1.6 Network structure

OSI Model and basics of network terminology

The Open Systems Interconnection (OSI) Reference Model is a conceptual framework that describes functions of the networking or telecommunication system independently from the underlying technology infrastructure. It divides data communication into seven abstraction layers and standardises protocols into appropriate groups of networking functionality to ensure interoperability within the communication system regardless of the technology type, vendor and model.

Each layer serves the layer above it and is served by the layer below it. We will look at the first four in some detail, but you can read an explanation of all the layers here.

The lowest layer of the OSI model, the **physical layer**, is concerned with data communication in the form of electrical, optic, or electromagnetic signals physically transmitting information between networking devices and infrastructure. The physical layer is responsible for the communication of unstructured raw data streams over a physical medium. It defines a range of aspects, including:

- electrical, mechanical, and physical systems and networking devices that include specifications such as cable size, signal frequency, voltages, etc
- hardware including networking devices, antennas, cables, modem, and intermediate devices such as repeaters and hubs.

The second layer, the **data link**, of the OSI model concerns data transmission between the nodes within a network and manages the connections between physically connected devices such as switches. The raw data received from the physical layer are synchronised and packaged into **data frames** that contain the necessary protocols to route information between appropriate nodes.

The third layer, the **network layer**, of the OSI model organises and transmits **data packets** between multiple networks. The network layer is responsible for routing the data via the best physical path based on a range of factors including network characteristics, best available path, traffic controls, congestion of data packets, and priority of service, among others. The network layer implements logical addressing for data packets to distinguish between the source and destination networks. Network layer hardware includes routes.

The fourth layer of the OSI model, the **transport layer**, ensures complete and reliable delivery of data packets. The transport layer provides mechanisms such as error control, flow control, and congestion control to keep track of the data packets, checking for errors and duplication, and resending the information that fails delivery. Packet segmentation and reassembly ensure that the data are divided and sequentially sent to the destination where they are rechecked for integrity and accuracy based on the receiving sequence.

Common protocols that operate in the transport layer include the Transmission Control Protocol (TCP) for connection-oriented data transmission and User Datagram Protocol (UDP) for connectionless data transmission (UDP is faster than TCP, however, UDP is less secure in terms of delivery of the packets, as some packets can be lost). During the course, we are also going to see some protocols that belong to level 6 and 7, such as SSL/TLS and DNS.

The OSI model will be used throughout this module so make sure to familiarise yourself with it. You should be able to replicate the diagram and brief explanation of the layers from memory.

The general model of a link layer, whether wired or wireless, is as a broadcast medium. This common ‘medium’ is easily accessed by anyone, leading to simple attacks.

The picture here depicts a portion of a Local Area Network (LAN). A LAN is a computer network that spans a relatively small area. Most often a LAN is confined to a single room, building or group of buildings. The data link layer job is to take packets from the network layer and break them into smaller pieces called frames, rerouting them to their destination within the LAN.

To route between different LANs we need the network layer. Some information needs to be shared to find the correct route, but network operators want to keep private data private. The network layer can be represented by a Metropolitan-Area Network (MAN) or by a Wide-Area Network (WAN).

A Metropolitan-Area Network (MAN) is a computer network that interconnects users with computer resources in a geographic region of the size of a metropolitan area. The term MAN is applied to the interconnection of LANs in a city into a single larger network.

A Wide-Area Network (WAN) is a computer network that spans a relatively large geographical area. Typically, a WAN consists of two or more local-area networks (LANs). Computers connected to a wide-area network are often connected through public networks, such as the telephone system. They can also be connected through leased lines or satellites. The largest WAN in existence is the Internet.

Finally, the transport layer. We can think of it as an ‘end-to-end’ pipe for bits, from sender to receiver. It usually provides certain functionality:

- error correction to ensure reliability
- ensuring the correct ordering of data, typically First-In-First-Out (FIFO), where data are delivered in the order they were sent to the receiver
- dealing with network effects such as congestion.