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*Research Article*

# Data Transmission Scheme Using Mobile Sink in Static Wireless Sensor Network

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Multihop communication in wireless sensor network (WSN) brings new challenges in reliable data transmission. Recent work shows that data collection from sensor nodes using mobile sink minimizes multihop data transmission and improves energy efficiency. However, due to continuous movements, mobile sink has limited communication time to collect data from sensor nodes, which results in rapid depletion of node's energy. Therefore, we propose a data transmission scheme that addresses the aforementioned constraints. The proposed scheme first finds out the group based region on the basis of localization information of the sensor nodes and predefined trajectory information of a mobile sink. After determining the group region in the network, selection of master nodes is made. The master nodes directly transmit their data to the mobile sink upon its arrival at their group region through restricted flooding scheme. In addition, the agent node concept is introduced for swapping of the role of the master nodes in each group region. The master node when consuming energy up to a certain threshold, neighboring node with second highest residual energy is selected as an agent node. The mathematical analysis shows that the selection of agent node maximizes the throughput while minimizing transmission delay in the network.

## 1. Introduction

Recently, much attention has been paid to wireless sensor network (WSN) that uses mobile sink for data collection in order to support various applications, that is, enemy monitoring, healthcare monitoring, fire detection, habitat monitoring, and natural events (e.g., seismic activities). In WSN, each sensor node is equipped with a battery, a microcontroller, memory, and a transceiver, in most of the applications where sink node collects data from various sensors for processing and decision-making. This node usually is equipped with powerful computational capabilities. However, the sensor nodes may be dead by draining off their battery (energy) after a particular period. Once the battery (energy) is exhausted in such environment, it is hard to replace or charge the batteries in a wide range. Since wireless sensor nodes are suffering from limited computational capabilities, low battery power and less memory make WSN environment more challenging.

In most of the WSN applications, data collection/transmission by sink node is a difficult task that is discussed in detail [1–3]. The sensor nodes are deployed in the environment for sensing the data. The sensed data is then delivered to sink via intermediate nodes that are close to sink via the multihop manner using wireless transmission. However, such approach of data collection by sink has a major drawback that is the sensor nodes located closer to sink have to relay number of data packets and thus they have to exhaust more power than the nodes which are farther away from the sink. As a result, the network lifetime reduces significantly.

Due to the constraints mentioned above, using large-scale multihop transmissions leads to low data delivery because of network congestion and increased packet drop ratio. Furthermore, sensor nodes require high battery power for transmitting data packets in large-scale multihop communication. To cope with such issues, several data collection/transmission schemes have been proposed to collect the data by using the mobile sink in WSN [1, 2]. Sensor nodes are operated on batteries; hence prolonging network lifetime is a considerable matter in WSN. Most of the data collections/transmissions by mobile sink based schemes suffer a short network lifetime. All the network data are delivered to the mobile sink on the same route. Nodes nearer to the mobile sink consume more energy. Hence, they have a high chance of quick depletion of energy.

To address the problems mentioned above, we, therefore, propose a novel data collection scheme from leaf nodes by master nodes that disseminate the received data to the mobile sink upon its arrival. Our contributions in this work are threefold: (1) we propose a novel group-based scheme for selection of data collection from leaf nodes that efficiently collect data, (2) a scheme is developed that grouped leaf nodes and selects their master node, and (3) swapping of the role of master node with agent node enhances the overall network lifetime. Simulation results show that the proposed scheme reduces energy consumption and increases data delivery ratio at the mobile sink.

The rest of the paper is organized as follows. In Section 2, we briefly review some related work. In Section 3, we describe our proposed scheme. Finally, we present analytical results and discussion in Section 4, followed by conclusion in Section 5.

## 2. Related Work

Existing data collection schemes that uses mobile sink in WSN controls energy conservation, end-to-end network delay, and packet delivery ratio in WSN. These are a few among many of the issues. Long multipath propagation can lead to more delay in the network that consumes a considerable amount of energy, as well as packet loss.

Proposed schemes for data collection/dissemination by the mobile sink in [1–3] are based on the grid-based infrastructure and line based infrastructure that plays a role of the meeting point for data dissemination to various mobile sink. In [2], two-tier data dissemination (TTDD) scheme provides efficient and scalable data dissemination to multiple mobile sinks. In the proposed scheme, grid-based structure is proactively built by every source node to deliver data along with a grid to individual mobile sink. A mobile sink floods query-based message to find out data dissemination node in its signal range when leaving one cell and entering into another cell. The major drawback of this scheme is the time required to find out the dissemination node. Hence, it will add an additional delay in the network.

In [3] LBDD scheme is proposed that uses a vertical line as virtual infrastructure. These vertical lines are placed in the center of the sensor field so that each node can easily access it. All the sensor nodes are required to send data to these lines, Nodes within the boundaries of this wide line are called inline-nodes, while the other nodes are referred as ordinary nodes. The message are flooded alongside the line until they get into the inline node storing the data. After reaching inline node storing data, it is then forwarded to every sink. In this scheme, the mobility is provided to sink by means of progressive footprint chaining strategy [1].

An integer linear model (ILM) [4] is proposed that helps in finding out the location of mobile sinks with control mobility. The aim of this scheme is to minimize the energy cost required per node, as well as energy cost in each round of the mobile sink. However, this model maximizes the network lifetime as it does not depend on the residual energy of the sink node.

In WSN, a number of schemes have been proposed that exploit sink mobility to improve the network performance that is energy efficient and packet delay [5–10]. However, these approaches are divided into two categories, that is, proactive and reactive approach. In a proactive approach, the sensed data are transmitted to the nodes (to store) for selection by the mobile sink. However, in a reactive approach, the mobile sink pulls the sensed data from sensor nodes as it moves in the network.

In [11], Jea et al. mentioned the feasibility of a single mobile sink in a large area sensor network. Moreover, they suggest that the single mobile sink is not sufficient in a large area network. However, use of multiple sinks is recommended that require multiple controlled mobile elements which helps in data collection. In addition, load balancing algorithm has been introduced that periodically balanced the data collection among various multiple mobile sinks. Also, load balancing helps in balancing the assignment of sensor nodes to each mobile sink.

In [12] self-governing, mobile sink moving trajectory is proposed that gathers data from various sensor nodes. In this scheme, the authors divides data gathering phase into three categories, that is, (i) mobile sink movement, (ii) data collection, and (iii) letting the sensor nodes know the position of mobile sink. In this scheme, the mobile sink moves towards the sensor node whose energy is high amongst all sensor nodes. Thus, it is required for those nodes having high residual energy are meant for data forwarding. However, during the movement of the mobile sink, mobile sink avoids those nodes whose energy is comparatively low. The major drawback of this scheme is that it introduces additional delay by passing those nodes that have low energy level. Hence, searching for high residual energy sensor nodes consume much time and also increase the traveling cost of the mobile sink.

In [13] various sink mobility patterns and data collection schemes are discussed for different applications. It is shown that in those applications, where efficiency (in terms of time) is not necessary, the mobile sink can move throughout the network. Thus, it is appropriate for those networks that intend to save energy and avoid network delays. However, in a network where energy constraints are not obligatory and mobility of sink is unlimited, the best scheme is to follow the fixed trajectory along with multihop data communication. This scheme minimizes delay in the network. Furthermore, it is suggested that mobile sink trajectory should depend on the area of network and density of sensor nodes. The trajectory can be made in a way that divides the network into two portions that is approximately equal number of sensor nodes on each side. This approach helps in load balancing of the sensed data as well as the assignment of the sensor nodes to the relay nodes. The proposed scheme for data collection and dissemination to the mobile sink uses the said approach.

Various schemes have also been presented in literature survey that are supposed to deal with the energy efficient data collection using the mobile sink. However, the said schemes fail to attempt to achieve high energy efficient network. Hence, energy efficiency in mobile sink data collection WSN is still an area of interest for researchers. In this paper, we, therefore, present a novel hybrid scheme for data collection and data transmission scheme using the mobile sink in WSN, which aims to achieve high data delivery ratio and energy efficiency.

## 3. Proposed Data Transmission Scheme

This section describes the data collection by master nodes that transmit data to the mobile sink in WSN. In this scheme, we focus on achieving high data delivery and energy efficient network.

*3.1. Assumptions and Definitions.* In this section, we are presenting the assumptions made during the design of our network and simulation model. Some of the scenario related definitions are also given.

*Assumption 1* (homogenous nodes). All the sensor nodes have same configuration: sensing and communication range that is 100 m and have the same energy level that is 15 Joules.

*Assumption 2* (communication radius model). The communication range of a sensor node "$A$" has the radius "$R$" that is centered at "$c$." It can be defined as $\mathrm{CR}(c, R) = \{A, q \in S : |D(A - q)| \le R_A\}$. CR represents communication radius, $S$ represents the set of deployed nodes, and $D(A - q)$ is the distance between nodes $A$ and $q$ in the deployment area.

*Assumption 3* (reliable communication link). We have assumed AWGN channel and have adjusted signal to noise ratio (SNR) in such a way that the signal reaches the destination node with an energy that the overall detection probability is more than 0.5. In our case, the threshold value of detection probability is 0.4 for a readable received signal.

*Assumption 4* (reliable network nodes). The deployed network nodes are reliable and secure and will not be malfunctioning or hacked or die suddenly. The deployed nodes are considered as dead when their battery level reaches to a predefined threshold. In our case, we have considered the threshold of 0.5 Joules.

*Definition 5* (communicating neighbor set). All the nodes ($q_i$) which fulfill the following criteria are considered in the neighborhood of node $p$. Consider $|D(p-q_i)| \le R_p \ \forall_i$, where $i = 1, 2, 3, \ldots, n$ and $R_p$ is the communication radius of node $p$.

*Definition 6* (medium scale network). If all the deployed nodes have direct communication access to the base station (BS) then the network is considered to be medium scale network (MSN). In our simulation environment, the network comprising 100 nodes deployed in area of 100 m × 100 m is considered as MSN. This definition can be modeled as $\forall p \wedge p \in S, |D(p - \mathrm{GHN})| < R_p$, where $p$ is a node among the set "$S$" of deployed nodes and $D(p - \mathrm{GHN})$ is the distance between any of the deployed network node say, $p$, and the master node. $R_p$ is the communication radius of node $p$.

*Definition 7* (large-scale network). If any of the deployed nodes does not have direct communication access to the base station (BS) then the network is considered to be large-scale network (LSN). In our simulation environment, the network comprising 100 nodes deployed in area of 200 m × 200 m is considered to be large-scale network (LSN). This definition can be modeled as $\exists p \wedge p \in S, |D(p - \mathrm{BS})| > R_p$, where $p$ is a node among the set "$S$" of deployed nodes and $D(p - \mathrm{BS})$ is the distance between any of the deployed network node say, $p$, and the master node. $R_p$ is the communication radius of node $p$.

*3.2. System Model.* We consider a large-scale network with a dense deployment of sensor nodes along with the mobile sink as shown in Figure 1. In the network, all the sensor nodes are static and know their location information through any localization technique [14]. Furthermore, greedy parameter stateless routing (GPSR) [15] schemes are employed when there is a need for forwarding data or control messages.

On the contrary, a mobile sink is used which moves around a fix elliptical trajectory (see Section 3.3.4). In the network model, the master nodes are selected amongst various sensor nodes on the basis of residual energy and geographical location information (a node, which is near to mobile sink trajectory, has higher probability to choose a master node). These master nodes are used for the collection of data from their leaf nodes and disseminate their data to the mobile sink.

*3.3. The Operation of Proposed Scheme.* In our proposed scheme, several issues are addressed. Therefore, the operation of the proposed scheme is categorized into three different stages, that is, (i) firstly, how to determine the group region and its advertisement to member nodes, (ii) secondly, how to select master nodes in the group region, (iii), and finally, how to collect data from member nodes that is required to be disseminated to the mobile sink. Furthermore, there also remains the issue of the trajectory of the mobile sink. Hence, it is also considered as an essential element of proposed scheme.

*3.3.1. Selection of Master Node.* In this category, sensor nodes share their topology information with their one-hop neighbors. In addition, determination of the group-based region selection is also performed in this phase. The detailed process of this phase is given as follows.

As shown in Figure 1, the mobile sink moves in elliptical trajectory around a specified region (i.e., the region that needs to be surveyed) to determine the group region. In the first cycle, mobile sink moves around the survey region and periodically broadcasts "Hello Packet." The Hello Packet is

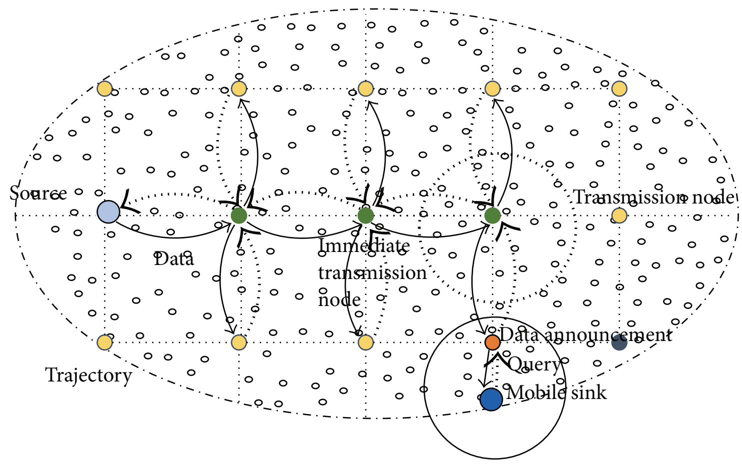


Figure 1: Mobile sink trajectory along with group-based data collection and transmission.

| Type | $T_{S_n}$ | $T_{F_n}$ |
|---|---|---|

Figure 2: Message format of *broadcast_message₁*.

| Source address | Cost |
|---|---|

Figure 3: Message format of *broadcast_message₂*.

the named as *broadcast_message*$_1$. Figure 2 shows the message format of *broadcast_message*$_1$.

The *broadcast_message*$_1$ includes the type of a node that is mobile sink, the starting time of the mobile sink ($T_{S_n}$), and the finishing time ($T_{F_n}$). The terms "$T_S$," "$T_F$," and "$n$" represent starting time and finishing time and the position of point of arrival at each the master node at each group region in the network, respectively. Upon receiving the *broadcast_message*$_1$, all the receiving sensor nodes compute their cost on the basis of three parameters that is current location of the sensor node (whether that node is near to mobile sink path or not), residual energy, and the time of arrival of *broadcast_message*$_1$. After computing the cost, each sensor node broadcasts another Hello Packet (named as *broadcast_message*$_2$). The format of the *broadcast_message*$_2$ is shown in Figure 3.

The *broadcast_message*$_2$ includes the type of a source address and cost of a sensor node. Upon receiving the *broadcast_message*$_2$, the nodes compare received cost value with their cost value. The node having the highest cost value is then selected as a master node that can act as a relay node.

To elaborate the selection of a master node, a scenario is illustrated in Figure 1. In this scenario, we have considered random number of sensor nodes. Assume that mobile sink broadcasts "*Hello Packet*" and the recipient's sensor nodes are $n_1, n_2, n_3, \ldots, n_k$. After receiving a broadcast_message$_1$, all sensor nodes compute their cost value; that is, $(n_1 = l), (n_2 = m), (n_3 = n), \ldots, (n_5 = z)$. The terminologies $l$, $m$, $n$, $o$, and $z$ represent the cost values. After computing the cost values, all sensor nodes broadcast another *broadcast_message*$_2$. Upon receiving the *broadcast_message*$_2$, each node compares the cost values, that is, *broadcast_message*$_1$ cost value and *broadcast_message*$_2$ residual energy. The node having a higher cost value is then selected as the master node.

It is often seen in WSN that, during data communication, a node near to the relay node consumes more energy as compared to other ordinary nodes, since it receives all the data coming from various nodes. Therefore, master nodes consume more energy compared to member nodes, resulting in minimizing the network lifetime. In order to increase the network lifetime, the agent node selection concept is introduced. The neighboring sensor node of the master node having high residual energy, as well as cost value, is selected as agent node. The agent node is usually nearer to the relay node that takes charge of the master node after certain amount of time. The procedure of swapping the role of the master node with agent nodes is as follows.

In the proposed scheme, each master node checks its residual energy after every "$t$" intervals. We have set an absolute threshold value for a master node's residual energy. After reaching the threshold value, the master node broadcasts a "leaving status" to its neighboring nodes. Upon receiving the "leaving status," all member nodes in the neighboring of master node share their residual energy and cost value information with each other. A new master node is then selected among member nodes based on the residual energy. The new master node information is sent to all member nodes of the group region in order to update their routing table. Hence, in the coming cycle, mobile sink communicates with newly selected master node.

*3.3.2. Selection of Group Region and Advertisement to Group Member Nodes.* Group-based region selection is based on self-capability of organizing of sensor nodes. Assume that all the sensor nodes know their location as well as their neighbors in the network. Since the nature of sensor nodes is

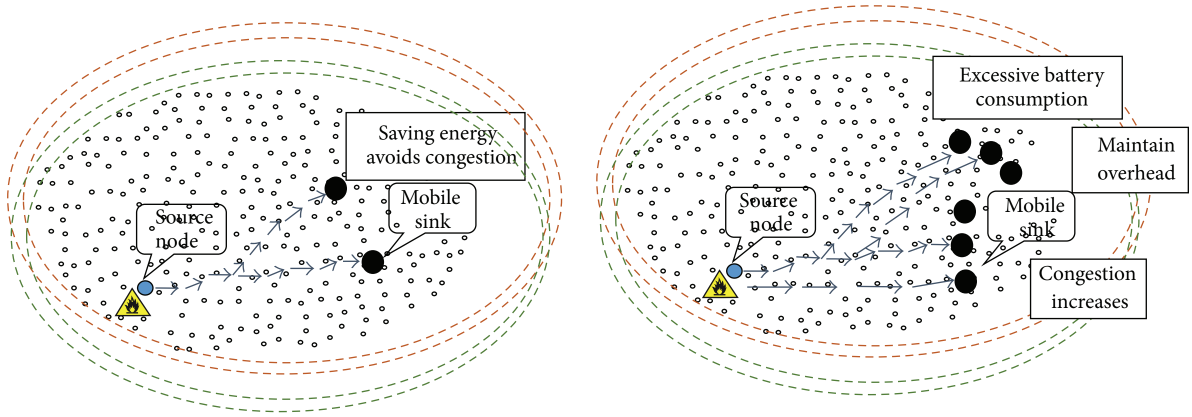


Figure 4: Comparison of the single mobile sink and multiple mobile sinks.

homogenous, therefore, to determine the group-based region selection for each master node, each sensor node attaches itself to the master node on the basis of residual energy. The term residual energy is named as the *weight* of the received *"Hello Packet"* that was broadcasted by master nodes. The *"Hello Packet"* contains an entry point ($T_{S_1}$) and exit point ($T_{S_2}$) of the mobile sink in master node signal range. Hence, entry and exit points help the member nodes to transmit data in the fixed interval of time as mobile sink enters into the range of a master node. *Weight* is computed by all sensor nodes upon receiving "*Hello Packet.*" Therefore, the receiving node compares the *weight* of "*n*" received invitations. Hence, the node having maximum *weight* value should join that master node. We assume that the master node is located in a circular region as shown in Figure 4. The whole procedure is defined as below:

$$S_{\text{weight}_i} > S_{\text{weight}_j} \quad \{\forall j\}, \tag{1}$$

where $S_{\text{weight}}$ is weight or strength of received signal of the invitee master node.

$$\text{If } S_{\text{weight}_i} = S_{\text{weight}_j} \quad \{\forall j\}, \tag{2}$$

then the selection is on the basis of

$$S_{\text{weight}_i} > S_{\text{weight}_j} \quad \{\forall j\}, \tag{3}$$

where $S_{\text{weight}}$ is the weight of energy level of invitee master node and

$$\text{if } S_{\text{weight}_i} = S_{\text{weight}_j} \quad \{\forall j\} \tag{4}$$

then random selection is made.

*3.3.3. Data Collection and Transmission.* The proposed scheme uses the mechanism somehow related to [16] in order to collect data from member nodes and disseminates it to the mobile sink. Previously, the information of entering point ($T_{S_1}$) and leaving point ($T_{S_2}$) of the mobile sink was calculated by master nodes. This information is broadcasted by master nodes in their group region. All the master nodes start collecting data from their member nodes when mobile sink enters into their signal range. This collection and transmission of data to the mobile sink continues till leaving the signal range of the master node at $T_{S_2}$. As we are dealing with the maximum amount of data to be received by mobile sink node, therefore, all the member nodes of each group region use GPSR [15] to deliver their data at master node.

After the collection of data from member nodes, the master nodes disseminate the amount of collected data to the mobile sink during a specified communication time. The procedure for calculating communication time between the master node and mobile sink is as follows. All gateway nodes know the time when mobile sink starts its traveling from a position "*s*" and the time when mobile sink returns to its starting position "*s*" at a time "*t*." Furthermore, there should be time synchronization between master nodes and mobile sink. The communication time varies depending on the distance between the master nodes and mobile sink; that is lesser is the distance between the master node and mobile sink; greater the communication time is required. As shown in Figure 1, when mobile sink enters into the signal range of master node$_1$ at time $t_1$ and leaves at time $t_2$, the master node$_1$ calculates the total time for communication as

$$T_{S_1} = t_2 - t_1. \tag{5}$$

Master nodes then start forwarding their data to the mobile sink entering into the transmission range of a master node. Figure 1 illustrates a scenario of data collection and transmission to the mobile sink through their master nodes, where $n_1, n_2, n_3, \ldots, n_k$ are member nodes that forward data to master node.

The doted circle shows the transmission range of a master node. The master node disseminates data to the mobile sink until it leaves the transmission range of a master node. All the member nodes stop forwarding their data and wait for their next turn in the coming cycle of mobile sink.

*3.3.4. Mobile Sink Trajectory.* When a mobile sink moves in a designated trajectory, data delivery is guaranteed without additional operations. Frequently, when a mobile sink moves in a fixed trajectory, it is not required to update its location to either member nodes or grouped nodes. One of the serious problems that may arise in the group region is congestion and overhead at each master node. However, in the proposed scheme, master nodes collect data through restricted local flooding. It is not entirely dependent on the density of the sensor nodes or frequency of the mobile sink. It may increase the amount of data collection and transmission to the mobile sink that minimizes overhead and maximizes the energy efficiency of the network. This leads to a prolonging lifetime of the network.

Thus, the proposed scheme selects the best mobile sink trajectory in the deployment region [17]. More precisely, a mobile sink trajectory is defined by the following elliptical equation:

$$\frac{(x-h)^2}{a^2} + \frac{(y-k)^2}{b^2} = 1, \quad (6)$$

where "*an*" and "*b*" are the radii along $x$-axis and $y$-axis, respectively, $a^2 > b^2$, center of ellipse is $(h, k)$, and vertices are $(h+a, k)$ and $(h-a, k)$, that is, end points of minor axis.

In order to make the elliptical movement pattern for a mobile sink in NS2, an elliptical trajectory is partitioned into several line segments that is represented by $(x_1, y_1)$. The following parameters are used for mobile sink movement in the area of 2,000 m × 3,000 m. In addition, if we deploy more mobile sinks, then the following scenarios can be built and will have the corresponding drawbacks as shown in Figure 4.

## 4. Analytical Results and Discussion

In this section, we present the performance evaluation of our proposed scheme by using analytical analysis. The proposed scheme is compared with the same network architecture having a single mobile sink (static) and static sinks (cluster head).

*4.1. Discussion.* Wireless sensor nodes and mobile sink were deployed within an area of 1,500 m × 2,000 m. For our analysis, we have assumed different numbers of sensor nodes, that is, 18, 30, 42, 54, 66, 78, 90, 102, 114, and 126. The distance between each sensor node is fixed to 250 m, and initial energy was set to 15 Joules. Each sensor node generates data packets after every 10 seconds. Initially, the packet size is fixed and is considered at 10 KB. For our extensive analysis, the data size has increased to 100 KB, whereas the 802.11n protocol is used as our underlying MAC protocol. Mobile sink broadcasts Hello Packet every 10 seconds.

Figure 4 shows the total amount of data collected by the mobile sink in one cycle. The total amount of data collection depends on the mobile sink cycle time (i.e., time required to complete one cycle) and speed of mobile sink. We have assumed an average speed of the mobile sink, that is, 10 m/s.

In order to find the throughput of the proposed scheme, we have used the following equations [18]. The below equation is achieved by dividing the overall size of the transmitted data packets in one session. One session is referred to the one cycle of the mobile sink

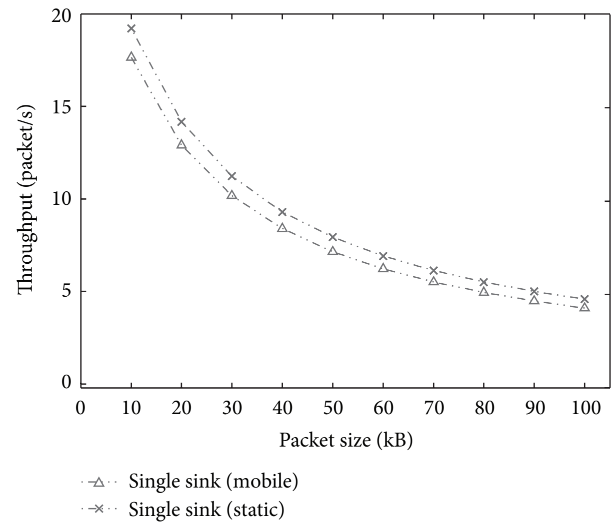


Figure 5: Throughput based on packet size: single sink and mobile sink.

$$T^u = \frac{P(s) * Z(p)}{R^u + \alpha P((s)-1)}. \quad (7)$$

In the above equation, $P(s)$ is the number of data packets transmitted in one complete cycle of the mobile sink and $R^u$ is the data packet reception time at mobile sink, whereas $Z(p)$ is the length of the packet.

Furthermore, to calculate the transmission delay between the mobile sink and the master node, we have used the below equation

$$T_D = \left(\frac{1}{1-q}\right)\left(\frac{S_D}{B_{wL}} + L_{\text{delay}}\right). \quad (8)$$

In the above equation, $q$ is the error rate in the wireless link in WSN, $S_D$ is the packet size, and $B_{wL}$ is the link bandwidth, whereas $L_{\text{delay}}$ is the delay in a wireless link of WSN.

Based on (7) and (8), we have constructed Figures 5, 6, 7, and 8.

Figures 5 and 6 show the throughput per second measurements for variable number of sensor nodes along with a sink (static/mobile). It is observed that the proposed scheme outperforms in the scenario where single sink (static) is used. Since a single static sink in each network has high throughput. Hence, it requires minimum energy to transmit the data packets to surface sink. Therefore, the throughput is comparatively high as compared to static sink. However, in a single sink scenario, there is multihop communication between various static sinks in order to deliver the data to the surface sink. Therefore, due to collision and lack of time synchronization among various multiple sinks, the throughput is low, since redundant and a large amount of data packets are dropped, also, resulting in minimizing the number of packets successfully transmitted to surface station. On the other hand, the proposed scheme introduces the concept

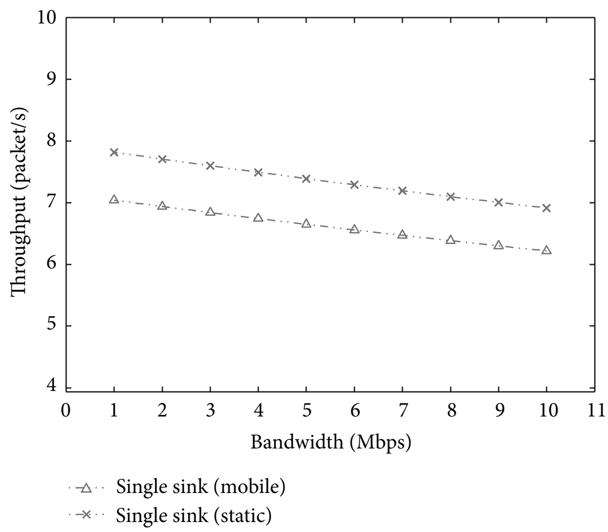


Figure 6: Throughput based on bandwidth: single sink and mobile sink.

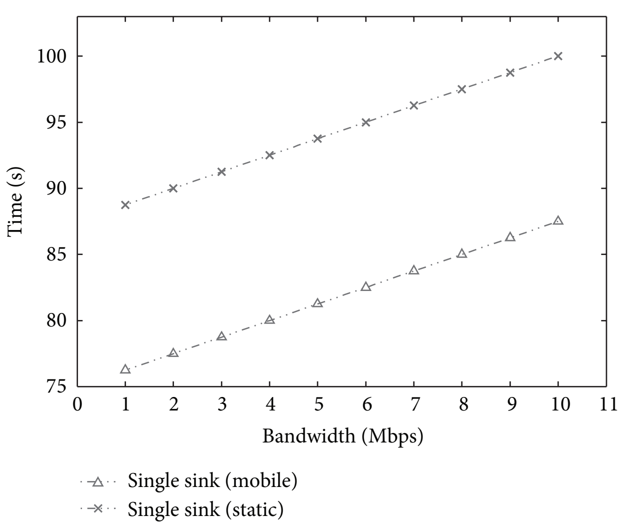


Figure 7: Transmission delay based on packet size: single sink and mobile sink.

of group region based data collection and transmission; the considerable amount of throughput has been obtained, since it uses a single mobile sink that has a tight time synchronized with all master nodes, thus helping in achieving greater throughput (packet per second). The throughput varies with the increase or decrease in the bandwidth as shown in Figure 6.

Similarly, in order to check the performance of the proposed scheme in terms of transmission delay, the same scenario is considered, in which we have deployed a single mobile sink and static sink as shown in Figure 7. In the mobile sink scenario, a mobile sink follows the fixed trajectory, and the master node directly transmits the data. Moreover, if a mobile sink is not in a signal range of the master node, the master node buffers the received data and waits for the mobile sink. Hence, the time required for the master node

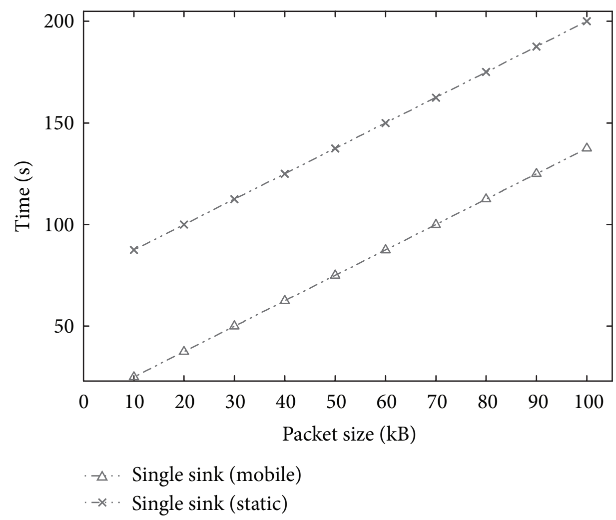


Figure 8: Transmission delay based on bandwidth: single sink and mobile sink.

to transmit the data is very short. Therefore, there is very less delay noticed. However, in a single sink scenario, all the sensor nodes transmit their data to their static sink via multihop communication. As a result, the transmission delay increases due to excessive communication with that network, resulting in dropping of the packets. Such kind of phenomena is also noticed when there is increase in the bandwidth of the wireless link of the WSN as shown in Figure 8.

## 5. Conclusion

In this paper, we have proposed a novel scheme for data collection/transmission to the mobile sink. The proposed scheme operates in three phases, that is, master node selection, group-based region formation, and data transmission to the mobile sink. In master node selection, master nodes are selected on the basis of cost value that is calculated by receiving the Hello Packet sent by the mobile sink. The nodes are other than the master nodes called member nodes transmitting data towards their master node. Furthermore, agent node selection prolongs the network lifetime by swapping of their role with the master node. This swapping of the role of the master node is based on their residual energy. The simulation results have shown that the proposed scheme achieves better throughput, increase in a number of data collections by the mobile sink, and achieves considerable high energy efficient packet reception ratio. A similar scheme shall also work well for video application [19, 20], parallel reconfigurable methods yield fruitful result [21, 22] more over dependability, and reliability of mobile sink in WSN [23] is a vital challenges that we are looking ahead.

## Conflict of Interests

The authors declare that there is no conflict of interests regarding the publication of this paper.

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