ATM Networks

ATM

- Fast Packet Switching Bearer Service
- Asynchronous Transfer Mode
- Asynchronous Time Division Multiplexing
- Cell multiplexing and switching
- Label switching based

Comparison with other bearer services

Issue	DQDB	SMDS	X.25	Frame Relay	ATM AAL
Connection oriented	Yes	No	Yes	Yes	Yes
Normal speed (Mbps)	45	45	.064	1.5	155
Switched	No	Yes	Yes	No	Yes
Fixed-size payload	Yes	No	No	No	No
Max payload	44	9188	128	1600	Variable
Permanent VCs	No	No	Yes	Yes	Yes
Multicasting	No	Yes	No	No	Yes

Comparison with other bearer services

Issue	DQDB	SMDS	X.25	Frame Relay	ATM	ATM AAL
Connection oriented	Yes	No	Yes	Yes	Yes	Yes
Normal Speed (Mbps)	45	45	0.64	(1.5) 2	155	155
Switched	No	Yes	Yes	Yes	Yes	Yes
Fixed-size payload (octets)	Yes	No	No	No	Yes	No
Max. Payload size (octets)	44	9 K	128	1500	48	64 K
Multicasting	No	Yes	No	No	(Yes)	(IP)

Characteristics of ATM

- Fragmentation into fixed size cells
- Statistical multiplexing
- Virtual Circuit Routing
- Support for narrow & wide bit rates
- Constraints on cell delay & loss
- Handling of cell loss priorities
- Designed for future unforeseen demands

Advantages of ATM

- Better utilization of the bandwidth due to statistical multiplexing gain
- Switching systems can be made simpler
- Allows for variable bit rates
- Allows for end-to-end flow and error control

Disadvantages of ATM

- Overhead in cell header
- Variable delays and delay jitter
- Complex mechanisms required to ensure fair and appropriate bandwidth allocation (QoS)
- Correlated cell losses in times of congestion

BISDN is ATM

- ITU-T recommendation I.121 presents an overview of B-ISDN capabilities:
  - B-ISDN supports switched, semi-permanent and permanent, point-to-point and point-to-multipoint connections and provides on-demand, reserved and permanent services. Connections in B-ISDN support both circuit mode and packet mode services of a mono-and/or multimedia type and of a connectionless or connection-oriented nature and in a bidirectional or unidirectional configuration.
  - A B-ISDN will contain intelligent capabilities for the purpose of providing advanced service characteristics, supporting powerful operation and maintenance (OAM) tools, network control and management.

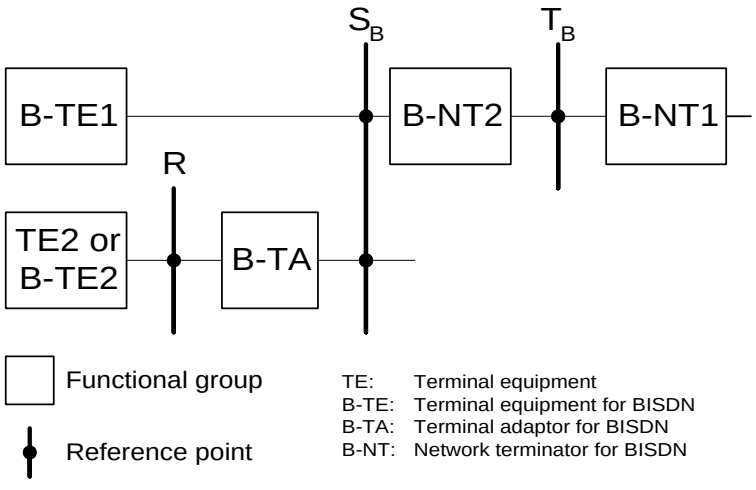
BISDN is ATM

- The asynchronous transfer mode is considered the ground on which B-ISDN is to be built [ITU-T I.121]:

  "Asynchronous transfer mode (ATM) is the transfer mode for implementing B-ISDN …"

- The term *transfer* comprises both transmission and switching aspects, so a *transfer mode* is a specific way of transmitting and switching information in a network

BISDN Reference Configuration



From "ATM Networks: concepts, protocols, applications" by Händel, Huber and Schröder, 2th edition.

Oscar Iván Lepe Aldama:

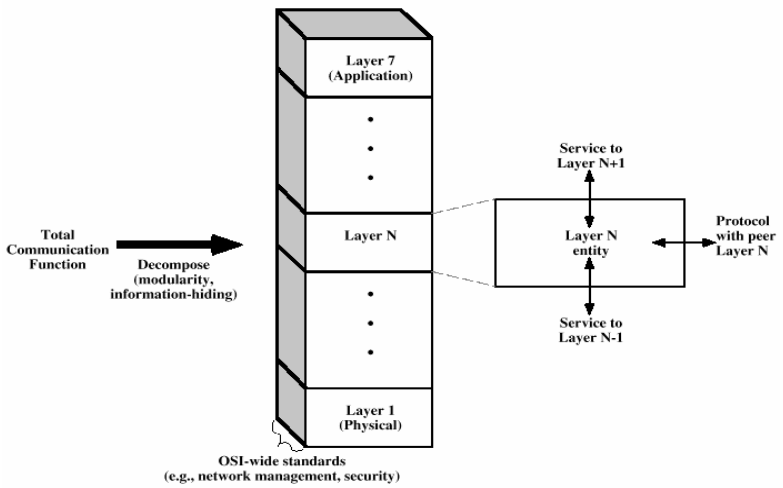
Falta agregar los diversos tipos de configuraciones según la I.121 y la I.413.

Reference Configuration

jdp:

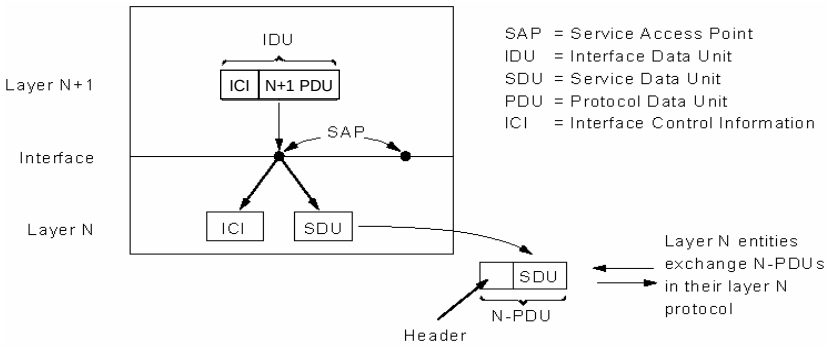
I.121

ISO/OSI Reference Model



From "Data and computer communications" by W. Stallings, 5th edition.

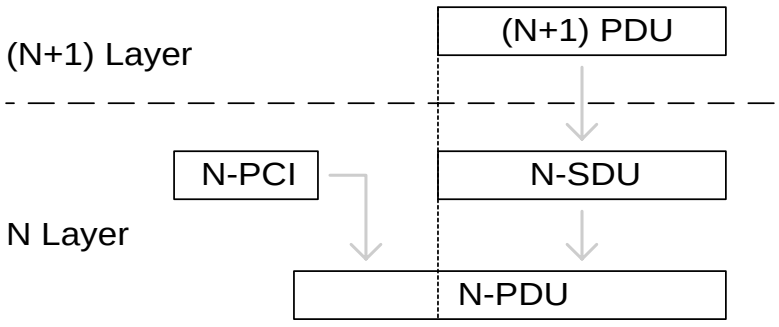
ISO/OSI Service Access Interface



©UPC/DAC/JDP

From "Computer Networks" by A. Tanenbaum, 3er. edition.

ISO/OSI Data and Control Information Exchange

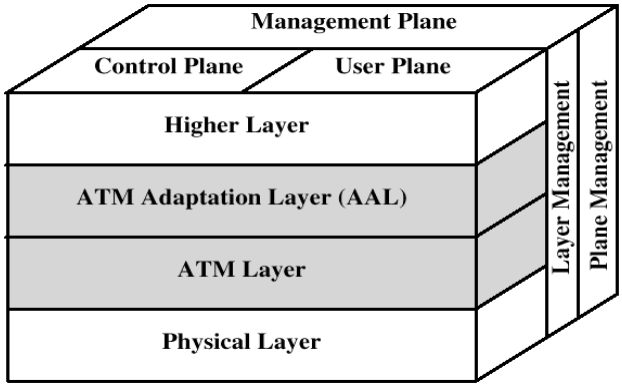


PCI Protocol control information
PDU Protocol data unit
SDU Service data unit

©UPC DAC JDP

From "ATM Networks: concepts, protocols, applications" by Händel, Huber and Schröder, 2th edition.

ATM Reference Model



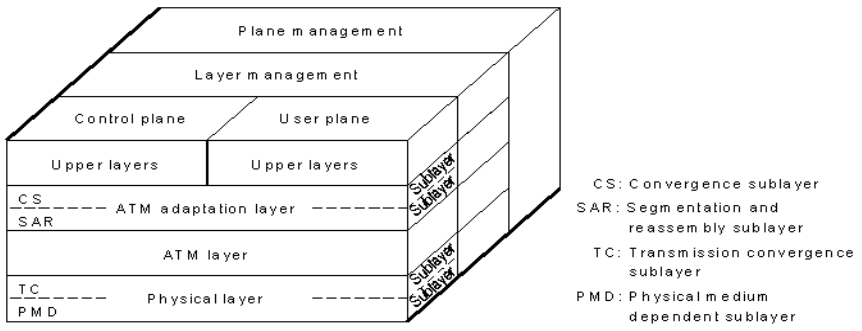
BISDN definition of “cell”

- The term cell is essential for BISDN, and therefore it is defined in ITU-T recommendation I.113:
  - A cell is a block of fixed length. It is identified by a label at the ATM layer of the BISDN PRM.

Kinds of cells

- The different kinds of cells are presented in ITU-T recommendation I.321:
  - Idle cell (physical layer): A cell which is inserted / extracted by the physical layer in order to adapt the cell flow rate at the boundary between the ATM layer and the physical layer to the available payload capacity of the transmission system used.
  - Valid cell (physical layer): A cell whose header has no errors or has been modified by the HEC.
  - Invalid cell (physical layer): A cell whose header has errors and has not been modified by the cell HEC verification process. This cell is discarded at the physical layer.
  - Assigned cell (ATM layer): A cell which provides a service to an application using the ATM layer service.
  - Unassigned cell (ATM layer)

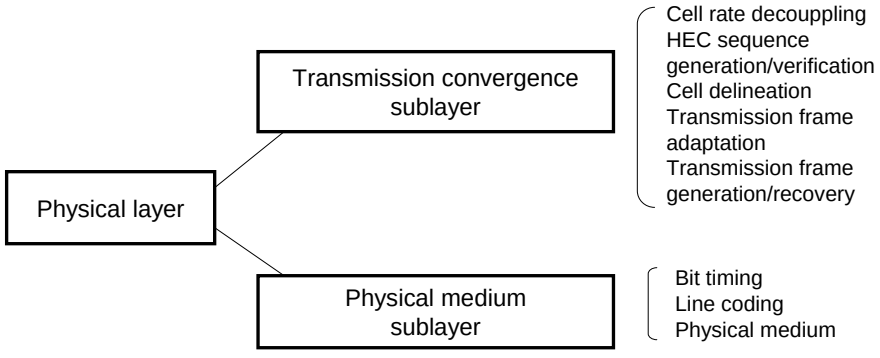
ATM Reference Model



ATM Layer Functions

OSI layer	ATM layer	ATM sublayer	Functionality
3/4	AAL	CS	Providing the standard interface (convergence)
		SAR	Segmentation and reassembly
2/3	ATM		Flow control Cell header generation/extraction Virtual circuit/path management Cell multiplexing/demultiplexing
2	Physical	TC	Cell rate decoupling Header checksum generation and verification Cell generation Packing/unpacking cells from the enclosing envelope Frame generation
1		PMD	Bit timing Physical network access

ATM Physical layer structure

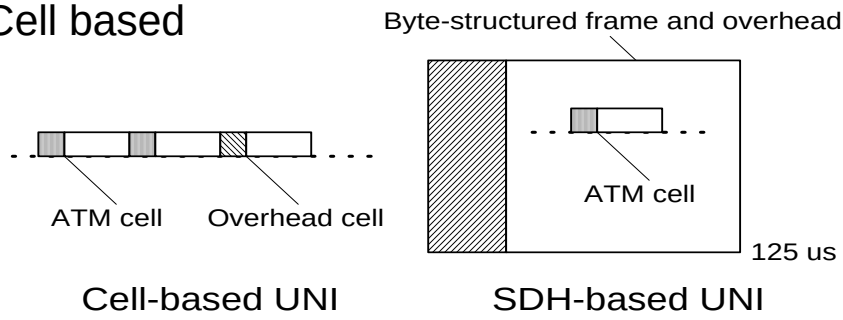


HEC : Header error control

From “ATM Networks: concepts, protocols, applications” by Händel, Huber and Schröder, 2th edition.

ATM Physical medium sublayer

- SONET / SDH based
- Cell based



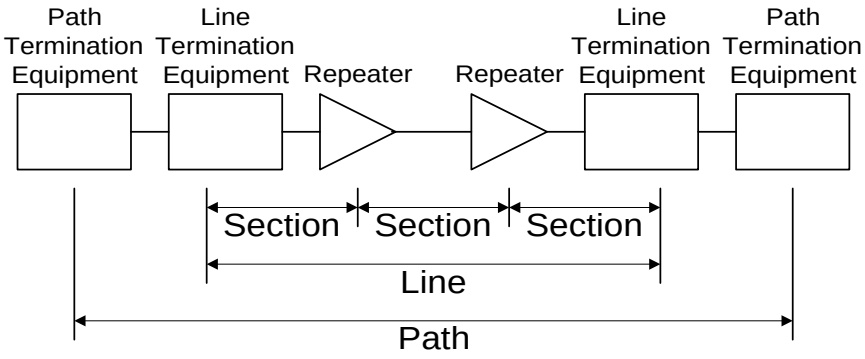
ATM	Asynchronous transfer mode
SDH	Synchronous digital hierarchy
UNI	User-network interface

From "ATM Networks: concepts, protocols, applications" by Händel, Huber and Schröder, 2th edition.

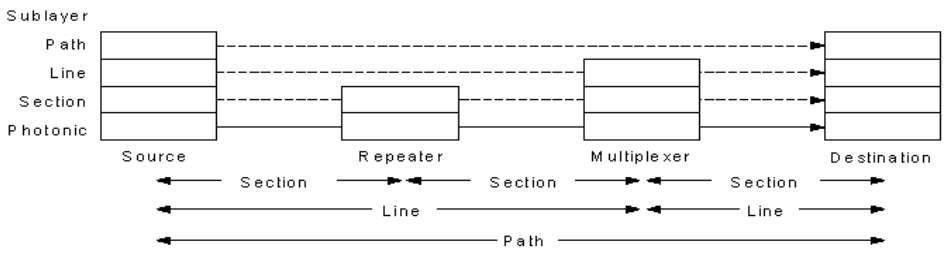
SONET and SDH bit rates

SONET		SDH	Data rate (Mbps)		
Electrical	Optical	Optical	Gross	SPE	User
STS-1	OC-1		51.84	50.112	49.536
STS-3	OC-3	STM-1	155.52	150.336	148.608
STS-9	OC-9	STM-3	466.56	451.008	445.824
STS-12	OC-12	STM-4	622.08	601.344	594.432
STS-18	OC-18	STM-6	933.12	902.016	891.648
STS-24	OC-24	STM-8	1244.16	1202.688	1188.864
STS-36	OC-36	STM-12	1866.24	1804.032	1783.296
STS-48	OC-48	STM-16	2488.32	2405.376	2377.728

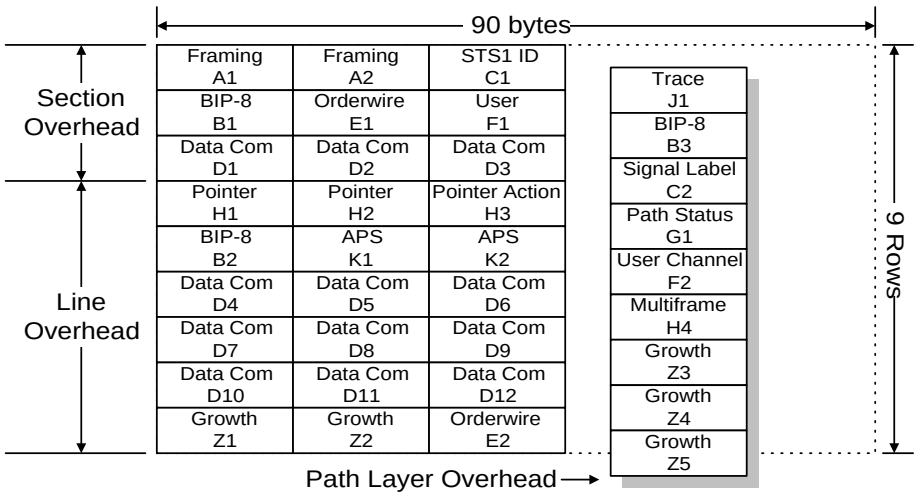
SONET Hierarchy (1/2)



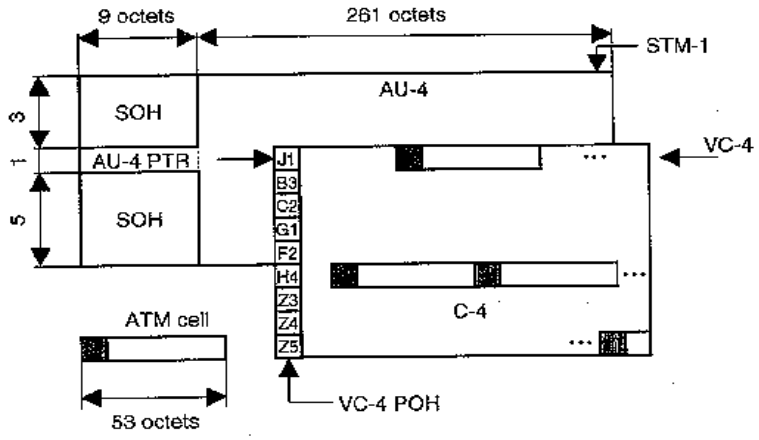
SONET Hierarchy (2/2)



SONET Overhead

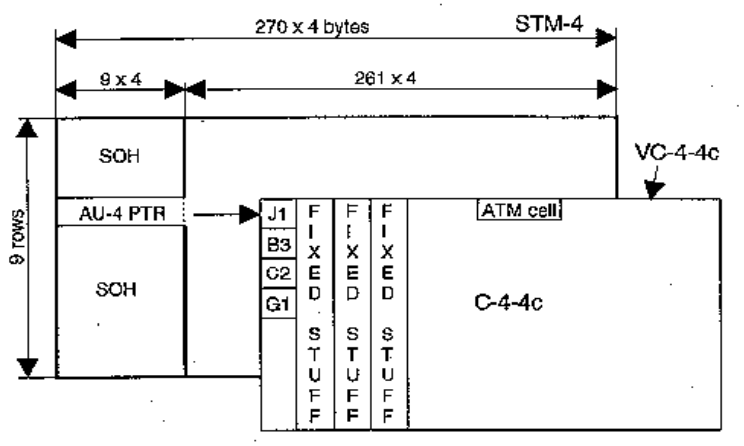


ATM at 155.520 Mbps over SDH



260 x 9 x 8 / 125 μs = 149.760 Mbps

ATM at 622.080 Mbps over SDH



260 x 9 x 4 x 8 / 125 μs = 599.040 Mbps

Cell based interface

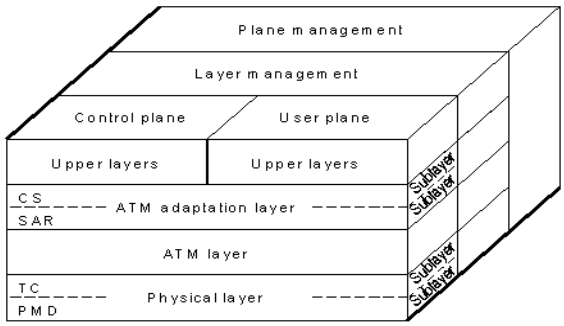
ATM cell OAM cell

One OAM (Operation and Maintenance) cell each 27 cells

STM1: 155.520 x 26/27 = 149.760 Mbps (150 Mbps)

STM4: 622.080 x 26/27 = 599.040 Mbps (600 Mbps)

ATM Reference Model



CS: Convergence sublayer
SAR: Segmentation and reassembly sublayer
TC: Transmission convergence sublayer
PMD: Physical medium dependent sublayer

Functions of the Transmission Convergence Sublayer

At the physical bit level the B-ISDN user-network interface has a bit rate of 155.520 Mbit/s or 622.080 Mbit/s, respectively. The interface transfer capability is defined as [62]:

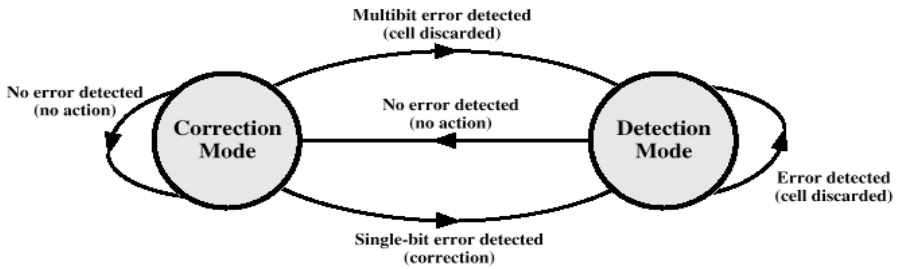
... the bit rate available for user information cells, signalling cells and ATM and higher layer OAM information cells, excluding physical layer related OAM information, transported in bytes or cells.

Header pattern for idle cell identification

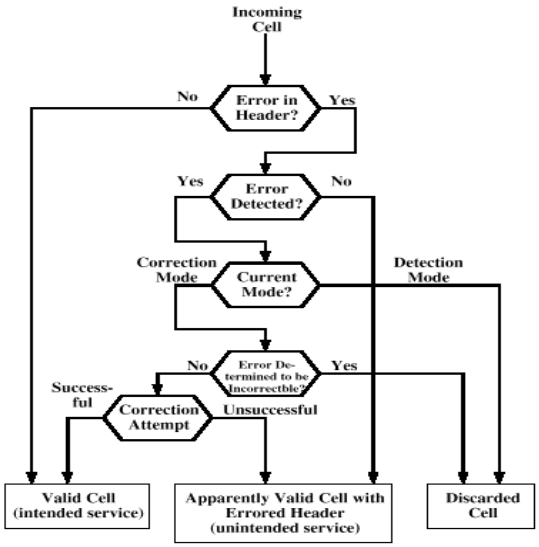
Octet 1	Octet 2	Octet 3	Octet 4	Octet 5
00000000	00000000	00000000	00000001	HEC valid code

HEC : Header error control

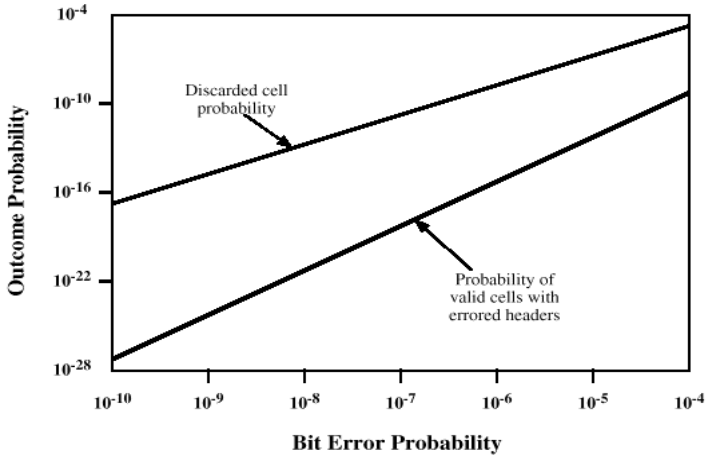
HEC operation at receiver



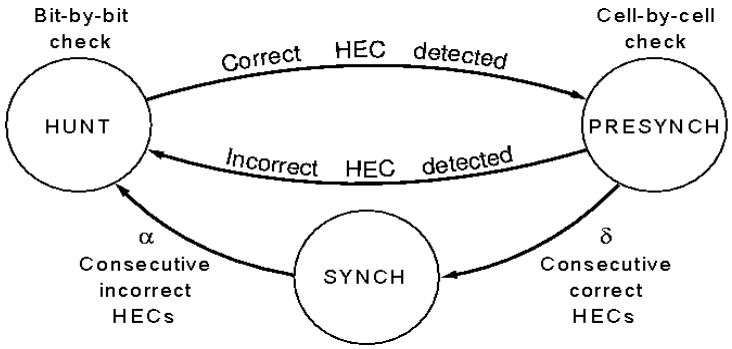
Effect of error in cell header



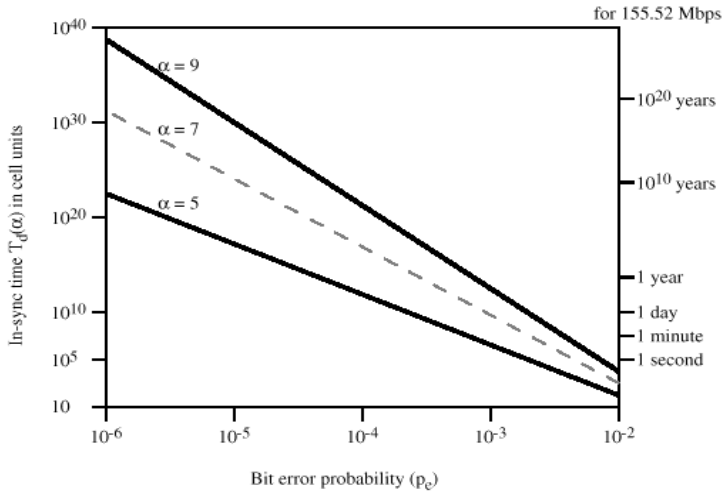
Impact of random bit-errors



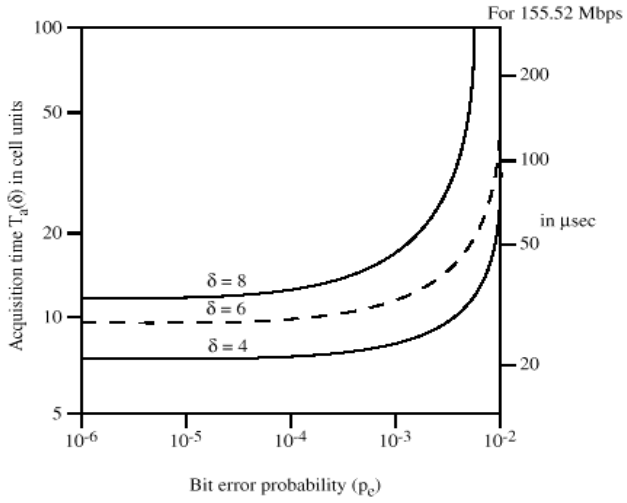
Cell delineation



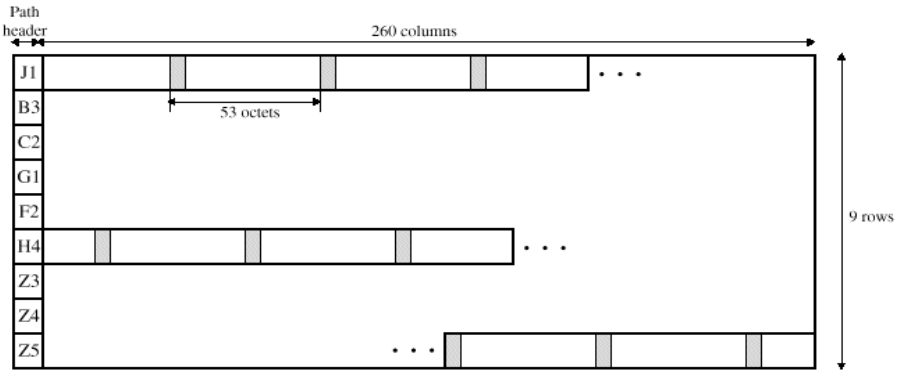
Cell delineation performance



Cell delineation performance re-synchronization time

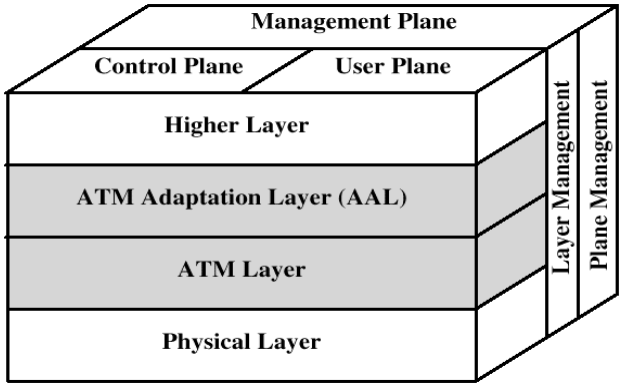


SDH-based ATM cell transmission



STM - 1

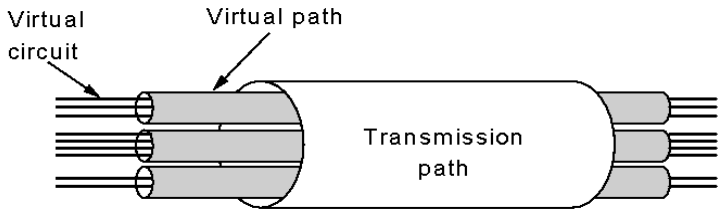
ATM Reference Model



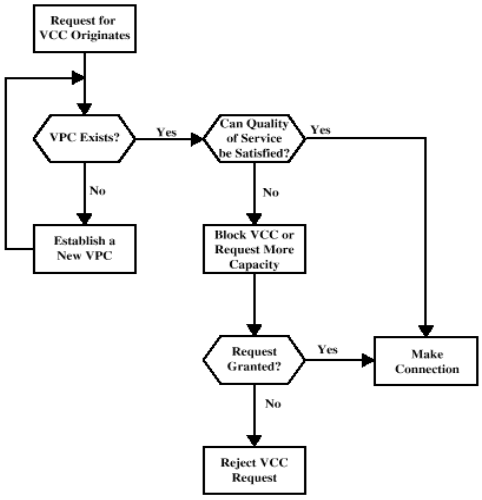
Layer Functions

OSI layer	ATM layer	ATM sublayer	Functionality
3/4	AAL	CS	Providing the standard interface (convergence)
		SAR	Segmentation and reassembly
2/3	ATM		Flow control Cell header generation/extraction Virtual circuit/path management Cell multiplexing/demultiplexing
2	Physical	TC	Cell rate decoupling Header checksum generation and verification Cell generation Packing/unpacking cells from the enclosing envelope Frame generation
1		PMD	Bit timing Physical network access

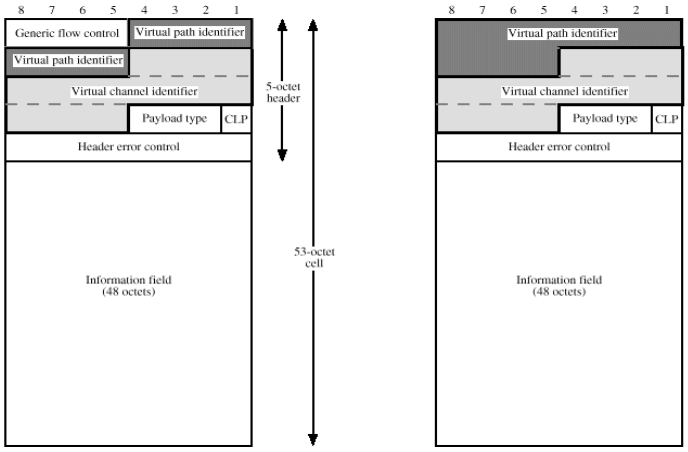
ATM connection relationships



VP connection establishment



ATM cell formats

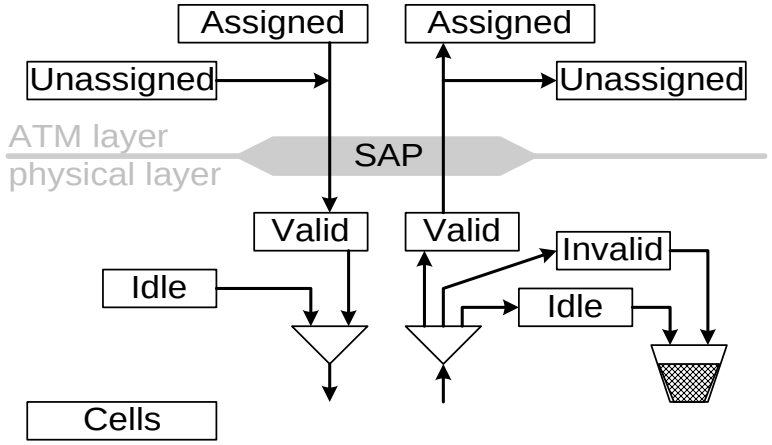


Pre-assigned Values of the Cell Header at the Physical Layer

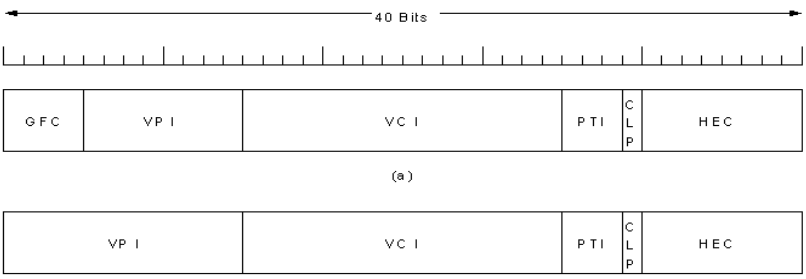
Cell type	Octet 1	Octet 2	Octet 3	Octet 4
IDLE cells	00000000	00000000	00000000	00000001
Physical Layer OAM	00000000	00000000	00000000	00001001
Reserved for use by Physical Layer	PPP0000	00000000	00000000	0000PPP1

P : Bit is available for use by the PHY layer

Insertion and extraction of ATM cells



ATM Cell Header at UNI and NNI

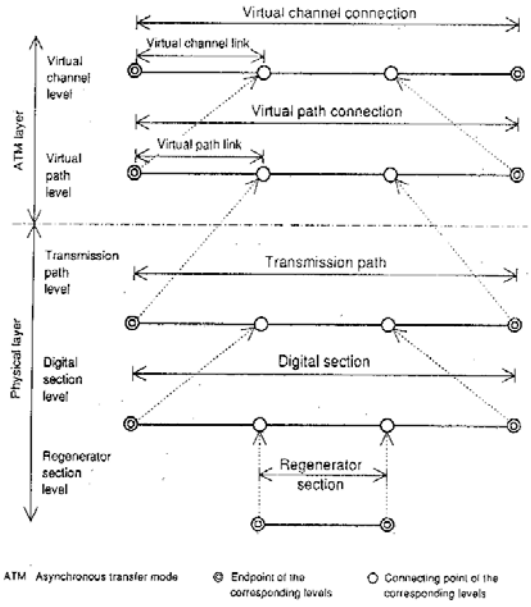


Payload Type Indicator

Payload type	Meaning
000	User data cell, no congestion, cell type 0
001	User data cell, no congestion, cell type 1
010	User data cell, congestion experienced, cell type 0
011	User data cell, congestion experienced, cell type 1
100	Maintenance information between adjacent switches
101	Maintenance information between source and destination switches
110	Resource Management cell (used for ABR congestion control)
111	Reserved for future function

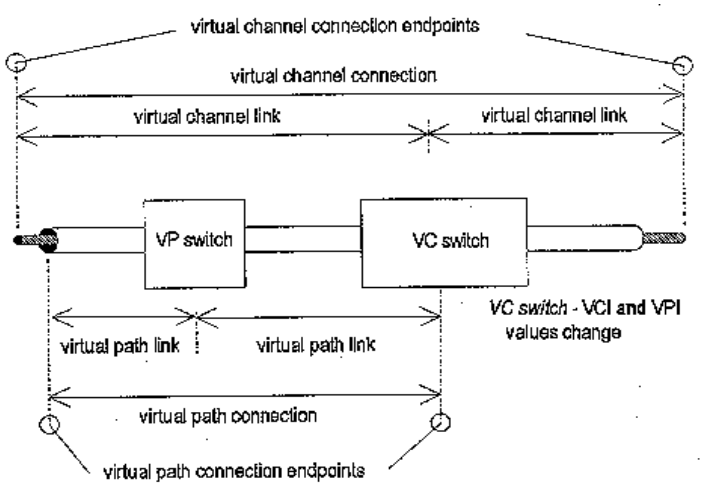
©UPC DAC.3DP

Virtual Channel and Virtual Path

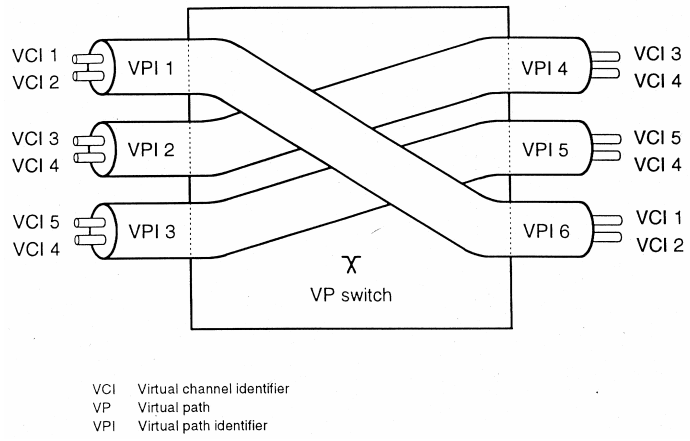


©UPC DAC.3DP

Difference between VC and VP connections



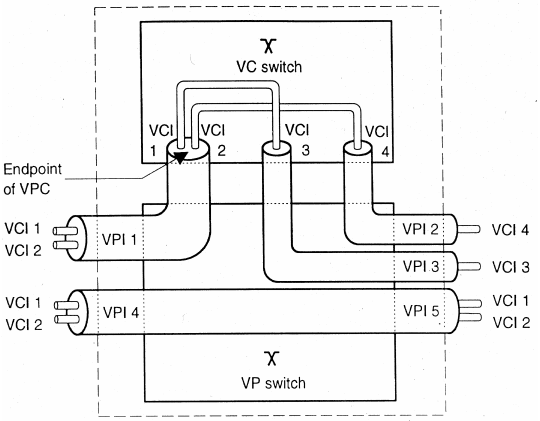
Virtual Path switching



VCI Virtual channel identifier
VP Virtual path
VPI Virtual path identifier

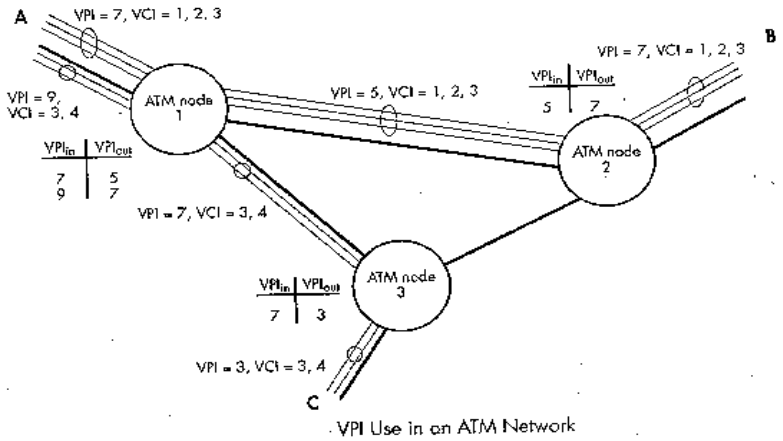
From "ATM Networks: concepts, protocols, applications" by Händel, Huber and Schröder, 2th edition.

Virtual Channel Switching



From "ATM Networks: concepts, protocols, applications" by Händel, Huber and Schröder, 2th edition.

VPI and VCI relation



VPI Use in an ATM Network

Virtual Path Connection

- “A concatenation of virtual path links that extends between the point where the virtual channel identifier values are assigned and the point where those values are translated or removed” [ITU-T I.113]

VPC establishment and release

- On a subscription basis. No signaling procedure is necessary. (Permanent PVC).
- Controlled by customer. Signaling or network management procedures are used. (Switched PVC).
- Controlled by the network through signaling procedures. (S PV).

VPC characteristics

- Cell sequence integrity is preserved for each VCC.
- Traffic parameters are negotiated during VPC establishment phase.
- Traffic parameters may be re-negotiated, if necessary.
- User cells are monitored according with the negotiated traffic parameters.
- VPC is uni-directional.

Virtual Channel Connection

- “A concatenation of virtual channel links that extends between two points where the adaptation layer is accessed” [ITU-T I.113]

VCC establishment and release

- On subscription basis. Permanent or semi-permanent VCCs. No signaling.
- Meta-signaling procedure. Applied for establishing a signaling VC.
- User-to-network signaling for a switched end-to-end VCC.
- User-to-user signaling if a VPC already exists between two UNIs.

VCC Characteristics

- Cell sequence integrity is preserved within a VCC.
- Traffic parameters are individually negotiated at VCC establishment.
- VCCs are uni-directional.
- One permanent meta-signaling VC per UNI (bidirectional).

Advantages of the VP/VC concept

- Simplified network architecture. VC switching for individual logical connections and VP switching for a group of logical connections.
- Increased network performance and reliability.
- Reduced processing for new VCCs in an already established VPC.
- Enhanced network services (closed user groups).