CSE2029: Data Communication & Computer Networks

Lecture-1: Introduction

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Outline

- *What Is the Internet: A Nuts-and-Bolts Description*
- *What Is the Internet: A Services Description*
- *What Is a Protocol?*
- *The Network Edge*
- *Access Networks*
- *Physical Media*
- *The Network Core*
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What Is the Internet: A Nuts-and-Bolts Description

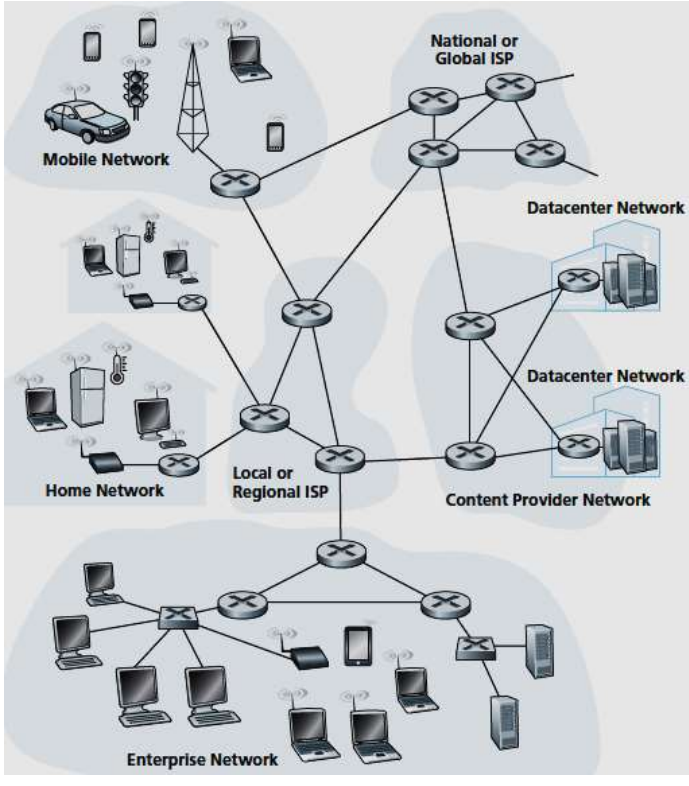


Fig: Some pieces of the Internet *(Source: Computer Networking: A Top-Down Approach," by James F Kurose and Keith W Ross)*

What Is the Internet: A Nuts-and-Bolts Description

- **End systems** are connected together by a network of **communication links** and **packet switches**. There are many types of communication links, which are made up of different types of physical media, including coaxial cable, copper wire, optical fiber, and radio links. Different links can transmit data at different rates, with the transmission rate of a link measured in bits/second. When one end system has data to send to another end system, the sending end system segments the data and adds header bytes to each segment. The resulting packages of information, known as **packets** in the jargon of computer networks, are then sent through the network to the destination end system, where they are reassembled into the original data.

What Is the Internet: A Nuts-and-Bolts Description

- A **packet-switch** takes a packet arriving on one of its incoming communication links and forwards that packet on one of its outgoing communication links. Packet-switches come in many shapes and flavors, but the two most prominent types of packet-switches are routers and link-layer switches. Both types of switches forward packets toward their ultimate destinations. Link-layer switches are typically used in access networks, while routers are typically used in the network core. The sequence of communication links and packet switches traversed by a packet from the sending end system to the receiving end system is known as a **route** or path through the network.

What Is the Internet: A Nuts-and-Bolts Description

- End systems access the Internet through **Internet Service Providers (ISPs),** including residential ISPs, corporate ISPs; university ISPs; ISPs that provide WiFi access in airports, hotels, and other public places; and cellular data ISPs. Each ISP is in itself a network of packet switches and communication links. ISPs also provide Internet access to content providers, connecting servers directly to the Internet.
- The Internet is all about connecting end systems to each other, so the ISPs that provide access to end-systems must also be interconnected. These lower tier ISPs are thus interconnected through national and international upper-tier ISPs and these upper-tier ISPs are connected directly to each other. An upper-tier ISP consists of high-speed routers interconnected with high-speed fiber-optic links.
- Each ISP network, whether upper-tier or lower-tier, is managed independently, runs the **IP protocol**, and conforms to certain naming and address conventions.

What Is the Internet: A Nuts-and-Bolts Description

- End-systems, packet switches, and other pieces of the Internet run **protocols** that control the sending and receiving of information within the Internet.
- The Transmission Control Protocol (TCP) and the Internet Protocol (IP) are two of the most important protocols in the Internet.
- The IP protocol specifies the format of the packets that are sent and received among routers and end systems.
- The Internet's principal protocols are collectively known as TCP/IP.

What Is the Internet: A Services Description

- Nuts-and-Bolts Description has identified many of the pieces that make up the Internet. But **we can also describe the Internet from an entirely different angle—namely, as an infrastructure that provides services to applications.**
- In addition to traditional applications such as e-mail and Web surfing, Internet applications include mobile smartphone and tablet applications, including Internet messaging, music streaming, television streaming, online social media, video conferencing, multi-person games, etc. These applications are said to be **distributed applications**, since they involve multiple end systems that exchange data with each other.
- Importantly, Internet applications run on end-systems and NOT in the packet-switches. Although packet-switches facilitate the exchange of data among end-systems, they are not concerned with the application that is the source or sink of data.

What Is the Internet: A Services Description

- What we mean by an infrastructure that provides services to applications?
- To this end, suppose you have an exciting new idea for a distributed Internet application. How might you go about transforming this idea into an actual Internet application? Because applications run on end-systems, you are going to need to write programs that run on the end systems. You might, for example, write your programs in Java, C, or Python.
- Now, the programs running on the different end-systems will need to send data to each other. And here we get to a central issue—one that leads to the alternative way of describing the Internet as a platform for applications.
- **Question: How does one program running on one end system instruct the Internet to deliver data to another program running on another end system?**

What Is the Internet: A Services Description

- **Answer:** End systems attached to the Internet provide a **socket interface** that specifies how a program running on one end-system asks the Internet infrastructure to deliver data to a specific destination program running on another end-system. This Internet socket interface is a set of rules that the sending program must follow so that the Internet can deliver the data to the destination program.

What Is a Protocol?

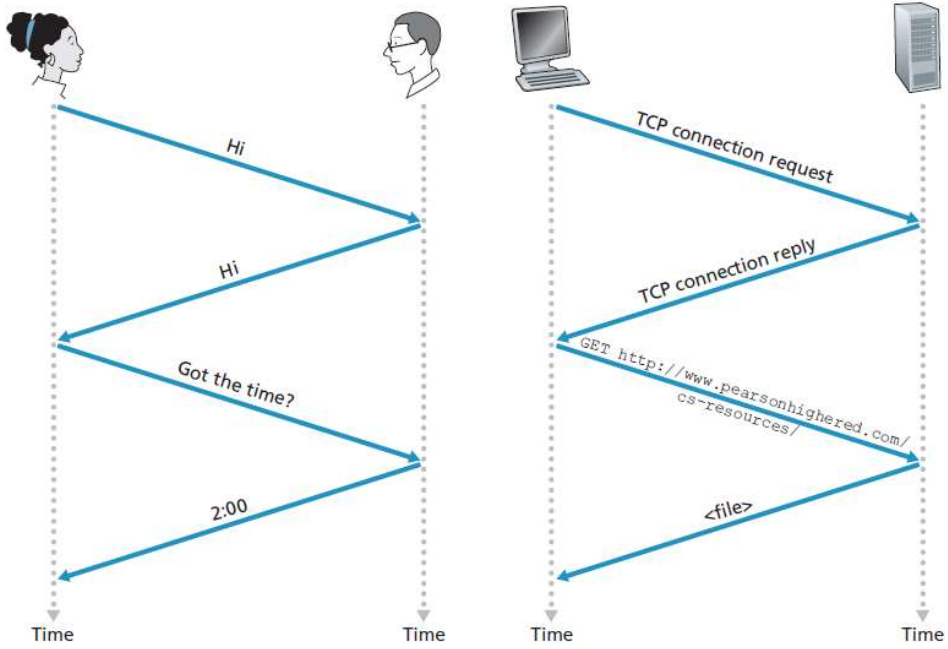


Fig: A human protocol and a computer network protocol

(Source: Computer Networking: A Top-Down Approach," by James F Kurose and Keith W Ross)

What Is a Protocol?

- A **network protocol** is similar to a human protocol, except that the entities exchanging messages and taking actions are hardware or software components of some device (for example, computer, smartphone, tablet, router, or other network-capable device).
- All activity in the Internet that involves two or more communicating remote entities is governed by a protocol. For example, hardware-implemented protocols in two physically connected computers control the flow of bits on the "wire" between the two network interface cards; congestion-control protocols in end systems control the rate at which packets are transmitted between sender and receiver; protocols in routers determine a packet's path from source to destination. Protocols are running everywhere in the Internet.

What Is a Protocol?

- A **protocol** defines the format and the order of messages exchanged between two or more communicating entities, as well as the actions taken on the transmission and/or receipt of a message or other event.

- The Internet, and computer networks in general, make extensive use of protocols. Different protocols are used to accomplish different communication tasks. We can learn some protocols are simple and straightforward, while others are complex and intellectually deep. Mastering the field of computer networking is equivalent to understanding the what, why, and how of networking protocols.

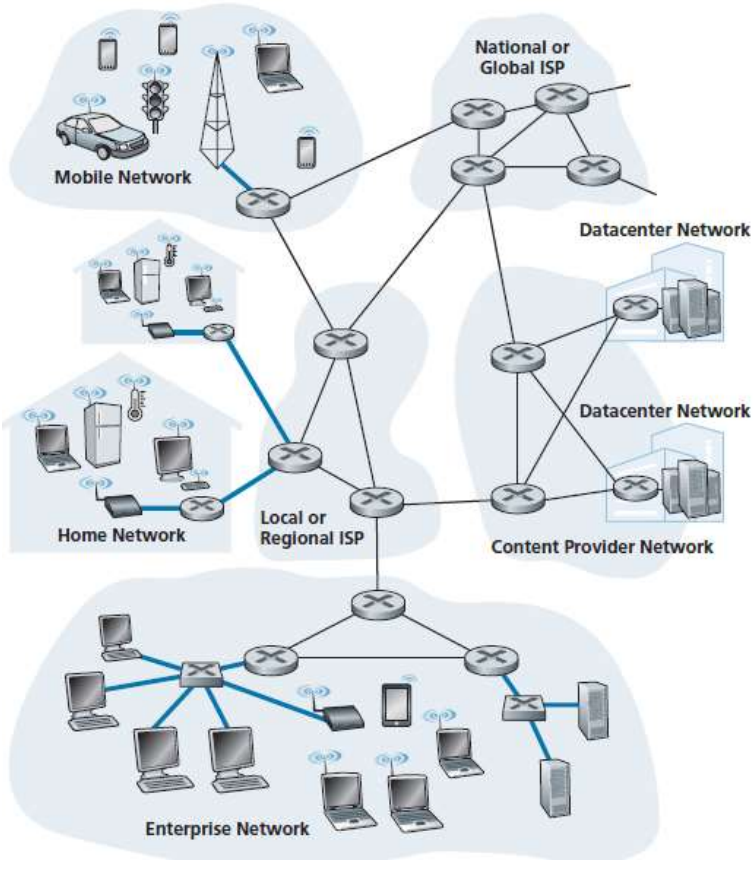
The Network Edge

- "The **network edge** refers to the **end points** where the end-systems are connected."
- The end systems include desktop computers (e.g., desktop PCs, Macs, and Linux boxes), servers (e.g., Web and e-mail servers), and mobile devices (e.g., laptops, smartphones, and tablets). Furthermore, an increasing number of non-traditional "things (IoT)" are being attached to the Internet as end systems.
- End systems are also referred to as hosts because they host (that is, run) application programs such as a Web browser program, a Web server program, an e-mail client program, or an e-mail server program.

The Network Edge Cont'd…

- **Hosts** are further divided into two categories: **clients and servers.** Informally, **clients** tend to be desktops, laptops, smartphones, and so on, whereas **servers** tend to be more powerful machines that store and distribute Web pages, stream video, relay e-mail, and so on.
- Today, most of the servers from which we receive search results, e-mail, Web pages, videos and mobile app content reside in large **data centers**.
- The **data centers** is a large group of networked computer servers typically used by organizations for the remote storage, processing, or distribution of large amounts of data.

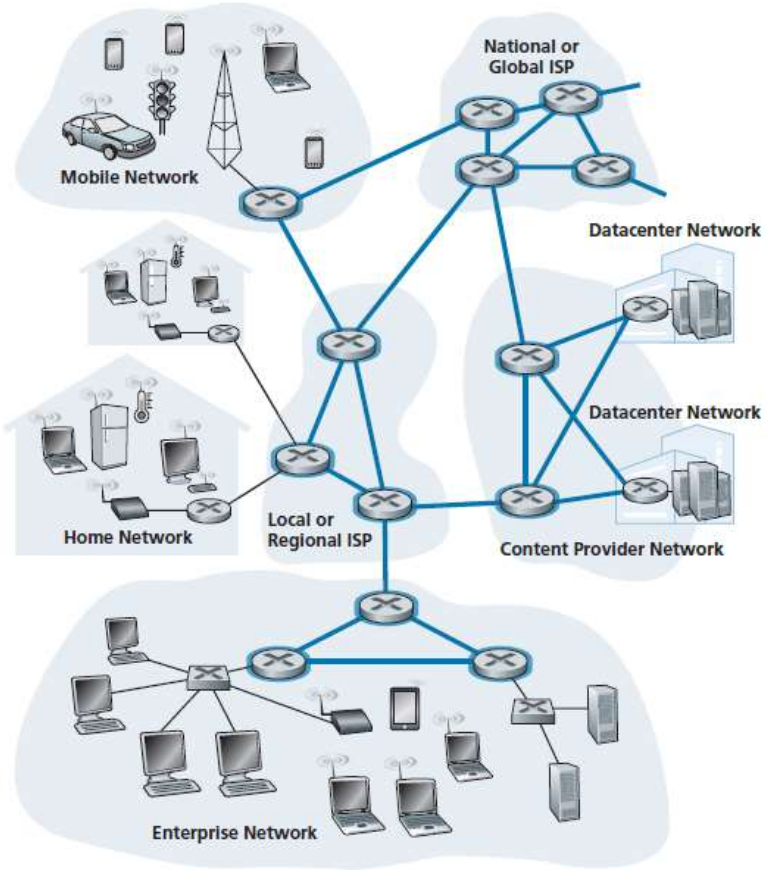
Access Networks



- A network that connects directly to the end user or customer is called the access network.
- The access network physically connects an end system to the first router *(edge router)* on a path from the end system to any other distant end system.
- Figure shows several types of access networks with thick, shaded lines and the settings (home, enterprise, and wide-area mobile wireless) in which they are used.

Physical Media

- The data travels from one system to another through is medium which is called the physical media. Physical media fall into two categories: **guided media** and **unguided media**. With guided media, the waves are guided along a solid medium, such as a fiber-optic cable, a twisted-pair copper wire, or a coaxial cable. With unguided media, the waves propagate in the atmosphere and in outer space, such as in a wireless LAN or a digital satellite channel. Some of the important physical media are as follows:
  - Twisted-Pair Copper Wire
  - Coaxial Cable
  - Fiber Optic Cable
  - Terrestrial Radio Channels
  - Satellite Radio Channels



The Network Core

- It is defined as the **mesh of packet-switches and links** that interconnects the Internet's end systems.
- The Figure highlights the network core with thick, shaded lines.

Packet Switching

- In a network application, end systems exchange messages with each other. Messages can contain anything the application designer wants. Messages may perform a control signal or can contain data, such as an e-mail message, a JPEG image, or an MP3 audio file.
- To send a message from a source end system to a destination end system, the source breaks long messages into smaller chunks of data known as **packets**. Between source and destination, each packet travels through communication links and packet switches (routers and link-layer switches).
- Packets are transmitted over each communication link at a rate equal to the full transmission rate of the link. So, if a source end system or a packet switch is sending a packet of L bits over a link with transmission rate R bits/sec, then the time to transmit the packet is L / R seconds.

Thank you.