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SOURCE : Japan
TITLE : Considerations on Statistical Multiplex Gain according to the First Simplified Network Model
PURPOSE : Discussions

1. Introduction

Statistical Multiplex Gain for VBR coding is calculated using the First Simplified Network Model [1], and the advantage of VBR coding is discussed. Necessary future work is also discussed.

2. Definition of SMG

Assume an ON/OFF model and a VBR coded video source having a maximum bit rate of Peak and an average bit rate of Mean.

With a maximum available bandwidth of CAP, it is evident that as many as N_0 = CAP / Peak calls can be simultaneously accepted without any cell losses. Also, some larger number of calls, N_{Loss} can be accepted if we allow a cell loss rate of CLR, which is typically in the order of 10^{-8}.

Statistical Multiplex Gain (SMG) is defined as N_{Loss}/N_0, and it is a function of Peak, Mean, CAP and CLR. The value of SMG is always greater than 1.0.

3. An example

SMGs with various source and network conditions are given in the Annex. This section gives only one example to clarify the meaning of SMG.

Peak = 4 Mbps, Mean = 1 Mbps
CAP = 100 Mbps, CLR = 10^{-8}
$\Longrightarrow$
SMG = 1.33
(33 calls instead of 25.)

Implications

The above example implies that the two different coding schemes VBR(Peak = 4Mbps, Mean = 1Mbps) and CBR(Mean = 3Mbps) consume the same amount of network resources,

namely 1/33 of the maximum available bandwidth of 100 Mbps, and that the subjective quality of the former must be better than the latter to make VBR coding advantageous over CBR coding.

4. Discussions

As can be seen from the Tables and Figures in the Annex,

1. SMG becomes larger as networks grow, assuming the value of CAP increases accordingly.
2. The increase of SMG by allowing higher CLR is rather limited, and becomes even smaller as networks grow.
3. Considering (2), a service class which provides cells with reduced charge but with higher CLR may not be advantageous enough to justify the increased complexity of the terminal equipment.

5. Some factors affecting SMG

The values of Peak and Mean of the source are necessary to obtain SMG. Previously measured such values comes from a VBR coding scheme without control (open loop case, such as with fixed stepsize quantizers). A VBR coding scheme that obeys Usage Parameter Control (UPC) imposed by the network may exhibit different natures in terms of these parameters, thus affecting the absolute values of the SMG.

Further improvement of the Network Model may also affect the SMG. (For example, current model seems to give much higher CLR values than other models, thus resulting in lower SMG values.)

Although the particular values of SMG may differ as we improve the source and the network models, we believe the discussions in the previous section will still hold.

6. Future study

As is mentioned in section 3 as Implications, evaluation and comparison of subjective quality between VBR and CBR coded video signals is necessary to determine the effectiveness of VBR coding, particularly under the restriction of UPC.

Since SMG is only one of the possible parameters in such evaluation work, relationship between the two coding schemes in terms of subjective quality, once established, will be

always useful in spite of the possible improvement of SMG calculation.

7. Conclusion

Statistical Multiplex Gain for VBR coding is calculated using the First Simplified Network Model, and necessary future study is suggested.

Reference

[1] Annex 4 to Doc. AVC-22R, "First Simplified Network Model".

Annex

Statistical Multiplex Gain: Table and Figure

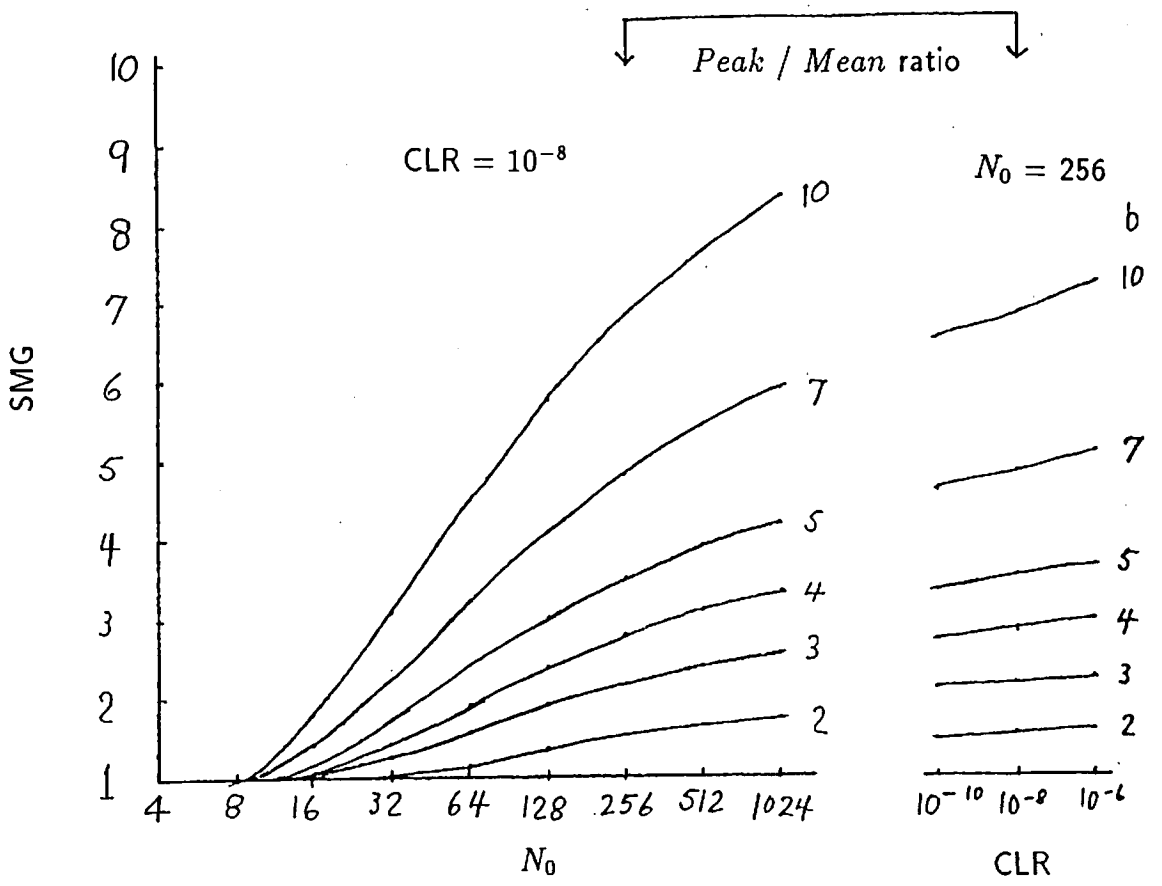
Statistical Multiplex Gain: Table and Figure

$Peak/Mean$	N_0	N_1	N_2	N_1/N_0	N_2/N_1
4	32	48	70	1.50	1.47
	64	128	169	2.00	1.32
	128	315	382	2.46	1.21
	256	729	833	2.85	1.14
	512	1614	1773	3.15	1.10
2	32	33	41	1.03	1.24
	64	77	93	1.20	1.21
	128	177	203	1.38	1.15
	256	393	435	1.54	1.11
	512	848	912	1.66	1.07
				Note 1	Note 2

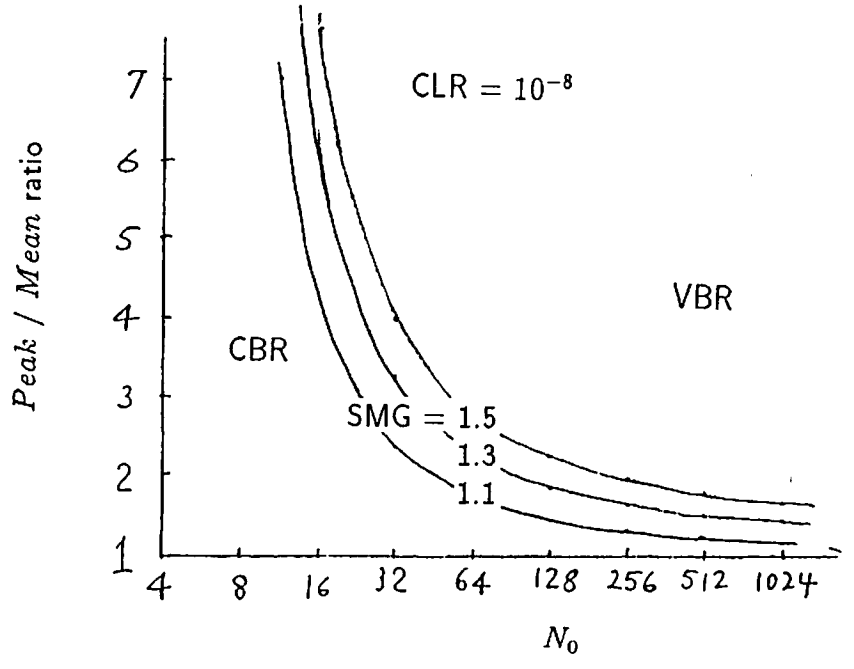
N_0 is the number of available channels without cell loss.
N_1 is the number with CLR = 10^{-8}.
N_2 is the number with CLR = 10^{-3}.

Note 1: SMG with CLR = 10^{-8}.
Note 2: SMG improvement ratio by accepting 10^5 times higher CLR.

Table 1. Effect of higer CLR on SMG

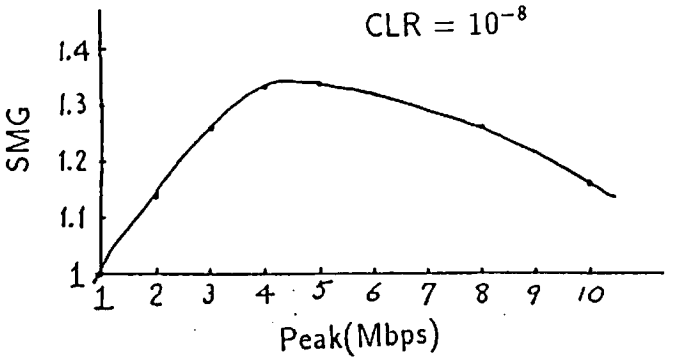


(a) SMG vs. N_0 (b) SMG vs. CLR

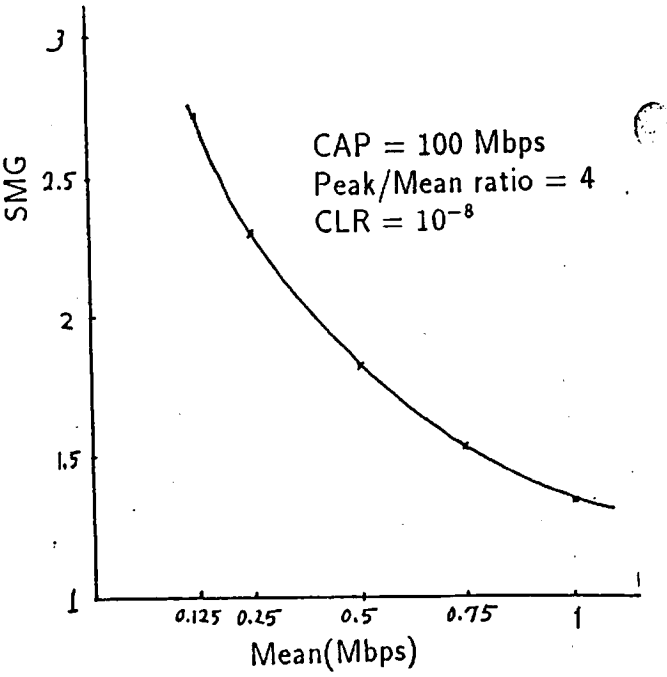


(c) Iso-VBR lines

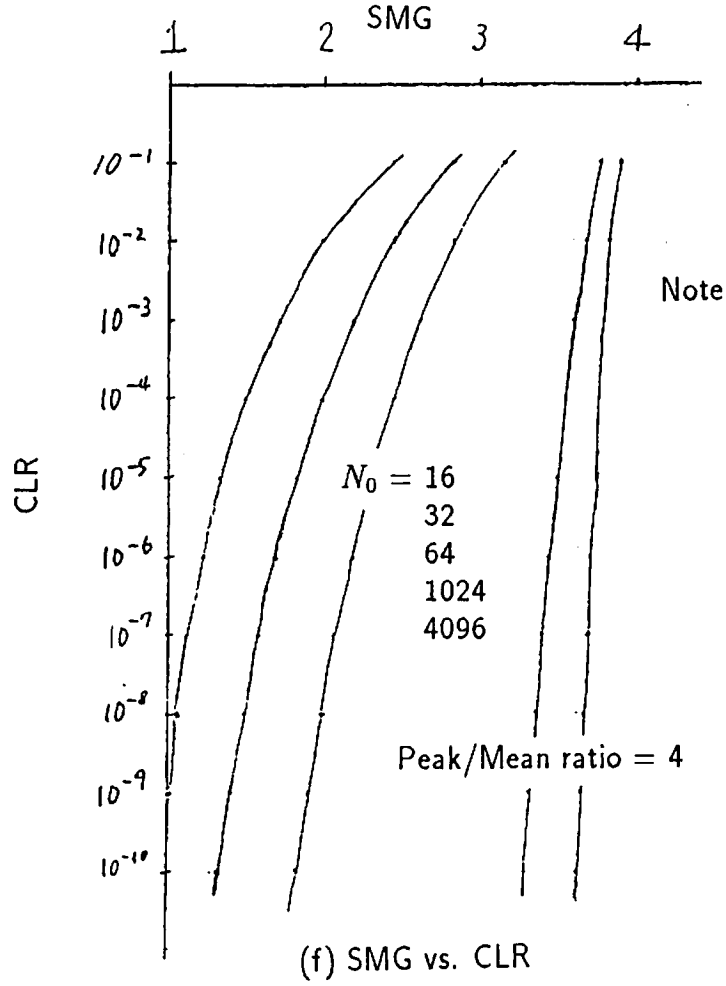
Fig.1 Statistical Multiplex Gain



(d) SMG vs. Peak



(e) SMG vs. Mean



Note: SMG approaches 4 when $N_0 \rightarrow \infty$.

(f) SMG vs. CLR

Fig.1 Statistical Multiplex Gain (continued)