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SURVEY: ON SELECTION OF FLAT ROUTING PROTOCOLS BASED ON WIRELESS NETWORK CONDITIONS

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ABSTRACT

Flat routing protocol is a network communication protocol implemented by routers in which all nodes are routers and are each other's peers. Flat routing protocol distributes routing information to routers that are connected to each other without any organization or segmentation structure between them. They enable the delivery of packets among routers through any available path.

Flat routing protocols are primarily those that don't work under a predefined network layout. Flat routing protocol is implemented in networks where each router node routinely collects and distributes routing information with its neighboring routers. The entire participating node addressed by flat routing protocol performs an equal role in the overall routing mechanism.

This paper presents the features and infrastructure required for various routing protocols. With the help of this paper, a particular flat routing protocol can be selected based on the infrastructure available.

Keywords: Gradient, Reinforcement, Interest, Event, Negotiation

I. INTRODUCTION

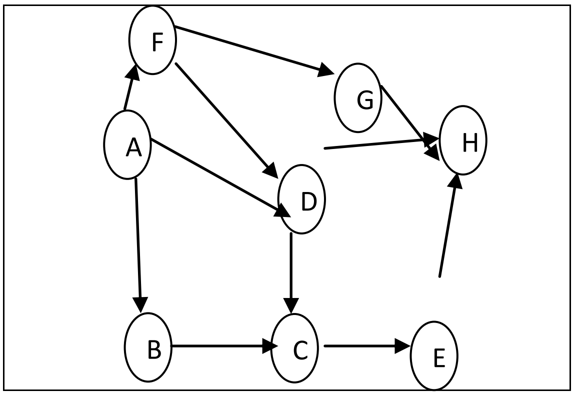
Sensor networks will be composed of a large number of densely deployed sensor nodes. Each node in the sensor network consist of one or more sensors, a low power radio, portable power supply, and possibly localization hardware, such as a GPS (Global Positioning System) unit or a ranging device.[1]For transmission of data in a network, initially the resources that are available with the network must be estimated. Based the resources available and the reqiuired resultant, protocols can be chosen.

The rest of the paper is organized as follows. We briefly discuss various flat protocols in Section 2[2]. In Section 3, the various conditions that can be prevailing in networks are shown and based upon these , the suitable protocol for the situation is indicated. This section also shows the consequences or drawbacks that occur if a protocol is selected. Section 4 presents the conclusions.

II. RELATED WORK

(i) Flooding:

Flooding can be used for routing wireless sensor networks[3]. It uses broadcast approach. In flooding, a node sends a packet received, to all its neighbors other than the neighbor which sent the packet to it, if the packet is not destined to itself or the maximum number of hops a packet can pass is not crossed[4]. Flooding is very simple to implement, and it is reactive protocol, as it does not maintain any routing table (topology maintenance) and does not require discovering any routes. But this technique has several disadvantages, the most important being, it is responsible for large bandwidth consumption and it wastes valuable energy. This is not an energy aware protocol also. This protocol is not designed specifically for sensor networks. Similar data produced by nodes in the same region are also flooded, i.e. there is no data aggregation done. The diagram below gives an example for flooding.



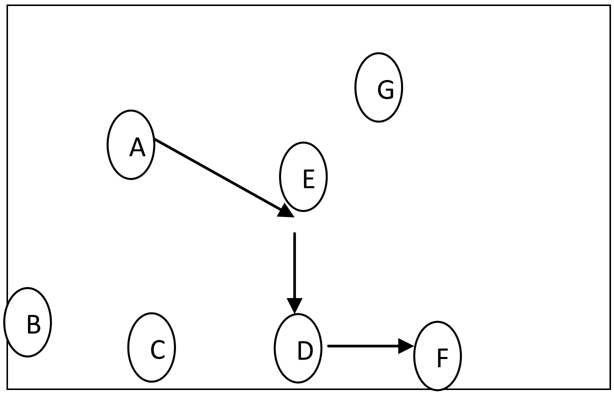
Flooding in WSN(A-source node, H-destination node)

Node A sends a packet to node B,D,F, which in turn sends the packet to all its neighbors, i.e. to node C, node G , and node D & G respectively. Node D does not send the packet to node A because node D knows that node A only sent the data to it.

The main problems that occur here are resource blindness, implosion and overlap.In resource blindness, a node with power deficiency cannot be identified easily.Implosion means data is present in multiple copies.Overlap makes the network to have multiple routes to destination where intermediate nodes are repeated.

(ii) Gossiping:

Gossiping is similar to flooding except that, a node receiving a packet, instead of broadcasting, the node sends it to only one of its randomly selected neighbor and the neighbor in turn sends the packet to one of its randomly selected neighbor, this continues until the packet reaches its destination[3]. Gossiping reduces the number of packets in the network but the delay to reach destination in some cases may be very large. The diagram below shows gossiping.



Gossiping in WSN(A-source node, F-destination node)

Node A randomly selects node E among its neighbor to forward the packet, similarly node E selects node D among its neighbors. Node D forwards the packet to F.

(iii) Directed Diffusion:

Directed diffusion consists of several elements: interests, data messages(events), gradients and reinforcements. The base station floods the sensor network with a query for the events[5]. The query is called as interest which is sent by base station and the data messages are the events generated by a single or a group of nodes as response to the queries sent. The interest queries are disseminated throughout the sensor network as an interest for named data. This dissemination sets up the "gradients" within the network to extract events[6]. A gradient is a direction state created in each node that receives an interest The node, which generates the events, sends the events back to the base station along multiple gradient paths. In directed diffusion algorithm, each node knows its location once deployed.The base station tries to determine if there any nodes in the specified region that sense the task specified. Then base station starts sending interest to all nodes[7].

Initially time taken for setting up the gradients and fetching the data from nodes will be more. Each node in the network maintains an interest cache. The interest cache contains the information about the interest it received. Interest cache does not have information about the base station but the one-hop neighbor from which it received the interest. When a node receives an interest, it checks the interest cache to see if the interest already exists. If no matching entry exists in the interest cache, then the node creates one interest entry and stores the information about the interest. This entry has a single gradient towards the neighbor from which it received the interest.

The node has to distinguish the neighbors in order to send the data at the requested rate. When a gradient expires, it is removed from its interest entry. After storing the information about the interest, a node will send the interest to all its neighbors.

The gradient specifies the data rate and the direction in which to send events.

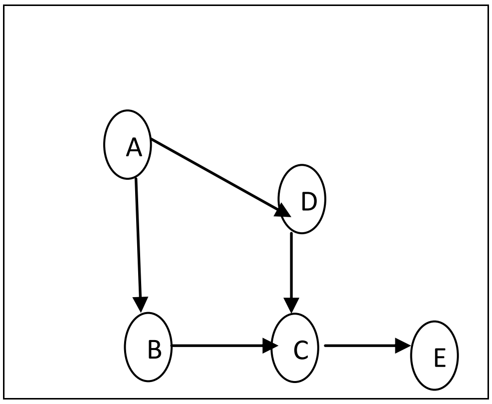
In summary, interest propagation sets up state in the network to pull down the data events from the source node. The rules for interest propagation are application specific .Due to the multi-path transmission of the interest, it is not possible for an adversary to prevent the interest information from reaching the nodes in the network .

When a node receives an interest from a target node, the then it will search its interest cache for a matching interest entry. If a matching interest is found then the node will look at the data rate parameter for all the gradients and forward the data at the rate specified. It will initially be slower for all gradients. So, all the neighbors receive a copy of the event. The source node unicasts the events, to all the neighbors for which it has a gradient. The node which receives the events from the source, attempts to find a matching entry in its interest cache. If a match does not exist then the data message is dropped silently. If there exists a match, the received message is added to the data cache and the data message is sent to the node's neighbors.The data message will eventually reach the base station.

Reinforcement approach is used here. The reinforcement is sending the same interest message with an increase in the data rate.

The base station reinforces one particular neighbor, and that neighbor, reinforces one of its upstream neighbors. The reinforcement continues till the message reaches the source node. The higher data rate events allow high quality tracking Any node in the network can send a positive reinforcement to its upstream neighbor if that node consistently sends the unseen event to it.

Like positive reinforcement, the negative reinforcement message is also forwarded to the source node. The nodes receiving this message change their data rate of the neighbor. For example, let us consider from the following figure that the data flows in the path A-B- C- E and the link A-B is congested. Now node C will receive the data message from the node D (since the other link is congested). This prompts node C to negatively reinforce node B and positively reinforce node D.

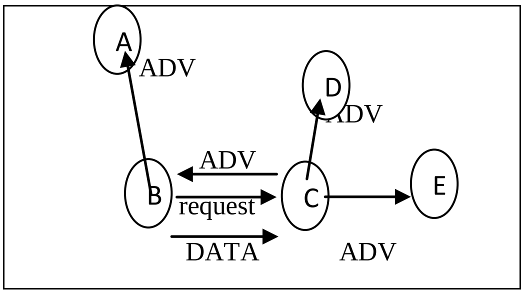


Direct Diffusion in WSN (A-source node, E-base station)

(iv)Spin:

SPIN stands for Sensor Protocol for Information via Negotiation[8].These protocols are designed to address the deficiency of flooding and gossiping.

SPIN uses three types of messages, ADV(Advertisement), REQ(Request) and DATA. The ADV message is broadcasted by a node which has some data. This message shows the type of data contained by the advertising node. Interested nodes which got the ADV message send REQ message requesting for the data. The node having the data sends the data to the interested nodes. The nodes after receiving data send ADV message to other neighbor nodes in their sensing area and the process continues. This can be seen in figure below.



Spin in WSN(B –source node, C – destination node)

Node B sends ADV message to all its neighbors, A and C. Node C requests for the data using REQ message, for which node B send data using message DATA to node C. After receiving the data Node C sends ADV message to its neighbors D and E and the process continues. It does not send to B because C knows that it received data from B.

The data is described in the ADV packet using high level data descriptors, which are good enough to identify the data. These high level data descriptors are called meta-data. The meta-data of two different data's should be different and meta-data of two similar data should be similar. The use of meta-data prevents, the actual data being flooded through out the network. The actual data can be given to only the nodes which need the data. This protocol also makes nodes more intelligent, every node will have a resource manager, which will inform each node about the amount various resources left in the node. Accordingly the node can make a decision regarding, whether it can act as forwarding node or not.

(v) Romour Routing:

The key idea is to route the queries to the nodes that have observed a particular event rather than sending to the entire network to retrieve information about the occurring events[9].In order to send events through the network, the rumor routing algorithm employs long-lived packets, called agents. When a node detects an event, it adds such event to its local table, called events table and generates an agent. Agents travel the network in order to propagate information about local events to distant nodes. When a node generates a query for an event, the nodes that know the route, may respond to the query by inspecting its event table. Hence, there is no need to send to the whole network, which reduces the communication cost.

On the other hand, rumor routing maintains only one path between source and destination as opposed to directed diffusion where data can be routed through multiple paths at low rates. However, rumor routing performs well only when the number of events is small. For a large number of events, the cost of maintaining agents and event-tables in each node becomes infeasible if there is not enough interest in these events from the Base Station[2]. Moreover, the overhead associated with rumor routing is controlled by parameters used in the algorithm such as time-to-live (TTL) pertaining to queries and agents. Since the nodes become aware of events through the event agents,the heuristic for defining the route of an event agent highly affects the performance of next hop selection in rumor routing.

(vi) Gbr(Gradient Based Routing):

In this algorithm, the queries generated by the sink are propagated among the nodes that have observed an event related to the queries[10] . To do so, a node that observes an event inject a long-lived packet called agent. The agents are propagated in the network so distant nodes have knowledge about which nodes have perceived certain events. To optimize the behavior of agents, when an agent reaches a node which has detected another event, the agent is still forwarded but aggregating the new discovered event. Additionally, the agents maintain a list of the recent visited nodes so loops are partially avoided.

On reception of agents, nodes can acquire updated information about the events in the network. This knowledge is reflected in the node's event caches. By using the event cache, a node can conveniently send a query message. However, some nodes may not be aware of the event's originator. Under these circumstances, the query is sequentially propagated to one of the neighbors selected randomly. Once the query arrives at a node with an entry related to the demanded event in its event cache, the query is then forwarded through the learnt path. Following this procedure, the cost of flooding the network with the query is clearly suppressed.

(vii) Cadr (Constrained Anisotrophic Diffusion Routing Protocol):

Two routing techniques, namely, information-driven sensor querying (IDSQ) and constrained anisotropic diffusion routing (CADR) were proposed in[11] .CADR aims to be a general form of directed diffusion. The key idea is to query sensors and route data in the network such that the information gain is maximized while latency and bandwidth are minimized. CADR diffuses queries by using a set of information criteria to select which sensors can get the data. This is achieved by activating only the sensors that are close to a particular event and dynamically adjusting data routes. The main difference from directed diffusion is the consideration of information gain in addition to the communication cost. In CADR, each node evaluates an information/cost objective and routes data based on the local information/cost gradient and end-user requirements. Estimation theory was used to model information utility measure. In IDSQ, the querying node can determine which node can provide the most useful information with the additional advantage of balancing the energy cost. Therefore, IDSQ can be seen as a complementary optimization procedure.

(viii)Cougar:

Under this approach, the network is foreseen as a distributed database where some nodes containing the information are temporary unreachable . Since node stores historic values, the network behaves as a data warehouse. Additionally, it is worth noting that poor propagation conditions may lead to the storage of erroneous information in the nodes. Taking into account this circumstance, COUGAR provides a SQL-like interface extended to incorporate some clauses to model the probability distribution[6]. The sink is responsible for generating a query plan which provides the hints to select a special node called the leader. The network leaders perform aggregation and transmit the results to the sink[10].

(ix) Acquire (Active Query Forwarding In Sensor Networks):

The following table shows the different conditions that may be prevailing in a wireless network. The table also shows the suitable protocol and its corresponding drawbacks if chosen.

Features and conditions prevailing during the configuration of the wireless sensor network							Protocol Applicable	Disadvantages observed if protocol is selected
Topology maintainance using routing	**Routing**	**Energy conservation**	**Query based**	**Data reaches destination**	**Node Failure Detection**	**Data Aggregation**		
Not needed	Complex	No energy conservation	No	Reaches destination	Not possible	Required	Flooding	1.Impulsion 2.Overlap 3.Resource
Required	Simple	No energy conservation	Yes	Reaches destination	Not possible	Required	Gossiping	1.Delay in transmission
Required	Simple	Limited Energy is conserved	Yes	unpredictable	Not possible	Required	SPIN	1..Delay in transmission
Not needed	Simple	Limited Energy is conserved	Yes	Reaches destination	Failure detection and recovery also possible	Required	Direct Diffusion	1.overhead at nodes 2.limited memory storage at sensor nodes. 3. Delay in continuous transmission
Required	Simple	Energy is conserved	Yes	Reaches destination	possible	Required	Romour Routing	1.does not support for network with large number of nodes
Required	Simple	Energy is conserved	Yes	unpredictable	possible	Required	Gradient based routing	1.Entire network fails if a node fail.
Required	Simple	Energy is conserved	No	unpredictable	Not possible	Required	CADR	1.Route path cannot be identified easily.
Required	Simple	Limited Energy is conserved	Yes	unpredictable	possible	Required	COUGAR	1.Dynamic maintainance of leader node to avoid
Not needed	Complex	Energy is conserved	Yes	Reaches destination	Not possible	Required	ACQUIRE	During some conditions, 1.Impulsion 2.Overlap 3.Resource

This technique also considers the wireless sensor network as a distributed database. In this scheme, a node injects an active query packet into the network[2]. Neighboring nodes that detects that the packet contains obsolete information, emits an update message to the node[6]. Then, the node randomly selects a neighbor to propagate the query which needs to resolve it. As the active query progress through network, it is progressively resolved into smaller and smaller components until it is completely solved. Then, the query is returned back to the querying node as a completed response.

IV.CONCLUSION

Different flat routing protocols are classified in this paper based on their conditions of working.This paper helps to choose a particular protocol based on the conditions prevailing during network coneections.This information is essential and can be used for real time applications. The information related the drawbacks of each protocol can also be considered during real time scenario which are the consequences of the implemented protocol.

In future , for implementation of any real time applications using wireless network protocols , this paper provides the brief information regarding each flat type protocols.

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