Topic: Low Complexity Optimal Channel Decoder for Digital Radio Mundiale (DRM)

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Context: Digital Radio Mundiale (DRM) is a universal digital radio broadcasting system and has been designed specifically as a high quality digital replacement for current analogue radio broadcasting in the AM band (DRM30: up to 30 MHz) and FM/VHF bands (DRM+). Although the FM band (88-108 MHz) is gradually moving to a digital audio broadcasting (DAB) standard, the possibilities for extending coverage/range are limited in this band. Therefore, DRM30 is of great interest for broadcasters who recognize advantages of digital radio over analogue in the AM band. In short, these are high quality audio and services that enhance the listener's experience. E.g. stereo reception in AM band, or surround sound in cars are just a few advantages to name.

The DRM standard aims to enable such reliable communication in a hostile mobile wireless channel via a forward error correction scheme. The error correction method consists of a multilevel coding system which demultiplexes the incoming digital stream into multiple levels (three levels for 64-QAM) and individually encodes these levels before interleaving and mapping them to symbols from a complex signal constellation (64 symbols for 64-QAM). Each individual layer is protected with a convolutional code, therefore each layer is decoded by using the well-known Viterbi decoder that produces hard output (hard decisions on bits i.e. 1 or 0). Furthermore, this multilevel coding scheme allows a sequential decoding scheme where one selects the most reliable layer first and use the result of the decoded information – a-priori information - in decoding another layer more reliably known as onion peeling approach (as Multi-Stage Decoding). It is also possible to re-decode all the layers in an iterative manner by using the results of a previous iteration, improving the bit error rate with each iteration. A third approach would be to combine the sequential and iterative decoding schemes. There are several algorithmic limitations using the hard-output Viterbi decoder in all of these approaches although such a decoder comes readily available in the current NXP HW platform. Instead a soft-output Viterbi (a.k.a. SOVA) would allow - for all the wireless channel profiles involved – an easy determination of a proper decoding order – in the MSD case – and optimal a-priori information combining in all approaches listed.

GOAL: The challenge is to investigate a low complexity channel decoding strategy for DRM. In particular using the SOVA algorithm, the goal is to come up with the best performing (lowest bit-error-rate for a given SNR) channel decoding strategy for : (i) MSD, (ii) Iterative or (ii) a combination of the two.

Some Milestones:

- Implement SOVA in matlab (float) and [optional] to C/C++ to accelerate code
- Benchmark the current MSD approach with its fixed decoding order using the SOVA algorithm vs. the one with the hard-output Viterbi
- Derive a decoding order based on using the SOVA reliability metrics per each layer on the fly and benchmark this approach vs. the current approach with its fixed order

- Integrate SOVA into the existing brute-force iterative approach and benchmark vs. the previous approaches, find the optimal iteration number vs. the algorithmic performance improvements
- Estimate MIPS (cycle count) for a vector DSP for the most promising approach [optional: implement the approach on a vector DSP existing on the NXP HW platform]