WEB TECHNOLOGY

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Internet Protocols

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Outline

- Internet Protocol Suite
- OSI and TCP/IP Model
- Essential Protocol Suite
- Email Protocols

Internet Protocol Suite

Protocol is a detailed specification of how communication between two computers will be carried out in order to serve some purpose.

Protocols specify interactions between the communicating entities.

In the standard model known as Open Systems Interconnection (**OSI**), there are one or more protocols at each layer in the telecommunication exchange that both ends of the exchange must recognize and observe.

Internet Protocol Suite

Internet Protocol is the principal communications protocol in the Internet protocol suite for relaying datagrams across network boundaries.
Internet Protocol is responsible for addressing host interfaces, encapsulating data into datagrams (including fragmentation and reassembly) and routing datagrams from a source host interface to a destination host interface across one or more networks.

Internet Protocol Suite

Internet protocol suite is the conceptual model and set of communications protocols used in the Internet and similar computer networks. It is commonly known as TCP/IP because the foundational protocols in the suite are the Transmission Control Protocol (TCP) and the Internet Protocol (IP).
Internet protocol suite provides end-to-end data communication specifying how data should be packetized, addressed, transmitted, routed, and received.

Internet Protocol Suite

This functionality is organized into four abstraction layers, which classify all related protocols according to the scope of networking involved. From lowest to highest, the layers are …

- **Link layer**, containing communication methods for data that remains within a single network segment (link).
- **Internet layer**, providing internetworking between independent networks.

Internet Protocol Suite

- **Transport layer**, handling host-to-host communication.
- **Application layer**, providing process-to-process data exchange for applications.

The Internet protocol suite predates the **OSI model**, a more comprehensive reference framework for general networking systems.

OSI Model & TCP/IP Model

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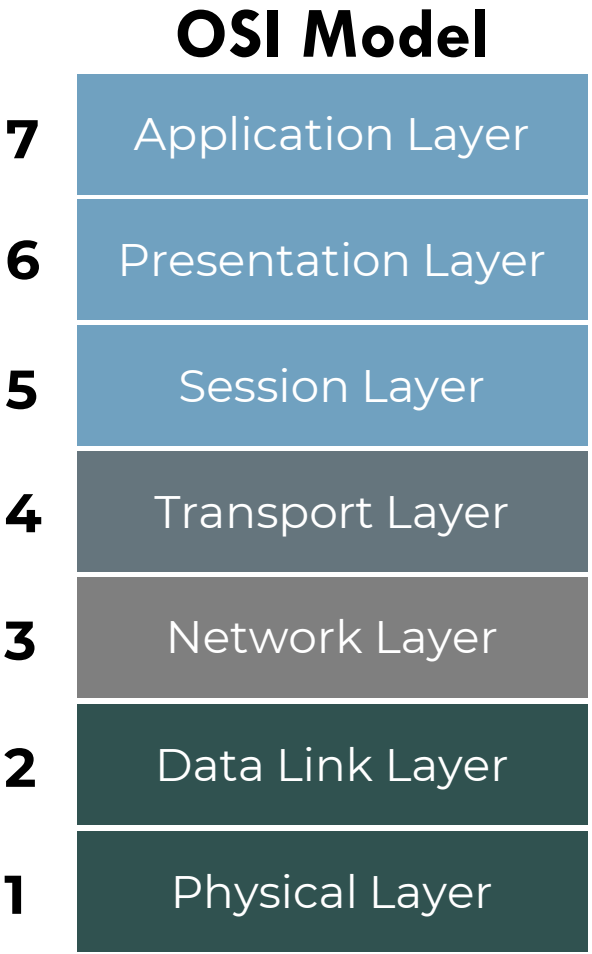
OSI model (Open Systems Interconnection model) is a conceptual model that characterizes and standardizes the communication functions of a telecommunication or computing system without regard to its underlying internal structure and technology.

- Its goal is the interoperability of diverse communication systems with standard communication protocols.
- The model partitions a communication system into abstraction layers. The original version of the model had seven layers.

OSI Model & TCP/IP Model



Message format, Human-Machine Interfaces

Encryption & Compression

Authentication, Permission, Session restoration

End-to-End error control

Network addressing, Routing or Switching

Error detection, Flow control on physical link

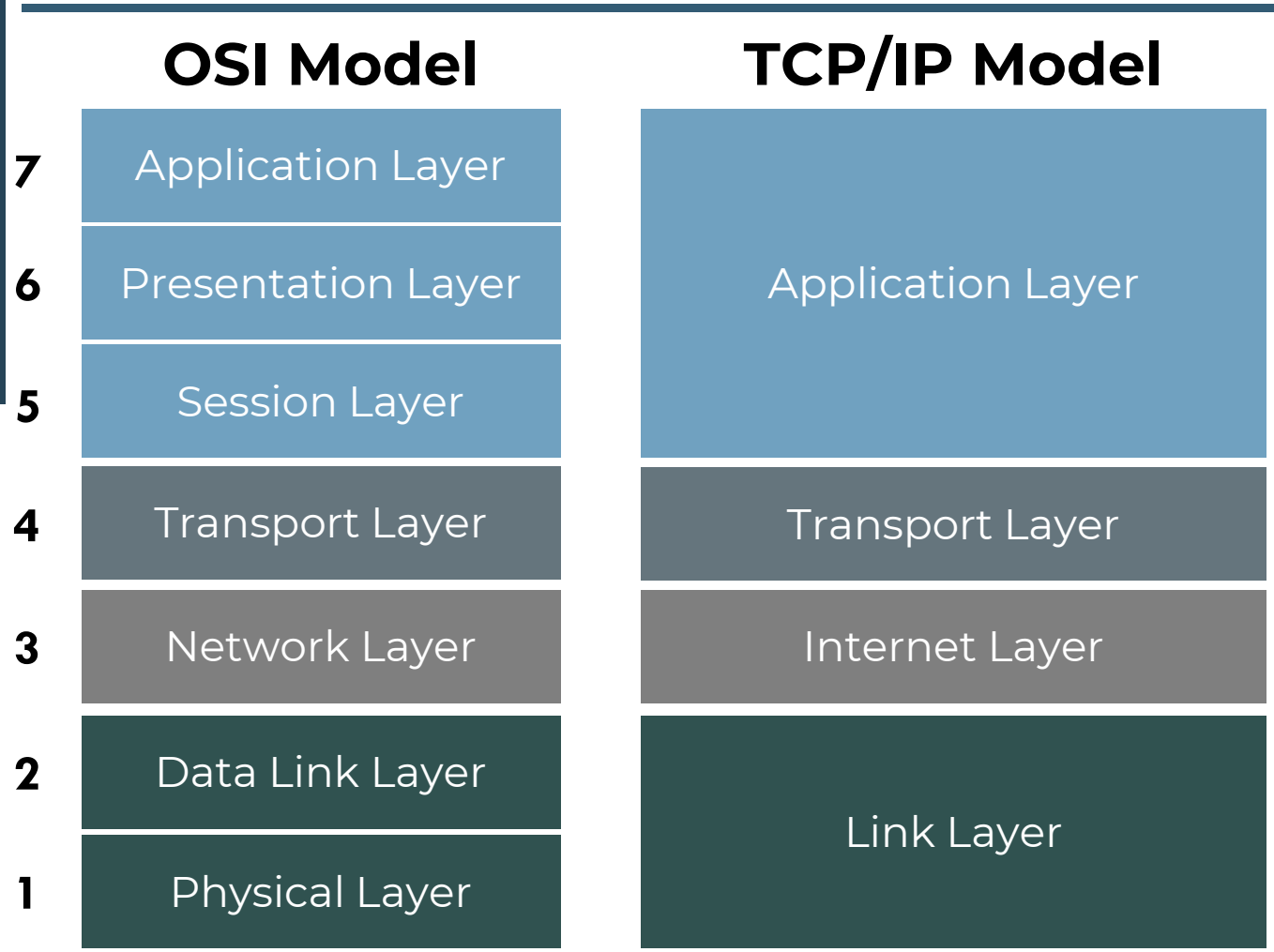
Bit stream : physical medium, method of representing bits

OSI Model & TCP/IP Model

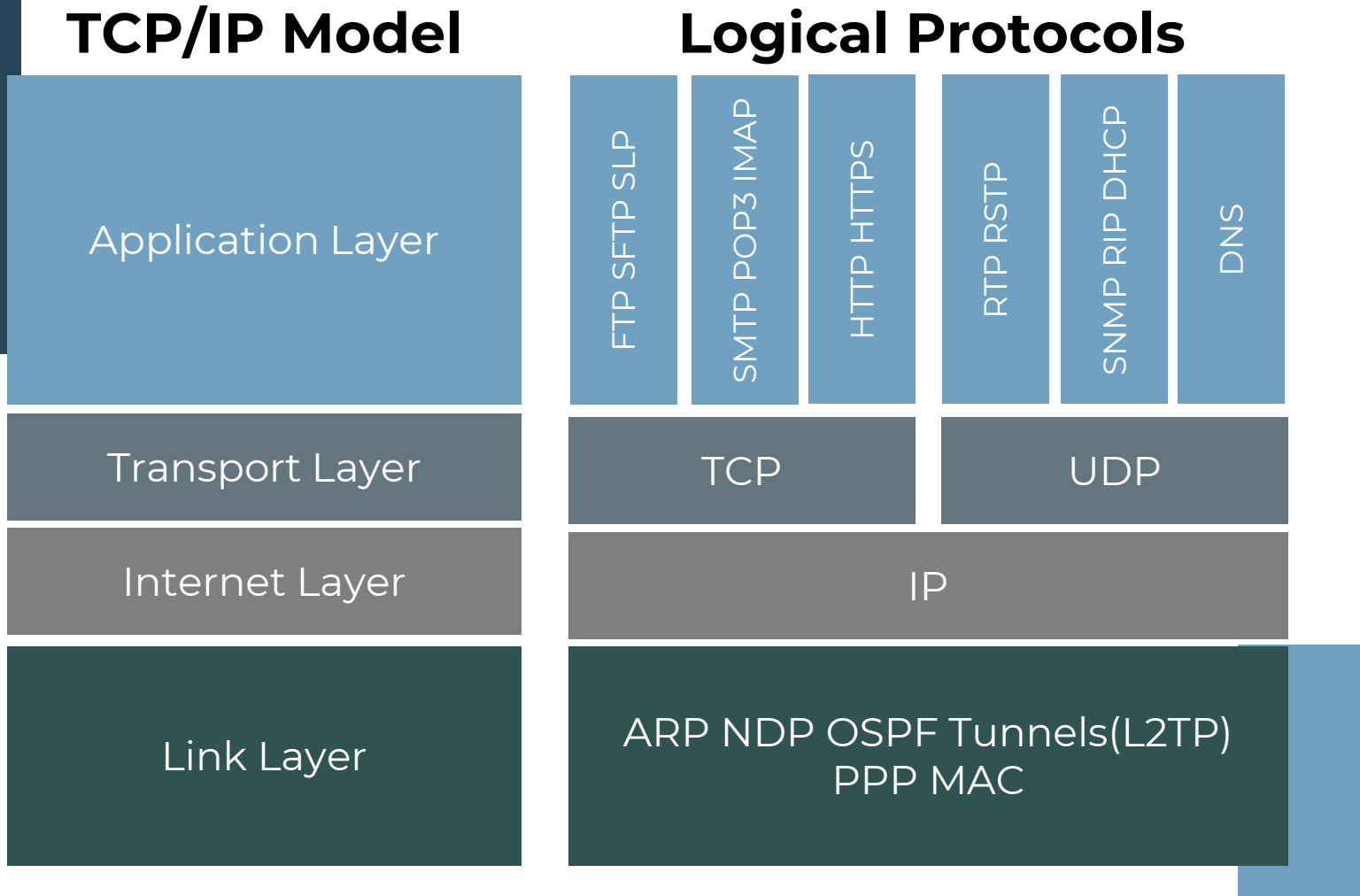
The **TCP/IP model** is a concise version of the *OSI model*. It contains four layers, unlike seven layers in the OSI model. The layers are:

- Process/Application Layer
- Host-to-Host/Transport Layer
- Internet Layer
- Network Access/Link Layer

OSI Model & TCP/IP Model



OSI Model & TCP/IP Model



Essential Protocols – TCP/IP

TCP/IP is fundamental to the definition of the Internet, it's natural to begin study of Internet protocols with these protocols.

- TCP and IP are actually two different protocols.
- TCP(Transmission Control Protocol) defines how computers send packets of data to each other.
- IP (Internet Protocol) is fundamental to the definition of the Internet. A key element of IP is the *IP address*, which is simply a 32-bit number.

Essential Protocols – DHCP

Dynamic Host Configuration Protocol (DHCP) is a network management protocol used on UDP/IP networks whereby a DHCP server dynamically assigns an IP address and other network configuration parameters to each device on a network so they can communicate with other IP networks.
A **DHCP** server enables computers to request IP addresses and networking parameters automatically from the Internet service provider (ISP), reducing the need for a network administrator or a user to manually assign IP addresses to all network devices.

Essential Protocols – TCP

TCP (Transmission Control Protocol) is a connection oriented protocol and offers end-to-end packet delivery. It acts as back bone for connection. It exhibits the following key features:

- TCP corresponds to the Transport Layer of OSI Model.
- TCP is a reliable and connection oriented protocol.

Essential Protocols – TCP

- TCP offers:
  - Stream Data Transfer.
  - Reliability.
  - Efficient Flow Control
  - Full-duplex operation.
  - Multiplexing.
- TCP offers connection oriented end-to-end packet delivery.

Essential Protocols – IP

Internet Protocol (IP) is connectionless and unreliable protocol. It ensures no guarantee of successfully transmission of data. In order to make it reliable, it must be paired with reliable protocol such as TCP at the transport layer.

- Each device on the Internet has one or more **IP addresses** associated with it.
- **IP addresses** are normally written as a sequence of four decimal numbers separated by periods, as in **192.0.34.166**. Each decimal number represents one byte of the **IP address**.

Essential Protocols – UDP

UDP (User Datagram Protocol) is an alternative protocol to TCP that also builds on IP. The main feature that UDP adds to IP is the port concept that we have just seen in TCP.

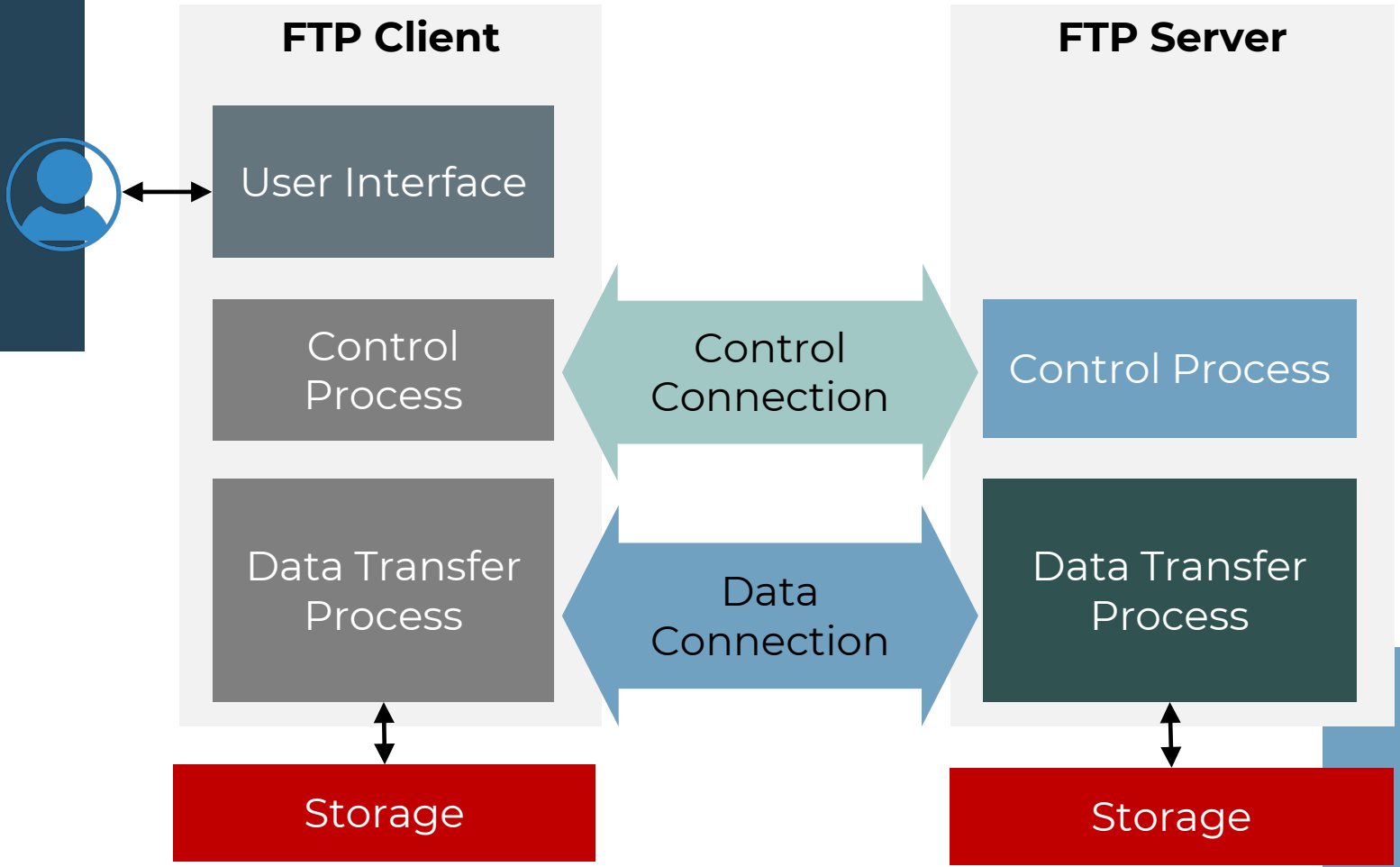
- It does not provide the two-way connection or guaranteed delivery of TCP.
- Its advantage over TCP is speed for simple tasks.
- One Internet application that is often run using UDP rather than TCP is the DNS.

Essential Protocols – FTP

FTP (File Transfer Protocol) is used to copy files from one host to another. FTP offers the mechanism for the same in following manner:

- FTP creates two processes such as Control Process and Data Transfer Process at both ends i.e. at client as well as at server.
- FTP establishes two different connections: one is for data transfer and other is for control information.
- Control connection is made between control processes while Data Connection is made between data transfer processes.

Essential Protocols – FTP



Essential Protocols – FTP

How to use FTP

- **Graphical FTP clients**: A graphical FTP clients simplify file transfers by allowing you to drag and drop file icons between windows.
- **Web browser**: You can use a web browser to connect to FTP addresses exactly as you would to connect to HTTP addresses.
- **Command-line FTP**: Windows, macOS, and Linux have built-in command-line clients.

Essential Protocols – HTTP

HTTP (Hypertext Transport Protocol) is a form of communication protocol, in particular a detailed specification of how web clients and servers should communicate. The basic structure of HTTP communication follows what is known as a "request–response model".

HTTP is the primary TCP-based protocol used for communication between web servers and browsers.

Essential Protocols – HTTP

A nice feature of **HTTP** is that these request and response messages often consist entirely of plain text in a fairly readable form.

```
Server: Apache/1.3.27 (Unix)  (Red-Hat/Linux)
Last-Modified: Wed, 08 Jan 2003 23:11:55 GMT
ETag: "3f80f-1b6-3e1cb03b"
Accept-Ranges: bytes
Content-Length: 438
Connection: close
Content-Type: text/html

<HTML>
<HEAD>
<TITLE>Example Web Page</TITLE>
</HEAD>
<body>
```

Essential Protocols – HTTPS

HTTP Secure (HTTPS) is an extension of the HTTP for secure communication over a computer network and is widely used on the Internet.

- The communication protocol is encrypted using Transport Layer Security (TLS), or formerly, its predecessor, Secure Sockets Layer (SSL).
- The protocol is therefore also often referred to as HTTP over TLS, or HTTP over SSL.

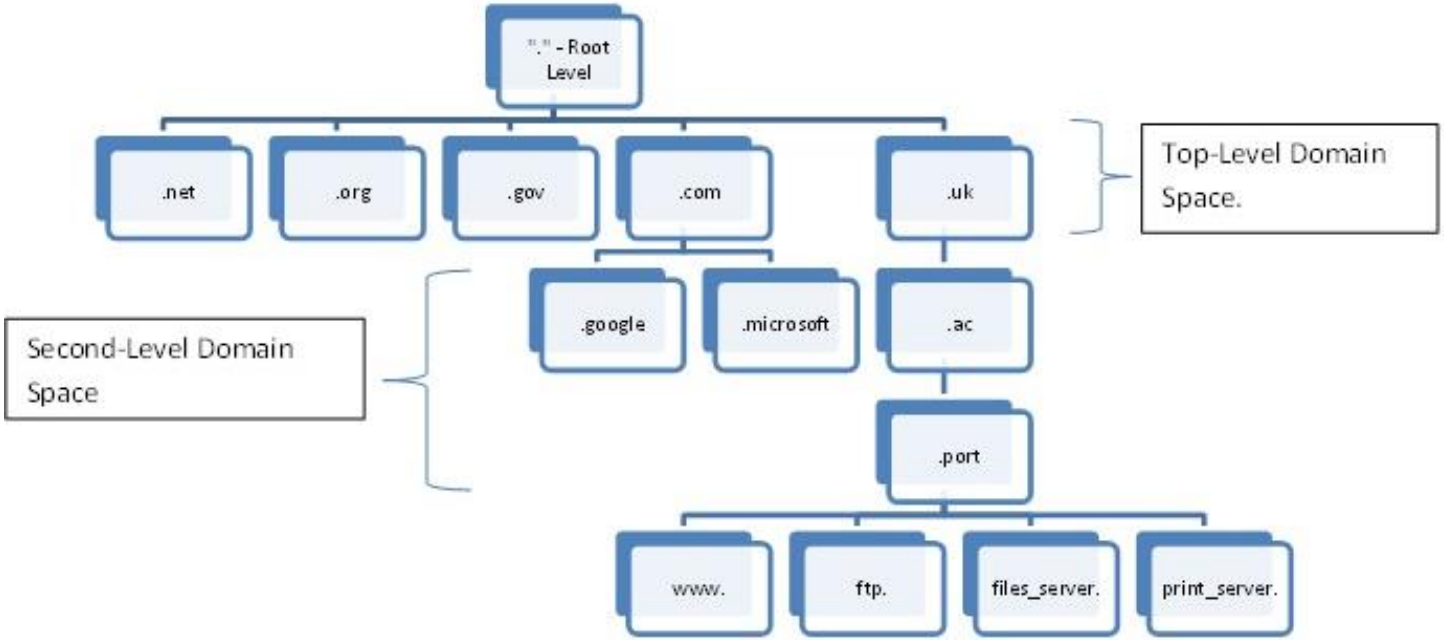
Essential Protocols – DNS

DNS (Domain Name System) is the way that internet domain names are located and translated into internet protocol (IP) addresses. The DNS maps the name people use to locate a website to the IP address that a computer uses to locate a website.

Domain names are formed by the rules and procedures of the Domain Name System (DNS). Any name registered in the DNS is a domain name.

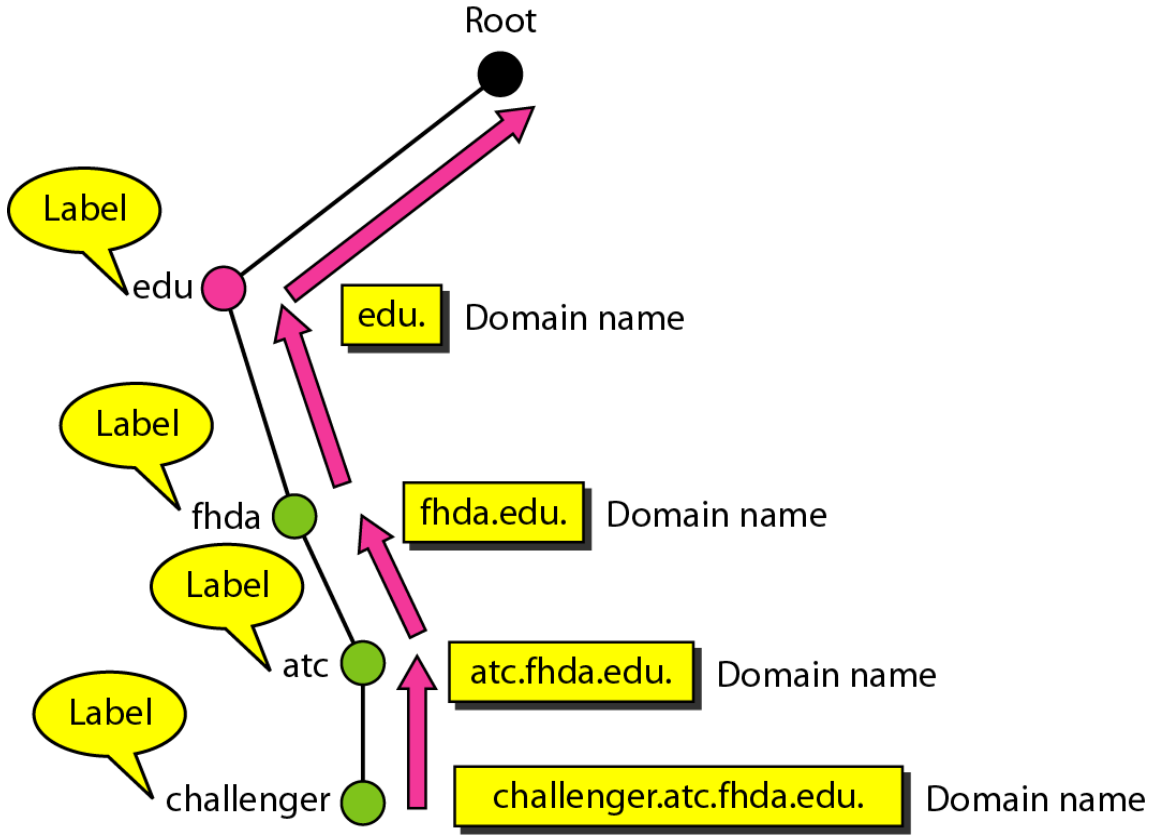
Essential Protocols – DNS

Domain name is the sequence of labels from a node to the root, separated by dots (“.”s), read left to right.



Essential Protocols – DNS

Domain names and labels



Email Protocols

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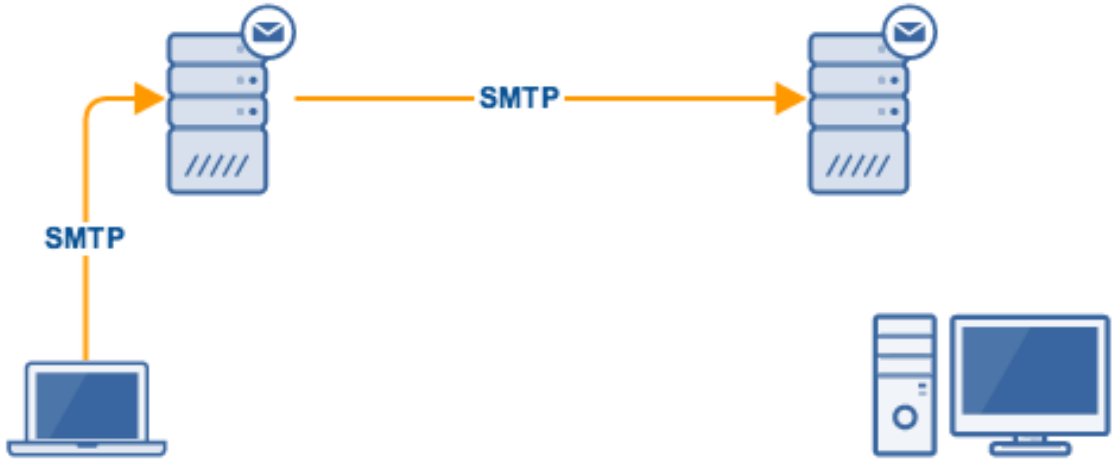
SMTP, **POP3** and **IMAP** are TCP/IP protocols used for mail delivery. Each protocol is just a specific set of communication rules between computers.

SMTP(Simple Mail Transfer Protocol) is mostly used for sending out email from an email client to an email server.

SMTP, which is specified in RFC 5321, uses port 25 by default. It may also use port 587 and port 465

Email Protocols

It's also used for relaying or forwarding mail messages from one mail server to another. The ability to relay messages from one server to another is necessary if the sender and recipient have different email service providers.



Email Protocols - POP3

POP3 (Post Office Protocol) is used to retrieve email messages from a mail server to a mail client. POP3 supports extensions and several authentication mechanisms. Authentication features are necessary to prevent malicious individuals from gaining unauthorized access to users' messages.

Email Protocols - POP3

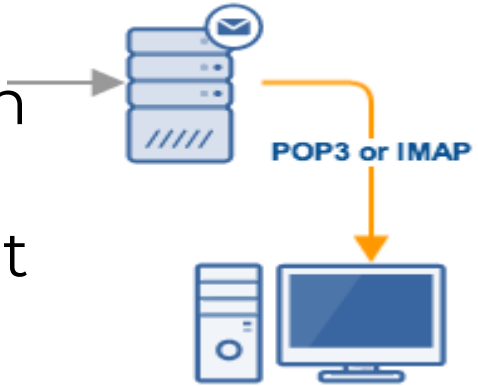
POP3 client retrieves email in the following manner:

- Connects to the mail server on port 110 (or 995 for SSL/TLS connections)
- Retrieves email messages
- Deletes copies of the messages stored on the server
- Disconnects from the server
- POP3 does not synchronize.

Email Protocols - IMAP

IMAP (Internet Message Access Protocol) is a more sophisticated protocol. It allows users to group related messages and place them in folders, which can in turn be arranged hierarchically.

It's also equipped with message flags that indicate whether a message has been read, deleted, or replied to. It even allows users to carry out searches against the server mailboxes.



Email Protocols - IMAP

How IMAP works ?

- Connects to the mail server on port 143 (or 993 for SSL/TLS connections)
- Retrieves email messages
- Stays connected until the mail client app is closed and downloads messages on demand.
- Notice that messages aren't deleted on the server.
- IMAP does synchronize.

Email Client

An **email client** (email reader) is a computer program used to access and manage a user's email.

A web application which provides message management, composition, and reception functions may act as an email client.

An email client may also refer to a piece of computer hardware or software whose primary or most visible role is to work as an email client.

Email Client

Retrieving messages from a mailbox

A user's mailbox can be accessed in two dedicated ways.

- The Post Office Protocol (POP) allows the user to download messages one at a time and only deletes them from the server after they have been successfully saved on local storage.
- Alternatively, the Internet Message Access Protocol (IMAP) allows users to keep messages on the server, flagging them as appropriate.

Email Client

Message composition

The email client is usually set up automatically to connect to the user's mail server, which is typically either an MSA or an MTA, two variations of the SMTP protocol. The email client which uses the SMTP protocol creates an authentication extension, which the mail server uses to authenticate the sender.

Client settings require the name or IP address of the preferred outgoing mail server, the port number (25 for MTA, 587 for MSA), and the user name and password for the authentication, if any.

More Information

- Gmail SMTP Settings for Sending Mail.

  https://www.lifewire.com/what-are-the-gmail-smtp-settings-1170854

- POP3 vs IMAP - What's the difference?
  https://www.youtube.com/watch?v=SBaARws0hy4

- TCP/IP model
  https://www.geeksforgeeks.org/tcp-ip-model/

- OSI Model
  https://www.geeksforgeeks.org/layers-osi-model/