NORTEL
NORTHERN TELECOM

Magellan ATM Network Engineering

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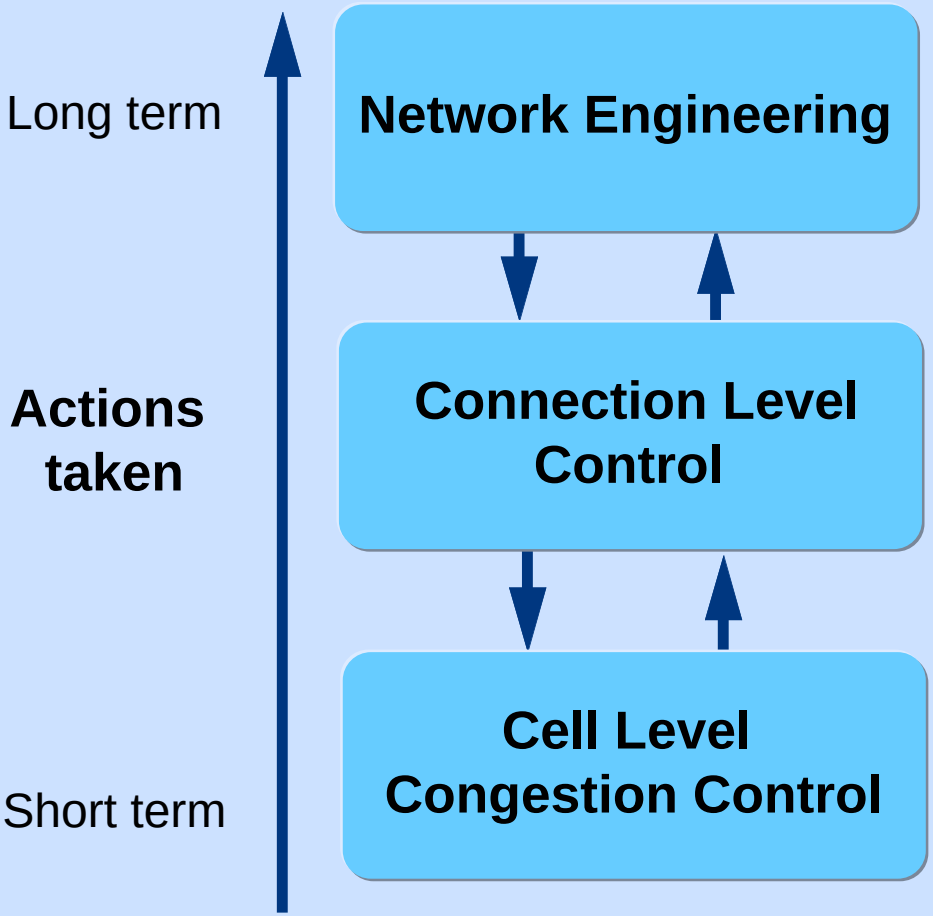
Agenda

- ATM Traffic Management
- Bandwidth Allocation and Control
- ATM Network Engineering: A Case Study
- Summary

Agenda

- **ATM Traffic Management**
  - **ATM Traffic Management Layers**
  - **ATM QOS Attributes**
  - **ATM Classes of Service**
- **Bandwidth Allocation and Control**
- **ATM Network Engineering: A Case Study**
- **Summary**

ATM Traffic Management Layers



- **Topology selection**
- **Dimensioning of network links**

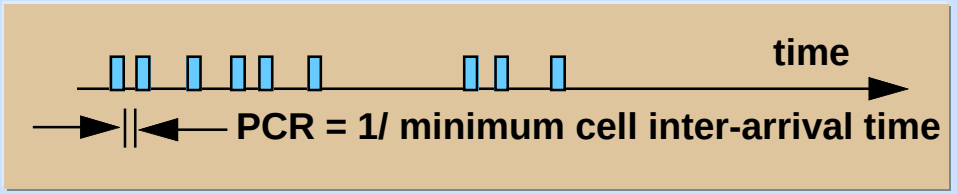
- **Connection admission control**
- **Path selection and routing**

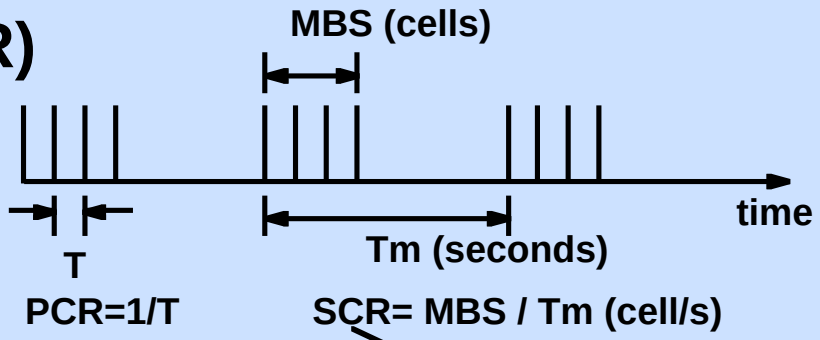
- **Usage parameter control**
- **Traffic shaping**
- **Emission scheduling**
- **Selective cell discard**
- **Congestion notification**
- **Packet discard**

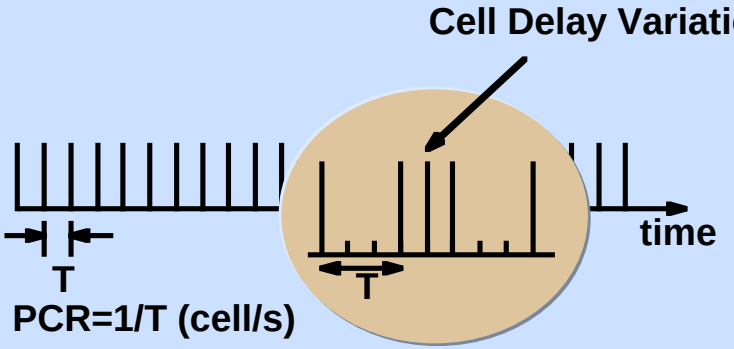
Comprehensive traffic management capabilities are key in achieving acceptable quality of service in multiservice networks

ATM Quality of Service (QOS) Attributes

- **Peak cell rate (PCR)**
  - cell delay variation tolerance (CDVT)
- **Sustained cell rate (SCR)**
  - maximum burst size (MBS)/ burst tolerance (BT)
- **Accuracy parameters**
  - cell loss ratio (CLR)
  - cell error ratio (CER)
- **Delay parameters**
  - cell transfer delay (CTD)
  - cell delay variation (CDV)







ATM Classes of Service

- **ATM classes of service**
  - **constant bit rate (CBR)**
  - **real-time variable bit rate (real-time VBR)**
  - **non-real-time variable bit rate (non-real-time VBR)**
  - **available bit rate (ABR)**
  - **unspecified bit rate (UBR)**

QOS parameters to be specified for each service class:

	ATM Layer Service Categories				
Attribute	**CBR**	**rt-VBR**	**nrt-VBR**	**UBR**	**ABR**
Traffic Parameters:					
PCR and CDVT	specified			specified	specified
SCR, MBS, CDVT	n / a	specified		n / a	
MCR	n / a			n / a	specified
QoS Parameters:					
peak-to-peak CDV	specified	specified	unspecified	unspecified	unspecified
maximum CTD	specified	specified	unspecified	unspecified	unspecified
CLR	specified			unspecified	See Notes
Other Attributes:					
Feedback	unspecified			unspecified	specified

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- ATM Traffic Management
- **Bandwidth Allocation and Control**
  - **ATM connection types**
  - **connection admission control**
  - **traffic shaping**
  - **usage parameter control**
  - **QOS and the Magellan multiple priority system**
- ATM Network Engineering: A Case Study
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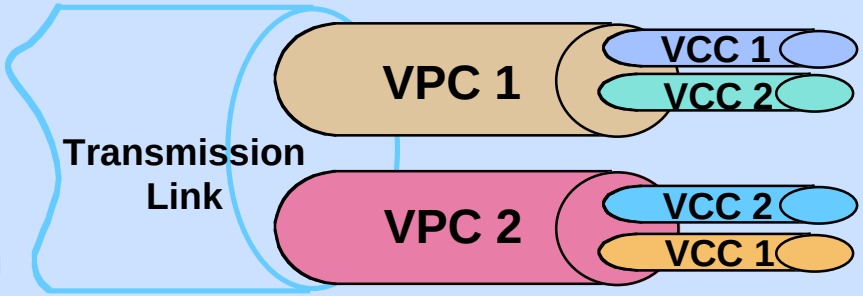
ATM Connection Types

- **Virtual channel connections (VCCs)**
  - **end-to-end**
  - **used to transfer**
    - **user information**
    - **signaling information**
    - **management information**



- **Virtual path connections (VPCs)**
  - **end-to-end**
  - **or network segment wide**

VPCs introduce the concept of virtual trunks, where multiple VCCs are grouped together into a VPC

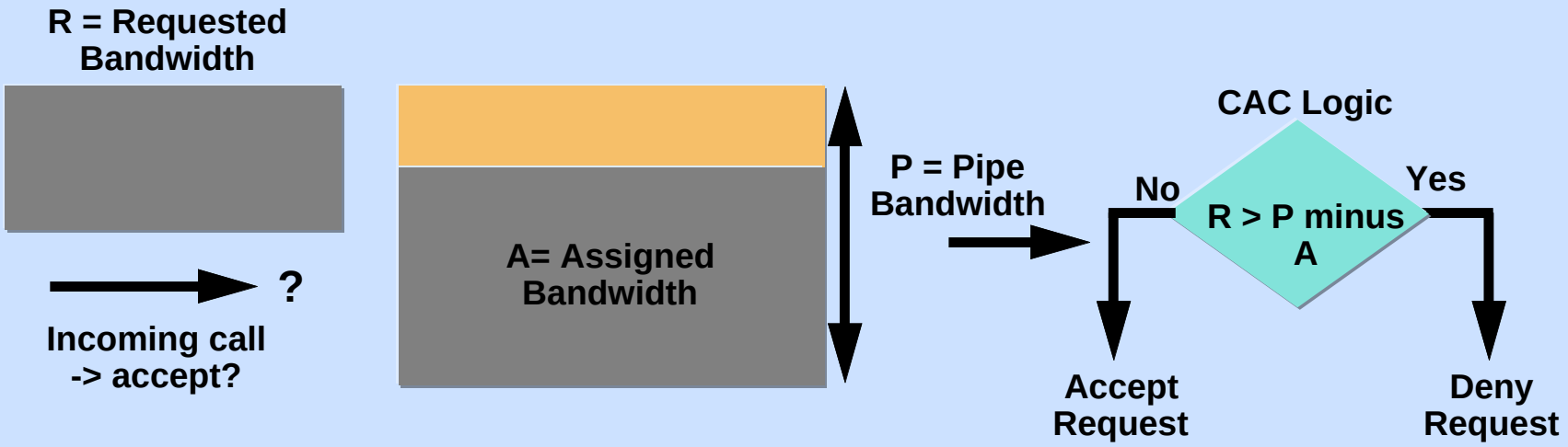
Connection Admission Control (CAC)

Function

- **To establish, at call set-up phase, whether a connection can be accepted or rejected, while maintaining QOS objectives**

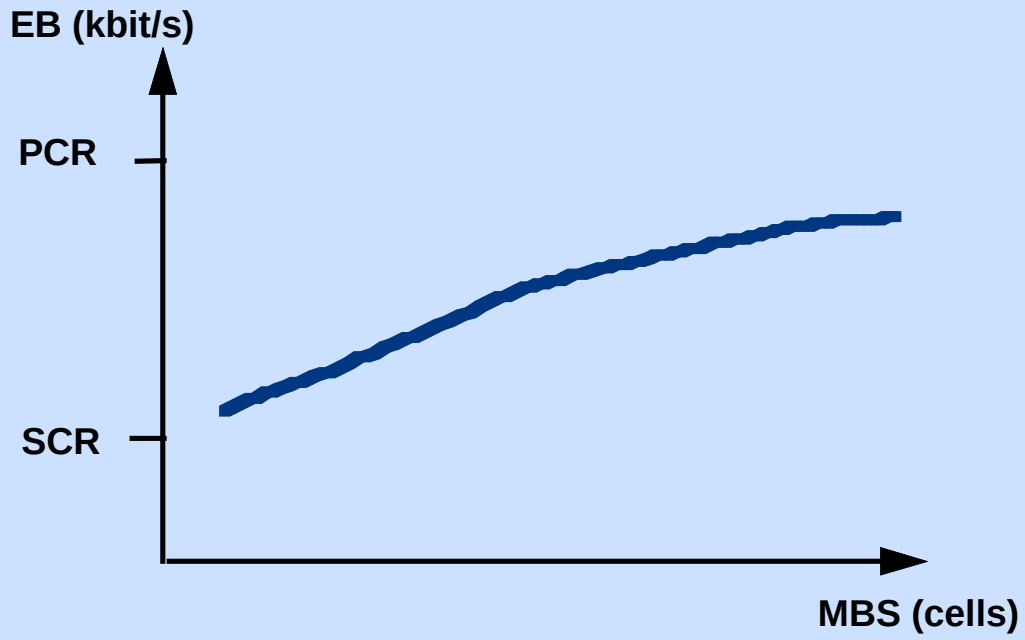
Benefit

- **Guarantee QOS requirements to new connections, as well as to already established connections**

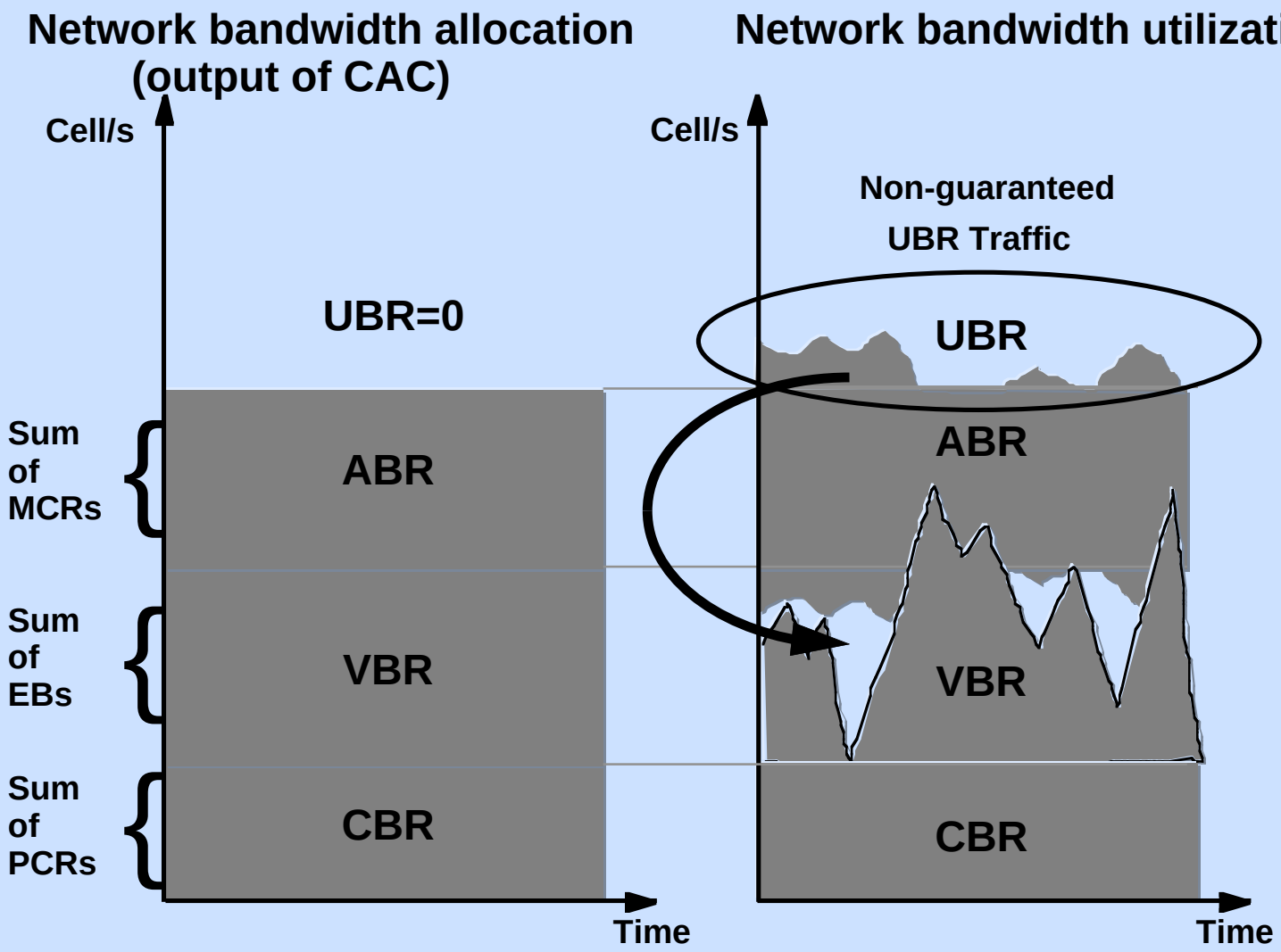


Example of CAC Algorithms

Traffic Category	Bandwidth allocated by CAC
CBR	PCR
VBR	Equivalent Bandwidth (EB); EB = function (PCR, SCR, MBS, buffer size, cell loss target)
ABR	MCR
UBR	zero (admit all connections)



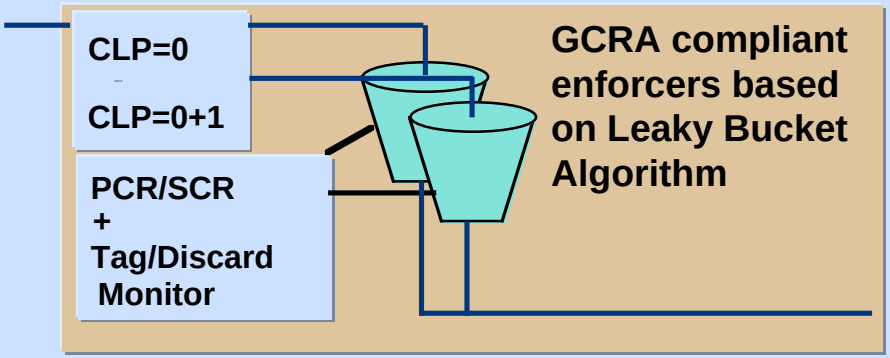
Network Bandwidth Allocation



Usage Parameter Control (UPC)

Function

- **To control the traffic offered by an ATM connection to ensure compliance with negotiated traffic contract**
- **ITU-T (in I.371) and ATM Forum standardized the generic cell rate algorithm (GCRA) enforcer**
- **Magellan has multiple provisionable enforcers, each based on the GCRA algorithm**

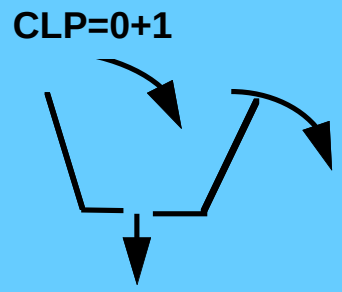


Magellan Usage Parameter Control (UPC)

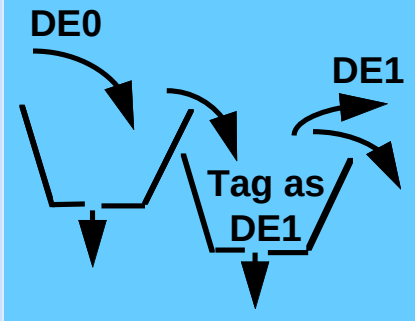
UPC Configurations

Mandatory configuration

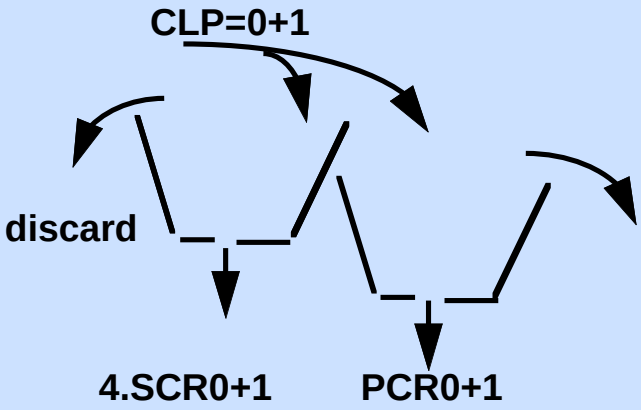
Peak Cell Rate (PCR)



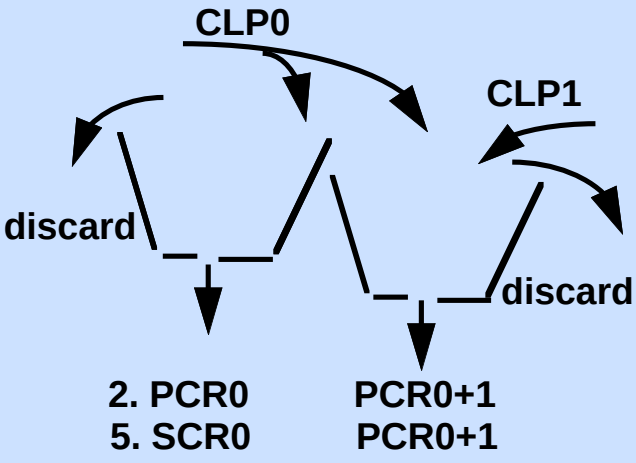
Refresher:
In the case of frame relay service



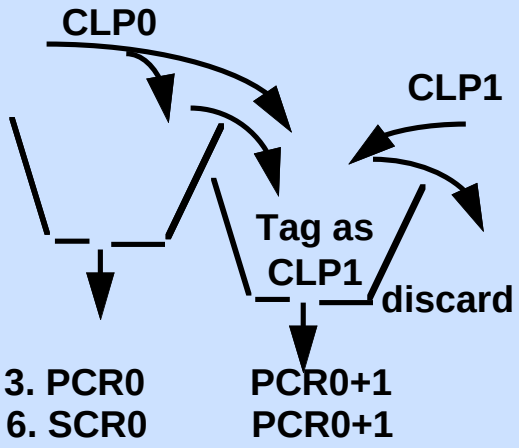
Sustained Cell Rate (SCR)



Cell Loss Priority (CLP)

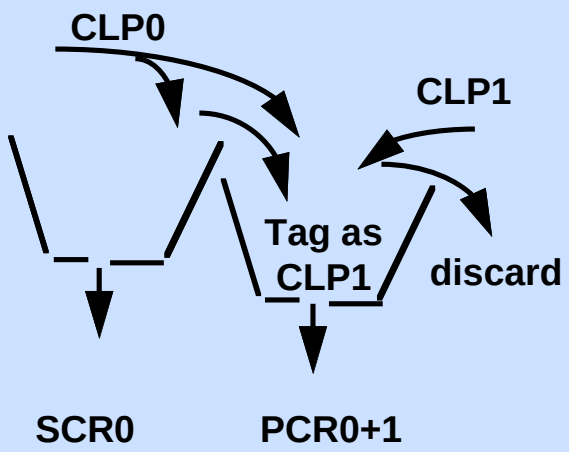


CLP Tagging



Example: UPC for Frame Relay/ ATM Service Interworking

Option 1



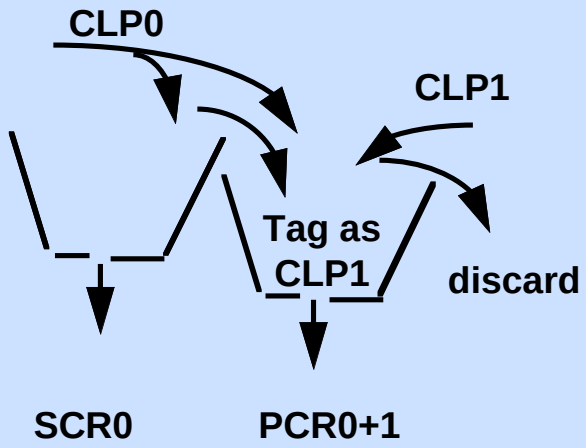
Traffic Parameter Mapping:

PCR_{0+1} = CIR+EIR

SCR_{0} = CIR

MBS_{0} = Bc [1/(1-CIR/AR) +1]

Option 2



Traffic Parameter Mapping:

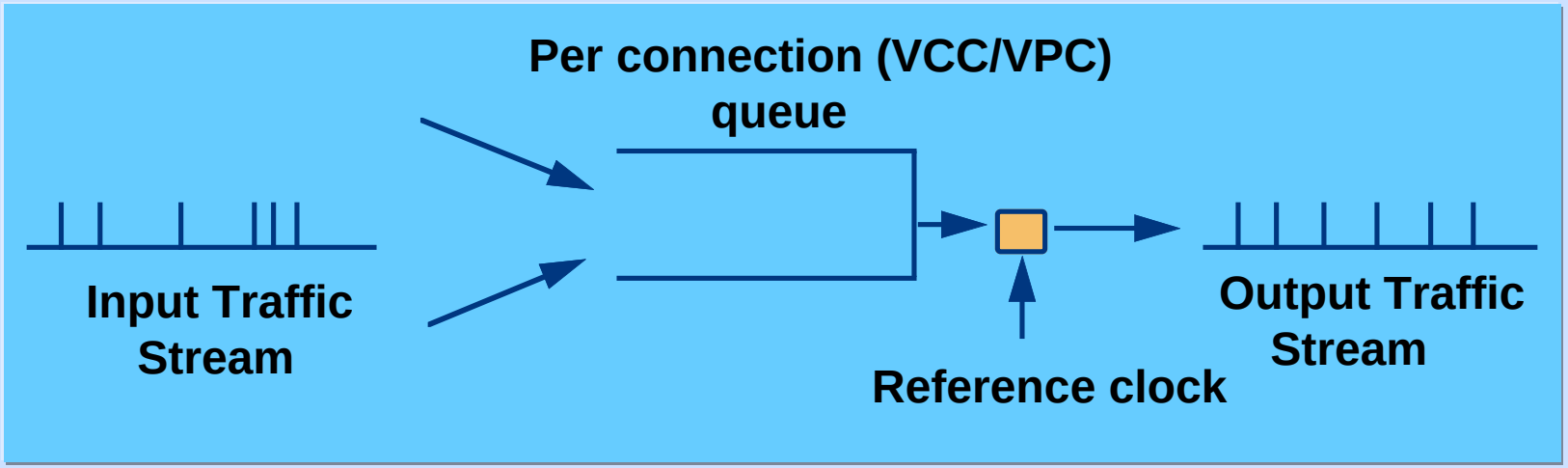
PCR_{0+1} = Access Rate (AR)

SCR_{0} = CIR

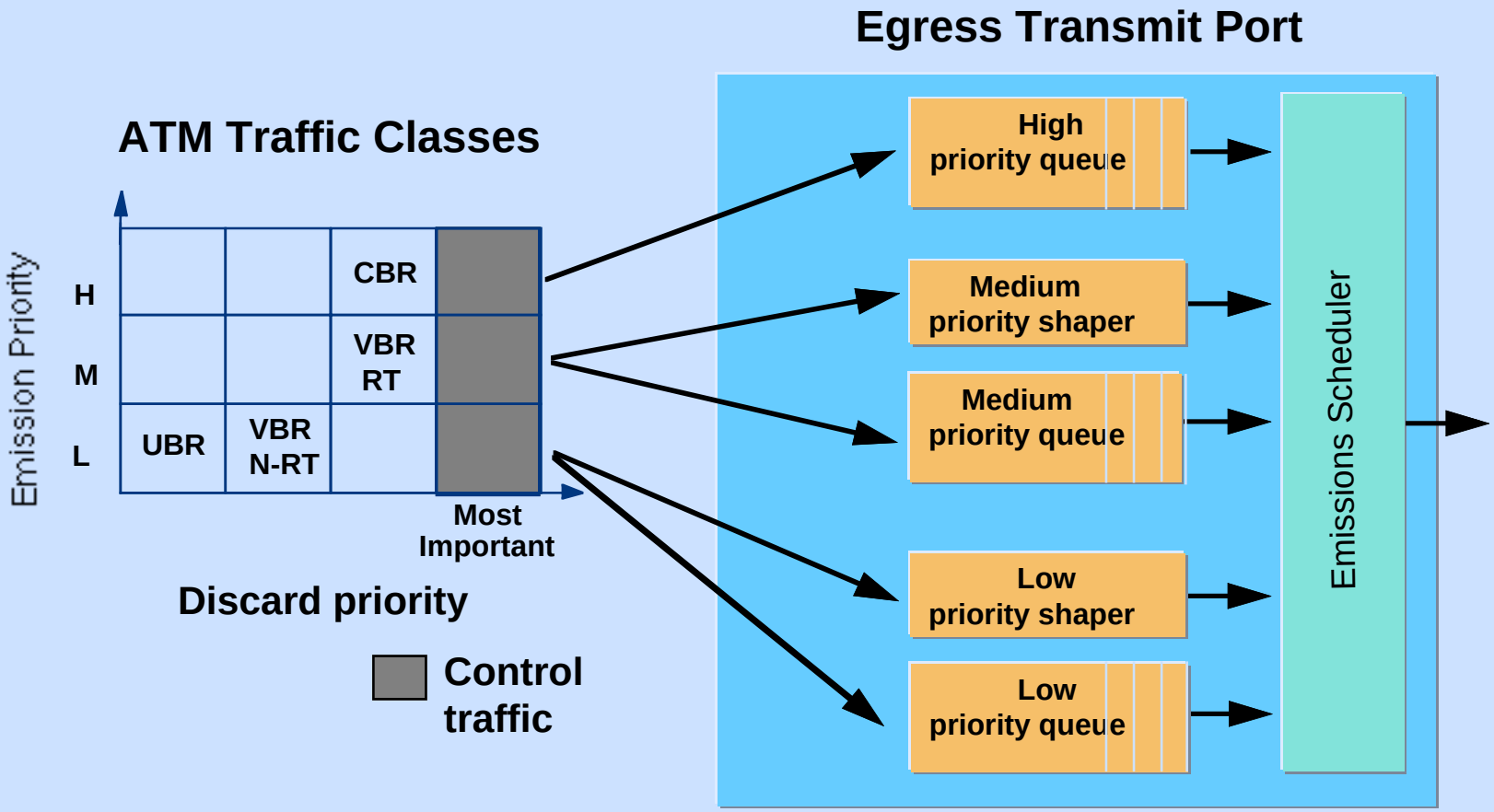
MBS_{0} = Bc [1/(1-CIR/AR) +1]

Traffic Shaping

- **Function**
  - **to alter the traffic characteristics of a stream of cells on a VCC or VPC to achieve the desired characteristics**
- **Benefits**
  - **reduce source burstiness**
  - **simpler bandwidth allocation approaches**
  - **guarantees adherence to traffic contract for public UNI**
  - **compensation for cell delay variation introduced by network**



QOS and the Magellan Multiple Priority System

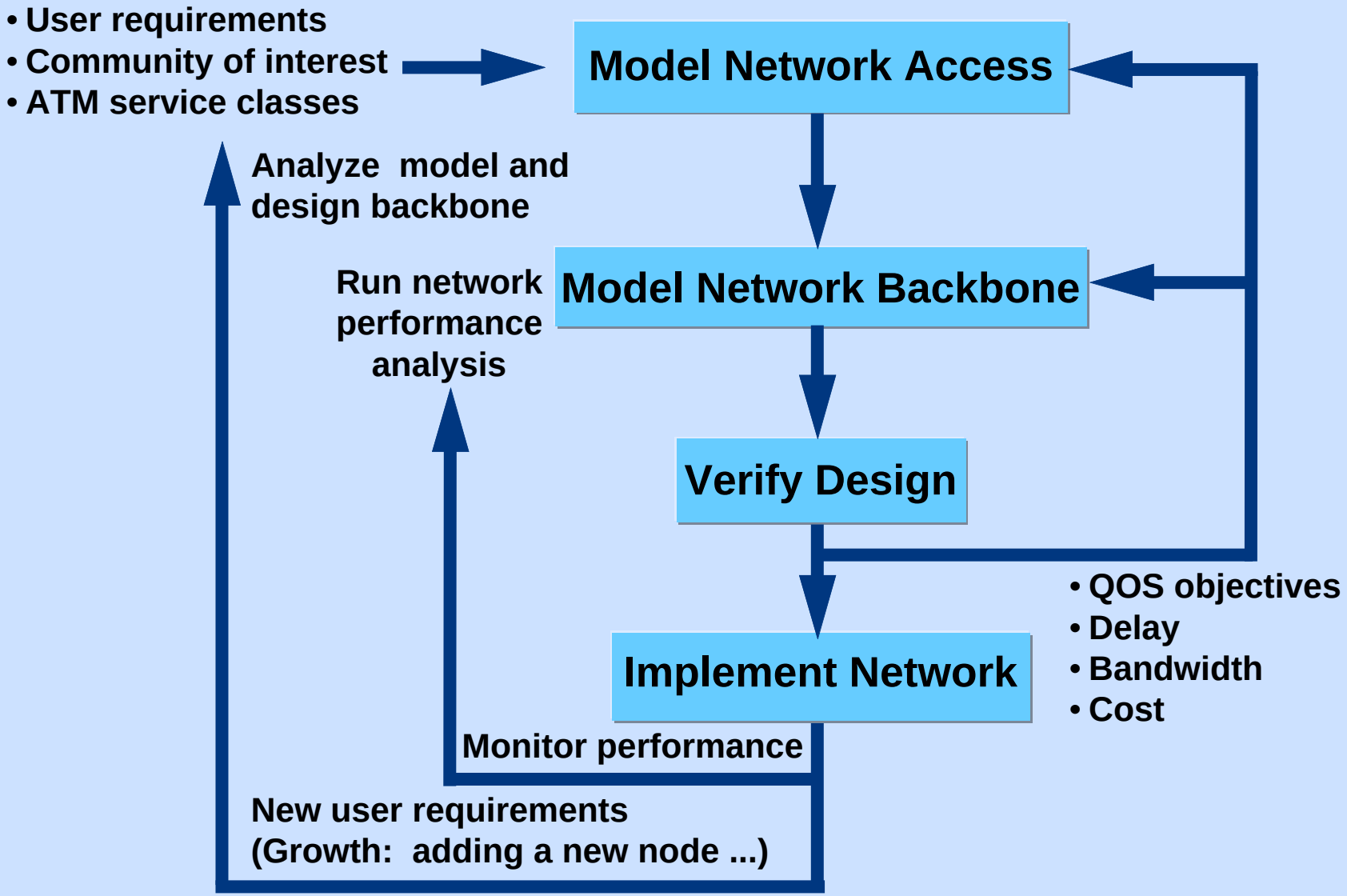


MPS is a key feature in achieving the desired QOS requirements

Agenda

- ATM Traffic Management
- Bandwidth Allocation and Control
- **ATM Network Engineering: A Case Study**
  - **network engineering cycle**
  - **model network access**
  - **model network backbone**
  - **design verification**
- Summary

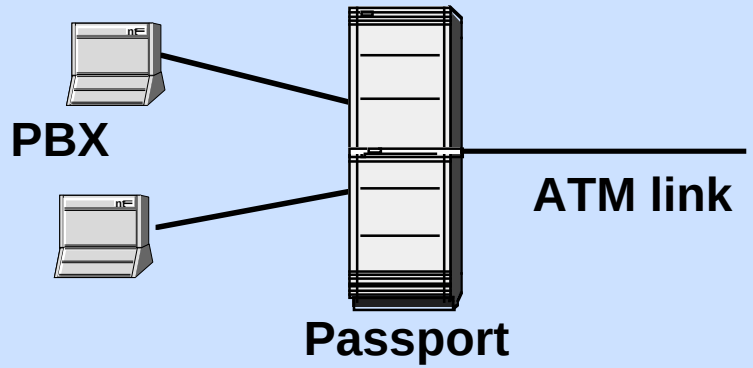
Network Engineering Cycle



Node Locations

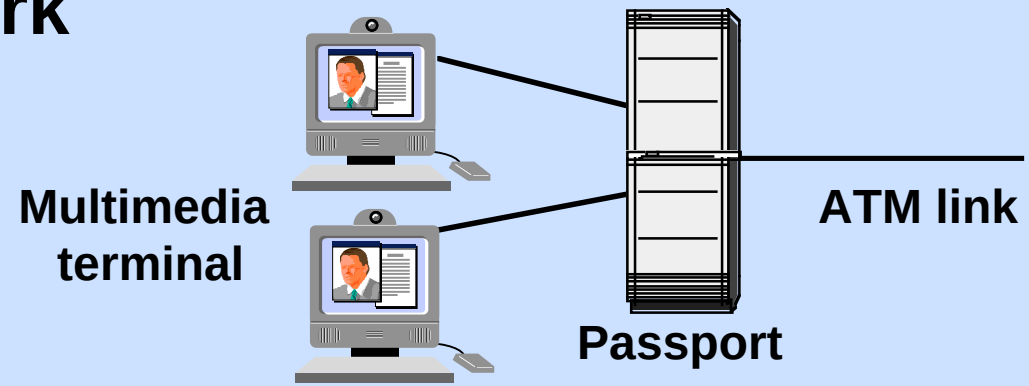
Access Services:
Voice Service Requirements

- Voice is treated as a rt-VBR service
- 64 kbit/s coding rate - no compression
- Speech activity detection (SAD) is ON
- 2% call blocking at the PBX
- Offered traffic of four DS1 at each node



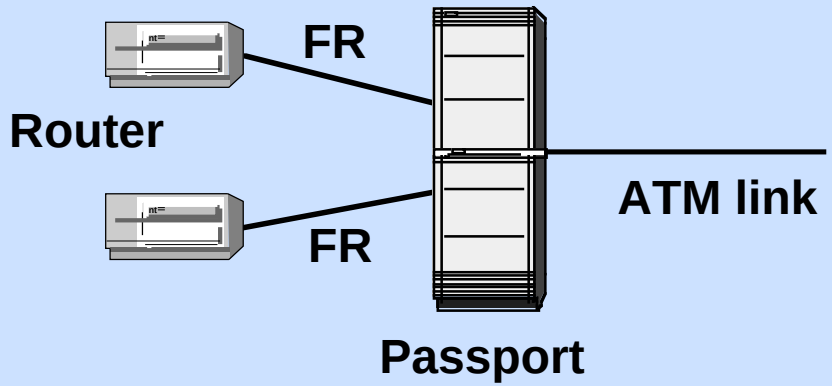
Video Service Requirements

- **Video service is generated as a CBR cell relay stream from the user terminal**
- **Multiple streams with an aggregate bandwidth requirement of 10 Mbit/s**
- **Video traffic is transported as a virtual path (VP) connection between source and destination (SF and London) across the Magellan network**



Data Service Requirements

- **Frame relay traffic generated by frame relay routers**
- **Average frame size of 256 bytes**
- **CIR rate and community of interest (COI) information depend on user population**



Bandwidth Allocation for Frame Relay Service

Conservative

1. ATM trunk bandwidth = $\Sigma_{\text{over all access links}}$ Access Rate x overheadA(n)

2. ATM trunk bandwidth = $\Sigma_{\text{over all DLCI's}}$(CIR + EIR) x overheadB(n)

3. ATM trunk bandwidth = fraction x $\Sigma_{\text{over all DLCI's}}$(CIR + EIR) x overheadB(n)

4. ATM trunk bandwidth = $\Sigma_{\text{over all DLCI's}}$ CIR x overheadB(n)

5. ATM trunk bandwidth = fraction x $\Sigma_{\text{over all DLCI's}}$ CIR x overheadB(n)

Risky

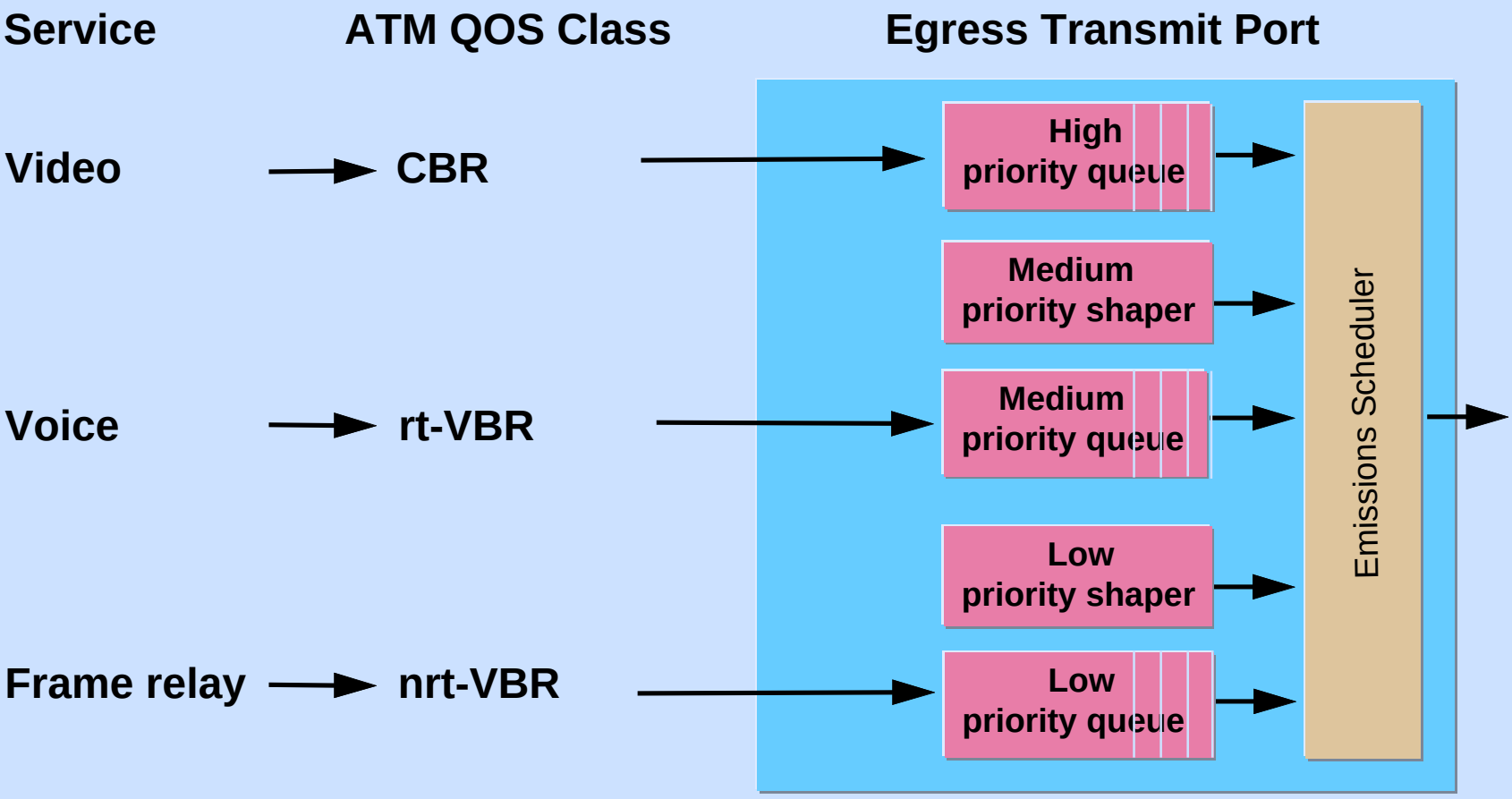
and

$$PCR_{0+1} = \text{bandwidth} / (53 \times 8) \text{ (cells/sec)}$$

where

n = number of user information bytes in a frame
overheadA(n)= frame relay access overhead x ATMoverhead
= n/(n+5) x ATMoverhead
overheadB(n)=ATMoverhead
fraction = real number less than 1 (inverse of over-subscription factor)

Services to QOS Mapping



Community of Interest - Voice

- **Community of interest (COI) information for voice service is as follows (number of channels)**

	Atlan	Chicag	NY	SF	Wash	Lond
Atlan	36	12	12	12	12	12
Chicag	12	36	12	12	12	12
NY	12	12	36	12	12	12
SF	12	12	12	36	12	12
Wash	12	12	12	12	36	12
Lond	12	12	12	12	12	36

- **Around 30% of offered voice traffic is local, while 70% is external**

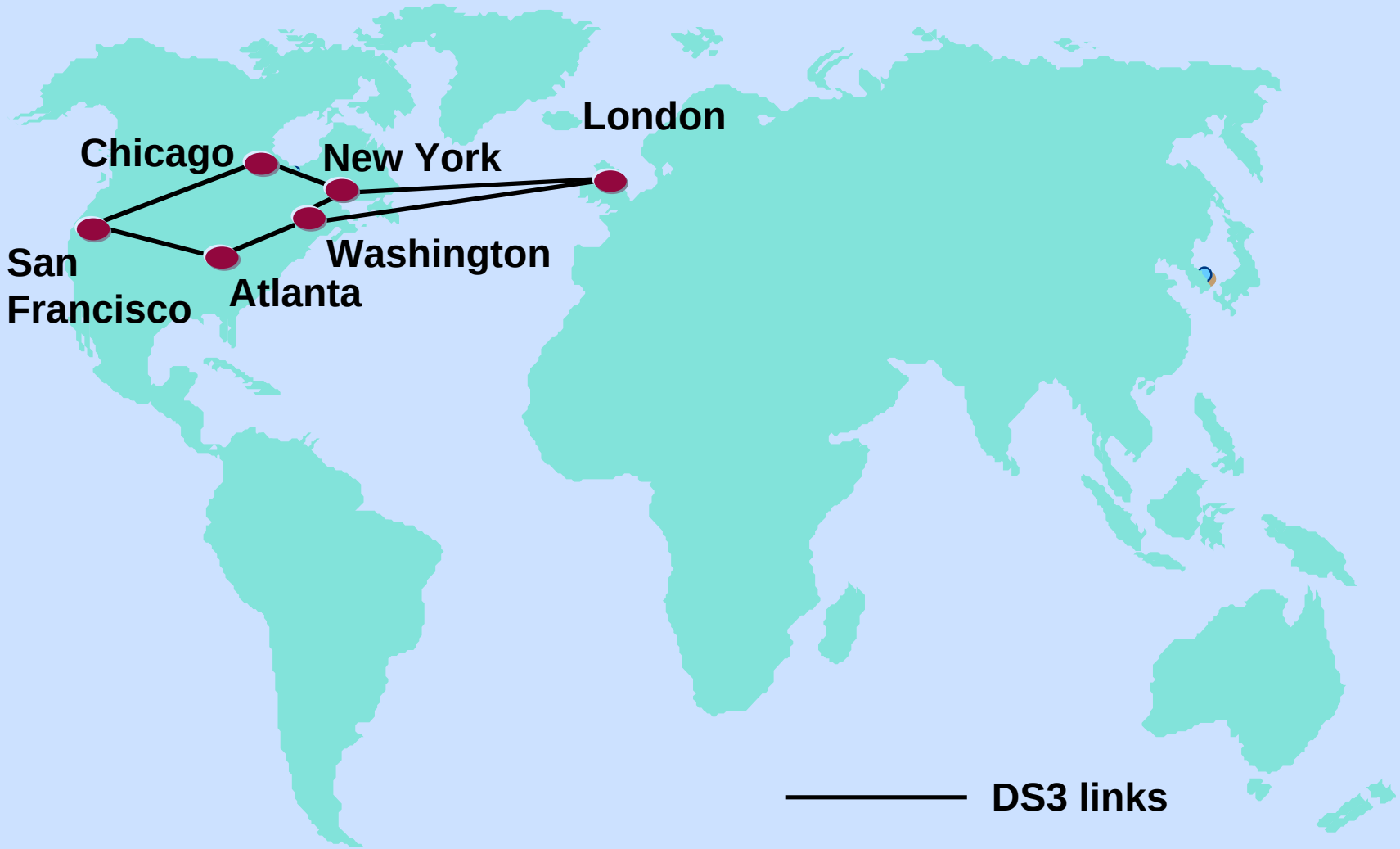
Community of Interest – Frame Relay

- **Community of Interest (COI) information for frame relay service is as follows (CIR in kbit/s)**

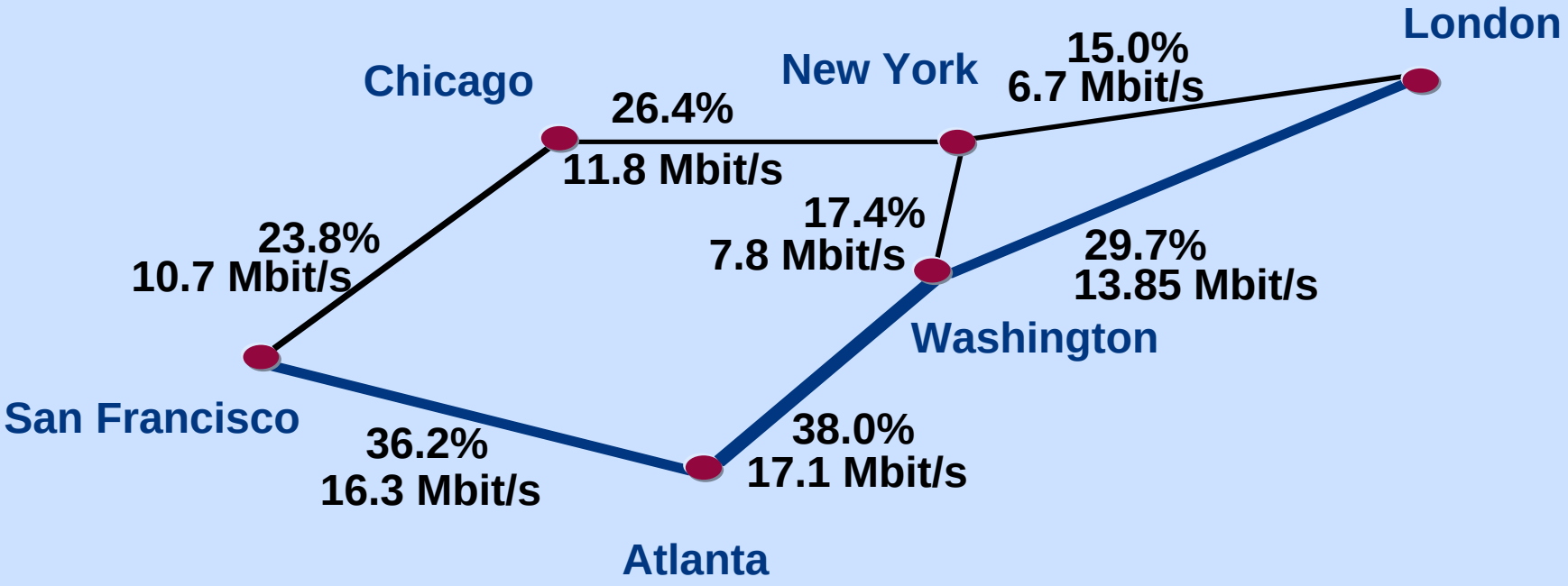
	Atlan	Chicag	NY	SF	Wash	Lond
Atlan	2560	768	2048	640	512	1152
Chicag	415.1	2560	2214	692	553.5	1245.4
NY	568.9	1137.8	2560	948.15	758.5	1706.7
SF	404.2	808.4	2155.8	2560	539	1212.6
Wash	393.8	787.7	2100.5	656.4	2560	1181.5
Lond	349.1	698.2	1861.8	581.8	465.5	2560

- **30% of offered frame relay traffic is local, while 70% is external**

Backbone Network Model



ATM Bandwidth Requirements



Links carrying VCCs for voice and data

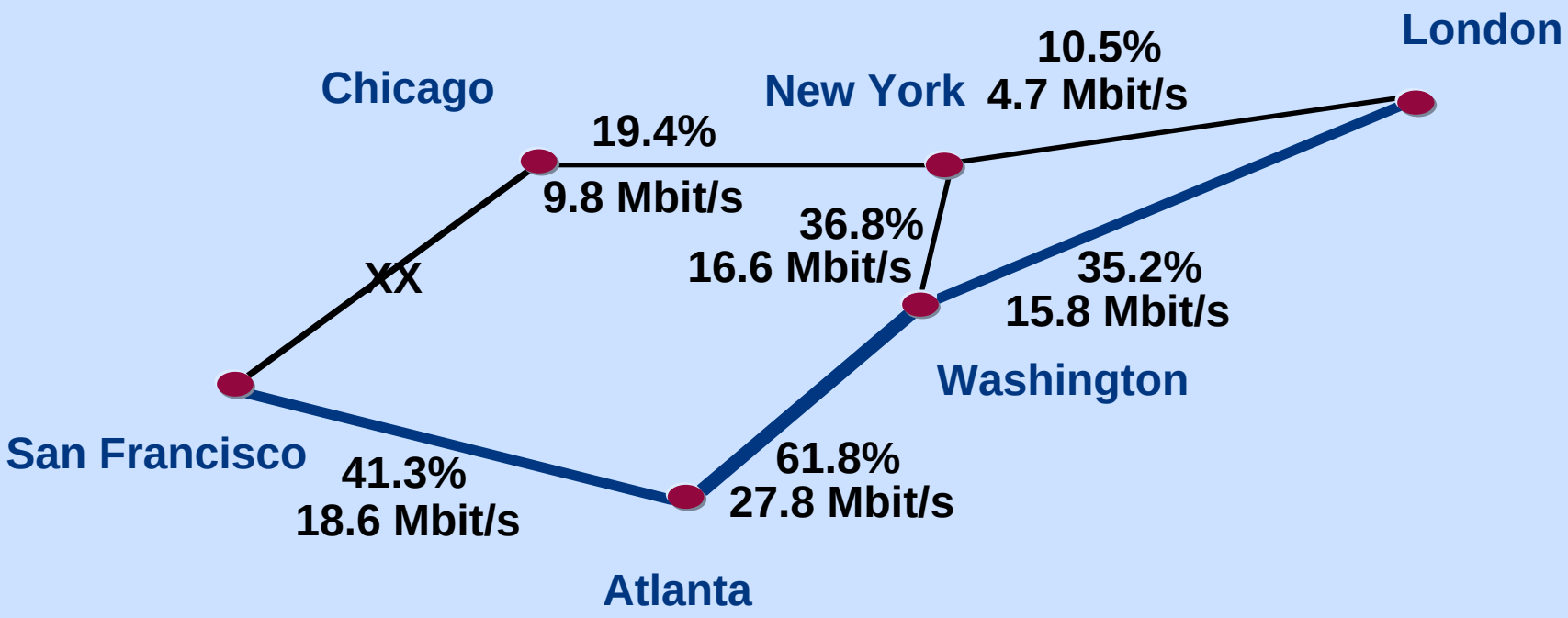
Links carrying VPC for video and VCCs for voice and data

All links are at DS3 rate

Design Verification

City 1	City 2	mi	Data Total Delay ms	Data Queueing Delay ms	Voice Total Delay ms
Atlanta GA	Chicago IL	3991	31.0	0.09	30.92
Atlanta GA	London	4207	32.7	0.09	32.58
Atlanta GA	New York NY	746	6.0	0.09	5.96
Atlanta GA	San Francisco CA	2136	16.6	0.08	16.55
Atlanta GA	Washington DC	542	4.4	0.08	4.28
Chicago IL	Atlanta GA	3991	31.0	0.08	30.92
Chicago IL	London	4172	32.4	0.07	32.31
Chicago IL	New York NY	712	5.6	0.07	5.58
Chicago IL	San Francisco CA	1855	14.4	0.06	14.38
Chicago IL	Washington DC	916	7.3	0.07	7.26
London	Atlanta GA	4207	32.6	0.08	32.58
London	Chicago IL	4172	32.4	0.07	32.31
London	New York NY	3460	26.8	0.06	26.73
London	San Francisco CA	6027	46.7	0.07	46.69
London	Washington DC	3665	28.4	0.08	28.30
New York NY	Atlanta GA	746	6.0	0.08	5.96
New York NY	Chicago IL	712	5.6	0.06	5.58
New York NY	London	3460	26.8	0.06	26.73
New York NY	San Francisco CA	2566	20.0	0.07	19.96
New York NY	Washington DC	204	1.7	0.06	1.68
San Francisco CA	Atlanta GA	2136	16.6	0.08	16.55
San Francisco CA	Chicago IL	1855	14.4	0.07	14.38
San Francisco CA	London	6027	46.8	0.08	46.69
San Francisco CA	New York NY	2566	20.0	0.08	19.96
San Francisco CA	Washington DC	2678	20.9	0.09	20.83
Washington DC	Atlanta GA	542	4.3	0.08	4.28
Washington DC	Chicago IL	916	7.3	0.07	7.26
Washington DC	London	3665	28.4	0.08	28.30
Washington DC	New York NY	204	1.7	0.06	1.68
Washington DC	San Francisco CA	2678	20.9	0.09	20.83

Single Link Failure



Links carrying VCCs for voice & data

Links carrying VPC for video and VCCs for voice & data

All links are at DS3 rate

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Summary

- **Comprehensive traffic management capabilities are key in achieving distinct QOS requirements of multiple services**
- **ATM network design should take into consideration the services' QOS requirements**
- **Nortel has the expertise to design ATM networks**