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

Document AVC-98
August 14-16, 1991

SOURCE: RTT BELGIUM
TITLE: Requirements analysis for video services
PURPOSE: For Information

I. INTRODUCTION

During the last CCITT SGXV/1 Experts Group meeting for ATM video coding, it was decided to contribute actively to the upgrading of the Integrated Video Services (IVS) Baseline Document. In this context, we provide information about ATM network issues, more specific concerning the impact of video service requirements on ATM network parameters and required error handling. The interaction between QOS objectives, network performance, error handling and coding algorithm will be discussed.

II. ATM NETWORK REQUIREMENTS

In annex 1, the interaction between the service and network requirements is shown for a broad range of services. The third column of the table gives estimates of QOS requirement values, indicating the average time between errors. These values serve as a guide for the calculations of the required ATM network parameters to achieve this QOS requirements, in particular the required end-to-end bit error rate (BER) and cell loss ratio (CLR) of the ATM network. They are, amongst others, a measure for the performance of the ATM network. For the figures in the table, the bit errors and cell losses are assumed to be isolated.

A. Network dimensioning and loading

When no error handling is accomplished, the network requirements are very demanding. In order to have on the average only one error in 30 minutes, a videoconferencing call of 5Mbps requires BER<1e-10 and CLR<4e-8 network figures. For TV distribution services the requirements are even more stringent.

B. Error visibility

Even when the ATM network guarantees such low error figures, still ATM related errors can occur, although few. Then another aspect is the visibility of this error. Even in the event of on average only one error during a call, this error could cause a synchronization loss, which would be unacceptable from the quality of service point of view.

III. IMPACT OF BIT ERROR HANDLING ON THE ATM NETWORK REQUIREMENTS

A. ATM payload scrambling

A self synchronising scrambler 1+x**43 will be used on UNI and NNI. The result of this is an error multiplication by a factor of two. This means that correlated double bit error will occur in the ATM payload (distance 43 bits).

B. Cell based bit error correction

A forward error correction polynomial 1+x+x**4+x**5+x**9+x**10 can cope with such a correlated double bit error. A FEC field of 10 bit performed over the entire contents of the SAR-PDU (i.e. the complete cell without the ATM header) is sufficient to implement this function.

For a videoconferencing application with a 5Mbps bit rate and given QOS requirement, the required bit error rate decreases from 1e-10 to 8e-7 when such a bit error correction scheme is implemented in the AAL (see annex 1). Thus the bit error rate requirements become more relaxed.

Table 1 indicates, for the services considered, whether bit error correction on cell basis is required and sufficient to fulfil the QOS requirements. Two different bit error rates are considered. The table illustrates, that under certain circumstances, a single bit error correction on a cell level is not sufficient. For these particular services, additional error handling is required (see further).

BIT ERROR RATE	BER=1e-6	BER=1e-8
Videophone H261	- (user layer)	- (user layer)
Videophone VBR	M	M
Videoconference	M but not sufficient	M
TV distribution	M but not sufficient	M
MPEG1 core	M	M
MPEG2 core	M but not sufficient	M

Table 1: Bit error correction on cell level

- : bit error correction on a cell level is not needed
M : bit error correction on a cell level is mandatory

C. Bit error correction in user layer (existing services)

Existing services have their own bit error correction mechanisms. It is important to note that the ATM network characteristics have impact on the effective correction capabilities of already implemented correction mechanisms in the user layer. Consider for instance the H261 case, where a BCH(511,493) error correction code is implemented on the video stream. This scheme is able to correct up to 2 isolated bit errors. Only single bit errors on an ATM link can be corrected with this BCH(511,493) of the H261 algorithm, for ATM payload scrambling doubles this bit error. This results in a significant reduction of the H261 error correcting capabilities due to specific ATM impairments.

IV. IMPACT ADDITIONAL CELL LOSS HANDLING ON THE ATM NETWORK REQUIREMENTS

A. Cell loss detection

Cell loss is a typical ATM related error. Existing services for instance, such as H261, are designed to work in a N-ISDN environment where cell loss is an unknown concept.

A single cell loss corresponds to an erasure of 384 bits of information. This may result in synchronization loss at the receiver, which can last for several time. In order to cope with this information erasure, a minimum requirement is the possibility to detect such errors. The handling of this error may, depending on the service, consist of replacement of the lost cell by a dummy cell, correction of the lost cell or concealment of the error.

B. Single cell loss correction

Depending on the cell loss ratio of the ATM network and the service, additional cell loss correction capabilities are needed. Annex 1 shows, that for a CLR of 1e-8 (isolated errors), only TV distribution requires additional cell loss correction. In that case, a simple correction method is described in [2]. It consists of a parity cell each 31 service cells in combination with cell numbering. Parity is calculated vertically on the 31 service cells and is stored in the parity cell which becomes the 32th cell of the block. Single cell loss correction relaxes the network requirements: for the videoconference application, the required CLR lowers from 4e-8 to 5e-5.

Table 2 indicates for a range of services whether single cell loss correction is required for 2 given cell loss rates of the ATM network.

CELL LOSS RATE	CLR=1e-6	CLR=1e-8
Videophone H261	M	-
Videophone VBR	M	-
Videoconference	M	-
TV distribution	M	M
MPEG1 core	M	-

MPEG2 core	M	-

Table 2: cell loss correction

-: single cell loss correction is not needed
M: single cell loss correction is mandatory.

In general, the recovery of lost cells implies the use of inter-cell protection. The cells are then protected by blocks. This is done by means of redundancy cells appended to the end of each block of service cells [3]. It is important to note that the sequence number used for cell loss detection does not need to be protected by the redundancy cells, since the cyclic redundancy of the sequence number can be used to reconstruct the sequence number of the lost cell.

C. Possible interaction with bit error correction/detection

In table 1 it is shown that under certain circumstances, a single bit error correction on a cell level is not sufficient to fulfil the QOS requirements. A possible solution is to use the bit error correction scheme in combination with cell loss handling. If a cell has non correctable bit errors, these bit errors can be detected when they fall within the detection capabilities of the code used. The corrupted cell (with non-recoverable bit errors) is then replaced by a dummy cell and corrected with the additional cell loss correction mechanism. Comparison between the last two columns of the table in annex 1 illustrates the further reduction of the required bit error rate. Note that for these calculations, it was assumed that the bit error handling mechanism corrects all single ATM link bit errors and detects all double ATM link bit errors (remark: the 10 bit FEC described above corrects all single ATM link bit errors and detects only part of the double ATM link bit errors).

D. Bursty cell loss correction

The described cell loss correction method based on inter-cell protection is useful in case of isolated losses. If the maximum value of consecutive cell losses was known, one could construct a code to correct for this. For instance, in [3] it is shown that with a Reed Solomon code over GF(256), a protection mechanism can be constructed based on the use of four redundancy cells built from 124 consecutive service cells and shuffled into the cell flow to form a 128 cell block. The method allows the recovery of four lost cells per code block of 128 cells. The method is useful if it is known a priori that the cell loss bursts for the corresponding service are not exceeding four.

Methods which allow for recovery of a larger number of lost cells, require complex configurations, with large buffers and long processing delays.

E. Cell loss concealment

A good way to handle bursts of cell loss is, since no a priori knowledge about the burstiness behaviour of cell loss in the network is present, to cope for it from the early beginning when designing the coding algorithm. Of course, the method is only to be used for new standards, where it is still possible to take into account in the algorithm the specific ATM network characteristics. A valid solution is the use of a layered coding scheme [4]: using layered coding it is possible to divide the video information into classes depending on the importance of the information. Cell loss concealment principles are described in [5].

V. CONCLUSION

A requirements analysis for video services has been elaborated. Aspects concerning the interaction between QOS objectives, network performance, error handling and coding algorithm used have been discussed. It is suggested that this information will be taken into consideration by CCITTSGXV/1 Experts Group on ATM video coding when upgrading the AVS Baseline Document.

REFERENCES

[1] Annexes 5 and 6 of the report of WPXVIII/8, TD40, CCITT SGXVIII/8, 26/11-7/12/90, Matsuyama
[2] S. D'Agostino, "ATM channel adaptor for universal videocodec", Australian Video Communications Workshop, Melbourne, 9-11 July 1990.
[3] RTT Belgium, "ATM Adaptation Layer for VBR class 2 services with protection against multiple cell losses, ETSI/NA5 TD90/77, Roma, 5-9 March 1990.
[4] W.Verbiest, B.Voeten, L.Elewaut, "Definition of a Universal ATM Video Coding Architecture", 3th international workshop on packet video, Morristown, March 90.
[5] Bell Telephone M.C.,"Impact of the ATM technique on video coding", AVC-20, CCITT SGXV/WP1 experts group on ATM video coding, 7/11/90.

ANNEX 1: INTERACTION SERVICE AND NETWORK REQUIREMENTS.

Service	**Bit rate**	**QOS requirements (***)**	**Required BER/CLR without error handling in AAL**	**AAL type**	**Required BER/CLR after single bit error correction on cell basis in AAL (*)**	**Required BER/CLR after single bit EC on cell basis and addit. cell loss correction in AAL (**)**
Communication						
videophone	64kbps/2Mbps FBR (H261)	30 min error free	BER<1.e-6 CLR<1.e-7 (BCH(511,493) FEC in user layer)	type 1	in user layer	BER<... CLR<8.e-5
videophone	2Mbps VBR	30 min error free	BER<3e-10 CLR<1e-7	type 2	BER<1.2e-6 CLR<1e-7	BER<2.3e-5 (CLR=1e-6) CLR<8e-5
videoconference	5Mbps VBR	30 min error free	BER<1e-10 CLR<4e-8	type 2	BER<8e-7 CLR<4e-8	BER<1.8e-5 (CLR=1e-6) CLR<5e-5
videodistribution						
TV distribution	20-50Mbps VBR	2 hours error free	BER<3e-12 CLR<1e-9	type 2	BER<1.2e-7 CLR<1e-9	BER<6e-6 (CLR=1e-6) CLR<8e-6
MPEG1 core	1.5Mbps VBR	30 min error free	BER<4e-10 CLR<1e-7	type 2	BER<1.4e-6 CLR<1e-7	BER<2.5e-5 (CLR=1.e-6) CLR<9.5e-5
MPEG2 core	10Mbps VBR	30 min error free	BER<6e-11 CLR<2e-8	type 2	BER<5.4e-7 CLR<2e-8	BER<1.5e-5 (CLR=1.e-6) CLR<4.e-5
Interactive video accesses						
video database, tex, mail, instruction				type 3/4		

(*) Payload scrambling polynomial 1+x**43 produces double, correlated bit errors.

(**) Based on parity cell built from 31 consecutive data cells (see further in annex 1). The cell losses are assumed to be isolated. With this simple correction scheme, single cell losses can be corrected if combined with cell loss detection by cell numbering. Also non-corrected but detected bit errors in a cell are handled by replacing this faulty cell by a dummy cell followed by correction of this cell by the cell parity mechanism. The BER calculations are done in the assumption that all double ATM link errors (2 times 2 correlated errors due to payload scrambling) can be detected.

(***) QOS requirements, as visualized by viewers; not directly related to channel errors.