1. **H. Balta**, C. Douillard, R. Lucaciu, "Multi-non-binary turbo codes", EURASIP Journal on Wireless Communications and Networking, ISSN 1687-1499, doi: 10.1186/1687-1499-2013-279, Dec 5, 279-2013.

Abstract—This paper presents a new family of turbo codes called multi-non-binary turbo codes (MNBTC) that generalizes the concept of turbo codes to multi-non-binary (MNB) parallel concatenated convolutional codes (PCCC). An MNBTC incorporates, as component encoders, recursive and systematic multi-non-binary convolutional encoders. The more compact data structure for these encoders confers some advantages on MNBTCs over other types of turbo codes, such as better asymptotic behavior, better convergence and reduced latency. This paper presents in detail the structure and operation of an MNBTC: MNB encoding, trellis termination, Max-Log-MAP decoding adapted to the MNB case. It also shows an example of MNBTC whose performance is compared with the state-of-the-art turbo code adopted in the DVB-RCS2 standard.

2. **H. Balta**, C. Douillard, A. Isar, **"**On the Equivalence Between Canonical Forms of Recursive Systematic Convolutional Transducers Based on Single Shift Registers", IEEE Access, ISSN 2169-3536, vol. 2, pp. 381 – 394, April 18, doi: 10.1109/ACCESS.2014.2316413, 2014.

Abstract—The standardized turbo codes (TC) use recursive systematic convolutional transducers of rate $b/(b+d)$, having a single feedback polynomial ($b+d$RSCT). In this paper we investigate the realizability of the $b+d$RSCT set through two single shift register canonical forms (SSRCF), called in the theory of linear systems constructibility and controllability. The two investigated SSRCF are the adaptations, for the implementation of $b+d$RSCT, of the better-known canonical forms controller (constructibility) and observer (controllability). Constructibility is the implementation form actually used for convolutional transducers in TCs. The study shows that any b+1RSCT can be implemented in a unique SSRCF observer. As a result, we build a function, $\xi:\mathcal{H}\rightarrow\mathcal{G}$, which has as definition domain the set of encoders in SSRCF constructibility, denoted by $\mathcal{H}$, and as co-domain a subset of encoders in SSRCF observer, denoted by $\mathcal{G}$. By proving the non-injectivity and non-surjectivity properties of the function ξ we prove that $\mathcal{H}$ is redundant and incomplete in comparison with $\mathcal{G}$, i.e. the SSRCF observer is more efficient than the SSRCF constructibility for the implementation of b+1RSCT. We show that the redundancy of the set $\mathcal{H}$ is dependent on the memory m and on the number of inputs b of the considered b+1RSCT. In addition, the difference between $\mathcal{G}$ and $\xi(\mathcal{H})$ contains encoders with very good performance when used in a TC structure. This difference is consistent for $m\approx b>1$. The results on the realizability of the b+1RSCT allowed us some considerations on $b+d$RSCT, with $b,d>1$, as well, for which we proposed the SSRCF controllability. These results could be useful in the design of TC based on exhaustive search.

3. **H. Balta**, R. Lucaciu, and A. Mihaescu, "Study on intra-symbol interleaving for multi-non-binary turbo codes", Proceedings of the 37th International Conference on Telecommunications and Signal Processing (TSP), ISBN 978-80-214-4983-1, ISSN 1805-5435, July 1-3, Berlin, Germany, pp. 125-128, 2014.

Abstract—Multi-Non-Binary Turbo Codes (MNBTC), i.e. the latest generation of turbo codes, operate with arrays of symbols, each symbol consisting of several bits. The interleaving for these multi-binary arrays of symbols required in turbo coding involves two steps: an inter-symbol interleaving and an intra-symbol interleaving. Inter-symbol interleaving mixes the data arrays columns. This can be achieved by using already existing dedicated interleavers. The novelty is intra-symbol interleaving, mixing symbols or even bits in each column of the data array. This paper investigates several possible intra-symbol interleaving methods in terms of their bit/frame error rate versus signal to noise ratio (BER/FERvsSNR) performances. The study allows some practical conclusions.

4. **H. Balta**, J. Gal, and C. Stolojescu-Crişan, "On the Double-Binary Turbo Coded Bits Allocation Mode in the Case of 256-QAM Square Modulation", Proceedings of the 37th International Conference on Telecommunications and Signal Processing (TSP), ISBN 978-80-214-4983-1, ISSN 1805-5435, July 1-3, Berlin, Germany, pp. 129-134, 2014.

Abstract—This paper presents a study concerning the allocation possibilities of the bits generated by the double binary turbo encoder (DBTE) in the modulator symbol, in the case of the quadrature amplitude squared modulation with 265 signal points (256-QAM), in AWGN channel. We compared the bit/frame error rate (B/FER) versus signal to noise ratio (SNR) performances of memory 3 and 4 double-binary turbo codes (DBTC), defined in DVB-RCS and DVB-RCS2 standards. We considered both DBTC common coding rate, ½, and the coding rate of ¾ obtained using puncturing. The simulations results lead to some conclusions for the selection of the best allocation methods, both in the water fall region and in error floor region.

5. **H. Balta**, C. Stolojescu-Crişan, J. Gal, "APP based iterations stopping criteria for MNBTC", Proceedings of the 19th International Conference on Methods and Models in Automation and Robotics (MMAR), ISBN 978-1-4799-5081-2, September 2-5, Miedzyzdroje, Poland, pp. 125-128, 2014.

Abstract—A study of the iterations stopping criteria adapted to multi-non-binary turbo-decoders, based on the evolution of a posteriori probability density (APP) is presented. The performaces bit / frame error rate (B/FER) versus signal to noise ratio (SNR) of multi-non-binary turbo codes (MNBTC) equipped with the iterations stopping mechanism proposed in this study are compared with those obtained using the genie iterations stopping criterion. Details about the redundancy in the number of processed iterations as compared to the ideal criterion are also presented.

6. M. Kovaci, **H. Balta**, "Turbo Coding over Nakagami-m Fading Channels", Proceedings of the Second International Conference on Advances in Computing, Electronics and Communication – ACEC, pp. 196-200, October 25-26, Zurich, Switzerland, ISBN: 978-1-63248-029-3, doi: 10.15224/ 978-1-63248-029-3-180, pp. 196-200, 2014.

Abstract—Nakagami-*m* channels are communication channels that can be modeled using the Nakagami-*m* distribution. The Nakagami-*m* distribution provides a wide range of models for channels exhibiting fading (fluctuating channels). By suitably choosing the *m* parameter, a certain fading intensity/strength can be simulated. This paper aims to assess the performance of different types of turbo-codes (TC) over Nakagami channels.

7. **H. Balta**, R. Lucaciu, and J. Gal, "Performances of Convolutional Encoders Trellises Termination Methods, Components of MNBTCs", Proceedings of the 11th International Symposium on Electronics and Telecommunications, ISBN 978-1-4799-7265-4, November 14-15, Timişoara, România, pp. 187-190, 2014.

Abstract—The closure/termination of convolutional encoders (CE) trellises can be achieved through several strategies, each offering advantages and disadvantages compared with the others. Because multi-non-binary turbo codes (MNBTCs) operate with shorter lengths of blocks of data than other families of turbo codes (TC), the strategy of terminating component CE trellises has a stronger influence on the encoding rate, and, implicitly, on the bit/frame error rate (B/FER) performance. This paper compares the performance of B/FER versus signal to noise ratio (SNR) for the main strategies for terminating the CE trellises, components of MNBTCs.

8. **H. Balta**, F. Alexa, A. Vesa, "On the Allocation of Double-Binary Turbo Coded Bits in the Case of 16-QAM Modulation", Proceedings of the 11th International Symposium on Electronics and Telecommunications, ISBN 978-1-4799-7265-4, November 14-15, Timişoara, România, pp. 191-196, 2014.

Abstract—It is well known that the 16-quadrature amplitude modulation (16-QAM) differently protects the bits of the same symbol. In turbo-coded transmission systems, several ways for allocating the bits generated by the turbo encoder can be considered. Thus, the bits generated by the turbo encoder can occupy different positions in the modulator input symbol. In this paper, we investigated the performance of transmission systems, in terms of bit/frame error rate versus signal to noise ratio (BER/FERvsSNR), in case of using double-binary turbo codes (DBTC) and 16-QAM square modulation, in AWGN channel, for various allocation modes. In our simulation we considered two coding rates, namely ½ and ¾. Intensive simulations up to FER $\approx 10^{-7}$, allow some practical tips on choosing the best allocation methods, both in the water fall and error floor regions.

9. **H. Balta**, C. Douillard, C. Stolojescu-Crisan, J. Gal, "The Performance Prediction of the DBTC with High Order Modulations in AWGN Channel", Advances in Electrical and Computer Engineering (AECE), ISSN 1582-7445, doi: 10.4316/AECE.2014.04005, is. 4, vol. 14, pp. 29-34, November 2014.

Abstract—In this paper, we present a method for turbo codes (TC) performance prediction, in terms of bit error rate (BER) and frame error rate (FER) versus signal to noise ratio (SNR), when they are used with high-order modulations (HOM). The method is based on two simplifying hypotheses and assumes that the BER/FER vs. SNR performance, in the case of BPSK modulation, is known. For the simulations we have chosen the double-binary turbo codes (DBTC) used in the DVB-RCS standard. The experimental results confirm the good accuracy of the proposed prediction method and validate our assumptions. The method has been applied in the case of 16-Quadrature Amplitude Modulation (16-QAM), but it can be easily extended to any other type of modulation.

10. R. Lucaciu, M. Kovaci, J. Gal, A. Mihaescu, and **H. Balta**, On the Turbo Coded Bits Allocation Mode for the 64-QAM Square Modulation, 38th International Conference on Telecommunications and Signal Processing (TSP-2015), July 9-11, Prague, Czech Republic, pp. 205-209, 2015

Abstract—This paper presents a study on turbo coded bit allocation in the modulator symbol for square quadrature amplitude modulation with 64 signal points. The simulations have involved both single binary turbo code of the LTE standard with coding rates 1/3 and 2/3 and double binary turbo code of the DVB-RCS2 with coding rate 2/3. The simulation results show that different investigated allocation methods affect dramatically the performance of bit/frame error rate versus signal to noise ratio of the turbo coded system. Hierarchies in performance of the allocation methods are completely different in regions with water fall versus error floor.

11. R. Lucaciu, M. Kovaci, J. Gal, **H. Balta**, On the Binary Allocation of Modulator Symbol in the Case of Turbo Coded 32-QAM Rectangular Modulation, 20th International Conference on Methods and Models in Automation and Robotics (MMAR-2015), August 24-27, Międzyzdroje, Poland, pp. 175-179, 2015

Abstract— This work is a continuation of the study on interfacing between turbo encoding and (digital) quadrature amplitude modulation (QAM). In the previous studies we have considered only the square constellations with 16, 64 and 256 signal points respectively. In this paper we investigated the performances of the turbo codes when using 32-QAM with a rectangular constellation. The placement variants of the turbo coded bits into the modulator symbol have bit/frame error rate (BER/FER) performance against signal to noise ratio (SNR) significantly different. Due to the presence of the 5 bits in 32-QAM modulator symbol, for a direct coupling between the turbo coding and the modulation blocks, in our simulations we used the 3/5 coding rate and two turbo codes (TCs). The first one is a double-binary turbo code (DBTC) defined in DVB-RCS2 standard and the second one is a triple binary turbo code (TBTC). If for DBTC it is required to use puncturing to obtain the coding rate of 3/5, for the TBTC this 3/5 coding rate is the natural one. The simulations made show that the two TCs behave similarly for all the cases of coding to modulation bit mapping (CMBM).

12. A. Vesa, M. Kovaci, L. Trifina, **H. Balta**, Memory 4 Triple-Binary Turbo Codes of Rate 0.6, 20th International Conference on Methods and Models in Automation and Robotics (MMAR-2015), August 24-27, Międzyzdroje, Poland, pp. 817-822, 2015

Abstract— In this paper, a triple binary turbo codes (TBTCs) family with rate 3/4 constituent convolutional codes of memory 4 is presented. With an observer canonical form implementation of component encoders, the family has over 500,000 units. In this family, we addressed the issue of selecting turbo codes. Through an exhaustive search using a selection criterion based on the convergence of the iterative process of turbo-decoding, we selected triple binary convolutional encoders (TBCEs). In simulations performed at their natural coding rate of 3/5 and at a coding rate of 3/4 obtained by puncturing, TBTCs resulted outperform in terms of bit/frame error rate versus signal to noise ratio (BER/FERvsSNR) the double-binary turbo code (DBTC) used in the DVB-RCS2 standard. In addition, TBTCs provide the advantages of a more compact data block structure.

13. M. Kovaci, **H. Balta**, A study on turbo coded 16-QAM bit allocation in Rice flat fading channel, The 10th International Conference on Future Networks and Communications (FNC 2015), August 17-20, Belfort, France, pp. 300-308, 2015

Abstract— The study presented in this paper shows that the coding gain between different allocation modalities between turbo encoder and quadrature amplitude modulator with 16 signal points is over 0.6dB in fading environment. The study presents comparatively the performances obtained with the single binary and double binary turbo codes of memory 4 (with 16 states) used in the LTE and DVB standards. It took into consideration the channel with flat fading, non-selective in frequency, of Ricean type for various degrees of strength. Because of the preferential protection offered by the quadrature amplitude modulation, the various modes of binary allocation between turbo encoding and the quadrature amplitude modulation provide very different bit error rates performances. The hierarchies in performance are strongly influenced by the signal per noise ratio at which work is done. The presented results are a guide for choosing the most adequate binary allocation modality between coding and modulation for specific applications.

14. Jonghoon Ryu, L. Trifina, **H. Balta**, The limitation of permutation polynomial interleavers for turbo codesand a scheme for dithering permutation polynomials, International Journal of Electronics and Communications (AEÜ), vol. 69, is. 10, pp. 1550-1556, 2015

Abstract— In this letter, partial upper bounds on minimum distance for turbo codes with permutation polynomial (PP) based interleavers over integer rings are derived using the fact that PPs are equivalent to a family of linear permutation polynomials (LPPs). It is shown that upper bounds on minimum distance of turbo codes using higher order PP based interleavers are bounded by a function of the number of equivalent LPPs for PPs. Besides, it is shown that when the constant terms of LPPs are dithered, the resulting dithered LPP interleavers perform better than the quadratic permutation polynomial (QPP) based interleavers used in long term evolution (LTE) standard or than other good QPP or cubic permutation polynomial (CPP) based interleavers given in the literature.

15. A. Vesa, F. Alexa, **H. Balta**, Comparisons between 2D and 3D Uniform Array Antennas, Federated Conference on Computer Science and Information Systems (FedCSIS-2015), September 13-16, Lodz, Poland, pp. 1295-1399, 2015.

Abstract— For any wireless communications antenna system becomes indispensable. In this paper we analyzed linear array, planar array and three - dimensional (3D) array antennas. The array systems are simulated in Matlab based on uniform linear array antennas. Comparisons between planar array antenna and 3D array antenna are provided take into account different phases of currents injected in antenna elements. Also we propose to use the array antenna in WSN due to the advantages in signal to noise ratio and power consumption.

16. M. Kovaci, **H. Balta**, Performance of Turbo Encoders with 64-QAM Modulators Interfacing Systems in Fading Environment, Buletinul Stiintific al Universitatii Politehnica Timisoara, Transactions on Electronics and Communications, vol. 60(74), is. 1, pp. 27-32, 2015.

Abstract— This paper presents a study on the interfacing between the turbo encoder and modulator. The binary allocation of the bits from a turbo coded symbol towards the modulator symbol can be done in several ways. This study shows the performance of the allocation modes taking into account the quadrature amplitude modulation with 64 points and the Rice fluctuating transmission channel. The simulations presented show that the performance of the entire transmission system, measured in coding gain may be influenced by up to 1 dB by a suitable choice of the allocation method