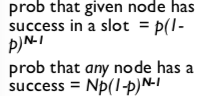
**Link Layer, LANS**

* Terminology
  + Nodes: hosts and routers
  + Links: wired links, wireless links, LANs
  + Frame: layer-2 packet, encapsulates datagram
* Link layer services
  + Framing: adding header, tailer
  + Link access: channel access if shared medium, MAC addresses
  + Reliable delivery between adjacent nodes
  + Flow control
  + Error detection
  + Error correction
  + Half-duplex and full-duplex
* Link layer implemented
  + In each and every host/router
  + “Adaptor” aka NIC (Network interface card) or on a chip
* Adaptors communicating 网卡间通信
  + Sending side
    - Encapsulates datagram in frame
    - Adds error checking bits, rdt, flow control etc.
  + Receiving side
    - Looks for errors, rdt, flow control, etc
    - Extracts datagram, passe to upper layer at receiving side
* Error detection not 100% reliable
  + D (Data) + EDC (Error Detection and Correction bits)
* CRC (Cyclic redundancy check)
* 2 types of ‘links’
  + Point-to-point: e.g. PPP, Ethernet switch and host
  + Broadcast (shared wire or medium) e.g. 802.11
* MAC protocols
  + Why? Collision if node receives two or more signals at the same time
  + Channel partitioning
    - TDMA, FDMA
  + Random access
    - Slotted ALOHA
      * If no collision: node can send new frame in next slot
      * If collision: node retransmits frame in each subsequent slot with prob. p until success
      * Efficiency: max = 37%



* + - ALOHA
      * Efficiency: max = 18%
    - CSMA, CSMA/CD, CSMA/CA
      * CSMA: listen before transmit, collisions may occur (propagation delay)
      * CSMA/CD: colliding transmissions aborted, reducing channel wastage
  + ‘Taking turns’
    - Polling
      * Master node ‘invites’ slave nodes to transmit in turn
      * Typically used with “dumb” slave devices
    - Token passing
      * Control token passed from one node to next sequentially
      * Token message
    - Bluetooth, FDDI, token ring
* MAC addresses and ARP
  + 32-bit IP address
  + 48-bit MAC address (for most LANs), burned in NIC ROM, sometimes software settable
  + Each adaptor on LAN has unique LAN/MAC address
  + MAC address allocation administered by IEEE
  + MAC flat address → portability
  + IP hierarchical address not portable
* ARP: address resolution protocol
  + ARP table: <IP address, MAC address, TTL>

