

# CSIS 625 Week 11

## X.25, Frame Relay, ATM

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1

## Overview

- Packet Switching technologies
  - X.25
    - PVCs & SVCs
    - PADs and PSEs
  - Frame Relay
    - PVCs
    - FRADs and switches
  - ATM
    - Cells & Adaptation layers
    - Switching Policies

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2

## What is X.25

- A protocol suite defined in ITU standards
- Covers Physical, Data Link and Network layers
- Called Physical, Frame or Link, and Packet layer
- Defines DTE ? DCE interface
- Has both link layer and packet layer error detection and retransmission
- Very robust - developed for high-noise and unreliable communications links.
- The nodes inside the X.25 cloud are PSE - Packet Switching Exchanges

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3

## X.25 Layers

- Physical Layer
  - X.21 is the defined standard
  - RS-232 (EIA-232) is often used
  - V.35 is often used
- Link Layer
  - LAPB - Link Access Protocol - Balanced
  - LAPB is a subset of HDLC
  - I-Frames - encapsulates packet layer data
  - S-Frames - Flow and error control
  - U-Frames - set up and disconnect link layer

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4

## X.25 Layers

- **Packet Layer**
  - PLP - Packet Layer Protocol
  - Responsible for End-to-end delivery of packets
  - Virtual Circuits
    - Packet layer multiplexes multiple virtual circuits over the link.
    - Up to 4095 virtual circuits
- **Virtual Circuits**
  - LCN - Logical Channel Number - the arbitrary number that identifies the virtual circuit
  - One LCN is established for the local or near-end DTE? DCE interface and another for the remote or far-end DTE? DCE interface

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5

## X.25 Virtual Circuits

- **Permanent Virtual Circuit -PVC**
  - Established by the network operator.
  - Use LCNs starting at 0 and going up
- **Switched Virtual Circuits - SVC**
  - Established by DTE signaling to the DCE that it wishes to establish a connection to the remote DTE.
  - Uses X.121 addresses plan (14 digits - kind of like phone number)
  - DTE picks local LCN number (starts with 4095 and works down)
  - DCE picks far-end LCN numbers (starts with numbers above PVCs)

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6

## X.25 PAD

- PAD - Packet assembler/disassembler
- A device that connects to X.25 network as a DTE, and has connections for dumb-terminal type devices.
- Device knows how to take individual characters and put them into a packet
  - And the inverse
  - PAD knows how to handle Enter key, arrow keys, etc.
  - PAD can handle local echo, line buffering, etc.
- A PAD is a DTE to the X.25 network
- A PAD is a DCE for a dumb-terminal

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7

## Frame Relay

- Also a packet Switched Service, like X.25
- Derived initially from ITU-T I.122 ISDN frame-mode bearer services
- Decoupled from ISDN by The Group of Four, Cisco, Stratacom, DEC and Northern Telecom, which became the initial Frame Relay proposal group
- Currently Frame Relay Forum handles all of the FR-related standardization work

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8

## Frame Relay

- Designed to hide network specifics from the user
- The only standardized parts are the UNI, or User-Network Interface, and LMI, or Logical Management Interface
- Designed to provide flexible service -- Bandwidth on Demand
- Takes into account modern, “intelligent” computer systems and reliable communication systems

## Frame Relay - FRADs and switches

- FRAD - Frame Relay access device.
  - Like X.25 PAD
  - FRAD is a DTE to the Frame Relay network
  - FRAD is a DCE for the computers connection to the Frame Relay network
- Frame Relay Switch - node inside the frame relay cloud.

## Frame Relay Specifications

- Physical Layer
  - No specification provided
- Data Link Layer
  - Employs a simplified version of HDLC frame
  - Handles flow control
  - Has facilities to perform congestion notification
  - Uses DLCI -- Data Link Layer Identifier -- as an address
- Utilizes primarily PVCs, although some proprietary versions support SVCs as well
- Uses end-to-end error recovery, implemented either by upper layer protocols in user's application or the router
  - Bad packets are discarded by the network.

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11

## Frame Relay - Routing

- Based on DLCI, Data Link Layer Control Identifier
- Although switching is a Network Layer functionality, it is generally accepted that Frame Relay does not implement true switching, and thus "relaying" is treated as Data Link Layer function
- Switch accepts a DLCI on an input port, and, using internal tables, routes it to the output port, modifying the DLCI in the process.

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12

## Frame Relay - Policing

- CIR - Committed Information Rate is a guaranteed level of service between two points.
- Typically frame relay service is purchased with a CIR, and some burst rate allowed.
- Frames that exceed the CIR have the Discard Eligibility (DE) bit in the header set.
- Frames with the DE bit set may be discarded by switching nodes that encounter congestion.
- The Frame Relay switch must set the DE bit
  - Can't trust a FRAD owned by the subscriber.

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13

## Frame Relay - Policing

- Burst rate is the maximum rate that information can be sent at.
  - Sender may use the burst rate for up to some time limit (2 seconds for example)
- It may not be wise for a service provider to allow high burst rates
  - When network is initially set up, the subscriber gets all their burst data through because congestion is very rare.
  - Subscriber gets used to this kind of service.
  - More subscribers sign on.
  - Congestion starts to occur and packets get dropped
  - Subscriber is irate because they aren't getting the service they are used to.

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14

## ATM

- Goal of ATM is to allow all data: voice video and data to co-exist on the same network.
  - The be-all and end-all of networking protocols
- Everything in ATM is based on Cells.
  - A cell is 53 bytes long
    - 5 bytes for header
    - 48 bytes of data
      - 32 bytes wanted by Europeans and
      - 64 bytes wanted by Americans.
      - 32 bytes => 4 milliseconds which means no need for echo cancellation
      - Americans have to do echo cancellation anyway because of distance, and wanted something more efficient for data applications
      - Typical committee, they compromised so no one is happy

## ATM - Why short fixed length cells?

- The use of relatively short cells makes sure that if high priority traffic comes in, it doesn't have to wait very long behind a big packet.
- Fixed length cells allow for easier hardware implementations.
- Easier implementations means that very high speed circuits can be created to allow higher speed applications to work.
- Fixed length cells mean that buffer memory is always efficient.

## ATM – UNI and NNI

- UNI – User-to-Network Interface
- NNI – Network-to-Network Interface
- In ATM networks, a distinction is made between an end point connecting to an ATM switch (UNI) and two ATM switches connecting together (NNI)

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17

## ATM – VPI/VCI

- In an ATM network, a virtual circuit identifier is identified by a pair of numbers, the VPI and VCI.
  - VPI – Virtual Path Identifier
  - VCI – Virtual Circuit Identifier
- Some ATM switches switch only on VPI
  - A cell comes in, and the switch sends it to another port based on it's VPI
  - A new VPI is written into the cell
  - The VCI is left untouched in this process.
- Some ATM switches switch on VPI & VCI
  - A cell comes in and the switch sends it to another port based on both the VPI and VCI
  - A new VPI and VCI is written into the cell

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18

## ATM – Header fields (UNI)

- 5 bytes in the header. The fields are:
  - GFC (4 bits) – General Flow Control Identifier
    - Used for flow control between the network and the DTE
  - VPI (8 bits) – Virtual Path Identifier
  - VCI (16 bits) – Virtual Circuit Identifier
  - PTI (3 bits) - Payload Type Indicator
  - CLP (1 bit) – Cell loss priority
    - Marked with a 0 means that it is to be discarded before cells marked with a 1.
  - HEC (8bits) – Header Error Control
    - An 8-bit CRC to catch errors in the header
    - Does not catch errors in the data body

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19

## ATM – Header fields (NNI)

- 5 bytes in the header. The fields are:
  - VPI (12 bits) – Virtual Path Identifier
  - VCI (16 bits) – Virtual Circuit Identifier
  - PTI (3 bits) - Payload Type Indicator
  - CLP (1 bit) – Cell loss priority
  - HEC (8bits) – Header Error Control
- NNI interfaces have more VPIs, based on the idea that inside of the ATM cloud, there might be more VPI switches than full VPI/VCI switches.
- This is all nice and good – but not normally used

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20

## Payload Type

- 3 bits
- First one defines management or not
- Enumerated out:
  - 000 –no congestion, no signaling
  - 010 – no congestion, signaling
  - 001 – congestion encountered, no signaling
  - 001 – congestion encountered, signaling
  - 100 – Management, link associated management
  - 101 – Management, end to end management
  - 110 – Management, resource management
  - 111 – reserved

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21

## ATM – Service Classes

- CBR – Constant Bit Rate
  - For real-time audio or video
  - Similar to that service of a dedicated T1 line
- VBR – Variable Bit Rate
  - VBR-RT – Variable Bit Rate – Real Time
    - For those services that use compression to create a variable bit rate stream, but still need real-time characteristics.
  - VBR-NRT – Variable Bit Rate – Non-real time
    - Ditto – but don't require real-time

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22

## ATM – Service Classes

- ABR – Available Bit Rate
  - Delivers a minimum cell rate
  - If network capacity is available, higher cell rates are achievable.
- UBR – Unspecified Bit Rate
  - Best effort delivery that doesn't guarantee anything

## ATM – QOS attributes

- Different service classes allow specifying some or all of these attributes.
  - SCR – Sustained Cell Rate
  - PCR – Peak Cell Rate
  - MCR – Minimum Cell rate
  - CVDT – Cell variation delay tolerance

## ATM Adaptation Layers - AAL

- AAL's are standards that specify how the 48 byte data payload is used.
- AAL1 – Supports constant bit rate applications such as T1, T3, etc.
  - Has a 1 byte header and 47 bytes of data
- AAL2 – support for variable bit rate applications (like compressed voice)
  - Has a 1 byte pointer and 47 bytes of data
  - The 47 bytes contain variable length packets that each have a 3 byte header.

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25

## ATM Adaptation Layers - AAL

- AAL3/4 – combined #3 and #4
  - Support for data services
  - Each cell has a 2 byte header and 2 byte trailer
  - The data packet (up to 64k bytes) is given a 4 byte header and 4 byte trailer and padded to a multiple of 44.
  - The data packet is then sliced into 44 byte chunks to be put into each cell
  - Supports sequencing and error control

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26

## ATM Adaptation Layers – AAL

- AAL5 – data applications that don't require sequencing and error control of AAL3/4
- Data packet (up to 64k bytes) has an 8 byte trailer added and padded up to multiple of 48 bytes.
- Data packet is then sliced into 48 byte chunks to be put into each cell.
- The PTI signaling bit in the header indicates when the end of a packet occurs.