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LBMS: Location Based Mobility Scheme in Wireless Sensor Networks

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Abstract— A wireless sensor network can work efficiently only if can provide good mobility support. However the existing mobility protocols do not provide the optimal solution due to long handover latency and high packet loss. The term handover or handoff refers to the process of transferring an ongoing call or data session from one channel connected to the core network to another channel this leads to delay. In order to overcome these disadvantages we use location-based mobility support scheme. Mobility support algorithm is used which is based on cluster domain. In this scheme the handover in data link layer (DLL) and network layer are done simultaneously and mobile nodes do not participate in handover process. Hence packet loss due to change in address and node mobility is avoided. Moreover a cluster head's IPV6 address includes location information so there is automatic establishment of routing path to the destination cluster without routing discovery. The main advantage of using location based mobility support is that packet loss and handover cost is reduced. The task of routing data from a source to the sink is a critical issue in wireless sensor networks. To overcome these critical issues we use fuzzy logic to perform role assignment during route establishment and maintenance is proposed. An incremental approach is presented and compared with similar existing routing protocols. Efficient routing approaches provide network load balance to extend network lifetime, efficiency improvements, and data loss avoidance.

Keywords—wireless sensor network, Location information,Cluster domain, Mobility handover, Intelligent routing protocols, Fuzzy logic

I. INTRODUCTION

Wireless sensor network is a network comprising of many wireless mobile nodes (heterogeneous sensors) which are spatially distributed in a given field of interest. They differ from other networks due to varies reasons like -sensor nodes have limited energy supply, constraint dependent computation and communication abilities. Hence it is very important to prolong the network lifetime. The Internet of Things (IoT) is the network of physical objects or "things" embedded with electronics, software, sensors and connectivity to enable it to achieve greater value and service by exchanging data with the manufacturer, operator and/or other connected devices. Each thing is uniquely identifiable through its embedded computing system but is able to interoperate within the existing Internet infrastructure.

Typically, IoT is expected to offer advanced connectivity of devices, systems, and services that goes beyond machine-to-machine communications (M2M) and covers a variety of protocols, domains, and applications. With the advent of this internet of things it becomes urgent to connect a wireless sensor network to the internet. In IoT, sensed data make decisions on behalf of the user so in order to dissipate sensed data it is required to connect to internet. Many protocols are used for WSN like 6LOWPAN, it provides point-to-point communication with the internet and helps in mobility of sensor nodes .At present the mobility support is divided into two categories- host-based scheme and network based schemes
There are a few problems relating to the host-based scheme like handover latency and high packet loss rate and the problems related to network-based scheme is that they are degraded by the mobility-related messages which pass through a non-optimized routing path. There are many ways to overcome or improve the mobility support. Many routing protocols have been specified for WSNs such as data centric , hierarchical and location based. The routing protocols are used based on intelligent algorithms like reinforcement learning (RL), ant colony optimization (ACO), fuzzy logic(FL),genetic algorithm(GA) nd neural networks(NNs).The main idea behind using these intelligent protocols is to provide a collaboration between WSN and computational intelligence(CI)also it analyzes the network based on performance of network life time and they exhibit intelligent behavior in complex and dynamic environments. However these algorithms cannot be used arbitrarily. Each algorithm has their own specifications.
GA and NNs have very high processing demands and give centralized solutions. They are better suited for clustering. FL is suitable for implementing routing and clustering heuristics like link or cluster head quality classification. ACO is very flexible, but generates a lot of additional traffic because of forward and backward ants. RL should be the first choice while choosing intelligent algorithms.it has been proved to work very well for routing and is implemented with no additional cost. Another way to overcome latency delay and packet loss is to use location-based mobility support scheme and it has the following contributions.

1. The architecture based on clusters are built according to the cluster domain construction algorithm based on location information.in this method when a cluster member moves in a cluster domain the mobility handover is performed within the domain itself and control messages are only exchanged between neighboring nodes. As a result, the mobility handover cost and delay are reduced.
2. The mobility handover algorithm is used in which the handover in the network layer (L3) and the one in link layer(L2) are performed at the same time so handover delay is shortened.

3. A cluster head's address includes the location information. Based on the destination address the routing path is found automatically without routing discovery. As a result of this the handover cost and delay is reduced.

II. Related works

In Ha et al [1], each mobile node on neighbor personal area network (PAN) coordinators. A mobile nodes partner node can perform the pre-configuration process for the mobile node. In Bag et al [2], the 6LOWPAN dispatch types are used to determine the next hop. As a result, the handover delay is prolonged and the network scalability is also limited. Jara et al [3], proposed a mobile protocol for IP-based WSN to save the energy and maximize the network lifetime. However this scheme cannot handle the inner-network mobility handover since a MAC address can only uniquely identify a node in a WSN. Xiaonam Wang et al[4], talks about the mobility support using location based mobility protocols and how the drawbacks of other mobility protocols can be avoided. Wenjing Guo et al[5], describes the various intelligent routing protocols and the use of computational intelligence in routing and explains how efficient it is. Kim et. al. [6], define the movement notification of a sensor node and use the router solicitation (RS) and router advertisement (RA) to achieve the mobility handover. This scheme improves the mobility handover performance. Kim et a l[7], a mobile node achieves the mobility support through mobile routers. This scheme adds the mobility header in the IPv6 payload by modifying 6LOWPAN dispatch, but this is not compatible with the hierarchical design principles of the IPv6 protocol.

III. Proposed Architecture

Every LBSs contain a number of components including maps and Geographic Information System (GIS) information, location collection services, and LBS application-specific subcomponents. The architecture of LBS can be generalized as shown in figure 1.

Location Tracking

This component stores the location trace of individual users. This represents a fundamental component in next generation. LBS as it contains the data that allows a user's route to be determined and potentially predicted. In particular, this component would typically support the following functionality:

1. Keep records on user's current and past locations.
2. Notify other components when a specific user has moved, or when they move in or out of an area. This supports location-based notifications being sent to users.
3. Determine which users are within a defined location this supports geo-casting features.

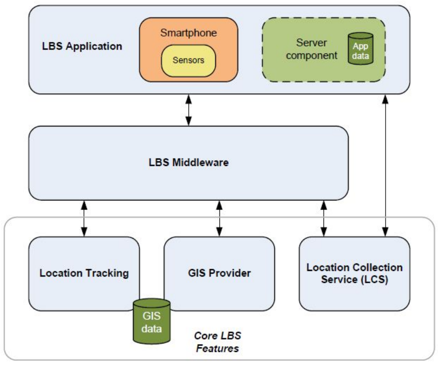

Fig. 1. Location Based Mobility Scheme

4. Queries of location trace to generate user movement Models

A. GIS Provider

This component provides geospatial functionality for many LBSs including map information, map visualization and directory services. Google Maps with its API can be considered a GIS provider.

B. Location Collection Service

This component performs location collection to get a latitude and longitude for a specific user. Depending on the technology, this component may be accessed via the LBS Middleware (e.g., mobile network triangulation via a service provider) or directly (e.g., via GPS receiver in the Smartphone). Android provides access to the above components to facilitate the implementation of LBS services through the help of following classes:

1. Location Manager
2. Location Provider
3. Geo-coding
4. Google-Map

C. LBS Application

This represents a specific application such as a —find my friends‖ application. This consists of a Smartphone component, which has a number of sensors, and potentially a server component that includes application specific data (such as location-tagged information.

D. LBS Middleware

This wraps access to Core LBS Features (Location Tracking, GIS Provider and Location Collection Services) to provide a consistent interface to LBS applications.

IV. FUZZY LOGIC BASED ROUTING PROTOCOL

1. FCH

Unlike the normal set theory fuzzy logic can establish intermediate values based on linguistic variables and inference rules. It is a mathematical discipline to express human reasoning. Linguistic variable have values which are words or sentences in natural or artificial language and inference rule is used to govern the reasoning by using hedges like ‘more’, ‘many’, ‘few’, and connectors like ‘AND’,‘OR’, ‘NOT’. In a fuzzy set a element is allowed partial membership in the range [0,1] There are two important parts in FL.

First, a fuzzy membership function is defined to compute membership corresponding to a given value of a linguistic variable.

In addition, FL offers a fuzzy aggregation operator, Ordered Weighted Averaging (OWA), as an alternative to weighted sum, for designing a multi-objective cost function. Usually, the “Or-like” and “And-like” OWA operators are used in FL, which are implemented in Eqs. (1) and (2), respectively.

$$\mu_{A\cup B}(x) = \beta \times \max(\mu_A, \mu_B) + (1-\beta) \times \frac{1}{2}(\mu_A + \mu_B) \quad \text{--------- (1)}$$

$$\mu_{A\cap B}(x) = \beta \times \min(\mu_A, \mu_B) + (1-\beta) \times \frac{1}{2}(\mu_A + \mu_B) \quad \text{--------- (2)}$$

FL has been applied successfully in digital image processing, pattern recognition, and control systems such as control of vehicle subsystem, power systems, home appliances, elevators etc.

A. Protocol definition

Fuzzy logic approach is used mainly for cluster-head election for WSNs. In this cluster heads are selected by the base station in each round. For each node, energy, concentration and centrality are considered as the three linguistic variables to Determine the chance to become the cluster head. The linguistic variables node energy and node concentration are divided into three levels: low, medium and high, and node centrality is divided into three levels: close, adequate and far. The outcome to represent the node cluster- head election chance was divided into seven levels: very small, small, rather small, medium, rather large, large, and very large. The fuzzy rule base currently includes rules like the following: if the energy is high and the concentration is high and the centrality is close then the node's cluster-head election chance is very large. Thus there are 3^3=27 rules for the fuzzy rule base.

B. Functioning of the scheme

The operation of this fuzzy cluster-head election scheme is divided into rounds consisting of a setup and steady state phase. In the setup phase, all the nodes are compared on the basis of chances and the node with the maximum chance is then elected as the cluster-head. If there are multiple nodes having maximum chance, then the node having more energy is selected. Each node in the cluster associates itself to the cluster-head and starts transmitting data.

C. Results and performance

FCH gains a substantial increase in network lifetime. If we compare the results with another approach called the LEACH steady-state phase which rotates the cluster-head on the basis of the defuzzified chance value and incorporates different values for the linguistic variables we can see that the FCH approach is on an average 1.8 times greater than LEACH.

2. FMO

A. Protocol definition

Fuzzy multi-objective routing algorithm (FMO) proposed in Minhas et al[7]. (2008) is to simultaneously optimize two routing objectives for WSNs. For the routing objectives, it uses fuzzy membership functions and rules in the design of cost functions. In FMO, a static WSN deployment is modeled as a directed graph G (V,E), where V is the set of nodes and E is the set of links.

B. Functioning of the scheme

This algorithm operates as follows:

When a routing request rh(sm, tn) is initiated, a fuzzy lifetime membership and a fuzzy minimum energy membership are computed for each edge using Eqs. (5) and (6), respectively. Then, the corresponding multi-objective membership is calculated by Eq. (7). Having gotten the multi-objective membership, each edge is assigned a weight according to Eq. (3). Following the weight assignment, the multi-objective path ph between sm and tn is found using Dijkstra's shortest path algorithm .

$$\mu_{lt}^{ij} = \begin{cases} 1-\left(\frac{1-\gamma}{1-\alpha}\right)\cdot\left(1-\frac{re(v_i)}{\sigma}\right) & if\, \alpha\cdot\sigma < re(v_i) \le \sigma \\ \frac{\gamma}{\alpha\cdot\sigma-TX_{ij}} \times (re(v_i)-TX_{ij}) & if \quad TX_{ij} < re(v_i) \le \alpha\cdot\sigma \\ 0 & if \quad re(v_i) \le TX_{ij} \end{cases} \quad \text{--------------- (3)}$$

$$re(v_i) = ce(v_i) - TX_{ij} \quad \text{------------- (4)}$$

where re(vi) and ce(vi) denote the residual energy and current energy of node vi respectively, s is the initial energy of nodes, TXij represents the consumed energy in transmission from node vi to node vj, and α, γ are the algorithmic parameters.

$$\mu_{me}^{ij} = 1 + \frac{(\Delta-1) \times TX_{ij}}{\max(TX_{ij})} \quad \text{-------------------(5)}$$

$$\max(TX_{ij}) = \max_j\{TX_{ij}\} \quad \forall j\, s.t. \quad v_j \in N_i \quad \text{--------------(6)}$$

where Δ is an algorithmic parameter which can be adjusted to alter the lowest membership. The above function assigns the lowest membership value to an edge requiring the maximum transmission energy among all the neighboring edges, which encourages the selection of such edges that require lesser trans- mission energy.

$$\mu^{ij} = \beta \times \min(\mu_{lt}^{ij}, \mu_{me}^{ij}) + (1-\beta) \times \left(\frac{\mu_{lt}^{ij} + \mu_{me}^{ij}}{2}\right) \quad \text{-------------------(7)}$$

where μ^{ij} is the fuzzy multi-objective membership of the edge $e(v_i, v_j)$, and β is a constant.

$$w_{ij} = 1 - \mu^{ij} \quad \text{------------------ (8)}$$

C. Results and performance analysis

FMO makes use of the FL algorithm to simultaneously optimize multiple objectives. Simulation results show that this approach is superior to a number of other well-known online routing heuristics in the performance of network lifetime in terms of the first definition.

D. Applications

Because of the characteristic of FMO, this protocol can be applied to simultaneously achieve multiple routing objectives for WSNs.

V. SIMULATION RESULTS

The simulation scenario consists of 500 nodes randomly placed in an area of 500 X 500 m. The radio range id varied in order to achieve different network densities in terms of a mean umber of neighbors. Note that this is equivalent to using a fixed radio range and increasing the simulation area. Densities considered were a mean number of 5, 6, 7, 8, 9, and 10 neighbors per node, whereas the number of multicast destinations was 5, 10, 25, and 50. Receivers were also randomly selected from the set of sensor nodes. For each configuration, our results are the mean over a total number of 8 simulation runs, which proved to be sufficient to provide a small 95% confidence interval. Figure 2 shows the throughput simulation result which is implemented using NS2

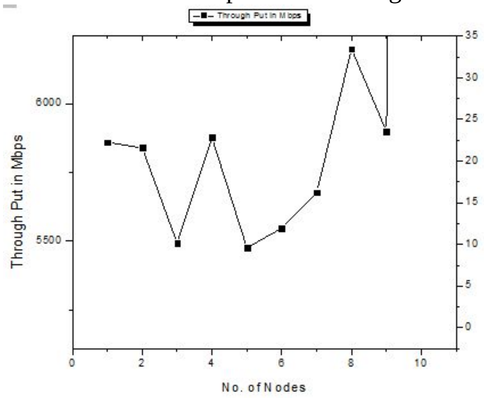

Fig. 2. Simulation result of Throughtput in Mbps

VI. CONCLUSION

The FL-based protocols implement clustering heuristics or routing optimization to simultaneously achieve multiple objectives. FCH considers energy, concentration and centrality as three linguistic variables to determine the chance of becoming cluster head. It has been validated to gain a substantial increase in network lifetime in terms of the first definition. In this aspect, FMO is also superior to a number of other well-known online routing heuristics. It uses fuzzy membership functions and rules in the design of cost functions to simultaneously optimize multiple objectives. Here we have taken the example of fuzzy logic which is only one of the intelligent algorithms. Like this there are more which have different methods of implementation and all of them serve as an optimal source of routing in wireless sensor networks.

The location-based mobility scheme also helps a great deal in reducing handover delay and packet loss as in this method the handover of one layer does not interfere with the other layers and the cluster heads contain the location of the destination due to which the routing path is automatically built without any route discovery. When a cluster member moves within a cluster domain it remains local to that domain and the control message is sent to the immediate neighbors only this also reduces the handover delay to a great extent. Hence we can say that among the three types of WSN protocols - data centric, hierarchical and location-based, location- based is more optimal.

REFERENCES

[1]. Halawani Sami, Khan Abdul Waheed. sensors lifetime enhancement techniques in wireless sensor networks—a survey. journal of computing, 2010:34-47.

[2]. Bag G, Raza MT, Kim KH, et al. LoWMob: intra-PAN mobility support schemes for 6LoWPAN. Sensors 2009;5844–77.

[3]. Jara AJ, Silva RM, Silva JS, et al. Mobile ip-based protocol for wireless personal area networks in critical environments. Wirel Pers Commun 2011;711–37.

[4]. Xianon Wang,Deguang Le, et al. Location-based mobility support for 6LOWPAN wireless sensor networks.2014

[5]. Wenjing Guo,Wei Zhang*.A servey on intelligent routing protocols in wireless sensor networks.2013

[6]. Kim J, Haw R, Cho EJ, et al. A 6LoWPAN sensor node mobility scheme based on

[7]. Minhas Mahmood R, Gopalakrishnan Sathish, Leung Victor CM. Fuzzy algorithms for maximum lifetime routing in wireless sensor networks. Global telecommunications conference; 2008. p. 1–6.