Categories of Networks

- Circuit switched
- Packet switched

Compromise: virtual packet switched
Virtual Circuits

- Problems with packet-switched networks:
  - no connection between packets
  - difficult to provide QoS
  - difficult to provision resources
  - difficult to control routes the packets take
  - reactive fault-tolerance

- All these problems can be addressed in circuit-switched networks
Virtual Circuit Switching

- Virtual Circuit (VC)
  - separation of routing and forwarding

- Circuit Switching Table
  - state-full forwarding

- Virtual Circuit Identifier (VC id)
  - global circuit vs locally significant circuit identifier
VIRTUAL CIRCUIT SWITCHING
Circuits vs Virtual Circuits

- Virtual Circuit Switched Networks
  - an overlay on top of a packet switched network that provides a circuit-based service
  - “most of the benefits at a fraction of the cost”
  - trading ability to control for loss of simplicity

- Always the next big thing
  - OSI - Open System Interconnect (R.I.P.)
  - ATM - Asynchronous Transfer Mode (R.I.P.)
  - MPLS - MultiProtocol Label Switching (alive and well)
MPLS

MultiProtocol Label Switching

- a protocol providing virtual circuit service
- designed to coexist and complement existing protocols, not to replace them

One protocol, many uses:

- simplification of forwarding
- traffic engineering
- protection and restoration
- support for legacy services
MPLS Terminology

- Label Switched Path (LSP): a VC
- Label: VC id
- Label Switched Router (LSR): a switch
- Forwarding Equivalence Class (FEC)

Typically:
- Network Layer
- MPLS Layer
- Link Layer

MPLS packet:
- Link header
- MPLS header
- IP header
- Transport and application
Link Layer
Link Layer

- Delivers packets using streams of bits

- Standard services:
  - addressing
  - error control
  - flow control
  - QoS
Components of Link Layer

- Data Link Control
  - addressing
  - framing
  - error detection and correction
  - flow control
  - QoS

- Media Access Control (MAC)
  - controlling access to the shared medium
Channel Capacity

Shannon’s (noisy-channel coding) Theorem:

\[ C = B \cdot \log_2 \left( 1 + \frac{S}{N} \right) \]

- \( C \) - channel capacity
- \( B \) - channel bandwidth
- \( S/N \) - signal to noise ratio