



High speed computer networks

Asynchronous transfer mode (ATM)

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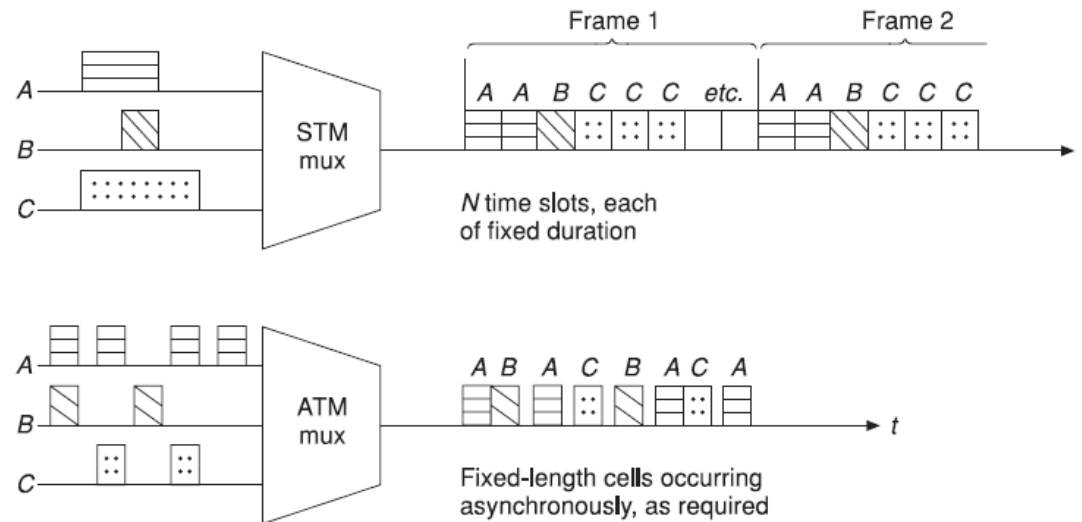
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Overview

- ❑ Asynchronous transfer mode
- ❑ Protocol architecture
- ❑ Logical connection
- ❑ ATM cells

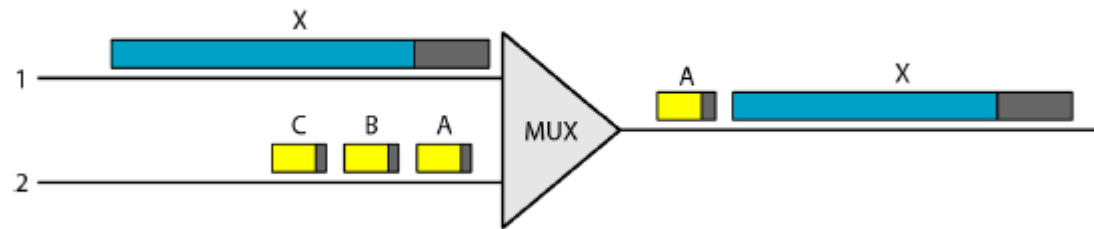
Asynchronous transfer mode (ATM)

- ❑ Asynchronous Transfer Mode (ATM) is the cell relay protocol designed by the ATM Forum and adopted by the ITU-T
- ❑ Asynchronous vs. synchronous transfer



ATM

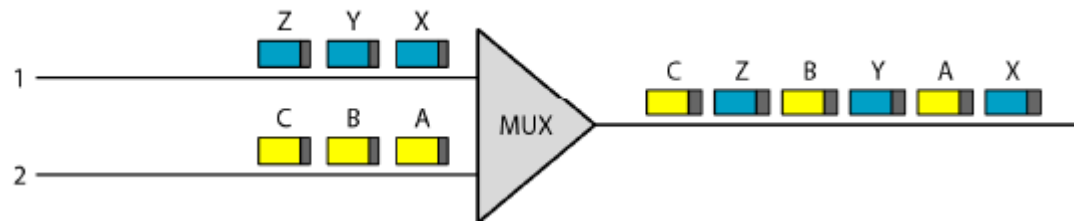
- ❑ Frames of varying size
 - ✓ Difficult to provide consistent data rate
 - ✓ E.g., multiplexing using different frame sizes



- ❑ Audio and video frames ordinarily are small - mixing with data traffic often creates unacceptable delays
 - ✓ Making the shared frame links unusable for audio and video information

Cell networks

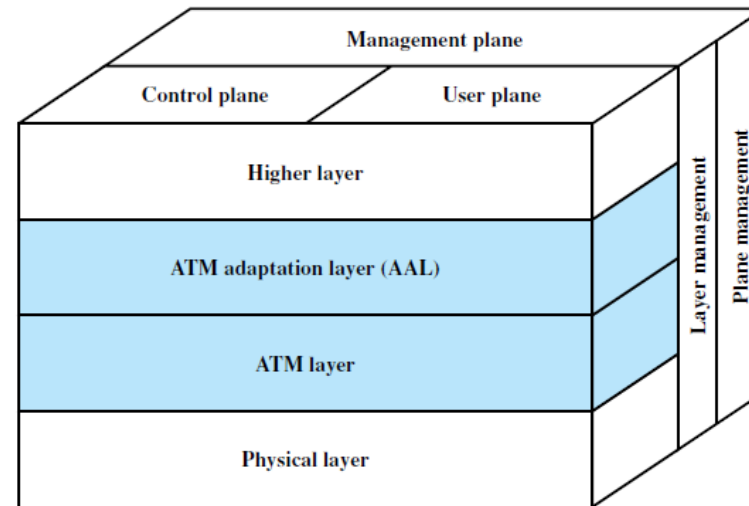
- Many of the problems associated with frame internetworking are solved by adopting a concept called cell networking
- A cell is a small data unit of fixed size



ATM Protocol architecture

- ❑ ATM is a cell-switched network
- ❑ Similar to packet switching using X.25 and frame relay
 - ✓ ATM involves the transfer of data in discrete chunks
 - ✓ Allows multiple logical connections to be multiplexed over a single physical interface

❑ ATM Protocol architecture



Protocol architecture

- Illustrates the basic architecture for an interface between user and network
 - ✓ The physical layer involves the specification of a transmission medium and a signal encoding scheme
 - ✓ Two layers of the protocol architecture relate to ATM functions
 - ATM layer common to all services that provides packet transfer capabilities
 - ATM adaptation layer (AAL) that is service dependent
- ATM layer defines:
 - ✓ the transmission of data in fixed-size cells
 - ✓ the use of logical connections
- AAL layer
 - ✓ Used to support information transfer protocols not based on ATM
 - ✓ maps higher-layer information into ATM cells to be transported over an ATM network
 - ✓ collects information from ATM cells for delivery to higher layers

Protocol architecture

□ Three separate planes

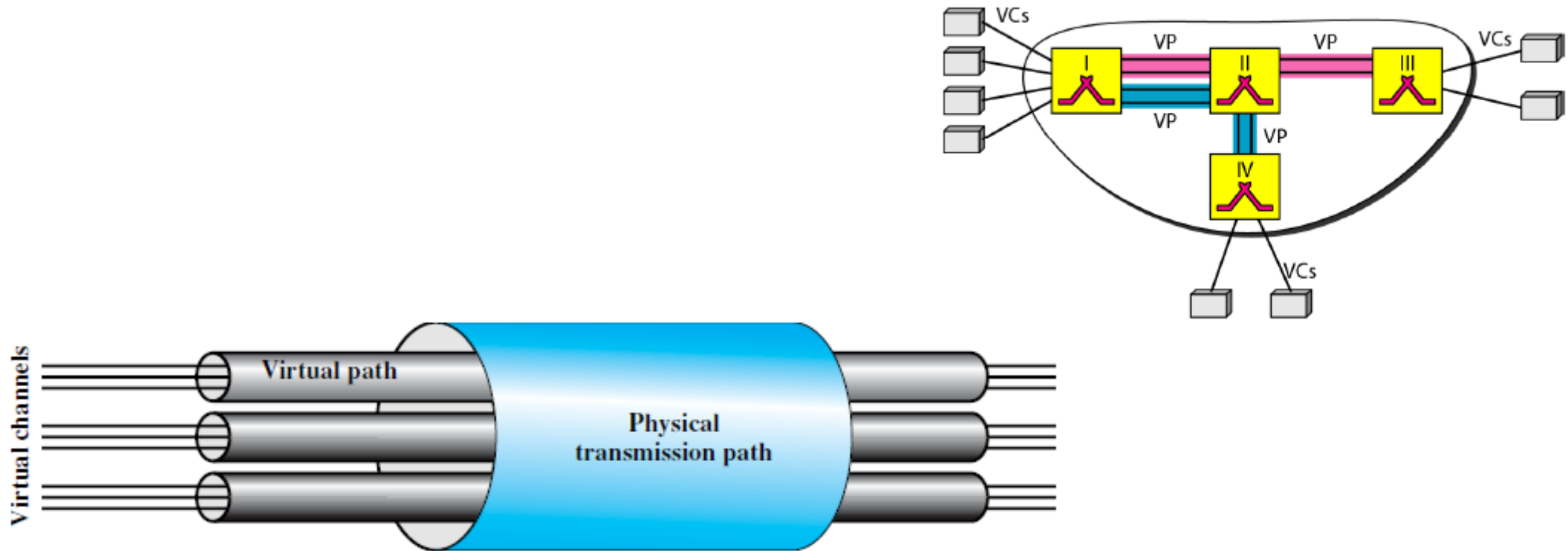
- ✓ **User plane:** for user information transfer
- ✓ **Control plane:** Performs call control and connection control functions
- ✓ **Management plane:**
 - plane management - performs management functions related to a system as a whole and provides coordination between all the planes
 - layer management - performs management functions relating to resources and parameters residing in its protocol entities

ATM logical connection

- ❑ The logical connection in ATM are referred as **virtual channel connections (VCCs)**
 - ✓ VCC (Virtual Channel Connection): a logical connection analogous to virtual circuit in X.25 or data link connection in FR
 - ✓ A VCC is set up between *two end users* through the network
 - ✓ VCCs are also used for *user-network exchange* (control signaling) and *network-network exchange* (network management and routing)
- ❑ **virtual path connection (VPC)**
 - ✓ A bundle of VCCs that have the same endpoints
 - ✓ The virtual path technique helps contain the control cost by grouping connections sharing common paths through the network into a single unit
- ❑ **VCC and VPC are full-duplex connections**
 - ✓ *However, the channel or path bandwidth and other traffic parameters can be configured to be different in the transmit and receive directions*

ATM logical connection

- Transmission path: a physical connection between end points



Advantages of Virtual Paths

❑ **Simplified network architecture**

- ✓ Network transport functions can be separated into virtual channel and virtual path

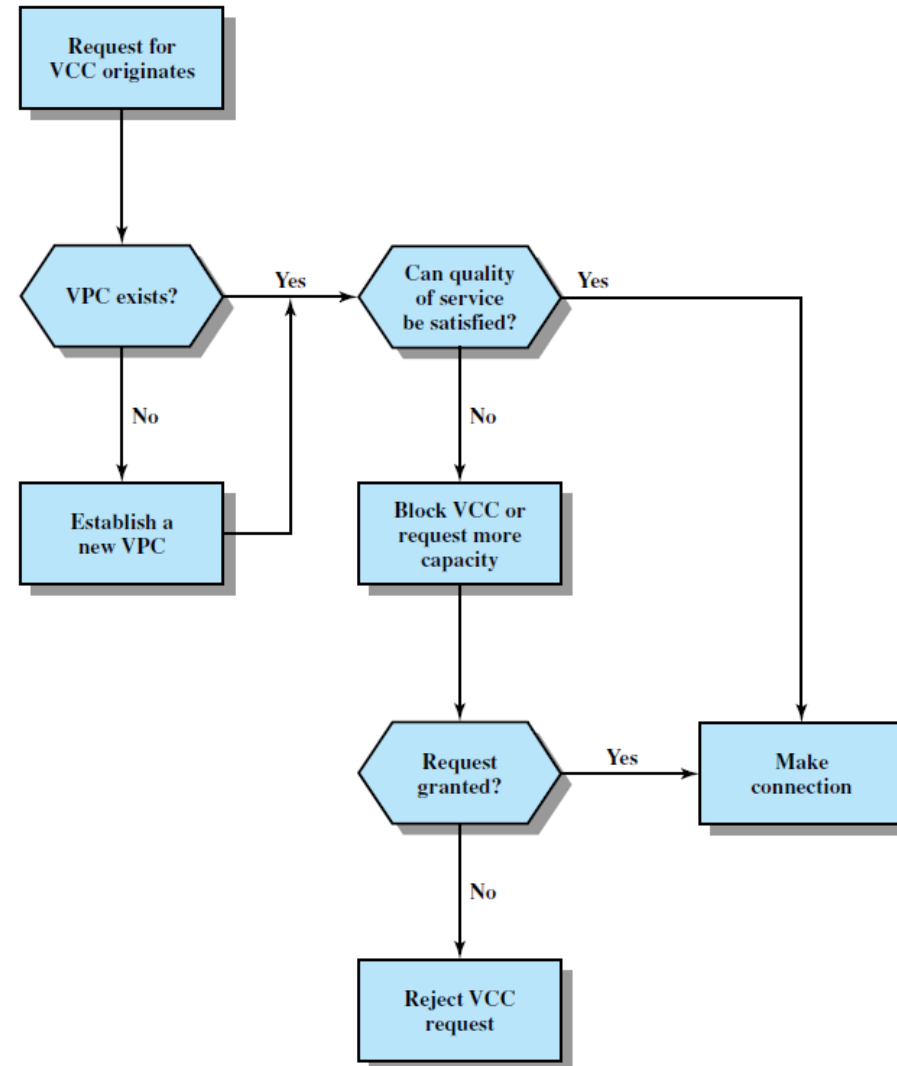
❑ **Increased network performance and reliability**

- ✓ The network deals with fewer, aggregated entities

❑ **Reduced processing and short connection setup time**

- ✓ The addition of new virtual channels to an existing virtual path involves minimal processing
 - new virtual channel connections can be established by executing simple control

Call Establishment Using Virtual Paths



Virtual channel connection uses

❑ **Between end users**

- ✓ to carry end-to-end user data
- ✓ to carry control signaling between end users

❑ **Between an end user and a network entity**

- ✓ Used for user-to-network control signaling

❑ **Between two network entities**

- ✓ Used for network traffic management and routing functions

VP/VC characteristics

- ITU-T Recommendation I.150 lists the following as characteristics of virtual channel connections
 - ✓ **Quality of service (QoS):** A user of a VCC is provided with a QoS specified by parameters such as cell loss ratio and cell delay variation.
 - ✓ **Cell sequence integrity:** The sequence of transmitted cells within a VCC is preserved.
 - ✓ **Traffic parameter negotiation and usage monitoring:**
 - Traffic parameters (such as average rate, peak rate, burstiness, and peak duration) can be negotiated between a user and the network for each VCC
 - monitors the input of cells to the VCC, to ensure that the negotiated parameters are not violated
 - ✓ **Virtual connections**
 - **Switched VCC:** an on-demand connection, which requires a call control signaling for setup and tearing down
 - **Semipermanent VCC** is of long duration and is set up by configuration or network management action.
 - ✓ **VPI restriction** – One or more virtual channel identifiers may be reserved for network use (VCCs used for network management)

Control signaling

- ❑ A mechanism for the establishment and release of VPCs and VCCs
- ❑ VCC establishment/release
 - ✓ Semi-permanent VCCs – no control signaling is required
 - ✓ Meta-signaling channel – used to set up VCCs that can be used for call control signaling
 - ✓ The meta-signaling channel can also be used to set up
 - **A user-to-network signaling virtual channel**
 - can then be used to set up VCCs to carry user data
 - **A user-to-user signaling virtual channel**
 - can then be used to allow the two end users, without network intervention, to establish and release user-to-user VCCs to carry user data
 - Such a channel must be set up within a pre-established VPC

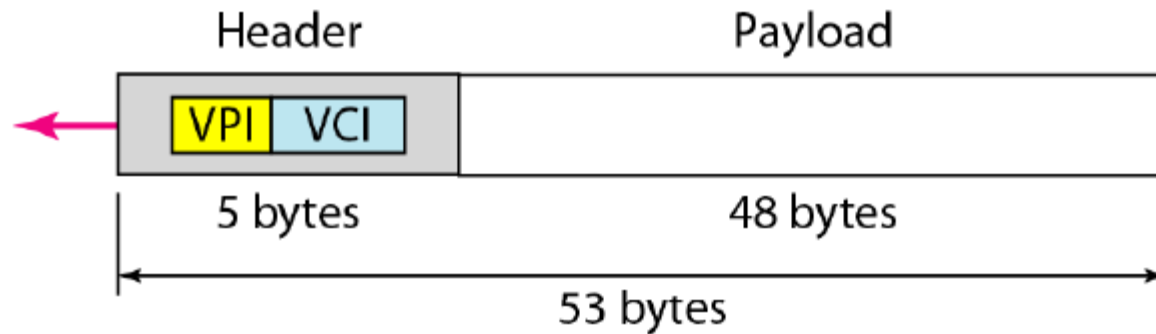
Control signaling

□ VPC establishment/release

- ✓ Semi-permanent VPC- no signaling
- ✓ Customer controlled
 - the customer uses a signaling VCC to request the VPC from the network
- ✓ Network controlled
 - The network establishes a VPC for its own convenience
 - The path may be network-to-network, user-to-network, or user-to-user.

ATM cells

- ❑ The asynchronous transfer mode makes use of fixed-size cells



- ❑ fixed-size cells

- ✓ May reduce queuing delay for a high-priority cell
- ✓ With fixed-size cells, it is easier to implement the switching mechanism in hardware

ATM headers

❑ Generic flow control

- ✓ used for control of cell flow only at the local user-network interface
- ✓ alleviates short-term overload conditions in the network

❑ Virtual Path Identifier (VPI)

❑ Virtual Channel Identifier (VCI)

❑ Payload type

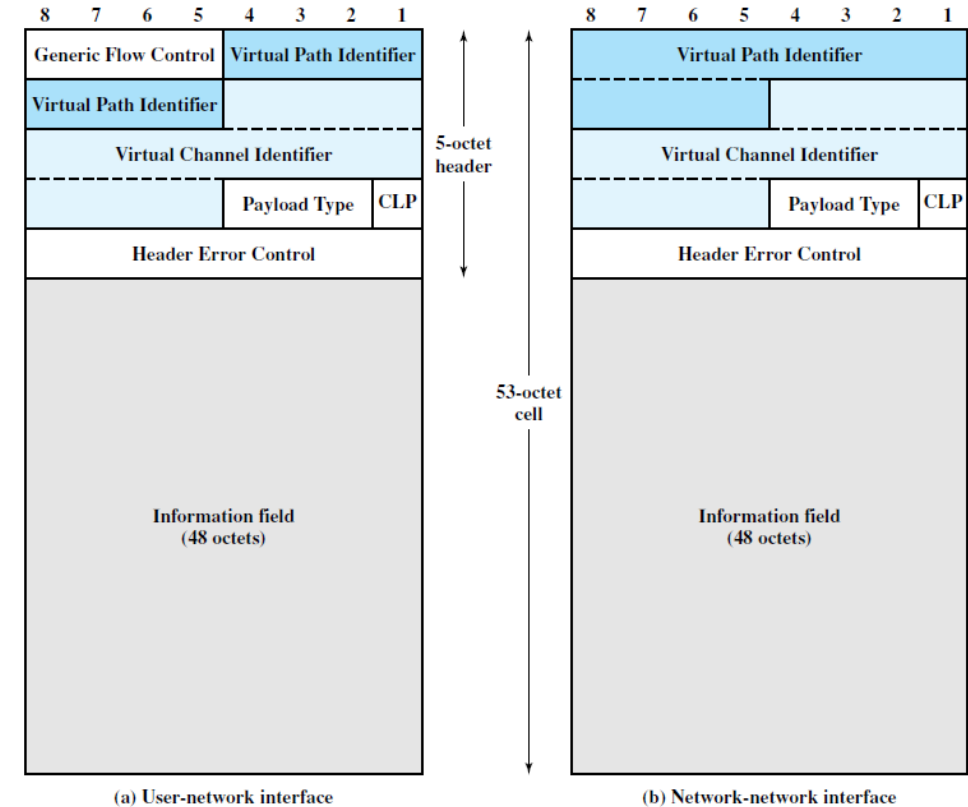
- ✓ user information, network management and maintenance information

❑ Cell loss priority (CLP)

- ✓ provide guidance to the network in the event of congestion

❑ Header error control

- ✓ Contains eight check bits which are used for checking the header
- ✓ The payload of an ATM cell is not checked for errors



ATM service categories

- An ATM network is designed to be able to transfer many different types of traffic simultaneously, including real-time flows such as voice and video
 - ✓ Each is handled as a stream of 53-octet cells traveling through a virtual channel
 - ✓ But, the way in which each data flow is handled within the network depends on the **characteristics of the traffic flow** and the **requirements of the application**

ATM service categories

❑ Real time service

- ✓ Audio and video have a strict constraint on delay and the variability of the delay
- ✓ Interactive applications have tight constraints on delay

❑ Constant Bit Rate (CBR)

- ✓ It is used by applications that require a fixed data rate that is continuously available during the connection lifetime and a relatively tight upper bound on transfer delay
- ✓ commonly used for uncompressed audio and video information
- ✓ E.g. videoconferencing, interactive audio

❑ Real-Time Variable Bit Rate (rt-VBR)

- ✓ intended for time-sensitive applications; i.e., those requiring tightly constrained delay and delay variation
- ✓ For example, the standard approach to video compression results in a sequence of image frames of varying sizes. Because real-time video requires a uniform frame transmission rate, the actual data rate varies

ATM service categories

□ Non-Real-Time Services

- ✓ intended for applications that have bursty traffic characteristics and do not have tight constraints on delay and delay variation

□ Non-Real-Time Variable Bit Rate (nrt-VBR)

- ✓ The end system specifies a *peak cell rate*, a *sustainable or average cell rate*, and a measure of how bursty or clumped the cells may be.
- ✓ With this information, the network can *allocate resources to provide relatively low delay and minimal cell loss*
- ✓ nrt-VBR service can be used for data transfers that have critical response time requirements. E.g., include airline reservations, banking transactions, and process monitoring.

ATM service categories

□ Unspecified Bit Rate (UBR)

- ✓ suitable for applications that can tolerate variable delays and some cell losses
- ✓ With UBR, cells are forwarded on a first-in-first-out (FIFO) basis using the capacity not consumed by other services
- ✓ Best effort service- e.g. Text/data/image transfer

□ Available Bit Rate (ABR)

- ✓ An application using ABR specifies a *peak cell rate (PCR)* and a *minimum cell rate (MCR)* that it requires
- ✓ The network allocates resources so that all ABR applications receive at least their MCR capacity
- ✓ Any capacity not used by ABR sources remains available for UBR traffic
- ✓ The ABR mechanism uses explicit feedback to sources to assure that capacity is fairly allocated

ATM vs. frame relay

□ ATM

- ✓ designed to be convenient for hardware implementation - cost is higher compared to frame relay
- ✓ 8 bit of error control field in header part of ATM cell is used for error control. Provides flow control at user to network interface (UNI) level only
- ✓ Supports quantifiable QoS
- ✓ Frame size is fixed in ATM networks. Therefore it gives less processing overhead.
- ✓ The cell transfer speed of ATM is high

□ Frame relay

- ✓ software controlled - less expensive
- ✓ does not provide flow control or error control. These functions must be supported by upper layers.
- ✓ Carry traffic in the form of data only
- ✓ Do not support quantifiable QoS
- ✓ Frame size is variable in frame relay networks. Therefore it gives medium processing overhead
- ✓ Frame transfer speed is low