

V. CONCLUSION

In this paper we contrasted novel approaches, cooperative network coding and cooperative diversity coding that provide enhanced throughput, increased reliability and transparent self-healing for Wireless Body Area Networks. Cooperation provides increased reliability while coding (network coding or diversity coding) provide increased throughput by using spatial and time diversity. Additionally, latency, which is an important metric in some WBANs applications, is decreased because of the feed-forward nature of these approaches.

Also, since the topology of these networks (few hops) is known, Cooperative Diversity Coding provides higher throughput when compared to the other networks that we have considered in this paper including Cooperative Network coding, Cooperative Communications without coding and Diversity Coding without cooperation.

Although, these approaches provide similar benefits, CDC provides higher throughput than CNC because since in CDC both data (uncoded) and protection (coded) packets are transmitted, it is possible to obtain some or all of the original information from the uncoded packets; while since in CNC only coded packets are transmitted, it is required that the destination receives at least equal number of coded packets as to the original packets to be able to decode the original information. Moreover, CDC requires lower complexity because the coding coefficients are known by the source and destination nodes. Additionally, since the packet length is not increased (no need to embed the coding coefficients into the packet's header), the probability of packet error is smaller.

REFERENCES

- [1] S. Ullah, H. Higgins, B. Braem, B. Latre, C. Blondia, I. Moerman, S. Saleem, Z. Rahman, and K. S. Kwak, "A Comprehensive Survey of Wireless Body Area Networks," *Journal of Medical Systems*, Aug. 2010.
- [2] M. Patel and Jianfeng Wang, "Applications, challenges, and prospective in emerging body area networking technologies," *Wireless Communications, IEEE*, vol. 17, no. 1, pp. 80-88, 2010.
- [3] "IEEE 802.15 WPAN™ Task Group 6 (TG6) Body Area Networks." [Online]. Available: <http://www.ieee802.org/15/pub/TG6.html>. [Accessed: 15-Sep-2011].
- [4] M. Chen, S. Gonzalez, A. Vasilakos, H. Cao, and V. C. M. Leung, "Body Area Networks: A Survey," *Mobile Networks and Applications*, vol. 16, pp. 171-193, Aug. 2010.
- [5] B. Latré, B. Braem, I. Moerman, C. Blondia, and P. Demeester, "A survey on wireless body area networks," *Wireless Networks*, vol. 17, pp. 1-18, Nov. 2010.
- [6] Y. Hao and R. Foster, "Wireless body sensor networks for health-monitoring applications," *Physiological Measurement*, vol. 29, p. R27-R56, Nov. 2008.
- [7] Z. J. Haas and Tuan-Che Chen, "Cluster-based cooperative communication with network coding in wireless networks," in *MILITARY COMMUNICATIONS CONFERENCE, 2010 - MILCOM 2010*, 2010, pp. 2082-2089.
- [8] G. E. Arrobo and R. D. Gitlin, "Cooperative Diversity Coding for improving the performance of Wireless Body Area Networks," in *Submitted to IEEE Wireless Communications and Networking Conference (WCNC-2012)*, 2012.
- [9] R. Ahlswede, Ning Cai, S.-Y. R. Li, and R. W. Yeung, "Network information flow," *Information Theory, IEEE Transactions on*, vol. 46, no. 4, pp. 1204-1216, 2000.
- [10] T. Ho, M. Medard, R. Koetter, D. R. Karger, M. Effros, Jun Shi, and B. Leong, "A Random Linear Network Coding Approach to Multicast," *Information Theory, IEEE Transactions on*, vol. 52, no. 10, pp. 4413-4430, 2006.
- [11] A. K. Sadek, Weifeng Su, and K. J. R. Liu, "Clustered cooperative communications in wireless networks," in *Global Telecommunications Conference, 2005. GLOBECOM '05. IEEE*, 2005, vol. 3, p. 5 pp.
- [12] C. E. Perkins and E. M. Royer, "Ad-hoc on-demand distance vector routing," in *Mobile Computing Systems and Applications, 1999. Proceedings. WMCSA '99. Second IEEE Workshop on*, 1999, pp. 90-100.
- [13] Yongxuan Lai and Hong Chen, "Energy-Efficient Fault-Tolerant Mechanism for Clustered Wireless Sensor Networks," in *Computer Communications and Networks, 2007. ICCCN 2007. Proceedings of 16th International Conference on*, 2007, pp. 272-277.
- [14] P. A. Chou and Yunnan Wu, "Network Coding for the Internet and Wireless Networks," *Signal Processing Magazine, IEEE*, vol. 24, no. 5, pp. 77-85, 2007.
- [15] E. Ayanoglu, Chih-Lin I, R. D. Gitlin, and J. E. Mazo, "Diversity coding for transparent self-healing and fault-tolerant communication networks," *Communications, IEEE Transactions on*, vol. 41, no. 11, pp. 1677-1686, 1993.
- [16] A. Sendonaris, E. Erkip, and B. Aazhang, "User cooperation diversity-part I: system description," *IEEE Transactions on Communications*, vol. 51, pp. 1927-1938, Nov. 2003.
- [17] A. Nosratinia, T. E. Hunter, and A. Hedayat, "Cooperative communication in wireless networks," *Communications Magazine, IEEE*, vol. 42, no. 10, pp. 74-80, 2004.
- [18] T. Ho, M. Medard, R. Koetter, D. R. Karger, M. Effros, Jun Shi, and B. Leong, "A Random Linear Network Coding Approach to Multicast," *Information Theory, IEEE Transactions on*, vol. 52, no. 10, pp. 4413-4430, 2006.