Telecommunication Standardization Sector
Study Group 15
Experts Group for ATM Video Coding
(Rapporteur's Group on Part of Q.2/15)

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TITLE   :   B-ISDN & Video Services Tutorial

PURPOSE : Discussion

ABSTRACT

This document gives an overview of Broadband ISDN as described in the ITU-TSS Recommendations. The aim is to assist in a common understanding of Broadband ISDN principles and terminology.

Broadband-ISDN

Broadband-ISDN (B-ISDN) development has been driven by:

- emerging demand for high speed services
- availability of high speed transmission technology
- availability of high speed switching technologies
- need to integrate interactive and distributive services in one universal network
    - economic advantages in planning, implementation, operation and maintenance
    - efficient use of network resources
- need to provide flexibility to user and network operator
- new ideas
    - shift of transport functions to network edge

The following have contributed to B-ISDN technology

- digital transmission hierarchy (SDH)
- integrated transport (ATM)

B-ISDN

B-ISDN will support:

- switched, semi-permanent and permanent services
- point-to-point and point-to-multipoint connections
- on demand, reserved and permanent services
- circuit mode and packet mode connections
- mono and/or multimedia connections
- connectionless or connection-oriented services

B-ISDN Service Aspects (I.211)

Classification of services so that B-ISDN capabilities can be defined

Service classes

- Interactive services
    - Conversational
    - Messaging
    - Retrieval
- Distribution services
    - without user presentation control
    - with user presentation control

General network aspects

Video coding aspects

- maximum integration of video services
    - commonality of coding schemes
    - integration of control and signalling schemes
    - maximise commonality of display devices

Integrated Video Services (IVS) Baseline Document

    - cooperation and liaison between CCITT SGXVIII, CCITT SGXV, CCITT SGX1, CCITT SGXVIII, CMTT, CCIR SG11, IEC/ISO MPEG

B-ISDN Protocol Reference Model (PRM)
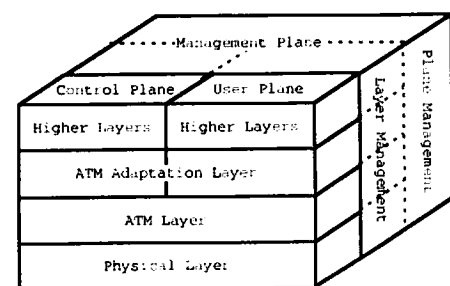
OSI Reference Model

- protocol layering
- layer service definition
- service primitives
- layer independence - not fully applied in B-ISDN PRM
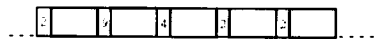
Planes

- user
- control
- management

B-ISDN PRM Functions

	Higher Layer Functions	Higher layers
L a y e r	Convergence Segmentation and Reassembly	C S — A A L S A R
M a n a g e m e n t	Generic flow control Cell header generation/extraction Cell VPI/VCI translation Cell multiplex and demultiplex	A T M
	Cell rate decoupling HEC header sequence generation/verification Cell delineation Transmission frame adaptation Transmission frame generation/recovery Bit timing Physical medium	T C — P M P h y s i c a l L a y e r

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Transmission Convergence Sublayer

1) Synchronous Digital Hierarchy (SDH)

- SDH developed as alternative to Plesiochronous Digital Hierarchy (PDH)

- SDH has

  - flexible add/drop capabilities

  - high capacity for Operations And Maintenance (OAM)

  - inherent flexibility for transport of different signals

- SDH is for transmission; it is over dimensioned for the UNI. However SDH in UNI gives compatibility with NNI

2) Cell based

- continuous stream of ATM cells

- Physical layer OAM carried in special OAM cells inserted identified by unique cell header bit patterns

- OAM cells might be inserted periodically or on demand

Asynchronous Transfer Mode (ATM) - 1

User information is transported in fixed length cells

- 5 byte cell header contains routing information

- 48 byte user payload

ATM is characterised by

- simple header

- relatively small information field length

- no link-by-link error protection or flow control

- connection oriented

  - network resources are allocated at start of the call and released at end

  - in B-ISDN network guarantees performance of existing connections through proper allocation of network resources.

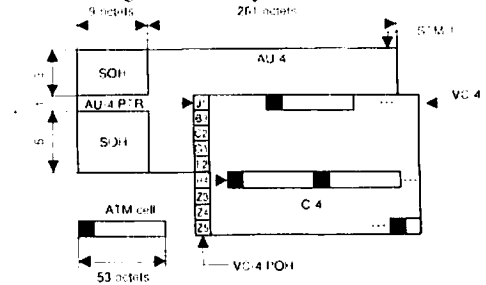Flexible bit rate allocation

- variable bit rate sources

Cell sequence integrity

- B-ISDN guarantees that cells arrive at receiver in order
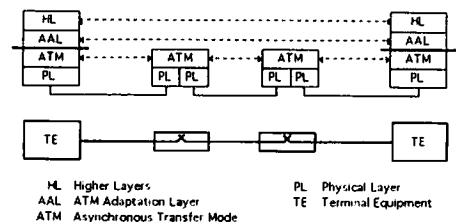

Asynchronous Transfer Mode (ATM) - 2

ATM errors

- some cells may be lost

- some cells may be incorrectly inserted

- the user data in some cells may contain bit errors

Service independence

- ATM layer does not look into user payload

- network resources can be shared amongst all service types

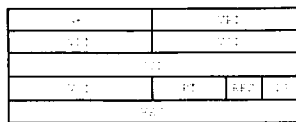- service specific functions reside above ATM layer at network edge

HL   Higher Layers   PL   Physical Layer
AAL   ATM Adaptation Layer   TE   Terminal Equipment
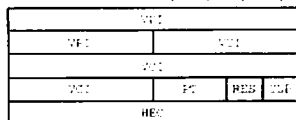ATM   Asynchronous Transfer Mode

ATM Cell Header

B-ISDN UNI

B-ISDN NNI

Routing - a virtual channel is identified by both Virtual Path Identifier (VPI) and Virtual Channel Identifier (VCI)

Payload Type (PT) - indicates if cell is contains user information or network information

Generic Flow Control (GFC) - provides for fair and efficient sharing of capacity in shared access medium CPN networks

Cell Loss Priority (CLP) - indication to the network of how cell should be treated with respect to loss priority

Header Error Control (HEC) - correct single bit errors and detect multiple bit errors. Assists on cell delineation.

Virtual Channel and Virtual Path

FIGURE 1/I 311

Relationship between the Virtual Channel the
Virtual Path and the Transmission Path

Virtual Channel (VC)

- VC link is originated or terminated by assignment or removal of VCI value

- VC links are concatenated to form a Virtual Channel Connection (VCC)

Virtual Path (VP)

- a VP is a generic term for a bundle of VC links

- VP link is originated or terminated by assignment or removal of VPI value.

- VP links are concatenated to form a Virtual Path Connection (VPC)

- VCI values are preserved within a VPC

- at a VPC endpoint VCIs are originated, translated, or terminated

ATM Switching

The ATM switch performs

- transporting of cells from a physical input to a physical output

- translation of VCI/VPI values

Contention occurs when two or more cells compete for the same output

Queueing disciplines
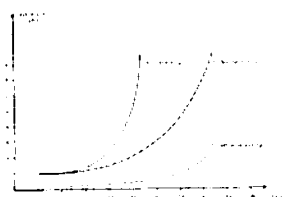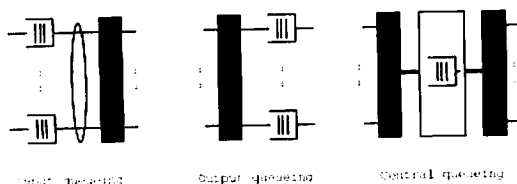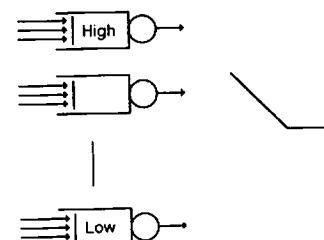
- input queueing

- output queueing

- central queuing

Fig 4.8 - Queue Size as Function of the Load [Cell Loss Rate = 10⁻⁹]

Cell Priority - Types

Delay priority

- high priority queue is served first i.e. minimum delay

- only suitable for delay insensitive traffic

Loss priority

- discard low priority cells during congestion

Whether delay or loss priority, all cells of a VC must use same queue otherwise cell sequence integrity could not be maintained

Preferable if all cells of a VP used same queue. Could then guarantee zero inter VC delay jitter

Cell Priority - Indication

Implicit

- establish priority at call setup
- delay priority - route VCs to appropriate queue
- loss priority - use tables at switch to map VCI/VPI value to priority
- flexible, any number of priorities
- cannot have priorities within a VC

Explicit

- indicate within each cell
- easier implementation
- allows multiple loss priorities within a VC

Quality of Service

Quality of Service (QOS) described by parameters observable at the user service access point

Time parameters

- delay
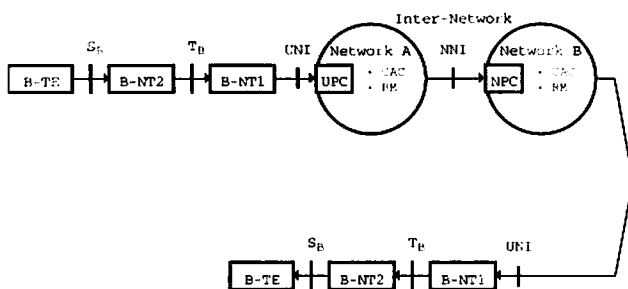- delay jitter
- inter VC delay jitter

Error parameters

- bit error rate
- cell loss rate
- cell insertion rate

Traffic and Resource Management Control - 1

Reference Configuration

B-TE - Broadband terminal equipment
B-NT - Broadband network termination
UNI   - User Network Interface
NNI   - Network Network Interface
UPC   - Usage Parameter Control
NPC   - Network Parameter Control
CAC   - Call And Connection control
RM   - Resource Management

Traffic Control and Resource Management- 2

Traffic Contract defined at T_B reference point

- source traffic descriptor
    - list of traffic parameters
        - peak cell rate: defined as inverse of minimum inter arrival time between two requests to send ATM-PDU at the Physical Layer SAP
        - average cell rate
        - burstiness
        - source type
        - parameters required for both CLP=0 and CLP=0+1
- requested QoS
- maximum cell delay variation tolerance

Call Admission Control

- set of actions at call (connection) set up to establish whether call (connection) is accepted or rejected
- based on Traffic Contract

Traffic Control and Resource Management - 3

Usage Parameter Control and Network Parameter Control

- network must protect itself against malicious and unintentional behaviour so as to maintain QoS of existing connections

- checks validity of VCI/VPI values

- checks that agreed parameters of the Traffic Contract are not violated for active VCs and active VPs

- actions

  - cell passing, cell re-scheduling (compliant)

  - cell tagging, cell discarding (non compliant)

- variable bit rate mechanisms

  - allow reasonable statistical multiplexing gain while providing some guarantees

  - must detect illegal traffic, have rapid response, and be simple

  - leaky bucket, sliding window, jumping window
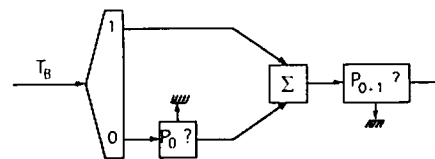
Fast Resource Management

Congestion Control

- selective cell discard
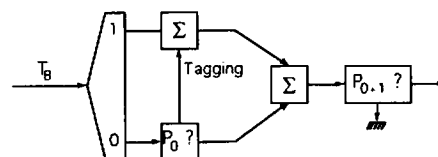
- explicit forward congestion indication

Traffic Control and Resource Management - 4

UPC and Cell Loss Priority

- No cell tagging

- Cell tagging

ATM Adaptation Layer (AAL)

AAL enhances the service provided by the ATM layer

Multiple protocols to support different AAL service users

Service classification to avoid proliferation of AALs

	Class A	Class B	Class C	Class D
Timing required	Required		Not required	
Bit rate	Constant	Variable		
Connection mode	Connection oriented			Connectionless

AAL types are mapped to AAL service classes

- AAL type 1 - Class A

- AAL type 2 - Class B

- AAL type 3/4 - Class C and D

- AAL type 5 - Class C

AAL functions

- handling of quantization effects of cell information field size

- bit errors

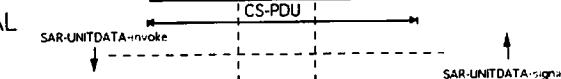- cell loss and misinsertion

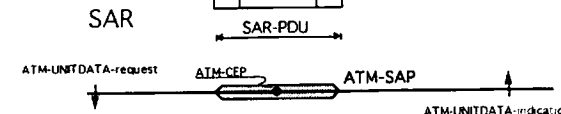- flow control

- timing control

B-ISDN PRM and terminology

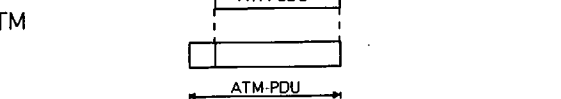| HL	Higher Layers	SDU	Service Data Unit
AAL	ATM Adaptation Layer	PDU	Protocol Data Unit
CS	Convergence Sublayer	CEP	Connection End Point
SAR	Segmentation And Reassembly		
ATM	Asynchronous Transfer Mode		

B-ISDN Signalling

B-ISDN will support multiparty/multiconnection calls

- simultaneous establishment or release of multiple connections belonging to a call

- add or remove connections to and from an existing call

- add and remove party from a multiparty call

Signalling Virtual Channels (SVC) at UNI

- meta-signalling channel

- point-to-point SVC

- selective broadcast SVC

- broadcast SVC

Short term

- signalling protocols will be based upon modified versions of existing protocols

- user access - Q.931

- inter exchange - ISDN User Part (ISUP)

    - ISUP modification includes separation of call and connection control

Long term

- ISDN Signalling Control Part (ISCP)

- call control is of end to end significance

- bearer control is of link to link significance

Broadband-ISDN Recommendations

Principles of B-ISDN and terminology

- I.121, "Broadband Aspects of ISDN"
- I.113, "Vocabulary of terms for Broadband aspects of ISDN

Asynchronous Transfer Mode

- I.150, "B-ISDN ATM Functional Characteristics"
- I.361, "B-ISDN ATM Layer Specification"
- I.356, "B-ISDN ATM Layer Cell Transfer Performance"

ATM Adaptation Layer (AAL)

- I.362, "B-ISDN Adaptation Layer (AAL) Functional Description"
- I.363, "B-ISDN ATM Adaptation Layer (AAL) Specification"

Service Aspects

- I.211, "B-ISDN Service Aspects"

Network Aspects

- I.311, "B-ISDN General Network Aspects"
- I.321, "B-ISDN Protocol Reference Model"
- I.327, "B-ISDN Functional Architecture"
- I.371, "Traffic Control and Congestion Control in B-ISDN"

User-network interface (UNI)

- I.413, "B-ISDN User-Network Interface"
- I.432, "B-ISDN User-Network Interface Physical Layers Specification

Operations and maintenance (OAM)

- I.610, "B-ISDN Operations and Maintenance Principles and Functions"

Bibliography

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[2] Rainer Haendel, Manfred N. Huber, "Integrated Broadband Networks: An introduction to ATM-Based Networks", "Addison-Wesley Publishers Ltd., 1991.

[3] G. M. Woodruff, R. Kositpaiboon, "Multimedia Traffic Management Principles for Guaranteed ATM Network Performance", IEEE Journal on Selected Areas in Communications, vol. 8, no. 3, April 1990, pp 437-446.

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[6] Andrew Day, "International Standardization of BISDN", IEEE LTS - The Magazine of Lightwave Telecommunications, Vol. 2, No. 3, August 1991.

[7] Faramak Vakil, Hiroshi Saito, "On Congestion Control on ATM Networks", IEEE LTS August 1991.

[8] CCITT Draft B-ISDN Recommendations 1990, plus revisions June 1992.

[9] CCITT SGXVIII, "Integrated Video Services (IVS) Baseline Document", January 1993, Geneva.

[10] Willem Verbiest, Luc Pinnoo, "A Variable Bit Rate Video Codec for Asynchronous Transfer Mode Networks", IEEE Journal on Selected Areas in Communications, Vol. 7, No. 5, June 1989.

[11] M. J. Karol, M. G. Huchy, S. P. Morgan, "Input Versus Output Queueing on a Space Division Packet Switch", IEEE Transactions On Communications, vol. com. 35, no. 12, December 1987, pp 1347-1356.

[12] M. De Prycker, R. Peschi, T. Van Landegem, "B-ISDN and the OSI Protocol Reference Model", IEEE Network, March 1993, pp 10-18.