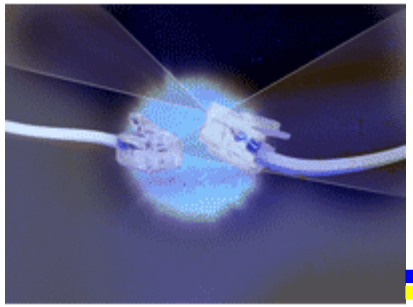
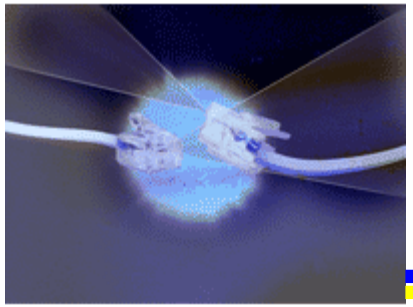


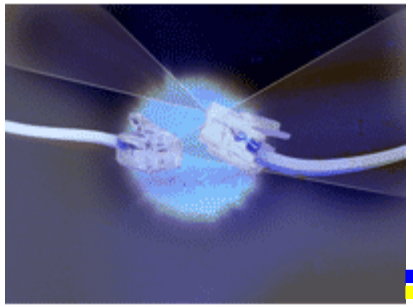
Asynchronous Transfer Mode (ATM)

- Switching technology that was widely used in 1980s and early 1990s
  - Higher speed that 802.3 and 802.5
  - Adopted by telephone companies
- Best example of *cell switching*, where all packets have the same length



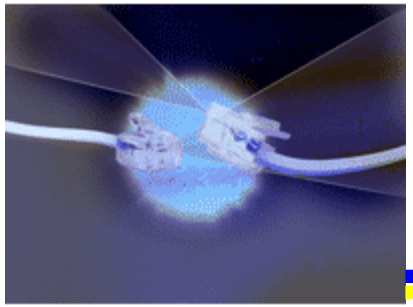
ATM Basics

- Connection-oriented, packet switched
  - Connection setup, called *signalling* protocol, is Q.2931
  - Discovers route through network, allocates resources in switches to guarantee QoS
- Several address formats, including E.164 and NSAP (network service access points)
- All packets are fixed length – 48 bytes of data and 5 byte header



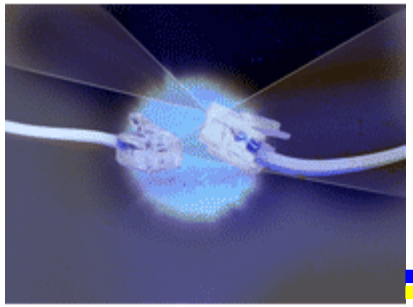
Cells

- Each fixed-length packet is called a *cell*
- Cell switching designed for speed, with limited hardware resources – based on telephone switch design
- Advantages of cells
  - Easier to build hardware to switch cells
  - Easy to do parallel switching – all operations complete in the same amount of time
  - Gives limits on latency of queues



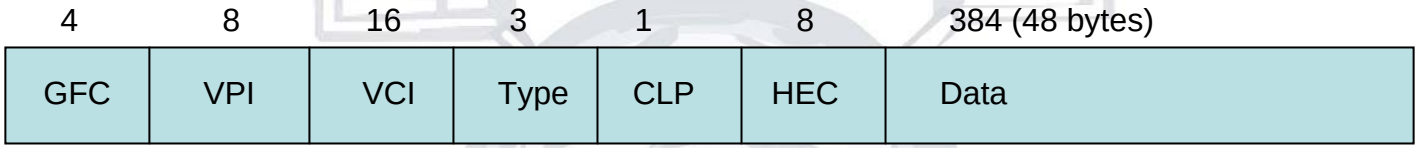
Cells (cont.)

- Cell size considerations
  - Small cells mean more overhead for headers
  - Large cells mean wasted space padding out cells that aren't full of data
  - Want efficient link utilization, but want to be able to transmit voice effectively (telephony); can't introduce too much buffering delay or it will be noticeable
  - 48 bytes is an odd choice – just the average of 32 bytes and 64 bytes

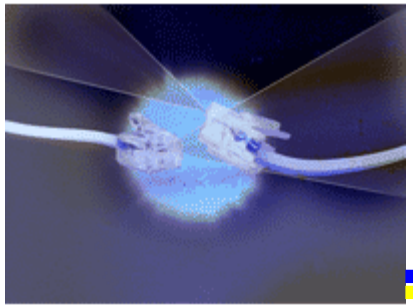


Cell Format

- Two different cell formats
  - UNI (user network interface)

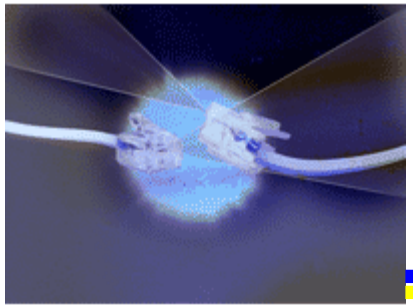


    - GFC – generic flow control
    - VPI – virtual path identifier VCI – virtual circuit identifier
    - Type – 4 management / 4 user data
      - EFCI – explicit forward congestion indication
      - User signalling bit
    - CLP - cell loss priority (indicate if cell can be dropped)
    - HEC – header error check (CRC-8)



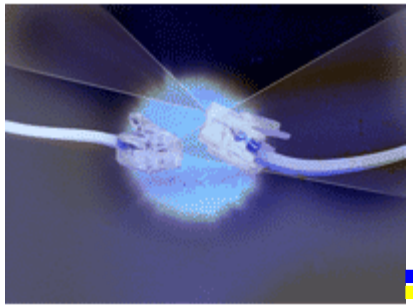
Segmentation / Reassembly

  - NNI (network-network interface)
    - Same, but GFC replaced by 4 more bits of VPI
- Higher-level variable length messages (like IP) must be broken up into cells, transmitted, and reassembled
  - Done in ATM Adaptation Layer (AAL)
  - Four different standards defined: AALs 1, 2, 3/4, and 5



AALs

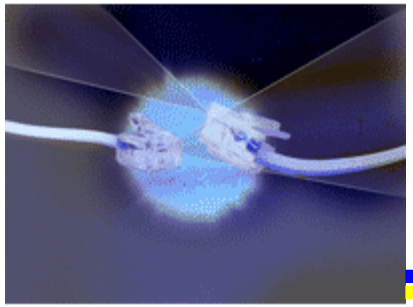
- AAL1, AAL2 designed for applications that require guaranteed bit rates, like voice
- AAL3 supports connection-oriented services (X.25), AAL4 supports connectionless services (IP)
- 3 and 4 merged, AAL5 proposed later



ATM Adaptation Layer 3/4

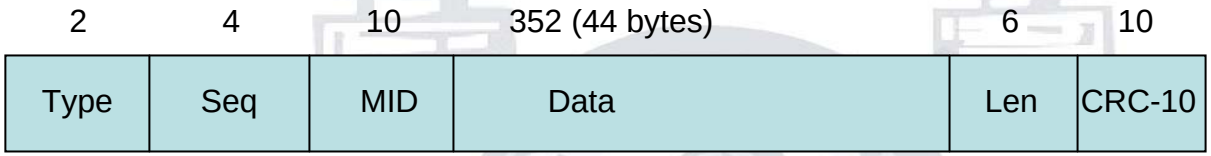
- Packets called *protocol data units (PDUs)*
  - Convergence sublayer PDU (CS-PDU)

    - CPI – common part indicator (format version)
    - Btag (begin tag) & Etag (end tag) match – seq #
    - BASize – buffer allocation size
  - Packet padded to 4*n* - 1 bytes

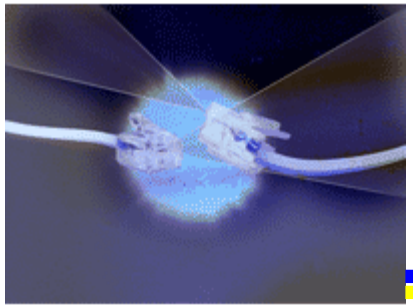


AAL3/4 (cont.)

- Each cell has additional header / trailer

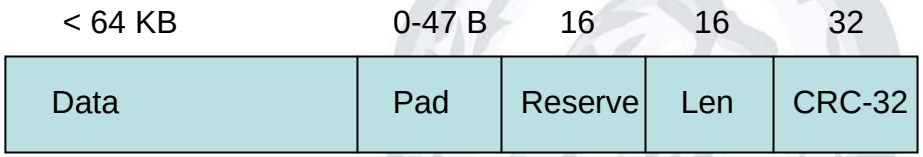


  - Type COM (cont. of msg) BOM (begin of msg)
    EOM (end of msg) SSM (single seg msg)
  - SEQ – seq. num
  - MID – multiplexing ID (like a port number)
  - Len – 44 for BOM or COM cells
- Lots of header/trailer – max 83% efficiency

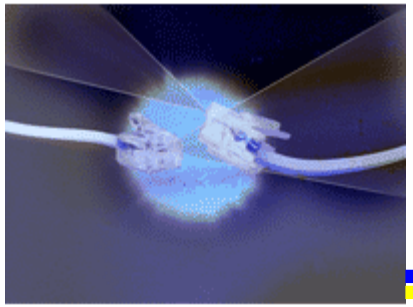


ATM Adaptation Layer 5

- Replace 2-bit Type in AAL3/4 with 1 bit in ATM header (user signalling bit)
- CS-PDU format

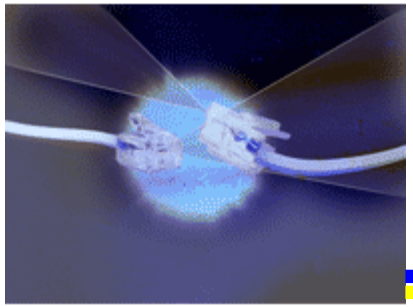


  - Only adds 8-byte trailer to packet
  - Len doesn't include padding or trailer
  - Provides as much protection as AAL3/4 – CRC32 catches more errors
  - Missing ability to multiplex (MID field)



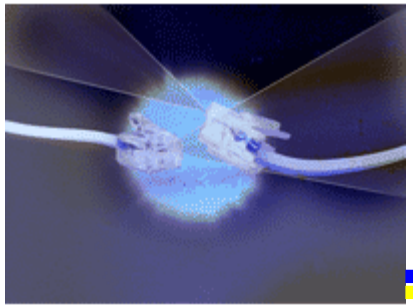
Virtual Paths

- 24-bit ID for virtual circuit – 8 bit VPI and 16-bit VCI
  - Hierarchy of addresses
  - VPI used to route between networks
  - VCI used to switch within network
  - Similar to subnetting of IP network addresses



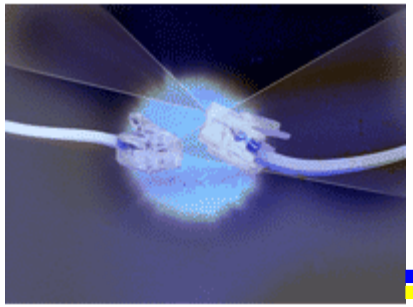
Physical Layer

- Typically ATM used over SONET
- Can also use TAXI, FDDI's physical layer, wireless, or other physical medium
- Finding boundaries
  - Use framing of physical layer
  - Resynch by computing 5-byte CRC-8 every 53 bytes – if it comes out with no errors several times, probably on correct cell boundary



ATM within LANs

- Originally used for large networks, but then adopted for use in LANs
  - Switched technology
  - Designed for higher speed links
  - Lacks length limitations of Ethernet segments
- Probably made irrelevant by Gigabit Ethernet



ATM within LANs (cont.)

- Problem with switched networks - hard to do broadcast / multicast
- Alternatives
  - Don’t use broadcast (ATMARP)
  - LAN emulation (LANE)
    - Assign MAC address to each ATM device
    - Create LAN Emulation Client (LEC) in each node