

# **BROADBAND AND HIGH SPEED NETWORKS**

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## **Asynchronous Transfer Mode (ATM)**

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# ATM SERVICE CATEGORIES

- **Service Categories** : represent particular combinations of traffic parameters and QoS parameters. These parameters are determined by users for a connection to meet the needs of higher-level applications.
  - **CBR (Constant Bit Rate)** support real-time applications requiring constrained delay variation (**voice, video**).
  - **RT-VBR (Real Time Variable Bit Rate)** support real time applications with bursty traffic (e.g., **video conferencing**).
  - **NRT-VBR (Non-Real Time Variable Bit Rate)** support non-real time applications with bursty traffic (e.g., **multimedia email**).
  - **UBR (Unspecified Bit Rate)** Represents a “best-effort service” intended for a non-real time applications that don’t require tightly constrained delay or delay variation and are tolerant to cell rate (**no feedback to the sender when the congestion occurs**).
  - **ABR (Available Bit Rate)** similar to UBR but enhanced to handle applications that require minimum bandwidth requirement (**feedback to the sender when the congestion occurs**).

# ATM SERVICE CATEGORIES

<b>Class</b>	<b>Description</b>	<b>Example</b>
<b>CBR</b>	Constant bit rate	T1 circuit
<b>RT-VBR</b>	Variable bit rate: real time	Real-time Videoconferencing
<b>NRT-VBR</b>	Variable bit rate: non-real time	Multimedia Email
<b>ABR</b>	Available bit rate	Browsing the Web
<b>UBR</b>	Unspecified bit rate	Background file transfer

# SERVICE CATEGORIES

Service Characteristic	CBR	RT-VBR	NRT-VBR	ABR	UBR
Bandwidth guarantee	Constant	Average	Average	Minimum	None
Suitable for real-time traffic	Yes	Yes	No	No	No
Suitable for bursty traffic	No	YES	Yes	Yes	Yes
Feedback about congestion	No	No	No	Yes	No

# AAL CLASSES OF TRAFFIC

<b>Class A</b>	Constant bit rate (CBR)
	Connection-oriented, e.g., CBR for video
	Timing relationship between source and destination: Required
<b>Class B</b>	Variable bit rate (VBR)
	Connection-oriented, e.g., VBR for video or voice
	Timing relationship between source and destination: Required
<b>Class C</b>	Variable bit rate (VBR)
	Connection-oriented, e.g., bursty data services
	Timing relationship between source and destination: Not required
<b>Class D</b>	Variable bit rate (VBR)
	Connectionless, e.g., bursty datagram services
	Timing relationship between source and destination: Not required
<b>Class X</b>	Traffic type and timing requirements defined by the user

# AAL CLASSES OF TRAFFIC

<b>Class</b>	<b>A</b>	<b>B</b>	<b>C</b>	<b>D</b>
<b>Timing</b>	<b>Synchronous</b>		<b>Asynchronous</b>	
<b>Bit transfer</b>	<b>Constant</b>	<b>Variable</b>		
<b>Connection mode</b>	<b>Connection-oriented</b>			<b>Connectionless</b>

# ATM CONNECTIONS

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- ✘ ATM supports two types of connections:
  - + *Point-to-point*
  - + *Point-to-multipoint*

# ATM CONNECTIONS

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- × **Point-to-point** connects two ATM end systems and can be *unidirectional* (one-way communication) or *bidirectional* (two-way communication).
- × **Point-to-multipoint** connects a single-source end system (known as the root node) to multiple destination end systems (known as leaves). Such connections are unidirectional only. Root nodes can transmit to leaves, but leaves cannot transmit to the root or to each other on the same connection. Cell replication is *done within the ATM network by the ATM switches* where the connection splits into two or more branches.

# ATM QUALITY OF SERVICE

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- × ATM supports:
  - + *Traffic contract*
  - + *Traffic shaping*
  - + *Traffic policing*

# ATM QUALITY OF SERVICE—TRAFFIC CONTRACT

- ❑ When a virtual circuit is established, both *the transport layer in the host machine* and *the network* must agree on a *contract* defining the service.
- ❑ A **traffic contract** specifies the intended data flow.
- ❑ When an *ATM end system* connects to an *ATM network*, it enters a contract with the network, based on *QoS parameters*.
- ❑ The *contract* between the customer and the network depends on :
  - ❑ *The traffic to be offered (traffic descriptor).*
  - ❑ *The service agreed upon (quality of service desired by the customer and accepted by the network).*
- ❑ The contract may be *different* for each direction.

# ATM QUALITY OF SERVICE—TRAFFIC CONTRACT

## □ Peak Cell Rate (PCR):

- *PCR* is the maximum rate at which the sender is planning to send cells.
- If a cell is sent every 4  $\mu$ sec at minimum, its *PCR* is 250,000 cells/sec.

## □ Sustained Cell Rate (SCR):

- *SCR* is the expected cell rate averaged over a long time interval.
- For *CBR*, *SCR* will be equal to *PCR*, but for all the other service categories, it will be substantially lower.

## □ Minimum Cell Rate (MCR):

- *MCR* is the minimum number of cells/sec that the customer considers acceptable.
- When *ABR* service is requested, then the actual bandwidth used must lie between *MCR* and *PCR*.
- If the customer and the network agree to set *MCR* to 0, then *ABR* service becomes similar to *UBR* service.

## □ Cell Variation Delay Tolerance (CVDT):

- *CVDT* tells how much *variation* will be present in cell transmission times.

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- ❑ The following *QoS parameters* describe characteristics of the network and are measured at the receiver.
    - ❑ **Cell Loss Ratio (CLR)** is the fraction of the transmitted cells that lost or are delivered too late.
    - ❑ **Cell Transfer Delay (CTD)** is the average transit time from the source to destination.
    - ❑ **Cell Delay Variation (CDV)** measures how uniformly the cells are delivered.
    - ❑ **Cell Error Ratio (CER)** is the fraction of the cells that are delivered with one or more bits wrong.
    - ❑ **Severely-Errored Cell Block Ratio (SECBR)** is the fraction of N-cell blocks of which M or more cells contain an error
    - ❑ **Cell Miss-insertion Rate (CMR)** is the number of cells/sec that are delivered to the wrong destination because of an undetected error in the header.

# ATM QUALITY OF SERVICE—TRAFFIC CONTRACT

Parameter	Acronym	Meaning
Peak Cell Rate	<b>PCR</b>	Maximum rate at which cells will be sent
Sustained Cell Rate	<b>SCR</b>	The long-term average cell rate
Minimum Cell Rate	<b>MCR</b>	The minimum acceptable cell rate
Cell Delay Variation Tolerance	<b>CDVT</b>	The maximum acceptable cell cell jitter
Cell Loss Ratio	<b>CLR</b>	Fraction of cells lost or delivered too late
Cell Transfer Delay	<b>CTD</b>	Average transit time from source to destination
Cell Delay Variation	<b>CDV</b>	The variance in cell delivery times
Cell Error Ratio	<b>CER</b>	Fraction of cells delivered with error
Severely-Errored Cell Block Ratio	<b>SECBR</b>	Fraction of blocks garbled
Cell Miss-insertion Rate	<b>CMR</b>	Fraction of cells delivered to wrong destination

# ATM QUALITY OF SERVICE —TRAFFIC SHAPING

- **Traffic shaping** is the use of queues to constrain data bursts, limit peak data rate, and smooth jitters so that traffic will fit within the promised envelope. **ATM devices are responsible for adhering to the contract by means of traffic shaping.**

# ATM QUALITY OF SERVICE —TRAFFIC POLICING

- ✘ ATM switches can use **traffic policing** to enforce the contract.
- ✘ The switch can measure the actual traffic flow and compare it against the agreed-upon traffic envelope. If the **switch finds that traffic is outside of the agreed-upon parameters, it can set the cell-loss priority (CLP) bit of the offending cells.**
- ✘ Setting the *CLP* bit makes the cell *discard eligible*, which means that any **switch handling the cell is allowed to drop the cell during periods of congestion.**