CALVIN
INSTITUTE OF TECHNOLOGY

Computer Networks

(IEE2072 & IBDA2022 – Jaringan Komputer)

Lecture #02 – Internet & Standards

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Every Byte Speaks the Glory of God

@eaJAN25

Learning Objectives

- Introduces a brief history of the Internet.

- Introduces protocols, standards and its organizations.

PART 1: The Internet

The Internet Today




Customer network ... Customer network

Customer network ... Customer network

Provider network ... Provider network

National/Regional ISPs

MyRepublic

International ISPs

Peering point

Backbones

Peering point

Biznet Home

FIRST MEDIA

Provider network

Provider network

Provider network

Customer network ... Customer network

Customer network ... Customer network

Customer network ... Customer network


A peering point, also known as an Internet Exchange Point (IXP)

A physical location where multiple ISPs and networks connect to exchange traffic.

It acts as a central hub, facilitating efficient data exchange and enhancing Internet connectivity

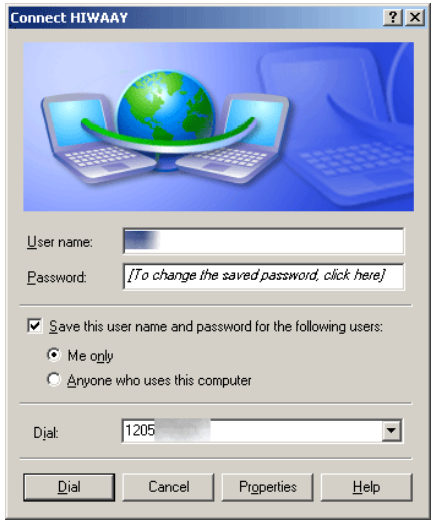
Internet: How to Access (1a/3)

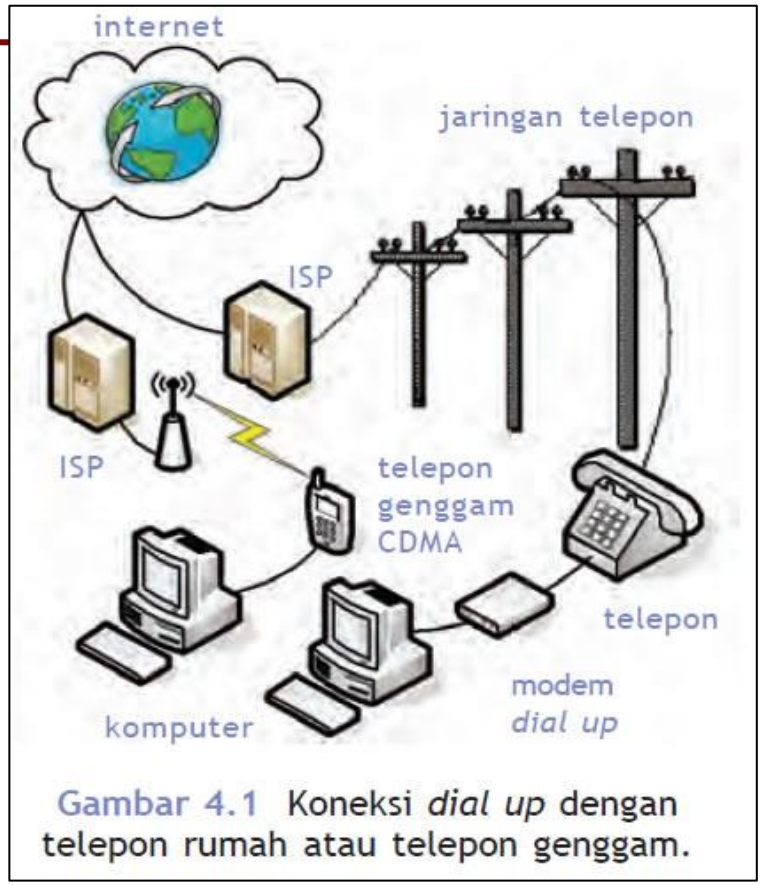
Using Telephone Networks

- The first solution is to add to the telephone line a modem that converts data to voice – this is known as dial-up service.

- The software installed on the computer dials the ISP and imitates making a telephone connection.

- Sadly, some disadvantages:
  - Very slow
  - Data **can't** be used together with voice connection.

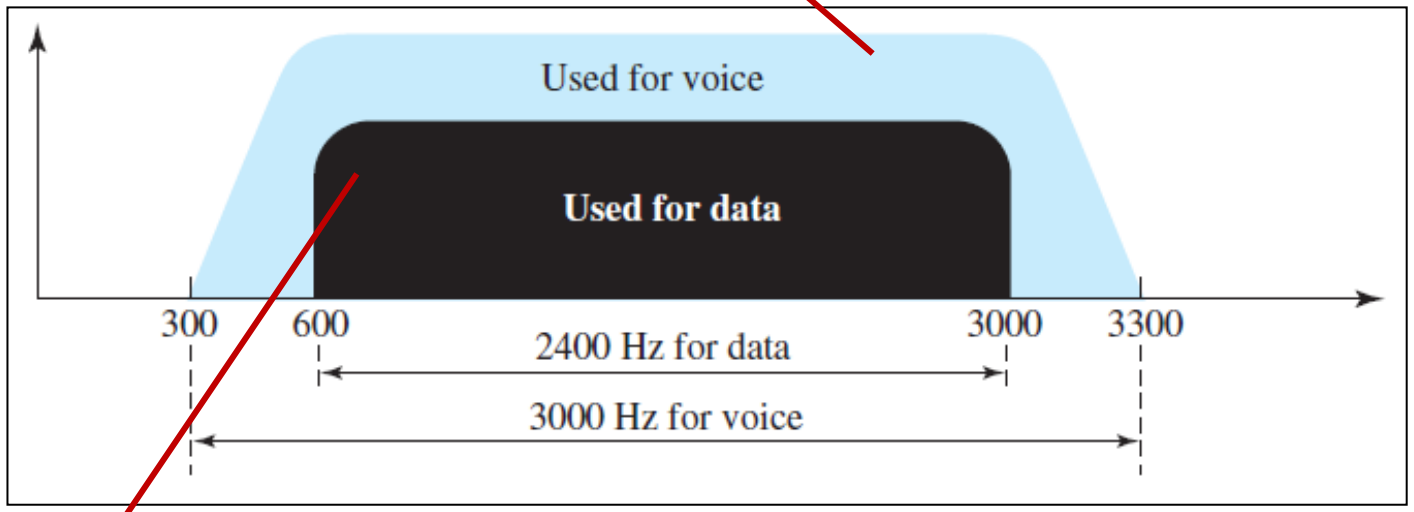




Gambar 4.1 Koneksi *dial up* dengan telepon rumah atau telepon genggam.

Internet: How to Access (1a/3)

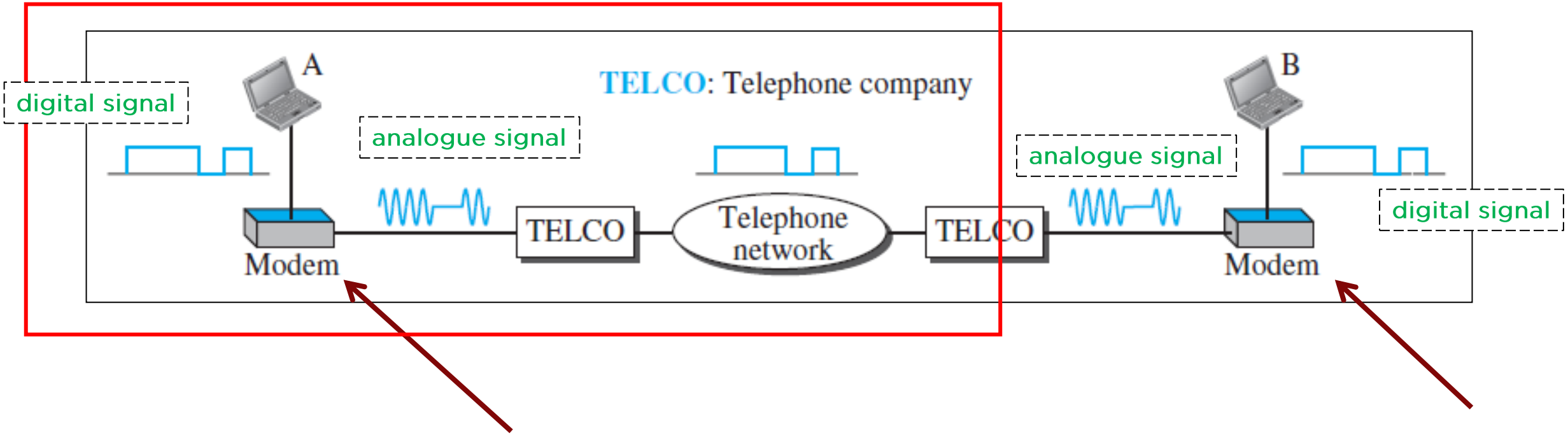
- Traditional telephone lines can carry frequencies between 300 and 3300 Hz, giving them a bandwidth of 3000 Hz.
  - All this range is used for transmitting voice, where a great deal of interference and distortion can be accepted without loss of intelligibility.



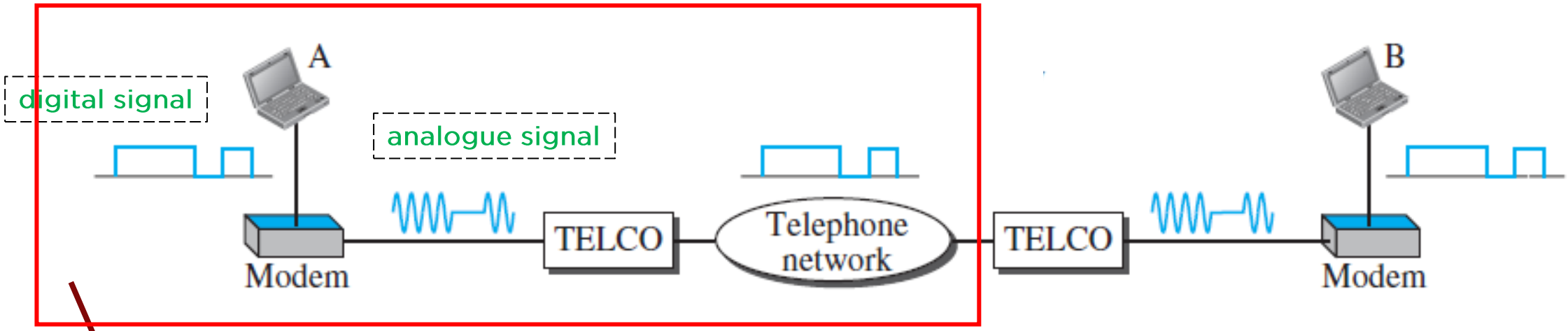
- However, data signals require a higher degree of accuracy to ensure integrity. For safety's sake, therefore, the edges of this range are not used for data communications.

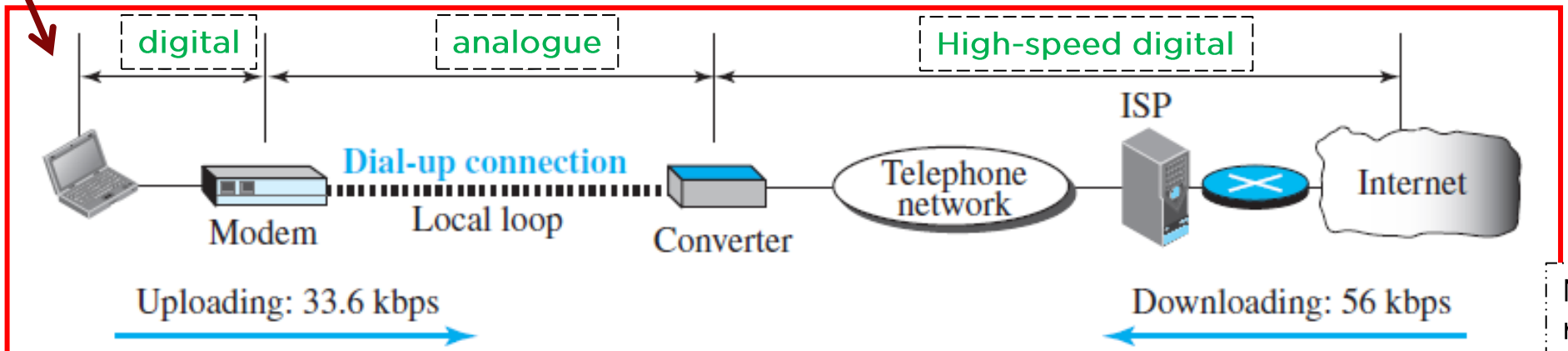
Internet: How to Access (1a/3)

- The term modem is a composite word that refers to the two functional entities that make up the device: a signal *mo*dulator and a signal *dem*odulator.
  - A **modulator** creates a bandpass analogue signal from binary data.
  - A **demodulator** recovers the binary data from the modulated signal.



Internet: How to Access (1a/3)





Traditional modems have a data rate limitation of **33.6 kbps**, as determined by the Shannon capacity (later).

We can calculate the theoretical highest bit rate of a regular telephone line. A telephone line normally has a bandwidth of 3000 Hz (300 to 3300 Hz) assigned for data communications. The signal-to-noise ratio is usually 3162. For this channel the capacity is calculated as

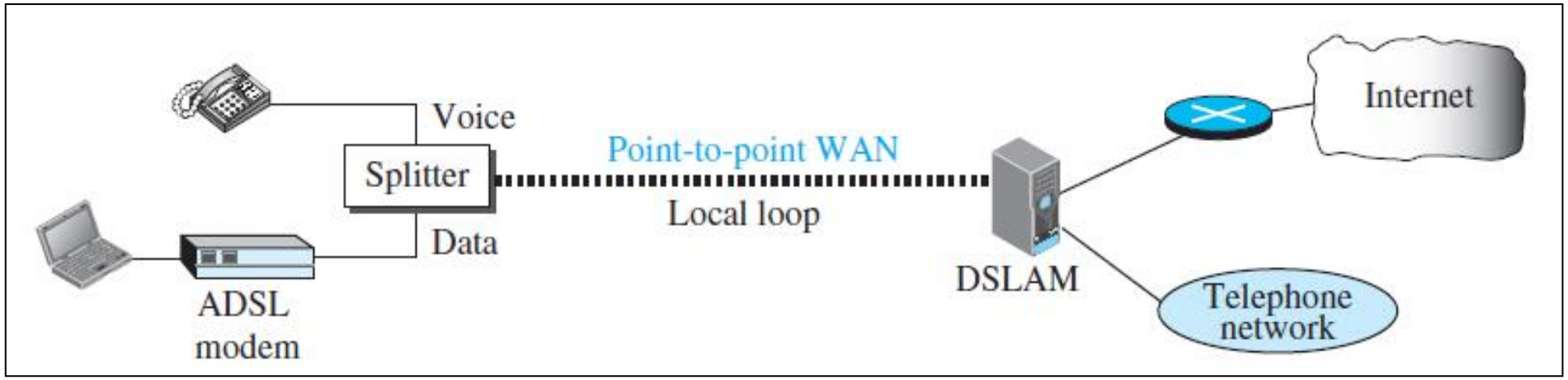
$$C = B \log_2 (1 + \text{SNR}) = 3000 \log_2(1 + 3162) = 3000 \times 11.62 = 34{,}860 \text{ bps}$$

Modern modems with a bit rate of 56,000 bps are available → *56k modems*

Internet: How to Access (1b/3)

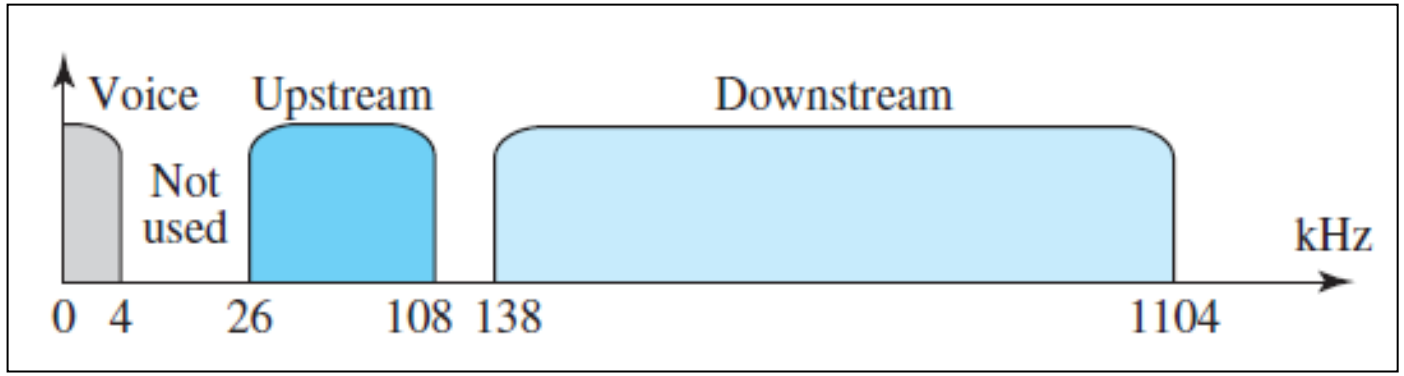
Using Telephone Networks

- Second solution is Digital Subscriber Line (DSL) Service - allows the line to be used **simultaneously** for voice and data communication.
  - Digital subscriber line (DSL) technology is one of the most promising for supporting high-speed digital communication over the existing telephone.
  - DSL technology is a set of technologies, each differing in the first letter (ADSL, VDSL, HDSL, and SDSL) → *x*DSL, where *x* can be replaced by A, V, H, or S.



Internet: How to Access (1b/3)

- Case of Asymmetric DSL (ADSL)
  - ADSL provides higher speed (bit rate) in the downstream direction (ISP to residents) than in the upstream direction (Resident to the ISPs). That is the reason it is called *asymmetric*.



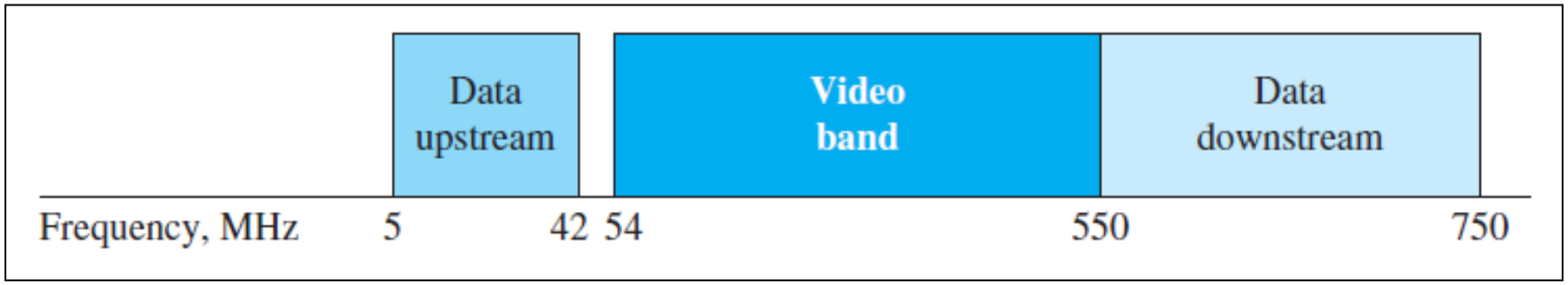
- ADSL allows the subscriber to use the voice channel and the data channel at the same time.
  - The rate for the upstream can reach 1,44 Mbps. However, the data rate is normally below 500 Kbps because of the high-level noise in this channel.
  - The downstream data rate can reach 13,4 Mbps. However, the data rate is normally below 8 Mbps because of noise in this channel.

Internet: How to Access (2/3)

Using Cable Networks

- More and more residents over the last two decades have begun using cable TV services instead of antennas to receive TV broadcasting.

- The cable companies have been upgrading their cable networks and connecting to the Internet.
  - The **video band** occupies frequencies from 54 to 550 MHz.
  - The **downstream data** (from the Internet to the subscriber premises) occupies the upper band, from 550 to 750 MHz.
  - The **upstream data** (from the subscriber premises to the Internet) occupies the lower band, from 5 to 42 MHz.



Internet: How to Access (3/3)

Using Wireless Networks

- Wireless connectivity has recently become increasingly popular. A household or a small business can use a combination of wireless and wired connections to access the Internet.

- With the growing wireless WAN access, a household or a small business can be connected to the Internet through a wireless WAN.

- Several access network:
  - WiMAX (Worldwide Interoperability for Microwave Access)
  - Cellular Telephony (1G, 2G, 3G, 4G, 5G, . .)
  - Satellite Networks (GEO, MEO, LEO)

Internet History

(1) Early History

- There were some communication networks, such as telegraph and telephone networks, before 1960.
  - These networks were suitable for constant-rate communication at that time, which means the (encoded) message could be exchanged after a connection was made.

- A computer network, on the other hand, should be able to handle bursty data, which means data received at variable rates at different times.

- The world needed to wait for the packet-switched network to be invented, i.e. ARPANET
  - Software called the **Network Control Protocol (NCP)** provided communication between the hosts.

(2) Birth of the Internet

- In 1972, Vint Cerf and Bob Kahn, both of whom were part of the core ARPANET group, collaborated on what they called the *Internetting Project.*

- Cerf and Kahn devised the idea of a device called a **gateway** to serve as the intermediary hardware to transfer data from one network to another.

- In 1973, a paper outlined the protocols to achieve end-to-end delivery of data by Cef and Kahn . . .
  - This was a new version of NCP.
  - This paper on **Transmission Control Protocol (TCP)** included concepts such as encapsulation, the datagram, and the functions of a gateway.

(3) Internet Today

World Wide Web

- The 1990s saw the explosion of Internet applications due to the emergence of the World Wide Web (WWW).
- The Web was invented at CERN by Tim Berners-Lee. This invention has added the commercial applications to the Internet.

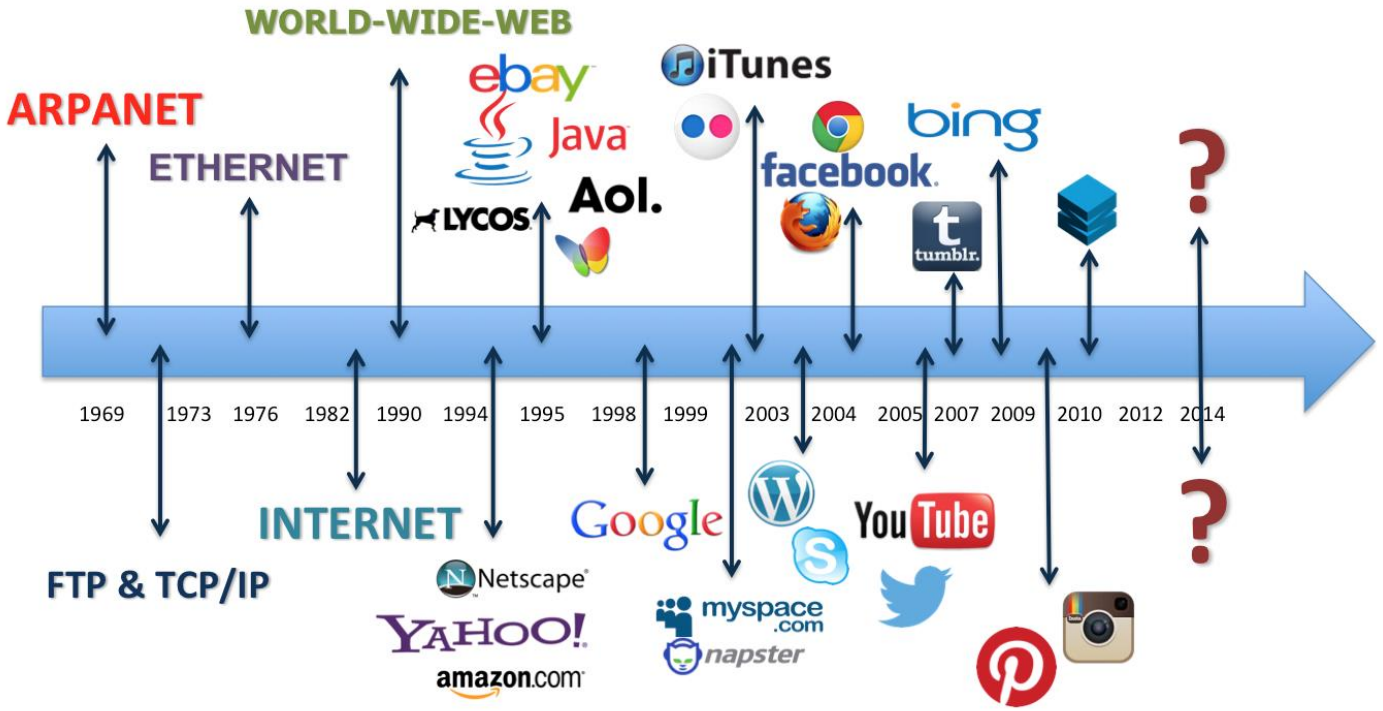
Multimedia

- Recent developments in the multimedia applications such as voice over IP (telephony), video over IP (Skype), view sharing (YouTube), and television over IP (PPLive) has increased the number of users and the amount of time each user spends on the network.

Peer-to-Peer Applications

Internet: Now and Future

- The Internet today is a set of pier networks that provide services to the whole world.
- What has made the Internet so popular is the invention of new application (app).



http://malonemediagroup.com/history-of-the-internet-timeline-an-ever-evolving-digital-world/

PART 2: Protocols & Standards

Protocols (1/4)

- A protocol is a set of rules that governs communications.
  - Ex. How to start/continue/end the communication between two persons?
  - Ex. In starting a phone call. What's the protocol?

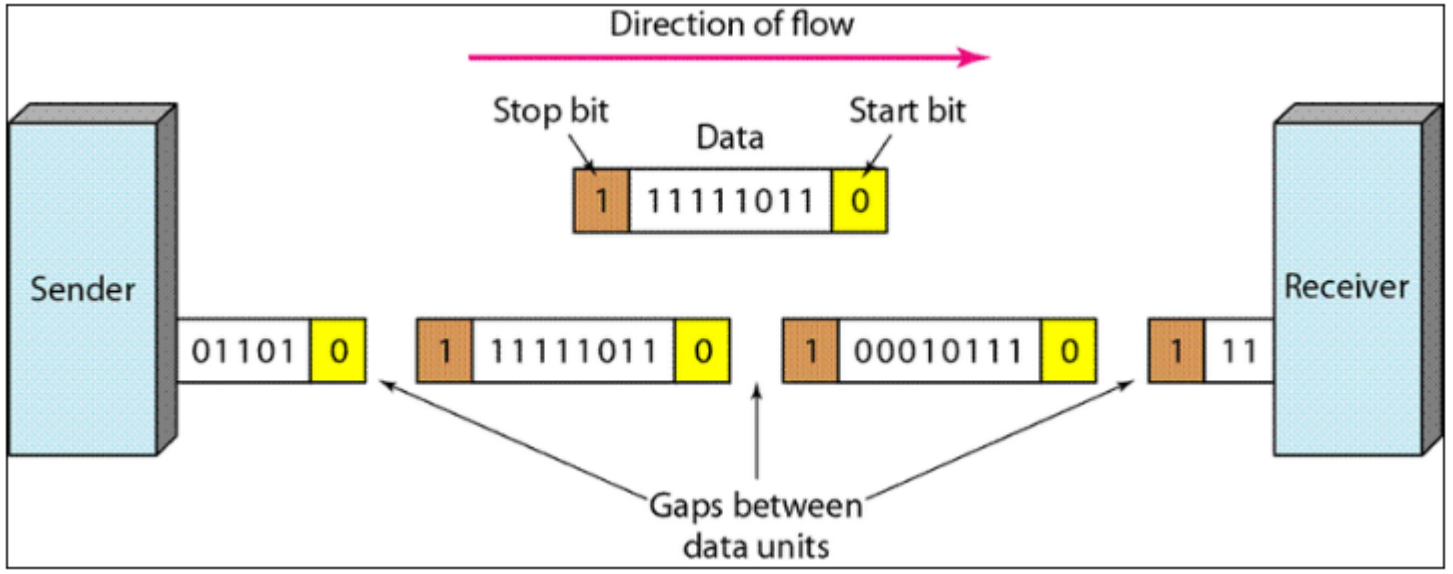
- In computer networks, communication occurs between units in different systems.
  - Two entities can send or receive information, **however** they cannot simply send them and expect to be understood.
  - Both entities must agree on a protocol.
  - A protocol defines what is communicated, how it is communicated, and when it is communicated.

- The key elements of a protocol are syntax, semantics, and timing.

Protocols (2/4)

Syntax

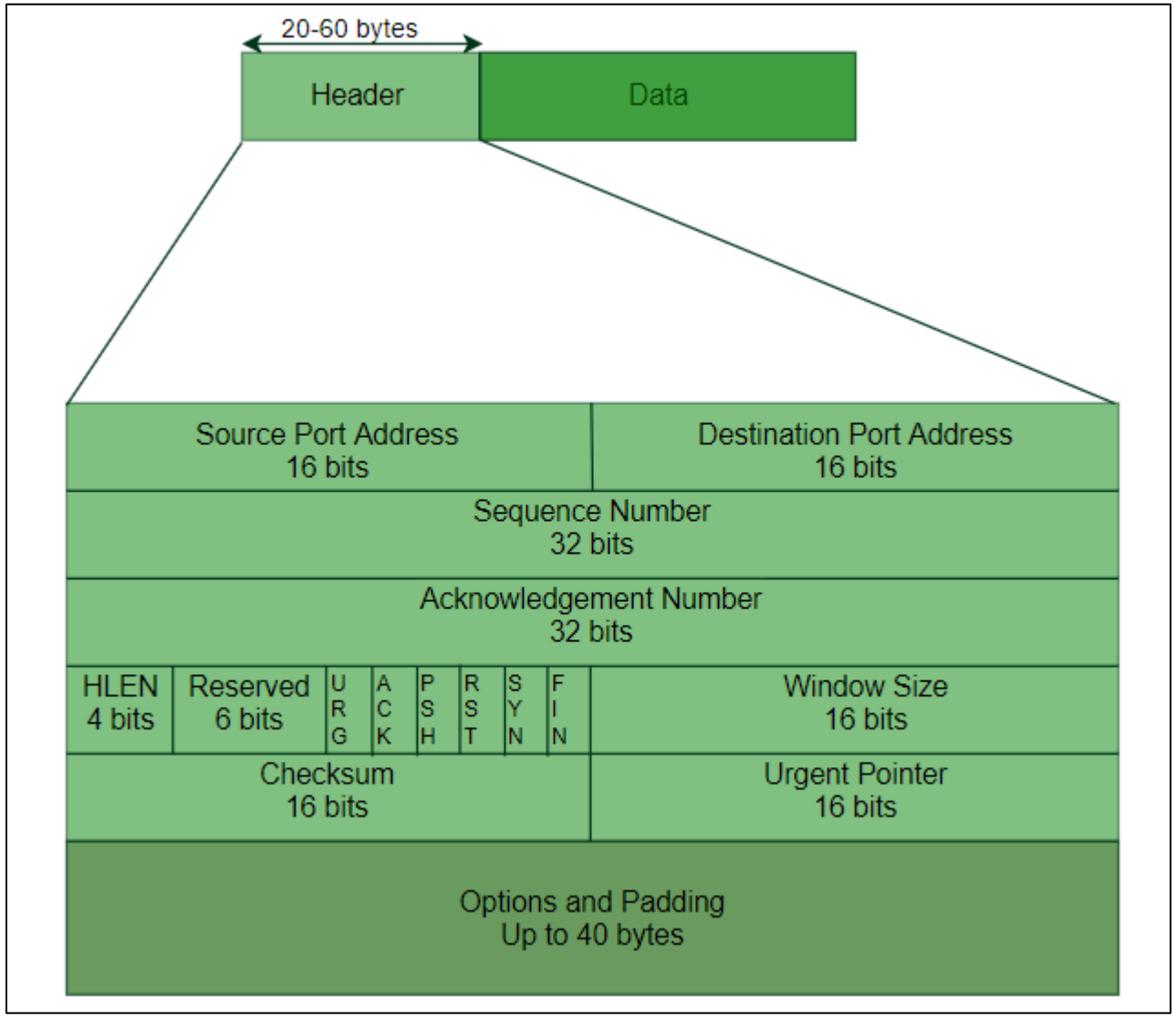
- Syntax refers to the structure or format of the data, meaning the order in which they are presented.
- Example, a protocol might specify 1 start and stop bit, and the rest of the stream to be the message (“data”) itself.



Protocols (3/4)

Semantics

- Semantics refers to the meaning of each section of bits.
- How is a particular pattern to be interpreted, and what action is to be taken based on that interpretation?
- For example, does an address identify the route to be taken or the final destination of the message?



Protocols (4/4)

Timing

- Timing refers to two characteristics: when data should be sent and how fast it can be sent.
  - For example, if a sender produces data at 100 megabits per second (100 Mbps) but the receiver can process data at only 1 Mbps, the transmission will overload the receiver and data will be largely lost.

Standards (1/3)

- Networks are literally everywhere -- every hardware device or protocol is governed by at least one standard, or many.

- These standards are very important since it facilitates the interoperability of network technologies! It is essential in terms of:
  - maintaining an open and competitive market for equipment manufacturers
  - guaranteeing national and international interoperability of data and telecommunications technology and processes.

- Data communication standards fall into two categories:
  - De facto (*by fact*)
    Standards that have been adopted through widespread use *YET* not approved by an organized body. De facto standards are often established originally by manufacturers who *seek* to *define* the functionality of a *new* product or technology.

  - De jure (*by law/regulation*)
    Standards that have been legislated by an officially recognized body.

Standards (2/3)

- You can't study networking without encountering a whole host of **standards** that are related to the subject; this also including the **organizations** that create these standards.

- Several standards organizations that you are likely to encounter related to networking and the Internet:

International Organization for Standardization (ISO)

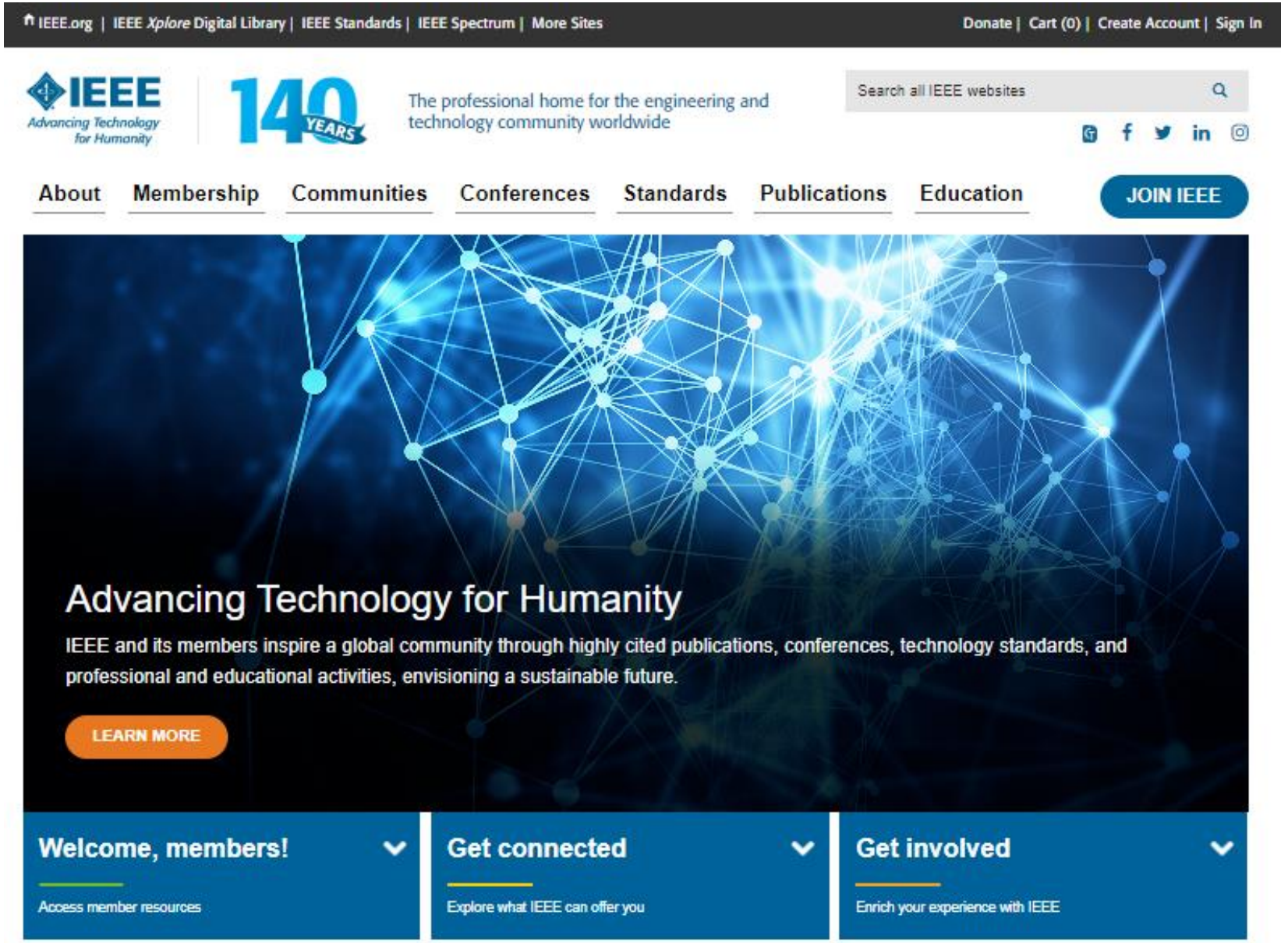
- Probably the biggest standards organization in the world, the ISO is really a federation of standards organizations from dozens of nations.
- In the ICT field, an **Open Systems Interconnection** (OSI) is a model for network communication..

Institute of Electrical and Electronics Engineers (IEEE)

- The IEEE is a well-known professional organization for those in the electrical or electronics fields, including computers and networking.
- IEEE 802 is a family of IEEE standards for (LANs), (PANs), and metropolitan area networks (MANs).

https://en.wikipedia.org/wiki/IEEE_802

https://ieee.org



Standards (3/3)

American National Standards Institute (ANSI)

European Telecommunications Standards Institute (ETSI)

International Telecommunication Union - Telecommunication Standardization Sector (ITU-T)

Electronic Industries Association (EIA)

World Wide Web Consortium (W3C)

Open Mobile Alliance (OMA)

... and others

Internet Standards

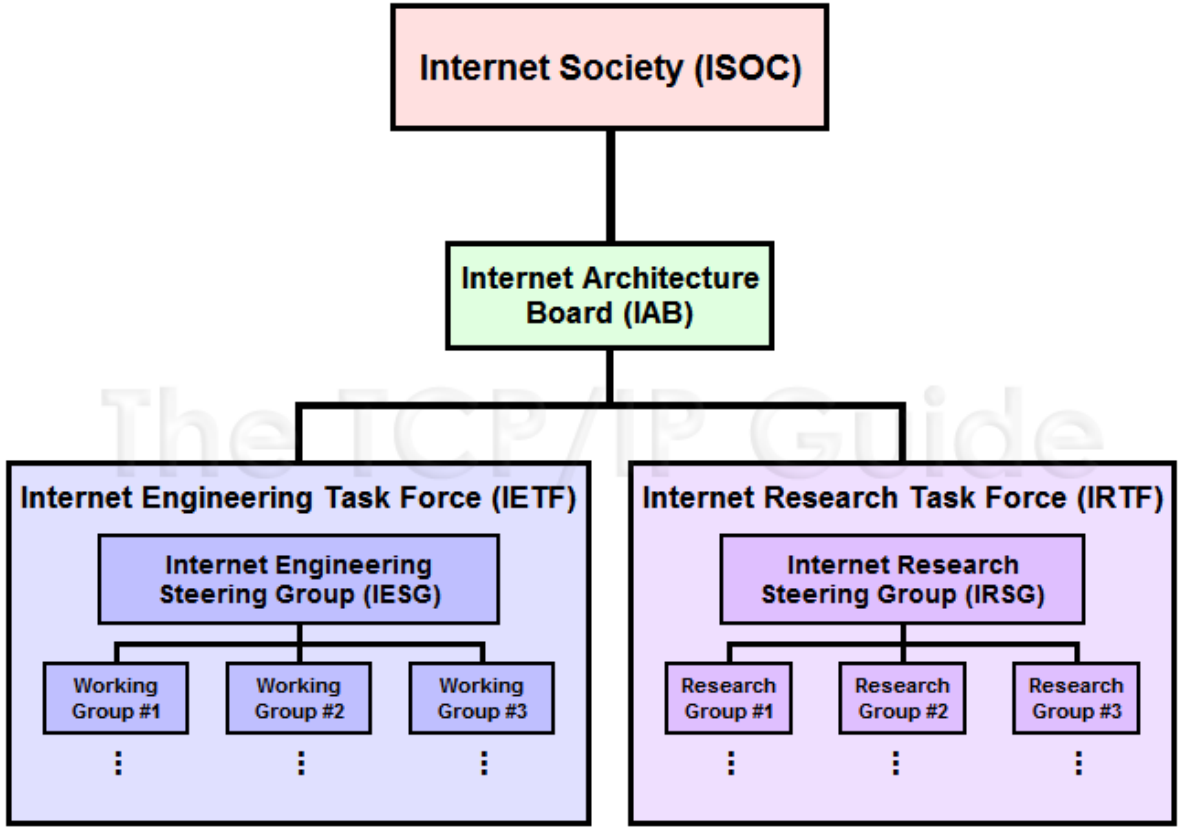
- Nobody sat down one day and said, *"hey, let's create the Internet!"*
  - It began as a small research network, and was developed over time concurrently with the technology set that implemented it: TCP/IP

- At first, a relatively small organization was sufficient to manage the development of Internet standards and oversee its activities, but as the Internet continued to grow, this became inadequate.

- Eventually a more formalized structure of organizations was required, to manage the Internet development process and other activities to ensure the continued success and growth of the Internet and the TCP/IP technologies that power it.

Internet Administration

- Today, there are six organizations that are responsible for the development of the Internet's architecture, standards and policies, and related activities.



http://www.tcpipguide.com/

to be continued