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Performance Analysis for Efficient Data Collection with path Constrained Mobile sink Using SPMA Scheme in WSNs

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Abstract: A crucial issue for data collection in wireless sensor networks is that the energy consumption of the sensor nodes placed near the sink is very high. This is because the sensors placed near the sink have to forward the data to the sink on behalf of others resulting in the depletion of energy quickly, which will lead to network partitioning and limitation in the network lifetime. In order to solve this issue, mobile sinks are introduced, which changes their location when then nearby sensor's energy becomes low. Thus the sensors placed near sinks always change over time. According to the recent study, it has been proved that that the sink mobility along a constrained path can improve energy efficiency in wireless sensor networks. However, due to the path constrained, the mobile sink has limited communication time to collect data from sensor nodes which are placed randomly. To solve this issue, the Shortest Path Member Assignment Scheme(SPMAS) is proposed which will improve the energy efficiency as well as throughput by providing the optimal assignment of sensor nodes. To implement SPMAS scheme, the two-phase communication protocol based on zone partition is designed. In addition to this, the proposed schemes is designed to work on different scenarios by varying the speed of mobile sink as well as by considering the link error probabilities of the sensor networks. The proposed system is validated using NS-2.

Index Terms—Sensor networks, mobile sinks, path constraint, data collection, energy efficiency, network partitioning, link error probabilities.

INTRODUCTION

This paper focuses on wireless sensor networks with path constrained mobile sinks that can be mapped with real world applications like health monitoring of large buildings. In Fig. 1, let a mobile sink S, move along a fixed path P periodically. Assume that the sensor nodes are randomly deployed. The mobile sinks gathers data from sensor nodes when it comes closer to them. The whole network region is divided into two parts. Direct communication area (DCA) between trajectories P1 and P2 and multihop communication area(MCA) for far-off sensor nodes. In DCA, the sensor nodes called subsinks can directly transmit data to mobile sinks and in MCA, the sensor nodes called members first transmit data to the subsinks which then relays final data to the mobile sinks. The duration (communication time) between each subsink and the mobile sink is assumed to be fixed. The throughput is dependent on the upper bound on the data collected and the total number of members associated with each subsink. The main challenge here is to find an optimal assignment of members to their subsinks that improves data delivery performance as well as reduces energy consumption. In addition to this, the performance of proposed scheme is validated by considering the two scenarios. First, the speed of mobile sink is varied and second the link error probability of the sensor network is taken into account since the link error probability affects the performance of routing protocols in WSNs.

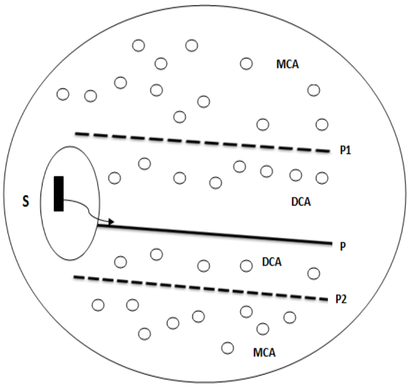


Fig. 1 : Mobile Sink with Constrained Path

RELATED WORK

Existing work has shown that the sink mobility can improve the performance of WSNs [1],[2],[3],[4],[5],[6]. In [1],[2], the mobile sinks are deployed randomly to collect interested data sensed by the sensor nodes. In [3],[4], since the path constrained sink mobility improves the energy efficiency of single hop sensor networks which may not be suitable due to the limits of path location and the communication power. The multi hop sensor networks with path constrained mobile sinks in [5],[6],uses shortest path tree(SPT) scheme that results may result in low energy efficient data collection. In [5],[6], the shortest path tree mechanism(SPT) is used to choose the nearest subsinks and transmits data from members. Each member selects the subsinks based on hop distance metric and then forwards its data towards subsinks in shortest path trees. With this approach it is possible that some subsinks with longer communication time own few members, which leads to less data collection. However, some subsinks with very short communication time own too many members which leads to oversaturated subsinks. With this it can be concluded that the SPT has low energy efficiency for data collection.

System Overview

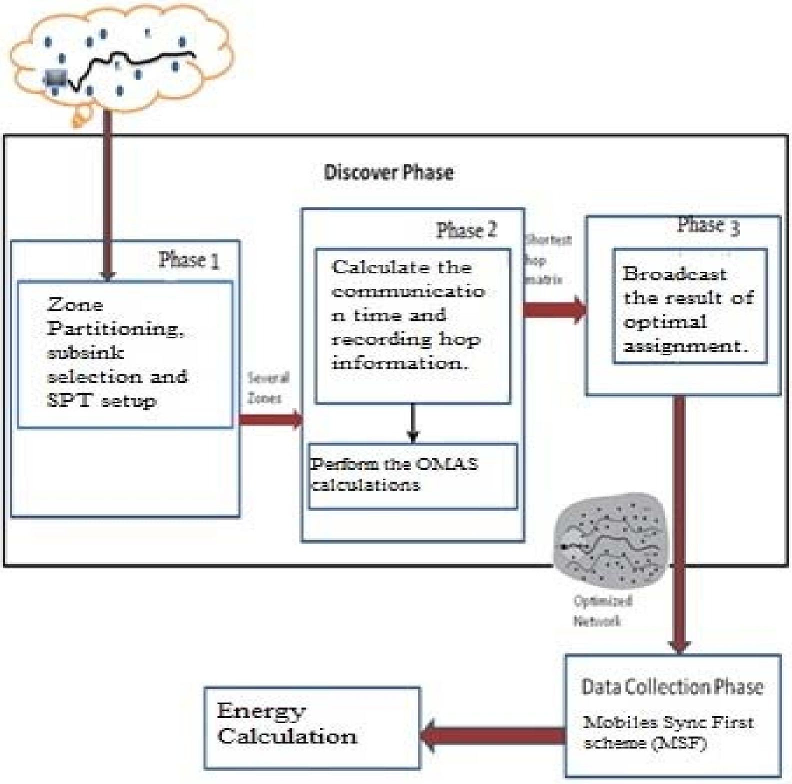


Fig. 2 : System Architecture

Let the maximum computations be executed by the mobile sink in the communication protocol that consists of two main phases: discover phase and the data collection phase.

Discover Phase:

The aim of the discover phase is to assign members to the subsinks. In order to complete the tasks of the discover phase , this phase has to undergo in three different rounds explained below.

Round 1:

In this round of discover phase, the mobile sink relays broadcast messages continuously. The nodes which receives broadcast messages are considered as subsinks. After that the subsinks start building shortest path trees (SPTs) from themselves to the entire network. In this way each and every node gets the shortest hop information from themselves to all subsinks. It then further sends this hop information to the corresponding subsink.

Round 2:

In this round, all the subsinks transmits this hop information to the mobile sink. In this round, the shortest hop matrix is obtained which is required for the SPMAS calculation.

Round 3:

In this round, the mobile sink moves along the constrained path again and then broadcasts the member assignment information to the monitored area. This broadcast message contains the mapping between each member and its corresponding subsink. Each node then floods this member assignment information in the entire network. Hence in this way, every node in the network will get the optimized member assignment information.

Data Collection Phase:

In this phase, all nodes collect data from the monitored area. The members send the sensed data to their respective subsinks, according to the routing table build in discover phase. The mobile sink however may not collect the expected amount of data due to the interference between transmission and reception on the subsink. Based on this observation, the mobile sink first (MSF) scheme is proposed. In this the subsink will stop sending the sensed data from its members and make use of all resources to transmit data to the mobile sink when its current subsink's turn for transmission.

Shortest Path Member Assignment Scheme (SPMAS)

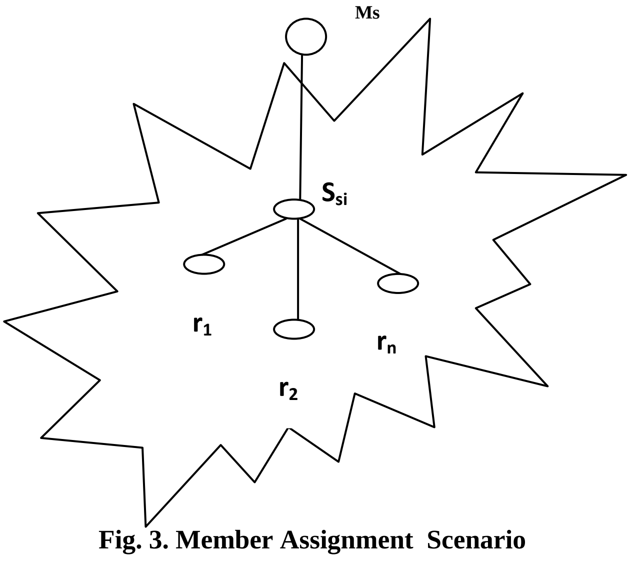


Fig. 3. Member Assignment Scenario

Objective: The first optimization objective is to maximize the total amount of data collected by the mobile sink per round (d_{total}).

The second optimization objective is to find the assignment of members to the subsinks in order to minimize the sum of hops from each member to its corresponding subsink under the condition of minimum/maximum requirements on the number of members are met.

Input: q_i is amount of data from subsink i per round.
M_s denotes the mobile sink.
S_{si} denotes the subsink(i^{th}).
r_i denotes the members attached with each subsink.
t denotes the length of one movement round.
d_s denotes the data collection rate of sensor node.
n_s denotes the number of subsinks.
t_i denotes communication duration between subsink and mobile sink.
d_t denotes the data rate between subsink and mobile sink.
r_i^m denotes the minimum/maximum requirement on the number of members.
h_i denotes the number of hops from members to subsink.

Mathematical Calculations: $_i$

1) The amount of data mobile sink can receive in t_i duration
   d_tt_i - - - - - - -(1)
2) Amount of data subsink can collect is:
   $d_s(r_i + 1)t$ - - - - - - -(2)
3) If $d_tt_i > d_s(r_i + 1)t$,then mobile sink can collect $d_s(r_i + 1)t$ amount of data. Here the network density is low.
4) It is possible to gather all data generated if $d_tt_i < d_s(r_i + 1)t$, then mobile sink can collect d_tt_i amount of data. Because it is impossible for a mobile sink to collect all data sensed by the nodes due to the limit of total length of communication time (t_i).
   i.e. $q_i = \min[d_tt_i , d_s(r_i + 1)t]$ - - - -(3)
   $q_{total} = q_{i.}$ - - - - - - -(4)
5) **Optimization Problem:** Maximize the total amount of data collected by mobile sink per round i.e. $q_{total.}$
   For maximizing q_{total} network density is the key parameters,
   if $d_tt_i > d_s(r_i + 1)t$ (low density) - - -(5)
   if $d_tt_i < d_s(r_i + 1)t$ (high density) - - -(6)
6) To optimize q_{total} :
   $d_s(r_i + 1)t = d_tt_i$ - - - - - - -(7)
   $r_i = [d_tt_i / d_st] – 1$ - - - - - - -(8)
   $r_i^m = [d_tt_i / d_st] – 1$ - - - - - - -(9)
   if there are n_s subsinks then, total number of subsinks attached to mobile sink is given by:

$\sum_{i=1}^{n_s} r_i^m$ **(Optimization figure) - -(10)**

if $n_m > \sum_{i=1}^{n_s} r_i^m$ (high density networks)

if $n_m < \sum_{i=1}^{n_s} r_i^m$ (low density networks)

Here, r_i^m is the lower bound on the number of members in high density network so as total communication time can be utilized completely for data delivery. In order to maximize the total amount of data in low density network, it must be guaranteed that no subsink owns more members than its value. Otherwise, unnecessary traffic will lead to saturation of subsinks instead of being transmitted to the mobile sink.

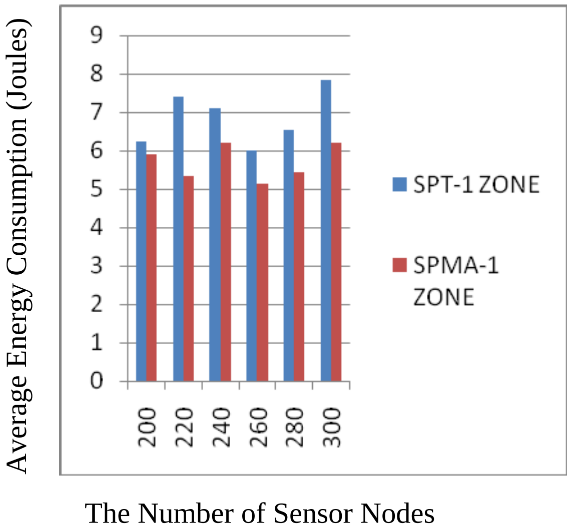
The optimization objective can be reformulated as finding an assignment of members to the subsinks so as to minimize the sum of hops from each member to its corresponding subsink under the condition that the minimum/maximum requirements of all subsinks are met.

Min $[\sum_{i=1}^{n} h_i]$ **- - - - - (11)**

Here in this approach , the heuristic solution for the SPMAS problem based on Genetic Algorithm(GA) is proposed. The similar approach similar to one in [7] and [8] is used in order to generate potential solutions and then improve feasibility and optimality simultaneously.

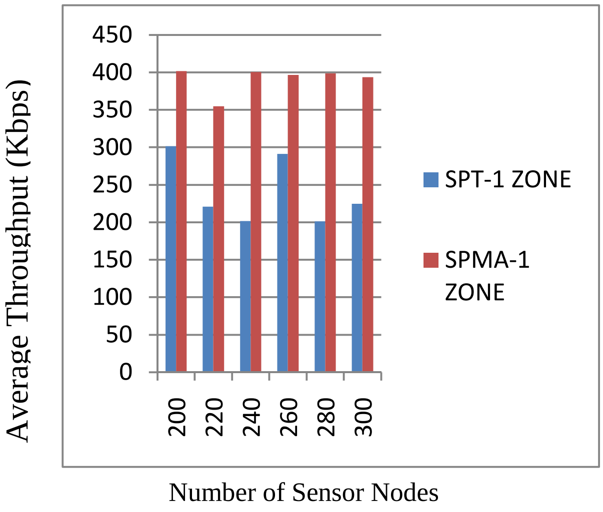
RESULTS

G.1 : Average energy consumption for 1-zone sensor network for SPMA and SPT



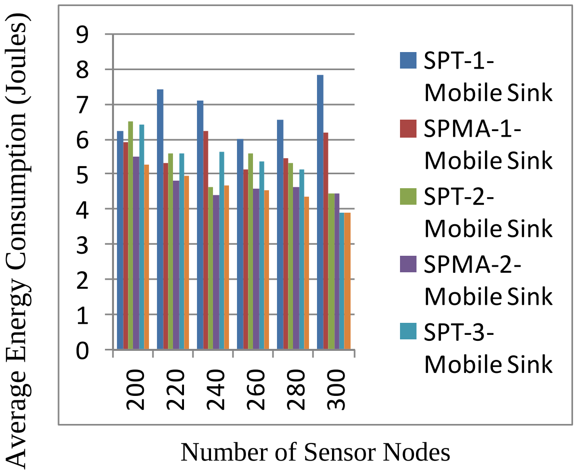
In graph G.1, it is clear that the performance in terms of Average Energy Consumption of SPMA is incredibly better than the SPT

G.2 : Average Throughput for 1-zone sensor network for SPMA and SPT



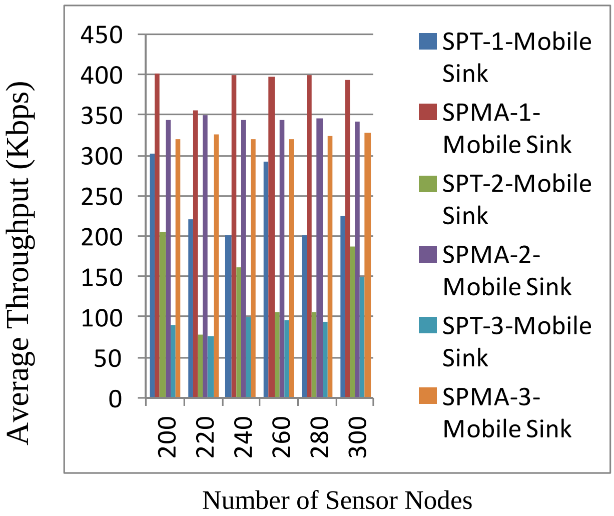
In graph G.2, the Average Throughput of SPMA is higher than the SPT

G.3 : Performance in terms of Average Energy Consumption of SPMA and SPT with a multiple Mobile Sinks:



In graph G.3, the comparison of SPMA is done with SPT with Variable Mobile sinks. From the graph it is clear that SPMA with 1, 2, 3 mobile sinks consumes less energy than SPT with 1,2, 3 mobile sinks.

G.4 : Performance Analysis in terms of Throughput of SPMA with SPT



In the graph G.4, the throughput of SPMA with 1,2,3 Mobile sinks is higher than SPT with 1,2,3 Mobile sinks.

CONCLUSION AND FUTURE WORK

In the proposed scheme, the mapping between the sensor nodes and the subsinks is optimized in order to maximize the amount of data gathered by mobile sinks as well as balance the energy consumption. The two phase communication protocol is designed that supports SPMAS and adapts to dynamic topology changes. From the graphs G.1 and G.2, it is clearly seen that the SPMAS outperforms SPT method in terms of average energy consumed and average throughput.Here, the performance of the proposed scheme is evaluated by varying the speed of mobile sink and then the results of SPT and SPMAS in terms of average energy consumption is compared. On the basis of graph G.3 it is seen that the SPMAS outperforms the SPT in terms of energy efficiency. Further, the proposed scheme is evaluated by considering the link error probability and then the results of SPMAS and SPT are compared. It is clear from graph G.4 that SPMAS is consuming less energy than SPT. It is been observed that for scenarios like varying speed of mobile sink and link error probability, even though the SPMAS outperforms SPT in terms of energy efficiency but does not outperform in terms of throughput. The proposed work does not consider the subsink selection problem, which could be the ultimate aim for future.

REFERENCES

[1] R.C. Shah, S. Roy, S. Jain, and W. Brunette, “Data MULEs: Modeling a Three-Tier Architecture for Sparse Sensor Networks,” Proc. First IEEE Int’l Workshop Sensor Network Protocols and Applications, pp. 30-41, 2003.

[2] S. Jain, R.C. Shah, W. Brunette, G.Borriello, and S.Roy, “Exploiting Mobility for Energy Efficient Data Collection in Sensor Networks,” MobileNetworks and Applications, vol.11,no. 3, pp. 327-339, 2006.

[3] A. Chakrabarti, A. Sabharwal, and B. Aazhang, “Communication Power Optimization in a Sensor Network with Path- Constrained Mobile Observer,” ACM Trans. Sensor Networks, vol. 2, no. 3, pp. 297- 324, Aug. 2006.

[4] L.Song and D. Hatzinakos,“Architecture of Wireless Sensor Networks with Mobile Sinks:SparselyDeployed Sensors,” IEEE Trans. Vehicular Technology, vol. 56, no.4,pp. 1826-1836, July 2007.

5] D.Jea, A. Sundara, and M. Srivastava, “Multiple Controlled Mobile Elements (Data Mules) for Data Collection in Sensor Networks,” Proc. First IEEE/ACM Int’l Conf. Distributed Computing in Sensory systems (DCOSS), pp. 244-257, 2005.

[6] A. Kansal, A. SSPMASundara, D. Jea, M.Srivastava, and D. Estrin, “Intelligent Fluid Infrastructure for Embedded Networks,” Proc. ACM MobiSys, pp. 111-124, 2004.

[7] C. Chu and E. Beasley, “A Genetic Algorithm for the Generalised Assignment Problem,” Computers and Operations Research, vol. 24, no. 1, pp. 17-23, 1997.

[8] S.N. Sivanandam and S.N. Deepa, Introduction to Genetic Algorithms. Springer, 2008.