



ENHANCE FAIR ROUTING WITH RESOURCE FLEXIBLE NODE ALLOCATION IN WIRELESS SENSOR NETWORKS

E. Balamurugan* & Dr. Kumar Charlie Paul**

* Department of Computer Science & Engineering, SSM College of Engineering,
Komarapalayam, Tamilnadu

** Principal, SSM College of Engineering, SSM College of Engineering, Komarapalayam,
Tamilnadu

Cite This Article: E. Balamurugan & Dr. Kumar Charlie Paul, "Enhance Fair Routing With Resource Flexible Node Allocation in Wireless Sensor Networks", International Journal of Computational Research and Development, Volume 2, Issue 1, Page Number 46-50, 2017.

Abstract:

Wireless sensor network is a network composed of a large number of sensor nodes with limited radio capabilities and one or a few sinks that collect data from sensor nodes. Sensor nodes are powered by small batteries, hence, the energy consumption in operating a WSN should be as low as possible. The wireless sensor network present all sensor nodes generate an equal amount of data packets in a WSN, nodes around a sink have to relay more packets and tend to die earlier than other nodes because the energy consumption of sensor nodes is almost completely dominated by data communication rather than by sensing and processing. Hence, the whole network lifetime can be prolonged by balancing the communication load at heavily loaded nodes around a sink. This problem is called the energy hole problem and is one of the most important issues for WSNs. Existing system analysis the heterogeneity of networks and a fair cooperative routing method, to avoid unfair improvement only on certain networks and to introduce one or a few shared nodes that can use multiple channels to relay data packets.

Index Terms: Sensor Network, Cooperative Routing, Fairness, Heterogeneous Environment & Load Balancing

1. Introduction:

A WSN is a network composed of a large number of sensor nodes with limited radio capabilities and one or a few sinks that collect data from sensor nodes. Generally, sensor nodes are powered by small batteries, hence, the energy consumption in operating a WSN should be as low as possible. Some methods for prolonging network lifetime are required in WSNs. The sinks and shared nodes can communicate with any WSNs node, different WSNs can use cooperative routing with each other since shared nodes allow sensor nodes to forward data from another WSN as the function of interchange points among respective WSN planes. When receiving a packet, a shared node selects the route to send the packet, according to proposed route selection methods. This cooperation prolongs the lifetime of each network equally as possible. The wireless sensor network present all sensor nodes generate an equal amount of data packets in a WSN, nodes around a sink have to relay more packets. Prolonged by balancing the communication load at heavily loaded nodes around a sink. This issue is called the energy hole problem and is one of the most important issues for WSNs. There are numerous studies about load balancing for WSNs such as clustering. In addition, as WSNs are diffused widely, multiple overlapping WSNs constructed on the same area become more common. In such a situation, cooperation among the WSNs to prolong network lifetime has been studied. Assuming that each sink of WSNs has a different location, the heavily loaded area is also different. In this case, cooperation of multiple WSNs may be able to improve the network lifetime of each WSN by load balancing all over the WSNs. Note that even in a case where multiple WSNs are constructed at the same place, they operate their applications independently and they have heterogeneous characteristic features. However, most of the existing studies do not consider this issue. For instance, if battery capabilities of sensor nodes in each network are different, in order to cooperate in a profitable way, we need to consider some parameters, such as their energy consumption rate, not only their remaining battery. Otherwise, it is possible that certain WSNs prolong their lifetime but others shorten their lifetime. Since their applications are different, data sending interval and/or packet size may be also different. Hence, for fair cooperation, it is necessary to consider the total number of times that the node have forwarded a packet, instead of focusing on each packet forwarding only. Furthermore, operation start time, the number of nodes and/or sensing area of each network may be also different.

2. Problem Issues:

A. Traditional Approach for Longer Lifetime: Clustering is one of the most famous methods because of its good scalability and the support for data aggregation. Data aggregation combines data packets from multiple sensor nodes into one data packet by eliminating redundant information. This reduces the transmission load and the total amount of data. In clustering, the energy load is well balanced by dynamic election of cluster heads (CHs) By rotating the CH role among all sensor nodes, each node tends to expend the same amount of energy over time. Nevertheless, as with usual multihop forwarding, a CH around a sink tends to have higher traffic than other CHs. As a result, nodes around sinks die earlier than other nodes, even in clustered WSN. In general, a single WSN has a single sink. The amount of traffic increases around the sink, therefore nodes around the sink tend to die earlier. This is called energy hole problem. Moreover, in a large-scale WSN with a large number of

sensor nodes, the energy hole problem is more serious. Then, some researchers have proposed construction methods of multiple-sink networks. In a multiple-sink WSN, sensor nodes are divided into a few clusters. Sensor nodes within a cluster are connected with one sink, which belongs to that cluster. In contrast to a single-sink WSN, in which nodes around the sink have to relay data from almost all nodes, nodes around each sink relay smaller amount of data only from nodes that are in the same cluster. Therefore, the communication load of nodes around sinks can be reduced. However, there are some problems such as how to determine the optimal location of each sink and the optimal number of sinks.

B. Cooperation Between Multiple WSNs: In existing studies, most researches assume that a single network is deployed by a single authority in the sensing area. However, as WSNs get utilized more widely, multiple WSNs tend to be deployed in the same area. For instance, in the UK, some different networks of cameras by different authorities such as police, highway patrol, and local city authorities are deployed on the same roads. Recently, some researchers have proposed the cooperation method of multiple WSNs in such situations. When multiple WSNs are constructed in close proximity, they can help each other by forwarding data so that all networks involved benefit from collaborative effort. In the potential benefits of cooperation in multiple WSNs are investigated. The authors formulated the system model with objective function and a set of problem constraints. Then, a linear programming framework is used to solve the optimization problem. Since their goal is to investigate the maximum achievable sensor network lifetime with different multi-domain cooperation strategies, optimization objective is network lifetime, which is defined as the time when the first sensor node in a network exhausts its battery and dies. The authors also investigated the cooperation in multiple networks that are deployed slightly different location. Some researchers have addressed the cooperation problem with using a game-theoretic framework. It is assumed that a WSN has a rational and selfish character and will only cooperate with another network if this association provides services that justify the cooperation. Virtual Cooperation Bond (VCB) Protocol is one of the game-theoretic approaches. It is a distributed protocol that makes different networks to cooperate, if and only if all the networks obtain some benefits by the cooperation. The authors formulated the cooperation problem among different WSNs as a cooperative game in game theory. In VCB protocol, the energy consumption of data communication is used as costs. When the cost gets higher, the payoff of a network gets lower. A sensor node and another node that belongs to another network forward a data packet coming from the other side, only if both networks can obtain the higher payoffs than no cooperation scenario. The simulation results showed that the VCB can save transmission energy between 20% and 30% in a certain environment.

C. Problematic Issues: As discussed above, we assume that multiple WSNs are deployed by different authorities in the same area. Those WSNs operate different applications independently, hence, they have heterogeneous characteristics, such as battery capacity, operation start time, the number of nodes, nodes locations, energy consumption, packet size and/or data transmission timing. However, most existing cooperation methods do not consider this heterogeneity. For instance, when batteries capacities on sensor nodes are quite different by a WSN, a cooperative routing method based on residual energy is not appropriate since a WSN which has the maximum battery capacity always forwards packets from other WSNs. As a result, although certain WSNs prolong their lifetime, the other WSNs may shorten their lifetime. In such a situation, fairness of cooperation is a highly important issue.

3. Proposed Method:

Assumed Environment: In a sensing field, m different WSNs are constructed, and different applications are operating on each WSN independently. It shows an example where two WSNs are constructed. If heavy loaded nodes are in different places among the WSNs as indicated in the example, it is possible that data packets via heavy loaded nodes are forwarded by other nodes in another WSN. However, each network adopts different channel, hence sensor nodes are unable to communicate with a node belonging to another WSN. To overcome this limitation, q shared nodes, which are high-end nodes with multi-channel communication unit, are deployed in the area. Shared nodes and sinks are able to communicate with any nodes belonging to all WSNs.

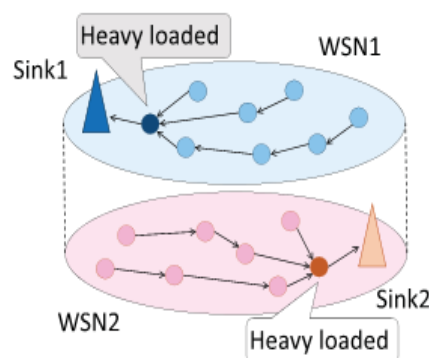


Figure 1: Two WSNs at the Same Area

Route Discovery: Each sensor node creates its routing table based on a routing protocol. Here used ad hoc on-demand distance vector (AODV) as a routing protocol, because AODV was developed for wireless ad hoc networks and was adopted for some WSN protocols such as Zigbee and ANT. In route discovery, each sensor node discovers its routes not only to the sink in its WSN but also to all the other sinks in the different WSNs for opportunities to forward data packets from nodes in different WSNs to their sink. Therefore, the routing table of each sensor node has m routes corresponding to each sink in all WSN. A shared node discovers its route with a slightly different mechanism. A shared node creates m routes via m different WSNs to a sink. There are m sinks, in total, corresponding to m WSNs. Therefore, a shared node has $m \times m$ routes. In AODV route discovery, each node chooses a route that has the minimum number of hops to the sink. However, the proposed method uses not the number of hops but a cost calculated by simple accumulation, so that more routes are established via shared nodes. This is because different WSNs can be used only via shared nodes as alternative routes.

Obtaining Lifetime Information: For cooperation considering the fairness among multiple WSNs, shared node s_k maintains estimated lifetime information, network lifetime L_i , minimum lifetime L_i^0 and route lifetime $L_{R_{kl}}^i$. We explain how to obtain this information as follows. At the time of transmitting a data packet, sensor node n_{ij} adds the values of its network lifetime L_i and route lifetime $L_{R_{kl}}^i$ to the MAC frame header of the packet. If the node does not have any information on network lifetime or route lifetime yet, for instance at the time immediately after creating or updating the route, its own node lifetime L_{ij} is added alternatively. Specifically, when node n_{ij} overhears a data packet, it compares the value of the network lifetime in the data packet and L_i in its own information, and updates its own L_i to the smaller value between them. In addition, if the packet is from a node which is contained in R_{ji}^i , the route from n_{ij} to BS_i , it checks the value of route lifetime in the packet header, and updates its route lifetime by the smaller value as in the case of updating L_i . After that, the overhearing node discards the packet immediately if the destination of the packet is not itself. The cost and benefit analysis may be concluded that computerized system is favorable in today's fast moving world. The assessment of technical feasibility must be based on an outline design of the system requirements in terms of input, output, files, programs and procedure. The project aims to presents an innovative and effective pattern discovery technique which includes the processes of pattern deploying and pattern evolving, to improve the effectiveness of using and updating discovered patterns for finding relevant and interesting information. The current system aims to overcome the problems of the existing system. The current system is to reduce the technical skill requirements so that more number of users can access the application. Each node updates this information by overhearing data packets from other nodes. Specifically, when node n_{ij} overhears a data packet, it compares the value of the network lifetime in the data packet and L_i in its own information, and updates its own L_i to the smaller value between them. In addition, if the packet is from a node which is contained in R_{ji}^i , the route from n_{ij} to BS_i , it checks the value of route lifetime in the packet header, and updates its route lifetime by the smaller value as in the case of updating L_i . After that, the overhearing node discards the packet immediately if the destination of the packet is not itself.

Resource Allocation: In this method, the flexible channel cooperation that opens up all dimensions of resource allocation for the primary and secondary users. The module further divided into following modules such as,

- ✓ Distributed Bargaining
- ✓ Rounding Based Sub Channel Assignment

Distributed Bargaining: In this method, the primary users and secondary users are added in to list box controls. The primary users after initializing the power and band width requirement, they select the secondary users which are capable to provide the requirements. The secondary users maintain the list of primary users for which the channels are allotted.

- ✓ The primary BS runs a multiuser scheduling algorithm to determine R_i^{\min} for PUs without cooperation
- ✓ Each user initializes its power price $\lambda_n^{(0)}$. Each PU initializes the dual variable $\mu_n^{(0)}$.
- ✓ Given $\lambda^{(0)}$, each PU i solves the per-sub channel resource allocation problem using sub routine.
- ✓ Each user n bargains by performing a sub gradient update for the price λ_n . Each PU i also updates μ_i . return to step 3 until convergence
- ✓ Every user updates R'_n from its total throughput R_n in this epoch. Every PU i updates $R_i^{\prime \min}$ from R_i^{\min} in step 1. They will be used for resource allocation in next epoch.

Using this information, the sub channels can be assigned such that each Secondary user assigns the primary users in the order of least bandwidth. The time is equally divided into two slots among cooperating users. PUs transmit in the first slot to SUs, and SUs transmit in the second to the primary base station (BS) and to their own access point (AP). A SU strategically optimizes its use of the leased resources.

Rounding Based Sub Channel Assignment: For each set of users belongs to a different type (time slot and primary/secondary). The profit of allocating an item (sub channel) depends not only on the knapsacks but also the type of them. The one-type of multiple user problem is known to be NP-hard and even hard to approximate and this could be resolved in this module using rounding based sub channel assignment. It ensures that each sub channel is assigned to at most one user for both slots.

Synchronization: In this module, an effort to address the energy efficiency problem by synchronizing the transmission times of all the nodes in the system is proposed. Transmission synchronization presents energy saving opportunities through dynamic power management of the network interface. That is, nodes can switch off their wireless interfaces between transmissions.

Weight Based Synchronization: In this method, each node to locally maintain a variable monitoring the size of the cluster of synchronization which contains the node. The variable is called the weight of the node/cluster. Initially, the weight of each node is 1. Each node includes its weight in all its CPMP updates. Certainly, nodes cannot maintain globally accurate weights. Instead, each node needs to use only local knowledge extracted from packets received from neighbors to update the value of this variable. At the end of each active interval, a node uses the slot Array structure to decide its next transmission time. The slot Array structure has s entries, one for each slot of the next (sleep) interval. The node has to choose one of these slots, called winner slot, and synchronize with it. That is, the node has to advertise the time of its next transmission (T_x value) such that the update packet will be placed into that winner slot by its neighbors.

Future Peak Detection: FPD works by counting the number of packets that are stored in each slot of the current active interval. Note that each packet received during the current active interval is stored in the slot corresponding to the packet sender's next transmission time. FPD then makes a greedy choice for the winner slot, by choosing the slot x whose $\text{slotArray}[x] = \max_{i=1}^* |\text{slotArray}[i]|$. $\text{slotArray}[x]$ denotes the number of packets stored in the x^{th} entry of slotArray . This choice ensures that the node's next transmission is in sync with most of its neighbors. In case of ties, N chooses the earliest slot to sync. In this module the algorithm executed at the end of each active interval, the $\text{set}T_x$ method first determines the maximum number of packets stored in any slot of the interval and marks that slot as the winner slot. If the winner slot is different from the node's current transmission slot, the node synchronizes with the winner slot, by setting the node's T_x value to the winner Slot value and correspondingly updating the time of the node's next transmission. FPD makes a greedy choice for the winner slot, ensuring that a node's next transmission is in sync with most of its neighbors.

Randomized Future Peak Detection: FPD is unable to completely synchronize, the situation changes when imperfect channel conditions are considered. Specifically, for a network of 100 nodes with 15 percent packet loss rates, FPD synchronizes the entire network in 21,000 s. While in a network with perfect channel conditions clusters created by FPD are stable, packet loss can make nodes move from one cluster of synchronization to another, thus breaking the stability. If enough nodes switch, clusters may engulf other clusters in their vicinity, eventually creating a single cluster of synchronization. However, relying only on packet loss is insufficient. One of our requirements is that a network synchronizes in a timely manner. To achieve this, we extend FPD with randomization: nodes choose to synchronize with their neighbors in a weighted probabilistic fashion.

4. Conclusions:

To avoid unfair improvement only on certain networks, in this project heterogeneity of networks and a fair cooperative routing method is proposed and analyzed. In this project, one or a few shared nodes that can use multiple channels to relay data packets. The sinks and shared nodes can communicate with any WSNs node, different WSNs can use cooperative routing with each other since shared nodes allow sensor nodes to forward data from another WSN as the function of interchange points among respective WSN planes. When receiving a packet, a shared node selects the route to send the packet, according to proposed route selection methods. This cooperation prolongs the lifetime of each network equally as possible. In particular, Pool-based cooperation achieved quite small variance of lifetime improvement, that is, it provided quite fair cooperation. As a future work, implement the proposed method on an experimental system and evaluate its feasibility. And also to address the energy efficiency problem by synchronizing the transmission times of all the nodes in the system is explored in the future works.

5. References:

1. A. Abbasi and M. Younis , (2007), "A survey on clustering algorithms for wireless sensor networks," *Comput. Commun.*, vol. 30, nos. 14–15, pp. 2826–2841.
2. K. Bcakci and B. Tavli(2010), "Prolonging network lifetime with multi-domain cooperation strategies in wireless sensor networks," *Ad Hoc Netw.*, vol. 8, no. 6, pp. 582–596
3. L. Buttyán, T. Holczer, and P. Schaffer (2005), "Spontaneous cooperation in multi-domain sensor networks," in *Proc. 2nd Eur. Workshop Secur. Privacy Ad-Hoc Sensor Netw.*, pp. 42–53.
4. Dietrich and F. Dressler (2009), "On the lifetime of wireless sensor networks," *ACM Trans. Sensor Netw.*, vol. 5, no. 1, Art. no. 5
5. G. Gupta and M. Younis (2003), "Performance evaluation of load-balanced clustering of wireless sensor networks," in *Proc. 10th Int. Conf. Telecommun. (ICT)* pp. 1577–1583.
6. J. Li and P. Mohapatra(2007), "Analytical modeling and mitigation techniques for the energy hole problem in sensor networks," *Pervasive Mobile Comput. J.*, vol. 3, no. 3, pp. 233–254.
7. J. Nagata, Y. Tanigawa, K. Kinoshita, H. Tode, and K. Murakami(2012), "A routing method for cooperative forwarding in multiple wireless sensor networks," in *Proc. 8th Int. Conf. Netw. Services (ICNS)*pp. 43–46.

8. E. I. Oyman and C. Ersoy (2004), "Multiple sink network design problem in large scale wireless sensor networks," in Proc. IEEE Int. Conf. Commun. (ICC), vol. 6, pp. 3663–3667.
9. M. J. Shamani, H. Gharaee, S. Sadri, and F. Rezaei (2013), "Adaptive energy aware cooperation strategy in heterogeneous multi-domain sensor networks," *Procedia Comput. Sci.*, vol. 19, pp. 1047–1052
10. P. O. S. Vaz de Melo, F. D. Cunha, and A. A. F. Loureiro (2013), "A distributed protocol for cooperation among different wireless sensor networks," in Proc. IEEE Int. Conf. Commun. (ICC), pp. 6035–6039.