CSC-304
Web Programming

HTML , CSS , JavaScript , Git-hub based web development.

Objectives

1. Definitions and History
2. Internet Protocols
3. Client-Server Model
4. Where is the Internet?
5. Domain Name System
6. Uniform Resource Locators (URL)
7. Hypertext Transfer Protocol (HTTP)
8. Web Servers

Section 1 of 8

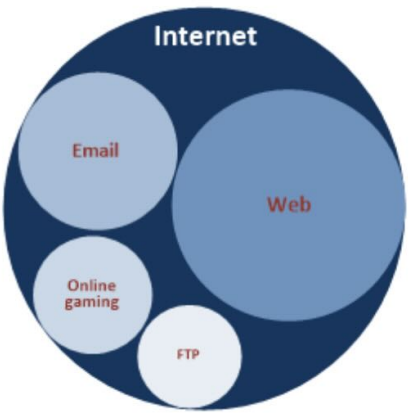
DEFINITIONS AND HISTORY

Internet = Web?

The answer is no

The World-Wide Web (WWW or simply the Web) is certainly what most people think of when they see the word “internet.”

But the WWW is only a subset of the Internet.



Communication Definitions

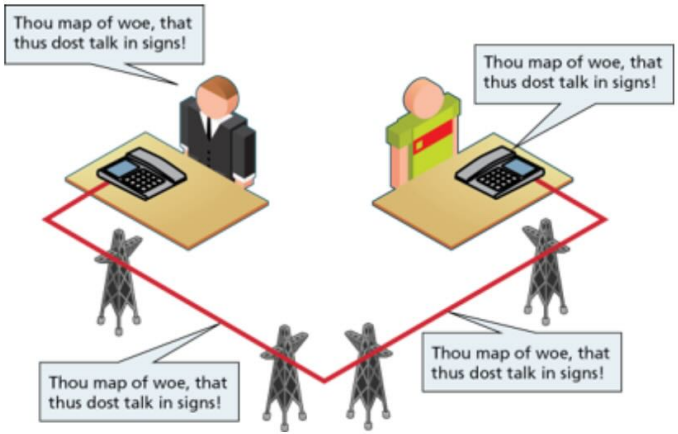
We will begin with the telephone

Telephone networks provide a good starting place to learn about modern digital communications.

In the telephone networks of old, calls were routed through operators who physically connected caller and receiver by connecting a wire to a switchboard to complete the circuit.

Circuit Switching

A **circuit switching** establishes an actual physical connection between two people through a series of physical switches.



Circuit Switching

Its Limitations

Circuit Switching Weaknesses

- You must establish a link and maintain a dedicated circuit for the duration of the call
- Difficult to have multiple conversations simultaneously
- Wastes bandwidth since even the silences are transmitted

ARPANET

The beginnings of the Internet

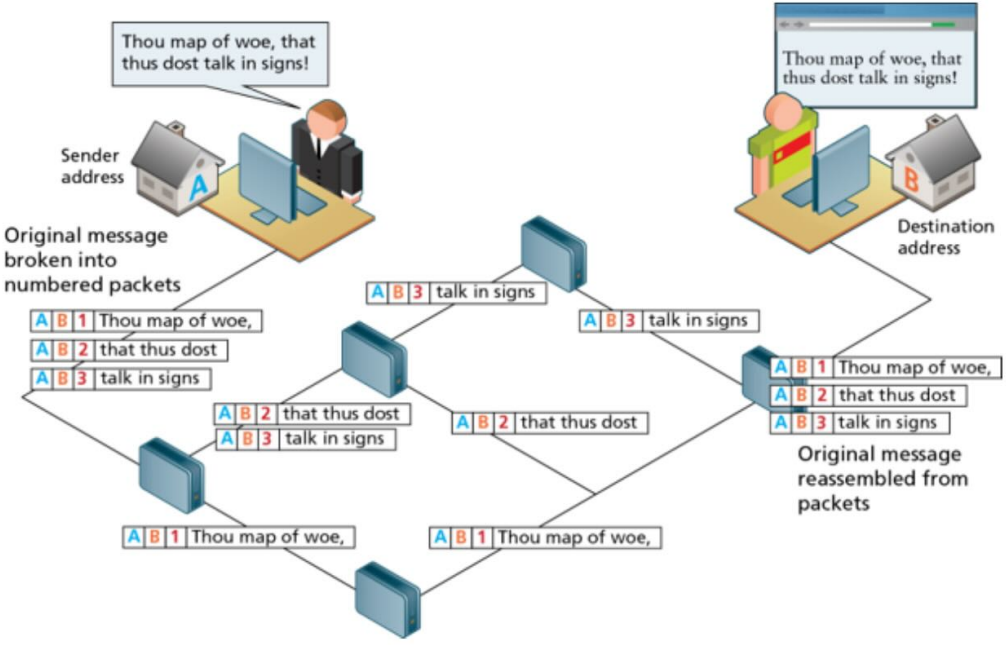
The research network ARPANET was created. In the 1960s

- ARPANET did not use circuit switching
- it used **packet switching**

A packet-switched network does not require a continuous connection. Instead it splits the messages into smaller chunks called **packets** and routes them to the appropriate place based on the destination address.

The **packets** can take different routes to the destination.

Packet Switching



Packet Switching

Isn't this more complicated?

While **packet switching** may seem a more complicated and inefficient approach than **circuit switching**, it is:

- more robust (it is not reliant on a single pathway that may fail) and
- a more efficient use of network resources (since a circuit can communicate multiple connections).

Short History of the Internet

Perhaps not short enough

The early ARPANET network was funded and controlled by the United States government, and was used exclusively for academic and scientific purposes.

The early network started small with just a handful of connected campuses in 1969 and grew to a few hundred by the early 1980s.

TCP/IP

Rides to the rescue

To promote the growth and unification of the disparate networks a suite of protocols was invented to unify the networks together.

By 1981, new networks built in the US began to adopt the **TCP/IP** (**Transmission Control Protocol / Internet Protocol**) communication model (discussed in the next section), while older networks were transitioned over to it.

Tim Berners-Lee

I meant Sir Tim Berners-Lee

The invention of the WWW is usually attributed to the British Tim Berners-Lee, who, along with the Belgian Robert Cailliau, published a proposal in 1990 for a hypertext system while both were working at CERN in Switzerland.

Core Features of the Web

Shortly after that initial proposal Berners-Lee developed the main features of the web:

1. A URL to uniquely identify a resource on the WWW.
2. The HTTP protocol to describe how requests and responses operate.
3. A software program (later called web server software) that can respond to HTTP requests.
4. HTML to publish documents.
5. A program (later called a browser) to make HTTP requests from URLs and that can display the HTML it receives.

W3C

The World Wide Web Consortium

Also in late 1994, Berners-Lee helped found the **World Wide Web Consortium (W3C)**, which would soon become the international standards organization that would oversee the growth of the web.

This growth was very much facilitated by the decision of CERN to not patent the work and ideas done by its employee and instead left the web protocols and code-base royalty free.

Web Apps Compared to Desktop Apps

First the advantages of web apps

Some of the advantages of web applications include:

- Accessible from any internet-enabled computer.
- Usable with different operating systems and browser platforms.
- Easier to roll out program updates since only need to update software on server and not on every desktop in organization.
- Centralized storage on the server means fewer concerns about local storage (which is important for sensitive information such as health care data).

Web Apps Compared to Desktop Apps

Now the disadvantages of web apps

Some of the disadvantages of web applications include:

Requirement to have an active internet connection (the internet is not always available everywhere at all times).

Security concerns about sensitive private data being transmitted over the internet.

Concerns over the storage, licensing and use of uploaded data.

Problems with certain websites on certain browsers not looking quite right.

Limited access to the operating system can prevent software and hardware from being installed or accessed (like Adobe Flash on iOS).

What is an “Intranet”?

A short digression

One of the more common terms you might encounter in web development is the term “**intranet**” (with an “**a**”), which refers to an internet network that is local to an organization or business.

Intranet resources are often private, meaning that only employees (or authorized external parties such as customers or suppliers) have access to those resources.

Thus Internet (with an “e”) is a broader term that encompasses both private (intranet) and public networked resources.

What is an “Intranet”?

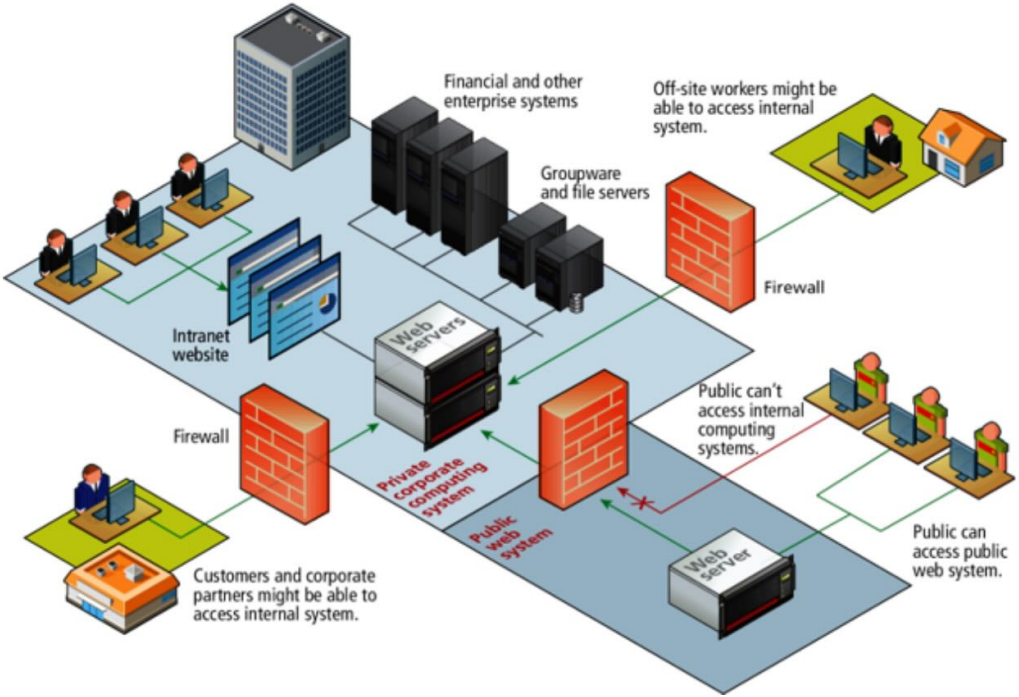
Intranets are typically protected from unauthorized external access via security features such as firewalls or private IP ranges.

Because intranets are private, search engines such as Google have limited or no access to content within a private intranet.

Due to this private nature, it is difficult to accurately gauge, for instance, how many web pages exist within intranets, and what technologies are more common in them.

> Some especially expansive estimates guess that almost half of all web resources are hidden in private intranets.

Intranet versus Internet



Intranets and the Job Market

Being aware of intranets is also important when one considers the job market and market usage of different web technologies.

If one focuses just on the public internet, it will appear that, for instance, PHP, MySQL, and WordPress, are absolutely dominant in their market share.

But when one adds in the private world of corporate intranets, other technologies such as ASP.NET, JSP, SharePoint, Oracle, SAP, and IBM WebSphere, are just as important.

Static Web Sites

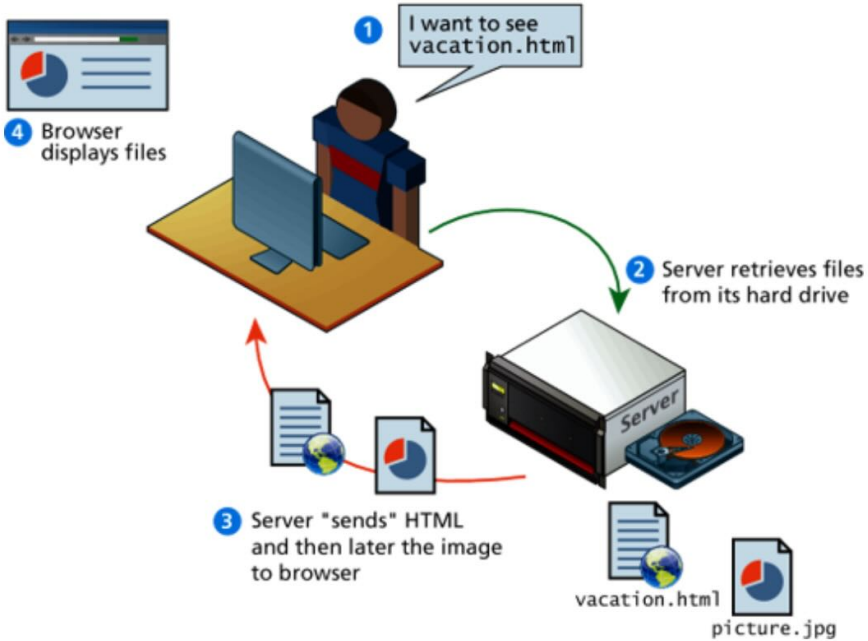
Partying Like It's 1995

In the earliest days of the web, a **webmaster** (the term popular in the 1990s for the person who was responsible for creating and supporting a web site) would publish web pages, and periodically update them.

In those early days, the skills needed to create a web site were pretty basic: one needed knowledge of the HTML markup language and perhaps familiarity with editing and creating images.

This type of web site is commonly referred to as a **static web site**, in that it consists only of HTML pages that look identical for all users at all times.

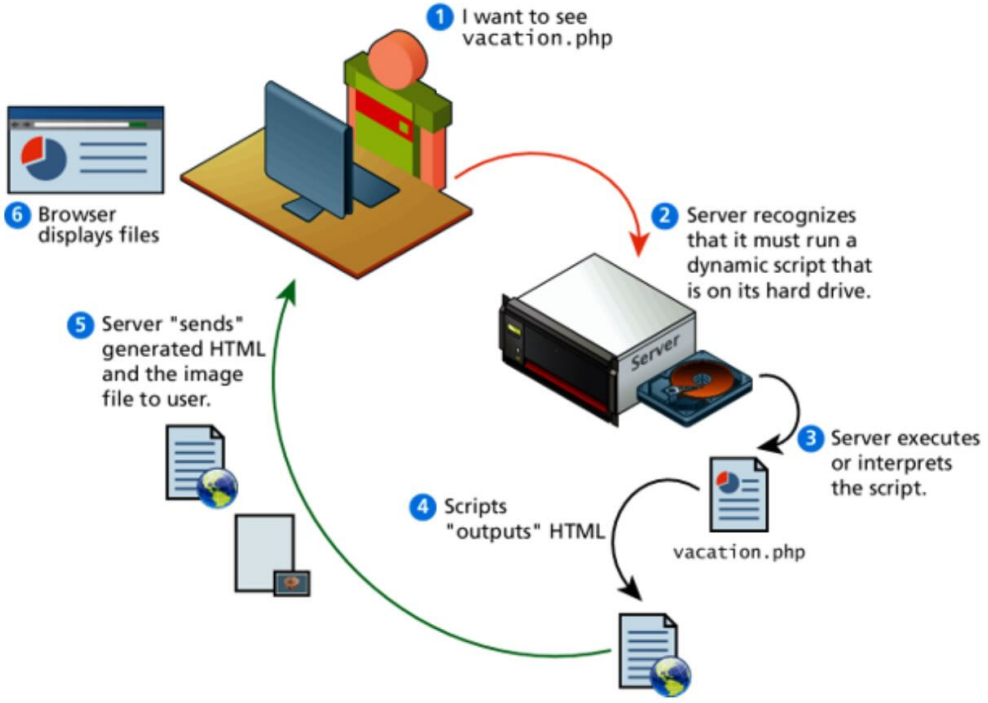
Static Web Sites



Dynamic Web Sites

Within a few years of the invention of the web, sites began to get more complicated as more and more sites began to use programs running on web servers to generate content dynamically.

Dynamic Web Sites



Dynamic Web Sites

What are they?

These server-based programs would read content from databases, interface with existing enterprise computer systems, communicate with financial institutions, and then output HTML that would be sent back to the users' browsers.

This type of web site is called here in this book a **dynamic web site** because the page content is being created at run-time by a program created by a programmer; this page content can vary for user to user.

Web 2.0 and Beyond

In the mid 2000s, a new buzz-word entered the computer lexicon: **web 2.0**.

This term had two meanings, one for users and one for developers.

Web 2.0

Its meaning for users

For the users, Web 2.0 referred to an interactive experience where users could contribute *and* consume web content, thus creating a more user-driven web experience.

Web 2.0

Its meaning for developers

For software developers, Web 2.0 also referred to a change in the paradigm of how dynamic web sites are created.

Programming logic, which previously existed only on the server, began to migrate to the browser.

This required learning Javascript, a rather tricky programming language that runs in the browser, as well as mastering the rather difficult programming techniques involved in asynchronous communication.

Section 2 of 8

INTERNET PROTOCOLS

What's a Protocol?

The internet exists today because of a suite of interrelated communications protocols.

A **protocol** is a set of rules that partners in communication use when they communicate.

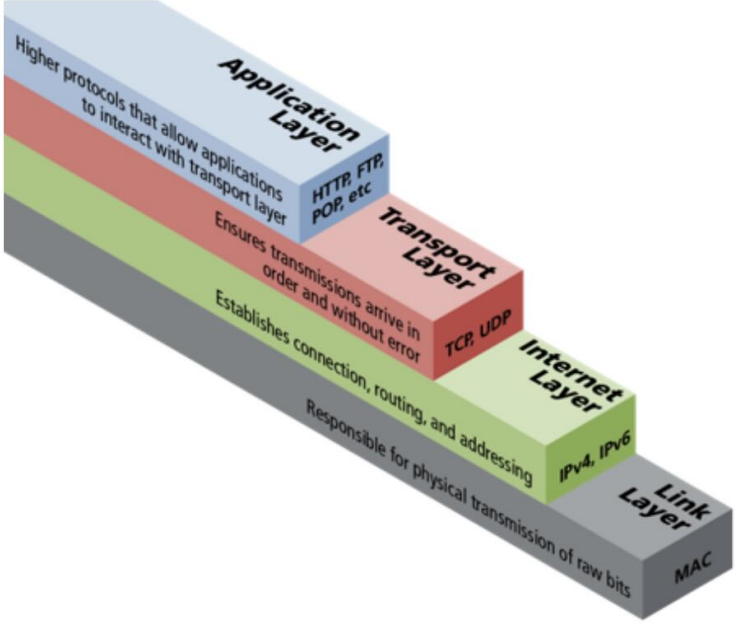
A Layered Architecture

The TCP/IP Internet protocols were originally abstracted as a four-layer stack.

Later abstractions subdivide it further into five or seven layers.

Since we are focused on the top layer anyhow, we will use the earliest and simplest **four-layer network model**.

Four Layer Network Model



Link Layer

Save this for your networking course

The **link layer** is the lowest layer, responsible for both the physical transmission across media (wires, wireless) and establishing logical links.

It handles issues like packet creation, transmission, reception and error detection, collisions, line sharing and more.

Internet Layer

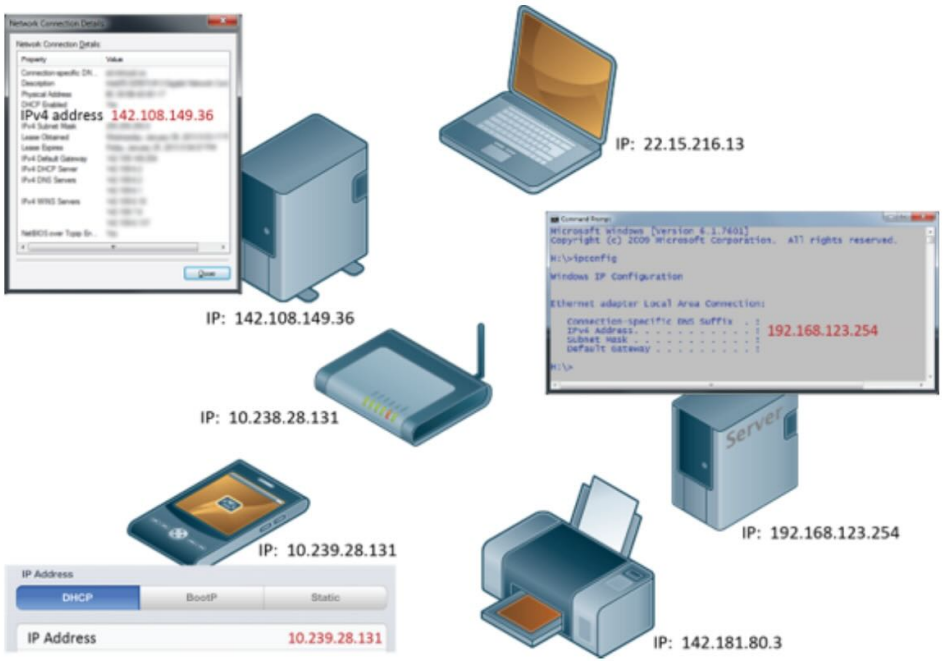
The **internet layer** (sometimes also called the IP Layer) routes packets between communication partners across networks.

Internet Protocol (IP)

The Internet uses the **Internet Protocol** (**IP**) addresses to identify destinations on the Internet.

Every device connected to the Internet has an **IP address**, which is a numeric code that is meant to uniquely identify it.

IP addresses and the Internet



IP Addresses

Two types

IPv4 addresses are the IP addresses from the original TCP/IP protocol.

In IPv4, 12 numbers are used (implemented as four 8-bit integers), written with a dot between each integer.

Since an unsigned 8-bit integer's maximum value is 255, four integers together can encode approximately 4.2 billion unique IP addresses.

IP Addresses

Two types

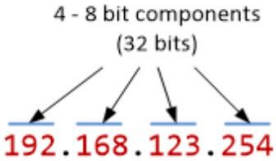
To future proof the Internet against the 4.2 billion limit, a new version of the IP protocol was created, **IPv6**.

This newer version uses eight 16-bit integers for 2^{128} unique addresses, over a billion billion times the number in IPv4.

These 16-bit integers are normally written in hexadecimal, due to their longer length.

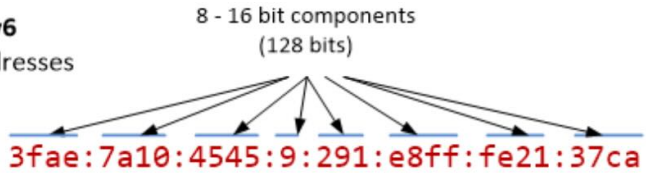
IPv4

2^{32} addresses



IPv6

2^{128} addresses



IP Addresses

Inside of networks is different

Your IP address will generally be assigned to you by your Internet Service Provider (ISP).

In organizations, large and small, purchasing extra IP addresses from the ISP is not cost effective.

In a local network, computers can share a single IP address between them.

Transport Layer

The **transport layer** ensures transmissions arrive, in order, and without error.

This is accomplished through a few mechanisms.

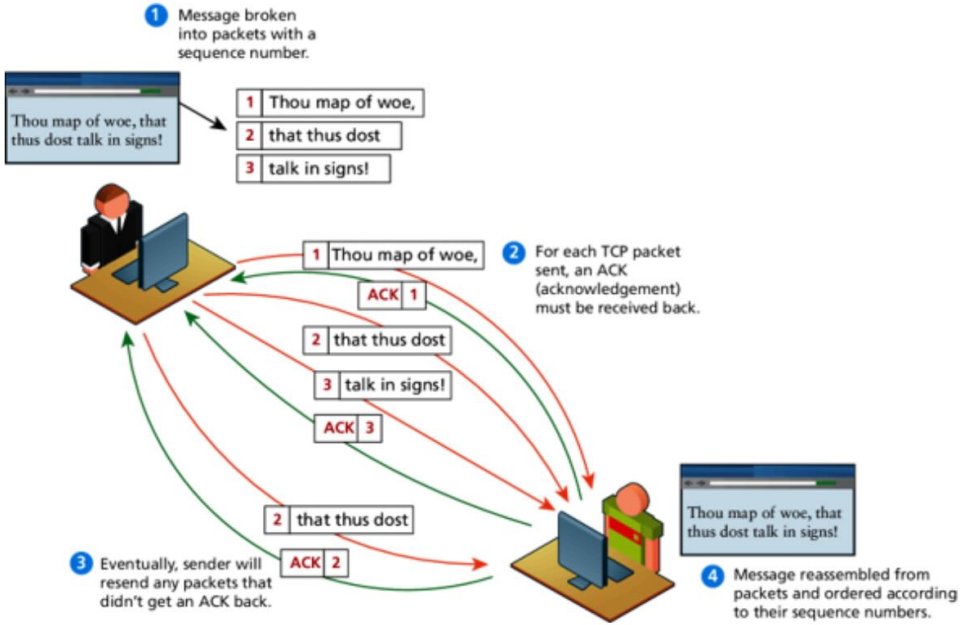
First, the data is broken into packets formatting according to the **Transmission Control Protocol** (**TCP**).

Transport Layer

Secondly, each packet is acknowledged back to the sender so in the event of a lost packet, the transmitter will realize a packet has been lost since no ACK arrived for that packet.

That packet is retransmitted, and although out of order, is reordered at the destination.

TCP Packets


1 Message broken into packets with a sequence number.
Thou map of woe, that thus dost talk in signs!
1 Thou map of woe,
2 that thus dost
3 talk in signs!
1 Thou map of woe,
2 For each TCP packet sent, an ACK (acknowledgement) must be received back.
ACK 1
2 that thus dost
3 talk in signs!
ACK 3
2 that thus dost
ACK 2
3 Eventually, sender will resend any packets that didn't get an ACK back.
Thou map of woe, that thus dost talk in signs!
4 Message reassembled from packets and ordered according to their sequence numbers.

Application Layer

With the **application layer**, we are the level of protocols familiar to most web developers.

Application layer protocols implement process-to-process communication and are at a higher level of abstraction in comparison to the low-level packet and IP addresses protocols in the layers below it.

Examples: HTPP, SSH, FTP, DNS, POP, SMTP.