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

Document AVC-20
7/11/90

SOURCE: Bell Telephone Mfg. Co S.A.
TITLE: Impact of the ATM technique on video coding.
PURPOSE: Discussion.

1 Introduction

In this contribution an overview is given of the ATM characteristics that have an impact on video coding, and of video coding techniques that are adapted to these characteristics.
The purpose of the contribution is to come to a complete list within the experts group, to guide further study.
The contribution is accompanied by a video tape that illustrates different techniques.

2 ATM characteristics

The ATM technique shows following characteristics that impact video coding:

1. Availability of high bandwidths: link rates of approximately 150 Mbit/s and 600 Mbit/s are envisaged.

2. High bandwidth flexibility: a continuous spectrum of bit rates between 0 and the maximum allowable load on a link is available.

3. Variable Bit Rate capability: an ATM network is well suited to support VBR connections. Whether statistical multiplexing gains are achievable, depends on the provision of extra functionality, such as bandwidth allocation and policing functions.

4. Cell loss: because of the statistical nature of ATM, and because of bit errors in the cell header, a finite cell loss probability exists. With proper dimensioning, and the defined header error correction, end to end cell loss rates of 1E-8 or better can be achieved. Cell loss is most important for high quality high bit rate services.

5. Cell delay jitter: because of the presence of queues in an ATM network, the propagation time of a cell through an ATM network is not constant. Ref. [1] discusses values of cell delay jitter. Values in the order of 200 us must be taken into account.

4

6. Packetization delay. The time to packetize and depacketize information is determined by the cell length (48 octets) and the instantaneous bit rate of the source.

3 Video coding techniques adapted to ATM networks

Following techniques and methods take advantage of the ATM characteristics, or provide a method to cope with the ATM defects.

1. Coding at high bit rates.

Compared to the N-ISDN network, an ATM network will offer an increment of about 2 orders of magnitudes in bandwidth. This can be exploited to:

- reduce the complexity and cost of video codecs
- increase the quality of video codecs
    - better picture quality
    - shorter processing delays

2. Multiplexing of service components.

The bit rate flexibility of the ATM technique makes it possible to transport different service components on separate virtual circuits, without loss of bandwidth resources. This makes it e.g. possible to start a videophone call as a standard telephone call, and add an extra virtual circuit for the video component, after mutual agreement of the parties. When using this technique, attention must be payed to differential transport delays, and to differences in packetization delays.

3. User selectable picture quality and bit rate.

Because of the bit rate flexibility, it is possible to adapt bit rate and picture quality to the precise service requirements. These may vary from call to call, and the subscriber can determine the best compromise between picture quality and cost.

Because of this bit rate flexibility, it is technically feasible to cover the quality requirements of a wide range of services with a single coding scheme, e.g. video telephony, video distribution and video contribution applications. Whether a common coding scheme can be defined for these different applications, will largely depend on the coordination of MPEG, CMTT and SGXV/1 activities.

To operate over a wide range applications, variable length codes should be used that can be adapted to the source statistics. The Universal Variable Length Coding discussed in [2] automatically adapts to the source statistics.

4. Layered coding.

Because of the bit rate flexibility of the ATM technique, it is possible to divide the video information into multiple, complementary layers, with minimal loss of bandwidth efficiency. This can be done for following purposes:

- provide compatibility of video services over a wider picture quality range, e.g. including HDTV.
- to control the statistical multiplexing of VBR video sources, e.g. by guaranteeing a low resolution layer fixed bit rate coded on a high priority virtual circuit, and a high resolution layer VBR coded on a low priority virtual circuit
- cell loss concealment (cfr. infra).

5. Cell loss correction and concealment.

Cell loss correction can be achieved by the introduction of error correcting codes, e.g. parity cells [3], or Reed-Solomon codes combined with interleaving [4].

Cell loss concealment is based on layered coding. Following principles can be used:

- <u>statistical protection</u>: the most important layers take only part of the bit rate, therefore the average period between cell loss will be lower in the most important layers.
- <u>error correction adapted to the sensitivity of the layers:</u> for the most important layers, powerful cell loss restitution mechanisms can be used.
- <u>Coding adapted to the error sensitivity of the layers</u>: more important layers can be coded with algorithms that are less error sensitive: e.g. use no variable length codes.
- <u>Semantic priorities:</u> as the ATM technique offers two levels of priority, the most important layer can be assigned a high priority.

6. Service synchronization

Video service synchronization in an ATM network can be obtained in the following ways:

1. *Reference to the transmission clock.* If a common transmission clock is used in the ATM network, it is possible to derive the service clock by reference to the transmission clock at encoder and decoder side: e.g Synchronous Frequency Encoding Technique (SFET, Bellcore)

2. *Buffer filling level.* For FBR video the input buffer filling level at the decoder is a measure for the deviation of the local oscillator.

3. *Time stamping.* For VBR video, timing information can be inserted in the video bit stream in an implicit or explicit way. The difference with locally generated time stamps at the decoder side gives a measure for the deviation of the local oscillator. Examples of time stamping methods are given in [3] (RTSW) and [5].

4 Conclusions

A list of ATM characteristics that have an impact on video coding is given, together with a list of possible video coding techniques that adapt to these characteristics. Several techniques have been illustrated by a video tape. The list can be of use to guide further work within the experts group.

5 References

[1] RTT Belgium, "WD10 ATD information field size", CCITT SGXVIII Meeting, Seoul, South Korea, Jan.25-Feb.5, 1988.

[2] Belgium, "Digital Transmission of component-coded television signals at 34 and 45 Mbit/s. - Universal Variable Length coding and Video-Framing", CMTT-2/131, March 1990.

[3] S. d'Agostino, "ATM channel adaptor for universal videocodec", Austratlian Video Communications Workshop, Melbourne, 9-11 July, 1990

[4] J.-P. Jallet, M. Dekesel, "A Compatible HDTV codec for the Belgian Broadband Experiment", 3th international Workshop on Packet Video, March 22-23, 1990, Morristown.

[5] W. Verbiest, L. Pinnoo, "A Variable Bit Rate Video Codec for Asynchronous Transfer Mode Networks", IEEE JSAC Vol.7, No.5, 1989.