Plan

1. Computer Networks and the Internet
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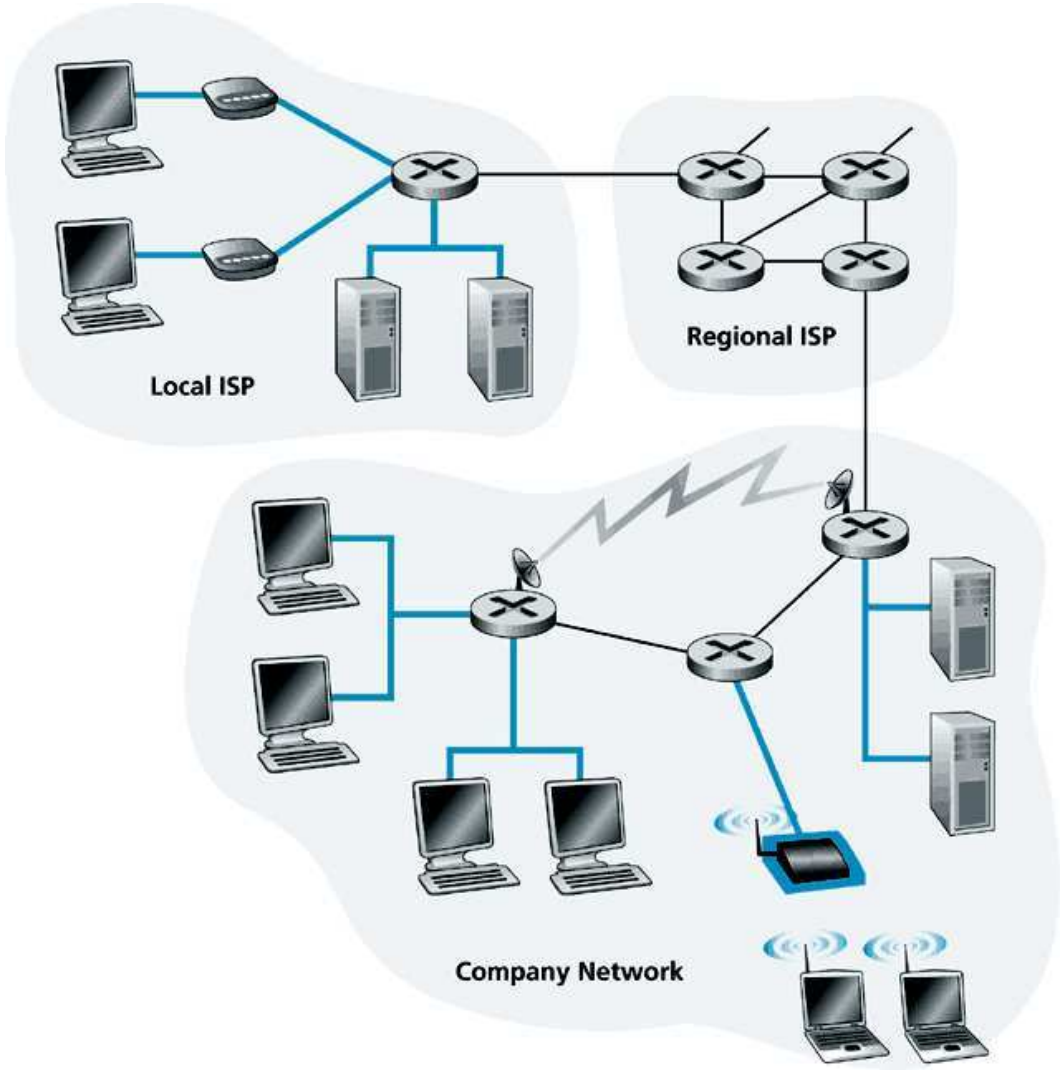
Network access and physical media

The network access is the physical media that connect an end system to its **edge router**, which is the first router on the way to another end system.

The access links in the facing picture are in thick blue.

Network access and physical media (cont)



Network access and physical media

Network access can be loosely classified into three categories:

- **Residential access**, connecting home end systems into the network;
- **Company access**, connecting end systems in a business or educational institution in the network;
- **Mobile access**, connecting mobile end systems into the network.

Note that these categories are not tight, for instance a company may use access technology we ascribe to residential access.

Network access/Residential access

Residential access refers to connecting a home end system, say a computer, to an edge router.

In Europe, a common way is the **dial-up modem** over a wired telephone line. The modem converts the digital output of the computer into the analog format of the phone line, which is a **twisted-pair copper wire** (same as a phone cable). On the other side of the phone line, at the ISP, there is another modem which converts back the analog signal into digital signal which is directed to the edge router.

The data rate can be up to 56 Kbps, with hardware compression and if the telephone line is of good quality.

Disadvantages are a slow data rate for nowadays applications and the fact that the phone line is entirely devoted to the modem.

Network access/Residential access (cont)

Other access technologies are **digital subscriber line** (**DSL**) and **hybrid fiber coaxial cable** (**HFC**).

DSL is a new modem technology running over existing twisted-pair telephone line. But by shortening the distance from home to the ISP, the data rate is much higher. The rate is not symmetric: the rate from the ISP to home (called **downstream**) is higher than from home to the ISP (called **upstream**). Indeed, the standard assumes that the user wants more probably to get information than produce data.

In theory, DSL can provide rates of more than 1 Mbps from ISP to home and more than 1 Mbps from home to ISP, but in practice the real rates are much lower.

Network access/Residential access (cont)

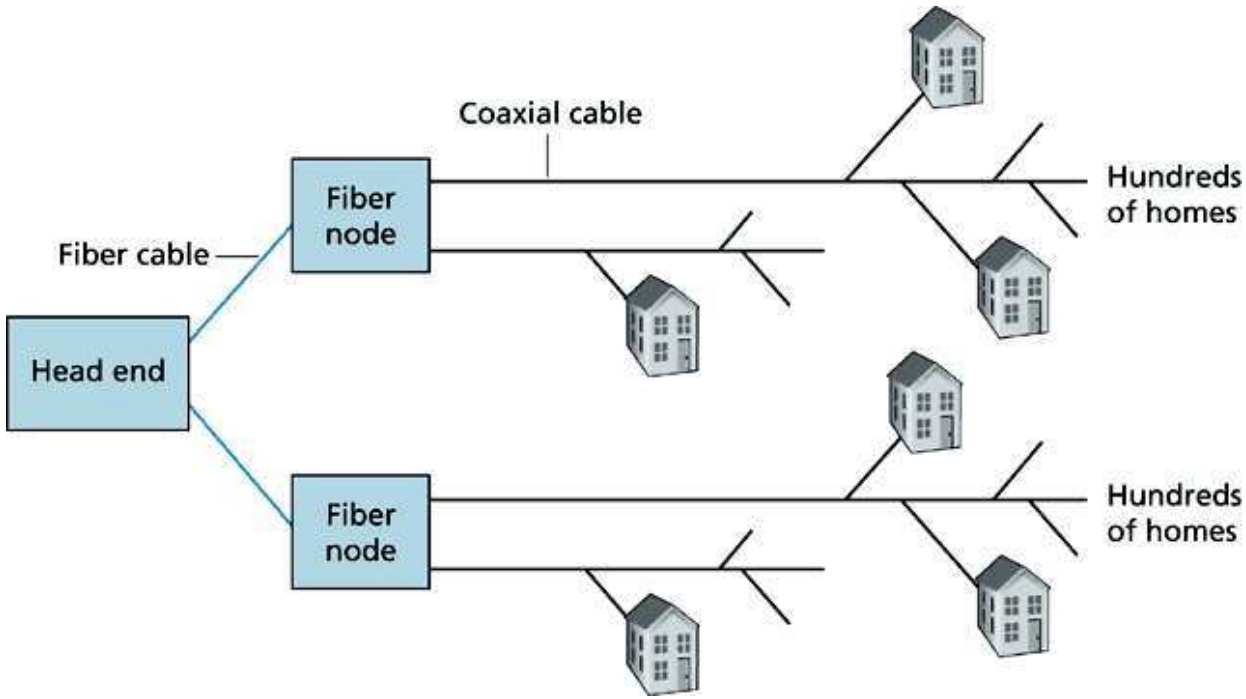
DSL uses frequency division multiplexing (FDM), see page 27. In particular, DSL divides the communication link into three non-overlapping frequency bands:

- a high-speed downstream channel, in the 50kHz-1MHz band;
- a low-speed upstream channel, in the 4kHz-50kHz band;
- an ordinary two-way telephone channel, in the 0-4kHz band.

This allows to keep the same link available for conference calls while being connected to the network.

Network access/Residential access/HFC

HFC are extensions of the existing cable network for television broadcasting.



Network access/Residential access/HFC (cont)

As with DSL, HFC requires special modems, called **cable modems**. This is an external device that is connected to the home computer through a **10-BaseT Ethernet** port (discussed later).

Cable modems divide the HFC network into downstream and upstream channels. As with DSL, the former is faster than the latter.

There is an important difference with DSL: HFC is a **shared broadcast medium**.

Network access/Residential access/HFC (cont)

Every packet sent by the head end is sent (on the downstream channel) to *all* the connected homes (this is broadcasting, a useful feature for television).

So if users download at the same time, the actual rate is slowed down. But if they are surfing the web, the pages will be likely to arrive at full speed, since it is improbable they all click at the same time.

Since the upstream channel is also shared, two packets sent from different homes at the same time will collide (but there is no broadcasting on the upstream channel).

Network access/Company access

On corporate and university campuses, a **local area network** (**LAN**) is used to connect an end system to the edge router. This means that the end system has to be connected first to the LAN.

The most access technology to do so is the **Ethernet**. It uses either twisted-pair copper wire or coaxial cable with each other and with an edge router. The rates vary depending on the version: 10 Mbps, 100 Mbps, 1 Gbps or 10 Gbps.

Like HFC, Ethernet uses a shared medium, so end users share the transmission rate of the LAN.

There is now **switched Ethernet**, which uses multiple twisted-pair Ethernet segments connected at a special switch.

Network access/Mobile access

The most popular wireless access to the Internet is through a **wireless LAN** (or **Wi-Fi**). Mobile users are connected to a radio **base station**, also called **wireless access point**, which is itself connected to the Internet. The IEEE 802.11b provides a bandwidth of 11 Mbps.