Introduction to Wide Area Switching

- Switching often distinguishes LOCAL or ACCESS layer (“last mile” “last kilometer”)
  - First place individual devices connect to the network
  - Example: olden days phone to human operator
  - Example: mobile phone to cell tower (or MTSO)

- From INTERCONNECTION or WIDE AREA or LONG DISTANCE switching (“core network”)
  - Connecting cooperating switching nodes into a network. Connected via Trunks or Gateways
  - Example: two ISPs delivering traffic between them

- Both can have multiple companies, many technologies (and protocols)

Basic Network Architecture

- Often distinguish between
  - Circuit
    - A path / route / connection exists for as long as you want to use it for a conversation
    - Whole conversation stays together and has the channel for the entire time (or thinks it has the channel)
    - Some things added to help it on its way through the network
  - Packet
    - A more ad hoc way to send things by breaking up the whole conversation and sending it in pieces
    - The channel or connection is used when needed (and free for other uses when not needed)
    - Some functions need to be provided during the connection to keep things organized

- And the two coexist in many networks
Switched Network

Nodes
- A collection of nodes and connections is a communications network
- Nodes may connect to other nodes only, or to stations and other nodes
- Network is usually partially connected
  - Some redundant connections are desirable
- Have two different switching technologies
  - Circuit switching
  - Packet switching

Circuit Switching
- Uses a dedicated path between two stations
- Has three phases
  - Establish
  - Transfer
  - Disconnect
- Inefficient
  - Channel capacity dedicated for duration of connection
    - If no data, capacity wasted
- Set up (connection) takes time
- Once connected, transfer is transparent
Blocking or Non-blocking

- blocking network
  - may be unable to connect stations because all paths are in use
  - used on voice systems
- non-blocking network
  - permits all stations to connect at once
  - used for some data connections

Space Division Switch

3 Stage Space Division Switch
Time Division Switching

- modern digital systems use intelligent control of space & time division elements
- use digital time division techniques to set up and maintain virtual circuits
- partition low speed bit stream into pieces that share higher speed stream
- individual pieces manipulated by control logic to flow from input to output

Softswitch

Traditional Circuit Switching
Packet Switching

- circuit switching was designed for voice
- packet switching was designed for data
- transmitted in small packets
- packets contain user data and control info
  - user data may be part of a larger message
  - control info includes routing (addressing) info
- packets are received, stored briefly (buffered) and passed on to the next node

Advantages

- line efficiency
  - single link shared by many packets over time
  - packets queued and transmitted as fast as possible
- data rate conversion
  - stations connect to local node at own speed
  - nodes buffer data if required to equalize rates
- packets accepted even when network is busy
- priorities can be used
Switching Techniques

- station breaks long message into packets
- packets sent one at a time to the network
- packets can be handled in two ways
  - datagram
  - virtual circuit

Datagram Diagram

Virtual Circuit Diagram
Virtual Circuits v Datagram

- virtual circuits
  - network can provide sequencing and error control
  - packets are forwarded more quickly
  - less reliable
- datagram
  - no call setup phase
  - more flexible
  - more reliable

User Data and X.25 Protocol Control Information

- User data
- Layer 3 header
- X.25 packet
- LAPD header
- LAPD frame