CCITT SGXV
Working Party XV/1
Experts Group for ATM Video Coding

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CCITT
STUDY GROUP XV
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Temporary Document (XV/1)

Questions: 3/XV, 4/XV

SOURCE: CHAIRMAN OF THE EXPERTS GROUP FOR ATM VIDEO CODING
TITLE : SECOND PROGRESS REPORT

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1. General

We have met twice since we presented the first progress report (TD 13 - XV/1) at the previous Working Party XV/1 meeting in February 1991;

The second meeting	23-31 May 1991 in Paris (France) at the kind invitation of CNET and ENST,
The third meeting	14-23 August 1991 in Santa Clara (USA) at the kind invitation of AT&T, Bellcore, C-Cube Microsystems and CLI.

We had joint sessions with ISO/IEC JTC1/SC2/WG11 (MPEG) as well as CCITT sole sessions in these two meetings. The list of participants appears in Annex 1.

This document reports major achievements toward defining Recommendation H.26X for high quality video coding in the ATM environments, and particular items for consideration of the Working Party XV/1.

2. Technical discussion

2.1 Picture format

One of the video service qualities under consideration currently is that near broadcast TV quality, where there are 625/50 and 525/60 versions of CCIR Rec. 601, future progressive scan television signals, etc. We are discussing whether the notion of worldwide unique SCIF (super CIF) is applicable and appropriate, or alternatively multiple source coding formats (SCIF can be one of them) are to be adopted. We intend to check the two approaches in picture quality, coding efficiency, delay, compatibility with the current CIF, and implementation.

An interim common view of the Experts Group is summarized as follows;

1) No standardization of format conversion.
2) Can specify a maximum resolution for the "601" class of services

    a. 59.94Hz frame rate
    b. Progressive
    c. 576 lines
    d. 7xx pels/line
    e. 4:3 aspect ratio

3) Support CIF Pel Aspect Ratio
4) Above applies to the decoder.

The remaining outstanding questions are;

a. Impact of square pels?
b. Next class is HDTV or EDTV?
c. Are Max and SCIF the same?
d. Which subsets are allowed?

We agreed to reach an agreement on the picture format issue at the earliest occasion in 1992.

2.2 Framework for H.26X

The aim of H.26X is to cover a range of video applications, bit rates, resolutions, qualities, and services for B-ISDN. The requirements to H.26X have been summarized as in Annex 2.

H. 26X compatibilities with existing standards such as H.261, MPEG-1 and future companion standards such as MPEG-2, CMTT/2 are one of the most concerned items of the Experts Group. Our position is illustrated in § 5/Annex 2. We think direct communication between H.320 and H.32X terminals are mandatory.

Further study is necessary on the balance of achieving compatibility and highest coding performance. We agree on a guideline that the compatibility between the new coding system and existing and emerging systems should be highly respected, and that the means for interworking between H.320 terminals connected to the N-ISDN and H.32X terminals connected to the B-ISDN should be developed in this group.

2.3 VBR vs CBR

Advantages of VBR over CBR could be expected in following domains:

- statistical multiplexing gains
- reduced coding-decoding delay
- picture quality
- others

VBR coding benefits, however, largely depend on the UPC (usage parameter control, or policing) mechanism in the network by which the average bit rate of the source is monitored and the input cells are regulated. Therefore, we recognize it as an urgent study item to clarify the advantages of VBR video coding against CBR video coding, particularly under the network operation restrictions. It is also a common understanding that applications should be clarified where VBR is most effective.

It is also recognized that CBR is a special case of VBR, and that as such, depending on the application, a VBR codec could operate in CBR or VBR mode.

2.4 Network loading model

We feel it would facilitate our making a good progress of VBR study if we use a common network loading model. The first model has been established and updated as in Annex 3. This is based on the probability that the total of bit rates for multiple calls, each of which has given peak and average rates, becomes greater than the capacity of the transmission pipe assuming on/off model sources.

We feel at the same time this model is not sufficient for more precise study and deeper insight, awaiting further detailed studies.

2.5 Video coding algorithms

This is one of the main areas of joint work among MPEG, CCITT and CMTT. According to the identified requirements, a number of proposals have been submitted for the subjective test that is to be carried out at JVC-Kurihma in November 1991. We expect this test would be the first step to find promising techniques and to define a Test Model (same in role as Reference Model for developing H.261) as a test bed for further collaborative work.

Layered coding is a technique to provide compatibilities among different generation coding standard. Full layering is a notion where all the constituent coding layers are included. Generally, coding efficiency is lost with full layering to some extent, because use of the lower layers constrains the total coding efficiency compared to the single layer scheme. On the other hand flexible layering is a notion structuring coding into layers but switching off some constituent layers as necessary to achieve interworking among different service classes.

We are interested in this flexible layering, and several experimental results of such layered coding have been presented.

2.6 Multimedia multiplexing

The following methods for multimedia multiplexing are conceivable in the B-ISDN environment (Annex 4);

1) Cell multiplex : each medium is identified by the cell header.
2) Message multiplex: each medium is identified by the IT of SAR.
3) Media multiplex : each medium is identified by the CS header.
4) User multiplex : multimedia signals are multiplexed in the layer above AAL

Cell multiplex has several merits as follows;

- The QOS (and therefore cost) can be customized to the requirements of the different media.
- It fits to broadcasting because the selection of media by the receiver is easy.
- Usage parameter control for each medium is easy.
- Multiplexing delay is considered to be short.

Therefore we adopt cell multiplex as a reference method for our future work. Further studies are required for the following items;

- How to cope with differential delay between several VCs. To set several VCs in the same VP may be one solution, but desirably network provision of appropriate signalling and control for bounded cross media delay may be a better solution.
- Whether tariff penalty exists or not to use multiple VCs.
- How to connect with the audiovisual terminals which adopt user multiplex, for example N-ISDN audiovisual terminals (H.320) or MPEG terminals.

2.7 AAL (ATM Adaptation Layer)

The following solutions can be considered for AAL that is suitable for AV systems;

1) AAL has minimum functions which are required from all types of audiovisual terminals.
2) AAL has maximum functions which are sufficient for all types of audiovisual terminals.
3) Middle of 1) and 2).

The Experts Group support that AAL Type 2 be commonly used for VBR and CBR audiovisual communications, and recognized the urgency of study on the definition of AAL Type 2 by the Experts Group.

We are discussing where necessary error correction and cell loss protection be carried out, at SAR (Segmentation and Reassembly Sublayer), CS (Convergence Sublayer) or user layer depending on the network performance. The following factors should be considered in this study:

- Interworking with N-ISDN terminals should also be considered where bit errors are taken care of at the user layer.
- It should be noted that scrambling in ATM layer causes correlated errors in SAR-PDU (SAR Protocol Data Unit).
- Order of scrambling, error correction and encryption should be carefully considered.
- If video is layered, different layers may take advantage of different levels of bit error and cell loss performance.

There is a question whether audiovisual terminals use Type 1 as well if both VBR and CBR are covered by Type 2. One of the cases identified is interworking between B-ISDN and N-ISDN. We feel ambiguous about whether Type 1 for interworking be required in H.32X terminal, or it may be covered by the interworking unit in the network. It is also pointed out that the existing N-ISDN terminals are quite susceptible to cell loss if it occurs in the circuit emulation mode.

3. Harmonization with other groups

3.1 Work method

1) SGXVIII

Since our video coding design depends heavily on the B-ISDN characteristics, the Experts Group are very keen to have close contacts with SGXVIII on the network aspects. The following three work methods are currently used for this method;

- Exchange liaison statements
- Exchange comments on the IVS Baseline Document
- Direct interaction at the IVS Co-ordination Meeting

2) MPEG and CMTT/2

This group seeks to carry out joint work with TG CMTT/2 Special Rapporteur's Group and ISO/IEC JTC1/SC2/WG11 (MPEG) in order to avoid different standards in the same or similar areas and to avoid duplication of standardization work as well.

To this end the CCITT group proposed to MPEG and CMTT/2 SRG that joint meeting sessions be arranged in the areas of overlapping interest and responsibility, namely;

- source video coding algorithm and video multiplexing,
- system issues concerning multimedia multiplexing and synchronization,
- implementation considerations.

The MPEG Berlin meeting of December 4-7, 1990 concluded in response to our liaison statement that the ongoing phase of work on audiovisual coding at bit rates up to about 10 Mbit/s be carried out in collaboration with CCITT, by holding joint meetings on matters of common interest such as video, systems, implementation. It was confirmed there that both groups have a common target date of freezing draft specifications as end of 1992. It was also confirmed that a "Test Model" would be defined after subjective tests of candidate algorithms for further collaborative elaboration. Two such meetings have already been experienced, and we will make continuous efforts to achieve the objectives.

The TG CMTT/2 Tokyo meeting of March 25-28, 1991 concluded that the aspects of practical collaboration with Study Group XV are addressed through Special Rapporteur and that a delegation of TG CMTT/2 is expected to attend common meetings of Study Group XV and ISO/MPEG.

3.2 Liaison statements

As outcome of the two meetings, the Experts Group submitted the following liaison statements as contained in a companion TD;

To SGXVIII

1) Network related questions, IVS Baseline Document	May 1991
2) IVS Baseline Document, questions and requirements	Aug 1991

To CMTT/2 Special Rapporteur's Group

3) Mutual collaboration	May 1991
4) Requirements for secondary TV and HDTV distribution	Aug 1991
5) Harmonization of the work	Aug 1991

This action was taken, without being able to consult with WPXV/1 due to the time constraint, based on our understanding that we are competent to directly coordinate with other CCITT Groups, CMTT and ISO/IEC on video coding.

4. Future activities

The 4th meeting

Joint sessions with MPEG	18-26 November 1991	Japan
CCITT sole sessions	27-29 November 1991	Japan

The 5th meeting

Joint sessions with MPEG	7-9 January 1992	Singapore

The 6th meeting

CCITT sole sessions	March 1992	to be decided
Joint sessions with MPEG	23-27 March 1992	Israel

5. Specific items requiring the consideration of Working Party XV/1

1) Methods of collaboration with other groups

We have been taking a practical method to collaborate with ISO/IEC JTC1/SC2/WG11 (MPEG) in that the two groups meet in the same place and have joint meeting sessions in the areas of common interest. The objective is hopefully to define a common video coding standard authorized by both ITU and ISO/IEC JTC1. We are now concentrating on solving the technical problems, but at a later stage some formality should also be sought. Consideration of the Working Party is requested.

2) System aspects

The Experts Group will study the multimedia multiplexing method to the extent that it facilitates the video coding study, recognizing that the responsibility for the system aspects study is in Working Party XV/1. We suggest that all necessary elements of audiovisual systems in B-ISDN be identified and a systematic study program be made as was done for the N-ISDN systems.

END

Annex 1

List of Participants of the second meeting
of the Experts Group for ATM Video Coding
(23 -31 May 1991, Paris)

FRG	Mr. F. May	Daimler-Benz Research	CM
	Mr. G. Zedler	DBP Telecom	CM
Australia	Mr. M. Biggar	Telecom Australia	CM
Belgium	Mr. L. Elewaut	Alcatel Bell Telephone	
	Mr. O. Poncin	University of Louvain	
	Mr. W. Verbiest	Alcatel Bell Telephone	CM
Canada	Mr. D. Lemay	BNR	CM
USA	Mr. P. Alexander	PictureTel	
	Mr. B.G. Haskell	AT&T Bell Labs	
	Mr. A. Deutermann	DIS	(CM)
	Mr. A.J. Tabatabai	Bellcore	CM
	Mr. J. Zdepski	David Sarnoff Research Center	
France	Mr. G. Eude	France Telecom	
	Mr. J. Guichard	France Telecom	CM
Italy	Mr. B. Riolfo	CSELT	(CM)
Japan	Mr. S. Hattori	Mitsubishi Electric	
	Mr. Y. Katayama	GCT	
	Mr. K. Matsuda	Fujitsu	
	Mr. T. Odaka	Toshiba	
	Mr. S. Okubo	NTT	Chairman
	Mr. T. Tanaka	NTT	CM
	Mr. M. Wada	KDD	CM
	Mr. M. Yano	NEC	
	Mr. T. Yukitake	Matsushita Communication	
	Mr. H. Watanabe	NTT	
Norway	Mr. G. Bjoentegaard	Norwegian Telecom	
	Mr. H. Sandgrind	Norwegian Telecom	CM
Netherlands	Mr. H. Carbiere	PTT Research	LR (CMTT)
	Mr. D. Schinkel	PTT Research	CM
UK	Mr. M.D. Carr	BT	
	Mr. D.G. Morrison	BT	CM
Sweden	Mr. H. Brusewitz	Swedish Telecom	CM

CM: Coordinating Member
(CM): Substitute for CM
LR: Liaison Representative

List of Participants of the third meeting
of the Experts Group for ATM Video Coding

(14-23 August 1991, Santa Clara)

FRG	Mr. F. May	Daimler-Benz Research	CM
	Mr. G. Zedler	DBP Telecom	CM
Australia	Mr. G. Smith	AUSSAT	
	Mr. P. Stevens	Siemens	
Belgium	Mr. O. Poncin	RTT	
	Mr. W. Verbiest	Alcatel Bell Telephone	CM
Canada	Mr. D. Lemay	BNR	CM
USA	Mr. M.M. Anderson	Bellcore	LR-ISO
	Mr. B.G. Haskell	AT&T Bell Labs	
	Mr. M. Liou	Bellcore	
	Mr. R.P. Rao	Compression Labs	
	Mr. R.A. Schaphorst	Delta Information Systems	CM
	Mr. A.J. Tabatabai	Bellcore	CM
	Mr. X. Yuan	PictureTel	
	Mr. J. Zdepski	David Sarnoff	
France	Mr. G. Eude	France Telecom	
	Mr. J. Guichard	France Telecom	CM
Italy	Ms. L. Conte	CSELT	(CM)
Japan	Mr. Y. Kato	Mitsubishi Electric	
	Mr. T. Odaka	Toshiba	
	Mr. S. Okubo	NTT	Chairman
	Mr. T. Soejima	Fujitsu America	
	Mr. T. Tanaka	NTT	CM
	Mr. Y. Takishima	KDD	(CM)
	Mr. H. Yasuda	NTT	
	Mr. T. Yukitake	Matsushita Communication	
Norway	Mr. H. Sandgrind	Norwegian Telecom	CM
Netherlands	Mr. H. Carbiere	PTT Research	LR-CMTT
	Mr. A. Koster	PTT Research	(CM)
UK	Mr. I. Parke	BT	
	Mr. D.G. Morrison	BT	CM
Sweden	Mr. H. Brusewitz	Swedish Telecom	CM

CM: Coordinating Member
(CM): Substitute for CM
LR: Liaison Representative

Annex 2

H.26X REQUIREMENTS

Status notation

(A) Agreed
(P) Preferable
(M) Mandatory
(T) Target
(FS) Implementation method is for further study

1. BIT RATE

up to several 10s Mbit/s	(A)

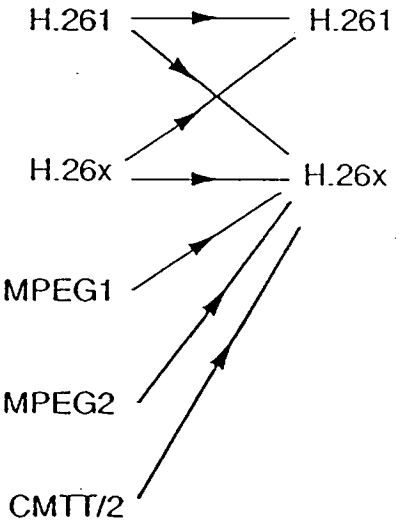
2. CODEC SOURCE FORMAT

QCIF/CIF	(A)
"601" class	(FS)
EDTV	(?)
HDTV	(?)

3. COMPATIBILITY

encoder		decoder		
H.320	--->	H.32X	(terminal)	(A,M)
H.32X	--->	H.320	(terminal)	(A,M)
H.261	--->	H.26X		(P,FS)
H.26X	--->	H.261		(P,FS)
MPEG1	--->	H.26X		(P,FS)
MPEG2	--->	H.26X		(P,FS)
*"CMTT/2"	--->	H.26X		(P,FS)

* Secondary distribution, which may include classes above "601"

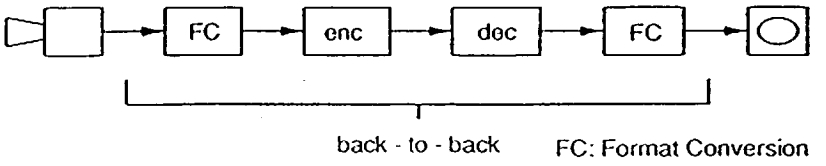


4. PICTURE QUALITY

"PAL/NTSC" at 3-5 Mbit/s and delay=? (T,FS)
"Rec. 601" at 8-10 Mbit/s and delay=? (T,FS)

5. DELAY

less than about 150 ms at bit rate > 2 Mbit/s (FS)



6. CODEC COMPLEXITY

complex/high performance
vs
simple/low performance
ex. pure intra-codec

7. APPLICATIONS

CTV Cable TV Distribution on optical networks, copper, etc.
ENG Electronic News Gathering (including SNG, Satellite News Gathering)
IPC InterPersonal Communications (videoconferencing, videophone, etc.)
ISM Interactive Storage Media (optical disks, etc.)
NDB Networked Database Services (via ATM, etc.)
RVS Remote Video Surveillance
SSM Serial Storage Media (digital VTR, etc.)
STV Satellite TV Broadcasting
TTV Terrestrial TV Broadcasting

8. ATM

VBR and CBR (A,M)
Cell loss resilience (M,FS)
Bit error resilience (M,FS)
High/low priority cell utilization (P,FS)
High/low priority cell independent rate control (P,FS)
Usage Parameter Control (M,FS)

9. MULTIPOINT

Continuous presence possible (P,FS)

- Time-sliced decoding
- Editing without decoding-recoding

Mix of H.320 and H.32X (M,FS)

10. H.32X TERMINAL

Interwork with

H.320 terminal	(A,FS)
Network database	(P,FS)
Distributive service	(P,FS)
Multipoint	(A,FS)
Stored bitstream	(P,FS)
Multimedia multiplexing	(M,FS)
Audio quality > ?	(FS)
Relative audio/video delay < ?	(FS)
Video clock recovery	(FS)
Encryption/scrambling	(FS)

END

Annex 3

Update of the First Simplified Network Model

The first simplified network model, Annex 4 to AVC-22R (Hague), has been updated to calculate the cell loss ratio. See AVC-97. It is noted that the cell loss ratio CLR is calculated in general according to the following equation:

$$CLR = \int_0^{\infty} L(R) * p(R) dR \; / \; \int_0^{\infty} R * p(R) dR$$

where R is instantaneous rate of multiplexed signals, p(R) is probability density for instantaneous rate being R, L(R) is loss function. L(R) can be approximated as

$$L(R) = 0 \qquad \text{for } R < CAP \text{ (capacity of the multiplex)}$$
$$= R - CAP \qquad \text{for } R \geqq CAP$$

1) A single stage multiplex is assumed.

2) The network is assumed to exhibit a cell loss/network load characteristics as shown in Appendix 1. An example of these characteristics are shown in Appendix 2.

3) The multiplex is assumed to have a maximum available bandwidth (CAP) of 100 Mbit/s.

4) Cell loss is assumed to be random.

5) The model is independent of the shape of the source.

6) The model provides the lower limit for the network loading, ie it is a conservative model because of point 5 above.

Note - We need more accurate model(s) for the precise study of VBR vs CBR issue and to obtain better understanding and deeper insight to the statistical multiplexing problem. Suitable models for this purpose need continued study.

Appendix 1

Psat = exp(-n * k) where Psat is the probability of saturation

k = (a * ln(a/p)) + ((1-a) * ln((1-a)/(1-p)))

a = CAP / (n * Peak) Note: 0 < a < 1

CAP = Maximum capacity of the multiplexer output in Mbit/s

n = percentage of network loading

Note: n is the number of sources, 0 < n <= 100. The illustration corresponds to the case of Mean = 1 Mbit/s.

Peak = The maximum bit rate over simulation interval (measured on a per frame basis)

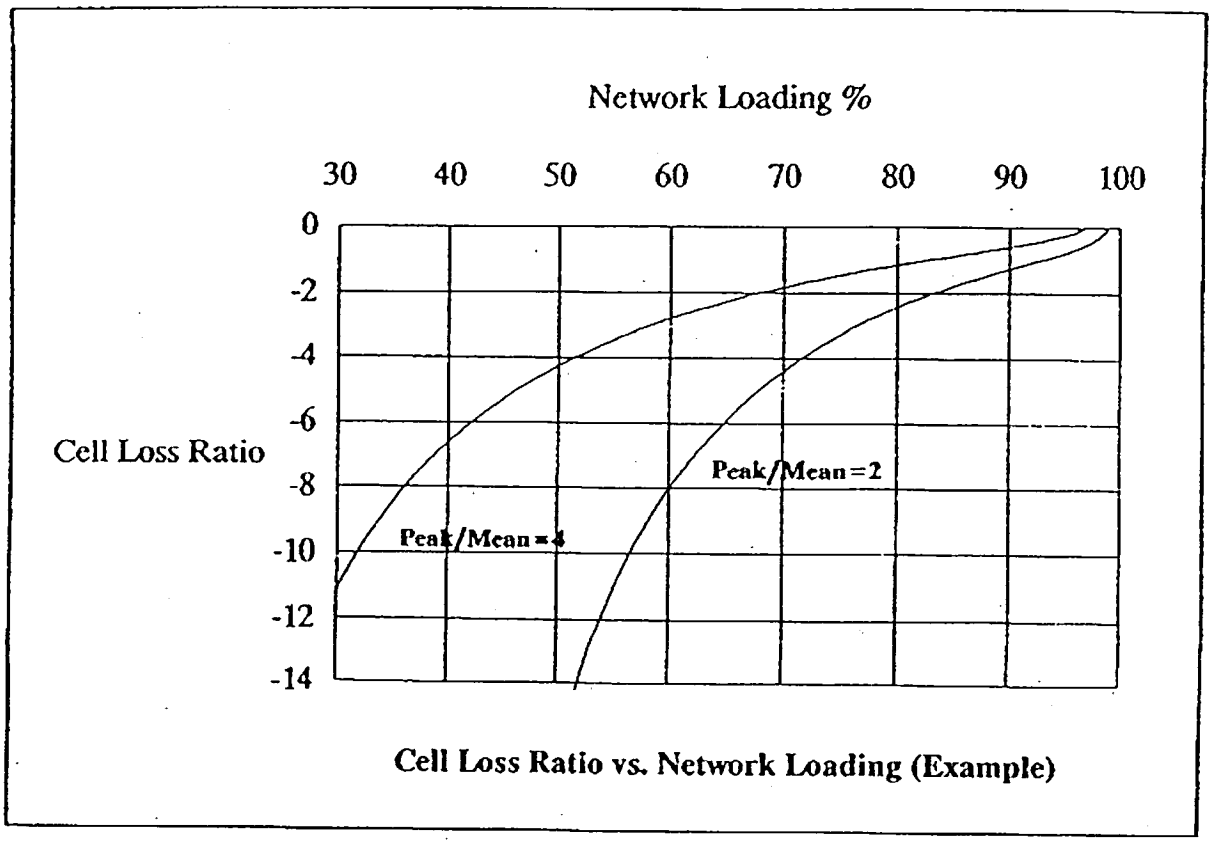
p = Mean/Peak Note: 0 < p <= 1

Mean = The average bit rate over the simulation interval

CLR = Psat / (n * p * ln ((a * (1-p))/(p * (1-a))))
where CLR is the cell loss ratio.

ln = log to the base 'e'

Appendix 2



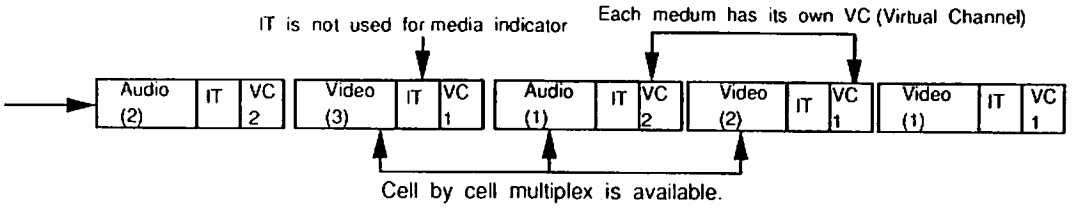
Cell Loss Ratio vs. Network Loading (Example)

Annex 4

Multimedia Multiplex Methods

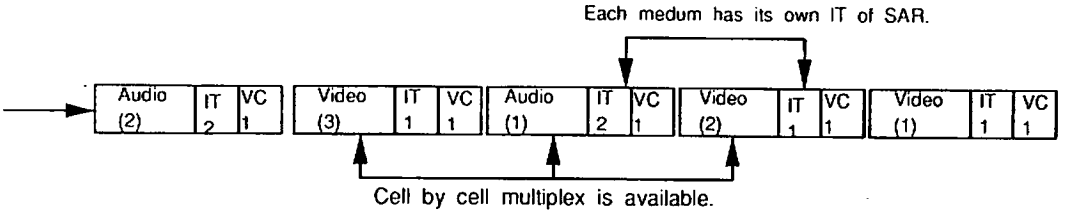
1.Cell Multiplex

Each medium is identified by the cell header.



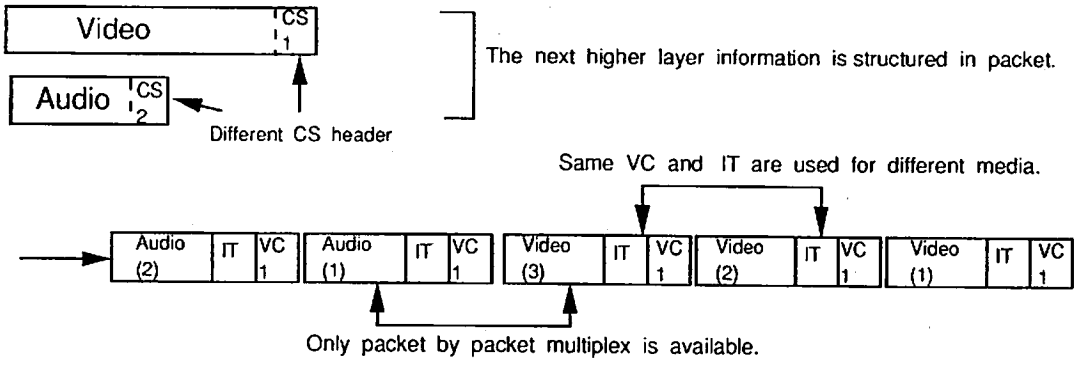
2.Message Multiplex

Each medium is identified by the IT of SAR.



3.Media Multiplex

Each medium is identified by the CS header .



4.User Multiplex

The user multiplexes several media in the terminal.