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

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SOURCE : WORKING PARTY XVIII/8
TITLE : INTEGRATED VIDEO SERVICES (IVS) BASELINE DOCUMENT
PURPOSE: Report

A baseline document on Integrated Video Services (IVS) in B-ISDN has been initiated to provide the framework for ongoing studies on the video service aspects of B-ISDN. The baseline document provides a good basis for the complex task of harmonising the work of the wide range of groups involved in video service studies to ensure consistency with B-ISDN.

It is proposed that the groups involved have joint ownership of the baseline document and that it be used as the vehicle to facilitate and promote discussion, liaison and agreements in Integrated Video Services in B-ISDN. As such, each of the groups involved in video service standardisation for the B-ISDN is invited to contribute the results of their studies to this baseline document and to comment on the inputs provided by the other groups. SGXVIII, in cooperation with these groups, aims to coordinate the contents of the baseline document to achieve consistency with the B-ISDN and to achieve convergence of the different inputs to a common level of understanding and agreement.

The proposed baseline document is attached.

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1. General

This document is initiated by CCITT SGXVIII to gather information related to Integrated Video Services (IVS) support on B-ISDN. The document contains aspects related to the work of several other groups to provide a consolidated overview of Integrated Video Service issues and the areas that need to be addressed and specified to become both technically and commercially viable. The prime purpose is to provide a common basis for the ongoing study of Integrated Video Services by SGXVIII and other groups.

It is the intention of SGXVIII to maintain and update this baseline document until such time as the relevant information is transferred to Recommendations for which different groups are responsible.

To keep this document updated and complete, all groups involved are invited to study it carefully and provide appropriate input.

Major areas which require further development are contained in separate annexes to this document.

2. Objectives

Video and image services represent an increasingly important form of communications. With the establishment of powerful and extensive broadband network facilities, customer interest in video and image services is expected to lead to growing demands for greater service variety and higher quality.

The B-ISDN will form the foundation of public networks capable of the integrated support of voice, data and video applications. In addition to a consistent broadband transmission and switching fabric, the B-ISDN will provide common interfaces for the support of all customer services and supplementary services (e.g. picture within picture), ensuring connectivity and a competitive multi-vendor equipment environment.

Integrated network support and delivery of the various service classes can provide advantages in terms of efficient handling of service types within the network and a consistent application environment within the customer's premises.g. common display, control, etc.

Service integration can occur at many levels within networks and customer equipment. The emergence of B-ISDN standards and network technology provides an opportunity to rationalise video service support by developing a framework for the integration of interactive and distribution video service delivery. Video service integration will provide a means of

maximising the rate and extent of video service development and application within both the residential and business market sectors. The objective is therefore to develop a communications environment which can provide effective and flexible video service support, across all service types, together with positive incentives for new service development and deployment.

From a customer viewpoint, the integrated support of video services would offer lowered costs and enhanced flexibility.

To achieve this flexibility and provide integrated service support requires alignment and consistency between related service standards.

Video service integration benefits will be maximised under conditions offering commonality of User-Network Interface, signalling and control formats, coding techniques and display devices across a range of service types.

Draft Recommendation I.211 "B-ISDN Service Aspects" provides a classification of services to be supported by the B-ISDN, and basic considerations of the network capabilities required by the B-ISDN. For video service applications, it identifies the key objective of maximum integration through common coding and integration of control and signalling systems, and also provides an overview of the related coding and service interworking issues.

The development of common coding schemes will help to fulfill the following objectives:

- economic provision of multiservice terminals and customer equipment;
- ease of adaptation of terminal equipment for different services;
- minimisation of interworking requirements;
- minimisation of transcoding requirements within the network.

To achieve these objectives it will be necessary that there be close cooperation and liaison between all the B-ISDN video services standardisation groups. It is the prime purpose of this baseline document to provide the vehicle for achieving this liaison and the required level of cooperation and commonality of direction.

3. Responsibilities

CCITT SGXVIII

Responsible for, amongst other tasks:

- Recommendations on all network aspects of the B-ISDN, including the network architecture, transport techniques, User-Network Interface, access and inter-exchange signalling and ATM Adaptation Layer specifications;
- identifying network wide impact on B-ISDN service support, including the coordination across ITU bodies necessary to maximise commonality between communicative and distribution video services;
- establishing the framework for video service support in the B-ISDN;
- general aspects of quality of service and network performance in digital networks including ISDNs;
- providing coordination across different groups on Integrated Video Services in B-ISDN.

The following areas of responsibility are SGXVIII's understanding of the terms of reference for the other groups interested in video services on B-ISDN.

CCITT SGXV

Responsible for, amongst other tasks:

- Recommendations on video coding algorithms necessary to support a range of different quality communicative video services on the B-ISDN;
- Recommendations for transmission systems and equipment utilised in the B-ISDN;
- Recommendations for audiovisual system aspects;
- cooperatively assess compatibility between video coding algorithms used for the support of communicative and distribution video services with CMTT.

CCITT SGXI

Responsible for, amongst other tasks:

- Recommendations on Stage 2 and Stage 3 service descriptions for the Stage 1 service descriptions as provided by SGI.

CCITT SGVIII

Responsible for, amongst other tasks:

- Recommendations on coding for still image communication.

CCITT SGI

Responsible for, amongst other tasks:

- Recommendations on the service attributes including end-to-end service quality of all communicative services supported on the B-ISDN;
- Stage 1 service descriptions;
- cooperatively assess compatibility of end-to-end performance levels of television and communicative services on the B-ISDN with CCIR SG11.

CMTT

Responsible for, amongst other tasks:

- Recommendations on the bit rate reduction coding, packaging and transmission of television and sound programme signals in all portions of the telecommunications network; this includes contribution, primary distribution and secondary distribution signals;
- cooperatively assess compatibility between video coding algorithms used for the support of communicative and distributive video services with CCITT SGXV.

CCIR SG11

Responsible for, amongst other tasks:

- Recommendations defining and assessing the subjective and objective performance of digital television coding schemes proposed by the CMTT and supported on the B-ISDN proposed by CCITT SGXVIII;
- cooperatively assess compatibility of end-to-end performance levels of television and communicative service on the B-ISDN with CCITT SGI.

IEC/ISO

Responsible for, amongst other tasks:

- Through the Moving Picture Experts Group (MPEG), develop standards for storage and retrieval of moving images and sound for Digital Storage Media (DSM);
- development of standards for display devices.

4. Range of Services

CCITT Recommendation I.211, "B-ISDN Service Aspects", identifies two broad service categories; interactive and distribution.

Full integration of the coding schemes to be adopted for all video services, including the following, should be pursued:

- distribution services including entertainment and information;
- conversational services including videotelephony and videoconferencing;
- messaging services including moving picture mail;
- retrieval services including film libraries and high resolution images.

Video service applications in B-ISDN fall across this entire range of broad service types and thus must be considered when developing a framework for B-ISDN video coding studies.

Annex 1. Work Plan

1990-92

- Communicative video services support on B-ISDN (point-to-point);
- Initial services - videotelephony and videoconferencing (using limited point-to-multipoint connections),
  - lower rate retrieval;
  - point-to-point switched;
- Initial emphasis on CBR mode;
- Assessment of VBR vs CBR advantages/disadvantages;
- AAL Type 1 SAR and CS to be specified;
- AAL Type 2 SAR specified;
- Degree of compatibility with existing coding standards required;
- SGXVIII Recommendation on network aspects of Integrated Video Services on B-ISDN;
- Studies on layered coding for service interworking in IVS;
- Traffic control and resource management.

1992-94

- Lower rate (?) distribution services;
- Support of VBR mode emerging, with use of CLP;
- AAL Type 2 CS specified;
- Digital television distribution.
- Enhanced multimedia video services;
- Enhanced signalling and control capabilities;
- Recommendations relating to service interworking in IVS and B-ISDN
- Architecture aspects.

1994+

- Wide range of interactive and distribution services;
- Digital HDTV services - broadcast and non-broadcast applications

Annex 2. Network Aspects

1. Information Flows

The nature of service information flows within a communications network influences the design and dimensioning of switches and transmission links and interfaces. Approaches to network resource management are also influenced by the characteristics of the service information flow. This issue is particulary relevant to B-ISDN given the diverse range of video service types and qualities to be supported.

Video service information can be characterised in many ways, including:

- The direction of information flow: video services may be bidirectional, eg. videotelephony and videoconference, or essentially unidirectional, eg. video distribution services for business and entertainment.

- The symmetry of information flow: messaging, retrieval and distribution services are characterised by asymmetrical information flows.

- The origin of the source material: how video signals enter the network (eg. direct from camera, from storage media, via satellite or other delivery mechanisms) can also provide a means of characterising service information flows.

2. Switch Functionality

The switching infrastructure of a Broadband ISDN may be required to support a variety of switched services. For example, among the interactive services, videotelephony will require point-to-point

switching while videoconferencing and lecture distribution require point-to-multipoint.

For distribution services both point-to-multipoint and broadcast switching will be required to offer closed-user-group and general service access respectively.

3. Signalling Requirements

The proposed service diversity of Broadband ISDN may require some associated enhancement of signalling protocols to accommodate the expanded service range. Signalling is necessary for the flexible implementation of multiparty and multiconnection calls for customers with multisite, multimedia communication needs.

Distribution services of all types (eg. data, audio, video, image and multimedia) require a means of selecting items from the range available at the point of service distribution.

4. Connection Control

The multimedia and multipoint nature of many B-ISDN services will require flexible means of connection control. It should, given that network resources are available, be possible to add or remove parties from a multiparty call and add or remove services from a multimedia call.

5. Storage Requirements

Many video and image services may require the network to store some aspect of the service. For example, video and messaging services will require network resident storage facilities, as will many forms of database. The efficiency and economy of such services is strongly influenced by the ease of coding and decoding images for storage and the characteristics of the storage medium itself eg. compact disk, videotape, magnetic disk.

6. Service Bit Rates

Services may be provided as either constant or variable bit rate. In the case of VBR,

Service bit rates and the nature of any bit rate variability are important issues associated with the development and implementation of network call admission and resource management strategies. Parameters such as the average bit rate, peak rate, likely burstiness and peak duration allow the network provider to determine whether sufficient network resources are available to support the call in the manner requested by the customer. Further, once a call is established, these parameters may play a role in usage monitoring at the User-Network Interface to ensure that conditions agreed at call establishment are not violated.

7. Quality of Service Aspects

Customer control of video and image service quality is an issue of both technical and economic importance. The flexibility to select the

required service quality based on tariff, application, or other considerations requires the availability of suitable mechanisms for characterising different qualities.

8. Timing Issues

The support of real-time services over an ATM network requires mechanisms to achieve timing recovery and compensate for variable, although bounded, network delays.

Cell jitter (the variable delay in cell arrivals) must be buffered within the codec. The size of the required buffers is determined by the cell jitter and the service bit rate.

For multimedia services there is a need to ensure differential delay between the various services, particularly the video and audio, is acceptable.

Annex 3. ATM Adaptation Layer

A3.1 AAL Type 1

A3-1-1 Service provided by AAL type 1

The services provided by AAL type 1 to the higher layer are:

- transfer of service data units with a constant source bit rate and the delivery of them with the same bit rate;
- transfer of timing information between source and destination;
- indication of lost or errored information which is not recovered by AAL type 1.

A3-1-2 Interaction with the management

The following indications may be passed from AAL type 1 in the user plane to the management plane:

- errors in the transmission of user information;
- lost or misinserted cells (further study is required on whether it is necessary to distinguish between lost and misinserted cells);
- cells with errored AAL Protocol Control Information (AAL-PCI) (further study is required to determine if this indication is necessary for services supported by this AAL type);
- loss of timing/synchronization.

A3-1-3 Functions in AAL type 1

The following functions may be performed in the AAL in order to enhance the service provided by the ATM layer:

a) segmentation and reassembly of user information;

b) handling of cell delay variation;

c) handling of lost and misinserted cells;

d) source clock frequency recovery at the receiver;

e) monitoring of AAL-PCI for bit errors;

f) handling of AAL-PCI bit errors;

g) monitoring of user information field for bit errors and possible corrective action (the use of this function for voice service is for further study);

h) other service specific functions are for further study.

The allocation of these functions to the CS or SAR is for further study.

Note - For circuit emulation a need has been identified to monitor the end-to-end QOS. This may be achieved by calculating a CRC for the CS-PDU payload, carried in one or more cells, and transmitting the result in the CS-PDU or by the use of an OAM cell. Further study is required.

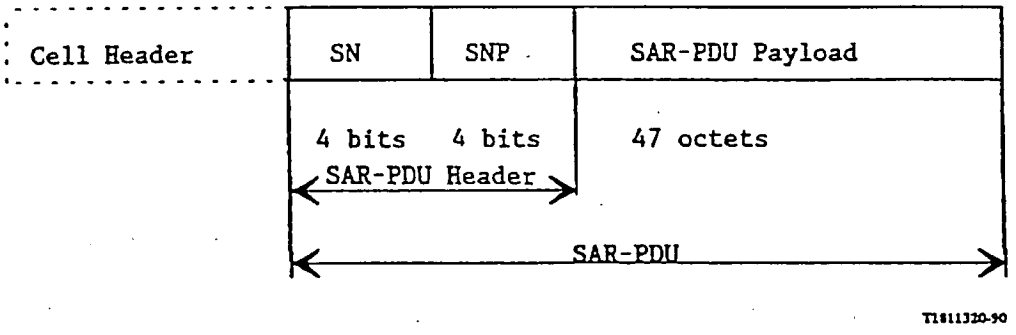
A3-1-4 Segmentation and Reassembly sublayer

Functions of the SAR Sublayer

The definitions of these functions are for further study.

The SAR functions are performed on a ATM-SDU basis.

SAR-PDU structure and coding



SN: Sequence Number (4 bits); to detect lost or misinserted cells.

A specific value of the sequence number may indicate a special purpose, e.g. the existence of Convergence Sublayer functions.

The exact counting scheme is for further study.

SNP: Sequence Number Protection (4 bits).

The SNP field may provide error detection and correction capabilities. The polynomial to be used is for further study.

FIGURE 1/I.363

SAR-PDU format for AAL type 1

A3-1-5 Convergence Sublayer

Functions of the CS

The CS may include the following functions

a) For high quality audio and video forward error correction may be performed to protect against bit errors. This may be combined with bit interleaving to give more secure protection against errors.

b) For some services, this sublayer provides the clock recovery capability for the receiver e.g. by monitoring the buffer filling. This requires no specific field in the CS-PDU.

c) For services requiring explicit time indication, this may be provided by means of a time stamp pattern inserted in the CS-PDU. Other mechanisms may be used to provide this function.

d) Further sequence number processing may be performed at this sublayer. The handling of lost and misinserted cells is also performed in this sublayer.

A3.2 AAL Type 2

A3-2-1 Service provided by AAL type 2

The services provided by AAL type 2 to the higher layer may include:

- transfer of service data units with a variable source bit rate;
- transfer of timing information between source and destination;
- indication of lost or errored information which is not recovered by AAL type 2.

A3-2-2 Interaction with the management

The following indications may be passed from the AAL type 2 in the user plane to the management plane:

- errors in the transmission of user information;
- loss of timing/synchronization;
- lost or misinserted cells (further study is required on whether it is necessary to distinguish between lost and misinserted cells);
- cells with errored AAL-PCI (further study is required to determine if this indication is necessary for all services supported by this AAL type).

A3-2-3 Functions in AAL type 2

The following functions may be performed in the AAL type 2 in order to enhance the service provided by the ATM layer:

a) segmentation and reassembly of user information;

b) handling of cell delay variation;

c) handling of lost and misinserted cells;

d) source clock frequency recovery at the receiver;

e) monitoring of AAL-PCI for bit errors;

f) handling of AAL-PCI bit errors;

g) monitoring of user information field for bit errors and possible corrective action (the use of this function for voice service is for further study);

The allocation of these functions to the CS or SAR is for further study. Other service specific functions are for further study.

A3-2-4 Segmentation and Reassembly sublayer

Functions of the SAR

For further study.

The SAR functions are performed on a ATM-SDU basis. As the SAR accepts variable length CS-PDUs from the convergence sublayer the SAR-PDUs may need to be partially filled.

SAR-PDU structure and coding

The SAR-PDU structure and coding requires urgent further study.

A3-2-4 Convergence Sublayer

Functions of the CS

The functions to be performed are for further study.

The Convergence Sublayer may perform the following functions:

a) clock recovery for variable bit rate audio and video services by means of the insertion of a time stamp or real time synchronization word in the CS-PDU. Other mechanisms may be used to provide this function;

b) sequence number processing may be performed to detect the loss or misinsertion of ATM-SDUs. The handling of lost and misinserted ATM-SDUs is also performed in this sublayer;

c) for audio and video services forward error correction may be performed.

A3-2-5 SGXVIII intends to continue its studies on AAL Type 2 in both the SAR and Convergence Sublayers to further elaborate the above text. As the AAL Type 2 will be used for a range of different services, SGXVIII is aiming to first establish the functional requirements for AAL type 2, identifying those which may be mandatory or optional for particular service applications. Inputs to SGXVIII from the specialist video coding groups of CCITT SGXV, CMTT and CCIR SG11 on video and image service AAL functional requirements are requested.

Annex 4. Video Service Interworking

Layered coding has been identified in Draft Rec I.211 as a promising means of facilitating interworking between video services, as well as providing protection in the event of cell loss. For comparison, however, non-layered coding methods should be considered. This would help identify the advantages and disadvantages in using a layered coding scheme and may reveal other means of achieving interworking.

Annex 5. Coding Aspects

A5.1 Constant Bit Rate (CBR) and Variable Bit Rate (VBR) coding

Restrictions of traditional circuit switched networks have meant that all commercial digital video codecs operate at a constant bit rate, this despite the inherently varying information content of a motion video sequence (being dependent on changing image complexity, degree of motion, frequency of scene changes, etc.). The internally varying rate in these codecs is smoothed by buffering, and dynamic control of codec parameters (sensitivity, quantiser stepsize, etc.) ensures that the buffer neither empties nor overflows. Such codecs operate in a fixed rate, but variable quality, mode.

ATM Networks will support Variable Bit Rate (VBR) coded video, allowing the transmitted bit rate to reflect the information content of the changing video signal, limited by the maximum channel capacity and parameters agreed with the network management system.

A VBR codec can therefore (usually) maintain a fixed quality, variable bit rate mode of operation. The possible advantages of this are:

- Because data is not transmitted when the information content is low, and because high rates are only used when necessary, VBR codecs are expected to deliver a given overall quality at a lower average rate than a CBR codec;
- The reduction in buffer size and easing of constraints on rate control means that there could be savings in codec complexity and cost;
- Reduced buffering may mean that end-to-end delays will be reduced; this is an important consideration for communicative services such as videotelephony and videoconferencing.

There may be substantial savings in average bit rate through the use of VBR coding and statistical multiplexing of multiple sources on the one network. Studies are required to confirm this advantage under realistic network conditions and to determine its sensitivity to the type of application (videoconferencing, television distribution, etc.) and method of coding. Delayed contribution D.962 from FRG to the Nov/Dec 1990 meeting of CCITT SGXVIII reported the results of some measurements which indicate that under certain conditions the statistical multiplexing gain of some VBR video service applications is only small.

Studies are also required to quantify the reduction in delay resulting from VBR coding, and to look at this saving in relation to limits obtained from human factors investigations.

A5.2 Compatibility Aspects.

It is important to consider the various applications of coded video signals and to maximise commonality where possible to achieve a truly integrated video services structure. A particularly important area for compatibility is in the coded representation of video for communications and storage.

Stored video has some constraints that are not applicable for communications applications. For example, there may be the requirement for fast forward, and reverse play. The constraints may differ depending on whether tape or disk based storage is used.

Efforts to provide commonality between stored and transmitted video formats have already been initiated by the ISO/IEC MPEG group. If, however, the coding techniques cannot be made identical, care should be taken to ensure that compatibility can be facilitated readily.

Compatibility between an IVS signal format and existing or emerging standard digital video formats for circuit switched networks should be the objective during the interim period before full B-ISDN support.

A5.3 Cell-based (ATM) Transport aspects relating to Video Coding

Transmission of video information in cells requires consideration of several factors:

- Error protection. A layered coding approach (see Annex 4) appears attractive as a means of minimising the effect of cell loss, particularly if it occurs in bursts. This requires separation of the video information into high and low priority components and appropriate setting of the cell loss priority (CLP) bit in the ATM cell header.
- Error propagation. Mechanisms to avoid propagation of errors in the event of a cell loss need to be investigated.

Annex 6. Multimedia Service Support

Support of multimedia services on B-ISDN will permit the use of virtual channels for separate service components of the multimedia connections. Issues that must be studied in this area include:

- Interworking with a terminal multiplexed multimedia connection (e.g. using H.221);
- Differential delays between virtual channels (particularly important for audio and associated video);
- Network usage parameter control and charging based on ensembles of virtual channels within one or multiple virtual paths;
- Signalling to support multi-connection calls within a single call, or use of multiple calls (each supporting one connection).