CCITT SGXV
Working Party XV/1
Specialists Group on Coding for Visual Telephony

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Subject: Reference-Decoder Buffer Specification

Source: Bellcore

In document # 523 the concept of a Reference-Decoder was presented and several discussions were held on defining a decoder buffer size so that, under normal error-free transmission, it would never overflow. Consequently, a coding control formula based on minimum bit requirement as a function of decoder buffer size B was proposed. The formula did not however specify any numerical value for B. In this document, a brief analysis of the dynamics of buffer operation is given. This is then used as a basis to provide a specification for buffer-size B.

Let,

A_k = Number of bits in k^{th} frame

R = Channel rate in bps

P = Output decoder frame rate

B = Decoder buffer size

The dynamics of buffer operation can be best explained by referring to Fig.1. In this Figure Y_n denotes total number of bits in "n" coded frames (i.e., $Y_n = \sum_{k=1}^{k=n} A_k$). Clearly, with no coding control strategy, a bound on B cannot be found to guarantee normal operation of the buffer. For example, given any value for B, it is possible to have overflow at frame n^*, where

$$n^* > \frac{B - \frac{R}{2P}}{\frac{R}{2P}}$$

when $A_1 = A_2 = \ldots\ldots = A_{n^*-1} = \frac{R}{2P}$.

In fact using RM8, and based on the number of bits per frame generated for each CCITT test sequence, a measure of interframe variance, D, was calculated. The minimum value for D was 224 (corresponding to Swing), and its maximum value was 388 (corresponding to Salesman). This was used to find probability of buffer overflow as a function of buffer size B. Table I summarizes our findings.

Table I
Probability of Buffer Overflow in Two-Hour

D \ B	6400	12800	25600
388	0.257×10^{-3}	0	0
800	0.15×10^{-1}	0.186×10^{-6}	0.292×10^{-20}

Note that, to incorporate frames with higher interframe variance, an artificial value for D (e.g., D=800) was chosen and its results were also included in the the Table.

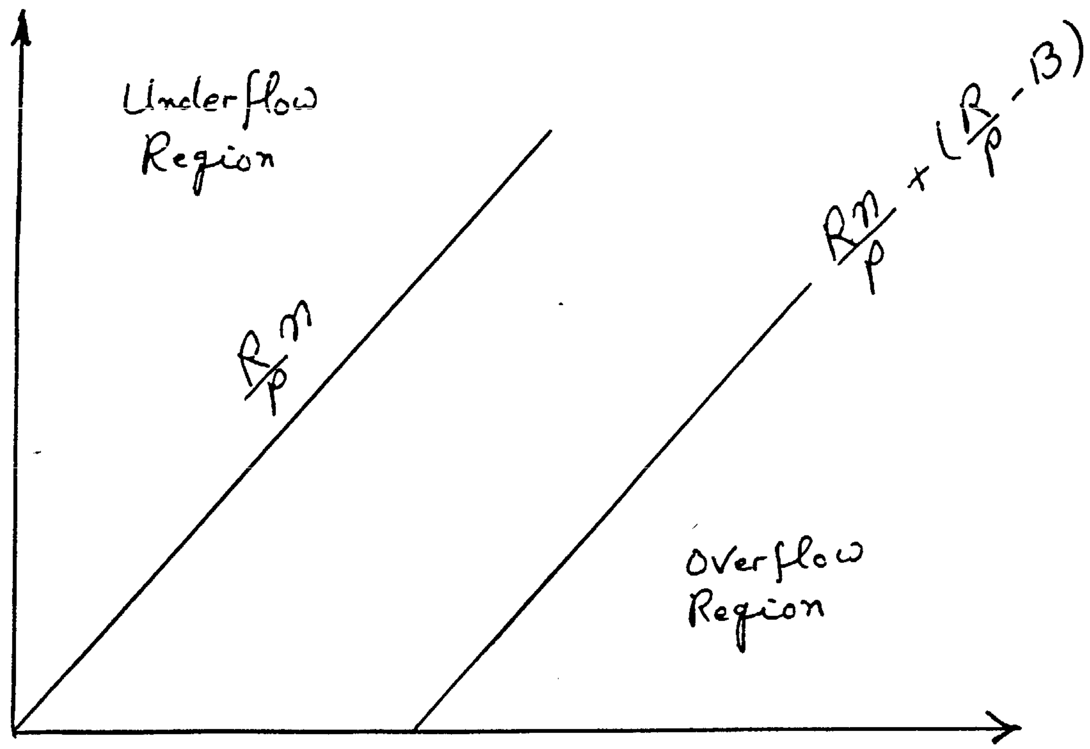
As expected, probability of overflow decreased rapidly with buffer size B, and it was inversely related to D. In both cases, however, it remained zero at $B = 25600 = 4 \times 6400$ for all practical purposes.

Now, by imposing minimum bit requirement at the encoder (as suggested in the Stuttgart formula) we can ensure frames with fewer bits than a pre-specified threshold value ,B_{avg}, will not cause buffer overflow. B_{avg}, can simply be found by equating the input and output rates at the decoder (i.e., $B_{avg} = \frac{R}{P}$ bits/frame). Under the above condition it is easy to show that buffer will not overflow if:

$$B \geqslant \frac{R}{P}$$

Considering factors such as end-to-end delay and transmission efficiency we obtain $B = \frac{R}{P}$.

Finally, for the case where number of coded bits/frame exceeds, B_{avg}, a limit on its maximum number has been specified (i.e., 256 Kbits CIF and 64 Kbits QCIF). With respect to buffer size B, however, our preliminary studies indicate that a buffer of size $\frac{4 \times R}{P}$ may suffice (see Table I).



Dynamics of Buffer Operation

Fig. 1