

ARC '16

مؤتمر مؤسسة قطر
السنوي للبحوث
QATAR FOUNDATION
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<http://dx.doi.org/10.5339/qfarc.2016.ICTPP2616>

Energy Efficient Antenna Selection for a MIMO Relay Using RF Energy Harvesting

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Due to rapid growth in traffic demands and the number of subscribers, the transmit energy consumption becomes critical, both environmentally and economically. Increasing energy efficiency for wireless networks is the main goal for the 5G network research. The research community has proposed promising solutions supporting green communication techniques. However, energy efficiency can also be enhanced in a different way. We can get energy from the renewable sources, which can compensate (totally or partially) the traditional power consumption from the power grid. Energy harvesting has emerged as a promising technique which helps to increase the sustainability of wireless networks. In this paper, we investigate energy efficient antenna selection schemes for a MIMO relay powered by a hybrid energy source (from grid or through RF energy harvesting). We try to utilize the large number of antennas efficiently for both data decoding and energy transfer. Then, we formulate an optimization problem and provide the optimum antenna selection scheme such that the joint power consumption (source and relay power) is minimized while meeting the rate requirements. The problem is categorized as a mixed non-linear integer and non-convex, i.e., prohibitively complex. We propose two special cases of the general problem, Fixed Source Power Antenna Selection (FSP-AS), in which we assume a fixed source power and control the antenna selection only, and All Receive Antenna Selection (AR-AS), in which we choose to turn all receiving antennas ON. Finally, we introduce two less complex heuristics, Decoding Priority Antenna Selection (DP-AS) and Harvesting Priority Antenna Selection (HP-AS). Finally we compare our work with the Generalized Selection Combiner (GSC) scheme used in some previous works.

The main contributions of our work can be summarized as follows:

- (1) We introduce the energy harvesting technique as an effective way to improve the energy efficiency by using it as a substitute for the grid energy.
- (2) In addition to the transmitted energy, we model the circuit power as an important part of the total energy consumption which can affect the energy efficiency.

Cite this article as: Mohamed A, Samy I. (2016). Energy Efficient Antenna Selection for a MIMO Relay Using RF Energy Harvesting. Qatar Foundation Annual Research Conference Proceedings 2016: ICTPP2616 <http://dx.doi.org/10.5339/qfarc.2016.ICTPP2616>.

- (3) We make a possibility to turn each antenna ON or OFF individually, so we can turn off only the antennas we don't need to save the energy as much as possible.
- (4) We introduce two special case schemes, each of them care about a special type of energy consumption, FSP-AS scheme cares more about the circuit energy, while the AR-AS concentrates mainly on the transmitted energy.
- (5) We also propose two heuristics to accommodate the complexity of the target problem. We evaluate the performance for the proposed schemes numerically. Our key performance indicator (KPI) is the joint power consumed in both the source and the relay. The simulation results show the gain of our optimal scheme in terms of energy efficiency, which can be up to 80% as compared to solutions proposed in the literature. Our developed heuristics show reasonable performance at small rate with almost no gap with the optimal scheme at higher target rates. In our future work, we will consider modeling more than one source and destination nodes and extend this model to include interference scenarios.