Broadband Packet Switching & Routing

Section 4

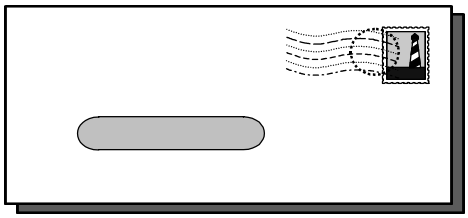
Broadband Switching and Routing

- **Frame and Cell header details**

Flow Control	Virtual Path Ident.	
Virtual Path Ident.	Virtual Circuit Ident.	
Virtual Circuit Identifier		
Virtual Circuit Ident.	Payload Type	CLP
Error Control (CRC-8)		

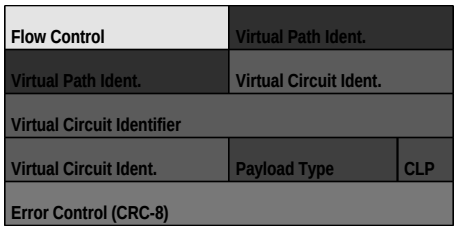
Connection-oriented PDUs

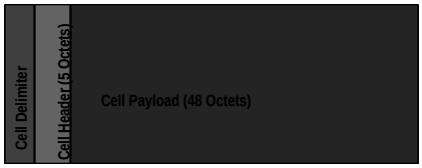
- PDU addressing is the key to statistical (packet) multiplexing and switching
- Both ATM and Frame Relay PDUs are inherently connection oriented.
- The connection identifies a logical circuit number



ATM Cell Structure

- 53 Octet cell with 5 octet header and 48 octet payload
- All of payload may or may not be available for actual data; depends on "AAL"
- Physical layer delimiter
- Error control for header only





ATM Cell Header @ UNI

- Addressing sufficient for over 16 million virtual circuits @ UNI; over 268 million @ NNI
- VPI/VCI split for ease of switching
- "Payload type" identifies user/ctl cell, continuation of AAL PDU, & congestion.

Flow Control	Virtual Path Ident.	
Virtual Path Ident.	Virtual Circuit Ident.	
Virtual Circuit Identifier	Payload	
Virtual Circuit Ident.	Type	CLP
Error Control (CRC-8)		

ATM Cell Header @ UNI

- "Flow control" for multiple access on UNI facilities; NOT for congestion management
- CLP (Cell Loss Priority) *is* for congestion management and priority

Flow Control	Virtual Path Ident.	
Virtual Path Ident.	Virtual Circuit Ident.	
Virtual Circuit Identifier	Payload	
Virtual Circuit Ident.	Type	CLP
Error Control (CRC-8)		

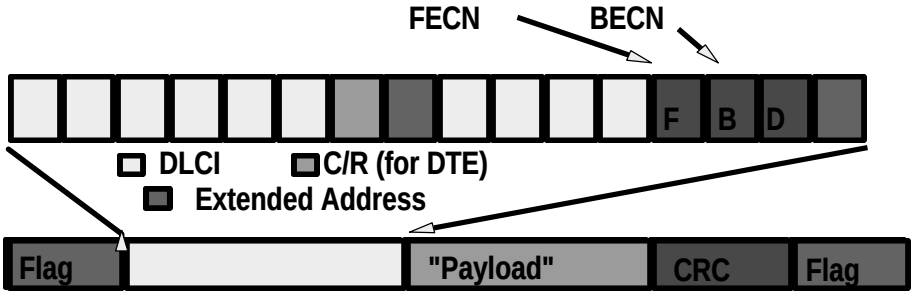
ATM Cell Header @ NNI

- Addressing sufficient for about 268 million circuits at NNI
- No "flow control" at this level
- Congestion indication bit in Payload Type.

Virtual Path Ident. (VPI)		
Virtual Path Ident.	Virtual Circuit Ident.	
Virtual Circuit Identifier		
Virtual Circuit Ident.	Payload Type	CLP
Error Control (CRC-8)		

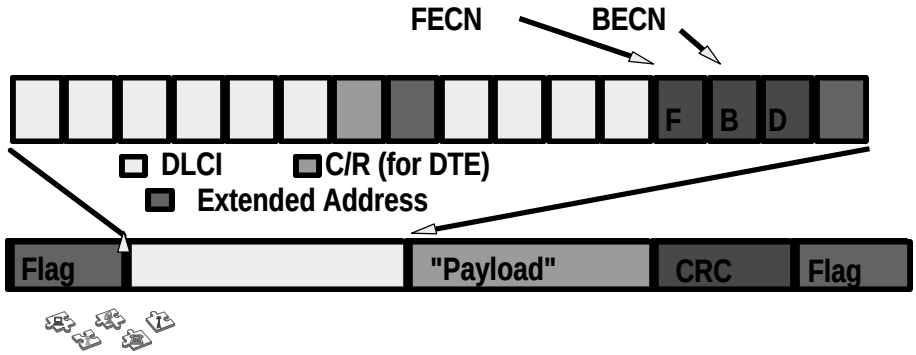
Frame Relay Header

- Similar to ATM
- Has default address space for 1024 virtual circuits per physical link



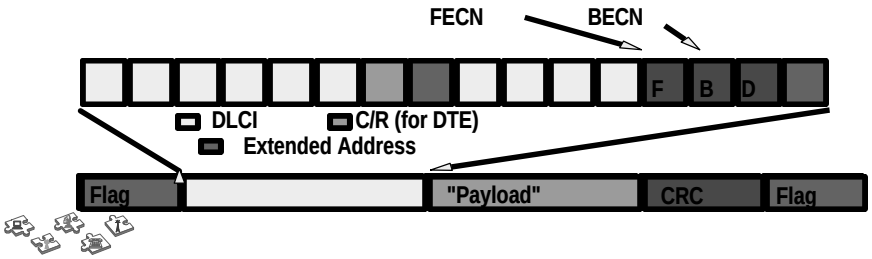
Frame Relay Format

- C/R bit passed through
- Extended address allows for multiple octets of additional addresses on a DLCI-by DLCI basis



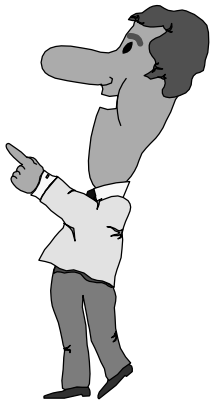
Frame Relay Format

- CRC provides protection for header; available hardware convenience
- Extended address allows for multiple octets of additional addressing
- Possible multiprotocol interconnect information



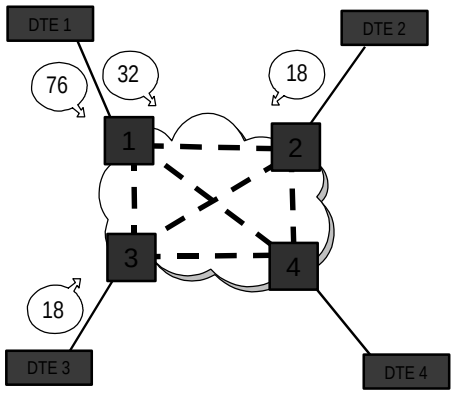
Broadband Switching and Routing

- ▼Frame and Cell header details
- ▼Wide area routing example and issues



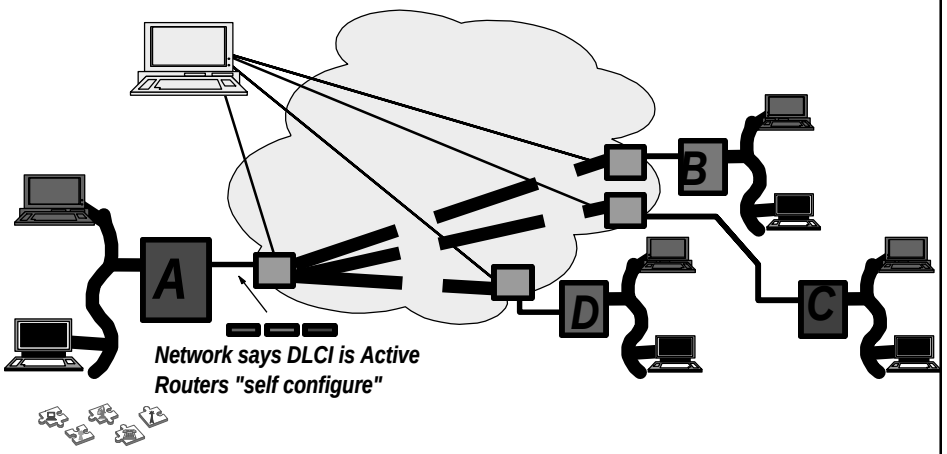
Virtual Circuit Addressing

- ▼ Circuit numbers are meaningful on local (single interface) only
- ▼ Switches may translate circuit numbers
- ▼ Switches are responsible for finding paths through the network, rerouting, etc.



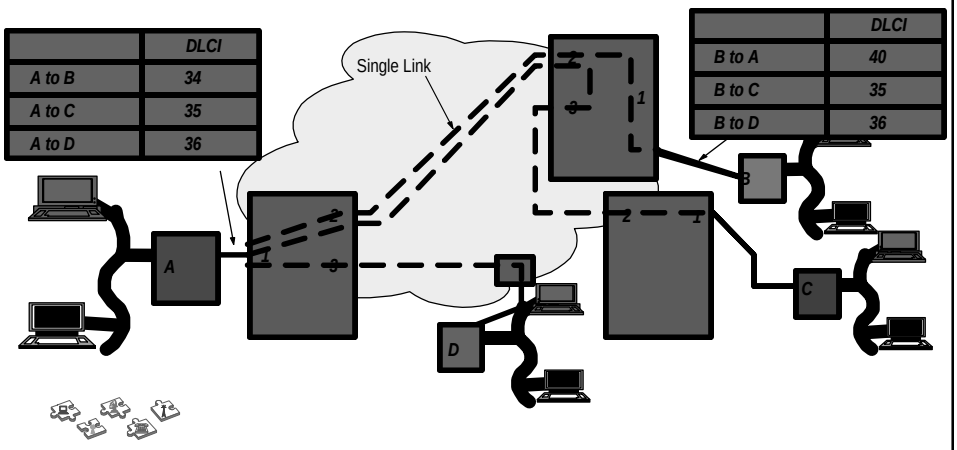
Network Routing Example

- 1. Operator defines endpoints for virtual circuits



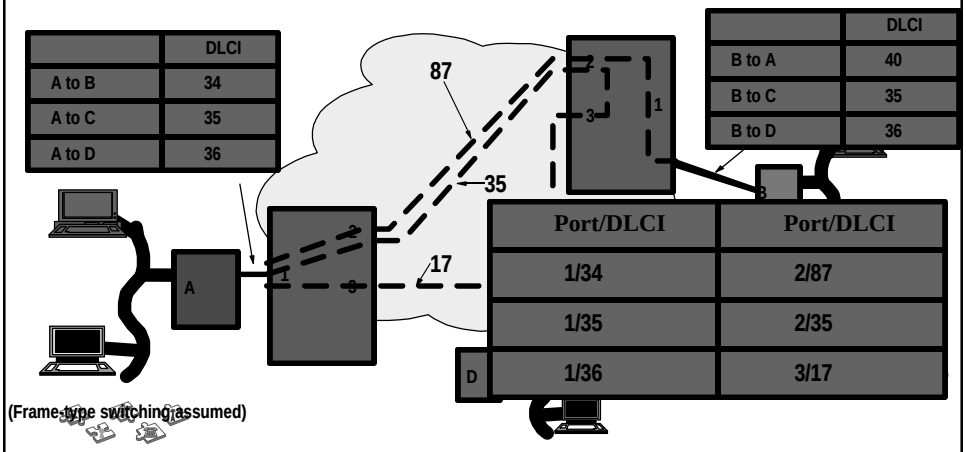
Network Routing Example

- 2. DLCIs (or VPI/VCI) assigned on external links.



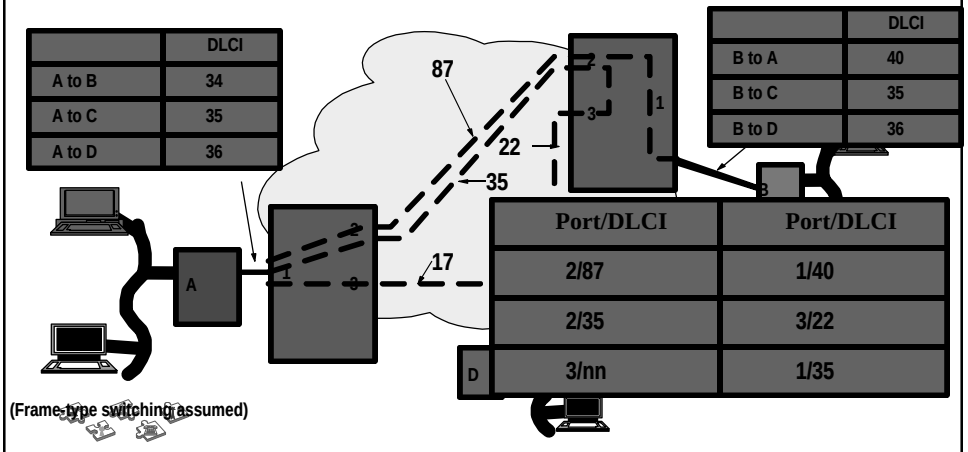
Network Routing Example

- 3. Routing table at network node "A"



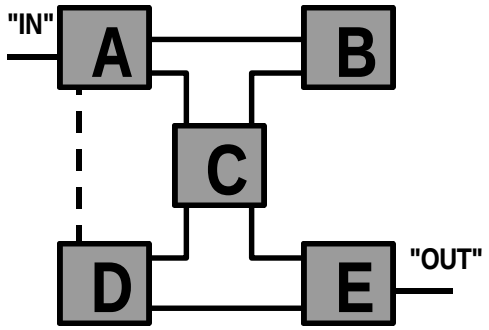
Network Routing Example

- Routing Table at node "B"



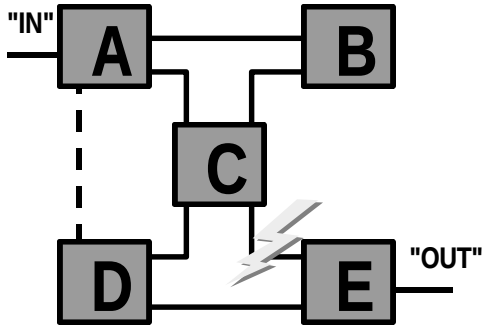
Routing Table Issues

- Algorithmic vs. manual generation
  - Most networks "self-configure"
  - External vs. network routing
  - "Neighbor Node" vs. global routing
  - "Source Routing"



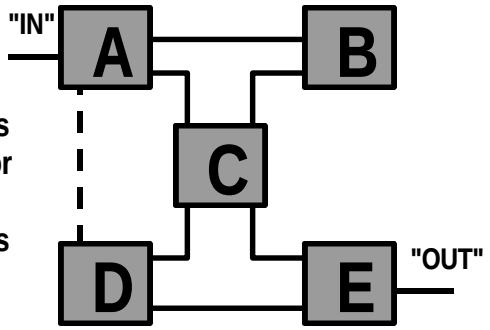
Routing Table Issues

- ✓ Algorithmic vs. manual generation
- When to reroute
  - Link / equipment failure
  - Network congestion (circuit vs. packet)
  - Reoptimization



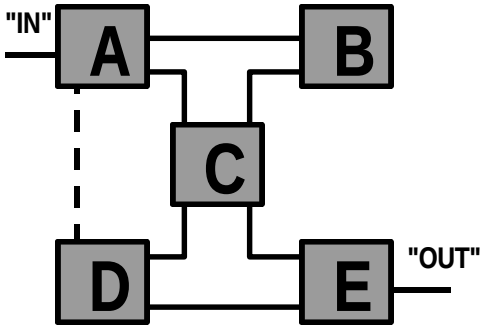
Routing Table Issues

- ✓ Algorithmic vs. manual generation
- ✓ When to reroute
- ▼ PVC vs. SVC
  - PVC changes & generates tables at network operator request
  - SVC changes & generates tables at user request



Routing Table Issues

- ✓ Algorithmic vs. manual generation
- ✓ When to reroute
- ✓ PVC vs. SVC
- ▼ Connection / Connectionless
  - Semi-permanent vs. dynamic routing tables
  - LAN vs. WAN issues



Wide-Area Routing Issues

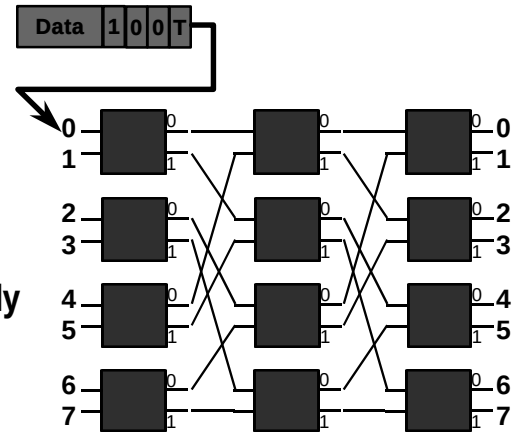
- Multicast
  - Mutlicast vs. Broadcast
  - Groups may be defined
  - Administration in large networks
- Global Addressing
  - Usefull in small networks
  - Initial option for frame relay
  - "Look like" connectionless

Broadband Switching and Routing

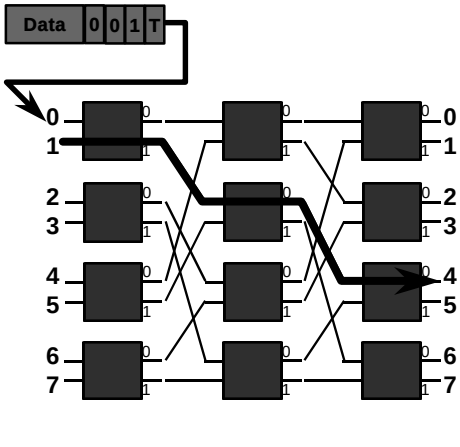
- **Frame and Cell header details**
- **Wide area routing example and issues**
- **Frames versus cells: Summary**

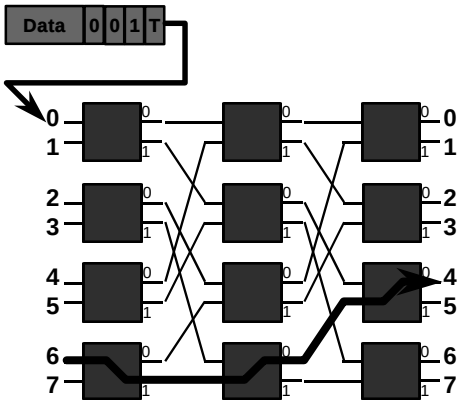
Banyan Switching

- Often associated with ATM
- Switch -- not network -- architecture
- "Non-blocking" so long as paths are different
- Doesn't necessarily imply "cut-through" routing



Two Examples

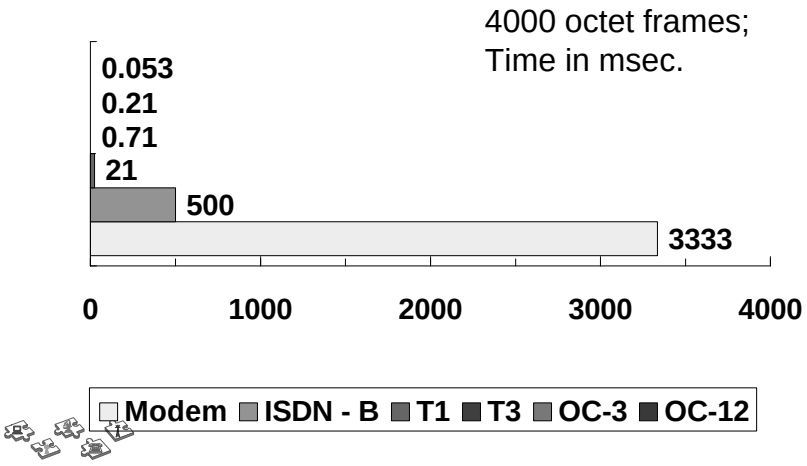




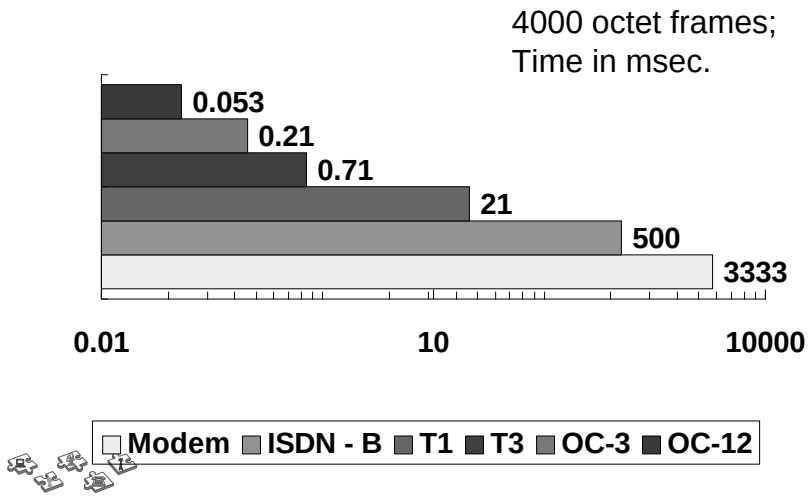
Frame vs. Cell Switching

- Same basic function for switching frames and cells
- Cell switching has lower delay per node
  - Switches generally must accept a full PDU, process/switch the PDU, and retransmit the the PDU
  - Delay is proportional to the "PDU Time"
  - PDU Time = PDU length / Facility speed

Freeze-out Time at Various Speeds



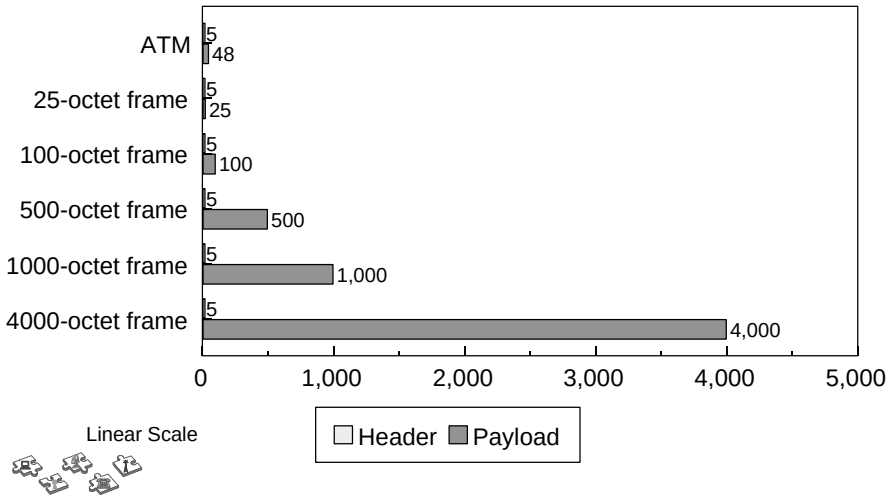
Freeze-out Time at Various Speeds



Frame vs. Cell Switching

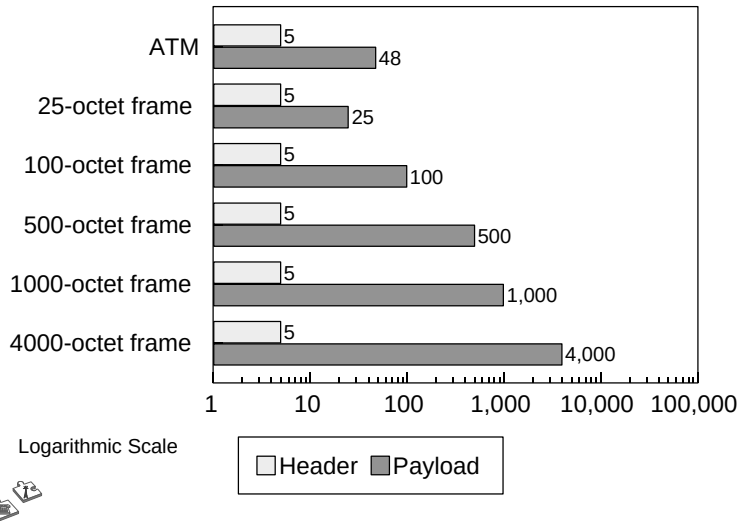
- Overhead
  - Cell overhead is fixed
  - Frame overhead is variable
  - Frames have ability to vary maximum frame size to balance delay versus overhead
- Cell size must be chosen carefully

Overhead per Cell Size



Linear Scale

Overhead per Cell Size



Logarithmic Scale

Cell Size Trade-offs

Short cells	Long cells
Short "fill times"	Good for overhead
Small "last cells"	
Short cell freeze-out	

Frame vs. Cell Issues

- Should one check the PDU integrity at intermediate Nodes?
  - Easy to do with frame switch; more difficult (for entire PDU) with a cell switch
  - Factor: Link reliability
- Should one check for frame-level discard eligibility at intermediate nodes?
  - Factor: Ability to discard ALL of a PDU
  - Factor: "Edge" control of network

Frame vs. Cell Issues

- How important is the PDU delay?
  - Is there "real time" traffic?
  - What is the maximum PDU length?
  - What is the minimum facility speed?
  - How many intermediate nodes? (Delay is per node)
- Price of technology, targeted speeds & applications, and network "religion"

Frame vs. Cell Summary

	Frame Switch	Cell Switch
Switching concept	Simple	More complex
Technology	More complex	Simpler
Inherent delay	Higher	Lower
Segmentation	No	Yes
Bandwidth efficiency	High	Lower
Overhead	Usually lower	Usually higher
Predictable delay	No	Yes
Voice capabilities	Not explored	Good
Intermed. discard	Possible	Difficult
Congestion ctl.	Simpler	More difficult
Primary technology	Software	Hardware
Connections	PVC/SCV	PVC/SVC