Cell Switching (ATM)

- Connection-oriented packet-switched network
- Used in both WAN and LAN settings
- Signaling (connection setup) Protocol: Q.2931
- Specified by ATM forum
- Packets are called *cells*
  - 5-byte header + 48-byte payload
- Commonly transmitted over SONET
  - other physical layers possible

Variable vs Fixed-Length Packets

- **Variable length packets can adapt their overhead to the requirements of the applications**
  - **Small packets (e.g. ACK) can be sent in a min. sized packet**
  - **Large transfers can be broken into max.s sized packets**
- **There is no optimal length for packets**
  - **if small: high header-to-data overhead**
  - **if large: low utilization for small messages**
- **Fixed length packets are easier to switch in hardware**
  - **Simpler hardware**
  - **Data parallelism can be exploited**

The big debate: big vs small packets

- **Small packets improve queue behavior**
  - **finer-grained pre-emption point for scheduling link**
    - **maximum packet = 4KB**
    - **link speed = 100Mbps**
    - **transmission time = 4096 x 8/100 = 327.68us**
    - **high priority packet may sit in the queue 327.68us**
    - **in contrast, 53 x 8/100 = 4.24us for ATM**
  - **near cut-through behavior**
    - **two 4KB packets start to arrive at same time**
    - **link idle for 327.68us while both arrive into buffers**
    - **at end of 327.68us, still have 8KB to transmit**
    - **in contrast, if the packets arrive as an ATM cell train, we can transmit first cell after 4.24us**
    - **at end of 327.68us, just over 4KB left in queue**

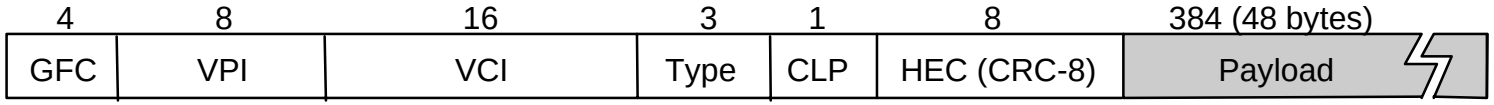
Big vs Small packets (cont)

- **Small packets improves latency (for voice)**
  - **voice digitally encoded at 64KBps (8-bit samples at 8KHz)**
  - **need full cell's worth of samples before sending cell**
  - **example: 1000-byte cells implies 125ms per cell (too long)**
  - **smaller latency removes the need for echo cancellors**

- **ATM Compromise: 48 bytes = (32+64)/2**

Cell Format

User-Network Interface (UNI)



- host-to-switch format
- GFC: Generic Flow Control (still being defined)
- VCI: Virtual Circuit Identifier
- VPI: Virtual Path Identifier
- Type:
  - MSB set: management,
  - MSB Clear: EFCI, AAL5 last frame marker (later)
- CLPL Cell Loss Priority
- HEC: Header Error Check (CRC-8)

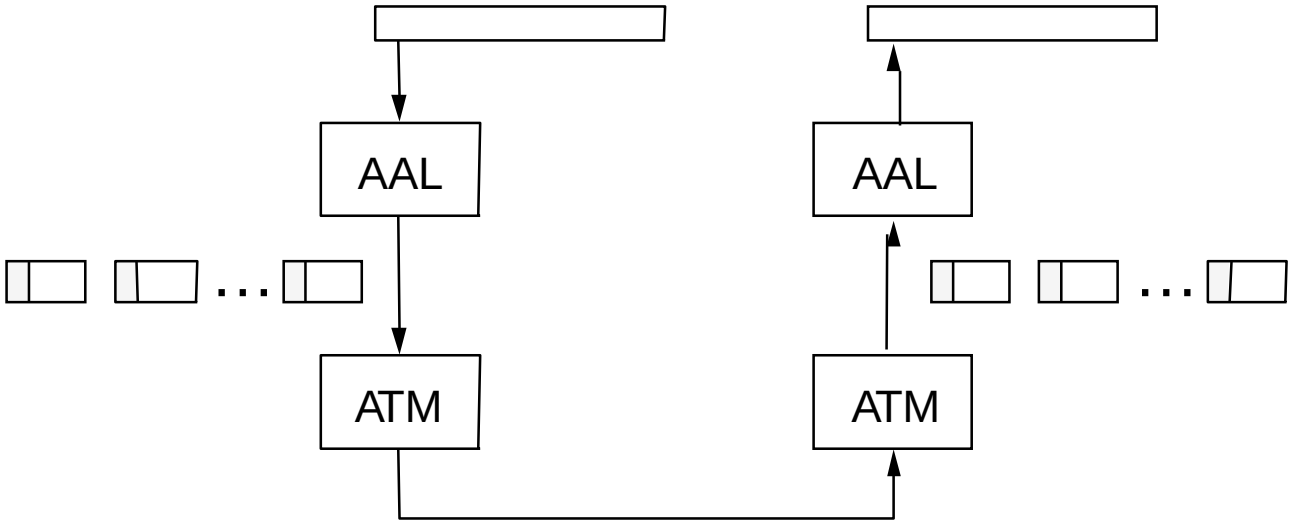
Network-Network Interface (NNI)

- switch-to-switch format
- GFC becomes part of VPI field

Segmentation and Reassembly

ATM Adaptation Layer (AAL)

- AAL 1 and 2 were designed for applications that need guaranteed rate (e.g., voice, video)
- AAL 3/4 designed for packet data (conn. Oriented and connectionless)
- AAL 5 is an alternative standard for packet data



Virtual Paths

- **Used to multiplex multiple VCI's "heading" the same way into one fat pipe.**

- **Core ATM switches need to route just by the 8 bit VCI, rather than the entire 24 bit address**
  - **Reduces cost of maintaining per connection state.**

ATM in LANs

- When introduced it offered bandwidth scalability advantages over LANs
  - ATM is switched vs. shared media Ethernet
- ATM has no length restrictions
- Both these arguments in favor were soon countered by Ethernet switches and gigabit Ethernet respectively
- Problem:
  - ATM is not a shared media LAN. How do you support broadcast and multicast?

ATM in LANs

- **Soln:**
  - **LANE: LAN Emulation mode.**
- **The ATM network uses a slew of servers to emulate traditional LANs.**
- **Higher layer protocols are shielded from the complexity of modifying code to adapt to ATM.**

ATM in LANs

- Involves 3 servers
  - LAN Emulation configuration server
  - LAN emulation server
  - Broadcast and unknown server
- On boot, LANE clients contact LECS for config info over a well defined VC
- LECS returns LAN info and address of LES
- Client registers itself with LES, LES returns address of BUS
- BUS maintains a point to multipoint VC.
  - All broadcast transfers are sent to BUS

ATM in LANs

- **Unicast:**
  - **Problem: Source has no VC to destination, it does not even know the ATM address of the destination**
  - **Source sends data to BUS and and ARP like request to the LES**
  - **LES returns ATM address of destination**
  - **Source opens a VC to the destination**