Basic Concepts (II)

Common Functions of a Layer
- **Encapsulation** and **decapsulation**
- **Error Control**
  - error detection, error correction
  - encoding/decoding for data integrity (A), out of order detection (T), cyclic redundancy check (CRC) (L)
- **Flow Control**
  - traffic management, congestion control
  - sliding window (T), conflict detection (L)
- **Addressing**
  - Hostname (A), port (T), IP address (N), MAC (L)

Basic Devices
- **Router**
  - A network layer device (examines IP addresses)
  - route packets among LANs or WANs
- **Switch**
  - A link layer device (examines MAC addresses)
  - forward packets between LAN segments

Performance Measures
- **Throughput** — number of bits/bytes/packets delivered per second
- **Latency** — time to deliver a packet
  - typically measured from the first bit transmission to the last bit reception
  - **RTT** (round-trip-time) — two-way latency
- **Packet Loss Rate**
  - The percentage of unreceived packets during a period of time

Time-Space Diagram
- End-to-end delay (latency) = $d_{tr} + d_{prop}$
- $d_{tr}$: transmission delay, time to send a packet out of the door
- $d_{prop}$: propagation delay, time between the moment the last bit out of the door and the moment it’s received
- $R$: the width of the door
- $d$: the distance between the two ends
- $c$: the speed of bits (m/s)
Example: How long does it take to deliver three packets back-to-back to the destination? Assume that the packet length is L, the distance between the source and destination is d, the transmission rate is R, and the propagation speed is C.

- $3 \times \text{d}_{tr} + \text{d}_{prop} = \frac{3L}{R} + \frac{d}{C}$

Disclaimer: Notes adapted from the textbook and online resources.