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Experts Group for ATM Video Coding

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Recommendation I.211 (Proposed Revision)

I.211 : B-ISDN SERVICE ASPECTS

Foreword

[No change is proposed.]

1 Classification of broadband ISDN services

[No change is proposed.]

2 General network aspects of broadband services

2.1 General

The purpose of this section is to give guidance concerning some of the important aspects which need to be taken into account when supporting and developing services for the B-ISDN.

In addition, Recommendations I.362 and I.363 describe ATM Adaptation Layer functions for B-ISDN services identified on the basis of timing relation (between source and destination), bit rate (constant or variable) and connection mode (connection oriented or connectionless).

2.2 Multimedia aspects

Broadband services may (ref. to 2.174) involve more than one information type. These services are termed multimedia services. For example, video-telephony will include audio, video and possibly some form of data. Other information types may be text and graphics for example. A structured approach to the development of multimedia services is recommended to ensure:

- flexibility for the user;
- simplicity for the network operator;
- control of interworking situations;
- commonality of terminal and network components.

The B-ISDN provides independent call and connection control facilities which should be exploited to help achieve the above objectives. The B-ISDN will make it possible, within a single call associated with a specific service, to establish a number of connections which may each be associated with a specific information type. The B-ISDN will enable the addition and/or deletion of optional information types during a call.

It is recommended therefore that the development of multimedia services proceeds on the basis of the following principles:

- that a limited set of standardized information types be developed;
- that the association of services and standardized information types be controlled, but in a flexible manner.

2.3 Quality of Service (QOS) aspects

2.3.1 General

Principles of Quality of Service (QOS) and Network Performance (NP) and their relationship with each other are described in Recommendation I.350. A method of identifying QOS and NP parameters is given in Annex A of Recommendation I.350. Further enhancement of the methodology and the definition of individual parameters for B-ISDN are for further study.

2.3.2 QOS indication and negotiation

QOS is negotiated during the call set up phase and possibly during a call. It is for further study whether specific QOS parameter values will be explicitly indicated (e.g. by a specific cell loss ratio value) or implicitly associated with specific service requests (e.g. a standardized service will by definition include the specification of all relevant QOS parameters). For several reasons, including network operation, interworking and service development, a limited number of specific QOS will be standardized.

Additionally, for some services there may be a need for an explicit Cell Loss Priority (CLP) indication on a cell by cell basis as a means of managing cell loss during periods of network congestion. This allows a user to use two levels of cell loss ratios for ATM connection. However, if this indicator is used it will be necessary during the call set up phase to indicate the intended incidence of use of this indicator. This is necessary to facilitate appropriate network resource allocation and usage/network parameter control. Further details on the use of CLP bit are in Recommendation I.371.

2.4 Service bit rate aspects

2.4.1 General

The issue of service bit rates and associated user assurances is very much related to suitable allocation of network resources. The objectives should include:

- support of service bit rate requirements;
- simplicity of service bit rate expressions;
- efficient utilization of network resources;
- exploitation of the inherent variable bit rate capability of ATM;
- increased use of network resources during lightly loaded periods.

2.4.2 Constant Bit Rate (CBR) services

Constant bit rates are expressed by a number of parameters, related to the traffic characteristics described in Recommendation I.371.

Constant service bit rates are negotiated at call set up time for on demand services and that the necessary network resources are fully allocated at this stage for the duration of the call. Changes to bit rates during a call may be negotiated via signalling and details are for further study. Service bit rates for permanent and semi-permanent connections may be determined by signalling, or by agreement with the Administration/RPOA, or some other method. This approach is consistent with that adopted for STM networks.

For several reasons, including network operation, interworking and service development, a number of specific bit rates will be standardized. A set of discrete bit rates will be chosen. For example, the circuit mode nx64rates of the 64 kbit/s-based ISDN, and the rates of the 1.544 Mbit/s and 2.048 Mbit/s hierarchies (see Recommendation G.702) will be supported. Other specific bit rates are for further study.

2.4.3 Variable bit rate (VBR) services

Variable bit rates are expressed by a number of parameters, related to the traffic characteristics described in Recommendation I.371.

These parameters for on demand services should be negotiated at call set up time, and if agreed, supported for the duration of the call. Service bit rates for permanent and semi-permanent connections may be determined by signalling, or by agreement with the Administration/RPOA, or some other method. Changes to these parameters may be negotiated within the call period and details are for further study. A set of discrete bit rates will be chosen. Further study of the specific bit rates and time periods is required.

The support of additional traffic exceeding the negotiated traffic parameter values is for further study.

2.4.4 Maximum service bit rate supported by the 155.520 Mbit/s interface

The transfer capability at the user network interface is 155.520 Mbit/s with a payload capacity of 149.760 Mbit/s. With the ATM cell format of a 5 octet header and 48 octet information field, the maximum rate available from the interface from all cell information fields is 135.631 Mbit/s.

The maximum service bit rate which can be supported on this interface may be equal to or less than 135.631 Mbit/s. The actual maximum service bit rate is for further study. The following factors, if applicable, will affect the actual maximum service bit rate:

- the service delay and buffering requirements ;
- the transfer capacity for signalling and OAM cells;
- the ATM Adaptation Layer overheads.

Note - The transfer over the B-ISDN of signals at service bit rates above 135.631 Mbit/s (e.g. TV signals near 140 Mbit/s, specified in CCIR Recommendation 721/CMTT) requires further study. In the interim such TV signals could be carried for example, via direct access to VC-4 containers in Synchronous Digital Hierarchy (SDH)-based transport networks, or via Plesiochronous Digital Hierarchy (PDH)-based networks, without the use of ATM.

2.4.5 Maximum service bit rate supported by the 622.080 Mbit/s interface

The transfer capability at the user network interface is 622.080 Mbit/s with a payload capacity of 599.040 Mbit/s. With the ATM cell format of a 5 octet header and 48 octet information field, the maximum rate available from the interface from all cell information fields is 542.526 Mbit/s.

The maximum service bit rate which can be supported on this interface may be equal to or less than 542.526 Mbit/s. The actual maximum service bit rate is for further study. The following factors, if applicable, will affect the actual maximum service bit rate:

- the service delay and buffering requirements;
- the transfer capacity for signalling and OAM cells;
- the ATM Adaptation Layer overheads.

2.4.6 Bit rate assurances

Constant bit rates negotiated at call set up time and negotiated by the Administration/RPOA should be assured to the user for the duration of the call. Similarly the parameters relating to VBR services should be assured for the call duration. No assurances can be given concerning additional traffic above that negotiated.

2.5 Service timing/synchronization aspects

2.5.1 General

Service requirements for timing functions vary widely and may be supported in a number of ways based both on end-to-end service information and on facilities available from the network.

Some existing services of 64 kbit/s-based ISDN will require 8kHz structured information transfer on an end-to-end basis. Such structured information transfer can be provided by B-ISDN for CBR services (see Recommendation I.363).

2.5.2 Source clock frequency recovery

Some services will require end-to-end transfer of source clock frequency. For these services the following are examples of methods available:

i) Synchronous Residual Time Stamp (SRTS) method: The transmitter provides a measure of the difference between the local service clock and the network provided reference clock. This information is encoded as a residual time stamp for transport to the receiver. The receiver uses the received residual time stamp and the network provided reference clock to reconstruct the local service clock.

ii) Adaptive clock method: The receiver writes the received information field into a buffer and then reads it with a local clock. The filling level of the buffer is used to control the frequency of the local clock.

iii) Use of a synchronization pattern: The transmitter writes an explicit synchronization pattern in its information field which is then used by the receiver to synchronize the local clock.

For more detailed descriptions of SRTS and adaptive clock methods, see Recommendation I.363.

2.5.3 Network provided timing information

Mechanisms should be provided to enable the full requirements regarding network provided timing and synchronization to enable services with 8kHz integrity to be supported. For some services, SRTS method of source clock frequency recovery will rely on network provided clock to meet timing requirements.

Two examples of network provided timing are:

- driving a local clock with timing information available from the T interface;
- the provision of network sourced time stamped cells.

2.6 Simultaneous service capabilities

The B-ISDN interfaces will be able to simultaneously support many combinations of services requiring different bit rates (both CBR and VBR) including broadband and existing ISDN services. The simultaneous service capabilities will be bounded by the payload capacity of the appropriate interface (e.g. 155.520 or 622.080 Mbit/s user-network interface).

2.7 Connectionless data service aspects

A connectionless data service supports data transfer between users based on connectionless data transfer techniques. It need not directly imply connectionless methods implemented within B-ISDN.

In the B-ISDN, virtual channels are established at the ATM layer only by means of the connection oriented technique. Therefore, connectionless data service can be supported using the B-ISDN in two ways as follows:

i) Indirectly via a B-ISDN connection oriented service: In this case a transparent connection of the ATM layer, either permanent, reserved or on demand, is used between B-ISDN interfaces. Connectionless protocols operating on and above the adaptation layer are transparent to the B-ISDN. The connectionless service and adaptation layer functions are implemented outside the B-ISDN. The B-ISDN thus imposes no constraints on the connectionless protocols to be adopted.

ii) Directly via a B-ISDN connectionless service: In this case the connectionless service function would be provided within the B-ISDN. The Connectionless Service Function (CLSF) handles connectionless protocols and routes data to a destination user according to routing information included in user data. Thus a connectionless service above the adaptation layer is provided in this case. (See Recommendation I.327)

Service i) above, may lead to an inefficient use of virtual connections of user-network interface and network-node interface, if permanent or reserved connections are configured among users. With the availability of signalling capabilities, an end-to-end connection may be established on demand at the commencement of connectionless data service. This on demand operation of Service i) above may cause call set up delay, and may introduce a load on call control functions within the network.

For service ii) above, there are also two options depending on the availability of B-ISDN signalling capabilities. Option one is to use preconfigured or semi-permanent virtual connections between users and connectionless service functions to route and switch connectionless data across the network. Option two is to establish virtual connections at the commencement of the connectionless service session.

Support of service i) above will always be possible. The support of a direct B-ISDN connectionless service (service ii) above) and the detailed service aspects are ~~for further study~~ (described in I.364).

2.8 Interworking aspects

The ISDN will have broadband (see Recommendation I.413) and narrow-band (see Recommendation I.412) interfaces connected logically to the same network. Services normally available from narrow-band interfaces will also be available from broadband interfaces. Such services will fully interwork without limitations.

2.9 Signalling aspects

The following are signalling requirements from the service perspective. Other aspects are for further study.

2.9.1 Interactive services

- Generic signalling mechanisms should be capable of simultaneously supporting many combinations of services as described in § 2.6.

- Specific signalling mechanisms are needed to achieve the capabilities required for B-ISDN signalling as described in Recommendation I.311.

- Several attribute values of the service need to be signaled and possibly negotiated during call establishment and possibly during a call such as:

  - Quality of Service parameters;
  - service bit rates for CBR and VBR services (see § 2.4);
  - ATM layer parameters (e.g. VCIs and VPIs).

[Note to Secretariat: In 1990 version, three lines above should be indented.]

Moreover, negotiated parameters need to be assured. The parameters that can be negotiated are for further study.

- Signalling mechanisms should exist for the transport of parameters associated with layers above ATM (e.g. ATM Adaptation Layer) up to and including the network layer.

- Signalling mechanisms must support the interworking requirements in § 2.8.

2.9.2 Distribution services

The signaling requirements for distribution services are characterized by frequent and simultaneous request by several users (e.g. video broadcast programme changes). Other aspects are for further study.

2.10 Service aspects of Virtual Path Connection (VPC) and Virtual Channel Connection (VCC)

Users can utilize two types of ATM connections, i.e., Virtual Path Connection (VPC) and Virtual Channel Connection (VCC) as described in Recommendation I.311. A VPC is a bundle of Virtual Channel (VC) links with common VC end-points. When using a VPC, identifiers of VC links are transparently conveyed through the VPC.

3 Video services and coding aspect

3.1 General

Coordination of video coding studies is required to ensure that maximum integration of video services is achieved through commonality of coding schemes and integration of the control and signalling system. Conformity of video coding studies with B-ISDN studies will allow the advantages available through an ISDN to be extended to the end user by minimizing the number of video terminals needed to access a range of interactive and distribution video and still image based services. The objective is to achieve the highest level of service integration through minimizing the number of coding techniques used across a wide range of video services and maximizing commonality of display devices.

The use of a common display device facilitates rationalization of a user's terminal needs for access to multiple video services. However, when this is combined with a single common decoder capable of handling different coding techniques and integration of the control and signalling system, the objective of maximizing commonality between interactive and distribution services can best be realized.

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

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

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

- economic provision of multi-service terminals and customer equipment;
- ease of adaptation of terminal equipment for different services;
- minimization of interworking requirements;
- minimization of trans-coding requirements in the network.

The following paragraphs identify the relevant service, network and video coding issues.

3.2 ATM network impacts on video coding

The ATM aspects, important from a video coding perspective, which need to be considered include:

- Information will be transported in cells.

- The QOS parameters (cell loss, absolute and relative network delays) will occur within specified limits (the parameters and the limits are for further study and are dependent on connection type).

- Network based timing information will be available (the relationship between network timing and service timing is described in § 2.5).

- The network will support both variable and constant bit rate services.

- The network will offer independent call and connection control facilities.

The implications of the above network aspects include:

- Coding studies and service developments must be consistent with the inherent capabilities provided by the ATM based B-ISDN.

- Codecs must be tolerant of cell loss which will also affect codec design in terms of the amount of error control and rate of forced image refresh.

- Call establishment and termination, which may require multiple connections, and other network related operation during a call, must be common across the multiple interworking video services.

- Control of the audio and video components of the connection must also be considered with the differential delay within specific bounds to allow independent support.

- End-to-end delay limits must be taken into account in both network and codec design for interactive services.

3.3 Video service interworking and coding aspect

The interworking of video services is such that a video receiver of the related terminal is able to present video information from a service other than that of its primary application. For example, a relatively low resolution video-telephony terminal should be able to display, within the limits of its resolution, a video signal of the quality level comparable to say a high quality TV service. Conversely, a relatively high quality receiver should be able to display a video-telephony image either as a small image on the screen or perhaps expanded to fill the screen. Terminals intended to receive moving images (i.e. video) should also be capable of accessing still image services.

B-ISDN will be capable of supporting a range of service applications (e.g. communicative real-time video, retrieval or store-and-forward video, and distribution services), covering a wide range of resolutions from video-telephony to High Definition Television (HDTV) at a range of qualities. Interworking of video services should be recognized as a key objective for both network capabilities and coding techniques. It should also be recognized that the definition of a family of picture formats (e.g. hierarchically defined from low to high resolutions) would be beneficial to provide easy interworking, or conversion where appropriate, between services, and to use common display components on a terminal device intended to access multiple video services.

The following three methods have been identified to achieve video service interworking:

i) Negotiation, or switchable encoder, approach : At the commencement of a connection, terminals negotiate a set of parameters with which both can cope. A set of standards of increasing quality would be defined and a basic capability assumed for all terminals.

ii) Simulcast : Transmitting terminals contain multiple encoders, operating at a variety of resolutions and quality levels so that broad inter-connectivity can be achieved by transmitting multiple parallel encoded signals. Receiving terminals could be simple devices able to receive one of the bit streams, or could contain multiple decoders allowing a selection.

iii) Layered signal approach : A layered representation of the video signal is defined. Coders transmit a baseband signal which provides a basic quality service. Incremental signals, which can be used along with the baseband to recover a high quality signal, are also transmitted. Receiving terminals utilize the baseband and an appropriate number of incremental signals to recover the video signal to the quality which they are capable of displaying.

A range of issues needs to be studied in comparing these different approaches, including complexity of network and coding capability, coding rate penalties and performance. They may provide different levels of compatibility, impose different constraints on both network and coding design and may be better matched to different applications. For example, the negotiation approach would seem inappropriate for multipoint and distribution services, whereas simulcast approach seems inappropriate for store-and-forward services. The layered signal approach seems suited to the wide range of applications. Studies should continue to identify the applicability, advantages and disadvantages of the various techniques.

3.4 Cell loss resilience and coding aspects

The layered signal approach described in item iii) of the previous section also offers improved cell loss protection. By decomposing the coded video information into separate layers, it is also possible to localize the most important and least important information into separate cells rather than combining all the information for one part of the picture within one cell. Since the most important information will occupy only a small proportion of the total number of transmitted cells, this means that the probability of a significant error (one that is highly visible) is reduced, i.e. it provides statistical error protection. This advantage is significantly enhanced if cell losses are controlled by the network by selectively discarding cells when necessary by use of the Cell Loss Priority (CLP) indicator. This necessitates layer identification on a cell-by-cell basis, and techniques to do this need to be studied.

Video signals of the layered structure may be coded either at variable bit rate or at constant bit rate. Although both systems could be supported in the B-ISDN, variable bit rate coding is particularly attractive for an ATM based network.

3.5 Variable Bit Rate (VBR) coding aspects

VBR coding is a coding method which produces a stream of bits whose rate is time varying according to the variation of amount of information in the original signal. A VBR video coder may produce only coded data of the video signal necessary to maintain a given image quality at each point in time. A VBR codec can therefore maintain a fixed quality. ATM based B-ISDNs can support VBR coding.The possible advantages of this are:

- Redundant data which may need to be sent in a constant bit rate (CBR) coding is not sent in VBR coding. Therefore, the network resources needed to support a VBR coding may be less than those necessary for CBR coding.

- Because very little data is transmitted when the information content is low, and because high rates are used only when necessary, VBR codecs are expected to provide an overall higher quality at a lower average rate than a CBR codec.

- The reduction in buffer size and easing of constraints on rate control in codecs means that there could be savings in codec complexity and cost.

- Reduced buffering may also mean that end-to-end delays will be reduced; this will be an important consideration for communicative services such as video-telephony and video-conferencing.

Savings of network resources from VBR coding increase as the inherent burstiness of the information rate increases. Retrieval services, for example, could lead to large bursts of data separated by long idle delays while a user is reading or considering the information. It also should be noted that the use of VBR coding on these very bursty services may facilitate relatively easy service interworking. A still image, for example, could be transmitted as a video signal. The interframe differences would rapidly decrease to zero. VBR coding can easily accommodate this variation.

Furthermore, there may be advantages through the use of VBR coding and ATM statistical multiplexing of multiple sources. The applicability of VBR coding to specific services (e.g. communicative or distribution, video-telephony, video-conferencing and HDTV) should be studied. Studies should also be addressed for facilitating codec design to conform to ATM network resource management (e.g., usage/network parameter control and connection admission control), in order to ensure that no violation of the negotiated agreements occurs.

3.6 Constant Bit Rate (CBR) coding aspects

Traditional video codings producing a constant bit rate will continue to be supported on the B-ISDN. The network will support specific rates up to the maximum service bit rate (see § 2.4.4) which will be assured by the network for the duration of the call. The assurance will refer to a specific maximum rate of cell loss, insertion and delay associated with the specific service negotiated during call set up and possibly during the call.

Bit rates for coding schemes should be chosen such that they can be conveniently carried with the required simultaneity within the user network interface. Section 2.6 indicates some of the necessary considerations. For example, if only one of a certain video service is required then this may use a bit rate up to the maximum service bit rate. The guidelines in § 2.6 should be used for assessing other capabilities.

When an existing CBR codec is to be connected to an ATM network, additional adaptation functions may be necessary, since the codec may not include functions required to cope with the ATM network characteristics such as cell losses and cell delay variations.

ANNEX A
(to Recommendation I.211)

Alphabetical list of abbreviations used in this Recommendation

CBR Constant Bit Rate
CLP Cell Loss Priority
CLSF Connectionless Service Function
HDTV High Definition Television
NP Network Performance
PDH Plesiochronous Digital hierarchy
OAM Operation and Maintenance
QOS Quality of Service
SDH Synchronous Digital Hierarchy
SRTS Synchronous Residual Time Stamp
VBR Variable Bit Rate
VC Virtual Channel
VCC Virtual Channel Connections
VCI Virtual Channel Identifier
VP Virtual Path
VPC Virtual Path Connection
VPI Virtual Path Identifier
