A REVIEW ON ENERGY OPTIMIZATION RELAY SELECTION SCHEME FOR WIRELESS SENSOR NETWORKS

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ABSTRACT

Author considered a wireless sensor network (WSN) with identically distributed nodes, and a two phase cooperative protocol where the source transmits and is overheard by multiple relays which in turn transmit to the destination or fusion center (FC). The Author introduces a selection scheme that will pick a subset of the relays that overhear the message and transmit to the FC. This scheme will aim at making the least number of relays active while minimizing the outage probability and sending the least amount of information enough to reconstruct the message at the FC. The reduced amount of information being transmitted through the network along with an even distribution of active relays leads to a more energy efficient system. The use of cooperative diversity, where neighboring stations may act as relay nodes to transfer the source data to the desired destination node through an independent relay channel, has shown to provide diversity gain and consequently improve the achievable bit rate. The network performance under the proposed settings is modeled using continuous Markov chains. The steady-state transmission blocking probability and the average network throughput are obtained by analyzing the derived Markov model. Author's scheme first selects the best relay from a set of available relays and then uses this "best" relay for cooperation between the source and the destination. The outage probabilities of selection relaying protocols are analyzed and compared for cooperative wireless networks. These multiple relay selection schemes require the same amount of feedback bits from the receiver as single relay selection schemes.

Keywords: Wireless Sensor Network (WSN), Burst Erasure Channel (Buec), Cooperative Communications, Channel State Information (CSI), Fusion Center (FC), Sensors (Relays), Outage Probability, Expected Number Of Bits, Transition Probability.

I. INTRODUCTION

Nowadays wireless sensor networks (WSNs) are widely used in many applications. They are employed in field trials and performance monitoring of solar panels, in target detection through digital cameras, and even in the petrochemical industry field. The main challenge for WSNs is the energy constraint on the network, the sensors are powered by batteries and replacing these batteries is extremely difficult if not impossible in most cases. Much research is conducted on low power dissipation communication protocols that can improve the network throughput and lifetime while achieving minimum symbol error at the destination (e.g., [16]) In [3]-[11] relay selection protocols are introduced that pick a single relay to transmit to the destination. In [3] the selection is based on geographical information; in [4] amplify-and-forward (AF) coded cooperative system is proposed and investigated under relay selection. In [6], [7] a "best" relay is chosen based on the source-relay and relay-destination channels where both source and relay transmit without any power consideration. In [8], [9], [10], [12] a best relay is again chosen to transmit along with the source but transmission power is divided between the two in a way that optimizes transmission performance. Having a single node to relay the message saves on bandwidth and energy but the tradeoff comes at the expense of the symbol error rate at the destination. It is shown in [11] that multiple relay selection schemes perform much better than their corresponding single relay selection schemes. The question then arises how many relays should transmit and how to select them considering the energy constraints on the sensors. A variety of schemes have been introduced based on different perspectives [13]-[24]; some take advantage of the static topology of the network, others attempt to maximize the signal-to-noise ratio (SNR) and some use amplify-and-forward to send the data. In [14], a source coding technique is proposed to compress the source information using incremental compression using turbo coding technique to ensure lossless compression. Different from [14], the authors in [15] proposed a new signal processing scheme referred to as decode-compress-and-forward where turbo coding is applied at both source and relay nodes. In [15], coding is used to correct errors in transmissions and plays an important role in relay selection. In this paper, we introduce a relay selection scheme that saves on energy and at the same time guarantees message delivery to the destination based on the channel state information (CSI) provided by the relays to the fusion center (FC). Author shows that selecting a subset of two relays that have the complete source message will offer the best result considering power consumption and complexity at the receiver. In section II, we provide a description of the network model, the motivation behind our work and proposed relay selection scheme. In section III, author analyse the performance of the proposed relay selection schemes in-terms of the outage probability and the expected number of bits transmitted for subsets of any number of relays. Author's follow up in section IV by presenting simulation results along with the analytical ones. In section V, author present results for a more realistic channel model and show that they are comparable to the results under his earlier assumptions for the network model. Author concludes with some final remarks and potential for future work in section VI. In cooperative networks, a node at any given time can act as a sender, destination or relay depending on the network traffic and topology. Neighboring stations to the transmitter and/or receiver can act as relay nodes to transfer the source data to the desired destination node through an independent relay channel, that is, independent from the source–destination channel [6]. The function of the relay node can be as simple as to amplify and forward the received source data or to decode and regenerate an estimate of this data. Wireless sensor networks (WSNs) consist of a large amount of sensor nodes deployed over a certain wide area, where the sensor nodes are required to be low-cost and low-power devices for long lifetime requirements. One very challenging task in WSNs due to the limited resources is to develop efficient and scalable protocols meeting the demands for different network functions, such as transmission, routing, and scheduling protocols. Employing multiple relays may substantially provide high-order cooperative diversity, but it leads to more waste of bandwidth while increasing difficulty in time and carrier synchronization among nodes. To avoid these drawbacks, many recent studies focus on the issue of relay selection [4], i.e., choosing the best relay among the available relays when it has the best channel condition. The authors suggested the relay is the one closest to the destination, depending on its geographic position. Relay selection technique is recognized as a promising solution to realize the benefits of multiple-relay cooperation with a low implementation complexity. Sensor networks play a major role in many aspects of society including home automation, consumer electronics, military application [1, 2], agriculture, environmental monitoring, health monitoring and geophysical measurement. Usually sensor devices are small and inexpensive, so they can be produced and deployed in large numbers. Their resources of energy, memory, computational speed and bandwidth are severely constrained [5]. Therefore, it is important to design sensor networks aiming to maximize their life expectancy.

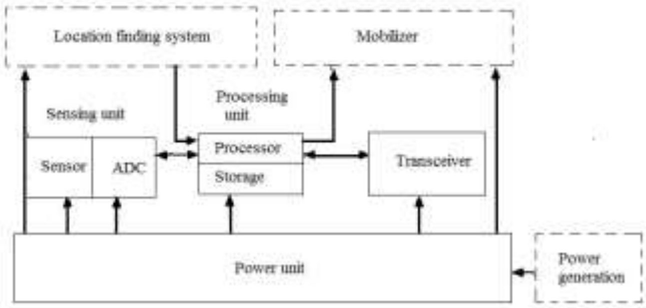

Fig.1 The Components of A Sensor Node.

II. NETWORK MODEL AND PROPOSED SCHEME

The Author considers a two phase wireless sensor network with no direct source-destination link, and communication can only be done through aid of relays. The source broadcasts its message on the channel and the relays overhear a noisy version of the message. Upon receiving the message, the relays encode their channel state information (CSI) by a run length code then transmit to the destination. Figure 2 show a network model with i relays overhearing the message transmission from the source.

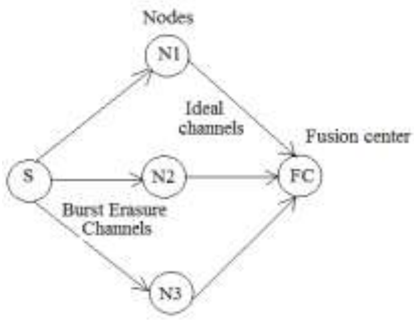

Fig. 2 Network Model with 3 Overhearing Relay

Based on the selection scheme being used, the fusion center selects the relays that will transmit and send feedback bits to the network that will dictate whether each relay will transmit or not. The channels between the source and the relays are modeled as independent burst erasure channels (BuEC) shown in Figure 2. The author assumes that the channels between the relays and the fusion center are ideal.

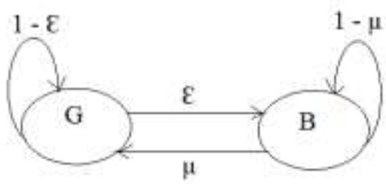

Fig. 3 Burst Erasure Channel Model

The simplest model for wireless fading channels is the two state Gilbert-Elliott model. In this model, there exists a good channel state, for which the channel SNR is large, and a bad channel state, for which the SNR is low. The Gillbert Elliot channel model is a simple model for fading channels; It has a good state when the signal-to-noise ratio (SNR) in the channel is very high and a bad state when the SNR is very low. Let the probability of going from good state (G) to bad state (B) be Ɛ and the probability of going from bad state to good state be μ. The BuEC is a special case of this model where we assume that the SNR is high in good state and therefore the bit is always received correctly and low in bad state therefore the bit is flagged as erasure. Upon receiving the CSI from the relays, the FC will have the task of selecting a subset of these relays to transmit. Here we introduce a general selection scheme that the FC can use to determine which of these relays will be active and give a specific example to illustrate the results. We define the outage probability as the probability that none of the subsets of relays/sensors in the network has enough information to reconstruct the message error free at the fusion center. In this case, we assume that the FC checks whether the aggregate information of all sensors is sufficient to decode the message. If this is the case, the FC prompts all sensors to transmit together. Authors also define the expected number of bits transmitted as the number of bits transmitted by all active sensors. The sensors (relays) in the WSN that send their CSI to the FC are divided into subsets of x relays; for example if six relays overhear the transmission and x = 2, one can group relays 1-2, relays 3-4 and relays 5-6; if x = 3 (subsets with three relays), author can group relays 1-2-3 and 4-5-6. The FC selects the subset that has enough information to reconstruct the message and has the least number of bits to transmit. If no subset is able to provide all the information necessary to reconstruct the message, then all relays transmit. Consider the network model in which relay selection is applied in the cluster-based cooperative wireless sensor network. The transmission procedures that a sensor transmits its data to the fusion center can be described as follows: First, a sensor shares the data to its cluster head. Next, the cluster head selects an optimum cooperating sensor within its cluster to collaboratively transmit the data to the neighboring cluster head. Finally, the cluster-based multihop transmission is completed by concatenating this single-hop scheme, and the fusion center is the final destination. A simplified cooperative communication model is one with a source, a relay and a destination. Various cooperative protocols proposed in [2]–[5] consist of two phases. In Phase 1, the source broadcasts its information received by both the destination and the relay. Then, in Phase 2, the relay simply forwards the received signal to the destination. We consider a single-relay scenario, consisting of three nodes; source (S), relay (R) and destination (D). Assume that the source intends to transmit a message consisting of K binary unbiased i.i.d. bits to the destination, with possible collaboration from the relay. For this, the source encodes the message by a turbo code, punctures a defined number of parity bits to achieve a target code rate, and starts broadcasting the generated codeword. Authors assume here that the turbo code consists of two parallel concatenated convolutional codes, separated by a code interleaver.

III. RELAY SELECTION SCHEMES

Relay selection schemes conserve energy and increase the lifetime of the network and reducing the amount of data being transmitted from the sensor nodes. Relay selection scheme aims at minimizing the outage probability and reducing the number of bits transmitted from the sensor nodes. Upon receiving the channel state information (CSI) from the nodes, the fusion center (FC) will have the task of selecting a subset of these nodes to transmit. Author introduced three selection schemes that the FC can use to determine which of these nodes will be active.
Author defines the outage probability that none of the subsets of sensors in the network has enough information to reconstruct the message error free at the FC. In this case, the FC checks whether the aggregate information of all sensors is sufficient to decode the message and if yes then FC prompts all the nodes to transmit.Author defines expected number of bits transmitted as the number of bits transmitted by all the active sensors.

Scheme 1: Fixed pairs

The nodes that send their CSI to the FC are divided into clusters of two. For example, if 6 nodes are there, they can be grouped as nodes 1-2, nodes 3-4, and nodes 5-6. The FC selects the cluster that has enough information to reconstruct the message and has the least amount of bits to transmit. If no cluster is able to provide all the information necessary to reconstruct the message then all nodes transmit. In a network with six nodes, they can be grouped as nodes 1-2-3 and 4-5-6.

Scheme 2: All pair combinations

In this scheme, the FC looks at all pair combinations of nodes. The FC again selects the pair with the least amount of bits to send but enough to reconstruct the message at the destination. As in the previous scheme if no pair has the necessary information to reconstruct the message at the FC, then all nodes will transmit.

Scheme 3: Singles, pairs or triplets

The FC in this scheme looks first for nodes that have received the entire message error free. If one is found then it will be selected by the FC to transmit. If none are found then the FC looks for any pair of sensors to transmit (scheme 2). If no pairs are found the FC looks for any cluster of three nodes that has the full information to send. Again if no single node, pair or triplet of nodes has the full message to deliver to the FC then all nodes transmit.

IV. ANALYTICAL RESULTS

4.1 Outage Probability

Outage probability is defined as the probability that none of the subsets of relays/sensors in the network has enough information to reconstruct the message error free at the fusion center. In this case, author assumes that the FC checks whether the aggregate information of all sensors is sufficient to decode the message. If this is the case, the FC prompts all sensors to transmit together.

The marginal probability of being in good and bad states assuming that we are in steady state is:

$$\begin{aligned} P_G &= p_{(G \to G)|G} \times P_G + p_{(B \to G)|B} \times P_B \\ &= p_{(G \to G)|G} \times P_G + P_{(B \to G)|B} \times \left(1 - P_G\right) \\ &= \frac{p_{(B \to G)|B}}{1 + p_{(B \to G)|G} - p_{(G \to G)|G}} \\ &= \frac{\mu}{1 + \mu - (1 - \epsilon)} \\ &= \frac{\mu}{\epsilon + \mu} \end{aligned}$$

$$\begin{aligned} P_B &= 1 - P_B \\ &= 1 - \frac{\mu}{\epsilon + \mu} \\ &= \frac{\epsilon}{\epsilon + \mu} \end{aligned}$$

$$P_G + P_B = 1$$

Given the channels are independent, one can now easily find the probability of the states that describe two source-node channels

$$P_{GG} = P_G \times P_G = \frac{\mu^2}{(\epsilon + \mu)^2}$$

$$P_{GB} = P_G \times P_B = \frac{\mu \epsilon}{(\epsilon + \mu)^2}$$

$$P_{BG} = P_B \times P_G = \frac{\epsilon \mu}{(\epsilon + \mu)^2}$$

$$P_{BB} = P_B \times P_B = \frac{\epsilon^2}{(\epsilon + \mu)^2}$$

Assuming uncoded communication between source and relays, if the state with all bits in error is visited at least once then the subset will not have enough aggregate information to reconstruct the entire message. Given this, we define a new state OUT which is an absorbing state that when entered cannot be left; we go to state OUT once we enter the state with all x bits in error for the first time (for fixed pairs it is once state BB is visited). Figure 4b shows the new state diagram for x = 2. To calculate the outage probability we first find the transition matrix Q of the state diagram shown in Figure 4b. Note that element Q_{ij} represents the transition probability from state i to state j. Table 1 shows the states and their corresponding labels for fixed pairs where x = 2 and the number of states is $2^x = 4$.

Table1: State Labeling For Transition Matrix.

Label	State
1	GGG
2	GGB
3	GBG
4	GBB
5	BGG
6	BGB
7	BBG
8	BBB(OUT)

4.2 Clusters with 3 Or More Nodes

In this section author present some guidelines on how to evaluate the outage probability and expected number of transmitted bits for the proposed relay selection scheme in cases with three or more nodes. Author illustrate it by presenting the results for clusters of $x = 3$ nodes.

Author start by forming a state diagram of the Markov process that jointly describes channel realizations for x independent source-node channels. The state diagram will have 2^x states (author will have 8 states for $x = 3$). As defined earlier "G" is an error free bit and "B" is a bit received as erasure. If the state with all the bits as erasure is visited at least once then the cluster will not have enough aggregate information to reconstruct the whole message. We enter the absorbing state "Out" when all x bits are received as erasure at once for the first time (for $x = 3$ it is once state "BBB" is visited).

The transition matrix Q for clusters with x nodes will have $2^x \times 2^x$ dimensions (for $x = 3$, Q will be an 8×8 matrix). Element Q_{ij} represents the transition probability from state i to state j. Below is the transition matrix for $x = 3$.

$$Q = \begin{bmatrix} (1-\epsilon)^3 & \epsilon(1-\epsilon)^2 & \epsilon(1-\epsilon)^2 & \epsilon(1-\epsilon)^2 & \epsilon^2(1-\epsilon) & \epsilon^2(1-\epsilon) & \epsilon^2(1-\epsilon) & \epsilon^3 \\ \mu(1-\epsilon)^2 & (1-\mu)(1-\epsilon)^2 & \epsilon\mu(1-\epsilon) & \epsilon\mu(1-\epsilon) & \epsilon(1-\epsilon)(1-\mu) & \epsilon(1-\epsilon)(1-\mu) & \mu\epsilon^2 & (1-\mu)\epsilon^2 \\ \mu(1-\epsilon)^2 & \epsilon\mu(1-\epsilon) & (1-\mu)(1-\epsilon)^2 & \epsilon\mu(1-\epsilon) & \epsilon(1-\epsilon)(1-\mu) & \mu\epsilon^2 & \epsilon(1-\epsilon)(1-\mu) & (1-\mu)\epsilon^2 \\ \mu(1-\epsilon)^2 & \epsilon\mu(1-\epsilon) & \epsilon\mu(1-\epsilon) & (1-\mu)(1-\epsilon)^2 & \mu\epsilon^2 & \epsilon(1-\epsilon)(1-\mu) & \epsilon(1-\epsilon)(1-\mu) & (1-\mu)\epsilon^2 \\ (1-\epsilon)\mu^2 & \mu(1-\epsilon)(1-\mu) & \mu(1-\epsilon)(1-\mu) & \epsilon\mu^2 & (1-\epsilon)(1-\mu)^2 & \epsilon\mu(1-\mu) & \epsilon\mu(1-\mu) & \epsilon(1-\mu)^2 \\ (1-\epsilon)\mu^2 & \mu(1-\epsilon)(1-\mu) & \epsilon\mu^2 & \mu(1-\epsilon)(1-\mu) & \epsilon\mu(1-\mu) & (1-\epsilon)(1-\mu)^2 & \epsilon\mu(1-\mu) & \epsilon(1-\mu)^2 \\ (1-\epsilon)\mu^2 & \epsilon\mu^2 & \mu(1-\epsilon)(1-\mu) & \mu(1-\epsilon)(1-\mu) & \epsilon\mu(1-\mu) & \epsilon\mu(1-\mu) & (1-\epsilon)(1-\mu)^2 & \epsilon(1-\mu)^2 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 \end{bmatrix}.$$

The outage probability for a given message size K, is the probability that we end up in state "Out" after K transitions

$$P_{out}(K, x) = \left(AQ^k\right)_{2^x}$$

where A in (3.11) is the vector of marginal state probabilities with dimensions 1×2^x. And Q^k is the matrix of transition probabilities after k transitions (It is proven that element ij of $Q^k$is the probability that we end up in state j after k transitions).by Multiplying Q^k by the initial probabilities for each state A gives the probability that we reach any of the states after k transitions. The $(2^x)^{th}$ element of AQ^k gives the probability that we reach state "Out" after k transitions which is why we added the subscript 2^x to $(AQ^k)_{2^x}$. For the case of $x = 3$ nodes per cluster we have$P_{out}(k, 3) = (AQ^k)_8$. Where A is the vector of marginal state probabilities, derived the same way we did for pairs from (3.1) and (3.2).

$$A = \left[\frac{\mu^3}{(\epsilon+\mu)^3} \quad \frac{\epsilon\mu^2}{(\epsilon+\mu)^3} \quad \frac{\epsilon\mu^2}{(\epsilon+\mu)^3} \quad \frac{\epsilon\mu^2}{(\epsilon+\mu)^3} \quad \frac{\mu\epsilon^2}{(\epsilon+\mu)^3} \quad \frac{\mu\epsilon^2}{(\epsilon+\mu)^3} \quad \frac{\mu\epsilon^2}{(\epsilon+\mu)^3} \quad \frac{\epsilon^3}{(\epsilon+\mu)^3} \right]$$

The 3 in $P_{Out}(k, 2)$ indicates that this is the outage probability for a cluster of 3 nodes. The outage probability for a network with n clusters will be $(P_{Out}(k, x))^n$. Using (3.12) Author calculate the outage probability for $x = 3$ nodes per cluster. We run simulations where 6 nodes overhear a message of size $K = 10000$ bits and for bursterasure channel parameters $\epsilon = 5 \times 10^{-4}$ and vary μ. We compare the results to those from the clusters with 2 nodes (Figure 3.11).

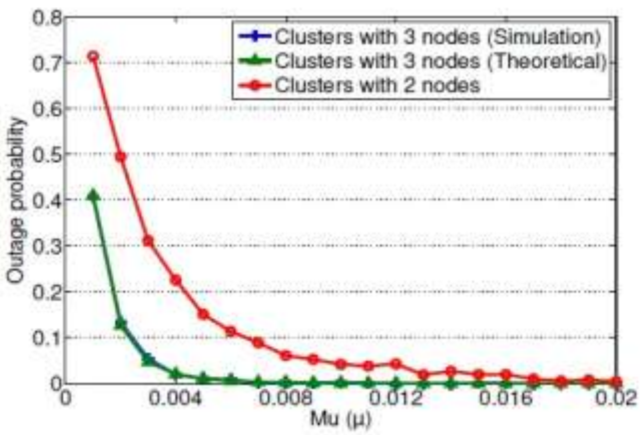

Figure 3.11: Simulation Vs Theoretical Outage Probability

Author can see from Figure 3.11 that the simulation and theoretical results match. Author also notice that the outage probability for clusters with 3 nodes is lower than that of clusters with 2 nodes. The total outage probability for a network with n clusters and x nodes per cluster ($x \times n$ total nodes) is $(P_{Out}(k, x))^n$. The marginal probability of being in the good state (receiving an error free bit) is $\frac{\mu}{\mu \times \varepsilon}$ (3.1). Hence the expected number of bits received correctly through each burst erasure channel is $\frac{\mu}{\mu \times \varepsilon} \times K$

Therefore we can write that for a cluster of x nodes

$$E(B_c) = \frac{x\mu}{\mu + \varepsilon} K$$

where $E(Bc)$ is the expected number of bits received correctly by a single cluster. The total expected number of bits transmitted by the nodes is given by

$$E(B) = (1 - P^n_{out}(K, x))\, E(B_c) + P^n_{out}(K, x) \times nE(B_c). \qquad (3.14)$$

For the case of $x = 3$ nodes and $n = 2$ clusters, we have

$$E(B_c) = \frac{3\mu}{\mu + \varepsilon} K$$

and

$$E(B) = \left(1 - P_{out}^2(K,3)\right) E(B_c) + P_{out}^2(K,3) \times 2E(B_c), \qquad (3.16)$$

where the first term is the probability that at least one of the clusters is not in outage multiplied by the expected number of bits transmitted by a cluster. And the second term in (3.16) is the probability that all clusters are in outage multiplied by theexpected number of bits when all nodes transmit (all *n* clusters).

Author consider the same configuration as before, 6 nodes and $x = 3$ nodes per cluster ($n = 2$ clusters) that overhear a message of size $K = 10000$ bits. We consider burst erasure channel parameters $\epsilon = 5 \times 10^{-4}$ and vary μ. We have shown in the previous subsection how to calculate P_{Out} (k, 3) from (3.12). Using (3.15) and (3.16), Author cannow calculate the expected number of bits transmitted by all nodes. We compare the results to those Author obtained from the simulations and to the results from the clusters with 2 nodes (Figure 3.12). Author also show the average number of active nodes per transmission for clusters with 2 and 3 nodes (Figure 3.13).

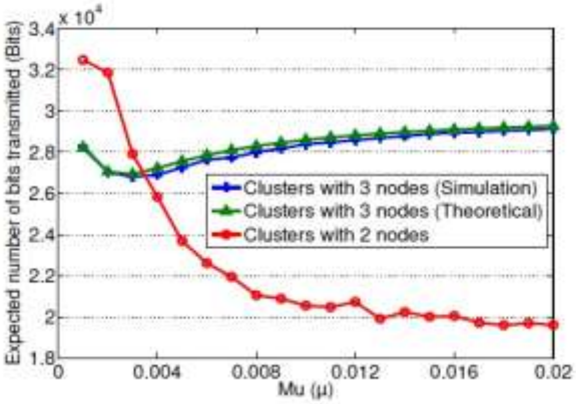

Figure 3.12: Simulation Vs Theoretical Expected Number of Bits Transmitted.

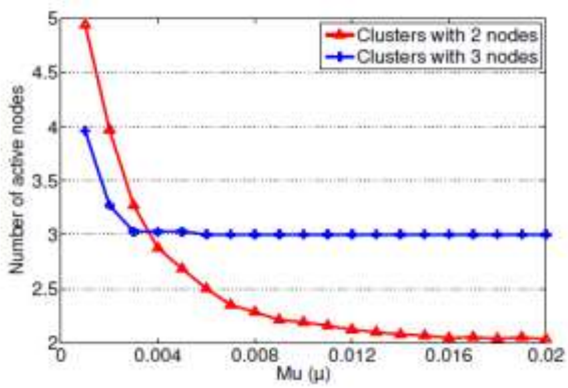

Figure 3.13: Node Activity For Clusters With 2 and 3 Nodes.

Again we can see that the theoretical and simulation results in Figure 3.12 coincide. We also notice from Figures 3.12 and 3.13 that for bad channels (smaller values of μ) the number of bits transmitted and the number of active nodes is higher in theclusters with 2 nodes than in the clusters of 3. For better channels (larger values of μ) the clusters with 3 nodes transmit more bits and more nodes are active. We can extrapolate by saying that for good channels smaller clusters of nodes will have enough information to send the full message. Therefore we will have less active nodes and less bits transmitted compared to larger clusters of nodes. On the other hand, for poor channels the smaller clusters will have a higher outage probability and more often than not all the nodes will have to be active. Larger clusters will have a larger likelihood of having the entire message to relay hence the smaller outage probability and expected number of bits transmitted for poor channels.

4.3 Expected Number of Bits Transmitted

- Since we are sending a message with K bits, the expected number of bits received correctly through each burst erasure channel is

$$\frac{\mu}{\mu \times \varepsilon} \times K$$

- So we can write for a subset of x relays,

$$E(B_s) = \frac{x\mu}{\mu + \varepsilon} K$$

Where E (B_s) is the expected number of bits received correctly per subset.

- The total expected number of bits transmitted by the relays is given by:

$$E(B) = \left(1 - P^{n}_{out}(K, x)\right) E(B_s) + P^{n}_{out}(K, x) \times n\, E(B_s)$$

For x=2 we get;

$$E(B_i) = \frac{2\mu}{\mu + \varepsilon} K \quad \text{……………………………………………………….......................} (2)$$

$$E(B) = \left(1 - P^{n}_{out}(K, 2)\right) E(B_s) + P^{n}_{out}(K, 2) \times n\, E(B_s) \quad \text{…………………………….} (3)$$

The first term is the probability that at least one of the subsets is not in outage multiplied by the expected number of bits transmitted by a subset. The second term is the probability that all subsets are in outage multiplied by the expected number of bits when all relays transmit (all n subsets). Author consider the same configuration as before, 6 relays and x = 2 relays per subset (n = 3 subsets) that overhear a message of block length K = 10000 bits and burst erasure channel parameters $\mathcal{E} = 5 \times 10^{-4}$ and varying μ. Using (2) and (3) we can calculate the expected number of bits transmitted by all relays. The energy (E) consumed by a sensor for transmitting a message is a linear function of the size of the message

E = m × size + b,

Where b is a constant dependent on device state and channel acquisition overhead, and m × size is an incremental component proportional to the size of the message. For large messages, b is negligible and we can assume that the energy consumed by a sensor to relay a message is directly proportional to the size of the message. When a relay is not transmitting it is idle and its power consumption is negligible.

Table: Analytical values for Fig. 3.11

S No.	Cluster	Mu (μ)	Outage probability
1	Clusters with 3 nodes (simulation)	0.001	0.40
		0.002	0.13
		0.004	0.20
		0.020	0.00
2	Cluster with 3 nodes (theoretical)	0.001	0.41
		0.002	0.13
		0.004	0.02
		0.020	0.00
3	Cluster with 2 nodes	0.001	0.71
		0.002	0.50
		0.004	0.22
		0.008	0.08
		0.012	0.05
		0.016	0.02
		0.020	0.00

Table: Analytical Values for Fig3.12

S No.	Cluster	Mu (μ)	Expected number of bits transmitted
1	Clusters with 3 nodes (simulation)	0.001	2.82×10^4
		0.002	2.70×10^4
		0.004	2.76×10^4
		0.008	2.80×10^4
		0.012	2.86×10^4
		0.016	2.90×10^4
		0.020	2.94×10^4
2	Cluster with 3 nodes (theoretical)	0.001	2.84×10^4
		0.002	2.70×10^4
		0.004	2.74×10^4
		0.008	2.83×10^4
		0.012	2.89×10^4
		0.016	2.90×10^4
		0.020	2.93×10^4
3	Cluster with 2 nodes	0.001	3.26×10^4
		0.002	3.20×10^4
		0.004	2.60×10^4
		0.008	2.10×10^4
		0.012	2.09×10^4
		0.016	2.00×10^4
		0.02	1.98×10^4

V. CONCLUSION

Author introduced three selection schemes that aim at decreasing the number of active nodes in a wireless sensor network and send less information through the network while maintaining a certain level of performance. Author saw how the reduced number of bits transmitted leads to energy saving for the sensor nodes in the network. Author also showed that even without the initial assumptions of perfect node-FC channels author is still able to gain a significant improvement on the lifetime of the sensors when using his proposed schemes. From the above data author analyse that Scheme 3 (Singles, pairs or Triplets) is the best for relay selections because outage probability is minimum for different values of Mu (μ) and that is we want and the outage probability for all schemes should decrease as the source node channel quality becomes better. So the author analyse that Scheme 3 (Singles, pairs or Triplets) is the best for relay selections because expected number of bits transmitted is minimum for different values of Mu (μ) and that is we want. We expect that expected number of bits transmitted for all schemes should decrease as the source node channel quality becomes better.

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