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Fair cooperative protocols based on energy harvesting relays

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ABSTRACT

The cooperative communication becomes an important topic in the field of a wireless communication network to improve the reliability and speed of communication over long-distance and curve bed surface. As the distance is increasing between transmitter and receiver, the transmitter RF power requirement goes up to maintain the required SNR. The cooperative communication is an alternative way to fulfill this requirement with the help of relaying techniques. There is a number of research articles have been published in the area of cooperative communication. The major research works have been carried out the AF, DF and CF protocols.

Future generations of cellular communications require higher data rates and a more reliable transmission link with the growth of multimedia services while keeping the satisfactory quality of service, Multiple inputs multiple output (MIMO) antenna systems have been considered as an effective approach to address these demands by offering significant multiplexing and diversity gains over single antenna systems without increasing bandwidth and power. Although MIMO systems can unfold their huge benefit in cellular base stations, they may face limitations when it comes to their deployment in mobile handsets. To overcome this drawback, relays (fixed or mobile terminals) can cooperate to improve the overall system performance in cellular networks. Cooperative communications can effectively combat the severity of fading and shadow through the assistance of relays. It has been found that using relays the capacity and coverage of cellular networks can be extended without increasing mobile transmit power or demanding extra bandwidth.

Keywords: *Cooperative communication, Amplify and forward, Decode and forward, Compress and forward, Rayleigh fading channel, Relay.*

1. INTRODUCTION

The increasing numbers of users demanding service have encouraged intensive research in wireless communications. The problem with the cooperative communications is the unreliable medium through which the signal has to travel. To mitigate the effects of the wireless channel, the idea of diversity has been deployed in many wireless systems. Diversity is a communication technique where the transmitted signal travels through various independent paths and thus the probability that all the wireless paths are in fade is made negligible. Frequency diversity, time diversity and space diversity are the three basic techniques for providing diversity to the wireless communication systems.

a) As the distance is increasing between transmitter and receiver, the transmitter RF power requirement goes up to maintain the required SNR. The cooperative communication is an alternative way to fulfill this requirement with the help of relaying techniques.

b) Cooperative communications can efficiently combat the severity of fading and shadow through the assistance of relays. It has been found that using relays the capacity and coverage of cellular networks can be extended without increasing mobile transmit power or demanding extra bandwidth.

c) In wireless networks, energy and power are two important issues to deal with. To solve these issues an efficient approach is that idle users can play the role of relays to help an active user to communicate with its destination.

In cooperative communication protocols, to enable cooperation among users different relaying protocol and techniques could be employed depending on the relation user location, channel conditions, and transceivers complexity. These are methods that define how data is processed at the relays before onward transmission to the destination. There are different types of cooperative communication protocols which would be outlined.

• Amplify and forward

• Decode and forward

• Detect and forward

• Selections detect and forward

• Coded cooperation

• Time Switching based cooperative Protocol using EH

• Power splitting based cooperative Protocol using EH

1) Amplify and Forward: Each user in this method receives a noisy version of the signal transmitted by its partner. As the name implies, the user then amplifies and retransmits this noisy version. The base station combines the information sent by the user and partner and makes a final decision on the transmitted bit. Although noise is amplified by cooperation, the base station receives two independently faded versions of the signal and can make better decisions on the detection of information.

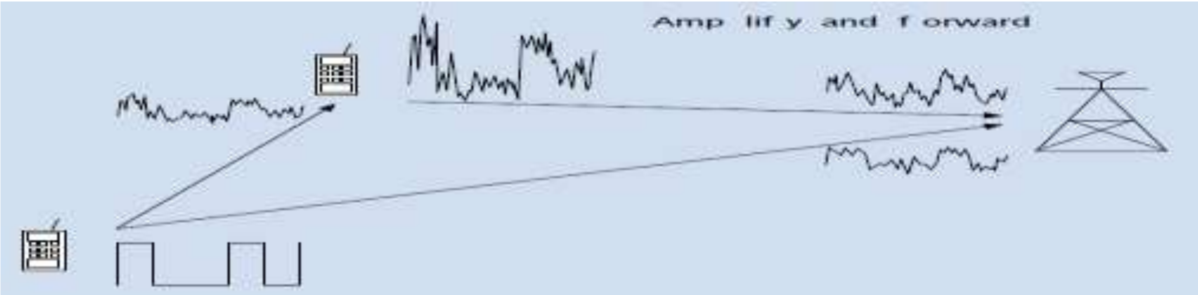

Fig. 1: Amplify and Forward scheme

2) Decode and forward: In this scheme, in the first and second intervals, each user transmits its own bits. Each user then detects the other user's second bit (each user's estimate of the other's bit). In the third interval, both users transmit a linear combination of their own second bit and the partner's second bit, each multiplied by the appropriate spreading code. The transmit powers for the first, second, and third intervals are variable, and by optimizing the relative transmit powers according to the conditions of the uplink and inter-user channels, this method provides adaptability to channel conditions.

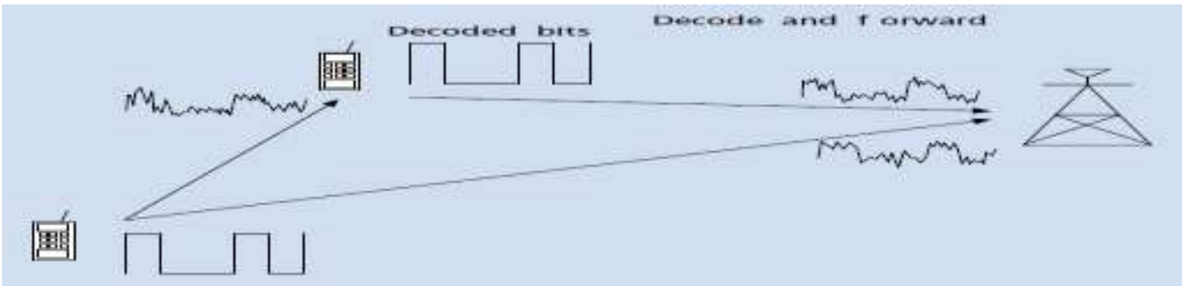

Fig. 2: Decode and forward scheme

3) Detect and forward: This method is perhaps closest to the idea of a traditional relay. In this method, a user attempts to detect the partner's bits and then retransmits the detected bits (Fig. 3). The partners may be assigned mutually by the base station, or via some other technique.

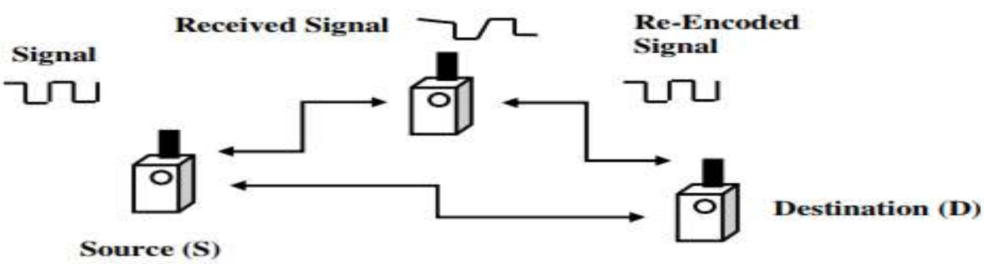

Fig. 3: Detect and forward a scheme

4) Selection detects and forward: The best relay is selected to forward the signals from the source to the destination.

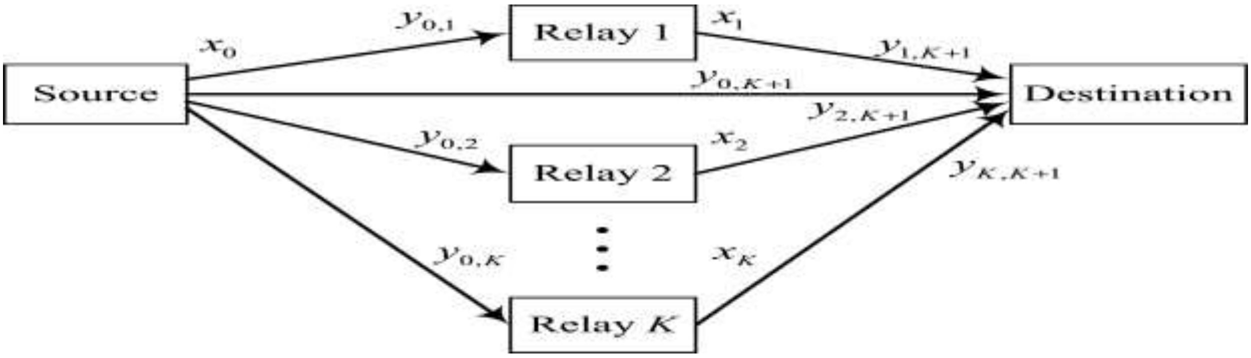

Fig. 4: Selection Detect and Forward Scheme

5) Coded cooperation: In coded cooperation, each of the users' data is encoded into a code word that is partitioned into two segments, containing N1 bits and N2 bits, respectively. It is easier to envision the process by a specific example: consider that the original code word has N1 + N2 bits; puncturing this code word down to N1 bits, we obtain the first partition, which it selves is a valid (weaker) code word. The remaining N2 bits in this example are the puncture bits.

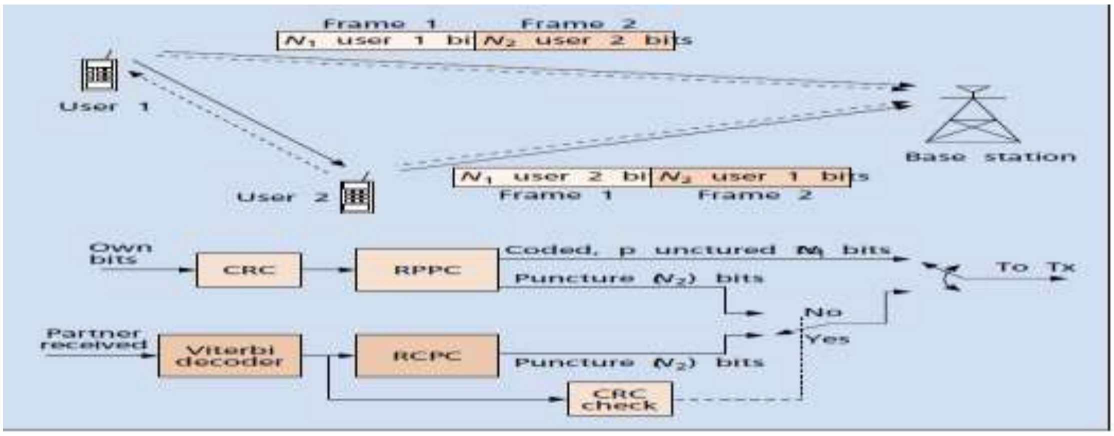

Fig. 5: Coded Cooperation scheme.

6) Time Switching based cooperative Protocol using EH: The key parameters of the proposed time switching-based protocol are shown in Figure 6 in a block time of T seconds. Each block time T is divided into three "slots". In the first slot, α T, the source node S transmits an information signal which is used for energy harvesting at the relay node R and for information decoding at the destination node D. In the second slot, (1-α)T/2, the source node transmits an information signal (different from that which was sent in the first slot) and is received by both relay and destination. In the remaining slot of the block time, the relay amplifies-and-forwards the signal received from the source in the second slot using all the energy harvested during the first slot [6].

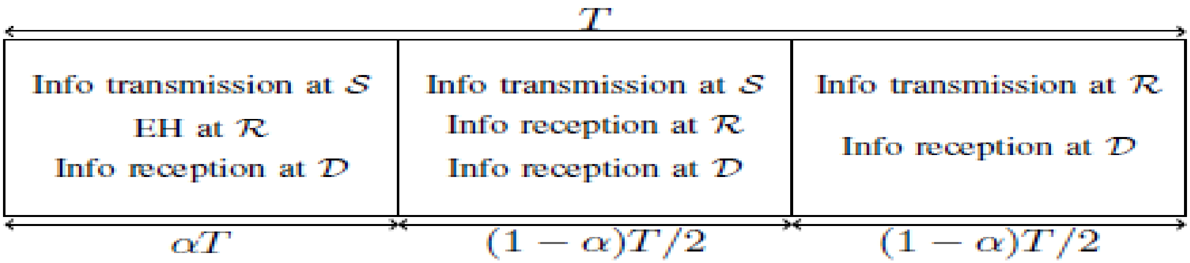

Fig.6: Proposed Time Switching based cooperative Protocol

Where,
S: Source Station
R: Relay
D: Destination
T: Block time in seconds
α T: First-time slot
(1-α)T/2: Second Time slot
(1-α)T/2: Third Time slot

7) Power splitting based cooperative Protocol using EH: The key parameters of the PS-based relaying protocol are shown in Figure 7. The destination can receive the signal sent by the source. In the PS-based protocol, a power splitter at the relay receiver splits the received signal by the relay such that a fraction of the received signal is used to harvest energy and remaining signal is sent to the information receiver. The first slot of block time T in the proposed PSR protocol is dedicated for the source transmission and the second slot for the relay transmission. It is assumed that the total harvested energy by the relay in the first slot is used to relay the information signal. The harvested energy by the relay is calculated using the expression (29) in [6].

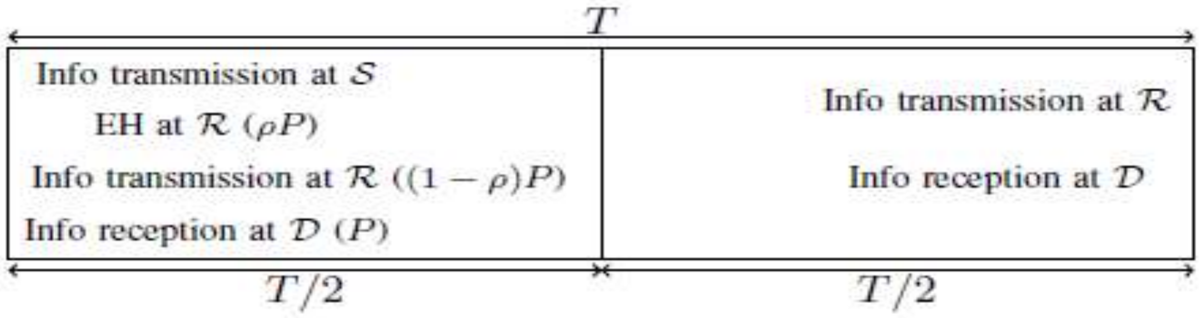

Fig.7: Proposed Power Splitting based cooperative Protocol

Where,
S: Source Station
R: Relay
D: Destination
T: Block time in seconds
α T: First-time slot
(1-α)T/2: Second Time slot
(1-α)T/2: Third Time slot

2. OBJECTIVES

• Study of different protocol for Cooperative communication.

• Comparison of these protocols based on the different performance parameter.

• Introduction of an adaptive technique for optimized performance of Cooperative Communication.

3. LITERATURE SURVEY

Noteworthy contributions in the field of proposed work:

Juhi Garg, Priyanka Mehta and Kapil Gupta [1] As stated at the outset, the field of high-data-rate, efficient and reliable wireless communication, is currently receiving much attention. Cooperative transmission is emerging as an effective technique for combating effects of path loss, shadowing, and multi-path fading. This tutorial elaborates wireless cooperative communication, a technique that both allow single antenna mobiles to share their antennas and reap the benefits of multiple antenna systems. Cooperative relaying provides diversity gain, reduces outage probability and improves BER performance. Various types of relays, mode of operation, applications, and tracks for future work have been discussed here. This paper will be helpful for incorporating a relay based system in a real scenario. Throughout this paper, we focused on only two Protocols viz AF & DF but there are many other protocols as well that deserve attention. We also didn't include Power Allocation i.e. at what power; source/relay should transmit without causing interference for others.

Weifeng Su, Ahmed K.Sadek, K. J. Ray Liu [2] analyzed the SER performances of the uncoded cooperation systems with DF and AF cooperation protocols, respectively, and also compare their performances. From the theoretical and simulation results, they can draw the following conclusions. First, the equal power strategy is good, but in general not optimum in the cooperation systems with either DF or AF protocol, and the optimum power allocation depends on the channel link quality. Second, in case that all channel links are available in the DF or AF cooperation systems, the optimum power allocation does not depend on the direct link between source and destination, it depends only on the channel link between source and relay and that between relay and destination. Specifically, if the link quality between source and the relay is much less than that between relay and destination, i.e., δ2 s,r << δ2 r, d, then we should put the total power at the source and do not use the relay. On the other hand, if the link quality between source and the relay is much larger than that between relay and destination, i.e., δ2 s,r >> δ2 r, d, then the equal power strategy at the source and the relay tends to be optimum. Third, we observe that the performance of the cooperation systems with the DF protocol is better than that with the AF protocol. However, the performance gain varies with different modulation types. The larger the signal constellation size, the less the performance gain. In case of BPSK modulation, the performance gain cannot be larger than 2.4 dB; and for QPSK modulation, it cannot be larger than 1.2 dB. Therefore, for high data-rate cooperative communications (with large signal constellation size), we may use the AF cooperation protocol to reduce system complexity while maintains a comparable performance. Finally, we want to emphasize that the discussion of the optimum power allocation and the performance comparison in the paper is based on the asymptotically tight SER approximations that hold in sufficiently high SNR region, they may not be valid for low to moderate SNR regions. However, from the simulation results, we observe that the results from the high- SNR approximations also provide a good match to the system performance in the moderate-SNR region.

In [3], S. Ulukus, A. Yener, E. Erkip, O. Simeone, M. Zorzi, P. Grover, and K. Huang stated that One of the main disadvantages is that idle users spend their own energy to help other users, leading to decrease their battery life. Recently, the energy harvesting (EH) technique has received significant attention as an alternative method to power energy-constrained wireless networks. It enables wireless nodes to collect energy from the surrounding environment (e.g. solar energy, radio frequency signals (RF), etc.).

In [4], L. R. Varshney et al studied that RF energy harvesting has an advantage over other sources of energy due to the fact that RF signals can carry both information and energy.

In [5], A. Nasir, X. Zhou et al, proposed a new cooperative scheme for the two-hop relay channel based on both information and wireless transfer such that the relay can receive energy signals from the sender besides the information signal to be relayed to the destination. In such schemes, the circuits for energy harvesting and signal detection are operated in a time-sharing or power splitting manner, because practical circuits cannot realize energy harvesting and data detection from the same signal In wireless networks, idle users can play the role of relays to help an active user to communicate with its destination. The use of relays can enhance the coverage and the capacity of networks. Mobile relaying has several advantages and disadvantages compared to fix to relay.

4. PROBLEM IDENTIFICATION

a) Resources over utilization: cooperative –diversity systems need M+1 Channels to send one message from the source to the destination using M relay.

• Best –relay selection.

b) Complexity

• Signal combining and detection

• Channel estimation

• Relaying protocols

• Synchronization

• Resource management

c) Outage Probability.

d) Throughput Maximization.

Summary: As stated at the outset, the field of high-data-rate, efficient and reliable wireless communication, is currently receiving much attention. Cooperative transmission is emerging as an effective technique for combating effects of path loss, shadowing, and multi-path fading. This research elaborates wireless cooperative communication, a technique that allows both antenna mobiles to share their antennas and reap the benefits of multiple antenna systems. Cooperative relaying provides diversity gain, reduces outage probability and improves BER performance. Various types of relays, mode of operation, applications, and tracks for future work have been discussed here. This research will be focused on incorporating a relay based system in a real scenario. Throughout this research, we focused on only design new Protocols better than AF & DF , CF but We also include Power Allocation i.e. at what power; source/relay should transmit without causing interference for others.

5. COMPARISON OF THESE PROTOCOLS BASED ON THE DIFFERENT PERFORMANCE PARAMETER

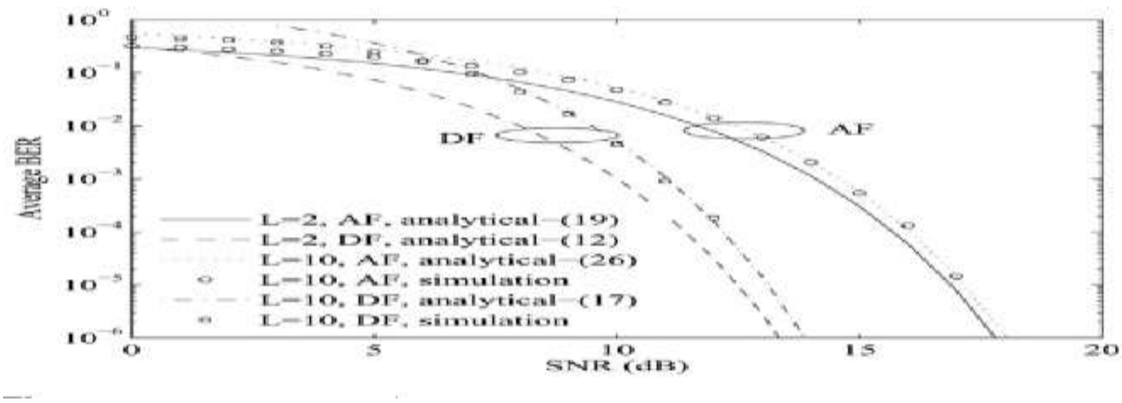

Fig. 8: Comparison between Amplify and Forward and Decode and Forward in terms of Average BER and SNR

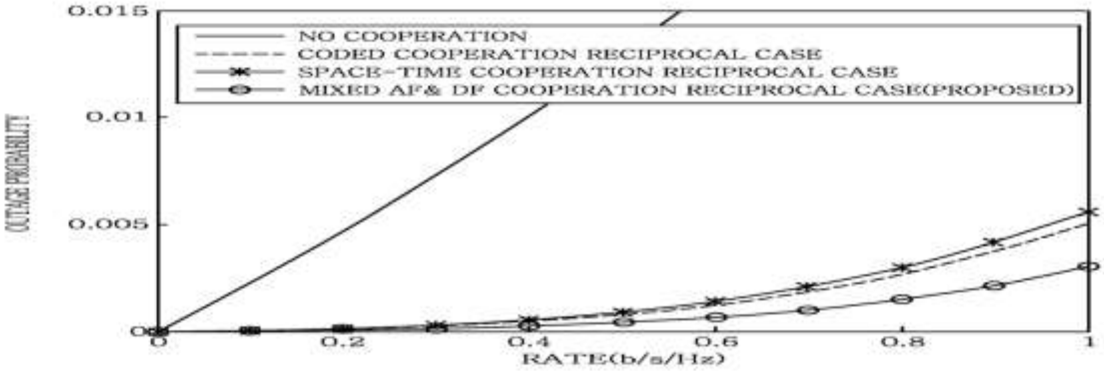

Fig. 9: Comparison between No cooperation and coded cooperation in terms of Outage Probability and transmission rate

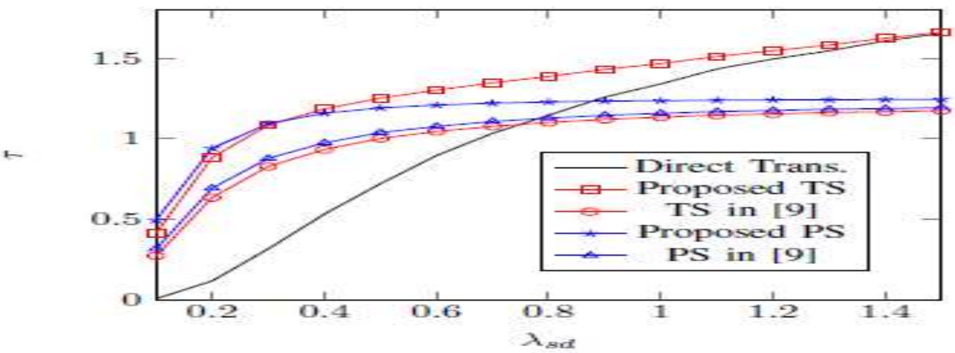

Fig. 10: Comparison between proposed TS and PS approach in terms of Throughput and mean signal gains

6. CONCLUSION

The work discussed comprises different cooperative protocols and proposed TS (time-switching) based and PS (power-splitting) based cooperative protocols with energy harvesting and information processing capabilities. It has been studied that the proposed protocols do not only provide a fair cooperation but also achieve good throughput which is at least equal to that of the direct transmission depending on channel conditions and system parameters.

7. REFERENCES

[1] Zeina Mheich et al., “Cooperative communication Protocols with Energy Harvesting Relays”, IEEE, 2017.
[2] Juhi Garg, Priyanka Mehta, and Kapil Gupta “A Review on Cooperative Communication Protocols in Wireless World “International Journal of Wireless & Mobile Networks (IJWMN) Vol. 5, No. 2, April 2013 DOI: 10.5121/ijwmn.2013.5209 107.
[3] Weifeng Su • Ahmed K. Sadek • K. J. Ray Liu” Cooperative Communication Protocols in Wireless Networks: Performance Analysis and Optimum Power Allocation” Wireless Pers Commune DOI 10.1007/s11277-007-9359-z, © Springer Science + Business Media LLC 2007.
[4] S. Ulukus, A. Yener, E. Erkip, O. Simeone, M. Zorzi, P. Grover, and K. Huang, “Energy harvesting wireless communications: A review of recent advances,” IEEE Journal on Selected Areas in Communications, vol. 33, no. 3, pp. 360–381, March 2015.
[5] L. R. Varshney, “Transporting information and energy simultaneously,” in IEEE ISIT, July 2008, pp. 1612–1616.
[6] Nasir, X. Zhou, S. Durrani, and R. Kennedy, “Relaying protocols for wireless energy harvesting and information processing,” IEEE Transactions on Wireless Communications, vol. 12, no. 7, pp. 3622–3636, July 2013.