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- Network edge: *host = end system*
  - End systems are also referred to as hosts because they host application programs.
  - Models: **client/server model** v.s. **peer-peer model**.
- Access networks: digital subscriber line (DSL), cable, fiber to the home (FTTH), dial-up, satellite, ethernet, WiFi, 3G, and LTE.
- **Digital subscriber line (DSL)**:
  - A residence typically obtains DSL Internet access from the same local telephone company (telco) that provides its wired local phone access.
  - Each customer's DSL modem uses the existing telephone line to exchange data with a **digital subscriber line access multiplexer (DSLAM)** located in the telco's local **central office (CO)**.
  - On the customer side, a splitter separates the data and telephone signals arriving to the home and forwards the data signal to the DSL modem.
  - On the telco side, in the CO, the DSLAM separates the data and phone signals and sends the data into the Internet.
  - Because the downstream and upstream rates are different, the access is said to be *asymmetric*.
  - The maximum transmission rate can be limited by (1) the distance between the home and the CO, (2) the gauge of the twisted-pair line and (3) the degree of electrical interference.
  - DSL provides *dedicated* access.
- Cable internet access:
  - Cable Internet access makes use of the cable television company's existing cable television infrastructure.
  - Because both fiber and coaxial cable are employed in this system, it is often referred to as **hybrid fiber coax (HFC)**.
  - The cable modem is typically an external device and connects to the home PC through an Ethernet port.
  - At the cable head end, the **cable modem termination system (CMTS)** serves a similar function as the DSL network's DSLAM.
  - Access is typically *asymmetric*.
  - Cable Internet access is a *shared* broadcast medium.
- Fiber to the home (FTTH):
  - Two competing optical technologies: **active optical networks (AONs)** and **passive optical networks (PONs)**.

- Physical media: **guided** v.s. **unguided** media
  - *Guided*: twisted pair copper wire, coaxial cable, fiber optics.
  - *Unguided*: terrestrial radio channels, satellite radio channels.
- **Circuit switching**:
  - A *dedicated* end-to-end connection between the two hosts.
  - Bandwidth is divided into "pieces" with either **frequency-division multiplexing (FDM)** or **time-division multiplexing (TDM)**.
- **Packet switching**:
  - Each packet travels through communication links and **packet switches** (**routers** and **link-layer switches**).
  - Each packet uses *full link* bandwidth.
  - **Store-and-forward transmission**: the packet switch must receive the entire packet before it can begin to transmit the first bit of the packet onto the outbound link.
- Four sources of packet delay: *processing delay*, *queueing delay*, *transmission delay*, *propagation delay*.