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CLUSTER-BASED ROUTING IN DYNAMIC SENSOR NETWORK WITH MOBILE SINK

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Abstract: In wireless2sensor networks (WSNs), the2benefits of exploiting2the sink2mobility to prolong2network lifetime2have been well2recognized. In physical environments, all kinds of obstacles2could exit in the2sensing field. Therefore, a2research challenge is2how to efficiently dispatch2the mobile sink2to find shortest2route. This project2presents an energy-efficient routing mechanism2based on the cluster-based2method for the2mobile sink in WSNs. According to the2cluster-based method, the2nodes selected as2cluster heads2collect data from2their cluster members2and transfer the data2collected to the2mobile sink. In this project, the2mobile sink starts the2data-gathering route2periodically from the2starting site, then2directly collects data from these2cluster heads in a2single-hop range, and2finally returns to the2starting site. However, due to2the complexity of the2scheduling problem in WSNs, the conventional algorithms are difficult to resolve. To remedy this issue, we propose an efficient scheduling mechanism based on Shortest path (Dijkstra's) Algorithm We present a heuristic tour-planning algorithm for the2mobile sink to find the2shortest route. Simulation2results verify the2effectiveness of our2method.

Index Terms: Wireless Sensor Networks (WSN), Heterogeneous Networks (HN), End-to-End delay (E2E), QoS (Quality of Service).

I. INTRODUCTION

A wireless2sensor network (WSN) consists of spatially distributed autonomous sensors to monitor physical or environmental conditions and to cooperatively pass their data through the network to a main location. The more modern networks are bi-directional, also enabling control of sensor activity. The development of wireless sensor networks was motivated by military applications such as battlefield surveillance; today such networks are used in many industrial and consumer applications, and so on. Energy efficiency has become the most key issue for WSNs. However, power supplies for sensor nodes are limited and hard to replace. In addition, compared with other nodes, nodes near the base station (also called the sink) consume more energy, since the nodes relay the data collected by sensor nodes far away from the sink. Hence, once these sensors near the sink fail, the data collected by other sensors cannot be transferred to the sink. Then, the entire network becomes disconnected, although most of the nodes can still have a lot of energy. Therefore, to extend the network lifetime, minimizing the energy consumption of sensor nodes is the key challenges for WSNs. Different approaches are proposed to prolong the lifetime of WSNs. We proposes a cross-layer optimized geographic node-disjoint multipath routing algorithm. Recent work shows that we can use mobile nodes to reduce the energy expenditure of WSNs to a large extent. Consequently, the lifetime of WSNs is prolonged. Compared with static nodes, mobile nodes have more energy and more powerful capabilities. Mobile nodes, which are usually mounted on a mobile vehicle equipped with enough energy, can collect data from all static nodes by moving across the sensing field. The data from static nodes can be collected by mobile nodes in one-hop or multi-hop way. Here, mobile nodes are used as the mobile sink which moves across the sensing field to collect data. On the one hand, the mobile sink reduces the communication overhead for sensor nodes close to the base station or the sink, which leads to the uniform energy consumption. One the other hand, with the movement of the sink, we can better handle the disconnected and sparse network. Therefore, the network lifetime can be significantly extended by the optimum control of the route of the mobile sink. In physical environments, the sensing field could contain various obstacles. Hence, to prolong the network lifetime, a research challenge is how to find a shortest route for the mobile sink. The mobile sink will move through the network with obstacles to find the possible shortest route. At the same time, the mobile sink must consider the energy consumption balance among nodes while moving across the sensing field. To dispatch the mobile sink efficiently, we utilize the cluster-based method. According to the cluster-based method, all sensor nodes in the sensing field are divided into two categories: cluster heads and cluster members. Cluster heads collect data from corresponding cluster members which collect environment information, and then pass data to the mobile sink. We assume that WSNs can tolerate some extent of delay so that the mobile sink collects all sensing data from cluster heads. The mobile sink begins its periodical movement from starting site and finally returns. During its movement, the mobile sink collects the sensing data from cluster heads. Once its moving path is planned, the mobile sink can move near the cluster heads and consume less energy. Hence, the network lifetime can be prolonged significantly. The network lifetime is defined as the time interval from sensor nodes start working until the death of all static sensors. However, in physical environments, the sensing field may contain various nodes which make the scheduling for the mobile sink more complex. Here, the mobile sink can move to any site except the site of obstacles. Therefore, a research challenge is how to efficiently dispatch the mobile sink to find an efficient shortest route. The remaining part of the paper is organized as follows: Section II point to related work. Section III discusses Key

Management and Adversaries. Design and System Flows are illustrated in Section IV. Section V presents Simulation setup and Results and Conclusions are drawn in Section VI and VII Respectively.

II. RELATED WORK

Recent work shows that the advantage utilizing the mobility of nodes has been well recognized. By using the mobility of nodes in WSNs, we can ease the traffic burden and enhance energy efficiency. Hence, the network lifetime is extended significantly. Many papers have proposed several different approaches. We then study the related works of the mobility of nodes in the literature.

A. W. Khan et.al, the authors present a VGDRA scheme for the mobile sink to minimize the communication cost. The sensor field is divided into a virtual grid containing the same size cells and the nodes near the center are chosen as the cell-header nodes. In addition, a virtual backbone structure consisting of the cellheader nodes is constructed The mobile sink moves across the sensor field and collects the sensing data by communicating with the border cellheader nodes. To reduce the overall communication cost, the routes reconstruction process includes only a subset of cell-header nodes.

O. Cayirpunar et al., here the authors propose a mixed integer programming framework for base station to mitigate the suboptimal energy dissipation. To reverse the suboptimal energy dissipation trends, the base station mobility is introduced to WSNs. The network lifetime is finally extended by using mobility patterns for base station.

F. Tashtarian et.al, utilizes the support vector regression technique to construct a convex optimization model, by which the optimal trajectory of the mobile sink can be determined. The network lifetime is affected by the trajectory (called COT). To maximize the network lifetime, the mobile sink in the event-driven is used to collect the captured data of events.

M. Ma, Y. Yang, and M. Zhao, the authors propose a mobile data-gathering tour for different sensor networks. An M-collector similar to a mobile base station is introduced to collect sensing data from static sensors. The MDC begins its periodical movement from the base station and finally returns for transferring the data to the base station. For some applications in large-scale networks, the authors take a divide-and-conquer strategy and use multiple M-collectors, each of which moves through a shorter data-gathering tour.

L. Xie, Y. Shi et.al the authors adopt a wireless energy transfer technology for charging sensor nodes. The Wireless Charging Vehicle (WCV) starts a periodical tour from the service station, moves across the network for charging some sensor nodes wirelessly, and finally returns. According to the novel Reformulation-Linearization Technique (RLT), the authors design a near-optimal solution for the optimization problem.

Y.-C. Wang et.al, the authors consider the dispatch of mobile sensors as a multi-round and multi-attribute sensor dispatch problem. In a hybrid WSN, static sensors monitor and collect environment information. Once events happen, each static sensor can only sense one attribute of events. Compared with static sensors, a mobile sensor can evaluate multiple attributes of events. According to the sensing data from static sensors, mobile sensors move to corresponding hot locations for more in-depth analysis. To minimize the energy consumption, the authors present a two-phase heuristic algorithm to dispatch mobile sensor for hot locations. In the first phase, the authors dispatch MAM sensors to hot locations in a one-to-one approach. In the second phase, according to unassigned hot locations, the authors present a spanning-tree construction algorithm for the displacement of MAM sensors. Due to similar capabilities of sensors, a research challenge is how to dispatch mobile sensors to these hot locations. However, A.W Khan and Y.C Wang, the authors don't consider that the sensing field may contain various obstacles. In fact, the route for mobile nodes in sensing field containing obstacles is more complex than that sensing field without obstacles.

G. K. Shwetha et.al and H. A. S. Kumari, the authors consider the dispatch of mobile sensors in the network area with obstacles, where static sensors detect environment information. Once mobile sensors receive the sensing data from the static sensors, they will move to these hot locations to conduct further analysis. A research challenge is how to find an obstacle-avoiding shortest path for the mobile sensor to the hot location.

The authors propose modified Dijkstra's algorithm to solve scheduling for the mobile sensor in the presence of obstacles. In summary, current research has addressed some scheduling problem of mobile nodes in WSNs from different aspects. However, as discussed above, to prolong the network lifetime, a research challenge is how to find a shortest route for mobile nodes. This paper aims to presents a solution to this issue.

III. KEY MANAGEMENT AND ADVESARIES

We consider a heterogeneous dynamic wireless sensor network. The network consists of a number of stationary or mobile sensor nodes and a BS that manages the network and collects data from the sensors. Sensor nodes can be of two types: (i) nodes with high processing capabilities, referred to as H-sensors, and (ii) nodes with low processing capabilities, referred to as L-sensors. We assume to have N nodes in the network with a number Nl of H-sensors and a number N2 of L-sensors, where N = Nl + N2, and Nl ≤ N2. Nodes may join and leave the network, and thus the network size may dynamically change. The H-sensors act as cluster heads while L-sensors act as cluster members. They are connected to the BS directly or by a multi-hop path through other H-sensors. H-sensors and L-sensors can be stationary or mobile. After the network deployment, each H-sensor forms a cluster by discovering the neighboring L-sensors though beacon message exchanges. The L-sensors can join a cluster, move to other clusters and also re-join the previous clusters. To maintain the updated list of neighbors and conectivity, the nodes in a cluster periodically exchange very lightweight beacon messages. The H-sensors report any changes in their clusters to the BS, for example, when a L-sensor leaves or joins the cluster. The BS creates a list of legitimate nodes, M, and updates the status of the nodes when an anomaly node or node failure is detected. The BS assigns each node a unique identifier. A L-sensor nLi is uniquely identified by node ID Li whereas a H-sensor nHj is assigned a node ID Hj . A Key Generation Center (KGC), hosted at the BS, generates public system parameters used for key management by the BS and issues certificateless public/private key pairs for each node in the network. In our key management system, a unique individual key, shared only between the node and the BS is assigned to each node. The certificateless public/private key of a node is used to establish pairwise keys between any two nodes. A cluster key is shared among the nodes in a cluster.

Adversary Model and Security Requirements
We assume that the adversary can mount a physical attack on a sensor node after the node is deployed and retrieve secret information and data stored in the node. The adversary can also populate the network with the clones of the captured node. Even without capturing a node, an adversary can conduct an impersonation attack by injecting an illegitimate node, which attempts to impersonate a legitimate node. Adversaries can conduct passive attacks, such as, eavesdropping, replay attack, etc to compromise data confidentiality and integrity. Specific to our proposed key management scheme, the adversary can perform a known-key attack to learn pairwise master keys if it somehow learns the short-term keys, e.g., pairwise encryption keys. In order to provide a secure key management scheme for WSNs supporting mobile nodes, the following security properties are critical:

- Compromise-Resilience: A compromised node must not affect the security of the keys of other legitimate nodes. In other words, the compromised node must not be able to reveal pairwise keys of non-compromised nodes. The compromise-resilience definition does not mean that a node is resilient against capture attacks or that a captured node is prevented from sending false data to other nodes, BS, or cluster heads.
- Resistance Against Cloning and Impersonation: The scheme must support node authentication to protect against node replication and impersonation attacks.
- Forward and Backward Secrecy: The scheme must assure forward secrecy to prevent a node from using an old key to continue decrypting new messages. It must also assure backward secrecy to prevent a node with the new key from going backwards in time to decrypt previously exchanged messages encrypted with prior keys. Forward and backward secrecy are used to protect against node capture attacks.
- Resilience Against Known-Key Attack: The scheme must be secure against the known-key attack.

IV. SYSTEM DESIGN

Network model comprised of 5 phases: Environment setup, Pair wise key generation, cluster formation, key update, and node movement.

Environment Setup
Before the topology build up Base Station generates system parameters and Registers the node by including in a member list. In this Networks, there is no one-for-all scheme that works well in scenarios with different network sizes, traffic overloads, and node mobility patterns. Routing performance is compared based on simulation results. Ns-2 is a discrete event simulator using in networking research. Ns-2 can fully simulates a layered network from the physical radio transmission channel to high-level applications.

Pairwise Key Generation
In this phase, two symmetric shared keys, a secret key and a public key, are encrypted by the pre-distributed key and are distributed locally. Keys are shared by a cluster head to all its cluster members, which is mainly used for securing locally broadcast messages, e.g., routing control information, or securing sensor messages. Moreover, in order to form a secure communication channel between the gateways of adjacent clusters, a symmetric shared key may be used to encrypt the sending message. In this phase, another challenge encrypted by a key may be made to guard against adversaries. Therefore, the security of intra-cluster communication and inter-cluster communication are established upon shared keys, respectively.

Cluster Formation
The network is evenly divided into small grids. Each grid has a relative location based n the grid information. The node in each grid with the highest energy level is selected as the head node or message forwarding. The head node can be reelected if the energy level becomes lower than other nodes in the grid. In addition, each node in the grid will maintain its own attributes, including location information, remaining energy level of its grid, as well as the attributes of its adjacent neighboring grids. The information maintained by each sensor node will be updated periodically. We assume that the sensor nodes in its direct neighboring grids are all within its direct communication range. We also assume that the whole network is fully connected through multi-hop communications. In addition, through the maintained energy levels of its adjacent neighboring grids, it can be used to detect and filter out the compromised nodes for active routing selection.

Key Update
Using the same encryption key for extended periods may incur a cryptanalysis risk. To protect the sensor network and prevent the adversary from getting the keys, key update may be necessary. Initially, all cluster heads (CHs) choose an originator to start the “key updates”, and then it will send the index to all cluster heads in the network. After selecting the originator, it initializes the “Key update” process and sends the index to its neighboring clusters by heads. Then the cluster head refreshes the two keys from the key pool and distributes the two new keys to their cluster members locally.

Node Movement
When a node moves between clusters, the H-sensors must properly manage the cluster keys to ensure the forward/backward secrecy. Thus, the H-sensor updates the

cluster key and notifies the BS of the changed node status. Through this report, the BS can immediately update the node status in the M. We denote a moving node as nLm .

Method/Algorithm
The steps involved in proposed algorithm are as follows:
WSN implementation for military network

  - Creating nodes and grouping them as clusters(LEACH algorithm)
  - Identifying the cluster heads.
  - Identifying the neighbours of cluster members
- Intra cluster data transaction (members of cluster send data to its head).
- Checking the status of data which comes from the member and assigning the priorities for the data at the cluster head.
- The data with the highest priority takes first place in the queue and followed by the other.
- Identifying all available paths from the cluster head and the base station.
- Calculation of required parameters like distance, latency.
- Routing protocol decides the best path from the distance and latency estimated results.
- Sending the encoded data on the path which satisfies the required parameters.
- At the base station the encoded data is decrypted.
- The Parameter metrics such as throughput, packet delivery ratio, packet drop ratio and energy consumption graphs are plotted.

V. SIMULATION SETUP

In WSN, there is no one-for-all scheme that works well in scenarios with different network sizes, traffic overloads, and node mobility patterns. Ns-2 is a discrete event simulator using in networking research. NS-2 used for wired and wireless network to provides significant support for simulation of TCP, routing and multicast protocols. It is combination of two simulation tools. The network simulator (ns) contains all commonly used IP protocols. The network animator (nam), which is use to visualize the simulations. Ns-2 can fully simulates a layered network from the physical radio transmission channel to high-level applications.

Table: 1 Simulation Parameters

Simulation Parameters	Value
Simulator	Ns-2 (2.35)
Topology	1200*1000
Propagation Model	TwoRayGround
No. of Nodes	0- 38
Bandwidth	3 Mbps
Queue length	340
Packet Size	512 bytes
Simulation Time	20 s
Initial Energy	100 Joules
Routing Protocols	DSR

The initial topology settings required for the setting up of the network environment. First the n numbers of mobile nodes are deployed using ns-2.35 simulator tool to form a MANET structure. Then the network is divided into clusters using LEACH algorithm and selection of cluster head is done. Here we have created the network with 29 mobile nodes, 4 clusters, 4 gateway nodes acting as cluster head and one base station. The fig below gives the design of the initial topology required to setting up the environment.

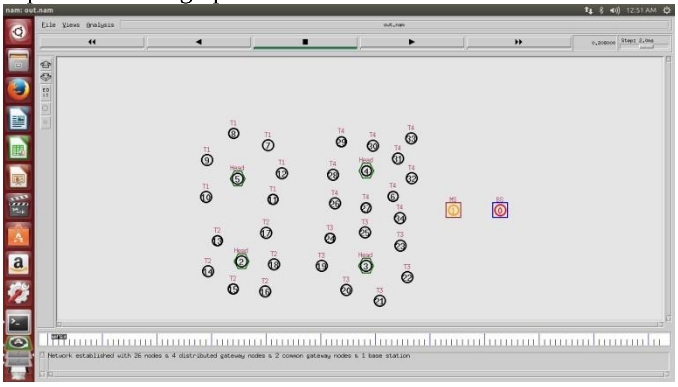
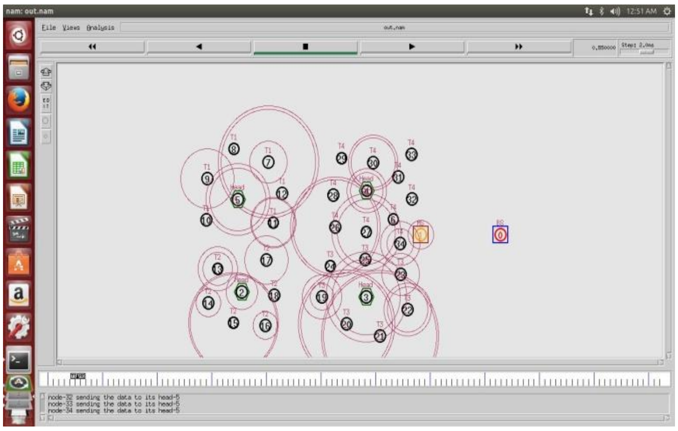


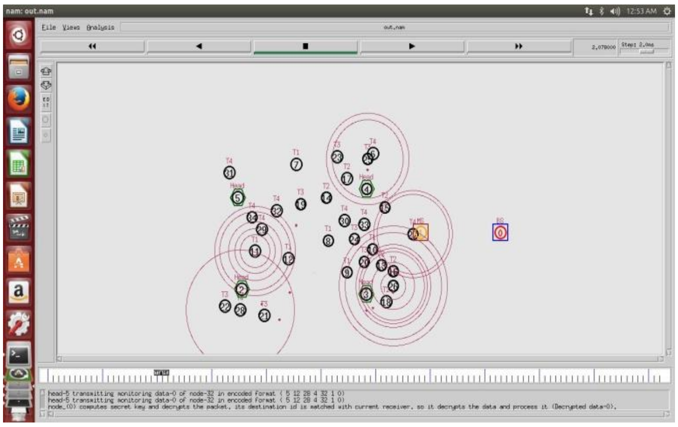
Fig 1 Initial Topology Design for WSN

VI. RESULTS

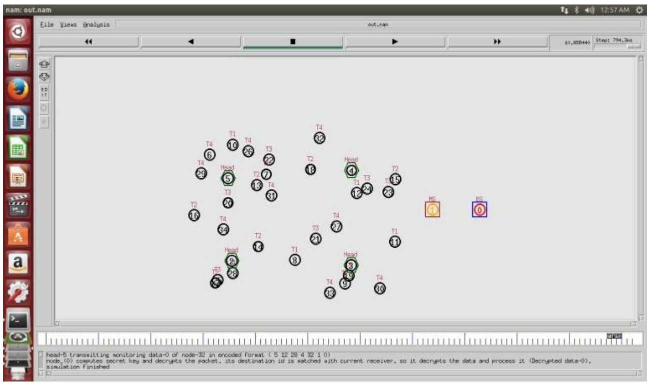
Mobile Node (MS) Sense the information and goes near cluster to collect information from the different clusters.



Now Nodes are shuffled and need to recreate the Cluster.



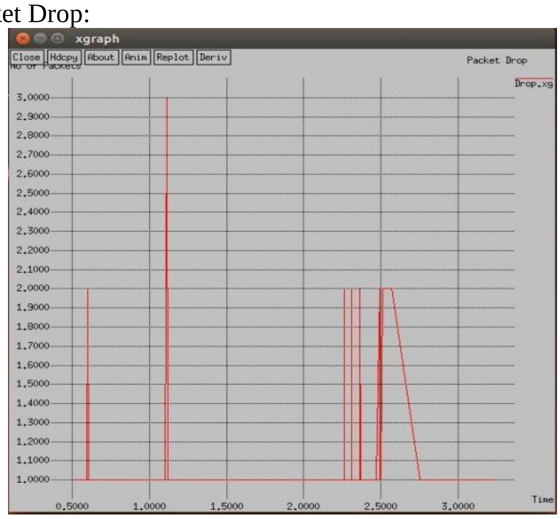
Once the communication gets over between cluster head and Base Station. Mobile Sink node goes back to original position.



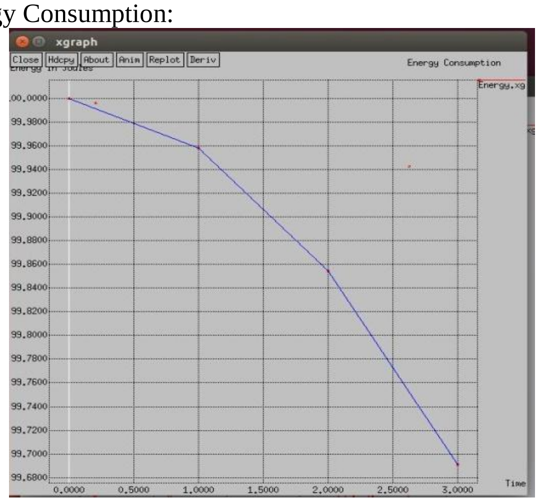
Performance Evaluation

In this section, evaluate the performance of simulation. We are using the xgraph for evaluate the performance. We choose the some evaluation metrics: Packet delivery ratio – the ratio of the total number of packets received by the destination node to the number of packet sent by the source, Energy Consumption – the energy consumed by the source node and destination node and also calculate the Throughput and PDR. Along these evaluation metrics we have to eva1uate the simulation performance in xgraph.

Packet Drop:



Energy Consumption:



VII. CONCLUSION

We utilized the mobile sink to prolong the network lifetime. In physical environments, the sensing field could contain various nodes. To simplify the scheduling for the mobile sink, we introduced the grid-based technique to the WSN. At the same time, we constructed the djikstra's algorithm for the mobile sink to find a essential shortest route. Based on the cluster-based method, applies the heuristic algorithm to dispatch the mobile sink. And also conducts simulation by using Network simulator and experimental results show that our cluster-based approach is feasible for the dispatch of the mobile sink. We finally found an shortest route for the mobile sink to communicate message within the network and hence lifetime was achieved and prolonged.

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