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Network Coding- Based Energy-Efficient Geographic Routing Protocols in Wireless Sensor Networks Using XOR

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Abstract: ***Energy awareness is an essential design issue in wireless sensor network. Therefore, attention must be given to the routing protocols since they might differ depending on the application and network architecture. It is desired to design the energy efficient routing protocols to conserve the power supply of sensor node and prolong its lifetime. In this paper Network Coding-Energy efficient geographic routing protocol (NC-EGRPM) in Wireless Sensor network is an energy efficient scheme which prolong the network life time using the mobile sinks. These algorithms focus on the efficiency of network coding, which could be adoptive, flexible, and intelligent enough to distribute the load among the sensor nodes that can enhance the network lifetime. By using NC (Network Coding), we propose an energy efficienct algorithm to handle uncertain level decision better than other models. We also use the concept of XOR encoding and decoding as a mechanism not only for enhancing energy efficiency but also for reducing the end-to-end-delay. XOR-based coding works on a hop-by-hop basis, i.e. packets encoded by a node are decoded by its neighbouring nodes. The idea is that each node v can combine packets using bitwise XOR operations in order to produce an encoded packet. We are implementing our proposed work using NS2 and measure its performance.***
Keywords: Network coding, XOR, NS2, WSN

I. INTRODUCTION

A. Wireless Sensor Network

Wireless Sensor Networks (WSNs) consist of spatially distributed autonomous sensors to monitor physical or environmental conditions, such as temperature, sound, vibration, pressure, humidity, motion, or pollutants. These sensors cooperatively pass their data through the network to a main location, the base station. Modern WSNs are bidirectional, enabling users to control the activity of the sensors.. Each such sensor network node typically has several parts: a radio transceiver with an internal antenna or connection to an external antenna, a microcontroller, an electronic circuit for interfacing with the sensors, and an energy source, usually a battery or an embedded form of energy harvesting.

Typically, a large number of tiny sensor devices called motes constitute a WSN, where motes are considered as constrained in resources, such as limited on-board memory, short-range radio transceivers and limited battery power.

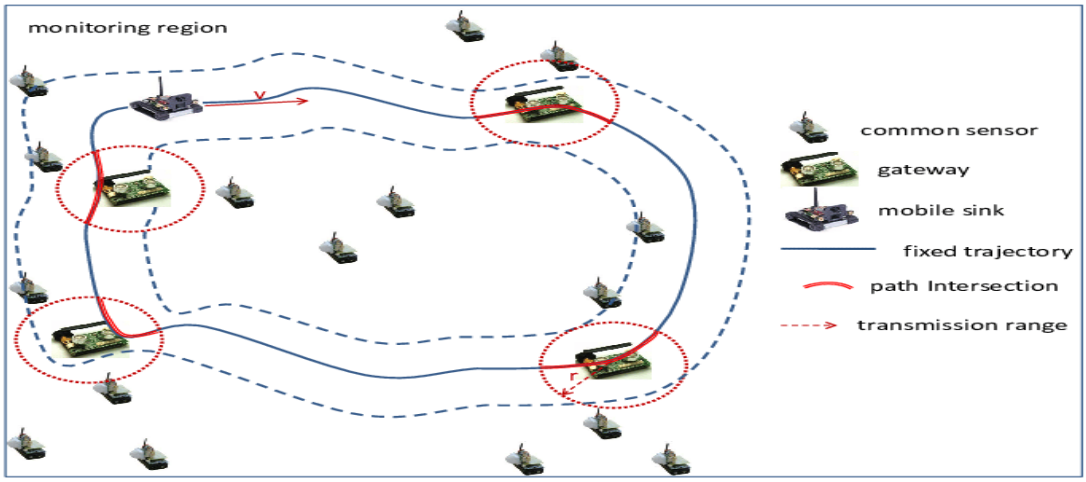


Fig 1: WSN Mobile Sink Network

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These sensor nodes form a decentralized, multi-hop, self-organized network system. Depending on the application environment, nodes are interfaced with various sensors for monitoring some phenomenon of interest (temperature, humidity, pressure, etc.) and forward the stimulus data to the data centres (Sinks) through multi-hop communication. To prolong network lifetime, the energy consumption of individual sensor nodes is important, as well as balanced energy consumption among all the sensor nodes is also desired. In traditional WSNs, sensor nodes are distributed in the sensing field whereupon detecting some event of interest, nodes report the sensed event back to some static sink(s) through single-hop or multi-hop communication. One major drawback of such communication infrastructures is occurrence of hot-spot or sink-hole problem in the neighbourhood of the sink(s). This is because sensor nodes close to the static sink will consume more energy and thus their energy will deplete quickly.

To overcome hot-spot or sink-hole problem, the concept of mobile sink was introduced in WSN, that not only results in balanced energy consumption among the nodes but can also be exploited to connect isolated segments of the network.

The mobile sink(s) are more energy efficient than the static, but has the additional overhead such as sink's location maintenance, continuous data delivery and dynamic route adjustments with sink mobility. There are various routing protocols proposed for WSN in order to deal efficiently with the sink mobility. The mobile sink has the multifold advantages like hotspot problem removal, energy efficient, longer network lifetime etc., but also include new challenges such as sink location management and dynamic route adjustments. There are many protocols developed for WSN, which support the mobile sink(s) such as Directed Diffusion, GEAR, GBR. These protocols maintain the location of the mobile sink by continuously propagating the location of the sink throughout the sensor network, so that all sensor nodes are updated with the recent location of the sink(s). But frequent updating cause traffic increase in WSN, collision in wireless transmission and more power consumption. TTDD provides two disseminating tiers for large-scale sensor networks with multiple mobile sinks. TTDD architecture exploits the fact that the sensor nodes are stationary and are location aware and queries of multiple mobile sinks are confined within the local only. In TTDD, on event detection each source node proactively constructs a grid throughout the sensor field. Therefore, as number of sources increases, the data dissemination point management overhead increases considerable.

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B. Energy-Efficient Routing Scheme Using Mobile Sinks

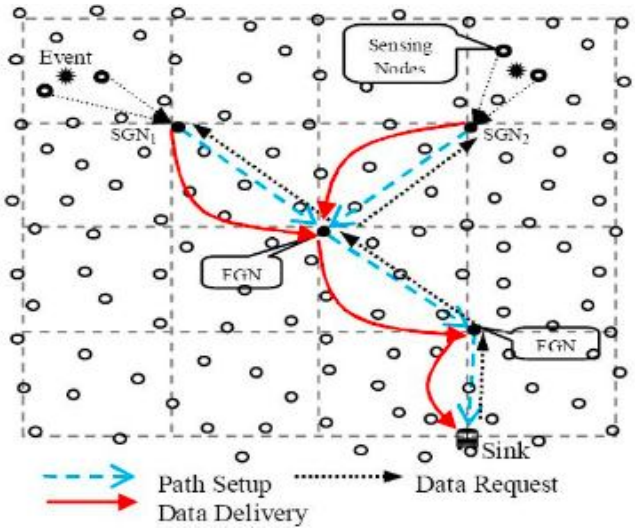
The basic assumption considered for EERS-MS protocol are mentioned below:

- The sensor field is represented as a two-dimensional plane constructed along x-axis and y-axis and divided into equal sized cells.
- The sensor nodes are randomly deployed in two dimensional square fields. The Sensor nodes remain stationary and aware of their geographical location using GPS system or localization algorithm. The coordinates (x,y) obtained thus serve as the node unique node identification number (NodeID).
- Data/query is disseminated using single-hop or multi-hop communication.
- EGRPM-MS uses the grid that is constructed by the sink appearing first in the sensor field or when no valid grid exists. All other sources and sinks appear thereafter use the same existing grid.
- Each sensor node is aware of its available energy. One or more mobile sinks are deployed in the sensor field to gather data.

1) *Grid Construction and Cell Size Determination:* In EGRPM-MS scheme, the grid construction is initiated by the sink appears first in the sensor field or when no valid grid exists. Sink starts grid construction process by keeping itself at one of crossing point (CP) of the grid with coordinates (XS, YS). The grid is constructed in same way as mentioned in SLDD. The two-dimensional geographical coordinates (x, y) of this sink thus become starting point for formation of grid of square sized cells. In this scheme, the node nearest to the CP and within radius of l (where l = T/8 and T is the transmission range of a sensor node) from CP is selected as Grid Node (GN). Each GN can communicate with its neighbouring GNs in a single hop communication. Thus, in EGRPM-MS, the cell size is determined by the radio range of sensor node. As each GN can forward the data to all neighbouring GNs in a single hop, therefore, two GNs lying diagonally can't be apart more than their transmission range T.
2) *Initial Routing Path Setup:* In this section EERS-MS describes the initial routing path setup from source to sink upon occurrence of an event. As grid constructed by sink, therefore, every node in the cell is aware about the location of the sink and the location of the grids nodes (GNs) of the cell in which it is lying. When a sensor node detects an event, it selects the GN that is nearest to the sink. This GN becomes the Source Grid Node (SGN) and responsible for path setup and data delivery to sink. The SHN sends the path setup message to upstream GN towards sink, which in turn further forwards the message to its upstream GN towards sink. This process continues till message reaches at the sink. All intermediate GNs on the routing path are

called as Forwarding Grid Node (FGN). If path setup message reaches at a GN that is already acting as FGN, then the message further forwarded through the already existing path leading towards sink.

3) *Data Request and Data Delivery:* Upon the receipt of the data announcing message, sink selects the nearest sensor node as primary agent (PA). PA sends a data request message to the SGN through the reverse path. When SGN receives the data request, it generates the data packets and sends it to PA through the same path in which request message was received as shown in Figure 2. Then PA forwards the data to the sink



4) *Handling Sink Mobility:* As proposed scheme supports the sink mobility, therefore it is required to maintain the path for continuous data delivery. When sink moves, the node that is nearest initial CP is selected as Primary Agent (PA). PA communicates with the mobile sink while it moves within one hop distance. PA is responsible for receiving he query from the sink and forwards the data to it. Every sink maintains a location information table (LINT) in its cache. Each entry in LINT table contains a tuple of information (Node_Info, NodeID, hc). The Node_Info indicated the role of node (i.e. whether node is SGN, FGN, PA or IA), NodeID is location/coordinate a node and hcis hop count of node from SGN. Entries in the table are in descending order of hop count (hc) from SGN to PA. As hc counts the numbers of hops SGN away from GNs. Therefore, hc for SGN is set to 0 and increment at each hop on routing path toward sink. The table information is updated as and when the route is modified. This table information also helps to avoid the detour problem if occurs.

C. *Sensor Energy Consumption*

The main sources of power consumption at sensor nodes are the communication tasks, followed by computation and sensing operations. Although different sensing platforms will have different energy consumption profile, the following remarks generally hold:

1) The communication subsystem has an energy consumption much higher than the computation subsystem. Therefore, communication should be traded for computation.
2) The radio energy consumption is of the same order of magnitude in the reception, transmission, and idle states, while the power consumption drops of at least one order of magnitude in the sleep state. Therefore, the radio should be turned off whenever possible.
3) Depending on the specific application, the sensing subsystem might be another significant source of energy consumption, so its power consumption has to be reduced as well.

D. *Network Coding*

Network Coding is used to reduce the traffic in broadcast scenarios by sending a linear combination of several packets instead of a copy of each packet. To illustrate net-work coding, Figure shows a five-node topology in which node 1 must broadcast two items of data, a and b. If nodes simply store and forward the packets they receive, this will generate six packet transmissions (2 for each node 1, 2 and 3 respectively). With the NC approach, nodes 2 and 3 can transmit a linear combination of data items a and b, so they will have to send only one packet. Nodes 4 and 5 can decode the packet by solving linear equations.

Therefore, two packets are saved in total in the example. Network coding exploits the trade-off between computation and communication since communications are slow compared to computations and more power-hungry.

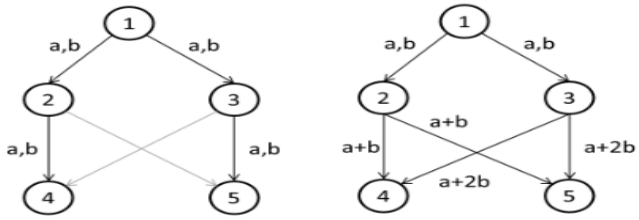


Fig : Network Coding

Combine network coding and Connected Dominating Sets to further reduce energy consumption in broadcast scenarios. AdapCode is a data dissemination protocol where a node sends one message for every N messages received, saving a fraction of the bandwidth up to (N-1)/N compared to naive flooding. The receiver node can recover the original packets by Gaussian elimination after receiving N coded packets successfully. Moreover, AdapCode improves reliability by adapting N to the node density, because when N increases and the density decreases, it becomes harder to recover enough packets to decode the data. Reliability is further enhanced by allowing nodes receiving less than N packets to send a negative acknowledgement to retrieve missing data .XOR Network Coding is a special case of linear network coding that is used in this work.

II. SYSTEM MODEL AND PROPOSED APPROACH

WSN consist of larger number of sensor nodes and each sensor nodes have the capability to communicate each other or directly to base station (BS) that is called as sink node. As more number of sensor over the sensing area will lead to more accurate and redundant data. In all these WSNs, battery is the only energy source of the nodes. Thus, energy conservation has become a crucial issue in WSNs. Therefore, designing energy-aware algorithms becomes an important factor for extending the lifetime of sensors. Energy is the one of the important factor one should consider while designing security measures for sensor nodes. It is very important to limit the energy consumption and thereby extend the battery life. However, adding security measures to sensor networks necessarily has a significant impact on its energy consumption, for example, to perform the encryption and decryption functions, to store, manage and send the encryption keys etc.

Developing an energy-efficient communication protocol is a critical goal in WSN. Several energy-efficient routing protocols were proposed to address this issue. They all adopt the idea of clustering or chaining sensor nodes so the transmission to the BS occurs in multi-hops. Clustering allows multi-hop transmission, data aggregation, data compression, and redundant data elimination. The benefits from clustering depend on the perfection of the clustering algorithm and the fitness of the exploited parameters. Unlike distributed clustering algorithms, which are performed by individual sensor nodes using their local information, the centralized clustering algorithms performed by the BS allow optimal clustering solutions, because the overall view of the WSN is available. Many factors affect the clustering algorithms in WSN, for example the remaining energy in the sensor nodes and the distances from their BS. However, if the problem is carefully analyzed, other factors can be considered. Obtaining an optimal clustering solution requires scaling each parameter by a weight corresponding to its influence on the dissipated energy and network lifetime. Therefore, if the clustering algorithm exploits more energy-affecting factors, the clustering will be more efficient.

A. Existing Work

Many years WSN faces the problem of energy conservation, hence it does not satisfy the energy efficiency problem, and due to the regular transmission of data it must have the prolonged energy in WSN network. For solving this clustering algorithm was raise, but in many factors affect the clustering algorithms in WSN, for example the remaining energy in the sensor nodes and the distances from their BS. However, if the problem is carefully analysed, other factors can be considered. Obtaining an optimal clustering solution requires scaling each parameter by a weight corresponding to its influence on the dissipated energy and network lifetime. Therefore, if the clustering algorithm exploits more energy-affecting factors, the clustering will be more efficient. No guarantee that all packets are delivered in an energy-efficient manner for resource-constrained WSNs. While in load balancing it provide some issue like energy cut situation, data loss due to energy problem. However, these problem must be analyzed, and provide considered solution, so that only it will provide a good data transmission. For this we propose a clustering algorithm to handle uncertain level decision better other models.

B. Proposed Work

We present the proposed solution for the energy-aware and secure data aggregation for WSN. In wireless sensor networks energy consumption is one of the important issues not only because of battery operated sensor nodes but also due to its significant impact on the idea of green computing. In wireless sensor network, clustering approach plays important role. Clustering approach increases network life time, improved bandwidth utilization and also reduces wasteful energy consumption thereby reducing overhead. In direct communication WSN, the sensor nodes directly transmit their sensing data to the central control or Base Station (BS) without any coordination between the two. However, in Cluster-based WSNs, the network is divided into clusters. Each sensor node exchanges its information only with its cluster head (CH), which transmits the aggregated information to the BS. Aggregation and fusion of sensor node data at the CHs because a significant reduction in the amount of data sent to the BS and so results in saving both energy and bandwidth resources. Once the clusters are constructed, each sensor node will be given an exclusive time slot; therefore, each sensor node knows when to transmit. Consequently, a node does not require being awake during the complete Time. Clustering in WSNs has focused on developing centralized and distributed protocols to compute sets of CHs and to form clusters. Centralized approaches are rather inefficient in the case of large scale networks since collecting the entire amount of necessary information at the central control BS is both time and energy consuming. Distributed approaches are more efficient for large scale networks. In these approaches, a node decides to become a CH or to join a cluster based on the information obtained solely from neighbors within its proximity.

Clustering is an effective approach for organizing a network into a connected hierarchy, load balancing, and prolonging the network lifetime. On the other hand, fuzzy logic is capable of wisely blending different parameters

1) *Monitoring Network Model:* Sensor nodes are considered to be deployed uniformly to monitor the environment continuously. All the sensor nodes are considered to be static including the base station. Homogeneous networks have been considered such that all the sensor nodes have initial equal energy. Distance between the base station and the sensor node is computed based on received signal strength indicator (RSSI). Let us consider that a multi-hop WSN is expressed in the form of an undirected graph as GR= (ND, AR) where ND represents the set of multiple numbers of nodes as ND= {1, 2, 3, 4…n}, where n denotes the total number of nodes present in the network and, AR denotes the feasible number of arcs or links among nodes in the deployed network. Here we assume that each node has a fixed transmission range R. According to this model, initially, nodes are distributed randomly in region R where R1, R2. For generality, we consider that these sensor nodes are deployed in the square field where finite number of cluster head can be present in the region R. In the given region R, the distance between sensor node I+ND and j+ND is expressed as Dij, distance from the current sensor node i+ND to base station BS is denoted by bi, the battery level of this node is denoted by which helps to transmit a data packet l of bits size. During the transmission of l bit packet, transmitter and receiver circuits consume specific energy denoted by E J/bit, data aggregation coefficient is denoted by DDA J/bit. In this work, we present a novel approach where each node is evaluated whether it has the positive level of batter for communication and total nodes which are having a positive energy level, are denoted as N and nodes are denoted as 0 if it doesn't have enough energy level otherwise 1. In order to determine the cluster head selection, we use a constant which is obtained using Fuzzy decision rules as discussed in next sub-section.
2) *Energy Model:* In WSNs, energy consumption and prolonging life time of the network are two critical issues. WSNs nodes are low powered battery device, replacement of battery or recharge of battery is very difficult task in hostile environment. The components of senor node consume a large amount of energy either in active mode or idle mode. Therefore, there is a need of power management scheme to save the energy. The sensor network is divided into number of levels. The sensor nodes from sensor network form the cluster of different size at different levels. Each cluster has a CH. The information sensed by each node is transmitted to CH. Each CH gathers the data from its cluster members compresses it and sends the compressed data to the base station. Since most of the energy is dissipated during the transmission, the energy optimization technique has been used. The transmitter dissipates energy to run the radio electronics and power amplifier whereas the receiver dissipates energy to radio electronics. The amount of energy consumption required for l bits to travel to a distance d (from the transmitter to the receiver) during transmission and reception.

$$E\ T\ x\ (l, d) = ETx{-}elec\ (l) + ETx{-}amp\ (l, d)$$

Here l represents the bits to travel and d represent distance, Eelec represents the energy dissipated per bit to run the transmitter or the receiver circuit. The amount of energy consumption depends on some parameters such as digital coding, modulation, filtering and spreading of the signal.

3) *Mobile Sink:* The mobile sink moves with a constant angular velocity and the current position of the mobile sink can be calculated using its initial position and moving time. Hence, the mobile sink only needs to announce its initial position and angular velocity such that the broadcast message of the network is greatly reduced. Mobile sinks query the network to collect the location of source nodes. After getting the location of the source node, the sink can directly send the data request query to the source node with consideration of source node's location and direction of sink's movement. Here, mobile nodes are termed as the mobile sink that usually helps to gather data by travelling in the field of sensing. The sensor nodes' Communication overhead is reduced by the mobile sink which is nearer to the base station or the sink. The consumption of energy is processed constantly in a uniform way. The network of disconnected and sparse can be handled in a better way by including the sink's movement. With the route's optimum control of the mobile sink, the lifetime of a network can be extended significantly. Different types of obstructions could be contained in the sensing field of physical environments. A research challenge is included specifically relevant to the how to determine an obstacle-avoiding shortest route for the mobile sink. he mobile sink can be reached closer to the cluster heads and lower energy is conserved. Significantly, lifetime of a network can be improved. The definition of lifetime of a network is nothing but the time interval of initiating the operating of sensor nodes until all static sensors' death. Many obstacles may be contained in the sensing field of physical environments that will complicate the mobile sink's scheduling. We suppose the initial position of the mobile sink is P0, and after a Δt time interval, the mobile sink will have moved to a new position PΔt, as is shown in Figure 5.

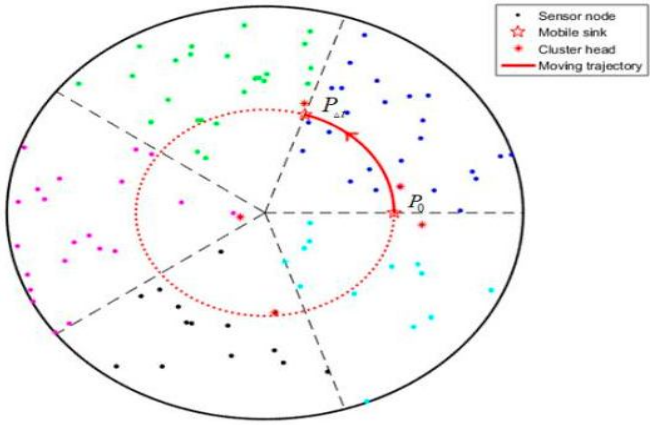


Fig 5: Trajectory of mobile sink

The prediction of the mobile sink demands that the clock of sensors is synchronized and the position information will be calibrated every few rounds. When there is only one mobile sink in the network, the initial position of the mobile sink P0 can be set at any position of the circle with radius r. Once there are multiple mobile sinks, their initial positions are evenly distributed at the edge of the circle with radius r.

4) *Network Coding:* Network coding is a technique which allows the intermediate nodes to encode data packets received from its neighboring nodes in a network. The encoding and decoding methods of linear network coding are described below . Encoding operation: A node, that wants to transmit encoded packets, chooses a sequence of coefficients q = (q1, q2, ..., qn), called encoding vector, from GF(2s). A set of n packets Gi(i = 1, 2, 3, 4, ..., n) that are received at a node are linearly encoded into a single output packet. The encoding vector is used at the receiver to decode the encoded data packets. Decoding operation: A receiver node solves a set of linear equations to retrieve the original packets from the received coded packets. The encoding vector q is received by the receiver sensor nodes with the encoded data. Let, a set (q1, Y 1), ...,(qm, Y m) has been received by a node. The symbols Y j and qj denote the information symbol and the coding vector for the jth received packet respectively. A node solves the following set of linear equations with m equations and n unknowns for decoding operation.The XOR network coding, a special case of linear network coding, has been used in this work.

5) *XOR Network Coding:* We can use XOR coding as a mechanism not only for enhancing energy efficiency but also for reducing the end-to-end-delay. XOR-based coding works on a hop-by-hop basis, i.e. packets encoded by a node are decoded by its neighbours. The idea is that each node v can combine packets using bitwise XOR operations in order to produce an encoded packet. For the neighbouring nodes to be able to decode the encoded packet, the choice of native, i.e. non coded, packets is very

important. More specifically, for a successful coding of k packets, each neighbour should know k − 1 of those packets beforehand. This requirement guarantees that each neighbour should be able to decode the encoded packet. The existence of k > 1 packets that can be encoded is known as a coding opportunity It is clear that, finding a coding opportunity depends on v's knowledge about the packets that each of its neighbours has already received. To acquire such information, v employs opportunistic listening and snoops all communication in the wireless medium. The acquired information is stored in what is called the neighbour reception table. Moreover, node v should store in what is called the packet pool all recently received native packets in order to be able to perform decoding of encoded packet.

Below are the two algorithms that are developed for this system inorder to increase efficiency and network lifetime.

- *Algorithm 1:* DataPacketProcess(Pi) : DataPacket processing at a node inside the network coding layer

Require: DataPacket transmission and reception starts, received DataPackets inserted into the RecvDataQueue()
Ensure: Encoded DataPacket transmitted or discarded
1. Pick a DataPacket Pi from RecvDataQueue(Pi)
2. If DataPacket Pi ∈ ForwardDataPacketSet(Pi) exit;
3. If Node n ∈ EncoderNodeSet() continue;
4. If native(Pi) then
5. CN =ExorEncoding();
6. Node n transmits the coded DataPacket CN to Sink
7. Insert the processed DataPacket Pi to ForwardDataPacketSet();
8. else
9 Discard(Pi);
10 endif
10. else
11. Node n acts as relay and transmits the DataPacket Pi to the Sink;
12. endif
13. endif
14. If (RecvDataQueue() = empty)
15. goto step 1;
16. else exit;
17. endif

- *Algorithm 2:* ExorEncoding() : Encoding algorithm

Require: A received queue RecvdataQueue() and a sensed queue SenstheQueue()
is maintained at an encoder node
Ensure: Generation of network coded packet CN
1. If SenstheQueue() is not empty then continue;
2. Pick a packet Pi from head of the RecvdataQueue();
3. Pick a packet Pj from head of the SenstheQueue();
4. CN = Pi ⊕ Pj ;
5. else
6. Pick next packet Pi+1 from the RecvdataQueue();
7. CN = Pi ⊕ Pi+1;
10. endif;
11. return CN

The protocols that use centralized network, where the base station utilize the global information of the network for selection and formation, can produce better that require less energy for data transmission, we propose a routing protocol for a mobile sink group by utilizing its movement pattern which has a slow variance and continuous stream i.e. moving properties. In the proposed protocol, a source sends its data only to sensor nodes on a line that a mobile sink group potentially passes, and mobile sinks get the data from the line when they pass it. Simulation results show that the proposed protocol has better performance than the existing protocols.

III. EXPERIMENTAL RESULT

In this section, we discuss the influence of different parameters on the performance of the network. The radius of the moving trajectory of the mobile sink has a significant influence on the topology construction. Then, the method for weight calculation determines the usage ratio of the energy. The number of the clusters and the speed of the sink may also affect the performance. Additionally, multiple mobile sinks are also discussed in this section. The simulation has been performed by NS2.

A. Performance Analysis

In this section we evaluate the results of the simulations that were conducted to compare the performance . The performance is evaluated by comparing it to Existing system(EGRPM) in terms of in terms of total energy consumption, average delay with varying number of nodes, sinks and sink mobility. In this performance evaluation we use the energy model as described by the key energy parameters are the energy needed to sense a bit (Esense), receive a bit (Erx) and transmit a bit over a distance d (Etx). Assuming path loss in energy model is1/dη. The default simulation setting has a square sensor field of size 2000 x 2000 m2 in which 200 sensor nodes are uniformly distributed. Some of these sensor nodes act as sources and generate one data packet per second. Simulation model is run 100 times and the observation is based on the varying numbers of sensor nodes, sinks and sinks mobility. There is one or more mobile sink(s) in the sensor field. The size of control/query packet is 36 bytes and data packets are 64 bytes. Path loss is set as η = 2. The transmission range T of each sensor is 100 m and the value of α is evaluated. The result shown below

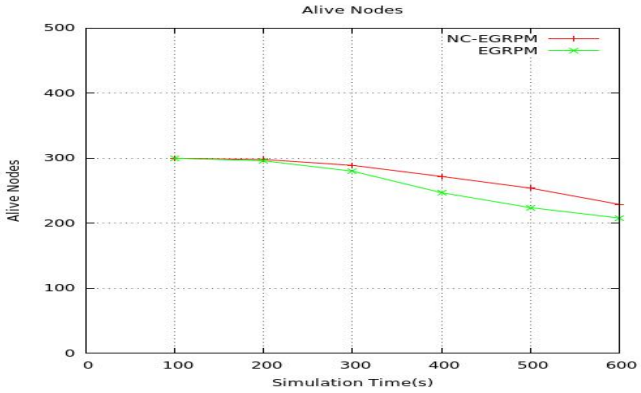


Chart 1: Alive Node

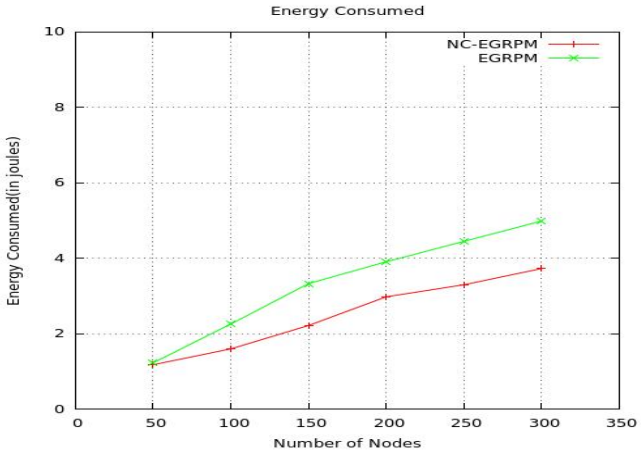


Chart 2: Energy Consumed

B. Effect Of Node Density On Total Energy Consumption

In this subsection we evaluate the total energy consumption with varying node density. The number of sensor node varies from 100 to 600 and four numbers of sinks are moving in the field at a speed of 10 m/s. The total energy consumed by NC-EGRPM is less energy as compared to EGRPM as shown in chart. This is because node density doesn't impact much in case NC-EGRPM protocol as the data/query communication through GN only. Also, in NC-EGRPM the sink's location is used for path setup instead of flooding a route request packet (REQ) as in EGRPM.

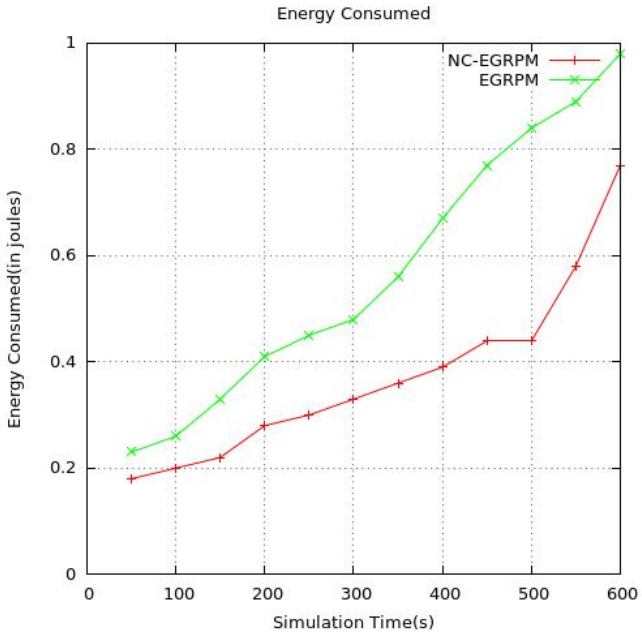


Chart 3: Energy consumed based on simulation

C. Effect of Number Sink on Total Energy Consumption

This approach shows the total consumed energy for the different numbers of mobile sinks. Number of sinks are varying from 1, 2, 4, 6, 8 whereas the node density in the field is 200 nodes.

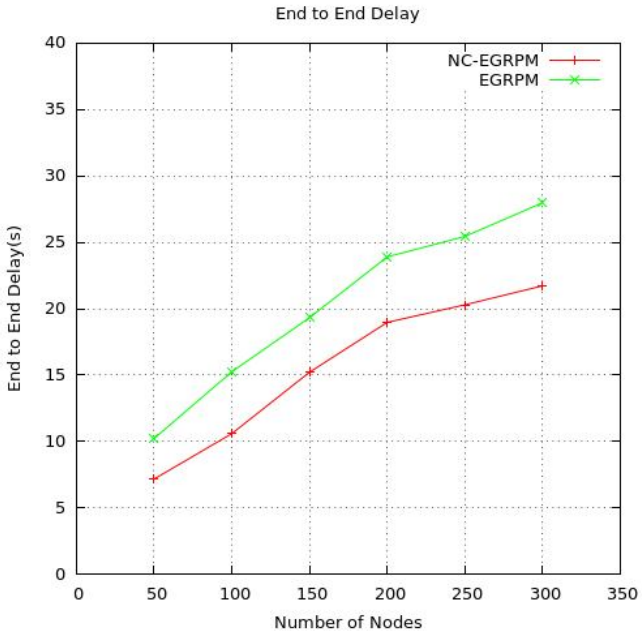


Chart 4: End to End Delay calculation

D. Effect Of Sink Speed On Total Energy Consumption And Average Delay

In this section we evaluate the total consumed energy with varying sink speed. There are 4 sinks in the field and maximum speed of the sinks varies from 5, 10, 15, 20m/s. There are 200 sensor nodes deployed in the field. The total energy consumed by NC-EGRPM is considerably less as compared to EGRPM when speed of sink is below 18m/s as shown in figure. But, as sink speed increases EGRPM consume more energy. Figure shows the average delay with varying sink speed. The NC-EGRPM has less average delay as

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compared to EGRPM. This is because NC-EGRPM has the ability to modify partial or full path efficiently to avoid any detour problem.

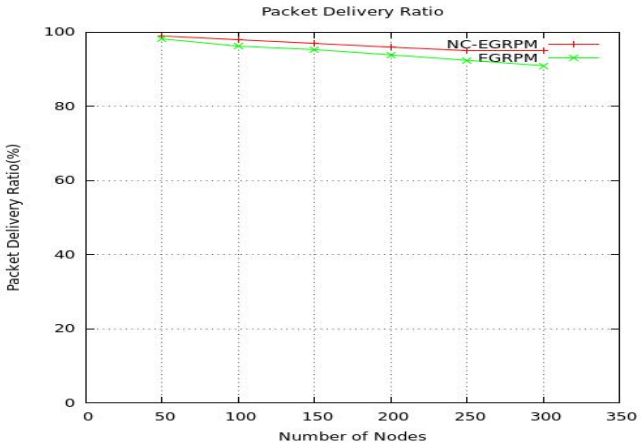


Chart 5: Packet Delivery ration

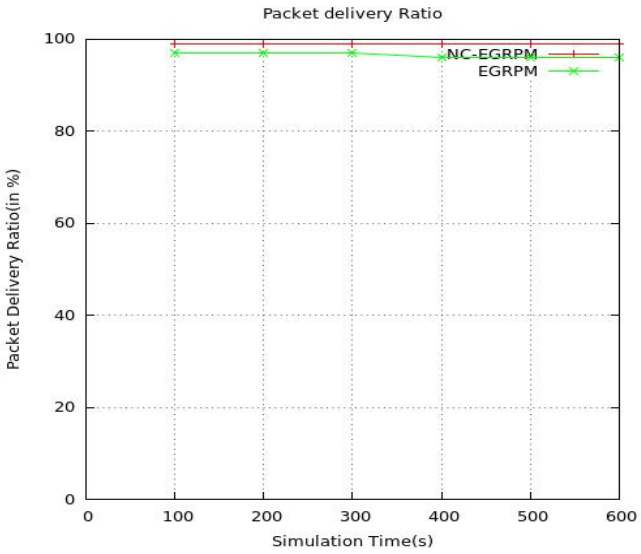


Chart 6: Packet delivery ration based on simulation time

It can be clearly seen that the lifetime of the network was almost unchanged with the increasing speed of the mobile sink. Therefore, we draw a conclusion that the speed of the mobile sink has little influence on the lifetime of the network, and it should not be too fast or too slow. when the number of the mobile sinks increased, the upward trend of the energy consumption of the whole network decreased. When the number of the mobile sinks exceeded three, the performance of the whole network does not change much. Energy consumption by a network coder node is assumed to be same as energy consumption by a relay node to transmit one-bit data inside the bottle-neck zone. The overhead of encoding process is negligible in view of single hop communication between the network coder node and the Sink. proposed network coding based approach and the general network. As the value increases, the network lifetime decreases in case of the proposed network coding approach because less traffic flow though the network coder nodes. The network lifetime in case of a general network remains constant irrespective of the value offhand it is significantly less than the proposed approach. Furthermore, an increase of the value of m, the network lifetime decreases in both the cases.

IV. CONCLUSION

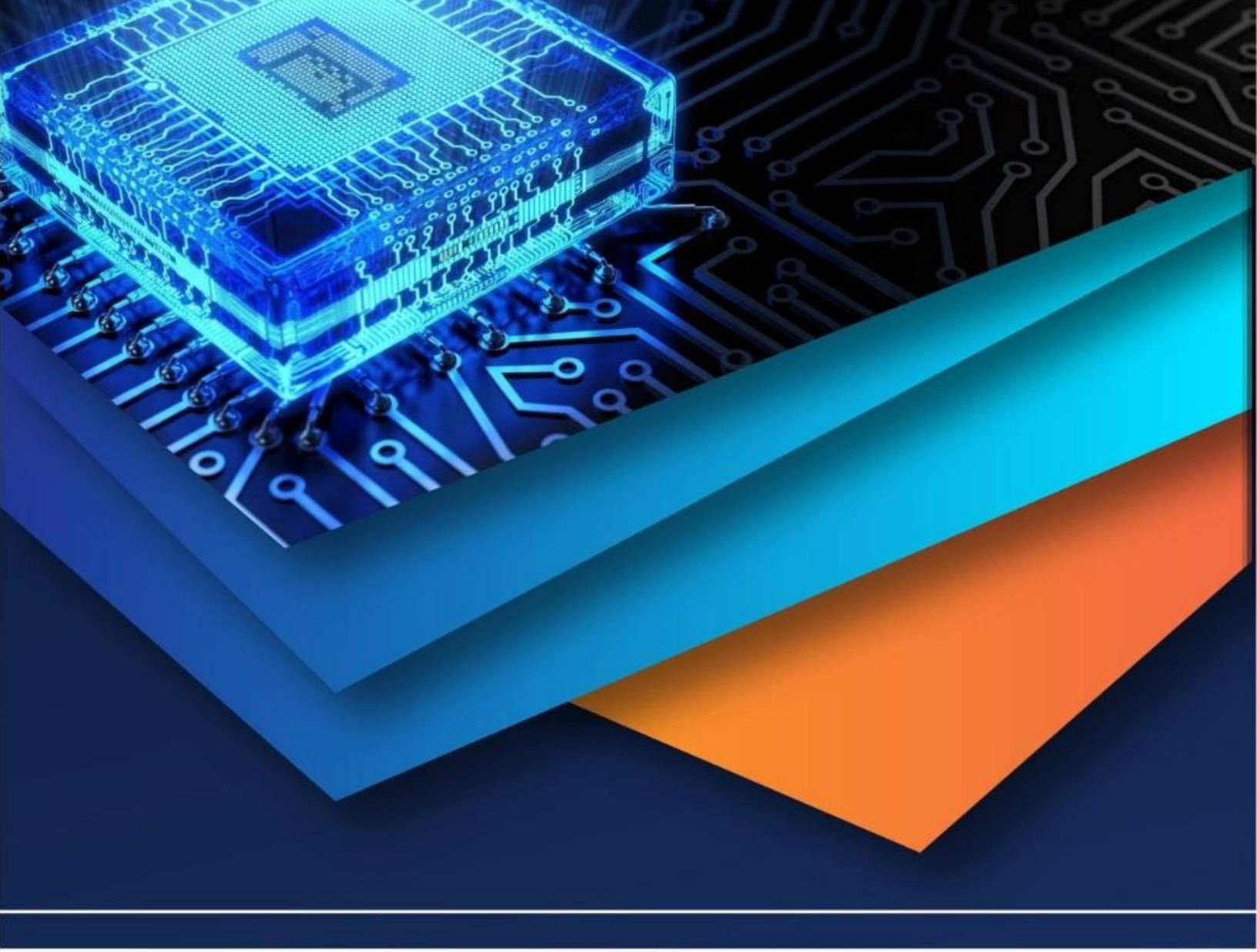
Wireless Sensor Network (WSN) is an emerging field with lot of applications. Sensors are usually deployed densely in wireless sensor network. Due to this dense environment, it can suffer significant interference which greatly impairs network performance. Therefore, to discover different technique for reducing power consumption in the presence of interference and shadowing environments are also very important.

We use XOR encoding and decoding as a mechanism not only for enhancing energy efficiency but also for reducing the end-to-end-delay. There is also the discussion on how the proposed method improves the network lifetime as compared with existing. The complete experimental performance analysis from various constrains was described. The complete analysis shows that the proposed approach achieves promising performance when compared with the existing techniques. However, the proposed method provides energy conservation using clustering approach and help to provide monitoring in WSN. For the future works, we will further improve our algorithm aiming at security routing problems to try to establish the trust evaluation model.

Developing an energy-efficient communication protocol is a critical goal in WSN. Several energy-efficient routing protocols were proposed to address this issue. This research work Proposed Network Coding-Energy efficient geographic routing protocol (NC-EGRPM) in Wireless Sensor network is an energy efficient scheme which prolong the network life time using mobile sinks. In NC-EGRPM, the grid is constructed by the source node appearing first in the sensor field or when there exists no valid grid. Cell size is entirely determines using the transmission range T, so that any source/sink appears thereafter can detect the valid grid using single hop communication. In this scheme sink location is used to setup up the shortest path between source and sink. Moreover, NC-EGRPM handles mobile sink very efficiently and maintains the path for continuous data delivery. It also construct/update a partial or new path between source and mobile sink if any detour problem occur thus conversing the sensor node energy and increasing the network lifetime. Simulation results also indicate that NC-EGRPM consumes less energy as compared to EGRPM when observed for different numbers of sensor nodes, sinks, and sink mobility.

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