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Soft information aided synchronization: recent results

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USUAL synchronisation methods are either DA (data-aided) or pilot-aided, DD (decision-directed) or NDA (non-data aided). However it is nowadays a quite common practice to use modules delivering soft symbol information in a digital receiver. A popular example is the reception of turbo-encoded information in which two SISO modules separated by appropriate (de)interleavers exchange soft information. After a number of iterations the outer turbo decoder is expected to deliver reliable bit a posteriori information.

The idea of exchanging soft information between different modules has been extended to other functions than just decoding, leading to the so called ”turbo principle”. A first example is the iterative demodulation and decoding of a bit-interleaved coded modulation (BICM) transmission scheme. Another example is turbo equalization where an outer SISO module performing decoding exchanges soft information with an inner SISO module corresponding to equalization.

It is thus a logical idea to try and extend the use of soft information to other functions of a digital receiver, like synchronization that is to say estimation of carrier phase, carrier frequency offset or timing offset, or also channel impulse response. The first question which arises is of course how to use soft information in a synchronizer (including channel estimation). The second question is to investigate the possible advantages and improvements associated with soft-information driven parameter estimation.

The use of soft information for parameter estimation purposes can be nicely structured by looking at the problem in the light of the expectation-maximization (EM) algorithm. This algorithm has already been applied to various problems. Another possible framework is that of the sum-product algorithm applied on factor graphs.

In this presentation, we will revisit the problem of soft information based estimation of carrier phase, carrier frequency offset, timing and amplitude in the light of the EM framework or of the factor graph approach. The algorithms will be illustrated by simulation results. Results will also be reported for turbo channel estimation in SISO or MIMO channels.