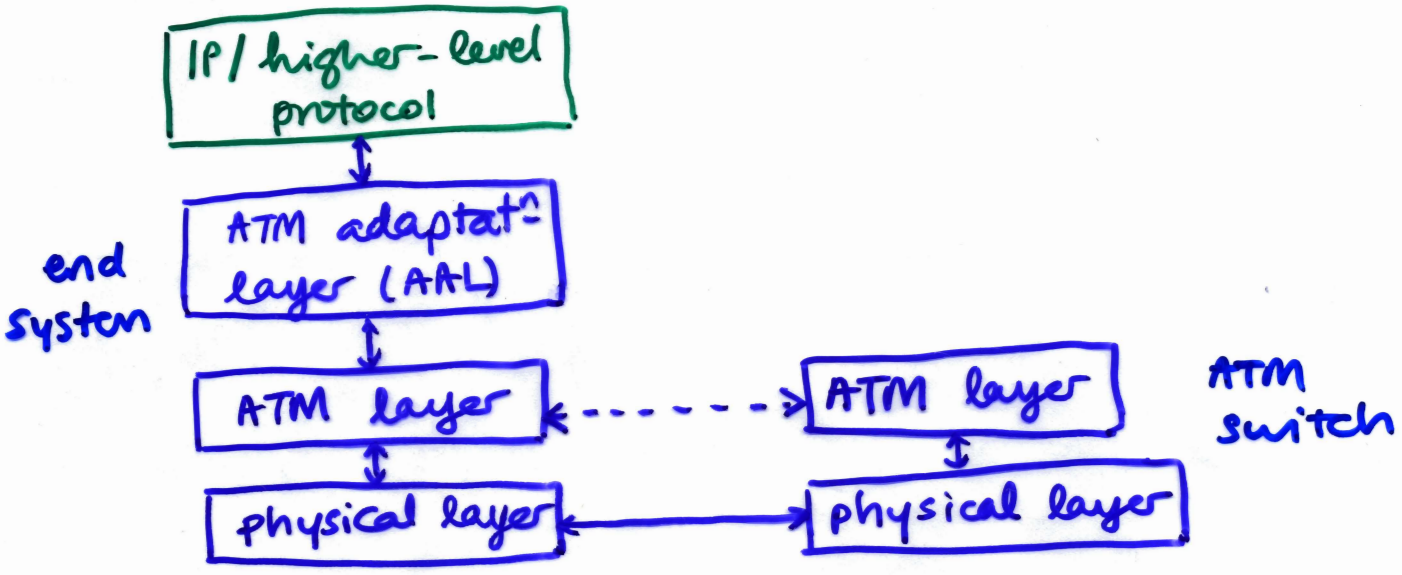
- LAN switches allow multiple LANs to be transparently connected, i.e. end hosts' protocols remain the same whether they are connected to a single LAN segment or to an extended LAN (for most functions)
- analagously, networks such as ATM networks can be viewed as a link layer that interconnects IP devices
- ATM was developed in the mid-1980s, & envisioned as an end-to-end integrated technology for both real-time & delay-insensitive data
- in practice, ATM has mainly been used as a link layer within IP networks

- **ATM cell switching**
  - packet switched, virtual circuit
  - ATM architecture

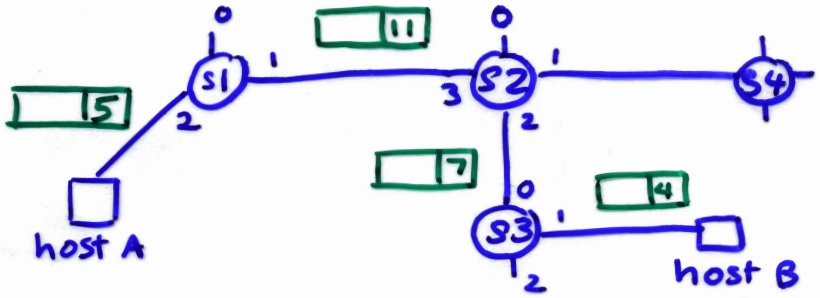


- ATM adaptation layer (AAL) is only found in ATM devices at the edge of the ATM network
  - different AALs for constant bit rate services, variable bit rate services & packet data
  - AAL performs segmentation & reassembly (SAR) & error detection (by CRC)

- ATM layer
  - switches fixed length cells (5 bytes header + 48 bytes payload)
    - header contains a virtual channel identifier (VCI), a type field (indicating management / user data, network congestion, and the last cell in a fragmented AAL protocol data unit), a cell-loss priority bit, & a header error control byte (8-bit CRC, particularly important to protect header to ensure correct delivery of cell)
    - small fixed-length cells facilitate fast parallel hardware switch, allow finer control of queues, ↓ packetization & store-&-forward delay, & reduce loss from padding; however header overhead ↑s for smaller cells
    - 48 bytes was a compromise between 64 bytes (favored by US telephone companies) & 32 bytes (favored by European companies)

- before sending data, a connection setup phase is needed to establish a virtual channel (VC) between the source & receiver nodes
  - many ATM backbones in the Internet have a permanent VC between each pair of entry/exit points (if not too many such points)
  - otherwise, VCs are set up & torn down dynamically through signalling (switched VCs)
  - Private Network-to-Network Interface (PNNI) is a suite of protocols commonly used to discover & store topology information, & admit/route connections, in ATM networks (uses a shortest path first algorithm)
  - each switch has a VC table containing an entry for each VC passing through the switch
  - the entry for a VC contains
    - its VCI (carried in the header of cells from that VC arriving at the switch)
    - its incoming interface
    - its outgoing interface
    - a potentially different VCI for cells from that VC leaving the switch (VCIs have link-local scope)
  - a switch identifies which VC a cell belongs to by the VCI in its header & the interface on which it is received

- the switch replaces the VCI in the cell header with the outgoing VCI, & transmits the cell on the outgoing interface, according to the appropriate VC table entry
- when a new connection is created, a VCI must be assigned, for each link on the path of the connection, that is not being used by an existing connection on that link
- eg.




| VC entry for | Incoming interface | Incoming VCI | Outgoing interface | Outgoing VCI |
|---|---|---|---|---|
| switch S1 | 2 | 5 | 1 | 11 |
| switch S2 | 3 | 11 | 2 | 7 |
| switch S3 | 0 | 7 | 1 | 4 |

- to set up a switched VC, the source sends a setup message which is routed through the network to the receiver
  - each switch on the path, & the receiver, picks an unused VCI on the incoming interface
  - the receiver sends an acknowledgement of the connection setup back along the same path
  - each switch, & the source, is notified of the VCI chosen by its downstream neighbor

- the ATM VCI has a 2 level hierarchy
  - 8 or 12 bits of the identifier, called the Virtual path identifier (VPI), are used to bundle together multiple VCs
  → reduces connection state information in large public network switches which use only VPIs
  - smaller networks at the edges use the rest of the identifier, often called the VCI, for switching