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

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Title : The network access for multi-layer and multi-resolution video services over the B-ISDN
Purpose : Discussion document

1. Introduction

Many organisations are now studying the possibility of transporting compressed video data over the future B-ISDN. The types of video services envisaged for operation on the B-ISDN range from low bit rate interactive real-time services such as videotelephony and videoconferencing, to high bit rate TV distribution. The use of 2-layer or multi-layer video coding, where a coded base layer is augmented with one or more enhancement layers, is gaining support by video coding experts as a suitable method for such video services. The main advantages of multi-layer coding are :-

a) high resilience to transmission errors such as incurred by cell loss,
b) scalability is provided by the selective display of different picture resolutions resulting from the combination of data from the various layers and
c) the possibility of better network loading when channels carrying the data of the various layers are operated with differing qualities of service (QOS).

2. Requirements of the network

For successful utilisation of multi-layer coding techniques, a number of requirements are demanded of the network. The main requirements are :-

2.1. Sufficiently small transmission delay for low bit rate services

One of the main advantages of the ATM based B-ISDN is that it offers a potentially small transmission delay due to the small cell/packet size of 53 bytes. This factor is of great importance to the usability of low bit rate videophone/videoconference type services whose success relies on short delays for conversational applications. A delay of a few milliseconds, which is understood to be currently envisaged for B-ISDN, is acceptable.

2.2. Need for layers to be transported with differing QOS

The very concept of multi-layer coding dictates the need for simultaneous transmission of parallel channels of compressed video data. Studies have shown that certain video codecs may offer higher network loading when the various layers are transported with differing qualities of services. This improved loading is achieved by utilising the codec's inherent resilience to

cell loss in the enhancement layers by operating the enhancement layer channels with a reduced QOS.

2.3. Minimal 'skew' in timing between received layers

Multi-layer codecs rely on picture information conveyed in the enhancement layers' channels to be synchronized and overlaid on the picture information conveyed in the base layer channel. However, the network may introduce timing 'skew' between the various received layers due different paths or priorities. Of course any 'skew' could be overcome by buffering the received datastreams but for videotelephony applications buffering should be kept to a minimum for the reason outlined above.

2.4. A maximum value of time for 'skew' between received layer data

In order to design multi-layered codecs for use on the B-ISDN it essential that a maximum limit is defined for the 'skew' between received datastreams of the various layer channels.

3. Current transmission scenarios

On close study and understanding of the current draft proposals for the B-ISDN produced by CCITT SGXVIII a number of scenarios have been identified as possible methods for conveying compressed video data produced by multi-layered codecs. ***It should be noted that from a video services point of view the term Virtual Path relates to an end-to-end path which may be at variance from how it is inferred by the draft B-ISDN recommendations.*** The design of a multi-layered codec demands that the base layer use a channel with a high QOS whilst the enhancement layers may use a reduced QOS. The following scenarios are explained using a 2-layer codec design as an example but the same principles apply to multi-layered codecs :-

3.1. 1 Virtual Path (VP) with 2 Virtual Channels (VCs) with differing qualities of service

It is understood that the current B-ISDN draft states that the QOS relates to a VP not a VC. However, by the introduction of the CLP bit, ambiguity exists in the draft recommendations. The ambiguity can be illustrated as follows: for a VP with a QOS of 10^{-8} it is implied that high priority cells (CLP=0) will have a QOS of 10^{-8} however it is still uncertain (under study!) what the QOS is for cell tagged as low priority (CLP=1).
Therefore it may be possible to make a connection between two terminals/codecs with 1 VP using 2 VCs. One VC is used to convey the base layer data with a high QOS and the second VC is used for the second (enhancement) layer using a reduced QOS.
However, this scenario introduces the possibility of timing 'skew' between the two channels within the VP if SGXVIII's view holds true that a VP only defines a route through a switch and not end-to-end..

3.2. 1 VP with 1VC using the CLP bit for multiplexing

An alternative connection is one made between two terminals/codecs with 1 VP using 1 VC. The base layer data cells are conveyed as high

priority cells (CLP bit = 0) and the second layer data cells are tagged as low priority (CLP bit = 1). This scheme effectively uses the CLP bit as the multiplexing switch. However this scenario is not recommended as the CLP bit may be modified by the network. This approach also limits the number of layers which can be simultaneously conveyed over the network to two. Of course, the multiplexing function could be performed by an inband indicator conveyed in the cell's information field, instead of relying on the CLP bit transported in the ATM header. The only advantage of this scenario is that by using 1 VC, both layers are synchronised and there is no possibility of timing 'skew'.

3.3. 2 VPs each with 1 VC

Another alternative is a connection consisting of 2 VPs each with 1 VC. This scenario conforms to the recommendation's linkage of VPs with QOS but still has the problem of possible timing 'skew' at the receiver. There is also the additional problem of the network management tracking the set-up of 2 (or more) VPs for a single call connection.

4. Clarification required from network specialists

In the light of the above comments it would greatly assist video coding experts in identifying suitable methods for conveying video data over the B-ISDN if network specialists could provide answers to the following questions :-

a) What is the best method of simultaneously transporting video data from different layers of a multi-layered video codec ?

b) Assuming that a multi-layered codec requires channels with differing QOS, is it true that the only option is to use multiple VPs, each with one VC ?

c) Does a signalling method exist which allows a single end-to-end call connection to be allocated multiple VPs ?

d) What is the maximum timing 'skew' between various VCs allocated to a single end-to-end call connection especially when using multiple VPs.