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Speaker: Giuseppe Caire, EE Department, USC
Title: Joint source channel coding
Abstract:

Digital communications have mainly focused on data transmission. Nevertheless, a large fraction of the traffic in communication networks involves the transmission of analog sources under some fidelity criterion. Killer applications over wireless and wired networks are MP3 downloads, media streaming, real-time voice and video, TV and audio multicasting and interactive gaming. For these sources, the information theoretic paradigm of large latency (large block length), vanishing block error rate and separation between source and channel coding fall short of capturing the essence of the problem. On a practical engineering level, the source coding techniques (e.g., MP3, JPEG2000, MPeg4) that have been developed assuming Shannon's separation theorem, i.e., assuming a perfect bit-pipe, impose overly restrictive requirements on the channel coding layer in terms of residual bit or block error rate. This yields either a large gap from optimal limits or a large complexity of the channel coding/decoding necessary to meet these requirements. In this tutorial presentation we shall review the basics of the rate-distortion limit for the lossy transmission of a source over a noisy channel. First we consider the case of a source over a binary-input output ymmetric noisy channel. We review the typical structure of most practical source coders and show that a concatenation of transform coding with linear binary channel coding achieves almost optimal performance (theoretically). We will discuss some practical example of implementation for the transmission of JPEG2000 encoded images over noisy channels. Then, we consider the case of multicasting of a single source to a number of different wireless receivers in different SNR conditions. We will discuss the canonical case of a Gaussian source over the compound Gaussian channel, and illustrate some interesting duality results. Finally, we shall consider the MIMO block-fading channel and discuss the optimal SNR exponent, that is, the largest d such that the average end to end distortion decreases as 1/SNR^d for large SNR (i.e., in the limit of high fidelity). We conclude by noticing that the ensemble of these results point out the need for a joint source-channel coding layer in next generation Internet and wireless internet in order to support efficient multi-media communications.