

FINAL REPORT

Student name: Alessandro Biason

Cycle: XXX

Curriculum: ICT

Supervisor name: **Michele Zorzi**

Thesis title (final): Stochastic Optimization of Energy Harvesting Wireless Communication Systems

PART 1 - COURSES, CONFERENCES AND MOBILITY

Courses for Ph.D. students

- Bayesian Machine Learning
- Real Time Systems and Applications
- Statistical Methods
- Information Theoretic Methods in Security

Summer schools, short courses, tutorials

- N/A

Seminars

- N/A

Participation to International Conferences and Workshops

- European Wireless 2015
- International Symposium on Wireless Communication Systems 2015
- International Conference on Computing, Networking and Communication 2016
- Information Theory and Applications Workshop 2016
- Riunione Annuale 2016 dell'Associazione Gruppo nazionale Telecomunicazioni e Tecnologie dell'Informazione
- International Symposium on Information Theory 2016
- European Signal Processing Conference 2016
- Wireless Communications and Networking Conference 2016

Other learning activities

- N/A

Mobility periods

- Oct 2015-Feb 2016, University of Southern California (USC), Los Angeles, USA.
Exploiting Channel State Information for Distributed Active State Tracking
- Mar 2017-July 2017, Intel Labs Europe (ILE), Leixlip, Ireland. **On the Energy Distortion Tradeoff in the IoT**

PART 2 - RESEARCH ACTIVITY

My research activity in the last three years can be divided in several different topics, all bounded together by a common approach and common procedures based on stochastic optimization. In particular:

- The main topic analyzed so far (which also represents the content of my dissertation) is the analysis of transmission policies in energy harvesting systems. We looked at this problem from a communication perspective and optimized the behavior of nodes in the IoT or WSNs in order to maximize their performance. Indeed, although energy harvesting enables new frontiers in wireless networks by extending the lifetime of the devices, it also leads to new challenges, as the new problem of *managing* the available energy arises.
- During my research period at USC, I studied the optimization of a distributed tracking system for wireless body area networks. In particular, we included the *communication channel* as an additional tool for improving the estimation performance without incurring in additional costs.
- Thanks to two projects sponsored by ESA, I had the opportunity to study medium access control schemes for satellite communications from ground nodes to satellites. Examples of such protocols are ACRDA, CRDSA, E-SSA, etc. In this context, we produced a new protocol that exploits the benefits of spreading and multiple transmissions to reduce the probability of collisions. In addition to that, we also studied how the E-SSA protocol should be extended when energy harvesting is taken into account.
- During the last year, I also focused on the multicast problem in mmWave systems. We showed that it is possible, under certain conditions, to use multicast in mmWave systems to increase the throughput of the network.

PART 3 - PUBLICATIONS

List of publications on international journals

- [J8] Biazon, A., Mitra, U., and Zorzi, M. (2017b). Exploiting channel state information for distributed active state tracking. To be submitted to *IEEE Wireless Communications*
- [J7] Biazon, A. and Zorzi, M. (2017b). Multicast via point to multipoint transmissions in directional 5G mmWave communications. submitted to *IEEE Communications*

Magazine

- [J6] Biazon, A., Dey, S., and Zorzi, M. (2016a). A decentralized optimization framework for energy harvesting devices. submitted to *IEEE Trans. on Mobile Computing*, *arXiv:1701.02081*
- [J5] Biazon, A., Pielli, C., Zanella, A., and Zorzi, M. (2016e). Optimized access control for iot nodes with energy and fidelity constraints. submitted to *IEEE Trans. on Wireless Communications*, *arXiv:1702.03695*
- [J4] Biazon, A., Pielli, C., Rossi, M., Zanella, A., Zordan, D., Kelly, M., and Zorzi, M. (2017c). An energy- and context-centric perspective on IoT architecture and protocol design. *IEEE Access*, 5:6894–6908
- [J3] Biazon, A. and Zorzi, M. (2016a). Battery-powered devices in WPCNs. *IEEE Trans. Communications*, 65(1):216–229
- [J2] Biazon, A., Laurenti, N., and Zorzi, M. (2016c). Achievable secrecy rates of an energy harvesting device. *IEEE J. Sel. Areas in Commun.*, 34(5):1502–1517
- [J1] Biazon, A. and Zorzi, M. (2015c). Joint transmission and energy transfer policies for energy harvesting devices with finite batteries. *IEEE J. Sel. Areas in Commun.*, 33(12):2626–2640

List of publications on conference proceedings (presented)

- [C15] Biazon, A. and Zorzi, M. (2017a). Multicast in directional mmWave communications. In *Proc. 23rd European Wireless Conf. (EW)*, pages 375–381
- [C14] Abd-Elmagid, M. A., Biazon, A., ElBatt, T., Seddik, K. G., and Zorzi, M. (2017). Non-orthogonal multiple access schemes in wireless powered communication networks. In *Proc. IEEE Conf. on Commun. (ICC)*, pages 192–197
- [C13] Biazon, A., Dey, S., and Zorzi, M. (2017a). Decentralized transmission policies for energy harvesting devices. In *Proc. IEEE Wireless Communications and Networking Conference (WCNC)*
- [C12] Pielli, C., Biazon, A., Zanella, A., and Zorzi, M. (2016). Joint optimization of energy efficiency and data compression in TDMA-based medium access control for the IoT. In *Proc. IEEE Global Communications Conf. (GLOBECOM), IoT-LINK Workshop*
- [C11] Biazon, A. and Zorzi, M. (2016d). Transmission policies in wireless powered communication networks with energy cooperation. In *European Signal Processing Conference (Eusipco)*, pages 592–596
- [C10] Biazon, A., Mitra, U., and Zorzi, M. (2016d). Improved active sensing performance in wireless sensor networks via channel state information. In *Proc. IEEE Symp. on Information Theory (ISIT)*, pages 2469–2473
- [C9] Biazon, A., Dittadi, A., and Zorzi, M. (2016b). Spreading and repetitions in satellite MAC protocols. In *Proc. IEEE Conf. on Commun. (ICC)*, pages 3697–3702
- [C8] Abd-Elmagid, M. A., Biazon, A., ElBatt, T., Seddik, K. G., and Zorzi, M. (2016). On optimal policies in full-duplex wireless powered communication networks. In

Proc. Symp. Modeling and Optimization in Mobile, Ad Hoc and Wireless Networks (WiOpt), pages 243–249


- [C7] Biazon, A. and Zorzi, M. (2016b). Long-term throughput optimization in WPCN with battery-powered devices. In *Proc. IEEE Wireless Communications and Networking Conference (WCNC)*, pages 391–397
- [C6] Biazon, A. and Zorzi, M. (2016c). On the effects of battery imperfections in an energy harvesting device. In *Proc. IEEE Conf. on Computing, Networking and Communications (ICNC)*, pages 942–948
- [C5] Biazon, A., Khamesi, A. R., Laurenti, N., and Zorzi, M. (2015). Achievable secrecy rates of an energy harvesting device with a finite battery. In *Proc. IEEE Global Communications Conference (GLOBECOM)*
- [C4] Biazon, A. and Zorzi, M. (2015a). Energy harvesting communication system with SOC-dependent energy storage losses. In *Proc. 12th IEEE Symp. on Wireless Communication Systems (ISWCS)*, pages 406–410
- [C3] Biazon, A. and Zorzi, M. (2015b). Joint online transmission and energy transfer policies for energy harvesting devices with finite batteries. In *Proc. 21st European Wireless Conf. (EW)*, pages 318–324
- [C2] Biazon, A. and Zorzi, M. (2015d). Transmission policies for an energy harvesting device with a data queue. In *Proc. IEEE Conf. on Computing, Networking and Communications (ICNC)*, pages 189–195
- [C1] Biazon, A., Del Testa, D., and Zorzi, M. (2014). Low-complexity policies for wireless sensor networks with two energy harvesting devices. In *Proc. 13th IEEE Annual Mediterranean Ad Hoc Networking Workshop (MED-HOC-NET)*, pages 180–187

List of other publications (books, book chapters, patents)

N/A

[14/09/2017]

Student signature



Supervisor signature

