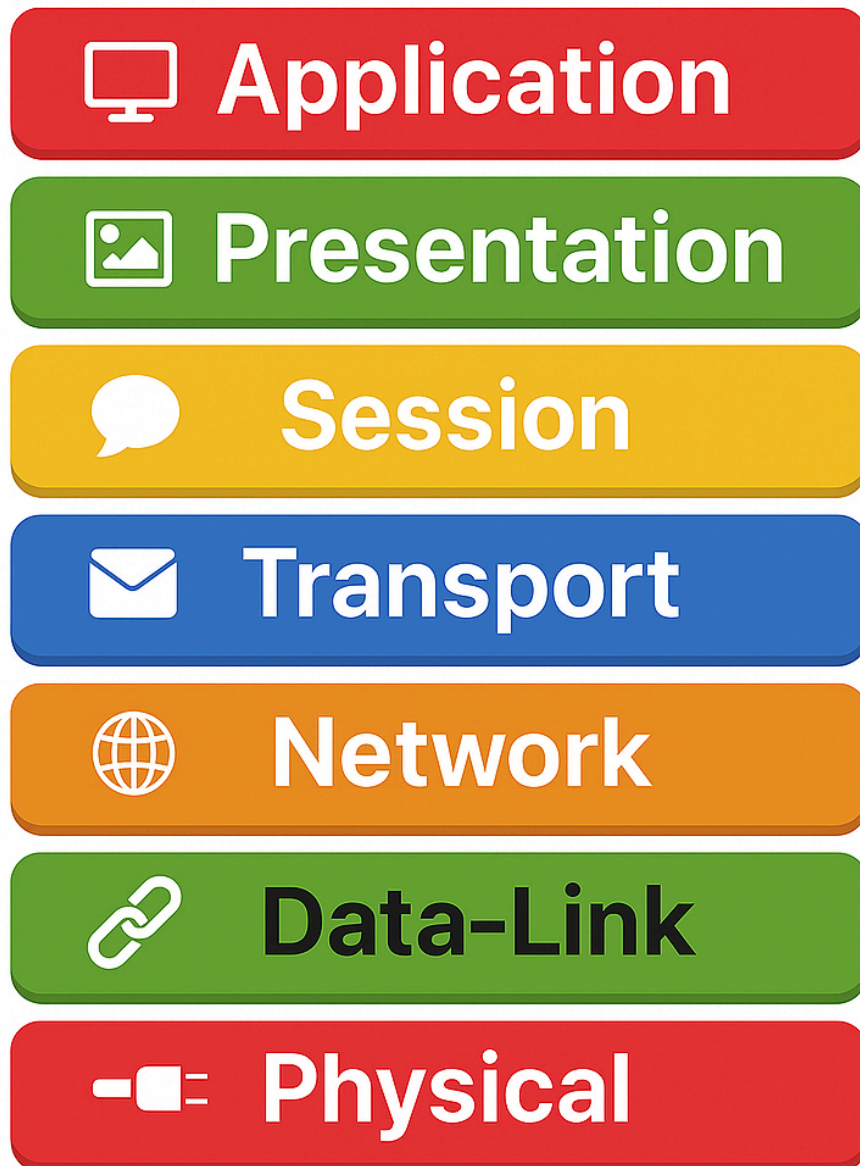
Purpose and value;

- **Standardisation:** The OSI Model is a standard for networking, which helps ensure that protocols, devices, and software can communicate with one another across multiple systems and technologies.
- **Simplification of network troubleshooting:** The model will break 'network functions' into 'layers', which will assist in making it easier to identify a problem with data transmission.
- **Design and development:** The OSI model can be a model of network protocols and can be referred to when you are developing networked systems.

There are 7 layers of the OSI Model to take a logical and structured approach to networking, each layer is responsible for a different task in communicating data. Networking in the past generally followed the OSI Model. Today, this is still valuable, but generally speaking, we only use the TCP/IP Model, which, of course, is a simplified model of the OSI Model, however, the OSI Model remains valuable in education for us to understand how networks operate.

The 7 Layers Breakdown

Every layer in the OSI Model has a reason and role to play in the process of network communication. Understanding how these layers work will help inform you of how data traverses a network, and from one device to another. Below is a description of each of the 7 layers from the Physical Layer (Layer 1) to the Application Layer (Layer 7).



1. Physical Layer (Layer 1)

The Physical Layer is responsible for transmitting raw bits (0s, 1s) over a physical medium. It defines the hardware elements involved in the process (cables, switches, radio), how it all works, and defines and encodes the bits which will ultimately be used for transmission.

Key Elements:

- Voltage characteristics and signal modulation
- Data rates (bit rate, baud rate)
- Physical connectors (RJ45, fibre optics, etc.)
- Transmission Media (copper, fibre, wireless)

Example(s):

Ethernet cables, Fibre optics, Radio waves (Wi-Fi, Bluetooth)

Device(s):

Hub(s), switch(s), and cables

2. Data Link Layer (Layer 2)

The data link layer establishes the link between two directly connected devices that are nearby. The data link layer accepts raw bits from the physical layer of the OSI model and converts the bits into data frames while preserving the integrity of the frame. The data link is also responsible for media access control (MAC) addressing to define the user's device on the local network.

Key Concepts:

- MAC Address (for device identification)
- Framing (the organisation of packing data into frames)
- Error Detection (if using a technique like cyclic redundancy check, CRC, to check for frame errors)
- Flow Control (to coordinate the transfer of data speeds)

Examples:

Ethernet (802.3), Wi-Fi (802.11), PPP (Point-to-Point Protocol)

Devices:

Network Interface Cards (NICs), Switches, and Bridges

3. Network Layer (Layer 3)

The network layer is to route packets among networks and ensure that the packets of data get to the correct destination. The network layer will determine the logical addressing (IP addressing) of the data, along with the routing, to send chunks of data as packets that can be sent across different types of networks and all their associated architectural challenges.

Key Concepts:

- IP Addressing (IPv4, IPv6)
- Routing (to route packets of data "along the best path")
- Fragmentation (to break packets of data to allow for access to a physical network)

Examples:

IP (Internet Protocol), ICMP (Internet Control Message Protocol), Routing Protocols (RIP, OSPF)

Devices:

Routers

4. Transport Layer (Layer 4)

The Transport Layer enables reliable end-to-end and device-to-device communications across the network. This layer breaks large messages into smaller segments, provides error recovery, and implements flow control in methods not to prevent dropping incoming data or sending duplicate data.

Key Concepts:

- Port numbers (used to identify services or programs running on a device)
- Segmentation (chopping the data into smaller pieces in order to transmit)
- Reliability (keeping the integrity of the data and resending if necessary)
- Flow control (the rate and amount of the transmission)

Examples:

TCP - Transmission Control Protocol (connection-oriented, reliable)

UDP - User Datagram Protocol (connectionless, faster and less reliable)

Devices:

Gateways (may operate at this layer for complex communications)

5. Session Layer (Layer 5)

The Session Layer consists of sessions or connections between applications. The layer establishes, maintains, and terminates sessions, ensuring that communications are organised logically as to when data takes place, and the Session Layer provides dialogue control and a means for the data to flow in half-duplex or full-duplex.

Key Concepts:

- Session establishment (opening the connection, maintaining, and closing the connection)
- Dialogue control (how the information is communicated)
- Synchronisation (providing checkpoints and recovery means)

Examples:

NetBIOS, RPC - Remote Procedure Call, SMB - Server Message Block

6. Presentation Layer (Layer 6)

The Presentation Layer performs data formatting and translation functions and is responsible for transmitting data between the two application layers in a format that either layer will recognise. The Presentation Layer also provides encryption and compression capabilities.

Key Concepts:

- Encoding data (such as ASCII and EBCDIC)
- Compressing data (such as making files smaller for transmission)
- Encrypting data (such as securing data while transmitting)

Examples:

SSL/TLS (to enable secure communication)
JPEG, GIF, MPEG (image and video formats)
encryption protocols (e.g. SSL/TLS, HTTPS)

7. Application Layer (Layer 7)

The Application Layer is the top layer of the OSI Model, and provides a direct interface to end users and their software application programs. This layer provides network services to the applications, such as file transfer, electronic mail, and web browsing, making it the layer that is closest to the user.

Key Concepts:

- User Interface (APIs, protocols)
- Application Protocols (communication rules between programs)
- Network Services (DNS, HTTP, FTP)

Examples:

HTTP (Hypertext Transfer Protocol), FTP (File Transfer Protocol)
SMTP (Simple Mail Transfer Protocol), DNS (Domain Name System)

Devices:

Web Servers, Email Clients, DNS Servers

Real-Life Analogy

OSI Layer		Postal Concept
7	Application	Writing a letter
6	Presentation	Choosing a language
5	Session	Agreeing to talk rules
4	Transport	Putting in an envelope
3	Network	Addressing
2	Data Link	Barcode on a box
1	Physical	Delivery truck

References

1. Webopedia – "OSI Model – The 7 Layers Explained":
<https://www.webopedia.com/definitions/7-layers-of-osi-model/>
2. GeeksForGeeks – "OSI Model"
<https://www.geeksforgeeks.org/open-systems-interconnection-model-osi/>