

Computer Control Networks

Asynchronous Transfer Mode



The Role of Asynchronous Transfer Mode (ATM)

- ATM uses **packets called cells**
- cells are small and **fixed-length**
- connection-oriented
- performance of a **circuit-switching network** and the **flexibility and efficiency** of a **packet-switching network**
- supports data, voice, video
- transmission based on priority and QoS

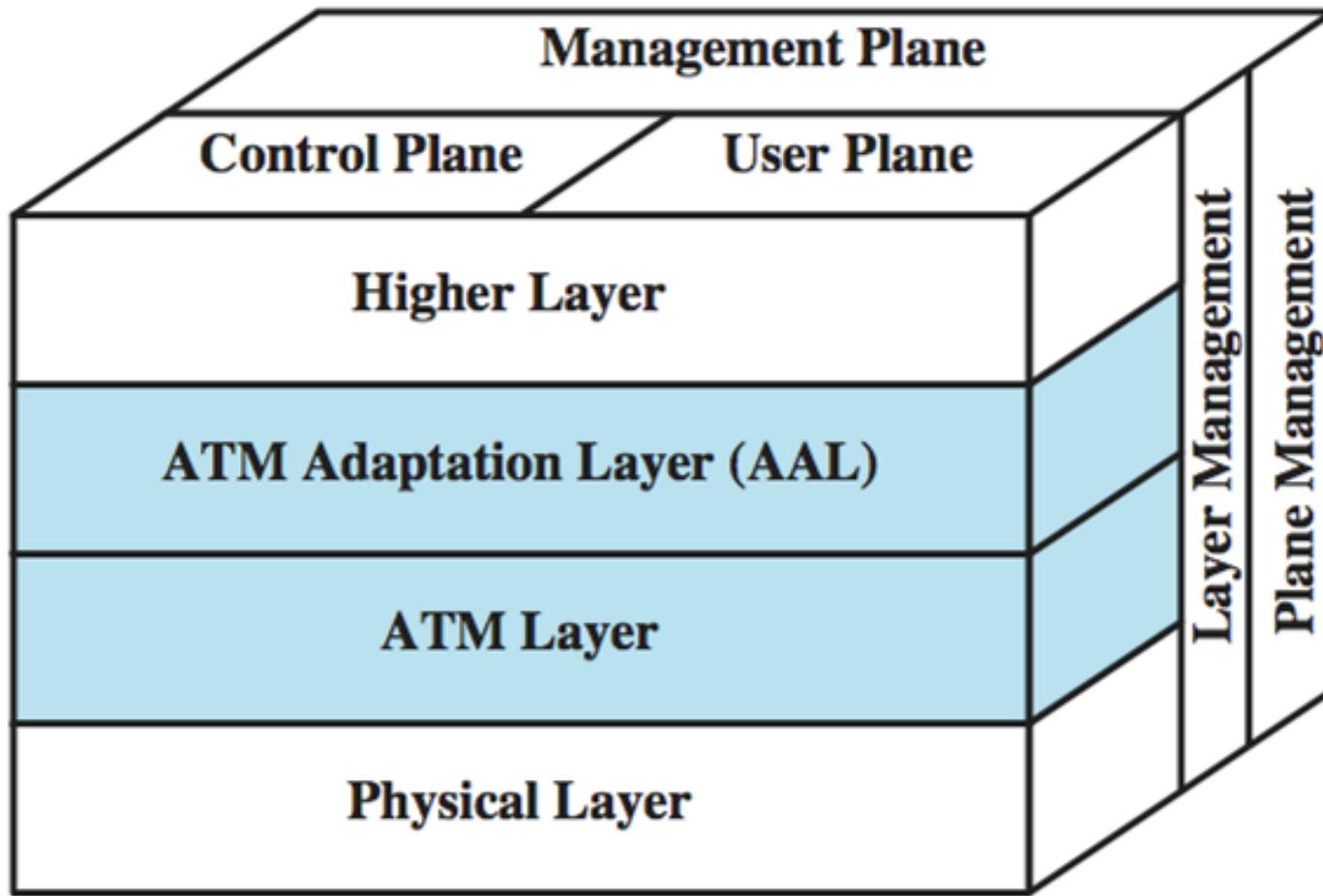
ATM

- ITU-T leading the development of standards
- ATM Forum ensures interoperability among private and public ATM implementations
- commonly used to implement WANs
- DSL uses ATM for multiplexing and switching
- used as a backbone in IP networks and Internet

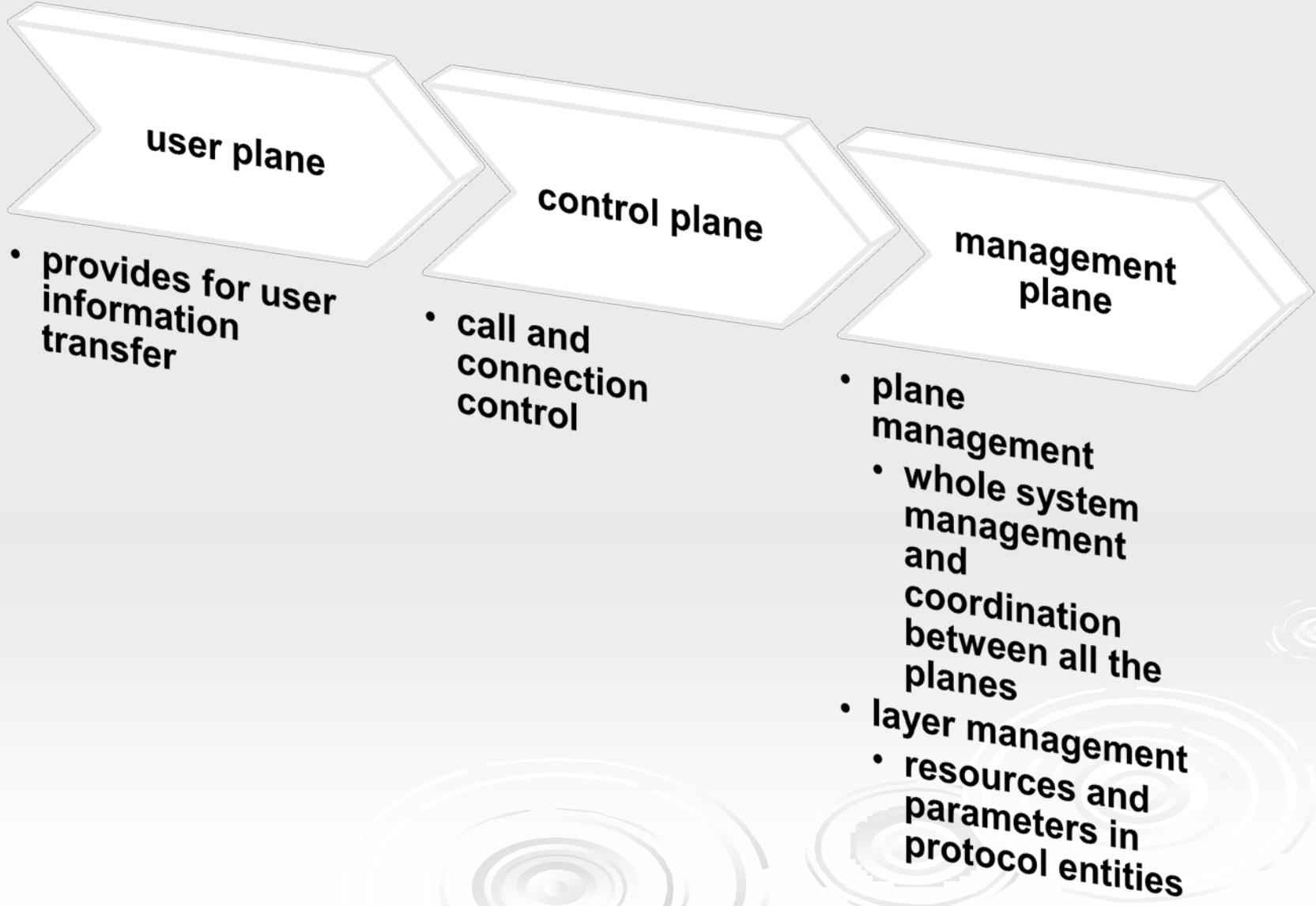
ATM

- a streamlined packet transfer interface
- similarities to packet switching and frame relay
 - transfers data in discrete chunks
 - supports multiple logical connections over a single physical interface
- ATM uses fixed sized packets called cells
- minimal error and flow control capabilities
- operates at high data rates

Protocol Architecture



Reference Model Planes



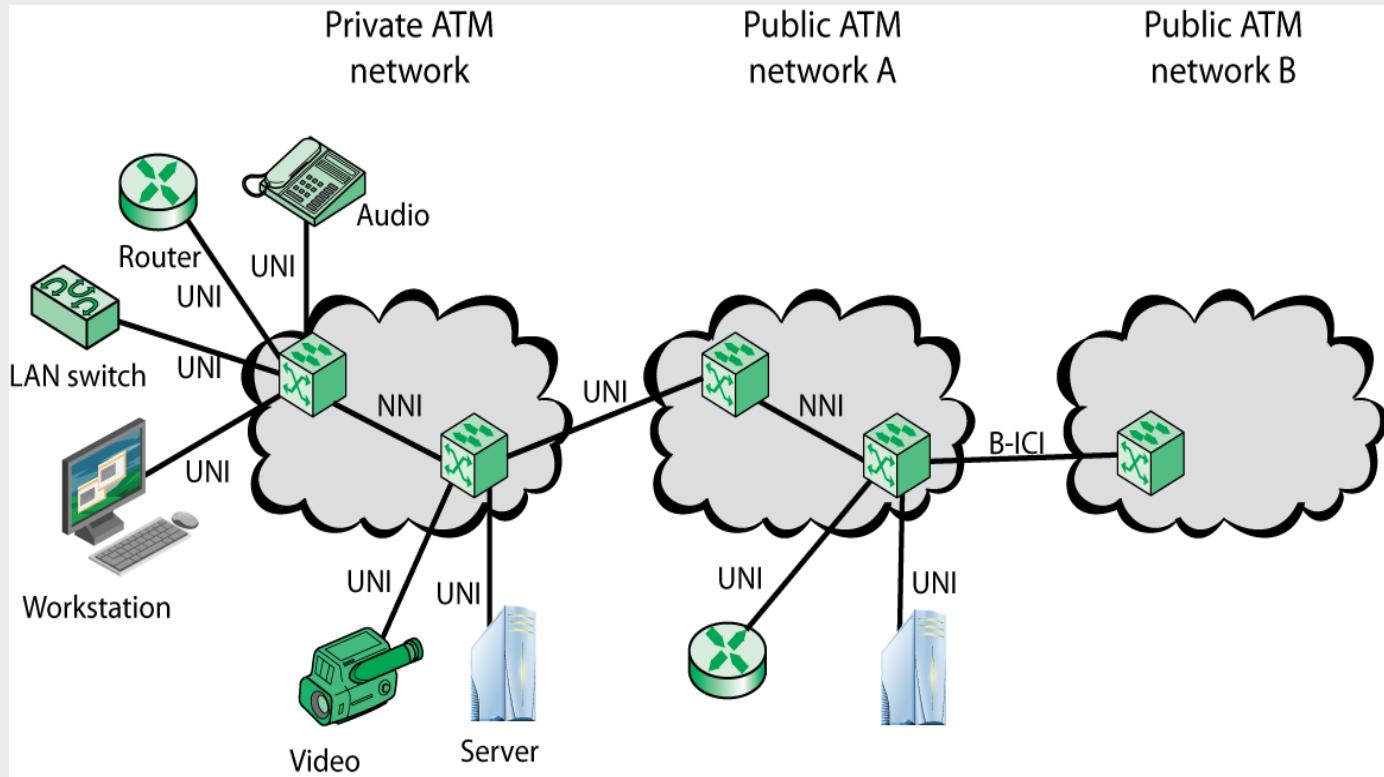
ATM Network Interfaces

➤ switches are interconnected by point-to-point ATM links called **interfaces**

- user-network interface (UNI)
- network node interface (NNI)
- interface specification includes:
 - definition of link types allowed
 - addressing formats
 - cell format
 - control signaling protocols

ATM

INTERFACES



B-ICI = broadband intercarrier interface

NNI = network node interface

UNI = user-network interface

Figure 11.3 ATM Interfaces

ATM Logical Connections

virtual channel connections (VCC)

- analogous to virtual circuit in X.25

*Same quality
service*

basic unit of switching between two end users

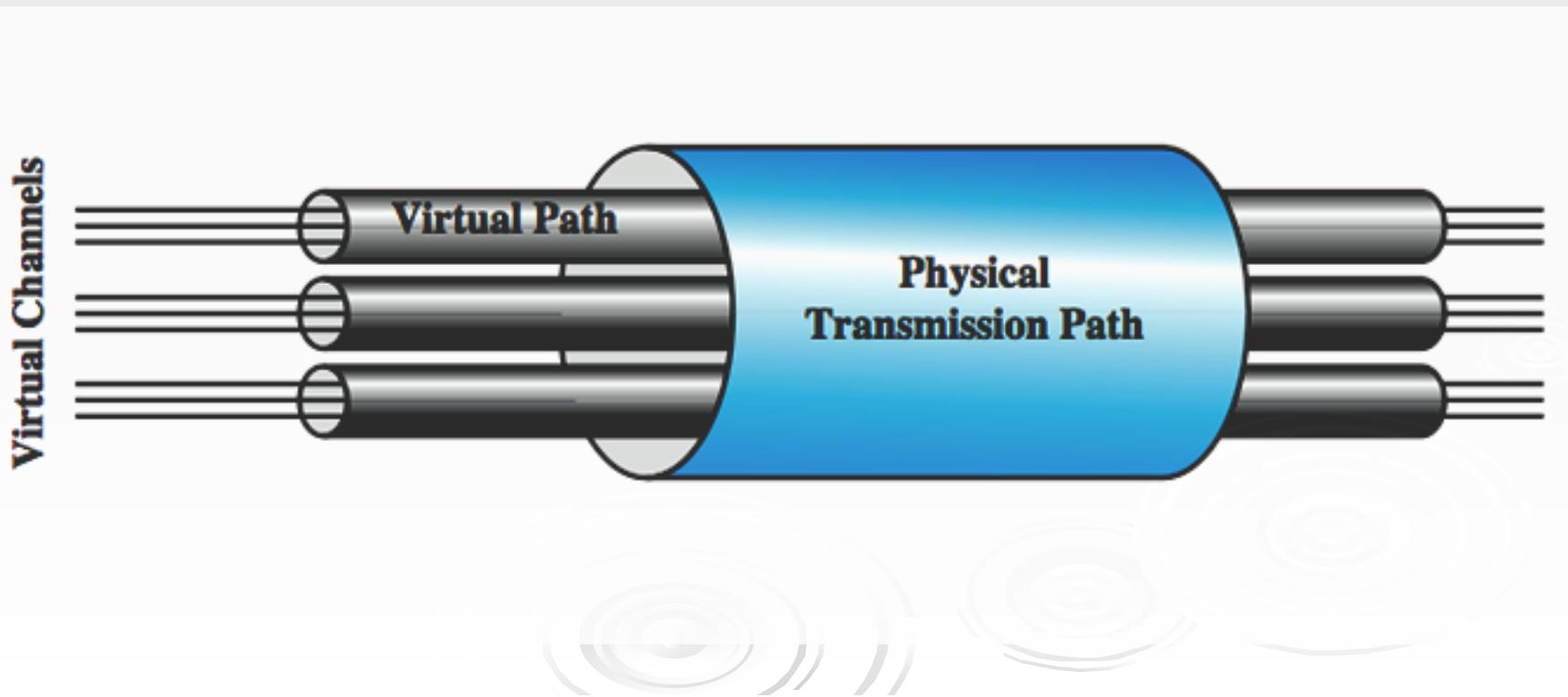
- variable rate
- full duplex
- fixed size cells

VCCs also used for

- user-network exchange (control signaling)
- network-network exchange (network management and routing)

ATM Virtual Path Connection

- virtual path connection (VPC)
 - bundle of VCC with same end points



Advantages of Virtual Paths

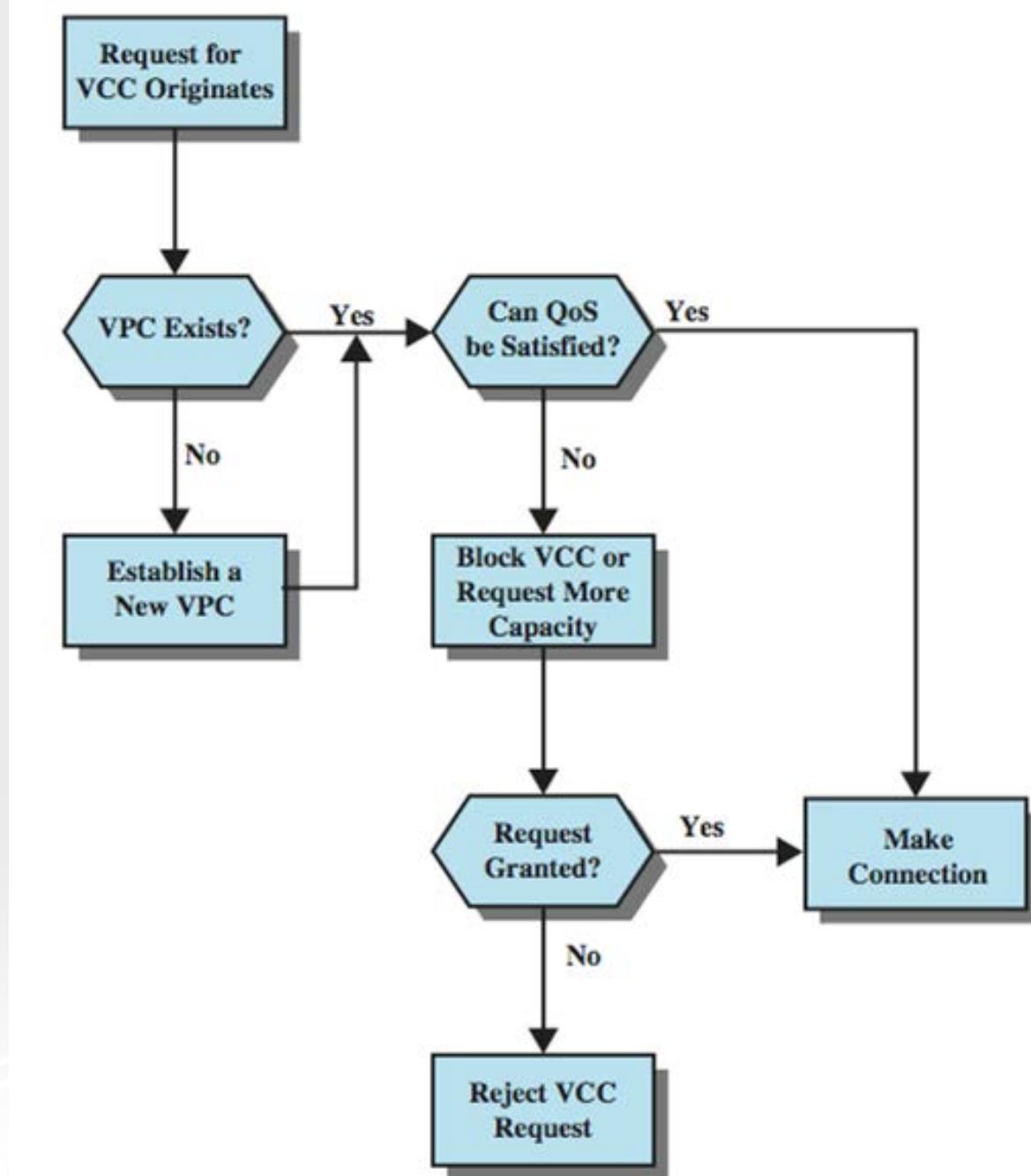
Several advantages can be listed for the use of virtual paths:

- simplified network architecture
- increased network performance and reliability
- reduced processing and short connection setup time
- enhanced network services

Virtual Path/Virtual Channel Terminology

Virtual Channel (VC)	A generic term used to describe unidirectional transport of ATM cells associated by a common unique identifier value.
Virtual Channel Link	A means of unidirectional transport of ATM cells between a point where a VCI value is assigned and the point where that value is translated or terminated.
Virtual Channel Identifier (VCI)	A unique numerical tag that identifies a particular VC link for a given VPC.
Virtual Channel Connection (VCC)	A concatenation of VC links that extends between two points where ATM service users access the ATM layer. VCCs are provided for the purpose of user-user, user-network, or network-network information transfer. Cell sequence integrity is preserved for cells belonging to the same VCC.
Virtual Path	A generic term used to describe unidirectional transport of ATM cells belonging to virtual channels that are associated by a common unique identifier value.
Virtual Path Link	A group of VC links, identified by a common value of VPI, between a point where a VPI value is assigned and the point where that value is translated or terminated.
Virtual Path Identifier (VPI)	Identifies a particular VP link.
Virtual Path Connection (VPC)	A concatenation of VP links that extends between the point where the VCI values are assigned and the point where those values are translated or removed, i.e., extending the length of a bundle of VC links that share the same VPI. VPCs are provided for the purpose of user-user, user-network, or network-network information transfer.

Call Establishment Using VPs



Virtual Channel Connection Uses

between end users

- ***end to end user data***
- ***carries control signaling***
- ***VPC provides overall capacity***
- ***VCC organization done by users***

between end user and network

- ***control signaling***
- ***VPC used to aggregate traffic***

between network entities

- ***network traffic management***
- ***routing***

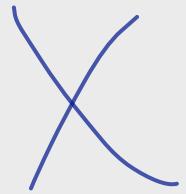
Virtual Channel Characteristics

- quality of service
- switched and semi-permanent channel connections
- cell sequence integrity
- traffic parameter negotiation and usage monitoring



Virtual Path Characteristics

- **quality of service**
- **switched and semi-permanent channel connections**
- **cell sequence integrity**
- **traffic parameter negotiation and usage monitoring**
- **virtual channel identifier restriction within a VPC**



ATM Signaling

UNI signaling

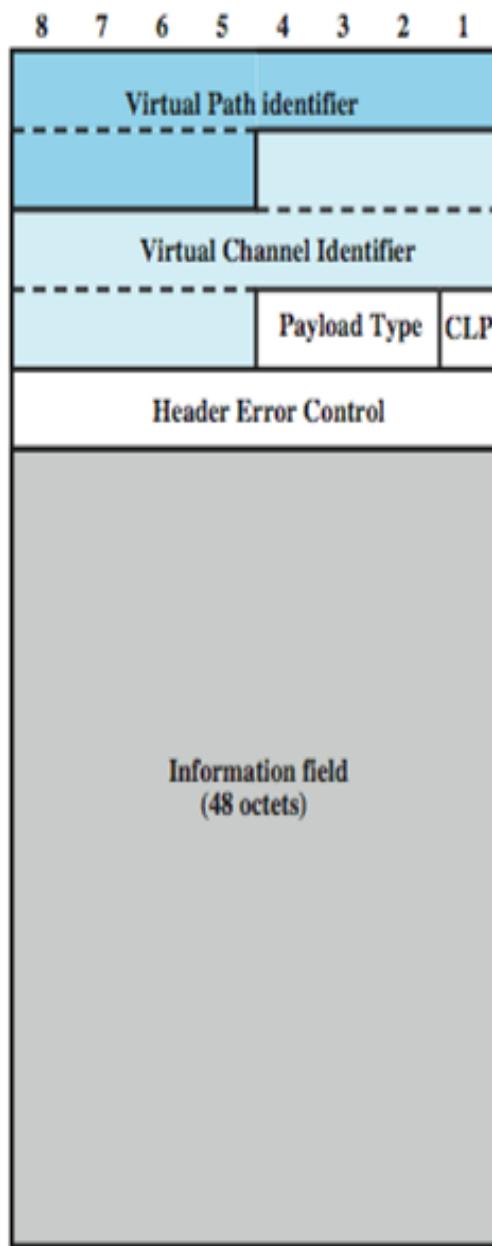
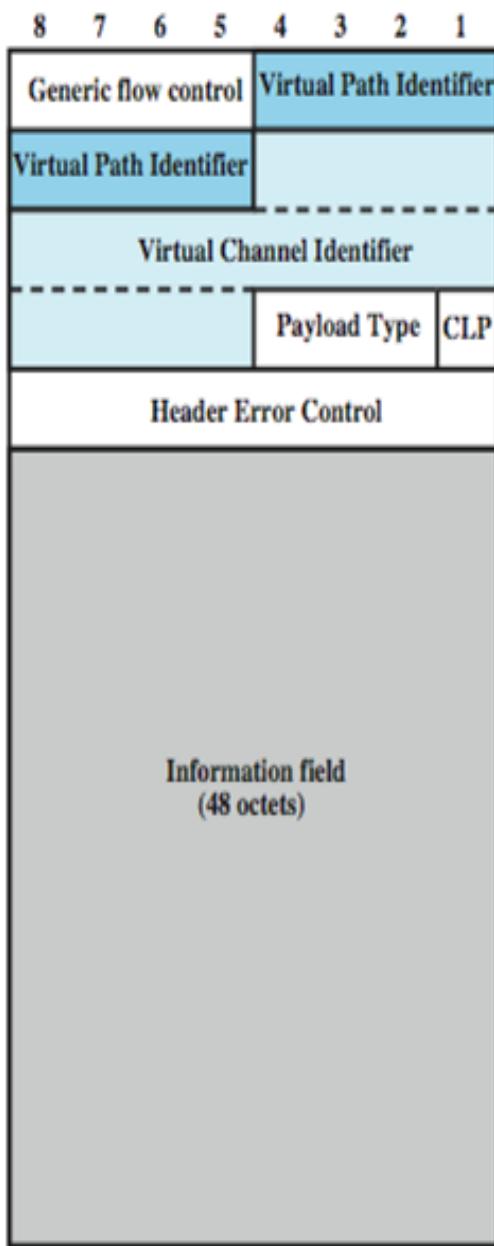
used between end system and switch across UNI links

defines protocol

NNI signaling

used between switches across NNI links

includes both signaling and routing



(a) User-network interface

(b) Network-network interface

No error detection

single bit error

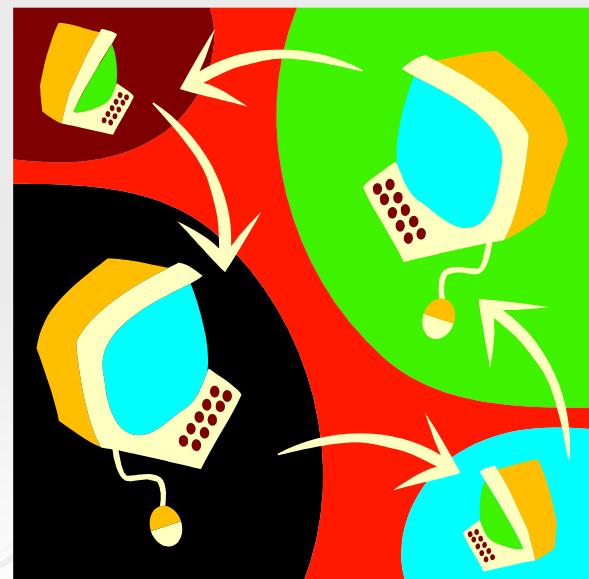
ATM Cells

ATM Header Fields

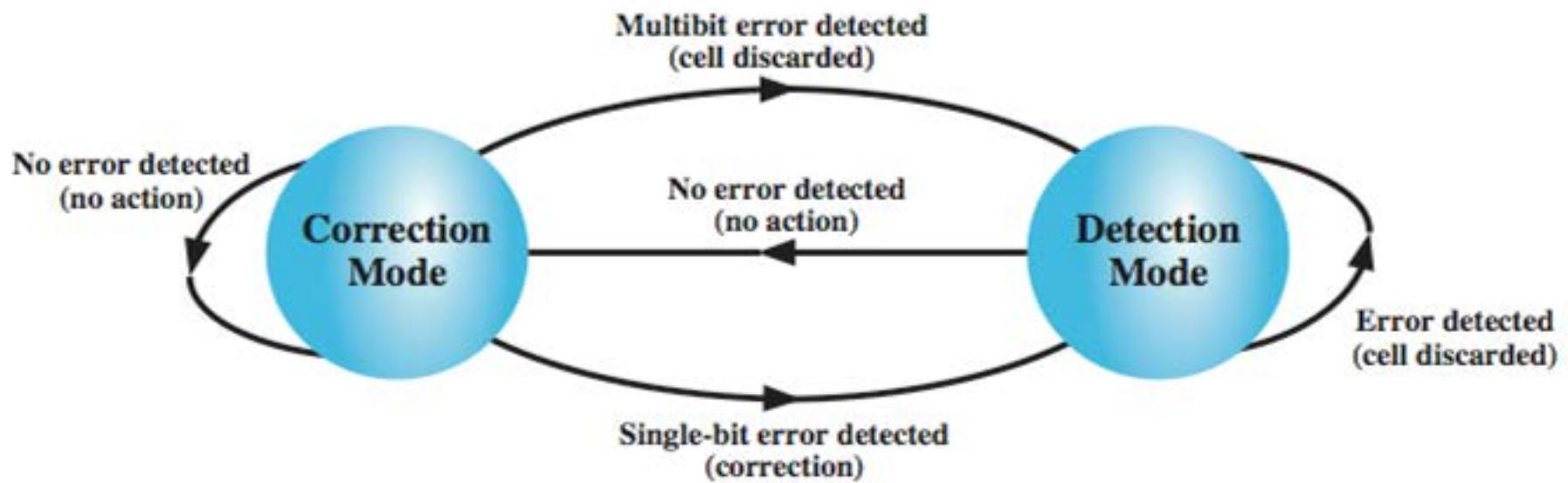
- generic flow control
- virtual path identifier
- virtual channel identifier
- (➤ payload type
- cell loss priority
- header error control



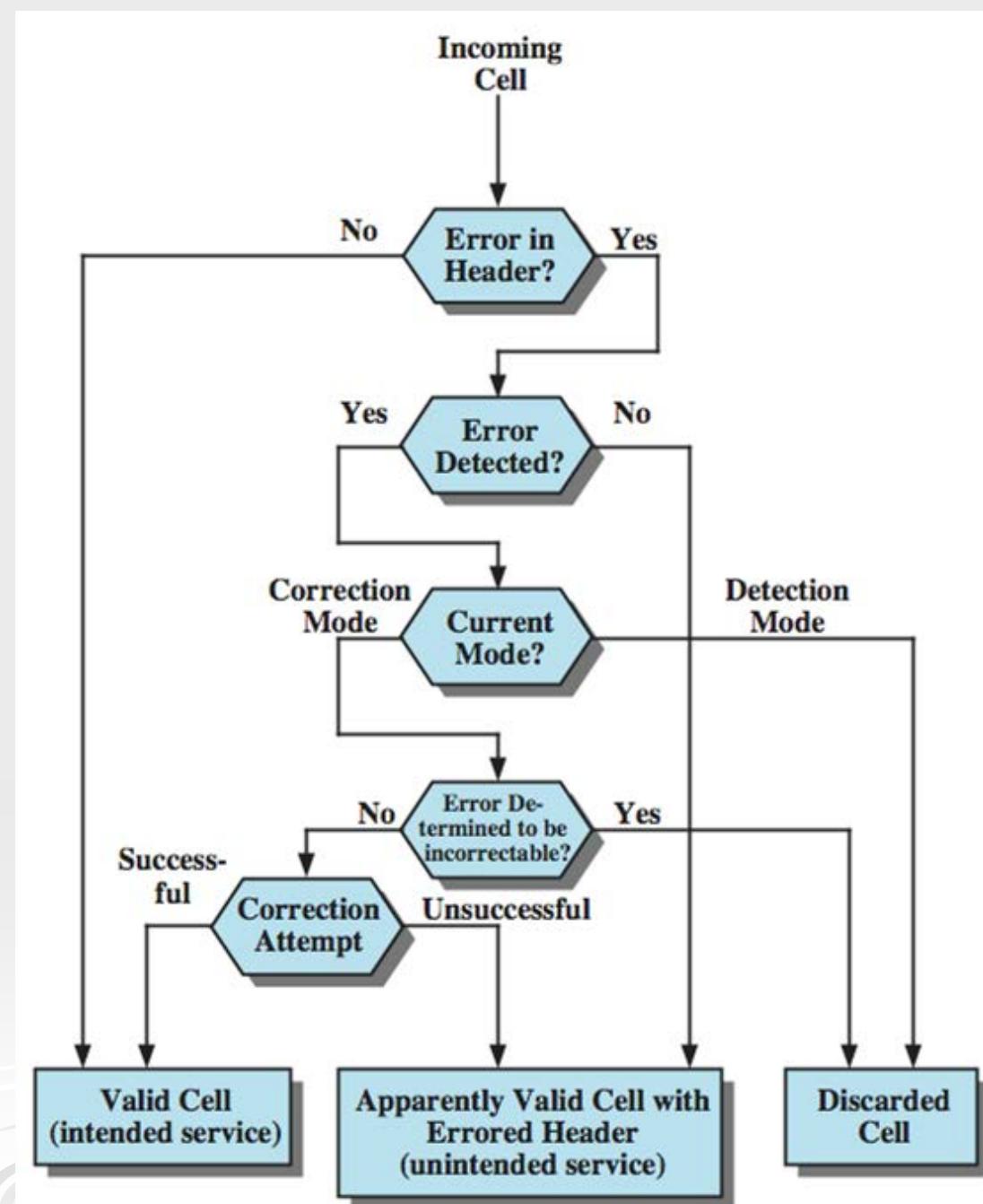
video
streaming
online
banking



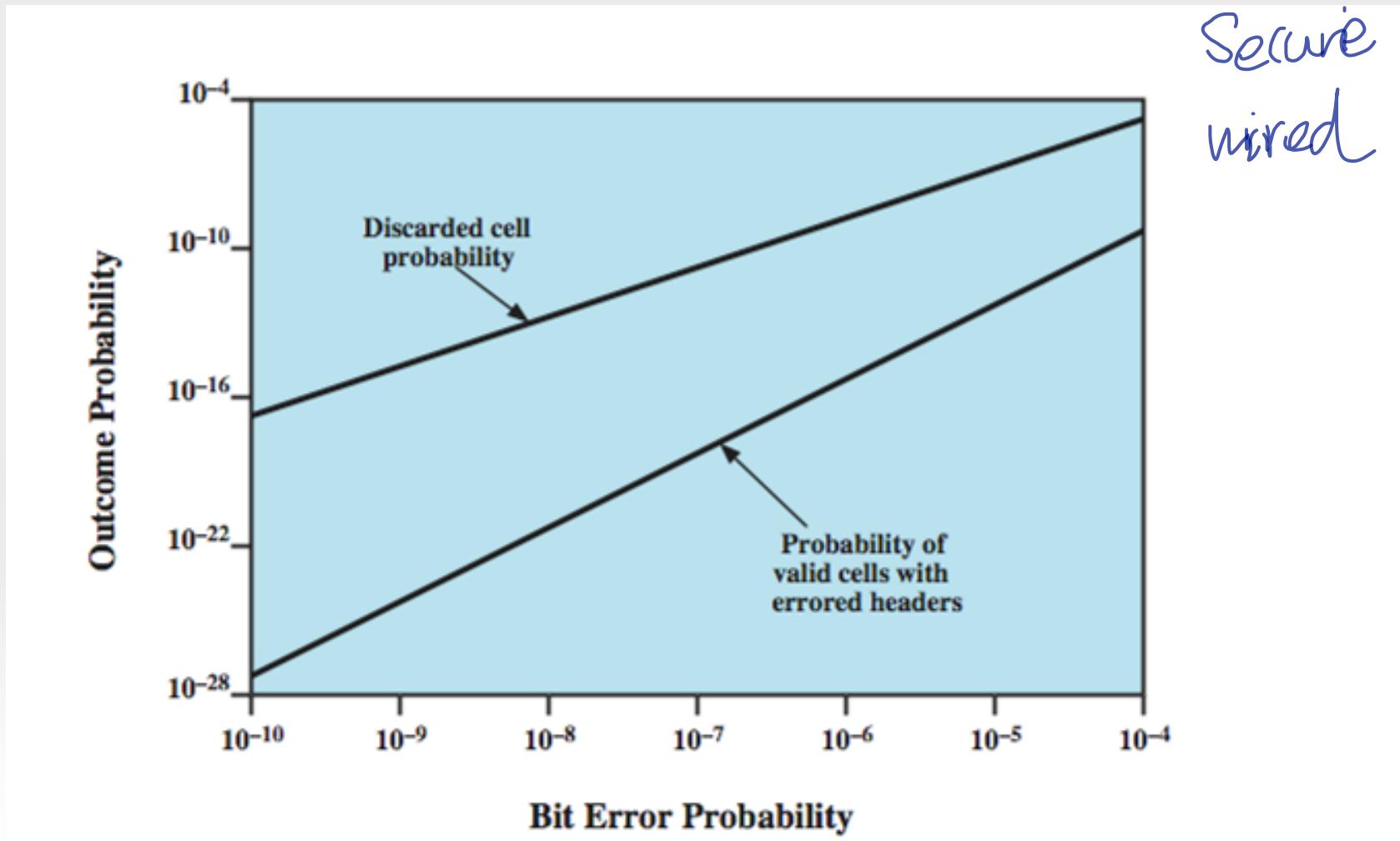
Header Error Control



Effect of Error in Cell Header



Impact of Random Bit Errors on HEC Performance



Transmission of ATM Cells

- I.432 specifies several data rates:
 - 622.08Mbps
 - 155.52Mbps
 - 51.84Mbps
 - 25.6Mbps
- two choices of transmission structure:
 - cell based physical layer
 - SDH based physical layer

Cell Based Physical Layer

- no framing imposed
- continuous stream of 53 octet cells
- cell delineation based on header error control field



ATM Service Categories

Real time - limit amount/variation of delay

- Constant bit rate (CBR)
- Real time variable bit rate (rt-VBR)

Non-real time - for bursty traffic

- Non-real time variable bit rate (nrt-VBR)
- Available bit rate (ABR)
- Unspecified bit rate (UBR)
- Guaranteed frame rate (GFR)

Constant Bit Rate (CBR)

- fixed data rate continuously available
- tight upper bound on delay
- uncompressed audio and video
 - video conferencing
 - interactive audio
 - A/V distribution and retrieval



Real-Time Variable Bit Rate (rt-VBR)

- for time sensitive applications
 - tightly constrained delay and delay variation
- rt-VBR applications transmit data at a rate that varies with time
- characterized as bursty
- allow more flexibility than CBR



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

- used for data transfers with critical response time
 - airline reservations, banking transactions
- end system specifies:
 - a peak cell rate
 - a sustainable or average cell rate
 - measure of how bursty or clumped cells can be



Unspecified Bit Rate (UBR)

- may be additional capacity over and above that used by CBR and VBR traffic
 - not all resources dedicated to CBR/VBR traffic
 - unused cells due to bursty nature of VBR
- for application that can tolerate some cell loss or variable delays
 - eg. TCP based traffic
- cells forwarded on FIFO basis
- best effort service
- examples:
 - text/data/image transfer
 - telecommuting

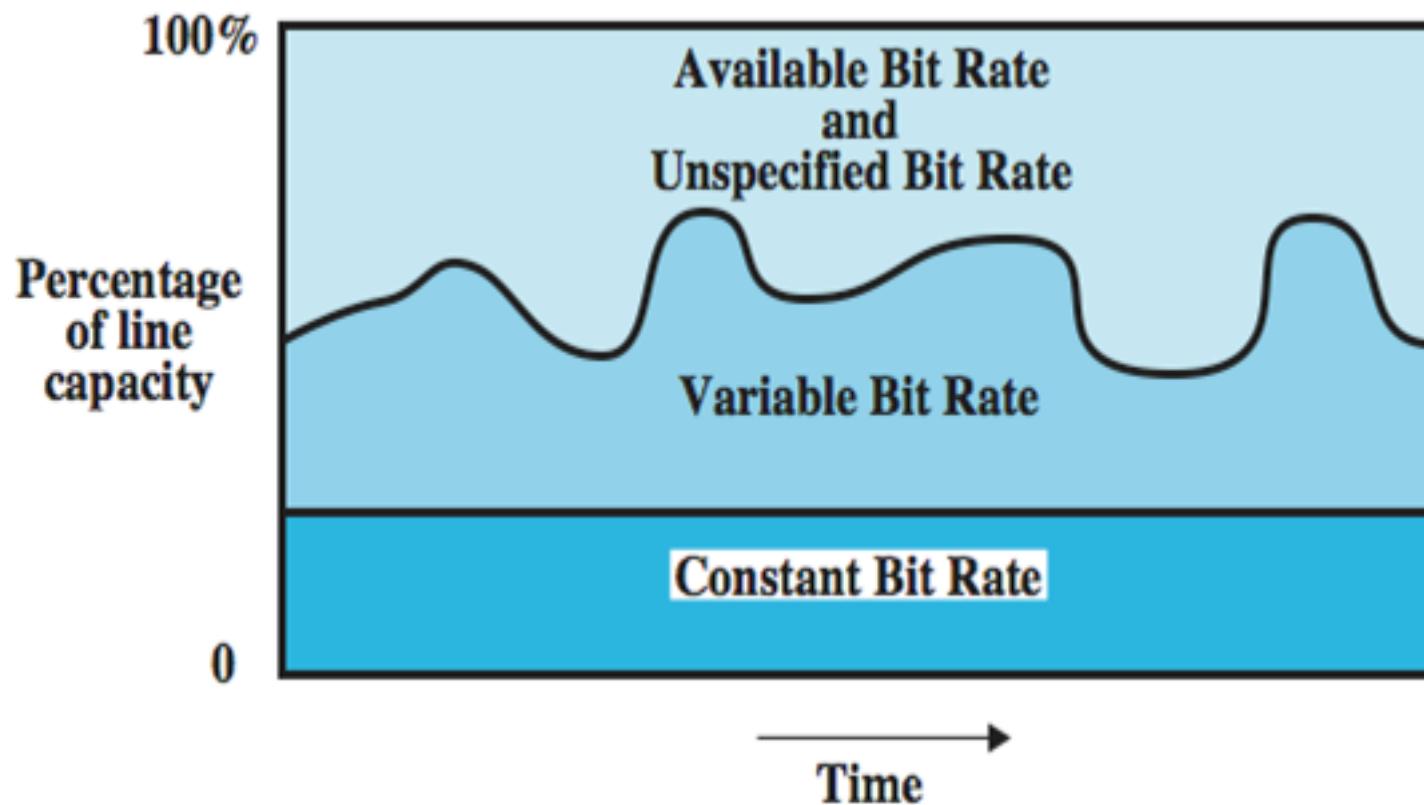


Available Bit Rate (ABR)

- application specifies peak cell rate (PCR) and minimum cell rate (MCR)
- resources allocated to give at least MCR
- spare capacity shared among all ABR sources
 - eg. LAN interconnection



ATM Bit Rate Services



Guaranteed Frame Rate (GFR)

- better service for frame based traffic
 - IP, Ethernet
- goal is to optimize traffic passing from LAN onto an ATM backbone network
 - large enterprise, carrier, Internet service providers
- allows user to reserve capacity for each GFR VC

Summary

- role of Asynchronous Transfer Mode (ATM)
- protocol architecture
- ATM logical connections
- virtual path/virtual channel
- ATM Cell format
- transmission of ATM cells
- ATM services

