ITU-T Telecommunication Standardization Sector
Study Group 15
Experts Group for Video Coding and Systems
in ATM and Other Network Environments

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Purpose: Report

1. Introduction[1]

During the ATM Video Coding (AVC) Experts Group meeting in Paris [1], the group agreed to establish a set of ATM network performance scenarios in order to facilitate the process of specifying Recommendations H.310, H.222.1, and H.321. In a previous report, the performance assumptions of key ATM-related parameters were documented and summarized [2]. After (a) exchanging several liaisons with ITU-T SG 13 Working Party 4, and (b) consulting with broadband network performance experts, more information became available to the AVC group. In this report, the ATM performance assumptions are updated to reflect the new information received by the group. However, and similar to the AVC-635 report [2], the data contained here represents the best available information that the AVC group can *assume* at this stage. As additional and more accurate information becomes available, the AVC group will modify the appropriate performance numbers. *It is important to note that the performance numbers summarized here do not represent official numbers from any national or international standardization bodies, or from any industrial affiliations.*

2. ATM Performance Assumptions

Table 1 summarizes the ATM performance assumptions for three scenarios. The end-to-end delay and Cell Delay Variation (CDV) numbers depend on:

- the number of ATM nodes in the ATM layer (virtual path/channel) connection[2],
- the characteristics of the arrival processes of the different queues in the system[3],
- and the cell's service time[4].

In addition, the performance numbers vary depending if one assumes that the arrival processes at the different nodes are independent or not. These and other factors explain the wide range of per-

1. This document is an update of Reference [2], AVC-635 "ATM Performance Assumptions".

2. Examples of ATM nodes are ATM multiplexers, ATM cross-connects, and ATM switches. A connection may have a very few ATM switches but a large number of ATM nodes (eight or more nodes in a national connection and even a larger number in an international connection).

3. Assuming a Poisson arrival process, as done in some simulations or queuing models, does not represent the most conservative assumption. Other arrival processes might be more suitable especially when VBR traffic is considered.

4. The service time can be modeled as a deterministic process with a constant value equals to the cell transmission time. Therefore, the service time represents the inverse of the cell transmission rate. Using an exponential distribution for the service time provides conservative CDV numbers [4].

formance numbers shown in the table.

Parameters	CBR (DRAFT ASSUMPTIONS)		
	Worst Case	Average Case	Best Case
Cell Loss Ratio[a] (Without FEC)	10^{-6}	10^{-9}	10^{-11}
Cell Loss Ratio[b] (With FEC)	See note[c]		
Severely Errored Cell Block (SECB) Ratio[d]	See note[e]		
BER[f]	10^{-7}	10^{-9}	10^{-11}
Burst BER Events	See note[g]		
End-to-End Delay[h] (UNI-UNI)	10 milliseconds + (propagation delay)	5 milliseconds + (propagation delay)	< [1 milliseconds + (propagation delay)][i]
End-to-End Delay (AAL/H.222.1 SAP)	See note[j]		
CDV[k] (UNI-UNI)	$(400\text{-}1000)\tau$	$(200\text{-}400)\tau$	$(150\text{-}200)\tau$[l]
PDU Delay Variation (PDV) (AAL/H.222.1 SAP)	See note[m]		

TABLE 1. Performance Parameters' Assumptions

a. Although several experts agree with these CLR numbers, many other experts believe that these assumptions for CLR are *very* conservative. Nevertheless, the CLR assumptions have little impact on the AVC group work since, even with the above conservative estimates, the group agreed that there would be no need for employing a cell loss-recovery scheme for the broadband audiovisual H.310 terminals and for the adaptation of narrowband H.320 terminals over ATM (i.e., H.321 terminals).

b. As mentioned above, the AVC Experts Group agreed not to employ any FEC cell-loss recovery scheme for H.310 and H.321 terminals. This entry of the table may be omitted in future versions of this document.

c. These performance numbers depend on the particular FEC method selected.

d. Although the definition of SECB is not finalized yet (see note e. below), based on an ITU-T SG 13-WP 4/13 input [6], "SECBs will likely occur with a frequency equivalent to today's SES events. (≤0.2% end-to-end network commitment, per G.826. The actual SES performance is often much better.)"

e. SECB is defined as *a block of N cells with M (or more) errored or lost cells* [5]. The values of the parameters *N* and *M* are under study by ITU-T. The ATM Video Coding Experts Group may consider (1) influencing the selection of the values *N* and *M*, or (2) defining a similar parameter which is meaningful for video services over ATM. For example, if a video service employs the short interleaver [16 cell-based (94.88) Reed-Solomon] FEC method, then it is important in this case to characterize the performance based on the *event of having more than two lost cells or four errored cells in a 16-cell block*.

Moreover, and as noted below (see note f.), the AVC Experts Group is currently specifying error-protection mechanism(s) for H.310 terminals. One possible outcome of this effort is the definition of a FEC frame in the H.222.1 layer. The length of this FEC frame may occupy the payload of several (possibly around five) ATM cells. Once the FEC frame format is finalized, it is feasible that the Experts Group may recommend (to SG 13) the group preferences regarding particular values for the *N* and *M* parameters of SECBs. This information has been already communicated with SG 13 WP 4/13 [7].

f. The 10^{-7} worst case BER assumption is based on an input from ITU-T SG 13 WP4/13 [6]. The WP 4/13 input also noted that "Typical BER performance may be much better". In addition, several network performance experts believe that our current worst-case (and even average-case) BER assumptions (shown in TABLE 1.) might be quite conservative. The AVC Experts Group have requested SG-13 WP 4/13 input regarding the average and best-case BER scenarios [7]. Meanwhile, and even based on a BER of 10^{-9}, the AVC Experts Group have agreed that some error-protection capability is needed for high bitrate (e.g., 3-6 Mbits/second) conversational (bidirectional) H.310 terminals. The specification of H.310 error-protection scheme(s) is currently under study by the Experts Group.

g. An example of a burst BER event is Severely Errored Second (SES) which is defined as a second with a BER of 10^{-3} or worse [8]. SES, however, does not provide a meaningful characterization of the end-to-end performance for video services. Similar to the previous case (footnote e.), the AVC Experts Group (and in collaboration with other ITU groups) may consider defining video service-related burst BER parameter(s). For example, a *30 millisecond burst with a BER of 10^{-3} or worse* can cause an H.320 terminal to loose synchronization due to the loss of H.221 framing.

h. This represents the unidirectional (i.e., not the round-trip) delay. This delay does not include the extra delay encountered in the terminals. The worst and best-case delay assumptions were modified (from AVC-635 [2]) based on an input from ITU-T Q16/13 experts as reflected in Reference [6]. The AVC Experts Group have requested SG-13 WP 4/13 input regarding the average-case end-to-end delay number [7].

i. As mentioned above, the end-to-end delay depends on, among other things, the number of nodes in the virtual connection or path.

j. The end-to-end delay at this interface depends on the specific AAL selected, and the amount of smoothing required to reduce (or eliminate) the CDV.

k. τ is the cell service (i.e., transmission) time, and is a function of the bitrate. The worst-case CDV expression shown in the table is translated into about 1-3 milliseconds for the 155 Mbits/second data rate. Most experts consulted agreed that the one-millisecond CDV scenario is a good number to assume and work with. It is important to note, however, that the CDV values shown here are only applicable for (a) high bitrate links (e.g., 155 Mbits/second), and (b) CBR traffic only. Therefore, higher values of CDV are possible for low bitrate links (e.g., 1.5 Mbits/second) and/or VBR traffic [6].

l. Similar to the end-to-end delay, CDV depends on the number of nodes in the virtual connection or path. It also depends heavily on the characteristics of the traffic arriving at the different nodes.

m. At this interface, the delay variation value depends on the AAL layer selected and the amount of buffering and delay that can be tolerated. Jitter removal functions within the H.222.1 layer of H.310 terminals are under study.

References

[1] Okubo, S., "Report of the fifteenth experts group meeting in Paris (16-25 March 1994) - Part I and Part II." Document AVC-632R, March 25, 1994.

[2] ITU-T SG-15 AVC Experts Group Report AVC-635, "ATM Performance Assumptions," DRAFT V1.0, July 5, 1994.

[3] CCITT Recommendation G.801 (Blue Book), "Digital Transmission Models," Volume III - Fascicle III.5, Geneva 1989.

[4] Kleinrock, L., "Queueing Systems,", John Wiley & Sons, 1975.

[5] ITU Draft Recommendation I.356, "B-ISDN ATM Layer Cell Transfer Performance," March 3, 1993.

[6] ITU-T SG 13, Working Party 4/13, Liaison to SG 15, "Assumptions Concerning Possible ATM Network Performance Levels," Annex 43 (to the report of SG 13), Geneva Meeting, 14-25 November 1994.

[7] ITU-T SG 15, Q.2/15, "Liaison on ATM Performance Assumptions," Annex 6 to AVC-704 ITU-T SG 15 AVC Experts Group Meeting Report, Kamifukuoka, Japan, 24-27 January 1995.

[8] ITU Recommendation G.826, "Error performance parameters and objectives for international, constant bit rate digital paths at or above the primary rate," November 1, 1994.