Appraisal of paper: Unequal error protection: An information theoretic perspective by S. Borade, B. Nakiboglu and L. Zheng

Brief description of paper:

The paper addresses the problems of either protecting some bits of information within a message or protecting some messages within a set of messages at different levels i.e. where some bits or some messages are more important to transmit with very low error probability than others. Such problems are referred to as *unequal error protection (UEP)* problems. This paper is very much an information-theoretic study of these problems of the first order. It identifies performance limits and optimal coding strategies for a variety of UEP scenarios and concentrates almost exclusively on the important case where the data rate is close to capacity.

It refers to the case of protecting important bits within a message as the *bit-wise UEP* case and of protecting certain important messages within a message set as *message-wise UEP*. In this last case it distinguishes the cases of *missed detection* and *false alarm* probabilities (depending on whether the messages are in the special set). A particular case of interest is where one particular message is of importance to receive at very low error probability. The work notes that in the case of communicating at rates essentially at capacity one cannot achieve error exponents, for either the bit-wise or message-wise cases, that decay exponentially fast with increasing block length if all bits or messages are uniformly of the same importance. The question is asked whether the error probability of a particular bit or message can be made to decay exponentially in these cases?

A wide variety of scenarios are studied (in depth). These include fixed and variable block length codes as well as non-feedback and feedback channels. Error exponents for both single important bits and messages and subsets of important bits and messages are considered. In each scenario the intuition behind the results obtained is given and optimal strategies proposed.

While following all the proofs is somewhat daunting, the paper is well written, making it easy to appreciate the problems studied.

Comments:

In my opinion the paper represents the first systematic study of UEP coding from an information-theoretic point of view, apart from some limited work of Csiszar in 1980. It concentrates mainly on achieving positive error exponents at rates close to capacity. It is an impressive piece of work both from the array of important problems it addresses as well as the depth of information-theoretic analysis it achieves. Treating both the fixed and variable block length cases as well as the feedback and non-feedback cases makes it a rather comprehensive study. I believe many of the information-theoretic techniques it introduces to analyze the various problems will be of importance to further both this line of work as well as other related problems. I find it quite remarkable that this work, in a sense, has elevated the UEP problem from a rather ad hoc set of specific (and interesting) coding techniques to a a very serious information-theoretic study that puts it on a level with more traditional information-theoretic error control techniques. I would rate this paper very highly in the *Best Paper Award* exercise and support it strongly.

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