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RESEARCH ARTICLE OPEN ACCESS

Mobile Element Routing, Data Gathering and Energy Efficient Data Transmission in Wireless Sensor Networks

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ABSTRACT
Recent research shows that significant energy saving can be achieved in wireless sensor networks with a mobile base station that collects data from sensor nodes via short-range communications. We consider the problem of gathering data from a sensor network using mobile elements. The system is limited to single receive antennas the non-optimization of encoding/decoding order. This project is to develop the Wireless Distributive System Management with high reliability, mobility and routing. We propose an algorithmic solution that to provide the energy efficient data path planning for the mobile system and we go for upper sampling in the encoding processing. The choice of implementing algorithm depends upon the power allocation, nodal analysis, data gathering and node localization. The system to multiple receives antennas for the non optimization of encoding/decoding order. Also the existing system is an approach to achieve lower data rate with sufficient performance (38Mbps). We should increase Data Rate of several Mb/sec (58Mbps). This can be achieved by linear processing. By balancing the system, the speed of the MIMO system is optimum.

Keyword: Wireless Sensor Network, Routing, Data Gathering, Energy efficient.

I. INTRODUCTION

A **Wireless Distribution System** (WDS) is a system that enables the wireless interconnection of access points in an IEEE 802.11 allows a wireless network to be expanded using multiple access points without the need for a wired backbone to link them, as is traditionally required. The notable advantage of WDS over other solutions is that it preserves the MAC addresses of client frames across links between access points. An access point can be either a main, relay, or remote base station. A main base station is typically connected to the wired Ethernet. A relay base station relays data between remote base stations, wireless clients or other relay stations to either a main or another relay base station. A remote base station accepts connections from wireless clients and passes them on to relay or main stations. Connections between "clients" are made using MAC addresses rather than by specifying IP assignments. All base stations in a Wireless Distribution System must be configured to use the same radio channel, method of encryption (none, WEP, or WPA) and the same encryption keys. They may be configured to different service set identifiers. WDS also requires that every base station be configured to forward to others in the system. WDS may also be referred to as repeater mode because it appears to bridge and accept wireless clients at the same time (unlike traditional bridging). However, with this method, throughput is halved for all clients connected wirelessly.

WDS can be used to provide two modes of wireless AP-to-AP connectivity:

- Wireless Bridging in which WDS APs communicate only with each other and don't allow Wireless clients or Stations(STA) to access them.
- Wireless Repeating in which APs communicate with each other and with wireless STAs.
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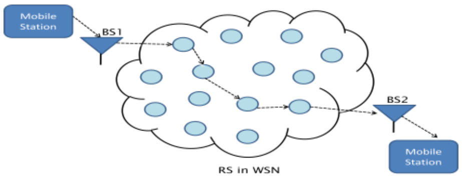


Figure 1.1: Relay Path

In the recent past, the popularity of wireless sensor networks (WSNs) has been manifested by their deployment in many real-life applications (e.g., habitat study and ecology monitoring. With potentially a large number of sensor nodes scattered in a region of interest, one of the challenging problems in WSNs is how to efficiently aggregate the data sampled at each node to a base station, which has the computational power to store and process all the collected data. Note that, sensor nodes are generally battery powered and it is hard (if not impossible) to replace those batteries after their deployment. Therefore, developing energy efficient data gathering schemes is ultimately important to reduce the energy consumption on individual sensor nodes, and thus extending the lifetime of WSNs. In conventional WSN deployments, the data aggregation is normally achieved through *multi-hop data forwarding* schemes.

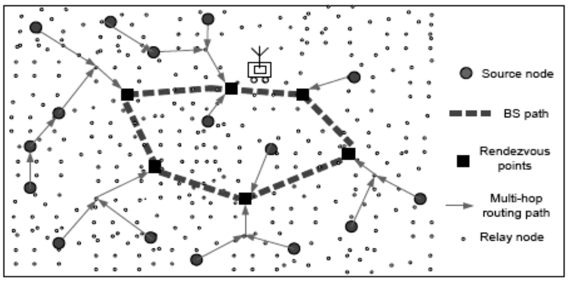


Figure 1.2: An example of data collection in a 500 X 500 m^2 sensing field. The BS moves at 0.5 m/s. It takes the BS about 20 minutes to visit all rendezvous points located within 100 m from the center of field. It takes more than 2hours to visit 100 source nodes randomly distributed in the field.

In these schemes, for the sensor nodes that are far away and cannot reach the base station in a single hop, their data will be relayed by their neighbors that are closer to the base station. However, the major shortcoming of such schemes is that the energy for the sensor nodes that are close to the base station will be quickly depleted due to their high data transmission activities, thus limiting the lifetime of WSNs. To address this problem, the ability of base stations has been exploited, where the base station moves around in the field to collect data from sensor nodes. For the cases where the base station is not moveable, energy efficient data gathering schemes that exploits mobile elements, which can move around the deployed field and convey the data from each sensor node to the base station, have been studied. The main challenge in these schemes is how to control the mobility of the mobile elements for efficient data gathering while satisfying various constraints (e.g., before buffer is full on each sensor node). More recently, considering the constraint that the mobile element may not be reachable from every sensor node, the hybrid approaches that combine the idea of multi hop data forwarding and mobile elements have been explored. Here, the data is first aggregated locally using multi-hop schemes to some rendezvous points. Then, the mobile element visits only these rendezvous points to pick the data up. Note that, in most of the existing studies involving mobile elements, only a *single* path is calculated for each mobile element and the same path is followed repeatedly during data gathering. However, such solutions with a single path for the mobile element may still lead today's in WSNs, especially for the cases where the mobile element needs to collect data directly from every sensor node but it cannot visit the location of all sensor nodes (due to, for example, energy budget of the mobile element or time limitations).

The sensor nodes that are far away from the path will need to transmit their data to the mobile element at higher power levels and thus use up their energy budget more quickly. For WSNs that rely on their entire sensor nodes for normal operations, such uneven energy depletion will lead to limited lifetime of WSNs. Different from the existing single-path solutions, in our preliminary study, we have proposed the idea of exploiting multiple paths for the mobile element in WSNs to extend the WSN's lifetime.

Wireless Sensor Networks (WSN) having large number of sensor nodes which will cover the earth in time to come. Sensor Networks covering vast areas are already in the wild and are instrumental in ways not possible using preexisting technology. The most important resource on these nodes is the energy supply and in almost all the cases a battery in the node is responsible for supplying energy for the entire lifetime of the node. The deployment of nodes could be at inaccessible locations and hence once the battery has drained the node is unusable for the network. Increasing the lifetime of the node becomes a very important factor to bring the technology mainstream. The biggest advantage in case of WSN is also their biggest limitation, the unconnected nature of the network also limits the life time of the network. Energy whole problem limits the total life time by disconnecting the network from the base node. For many WSN implementations it is practical to have a mobile base node, where a mobile base node traverses through the nodes on land or in air to collect data. Instead of communicating to each and every node the energy consumption can be decreased by using dynamic routing protocols developed for Ad hoc networking. Maintain a constant path for all the traversals of the base node is equally bad since even this will result in the formation of energy holes in the network. Generating a different path for each traversal with node energy as constraint will provide an equilibrium in energy consumption hence giving to the WSN. For the purpose of simulation the network is maintained within the following constrains.

1. Sensor nodes are distributed over a large area and may or may not have a layout in distribution.
2. The distance between two nodes is not greater than the communication range of the nodes and does not interfere with the formation of the network.
3. Individual nodes do not communicate to the base unit instead in a neighborhood a single node acts as an agent between the nodes and the base unit.

4. A mobile base unit is responsible for retrieval of data. Number of sensor nodes is limited and known, for larger number of nodes the heuristics will have to be updated.

We formally define the mobile element scheduling problem and present an integer linear programming (ILP) formulation that can be used to compute optimal solutions for relatively small instances. We then discuss two heuristics: one that is based on obtaining a solution of the Travelling Salesman Problem (TSP) and partitioning the resulting tour into smaller ones that meet all the constraints; and another that builds the mobile element tours in a greedy fashion (tour packing), based on a certain "cost" function for each node. Finally, we evaluate our heuristic algorithms by comparing their solutions to the optimal ones for small instances, as well as by demonstrating that they outperform a heuristic commonly used for the solution of a related vehicle routing problem with time windows. Recent years have seen the deployments of wireless sensor networks (WSNs) in data-intensive applications including emergency response, structural health monitoring (SHM), etc. WSNs in these applications often produce high-bandwidth sensor data that need to be collected under stringent delay constraints. For instance, SHM sensors must sample at higher than 100 Hz and stream the accumulated data to the base station (BS) every few minutes when the health of a structure needs to be inspected. On the other hand, sensors in such applications must operate on limited power supplies like batteries for extended lifetime up to years. Therefore, a fundamental challenge for these WSNs is to support high-bandwidth data collection with minimum network energy consumption. Several recent works have exploited the use of WSNs in data collection. In this approach, a small number of mobile devices referred to as mobile elements (MEs) roam about sensing fields and collect data from sensors. As a result, significant network energy saving can be achieved by reducing or completely avoiding costly wireless transmissions. On the other hand, the energy consumption of MEs is less constrained as they can replenish their energy supplies because of the mobility. However, the primary disadvantage of this approach is the increased latency. For instance, the typical speed of several practical ME systems (e.g., NIMs and Packbot is about 0.1-1 m/s. It is applied in the Gaussian broadcast channels. For a given transmit power constraint, those points on the boundary of the capacity region can be regarded as the set of optimal operational points. It provides high BER but QOS is not achieved in this type of channels. To achieve high transmit power and overcome transmit power constraint, we should balance transmit power by balancing the capacity of the channel by designing the proper transceiver of WSN. Optimum rate balancing should be achieved in the downlink of the wireless cellular system.

II. IMPLEMENTATION

2.1 Hand off Mechanism In Mobile WiMAX

For implementing a mobile network, a handoff mechanism must be defined to maintain uninterrupted user communication session during his/her movement from one location to another. Handoff mechanism handles subscriber station (SS) switching from one Base Station (BS) to another. Different handoff techniques have been developed. In general, they can be divided into soft handoff and hard handoff.

2.1.1 Soft Handoff

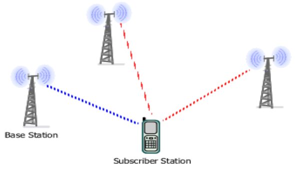


Figure 2.1: Soft Handoff

Soft handoff is used in voice-centric cellular networks such as GSM or CDMA. It uses a make-before-break approach whereas a connection to the next BS is established before a SS leaves an ongoing connection to a BS. This technique is suitable to handle voice and other latency-sensitive services such as Internet multiplayer game and video conference. When used for delivering data traffic (such as web browsing and e-mail), soft handoff will result in lower spectral efficiency because this type of traffic is bursty and does not require continues handover from one BS to another.

2.1.2 Hard Handoff

Mobile WiMAX has been designed from the outset as a broadband technology capable of delivering triple play services (voice, data, and video). However, a typical Mobile WiMAX network is supposedly dominated by delay-tolerant data traffic. Voice in Mobile WiMAX is packetized (what is called VoIP) and treated as other types of IP packets except it is prioritized. Hard handoff (HHO) is therefore used in Mobile WiMAX. In hard handoff, a connection with a BS is ended first before a SS switches to another BS. This is known as a *break-*before-make approach.

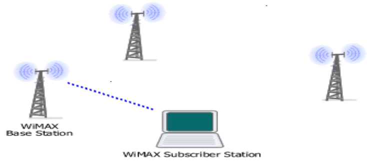


Figure 2.2: Hard Handoff

Hard handoff is more bandwidth-efficient than soft handoff, but it causes longer delay. A network-optimized hard handoff mechanism was developed for Mobile WiMAX to keep a handoff delay under 50 ms. A SS maintains a connection to a single BS at any given time.

2.1.3 Proposed Energy Efficient Algorithm

Energy saving is a paramount concern in wireless sensor networks (WSNs). A strategy for energy saving is to cleverly manage the duty cycle of sensors, by dynamically activating different sets of sensors while non-active nodes are kept in a power save mode. We propose a simple and efficient approach for selecting active nodes in WSNs. Our primary goal is to maximize residual energy and application relevance of selected nodes to extend the network lifetime while meeting application-specific QoS requirements. We formalize the problem of node selection as a knapsack problem and adopt a greedy heuristic for solving it. An environmental monitoring application is chosen to derive some specific requirements. Analyses and simulations were performed and the impact of various parameters on the process of node selection was investigated. Results show that our approach outperforms a naïve scheme for node selection, achieving large energy savings while preserving QOS requirements.

2.2 Relay-Assisted Communications System

In the relay-assisted communications system, multiple relays form a virtual array, and cooperate with one another to work, as shown in Figure 1. The relay-assisted broadband wireless communications networking enables diversified access modes, which is its major difference from legacy wireless access systems. Mobile terminals may access wireless networks either through relay stations directly or by cooperative relaying. As an effective technology for improving network coverage quality, radio relaying is a high-cost-performance solution to broadband wireless access at high frequency bands. Generally, the relay-assisted communications system has the following advantages as a new-type networking technology:

1. Multiple relays can use the same time slots and frequency simultaneously, which saves radio resources
2. Space diversity and space multiplexing can be used between relays to improve system capacity for transmission
3. It is unnecessary for the system to greatly change the existing backbone architecture, which will enable the smooth evolution of live communications networks.

2.2.1 Coverage

Owing to large-scale fading, the data transmission efficiency of BS-based Cell- structured communications systems gets worse along with the distance increase between users and BSs. Therefore, users in legacy cellular networks cannot really enjoy high data rates at the edge of the networks. Moreover, a BS always fails to cover every inch of its cells, because signal transmission is always influenced by geographic conditions, such as buildings in cities and underground environments. If relay stations are deployed in the areas with both weak BS coverage and the cell edges, dead spots will be effectively reduced and cell coverage will be expanded through signal relaying during communications. Compared to legacy cellular systems, the system with relay stations has wider coverage and better communications quality, based on low networking cost.

2.2.3 Transmission

This new wireless network integrating relay into the cellular network may send data to users through BS and relay stations simultaneously. Accordingly, capacity gains can be obtained through multiplexing or space diversity. Although the data transmission from BS to user via relay is a two-hop communications link, in which the relay requires certain frequency resources, data transmission to different users can use different relay stations. This may greatly compensate the capacity loss caused by the two-hop communications. When buildings and other geographic barriers hinder a transmission path from BS to user and lead to large-scale shadow fading, the capacity loss can even become a gain. With different relaying models and different message feedback modes, the number of relays in the relay-assisted communications network has different impacts on system capacity. If both BS and mobile terminal in the system are equipped with M antennas, and if both relay and mobile terminal have known channel messages, the system capacity will have a linear increase with M, and a logarithmic increase with the number of relays.

2.3 Architecture of Relay Stations

Two main points must be understood about RS. First issue is whether the BS knows about the RS. This means that if the BS needs to know nothing about RS, then the integration of RS into the service area is much simpler. No change to the BS is necessary and there is no special signaling between RS and BS. The RS is a pure helper for the BS. In this situation, RS causes no burden for the BS. Some of the earlier cellular systems such as GSM, used this kind of RS. They were simply called repeaters. The second point is the characteristic of the RS. Two kinds are popular: Amplify-and-Forward (A&F), or Decode-and-Forward (D&F). Each has different use and D&F equipment are generally more expensive than A&F.

2.3.1 Relays

Intelligent relays are an effective technology to achieve important deployment tools to provide cost effective methods of delivering high data rate and avoid coverage holes in deployments areas. In addition, upgrading the networks in order to support higher data rates is equivalent to an increase of signal-to-interference plus noise ratio (SINR) at the receivers' front-end. Also, through deployment the network providers have to avoid coverage area holes. A traditional solution to increase the receiver's SNR is to deploy additional BSs or repeaters to serve the coverage area holes with required data rates. In most of the cases, the cost of the BS is relatively high and arranging backhauls quickly might be a challenge in serving coverage holes. By now industry has used RF repeaters; however repeater has the problem of amplifying the interference and has no intelligence of signal control and processing. In order to achieve a more cost effective solution, relay stations (RS) capable of decoding and forwarding the signals from source to destination through radio interface would help operators to achieve higher SINR in cost effective manner. Relay stations do not need a wire-line backhaul; the deployment cost of RSs is expected to be much lower than the cost of BSs. The system performance could be further improved by the intelligent resource scheduling and cooperative transmission in systems employing intelligent relays.

2.3.2 Relays Vs Repeaters

They serve to expand the broadcast range of a television or radio station beyond the primary signal's coverage area, or to improve service in a part of the main coverage area which receives a poor signal due to geographic constraints Deploying RS can improve IEEE 802.16m network in different dimensions. The following figures illustrate the different benefits that can be achieved by deploying RS within an IEEE802.16m network and the relay-related connections in IEEE 802.16m. 16m BS (ABS) is a BS capable of acting as a 16m BS as well as a 16e BS. Multi hop relay BS (MRBS) is a 16e BS with 16j RS support functionality. 16m MS (AMS) a MS capable of acting as a 16m MS as well as a 16e MS. Yardstick MS (YMS) is a 16e MS. Advanced RS (ARS) is a 16m RS and RS is a 16j RS. Interconnections between the entities shown in solid lines are supported by using various protocols such as 16e, 16j, and 16m. There is no protocol specified to interconnections shown in dashed lines. Uni-directional zones (e.g. DL Transmit Zone) can exploit scheduling benefits and bi-directional zones (e.g. Network Coding Transmit Zone) can exploit throughput benefits by using network coding. Relaying is performed using a decode and forward paradigm, and ARS operates in time-division transmit and receive (TTR) mode. ARSs may operate in transparent or non-transparent mode. Cooperative relaying is a technique whereby either the ABS and one or more ARSs, or multiple ARSs cooperatively transmit or receive data to/from one subordinate station or multiple subordinate stations. Cooperative relaying may also enable multiple transmitting/receiving stations to partner in sharing their antennas to create a virtual antenna array.

2.4 Cooperative Relays

An interesting set of structures for relay stations is called Cooperative Relay. The signal from a base station is picked up by several relay stations, decoded, and forwarded to the mobile station through different radio paths. This scheme has the advantage that if one path is poor, another path is likely to make up for it. The improvement of Bit Error Rate (BER) at the mobile station is called Cooperative Diversity Gain. Wireless experts are working on three types of cooperative relays.

1. Same-Signal Cooperative Relay
2. Space-Time Coded Cooperative Relay
3. Hybrid Cooperative Relay

2.4.1 Same Signal Cooperative Relay

The same-signal cooperative relay is the simplest scheme. Here, multiple relay stations pick-up the same signal from the base station and forward it to the mobile station.

2.4.2 Space Time Coded Cooperative Relay

A slightly different scheme is to use Space-Time Block Coding (STBC) at the base station to enable the relay station to pick-up different signals. Here, the base station transmits two copies of its signal by using two antennas. The relay station can then make the most of the various received versions of the signal to improve the BER at the mobile station.

2.4.3 Hybrid Cooperative Relay

It is the combination of previous two cooperative relays. It is the most complex and provides the highest gain.

2.5 Individual Wireless Sensor Node Architecture

Depending on the sensors to be deployed, the signal conditioning block can be re-programmed or replaced. This allows for a wide variety of different sensors to be used with the wireless sensing node. Similarly, the radio link may be swapped out as required for a given applications wireless range requirement and the need for bidirectional communications. The use of flash memory allows the remote nodes to acquire data on command from a base station, or by an event sensed by one or more inputs to the node. Furthermore, the embedded firmware can be upgraded through the wireless network in the field. The microprocessor has a number of functions including:

1) Managing data collection from the Sensors.
2) Performing power management functions.
3) Interfacing the sensor data to the physical Radio layer.
4) Managing the radio network protocol.

A key feature of any wireless sensing node is to minimize the power consumed by the system. Generally, the radio subsystem requires the largest amount of power. Therefore, it is advantageous to send data over the radio network only when required. This sensor event-driven data collection model requires an algorithm to be loaded into the node to determine when to send data based on the sensed event. Additionally, it is important to minimize the power consumed by the sensor itself. Therefore, the hardware should be designed to allow the microprocessor to judiciously control power to the radio, sensor and sensor signal conditioner.

III. INDENTATIONS AND EQUATIONS

MIMO–TWO TRANSMITTING ANTENNAS AND TWO RECEIVING ANTENNAS (Tx=2, Rx=2)

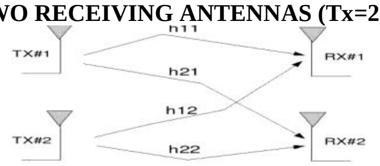


Figure 3.1: MIMO (Tx =2, Rx=2)

The received signal in the first time slot is,

$$\begin{bmatrix} y_1^1 \\ y_2^1 \end{bmatrix} = \begin{bmatrix} h_{11} & h_{12} \\ h_{21} & h_{22} \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} n_1^1 \\ n_2^1 \end{bmatrix}$$

Assuming that the channel remains constant for the second time slot, the received signal is in the second time slot is,

$$\begin{bmatrix} y_1^2 \\ y_2^2 \end{bmatrix} = \begin{bmatrix} h_{11} & h_{12} \\ h_{21} & h_{22} \end{bmatrix} \begin{bmatrix} -x_2^* \\ x_1^* \end{bmatrix} + \begin{bmatrix} n_1^2 \\ n_2^2 \end{bmatrix}$$

Where,
Y_1^1 and Y_2^2 are the received information at time slot 1 on receive antenna 1, 2 respectively,
Y_1^2 and Y_2^1 are the received information at time slot 2 on receive antenna 1, 2 respectively,
$\mathbf{h_{ij}}$ is the channel from ith receive antenna to jth transmit antenna,X_1,X_2 are the transmitted symbols, n_1^1 and n_2^1 are the noise at time slot 1 on receive antenna 1, 2 respectively and n_1^2 and n_2^2 are the noise at time slot 2 on receive antenna 1, 2 respectively.
Combining the equations at time slot 1 and 2,

$$\begin{bmatrix} y_1^1 \\ y_2^1 \\ y_1^{2*} \\ y_2^{2*} \end{bmatrix} = \begin{bmatrix} h_{11} & h_{12} \\ h_{21} & h_{22} \\ h_{12}^* & -h_{11}^* \\ h_{22}^* & -h_{21}^* \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} n_1^1 \\ n_2^1 \\ n_1^{2*} \\ n_2^{2*} \end{bmatrix}$$

Also,

$$\boldsymbol{H} = \begin{bmatrix} h_{11} & h_{12} \\ h_{21} & h_{22} \\ h_{12}^* & -h_{11}^* \\ h_{22}^* & -h_{21}^* \end{bmatrix}$$

To solve for x_1 x_2, we know that we need to find the inverse of $\boldsymbol{H}$.
We know, for a general m x n matrix, the pseudo inverse is defined as,

$$H^+ = (H^H H)^{-1} H^H.$$

The Term,

$$(H^H H) = \begin{bmatrix} |h_{11}|^2+|h_{21}|^2+|h_{12}|^2+|h_{22}|^2 & 0 \\ 0 & |h_{11}|^2+|h_{21}|^2+|h_{12}|^2+|h_{22}|^2 \end{bmatrix}$$

Since this is a diagonal matrix, the inverse is just the inverse of the diagonal elements, i.e

$$(H^H H)^{-1} = \begin{bmatrix} \frac{1}{|h_{11}|^2+|h_{21}|^2+|h_{12}|^2+|h_{22}|^2} & 0 \\ 0 & \frac{1}{|h_{11}|^2+|h_{21}|^2+|h_{12}|^2+|h_{22}|^2} \end{bmatrix}$$

The estimate of the transmitted symbol is,

$$\widehat{\begin{bmatrix} x_1 \\ x_2^* \end{bmatrix}} = (H^H H)^{-1} H^H \begin{bmatrix} y_1^1 \\ y_2^1 \\ y_1^{2*} \\ y_2^{2*} \end{bmatrix}$$

Multi BS MIMO

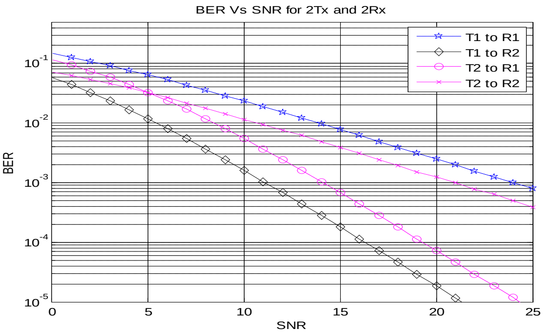
Multi-BS MIMO techniques are supported for improving sector throughput and cell-edge throughput through multi-BS collaborative precoding, network coordinated beam forming, or inter-cell interference nulling. Both open-loop and closed-loop multi-BS MIMO techniques can be considered. For closed-loop multi-BS MIMO, CSI feedback via codebook based feedback or sounding channel will be used. The feedback information may be shared by neighboring BSs via network interface. This places significant obligation in low latency backhauls. COMP - Coordinated multi-point (CoMP) is a new class of transmission schemes for interference reduction in the 16m technology. Enabling features such as network synchronization, cell- and user-specific pilots, feedback of multi cell channel state information and synchronous data exchange between the base stations can be used for interference mitigation and for possible macro diversity gain. The collaborative MIMO (Co-MIMO) and the closed-loop macro diversity (CL-MD) techniques are examples of the possible options. For downlink Co-MIMO, multiple BSs perform joint MIMO transmission to multiple MSs located in different cells. Each BS performs multi-user precoding towards multiple MSs, and each MS is benefited from Co-MIMO by receiving multiple streams from multiple BSs. For downlink CL-MD, each group of antennas of one BS performs narrow-band or wide-band single-user precoding with up to two streams independently, and multiple BSs.

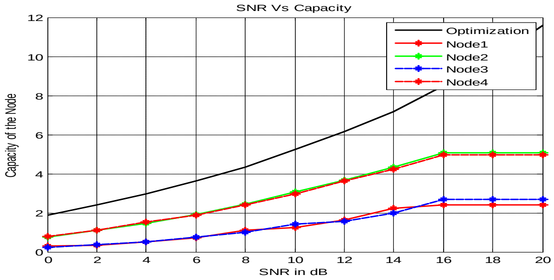
IV. SIMULATION RESULTS

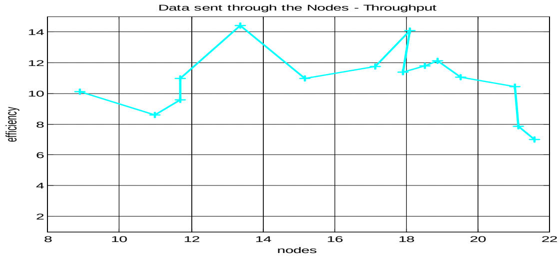
MATLAB IMPLEMENTATION

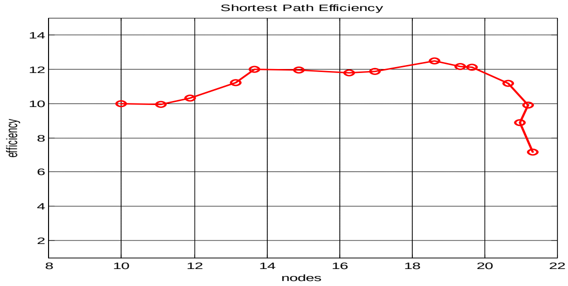
- Generate random binary sequence of +1's and -1's.
- Group them into pair of two symbols.
- Code it per the antenna, multiply the symbols with the channel and then add white Gaussian noise.
- Equalize the received symbols.
- Perform hard decision decoding and count the bit errors.
- Repeat for multiple values of $\mathbf{E_b/N_0}$ and plot the simulation and theoretical results.
- To select the Energy efficient nodes SVD algorithm (H= U.S.V*) is proposed. N-min (n_T , n_R) vectors are Rx Eigen Modes excited by the transmitter.
- Each node should have Kalman filter which is a linear optimal filtering approach which helps in node mobility management and node tracking.
- A Kalman filter combines available measurement data, plus prior knowledge about the system and measuring devices, to produce an estimate of the desired variables in such a manner that the error is minimized statistically.
- The Capacity of each nodes is calculated using Shannon Formula (C=log2 (1+(S/N)).

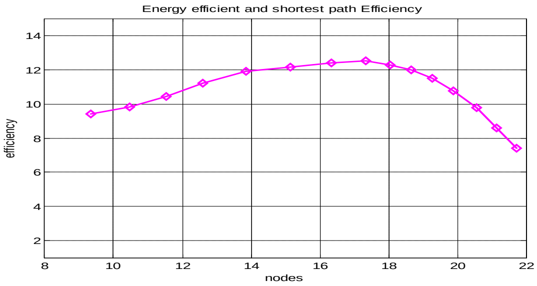
It tell about the performance analysis of this proposed algorithm ensures its effectiveness thereby providing Efficient Mobility, Low cost, higher bandwidth, maximum distance coverage, Low Bit error rate, High Signal to Noise ratio, Reduced ISI, High Data Rate simulated in MATLAB. These are the process done in that MATLAB Simulation Work and their results are furnished below.

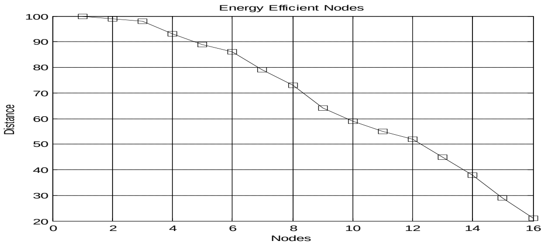

BER Vs SNR for 2Tx and 2Rx

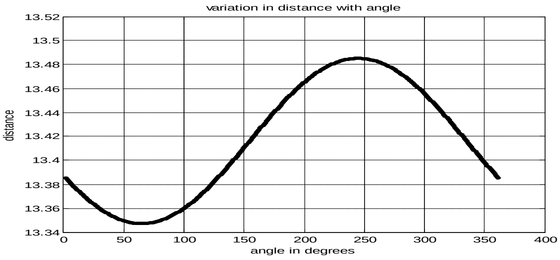

SNR Vs Capacity

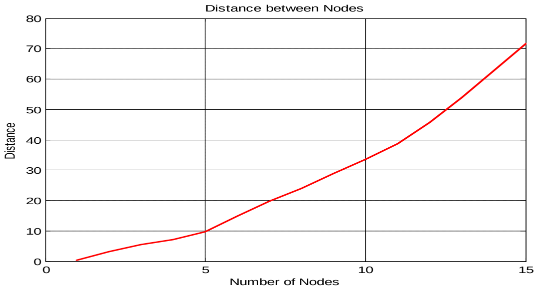

Data sent through the Nodes - Throughput

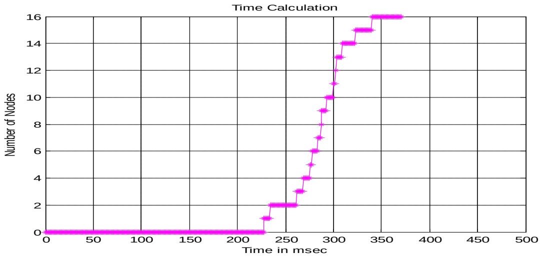

Shortest Path Efficiency

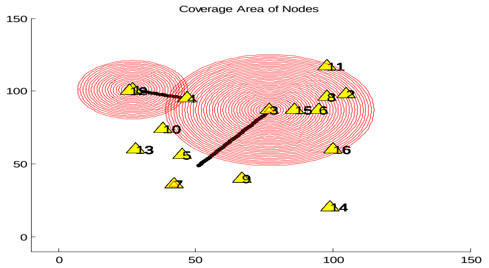

Energy efficient and shortest path Efficiency


Energy Efficient Nodes


variation in distance with angle







V. CONCLUSION

Wireless Sensor Networks composed of low cost, low-power, multifunctional sensor nodes. Applications of such WSN are medical treatment, environmental monitoring, outer-space exploration, emergency response, etc. senor nodes distributed over the field may act as information SOURCES. There is typically one or more SINK nodes for whom the measured data are destined to, which is located within or outside the sensing field. In order to improve energy efficiency, another efficient way is to maximize throughput without consuming much more power of nodes. MIMO (multiple-input and multiple-output), which is a multiple-antenna technique, is regarded as one of the most promising solutions for improving spectrum efficiency and increasing capacity of wireless systems. If we apply MIMO technique to the sensor network, it will enable more than one sensor nodes to send dissimilar information to the sink node simultaneously with energy efficiency. The observations motivate us to address the energy-efficient data gathering problem by simultaneously introducing mobility and MIMO capability to the sink nodes. The algorithm motivates us to address the energy efficiency and the scalability of the data gathering scheme can be greatly improved.

A mobile sink can be a robot or a vehicle equipped with advanced transceivers, sufficient power and large memory. Here the mobile sink has multiple antennas. It can concurrently receive data from multiple sensor nodes, which will dramatically reduce the gathering time by reducing the energy. The network cooperation between BS and multiple relays is proposed for improving communication capacity. In order to fulfill the cooperation, distributed schemes are necessary for legacy physical-layer-based multi-user MIMO technologies (such as dirty-paper coding, linear precoding and decoding, multi-user detection and STC) to implement cooperative data transmission among various nodes in the network. Accordingly, MAC-layer-oriented cooperation strategies seem extremely important. The relay-assisted communications system can use higher degree of freedom to improve resource allocation and optimize network performance. However, it also brings many non-convex optimization problems, which cannot be solved by traditional optimization algorithms. In fact, the heuristic interactive optimization and greedy search algorithms can achieve a good compromise between performance and complexity of computation.

It is also very important to synchronize BSs, RSs and multiple users in the relay-assisted communications system. Moreover, robust distributed STC designed in the condition of reducing inter-relay message exchanges is an effective technology for making full use of multi-relay space gains. Relay-based multi-hop transmission system has attracted much attention.

Future Enhancements

In the near future, sensor devices will be produced in large quantities at a very low cost and densely deployed to improve robustness and reliability. This project may be extended by introducing the concept of multiple-point-to-multiple-point, which enables free communications between any two nodes in network to fulfill quicker, convenient and economical data transmission which involves the automatic mapping and improved power saving.

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