Computer Networking Notes

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Computer Networks and the Internet

What is the Internet

The Internet is a computer network that interconnects hundreds of millions of computing devices throughout the world. In Internet jargon**,**all of these devices (comšuter, servers, tablets, tv, el devices...) are called **hosts** or **end systems.** End systems are connected together by a network of **communication links** and **packet switches**. Many types of communication links, which are made up of different types of physical media, including coaxial cable, copper wire, optical fiber, and radio spectrum. Different links can transmitdata at different rates, with the **transmission rate** of a link measured in bits/second. 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 af flavors but twp types are routers and link-layer switches. Link-layer switches are typically used in access networks, while routers are typically used in the network core.

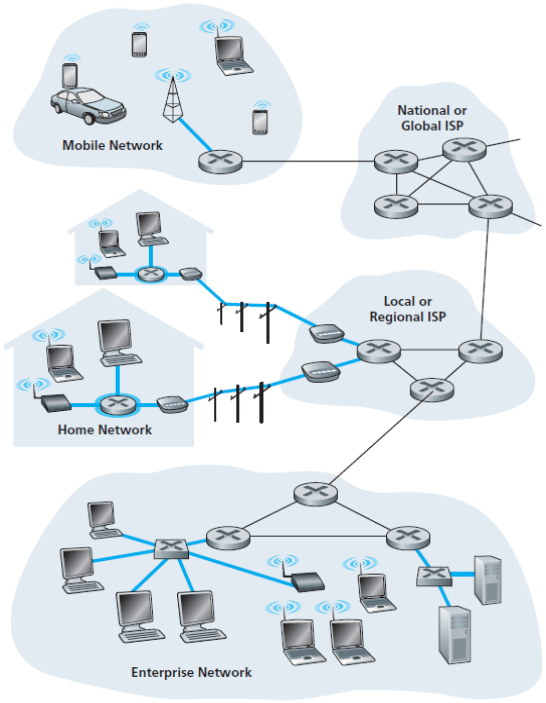
End systems access the Internet through **Internet Service Providers (ISPs)**, Each ISP is in itself a network of packet switches and communication links. These lower-tier ISPs are interconnected through national and international upper-tier ISPs such as Level 3 Communications. Each ISP network, whether upper-tier or lower-tier, is managed independently, runs the IP protocol (see below), and conforms to certain naming and address conventions.

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)**

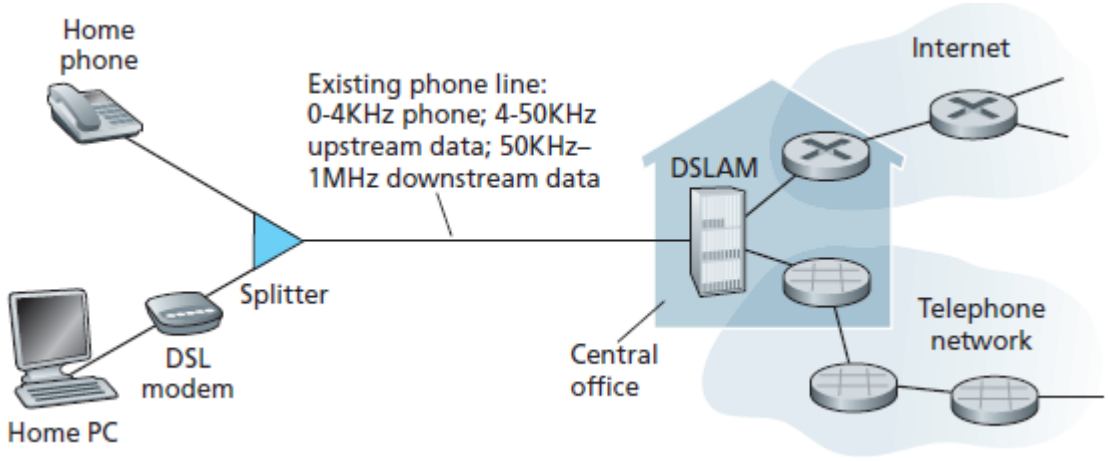
The Network Edge

Internet can be described as an infrastructure that provides services to applications. These app run on end systems – they do not run in the paked switches in the network core. End systems attached to the Internet provide an **Application Programming Interface (API)** 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. (Suppose Alice wants to send a letter to Bob using the postal service...)

End systems are also referred to as *hosts* because they host (that is, run) application programs. Hosts are sometimes further divided into two categories: **clients** and **servers**



Today, the two most prevalent types of broadband residential access are **digital subscriber line (DSL)** and cable. A residence (home)typically obtains DSL Internet access from the same local telephone company (telco) that provides its wired local phone access. Thus, when DSL is used, a customer's telco is also its ISP. The residential telephone line carries both data and traditional telephone signals simultaneously, which are encoded at different frequencies:



each customer's DSL modem uses the existing telephone line (twistedpair copper wire, which we'll discuss in Section 1.2.2) to exchange data with a digital subscriber line access multiplexer (DSLAM) located in the telco's local central office (CO). The home's DSL modem takes digital data and translates it to highfrequency tones for transmission over telephone wires to the CO.

While DSL makes use of the telco's existing local telephone infrastructure, **cable Internet access** makes use of the cable television company's existing cabletelevision infrastructure. A residence obtains cable Internet access from the same company that provides its cable television.

Cable internet access requires special modems, called cable modems. As with a DSL modem, the cable modem is typically an external device and connects to the home PC through an Ethernet port.

On corporate and university campuses, and increasingly in home settings, a local area network (LAN) is used to connect an end system to the edge router. Ethernet is by far the most prevalent access technology in corporate, university, and home networks

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.

The Network Core

There are two fundamental approaches to moving data through a network of links and switches: **circuit switching** and **packet switching**.

Packet Swiching

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.** Most packet switches use **store-and-forward transmission** at the inputs to the links. Store-and-forward transmission means that the packet switch must receive the entire packet before it can begin to transmit the first bit of the packet onto the outbound link.

Each packet switch has multiple links attached to it. For each attached link, the packet switch has an **output buffer** (also called an **output queue**), which stores packets that the router is about to send into that link.

In the Internet, every end system has an address called an IP address. When a source end system wants to send a packet to a destination end system, the source includes the destination's IP address in the packet's header.

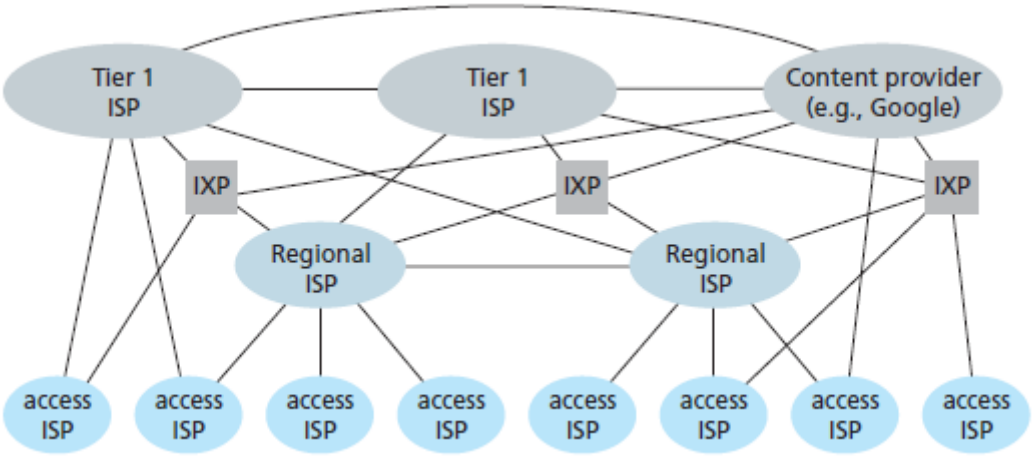
Each router has a **forwarding table** that maps destination addresses (or portions of the destination addresses) to that router's outbound links. Internet has a number of special **routing protocols** that are used to automatically set the forwarding tables. Traceroute program. Simply visit the site www.traceroute.org

Circuit Switching

The resources needed along a path (buffers, link transmission rate) to provide for communication between the end systems are *reserved* for the duration of the communication session between the end systems. In packet-switched networks, these resources are *not* reserved; Before the sender can send the information, the network must establish a connection between the sender and the receiver. A circuit in a link is implemented with either **frequency-division multiplexing (FDM)** or **time-division multiplexing (TDM)**.

Packet switching provides essentially the same performance as circuit switching, *but does so while allowing for more than three times the number of users.*

ISPs themselves must be interconnected. This is done by creating a *network of networks*—understanding this phrase is the key to understanding the Internet



Customer ISPs pay their provider ISPs to obtain global Internet interconnectivity

IXP Internet exchange point typically in a stand-alone building with its own switches), which is a meeting point where multiple ISPs can peer together.

ecosystem—consisting of access ISPs, regional ISPs, tier-1 ISPs, PoPs, multi-homing, peering, and IXPs. by adding **content provider networks**. Google

Throughput in Packet-switched Networks

The most important of delays are the **nodal processing delay, queuing delay, transmission delay,** and **propagation delay**; together, these delays accumulate to give a **total nodal delay.**

A packet can be transmitted on a link only if there is no other packet currently being transmitted on the link and if there are no other packets preceding it in the queue; if the link is currently busy or if there are other packets already queued for the link, the newly arriving packet will then join the queue.
The time required to examine the packet's header and determine where to direct the packet is part of the **processing delay**. The processing delay can also include other factors, such as the time needed to check for bit-level errors in the packet that occurred in transmitting the packet's bits from the upstream node to router

Protocol Layers and Thier Service Models

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Networks Under Attack

fslkfsa

History

fjslfsd

Summary

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